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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 twelve *Nephrops* stocks, five sole, five plaice, three cod, three haddock, three whiting, two megrim, two sea bass, 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 2022 survey information. In 2023, cod.27.7a advice was also issued in Autumn. Cod in division 6a (cod.27.6a) which was previously assessed by WGCSE will be addressed by WGNNSK as part of the North Sea Ecoregion, due to its close linkage with other North Sea cod stocks and fisheries (ICES, 2023a).

This year, analytical assessments using age-structured models were conducted for 12 fish stocks. Advice based on the application of the precautionary buffer was issued for five data-deficient stocks. A surplus-production model, without age or length structure, was used to assess lez.27.4a6a and lez.27.6b. Assessment of pol.27.67 was conducted based on Data-Limited Methods (ICES, 2020). Advice for pol.27-67 was revised following the ICES ADG working group to a category 2 SPICT assessment. For a number of stocks updates were presented, but no new advice was issued this year as previous multiannual advice remains in place (ple.27.7e, ple.27.7fg, ple.27.7h-k, had.27.6b, nop.27.6a, whg.27.6b)

Two stocks have gone through a benchmark procedure in the past year; pol.27.67 and cod.27.6a. These benchmarks resulted in a recommended change in assessment type for pol.27.67, from DCAC to SPICT, and a transfer of cod.27.6a to a multi-stock model as part of the cod.27.46a7d20 assessment by ICES WGNSSK..

Of the 14 fish stocks for which status could be assessed relative to MSY reference points; five were fished below F_{MSY} and were above MSY $B_{trigger}$, five were fished above F_{MSY} and were below MSY $B_{trigger}$, two stocks were fished above F_{MSY} and were above MSY $B_{trigger}$ and two stocks were fished below F_{MSY} and were below MSY $B_{trigger}$. For three fish stocks for which advice was issued in 2023 reference points were unknown.

Underwater TV (UWTV) survey-based assessments were conducted for ten *nephrops* functional units, with category 5 data-limited advice provided for the areas outside of functional units and subarea 7 and division 6a. Of the *nephrops* stocks with UWTV assessments, eight were fished below F_{MSY} and two stocks were fished above $F_{MSY,}$ five were above MSY $B_{trigger}$, and four were below MSY $B_{trigger}$. For one *nephrops* FU $B_{trigger}$ not yet defined.

ii Expert group information

Expert group name	Working Group for the Celtic Seas Ecoregion (WGCSE)
Expert group cycle	Annual
Year cycle started	2023
Reporting year in cycle	1/1
Chairs	Ruth Kelly, United Kingdom
	Jonathan White, Ireland
Meeting venue and dates	3–12 May 2023, Hybrid/Online and Ostend, Belgium, 29 participants 25-27 September 2023, Online, 15 participants
Expert group name	Working Group for the Celtic Seas Ecoregion (WGCSE)
Expert group cycle	Annual

1 Introduction

1.1 Terms of reference

1.1.1 Generic ToRs for Regional and Species Working Groups

2022/2/FRSG09 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 with a focus on:
   1. identifying and correcting mistakes and errors (both in the text, tables and figures); and
   2. proposing concrete evidence-based input that is considered essential for the advice but is currently under-developed or missing (with references and Data Profiling Tool entries, as appropriate).

   The input will feed into the annual updates of the overviews. Delivery of contributions other than those outlined above is also welcomed but will be utilised during the revision process (around every 5 years).

b) Conduct an assessment on the stock(s) to be addressed in 2023 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:
   1. 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.
   2. Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information.
   3. For relevant stocks (i.e. all stocks with catches in the NEAFC Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2022.
   4. For category 3 and 4 stocks requiring new advice in 2023, 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 (guidelines).
   5. Evaluate spawning–stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;
      (i) 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.

(ii) If the assessment is deemed no longer suitable as basis for advice, provide advice using an appropriate Category 2–5 approach as described in ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 or ICES.

(iii) If the assessment has been moved to a Category 2–5 approach in the past year, consider what is necessary to move back to a Category 1 and develop proposal for the appropriate benchmark process.

6. 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;
7. 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.

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

d) Review progress on benchmark issues and processes of relevance to the Expert Group.
1. update the benchmark issues lists for the individual stocks in SID;
2. review progress on benchmark issues and identify potential benchmarks to be initiated in 2024 for conclusion in 2025;
3. determine the prioritization score for benchmarks proposed for 2024–2025;
4. as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG).

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

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

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

h) If not completed previously, 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.

i) Deliver conservation status advice in accordance with the "Technical Guidelines on the conservation status advice". The advice is only to be given when conservation aspects were identified and where clear, demonstrable management action can be recommended for any non-catch anthropogenic pressure. It can also be used to highlight clear demonstrable sensitivity to climate change. The qualification required to show clear, demonstratable management action is high. Avoid generic statements that are of no specific application to management.

j) Update SAG and SID with final assessment input and output.

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

1.1.2 Specific ToRs

2022/2/FRSG09 The Working Group for the Celtic Seas Ecoregion (WGCSE), chaired by Jonathan White*, Ireland and Ruth Kelly, UK meet 3 to 12 May 2023 in Ostend, Belgium and in September 2023 (date and venue tbc) 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 2022 ICES data call.

WGCSE will report by 26 May 2023 for the attention of ACOM, and by 2 October 2023 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

Participation at the WGCSE meetings was hybrid at the May meeting and online only in September. There were 29 participants from 9 organisations. Countries with experts participating in the meeting were Belgium, Denmark, France, Republic of Ireland, and the UK (England, Scotland and Northern Ireland).

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.a; cod.27.7.e–k, had.27.7.a, had.27.7.b–k, ple.27.7.a, sol.27.7.a, sol.27.7.e, sol.27.7.fg, whg.27.6.a; whg.27.7a and whg.27.7.b–ce–k.

For these 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.

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

Category 1: UWTV survey based assessments and advice were used for nep.fu.11, nep.fu.12, nep.fu.13, nep.fu.14, nep.fu.15, nep.fu.16, nep.fu.17, nep.fu.19, nep.fu.2021 and nep.fu.22.

Category 2: A SPICT assessment was to determine stock status and a short-term catch forecast for Lez.27.6b;

Category 3: Several stocks were 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; anf.27.3a46; had.27.6a; pol.27.67 with trends from combined biomass index. For these stocks, with the exception of pol.27.67, advice issued in 2022, remains in place for 2023 and 2024, following ICES guidelines (ICES, 2019; 2020).

Category 5: For sol.27.7h–k; nep.27.6aoutFU and nep.27.7.outFU, category 5 data-limited approaches were applied (ICES, 2023).

Category 6: bss.27.6a7bj; cod.27.6b; sol.27.7bc category 6 data-limited approaches for stocks for which there are negligible landings and stocks caught in minor amounts as bycatch were applied (ICES, 2023b).

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. Data limitations specific to any individual stocks and/or surveys are described in stock specific chapters.

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), these reports were finalized 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 2023 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 and advice products.

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

Stocks recommended for next round(s) of benchmarks:

Listed for 2023–2024 Benchmark	Proposed for 2024–2025 Benchmark
had.27.6b	whg.27.7a
pok.27.7-10	ple.27.7e (if not in 2023-2024 cycle)
sol.27.7a	lez.27.4a–6a
anf.27.3a46	ple.27.7fg
ple.27.7e	ple.27.7fg (if not in 2023-2024 cycle)
Also requested for 2023–2024 Benchmark	
ple.27.7fg	

1.8 References

ICES 2019, Ninth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE IX). ICES Scientific Reports. 1:77. 131 pp. http://doi.org/10.17895/ices.pub.5550

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

ICES. 2023a. Benchmark workshop on Northern Shelf cod stocks (WKBCOD). ICES Scientific Reports. 5:37. 425 pp. https://doi.org/10.17895/ices.pub.22591423

ICES. 2023b. Advice on fishing opportunities. In Report of the ICES Advisory Committee, 2023. ICES Advice 2023, section 1.1.1. https://doi.org/10.17895/ices.advice.22240624

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

There are no updates to this chapter provided in 2023.

3 Cod in Division 6.a

This stock was benchmarked in 2022, and is now assessed together with the North Sea cod in the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK).

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

4.1 Introduction

Assessment in 2023

There is no assessment for this stock. Advice is provided on a triennial basis (and is provided this year for 2024, 2025 and 2026) according to the approach outlined below.

In 2023, the updated 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.

The limited available survey information and commercial landings per unit effort have conflicting signals and hence there is insufficient information to conclude that the current level of exploitation is appropriate for this stock. A precautionary buffer was therefore applied for the advice provided in 2023.

4.2 General

Advice

ICES advice has been provided on the basis of the precautionary approach since 2016. The advice for 2021, 2022 and 2023 was for catches of no more than 14 tonnes.

Stock description and management units

There is no information on stock identity of Rockall cod.

Management applicable

The TAC is set for the UK, EU and international waters of 6b, and UK and international waters of 12 and 14, and has been set at 74 tonnes since 2013. The TAC breakdown by country for 2023 is given below:

Species:	Cod *Gadus morhua*			Zone:	6b; United Kingdom and international waters of 5b west of 12°00' W and of 12 and 14 (COD/5W6-14)
Belgium	0	(1)		Precautionary TAC	
Germany	1	(1)			
France	7	(1)			
Ireland	14	(1)			
Union	22	(1)			
United Kingdom	52	(1)			
TAC	74	(1)			
(1)	Exclusively for by-catches of cod in fisheries for other species. No directed fisheries for cod are permitted under this TAC.				

The MCRS of cod at Rockall is 35 cm and the stock is fully under the landing obligation. In addition, the EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019) takes bycatch of this species into account, however there is no agreed shared management plan with UK for this stock.

4.3 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 71 tonnes in 2022. Some minor updates were made to historical landings. The official landings for 2018 to 2020 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 for the NEAFC area (subdivision 6.b.1) are given in Table 4.2. However, these data are incomplete in the two most recent years as UK preliminary official landings are not available by subdivision. UK data are available in InterCatch by subdivision for 2021 (0.2 t) and 2022 (1.3 t). The majority of the landings of this stock are taken from Subdivision 6.b.2.

While the total landings are below the TAC, national quotas have been restrictive in some years.

Landings data have been uploaded to InterCatch for 2022. For some countries in some years (e.g Faroes in 2022), ICES estimates are not provided and in such cases, the official landings are used instead. In 2022, the breakdown of ICES landings by gear is as follows:

Landings	
otter trawl 86%	other 14%
71 tonnes	

The other gears include landings with unknown gear in InterCatch and therefore may also include landings by otter trawl.

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	2022
Scottish OTB_DEF	1.96%	60.7%	2.4%	0.6%	23.4%	16.7%
Irish OTB_DEF	0.63%	NA	18.3%	NA	17.8%	0

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) and subsequent decline. The recording of hours fished data in the log sheets is not mandatory for the Scottish fleet and consequently effort data are therefore in units of kWdays. 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 the increase (and subsequent fluctuations) it seems unlikely to be completely attributable to an increase in stock size (an almost five-fold increase over two years).

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 survey has particularly high catch rates of cod.

Table 4.5 contains catch rates by age (per 10 hours fishing) from the Rock-WIBTS-Q3 survey and also the number of fish caught. The survey typically catches very few fish (< 10 individuals except in 2019 and 2022), has a very truncated age range of fish with a complete lack of 0-group, very few fish above age 4 and a complete absence of some cohorts (e.g. 2019). Despite this, the data were worked up into a survey index by deriving survey mean weights-at-age and calculating a total biomass index as a sum of products of the index and mean weights-at-age. The index is shown in Figure 4.4.

Rockall cod catch rates from the Scottish Irish Anglerfish Megrim Industry Science Survey (SIAMISS) were first made available to the WG in 2020 (worked up as part of the West of Scotland cod benchmark). These data indicate that in division 6b there has been an increase in cod biomass between 2015 and 2018 and a decline in 2019 (estimated with very wide confidence intervals) (Figures 4.5). This index was previously used to justify the non-application of the precautionary buffer (in 2020). However, the Rockall component of the SIAMISS survey was not carried out in

2020 or 2022, and in 2021 only a single fish was caught. This index therefore can no longer be used to justify an increasing biomass for the purposes of category 6 data-limited advice.

4.4 Application of the advice rule

There are a number of survey and commercial LPUE series available for this stock, however, neither of the survey indices catch particularly high numbers of fish and the LPUE indices are noisy. The indices also show inconsistent signals over time and hence the WG concludes that there is insufficient information to conclude that the current level of exploitation is appropriate for this stock. A precautionary buffer was therefore applied for the advice provided n 2023:

ICES framework for category 6 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was last applied in 2017 (for the 2018–2020 advice), and with no new information available to support the current level of catches the precautionary buffer is applied for the 2024 advice. Discarding is known to take place, but cannot be fully quantified. Note that the figures in the following table have been 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 (2021-2023)	**14 tonnes**
Discard rate	Unknown
Precautionary buffer	Applied 0.8
Catch advice^	11 tonnes
Landings advice	Unknown
% advice change *	-20

*** Advice value for 2024 relative to the advice value for 2023.**

^[Recent advised catches] x [precautionary buffer].

Discards from this stock are currently considered unknown due to low sampling levels and inter-annual and between fleet variability. According to ICES guidelines, in such a situation, ICES should provide advice only for landings rather than catch. However, for this stock, previous estimates suggested that discards were negligible and hence catch advice has been provided for this stock since 2015. Due to the lack of discard information, no estimate of landings consistent with the catch advice can be provided.

A discussion of potential future options for improving the advice basis for this stock was held during the WG. While there was agreement that there is unlikely to be sufficient data for an analytical assessment, suggestions were made for deriving improved biomass/abundance indicators and indicators of fishing pressure. These included:

- Collating fishery length composition data with a view to exploring the use of length-based indicators as a proxy of fishing pressure.
- Creating improved measures of effort and commercial LPUE through the analysis of VMS data.

4.5 References

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.

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

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.

Table 4.1. Cod in Division 6.b (Rockall). Official catch statistics and ICES estimated landings.

year	FO	FR	DE	IE	NO	PT	RU	ES	UKE	UKS	UK	Total	ICES landings
1984	18	9	0	0	373	0		241	161	221		1023	
1985	0	17	3	0	202	0		1200	114	437		1973	
1986	1	5	0	0	95	0		1219	93	187		1600	
1987	0	7	0	0	130	0		808	69	284		1298	
1988	31	2	3	0	195	0		1345	56	254		1886	
1989	5	0	0	0	148	0		0	131	265		549	
1990	0	0	0	400	119	0		64	8	758		1349	
1991	0	0	126	236	312	0		70	23	829		1596	
1992	0	0	2	235	199	0	0	0	26	714		1176	
1993	1	0	0	472	199	0	0	0	103	322		1097	
1994	0	0	0	280	120	0	0	0	25	236		661	
1995	0	0	0	477	92	0	0	2	90	370		1031	
1996	0	0	10	436	91	0	0	5	23	210		775	
1997	0	0	22	153	55	5	0	1	20	706		962	
1998	0	0	3	227	52	0	0	6	32	341		660	
1999	0	0	11	148	85	0	0	4	22	389		659	
2000	0	+	1	119	152	0	7	3	4	286		572	
2001	0	0	0	40	89	0	26	1	2	176		334	
2002	0	+	0	18	28	0	0	+	2	67		115	
2003	0	+	0	11	25	0	0	6	3	57		102	
2004	0	0	0	7	23	0	0	0	0	45		75	
2005	0	0	0	12	7	0	0	0	0	43		62	
2006	0	0	0	23	7	0	0	0	0	29		59	
2007	0	0	0	24	12	0	0	0	0	26		62	
2008	0	0	0	41	12	0	0	0	0	41		94	
2009	3	0	0	20	25	0	1	0	0	48		97	
2010	5	0	0	6	27	0	0	0	0	23		61	

year	FO	FR	DE	IE	NO	PT	RU	ES	UKE	UKS	UK	Total	ICES landings
2011	0	0	0	12	49	0	0	0	0	37		98	
2012	0	0.1	0	1	11	0	0	0	0	11		23.1	
2013	0	0	0	2	3	0	0	0	0	9		14	14
2014	0	0	0	6	1	0	0	0			10	16	16
2015	0	0	0	5	18	0	0	0			18	41	41
2016	+	0	0	15	11	0	0	0			37	63	63
2017	0	0	0	17	3	0	0	0			37	57	57
2018	0	0	0	14^	0.6	0	0	0			49	64^	64
2019	0	0	0	^	5	0	0	+			50.6	56^	68
2020	0	+	0	14^	0.95	0	0	+			26.7	42^	40
2021*	0	0	0	4	0	0	0	0			21.5	26	27
2022*	7	0	0	10	0	0	0	+			53.2	71	71

*** Preliminary.**

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

+ < 0.5 tonnes.

Table 4.2. Cod in 6.b. Official landings from NEAFC area.

Year	Subdiv 6b.1
2012	0.13
2013	0.39
2014	0.02
2015	13.23
2016	3.16
2017	2.52
2018	1.452^
2019	2.4^
2020	0.6^
2021^^	0.2 (0.4)
2022^^	0.4 (1.7)

^ Incomplete due to national GDPR clauses.

^^Preliminary. Known to be incomplete as UK data only reported at division level. Values in brackets include ICES estimates for UK.

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	414.94	9.14	45.39
1996	401.96	7.22	55.68
1997	130.48	7.17	18.20
1998	206.59	7.34	28.16
1999	137.82	8.68	15.88
2000	101.07	9.88	10.23
2001	33.25	7.23	4.60
2002	16.23	2.63	6.18
2003	9.90	4.54	2.18
2004	6.87	2.23	3.08
2005	8.79	3.28	2.68
2006	22.17	5.90	3.76
2007	23.85	6.59	3.62
2008	40.39	9.90	4.08
2009	21.66	4.35	4.97
2010	6.64	3.28	2.03
2011	9.02	2.53	3.56
2012	1.00	3.25	0.31
2013	1.76	3.81	0.46
2014	5.59	4.16	1.34
2015	4.14	4.75	0.87
2016	11.38	6.19	1.84
2017	15.20	14.89	1.02
2018	13.29	11.78	1.13
2019	9.08	17.24	0.53
2020	13.26	15.08	0.88
2021	3.56	7.18	0.50
2022	6.62	5.68	1.17

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

Year	landing(t)	effort(kwdays)	Lpue(kg/kwday)
2003	64.1	2504466	0.026
2004	39.8	1842103	0.022
2005	43.0	1217357	0.035
2006	28.3	1011354	0.028
2007	26.0	1060551	0.024
2008	40.3	1124197	0.036
2009	47.8	1631239	0.029
2010	22.7	1744452	0.013
2011	36.5	1565753	0.023
2012	10.8	901552	0.012
2013	9.1	532767	0.017
2014	9.7	668665	0.015
2015	19.9	563098	0.035
2016	34.0	514486	0.066
2017	37.7	794571	0.047
2018	49.3	794017	0.062
2019	50.7	1078714	0.047
2020	26.7	963518	0.028
2021	21.5	919033	0.023
2022	51.3	763331	0.067

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	Number of fish caught	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2011	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0
2013	3	0	0.394	0.394	0	0	0	0	0.43
2014	4	0	0.279	0.894	0	0	0	0	0
2015	5	0	0	0.922	0.307	0	0	0	0.307
2016	6	0	0	0.269	0.538	0.538	0	0	0.269
2017	5	0	0	0	0	0.922	1.062	0	0
2018	5	0	0	0.307	0.614	0.307	0.307	0	0
2019	16	0	1.117	0.922	2.432	0.307	0	0	0
2020	7	0	0	1.203	0.896	0.614	0	0	0
2021	7	0	0.504	0	1.116	0.561	0	0	0
2022	28	0	0.684	9.542	0	0.798	0	0.461	0

Figure 4.1. Cod in Division 6.b. Total of official landings by nation.

Figure 4.2. Cod in Division 6.b. Landings, effort and LPUE (kg/hr) from the Irish Otter-trawl fleet.

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 27.6.b. Biomass index (kg/hr) derived from Rockall Q3 survey. Upper figure shows estimates by age. Lower figure includes 95% confidence intervals.

Figure 4.5. Cod in Division 6b. Estimated biomass from SIAMISS survey. No survey of Rockall in 2020 and 2022. In 2021, only one fish was caught and hence raised estimates are not presented.

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, 2023) the recreational fishery was included in the assessment for the first time, however uncertainties in the data resulted in the exclusion of data from the assessments.

Type of assessment

The stock was benchmarked in February 2022 (ICES, 2023) and a Stock Synthesis (SS3) fully analytical model is now being used in the cod assessment.

ICES advice applicable to 2022 and 2023

ICES advised on the basis of precautionary approaches that there should be no directed fisheries, and bycatch and discards should be minimized in 2022. Advice for 2023 was zero catch under the MSY approach with precautionary considerations.

ICES advice applicable to 2024

ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024.

5.1 General

Stock description and management units

The stock and the management unit are both ICES Division 7.a (Irish Sea). Cod landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the 27.7.e–k cod stock since 2003.

Management applicable to 2022

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.

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=uriserv:OJ.L_.2022.104.01.0001.01.ENG

Landings in 2022 remained below the TAC of 206 tonnes.

TACs and landings in 2022

	TAC	Landed
Belgium	3	2.7
France	7	0
Ireland	104	25.3
The Netherlands	1	0
United Kingdom	91	70.1
EU (total)	**115**	**28**
Total	206	98.1

TAC in 2023

Species:	Cod *Gadus morhua*		Zone:	7a (COD/07A.)
Belgium	2	(1)	Precautionary TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply	
France	6	(1)		
Ireland	83	(1)		
Netherlands	1	(1)		
Union	92	(1)		
United Kingdom	73	(1)		
TAC	165	(1)		
(1)	Exclusively for by-catches of cod in fisheries for other species. No directed fisheries are permitted under this quota.			

Fishery in 2022

Landings remained below the set TAC for 2022 of 206 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 cod in Division 7.a in 2022 were 128 t, with ICES landings for the stock of 98 t, after a re-allocation to cod.27.7e–k of 30 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

Year	Tonnes
2018	20
2019	37
2020	71
2021	52
2022	30

The majority of landings in 2022 was taken by the TR1 (midwater demersal) fleet, followed by the *Nephrop*s fleet. Landings and discards by métier and country can be seen in Table 7. Total uptake of cod TAC was 61%.

A Fishery–Science Partnership Survey (FSP) was repeated in the western Irish Sea in spring 2022 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 unbiased 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 In quarter 1 of 2021, the full final tow of the Northern Irish 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.

7. 2022. Sampling by the Irish Republic did not take place in 2022 in the Irish Sea, however there were sufficient other samples to account for the missing sample data.

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 8 and Table 9; 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) 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, 2023). 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 11. 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	2004–2022 (EXCLUDING 2014)
NIGFS-WIBTS-Q4 (G7655)	0	1995–2022
NIGFS-WIBTS-Q1 (G7144)	1–4	1995–2022

5.2 Historical stock development

The advice is based on the assessment benchmarked in 2022 (WKNSCS, ICES 2023) and reviewed in 2023.

Deviations from Stock Annex

The recreational catches were removed from the model and tested in 2023. The effective sample size of the commercial fleet was reduced from 100 to 50 from 1990 onwards, following a former model using ASAP. This was necessary as around this time there was less sample size of the

commercial fleet with respect to the survey fleets. This change was reviewed internally and approved within WGCSE. An external review was conducted which confirmed that these changes had been implemented correctly in the SS3 assessment (see Annex 5). These changes necessitated a recalculation of reference points. The external reviewer was unable to approve the reference point calculation within the timeframe, and therefore, the revision to the reference points was conducted according to the previously approved method used in the 2022 benchmark (WKNSCS, ICES 2023). The reapplication of the benchmarked method of reference point calculation was discussed by external experts at WGNEPH ADG and considered to be an appropriate approach.

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 2–3, Figure 8 and Table 8–13, while summary of assessment results can be seen in Table 13.

The fit of the model catch-at-age data and to the indices is good, showing "all green" runs tests (Figure 13 and Figure 14) 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 0.02 and -0.08 respectively (Figure 15).

The final results of the assessment can be seen in Figure 5–6.

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 2. Geometric mean for recruitment is from 2002–2020 (Final year-2), which encompasses the block where recruitment is supposedly reduced.

Table 2. Short term forecast assumptions.

Variable	Value	Notes
$F_{ages\ 2–4}$ (2022)	0.028	$F_{sq} = F_{average(2019–2022)}$ *
SSB (2024)	11815	Short-term forecast fishing at F_{sq}; in tonnes.
$R_{age\ 0}$ (2022 and 2023)	21811	Geometric Mean (2002–2020); in thousands.
Total catch (2023)	288	Fishing at F_{sq}; in tonnes
Projected landings(2023)	262	Assuming average landing patterns (2020–2022); in tonnes
Projected discards (2023)	26	Assuming average discard patterns (2020–2022); in tonnes

*** F in 2020 was assumed to be unrepresentative due to the COVID-19 disruption and hence F_{sq} was calculated as $F_{average}$ (2019–2022) excluding 2020.**

Table 3 shows the catch scenarios. ICES provides zero-catch advice for this stock in 2024, based on precautionary considerations, because the forecast is very sensitive to the observations of 2021 and 2022 recruitment. The resulting estimated increase in SSB in 2024 and 2025, and therefore the provision of non-zero catch advice, would be highly dependent on the size of the 2021 cohort,

which would contribute 70% of landings in 2024 and 65% of SSB in 2025. Furthermore, given the current forecast assumptions, if fishing were to take place at the levels indicated by the MSY approach (1 110 t) in 2024, then a three-year forecast indicates that SSB would be below Blim by 2026 even with fishing at zero catch in 2025. Given the uncertainties in forecast and estimated recruitment, the unsustainability of the MSY approach in the three-year forecast, and stocks status being below Blim since 2019, ICES provides advice for zero catch based on precautionary considerations. The newly introduced F_{ECO} (ICES, 2023) is also included in a scaled version. With the Sea Surface temperature Index being high for the recent years, F_{ECO} is currently estimated at 0.191.

Table 3. Catch scenarios for 2024; all weights are in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change *	% TAC change ^
MSY approach: F = 0	0	0	0	0	0	0	10645	–9.9	-100
F_{MSY} × SSB (2024)/MSY $B_{trigger}$	1110	1085	25	0.155	0.147	0.0086	9445	–20	570
EU MAP**: $F_{MSY\ lower}$ × SSB (2024)/MSY $B_{trigger}$	918	897	21	0.127	0.120	0.0070	9651	–18.3	460
EU MAP**: $F_{MSY\ lower}$	1007	984	23	0.140	0.132	0.0077	9556	–19.1	510
F = F_{MSY}	1216	1188	28	0.171	0.162	0.0094	9331	–21	640
F = F_{pa}	1600	1563	37	0.23	0.22	0.0127	8920	–25	870
F = $F_{MSY\ upper}$	1536	1501	35	0.22	0.21	0.0122	8988	–24	830
F = F_{2023}	209	204	5	0.028	0.026	0.00154	10417	–11.8	27
F = F_{lim}	2156	2105	50	0.32	0.30	0.0177	8328	–30	1200
F=F_{eco}	1348	1317	31	0.191	0.180	0.0106	9190	–22	720
F_{eco} × SSB (2024)/MSY $B_{trigger}$	1232	1204	28	0.173	0.164	0.0096	9314	–21	650
Rollover TAC	165	161	4	0.022	0.021	0.00121	10465	–11.4	0
SSB (2025) = SSB (2024)***									
SSB=$SSB_{Btrigger}$=SSB_{BPA} ***									
SSB (2025) = B_{lim}	1185	1158	27	0.166	0.157	0.0092	9364	–21	620

*** SSB 2025 relative to SSB 2024.**

**** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

***** These options were left blank because they cannot be achieved in 2025, even with zero catches.**

^ Total TAC in 2024 relative to the TAC in 2023 (165 tonnes).

5.4 Biological reference points

Reference points were reviewed in 2023 when some minor changes in the model were necessary. These changes were a revision to the selectivity applied to the first two years on the assessment model, to match the intended benchmark settings, and a change in the estimated effective sample-size applied to commercial fleet sampling. This change to the effective sample size reduced the effective sample size of the commercial fleet was reduced from 100 to 50 from 1990 onwards, following the decisions of the previous WKIRISH 2017 benchmark (ICES, 2017).

The newly introduced F_{ECO} (ICES, 2023) has been agreed and reviewed at the benchmark for a stock for the first time. F_{ECO} is an opportunity to use environmental data in forecast scenarios (ICES, 2023). In case of cod in 7a, 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 FMSY ranges (ICES 2019,2020); for 2024 FECO is at 0.191, estimated as F_{MSY} lower + ((F_{MSY} upper - F_{MSY} lower)*Is). Reference points were reviewed in 2023 when some minor changes in the model were necessary.

Table 4. Biological reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	13012	B_{pa}	ICES, 2023
	F_{MSY}	0.174	Median point estimates of (F_{MSY}) EqSim with combined SR	ICES, 2023
	$F_{MSY\ lower}$	0.141	Median lower estimates of (F_{MSY}) EqSim with combined SR	ICES, 2023
	$F_{MSY\ upper}$	0.224	Median upper point estimates of (F_{MSY}) EqSim with combined SR	ICES, 2023
	F_{ECO}	0.191	Ecosystem Indicator (I_s); $F_{ECO} = F_{MSY\ lower} + ((F_{MSY\ upper} - F_{MSY\ lower})*I_s)$	ICES, 2023
Precautionary approach	B_{lim}	9362	Lowest SSB with above-average recruitment, excluding 2021	ICES, 2023
	B_{pa}	13012	B_{lim} combined with the assessment error	ICES, 2023
	F_{lim}	0.33	F with 50% probability of SSB less than B_{lim}	ICES, 2023
	F_{pa}	0.17	F_{P05}; the F that leads to SSB > B_{lim} with 95% probability	ICES, 2023

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 (Report citation). 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 in 2020 and 2021. Since 2022 the stock has 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.

ICES provides zero-catch advice for this stock in 2024, based on precautionary considerations, because the forecast is very sensitive to the observations of 2021 and 2022 recruitment.

In 2022 the stock size (SSB of 6 096 t) is estimated to be well below Blim (9 364 t), increasing to just above Blim in 2023 (SSB of 10 919 t). The 2023 SSB however, is dependent upon the recruitment of 2021, the estimation of which is strongly dependent on a single year's observations (2022). While the 2021 year class has been observed in surveys and commercial sampling as a result of the low stock size, sampling levels are proportionally low and result in considerable uncertainty in the estimation of recent cohorts. Model retrospectives confirm high uncertainty in the estimation of recent recruitment, and comparisons of the 2021 recruitment value showed large deviations (the estimation of this cohort in 2022 was 13 315 thousand individuals compared to this year's 86 374 thousand). A similar comparison of two year olds shows recent downward revisions (Figure 3). The following (2022) cohort is estimated to be extremely low.

The resulting estimated increase in SSB in 2024 and 2025, and therefore the provision of non-zero catch advice, would be highly dependent on this 2021 cohort, which would contribute 70% of landings in 2024 and 65% of SSB in 2025 (Figure 4).

Furthermore, given the current forecast assumptions, if fishing were to take place at the levels indicated by the MSY approach (1 110 t) in 2024, then a three-year forecast indicates that SSB would be below Blim by 2026 even with fishing at zero catch in 2025. Given the uncertainties in forecast and estimated recruitment, the unsustainability of the MSY approach in the three-year forecast, and stocks status being below Blim since 2019, ICES provides advice for zero catch based on precautionary considerations.

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 7a and 7e–g.

Under the current 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 5. 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	Netherlands	Spain	UK (England Wales, & NI)	UK (Isle of Man)	UK (Scotland)	Total	Landings in rectangles 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

Year	Belgium	France	Ireland	Netherlands	Spain	UK (England Wales, & NI)	UK (Isle of Man)	UK (Scotland)	Total	Landings in rectangles 33E2 & 33E3 ***	ICES Landings	ICES Discards
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
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	77	-	-	97	< 1	< 1	255	71	181	25

Year	Belgium	France	Ireland	Netherlands	Spain	UK (England Wales, & NI)	UK (Isle of Man)	UK (Scotland)	Total	Landings in rectangles 33E2 & 33E3 ***	ICES Landings	ICES Discards
2021*	3	0	93	-	-	89	<1	<1	185	52	133	4
2022*	3	0	55	-	-	70	<1	<1	128	30	98	27

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

a) total

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
2022	98	74	132

b) by country

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%
2022	**UK**	**Ireland**	**France**	**Belgium**	**Netherlands**	**Total**
Landings	70	25.3	0	2.7	0	98.1
TAC	91	104	7	3	1	206
%uptake	77%	24%	0%	90%	0	48%

Table 7. Landings and discard proportions by métier.

Catch (2022)	Landings				
125 tonnes	otter trawls		mid-water trawl	beam trawls	other gear types
	Nephrops directed 29%	demersal fish directed 48.8%	11.5%	9.3%	1.4%
	98 tonnes				
	Discards				
	otter trawls		mid-water trawl	beam trawls	other gear types
	57% *Nephrops* directed	<1% demersal fish directed	<1%	41.8%	<1%
	27 tonnes				

Table 8. 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

Year	0	1	2	3	4	5	6+
1983	47	1011	932	751	499	154	46
1984	37	1733	1195	439	240	161	75
1985	34	1360	2105	703	158	84	77
1986	49	1180	2248	699	203	64	65
1987	47	4522	1793	841	252	75	43
1988	43	2971	4734	702	263	71	38
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

Year	0	1	2	3	4	5	6+
1998	0	231	1928	335	80	28	8
1999	141	236	843	871	66	21	7
2000	62	1107	176	107	50	4	1
2001	7	403	841	53	13	9	2
2002	0	238	564	405	7	2	3
2003*	50	121	472	109	36	1	0
2004*	50	161	134	174	22	6	3
2005*	50	118	256	78	34	5	1
2006	50	89	174	128	17	8	3
2007	16	216	210	56	11	1	0
2008	6	77	169	87	9	3	0
2009	329	60	57	66	17	3	0
2010	49	220	188	16	7.5	2	1
2011	10	54	106	36	2	1	1
2012	8	84	135	145	10	0	0

Year	0	1	2	3	4	5	6+
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
2022	21.8	118.0	11.8	10.9	3.8	0.8	0.1

***Excluded from assessment due to very low sampling.**

Table 9. Mean weights-at-age in the landings (used for whole stock and catch). *mean weight at age in landings only available for Q1, hence considerably lower than previous years and not included.

	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

	0	1	2	3	4	5	6+
1983	0.1	1	1.84	3.99	5.96	7.97	9.97
1984	0.1	0.68	1.81	3.81	5.87	7.48	10.05
1985	0.1	0.78	2.02	4.24	5.83	7.5	9.04
1986	0.1	0.81	1.83	3.86	5.86	7.39	8.78
1987	0.1	0.71	2.16	3.91	6.41	7.82	10.32
1988	0.1	0.61	1.56	3.76	5.67	8.02	9.88
1989	0.1	0.94	1.85	3.22	5.41	6.57	9.47
1990	0.1	0.84	1.94	3.57	5.28	7.53	9.4
1991	0.1	0.86	1.64	3.54	5.42	6.39	9.11
1992	0.1	0.81	1.96	3.99	5.98	6.92	8.67
1993	0.1	0.85	1.71	3.67	5.68	7.37	10.17
1994	0.1	0.8	1.92	3.61	6.08	7.68	8.57
1995	0.1	0.9	1.84	4.00	5.79	8.45	9.14
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

	0	1	2	3	4	5	6+
1998	0.1	0.93	1.65	3.73	5.37	7.03	9.35
1999	0.1	0.85	1.62	3.18	5.51	7.52	10.25
2000	0.1	0.85	1.99	3.57	5.14	7.15	8.39
2001	0.1	0.99	1.82	4.15	5.61	7.33	9.51
2002	0.1	0.94	1.84	3.44	5.73	7.71	10.01
2003	0.1	1.21	1.66	3.29	5.43	10.2	11.09
2004	0.1	1.11	2.2	3.63	6.51	7.64	8.61
2005	0.1	0.91	1.94	3.51	5.32	7.74	8.89
2006	0.1	0.83	1.84	3.67	4.71	6.39	7.84
2007	0.1	0.83	1.85	3.78	5.35	7.99	10.04
2008	0.1	0.89	1.59	3.54	6.00	7.57	9.46
2009	0.1	1.1	2.01	3.46	5.31	7.1	6.82
2010	0.1	1.26	2.29	3.93	6.34	7.33	9.64
2011	0.1	0.95	1.88	3.75	5.54	6.75	9.04
2012	0.1	0.93	1.88	3.37	5.34	7.60	8.56

	0	1	2	3	4	5	6+
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	0.523	1.880	3.903	5.85	7.66	9.14
2021	0.1	0.187	1.831	4.164	6.485	8.64	7.25
2022	0.16	0.28	1.71	3.56	5.77	7.66	8.68

Table 10. Estimates of numbers discarded (a) and the discarded proportions (b) from 1968–2022. 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) Numbers discarded ('000 fish)

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

Year	0	1	2	3	4	5	6+
1981	37.67	157.97	0	0	0	0	0
1982	46.04	193.1	0	0	0	0	0
1983	46.98	197.05	0	0	0	0	0
1984	37.3	156.45	0	0	0	0	0
1985	33.89	142.12	0	0	0	0	0
1986	49.15	206.15	0	0	0	0	0
1987	47.38	198.69	0	0	0	0	0
1988	42.59	178.64	0	0	0	0	0
1989	41.03	172.09	0	0	0	0	0
1990	37.85	158.74	0	0	0	0	0
1991	46.64	195.61	0	0	0	0	0
1992	36.74	154.1	0	0	0	0	0
1993	39.4	165.24	0	0	0	0	0
1994	39.92	167.44	0	0	0	0	0
1995	42.97	180.2	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1996	87.95	128.79	0	0	0	0	0
1997	5.28	127.79	0.5	0	0	0	0
1998	0	27.47	2	0	0	0	0
1999	141.42	165.79	0	0	0	0	0
2000	62.36	817.69	0	0	0	0	0
2001	7.22	65.15	0	0	0	0	0
2002	0	42.49	0	0	0	0	0
2003 *	50.43	75.68	32.62	15.83	1.25	0.13	0
2004*	50.43	92.78	32.81	15.83	1.25	0.13	0
2005*	50.43	76.34	32.36	15.83	1.25	0.13	0
2006	50.43	75.08	32	15.83	1.25	0.13	0
2007	16	167	4.60	0	0	0	0
2008	5.50	63.40	3.40	0	0	0	0
2009	329.30	39.80	4.40	0.1	0	0	0
2010	48.70	180	60.30	1.4	0.5	0.1	0

Year	0	1	2	3	4	5	6+
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
2022	21.8	107.8	1.0	0	0	0	0

*** very low sampling levels.**

b) discarded proportions

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

Year	0	1	2	3	4	5	6+
1982	1	0.36	0	0	0	0	0
1983	1	0.19	0	0	0	0	0
1984	1	0.09	0	0	0	0	0
1985	1	0.10	0	0	0	0	0
1986	1	0.17	0	0	0	0	0
1987	1	0.04	0	0	0	0	0
1988	1	0.06	0	0	0	0	0
1989	1	0.23	0	0	0	0	0
1990	1	0.18	0	0	0	0	0
1991	1	0.09	0	0	0	0	0
1992	1	0.10	0	0	0	0	0
1993	1	0.43	0	0	0	0	0
1994	1	0.18	0	0	0	0	0
1995	1	0.27	0	0	0	0	0
1996	1	0.29	0	0	0	0	0

Year	0	1	2	3	4	5	6+
1997	1	0.20	0	0	0	0	0
1998	NA	0.12	0	0	0	0	0
1999	1	0.70	0	0	0	0	0
2000	1	0.74	0	0	0	0	0
2001	1	0.16	0	0	0	0	0
2002	NA	0.18	0	0	0	0	0
2003 *	1	0.63	0.07	0.15	0.03	0.12	NA
2004*	1	0.58	0.25	0.09	0.06	0.022	0
2005*	1	0.65	0.13	0.20	0.04	0.03	0
2006	1	0.84	0.18	0.12	0.07	0.02	0
2007	1	0.77	0.02	0	0	0	NA
2008	1	0.82	0.02	0	0	0	NA
2009	1	0.67	0.08	0	0	0	NA
2010	1	0.82	0.32	0.06	0.07	0.05	0
2011	1	0.80	0.01	0	0	0	0

Year	0	1	2	3	4	5	6+
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
2022	1	0.91	0.098	0	0	0	0

NA= not available.

***Data for 2020 are unavailable due to restricted discard sampling.**

Table 11 Maturity ogive updated for 2022. Prior to 1995 maturity was considered constant.

Year	1	2	3+
1996	0	0.292435	1
1997	0	0.34616	1
1998	0	0.398889	1
1999	0	0.450799	1
2000	0	0.502063	1
2001	0	0.552688	1
2002	0	0.601857	1
2003	0	0.644518	1
2004	0	0.666112	1
2005	0	0.679415	1
2006	0	0.688342	1
2007	0	0.695884	1
2008	0	0.70309	1
2009	0	0.7073	1
2010	0	0.706431	1

Year	1	2	3+
2011	0	0.704488	1
2012	0	0.7065	1
2013	0	0.711441	1
2014	0	0.723509	1
2015	0	0.738194	1
2016	0	0.75366	1
2017	0	0.769449	1
2018	0	0.785643	1
2019	0	0.802369	1
2020	0	0.819539	1
2021	0	0.836996	1
2022	0	0.854821	1

Table 12. Survey catch numbers-at-age and c.v. for all three surveys.

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

year	c.v.	1	2	3	4
2010	0.82	1022.12	208.96	14.66	2.26
2011	0.49	353.98	414.69	46.01	2.26
2012	0.81	161.90	222.82	99.27	14.25
2013	0.81	276.59	213.68	60.08	1.49
2014	0.63	314.41	222.80	53.29	13.66
2015	0.84	78.96	719.35	69.19	8.56
2016	1.06	349.20	175.00	148.30	10.70
2017	0.77	69.8	445.20	57.80	12.60
2018	1.26	138.1	50.50	62.60	0
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
2022	0.65	625.5	65.6	9.7	2

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

year	c.v.	0
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
2022	1.4297	0.0001

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

year	2	3	4	5	6+
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
2022	0.24	0.54	0.29	0.08	0.047

Table 7.9. 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

Year	CPUE	SD
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
2022	0.45	0.116429

Table 13. Assessment summary.

refer to 95% confidence intervals.

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
1968	117881	179755	241629	33225	43663	54101	8541	1285	0.182	0.24	0.30
1969	179162	256848	334534	28685	38905	49126	7991	1898	0.198	0.27	0.35
1970	296649	397373	498097	24774	34657	44540	6426	708	0.146	0.20	0.26
1971	87050	138878	190706	25494	35791	46087	9246	363	0.175	0.24	0.31
1972	264006	350572	437138	31610	43415	55220	9234	1546	0.169	0.23	0.29
1973	50612	86737	122862	36412	50061	63709	11819	1222	0.22	0.30	0.38
1974	206748	279634	352520	30349	42241	54133	10251	1749	0.20	0.28	0.36
1975	57575	94009	130442	29933	41932	53931	9863	857	0.21	0.30	0.39
1976	101002	149392	197782	23047	32985	42923	10247	381	0.22	0.32	0.42
1977	104340	153393	202446	22190	32462	42733	8054	201	0.20	0.30	0.40
1978	217412	287761	358110	16513	25316	34120	5662	0	0.150	0.22	0.30
1979	248480	321157	393834	17257	25593	33930	7548	0	0.196	0.28	0.36

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
1980	130452	181647	232842	20435	28386	36336	10599	0	0.24	0.32	0.40
1981	55043	86234	117425	28397	37057	45717	13958	0	0.29	0.37	0.46
1982	84196	121466	158736	31173	40846	50518	13381	313	0.31	0.41	0.50
1983	131637	177981	224325	24925	34492	44059	10015	372	0.26	0.36	0.46
1984	119274	164798	210322	16701	24266	31831	8383	2	0.25	0.36	0.46
1985	85877	125332	164787	17193	24134	31076	10483	61	0.30	0.41	0.52
1986	256259	322666	389073	17568	24309	31050	9852	154	0.31	0.42	0.53
1987	113423	158412	203401	17900	25012	32125	12894	128	0.38	0.51	0.63
1988	45751	75241	104731	17255	22977	28698	14168	109	0.44	0.57	0.70
1989	55470	90257	125044	18981	25018	31055	12751	202	0.45	0.60	0.75
1990	69692	105592	141492	13060	18955	24850	7379	159	0.32	0.46	0.60
1991	119494	161631	203768	8832	13573	18314	7095	163	0.38	0.56	0.73
1992	20097	37409	54721	8442	12906	17370	7735	98	0.40	0.54	0.68
1993	54074	76249	98423	9806	13559	17311	7555	155	0.41	0.56	0.70

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
1994	56425	75797	95169	9665	13743	17822	5402	142	0.35	0.50	0.64
1995	71089	91931	112773	6009	9275	12542	4587	166	0.32	0.45	0.57
1996	105119	132759	160399	6535	9364	12193	4964	140	0.37	0.51	0.64
1997	22784	34069	45354	7615	10588	13562	5859	120	0.37	0.50	0.63
1998	6264	11800	17336	9474	12887	16300	5318	29	0.31	0.44	0.56
1999	70966	100775	130584	8381	12303	16225	4784	159	0.36	0.60	0.84
2000	31311	47099	62886	3360	6831	10303	1274	699	0.154	0.29	0.42
2001	42012	59540	77067	5656	9575	13494	2252	64	0.109	0.183	0.26
2002	8794	14475	20156	7427	12263	17098	2695	46	0.151	0.24	0.34
2003	21113	30211	39309	7324	12254	17185	1285	215	0.089	0.144	0.199
2004	9526	14226	18925	7131	11858	16586	1072	254	0.091	0.146	0.20
2005	13045	18815	24585	5848	9560	13272	910	204	0.090	0.144	0.197
2006	17621	24945	32269	4410	7145	9881	840	185	0.117	0.187	0.26
2007	4922	8099	11275	3844	6393	8942	702	145	0.096	0.155	0.21

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
2008	13908	21213	28517	3557	5771	7985	662	61	0.095	0.153	0.21
2009	33817	51059	68301	2824	4607	6389	466	88	0.086	0.138	0.190
2010	22184	34975	47765	3355	5438	7522	464	386	0.075	0.123	0.171
2011	17646	29065	40484	4601	7244	9888	365	48	0.031	0.049	0.068
2012	24302	39818	55334	5898	9148	12398	198	678	0.067	0.107	0.146
2013	43629	69718	95808	6721	10743	14764	206	152	0.023	0.036	0.050
2014	12196	21497	30798	8373	13248	18123	213	184	0.0191	0.030	0.042
2015	23847	37852	51857	9620	15063	20505	161	147	0.0143	0.023	0.031
2016	4951	8955	12958	8631	13549	18467	82	60	0.0086	0.0133	0.0179
2017	14340	22768	31196	9525	14796	20067	84	59	0.0082	0.0126	0.0169
2018	11911	18988	26065	8026	12431	16836	215	42	0.0196	0.030	0.040
2019	8357	13587	18817	6973	10737	14501	295	7	0.024	0.036	0.049
2020	4612	8798	12984	5330	9059	11687	181	25	0.0196	0.030	0.040
2021	44489	86374	128258	5438	8363	11288	133	4	0.0152	0.023	0.031

Year	Recruitment age 0			SSB			Landings	Discards	Fishing mortality ages 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
2022	0	3429	9472	3984	6096	8209	98	27	0.0162	0.024	0.033
2023		21811*			10919						

*Geometric Mean 2002 to 2020.

Figure 1. Assessment summary.

Figure 2. Available data.

Figure 3. Landings and discards-at-age. Landings are shaded in grey, discards in white.

Figure 4. Proportion discarded at age. Ages 1 and 0 not displayed.

Figure 5. SSB with 95% confidence interval.

Figure 6. Recruitment with 95% confidence level. Recruitment in the figure for 2022 is model estimated and not the same as in the forecast.

Figure 7. F_{bar} ages 2–4.

Figure 8. Age compositions for commercial data and surveys.

Figure 9. Residuals at age.

Figure 10. Log CPUE fit NIGFS Q1.

Figure 11. Log index fit NIGFS Q4.

Figure 12. Log index fit UKFSP survey.

Figure 13. Results for runs tests for the three indices included and bottom row Mean age residual fits for total catches, NIGFSQ1 and UKFSP surveys.

Figure 14. RMSE with fitted LOESS smoother.

Figure 15. Mohns Rho for SSB and F_{bar}.

Landings yield 2024
2014 SS
2015 SS
2016 SS
2017 SS
2018 SS
2019 SS
2020 SS
2021 SS
2022 SS
2023 GM
2024 GM
1%
1%
1%
4%
5%
7%
6%
70%
3%
1%
0%
0
50
100
150
Tonnes
SSB 2025
2015 SS
2016 SS
2017 SS
2018 SS
2019 SS
2020 SS
2021 SS
2022 SS
2023 GM
2024 GM
2025 GM
2%
0%
2%
3%
4%
5%
65%
3%
15%
0%
0%
0
2000
4000
6000
8000
Tonnes

Figure 16.

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 2021 and 2022

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."*

2021 – ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2023.

6.1 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 2022 (Council regulation 2022/109)

L 21/60 EN Official Journal of the European Union 31.1.20

Species:	Cod *Gadus morhua*		Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	4	(1)	Analytical TAC Article 7(1) of this Regulation applies Article 9 of this Regulation applies Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply	
France	72	(1)		
Ireland	106	(1)		
Netherlands	0	(1)		
Union	182	(1)		
United Kingdom	4	(1)		
TAC	202	(1)		

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

TAC 2023

Species:	Cod *Gadus morhua*		Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	14	(1)	Analytical TAC Article 8 of this Regulation applies Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply	
France	231	(1)		
Ireland	336	(1)		
Netherlands	0	(1)		
Union	581	(1)		
United Kingdom	63	(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 2022, the catches are 573 t. TAC was nearly overtaken. 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 2022 is 75 t. It corresponds to a discards rate of 11.5%, which is slightly lower than the average discards rate of recent years (around 20%). In 2021, the discards rate

increased up to 50% as 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, followed by seine SCC_DEF_100–119_0_0_all. Seiners contributions to the catches increased in recent years. Beamers (i.e. TBB_DEF_70–99_0_0_all) also contribute to cod landings (Figure 6.3). Catches of OTB_DEF_70–99_0_0_all are low in recent years.

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

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.

6.2 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 effort were made to streamlining 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).

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. In 2022, Ireland did not provide information on discard rate and age structure for the main OTB Irish fleet, due to insufficient number of samples, which have reduced the amount of information available to estimate catch. The percentage of sampled versus raised data as well as the distribution of sampled data over the quarters were considered low (63 % of landings with missing discard data) but satisfactory (Figure 6.5).

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.

Catches

Age distribution of 2022 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 (Tables 6.2.a and 6.2.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 were 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). In 2022, age 1 and age2 represent each 64% and 16% of the catches respectively (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.

Discards 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 2021, French fleet have recorded high-grading pattern for its discards, may be due to restrictive TACs and delay in total TAC attribution. Individual TAC allocation was 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.

In 2022, discards are mostly composed of fish of 1 year (Figure 6.10).

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 did not impact catch weight. No important issues were reported.

Biological parameters are described in the stock annex and 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).

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. LUPE of the main otter trawls fleets are decreasing in 2022, while LPUE of Irish seiners increased.

Remark: The UK English and Welsh effort data are only reliable for vessels over 12 metres registered length, and therefore has always been provided to working groups for vessels greater than 12 metres. The fleet of over 12 meter vessels has been declining gradually over the years, until in 2016 no effort recorded from this fleet. The zero figures provided for 2016 have been checked and are correct (Figure 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. The VAST modelling index shows little retrospective bias and a slight increase in one year old fish in the last quarter of the year 2022.

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 quarter 2, 3 and 4), and the survey index are shown in Table 6.6.

Data issues

No important issues were reported this year. As a result of poor information on discard practices in 2022 and higher discarding practices in 2021 owing to late setting of the TAC, there is uncertainty around current discarding. In 2021 and 2022 it was not possible to forecast separate landings and discards estimates.

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

6.3 Stock assessment

Model used: 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 (Figures 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 complementary (survey versus commercial) but lead to distinct final estimates of F.

There is a tendency for the assessment to overestimate SSB and recruitment. (Figure 6.12a).

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 $F_{bar\ (2\text{-}5)}$, 23% for SSB and 48% for recruitment.

Remark: the 2018 run of the retrospective analysis is excessively flat, which might indicate that it did not converged.

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), the low stock size 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 were 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 75 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). The 2022 value is the lowest value of the time-series.

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 2018 and 2019 (Table 6.9 and Figure 6.11).

6.4 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. TAC constraint assumption lead to unreliable low F compared to recent F values estimates.

The recruitment age 1 fish values are 1108 thousands in 2023 and in 1102 thousands in 2023.

SSB is predicted to be 733 t in 2024 which would still be below B_{lim} (4200 t) (Table 6.11).

ICES provides zero-catch advice for this stock in 2024, because the median SSB remains below B_{lim} by 2025 under all catch scenarios (Table 6.12 and Table 6.13).

In the ICES advice framework, this would result in advised catches between 29 tonnes (at $F_{MSY\ lower} \times SSB_{2024}/MSY\ B_{trigger}$) and 48 tonnes (at $F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$), but the median SSB would remain below B_{lim} by 2025.

The assumed recruitment in 2023 and 2024 used in the forecast constitutes a significant part (75%) of the projected SSB in 2024 (49% and 26%, respectively; Figure 6.14 and Table 6.14).

6.5 Medium-term projection

No medium-term projections were carried out.

6.6 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.

6.7 Management plans

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

6.8 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.

6.9 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.

6.10 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.

6.11 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 Divisions 7.e–k. History of official commercial landings presented by country and used by the Working Group (series from 2004 were updated at WKCELTIC 2020). All weights are in tonnes.

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in 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
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

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in 33E2 and 33E3 *
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
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	130	0	1496	316	20
2019	43	369	554	84	NA	1050	300	37
2020	18	371	487	44	2	922	231	71
2021	11	261	309	46	0	627	733	52
2022	9	204	309	51	0	573	75	30

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

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

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

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	Year
467	885	403	122	27	4	6	2008
2212	421	424	120	47	11	4	2009
9794	618	151	107	46	14	5	2010
2325	4905	423	49	34	13	4	2011
746	1860	1757	117	18	14	11	2012
388	383	581	516	55	16	7	2013
4708	415	83	132	149	8	2	2014
242	2272	137	26	47	37	7	2015
624	195	707	33	7	17	16	2016
159	561	57	166	24	5	15	2017
902	172	137	14	38	5	2	2018
944	247	29	26	4	11	2	2019
342	548	36	3	2	2	2	2020
329	321	140	16	4	2	1	2021
225	58	37	29	3	1	0	2022

Table 6.3. Cod in divisions 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	12.53500
2022	0.580	1.797	4.462	7.188	9.387	10.841	12.65200

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

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
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	15.225000
2022	0.499	1.840	4.282	6.808	8.605	10.583	12.434000

Table 6.5a. Cod in divisions 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.

Effort	Landings	Year
264146	3692073	2002
240535	1978251	2003
214247	918840	2004
156961	714850	2005
125245	712566	2006
150288	1193033	2007
138626	814340	2008
143812	647808	2009
143730	705691	2010
258383	2332986	2011
252110	3393990	2012
190886	1696287	2013
151518	1113363	2014
185791	1374691	2015
178399	1122665	2016
137849	483571	2017
102586	163178	2018
114838	136473	2019
96907	149412	2020
97502	102964	2021
84073	60638	2022

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

Year	Beam trawlers 7gj	Scottish seiners 7gj	Gillnet 7gj	Otter trawlers 7j	Otter trawlers 7g
1995	0.8959162	2.1088512	0.6225272	1.8154882	1.3657463
1996	1.0668585	2.1559183	4.2506254	2.6496931	2.8186595
1997	1.2427154	1.2548458	0.4798469	2.3336993	1.0410506
1998	1.2923252	2.3723936	0.1697275	1.2430847	1.0693394
1999	1.2293226	0.2019260	0.9950683	0.3695621	0.8570788
2000	1.3025779	0.6470455	0.4829977	0.0397797	0.1973514
2001	-0.2882878	0.0075003	0.3148613	0.6256989	0.4957064
2002	-0.9368879	-0.8946958	-0.4965212	0.1765967	-0.7997174
2003	-1.5015352	-1.2518269	-0.6852390	-0.6283451	-1.2457870
2004	-1.3248230	-1.0760455	-0.4371844	-0.8571905	-1.2290666
2005	-0.4926166	-0.7094166	-0.2331990	-0.7566929	-1.0207422
2006	-0.7123486	-0.4038324	-0.2459910	-0.6874545	-0.5541952
2007	-0.9694969	-0.8193187	-0.2567463	-0.8165993	-1.0265475
2008	-0.5591574	-0.5947678	-0.3022953	-0.7846407	-0.8037037
2009	-0.8462574	-0.7616422	-0.4041776	-0.8937856	-0.6906130
2010	-0.5276729	-0.4551665	-0.4050779	-0.6891732	-0.2782094
2011	-0.5243248	-0.6208646	-0.2273086	-0.4354927	-0.3238119
2012	0.8072418	0.0551363	0.0215822	-0.4039848	1.0045852
2013	1.6664664	0.0600805	-0.2816147	-0.3034182	0.9981941
2014	0.6058423	0.2787564	-0.5497667	-0.4040145	0.2507693
2015	1.0060281	-0.0827381	-0.5668793	-0.0747053	-0.1499696
2016	-0.2396161	-0.5113665	-0.6329381	-0.4038978	-0.7651378
2017	-1.3467327	-0.6192736	-0.7869104	-0.5902898	-0.8540963
2018	-0.8455373	-0.3414987	-0.8253870	-0.5239178	-0.3568835
2019	-0.7100752	-0.8990503	-0.8011309	-0.7243375	-1.0152535
2020	-0.8885110	-0.8063711	-0.7591179	-0.6945155	-1.1794963
2021	-1.2674747	-1.1854071	-0.8119745	-0.9294170	-1.5862755
2022	-1.2191902	-1.0183307	-0.8529526	-0.9591706	-1.1395409

Year	Beam trawlers 7gj	Scottish seiners 7gj	Gillnet 7gj	Otter trawlers 7j	Otter trawlers 7g
1995	20.91260	11.68810	27.66375	93.18419	63.32935
1996	28.06515	17.88610	11.41350	70.18746	59.97495
1997	29.72535	26.80190	10.19030	82.65244	64.99685
1998	40.44650	21.48920	19.45400	89.06940	72.25215
1999	48.25450	9.41500	17.09650	40.50945	51.47875
2000	43.76650	13.35200	17.12800	63.91250	60.56250
2001	42.48500	20.74650	15.33055	67.42700	69.36530
2002	34.60709	29.74450	14.54500	90.40650	77.20150
2003	58.23900	27.98300	22.27900	107.36800	86.78000
2004	57.04300	26.48300	19.58200	88.29500	97.12100
2005	51.92600	20.45300	17.03000	71.30600	124.67000
2006	61.99900	20.10900	15.12600	64.53900	118.04400
2007	58.17400	19.32600	19.91900	78.33300	135.36300
2008	38.33700	14.48600	21.95800	66.67100	125.40700
2009	40.76600	11.50900	24.66500	73.02300	137.10600
2010	41.25800	14.03200	23.41600	85.74600	140.79000
2011	35.95100	15.57700	19.38600	62.75900	120.33200
2012	40.62150	19.48787	23.68783	65.64257	127.68090
2013	39.04300	19.76400	24.27343	61.31832	118.19917
2014	38.47100	19.87300	26.31900	53.86747	127.34400
2015	37.88500	14.60900	26.70983	46.90650	132.68990
2016	39.73400	15.74600	30.70825	50.69060	148.17492
2017	35.21500	15.07300	32.84802	56.43622	136.05400
2018	37.50500	16.09300	30.79725	52.13683	108.22200
2019	34.17800	21.57800	30.47917	53.35700	103.88850
2020	29.16600	19.12200	28.54073	44.11350	89.90500
2021	31.88700	20.08300	37.31900	40.27725	83.90350
2022	22.53400	22.09200	38.98567	32.14233	64.44800

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

	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
YEAR	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

	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
2010	65.62	12150	31.13	5185	15.27	2213
2011	99.03	13205	47.73	4354	26.00	1931
2012	165.63	13411	79.03	4312	30.95	2068
2013	114.49	12950	37.30	2014	22.94	1587
2014	87.55	12807	17.07	1606	14.06	1440
2015	89.39	12769	16.68	1061	14.40	978
2016	73.81	13913	0.00	0	0.00	0
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	1464	1.74	1076
2021	14.99	12600	2.54	1911	1.27	1374
2022	11.44	13584	3.93	1609	2.85	1246

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

Cod in divisions 7e–k, tuning fleets, WGCSE20

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FR-OTDEF Q2+3+4 trawlers in 7e–k

2002 2022

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
2022	84073	60638

IR-GFS FR-EVHOE Q4 combined indices - VAST Modelling

2003	2022	NA	NA
1	1	0.79	0.92
1	4	NA	NA

Year	Effort	Age 1	Age 2	Age 3	Age 4
2003	1	26.327	38.942	49.429	17.238
2004	1	37.372	33.426	16.727	18.123
2005	1	115.485	33.875	12.569	0.000
2006	1	78.020	41.141	8.646	0.000
2007	1	101.939	69.513	33.282	12.262
2008	1	29.964	68.151	31.164	10.737
2009	1	59.662	19.869	30.189	11.156
2010	1	508.563	59.404	5.877	7.077
2011	1	246.331	358.491	25.904	4.012
2012	1	21.744	108.881	149.011	25.149
2013	1	25.662	8.115	23.681	32.259
2014	1	295.182	29.167	14.095	20.217
2015	1	13.635	146.480	9.858	0.000
2016	1	128.083	21.929	110.613	17.508
2017	1	21.805	63.944	27.043	36.004
2018	1	37.514	8.718	12.416	10.625
2019	1	145.406	33.105	2.031	6.612
2020	1	55.596	103.984	3.034	0.896
2021	1	23.730	27.236	37.953	1.630
2022	1	80.787	11.297	18.168	7.813

Table 6.7. Cod in divisions 7e–k. Final SAM fishing mortality-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	Fbar(mean 2–5)
1980	0.498	0.972	0.910	0.890	0.875	1.104	1.104	0.912
1981	0.490	0.955	0.893	0.869	0.851	1.072	1.072	0.892
1982	0.468	0.910	0.847	0.820	0.801	1.005	1.005	0.845
1983	0.470	0.915	0.852	0.823	0.802	1.002	1.002	0.848
1984	0.435	0.842	0.781	0.751	0.731	0.911	0.911	0.776
1985	0.437	0.846	0.785	0.751	0.729	0.906	0.906	0.778
1986	0.457	0.888	0.826	0.789	0.763	0.940	0.940	0.817
1987	0.465	0.905	0.843	0.804	0.777	0.951	0.951	0.832
1988	0.451	0.875	0.814	0.771	0.745	0.906	0.906	0.801
1989	0.472	0.917	0.855	0.805	0.775	0.934	0.934	0.838
1990	0.505	0.986	0.922	0.866	0.831	0.995	0.995	0.901
1991	0.533	1.044	0.981	0.921	0.885	1.054	1.054	0.958
1992	0.534	1.046	0.984	0.920	0.885	1.052	1.052	0.959
1993	0.529	1.037	0.974	0.906	0.871	1.031	1.031	0.947
1994	0.541	1.061	0.998	0.926	0.889	1.051	1.051	0.969
1995	0.532	1.043	0.980	0.906	0.870	1.025	1.025	0.950
1996	0.539	1.058	0.995	0.913	0.874	1.023	1.023	0.960
1997	0.533	1.044	0.981	0.892	0.847	0.982	0.982	0.941
1998	0.545	1.068	1.005	0.910	0.859	0.987	0.987	0.961
1999	0.552	1.082	1.019	0.917	0.863	0.983	0.983	0.970
2000	0.547	1.073	1.010	0.905	0.850	0.960	0.960	0.960
2001	0.555	1.091	1.028	0.920	0.866	0.974	0.974	0.976
2002	0.566	1.113	1.050	0.934	0.876	0.980	0.980	0.993
2003	0.556	1.091	1.029	0.911	0.854	0.953	0.953	0.971
2004	0.544	1.067	1.007	0.890	0.836	0.934	0.934	0.950
2005	0.556	1.090	1.033	0.910	0.859	0.963	0.963	0.973
2006	0.524	1.020	0.968	0.855	0.814	0.919	0.919	0.914
2007	0.513	0.999	0.952	0.844	0.810	0.922	0.922	0.901
2008	0.495	0.964	0.925	0.824	0.799	0.917	0.917	0.878

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	Fbar(mean 2–5)
2009	0.491	0.957	0.922	0.826	0.808	0.936	0.936	0.878
2010	0.477	0.932	0.901	0.809	0.797	0.932	0.932	0.860
2011	0.475	0.931	0.898	0.806	0.796	0.937	0.937	0.858
2012	0.500	0.984	0.950	0.853	0.846	1.004	1.004	0.908
2013	0.519	1.029	0.994	0.894	0.892	1.064	1.064	0.952
2014	0.498	0.987	0.949	0.850	0.847	1.014	1.014	0.908
2015	0.511	1.016	0.974	0.870	0.868	1.046	1.046	0.932
2016	0.536	1.071	1.024	0.911	0.907	1.100	1.100	0.978
2017	0.604	1.214	1.159	1.031	1.026	1.248	1.248	1.107
2018	0.632	1.271	1.209	1.067	1.057	1.288	1.288	1.151
2019	0.631	1.272	1.205	1.060	1.047	1.283	1.283	1.146
2020	0.592	1.188	1.116	0.976	0.966	1.191	1.191	1.062
2021	0.629	1.263	1.184	1.036	1.024	1.260	1.260	1.127
2022	0.610	1.225	1.147	1.005	0.996	1.229	1.229	1.093

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

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	17604	4877	685	299	90	72	21
1981	8089	6624	1327	229	95	29	23
1982	3859	3001	1872	399	77	34	13
1983	8506	1405	868	644	141	29	15
1984	9577	3281	388	267	216	50	12
1985	8171	3785	1035	146	102	84	22
1986	9009	3177	1177	379	61	44	34
1987	28569	3358	934	383	129	25	25
1988	14447	11429	949	312	121	46	15
1989	4847	5641	3602	355	121	44	20
1990	6483	1765	1638	1128	146	44	22
1991	16803	2329	456	486	348	59	21
1992	19154	6112	579	131	139	105	24
1993	10496	6943	1578	163	43	43	34
1994	21155	3615	1806	461	53	15	23
1995	16925	7652	868	496	144	18	10
1996	12348	6039	1989	278	151	50	8
1997	12865	4320	1511	568	102	46	15
1998	7965	4642	1083	421	187	42	18
1999	4381	2808	1163	298	126	65	20
2000	16714	1450	686	315	93	42	26
2001	15061	6097	338	189	99	33	24
2002	5492	5368	1532	99	59	30	18
2003	3392	1862	1201	386	31	20	14
2004	4634	1238	442	305	118	11	11
2005	7958	1870	278	138	96	41	8
2006	8455	2723	478	62	45	32	16
2007	6255	2833	732	148	21	16	17
2008	2202	2174	712	215	51	8	11

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	5374	829	614	219	74	19	6
2010	24734	1977	247	188	79	25	8
2011	9310	9516	617	89	66	29	10
2012	1776	3529	2763	205	35	24	13
2013	2335	633	949	813	71	14	11
2014	12097	841	168	275	268	22	6
2015	1102	4752	242	50	92	86	9
2016	2322	400	1212	75	16	31	27
2017	661	819	108	299	27	6	16
2018	1502	221	171	26	72	8	4
2019	3497	461	44	35	8	18	3
2020	1108	1216	80	10	8	2	4
2021	432	368	240	21	4	3	2
2022	998	120	73	52	6	1	1

Table 6.9. 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	17604	8182	37874	10233	7806	13413	0.911	0.745	1.115	20123	13523	29944
1981	8089	3902	16771	13040	9886	17199	0.892	0.747	1.065	20728	14693	29242
1982	3859	1875	7943	13171	10458	16586	0.845	0.712	1.001	17076	13326	21880
1983	8506	4204	17212	10530	8682	12771	0.848	0.717	1.002	14835	11762	18710
1984	9577	4743	19338	8521	6881	10551	0.776	0.631	0.955	14316	10551	19424
1985	8171	4082	16357	9876	7890	12361	0.778	0.641	0.944	15658	11717	20925
1986	9009	4458	18203	10863	8756	13478	0.816	0.694	0.960	16598	12708	21677
1987	28569	14314	57019	10461	8500	12875	0.832	0.709	0.977	23484	16172	34102
1988	14447	7230	28868	16248	11853	22272	0.801	0.662	0.969	29325	20132	42718
1989	4847	2404	9773	21857	16748	28524	0.838	0.708	0.992	28330	21532	37275
1990	6483	3172	13247	17287	13890	21516	0.901	0.771	1.052	21291	17078	26543
1991	16803	8204	34411	10991	9141	13216	0.957	0.805	1.140	18856	13897	25586
1992	19154	9486	38676	10495	7984	13796	0.959	0.818	1.123	21737	14828	31865
1993	10496	5132	21465	13569	10255	17952	0.947	0.815	1.100	22425	16039	31354
1994	21155	10564	42362	13527	10718	17073	0.969	0.830	1.130	24214	17598	33318
1995	16925	8518	33627	14153	10853	18457	0.950	0.819	1.101	25656	18221	36125
1996	12348	6250	24398	15901	12447	20314	0.960	0.827	1.114	24965	18601	33508
1997	12865	6511	25419	14433	11626	17919	0.941	0.810	1.092	22434	17073	29479
1998	7965	4031	15737	12881	10383	15980	0.961	0.829	1.113	19161	14592	25160
1999	4381	2228	8612	10622	8641	13058	0.970	0.835	1.127	14399	11339	18285
2000	16714	8835	31621	7481	6214	9008	0.959	0.828	1.112	14802	10826	20239
2001	15061	8081	28069	8822	6650	11704	0.976	0.843	1.130	18473	13263	25731
2002	5492	3077	9803	11536	9269	14358	0.993	0.853	1.156	17499	13613	22494
2003	3392	2106	5462	9182	7741	10892	0.971	0.846	1.115	11985	10047	14297
2004	4634	2853	7526	5434	4662	6333	0.950	0.837	1.079	7681	6515	9055
2005	7958	5419	11687	4197	3648	4828	0.973	0.842	1.124	7536	6357	8933
2006	8455	5575	12823	5533	4707	6504	0.914	0.807	1.036	9836	8186	11817
2007	6255	4204	9305	6756	5731	7964	0.901	0.795	1.022	10664	8945	12713
2008	2202	1483	3270	6797	5800	7966	0.878	0.771	0.999	9379	7963	11046

Year	R(age 1)	Low	High	SSB	Low	High	F_{bar}(2–5)	Low	High	TSB	Low	High
2009	5374	3644	7927	5420	4630	6345	0.878	0.774	0.997	8461	7200	9942
2010	24734	17089	35800	5401	4643	6283	0.860	0.748	0.988	14012	11292	17386
2011	9310	6353	13641	9158	7690	10907	0.858	0.743	0.990	16834	13948	20316
2012	1776	1202	2622	14082	11765	16855	0.908	0.806	1.024	17606	14855	20868
2013	2335	1565	3485	10276	8701	12137	0.952	0.830	1.093	12069	10377	14038
2014	12097	8183	17883	6352	5425	7437	0.909	0.791	1.044	11473	9521	13825
2015	1102	738	1647	6542	5528	7742	0.932	0.812	1.070	9714	7980	11826
2016	2322	1561	3455	5842	4841	7051	0.978	0.857	1.117	7868	6630	9339
2017	661	434	1007	3205	2689	3821	1.107	0.962	1.275	3955	3347	4674
2018	1502	1003	2248	1669	1435	1941	1.151	0.997	1.329	2442	2098	2842
2019	3497	2376	5148	1090	935	1272	1.146	1.001	1.312	2702	2171	3362
2020	1108	745	1649	1320	1078	1615	1.062	0.898	1.255	2477	2002	3065
2021	432	270	691	1174	976	1411	1.127	0.945	1.343	1597	1340	1904
2022	998	483	2063	839	663	1063	1.093	0.862	1.386	1461	1054	2025

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

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-6.920	0.048	0.001	0.001	0.001
logFpar_1	-2.985	0.177	0.051	0.035	0.072
logFpar_2	-2.134	0.174	0.118	0.084	0.168
logFpar_3	-1.795	0.173	0.166	0.117	0.235
logSdLogFsta_0	-2.541	0.508	0.079	0.029	0.218
logSdLogN_0	-0.051	0.128	0.950	0.735	1.228
logSdLogN_1	-1.851	0.311	0.157	0.084	0.293
logSdLogObs_0	-0.656	0.205	0.519	0.345	0.781
logSdLogObs_1	-1.107	0.240	0.331	0.205	0.534
logSdLogObs_2	-1.273	0.113	0.280	0.223	0.351
logSdLogObs_3	-1.896	0.224	0.150	0.096	0.235
logSdLogObs_4	-0.305	0.146	0.737	0.551	0.986
transfIRARdist_0	-1.139	0.439	0.320	0.133	0.770
itrans_rho_0	1.790	0.763	5.990	1.303	27.546

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

Model	log(L)	#par	AIC
Current	-232.74	14	493.48
base	-209.68	14	447.37

Table 6.11. Cod in divisions 7e–k. Reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5800	B_{pa}; in tonnes	ICES (2020)
	F_{MSY}	0.29	Segmented regression with B_{lim} (EqSim).	ICES (2020)
Precautionary approach	B_{lim}	4200	B_{loss}, lowest observed SSB from which there has been some recovery (2005) rounded value; in tonnes	ICES (2020)
	B_{pa}	5800	B_{lim} × 1.4; in tonnes	ICES (2020)
	F_{lim}	1.13	Segmented regression with B_{lim} (EqSim)	ICES (2020)
	F_{pa}	0.77	F_{P05}; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2020)
Management plan (MAP)*	MAP MSY $B_{trigger}$	5800	MSY $B_{trigger}$; in tonnes	EU (2019), ICES (2020)
	MAP B_{lim}	4200	B_{lim}; in tonnes	EU (2019), ICES (2020)
	MAP F_{MSY}	0.29	F_{MSY}	EU (2019), ICES (2020)
	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 (2020)
	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 (2020)

Table 6.12. Cod divisions 7ek. Short-term forecast assumption.

Variable	Value	Notes
$F_{ages\ 3–5}$ (2023)	1.094	F = $F_{Average\ (2020–2022)}$
SSB (2024)	733	Short-term forecast; in tonnes
$R_{age\ 1}$ (2023)	1108	Median resampled (2015-2022); in thousands
$R_{age\ 1}$ (2024)	1102	Median resampled (2015-2022); in thousands
Total catch (2023)	812	Short-term forecast; in tonnes

Table 6.13. Stochastic Short-term forecast.

F_{MSY}

Year	Fbar median	Fbar low	Fbar high	Rec median	Rec low	Rec high	Ssb median	Ssb low	Ssb high	Catch median	catch: ow	Catch high
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	0.290	0.212	0.398	1102	432	3497	733	344	1606	343	183	723
2025	0.290	0.204	0.411	1102	432	3497	1734	795	3909	653	327	1367

Other scenarios

F status quo then Fmsy HCR

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	0.037	0.027	0.050	1102	432	3497	733	344	1606	48	26	104
2025	0.290	0.204	0.411	1102	432	3497	2189	1038	4921	793	396	1692

F status quo then F_{MSY} lower HCR

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	0.021	0.016	0.029	1102	432	3497	733	344	1606	29	15	61
2025	0.290	0.204	0.411	1102	432	3497	2221	1054	4992	802	401	1715

F status quo then F_{MSY} upper HCR

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	0.052	0.038	0.071	1102	432	3497	733	344	1606	68	36	146
2025	0.290	0.204	0.411	1102	432	3497	2159	1022	4854	783	392	1670

Stable SSB

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	1.255	0.916	1.721	1102	432	3497	733	344	1606	1019	537	2092
2025	1.251	0.881	1.773	1102	432	3497	733	284	1780	1017	491	2058

F2023

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	1.094	0.798	1.500	1102	432	3497	733	344	1606	940	497	1938
2025	1.094	0.770	1.551	1102	432	3497	844	337	2015	1035	504	2085

F_{pa}

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	0.770	0.562	1.056	1102	432	3497	733	344	1606	747	397	1551
2025	0.770	0.542	1.092	1102	432	3497	1123	476	2598	1008	501	2040

F_{lim}

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high
2022	1.093	0.867	1.380	1001	491	2035	850	675	1070	822	645	1085
2023	1.094	0.830	1.446	1108	432	3497	645	391	1068	812	505	1385
2024	1.130	0.825	1.549	1102	432	3497	733	344	1606	959	506	1974
2025	1.130	0.796	1.602	1102	432	3497	818	324	1958	1033	502	2081

B_{lim} - Not achievable.

B_{pa}, $MSYB_{trigger}$, not achievable.

Table 6.14. Catch option table.

Basis	Total catch (2024)	F_{total} (2024)	SSB	% SSB change*	% advice change^
			-2025		
ICES advice basis					
MSY approach: F = 0	0	0	2265	209	0
Other scenarios					
$F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$	48	0.037	2189	199	
EU MAP**: $F_{MSY\ lower} \times SSB_{2024}/MSY\ B_{trigger}$	29	0.021	2221	203	
EU MAP**: $F_{MSY\ upper} \times SSB_{2024}/MSY\ B_{trigger}$	68	0.052	2159	195	
$F=F_{MSY}$	343	0.290	1734	137	
$F=F_{MSYlower}$	212	0.170	1937	164	
$F=F_{MSYupper}$	460	0.410	1553	112	
$F=F_{lim}$	959	1.130	818	12	
$F = F_{pa}$	747	0.77	1123	53	
$SSB_{2025} = SSB_{2024}$	1019	1.255	733	0	
$F = F_{2023}$	940	1.094	844	15	
$SSB_{2025} = B_{lim}$***					
SSB_{2025} =Bpa = MSY $B_{trigger}$***					

*** SSB_{2025} relative to SSB_{2024}.**

**** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

*****The B_{lim}, B_{pa}, and MSY $B_{trigger}$ options were left blank because none of them can be achieved in 2025, even with zero catch in 2024.**

^ Advice value for 2024 relative to the corresponding 2023 value.

Table 6.15. Cod in divisions 7e–k. Forecast (a) yield in 2024 and (b) SSB in 2025.

recruitment	val	type	Prop	Age
2024	0,00	2024 Catch	20,67	1
2023	0,00	2024 Catch	46,16	2
2022	0,00	2024 Catch	21,95	3
2021	0,00	2024 Catch	3,03	4
2020	0,00	2024 Catch	3,29	5
2019	0,00	2024 Catch	4,33	6
2018	0,00	2024 Catch	0,56	7
2025	0,00	2025 SSB	0,00	1
2024	578,11	2025 SSB	26,53	2
2023	1068,63	2025 SSB	49,04	3
2022	386,16	2025 SSB	17,72	4
2021	45,71	2025 SSB	2,10	5
2020	47,94	2025 SSB	2,20	6
2019	52,35	2025 SSB	2,40	7

Figure 6.1. Cod in divisions 7e–k. Historical landings (in Tonnes) by country. Revised at WKCETIC 2020.

Figure 6.2. Cod in divisions 7e–k. Catches volume in tonnes (i.e. landings and discards) by area and country in 2023.

Figure 6.3. Cod in divisions 7e–k. Proportion of landings per métier (Level 6).

Figure 6.4. Cod in divisions 7e–k. Discard proportion per fleet and season.

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

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

Figure 6.6b. Cod in divisions 7e–k. Time-series of standardized lpue (a) and standardized fishing effort (b) for the Irish fleets.

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

big_xxx-00-00.00.00_09- big_xxx-00-00.00.00_10

Figure 6.7. Cod in divisions 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 divisions 7e–k. Final assessment. Residuals.

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

Figure 6.10. Cod in divisions 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
F_{2-5}
base
current
1980
1990
2000
2010
2020
Years

30000
25000
20000
15000
10000
5000
0
SSB
base
current
1980
1990
2000
2010
2020
Years

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

Rho -12%
F_{2-5}
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1980
1990
2000
2010
2020
Years
stockassessment.org, Cod_7ek_2023, r17358 , git: ec2c2a0c0dde

Rho 23%
SSB
0
5000
10000
15000
20000
25000
1980
1990
2000
2010
2020
Years
stockassessment.org, Cod_7ek_2023, r17359 , git: ec2c2a0c0dde

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

1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
F2-5
current
w.o. FR_OTDEF_Biomass
w.o. VAST_IGFS_EVHOE
1980
1990
2000
2010
2020
Years

25000
20000
15000
10000
5000
0
SSB
current
w.o. FR_OTDEF_Biomass
w.o. VAST_IGFS_EVHOE
1980
1990
2000
2010
2020
Years

Figure 6.12b. Cod in divisions 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 divisions 7e–k. Stock–recruitment plots and yield per recruits information.

Figure 6.14. Cod in divisions 7e–k. Forecast (a) yield in 2024 and (b) SSB in 2025.

7 Haddock in Division 6.b (Rockall)

7.1 Introduction

Biennial advice was provided for this stock last year on the basis of the 'rfb' category 3 data limited rule utilising a survey index and mean catch length indicator. This resulted in a 30% reduction in advice for 2023 and 2024 compared to advice for 2022. In previous years, an age-structured assessment model was used to provide advice as a category 1 stock. However, in 2022, the methods to update the previously utilised survey index were unavailable and the agreed assessment (and forecast) could not be carried out. The WG considers the category 3 approach to be a temporary measure until such a time as a benchmark for this stock can be scheduled.

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 4078 tonnes in each of the years 2023 and 2024.

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 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		

TAC 2023

Species:	Haddock Melanogrammus aeglefinus	Zone:	United Kingdom, Union and international waters of 6b; international waters 12 and 14 (HAD/6B1214)
Belgium	8	Analytical TAC Article 7(2) of this Regulation applies	
Germany	8		
France	368		
Ireland	264		
Union	648		
United Kingdom	3 430		
TAC	4 078		

The minimum conservation reference size of haddock taken by EU and UK vessels at Rockall is 30 cm and the stock is fully under the landing obligation. 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 efficiency 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, 2019).

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 2022

Russian fishery in 2022

No information was provided on the Russian fishery at Rockall in 2022 and no official landings were submitted by the Russian Federation. A comparison of catch estimates from the NEAFC area derived from VMS data including Russian data submitted to ICES (not shown) and estimates from InterCatch (which does not include Russian catches) suggests that Russian Rockall haddock catches are likely to be low as a proportion of total catch in 2022. Anecdotal information

from the fishing industry also supports the assumption that there has been limited Russian fishing activity at Rockall in recent years.

UK fishery in 2022

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 (Table 7.3.1). Quota uptake was also relatively low (~65%%) in 2022 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), although this has reduced to 22 % in 2022 (Table 7.3.2).

Irish fishery in 2021

Reported landings by Irish vessels also decreased slightly in 2022 compared to 2021 (Table 7.3.1). 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. 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 ten years, the majority of the reported landings come from the UK (almost 90% in 2022) with smaller amounts reported by Ireland and the Faroe Islands.

Data for the NEAFC area only (Subdivision 6b.1) are also shown in Table 7.3.1 and in Table 7.3.2 by nation. Up to 2019, this area taken from the official landings statistics. For 2020 to 2022, the estimates are a mixture of official landings and landings from InterCatch as landings for the UK are not available split by subdivision in the three most recent years. In some years, Russian landings are reported as being from 27.6b_NK (i.e. unknown subdivision), however it is assumed that all these landings have been taken in the NEAFC area (i.e. Subdivision 27.6.b.1). The proportion of the total landings coming from international waters is around 25% in 2022.

Anecdotal evidence suggests that misreporting of haddock from Rockall has occurred historically (particularly on fishing trips where vessels fish in both divisions 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. Note that Scottish landings are submitted by subdivision. Russian Federation landings were not submitted by the national data submitter for 2022, and official landings are also not available for 2022. Given the recent negligible level of Russian landings and estimates from NEAFC VMS (not presented), Russian landings are assumed to be only a small proportion of the total landings in 2022.

Due to the lack of Russian data, total landings (both official and ICES estimates) may be underestimated in 2022. However, the available evidence suggests that this underestimate is likely to be minor.

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. The weighting algorithm used is 'Mean weight weighted by numbers-at-age or length'. (Note that in recent years, Scottish data have been submitted to InterCatch by subdivision which often results in an 'unsampled' métier/division combination – usually Subdivision 6b.1. Scottish samples are allocated (discard rates and age compositions) to this unsampled métier as they are assumed to be the same métier operating across 6b.2 and 6b.1 with similar fishery characteristics.

The need to adopt a data-limited approach for the assessment and advice has meant that length frequency data are also processed within InterCatch. Landings length compositions were allocated to unsampled fleets in the same manner as age compositions. These data have been 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 available in the catch statistics. 4 t of BMS landings were reported in 2019, 2 t in 2020 and < 1 t in 2021 and 2022. The assessment includes BMS landings within total landings (although these unsampled data are allocated age/length compositions from sampled discards in InterCatch).

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 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 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. In addition, unsampled Scottish OTB_DEF>=120 in Subdivision 6b.1 are allocated samples from the Scottish OTB_DEF>=120 in Subdivision 6b.2.

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 subdivision with sampling available only for Subdivision 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 Subdivision 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% (equal to 20% in 2022). 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, 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. At older ages in particular, mean weights have begun to decline in more recent years and are levelling off in ages two to four.

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.

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 and shown in Figure 7.3.9. As a check on the trends in stock mean weights derived from catch mean weights-at-age, last year, the WG presented a comparison with survey mean weights. The values appeared relatively consistent (between surveys and catches) and the WG concluded that the use of the smoothed catch mean weights-at-age was appropriate for use in deriving a survey biomass index. The same approach is utilized this year to derive the total biomass index: the stock mean weights-at-age 1–7 are derived from the catch mean weights (5 year rolling mean) while age 0 stock mean weights-at-age are derived from the survey as these are in general not available from the catch sampling data.

Surveys

The Scottish Rock-IBTS-Q3 survey is the only survey available for this stock. The survey is co-ordinated by IBTS and described further in the IBTS reports, the Stock Annex and the 2019 benchmark report (ICES, 2020).

The survey originally began in the 1990s, but in 2011, a number of changes were made: the survey ground gear 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 ground gears suggested no significant differences in the catch rate of haddock. The assessment WG in 2012 (ICES, 2012) 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'). Last 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 of 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 (m²) 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 the WG report from 2021 (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.

From Figure 7.3.10 it is apparent that the survey estimate of age 1 in 2022 is the largest in the time-series while the age 0 in 2022 is one of the lowest. Figure 7.3.12 shows the spatial distribution of catch rates of juvenile haddock (<= 25 cm) over time, and indicates that the high catch rates of age 1 fish were widely distributed across the bank in 2022. (Given the relative catch rates of age 0 and age 1 fish in 2022, most of the fish <=25 cm are likely to be age 1).

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) over ages 0–7+. The index is shown in Figure 7.3.13 (and Table 7.3.13) in comparison to an SSB index (ages 3+) 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, shows a general decline from 2018 to 2021 and then an increase of over 300% in 2022 and is now well above the Itrigger value. It is clear from Figure 7.3.14 that this increase is almost entirely due to increase in age 1 individuals.

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 (See Figure 7.3.16 in ICES 2022b).

Last year's working group conducted an analysis of length and age data from the Scottish Q3 Rockall survey to determine the most appropriate von Bertalanffy growth parameters to determine LF=M for use in the category 3 'rfb' advice rule. Cohort dependent estimates showed significant variability and in the end, the WG agreed to use the median L_∞ (55 cm) and k (0.24) across cohorts in the data-limited approach. The estimated value of $L\infty$ is towards the lower end of the range of values in Fishbase but higher than the previously quoted value for Rockall haddock (ICES, 2022b).

Length-based indicator

Annual estimates for Lc and $L_{F=M}$ (assuming Linf=55) and are given 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). At the 2022 assessment WG, it was agreed that Lc would be calculated over the most recent five years of data (2017–2021). 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 (31.6 cm) in the catch can then be 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 and shown in absolute terms in Figure 7.3.15. Relative LBI values are greater than one (absolute values greater than 37.4 cm) for the whole time-series with the exception of 2022. This suggests that the stock has been fished below F_{MSY} in the recent past, but that fishing mortality increased in 2022 to above F_{MSY}.

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 $B_{trigger}$ 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.

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 in 2022 for advice in 2023 and 2024 and the basis for that advice is given in the table below. 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 applicable. Last year 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 the advice for 2022. 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).

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**	3389 tonnes

Stability clause (+20%/−30% compared to Ay, only applied if b≥1)	Applied	0.70
Discard rate	9.2%	
Catch advice for 2023 and 2024 (Ay × stability clause)	4078 tonnes	
Projected landings corresponding to advice***	3704 tonnes	
% advice change^	-30 %	

* 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.
**$Ay+1 = Ay \times r \times f \times b \times m$.
*** [Advised catch for 2023] × [1 – discard rate].
^ Advice value for 2023 and 2024 relative to the advice value for 2022 (5825 tonnes).

Although the advice is not updated this year, updated input values for an application of the 'rfb' rule are given in the table below.

Stock biomass trend	
Index A (2021, 2022)	1190 kg hr-1
Index B (2018, 2019, 2020)	524 kg hr-1
R: Index ratio (A/B)	2.27
Fishing pressure proxy	
Mean catch length (Lmean = L_{2022})	37.0 cm
MSY proxy length (LF = M)	37.4 cm
f: multiplier for relative mean length in catches (Lmean/LF = M)	0.99
Biomass safeguard	
Last index value (I_{2022})	1934 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{$I_{2022}/I_{trigger}$, 1}	1

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.

In addition, there is an EU multiannual management plan (MAP) for this stock which has been adopted by the EU (EU, 2019) but has not been agreed with UK.

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).

Type	Problem/Aim	Work Required	Data Required
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 assessment method which can account for this uncertainty is required (e.g. SAM).	Development of a SAM assessment.	Assessment input data.
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.	

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 was provided in 2022 for two years (2023 and 2024) (ICES, 2022a).

7.10 References

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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

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#
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^^
2022*	25			403							3565	3993^^	93	1037	4086^^

*** 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.

 # Historical values 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		0	15.3	11.6	133	0	584.6	744.6
2021*	0.2	0.012	140.9		20	0	1021.6	1182.7
2022*	24.709	0	63.2235				949.62	1037.533

***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 calculated as sum of products of numbers and weights. (* 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
2022	4086*	1040

Table 7.3.4. Haddock in 6.b. International landings numbers (*10³) at-age.

	Age						
Year	1	2	3	4	5	6	7
1991	87	6807	3011	1344	558	32	464
1992	86	3642	5623	964	580	364	160
1993	28	1919	4740	1157	489	144	290
1994	30	1160	5299	3665	1039	66	141
1995	1	146	5205	4791	1319	279	43
1996	2	5149	1861	4149	2347	473	85
1997	0	319	2102	2155	3658	1540	192
1998	4	392	1815	1340	1898	2284	1301
1999	245	2600	2994	1972	1228	1600	2291
2000	33	3446	5081	3006	1296	1176	1963
2001	402	994	1116	555	991	462	549
2002	657	2983	3998	2111	809	217	392
2003	920	8103	11010	1848	1189	879	593
2004	197	1765	9502	9119	1364	286	472
2005	887	2835	6866	7913	725	98	182
2006	2344	768	1290	2356	2269	428	150
2007	31	1220	2709	1074	1550	1634	719
2008	17	749	6191	1164	479	761	848
2009	5	11	244	5243	460	261	486
2010	0	71	196	352	4078	274	294
2011	2	23	71	177	181	2405	222
2012	0	0	134	51	0	35	410
2013	162	14	2	46	6	46	553
2014	226	1553	418	52	138	47	679
2015	9	820	3214	104	7	61	112
2016	127	612	2137	842	3	2	11
2017	7	1336	1783	2179	1207	58	59
2018	0	3418	502	2233	598	222	13
2019	10	1514	10556	59	484	90	60
2020	21	1936	1190	3392	364	518	180
2021	132	544	2863	556	1788	53	337
2022	0	5552	530	557	196	655	74

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
2022*	1913	2403	0	0	0	0	0

*** Data calculated using estimates from discard observer trips.**

Table 7.3.6. Haddock in 6.b. International catch (landings and discards) numbers- (*10³) at-age.

	Age						
Year	1	2	3	4	5	6	7
1991	21 186	33 847	15 189	5 341	1 704	346	522
1992	16 084	24 711	18 584	5 361	1 761	676	206
1993	11 178	19 375	15 494	4 938	1 617	461	359
1994	8 170	20 623	17 868	8 209	2 449	476	232
1995	2 749	9 831	21 584	9 756	2 464	787	79
1996	12 096	18 811	10 911	9 612	3 299	751	92
1997	9 957	10 535	5 388	4 098	5 002	1 758	206
1998	14 224	19 807	10 173	4 763	3 740	2 767	1 391
1999	17 282	21 949	12 203	5 499	3 419	2 684	2 776
2000	8 222	12 581	10 698	4 917	2 050	1 498	2 066
2001	7 669	2 013	1 699	821	1 041	477	570
2002	13 363	11 119	4 537	2 445	898	260	444
2003	6 576	23 606	14 568	2 065	1 286	927	602
2004	932	4 112	10 282	9 212	1 386	296	474
2005	1 061	3 723	7 420	8 124	753	109	193
2006	2 880	1 475	1 626	2 414	2 291	436	151
2007	1 489	9 829	3 630	1 514	2 227	1 827	720
2008	476	2 207	11 437	1 291	507	964	930
2009	223	707	1 237	8 046	495	263	504
2010	152	534	1 064	2 087	4 096	276	296
2011	4	59	75	183	181	2 579	249
2012	5	6	144	58	3	35	428
2013	4 896	98	101	86	39	84	565
2014	406	3 008	418	52	138	47	679
2015	80	2 973	3 387	104	7	61	112
2016	374	1 051	2 639	988	3	2	11
2017	1 194	1 670	1 802	2 191	1 207	58	59
2018	88	6373	504	2273	598	222	13
2019	288	1995	10866	67	560	90	60
2020	264	2202	1190	3392	364	518	180
2021	2931	2101	3202	628	1862	53	337
2022	1915	7957	680	557	196	655	74

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
2022	-	0.431	0.748	0.793	0.960	0.909	0.978

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	-	-
2022	0.176	0.293	-	-	-	-	-

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
2022	0.176	0.389	0.663	0.793	0.960	0.909	0.978

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
2022	0.017	0.175	0.387	0.575	0.770	0.895	1.150	1.420

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
2022	418.32	88402.78	5578.53	361.66	675.41	220.91	633.09	34.61

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
2022	20636.35	35487560.46	422730.285	1937.151	7607.51	1139.978	11749.649	20.214

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
2022	19339.26	1171863.78

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
2022	32	30	36.25	88

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
2022	1722	1934	2146	37	0.99	4085	1040	1	5181

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 2022. There are two Scottish OTB_DEF>=120 due to landings being submitted by subdivision.

Figure 7.3.3. Haddock in Division 6.b. ICES estimated landings and discards (for 2022) 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 unsampled landings and sampled and raised (unsampled) discards for 2022, 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 and stock.

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. Spatial distribuion of survey catch rates of juvenile haddock (<= 25 cm).

Figure 7.3.13. Haddock in Division 27.6.b. Comparison of survey biomass indices calculated over various age ranges with SSB (assumed ages 3+ - red).

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. Length-based indicator: mean length of fish in the catch. The exploitation status is below $F_{MSY\ proxy}$ when the mean length is higher than the MSY proxy reference length (blue line).

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8 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 2023

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 2648 tonnes.

ICES advice applicable to 2024

ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2263 tonnes.

8.1 General

Stock descriptions and management units

The stock and management units are both ICES Division 7.a (Irish Sea). Landings 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. The minimum landing size for haddock in the Irish Sea is 30 cm.

Landings obligation

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) are covered by the Landings Obligation. In UK waters All quota species must now be landed, however, these will no longer be taken into account when enforcing catch composition rules (DEFRA, 2023).

Fishery in 2022

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

The fishery in 2022 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 was in decline but since 2014 there has been a slight increase in activity due to abundance of the haddock stock and increased fishing opportunity. However, this continues to be pursued by a small number of vessel (<15). A proportion of the TAC is taken as bycatch in the *Nephrops* fishery in a mixed fishery.

In 2022, the uptake of TAC was 65%. The primary two nations exploiting the stock are the UK and Ireland. The UK used 54% of quota allocation whilst Ireland used 104%. 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. In 2022, this relocation was greater than the catch from the other rectangles in 7a. Table 8.1 gives nominal landings of haddock from the Irish Sea (Division 7.a) as reported by each country to ICES since 1984.

Data

The NIMIK survey [I9826] was not available for 2022 and there are lower sampling levels for some fleets which commonly discard haddock. Recent discard rates were used to estimate these unsampled catches. Sensitivity analyses indicated that this has minimal impact on the perception of the stock status.

Landings

Table 8.2 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 8.3. Sampling levels were not considered adequate to derive catch age compositions in 2003.

Discards

Annual discard data were updated for Northern Ireland. A linear model of discards per unit of effort (Kg/kW hour) was applied to estimate the discards of the Irish vessel. Sensitivity of the assessment to this method was explored by increase in the coefficient of variation assumed for the annual catch estimate within the model setup, results below. 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. The recent 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 (Table 8.4). The stock weights-at-age are given in Table 8.5.

Surveys

The survey data considered in the assessment for this stock are given in Table 8.6. 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 1992–2022). Acronym NIGFS-WIBTS-Q1.
- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2022). 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 2004–2022, the survey was not conducted in 2014).

In 2022 the UK (NI) Methot-Isaac Kid (NI MIK) net survey was not carried out. Experts from the survey deemed that due to survey timing it was unlikely that the survey provided a reliable indication of recruitment. In order to examine the robustness of the survey to this missing data sensitivity analysis was performed by using geometric mean, 5th percentile estimates, 95th percentiles estimates and comparison with the assessment treating the value as missing. The results indicated that assessment, specifically the estimate of age 0 fish was robust to the missing data. All outputs showed similar trends and the assessment tended toward lower estimates of age 0 similar to the 5th percentile assumption, results below. The relative log standardised indices for cohorts are plotted against time in Figure 8.1. Whilst ages 2 to 4 appear to show strong signal in the UKFspW the ability to detect the year class in age 5 haddock is less clear. The strong 2013 year class could be tracked in all indices, indicating that the different surveys are capturing the prominent year-class signals in this stock (Figure 8.1). Correlation between survey indices by age is positive for all surveys and show high consistency within each survey (Figure 8.2). 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 8.1).

8.2 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 & 2022
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); 2022 (0.175).

Option	Setting
Catch effective sample size	1993–2000 (50); 2003–2006 (1); 2007–2019 (50); 2020 (1); 2021–2022 (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 2013–2022, as applied in 2018 and with a lower starting value for selection of age 0 haddock in the final selectivity block. Additionally, there was an increase in the CV on catch due to the reduced sampling of at-sea catch for some fleets in 2022. Hence the changes as described in the stock annex were followed. Discards were combined with the landings as catch in the model.

Figure 8.3 shows the residuals of the model-fit to catch-at-age data.

Figure 8.4 shows the predicted and observed catch. The catch information from 2007 to present is regarded as the most confident, during 2003–2006 it is regarded that catch and sampling information is of relatively lower quality due to lack of sampling opportunity. Before 2003, the catch series is regarded as of intermediate confidence. The model has close fit to the current observed catch 2011–present. Before this time, there is consistent over estimation of the catch 2000–2011 following a period of consistent underestimation of catch 1993–2001. Figure 8.5 shows the residuals of the catch proportions-at-age. For all ages there appears to good fit with no consistent pattern, however, there are some large deviations from observed and predicted for age 5 fish since 2015. Figure 8.6 shows that the catch is dominated by fish <4 years, therefore the large residuals for fish of age 5 are likely to result from low sampling and small contribution of 5+ fish to the stock. The fishing pressure (F)-at-age is shown in Table 8.7.

The residuals of the indices are shown in Figure 8.7. 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 8.8 shows the residuals of the survey proportions-at-age. For all indices there is close fit between the observed and model predicted fit for fish up to four years old. The largest deviations occur in five year old fish in the UKFSPW survey, which over-reported five year old fish prior to 2014.

Figure 8.9 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 8.8.

Comparison with previous assessments

Figure 8.10 shows the comparison of the current assessment with previous ASAP and model. There is close agreement with the stock trends of the current assessment and the previous assessment. Mohn's Rho values were calculated for five retrospective runs 2021–2017 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 2022.

With low recruitment in 2020–2022, the SSB is further projected to decline in 2023 and 2024 and 2023.

8.3 Short-term projections

Short-term projections were performed using FLR libraries. Recruitment for 2023–2025 was estimated at 351 715 thousand (GM 1993–2020). The F used in the forecast for 2023 was derived as F_{sq}= $F_{average}$ (2019–2022), 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 8.9. The management options output is given in Table 8.10.

Estimates of the relative contribution of recent year classes to the 2024 landings and 2025 SSB are shown in Figure 8.11. The contribution to landings in 2024 consists mainly of the 2019 cohort (80%), with the SSB in 2025 largely be dependent on the 2020 cohort, comprising 62% of the SSB and both the 2021 cohort and assumed recruitment in 2023 each contributing 17%. This is an issue as the SSB will largely consist of the plus group.

8.4 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 8.11; 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.

8.5 Management plans

There is no specific management plan for haddock in the Irish Sea. The regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan due to potential for bycatch of cod in a fishery targeting haddock (Council Regulation (EC) 1342/2008).

8.6 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. For the first time in the time-series used in the assessment the reallocated catch is greater than the catch estimated for the Irish Sea catch. 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 23.0% of trips are observed and 2.4% of the main *Nephrops* targeted fishery trips observed. Some fleets which commonly discard haddock were not sampled in 2022. For these fleets recent discard rates were used to estimate these unsampled catches. Sensitivity analyses indicated that this has minimal impact on the perception of the stock status.

Sensitivity runs of model assuming different levels of confidence in the catch data to reflect higher uncertainly in catch estimates due to missing sampling data. The results show that the model is robust to the increasing the coefficient of variation with negligible change on the estimate numbers-at-age (Age 0 and Age 1) estimated by the model.

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. The NIMIK survey [I9826] was not available for 2022 sensitivity analyses indicated that this has minimal impact on the perception of the stock status.

Age 0 model estimates under different assumptions of the NI-MIK net survey. Sensitivity analysis of to examine robustness of model estimates due to missing recruitment survey index.

8.7 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 from separate targeting and non-targeting fisheries should be considered. Ecosystem based indicators of productivity should be investigated to allow progress toward Ecosystem Based Fisheries Management. There has been increasing uncertainty of 'older' (age 5 fish), contributing to a 'high' retrospective pattern; with the model predicting more older fish than observed in the fishery data. This may in part be due to the post-2020 change in fleet behaviour with a decline in the directed fishery. The stock definition should be revised to reflect the understanding that the southern rectangles of the Irish Sea are considered part of the Celtic Sea haddock stock,

8.8 References

DEFRA, 2023. Landing obligation general requirements.

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

ICES. 2018. EU request to ICES to provide plausible and updated FMSY ranges for the stocks of species inhabiting western EU waters. In Report of ICES Advisory Committee, 2018. ICES Advice 2018, sr.2018.04. 11 pp. https://doi.org/10.17895/ices.pub.4149.

Table 8.1. Landings (t) of haddock in Division 7.a, 1984–present, as officially reported to ICES. (Working Group figures are given in Table 8.2).

Year	Belgium	France	Ireland	Netherlands	UK (England & Wales)*	UK (Isle of Man)	UK (N. Ire-land)*	UK (Scot-land)**	United King-dom**	Total
1984	3	38	199	0	29	2	38	78	-	387
1985	4	31	341	0	28	5	215	104	-	728
1986	5	39	275	0	22	4	358	23	-	726
1987	10	50	797	0	41	3	230	156	-	1287
1988	12	47	363	0	74	3	196	52	-	747
1989	4	0	215	0	252	3	-	86	-	560
1990	4	0	80	0	177	5	-	316	-	582
1991	1	0	254	0	204	11	-	143	-	613
1992	8	73	251	0	244	13	-	114	-	703
1993	18	41	252	0	260	19	-	140	-	730
1994	22	22	246	0	301	24	-	66	-	681
1995	32	58	320	0	294	27	-	110	-	841
1996	34	105	798	1	463	38	-	14	-	1453
1997	55	74	1005	14	717	9	-	51	-	1925
1998	104	86	1699	10	1023	13	-	80	-	3015
1999	53	n/a	759	5	1479	7	-	67	-	2370
2000	22	49	1238	2	1061	19	-	56	-	2447
2001	68	184	652	0	1238	1	-	86	-	2229
2002	44	72	401	0	551	0	-	47	-	1115
2003^	20	146	229	0	248	0	-	31	-	674
2004	15	20	296	0	421	0	-	9	-	761
2005	22	36	139	0	344	0	-	6	-	547
2006	23	20	184	0	419	0	-	9	-	655
2007	30	11	477	0	559	0	-	1	-	1078
2008	15	6	319	0	521	1	-	17	-	879
2009	7	3	388	0	446	1	-	1	-	846

Year	Belgium	France	Ireland	Netherlands	UK (England & Wales)*	UK (Isle of Man)	UK (N. Ireland)*	UK (Scotland)**	United Kingdom**	Total
2010	9	2	333	0	593	0	-	2	-	939
2011	16	8	434	0	355	0	-	-	-	813
2012	13	3	562	0	-	0	-	-	236	814
2013	6	1	492	0	-	0	-	-	155	654
2014	7	0	541	0	-	0	-	-	426	974
2015	7	7	507	0	-	0	-	-	634	1155
2016	5	1	646	0	-	1	-	-	825	1478
2017	5	5	1115	0	-	15	-	-	1240	2380
2018	4	0	951	0	-	3	-	-	1611	2569
2019	9	0	1347	0	-	0	-	-	1197	2553
2020	4	0	759	0	-	0	-	-	531	1294
2021***	3	0	1162	0	-	0	-	-	884	2049
2022***	7	0	1051	0	-	0	-	-	656	1714

*** From 1989 to 2011, Northern Ireland is included with England and Wales.**

**** Since 2012, Northern Ireland, Scotland, England, and Wales have been combined to UK.**

***** Preliminary official landings.**

^ Underestimate or low confidence due to inadequate sampling.

Table 8.2. 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
2022	1714	851	345	1196	28%	865

Table 8.3. Haddock in 7.a: Catch numbers-at-age.

	Age					
	0	1	2	3	4	5
1993	790	1568	2066	19	1	1
1994	16857	821	258	922	3	2
1995	950	8079	1587	107	220	5
1996	15171	1380	5510	728	16	30
1997	347	8828	1528	2388	201	16
1998	4209	4642	10532	252	488	42
1999	4944	3200	3436	4773	25	57
2000	287	11118	1771	466	457	418
2001	7883	425	3246	1074	30	89
2002	2105	8229	789	2063	142	18
2003	2000	2000	400	800	50	25
2004	10797	2056	421	827	46	78
2005	6048	4342	1416	285	193	34
2006	5334	2971	656	524	63	51
2007	2282	3537	3371	671	60	47
2008	2158	4569	2052	837	242	36
2009	4327	2490	2021	629	121	36
2010	3933	4058	834	464	309	59
2011	5669	2324	942	239	97	52
2012	6235	2799	774	201	27	28
2013	4525	1162	558	156	41	17
2014	1392	3854	1265	189	17	10
2015	518	1915	3087	324	63	5
2016	512	1845	907	1079	109	108
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
2022	265	1837	259	919	996	153

Table 8.4. Haddock in 7.a. Proportion mature 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
2022	0	0.02	0.762	1	1	1

Table 8.5. 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
2022	0.033	0.067	0.161	0.319	0.517	0.834

***Average weights 2017–2019**

Table 8.6. Haddock in 7.a: available tuning data.

NIGFS-WIBTS-Q1

Year	1	2	3	4	5
1993	**139**	**569**	**31**	**0**	**0**
1994	644	58	183	0	0
1995	24823	437	0.1	43	0
1996	1065	3743	67	3	1.1
1997	25118	474	1457	44	2.1
1998	3913	8694	70	105	1.1
1999	6058	680	2072	16	11.1
2000	14028	1853	64	147	5
2001	3277	6990	770	40	20.1
2002	28755	842	1059	78	1.1
2003	6966	14162	341	356	26.1
2004	19945	2379	2206	45	35.1
2005	24488	6454	406	234	15
2006	13444	12721	2194	91	33.1
2007	20918	11325	3661	240	27
2008	7480	12009	2559	495	48.1
2009	9345	3888	2877	163	42
2010	17058	1765	524	239	27
2011	17278	5543	299	67	50
2012	13509	5266	1095	38	13
2013	8245	5202	751	119	20
2014	33807	2260	773	108	22
2015	15495	22420	1297	407	44
2016	14418	9109	5594	205	38
2017	4321	18887	5524	323	33
2018	7897	4683	7086	1709	1369
2019	38570	6789	814	832	183
2020	16709	28889	2571	260	257
2021	2478	17391	6691	551	41
2022	12070	23028	10823	3603	23

NIGFS-WIBTS-Q4

0 4

Year	0	1	2	3	4
1994	36.127	0.716	3.965	0	0
1995	2.042	151.766	1.171	0.959	0
1996	15.289	101.536	0.753	0	0.045
1997	1067.99	13.327	13.2	0.092	0.001
1998	160.434	398.722	1.81	0.886	0.04
1999	365.679	10.521	39.889	0.08	0.034
2000	685.913	28.002	0.527	1.633	0.001
2001	59.867	93.66	5.533	0.125	0.104
2002	584.902	19.354	28.408	0.947	0
2003	146.491	105.115	1.18	3.372	0
2004	552.309	59.354	30.746	0.295	0.27
2005	666.652	167.224	7.422	4.911	0.001
2006	476.2	122.094	12.378	0.264	0.052
2007	387.556	111.692	35.717	2.228	0.441
2008	94.667	102.086	37.1	11.654	0.375
2009	88.61	46.338	23.832	1.991	0.33
2010	451.303	45.695	6.139	4.891	0.23
2011	219.533	82.392	5.858	1.752	0.973
2012	207.925	42.145	7.808	1.044	0.093
2013	165.294	79.593	12.05	1.275	0
2014	1004.22	8.279	1.531	0.179	0
2015	339.218	311.607	68.768	3.016	0.423
2016	455.385	81.189	108.663	2.309	0.362
2017	99.046	154.865	52.207	4.273	0.281
2018	191.946	42.885	90.324	15.934	6.202
2019	690.663	167.338	12.891	16.507	2.003
2020	21.174	179.518	169.383	8.19	0.58
2021	133.3	1209	50	13.2	0.66
2022	75.4	146.5	20.5	63.3	8.7

NIMIK

0 0

Year	Value
1994	**47000**
1995	1700
1996	47800
1997	14500
1998	2500
1999	15400
2000	1700
2001	17100
2002	1200
2003	4250
2004	25970
2005	8250
2006	40240
2007	3820
2008	6638
2009	18540
2010	4532
2011	6606
2012	9818
2013	28325
2014	12892
2015	48463
2016	1800
2017	26900
2018	30954
2019	23942
2020	NA
2021	16800
2022	NA

FSP Haddock

0 5

Year	1	2	3	4	5
2005	**0**	**1.774**	**1.506**	**4.981**	**0.291**
2006	0.308	7.749	7.336	0.546	1.115
2007	0.208	42.727	37.286	6.289	0.697
2008	0	4.657	12.836	7.213	0.794
2009	0	0.662	3.99	1.443	0.541
2010	0.627	1.422	3.78	2.753	0.866
2011	0.048	0.598	1.976	1.121	0.81
2012	0.27	4.135	4.772	0.79	0.226
2013	0.035	3.684	7.674	1.742	0.176
2014	NA	NA	NA	NA	NA
2015	0.437	31.2	19.349	5.051	0.554
2016	0	0	59.769	12.592	6.205
2017	0	19.748	85.536	246.488	10.838
2018	0	0	36.397	62.861	55.448
2019	0.339	4.357	25.291	40.261	22.519
2020	0	0	26.759	16.887	16.539
2021	0	0	43.95	18.27	14.03
2022	0	40.60	84.51	10.46	0

Table 8.7. Haddock in 7.a: F-at-age.

	Age					
	0	1	2	3	4	5
1993	0.033	0.403	0.889	0.944	0.947	0.947
1994	0.043	0.523	1.153	1.224	1.228	1.228
1995	0.039	0.479	1.056	1.121	1.125	1.125
1996	0.025	0.312	0.688	0.730	0.733	0.733
1997	0.029	0.350	0.772	0.820	0.822	0.823
1998	0.032	0.396	0.873	0.927	0.929	0.930
1999	0.046	0.564	1.243	1.320	1.324	1.324
2000	0.031	0.378	0.832	0.883	0.886	0.886
2001	0.126	0.421	0.754	0.810	0.569	0.405
2002	0.159	0.532	0.955	1.025	0.719	0.512
2003	0.131	0.436	0.783	0.840	0.590	0.420
2004	0.128	0.429	0.769	0.825	0.579	0.412
2005	0.106	0.355	0.637	0.684	0.480	0.342
2006	0.061	0.202	0.363	0.389	0.273	0.195
2007	0.101	0.339	0.607	0.652	0.458	0.326
2008	0.152	0.537	0.615	0.583	0.319	0.155
2009	0.118	0.417	0.477	0.453	0.248	0.120
2010	0.175	0.619	0.708	0.671	0.368	0.178
2011	0.094	0.333	0.381	0.361	0.198	0.096
2012	0.099	0.351	0.402	0.381	0.209	0.101
2013	0.008	0.074	0.132	0.132	0.132	0.132
2014	0.011	0.097	0.171	0.171	0.171	0.171
2015	0.010	0.085	0.150	0.150	0.150	0.150
2016	0.006	0.057	0.101	0.101	0.101	0.101
2017	0.008	0.073	0.130	0.130	0.130	0.130
2018	0.010	0.093	0.164	0.164	0.164	0.164
2019	0.011	0.099	0.175	0.175	0.175	0.175
2020	0.005	0.044	0.077	0.077	0.077	0.077
2021	0.010	0.086	0.153	0.153	0.153	0.153
2022	0.007	0.067	0.118	0.118	0.118	0.118

Table 8.8. 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			SSB			Landings	Discards*	F 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
1993	46832	67251	87670	1151	1737	2323	813	365	0.55	0.93	1.31
1994	731847	890768	1049689	715	1262	1808	1042	468	0.64	1.20	1.76
1995	46093	73956	101819	325	798	1272	1736	780	0.63	1.10	1.57
1996	1129332	1393716	1658100	4279	5489	6700	2981	709	0.47	0.72	0.97
1997	147461	207507	267554	3331	4904	6477	3547	895	0.49	0.80	1.12
1998	251585	331688	411792	6889	8770	10652	4874	1015	0.64	0.91	1.18
1999	525383	653933	782484	4343	5918	7494	4095	634	0.86	1.29	1.73
2000	59400	91317	123233	1871	2852	3834	1357	802	0.51	0.87	1.22
2001	516593	651835	787077	2793	3924	5055	2246	269	0.47	0.71	0.95
2002	82436	119880	157323	1894	2866	3837	1817	387	0.56	0.90	1.24
2003	300032	407101	514170	2247	3250	4253	1517	390	0.44	0.74	1.03
2004	494449	634904	775360	1458	2414	3370	1217	392	0.41	0.72	1.04
2005	380613	485551	590490	1434	2285	3135	666	551	0.34	0.60	0.87
2006	447566	554086	660606	2040	2972	3904	633	306	0.192	0.34	0.49
2007	166054	215881	265708	2912	3954	4996	886	722	0.37	0.57	0.77
2008	112226	150358	188490	2944	4057	5170	786	643	0.33	0.51	0.68
2009	252066	322565	393064	2330	3483	4637	581	579	0.25	0.39	0.54
2010	183079	238382	293685	1901	2978	4056	679	508	0.36	0.58	0.81
2011	226397	292905	359414	1628	2644	3661	446	307	0.187	0.31	0.44
2012	206395	280407	354418	1852	2902	3952	343	599	0.197	0.33	0.46
2013	1094738	1370255	1645772	2384	3693	5001	254	282	0.076	0.132	0.188
2014	470789	617220	763652	3507	5105	6702	518	488	0.103	0.171	0.24
2015	701963	913075	1124186	8105	10802	13498	833	652	0.093	0.150	0.21
2016	206232	289283	372334	10832	14350	17868	1008	298	0.063	0.101	0.139
2017	272997	378792	484587	13867	18333	22799	1662	333	0.081	0.130	0.179
2018	696127	940853	1185578	14017	18753	23490	1993	568	0.100	0.164	0.23

Year	Recruitment			SSB			Landings	Discards*	F 2–4		
	Low	Value	High	Low	Value	High			Low	Value	High
2019	453540	637249	820958	11162	15536	19909	1778	672	0.103	0.175	0.25
2020	82037	137003	191969	10407	14695	18984	742	177	0.042	0.077	0.113
2021	189091	297015	404938	10973	15482	19991	1219	672	0.087	0.153	0.22
2022	21096	61276	101456	8226	12199	16172	851	345	0.060	0.118	0.175
2023		351715**			12539						

*** Discards estimates available since 2007, prior to 2007 discards estimates are based on limited sampling.**

****Geometric mean recruitment 1993–2020.**

Table 8.9. Forecast input data.

Variable	Value	Source	Notes
F ages 2–4 (2023)	0.148	ICES (2023)	Fsq = $F_{average(2019-2022)}$ excluding 2020
SSB (2024)	9888	ICES (2023)	Short-term forecast
R age 0 (2023 and 2024) (thousand)	351715	ICES (2023)	Geometric mean (1993–2020)
Catch (2023)	1496	ICES (2023)	Short-term forecast, fishing at F_{sq}
Wanted catch * (2023)	1235	ICES (2023)	Average discard rate (2019–2021)
Unwanted catch *(2023)	261	ICES (2023)	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 8.10. Haddock in Division 7.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change*	% advice change**
ICES advice basis									
MSY approach: F_{MSY}	2263	1807	456	0.28	0.162	0.118	7073	-28	-15
Other scenarios									
EU MAP***: F_{MSY}	2263	1807	456	0.28	0.162	0.118	7073	-28	-15
EU MAP*** $F_{MSY\ lower}$	1671	1338	333	0.20	0.116	0.084	7613	-23	-37
EU MAP*** $F_{MSY\ upper}$	2749	2191	558	0.35	0.20	0.147	6633	-33	3.8
F = 0	0	0	0	0.000	0.000	0.000	9159	-7.4	-100
F = F_{pa}	3143	2500	643	0.41	0.24	0.172	6278	-37	19
F = F_{lim}	3698	2934	764	0.50	0.29	0.21	5783	-42	40
$SSB_{2025} = B_{lim}$	6974	5413	1561	1.23	0.72	0.52	2994	-70	163
$SSB_{2025} = B_{pa}$	5565	4367	1198	0.86	0.50	0.36	4160	-58	110
$SSB_{2025} = SSB_{2024}$^									
SSB_{2025} = MSY $B_{trigger}$	5422	4259	1163	0.83	0.48	0.35	4281	-57	105
F = F_{2023}	1017	816	201	0.118	0.068	0.050	8214	-17	-62

*** SSB 2025 relative to SSB 2024.**

**** Advice value for 2024 relative to the F_{MSY} advice value for 2023 (2648 tonnes).**

***** EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

^ The $SSB_{2025} = SSB_{2024}$ option is left blank because it cannot be achieved in 2025 even with zero catches in 2024.

Table 8.11. 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 (2018)
	F_{MSY}	0.28	Median point estimates of EqSim with segmented regression stock–recruitment relationship	ICES (2018)
	$F_{MSYLower}$	0.20	F at 95% of MSY below F_{MSY}	ICES (2018)
	$F_{MSYUpper}$	0.35	F at 95% of MSY above F_{MSY}	ICES (2018)
Precautionary approach	B_{lim}	2994 tonnes	Lowest observed SSB with >75th percentile recruitment	ICES (2018)
	B_{pa}	4160 tonnes	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$	ICES (2018)
	F_{lim}	0.50	F with 50% probability of SSB <B_{lim}	ICES (2018)
	F_{pa}	0.41	$F_{p0.05}$; the F that leads to SSB>B_{lim} with 95% probability	ICES (2018)
Management plan	SSB_{MGT}	Not applicable		
	F_{MGT}	Not applicable		

Figure 8.1. Haddock in 7.a: Trends in log-standardised survey indices by cohort.

UKFspW
age 4 vs 5
age 3 vs 4
age 3 vs 5
age 2 vs 3
age 2 vs 4
age 2 vs 5
log index
log index

NIGFS-WIBTS-Q1
age 3 vs 4
age 2 vs 3
age 2 vs 4
age 1 vs 2
age 1 vs 3
age 1 vs 4
log index
log index

Figure 8.2. Haddock in 7.a: Scatterplot matrix of log indices of cohorts at different ages.

Figure 8.3. Standardised residuals from fitted and observed catch age proportions.

Figure 8.4. Fitted and observed catch from update assessment.

Figure 8.5. Fitted and observed catch age proportions from update assessment.

Figure 8.6. Observed catch numbers 2008–present.

Figure 8.7. Fitted and observed index series from update assessment.

Figure 8.8. Fitted and observed index age proportions from update assessment.

Figure 8.9. Retrospective plot the final update model.

Figure 8.10. Haddock in Division7.a. Historical assessment results.

Figure 8.11. Haddock in 7a. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

9 Haddock in divisions 7.b,c,e–k

Type of assessment in 2023

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 2023 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 2023

Last year's full advice is available in the Report of the ICES Advisory Committee, 2022. ICES Advice 2022, had.27.7b–k.

https://doi.org/10.17895/ices.advice.19447961.v1

The headline advice was as follows:

"ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 11 901 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by some of the relevant management authorities for this stock."

9.1 General

Stock description and management units

The basis for the stock assessment area 7.b,c,e–k is described in detail in the stock annex.

Figure 9.1 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).

2023 management (Council Regulation (EU) 2023/194)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0194

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7b-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	114	Analytical TAC Article 7(2) of this Regulation applies	
France	6 823		
Ireland	2 275		
Union	9 212		
United Kingdom	2 142		
TAC	11 901		

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.

9.2 The fishery

The official landings reported to ICES are given in Table 9.1. 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 three years uptake by France has reduced to around 50%. The UK quota share has increased substantially due to Brexit.

Figure 9.1 shows the distribution of international landings between 2016 and 2020. Most haddock landings were taken from the northern North Sea, Irish sea, Rockall and from the Celtic Sea.

Figure 9.2 shows a longer time-series of official landings and TAC. The time-series is characterized by a number of peaks with rapid increases in the landings, mostly followed by rapid decreases within a few years, suggesting the fishery was taking advantage of sporadic events of very high recruitment. During the 1960s and 1970s, three such peaks in landings occurred: the landings increased from less than 4000 t to 10 000 t or more. During the 1980s and early 1990s, landings were relatively stable around 2000–4000 t. During the mid-1990s the haddock landings increased again to over 10 000 t, mirroring increased landings in the Irish Sea in that period. Since the late 1990s the landings have varied between 7000 and 10 000 t and in 2012, the landings were the highest on record at more than 18 000 t.

Working Group estimates of the landings and discards are given in Table 9.2 and shown in Figure 9.3. 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 9.3 and Figure 9.4 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.

9.2.1 Information from the industry

No updated information from industry was received.

9.3 Data

9.3.1 Landings and discard numbers-at-age

Sampling levels have varied between countries in 2022. There was no OTB_CRU discard sampling data from Ireland in 2022 so discards were estimated using an overall discard ratio for 2022.

Discard and retained catch at age distributions are shown in Figure 9.5. Many of the discarded fish will be above the MLS, which is likely to be the result of restrictive quota. The strong 2018 year class was mainly discarded in 2020 and is mostly retained in 2021 at age 3 and at age 4 in 2022.

Landings numbers-at-age are given in Table 9.4 and discard numbers-at-age are given in Table 9.5. 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 9.6 shows proportional representation of landings relative to catch (discards + landings) by age, 2002–2022. Discards account for a large proportion of the catch numbers up to age 3. There were no age 0 discards sampled in 2022. Figure 9.7 shows the proportions-at-age that are discarded. In 2022, it appears that older fish are also being discarded.

Sampled and un-sampled catch (landings and discards) by year are shown in Figure 9.8. Similar discard fill ins were made in 2022 and 2021.

Figure 9.9 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).

9.3.2 Biological

The assumptions of natural mortality and maturity are described in the stock annex. The maturity ogive used in the assessment is quite sharp, with 0.39% of 2 year olds and 91% of 3 year olds mature (stock annex).

9.3.3 Surveys and commercial tuning fleets

The available surveys and commercial tuning fleets are described in detail in the stock annex. One survey index is used in the assessment: the FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys. This is standardised following the VAST procedure (stock annex).

The index data are given Table 9.6. The standardised indices are given by year in Figure 9.10 and by cohort in Figure 9.11. Figure 9.12 shows the scatterplot matrices of the log indices. These plots indicate that the internal consistency of the indices is robust. Notably, there is a considerable reduction in the estimate of age 0 fish in the VAST index for 2022. This was investigated during the working group and as the spatial and temporal coverage of the two contributing surveys was consistent with previous years this is indicative of very low recruitment for 2022.

9.4 Historical stock development

Model used: SAM

Software used: Stock Assessment.Org (https://www.stockassessment.org)

9.4.1 Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\ had.27.7.b–k on the ICES SharePoint.

https://tinyurl.com/mvsucxtf

9.4.2 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 9.13 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 negative residuals occur for the older age classes in 2006. Observed and assessment predicted catches are shown in Figure 9.14. The predicted catches were generally accurate while there was a tendency for under estimation from 2011–2018. The predicted catch is higher in 2020 and 2021. The observed and predicted index catch at age values are shown in Figure 9.15. 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 9.16). The assessment generally follows the survey index trends in age classes across the time-series.

The SAM assessment is shown in Figure 9.17, detailing catch, landings, SSB F and recruits with 95% confidence intervals. As noted, the predicted catch is higher in 2020 and 2021. The 2022 model estimate of catch is closer to the observation although still overestimated somewhat. Fishing mortality and SSB estimates are very close to last year's assessment. The terminal F (0.417) remains above F_{MSY} (0.353). Recruitment is downscaled compared to last year's assessment.

9.4.3 State of the stock

Table 9.7 shows the estimated fishing mortality-at-age and Table 9.8 shows the stock numbers-at-age. The stock summary is given in Table 9.9.

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. In 2022, recruitment is estimated to be the lowest in the observed time-series. SSB has declined, while fishing mortality (F) has been above F_{MSY} for the entire time-series but also shows a declining trend.

9.5 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 224 539 in 2023 and 2024 respectively, (median resampled 1993–2022; thousands). The

short-term predictions are expected to give a reasonably reliable estimate of landings and discards in 2023 (assuming average F 2020–2022 and average discard patterns seen in 2020-2022).

Intermediate year assumptions are given in Table 9.10. The management options are given in Table 9.11.

9.6 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}	0.708	$F_{p0.5}$; 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)

9.7 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 MSY approach. Catch scenarios consistent with the MAP FMSY ranges are provided.

9.8 Uncertainties and bias in assessment and forecast

9.8.1 Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics. Catch sampling in 2022 is lower than in previous years but is considered sufficient to describe the stock.

9.8.2 Discards

Irish discards have been monitored since 1995. The number of trips sampled has varied considerably over time (between three and 62 trips per year). Sample numbers were particularly low in 1995, 1999–2002 and 2006. During the remaining years, the number of sampled trips was considered sufficient to give reliable estimates of discards. In 2022, there was no sampling of the OTB_CRU fleet, however this metier only accounts for ~2% of the overall discard rate internationally.

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.

9.8.3 Assessment bias

Figure 9.18 shows the retrospective of the SAM 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 2%. Recruitment has a relatively high Mohn's Rho at 38% 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 9.19) shows a reduction in estimated stock size for the 2023 assessment as a result of recent low recruitment and older year classes being removed from the stock.

9.9 Forecast

The 2018 cohort is projected to account for 27% the projected catch in 2024. This strong cohort was picked up by both the Irish and French quarter 4 surveys in 2018 but its contribution only accounts for 11% of SSB in 2025.

Figure 9.20 shows the assessment and forecast of the final SAM run for the F_{MSY} catch option leading to an SSB of 27 781 tonnes in 2024 and advised catch of 8252 tonnes.

The assumed recruitment in 2023 and 2024 used in the forecast would constitute a minor part of the projected catches in 2024 (11%) and approximately 43% of the SSB in 2025 (Figure 9.21).

9.10 Recommendation for next benchmark

9.10.1 Stock audit

The audit of the 2022 report did not raise any concerns.

9.11 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.

9.12 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 under-size as well as marketable fish is a serious problem for this stock, with approximately $^{2}/_{3}$ in catch numbers and almost half the catch weight has been discarded on average over the past decade. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the EU landings obligation.

The minimum landing size of haddock is 30 cm, which is approximately the same as the mean length of two-year old haddock in the Celtic sea. Because gadoids are caught in a mixed fishery, restrictive quota in recent years have led to increased discarding of marketable fish as well as already considerable discarding of undersized fish. Technical measures have been introduced to reduce discards of undersize gadoids (110 mm square-mesh panel in the *Nephrops* fisheries and 100 mm in the gadoid fisheries). It is not clear whether this is sufficient to reduce discard mortality of future cohorts. It is important that technical measures are fully implemented and their effectiveness in reducing discards and impact on commercial catches are monitored and evaluated.

9.13 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 9.1. 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%)	444 (22%)	52	7360	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%)		4526 (82%)	1559 (84%)	516 (62%)	170	6861	8329
2020	107 (88%)		3808 (53%)	2628 (109%)	543 (50%)	222	7308	10859
2021	155 (105%)		4249 (48%)	3379 (114%)	515 (21%)	149	8447	15000
2022	190 (130%)		3904 (45%)	3110 (107%)	587 (23%)	234	8025	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 9.2. 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	0	7656	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
2022	189	230	3915	3974	584	4	8895	1219	1049	505	2773	11668

*** 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 9.3. 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
2010	131	30.83	54	4.36	144	7.33	101	5.15	103.7

	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
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
2022	NA	NA	40	4.66	73	15.50	75	1.96	NA

Table 9.4. 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
2022	0	187	1067	2455	4952	317	175	176	82

Table 9.5. 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
2022	0	3498	2128	2216	1743	29	18	0	0

Table 9.6. Haddock in 7.b,c, e–k. VAST survey data.

Year \Age	0	1	2	3	4	5	6	7
2003	**32566.8**	**168667.4**	**12660.8**	**1235.7**	**1061.4**	**26.6**	**13.8**	**7.6**
2004	**102168.7**	**18255.1**	**19722.7**	**2178.7**	**867.8**	**531.7**	**677.5**	**10.0**
2005	**64218.1**	**29497.5**	**3533.0**	**6025.1**	**805.7**	**214.0**	**42.5**	**0.0**
2006	**31287.0**	**9633.3**	**5490.7**	**1366.5**	**1296.4**	**256.9**	**50.9**	**33.4**
2007	**276179.4**	**15126.1**	**3290.3**	**1910.0**	**666.8**	**791.0**	**98.6**	**14.8**
2008	**85803.0**	**51670.1**	**2284.3**	**625.9**	**746.6**	**264.7**	**673.2**	**183.4**
2009	**873023.0**	**18028.4**	**13219.7**	**554.1**	**358.8**	**284.1**	**340.2**	**159.1**
2010	**32333.8**	**293342.2**	**8440.9**	**4286.3**	**266.7**	**222.0**	**295.8**	**108.4**
2011	**18184.5**	**13104.5**	**64695.3**	**2279.2**	**1273.4**	**234.6**	**124.8**	**52.9**
2012	**7720.9**	**6446.3**	**3446.0**	**12965.2**	**718.2**	**609.3**	**97.6**	**54.3**
2013	**250025.6**	**2829.7**	**2531.1**	**1430.9**	**5336.1**	**384.0**	**355.5**	**49.0**
2014	**25340.1**	**58717.7**	**1003.6**	**862.3**	**997.3**	**1919.8**	**304.8**	**132.0**
2015	**121309.3**	**28329.0**	**15915.4**	**626.6**	**394.9**	**637.0**	**1112.1**	**81.5**
2016	**22299.9**	**48576.4**	**10644.7**	**5416.1**	**434.5**	**221.0**	**847.8**	**273.3**
2017	**74866.7**	**7486.3**	**14262.3**	**2593.6**	**933.3**	**103.9**	**14.4**	**193.0**
2018	**268042.4**	**10406.1**	**1530.2**	**2546.6**	**1493.8**	**720.1**	**27.3**	**31.4**
2019	**102089.3**	**130085.6**	**4111.5**	**992.3**	**1721.9**	**528.3**	**317.5**	**27.1**
2020	**31818.6**	**34905.9**	**47444.5**	**954.3**	**511.5**	**1106.9**	**1173.7**	**364.7**
2021	**79518.0**	**14083.0**	**11694.3**	**10863.5**	**257.2**	**84.6**	**295.1**	**151.4**
2022	**815.9**	**22911.7**	**5230.8**	**4388.5**	**5933.5**	**199.8**	**85.3**	**133.6**

Table 9.7. Haddock in 7.b,c, e–k. Fishing mortality- (F) at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993		0.339	0.733	0.58	0.577	0.566	0.55	0.608	0.608
1994		0.328	0.702	0.55	0.539	0.524	0.51	0.563	0.563
1995		0.323	0.694	0.548	0.535	0.518	0.504	0.557	0.557
1996		0.313	0.683	0.55	0.54	0.521	0.508	0.558	0.558
1997		0.327	0.724	0.61	0.621	0.609	0.602	0.657	0.657
1998		0.318	0.716	0.616	0.648	0.648	0.649	0.702	0.702
1999		0.299	0.676	0.58	0.616	0.62	0.624	0.668	0.668
2000		0.326	0.756	0.654	0.701	0.715	0.724	0.756	0.756
2001		0.332	0.785	0.686	0.749	0.767	0.785	0.811	0.811
2002		0.32	0.772	0.675	0.749	0.775	0.803	0.829	0.829
2003		0.307	0.743	0.661	0.744	0.822	0.868	0.895	0.895
2004		0.31	0.749	0.664	0.735	0.818	0.86	0.864	0.864
2005		0.304	0.718	0.603	0.625	0.658	0.658	0.649	0.649
2006		0.261	0.601	0.495	0.498	0.519	0.518	0.537	0.537
2007		0.247	0.578	0.482	0.465	0.471	0.465	0.489	0.489
2008		0.249	0.602	0.524	0.5	0.498	0.497	0.542	0.542
2009		0.229	0.566	0.523	0.516	0.52	0.521	0.577	0.577
2010		0.207	0.522	0.505	0.515	0.539	0.553	0.628	0.628
2011		0.187	0.478	0.49	0.523	0.569	0.603	0.708	0.708
2012		0.176	0.453	0.484	0.53	0.595	0.644	0.776	0.776
2013		0.165	0.423	0.449	0.491	0.554	0.606	0.751	0.751
2014		0.151	0.396	0.428	0.459	0.524	0.578	0.733	0.733
2015		0.137	0.364	0.411	0.439	0.501	0.563	0.729	0.729
2016		0.135	0.359	0.419	0.45	0.509	0.569	0.74	0.74
2017		0.131	0.356	0.428	0.476	0.539	0.589	0.755	0.755
2018		0.123	0.342	0.423	0.47	0.536	0.577	0.737	0.737
2019		0.105	0.298	0.39	0.45	0.524	0.571	0.73	0.73
2020		0.09	0.253	0.347	0.417	0.498	0.538	0.679	0.679
2021		0.09	0.25	0.35	0.44	0.547	0.599	0.749	0.749
2022		0.084	0.233	0.326	0.411	0.515	0.568	0.708	0.708

Table 9.8. 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	135139	49284	12924	4436	1236	371	302	190	88
1994	408464	44994	17191	3464	1551	441	137	116	101
1995	468616	138512	15403	4777	1243	596	173	55	85
1996	164157	159216	47852	4261	1717	476	240	70	56
1997	58453	55184	58643	12884	1518	657	193	101	52
1998	88306	19403	18952	16782	4029	522	240	72	55
1999	367468	29425	6799	5235	5784	1274	178	84	42
2000	351883	125163	10812	1947	1863	2055	448	65	45
2001	467324	117968	43638	2836	624	614	658	142	36
2002	978329	156492	40288	11275	867	187	193	197	54
2003	224539	335416	56889	9818	3667	242	61	59	75
2004	343755	77830	115564	15087	3070	1104	66	18	36
2005	238663	113954	29199	30356	4698	890	280	16	15
2006	190031	79218	38368	7813	9792	1551	284	89	11
2007	700929	65288	29810	11731	3075	3862	599	116	36
2008	395303	228380	25232	9471	4420	1298	1594	254	68
2009	2404545	131298	84465	7803	3563	1738	565	659	125
2010	195875	806757	52417	26935	2994	1402	702	235	308
2011	82791	67211	310200	17329	9949	1266	554	275	209
2012	59948	27918	29271	105022	6594	3803	502	204	168
2013	645850	20867	11685	11962	38936	2554	1373	179	116
2014	204782	213878	8924	4297	5564	14960	1014	501	95
2015	496234	71977	88053	3434	1725	2592	5823	397	195
2016	106100	170033	32571	33464	1364	722	1140	2213	196
2017	158270	35485	68974	13289	12722	532	290	447	775
2018	901919	49258	15320	25923	5627	4932	197	112	399
2019	305863	304398	19518	6217	10351	2324	1884	76	175
2020	165621	99169	134327	7329	2590	4201	952	702	83
2021	221242	56384	44750	58177	2905	1073	1622	387	277
2022	4880	74164	24617	20133	25834	1176	418	576	212

Table 9.9. 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	Fbar(3-5)	Low	High	TSB	Low	High
1993	135139	64803	281817	9187	6152	13718	0.574	0.393	0.84	19556	13796	27722
1994	408464	248039	672646	10860	7544	15635	0.538	0.386	0.748	32595	23844	44557
1995	468616	285601	768908	11463	8165	16093	0.533	0.393	0.723	46666	35342	61618
1996	164157	100903	267063	20989	15547	28337	0.537	0.401	0.719	45309	35908	57172
1997	58453	35927	95101	25376	19251	33451	0.613	0.476	0.79	34836	27571	44015
1998	88306	54188	143904	19834	15474	25423	0.637	0.504	0.805	25754	20833	31837
1999	367468	226401	596432	13082	10458	16364	0.605	0.481	0.761	26679	21281	33447
2000	351883	217640	568928	11825	9731	14369	0.69	0.565	0.844	34835	27653	43882
2001	467324	294369	741898	18672	14213	24530	0.734	0.602	0.896	41824	33432	52322
2002	978329	628446	1523007	23719	18526	30370	0.733	0.602	0.893	62235	49832	77724
2003	224539	150363	335306	27793	22224	34759	0.742	0.603	0.914	73009	57733	92326
2004	343755	232086	509153	39835	31383	50564	0.739	0.586	0.932	63155	52112	76538
2005	238663	160571	354735	28406	23141	34869	0.628	0.506	0.781	55258	46487	65683
2006	190031	126678	285067	23831	19805	28675	0.504	0.393	0.646	44934	38072	53032
2007	700929	472360	1040098	22223	18818	26244	0.473	0.371	0.602	66652	53549	82959
2008	395303	267311	584578	20853	17573	24745	0.508	0.411	0.627	74866	61252	91506
2009	2404545	1617034	3575580	32517	26354	40123	0.519	0.422	0.64	194861	144966	261929
2010	195875	126032	304424	39105	32868	46525	0.519	0.423	0.638	182859	141167	236865
2011	82791	56331	121679	98934	77129	126905	0.527	0.43	0.648	122767	98121	153602
2012	59948	39830	90228	71264	56675	89607	0.536	0.434	0.663	81525	66046	100632
2013	645850	436255	956144	45832	36812	57062	0.498	0.404	0.614	89213	72432	109882
2014	204782	135937	308495	29164	23938	35530	0.47	0.381	0.579	76389	63208	92318
2015	496234	336612	731551	41119	33332	50725	0.45	0.364	0.556	94640	77447	115650
2016	106100	71569	157292	38032	31517	45895	0.459	0.371	0.568	77537	64680	92950
2017	158270	102716	243872	44283	36767	53335	0.481	0.387	0.599	64828	54942	76493
2018	901919	600655	1354284	34674	29038	41403	0.477	0.382	0.595	97153	76897	122745
2019	305863	201221	464921	30858	26227	36306	0.454	0.36	0.573	111037	88073	139990
2020	165621	105608	259737	58388	45358	75161	0.421	0.321	0.551	88163	71053	109392
2021	221242	128731	380232	56215	43748	72234	0.446	0.33	0.602	80486	64260	100809
2022	4880	2062	11549	46369	35014	61408	0.417	0.292	0.596	61411	47036	80178

Table 9.10. Haddock in divisions 7.b,c,e–k. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 3–5}$ (2023)	0.417	$F = F_{Average\ (2020–2022)}$ rescaled to F_{2022}
SSB (2024)	27 904	Short-term forecast; in tonnes
$R_{age\ 0}$ (2023, 2024)	224 539	Median resampled (1993–2022); in thousands
Total catch (2023)	12 100	Short-term forecast; in tonnes
Projected landings (2023)	10 540	Short-term forecast, assuming average 2020–2022 landing pattern; in tonnes
Projected discards (2023)	1560	Short-term forecast, assuming average 2020–2022 discard pattern; in tonnes

*** Random resampling of a distribution may lead to different median estimates.**

Table 9.11. Haddock in divisions 7.b,c,e–k. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change*	% advice change^
ICES advice basis									
MSY approach: F_{MSY}	8252	6772	1480	0.35	0.30	0.051	30295	9.0	-30.7
Other scenarios									
EU MAP ^^: F_{MSY}	8252	6772	1480	0.35	0.30	0.051	30295	9.0	-30.7
EU MAP^^ $F_{MSY\ lower}$	5492	4532	960	0.22	0.189	0.032	33103	19.16	-53.9
EU MAP^^ $F_{MSY\ upper}$	11318	9208	2110	0.52	0.45	0.075	27233	-2.0	-4.9
F = 0	0	0	0	0	0	0	38627	39.0	-100
F_{pa}	14210	11457	2753	0.708	0.61	0.103	24327	-12.4	19
F_{lim}	21682	17024	4658	1.400	1.20	0.20	17176	-38.2	82
$SSB_{2025} = B_{lim}$	30536	22585	7951	3.11	2.66	0.45	9227	-66.8	157
$SSB_{2025} = B_{pa}$ = MSY $B_{trigger}$	26420	20168	6252	2.11	1.80	0.31	12822	-53.8	122
$F = F_{2023}$	9484	7758	1726	0.42	0.36	0.06	29082	4.68	-20.31
$SSB_{2025} = SSB_{2024}$	10670	8696	1974	0.483	0.413	0.07	27904	0.44	-10.3

*** SSB2025 forecast relative to SSB2024.**

^ Advice values for 2024 relative to the MSY value for 2023 (11 901 tonnes).

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

Figure 9.1. International haddock landings by ICES rectangle (all gears; 2016–2020, data from https://stecf.jrc.ec.europa.eu/data-dissemination).

Figure 9.2. Haddock in 7.b,c,e–k. Official ICES landings and TAC of haddock in 7.b–k.

Figure 9.3. Haddock in 7.b,c,e–k. ICES estimates of landings and quota by country.

Figure 9.4. Haddock in 7.b,c,e–k. Effort ('1000 h) 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 9.5. Haddock in 7.b,c,e–k. Discarding by number by age class (grey = landings, white = discards).

Figure 9.6. Haddock in 7.b,c,e–k. Proportional representation of landings relative to catch (discards + landings) by age.

Figure 9.7. Haddock in 7.b,c,e–k. Proportion of discards by age (left) and year (right).

Figure 9.8. Haddock in 7.b,c,e–k. Distribution sampled and unsampled the catches by country.

Figure 9.9. Haddock in 7.b,c,e–k. Raw stock weights-at-age (right) and the three-year running average stock weights (left).

Figure 9.10. 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 9.11. Haddock in 7.b,c,e–k. Log VAST standardised tuning fleets by cohort.

Figure 9.12. Haddock in 7.b,c,e–k. Scatterplot matrix of log indices of cohorts at different ages.

Figure 9.13. Haddock in 7.b,c,e–k. Residuals of the proportions-at-age in catch (upper) and survey (lower).

Figure 9.14. Haddock in 7.b,c,e–k. Observed (line) and predicted (x) catches.

Figure 9.15. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) catch-at-age.

Figure 9.16. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) VAST survey indices.

Figure 9.17. Haddock in 7.b,c,e–k. SAM assessment stock summary plots.

Figure 9.18. Haddock in 7.b,c,e–k. Retrospective analysis of the final SAM assessment run. Catch (top left), recruitment (top right), F (bottom left) and SSB (bottom right).

Figure 9.19. Haddock 7.b,c,e–k. Historical assessment results (final-year recruitment and SSB assumptions included). The assessment was benchmarked in 2020.

Figure 9.20. Haddock in 7.b,c,e–k. Assessment and forecast of the final SAM run. SSB (top), and F (middle) and recruitment (bottom).

Figure 9.21. 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.

10 Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)

Type of assessment in 2023

Update of 2022 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 2024

ICES advise that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 6150 tonnes and 7900 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 Article 7(2) of this Regulation applies	
Denmark	7	(1)			
Germany	7	(1)			
France	45	(1)			
Netherlands	35	(1)			
Union	102	(1)			
United Kingdom	2 621	(1)			
TAC	2 723				
(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	530	(1)		Analytical TAC Article 7(2) of this Regulation applies	
France	2 068	(1)			
Ireland	605	(1)			
Union	3 203	(1)			
United Kingdom	2 296	(1)			
TAC	5 499				
(1)	Special condition: of which up to 25 % may be fished in: United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).				

2023 TAC for 4 and 2.a (upper) and TAC for 6, EC waters of 5.b and International waters of 12 and 14 (lower).

In Division 6.a, the uptake of the 2022 TAC for ICES Division 6 and EU waters of 5.b was just 17.2%. The small uptake was mainly due to poor utilisation of quota by France and the UK, managing only 3.7 and 22% respectively. In division 4.a, the uptake of the TAC for Area 4 and 2.a was 52%. The majority of available TAC (96%) is allocated to the UK, who take 49% of it.

Fishery in 2022

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 ICES landings estimate for 6.a and 4.a. is 2420 tonnes and 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. ICES landings are estimated from InterCatch and, if unavailable, we use official estimates. There are often minor differences between official data and InterCatch.

Discards

Discard data were made available by Ireland, Scotland and France and total discards were estimated to be 87 tonnes or 3.5% by weight for the stock area in 2022. Over the last nine years, total discard estimates have been reasonably consistent at around 5–10%, so this is a slightly lower discard percentage than historically, and is due to lower discards from the OTB_CRU métiers.

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 2022 catch by main gear type in InterCatch is given below:

Catch	Landings			Discards		
	Finfish trawls	*Nephrops* trawls	2507 tonnes	Finfish trawls	*Nephrops* trawls	2507 tonnes
2507 tonnes	99%	< 1%	1.6%	99%	< 1%	<1%
		2420 tonnes			87 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

A shortened Sco-IBTS-Q1 (G1022) survey in 2022 resulted in zero megrim catches, as the area that was surveyed was outside the expected megrim habitat and historically has minimal catches. The 2022 value of zero for the index was removed from the assessment. The model was shown to not be sensitive to this adjustment.

Figures 10.1 to 10.5 present the megrim biomass maps for the SIAMISS and IBTS surveys. The SIAMISS bubble plots (G3745 and G1794) show steady megrim abundance throughout the area over the time-series. Figures 10.2. (Sco-IBTS-Q3 (G2829) 4.a) and 10.3 (Sco-IBTS-Q1(G1022) 4.a) show the biomass in the northern North Sea. Biomass in the southern North Sea remains quite low. The Sco-IBTS-Q1 survey in 2022 was shortened and did not extend to the megrim habitat in the north, so the survey was removed from the assessment. The assessment was tested to be robust to this adjustment.

Figures 10.4 (ScoGFS-WIBTS-Q1(G1179) 6.a) and 10.5 (ScoGFS-WIBTS-Q4(G4299) 6.a) also show a steady 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. The biomass appears relatively stable over time in both areas. 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.

2023 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}, 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 2023 assessment assesses the biomass estimate to be stable at the 2021 levels; prior to being revised down in recent years. Estimates of fishing mortality decreased considerably after several years of 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 -0.014 for Fbar and 0.017 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 significantly 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 2023 is estimated to be 1.52 times B_{MSY} and the fishing mortality in 2022 is estimated to be have been 38% 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 2024 is projected to result in total catches of 7900 t (landings of 7510 t and discards of 390 t) and a Biomass of 1.38 times B_{MSY} in 2025.

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 WKM-SYREF3 (ICES, 2015) and the derivations are given below.

	MSY F_{lower} b)	F_{MSY} b)	MSY F_{upper} b) with AR	MSY $B^{trigger}$
Megrim in divisions 4.a and 6.a	0.39 × r d)	r/2 d)	r/2 d)	K d)

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 2023 and 2022 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.

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.

The removal of the 2022 value for the Sco-IBTS-Q1 survey due to the shortened survey was shown to have very little impact on the assessment. The 2022 assessment was rerun after removal of the equivalent data point for that year and the comparison is shown in Figure 10.13.

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.

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Table 10.2. Megrim in Division 6.a. History of commercial landings. All weights are in tonnes.

Year	Belgium	France	Ireland	Netherlands	Spain	UK (E, W, and NI)	UK (Scotland)	UK	Official total	ICES landings
1990	0	398	317	0	91	25	1093	-	1924	2210
1991	1	455	260	0	48	167	1223	-	2154	2432
1992	0	504	317	0	25	392	887	-	2125	2549
1993	0	517	329	0	7	298	896	-	2047	2721
1994	1	408	304	0	1	327	866	-	1907	2693
1995	0	618	535	0	24	322	952	-	2451	3498
1996	0	462	460	0	22	156	944	-	2044	4054
1997	0	192	438	1	87	123	954	-	1795	3272
1998	0	172	433	0	111	65	841	-	1622	2705
1999	0	0	438	0	83	42	831	-	1394	2648
2000	0	135	417	0	98	20	754	-	1424	2247
2001	0	252	509	0	92	7	770	-	1630	2473
2002	0	79	280	0	89	14	643	-	1105	1828
2003	0	92	344	0	98	13	558	-	1105	1642
2004	0	50	278	0	45	17	469	-	859	1328
2005	0	48	156	0	69	10	269	-	552	561
2006	0	53	221	0	52			346	672	875
2007	0	104	191	0	5			667	967	1301
2008	0	92	172	0	149			874	1287	1545
2009	0	174	188	0	112			953	1427	1387
2010	0	271	318	0	288			822	1699	1698
2011	0	153	227	0	217			715	1312	1297
2012	0	140	214	0	142			590	1086	1132
2013	0	105	203	0	213			470	991	949
2014	0	126	246	0	57			465	894	948
2015	0	140	311	0	140			520	1110	1110
2016	0	189	408	0	146			694	1437	1437

Year	Belgium	France	Ireland	Netherlands	Spain	UK (E, W, and NI)	UK (Scotland)	UK	Official total	ICES landings
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	120	250	0	302			711	1382	1380
2021*	0	123	378	0	335			633	1468	1464
2022*	0	79	186	0	197			488	950	958

*** Preliminary official landings.**

Table 10.3. Megrim in Division 6.a. History of commercial landings. All weights are in tonnes.

Year	Belgium	Denmark	France	Germany	Germany, Fed. Rep.	Ireland	Netherlands	Norway	Spain	Sweden	UK (E, W, and NI)	UK (Scotland)	UK	Official total	ICES landings
1990	4	2			3		24				17	1126		1176	837
1991	3	1		6			28				9	1169		1216	878
1992	2	4	36	3			27				47	1372		1491	1025
1993	7	6	25	4			30				8	1736		1816	1081
1994	2	1	27	1			28				19	2000		2078	1207
1995	7	2	24	2			26				44	2193		2298	1172
1996	5	7	14	1			9				4	3221		3261	1199
1997	3	5	16	2			20				3	3091		3140	1584
1998	5	18	14	4			30				5	2628		2704	1548
1999	4	21		1			26				4	2121		2177	1111
2000	10	29	7	3			20				2	2044		2115	1247
2001	2	52	5	1			11				2	1854		1927	1098
2002	5	8	6				9				3	1675		1706	975
2003	3	11	11	2		1	7	< 0.5			1	1235		1271	727
2004		7	9	2			11	< 0.5			1	1130		1160	739
2005		1	3	4			19	< 0.5			1	958		986	n/a
2006	0	3	4	1		0	6	1	0	0			1342	1357	1179
2007	0	11	18	4		0	1	1	0	0			1437	1472	1047
2008	0	31	20	1		0	1	4	0	0			1524	1581	1349
2009	0	54	9	0		0	0	6	0	0			1474	1543	1484
2010	0	22	1	0		0	1	2	0	0			1440	1466	1499
2011	0	23	10	3		0	0	1	0	0			1394	1431	1421
2012	0	35	5	3		0	0	1	0	0			1397	1441	1458
2013	0	48	8	3		0	0	17	0	0			1690	1765	1788
2014	0	35	6	1		0	0	12	0	0			1475	1530	1551
2015	0	26	7	0		0	0	8	0	0			1175	1217	1230
2016	0	46	13	2		0	2	21	0	0			1273	1357	1361

Year	Belgium	Denmark	France	Germany	Germany, Fed. Rep.	Ireland	Netherlands	Norway	Spain	Sweden	UK (E, W, and NI)	UK (Scotland)	UK	Official total	ICES landings
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	54	0	< 0.5			1769	1951	1935
2021*	0	73	74	9		0	1	49	0	< 0.5			1944	2150	2139
2022*	0	49	66	7		0	2	38	0	< 0.5			1311	1472	1463

*** 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.via.q1	sco.via.q4	sco.iva.q1	sco.iva.q3	monk.via	monk.iva
1985	2.59	NA	NA	NA	NA	NA
1986	1.69	NA	1.29	NA	NA	NA
1987	1.37	NA	1.52	NA	NA	NA
1988	2.01	NA	1.72	NA	NA	NA
1989	1.16	NA	1.34	NA	NA	NA
1990	1.07	1.59	0.77	NA	NA	NA
1991	0.79	1.27	0.51	0.34	NA	NA
1992	0.96	1.89	0.65	0.32	NA	NA
1993	1.01	2.06	1.11	0.32	NA	NA
1994	1.59	3.25	0.27	0.39	NA	NA
1995	1.56	1.86	0.00	0.41	NA	NA
1996	1.94	1.95	0.52	0.62	NA	NA
1997	1.10	1.08	0.43	0.44	NA	NA
1998	1.09	1.89	0.84	0.24	NA	NA
1999	1.32	1.36	1.01	0.26	NA	NA
2000	1.14	1.19	0.87	0.27	NA	NA
2001	1.00	0.97	0.30	0.10	NA	NA
2002	0.76	1.86	1.27	0.37	NA	NA
2003	1.27	1.20	0.52	0.33	NA	NA
2004	1.24	1.06	0.28	0.48	NA	NA
2005	0.69	1.01	0.59	0.83	1660	4753
2006	0.92	1.12	0.79	0.97	2689	3345
2007	0.91	1.20	0.87	1.42	3380	6348
2008	1.25	0.96	1.61	1.24	2467	7754
2009	1.57	1.40	1.95	1.15	3831	5947
2010	1.17	NA	1.77	1.83	3312	5395
2011	NA	NA	1.98	1.73	2502	4684
2012	NA	NA	2.61	1.59	3451	4839
2013	NA	NA	2.67	1.54	6175	6460
2014	NA	NA	2.20	1.32	3033	11970
2015	NA	NA	3.01	1.38	2563	4987
2016	NA	NA	1.44	1.35	3028	8208
2017	NA	NA	1.83	1.08	6509	10239
2018	NA	NA	1.41	1.14	3364	7154
2019	NA	NA	0.66	1.03	2144	7982
2020	NA	NA	1.36	0.91	NA	NA
2021	NA	NA	1.15	0.79	3268	6898
2022	NA	NA	NA	0.99	3063	8700

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	$\text{Uniform}(0.001, 2.0)$	
Carrying capacity	K	$\text{Uniform}(\ln(\max(C)), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)$	From the maximum catch to ten times the cumulative catch across all years assuming uniform distribution on the logarithmic scale
Catchabilities	$\log(q_j)$	$\text{Uniform}(-11.0, 0.0)$	Uniformly distributed on log-scale. See catchability sensitivity in Section 2.2.3.1
Process error variance	$\frac{1}{\sigma_u^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Measurement error variances	$\frac{1}{\sigma_{\varepsilon,j}^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Proportion of *K* in 1985	a	$\text{Uniform}(0.01, 2.0)$	

Table 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	Estimates 2023
r.hat	0.55	0.51	0.51	0.51	0.47	0.50	0.51	0.52	0.52	0.52
K.hat	43134	47216	46840	42681	55129	44116	42625	41634	40573	41556
MSY	5660	5612	5362	5072	5362	5123	5101	5020	4978	5030
F_{MSY}	0.28	0.26	0.26	0.25	0.23	0.25	0.26	0.26	0.26	0.26
B_{MSY}	21567	23608	23420	21340	27565	22058	21313	20817	20287	20778
B	4109	42416	42356	37610	38057	37062	32660	32408	31632	32752
F	0.08	0.07	0.07	0.07	0.08	0.08	0.1	0.1	0.12	0.08
B_{lim}	6470	7082	7026	6402	8269	6617	6394	6245	6086	6233
B_{trig}	10783	11804	11710	10670	13782	11029	10656	10408	10143	10389

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	1.15	2.34	3.72	4499	1928	0.36	0.67	1.20
1986	1.08	1.62	2.20	2858	1193	0.32	0.53	0.79
1987	1.05	1.53	2.02	4614	1874	0.55	0.93	1.38
1988	0.97	1.42	2.04	5212	2061	0.64	1.15	1.73
1989	0.79	1.16	1.61	3451	1327	0.48	0.87	1.30
1990	0.75	1.05	1.46	3047	1140	0.47	0.82	1.21
1991	0.69	1.00	1.34	3310	1204	0.56	0.94	1.42
1992	0.72	1.04	1.42	3574	1263	0.56	0.97	1.48
1993	0.79	1.11	1.51	3802	1305	0.56	0.97	1.44
1994	0.81	1.20	1.73	3900	1300	0.50	0.93	1.38
1995	0.86	1.22	1.75	4670	1511	0.59	1.10	1.67
1996	0.82	1.18	1.77	5253	1649	0.67	1.31	1.97
1997	0.70	1.01	1.41	4856	1478	0.73	1.39	2.14
1998	0.66	0.95	1.41	4253	1254	0.63	1.26	1.90
1999	0.62	0.91	1.36	3759	1074	0.54	1.13	1.72
2000	0.60	0.86	1.26	3494	966	0.53	1.10	1.68
2001	0.55	0.80	1.16	3571	956	0.64	1.20	1.87
2002	0.55	0.81	1.19	2803	725	0.44	0.89	1.36
2003	0.56	0.85	1.24	2369	592	0.36	0.70	1.10
2004	0.59	0.86	1.21	2067	499	0.32	0.59	0.92
2005	0.62	0.89	1.17	1527	356	0.25	0.41	0.62
2006	0.72	1.01	1.30	2054	461	0.30	0.49	0.76
2007	0.82	1.16	1.52	2348	508	0.29	0.49	0.74
2008	0.93	1.28	1.67	2894	602	0.34	0.56	0.85
2009	1.03	1.39	1.81	2871	574	0.30	0.51	0.76
2010	1.04	1.42	1.84	3197	614	0.34	0.55	0.84
2011	1.08	1.46	1.88	2743	526	0.29	0.46	0.68

Year	B/B_{MSY}			Landings	Discards*	F/F_{MSY}		
	Low	Value	High			Low	Value	High
2012	1.19	1.59	2.08	2545	449	0.25	0.42	0.60
2013	1.32	1.78	2.44	2737	327	0.22	0.36	0.53
2014	1.30	1.79	2.41	2500	309	0.20	0.33	0.48
2015	1.23	1.66	2.13	2340	159	0.20	0.31	0.44
2016	1.33	1.74	2.25	2792	167	0.23	0.35	0.49
2017	1.40	1.88	2.65	2594	193	0.19	0.32	0.44
2018	1.27	1.69	2.17	3003	255	0.25	0.40	0.57
2019	1.17	1.55	1.96	3197	184	0.29	0.45	0.66
2020	1.15	1.57	2.10	3315	214	0.29	0.47	0.67
2021	1.16	1.57	2.05	3603	200	0.31	0.51	0.73
2022	1.16	1.58	2.07	2420	87	0.20	0.32	0.48
2023	1.04	1.52	2.11					

*** Discard estimates prior to 2013 are approximated, based on limited sampling information.**

Table 10.8. Basis for the catch options.

Variable	Value	Notes
F_{2023}/F_{MSY}	0.32	*Status quo*: F_{sq} = relative F (2022)
B_{2024}/B_{MSY}	1.67	Short-term forecast
Catch (2023)	2349	Short-term forecast; in tonnes
Projected landings (2023)	2233	Assuming average landings ratio (2020–2022); in tonnes
Projected discards (2023)	116	Assuming average discard ratio (2020–2022); in tonnes

Table 10.9. The management option table.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	Fishing mortality F_{2024}/F_{MSY}	Stock size B_{2025}/B_{MSY}	% B change*	% advice change^	Basis
ICES advice basis								
MSY approach: *F= F_{MSY}*	7900	7510	390	1	1.38	-17.6	9.7	MSY approach: *F= F_{MSY}*
Other scenarios								*Other scenarios*
EU MAP^^: F_{MSY}	7900	7510	390	1	1.38	-17.6	9.7	*EU MAP^^: F_{MSY}*
EU MAP^^ $F_{MSY\ lower}$	6150	5847	303	0.78	1.47	-12.0	-14.6	*EU MAP^^ $F_{MSY\ lower}$*
EU MAP^^ $F_{MSY\ upper}$	7900	7510	390	1	1.38	-17.6	9.7	*EU MAP^^ $F_{MSY\ upper}$*
F = 0	0	0	0	0	1.80	7.8	-100	*F = 0*
$B_{2025} = B_{lim}$	29800	28331	1469	3.8	0.30	-82	314	*$B_{2025} = B_{lim}$*
$B_{2025} = B_{pa}$ = MSY $B_{trigger}$	24850	23625	1225	3.14	0.50	-70	245	$B_{2025} = B_{pa}$ = MSY $B_{trigger}$
$B_{2025} = B_{2024}$	2300	2187	113	0.29	1.67	0	-68	$B_{2025} = B_{2024}$

*** Biomass 2025 relative to biomass 2024.**

^ Advice value for 2024 relative to the advice value for 2023 (7200 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–present. 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 from the IBTS surveys.

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.

Figure 10.13. Sensitivity analysis using the 2022 assessment. Left plot shows the final assessment and the right shows the assessment with the 2021 SCO Q1 Iva survey missing.

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11 Megrim (*Lepidorhombus* spp.) in Division 6.b (Rockall)

Type of assessment in 2023

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 2024

ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2024 should be no more than 1115 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 2023 in 6 and 5b are given below:

Species:	Megrims *Lepidorhombus* spp.		Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	530	(1)	Analytical TAC	
France	2 068	(1)	Article 7(2) of this Regulation applies	
Ireland	605	(1)		
Union	3 203	(1)		
United Kingdom	2 296	(1)		
TAC	5 499			
(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 2022

Ireland had the highest catches in 2022 followed by the UK and Spain (Table 14.1). The majority of the landings and catches are from otter trawlers.

Catch	Landings		Discards
420 tonnes	Otter trawls 86%	Other gears 14%	Otter trawls 100%
	402 tonnes		18 tonnes

Landings

Official landings data for each country together with Working Group best estimates of catches 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 2022 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 Scottish and Irish Anglerfish and Megrim Industry Science Survey [G3745] which was cancelled 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. In 2023 the survey was successfully completed.

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 Scottish and Irish Anglerfish and Megrim Industry Science Survey 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 Scottish and Irish Anglerfish and Megrim Industry Science 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. There is some autocorrelation in the catch time series but generally 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}. The summary of the assessment is shown in Table 14.3.

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 (2023)/F_{MSY}	0.33	F corresponding to *status quo* catch
B (2024)/B_{MSY}	1.48	Short term forecast (STF) with *status quo* catch
Catch (2023)	657	Status quo catch (average 2020-2022) ; in tonnes

Four management scenarios were explored and the catch and relative reference points estimated for 2024. Adopting the MSY approach (using the 35th percentile of predicted catch under F=F_{MSY}) gave an estimated catch of 1115 tonnes, a F/F_{MSY} of 0.86 and a B/B_{MSY} of 1.4.

Basis ICES advice basis	Total catch (2024)	F_{2024}/F_{MSY}	B_{2025}/B_{MSY}	% B change ^	% advice change ^^
MSY approach (35th percentile of predicted catch distribution under F = F_{MSY})	1115	0.86	1.40	-5.8	9.1
Other scenarios					
F_{MSY}	1278	1.00	1.37	-7.9	25
F_{2022}	449	0.33	1.53	3.2	-56
F=0	0	0	1.62	9.2	-100

^ Biomass 2025 relative to biomass 2024.

^^ Advice value for 2024 relative to the advice value for 2023 (1022 tonnes).

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 last year to determine the impact on the assessment. The survey was successfully completed in 2023, and shows a short term increase in biomass and confirms that the stock biomass has been relatively stable for the last decade.

Currently the assessment uses the Scottish and Irish Anglerfish and Megrim Industry Science 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.

References

Gordon, J.D. 2001. (co-ordinator) Distribution and biology of anglerfish and megrim in waters to the west of Scotland. Final Report of EC DGXIV Study Contract 98/096 XX.

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (West of Scotland). Final report EU FAR contract MA-2-520.

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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	Germany	UK (England, Wales, & Northern Ireland)	UK (Scot-land)	UK	Official landings	ICES catch
1990	-	196	363	-	19	226	-	804	-
1991	-	240	587	-	14	204	-	1045	-
1992	-	139	683	-	53	198	-	1073	-
1993	-	128	594	-	56	147	-	925	-
1994	-	176	574	-	38	258	-	1046	-
1995	-	117	520	-	27	152	-	816	-
1996	-	124	515	-	92	112	-	843	-
1997	-	141	628	-	76	164	-	1009	-
1998	-	218	549	-	116	208	-	1091	-
1999	-	127	404	-	57	278	-	866	-
2000	4	167	427	-	57	309	-	964	-
2001	< 0.5	176	370	-	42	236	-	824	-
2002	< 0.5	87	120	-	41	207	-	455	-
2003	-	83	93	-	74	382	-	632	-
2004	-	43	71	-	42	372	-	528	-
2005	-	68	88	-	19	207	-	382	469
2006	-	95	59	-	9	181	-	345	419
2007	-	87	19	-	36	152	-	294	128
2008	-	68	84	-	1	141	-	294	353
2009	-	48	46	-	5	160	-	259	270
2010	-	47	41	-	6	87	-	180	165
2011	-	72	28	-	3	66	-	169	162
2012	-	120	61	-	-	89	-	270	245
2013	-	181	-	-	-	58	-	240	293
2014	-	230	73	-	-	95	-	398	358
2015	-	256	190	-	-	-	130	576	538
2016	-	272	69	-	-	-	116	457	550
2017	-	358	215	-	-	-	180	753	819
2018	-	438	61	-	-	-	263	763	967
2019	25	76 †	94	-	-	-	229	425 †	817
2020	41	467	112	-	-	-	246	866	920
2021	1	293	71	-	-	-	212	577	631
2022 *	-	248	57	<0.5	-	-	97	402	420

* 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 (Scottish and Irish Anglerfish and Megrim Industry Science Survey[G3745])

Figure 14.3. SPiCT model output for lez.27.6b. Top right: observed and fitted catch with 95 ci. Centre left: Biomass relative to BMSY. Centre: F relative to FMSY. Corresponding MSY quantities are shown in each plot as horizontal lines (0.5 BMSY 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

Table 14.2. SPICT results for Lez.27.6b.

```
Model parameter estimates w 95% CI
            estimate        cilow        ciupp    log.est
 alpha     5.8376976    0.7232372 4.711969e+01  1.7643365
 beta      0.2405784    0.0518333 1.116616e+00 -1.4247093
 r         0.3920538    0.2461448 6.244545e-01 -0.9363562
 rc        0.3920538    0.2461448 6.244545e-01 -0.9363562
 rold      0.3920538    0.2461448 6.244545e-01 -0.9363562
 m       903.7745319  626.8175134 1.303104e+03  6.8065799
 K      9220.9232504 4814.2825201 1.766108e+04  9.1292304
 q         0.5883121    0.2678719 1.292077e+00 -0.5304977
 sdb       0.0540159    0.0068839 4.238486e-01 -2.9184776
 sdf       0.3047147    0.2121488 4.376694e-01 -1.1883793
 sdi       0.3153282    0.2203778 4.511884e-01 -1.1541411
 sdc       0.0733078    0.0195933 2.742794e-01 -2.6130886
 pp        0.9646023    0.7832005 9.951587e-01  3.3050686
 robfac   13.7296502    2.4630772 1.117556e+02  2.5439339

Deterministic reference points (Drp)
           estimate        cilow        ciupp   log.est
 Bmsyd 4610.4616252 2407.1412600 8830.5396740  8.436083
 Fmsyd    0.1960269    0.1230724    0.3122272 -1.629503
 MSYd   903.7745319  626.8175134 1303.1039928  6.806580
Stochastic reference points (Srp)
           estimate        cilow        ciupp   log.est rel.diff.Drp
 Bmsys 4589.3748016 2399.1117560 8779.2329877  8.431499 -0.004594705
 Fmsys    0.1953061    0.1225965    0.3111384 -1.633187 -0.003690652
 MSYs   896.3176561  624.6128781 1286.2132190  6.798295 -0.008319457

States w 95% CI (inp$msytype: s)
                    estimate        cilow        ciupp    log.est
 B_2023.38      6643.9753265 3076.9924559 1.434596e+04  8.8014658
 F_2023.38         0.0627435    0.0240750 1.635203e-01 -2.7687009
 B_2023.38/Bmsy    1.4476864    1.0530967 1.990127e+00  0.3699667
 F_2023.38/Fmsy    0.3212571    0.1387105 7.440395e-01 -1.1355136

Predictions w 95% CI (inp$msytype: s)
                  prediction        cilow        ciupp    log.est
 B_2025.00      7049.6550201 3351.3927748 1.482895e+04  8.8607340
 F_2025.00         0.0627437    0.0184577 2.132863e-01 -2.7686965
 B_2025.00/Bmsy    1.5360818    1.1612798 2.031851e+00  0.4292349
 F_2025.00/Fmsy    0.3212585    0.1034085 9.980511e-01 -1.1355092
 Catch_2024.00   434.9897731  203.3936056 9.302952e+02  6.0753225
 E(B_inf)       7670.8967938           NA           NA  8.9451888
```

Table 14.3. Assessment summary. 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. High and low refers to 95% confidence intervals. All weights in tonnes.

Year	B/B_{MSY}			Land-ings	Dis-cards	F/F_{MSY}		
	Low	Value	High			Low	Value	High
1991	0.50	1.14	2.64	1045	209	0.67	1.24	2.3
1992	0.50	1.07	2.29	1073	215	0.79	1.34	2.3
1993	0.48	0.99	2.02	925	185	0.82	1.33	2.2
1994	0.48	0.94	1.83	1046	209	0.91	1.42	2.2
1995	0.46	0.87	1.63	816	163	0.93	1.42	2.2
1996	0.46	0.84	1.53	843	169	0.86	1.28	1.93
1997	0.47	0.81	1.42	1009	202	1.04	1.52	2.2
1998	0.44	0.74	1.25	1091	218	1.38	1.96	2.8
1999	0.40	0.64	1.04	866	173	1.43	1.99	2.8
2000	0.37	0.58	0.90	964	193	1.52	2.1	2.9
2001	0.32	0.48	0.73	824	165	1.90	2.6	3.6
2002	0.28	0.41	0.59	455	91	1.33	1.86	2.6
2003	0.28	0.40	0.57	632	126	1.22	1.75	2.5
2004	0.27	0.37	0.52	528	106	1.45	2.8	3.3
2005	0.24	0.35	0.49	382	87	1.04	1.72	2.8
2006	0.24	0.36	0.54	344	75	0.75	1.36	2.5
2007	0.24	0.39	0.63	106	22	0.55	1.12	2.2
2008	0.25	0.44	0.76	294	59	0.42	0.93	2.0
2009	0.27	0.50	0.92	226	44	0.31	0.71	1.6
2010	0.31	0.58	1.09	139	26	0.163	0.39	0.92
2011	0.38	0.70	1.29	155	7	0.104	0.25	0.58
2012	0.48	0.86	1.54	224	21	0.115	0.26	0.59
2013	0.58	1.01	1.77	278	15	0.138	0.30	0.66
2014	0.68	1.14	1.93	343	15	0.145	0.31	0.67
2015	0.78	1.26	2.05	453	85	0.194	0.40	0.82
2016	0.85	1.33	2.09	405	145	0.26	0.46	0.92
2017	0.92	1.39	2.10	586	233	0.27	0.54	1.07
2018	0.93	1.40	2.09	764	203	0.38	0.74	1.47
2019	0.92	1.37	2.04	783	34	0.35	0.72	1.45
2020	0.91	1.36	2.02	861	59	0.36	0.73	1.48
2021	0.90	1.34	1.98	566	65	0.32	0.65	1.33
2022	0.94	1.36	1.95	402	18	0.20	0.40	0.82
2023	1.02	1.42	1.98					

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 2023

The assessment of North Minch *Nephrops* in 2023 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 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.'

ICES advice applicable to 2023

'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 2019 – 2021, catches in 2023 should be no more than 3784 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 8325.4 tonnes in 2021, mostly reported by the UK with only 71 tonnes reported from Ireland. Table 12.1.2 and Figure 12.1.2 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 2022, 239 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 12.1.1). 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 13311 tonnes in 2023, down from 11862 tonnes in 2022.

During 2016–2020, 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. Demersal trawlers using a codend between 80mm–110mm and within 12 miles of shore are also exempt from the landings obligation. Since 2021, this stock is still under a landing obligation, and there are still exemptions in place.

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 2022, the fishery was generally described as fairly good, 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 2022 owing to the relaxation of COVID-19 pandemic rules. However, the creel sector remained fairly stable. It was noted that some dredgers/creelers changed gear to trawl for a period over the summer.

The largest part of the North Minch fleet is still based at Stornoway, numbering approximately 220 vessels in 2022. The majority of the Stornoway vessels (175) are below 10 m in length.

The fleet were targeting the same areas of the North Minch in 2022 as in previous years. Vessels based in Stornoway fish the North Minch with the fleet based in Barra moving between the North and South Minch. Approximately one third of the trawl fleet moved to the East coast from September onward as seen in recent years.

Very few vessels came from outside to fish in the area and are Spring to Summer visitors. These vessels did not land into Stornoway often in 2022.

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 2022 were successfully uploaded into InterCatch prior to the 2023 WG meeting.. Uploaded data were worked up in InterCatch to generate 2022 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Tables 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 2022 were 2188.4 tonnes, consisting of 1580 tonnes landed by trawlers targeting *Nephrops* (~72%), 393 tonnes landed by creel vessels (~18%) and 214 tonnes by other trawlers (~10%). In 2022, a small amount of *Nephrops* below minimum size (BMS) was also reported (0.4 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 and 2022 may be attributed to the relaxation of the COVID-19 pandemic rules. Note that the year range in effort time-series (2000–2022) 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 in 2020, sampling effort in 2022 was at a similar level to that seen in 2019. However, sampling is low in quarter two; this is due to staffing issues. In 2022, a co-sampling programme was established whereby fishers submitted catch samples at port for measurement by MSS. In FU11, 6 of the 7 discard trips were from the co-sampling programme. 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 2022. 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 2022, the mean size of males slightly decreased as did that of the females when compared to 2021..

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 2022 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. However, in 2022 the ration in quarter 2 is female dominated. This is due to the lack of sampling in quarter two and thus the ratio being dependent on a single sample.

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 before a decrease in 2022. 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 2012–2022. There is no obvious trend in North Minch trawl-

caught mean weights for females, however, there is an increase in the mean weight of trawl caught males. The mean weight in creel caught males has shown a slight decline of the time period. 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 2022 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 ~6.0% by number in the last three years (Table 12.2.4). In 2022, the discard rate decreased to 6.0% by number (from 6.2% in 2021).

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 2024 is 6.0% based on a three-year average of 2020 – 2022.

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 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. In 2023, the UWTV survey was carried out as planned with 100% of planned stations being sampled.

A total of 47 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 9.4%, lower than the precision level agreed (Table 12.2.6).

Figure 12.2.6 shows the distribution of stations in recent TV surveys (2012–2023), 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 2023 was 1489 million individuals, a 10.6% decrease from the 2022 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 2022 (dead removals/TV abundance = 5.4%) is below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 10.8%.

12.4 Catch Scenarios

Landings predictions and catch scenarios 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 2023 UWTV survey conducted in June. These were presented in September 2023 for the provision of advice.

The table below shows the agreed inputs to the catch scenarios table.

Variable	Value	Notes
Stock abundance (2024)	1489	UWTV survey 2023; individuals in millions
Mean weight in projected landings (2024)	26.76	Average 1999–2022; in grammes
Mean weight in projected discards (2024)	11.31	Average 1999–2022; in grammes
Projected discard rate (2024)	6.0	Average 2020–2022; percentage by number of the total catch
Discard survival rate (2024)	25	Percentage by number of discard

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 2022 for producing the catch scenarios.

* 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 improved 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) and is 5.4% in 2022. 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 landings length compositions from 1999 onwards, are derived from both creel and trawl samples. The creel fishery which accounted for 23% of landings in 2021 has decrease in 2022 to 18%. 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.

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, 1980–2022, 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
2022	-	71	-	953	7372.4	8325.4	8325.4

*** Includes 8.6 t landings reported by Isle of Man.**

Table 12.1.1(b). Nominal landings (tonnes) of *Nephrops* in Division 6.b, 1980–2022 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

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
1988	-	-	-	27	4	-	31
1989	-	-	-	14	-	-	14
1990	-	-	-	10	1	-	11
1991	-	-	-	30	-	-	30
1992	-	-	-	2	4	1	7
1993	-	-	-	2	6	9	17
1994	-	-	-	5	16	5	26
1995	1	-	-	2	26	1	30
1996	-	6	-	5	65	5	81
1997	-	-	1	3	88	23	115
1998	-	-	1	6	46	7	60
1999	-	-	-	5	2	5	12
2000	2	-	8	3	4	4	21
2001	1	-	1	14	2	7	25
2002	1	-	-	7	3	7	18
2003	-	-	1	5	6	18	30
2004	-	-	-	2	7	13	22
2005	3	-	1	1	5	7	17
2006	-	-	-	-	1	3	4
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013	-	-	-	-	-	-	0
2014	-	-	-	-	-	-	0
2015	-	-	-	-	-	-	0
2016	-	-	-	-	-	0	0

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
2017	-	-	-	-	-	2	2
2018	-	-	-	-	-	0	0
2019	-	-	0	-	-	-	0
2020	-	-	0.5	-	-	-	-
2021	-	-	0.02	-	-	-	0
2022	-	-	-	-	-	0.2	0.2

Table 12.1.2. ***Nephrops*, Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2022.**

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

Year	FU11	FU12	FU13	Other	Total
2001	3259	3991	3182	420	10852
2002	3440	3305	3384	397	10526
2003	3269	3879	3173	433	10754
2004	3082	3869	2973	403	10327
2005	2949	3848	3395	254	10446
2006	4166	4633	4780	241	13820
2007	3978	5471	6660	420	16529
2008	3799	5356	5923	128	15206
2009	3496	4285	4779	185	12745
2010	2413	3846	5843	569	12671
2011	2697	3702	6432	219	13050
2012	3542	3989	6687	435	14653
2013	3413	3776	5435	234	12858
2014	3257	3179	6207	53	12696
2015	3002	3400	5147	309	11858
2016	3529.4*	4402	6447	236	14614.4
2017	2490	3757	5403	250	11900
2018	1953	2540	4143	160	8796
2019	1977	2220	4683	173	9053
2020	1331	1976	3636	152	7095
2021	2075	2193	5015	237	9520
2022	2188.4*	2286*	3921	239	8634.4

***Includes below minimum size landed discards.**

Table 12.2.1. *Nephrops*, **North Minch (FU11), Nominal Landings of** *Nephrops*, **1981–2022.**

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	1549	53	472	1.1*	2075.1	0	2075.1
2022	1580	214	393	0.4*	2188.4	0	2188.4

***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).**

		2020		2021		2022	
FU		N trips*	N measured	N trips*	N measured	N trips*	N measured
North Minch	Landings	25	8 551	34	13 368	35	14 653
	Discards	4	443	9	1 439	10	989
South Minch	Landings	18	8 203	33	13 770	28	13 108
	Discards	7	673	3	306	7	385
Clyde	Landings	24	10 037	31	14 510	22	9 219
	Discards	-	-	-	-	-	-

* 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

Year	FU11	FU12	FU13
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
2022	31.78	33.50	18.88
Average**	26.76	27.68	17.70

*** From 1999 onwards mean weights are shown for trawl and creels combined.**

**** Average for FU11 and FU12 (1999–2022); FU13 (2020–2022).**

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

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)
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	2075.1	65	6.2	4.7	34.78	16.02
2022	69	4	72	1346	5.4	2188.4	52	6.0	4.6	31.78	11.77
2023				1489							
Average****									4.6	26.76	11.31

*** harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Includes below minimum size landings.**

****** Dead discard average: 2020–2022; Mean weight in landings and discards average: 1999–2022.**

Table 12.2.5. *Nephrops*, North Minch (FU11): Results of the 1994–2023 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
2023	47	0.51	-	-	1489	281

Table 12.2.6. *Nephrops*, North Minch (FU11): Results of the 2023 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)
2023 TV survey								
VMS	2908	47	0.512	0.11	1488.7	19698	1	
Total	2908	47			1488.7	19698	1	0.094

Figure 12.1.1 *Nephrops* Functional Units in 6.a. North Minch (FU11), South Minch (FU12), Clyde (FU13).

Figure 12.1.2. *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 12.2.2. *Nephrops*, North Minch (FU11), Catch length–frequency distribution (dotted) and landings (solid) for Nephrops, 2001 – 2022. 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.

Figure 12.2.3 (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 (2008–2022).

Figure 12.2.4. *Nephrops*, (FU11 North Minch, FU12 South Minch and FU13 Clyde), mean weight in the landings from 1990–2022 (from Scottish market sampling data).

Figure 12.2.5. *Nephrops*, (FU11 North Minch, FU12 South Minch, FU13 Clyde), mean weight in 2012–2022 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), 2012–2023. 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), 1994–2023 (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, 1994–2022 (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 2023

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 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.'

ICES advice applicable to 2023

'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 2019–2021, catches in 2023 should be no more than 5242 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 occuring 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 2022 and 2023

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 the local fleet isreported to be decreasing in size year-on-year. In 2022, there were 40 local vessels (29 < 10m vessels). There was no information available from Mallaig in 2021 or 2022. 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, others switch between trawling and creeling.

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 2022 were uploaded to InterCatch prior to the 2023 WG meeting. Uploaded data were worked up in InterCatch to generate 2022 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 has resulted in reduced sampling of commercial catches for FU12 since 2020. Discard sample data for FU12 was unavailable for quarter three of 2022, and so, the InterCatch estimate of discard rate for quarter three was based on samples collected in quarter two.

Following download of data from InterCatch, an alternate method of 2022 discard estimation was also considered, as the samples available from quarter two suggested a lower than expected discard rate and were deemed unreliable. It was agreed at WGCSE that estimates of discard rates and associated size distributions for quarters two and three of 2022 would be based on an averaging of discard samples across all available quarters between 2017 and 2022.

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 2022 were 2190 tonnes (plus 25 tonnes from other UK vessels, and 71 tonnes from Ireland), consisting of 1794 tonnes (82%) landed by Scottish *Nephrops* trawlers and 393 tonnes (18%) landed by Scottish creel vessels. A small amount of below minimum size (BMS) landings was also reported (3 tonnes). The proportion of creel caught landings has generally increased somewhat over the past decade, from 19% in 2012 to as high as 29% in 2020. In 2022 creel caught landings accounted for 18% of Scottish landings, very close to the long-term average of 17%.

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. However, in 2022, effort decreased once again. Note that the effort time-series range (2000–2022) 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. In 2022, a co-sampling programme was established whereby fishers submitted catch samples at port for measurement by MSS. In FU12, 80% of discard trips were from the co-sampling programme. These sampling levels are shown in Table 12.2.2 (see. Section 12 FU11 North Minch). Sampling effort in 2022 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 2003 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 females increased by ~10 mm in 2022, with the mean size of males remaining similar to 2021.

Sex ratio

The sex ratios observed in the South Minch since 2020 have shown 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 and 2022, 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 12.2.4 and 12.2.5; see. Section 12 FU11 North Minch, Table 12.2.3) 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 12.2.5). 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, and the past three years has seen the highest recorded mean weight in 2020, followed by a substantial decrease in 2021, and an increase in 2022 to the second highest value in the series.

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 2022, the discarding rate was 7.3% based on mean discard rates observed between 2017 and 2022. This represents a decrease from 2021 (7.6%). 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 (2020–2022), amounting to 7.6%.

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. Since 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 in order to inprove precision in abundance estimates (see. Annex 3). 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). A total of 41 valid TV stations were completed in 2023 and used in the survey analysis (Table 13.2.3).

TV survey abundance estimates from 1995–2023 are shown in Table 13.2.3 and Figure 13.2.4. Following an interbanchmark at WGCSE 2022, abundance estimates from 2007-2023 were calculated using a krigging method to reduce uncertainty in the estimation (see. Annex 3) and updated abundance estimates are presented in Table 13.2.3 along with a reduced time series relative to the new abundance estimates presented in 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 1211 million individuals between the lowest and highest points of a cycle (between 2012 and 2016). The 2023 abundance represents a 6% decrease in relation to 2022.

Following discussions at WGNEPS 2022, an MSY Btrigger reference point for the new abundance time series was estimated based on the method used for FU 19 and FU 22 (ICES, 2016f; see Annex 3). A normal distribution with mean and standard deviation equal to those of the time-series of kriged abundance estimates was randomly generated, and the 5% quantile of that distribution (960 million) was taken as MSY Btrigger (rounded to the nearest 10 million individuals). The new MSY Btrigger value is 5.9% lower than the former value of 1020 million individuals.

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 increased in 2023, in comparison to the 2022 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 and Figure 13.2.6). The CV for the 2023 TV survey (Table 13.2.4) is lower than the 20% precision level agreed by WGNEPS (2019).

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 2023 survey are shown in Table 13.2.4, and compared with the 2021 and 2022 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 2023 was 1494 million individuals, above the MSY $B_{trigger}$ value of 960 million and is used for the provision of advice.

The calculated harvest rate in 2022 (dead removals/TV abundance = 5.1%) 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 2023 UWTV survey conducted in June. These were presented at WGCSE NEPH in September 2023 for the provision of advice.

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 13.2.2 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 2022.

The table below shows the agreed inputs to the catch scenario table.

Input	Data	2023 assessment
Survey abundance (millions)	UWTV 2023	1494
Mean weight in projected landings (g)	1999–2022	33.50
Mean weight in projected discards (g)	1999–2022	11.21
Dead projected discards	2019–2022	5.6%*
Discard survival rate	Proportion by number (assumed)	25%**

*** Based on mean discard rate (2017-2022) allocated to 2022.**

**** 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%.

Following review at WGCSE 2022 and WGNEPS 2022, an, MSY $B_{trigger}$ for the new abundance time series has been defined as the fifth percentile of the probability distribution of abundance for the time-series 2007-2022, assuming a normal distribution; individuals in millions and is calculated as 960 million individuals (in 2023). 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. Due to the revised TV survey abundance estimates calculated in 2023; havest rates since 2007, have been recalculated and are presented in the tables with a reduced time series presented in Figure 13.5.1. 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 with a small decline in 2022 (5.1%).

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 13.2), 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 2022 meant that discard sample data was not available forQuarter three, and it was agreed at WGCSE that estimates of discard rates and size distributions for 2022 would be adequately approximated for the purpose of forecasting by averaging of discard samples across all available Quarters between 2017 and 2022. The landings length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery, which accounts for 18% of the landings in 2022 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. 2020–2022 for the 2023 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 FU 12 Nephrops, addressing the potential for provision of abundance estimates with reduced uncertainty using alternate estimation methods (ICES, 2022). An interbenchmark was presented at WGCSE 2023 (see. Annex 4) with the altenative abundance estimation process being accepted by WGCSE and used in the provision of advice for 2024.

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*, 1981–2022.

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

UK SCOTLAND						OTHER UK	IRELAND	TOTAL
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TOTAL			
2007	4437	21	959	0	5417	19	35	5471
2008	4433	12	896	0	5341	2	13	5356
2009	3346	24	900	0	4270	4	11	4285
2010	2836	19	969	0	3824	16	6	3846
2011	2876	11	783	0	3670	23	9	3702
2012	3159	32	773	0	3964	19	6	3989
2013	2490	543	729	0	3762	13	1	3776
2014	2490	3	637	0	3130	32	17	3179
2015	2662	18	665	0	3345	22	33	3400
2016	3450	22	838	0	4310	33	59	4402
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	1549	53	472	0.3	2074.3	77	42	2193.3
2022	1580	214	393	3	2190	25	71	2286

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

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)
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	1002	27.7	5471	903	22.4	17.8	23.95	13.73
2008	224	74	279	1617	17.3	5356	605	24.7	19.8	23.91	8.23
2009	179	26	199	1200	16.6	4285	216	12.5	9.6	23.87	8.44
2010	149	12	158	1898	8.3	3846	133	7.7	5.9	25.86	10.76
2011	118	11	126	1851	6.8	3702	92	8.2	6.3	31.1	8.78
2012	133	16	145	889	16.3	3989	145	10.8	8.3	29.17	9.05
2013	136	4	140	1514	9.2	3776	50	3.1	2.4	27.48	11.31
2014	105	19	120	1746	6.9	3179	233	15.6	12.1	29.91	12.04
2015	120	10	128	1850	6.9	3400	121	7.7	5.9	28.15	12.04
2016	177	31	201	2100	9.6	4402	365	14.9	11.6	24.76	11.74
2017	131	13	140	1283	11.0	3757	108	9.4	7	27.76	8.29
2018	91	4	94	1751	5.4	2540	54	4.5	3.4	27.27	12.74
2019	79	4	83	2170	3.8	2220	46	4.9	3.7	28.54	11.22
2020	54	5	57	1866	3.1	1976	46	7.8	6	36.58	9.91
2021	90	7	95	1160	8.2	2193.3	84	7.6	5.8	29.96	11.35
2022	77	6	82	1592	5.1	2286	68	7.3	5.6	33.5	11.21
2023	-	-	-	1494	-	-	-	-	-	-	-
Average^									5.8	27.68	10.22

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Values since 2007 have been updated due to revised abundance estimates.**

^Dead discard average: 2020–2022; Mean weight in landings and discards average: 1999–2022.

Table 13.2.3. ***Nephrops*, South Minch (FU12): Results of the 1995–2023 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	0.2	1002	194
2008	33	0.328	1617	230
2009	25	0.22	1200	410
2010	34	0.38	1898	493
2011	36	0.374	1851	496
2012	38	0.181	889	111
2013	38	0.305	1514	155
2014	36	0.348	1746	306
2015	35	0.379	1850	265
2016	37	0.425	2100	251
2017	41	0.257	1283	243
2018	39	0.348	1751	225
2019	40	0.429	2170	391
2020	40	0.381	1866	356

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS/m²)*	ABUNDANCE (MILLIONS)*	95% CONFIDENCE INTERVAL (MILLIONS)*
2021	41	0.231	1160	242
2022	41	0.332	1592	300
2023	41	0.299	1494	316

*Values since 2007 have been updated due to revised abundance estimates.

Table 13.2.4. ***Nephrops*** **South Minch (FU12). Results by stratum of the 2021–2023 TV surveys. Note that stratiication was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

STRATUM	AREA (km²)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m²)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (CV)
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
2022 TV Suvey								
M	303	3	0.483	0.059	146.2	1794	0.024	
SM	2741	18	0.355	0.131	974.7	54669	0.724	
MS	2028	20	0.258	0.092	523	19009	0.252	
Total	5071	41			1643.9	75502	1	0.161

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, 2003–2022. 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 (2008–2022).**

Figure 13.2.4. ***Nephrops*****, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias, solid black line), with 95% confidence intervals (dashed black lines), 2007–2023. The dashed red line is the rounded $B_{trigger}$ value of 960 million individuals.**

Figure 13.2.5. ***Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2012–2023. 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 13.2.6. Time series estimates of kriged *Nephrops* burrow density distribution surfaces for FU 12. Darker red pixels represent areas of higher estimated *Nephrops* burrow density, and lighter yellow pixels represent areas of lower estimated density.

Figure 13.5.1. ***Nephrops*, South Minch (FU12), harvest rate, 2007–2023. The dashed and solid lines are the F_{MSY} proxy harvest rate (11.7%) and the time-series of estimated harvest rates, respectively.**

Figure 13.6.1. 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 2023

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 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.'

ICES advice applicable to 2023

'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 2019–2021, catches in 2023 should be no more than 4596 tonnes (4122 tonnes for the Firth of Clyde and 474 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 component (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 2022 and 2023

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 fishing out of Ayr including 20 trawlers and six creelers, and 65 *Nephrops* vessels fishing out of Campbeltown including 29 trawlers and 36 creelers. Both ports report a continual movement of vessels entering and leaving the fishery, and an overall general decrease in fleet size over the past number of years. 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. Many vessels have had difficulty crewing their boats in recent years, as fuel costs have affected wages, and Brexit has limited the available workforce.

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 2022 were uploaded to InterCatch prior to the 2023 WG meeting. Uploaded data were worked up in InterCatch to generate 2022 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 has resulted in a reduced sampling effort of commercial catches for FU13 since 2020. There were no representative discards samples collected for FU13 in 2022, thus alternate methods of estimating discards were explored. It was agreed at WGCSE that estimates of discard rates and size distributions for 2022 would be based on an averaging of discard samples across all quarters from 2017-2019, the same procedure that has been carried out since 2020. 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 2022. Assessment estimates affected by changes in discard rates are annotated hereafter to reflect this; i.e. "x ($\underline{y/z}$)", 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 925 tonnes in 2022, with England reporting 1 tonne. Total reported Scottish landings in 2022 were 2995 tonnes (plus 926 tonnes from other UK vessels i.e. Northern Ireland & England), consisting of 2746 tonnes landed by trawlers (92%) and 249 tonnes (8%) landed by Scottish creel vessels. Scottish creel landings have generally increased in the most recent years, from approximately 3% in 2012 to just over 8% of total landings in 2022.

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 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 14.2.1). Effort increased in 2016 in comparison to 2015, but has been on a generally decreasing trend since then. Note that the effort time-series range (2000–2022) 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 2003 to 2022. 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 with a slight increase in 2022, whereas the mean size of males showed an increase until 2020, and then a slight decrease in 2021, increasing again in 2022.

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 & 2022, but an increased proportion of females was observed in quarter 2 for both years. 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. Between 2015 and 2018 there was a decreasing trend in this metric, but that trend has since given way to inter-annual variability with no obvious direction. Mean weight for FU13 is generally lower than other areas across 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 in recent years. However, sampling levels are relatively low. 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 since 2020, 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 2020-2022. 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 10.5% (7.6%/15.9%).

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 2023, 30 valid stations were used in the final survey analysis for the Firth of Clyde (Table 14.2.3) and 10 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 (2012–2023) 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 2023, the overall abundance decreased 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 2023(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 2023 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 2023 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 2023 was 1500 million individuals, a 10% decrease from the 2022 estimate, well above the $B_{trigger}$ value of 580 million. The abundance estimate for the Sound of Jura in 2023 was 320 million individuals, a 33% increase from the 2022 estimate, but again above the $B_{trigger}$ value of 160 million.

The harvest rate for the FU13 in 2022 (dead removals for both subareas/ Firth of Clyde and Sound of Jura TV abundance = 12%) was below 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 Scenarios

Landings predictions and catch scenarios 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 2023 UWTV survey conducted in June. These were presented in September 2023 for the provision of advice.

Catch scenario table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 14.2.2 and summarised below. The calculation of catch scenarios 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.

Variable	Value	Notes
Firth of Clyde stock abundance (2024)	1500	UWTV Survey 2023; individuals in millions
Sound of Jura stock abundance (2024)	320	UWTV Survey 2023; individuals in millions
Mean weight in projected landings (2024)	18.9	Average 2020–2022 (combined for the Firth of Clyde and the Sound of Jura); in grammes
Mean weight in projected discards (2024)	7.6	Average 2020–2022 (combined for the Firth of Clyde and the Sound of Jura); in grammes
Projected discard rate (2024)	10.5	Average 2020–2022 (combined for the Firth of Clyde and the Sound of Jura); percentage by number of the total catch
Discards survival rate (2024)	25	Percentage by number of the discards

* Based on mean discard rate (2017-2019) allocated to all Quarters of 2020, 2021 & 2022. Estimates of 21.5% and 1.3% 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 14.2.2 and Figure 14.4.1 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, increasing in 2021 to 20.6% from 9.4% in 2020 and has now decreased to 12.0% in 2023. 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 2022 has remained low since 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 (2020–2022) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch advice.

The cumulative relative to absolute conversion factor estimates for FU13 component is largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. The inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations, while in the Clyde the non-estimated sea loch areas are relatively small.

14.8 Recommendation for next benchmark

This stock was last benchmarked in 2009 (ICES, 2009). WGCSE recommends that the issue concerning the split of landings between Sound of Jura and the Firth of Clyde be examined when this stock is next proposed for benchmark process.

14.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could provide controls to ensure effort and catch were in line with resources available. In this FU, the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the landings advice.

Creel fishing takes place in part of this area although the relative scale of the fishery is smaller than in the Minches. Overall effort in terms of creel numbers is not known, and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the Firth of Clyde and estimated discards of whiting and haddock by the TR2 fleet are generally high in area 6.a. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm implemented as part of the previous Scottish Conservation Credits scheme. A seasonal closure (early spring) in the southwest part of the Firth of Clyde is in place to protect spawning cod although *Nephrops* vessels are derogated to fish in those parts where mud sediments are distributed.

14.10 References

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Table 14.1.1. ***Nephrops,*** **Clyde and Sound of Jura (FU13), ICES estimates of landings of** ***Nephrops*****, 1981–2022.**

UK SCOTLAND						OTHER UK	IRELAND	TO-TAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TO-TAL			
1981	2498	404	66	0	2968	0	0	2968
1982	2372	169	79	0	2620	0	0	2620
1983	3889	121	52	0	4062	14	0	4076
1984	3070	153	77	0	3300	10	0	3310
1985	3921	293	65	0	4279	7	0	4286
1986	4073	176	79	0	4328	13	0	4341
1987	2860	82	64	0	3006	3	0	3009
1988	3507	107	43	0	3657	7	0	3664
1989	2577	184	35	0	2796	16	0	2812
1990	2731	121	23	0	2875	34	0	2909
1991	2844	145	26	0	3015	23	0	3038
1992	2530	247	9	0	2786	17	0	2803
1993	3200	110	5	0	3315	28	0	3343
1994	2503	50	28	0	2581	49	0	2630
1995	3766	131	26	0	3923	64	0	3987
1996	3880	108	27	0	4015	42	0	4057
1997	3486	46	26	0	3558	63	0	3621
1998	4540	79	39	0	4658	183	0	4841
1999	3476	29	37	0	3542	210	0	3752
2000	3142	63	75	0	3280	137	0	3417
2001	2890	65	95	0	3050	132	0	3182
2002	3075	53	105	0	3233	151	0	3384
2003	2954	20	119	0	3093	80	0	3173
2004	2619	8	88	0	2715	258	0	2973
2005	3148	5	94	0	3247	148	0	3395
2006	4356	1	179	0	4536	244	0	4780
2007	6069	4	221	0	6294	366	0	6660

UK SCOTLAND						OTHER UK	IRELAND	TO-TAL**
YEAR	*NEPHROPS* TRAWL	OTHER	CREEL	BELOW MINIMUM SIZE	SUB TO-TAL			
2008	5320	3	184	0	5507	416	0	5923
2009	4304	1	191	0	4496	283	0	4779
2010	5162	5	211	0	5378	465	0	5843
2011	5664	9	219	0	5892	540	0	6432
2012	5617	4	203	0	5824	863	0	6687
2013	4708	4	212	0	4924	511	0	5435
2014	4770	1	258	0	5029	1178	0	6207
2015	4035	8	206	0	4249	898	0	5147
2016	4922	6	267	0	5195	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	0	3636
2021	3813	50	245	0	4108	907	0	5015
2022	2622	124	249	0	2995	926	0	3921

Table 14.2.1. ***Nephrops,*** **Clyde (FU13), ICES estimated landings of** ***Nephrops*****, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2022).**

YEAR	UK LANDINGS		
	FIRTH OF CLYDE	SOUND OF JURA	ALL SUBAREAS
1981	2277	691	2968
1982	1983	637	2620
1983	3395	681	4076
1984	2600	710	3310
1985	3561	725	4286
1986	3228	1113	4341
1987	2408	601	3009
1988	3509	155	3664
1989	2595	217	2812
1990	2592	317	2909
1991	2654	384	3038
1992	2383	420	2803
1993	2766	577	3343
1994	2095	535	2630
1995	3692	295	3987
1996	3671	386	4057
1997	3135	486	3621
1998	4373	468	4841
1999	3423	329	3752
2000	3229	188	3417
2001	2979	203	3182
2002	3350	34	3384
2003	3154	19	3173
2004	2965	8	2973
2005	3388	7	3395
2006	4768	12	4780
2007	6580	80	6660

YEAR	UK LANDINGS		
	FIRTH OF CLYDE	SOUND OF JURA	ALL SUBAREAS
2008	5845	78	5923
2009	4688	91	4779
2010	5782	61	5843
2011	6363	69	6432
2012	6634	53	6687
2013	NA	NA	5435
2014	NA	NA	6207
2015	NA	NA	5147
2016	NA	NA	6447
2017	NA	NA	5403
2018	NA	NA	4143
2019	NA	NA	4683
2020	NA	NA	3636
2021	NA	NA	5015
2022	NA	NA	3921

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	5015	292	219	10.5	8.1	15.27	7.59
2022	210	25	228	1665	241	12	3921	187	140	10.5	8.1	18.88	7.59
2023	-	-	-	1500	320	-	-	-	-	-	-	-	-
Average***											10.5	17.7	8.1

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 20120–2022; Mean weight in landings and discard average: 2020–2022.**

Table 14.2.3. ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Results of the 1995–2023 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

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m²)	ABUNDANCE (MILLIONS)	95% CONFIDENCE INTERVAL (MILLIONS)
2022	30	0.8	1665	316
2023	30	0.72	1500	314

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

YEAR	NUMBER OF VALID STATIONS	MEAN DENSITY (BURROWS / m²)	ABUNDANCE (millions)	95% CONFIDENCE INTERVAL (millions)
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
2023	10	0.807	320	47

Table 14.2.5. *Nephrops,* Clyde (FU13): Firth of Clyde subarea. Results by stratum of the 2021–2023 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).

STRATUM	AREA (km²)	NUMBER OF STATIONS	MEAN BURROW DENSITY (no./m²)	OBSERVED VARIANCE	ABUNDANCE (MILLIONS)	STRATUM VARIANCE	PROPORTION OF TOTAL VARIANCE	SURVEY PRECISION LEVEL (CV)
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
2023 TV survey								
M	716.8	11	0.60	0.049	432	2271	0.092	
SM	698.6	9	0.858	0.245	599.4	13290	0.539	
MS	664.6	10	0.704	0.205	468	9078	0.368	
Total	2080	30			1499.4	24639	1	0.102

Table 14.2.6. *Nephrops,* Clyde (FU13): Sound of Jura subarea. Results by stratum of the 2021, 2020, and 2023 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)
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
2023 TV survey								
M	90	2	0.559	0.013	50.3	52	0.092	
SM	150	4	0.676	0.065	101.5	366	0.258	
MS	142	4	1.185	0.029	168.2	145	0.65	
Total	382	10			320.1	563	1	0.074

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*****, 2003–2022. 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 (2008–2022).

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, 2012–2023. 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*), 1995–2023. 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*), 1995–2023. The dashed orange line is the rounded $B_{trigger}$ value of 160 million individuals.**

Figure 14.4.1. Clyde (FU13) *Nephrops* harvest rate, 1995–2022. 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 14.6.1. 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, noting FU18 not shown). 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 2022 and 2023

The TAC is currently set for the whole Area 7 with a special condition for Porcupine Bank (FU 16). The TAC for 2023 is set at 18,353 tonnes, which is an overall increase of 8% compared to the 17,038 tonnes set for 2022. 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 2022 (tonnes)		Allowances 2023 (tonnes)		Change from 2022	
	Division 27.7	FU 16	Division 27.7	FU 16	Division 27.7	FU 16
Spain	924	846	**981**	**1,142**	6%	35%
France	3,746	530	**3,974**	**715**	6%	35%
Ireland	5,682	1,016	**6,027**	**1,374**	6%	35%
Union	10,352	2,392	**10,982**	**3,231**	6%	35%
UK	6,686	412	**7,371**	**556**	10%	35%
TAC	17,038		**18,353**		8%	

Sources:

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

Council Regulation (EU) 2023/194 of 30 January 2023 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks

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	6,115	1,899	222	0	249	413	1,518		304	10,887	16,815
2021	519	6,779	2,476	498	0	415	697	1,616		346	13,346	18,026
2022	270	6,741	2,846	452	0	247	795	1,271		441	13,063	17,038
Average	552	8,112	2,122	616	16	714	2,138	2,046	3,589	261	15,806	22,026

***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 2023

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 2023 forms the basis of advice for this stock.

ICES advice published 28 October 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 2019–2021, catches in 2023 should be no more than 789 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 2022

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 15.2), 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. Landings in 2022 were 270 tonnes.

The fishery in FU 14 is dominated by UK vessel activity, on average accounting for 91% of the reported annual international landings since 2000. Since 2021, only UK vessels have reported landings from FU 14. In 2022, 58% of landings went into England (up from 36% in 2021), 41% went into Northern Ireland (down from 64% in 2021) and 1% went into Scotland (up from zero in 2021).

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 70% from Northern Irish vessels (75% in 2021), 29% from English vessels (22% in 2021), 1% from Scottish vessels (3% in 2021) and <1% from Scottish and Irish vessels (0% in 2021). The TR2 gear class (otter trawls with 70 – 99 mm mesh sizes) accounted for almost 100% (99% in 2021) of the landings; <1% (<1% in 2021) of landings were reported from

the FP0 (pots), MIS (miscellaneous) and BT2 (beam trawl) gear classes; no landings (1% in 2021) were reported from TR1 (otter trawls with >=100 mm mesh sizes).

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 2022 were successfully uploaded to InterCatch prior to the 2023 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. For 2021, only samples from Northern Ireland were available and these were allocated to all 2021 landings. For 2022, only samples from England were available and these were allocated to all 2022 landings. Averaging of sampling data was examined at WGCSE 2023 and documented in the stock annex. A longer time series of landings and discards length–frequency distributions covering 2016 - 2022 was used for the 2023 assessment. Mean weights and discard rates were also calculated as the average of the values for 2016 to 2022.

Landings

Official landings as reported to ICES from FU14 are presented in Tables 15.1 and 15.2. 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 2022, landings were 270 tonnes (down from 2021 at 519 tonnes), all into the UK, with 4 tonnes of reported discards (down from 29 tonnes in 2021).

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 15.3 and shown in Figure 15.2. 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 tripled compared to 2020; 2022 effort then halved compared to 2021.

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 were available. For 2022, only English samples were 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 15.3. Mean individuals weights and carapace lengths are listed in Table 15.4. 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 in 2021 compared with the 2017-2019 values whereas mean weight and carapace length in discards increased. On the basis of English samples, this effect was reversed in 2022, with mean weight and carapace length increasing in landings and decreasing in discards.

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. In 2022, the only samples were from England, 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 15.5. The ratio is quite variable but average sex ratio is 57% male (1999–2022). Sex ratio was estimated as an average of 2017 – 2019 sampling for 2020. In 2021, the male sex ratio increased to 73%, decreasing to 46% in 2022, its lowest since 2006.

Mean weight explorations

The annual mean weight estimate for landings and discards is provided in Table 15.4 and in Figure 15.6. 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 directly for 2020 due to no sampling. Northern Irish sampling resumed in 2021 but without complementing English sampling; English sampling resumed in 2022, but without complementing Northern Irish sampling. Due to the small sizes in the Northern Irish samples, compared with the English samples, the mean individual weights and sizes for these two years 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 15.4 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 15.4), 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 15.5 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 2023 are presented in Figure 15.7.

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 15.8. 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 15.6 and visualised in Figure 15.9 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 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 15.9). CVs over the entire time-series (Table 15.6) are within the accepted precision level of 20% (ICES, 2012).

The abundance estimate for 2023 (191 million) is a decrease of 50% compared to the 2022 figure of 386 million (Figure 15.10), 59% lower than the 2008–2022 average of 470 million and 45% lower than the $MSY_{Btrigger}$ value of 350 million. It is also the largest year-on-year change in abundance in the time series. Following the ICES survey protocols (Dobby H., *et al*. 2021), the footage from the 2022 and 2023 surveys will be reviewed for a forthcoming WGNEPS meeting, however this was not possible to complete in time for this report.

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 15.5 and Figure 15.9 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. There has limited sampling for 2021 (Northern Ireland only) and 2022 (England) only and the current assessment was carried out by WGCSE 2023 using the average weights and discarding rates are based on 2016 and 2022 sampling data. UWTV surveys were carried out uninterrupted and as usual. Therefore, the 2022 and 2023 abundance values were used for the assessment in 2023, according to the established procedure.

State of the stock

UWTV abundance estimates suggest that the stock size has historically fluctuated between abundance values of 350 and 694 million *Nephrops*. The 2023 estimate (191 million) decreased by 50% in relation to 2022 and is 45% below MSY $B_{trigger}$ (350 million).

Table 15.5 and Figure 15.11 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 15.5 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)	191	UWTV survey 2023; individuals in millions
Mean weight in projected landings	20.33	Average 2016—2022; in grammes
Mean weight in projected discards	9.07	Average 2016—2022; in grammes
Projected discard rate	12.4	Average 2016—2022; percentage by number of the total catch
Discards survival rate*	10	Percentage by number of the discards
Dead projected discard rate	11.3	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 2022 was 2.8%, with an average of 4.7% 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 previous 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. Comparison of the old and new systems in Functional Unit 16 has shown no significant difference in density estimates. However, previous assumptions relating to correction factors are still being applied despite some input parameters (such as field of view) now being different. This should be reviewed at WGNEPS.

A revised algorithm is now used to derive distance covered by the sledge is considered significantly more robust than the previous algorithm. However, comparison of the distances covered by the sledge and ship has shown no significant differences and hence ship position continues to be used for consistency with historic surveys.

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.
- Temporal changes in condition (length-weight factors). Fixed condition factors are currently used for this stock however they have demonstrated a slight decreasing trend over the sampling time series.
- Better knowledge of the difference in growth and population structure across the area.
- Following the 2022 advice, after which there was a high uptake recommended catches (78% of F_{MSY}), the stock decreased in 2023 to well below MSY $B_{trigger}$. The basis for setting MSY $B_{trigger}$ is currently from recent history and may be therefore be too high. Current low abundance 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 15.8.1. 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
2022	270	6741		

Table 15.8.2. 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 15.3. 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	-
2022	87,223	262.7	3.0	-	0	-

Table 15.4. 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	18.19	9.75	0.17
2022 *****	32.78	23.24	26.69	8.61	0.63

*** 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 for 2021**

******* Only English samples for 2022**

Table 15.5. 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	29	6	34	15.8	17.2	393	78	8.6	519	29	18.19	9.75

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
2022	11	1	11	6.3	7.0	386	110	2.8	270	4	26.69	8.61
2023						191	41					

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 15.6. ***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%
2023	40	0.16		191	41	10.8%

Note: Abundance is adjusted by using a cumulative absolute conversion factor of 1.2. Abundance (millions) including Wigtown Bay (1.9% 2008–2010; 6.6% 2011–2020).

Figure 15.1. Irish Sea East (FU14): Landings in tonnes by country. GBE=England; GBN=Northern Ireland; GBS=Scotland; Rep. of Ireland=Republic of Ireland.

Figure 15.2. Irish Sea East (FU14): Effort data (KW days) for UK and Irish directed *Nephrops* fleet.

Figure 15.3. 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 15.4. 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 15.5. 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. An average of 2017-2019 sampling is used for 2020.

Figure 15.6. 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. An average of 2017-2019 sampling is used for 2020

Figure 15.7. Irish Sea East (FU14): UWTV Survey stations for 2023. Highlighted stations were used in the assessment this year

Figure 15.8. 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 15.9. 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 15.10. 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 15.11. 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 was to be repeated in the summer of 2023 and forms the basis of advice for this stock in the autumn.

ICES advice applicable to 2024

"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 2020–2022, catches in 2024 should be no more than 12008 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 2022

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 2022 there was an increase in LPUE for Northern Irish vessels whilst for Irish vessels no effort data is available (Table 16.2).

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 2022 was 6741 t. Landings are derived primarily from Ireland and Northern Ireland.

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 fleet in 2022 increased to 3.9 kg/kWd while no effort data was available from the Irish Fleet.

Sampling levels

Since 2021 sampling levels are 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 2022 comprising 62% in landings and 58%. 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 (2016–2022) and mean weights in discards (2016–2022) 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 22.4% of the catch by number in 2022 (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 2023. In 2023 the survey was completed on both the RV Corystes (64 stations) and Tom Crean (32 stations). In 2021 there was change to using High Definition 'still' and video image cameras to collect footage onboard the RV Corystes, this was used again since. 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 2023 96 stations were completed, footage from 4 stations was not collected because of intensive fishing activity. Two stations were included as "true zeros" due to the abundance of rocks. Figures 16.7–16.10 are contour plot of the krigged-density estimates for FU15 over the period 2003–2023. The resulting krigged nephrop abundance estimate was 4649 million. A violin plot of the burrow densities observed in the survey (2003–2023) 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 2023 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 2022 (11.9%) 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 4650 million in 2023 follows a period (2016–2017) of above average size. Figure 16.14 is the stock summary plot for FU15. Recent harvest rates have fluctuated around F_{MSY}, but is estimated as 11.9 in 2022, which is in the range it has been since around 2017 (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 (2020–2022) 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 2023 UWTV survey.

The basis for the catch options.

Variable	Value	Notes
Stock abundance (2023)	4650	UWTV survey 2023; numbers of individuals in millions
Mean weight in projected landings	15.7	Average 2020–2022; in grammes
Mean weight in projected discards	8.6	Average 2020–2022; in grammes
Projected discard rate	27	Average 2020–2022; 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 2016–2022 fishery indicate that discarding above the minimum conservation reference size (MCRS) continues and has not changed markedly (Figure 3). ICES is providing advice for 2024 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, 2000–2022.

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		5676	0.0	8613
2015	2199		6433	0.3	8632
2016	1609		5715	3	7327
2017	1253		4896	0	6150
2018	1387		4369	0	5756
2019	1859		5731	0	7590
2020	1555		4560		6115
2021*	1512		5267		6779
2022*	1574		5156	10	6741

* provisional.

**Isle of Mann included in UK landings since 2014.

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 2000–2022.

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
2022	1574476	NA	NA	NA	NA

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, 2000–2022.

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				
2022*	5116			1314	3.89

* provisional.

Table 16.4. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2022.

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
2022	29.3	26.5	30.6	27.8	24.7	24.0

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, 2000–2022.

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
2022	28.2	24.7	29.1	25.9	22.2	21.7

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	415	120	536	11.9	6741	1090	22.4	20.1	16.3	9.01
2023	4650	0.035										

Table 16.7. Irish Sea West (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2023.

Year	Number of stations	Mean Density (No./M²)	Domain Area (km²)	Estimate (billions)	CV on Burrow estimate
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%

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%
2022	97	0.75	5791	4.5	3%
2023	96	0.80	5791	4.7	3.5%

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) 2000–2022.

Figure 16.3 *Nephrops* in FU15 (Irish Sea West). Sex ratio (percentage of males) of landings and discards (1986–2020).

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 2015–2020.

Figure 16.10. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea for 2021 to 2023

Figure 16.11. Irish Sea West (FU15): Box and kite plot of burrow density observed during UWTV survey 2003–2023.

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 2023

Available data on the fishery for 2022 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 since 2020 deviated from the stock annex and are detailed in 17.4 Data section below.

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."

ICES advice applicable to 2023

"ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming zero discards, catches in 2023 that correspond to the F ranges in the MAP are between 3054 and 3787 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 17.1. 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 2022 and 2023

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

TAC in 2023

Council Regulation (EU) 2023/194 of 30 January 2023 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks.

Species:	Norway lobster *Nephrops norvegicus*		Zone:	7 (NEP/07.)
Spain	981	(1)	Analytical TAC	
France	3 974	(1)		
Ireland	6 027	(1)		
Union	10 982	(1)		
United Kingdom	7 371	(1)		
TAC	18 353	(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 subarea 7 (NEP/*07U16)			
Spain	1 142			
France	715			
Ireland	1 374			
Union	3 231			
United Kingdom	556			

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

Approximately 14% of the defined fishing ground has been closed to fishing activities using bottom gears since 2023, owing to the implementation of the EU Deep-sea Access regulation (EU, 2016).

17.3 Fishery in 2022

WGCSE reviewed effort trends for Irish vessels that accounted for 58% of the total landings in 2022. The Irish fishery in 2022 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 in 2020, increased in 2021 and decreased in 2022 (Figure 17.4).

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, since 2020 graded information has not been 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.

17.4 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

[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.

Landings

Total international landings increased by 15% in 2022 to 2846 t (Figure 17.1 and Table 17.2). 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 17.3.

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.

Since 2020, 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 5, 12 and 9 *Nephrops* fishing trips, respectively in 2020, 2021 and 2022.

Commercial length–frequency distributions

The time-series of raised international length–frequency distributions of the sampled landings by sex are given in Figure 17.2. 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 17.4. These figures and tables are not updated since 2019.

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 17.3). 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 17.4 and Table 17.5. Since 2020, 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 *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. In 2022 discards were observed in three of the nine 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 2023 UWTV survey are available (Aristegui *et al*., 2023). 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 17.6. 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 2001–2022 (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 2022 survey for this report was taken from Fernández-Zapico *et al.* (2022).

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2022 is shown in Figure 17.5. 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 and 2022 (Figure 17.6).

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 since 2013 with significantly increased catch rates of individuals <21 mm (Figure 17.7). 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 17.7.

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 June 2023 UWTV survey (Aristegui *et al.* 2023).

State of the stock

The UWTV results are shown in Table 17.6. In 2017 the harvest rate was above FMSY for the first time. From 2018 to 2021 the harvest rate was below F_{MSY}, 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. However, in 2022, harvest rate was above F_{MSY} again, due to an increase in landed tonnes and numbers. Total abundance increased in 2023, and it is the highest value in the time-series. Due to the large increase in stock abundance in 2023, a review process was implemented according to the ICES UWTV Survey Protocols (Dobby *et al.*, 2021). This confirmed the high burrow density estimates in the 20% of stations that were recounted.

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 (2024)	2002	UWTV survey 2023; individuals in millions
Mean weight in projected landings (2024)	36.74	Average 2020 - 2022; in grammes
Mean weight in projected discards (2024)	-	Unknown
Projected discard rate (2024)	-	Unknown
Discards survival rate (2024)	-	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, increased in 2021 and decreased in 2022. 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 above F_{MSY}.

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 landings are considered fairly well estimated up to 2022 (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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Table 17.1. *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
2023	715	1374	1142	556	3787

Table 17.2. *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
2022	210	1649	380	<1	483	125	0	2846

Table 17.3. *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
2022					9	Unsorted Catch

Table 17.4. *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 1981–2022.

	Spain		Ireland		France		Porcupine Survey	
Year	Landings		Landings		Landings		Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
1981	39.9	34.5	-	-	-	-	-	-
1982	40.9	34.8	-	-	-	-	-	-
1983	40.8	34.0	-	-	-	-	-	-
1984	39.7	33.1	-	-	-	-	-	-
1985	38.7	33.5	-	-	-	-	-	-
1986	40.7	36.4	-	-	-	-	-	-
1987	39.3	35.0	-	-	-	-	-	-
1988	40.7	38.3	-	-	-	-	-	-
1989	40.5	36.8	-	-	-	-	-	-
1990	41.0	36.1	-	-	-	-	-	-
1991	39.4	34.5	-	-	-	-	-	-
1992	39.2	34.1	-	-	-	-	-	-
1993	41.6	36.1	-	-	-	-	-	-
1994	40.8	36.5	-	-	-	-	-	-
1995	41.3	36.6	40.7	36.5	43.2	38.3	-	-
1996	41.6	35.1	34.6	35.3	41.7	38.9	-	-
1997	39.7	34.8	35.9	34.5	41.9	38.4	-	-
1998	41.1	34.6	37.2	35.6	41.9	38.4	-	-
1999	41.5	35.7	36.6	33.7	43.1	39.1	-	-
2000	41.1	34.8	na	na	45.3	40.5	-	-
2001	41.1	36.3	37.8	35.4	45.4	39.4	36.0	28.9
2002	39.7	35.3	36.1	38.5	45.3	40.3	37.5	31.7
2003	41.4	37.8	44.5	36.2	46.2	38.9	39.7	30.9
2004	43.5	38.5	43.5	35.7	46.4	41.5	39.9	30.5
2005	43.4	38.1	46.9	40.6	45.9	41.0	45.1	33.8
2006	43.9	38.0	na	na	48.9	41.4	44.3	35.0

Year	Spain		Ireland		France		Porcupine Survey	
	Landings		Landings		Landings		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
2022	na	na	na	na	na	na	34.3	27.6

Table 17.5. *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
2022	97.7	2846	29.13
	Average 2020–2022		36.74

Table 17.6. *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	No survey		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	98	NA	98	7.2	2846	NA	NA	NA	36.7	NA
2023	2002	122										

***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 17.7. *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
2001	44	6	24	15	230.2	1.12
2002	54	5	18	18	339.8	1.3

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)
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
2022	na	na	na	na	1875.4	0.88

[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 17.1. *Nephrops* in FU16 (Porcupine Bank). WG's best estimates of landings in tonnes by country.

Figure 17.2. *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 17.3. *Nephrops* in FU16 (Porcupine Bank). The percentage males in the landings, survey and catches over time.

Figure 17.4. *Nephrops* in FU16 (Porcupine Bank). Mean weight in the commercial landings.

Figure 17.5. ***Nephrops*** **in FU16 (Porcupine Bank). Geographic distribution of** ***Nephrops norvegicus*** **in Porcupine surveys between 2010 and 2022. Top panel: catches (kg×30 min haul-1). Bottom panel: Number of juveniles (≤ 21 mm carapace length). (Fernández-Zapico** ***et al.*** **2022)**

Figure 17.6. *Nephrops* in FU16 (Porcupine Bank). Evolution of *Nephrops norvegicus* biomass and abundance indices in Porcupine surveys (2001-2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark boot-strap confidence intervals (α = 0.80, bootstrap iterations = 1000). (Fernández-Zapico *et al.* 2022)

Figure 17.7. 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 2001-2022. (Fernández-Zapico *et al.* 2022)

Figure 17.8. *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 2023

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 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."

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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 18.1.1. 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 recent years. The time-series of vessel power is shown as a box and kite plot in Figure 18.1.2.

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 2022

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 was 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 18.2.1 and Table 18.2.1. The 2022 landings decreased by about 9% from those made in 2021 and amounted to 452 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 18.2.2 and Table 18.2.2. 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, but are increasing in recent years.

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 18.2.3 and Table 18.2.3. 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 18.2.4. 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 and 2022. In 2022 the mean length of males also decreased, increasing their discard rate.

Sex ratio

In 2022 the difference on the sex ratios between the catches and the landings is explained by the higher discarding of females (Figure 18.2.5). 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 18.2.6). The annual mean weight estimate for landings and discards is shown in Figure 18.2.7. The mean weight estimates have been relatively stable from 2011, with the main

change occurring in 2008–2011. In 2020 the discards mean weight increased significantly, but is decreasing in recent years.

Discarding

Table 18.2.4 gives weights, numbers and proportions of the landings and discards 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). Operational details of the 2023 UWTV survey are available (Aristegui et al., 2023).

The spatial distributions of burrow densities are shown in Figure 18.2.8. 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 18.2.5 and plotted in Figure 18.2.10. The geostatistical abundance estimate adjusted is derived using the mean of the krigged grid where the mean of the observations is reported in Table 18.2.5. In recent years the Aran Grounds accounted for ~95% of the total estimated burrow abundance from FU17 (Table 18.2.5). Galway Bay accounted for ~4% and Slyne Head for ~1% (Table 18.2.6). The Galway Bay estimates fluctuate widely but are highly correlated with the Aran ground (Figure 18.2.9). 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 18.2.9).

Aran ground abundance estimate's CV (Table 18.2.5) 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 18.2.6) and within the recommendation, showing the surveys are precise. Figure 18.2.10 and Table 18.2.7 show the total abundance estimate for FU17 with the IBPNeph proposed MSY $B_{trigger}$. The 2023 combined abundance estimate (375 million) was 13% higher than in 2021 and is below the MSY $B_{trigger}$ (540 million).

Comparison with previous assessments

The WGCSE 2023 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

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 the lowest observed in the time-series and is below the MSY $B_{trigger}$. The 2023 abundance is

slightly higher, but remains below the average of the series (geomean [2002–2023]: 602 million). Harvest rate [calculated as (landings + dead discards)/abundance estimate] in 2022 was above $F_{MSYproxy}$ for the first time since 2016 (Table 18.3.1 and Figure 18.3.1). 2022 harvest rate was estimated using the mean of the 2021 and 2023 abundances (353 million), as UWTV survey was not carried out in 2022.

18.3 Catch scenario table

Catch scenario table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 18.3.1 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 (2024)	375	UWTV survey 2023; individuals in millions
Mean weight in projected landings (2024)	22.20	Average 2008–2022; in grammes
Mean weight in projected discards (2024)	11.19	Average 2008–2022; in grammes
Projected discards (2024)	29	Average 2020–2022; percentage by number
Discards survival (2024)	25	Percentage by number

Given the fluctuations observed in mean weights for landings and discards (Figure 18.2.7) 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).

18.4 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 18.2.10 and Table 18.2.7).

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.

18.5 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.

18.6 Quality of assessment and forecast

Biological sampling for this stock is adequate. Since 2002 a dedicated annual UWTV survey has provided abundance estimates for the Aran Grounds with high precision. The area of the Aran Grounds was revised in 2015, resulting in a recalculation of the abundance time-series which now also includes Galway Bay and Slyne Head. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of an inter-benchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. From 2016, fisheries catching *Nephrops* in Subarea 7 are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 5% discard rate by weight for the trawl fishery in 2019 (reduced from 6% in 2018 and 7% in both 2016 and 2017). The average discard rate by weight for FU17 over the last three years is 18.6%. 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).

18.7 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.

18.8 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.

18.9 References

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Table 18.2.1. *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
2022	0	445	8	452

Table 18.2.2. *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

Year	Effort (Kw Days)	Landings (Kgs)
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
2022	225,430	444,615

Table 18.2.3. *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

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2009	2	6	6	1685	1978
2009	3	6	6	2260	2726
2009	4	2	2	1491	1149
2010	1	4	4	3322	2322
2010	2	8	7	3577	2957
2010	3	2	2	951	742
2010	4	6	4	3209	1802
2011	1	7	7	3755	3537
2011	2	7	7	7399	6617
2011	3	4	2	3531	2386
2011	4	5	5	2440	2271
2012	1	3	3	1538	1250
2012	2	17	15	6481	5113
2012	3	0	0	-	-
2012	4	5	5	2333	1945
2013	1	10	9	3108	2983
2013	2	11	11	3733	3733
2013	2	3	3	1163	1263
2013	4	7	7	2956	1779
2014	1	3	3	1208	1223
2014	2	12	12	5365	3563
2014	3	2	2	786	499
2014	4	8	8	3542	2760
2015	1	2	2	827	611
2015	2	2	2	961	664
2015	3	0	0	-	-
2015	4	2	2	1047	1388
2016	1	5	4	2292	876

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
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
2022	1	4	4	1132	1126
2022	2	1	1	385	261
2022	3	2	2	647	552

Table 18.2.4. *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
2022	452	122	23,436	13,949	21.2	37.3

Table 18.2.5. *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
	2022***	-	-	-	-	-
	2023	34*	0.29	1196	356	3

*** reduced isometric grid.**

**** mean density of the observations.**

***** no UWTV survey.**

Table 18.2.6. *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
	2023	5	0.19	79.0	15.1	7

*** 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
	2022**	0	-	-	-	-
	2023	5	0.12	39.1	4.6	4

***estimated as no survey data available for these years.**

**** no UWTV survey.**

Table 18.2.7. *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	353*		
2023	375	415	336

*** 2022 abundance value is an interpolated value from 2021 and 2023 abundances**

Table 18.3.1. *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% Confi-dence 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% Confi-dence 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	No survey		23	14	34	9.6*	452	122	37.3	30.9	19.30	8.74
2023	375	40										

*** The harvest rate is estimated based on a linear interpolation of abundance (353 million), as no survey was carried out in this year.**

Figure 18.1.1. *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 18.1.2. *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 18.2.1. *Nephrops* in FU17 (Aran Grounds). Landings in tonnes by country.

Figure 18.2.2. *Nephrops* in FU17 (Aran Grounds). Effort data (kW days) for Irish directed *Nephrops* fleet.

Figure 18.2.3. *Nephrops* FU17 (Aran Grounds). Sampling levels for the Aran grounds.

Figure 18.2.4. *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 2022 (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 18.2.5. *Nephrops* FU17 (Aran Grounds). Proportion of males by number in the catch (blue) and landings (black).

Figure 18.2.6. *Nephrops* FU17 (Aran Grounds). Mean weight in catch samples by sex showing cyclical trends.

Figure 18.2.7. *Nephrops* FU17 (Aran Grounds). Annual mean weight (g) estimates of landings (blue) and discards (black).

Figure 18.2.8. *Nephrops* in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002 (top left) to 2023 (bottom right). No UWTV survey in 2022.

Figure 18.2.9. *Nephrops* FU17 Aran Grounds. *Nephrops* burrow estimates in FU17 Aran (blue), Galway Bay (green) and Slyne Head (red) grounds 2002–2023. 2022 UWTV was only carried out in Galway Bay.

Figure 18.2.10. Time-series of total abundance estimates for FU17.

Figure 18.3.1. *Nephrops* FU17 Aran Grounds. Harvest Rate represented by red line (% dead removed/UWTV abundance). The harvest rate in 2022 was calculated using an interpolated value for abundance, as no survey data are available.

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 2023

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).

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."

ICES advice applicable to 2023

"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 2019–2021, catches in 2023 that correspond to the F ranges in the MAP are between 302 and 338 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 have 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 2022

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 six vessels in 2022.

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

No revisions to catch data this year.

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). 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. Landing in 2022 were at a similar level to that reported in 2020. 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 with an increase in 2022 to 5.4 t. UK landings are minor < 0.5 t in 2022.

Total landings for years 2019 (value 249.1477 t) and 2020 (value 248.9602 t) are the same (249 t) due to rounding.

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 1995–2022 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 year period. 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 2022 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 2022. 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. This pattern has changed somewhat due to spatial extent of the discrete mud patches. 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 2022 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 slight decrease in 2022.

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 11–39% of total catch by weight and 18–56% 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 2023 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 2023 all discrete grounds were covered by the TV survey (Doyle *et al.,* 2023).

The 2023 mean density estimates vary between patches from the lowest value 0.04 (no./m²) observed at Galley Grounds 1 to the highest observed at 0.33 (no./m²) at Galley ground 3 (Table 19.2.6, Figure 19.2.8). The overall mean density for FU19 in 2023 is 0.11 (no./m²) which is the second lowest observed in the time-series (Table 19.2.7). In 2023 there was a high number of zero density stations observed (Table 19.2.8) which could account for the low abundance estimate.

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; 2016YY). The 2023 abundance estimate was 15% lower than in 2022 and at 220 million is below the MSY $B_{trigger}$ (430 million) with a RSE of 17% 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 2003–2022 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 2023 estimate is the second lowest observed and is below the MSY $B_{trigger}$. The 2023 abundance remains below the average of the series (geomean: [2011–2023]: 384 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 (2024)	220	Numbers of individuals (millions); UWTV survey 2023
Mean weight in projected landings	27.33	Average 2020–2022 in grammes
Mean weight in projected discards	13.70	Average 2020–2022 in grammes
Projected discards	47.9	Proportion by number; average 2020–2022
Discards survival	25	Proportion by number
Projected dead discards	40.8	Proportion by number; average 2020–2022

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 2023 UWTV survey. This will be presented in October 2023 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 2020–2022 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 2023 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 0.11 with a RSE of around 17% which is below the 20% threshold recommended by SGNEPS (ICES, 2012). The cumulative bias estimates for FU19 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterized, but is likely to be lower than that observed in the survey.

Landings data are adjusted to take into account landings that have been misreported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 19).

19.8 Recommendations for next benchmark

This stock was benchmarked by ICES in February 2014 (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

19.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to 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 2023 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
2012	11	837	1	849
2013	4	783	6	794
2014	6	459	3	468

Year	FU 19			
	France	Rep. of Ireland	UK	Total
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	<0.5	249
2021	1	413	1	415
2022	5	242	<0.5	247

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
2020	72.3	133.4	12.7	19.1

Year	All Vessels		Vessels >18 m	
	kW days ('000)	Landings Tonnes	kW days ('000)	Landings Tonnes
2021	125	261	29	47
2022	79	143	13	14

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
2013	1	3	0	0	1857	0	0

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
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
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
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

Year	Quarter	Number of samples			Numbers Measured		
		Catch	Discards	Landings	Catch	Discards	Landings
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
2022	1	3	3	0	1090	1117	0
2022	2	2	2	0	833	876	0
2022	3	2	2	0	700	590	0
2022	4	1	1	0	633	519	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
2022	32	38	210	67	30.1

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
2022	1,669	3,062	7,035	4,413	46.2

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/m^2) 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

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
2023	Bantry	4	0.21	0.11	0.05	0.17
2023	Cork Channels	10	0.06	0.12	0.04	0.08
2023	Galley Grounds 1	2	0.04	0.00	0.00	0.04
2023	Galley Grounds 2	2	0.24	0.24	0.17	2.12
2023	Galley Grounds 3	4	0.33	0.06	0.03	0.09
2023	Galley Grounds 4	14	0.05	0.07	0.02	0.04
2023	Helvick 1	2	0.14	0.05	0.04	0.45
2023	Helvick 2	2	0.09	0.09	0.07	0.85
2023	Kenmare Bay	2	0.12	0.06	0.04	0.50

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
2023	42	0.11	0.13	220	296	145	17

^ exploratory survey.

***No TV survey from 2007 to 2010.**

Table 19.2.8. *Nephrops* in FU19 (SW and SE Ireland). Number of UWTV stations with zero density observed.

Year	Number of zero density stations	Total Number of Stations achieved
2006^	0	6
2007*		
2008*		
2009*		
2010*		
2011	5	35
2012	1	40
2013	6	40
2014	4	40
2015	7	39
2016	4	42
2017	6	41
2018	7	42
2019	11	42
2020	5	42
2021	1	42
2022	3	42
2023	10	42

^ exploratory survey.

***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).

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	8.9	7.6	14.6	**46.2**	**39.2**	259	73	5.7	247	107	**27.8**	**14.0**
2023						**220**	**75**					
Average 2020–2022				**47.9**	**40.8**						**27.3**	**13.7**

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 2002–2022. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and visual reference 35 mm CL.

Figure 19.2.5. *Nephrops* in FU19 (Ireland SW and SE Coast). Annual sex ratio of landings from available time series.

Figure 19.2.6. *Nephrops* in FU19 (Ireland SW and SE Coast). Mean weight in available 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 of adjusted burrow density (burrow/m²) distributions by year from 2006–2023. 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 2003–2022. Vertical lines displayed are Minimum Conservation Reference Size 25 mm Carapace Length (CL) and visual reference 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 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."

ICES advice applicable to 2023

"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 2019–2021, catches in 2023 should be no more than 1803 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 the 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 (quarter 2 and 3), 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 five year period (2018–2022). 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 7 % of the landings from this FU in the recentfive year period (2018–2022) with highest landings recorded in 2018 (411 t).

Fishery in 2022

Ireland

In 2022, 38 Irish vessels reported landings from FU2021. Of these, 25 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 2022, 33 French vessels reported landings from FU20–21 where many of these switch between FU20–21 and FU22 within a trip. Of these seven vessels reported landings in excess of 10 t.

UK

10 UK vessels (UK E&W 9 vessel:, UKNI: 1 vessel) 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

A minor revision to landings reported by Ireland for year 2021 was presented and accepted by the working group. This data is used in assessment and resulted in a minimal impact on assessment.

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 Irish landings were the lowest value reported since 2005 and have shown a small increasing trend to 2022. French landings have gradually decreased since the early 2000s to the present reported landings of 148 t. Reported landings from the UK have fluctuated with an increasing trend since 2015. Minor landings were reported by the UK (6 t) and Belgium (< 0.5 t) in 2022.

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 1995–2022. The effort series is based on the same criteria for FU15, 16, 17, 19 and 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 2022, 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 has not been reported in recent years (2020-2022) due to very low level participation in this fishery.

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 2022 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 since 2021 due to the quite low level of participation in the fishery.

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 since 2013.

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 2023 full survey coverage was achieved. The geo-statistical analysis for years 2013 to 2023 follows the steps documented in Doyle *et al*., 2023.

The 2023 mean burrow density was 0.104 burrows/m^2 compared with 0.101 burrows/m^2 in 2022. The 2023 geostatistical abundance estimate was 1026 million a 1% decrease on the abundance for 2022 with a CV of 4% which is well below the upper limit of 20% recommended by SGNEPS 2012. There was a slight decrease in densities observed in 2023. 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 2023 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 2023 estimate is a very slight decrease from 2022 estimate by 1%.

The 2023 estimate is above the newly proposed MSY $B_{trigger}$ (450 million). The 2023 estimate (1026 million) is below the average of the series (geomean [2014–2023]: 1546 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 rates are presented in Table 23.3.1 and summarised below.

In line with previous practice an average (2020–2022) of mean weights is used to account for this variability. Three year average (2020–2022) 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)	1026	Numbers of individuals (millions); UWTV survey 2023
Mean weight in projected landings	31.2	Average 2020–2022 in grammes
Mean weight in projected discards	16.5	Average 2020–2022 in grammes
Projected discards	13.0	Proportion by number; Average 2020–2022
Discards survival	25	Proportion by number
Projected dead discards	10.1	Proportion by number; Average 2020–2022

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 2023 UWTV survey. This will be presented in October 2023 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 (2014–2023). Since 2019 the survey cam-

era 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 7%. 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 2023 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	572	9	3	697

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**
2022	148	640	6	<0.5	795

***Revision to reported landings**

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)
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
2022	350	506

Table 20.2.3. *Nephrops* FU 20–21. Effort data for the French fleet.

Year	Effort France ('000 hrs)	Lpue France (kg/hr)
1983	231	14
1984	205	16
1985	203	16
1986	163	15
1987	190	15
1988	171	16
1989	179	17
1990	230	16
1991	225	11
1992	277	12
1993	268	13
1994	259	14
1995	239	15
1996	220	14
1997	187	13
1998	155	13
1999	151	11
2000	194	14
2001	170	15
2002	166	19
2003	192	18
2004	153	16
2005	147	16
2006	137	16
2007	102	19
2008	100	23
2009	93	23
2010	67	17

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*		
2022*		

*** data not available due to low level fishery participation**

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

IRELAND		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
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	
2022	1	7	3		2,631	1,087	
2022	2	10	4		4,150	1,049	
2022	3	10	4		3,944	1,083	
2022	4	2	1		761	20	

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
2022	5,535	14,246	72

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**	-	-	-
2022**	-	-	-

***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**	-	-	-	-	-	-	-	-	-	-
2022**	-	-	-	-	-	-	-	-	-	-

***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
2022	19.8	3.6	22.5	11.9	15.3	8.1	640	56	32.4	15.8

***2021 data revision due to national landings error.**

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*	21.1	2.8	23.2	8.9	11.5	6.3	697	47	33.0	17.0
2022	24.6	4.4	27.9	11.9	15.3	8.1	795	70	32.4	15.8

***2021 data revision due to international landings error.**

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
	2023	100	0.10	10, 014	1026	4.4	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	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*	21.1	2.8	23.2	8.9	11.5	1202	92	1.93	697	47	33.0	17.0
2022	24.6	4.4	27.9	11.9	15.3	1032	96		795	70	32.4	15.8
2023						1026	89					
Average 2020–2022				**10.1**	**13.0**						**31.2**	**16.5**

* revision due to landings revision.

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 solid line.

Figure 20.2.6. ***Nephrops*** **FU 20–21. Contour plots of krigged density estimates for the UWTV surveys from 2013 to 2023.**

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 2023

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 2022 and 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 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."

ICES advice applicable to 2023

"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 2019–2021, catches in 2023 should be no more than 2548 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). 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 years and is mainly UK-Northern Irish vessels in this fishery.

Fishery in 2022

In 2022, 64 Irish vessels reported landings from FU22. Of these, 50 vessels reported landings in excess of 10 t. Vessels >18 m account for 90% of the landings in 2022. 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 2022, fourteen French trawlers reported landings for FU22. French vessels switch between FU20–21 and FU22. In 2022, two Northern Ireland 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 were no revisions to the catch data reported for this stock.

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 with the highest landings in 2016. Since then there has been an overall declining trend to the lowest level observed in 2022 (1242 t). French landings have gradually decreased since the early 2000s to the present. Reported landings from the UK have fluctuated with a decrease in 2022. Belgium reported minimal landings on average <7 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 1995–2022. 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 2022 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 21.2.3). 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*., 2023). 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. There is a declining trend in the recent years. The 2023 mean density 0.27 burrows/m^2 is approximately 12% decrease compared with density 0.31 burrows/m^2 in 2022. The summary statistics from this geostatistical analysis are given in Table 21.2.4 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 21.2.4.

The 2023 estimate of 776 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. The 2023 estimate is below the MSY $B_{trigger}$ (990 million). The 2023 estimate (776 million) is below the average of the series (geomean [2006–2023]: 1102 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 6.4% 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 (2020–2022) 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)	776	Number of individuals (million); UWTV survey 2022
Mean weight in projected landings	26.0	Average 2020–2022 in grammes
Mean weight in projected discards	12.9	Average 2020–2022 in grammes
Projected discards	20.4	Proportion by number; average 2020–2022
Discards survival	25	Proportion by number
Projected dead discards	16.18	Proportion by number; average 2020–2022

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 2023 UWTV survey. This will be presented in October 2023 for the provision of advice.

21.5 Reference points

New reference points were derived by WKMSYRef4 (ICES, 2016c, 2016d) 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 11%. 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 2023 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 2023.

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*.

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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	1616
2022	4	1242	17	9	1271

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
2022	599	1156	1.9

Table 21.2.3. *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)	Discards by weight (%)	Discards 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
2022	1242	138	47.5	11.2	10.0	19.1

Table 21.2.4. *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
2023*	41	0.27	3063	776	6.9

*** 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	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2003	95.2	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
2022	48.7	11.5	57.3	15.0	19.1	895	115	6.4	1271	141	26.1	12.3
2023						776	105					
Average 2020-2022				**16.18**	**20.42**						**26.0**	**12.9**

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).

23 Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)

Type of assessment in 2023

There is no assessment for this stock. Advice is provided on a triennial basis (and is provided this year for 2024, 2025 and 2026) according to the approach outlined below.

In 2023, the updated advice followed the agreed procedures for category 6 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.

23.1 General

Advice

The advice for 2024, 2025 and 2026 was for catches of no more than 15 tonnes (Table 23.1).

ICES framework for category 6 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was last applied in 2020 (for the 2021–2023 advice), and with no new information available to support the current level of catches the precautionary buffer is applied for the 2024 advice. Discarding patterns are unknown.

Table 23.1. Plaice in divisions 7.b and 7.c. The basis for the catch scenarios. *

Advised landings (2021–2023)		19 tonnes
Discard rate		Unknown
Precautionary buffer	Applied	0.8
Landings advice **		15 tonnes
% advice change ***		-20

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

**** [Recent advised landings] × [precautionary buffer].**

***** Advice value for 2024 relative to the advice value for 2023.**

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 Figures 23.1a and b. In recent years, the official landings differ from the ICES estimates due to confidentiality of data reported to Eurostat. The ICES estimated landings are presented in Figure 23.2.

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 therefore not sufficient to generate a time-series of annual length or age distributions. In 2022, there were only four sampling trips on board OTB_CRU vessels in the area, however no plaice were encountered, landed or discarded.

Table 23.1. Plaice in divisions 7.b and 7.c. History of commercial catch and landings; both the official and ICES estimated values are presented for each country. All weights are in tonnes.

Year	France	UK	Ireland	Others	Total	ICES estimates
1908	0	0	135	0	135	
1909	0	0	49	0	49	
1910	0	0	36	0	36	
1911	0	2	54	0	56	
1912	0	1	40	0	41	
1913	0	0	54	0	54	
1914	0	0	85	0	85	
1915	0	1	23	0	24	
1916	0	0	22	0	22	
1917	0	0	36	0	36	
1918	0	0	29	0	29	
1919	0	1	32	0	33	
1920	0	25	15	0	40	
1921	0	9	34	0	43	
1922	0	1	37	0	38	
1923	0	1	30	0	31	
1924	0	4	166	0	170	
1925	0	5	28	0	33	
1926	13	10	42	0	65	
1927	126	14	45	0	185	
1928	40	7	35	0	82	
1929	262	25	31	0	318	
1930	96	6	44	0	146	
1931	238	8	58	0	304	
1932	411	19	76	0	506	
1933	595	29	29	0	653	
1934	406	31	33	0	470	
1935	249	18	33	0	300	
1936	265	47	37	0	349	
1937	242	59	25	0	326	
1938	359	25	20	0	404	
1939	0	0	24	0	24	
1940	0	0	47	0	47	
1941	0	0	43	0	43	
1942	0	0	41	0	41	

Year	France	UK	Ireland	Others	Total	ICES estimates
1943	0	0	29	0	29	
1944	0	0	42	0	42	
1945	0	0	30	0	30	
1946	0	5	32	0	37	
1947	0	9	36	5	50	
1948	0	8	47	0	55	
1949	0	20	63	0	83	
1950	289	16	42	0	347	
1951	100	12	31	0	143	
1952	120	18	46	0	184	
1953	340	8	48	0	396	
1954	273	5	72	0	350	
1955	111	3	96	0	210	
1956	174	1	64	0	239	
1957	80	1	60	0	141	
1958	204	0	71	0	275	
1959	392	5	54	0	451	
1960	197	3	46	0	246	
1961	182	0	30	0	212	
1962	239	0	42	0	281	
1963	471	2	67	0	540	
1964	427	2	66	0	495	
1965	417	2	99	0	518	
1966	0	1	127	0	128	
1967	182	2	112	0	296	
1968	403	0	89	0	492	
1969	281	2	99	0	382	
1970	124	0	110	0	234	
1971	0	1	89	0	90	
1972	110	0	124	0	234	
1973	60	1	124	0	185	
1974	45	1	106	0	152	
1975	10	0	153	0	163	
1976	9	0	133	0	142	
1977	4	0	135	0	139	
1978	16	0	122	0	138	

Year	France	UK	Ireland	Others	Total	ICES estimates
1979	6	0	117	2	125	
1980	12	0	142	65	219	
1981	9	4	135	58	206	
1982	8	4	122	22	156	
1983	37	0	108	7	152	
1984	2	6	110	0	118	
1985	10	7	150	0	167	
1986	11	5	114	0	130	
1987	13	1	153	0	167	
1988	9	2	157	0	168	
1989	1	14	159	0	174	
1990	11	92	130	0	233	
1991	9	3	179	0	191	
1992	3	9	180	0	192	
1993	2	3	191	0	196	
1994	1	5	200	0	206	
1995	5	2	239	0	246	
1996	1	2	248	0	251	240
1997	3	0	206	0	209	213
1998	0	1	160	0	161	183
1999	0	2	157	0	159	172
2000	31	0	99	0	130	108
2001	8	0	70	0	78	87
2002	17	2	51	0	70	71
2003	7	0	56	2	65	72
2004	14	0	39	1	54	55
2005	12	0	25	0	37	38
2006	11	0	20	1	32	30
2007	12	0	23	0	35	34
2008	9	0	21	1	31	35
2009	7	0	45	0	52	53
2010	6	0	27	0	33	33
2011	2	0	16	0	18	16
2012	9	0	20	0	29	26
2013	3	0	15	0	18	18
2014	6	0	17	0	23	23

Year	France	UK	Ireland	Others	Total	ICES estimates
2015	7	0	15	0	22	22
2016	12	0	17	0	29	29
2017	1	0	11	0	12	12
2018	5	< 1	7	0	9	9
2019	< 1	0	< 1 [c]	< 1	1[c]	9
2020	< 1	0	0 [c]	< 1	<1 [c]	6
2021*	< 1	0	3	< 1	3	3
2022*	< 1	0	2	< 1	2	2

***Preliminary official landings.**

[c] Incomplete/missing, as part of the data is unavailable under data confidentiality clauses.

Figure 23.1a. Landings of plaice in 7.bc as officially reported to ICES (1908–2022).

Figure 23.1a. Landings of plaice in 7.bc as officially reported to ICES (2003–2022).

Figure 23.2. Plaice in divisions 7.b–c. ICES estimated landings.

24 Plaice in Division 27.7.a (Irish Sea)

Type of assessment in 2023

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 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 2925† tonnes.

Advice for 2022 is available at:

https://ices-library.figshare.com/articles/report/Plaice_Pleuronectes_platessa_in_Division_7_a_Irish_Sea_Replacing_advice_provided_in_2021/20116340?backTo=/collections/ICES_Advice_2021/5796932

†This advice was updated in May 2022 to reflect a revision to the calculation of NIGFS-WIBTS-Q1, and NIGFS-WIBTS-Q4 survey index calculation,

ICES advice applicable to 2023

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 2019–2021, total catches in 2023 should be no more than 2039 tonnes.

Advice for 2023 is available at:

https://ices-library.figshare.com/articles/report/Plaice_Pleuronectes_platessa_in_Division_7_a_Irish_Sea_/19453592?backTo=/collections/ICES_Advice_2022/5796935?backTo=/collections/ICES_Advice_2022/5796935?backTo=/collections/ICES_Advice_2022/5796935?backTo=/collections/ICES_Advice_2022/5796935

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 2022 and 2023

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.

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)

2023

Species:	Plaice *Pleuronectes platessa*	Zone:	7a (PLE/07A.)
Belgium	44	Analytical TAC Article 7(2) of this Regulation applies	
France	19		
Ireland	767		
Netherlands	13		
Union	843		
United Kingdom	1 042		
TAC	2 039		

(Source: Council Regulation (EU) 2023/194, ANNEX IA)

The fishery in 2022

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 (2022)		Landings			Discards		
71% dead	29% surviving	Beam trawl	Otter trawl	Other gear types	Beam trawl	Otter trawl	Other gear types
		74%	23%	3%	78%	19%	3%
663 tonnes		180 tonnes			484 tonnes		
					60% dead	40% surviving	

*** 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.**

The TAC for 2022 was 2747 tonnes and the working group estimate of landings in 2022 was 180 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 24%, 3.5%, 16% and 56% respectively of total landings in 2022. The landings of plaice are mainly split between beam trawlers (76%; primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (24%; primarily 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* (Figure 24.4 and Figure 24.5). 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).

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 the 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, reaching the highest level in 2016, then a subsequently decrease 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 have 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 (0.12.0); Pander (0.6.5); knitr (1.39); captioner (2.2.3); rmarkdown (2.14); icesAdvice (2.1.1); reshape (0.8.8); cowplot (1.1.1); ggplot2 (3.3.5); icesTAF (4.2.0).

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		2019	2020	2021	2022	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	1993–2018, ages 1–7	1993–2019, ages 1–7	1993–2019, ages 1–7	1993–2021, ages 1–7	1993–2022, 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	Survey omitted	Survey omitted
	UK(E&W) BT	Series omitted	Series omitted	Series omitted	Survey omitted	Survey omitted
	IR-OTB	Series omitted	Series omitted	Series omitted	Survey omitted	Survey omitted
	NIGFS-WIBTS-Q1	1992–2018	1992–2019	1992–2020	1992–2021	1992–2022
	NIGFS-WIBTS-Q4	1992–2018	1992–2019	1992–2020	1992–2021	1992–2022
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		1981–2018, ages 1–8+	1981–2019, ages 1–8+	1981–2020, ages 1–8+	1981–2021, ages 1–8+	1981–2022, ages 1–8+
Discards N at age		1981–2018, ages 1–8+	1981–2019, ages 1–8+	1981–2020, ages 1–8+	1981–2021, ages 1–8+	1981–2022, 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 four-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 2017–2022. 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 decrease 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 1.5% for recruitment, 0.9% for SSB and -1.6% 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 and in the most recent years. 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. A gradual slightly increase has been seen in the last two years. Catch has decreased to low levels and, since 2006, the majority of the catch has been discarded (60% in weight and 81% in 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 (2023) 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 2015–2022 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 a slightly increase in recent years (2021 and 2022). F *status quo*, Fsq, has been estimated by averaging the F over 2020–2022 (0.071).

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 1902 t (769 t of landings and 1133 t of discards including dead and survivors) in 2024 and SSB of 10054 t in 2025.

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 applicable		
	F_{mgt}	Not applicable		

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).

Landings and discards sampled weights-at-age from a portion of the beam trawl fleet showed a substantial decline in 2022 compared to previous years which was not observed in other fleets or the UK (E&W)-BTS-Q3 survey. As a result of the differing trends, the discard and landing weights-at-age were replaced by the average of 2019–2021.

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 plus group (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 plus group (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 plus group, 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
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	1	-	332	271
2021*	101	0	107	-	70	1	-	279	392
2022*	101	0	43	-	35	0	0	179	484

*** 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[8]	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	6.8	1.4	9.6	-	194	-[8]	223	-	13.9	13.2	8.9
2022		250	-	-	274	-[8]	104	5.1	0.8	5.3	-	133	-[8]	118	-	18.5	13.0	6.0

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
2022	13.17	16.61	12.15	2.90	8.39	2.81

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
2022	8.42	2.20	10.28	1.90	0.97	2.46

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
2022	174.18	0.36	3.86	2.66	1.09	0.97	0.35	0.38	0.22	0.14	0.27
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 1981–2022 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 2

1981 2022

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
0	6	21	81	91	89	76	147

Table 24.6. Irish Sea plaice: Landings weight-at-age 1 to 8+ (kg), where rows are years 1981–2022 and columns are ages 1 to 8+,

IRISH SEA PLAICE

1 3

1981 2022

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
0.072	0.211	0.247	0.285	0.306	0.351	0.362	0.429

Table 24.7. Irish Sea plaice: Discards weight-at-age 1 to 8+ (kg), where rows are years 1981–2022 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 23

1981 2022

1 8

1

0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.087	0.105	0.130	0.153	0.170	0.231	0.318	0.211
0.057	0.115	0.145	0.164	0.211	0.290	0.238	0.210
0.099	0.117	0.134	0.179	0.178	0.277	0.644	0.356
0.141	0.113	0.141	0.145	0.162	0.210	0.274	0.077
0.044	0.081	0.113	0.140	0.150	0.205	0.219	0.243
0.096	0.097	0.116	0.135	0.151	0.173	0.217	0.170
0.033	0.080	0.119	0.147	0.165	0.196	0.232	0.276
0.083	0.101	0.138	0.183	0.201	0.140	0.194	0.225
0.077	0.098	0.116	0.141	0.157	0.168	0.164	0.176
0.026	0.038	0.081	0.119	0.162	0.200	0.157	0.182
0.064	0.069	0.094	0.116	0.144	0.157	0.181	0.181
0.056	0.067	0.084	0.120	0.128	0.150	0.152	0.153
0.088	0.059	0.079	0.101	0.095	0.126	0.152	0.136
0.136	0.103	0.109	0.120	0.146	0.161	0.155	0.170
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
0.048	0.079	0.102	0.121	0.143	0.153	0.176	0.186

Table 24.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg), where rows are years 1981–2022 and columns are ages 1 to 8+.

IRISH SEA PLAICE

1 4

1981 2022

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	0.1	0.131	0.170	0.227	0.236	0.289	0.381
0.048	0.080	0.105	0.138	0.168	0.191	0.212	0.311

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
2022	0	6	21	81	91	89	76	147	512

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
2022	208	1017	959	709	486	380	319	138	4217

Table 24.11. Irish Sea plaice: Estimated population numbers-at-age (thousands).

year\age	1	2	3	4	5	6	7	8	total
1981	16999	19779	17720	7235	2021	692	329	765	65541
1982	22082	12738	13220	7745	3289	1010	393	657	61134
1983	23495	20320	7939	6401	3340	1666	569	641	64370
1984	22623	20983	14213	3386	2758	1505	886	699	67052
1985	21058	20143	14540	7237	1555	1425	816	938	67713
1986	21415	17708	14651	7011	3488	789	834	1001	66897
1987	20708	19476	12267	7522	3136	1822	404	1045	66381
1988	15676	19965	13082	5345	2968	1403	870	811	60120
1989	12815	13420	14511	5969	2180	1285	649	879	51708
1990	15815	9376	9127	7443	2748	1072	673	794	47047
1991	16238	14290	5607	4553	3662	1374	556	789	47069
1992	17667	12823	9614	2470	2108	2031	760	751	48223
1993	15972	16406	7660	4174	851	868	1103	776	47810
1994	15217	12354	11660	3514	1657	499	439	955	46296
1995	17896	10838	7564	5524	1524	792	284	722	45143
1996	21900	13547	6745	3468	2901	935	415	612	50524
1997	22637	17661	9768	3885	2090	1847	690	720	59297
1998	19808	20698	11990	4794	2240	1260	1105	951	62847
1999	19017	16960	15364	6422	2607	1329	876	1237	63812
2000	24146	14644	11766	9355	3696	1461	1023	1367	67459
2001	24319	18727	10484	6920	5809	2032	964	1568	70824
2002	24934	20779	15052	7187	4830	4261	1532	1733	80307
2003	22408	22340	16641	11214	4557	3461	2990	2319	85930
2004	21041	17748	17645	11693	7524	2618	2290	3270	83830
2005	18030	18517	13031	10938	7533	4759	1797	3524	78129
2006	22589	15106	14623	8613	6441	4380	2909	3316	77976
2007	26495	18525	11940	10552	5563	3762	3043	3912	83791
2008	21452	23182	13082	8391	7445	3447	2216	4566	83780
2009	17852	16528	18486	9054	6341	6058	2485	4623	81426
2010	23438	16090	12825	13240	7401	5261	5142	5441	88839
2011	27075	17534	11478	8240	9256	5436	3887	7481	90388
2012	24088	24810	14094	9443	6063	7005	4445	8572	98521
2013	23725	20486	19615	11967	8173	5199	5646	9294	104104
2014	27912	22037	17702	15355	10074	7209	4930	11409	116628
2015	17289	23814	17785	13921	11552	8927	5720	13305	112315
2016	14175	15474	18976	15817	11873	10039	8124	15407	109884
2017	10277	13353	13464	15217	13962	9843	8385	17967	102469
2018	12246	11023	11476	10797	11609	11070	8170	17262	93653
2019	11261	12314	10348	9445	8863	9400	9182	16433	87245
2020	8792	9207	8213	7439	7009	6498	7478	17185	71822
2021	10535	8493	8353	5859	5423	5057	4701	14840	63261
2022	13587	9591	6797	6822	4201	4436	3992	13633	63061

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	0.02	0.27	0.64	0.68	0.57	0.48	0.42	0.42	0.59
1982	0.02	0.26	0.63	0.67	0.57	0.48	0.42	0.42	0.59
1983	0.021	0.28	0.67	0.72	0.62	0.53	0.46	0.46	0.63
1984	0.0189	0.25	0.59	0.64	0.56	0.48	0.42	0.42	0.57
1985	0.0184	0.24	0.57	0.63	0.55	0.48	0.42	0.42	0.56
1986	0.0192	0.25	0.59	0.66	0.58	0.51	0.45	0.45	0.59
1987	0.023	0.3	0.7	0.78	0.69	0.6	0.52	0.52	0.69
1988	0.022	0.29	0.68	0.76	0.68	0.6	0.53	0.53	0.68
1989	0.02	0.26	0.6	0.67	0.6	0.53	0.47	0.47	0.6
1990	0.021	0.27	0.6	0.66	0.59	0.52	0.45	0.45	0.59
1991	0.022	0.28	0.61	0.67	0.6	0.52	0.45	0.45	0.6
1992	0.027	0.33	0.74	0.81	0.73	0.63	0.55	0.55	0.73
1993	0.024	0.3	0.65	0.72	0.66	0.58	0.5	0.5	0.65
1994	0.025	0.3	0.65	0.7	0.64	0.55	0.48	0.48	0.64
1995	0.025	0.29	0.61	0.65	0.57	0.49	0.42	0.42	0.58
1996	0.024	0.28	0.58	0.59	0.51	0.43	0.37	0.37	0.53
1997	0.025	0.29	0.58	0.58	0.5	0.42	0.35	0.35	0.52
1998	0.025	0.28	0.57	0.57	0.48	0.4	0.34	0.34	0.5
1999	0.0199	0.23	0.45	0.45	0.37	0.3	0.25	0.25	0.39
2000	0.0168	0.19	0.37	0.37	0.31	0.25	0.199	0.199	0.33
2001	0.0146	0.164	0.32	0.32	0.27	0.21	0.168	0.168	0.28
2002	0.0124	0.138	0.27	0.27	0.23	0.18	0.137	0.137	0.24
2003	0.0103	0.114	0.22	0.23	0.189	0.146	0.108	0.108	0.196
2004	0.008	0.088	0.169	0.172	0.144	0.11	0.078	0.078	0.149
2005	0.0109	0.117	0.22	0.22	0.184	0.138	0.095	0.095	0.191
2006	0.013	0.136	0.24	0.24	0.198	0.146	0.097	0.097	0.21
2007	0.0149	0.153	0.27	0.26	0.21	0.156	0.101	0.101	0.22
2008	0.0121	0.122	0.21	0.2	0.167	0.123	0.079	0.079	0.176
2009	0.009	0.091	0.155	0.151	0.126	0.094	0.061	0.061	0.132
2010	0.0131	0.13	0.22	0.21	0.182	0.136	0.087	0.087	0.188
2011	0.0089	0.086	0.143	0.141	0.121	0.093	0.06	0.06	0.125
2012	0.0089	0.085	0.143	0.141	0.123	0.097	0.061	0.061	0.126
2013	0.0062	0.058	0.096	0.095	0.083	0.066	0.042	0.042	0.085
2014	0.0063	0.058	0.096	0.097	0.087	0.071	0.045	0.045	0.088
2015	0.0039	0.037	0.062	0.065	0.061	0.052	0.034	0.034	0.06
2016	0.0036	0.033	0.054	0.057	0.054	0.047	0.031	0.031	0.053
2017	0.0047	0.042	0.068	0.071	0.067	0.058	0.038	0.038	0.066
2018	0.0055	0.049	0.075	0.075	0.067	0.056	0.035	0.035	0.068
2019	0.0061	0.055	0.083	0.082	0.073	0.058	0.036	0.036	0.074
2020	0.0043	0.039	0.059	0.059	0.053	0.043	0.026	0.026	0.053
2021	0.0062	0.055	0.083	0.081	0.07	0.055	0.033	0.033	0.072
2022	0.0075	0.066	0.1	0.096	0.084	0.066	0.039	0.039	0.086

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	11300	16999	25572	5638	7073	8873	0.45	0.59	0.78	10440	12853	15824	3179	4385	6047
1982	15499	22082	31461	5500	6798	8403	0.46	0.59	0.76	10316	12471	15075	3096	4059	5321
1983	16617	23495	33219	5012	6099	7421	0.49	0.63	0.82	10675	12934	15671	3039	3900	5006
1984	16092	22623	31805	6309	7703	9405	0.44	0.57	0.73	13014	15832	19261	3525	4558	5894
1985	15019	21058	29526	6923	8462	10342	0.43	0.56	0.72	13621	16557	20125	3883	5042	6547
1986	15257	21415	30059	7415	9059	11067	0.46	0.59	0.75	13859	16705	20135	4168	5391	6973
1987	14684	20708	29203	6993	8477	10276	0.54	0.69	0.88	13675	16457	19806	4420	5680	7299
1988	11182	15676	21975	6540	7949	9661	0.54	0.68	0.87	12234	14698	17658	4022	5144	6578
1989	8931	12815	18388	5802	7089	8661	0.47	0.6	0.77	10672	12915	15628	3349	4350	5651
1990	11345	15815	22047	5275	6449	7885	0.46	0.59	0.75	9253	11113	13346	2906	3751	4841
1991	11728	16238	22483	4237	5137	6229	0.47	0.6	0.76	9018	10810	12958	2364	3004	3816
1992	12895	17667	24204	4242	5140	6229	0.58	0.73	0.92	8391	10034	11998	2678	3394	4302
1993	12044	15972	21182	3562	4326	5254	0.51	0.65	0.83	7564	9053	10835	2206	2788	3524
1994	11440	15217	20243	3707	4559	5606	0.5	0.64	0.81	7435	8940	10751	2283	2890	3658
1995	13487	17896	23747	3198	3943	4861	0.46	0.58	0.74	6649	7997	9617	1887	2386	3018
1996	16454	21900	29148	3425	4252	5280	0.41	0.53	0.68	7193	8679	10473	1825	2287	2865

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
1997	17039	22637	30074	3634	4500	5573	0.41	0.52	0.66	7745	9353	11295	1957	2457	3084
1998	14927	19808	26285	3901	4863	6063	0.39	0.5	0.65	8010	9712	11777	2071	2608	3285
1999	14232	19017	25410	4497	5666	7138	0.3	0.39	0.52	8961	10943	13362	1971	2484	3130
2000	17779	24146	32793	4920	6262	7971	0.24	0.33	0.44	9214	11350	13982	1755	2234	2842
2001	18132	24319	32617	5860	7568	9775	0.21	0.28	0.39	10507	13062	16238	1753	2209	2782
2002	18488	24934	33629	6899	9002	11746	0.173	0.24	0.33	11771	14806	18622	1761	2210	2772
2003	16451	22408	30521	8188	10816	14288	0.139	0.196	0.28	13310	16985	21674	1722	2186	2774
2004	15542	21041	28487	8174	10827	14341	0.104	0.149	0.21	12908	16567	21264	1333	1708	2191
2005	13347	18030	24356	7926	10466	13822	0.135	0.191	0.27	12621	16053	20419	1568	1987	2518
2006	16831	22589	30316	7041	9332	12369	0.148	0.21	0.29	12349	15620	19759	1486	1874	2362
2007	19485	26495	36027	5805	7706	10230	0.161	0.22	0.31	8862	11323	14467	1281	1620	2049
2008	15974	21452	28808	5841	7734	10240	0.126	0.176	0.24	10177	12888	16322	1114	1400	1759
2009	13107	17852	24314	6632	8868	11857	0.093	0.132	0.186	9304	12041	15583	883	1128	1441
2010	17395	23438	31582	6779	8918	11734	0.133	0.188	0.26	10783	13670	17329	1272	1638	2108
2011	19965	27075	36717	7917	10689	14432	0.088	0.125	0.175	12023	15544	20097	946	1192	1502
2012	17866	24088	32477	6635	9017	12253	0.09	0.126	0.177	8656	11402	15021	752	947	1193
2013	17587	23725	32007	8059	10968	14927	0.06	0.085	0.12	11511	15057	19696	649	818	1031

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
2014	19965	27912	39023	8179	11082	15016	0.063	0.088	0.124	11620	15184	19843	688	867	1093
2015	12628	17289	23669	10552	14733	20570	0.042	0.06	0.085	13794	18566	24988	551	700	891
2016	10479	14175	19174	15327	21058	28930	0.037	0.053	0.076	19544	26077	34795	736	932	1181
2017	7464	10277	14150	11634	15892	21708	0.047	0.066	0.093	14402	19189	25567	687	868	1096
2018	8999	12246	16665	12505	17256	23811	0.048	0.068	0.097	14086	19141	26011	681	863	1093
2019	8233	11261	15402	11536	16117	22517	0.052	0.074	0.105	13294	18188	24884	630	802	1020
2020	6096	8792	12681	9024	12565	17495	0.037	0.053	0.078	10726	14579	19816	372	479	618
2021	7640	10535	14529	8067	11333	15921	0.051	0.072	0.103	9737	13283	18120	460	584	741
2022	9158	13587	20160	5964	8548	12251	0.06	0.086	0.125	7576	10418	14327	400	519	674

Table 24.14 Short-term forecast. Annual catch options. Intermediate year assumptions.

Variable	Value	Notes
$F_{ages\ 3–6}$ (2023)	0.071	$F_{sq}=F_{average\ (2020-2022)}$
SSB (2024)	10583	Tonnes; Fishing at *status quo* (F_{sq}).
R_{age} 1 (2023 and 2024)	12246	Median resampled recruitment (2015–2022) as estimated by a stochastic projection; in thousands.
Total catch (2023)	664	Tonnes; Fishing at F_{sq} plus surviving discards.
Projected landings (2023)	269	Tonnes; Assuming average discard pattern (2020–2022).
Projected discards (2023)	395	Tonnes; Assuming average discard pattern (2020–2022).
Discard survival rate	40%	Catchpole *et al*. (2015).
Projected surviving discards (2023)	158	Tonnes; Assuming average discard pattern (2020–2022) where 40% of the discards survive.
Projected dead discards (2023)	237	Tonnes; Assuming average discard pattern (2020–2022) where 40% of the discards survive.

Table 24.15. Short-term forecast. Annual catch options. All weights are in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected Surviving discards (2024)	Projected dead discards (2024)	Total projected discards* (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$** (2024)	SSB (2025)	% SSB change ***	% advice change^
ICES advice basis											
MSY approach: $F= F_{MSY}$	1902	769	453	680	1133	0.196	0.055	0.141	10054	-5	-6.7
Other scenarios											
$F= F_{MSY\ lower}$	1323	535	315	473	788	0.133	0.037	0.096	10526	-0.53	-35
$F= F_{MSY\ upper}$	2748	1111	655	982	1637	0.29	0.082	0.21	9404	-11.1	35
$F= F_{pa}$	3623	1465	863	1295	2158	0.4	0.112	0.29	8674	-18	78
F = 0	0	0	0	0	0	0	0	0	11538	9	-100
$F = F_{lim}$	4308	1742	1026	1540	2566	0.5	0.138	0.36	8196	-23	111
$SSB_{2025} = B_{lim}$	12607	5099	3003	4505	7508	3	0.84	2.2	2064	-80	520
$SSB_{2025} = B_{pa}$	8330	3369	1985	2977	4961	1.23	0.34	0.88	5294	-50	310
SSB_{2025} = MSY $B_{trigger}$	3539	1431	843	1265	2108	0.39	0.109	0.28	8757	-17.3	74
Rollover advice	2039	825	486	729	1214	0.21	0.059	0.152	9962	-5.9	0
$F = F_{2023}$	720	291	172	257	429	0.071	0.0197	0.051	10976	3.7	-65
$SSB_{2025} = SSB_{2024}$	1242	502	296	444	740	0.125	0.035	0.09	10583	0	-39

*** 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 line) 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 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 2011–2022 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 2011–2022 from the baseline model, showing final eleven 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

Last year (2022), ICES gave biennial advice for 2023 and 2024. Therefore, no new assessment/advice was produced at WGCSE 2023, and this report only details an update to the data.

Type of assessment in 2022

Last year's assessment report is available at: http://doi.org/10.17895/ices.pub.19863796.

Plaice in Division 7.e is a category 3 data-limited stock and the advice is based on the rfb rule (Fischer *et al*., 2021b).

ICES advice applicable to 2023 and 2024

Last year's advice is available at https://doi.org/10.17895/ices.advice.19453631 and stated:

ICES advises that when the MSY approach is applied, catches should be no more than 1219 tonnes in each of the years 2023 and 2024.

25.1 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). Last year's WGCSE 2022 assessment is available from https://github.com/ices-taf/2022_ple.27.7e_assessment. An updated version of this assessment with the newly developed "cat3advice" R package is available from https://github.com/ices-taf/2023_ple.27.7e_assessment/tree/simple2022. The current WGCSE 2023 update is available from https://github.com/ices-taf/2023_ple.27.7e_assessment and the data processing (InterCatch data, etc) from https://github.com/ices-taf/2023_ple.27.7e_assessment/tree/data2023.

All changes since last year's assessment can be accessed with the following link: https://github.com/ices-taf/2023_ple.27.7e_assessment/compare/simple2022..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.

25.2 General

25.2.1 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.

25.2.2 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 2022.

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).

The TAC and the national quotas by country for 2023

Species	Plaice *Pleuronectes platessa*	Zone:	7d and 7e (PLE/7DE.)
Belgium	889	Analytical TAC	
France	2963	Article 7(2) of this Regulation applies	
Union	3852		
United Kingdom	2020		
TAC	6775		

(Source: Council Regulation (EU) 2023/194, EU, 2023).

25.2.3 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.

25.3 Data

25.3.1 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 2022, 74% of the landings were taken by beam trawls, 19.8% by otter trawls, 2.7% by gillnets and 3.0% by other gears. Of the total international landings, 83.0% were taken by the UK, 7.2% by France, 9.8% 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 area amounted to 14% of the TAC in 2020, 15% in 2021 and 12% in 2022. The combined catches of plaice in 7.d–e accounted for 74% of the TAC in 2020, 34% in 2021, and 30% in 2022.

25.3.2 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 1331 t in 2021 and 1331 t in 2022, a decrease of 17%.

In addition to the estimated 2022 landings for Division 7.e, an extra of 85 tonnes (72 tonnes in 2021) 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.

25.3.3 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 2012–2022, France for 2014–2022, Belgium for 2012–2013 and 2015–2022, 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 23% of the landings in 2020 (impacted by Covid restrictions on sampling), 91% in 2021, and 81% in 2022. Of these discard estimates, age samples were provided for 18% in 2020, 79% in 2021, and 85% in 2022.

In analogy to the landings, the discards are also increased by a migration correction from 7.d. For 2022, 178 tonnes (15% of the mature quarter 1 plaice discards in 7.d, up from 95 tonnes in 2021) were added, resulting in total discards of 536 tonnes for the 7.e plaice stock.

For consistency, Figure 25.4 shows various historical 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 and 31.1% in 2022 (Figure 25.5).

25.3.4 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 2022 were available from the UK (England) and were provided for four fleets (GNS_DEF_all_0_0_all Q1, Q3, Q4; LLS_FIF_0_0_0_all Q2; MIS_MIS_0_0_0_HC Q2; 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 Q2, Q3; OTB_DEF_70-99_0_0 Q3). French age samples were removed from InterCatch, because they were based on few data only included five or fewer ages with gaps between ages. Sampling levels for landings and discards were good for plaice and age samples covered 90% of the total reported international landings and 85% for discards. Figure 25.6 visualises age samples and gives details about the number of samples and age readings in 2022.

Additional landings data were available by quarter/fleet from Belgium, France, , the Netherlands (<1t), UK (E+W, Guernsey) and UK Scotland (annual, 0 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 96% of all landings and 98% of submitted discards. Figure 25.7 visualises age samples and gives details about the number of samples and length readings in 2022.

An additional age composition data representing the migration adjustment (15% of the mature component of quarter 1 catches for 7.d) was supplied 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).

25.3.5 Revisions

No revisions to data prior to 2022 were provided in 2023.

25.3.6 Biological

The natural mortality and the maturity ogives used were identical to previous assessments and as described in the Stock Annex.

25.3.7 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).

25.3.7.1 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*., 2023) conducted another survey of sole and plaice abundance in the Western English Channel in 2022. The survey uses two 4 m beam trawls with 80 mm nominal codend mesh and focuses on the area around the English coast. 89 out of 90 tows were completed in 2022. 656 plaice otoliths were collected for aging in 2022.

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 between 2014 and 2020, increased in 2021 and decreased again in 2022. Plaice were encountered at 83% of the survey stations, with a similar distribution to previous years, with greater numbers off Plymouth (Figure 25.14, Burt *et al*., 2022). Plaice catches comprised mainly fish aged 3–5.

Internal consistency (cohort tracking) is acceptable for this survey for ages three and above (Figure 25.13).

25.3.7.2 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.

The 2022 survey was disrupted and only 55 out of 81 planned tows were fished (Figure 25.14). The main reasons for this disruption where (1) the vessel could initially only use one of two engines, (2) the delayed permission to enter the French exclusive economic zone, and (3) disruptions to the survey due to a health and safety review of lifting operations.

The disruption meant that the survey coverage was severely reduced, and the fished stations are mainly located around the English coast whereas in previous years the survey covered the entire Division 7.e. The survey index derived from the Q1SWBeam survey is the product of a modelling approach. Due to the missing stations in 2022, it was not possible to provide index values for 2022 consistent with the time-series.

This survey is not used in the rfb rule used for providing advice for this stock, so the impact of this missing data year is negligible.

25.3.7.3 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 have been decreasing since 2017.

25.4 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 introduced new data-limited advice rules for category 3 stocks developed by ICES WKLIFE X (ICES, 2020, 2022) and the advice in 2022 for 2023 and 2024 was based on the rfb rule.

25.5 Choice of method for providing advice

The choice of method for providing advice for plaice in 2022 was 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*).

25.5.1 Von Bertalanffy growth parameters

Individual growth parameters are 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" was applied in 2022 because k<0.32 year^{-1}.

25.6 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 advice from the rfb rule is valid for 2023 and 24. Therefore, WGCSE only provided a data update without applying the rfb rule again. Reference points (length at first capture L_c, reference length $L_{F=M}$, biomass index trigger value I_{trigger}) were not updated, following recommendations for the category 3 empirical harvest control rules (ICES, 2023).

25.6.1 Biomass index

The rfb rule uses a biomass index for component r (the biomass index trend/ratio) and b (the biomass safeguard). WGCSE 2022 decided to use the UK-FSP Q3 survey as the biomass index 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 with Q1SWBeam in previous stock assessment model fits and shows better internal consistency 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 are 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.

The biomass index time-series with one additional data point for 2022 is illustrated in Figure 25.17. The 2022 value is a decrease compared to the value from 2021 but still above the index trigger value (I_{trigger}).

25.6.2 Catch length data

The rfb rule requires catch length data. Catch length distributions were generated from InterCatch following the same raising and allocation principles as for the age distributions. Figure 25.18 illustrates international catch (landings and discards) length distributions for 2014–2022, and the annual length at first capture (L_c). Figure 25.19 and Table 25.4 show the annual mean catch length and Figure 25.20 the length indicator (mean catch length divided by the reference length) time-series. Table 25.4 summarises the annual length data.

The mean catch length decreased slightly in 2022 compared to 2021 and is still below the MSY proxy reference length. This indicates that the stock continues to be subject to overfishing.

25.7 Management plans

There is no management plan in place for this stock apart from the EU multiannual plan for the region.

25.8 Uncertainty about the stock structure

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.

25.9 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 in the following years.

25.10 Issue list

The plaice in Division 7.e stock has been recommended for a benchmark and an issue list is kept on the ICES system for rolling issues (https://sid.ices.dk/Manage/rollingissues.aspx) and also listed here:

- Stock structure
  - There is uncertainty about the stock structure and some mixing between 7.d and 7.e is considered.
  - Migration between different areas should be further investigated but can likely not be resolved in the near future. Assumptions about migration are likely to have a higher impact on analytical stock assessment models but are less important for category 3 empirical harvest control rules because these follow trends in the data without having to estimate population dynamics.
- Discards
  - Previously used age-structured stock assessment models did not include discards but discards are considered substantial.
  - Discard estimates are available in InterCatch for 2012–2022 and have been extrapolated back in time by WGCSE. Available discard data should be analysed, and it should be investigated whether more historical discard data are available.
- Surveys
  - Two scientific surveys (UK-FSP Q3 and UK-Q1SWBeam Q1) are routinely conducted for this stock. The current rfb rule only uses the UK-FSP survey. The Q1SWBeam survey was revised in 2020, data for 2022 are missing, and the cohort tracking of this survey is poor; in some cases, negative correlations were observed between ages.

    - The suitability of the surveys, particularly the Q1SWBeam survey, should be checked. It should be checked if the Q1SWBeam survey is appropriate to inform on the plaice stock.
- Biological data
    - Natural mortality (time and age invariant) and maturity ogives (time invariant) were borrowed from other plaice stocks, but are not used for these stocks anymore after benchmarks.
    - Updates to biological data should be considered. Natural mortality is unknown and no studies for this stock area exist. The assumptions for natural mortality have a crucial influence on the output of age-structured stock assessment models and depending on the assumptions, the stock status can vary considerably. This is likely to impair the use of age-structured stock assessment models. Maturity data is routinely collected by the two surveys but has not been explored.
    - Stock and catch weights are currently derived by applying a smoother to the annual weights-at-age from InterCatch. The use of raw weight-at-age or alternative formulations (e.g. von Bertalanffy growth model) and their impact should be explored. Raw catch weights for 2012-2022 are available from InterCatch.
- Assessment method
    - The advice for this stock is based on the category 3 data-limited rfb rule. The rfb rule is applied with generic parameters leading to a precautionary advice. There is potential to explore moving the stock to a category 1 data-rich assessment or to conduct a case-specific MSE. Recently published work on a comparison of category 1 and category 3 stocks through MSE included this stock as a case study.
    - The main conclusions were (1) that a single age-structured data-rich stock assessment can likely not capture the full dynamics of this stock because of high uncertainty, (2) a category 1 approach following ICES guidelines leads to an unacceptably high risk, and (3) that category 3 empirical methods can be tuned for this stock and provide a better management performance (higher catch, lower risk) compared to the default ICES category 1 approach.
    - An MSE framework for this stock already exists and only needs to be updated with the latest data. This stock is an ideal candidate for conducting case-specific MSE to tune category 3 methods.

25.11 Progress of work on the stock with relevance for a benchmark

This plaice stock is relatively data-rich for an ICES category 3 data-limited stock and is an ideal candidate for conducting a case-specific management strategy evaluation (MSE, in the sense of a closed-loop simulation) to tune the category 3 empirical harvest control rules, as recommended by WKLIFE X (ICES, 2020) and WKLIFE XI (ICES, 2023) and stated in the ICES technical guidelines (ICES, 2022).

Recently, work on a comparison of the new ICES category 3 data-limited empirical harvest control rules and the ICES data-rich category 1 MSY rule was published in Fischer et al. (2023) and has implications for ICES and advice provision for this stock:

> Abstract:
>
> Fisheries management needs to ensure that resources are exploited sustainably, and the risk of depletion is at an acceptable level. However, often uncertainty about resource dynamics exists, and data availability may differ substantially between fish

stocks. This situation can be addressed through tiered systems, where tiers represent different data limitations, and tier-specific stock assessment methods are defined, aiming for risk equivalence across tiers. As case studies, we selected stocks of European plaice, Atlantic cod and Atlantic herring, where advice is provided by the International Council for the Exploration of the Sea (ICES). We conducted a closed-loop simulation to compare risk equivalence between the data-rich ICES MSY rule, based on a quantitative stock assessment, and the revised data-limited empirical management procedures of the ICES advice framework. The simulations indicated that the data-limited approaches were precautionary and did not lead to a higher risk of depletion than the data-rich approach. Although the catch based on generic data-limited approaches was lower, stock-specific optimisation improved management performance with catch levels comparable with the data-rich approach. Furthermore, the simulation indicated the ICES MSY rule can fail to meet management objectives due to increased depletion risk when management reference points are set suboptimally. We conclude that the recent revisions of the ICES system explicitly account for risk equivalence for data-limited fisheries management and are a major step forward. Finally, we advocate further consideration of simple empirical management procedures irrespective of data limitations due to their ability to meet fisheries management objectives with greater simplicity.

This work included the plaice stock in Division 7.e as a case study and an MSE was conducted. This work has implications for the way ICES assesses and provides advice for this stock.

Fischer *et al*. (2023) conditioned seven operating models based on different parameterisation of the state–space SAM model. Operating models included a (1) most-plausible baseline operating model, and six alternative operating models with different assumptions:

- Recruitment (default: a Beverton–Holt model with autocorrelated residuals): (2) recruitment failure, (3) without autocorrelation in the recruitment residuals.
- Natural mortality (default: 0.12 for all ages): (4) higher mortality (+50%), (5) lower mortality (-50%), (6) age-dependent mortality following a Gislason model.
- Catch (default: landings and discards): (7) assume 100% discard survival/

The MSE framework was used to estimate stochastic reference points (B_{lim}, F_{MSY}, B_{MSY}, etc.) consistent with operating models and their uncertainty characterisation. It was shown that the reference points and the stock status crucially depend on the specific operating model. All operating models indicated that the stock is currently fished well above F_{MSY} and the SSB is below B_{MSY}. The conclusion for the operating model conditioning was that a single model (i.e. a single SAM stock assessment model) is not able to encompass the full uncertainty of this stock because important metrics such as natural mortality are unknown. This means that a category 1 assessment is unlikely to be useful in providing advice.

Management procedures were then tested for the operating models and included the default ICES category 1 approach (i.e. the ICES MSY rule based on a SAM assessment and short-term forecast, with reference points estimated with EqSim following ICES guidelines) and category 3 empirical harvest control rules (rfb rule, chr rule, with default parameterisations and also tuned to maximise yield while staying precautionary, Figures 25.21 and 25.22). For the plaice stock, the category 1 approach (ICES MSY rule) resulted in consistently high risks (risk of falling below B_{lim} above 30% for most operating models, i.e. well above the 5% limit imposed by the ICES precautionary approach) and often low biomass ($\leq 0.5B_{MSY}$) in the long term. On the other hand, the category 3 methods (rfb and chr rules) met the ICES precautionary approach criterion. However, the catch was relatively low for the default ICES parameterisations of the methods, but the catch could be substantially increased by tuning the parameters.

25.11.1 Conclusions and proposed path forward for the next benchmark

The conclusion from Fischer *et al*. (2023) with relevance for ICES and WGCSE is that although an upgrade of the stock to category 1 is possible, this is likely not a good idea because (1) an individual age-structured stock assessment model cannot model the full uncertainty about the stock dynamics and data and (2) the use of the ICES MSY rule with reference points estimated by EqSim leads to fisheries management that violates the ICES precautionary approach. Furthermore, an upgrade of the stock to category 2 (i.e. using SPiCT) is infeasible because it has been shown several times over the years that SPiCT cannot model the stock dynamics of this stock and would lead to unacceptably high uncertainty bounds. However, the category 3 methods (rfb and chr rules) work as intended and can be tuned with a case-specific MSE simulation.

Based on the conclusions of Fischer *et al*. (2023), the next benchmark should not purely aim to "upgrade" the stock to category 1 but instead allow a wider scope and include the option to conduct a case-specific MSE to tune category 3 empirical harvest control rules. The most promising method is the chr rule because it can provide the overall best management performance (high catch, low risk, less susceptible to recruitment failure, e.g. caused by environmental changes). The use of a case-specific MSE is explicitly recommended by the ICES technical guidelines (ICES, 2022). A case-specific MSE framework for this stock already exists and has been peer-reviewed and published in Fischer *et al*. (2023). The next benchmark could update the operating models with the latest data and use these in an MSE.

The benefits of developing/tuning simple empirical harvest control rules with MSE are that the method (1) has been simulation tested to show that it works and is robust to uncertainty, (2) is simpler to test and optimise in a simulation because there is no computing-intensive stock assessment in the feedback loop, (3) is simpler to understand and explain to stakeholders, (4) less susceptible to potentially subjective decisions required when conducting complex stock assessment models and short-term forecasts annually, (4) the application of the harvest control rule requires fewer data (no need for age data), (4) explicitly aligns with the ICES MSY and precautionary approach, and (5) can at least match or even exceed the management performance of more data-rich approaches as shown by Fischer *et al*. (2023).

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25.13 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***	ICES estimated 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***	ICES estimated 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	-	1523	1520	204	1725	366
2020	73	1	79	1124	-	1276	1275	98	1373	514
2021^	108	1	90	1129	-	1328	1331	72	1403	211
2022^	106	< 1	80	916	-	1102	1103	85	1188	536

*** Estimated by the working group.**

**** Migration correction (15% of the mature population caught in Quarter 1 in Division 7.d) added to stock.**

***** Includes the migration correction from Division 7.d.**

^ 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 2023
103
FSP-7e
2003 2022
1 1 0.75 0.80
1 27
1               0.020856124     0.3433485769    0.3441216408    0.2158870196    0.0411046343
                0.0419819271    0.0508897388    0.0336731872    0.0220129301    0.0020873631
                0.0009165312    0.0004889207    0.0001069026    3.28811e-05     0
                3.28811e-05     0               3.28811e-05     0.000191009     0               0
                0               0               0               0               0               0
1               0.0065579997    0.2073181227    0.8371714247    0.1724939743    0.2879986847
                0.0298421809    0.0183255702    0.0461069386    0.0115317964    0.0027420498
                0.0008620611    0.0002189197    0.0001591105    0               0.0001894145    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    0.0317905814
                0.0192454357    0.0153051535    0.0046721637    0.0019192342    0.0005160863
                0.0002430666    0.0001799535    0.0001019815    2.40095e-05     2.69813e-05
                2.40095e-05     0               2.69813e-05     2.69813e-05     2.69813e-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               0.002938544     1.0370464371    0.8029691027    0.3151187275    0.1107360625
                0.0103180765    0.0181288483    0.0132631865    0.0021540239    0.001984199
                0.0016157909    9.3059e-05      9.3059e-05      0.0029814941    0
                0.0011831925    0               3.26964e-05     0               0               0
                0               0               0               0               0               0
1               0.0494984978    0.3204995344    1.2439471655    0.5824145036    0.1365485082
                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
                0.5143799529    0.1222145317    0.0128907617    0.0566920837    0.0023809853
                0.0093154347    4.08854e-05     4.08854e-05     2.04427e-05     0
                2.04427e-05     0               2.04427e-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
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                0               0               0               0               0               0
                0               0               0               0               0
1               0.0002927298    0.1740715859    0.498282538     0.5247382096    0.482079318
                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
1               0               0.0894816048    0.8265493022    1.0442544083    0.7623116043
                0.1276341998    0.0531186375    0.0238785959    0.0208974009    0.0094880833
                0.0065601085    0.0013610534    0.0034083495    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               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 2022
1 1 0.75 0.80
1 27
1               0.0052844896    0.1215031858    0.1530914797    0.1097995455    0.0272513589
                0.0304282354    0.0393762173    0.0232137204    0.0214416111    0.0029760194
                0.0016473148    0.0009893494    0.0001644913    5.26496e-05     0
                5.26496e-05     0               5.26496e-05     0.000412429     0               0
                0               0               0               0               0               0
1               0.0012670803    0.0628516935    0.3266780146    0.0894363723    0.1472448025
                0.0191659507    0.0141324022    0.0454789538    0.0094626366    0.0047021015
                0.0011582775    0.0002272778    0.0001741316    0               0.0002958649    0
                0               0               0.0002408385    0               0               0
                0               0               0               0               0
1               0.0018342644    0.1115845973    0.1623681927    0.1157913399    0.0549227138
                0.0270754542    0.0102591669    0.0178596772    0.0345549048    0.0076868425
                0.0060651528    0               0               0               0.0012186908
                0.0009625308    0.0013530215    0               0.0012943051    0.0027718823    0
                0               0               0               0               0               0
1               0.0049869953    0.1883520601    0.1532175116    0.0972687325    0.0609787764
                0.028978287     0.0158729934    0.0040622491    0.0063580172    0.0152819209
                0.0025594871    0.0036230017    0               0               0.0003474219    0
                0               0.0011029388    0               0               0               0
                0               0               0               0               0
1               0               0.0346774134    0.1038624689    0.0708829128    0.0391171264
                0.0201717899    0.0079485584    0.0036769609    0.0052152438    0.0057022622
                0.0022468606    0.0041954154    0.0012809892    0               0               0
                0               0               0               0               0               0
                0               0               0               0               0
1               0.000762555     0.1657577188    0.0961174603    0.0704822029    0.0231913179
                0.016570394     0.0147893043    0.0059644543    0.0015792971    0.0007371656
                0.0003311276    0.0003043854    0.0001676491    3.09129e-05     5.29117e-05
                3.09129e-05     0               5.29117e-05     5.29117e-05     5.29117e-05     0
                0               0               0               0               0               0
1               0.0043287082    0.1540895933    0.1971841642    0.0805515208    0.0407740691
                0.0305261874    0.0183867908    0.0071709534    0.0053531527    0.0025530495    0
                0.0038770762    0               0               0               0               0
                0               0               0               0               0               0
                0               0               0               0
1               0.0077953986    0.2223438938    0.2405488301    0.2007688219    0.0326819925
                0.0283853654    0.0115565349    0.0061370637    0.0029625913    0.00716298
                0.002042332     0.0030410605    0               0               0               0
                0               0               0               0               0               0
                0               0               0               0               0
1               0.0003052276    0.2830476282    0.276090475     0.1433190168    0.0670970669
                0.0063359652    0.0198809047    0.010936955     0.0030207491    0.0027302621
                0.0022038619    0.0001445133    0.0001445133    0.0042099026    0
                0.0015336494    0               5.23538e-05     0               0               0
                0               0               0               0               0               0
1               0.0087825899    0.081271797     0.4006482022    0.2357376961    0.076461315
                0.0802592315    0.0132626993    0.0093944286    0.011571324     0.0024658113
                0.0058594291    0.0047321321    0               0               0               0
                0               0               0               0               0               0
                0               0               0               0               0
1               0               0.0493426842    0.4016846323    0.4665376235    0.2069123712
                0.1086554592    0.0542549173    0.0202150747    0.010110847     0.0035528435    0
                0.0014550441    0.0014550441    0               0               0               0
                0.0032902929    0               0               0               0               0
                0               0               0               0
1               0.0041401004    0.296033996     0.4567809683    0.7176828738    0.3407222057
                0.2615754031    0.0794357472    0.025108143     0.0290915886    0
                0.0049700235    0.0018371369    0               0               0.000926584     0
                0               0               0               0               0               0
                0               0               0               0               0
1               0.0001666927    0.1856975988    0.3967680662    0.3549554577    0.4325974812
                0.2540259792    0.0773165321    0.0127163242    0.037526888     0.0015570551
                0.0131987723    6.54661e-05     6.54661e-05     3.27331e-05     0
```

	3.27331e-05	0	3.27331e-05	0	0	0
	0	0	0	0	0	0
1	0.0002572494	0.0887311254	0.4321700691	0.33029376	0.1870151822	
	0.1805528336	0.1252767374	0.0139593132	0.0459469671	0	
	0.0088635596	0	0.0019439633	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.0007166172	0.0636257313	0.1688606232	0.5508671938	0.1523064567	
	0.2072453377	0.1556498663	0.0338106702	0.0918858901	0.0124465021	
	0.0197142882	0.0106094533	0.0053076674	0	0.003212512	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.0661520004	0.2126996576	0.3263252307	0.2835986161	
	0.105983836	0.0688427721	0.0691574641	0.0223061018	0.0231423024	
	0.003509849	0.0035265638	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	2.90726e-05	0.0393197407	0.1478005354	0.1767254096	0.2051982519	
	0.1566429404	0.069133305	0.0459155059	0.0218357553	0.0174043329	
	0.0104956824	0	0.0016332234	0.0006883778	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.1423399221	0.1795707795	0.0997959997	0.0633599822	
	0.0495348585	0.0472016563	0.0178293735	0.0199326151	0.0084231594	
	0.0096456266	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0.0001139874	0.1691897597	0.3913748139	0.2967467074	0.0759081909	
	0.0322075728	0.033996438	0.02900624	0.0065776229	0.0085331584	
	0.005266963	0.0053902308	0.0032274068	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	
1	0	0.0160475517	0.1662976213	0.2459631493	0.2242774076	
	0.0558682347	0.031824104	0.0175890282	0.0241757356	0.0065956609	
	0.0068742513	0.0012356653	0.0062086	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
2022	0.08	76.45	-2.02

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)
2014	24	26	31.1
2015	26	26	32.3
2016	26	26	33.3
2017	27	26	32.7
2018	26	26	32.7
2019	26	26	34.0
2020	26	26	32.2
2021	27	26	31.9
2022	26	26	30.7
2017–2021 (averaged)	26.4		
2017–2021 (pooled)	26		

Table 25.5. Plaice in 7e. The basis for the catch options in 2022. 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. This table was not updated at WGCSE 2023.

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).

25.14 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 2021–2022 numbers are not to scale. Source: Burt *et al*. (2021, 2022, 2023).

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 2017–2021.

Figure 25.17. Plaice in 7.e. The biomass index used in the rfb rule. The biomass index is based on the UK-FSP survey and includes ages 2–8. The horizontal orange lines indicate the average of the biomass index for 2017 to 2019 and for 2020 to 2021, as used by WGCSE 2022. The 2022 value is not used because WGCSE only provides a data update without new advice.

Figure 25.18. Plaice in 7.e. Total international length frequencies for 2014–2022 as raised within InterCatch for landings and discards, including length of first capture (Lc, calculated annually as first length class where the abundance is bigger or equal to half of maximum abundance).

Figure 25.19. Plaice in 7.e. Total international length frequencies for 2014–2022 as raised within InterCatch for landings and discards, including mean catch length (L_{mean}) above length of first capture (L_c, constant for all years).

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. Projections corresponding to the management procedures for the baseline operating model. The curves represent medians, surrounded by 50% and 90% confidence intervals (shaded areas). The dashed horizontal lines indicate MSY reference values (MSY, B_{MSY}), and the dotted lines are the biomass limit reference value (B_{lim}). The lines on the right of the panels show the distribution in the last simulation year (2040). Source: Fischer *et al.*, (2023).

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Figure 25.22. Plaice in 7.e. Summary statistics of all tested management procedures for plaice and all alternative operating models. Source: Fischer *et al*., (2023).

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26 Plaice in divisions 7.f–g (Celtic Sea)

26.1 Type of assessment in 2023

In 2022, the stock was assessed as a category 3 stock and the rfb rule (ICES, 2022a) was applied to provide advice for 2023 and 2024, so the working group did not carry out a new assessment for the stock in 2023. Last year's assessment report (ICES, 2022b) is available at: http://doi.org/10.17895/ices.pub.19863796

26.1.1 ICES advice applicable to 2022

Advice applied to 2022 (ICES, 2021) is available at https://doi.org/10.17895/ices.advice.7823 and stated:

ICES advises that when the precautionary approach is applied, catches in 2022 should be no more than 1735 tonnes.

26.1.2 ICES advice applicable to 2023 and 2024

Advice applicable to 2023 and 2024 (ICES, 2022c) is available at https://doi.org/10.17895/ices.advice.19453634 and stated:

ICES advises that when the MSY approach is applied, catches should be no more than 402 tonnes in each of the years 2023 and 2024.

26.2 General

26.2.1 Stock description and management units

A TAC is allocated to ICES areas 7.f–g which corresponds to the stock area.

26.2.2 Management applicable to 2022 and 2023

TACs and quotas set for 2022 (source COUNCIL REGULATION (EU) No 515/2022)

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	333
France	600
Ireland	237
Total EU	1170
United Kingdom	441
Total TAC	1735

TACs and quotas set for 2023 (source COUNCIL REGULATION (EU) No 194/2023)

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium	44
France	79
Ireland	147
Total EU	270
United Kingdom	103
Total TAC	402

26.2.3 Fishery in 2022

Most of the catch in 2022 came from ICES area 7.g (Figure 26.1). Plaice was harvested throughout the year, with the highest amount of fish landed in Q3 and the lowest in Q4. Total official landings were 527 t. The fleets harvesting plaice in the Celtic Sea primarily involved vessels from Belgium, France, Ireland and the UK, with negligible amounts taken by Spain. In 2022, Belgium reported 57.0% of the landings, France 9.7%, Ireland 24.8% and the UK 7.5%. The contribution of individual countries to total landings was similar to 2013–2021. The Working Group estimated that the reconstructed total catch (the sum of landings and discards) for 2022 was 748 t (Table 26.1), which is 43.1% of the TAC (1735 t). Reconstructed discards represented 30.3% of the catch.

Most of the catch (72.1%) was taken by beam trawlers and 21.3% by bottom otter trawlers. Effort and LPUE of fishing fleets are presented in Table 26.2–Table 26.4.

26.3 InterCatch data

26.3.1 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. Figure 26.2. Plaice in divisions 7.f–g. InterCatch landings data by year, country and gear. Figure 26.2 shows the landings data reported in InterCatch by country, gear and year.

26.3.2 Discards

Discarding in this fishery is considered high (Table 26.1). During the 2023 working group, discard information was made available as annual summaries for Belgium, and on a quarterly basis for Ireland. Figure 26.3 shows the discards data reported in InterCatch by country, gear and year. If discards were not reported for a particular year-quarter-country-métier combination, they are assumed to be unknown (non-zero) and they were estimated (i.e. raised) using InterCatch. The weighting factor for raising the discards was 'Landings CATON' (landings catch). Discard estimates were calculated based on the discard rates of similar fleets in terms of gear and mesh size. In 2023, discard rates were borrowed from the Irish fleet and allocation groups were created disregarding season and country:

- OTB_DEF_>=120
- OTB_DEF_100-119, OTB_CRU_100-119, OTT_CRU_100-119, OTT_DEF_100-119
- OTB_DEF_70-99, OTB_CRU_70-99
- TBB_DEF_70-99, TBB_DEF_>=120

- SSC_DEF, MIS, GNS, FPO, GTR, LLS

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 often exceeding landings (Figure 26.4). Estimated discards for 2022 were 226 t.

26.3.3 Biological information

26.3.3.1 Length composition

Length compositions for landings were provided by the UK (England), Ireland and France on a quarterly basis and on annual basis by Belgium; sampling covered 84% of all submitted landings. Length compositions for discards were provided on a quarterly basis by Ireland and on annual basis by Belgium; sampling covered 100% of all submitted discards. Length compositions from national sampling programmes in 2022 are summarised in Figure 26.5.

Catch length distributions were generated from InterCatch. If they were not reported, length distributions were calculated based on similar fleets in terms of gear and time (quarter /annual).

Length at first capture L_c was calculated annually for 2014–2022 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 (22–24 cm, Figure 26.6 and Table 26.5) and was 24 cm in 2022.

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 26.5, Figure 26.6).

26.3.4 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 26.6 and Table 26.7. . 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 (Figure 26.7). 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.

26.3.5 Commercial landings per unit of effort

Commercial indices of abundance from the different fisheries provide contradictory trends (Figure 26.8–Figure 26.10), 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 (>27 cm) were retained (Figure 26.11).

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 Bel-

gian 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).

26.3.6 Other relevant data

There were no early closures of the fishery for plaice in 2022. 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 trammelnet fishery 71–72%. The discard survival was also estimated as 19–20% for the North Sea UK otter trawl fishery and 4–15% in the Western Channel UK beam trawl fishery (Catchpole *et al*., 2015). Smaller undersized plaice that represent the bulk of discards are likely to have relatively higher mortality as with other flatfish species (review: Hendrikson, Nies, 2007). 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.

26.4 Stock assessment

26.4.1 Assessment model

In 2022, WGCSE provided advice for 2023 and 2024, so the assessment model was not updated during the 2023 working group. Details on the assessment model used by the working group in 2022 is available at: http://doi.org/10.17895/ices.pub.19863796

26.4.2 State of the stock

Index of the stock biomass is estimated to have been increasing between 2005 and 2015 and from 2016 declined until reaching the lowest values observed in 2022 (Figure 26.7).

26.4.3 Short-term projections

The short-term projections for the stock are not established.

26.4.4 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 (Figure 26.12, Table 26.5), 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 in the last assessment.

26.5 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.

26.6 References

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26.7 Tables

Table 26.1. Plaice in divisions 7.f–g. Official landings (t) by country 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
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
Discards 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
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
Discards 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
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
Discards as used by WG*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	274	321	453
	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
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
Discards as used by WG*	1288	583	608	670	1107	1123	1274	772	778	571

	2017	2018	2019	2020	2021^	2022^
Belgium	179	204	263	332	269	300
UK	38	40	45	47	48	40
France	108	127	84	47	51	51
Spain			1	<1	0.5	5
Netherlands			<1	<1		
Ireland	63	51	**	110	106	128
Total reported	388	422	394 **	536	476	524
Unallocated	1	0	-2	0	2	-2
Landings used by WG	389	422	642	536	468	522
Catch as used by WG	1284	930	831	893	846	748
Discards as used by WG*	895	508	189	357	378	226

*** Discard estimated by the working group.**

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

^Preliminary official landings.

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
1997	34.61	31.01	21.37	33.42	17.47	7.5	577	2661	370	770	122	146

	LANDINGS PER UNIT OF EFFORT (LPUE) kg\day						EFFORT, fishing days					
	VIIf LPUE		VIIg EAST LPUE		VIIg WEST LPUE		VIIf Effort		VIIg EAST Effort		VIIg WEST Effort	
YEAR	TRAWL	BEAM TRAWL	TRAWL	BEAM TRAWL	TRAWL	BEAM TRAWL	TRAWL (Days fished)	BEAM (Days fished)	TRAWL (Days fished)	BEAM (Days fished)	TRAWL (Days fished)	BEAM (Days fished)
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
2013	6.4	12.29	0.89	8.18	0.44	0.61	280	1611	72	265	37	77

	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)
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	6.28	23.68	35.1	17.14	17.35	0.16	155	1260	22	547	28	102
2022	14.79	17.24	7.89	21.64	6.36	0.95	90	1275	4	207	36	77

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	246.11	35.446	6.943
2022	280.004	42.274	6.624

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
2022	56.23	64.4	0.87	28.54	14.30	2.00

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	2022	52.46	22.50	2.33

Table 26.5. Annual values for length at first capture (Lc), mean length (L_{mean}) and MSY proxy length ($L_{F=M}$) reference point for plaice in areas 7.f and 7.g.

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
2022	29.2	24	30.2

Table 26.6. Plaice in divisions 7.f–g: Survey abundance indices (numbers-at-age) by age class (1 to 8+) for the Irish IBTS survey in area 7.g.

Year/Age	1	2	3	4	5	6	7	8+
2003	832	0	45	84	37	8	3	1
2004	980	2	6	31	51	20	13	1
2005	845	39	63	83	19	9	3	3
2006	1046	3	105	80	22	18	11	12
2007	1168	2	51	166	68	22	9	8
2008	1139	7	113	106	72	19	8	5
2009	1018	213	199	548	247	100	21	16
2010	1381	233	871	304	479	197	84	23
2011	1392	250	1150	701	195	210	84	107
2012	1470	358	992	901	277	50	49	71
2013	1439	37	386	894	473	173	47	148
2014	1487	9	195	354	336	151	84	54
2015	1236	16	778	580	267	312	61	102
2016	1438	27	332	805	333	221	215	101
2017	1233	17	236	264	267	222	76	95
2018	1028	3	94	168	113	135	54	56
2019	1386	37	167	134	303	134	118	92
2020	1178	15	160	137	100	116	74	129
2021	1349	14	623	686	391	126	100	116
2022	1152	5	55	85	97	72	26	49

Table 26.7. Plaice in divisions 7.f–g: Survey abundance indices (number per 100 km towed) by age class for the UK-BTS survey in area 7.f.

UK(E&W)-BTS-Q3												
	Age class											
Year	0	1	2	3	4	5	6	7	8	9	10+	Total
1993	3	102	90	37	2	4	0	1	0	0	0	239
1994	122	107	32	16	8	1	0	0	0	0	0	286
1995	1	240	90	17	3	7	2	0	0	2	0	361
1996	8	224	288	31	1	3	1	0	0	0	0	555
1997	7	225	102	35	4	2	2	1	0	0	0	378
1998	5	237	126	47	9	2	1	0	0	0	1	428
1999	162	153	80	29	20	7	0	0	2	0	0	452
2000	85	340	63	31	7	6	0	1	0	0	0	532
2001	36	211	156	16	9	4	3	2	0	0	0	437
2002	1	137	175	80	6	6	2	4	1	0	0	412
2003	61	98	80	61	22	3	2	1	1	2	0	330
2004	164	259	33	27	13	2	1	1	2	0	2	505
2005	3	193	75	21	8	11	3	1	0	0	1	314
2006	81	86	102	34	10	2	9	0	2	1	0	326

UK(E&W)-BTS-Q3												
	Age class											
2007	35	150	92	47	15	2	3	1	2	1	0	347
2008	6	141	217	47	16	5	1	2	0	0	1	435
2009	186	162	56	79	21	11	4	2	0	1	0	522
2010	143	332	89	26	40	7	4	1	0	1	2	644
2011	8	362	300	55	22	21	14	3	3	1	0	789
2012	17	142	431	101	22	9	13	5	1	0	0	740
2013	64	330	139	185	47	6	4	8	3	1	0	786
2014	0	372	202	65	106	24	2	3	2	2	2	778
2015	19	28	454	162	52	77	48	15	8	4	4	873
2016	0	13	163	268	102	28	33	16	6	1	1	631
2017	2	11	104	137	121	92	19	27	11	0	0	525
2018	87	4	45	90	58	75	58	18	10	4	5	456
2019	22	115	139	38	15	11	35	25	10	6	5	421
2020	2	7	113	140	43	12	10	8	19	2	4	359
2021	12	38	44	76	43	7	15	8	6	2	1	252
2022	62	18	45	26	35	19	8	2	5	2	2	224

26.8 Figures

Figure 26.1. Plaice in divisions 7.f–g: Distribution of catch of plaice (*Pleuronectes platessa*) by ICES area in 2022. Catch for area 7.f is in red and catches for area 7.g are in blue.

Figure 26.2. Plaice in divisions 7.f–g. InterCatch landings data by year, country and gear.

Figure 26.3. Plaice in divisions 7.f–g. InterCatch discards data by year, country and gear.

Figure 26.4. Plaice in divisions 7.f–g. Raised catch as estimated by WGCSE.

Figure 26.5. Plaice in divisions 7.f–g. Length composition of landings (blue) and discards (red) by different metiers in 2022, when both landings and discards were sampled simultaneously. As the minimum conservation reference size is 270 mm, it is seen that also fish of commercial size were discarded.

Figure 26.6. Plaice in divisions 7.f–g. Total international length frequencies for 2018–2022 as raised within InterCatch for landings and dis-cards 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 26.7. Plaice in divisions 7.f–g: Biomass index (standardised CPUEs) from UKBTS-Q3 and IrGFS-Q4 survey.

Figure 26.8. Plaice in divisions 7.f–g: Trends in CPUE by the UK fleets.

Figure 26.9. Plaice in divisions 7.f–g: Trends in CPUE by the Belgian beam trawl fleet.

Figure 26.10. Plaice in divisions 7.f–g: Trends in CPUE by the Irish fleets.

Figure 26.11. Plaice in divisions 7.f–g: Raised size structure of landings and discards in 2018–2022.

Figure 26.12. Plaice in divisions 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 2023

There was no assessment in 2023. Based on the assessment conducted in 2022, 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. 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.

27.1 General

27.1.1 Stock description and management units

The TAC specified for plaice in ICES divisions 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 2022 were 46 t, a 31% undershoot of the 2022 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 and 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).

27.1.2 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).

27.1.3 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.

27.2 Data

27.2.1 Commercial catch data

Belgium, France, Ireland, Spain, and the United Kingdom (England) uploaded commercial catch data for 2022 to InterCatch (Figures 27.2 and 27.3). Landings reported to InterCatch for this stock totalled 68 tonnes in 2022, which is a 20 tonne increase on 2021.

Discards submitted to InterCatch of plaice in divisions 7.h–k totalled 22 tonnes in 2022. Multiannual discard rate was not updated in 2023.

27.2.2 Survey indices

Although the assessment was not conducted this year, the survey indices was calculated to provide background information on the stock in 2022. 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 (1997–2022) (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 division 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 south west coast of Ireland and the south west 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.

27.2.3 Biological

As no advice was produced in 2023, there was no need to update this section.

In 2022, 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 ($L_{F=M} = 0.75*L_c + 0.25*L_\infty$). 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 (Figure 27.15, Figure 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 (Figure 27.15, Figure 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 Bertalanfy 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).

27.3 Advice

27.3.1 Analyses of stock trends and potential status indicators

In 2022 advice was 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, 2024 and 2025 was set using the HCR 'rfb' as outlined in the table below (ICES, 2020).

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 Blim 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.

27.3.2 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.

27.3.3 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 $I_{trigger}=I_{loss}\times1.4$, where I_{loss} is the lowest observed historical biomass index value from 2005. In estimated metric tonnes from derived form 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		

27.4 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.

27.5 References

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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 27.6. Plaice in Division 7.h–. raw variable discard rates (updated in 2022).

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)(no update in 2023).

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 (2004–2022)

Figure 27.15. Plaice in Division 7.h–k (2004–2022).

Figure 27.16. Plaice in Division 7.h–k. Lc. Updated in 2022.

Figure 27.17. Plaice in Division 7.h–k. Lmean. Updated in 2022.

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. Updated in 2022.

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. Updated in 2022.

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
2022*	8	12	33	14	0	67	68

Table 27.2. Plaice in divisions 7.h–k. Surveys incorporated into VAST biomass index.

Survey	Years	Quarters	Gear	Sources	Wing spread
IGFS	2003–2022	4	Otter	DATRAS	Available at haul level
IAMS	2003–2022	1	Otter & Beam	DATRAS	Available at haul level
EVOHE	2003–2022	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	2006–2022	1	Beam	DATRAS	Available at haul level
SWIBTS	2003–2012	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
2022	422.15	0.26	107.71

28 Pollack in the Celtic Seas (ICES subareas 6 and 7)

Type of assessment in 2023

The Celtic Sea and West of Scotland (subareas 6 and 7) Pollack stock is considered a Data-Limited Stock. A trends-based assessment was conducted using a combined survey index produced using VAST 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 2024 and 2025

ICES advises that when the precautionary approach is applied, commercial catches should not exceed 589 tonnes in each of the years 2024 and 2025.

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 constitutes 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 2022 TAC for Subarea 6 was 156 tonnes and uptake low at 21% and varied considerably between countries. France, which holds 48% of the TAC, only utilised 7.7% of their quota, whilst the UK utilised 28% of the 36.5% TAC allocation. Ireland has 14.1% of the total TAC and had the largest uptake using 52% of their TAC allocation.

In Subarea 7, which comprises the vast majority of landings and a TAC of 8012 tonnes, the uptake was also low at 25% and again varied considerably between countries. France, which holds the majority of the TAC allocation (67%), only utilised 9.2% of this. The UK utilised 37% of its 23% TAC allocation, Ireland utilised 62% of its 7.1% TAC allocation, Belgium and Spain, which hold very low TAC allocations at 2.9% and 0.2%, utilised 3.1% and 3.5% respectively.

Fishery in 2022

Landings

1558 tonnes of pollack were landed in 2022, 98% of which came from Subarea 7.

The official landings for ICES subareas 6 and 7 are shown in Tables 28.2 and 28.3 respectively.

For Subarea 6, there was an 52% decrease in landings (36 tonnes) in 2022 compared to the landings in 2021 (75 tonnes), which is way below the TAC of 156 tonnes. The UK declared the highest landings (44%) followed by Ireland (31%). There was a 24% decrease in landings (1525 tonnes)

for Subarea 7 in 2022 compared to 2021 (2011 tonnes). The UK had the highest landings (44%) followed by France (32%), Ireland (23%), Belgium (0.5%) and Spain (0.03%).

Landings by division

In 2022, 98% of catches came from Subarea 7, with only 2% of landings derived from Subarea 6 and of those, over 99% came from Division 6.a. The division with the highest proportion of landings derived from 7.e (39%) followed by 7.h (22%), 7.g (13.9%), 7.j (11.3%) and 7.f (8.4%). Landings in divisions 7.a, b, c, d and k were negligible (3.6%).

Landings by gear

The majority of Pollack landings in the Celtic Sea ecoregions were caught by gillnets and trammelnets (51%) followed by set lines (19.4%), bottom trawlers (16.1%) and miscellaneous gears. When separated by subarea, the predominant gears landing pollack in Subarea 6 were bottom trawlers (52%) followed by nets (20%) lines (17.1%) and miscellaneous gears (10.6%). In Subarea 7, nets had the highest landings (50%) followed by lines (19.5%), bottom trawlers (15.3%), and miscellaneous gears (9.0%).

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 (42%) followed by quarter 2 (23%), quarter 3 (18.1%) and quarter 4 (16.3%) respectively.

Discards

Discarding was negligible at 21 tonnes in 2022.

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

The stock was benchmarked at WKBMSYSPiCT in 2023. The SPiCT assessment agreed at the benchmark was subsequently considered inadequate to provide advice, due to concerns about the the appropriateness of the method, its performance, and the biomass index. The retrospectives for the assessment were outside of the ICES guidelines for Mohn's Rho and showed a consistent bias for biomass and fishing mortality.

At WGCSE it was decided that an ICES category 3 RFB method should be used to provide advice for this stock. The rfb rule is an index adjusted harvest control rule that uses a biomass index and catch length data (ICES, 2022) defined as:

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

where *Ay+1* is the new catch advice, *Ay* the previous advice, *r* the biomass ratio from a biomass index, *f* the fishing pressure proxy from catch length data, *b* a biomass safeguard and *m* a precautionary multiplier.

The advice uses the average catch from the last 3 years as an initial starting point for the assessment. An abundance index is produced using Vector Autoregressive Spatio-Temporal (VAST) and data since 2005 from the Irish Groundfish Survey (G7212), Irish Anglerfish and Megrim Survey (G3098), French Southern Atlantic Bottom Trawl Survey (G9527) and French Channel Groundfish Survey (G3425). A biomass index trend value (*r*) is produced by taking the mean of the last two years divided by the mean of the preceding three years. The biomass safeguard (*b*) is the last value of the biomass index divided by an $I_{trigger}$ value which is the lowest observed index value multiplied by 1.4. The fishing pressure proxy (*f*) is calculated from comparing the mean length data from commercial catches to a F_{MSY} proxy reference length (where $L_{F=M}$). The precautionary multiplier is based on the von Bertalanffy parameter *k*, and with the low *k* estimate for pollack would equate to a 0.95 multiplier.

2023 Results

Rather than using the prior advice which differs significantly from catches due to differences in quota uptake, the mean of the 3 most recent catches is used as basis for the advice (1967 tonnes, Table 28.4). The stock biomass is in a strong downward trend, with a biomass index mean value of the last two years of 280 tonnes, compared to a mean of 640 tonnes for the three years preceding that (Figure 28.1). This gives an *r* value of 0.44, and because the last index value (196 tonnes) is well below the $I_{trigger}$ value, the *b* component of the rfb method is 0.71. As this is below 1 the stability clause is not applied and advice can reduce more than 30%.

The fishing pressure proxy length is estimated at 590 mm (Figure 28.2). The mean catch lengths by year are shown in Figure 28.2, with a 2022 mean length of 590 mm. This produces an *f* value of 1.00 for the rfb method. This mean length over time has been relatively stable over time, with a slight increase in the last 4 years (Figure 28.4 and Figure 28.5). The multiplier (*m*) component of the rfb rule is set at 0.95, due to pollack life history and estimated k value of 0.1.

When applying the rfb method, the advice produced recommends that catches should be no more than 589 tonnes (Table 28.4). This is an 82% reduction in advice compared with 2023 advice.

Comparison with previous assessment

The previous DCAC assessment was based solely on landings, and the decline in landings had recently dropped below the catch levels that were assumed to be sustainable. It was impossible to determine if this was due to effort changes or stock depletion. This year advice was produced using the category 3 rfb method, which uses length data from landings and a biomass index. This has resulted in a large decrease in advice for this stock primarily due to the biomass index which has a strong declining trend.

Uncertainties in assessment and forecast

The surveys used to calculate the biomass index do not target preferred pollack habitat and the index is based on relatively few samples. Although the index is uncertain it shows a strong declining trend.

Recreational catches could be a large component of the total catch and are poorly quantified in terms of catch and mortality. These catches are not included in the assessment or in the management of the stock.

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 was benchmarked in 2023 (ICES, 2023). Although the SPiCT assessment was not accepted by WGCSE valuable progress was made that enabled the use of category 3 rules. However, work needs to be done to validate the biomass index due to the low pollack catches and to explore the impacts of the substantial recreational catches. 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.

28.3 References

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Table 28.1. 2023 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
1977	-	-	196	-	-	1	2	-	-	-	493	692
1978	-	-	196	-	-	-	4	-	-	-	553	753
1979	-	-	310	-	-	-	-	-	-	-	350	660
1980	-	-	36	-	-	-	-	-	-	-	233	269
1981	-	-	342	-	-	-	-	-	55	-	185	582
1982	-	< 0.5	272	-	-	-	-	-	95	-	103	470
1983	-	-	331	-	-	-	-	-	86	-	148	565
1984	-	-	212	-	-	-	-	-	222	-	194	628
1985	< 0.5	-	224	1	-	-	-	-	283	-	328	836
1986	-	-	145	-	223	-	-	-	2217	-	187	2772

Year	Bel-gium	Den-mark	France	Ger-many	Ire-land	Nether-lands	Nor-way	Portu-gal	Spain	Swe-den	UK	Total Sub-area 6
1987	-	< 0.5	108	-	103	-	-	-	860	-	259	1330
1988	-	< 0.5	128	-	163	-	-	-	1925	-	221	2437
1989	-	< 0.5	111	1	103	-	-	-	-	-	179	394
1990	-	-	76	-	150	-	1	-	-	-	192	419
1991	-	-	31	-	145	-	-	-	4	-	189	369
1992	-	< 0.5	21	-	23	-	-	-	< 0.5	-	203	247
1993	-	-	39	-	12	-	-	-	-	-	273	324
1994	-	-	34	< 0.5	26	-	< 0.5	-	-	-	276	336
1995	-	-	64	3	83	-	-	-	-	-	354	504
1996	-	< 0.5	29	< 0.5	97	-	1	-	-	-	210	337
1997	-	-	14	1	69	-	2	-	-	-	162	248
1998	-	-	21	-	60	-	-	< 0.5	< 0.5	-	147	228
1999	-	-	-	-	73	-	3	-	< 0.5	-	136	212
2000	-	-	11	2	62	-	-	-	-	-	116	191
2001	-	-	8	-	108	-	-	-	-	-	101	217
2002	-	-	9	-	26	-	-	-	-	-	96	131
2003	< 0.5	-	3	-	88	-	1	-	-	-	111	203
2004	< 0.5	-	2	-	68	-	1	-	-	-	65	136
2005	-	-	23	-	28	-	-	-	-	-	16	67
2006	-	-	3	< 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	-	16†	-	-	-	-	-	32	48†
2021*	-	-	2	-	29	-	-	-	< 0.5	-	43	75
2022*	-	-	7	1	11	-	-	-	-	-	16	36

*** Preliminary official landings.**

† Incomplete/missing as a result of part of the data being unavailable under data confidentiality clauses.

Table 28.3. Landings of Pollack in Subarea 7 as officially reported to ICES.

Year	Bel-gium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1950	93	-	-	-	-	-	-	-	375	468
1951	74	-	-	2	-	-	-	-	380	456
1952	80	-	-	10	-	-	-	-	336	426
1953	34	-	-	-	-	-	-	-	252	286
1954	17	-	-	4	-	-	-	-	365	386
1955	38	-	-	-	-	-	-	-	247	285
1956	67	-	-	1	-	-	-	-	155	223
1957	219	-	-	6	-	-	-	-	367	592
1958	342	-	-	17	-	-	-	-	233	592
1959	158	-	-	32	-	-	-	-	251	441
1960	317	-	-	-	-	-	-	-	267	584
1961	268	-	-	-	360	-	-	-	210	838
1962	367	-	-	1	369	-	-	-	170	907
1963	95	-	-	-	411	-	-	-	176	682
1964	299	-	-	-	342	-	-	-	194	835
1965	362	-	-	-	335	-	-	-	231	928
1966	456	-	-	-	438	-	-	-	175	1069
1967	417	-	-	-	474	-	-	-	202	1093
1968	214	-	-	-	508	-	-	-	167	889
1969	142	-	-	-	794	-	-	-	161	1097
1970	165	-	-	1	724	-	-	-	120	1010
1971	114	-	-	-	673	-	-	-	116	903
1972	142	-	-	-	1073	-	-	-	123	1338
1973	89	-	-	-	-	3	-	-	127	219
1974	299	-	-	-	-	13	-	-	223	535
1975	295	-	-	-	-	17	-	-	290	602
1976	339	-	-	-	-	4	-	-	421	764
1977	157	1	3569	-	-	1	-	-	465	4193
1978	186	21	5496	14	-	8	-	-	515	6240
1979	151	18	5119	76	-	1	-	-	696	6061
1980	237	7	5242	-	-	1	-	1	769	6257
1981	244	-	5814	-	-	3	-	23	780	6864
1982	154	-	4253	-	-	-	-	32	1022	5461
1983	167	-	6214	-	-	-	-	26	1045	7452
1984	207	-	3927	-	-	-	-	486	1100	5720
1985	269	-	3741	-	-	-	-	20	1022	5052
1986	241	-	4574	-	1335	-	-	17	1795	7962

Year	Bel-gium	Denmark	France	Germany	Ireland	Netherlands	Norway	Spain	UK	Total Subarea 7
1987	149	-	5213	-	848	-	-	19	2010	8239
1988	191	-	5211	-	1066	-	-	22	1740	8230
1989	145	-	3893	-	994	-	-	18	1487	6537
1990	133	-	4831	-	1066	-	-	26	1914	7970
1991	76	-	3211	-	1045	-	-	22	1962	6316
1992	62	-	2849	-	1014	-	-	19	1889	5833
1993	55	-	2325	-	1137	-	-	7	2135	5659
1994	94	-	2621	-	921	-	-	8	2391	6035
1995	88	2	2315	-	1107	-	-	4	2168	5684
1996	94	-	2684	-	1190	6	-	5	2519	6498
1997	99	-	2443	-	984	4	< 0.5	7	2540	6077
1998	92	-	2375	-	886	1	-	11	2347	5712
1999	86	-	-	-	976	-	3	19	1703	2787
2000	71	-	2422	-	1069	-	-	5	1810	5377
2001	100	-	2515	-	1274	-	-	9	1987	5885
2002	117	-	2481	-	1308	-	-	17	1999	5922
2003	113	-	2284	-	1151	-	-	12	1788	5348
2004	104	-	1914	-	1049	1	-	13	1705	4786
2005	98	-	2198	-	728	1	-	16	1684	4725
2006	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	-	602†	2	-	3	974	2182†
2021*	7	-	584	-	419	2	-	1	802	1816
2022*	7	-	494	-	355	1	-	< 0.5	671	1528

***Preliminary commercial landings.**
c Incomplete due to part of the data being unavailable under national GDPR clauses.

Table 28.4. Summary of rfb method and advice for Pol.27.67.

Mean catch Cy (2020, 2021, 2022)		1967 tonnes
Stock biomass trend		
Index A (2021,2022)		280 Est. Tonnes
Index B (2018,2019,2020)		640 Est. Tonnes
r: stock biomass trend (index ratio A/B)		0.44
Fishing pressure proxy		
Mean catch length (Lmean = L2022)		590 mm
MSY proxy length (LF=M)		590 mm
f: Fishing pressure proxy relative to MSY proxy (L2022/LF=M)		1.00
Biomass safeguard		
Last index value (I2022)		196 Est. Tonnes
Index trigger value (Itrigger = Iloss x 1.4)		270 Est. Tonnes
b: index relative to trigger value, min{I2022/Itrigger, 1}		0.71
Precautionary multiplier to maintain biomass above Blim with 95% probability		
m: multiplier (generic multiplier based on life history)		0.95
RFB calculation (r*f*b*m)		590 tonnes
Stability clause (+20%/-30% compared to Ay, only applied if b=1)	Not applied	
Catch advice for 2023 and 2024 (Ay * r * f * b * m)		589 tonnes

Figure 28.1. Stock biomass index for pol.27.6 including I_{loss} and $I_{trigger}$ levels. The horizontal red lines indicate the average of the last two years and the preceding three years.

Figure 28.2 Fishing pressure proxy for rfb method. Black bar represents $L_{F=M}$ length and red bar indicates length at first capture.

Figure 28.3 Mean catch length by year shown by red line. Dotted line represents the length at first capture.

Figure 28.4 Mean catch length over time compared to the MSY proxy length ($L_{F=M}$).

Figure 38.5 Indicator ratio $L_{F=M}/L_{mean}$ (inverse of the indicator ratio, f) form the length-based indicator (LBI) method is used for the evaluation of the exploitation status. The proxy fishing pressure is less than that corresponding to the F_{MSY} proxy ($L_{F=M}$) when the indicator ratio value is lower than 1 (shown by the horizontal blue line).

29 Sea bass (*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 sea bass: 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 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.

ICES advice applicable to 2023

ICES advises that when the MSY approach is applied, total removals† in 2023 should be no more than 2542 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

29.1 General

29.1.1 Stock definition and ecosystem aspects

Currently Atlantic stock identities are assumed to be as follows (ICES, 2012a,b):

A stock identity workshop was conducted in 2022 as part of the benchmark for the stocks bss.27.4bc7ad-h and bss.27.8c9a (ICES, 2023). It concluded that the current stock structure may be revised based on available evidence from tagging studies, genetics and larval dispersion models. Hypotheses put forward by the stock ID workshop group will be considered during the data and assessment workshops of the benchmark in 2023 and 2024.

29.1.2 Management

Historical management is described in the Stock Annex.

29.1.2.1 Management applicable from 2021 to 2023

In 2021, 2022 and 2023 the sea bass 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, 2023 respectively for full details[1,2,3,4]

[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/TXT/?uri=CELEX:32022R0515

[4] https://eur-lex.europa.eu/legal-content/FR/TXT/?uri=CELEX:32023R0194

	Year	Demersal trawl[1]	Seines[2]	Hook and Lines[3]	Fixed Gill-nets[4]
2021	January 2021 and 04/01/2021 to 07/31/2021	< 520 kg/2 months;	< 520 kg/2 months;		
		< 5% total catch/day	< 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		
		< 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*;	< 760 kg/2 months*;	5,95 t/year	1,5 t/year
		< 5% total catch/day	< 5% total catch/day		
	February-March 2022	no landings	no landings	no landings	no landings
2023	January 2023 and 04/01/2023 to 12/31/2023	< 3,8 t/year	< 3,8 t/year	6,2 t/year	1,6 t/year
		< 5% total catch/day	< 5% total catch/day		
	February-March 2023	no landings	no landings	no landings	no landings

*January/April; May/June; July/August; September/October; November/December

	Year	Recreational
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
2023	January–February–December 2023	0 fish/day
	01/03/2023 to 30/11/2023	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 2022, 1273 tonnes were landed (official source): 617 t by UK, 404 t by France, 225 t by Netherland, 24 t by Belgium and 1t by Denmark, Germany and Channel Island. Landings from France and the UK by gear are given in Figure 2.

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–present 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 sea bass. This has negligible impact on the assessment as this UK métier represented only 1% of total sea bass 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 sea bass 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 2022;

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 sea bass 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 sea bass 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 sea bass 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 (French fishers have been encouraged to report their discards in logbooks because of the landings obligation). Discarding is mainly attributed to bottom trawlers where sea bass is often a bycatch. Note that the level of sampling of the UK fleets since 2017 and FR fleets since 2019 has been low and so no raised estimate of discard length distribution was included in the assessment for these years.

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 2020–2023 (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 sea bass. 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

Four similar surveys have been done by Ifremer along the coast of France since 2014 to provide insight into French sea bass nurseries areas and pre-recruit dynamics. The new time-series will be provided to WKSEA BASS to be considered for inclusion in the new assessment. In the Channel, the survey takes place in the Seine estuary and indices are available from 2017. The survey is expected to continue in 2023 under a European Maritime and Fisheries Fund (EMFF) programme (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.

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 sea bass 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 sea bass 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 nine 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 sea bass 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	727.6
Catch	8.23e-013
Equilibrium catch	0.034
Survey	-41.97
Discards	34.71
Length compositions	399.5
Age compositions	310.8
Recruitment	24.29
Forecast Recruitment	0.275
Parameter soft bounds	0.020

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 (5yrs)	0.088
Fishing mortality (ages 4–15) (5yrs)	-0.063
Recruitment (age 0) (3yrs)	0.11

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 sea bass can be targeted, and it is possible for fisheries to maintain landings as total stock size declines, and hence inflict an increasing fishing mortality rate. The F has 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 2022 F has not changed compared to 2021, 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. However, the total biomass has decreased from 2022 to 2023 due to a decrease in fish age 3–5, so not all mature although some available to the fishery.

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 and 2016 was above the long-term geometric mean of 15 211. Uncertainties in the assessment are explored in a subsequent section.

29.3.4 Comparison with previous assessments

With the addition of the 2022 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 2023 when compared with the recent assessment (Figure 33) are very close, especially for SSB and F, 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 spawning 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. However, the last one of those appears to be in 2016, with a downward revision this year of the 2018 and 2019 recruitments, and so this year a decreased estimate of immature fish has led to a decrease estimate of total biomass in the interim year.

The period of increasing SSB in the 1990s and early 2000s also coincided with expansion of the stock in the North Sea. The enhanced productivity and geographic range of the stock at this time also coincided with a period of elevated sea temperatures (see WGCSE and Stock Annex for UK inshore sea temperature trends in relation to sea bass recruitment).

The assumption of a constant recreational fishing mortality over time implies that recreational harvests were a much larger fraction of total fishery removals in the 1980s compared with the 2000s onwards (Figure 10). It is likely that in the 1970s or earlier, sea bass 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 sea bass 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 (ten 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
2020	8226 thousand	
2021		10 875 thousand
2022		10 875 thousand
2023		10 875 thousand

29.5.2 Numbers of fish in 2023

These were derived from the update Stock Synthesis run with final year set at 2022. The numbers for ages 0–2 in 2023 were adjusted using the ratio of LTGM to SS3 values for 2021–2023 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 2022. 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 (2023), 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 2023.

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 2023 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 23**, assuming that F in 2023 is the average of 2020–2022 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 2023 at the same fishing mortality as in 2020–2022 for the commercial fleet, and with the current two bag limit for nine months for the recreational fleet, an SSB of 12978t is predicted in 2024, decreasing from 13 159 t in 2023. With the same fishing effort in 2024 the SSB would go down to 12 595 t. There is uncertainty in the forecast, as the actual rate of change 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 sea bass 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 0.154 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 2432 tonnes. This would be a decrease of 4.3% compared to the advice for 2023. The allocation between commercial and recreational fisheries depends on the balance of controls applied on recreational and commercial fishing in 2023 and 2024.

With zero F in 2024, SSB is expected to increase from 12 978 t in 2024 to 14 040 t in 2025. Therefore, it is not 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 Belgium. In 2022, age data were provided by Netherland. Their inclusion in the assessment should be considered during WKSEA BASS.

ICES has developed extensive advice on establishing statistically-sound sampling designs for estimating fishery length and age compositions and discard quantities (see reports of ICES Workshops on Practical Implementation of Statistically Sound Catch Sampling Programmes (WKPICS1–3, available on ICES website). Stratified random sampling of fishing vessels or harbours may lead to low sample sizes for species such as sea bass for which large fractions of the

total catches may be taken in relatively small numbers of fishing trips. The cost-benefit of expanding the sampling in vessel or harbour strata where most sea bass landings are recorded, without compromising statistical sampling design, should be investigated. The next benchmark should evaluate if sampling is currently sufficient to support continued application of Stock Synthesis fitting selection parameters to fishery composition data.

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 sea bass.

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 and should be reviewed during WKSEA BASS.

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 sea bass 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 has been 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 seven years will be available, also a juvenile sea bass index should be tested in the model. The trawl used was developed for catching sea bass. 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 sea bass catches have been recorded, was presented to IBPNEW in 2012 (ICES, 2012a). There were divergent trends between fleets where sea bass is 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 sea bass 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 sea bass may remain close inshore, and exploitation of young fish in coastal waters (<6 nautical miles offshore) may be predominantly by inshore fleets of that country. Mature fish originating from coastal waters of the UK, France or Netherlands or other countries may become increasingly vulnerable to offshore pelagic pair trawlers fishing mainly on mature fish during December to April. These spatial, ontogenetic patterns may lead to complex responses of length and age compositions to previous fishery catches of each country and fleet. This could potentially be addressed using spatial structuring in Stock Synthesis, but the data demands would increase substantially. Both the UK (England) and France have studies underway to improve knowledge of sea bass movement and mixing.

WKBASSID concluded that existing evidence does not support current ICES stock advice units for sea bass in divisions 8.a-b (northern and central Bay of Biscay) and divisions 4.b–c, 7.a and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel and Celtic Sea).

Firstly, there is evidence from the genetics/genomics and tagging studies of sea bass genetic structuring within divisions 4.b–c, 7.a and 7.d–h, with evidence of differentiation between the Irish (ICES Division 7.a) and Celtic Sea (ICES divisions 7.f–g) compared to the southern North Sea (ICES Division 4.c) populations, which was further supported by Child *et al*. (1992) who highlighted similar genetic breaks, but also connectivity between the southern North Sea and English Channel (ICES division 7.d–e). Tagging studies have contributed substantially to helping the group delineate sea bass boundaries. For example, Wright *et al*. (unpublished) revealed little

movement of sea bass tagged within the Irish or northern Celtic Sea (ICES divisions 7.f–g) beyond these regions, further strengthening this east-west break within the existing northern sea bass stock unit.

Secondly, there is evidence from genetic/genomic and tagging studies of connectivity between sea bass from the northern part of the Bay of Biscay (ICES Division 8.a), English Channel (ICES Division 7.e) and southern Celtic Sea (ICES Division 7.h). The tagging data provided by both de Pontual *et al*. (2019), de Pontual *et al*. (in revision) and Wright *et al*. (unpublished), as well as the pelagic connectivity research undertaken by Beraud *et al*. (2018) and Graham *et al*. (2023) evidenced substantial areas of connectivity within the northern Bay of Biscay (ICES Division 8.a), eastern English Channel (ICES Division 7.d), western English Channel (ICES Division 7.e) southern Celtic Sea (ICES Division 7.h) and southern North Sea (ICES Division 4.c). The genomics study by Lamb *et al*. (unpublished) found no significant genetic differences among sea bass within these ICES divisions, further suggesting substantial connectivity. These areas of connectivity, i.e. mixing, suggest the use of 'meta-population' terminology due to multiple biological and behavioural interaction levels, such as breeding habitats and summer feeding regions revealing, for the first time, a potential seasonal component to probable stock units (Pontual *et al*., 2019; de Pontual *et al*., in revision; Wright *et al*., unpublished).

Thirdly, from existing tagging data there is no evidence of connectivity between the southern Bay of Biscay (ICES Division 8.b) sea bass and any ICES division within the current northern sea bass stock unit (de Pontual *et al*., 2019). This information suggests a some-what isolated subpopulation within this region but with some connectivity with ICES Division 8.a (northern Bay of Biscay) as highlighted by the lack of genetic differentiation between these two regions (Robinet *et al*., 2020). However, it should be noted that research regarding the connectivity of the southern component of the Bay of Biscay to the Celtic/Irish Sea and English Channel is somewhat lacking and therefore cannot be ruled out completely.

Overall, the existing evidence supports the presence of a single metapopulation with three subpopulations, hypotheses of which are described below. While this workshop has added to the previous dearth of information regarding sea bass population structures and stock units, the group strongly believes that further research is required. Questions such as specific mixing regions, identification of regionally specific SNP's and connectivity or boundaries among non-assessed ICES regions must be clarified. This workshop should be viewed as just the beginning of the stock identification process and not the end.

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 sea bass 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

Sea bass 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 sea bass in the North Sea and Northeast Atlantic and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. A period of above-average sea temperatures and enhanced recruitment between 1989 and the mid-2000s generated a large increase in biomass and a geographic expansion.

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.

WGCSE notes that protection of juvenile fish through technical measures is good to improve the fishery selectivity and increase the number of sea bass that are able to spawn at least once, but this is probably not enough to ensure a sufficient decrease in F. Protection of juveniles already exists to an extent already through designation of 37 UK sea bass nursery areas where certain types of fishing on sea bass is prevented annually or seasonally.

No bio-economic scenarios are available at present to appreciate the effect of management measures for sea bass, based on economic considerations, and work is urgently needed in this area. The importance of sea bass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration that has implications for the type of scientific evidence needed. 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 current stock structure assumptions are pragmatic and need further evaluation. The sea bass population in coastal waters of the Republic of Ireland is currently considered as a separate stock, although it extends into at least one of the ICES divisions defining the 4.bc and 7.a,d–h stock. Further studies are needed to determine if the sea bass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds. Moreover, the Bay of Biscay is also currently considered as a separate stock although tagging program indicates some exchange with the area 4 and 7 stock studied assessed by WGCSE.

As bass is, at present, a non-TAC species, there is potential for continued displacement of fishing effort from other species with limiting quotas. The fisheries on sea bass have grown in the 1990s and 2000s due to good recruitment, and new markets have been established, competing with farmed bass. Fishing mortality 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 sea bass.

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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

Year	Belgium	Denmark	Germany	France	UK	Netherlands	Channel Is.	Total	Total ICES
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	526	223	15	1175	1042
2021*	45	0	0	385	613	231	1	1275	1126
2022*	24	1	1	404	617	225	1	1273	1126

Source: Official Landings Statistics. *2021 and 2022 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	1771
1986	84	33	2	1180	19	1597
1987	96	18	0	1840	25	1457
1988	129	30	8	1028	44	1353
1989	141	29	7	917	67	1253
1990	128	18	22	849	47	1129
1991	152	60	14	971	29	1037
1992	105	23	8	1001	49	1061
1993	146	62	1	979	68	1235
1994	354	154	0	786	76	1481
1995	424	169	4	1057	181	1661
1996	308	128	87	2395	104	1673
1997	335	119	71	1984	111	1588
1998	241	121	85	1773	170	1534
1999	274	148	220	1843	185	1536
2000	236	53	52	1805	261	1590
2001	263	58	97	1883	199	1675
2002	361	75	110	1825	251	1771
2003	353	65	127	2471	443	1852
2004	380	72	131	2604	544	1896
2005	353	59	68	3161	789	1892
2006	359	119	11	3259	629	1860
2007	413	166	37	2771	677	1855
2008	514	163	17	2750	663	1862
2009	486	147	9	2649	598	1836
2010	452	183	42	3236	649	1739
2011	462	143	98	2526	629	1598
2012	564	185	49	2610	579	1440

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
2013	530	191	39	2871	506	1229
2014	751	236	1	1303	391	1021
2015	440	199	0	1110	317	703
2016	305	210	2	547	231	215
2017	125	147	0	442	270	212
2018	160	267	0	313	208	153
2019	134	259	1	329	249	277
2020	190	306	0	409	137	447
2021	228	361	0	413	124	489
2022	236	337	0	408	145	509

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				
	Age		Length		Landings (t)	Age		Length		Landings (t)
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
1985	45	235	15	225	27	3	44	2	43	1
1986	18	216	28	2591	24					2
1987	41	421	54	1181	41	4	42	1	589	0.02
1988	23	257	23	1298	65	2	64	2	1684	8
1989	63	531	44	1595	80	4	126	4	1451	7
1990	63	883	48	773	67	8	19			22
1991	92	983	32	731	39	12	125	1	1490	14
1992	69	699	17	398	41	2	50	2	220	8
1993	118	1219	38	836	80	9	39			1
1994	182	1927	113	3925	125			1	127	0.3
1995	28	529	66	1995	162			1	19	4
1996	49	660	39	1041	122	1	41	3	392	87
1997	59	1660	52	2445	140	1	49			71
1998	28	676	39	1442	133	20	95	4	167	85
1999	24	379	46	1216	138	12	382	9	770	220
2000	92	759	42	1814	133	23	847	14	2463	52
2001	45	851	49	2152	141	3	58	5	691	97
2002	54	523	47	1454	161			4	545	110
2003	48	512	45	1418	207	15	459	4	744	127
2004	33	361	31	1295	173	8	161	5	522	131
2005	35	498	31	2432	181	3	149	2	299	68
2006	15	252	17	810	160	1	43	1	100	11
2007	44	385	21	903	173	1	20	3	355	37
2008	37	580	32	2151	196	6	409	8	1283	17
2009	24	1184	13	807	175	8	317	6	625	9
2010	25	360	28	1312	150	7	153	3	376	42
2011	25	577	49	1903	137	3	103	4	463	98
2012	18	182	41	751	157			1	199	49
2013	15	289	23	859	125					39
2014	14	164	22	523	104					1
2015	28	377	39	1277	100	1	4	1	4	1
2016	19	256	90	527	52					2
2017	38	510	128	915	51	0	0	0	0	0
2018	43	263	43	492	28	1	15	1	33	0
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
2022	36	136	36	500	69	0	0	0	0	0

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
2021	136	1362	136	3412	242	42	399	42	1424	154
2022	118	1505	118	3369	337	48	569	48	1711	189

Table 4. Bss.27.4bc7a d–h: Sampling of commercial fishery sea bass 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
2022			66	1367	130			53	496	80

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
2022			8	118	19			0	0	19

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
2022			7	21	2			103	1978	157

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).

#_Yr	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
l20	0	0	0	0	0	0	0	0	0	0	0	0	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	0
l24	0	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	0
l28	0	0	0	3455	0	0	0	0	0	292	0	0	1219	0	0	291	0	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	0
l32	0	0	0	58717	13057	9903	32459	181	8250	2239	9811	1976	1583	0	3076	2678	1481	0	0	0	0	80	0
l34	9931	17962	12469	105655	78811	29872	179130	4715	28986	10714	28290	13885	6518	1504	3620	5102	1440	137	0	0	0	0	27
l36	34932	19809	38249	125326	127801	97890	285704	39335	229758	124925	169311	57121	85760	29667	33532	44175	2814	2646	0	0	194	90	118
l38	85866	68920	46427	180475	124051	128022	217657	102714	263071	211881	177571	87842	172510	88507	68262	75546	4340	2523	91	0	1030	763	2491
l40	126730	76594	62503	119495	227214	231750	178250	146272	266408	225545	182105	128838	140273	149070	74871	93273	7417	3572	814	0	6255	7417	9937
l42	102836	98008	82461	145456	282390	266905	196868	145122	237160	193030	283064	187586	147895	146130	82684	115713	24816	9257	2444	2034	16127	24659	29248
l44	80478	109595	91064	104545	243107	344681	289998	164011	270810	222613	251956	201447	162333	123170	51365	122460	20422	14861	2954	2198	17867	22303	32840
l46	93344	106857	86723	130023	188494	270532	285451	130859	228996	238849	230227	199487	180752	140677	61292	95208	22427	9603	4379	1948	12708	20722	30358
l48	80934	77694	62163	115806	126685	239265	263272	100043	142650	155222	188149	194697	158490	127136	39844	59668	20653	7367	2606	635	9921	13639	26198
l50	55399	57055	55905	91915	72581	169478	200874	99210	112385	159658	186310	145447	130759	116842	38109	51436	15619	6801	3549	1246	5488	11644	22521
l52	52948	51658	46180	93878	82331	115269	119836	75929	74336	114530	109212	124239	107214	99156	29929	37860	10415	4599	2861	345	3890	7315	15998
l54	42094	36737	35998	48742	50633	62106	99509	74405	66260	84649	120550	92526	90638	103818	39911	21406	16034	3586	2702	456	2456	5362	10399

#_Yr	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
l56	26460	35839	26001	60839	60284	67741	99674	55147	48853	96257	71590	72471	78934	89197	32298	20681	9753	1012	2538	415	1515	4242	6270
l58	27357	22762	19019	31614	31334	61132	54522	46087	39689	51578	62211	46869	54869	59004	30016	13591	12328	2519	3581	0	1226	3181	5562
l60	23581	25834	14210	33688	19126	43591	45908	28056	29840	36547	31544	31690	35387	65851	21467	11946	7678	913	2008	0	1064	1996	3564
l62	14295	18773	11129	30691	23996	35774	23763	23057	28335	57472	19076	19998	33085	64579	16797	11776	7506	1120	1669	373	636	1617	3691
l64	18044	13532	16771	18823	14799	25788	20607	18091	14420	24016	62005	17624	17714	53482	16261	9356	4348	1369	1641	0	641	1199	1752
l66	10773	11068	11011	13230	10650	12456	14969	8715	12694	21415	26388	14720	15170	37744	8387	6653	2634	510	778	124	333	695	1371
l68	9903	9120	5447	7960	8569	13360	13976	8793	9039	27466	9340	7906	9374	23884	5579	2485	4465	315	463	124	378	882	825
l70	5709	11771	4795	5374	4880	8908	9653	4835	6821	20198	8541	6114	8114	32512	8995	1163	1353	345	255	0	133	468	910
l72	5721	5733	4559	5617	2974	8053	4521	2707	4714	12083	29128	2082	4147	14996	3027	660	956	408	47	0	62	141	347
l74	2345	5345	1825	3275	2675	9811	3424	1962	1623	7551	1884	1163	2313	9001	642	628	219	652	0	0	0	121	529
l76	2595	2782	1260	1356	2567	5020	2883	1010	1257	979	2114	1096	1540	2640	773	431	0	92	0	0	0	76	76
l78	2102	1691	357	297	548	2378	731	399	534	1765	182	476	1134	2073	0	9	127	718	0	0	0	5	0
l80	888	583	155	783	425	1365	201	158	261	264	5525	148	282	176	198	16	0	0	0	0	0	0	181
l82	1021	296	109	112	149	107	261	37	8	1004	6097	104	451	1566	0	278	0	92	0	0	0	3	0
l84	548	204	0	148	295	0	30	59	0	0	863	0	29	0	0	0	0	0	0	0	0	0	0
l86	123	0	0	0	0	0	0	0	0	0	0	0	27	1115	0	0	301	0	0	0	0	0	0
l88	0	61	0	0	149	0	0	0	0	0	1207	0	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).

year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
a2	0	0	0	2611	3	0	3138	0	1208	878	0	0	0	0	0	0	0	0	0	0	0	10	0
a3	0	2651	8114	10800	4	24195	74600	5307	79917	17293	6830	0	0	0	0	0	0	98	0	0	34	1505	1157
a4	9440	55640	73892	364427	80483	77794	131099	73224	175402	92501	64071	3481	265	0	2300	10607	1850	1065	735	2251	7217	13637	23133
a5	222655	47734	125531	241694	627951	253455	564668	135809	545960	77583	74708	109582	17233	6417	4138	28960	20182	1605	5490	2392	17734	30515	44663
a6	273687	298773	90294	318445	438799	735235	361515	460583	401231	49868	135505	152702	216615	16487	36582	39482	18999	6568	1582	2391	37642	23147	42533
a7	139562	211740	236147	96562	297961	352182	841651	124606	456312	17981	112579	142896	266517	133787	54484	30417	18589	4507	1571	112	3170	34777	35979
a8	79413	90962	86108	254050	65297	443765	146484	139879	143871	17887	117368	121070	240104	88986	43902	60049	20496	6102	776	1682	4038	11829	35191
a9	47258	44742	31151	114829	131612	39104	253945	79978	147881	0	57320	264916	222113	109206	41316	27137	14682	3870	2704	454	6130	9287	13174
a10	43924	21074	23025	57883	77533	161572	13655	69214	40719	28366	22351	105282	172833	143048	4541	17343	14879	2085	70	231	4343	0	4990
a11	49293	39908	17823	26223	25416	69617	132370	33191	57341	1248	10523	58721	82759	103915	1742	5353	10075	1160	0	386	211	2465	135
a12	20207	36007	14760	19879	14848	26314	84910	65868	17882	0	10414	24328	35102	47660	202	3804	0	727	306	0	1403	0	211
a13	10767	17787	15912	14232	14254	17996	22068	68599	35092	0	7096	18672	21967	18471	178	2650	1423	649	0	0	0	976	0
a14	4925	4394	9752	18088	13528	19238	6648	11131	12669	0	7652	4666	8640	16817	121	4485	131	351	0	0	0	471	0
a15	4927	6838	3743	6600	7628	17974	6999	9034	5518	0	213	3149	2570	1275	0	0	81	455	0	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	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

UK OTB NET	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16+
2009	0	2659	73056	169969	172602	64997	19002	14443	9064	8631	3610	2235	1302	0	249
2010	0	319	77100	155258	118179	78410	28938	11821	6979	6043	2645	2083	2273	534	1663
2011	0	845	28630	124625	92582	71094	54338	31775	10438	11227	6347	2933	2203	675	1692
2012	0	1620	14135	166965	219883	61319	39609	31669	15268	9427	4092	3864	2546	538	930
2013	0	0	45016	60547	182858	117821	33448	30222	22727	17473	11825	2908	2687	2429	2133
2014	0	6622	31923	107001	58412	114826	78809	38859	27037	30548	19853	5152	1776	1857	1487
2015	0	50	3716	20172	45807	36830	63272	35025	17302	12685	10431	2917	7265	7308	966
2016	0	0	1591	7863	13991	31088	24925	40386	24807	10618	8218	4788	1960	2098	1528
2017	0	0	39	454	2176	1179	881	928	852	713	107	257	41	144	236
2018	0	130	4361	18582	26874	18792	9488	6826	4615	6186	5377	1562	1164	960	766
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
2022	0	0	2360	15630	44573	40540	69169	18778	7351	3573	1820	971	676	985	748

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

	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16+
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
2022	0	0	2260	13346	43096	51174	90982	27064	10304	7761	6486	1614	1332	1046	1157

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).

	Age 3	Age 4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16+
1996	0	289	796	3892	7166	5583	1648	21	334	154	622	485	199	559
1998	0	245	5979	1184	8553	8135	2513	2517	345	93	53	119	893	569
1999	0	298	1840	1510	2714	1381	1806	4309	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	1977	2029	7042	5268	3124	2845	9666	857	636	123	261
2002	3	37	2380	1578	2408	9693	6297	5978	450	5664	9215	0	0	530
2003	0	268	1061	3925	7971	4055	1029	3162	3254	618	169	4043	77	281
2004	7	125	1250	1437	4810	3199	2069	8010	353	1797	1141	91	968	18
2005	0	114	2103	1532	1439	1740	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	1023	1364	1590	1364	4424	4233	2773	1688	1003	264	423
2012	0	391	4461	1077	1001	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	2022
(a) bottom otter trawls																					
4bc	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	1
Total	34	75	120	79	102	220	196	121	104	105	109	92	147	132	56	1	12	33	4	20	1
(b) Fixed/driftnets																					
4bc	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																					
4bc	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			

Division & fleet	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
(d) Midwater trawls																					
4bc	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																					
4bc	8	5	10	1	2	1	1	7	6	8	4	10		0	6	0	0	0			
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			12
Total	22	34	50	23	38	35	22	25	30	37	32	42	15	17	12	0	0	0			12

Table 11. Bss.27.4bc7ad–h: Estimated annual numbers and weight of sea bass retained and discarded by UK using fixed or driftnets, otter trawl, beam trawl and lines fleets in areas 4, 7.d, 7.eh and 7.afg, based on at-sea sampling, and raised from landings in sampled strata to landings in all strata. Numbers of sampled trips (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	11	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	46	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
2022	0	41	0	1	0	189	0	0	9	23	29	12	0	337	0	0	9	567	2

*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 sea bass 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				
2022*	0	2	0		0	0

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				
2022*	18	157	10		50	54

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	-	-		
2022*	0	80	0		41	1

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				
2022*	6	130	4.4		4	23

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	-	-	-	-
2022*	0	19	0		0	0

FR_ALL	discards (t)	Landings (t)	discard rates	cv indicator	Nb trip sampled	Nb fish sampled
2003	105.5	2473	4%		18	26
2004	84.2	2604	3%		24	3
2005	43.9	3162	1%		0	0
2006	168.4	3259	5%		24	36
2007	11.8	2770	0%		44	4
2008	143.5	2750	5%		78	67
2009^	33.2	2622	1%		356	126
2010^	94	3175	3%		280	116
2011^	101.3	2483	4%	7.25	131	103
2012^	54.1	2495	2%	3.67	433	165
2013^	62.4	2752	2%		312	147
2014^	37.5	1286	3%		381	128
2015^	80.2	1079	7%	1.62	466	390
2016*	152.7	529	22%		853	310
2017*	161.7	442	27%		61	141
2018*	34.2	313	10%			
2019*	79.2	329	19%		9	31
2020*	3	409	1%		16	4
2021*	13	413	3%		41	66
2022*	24	388	6%		99	78
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%			
2022**	196	388	34%			

^ included in the assessment (source onboard sampling programme).

*** not included in the assessment (source onboard 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
2022	42 cm	two fish	9 months	0.464
2023	42 cm	two fish	9 months	0.464

Table 14. Bss.27.4bc7ad–h: Time-series of Cefas Solent autumn survey of juvenile sea bass. 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	2023 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
2022		1.54

Table 15. Bss.27.4bc7ad–h: Numbers-at-age in Solent survey 1986–present: updated time-series of Cefas Solent autumn survey of juvenile sea bass.

	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
2022	0.87	0.61	0.06

Table 16. Bss.27.4bc7ad–h: Sea bass indices of abundance 2000–2014 (swept area) from the Channel Groundfish Survey. The relative standard error CV is the log-transformed value used in SS3 (sqrt(loge (1+CV^2)).

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 2023 assessment.

Year	Index	+- SE
2001	1.002	0.1408
2002	1.054	0.0864
2003	1.038	0.1149
2004	1.014	0.0875
2005	1.118	0.0774
2006	1.122	0.0762
2007	1.219	0.0908
2008	1.188	0.093
2009	1.097	0.0538
2010	1.019	0.0362
2011	0.893	0.0456
2012	0.815	0.0557
2013	0.809	0.0528
2014	0.669	0.0422
2015	0.68	0.0601
2016	0.56	0.0532
2017	0.522	0.0621
2018	0.548	0.0652
2019	0.738	0.1033
2020	0.814	0.1189
2021	1.001	0.1541
2022	0.878	0.1363

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 (2022)
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	2019
Last year no bias adjustment	1973.7
First year full bias adjustment	1981.6
Last year full bias adjustment	2019.8
First year recent year no bias adjustment	2020.8
Maximum bias adjustment	0.915

Table 19. Bss.27.4bc7ad–h: Final sea bass 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	845	1192	22012	8077	4959	1586	1453	1204	1651	4236	1425	905	676	518	379	262	572
1986	2474	664	937	17208	6243	3758	1172	1050	855	1159	2959	993	630	470	360	264	581
1987	21485	1946	522	731	13259	4702	2751	835	732	589	793	2016	676	428	319	245	575
1988	17453	16901	1527	406	560	9868	3378	1909	564	485	386	516	1309	438	278	207	532
1989	91611	13729	13270	1192	313	420	7190	2392	1323	386	329	261	349	884	296	188	499
1990	7473	72064	10780	10355	917	235	306	5084	1656	904	261	223	176	235	596	200	464
1991	15253	5879	56581	8411	7962	687	170	216	3512	1128	611	176	150	118	158	402	448
1992	22918	11998	4614	44096	6447	5928	494	118	146	2343	746	403	116	99	78	104	560
1993	8728	18028	9416	3595	33792	4804	4266	344	80	98	1546	490	264	76	64	51	435
1994	33595	6866	14150	7340	2759	25237	3468	2982	234	54	65	1024	324	174	50	43	322
1995	49919	26427	5392	11045	5644	2065	18280	2440	2056	160	37	44	691	219	118	34	247
1996	3098	39268	20747	4205	8474	4206	1485	12735	1662	1381	106	24	29	459	145	78	188
1997	57563	2437	30793	16120	3200	6225	2955	999	8281	1056	866	66	15	18	285	90	165
1998	17359	45280	1912	23946	12289	2358	4394	2003	657	5334	672	548	42	10	11	180	162
1999	56539	13655	35521	1487	18282	9082	1671	2993	1323	425	3412	428	348	27	6	7	217
2000	24448	44475	10711	27623	1134	13475	6402	1127	1950	843	267	2133	267	217	17	4	140
2001	27663	19231	34886	8330	21082	838	9568	4372	746	1265	540	170	1354	169	137	10	91
2002	43952	21760	15086	27137	6359	15585	595	6530	2892	484	810	344	108	859	107	87	65
2003	44557	34574	17071	11737	20717	4699	11058	406	4323	1877	310	517	219	69	547	68	97
2004	34542	35050	27106	13254	8917	15174	3287	7392	262	2720	1164	191	317	134	42	335	101

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2005	22954	27172	27475	21035	10058	6517	10578	2187	4740	164	1675	711	116	193	81	26	265
2006	24375	18056	21285	21272	15880	7281	4477	6901	1368	2877	97	987	417	68	113	48	171
2007	27594	19174	14144	16476	16051	11481	4990	2913	4305	828	1709	57	578	244	40	66	128
2008	14288	21706	15026	10963	12466	11656	7919	3276	1839	2645	500	1023	34	344	145	24	116
2009	12667	11240	17011	11647	8291	9043	8031	5197	2070	1132	1601	300	612	20	206	87	83
2010	2540	9964	8810	13192	8820	6031	6258	5303	3308	1284	692	971	181	369	12	124	103
2011	10543	1998	7804	6815	9934	6345	4098	4025	3265	1975	752	401	560	105	213	7	131
2012	4553	8293	1566	6046	5148	7186	4349	2667	2516	1985	1181	446	237	330	62	126	82
2013	15618	3582	6496	1211	4546	3686	4846	2773	1629	1492	1156	682	256	136	190	36	120
2014	31873	12286	2803	5010	904	3209	2429	2994	1630	924	828	635	372	140	74	104	85
2015	6754	25072	9631	2172	3765	643	2143	1540	1832	976	547	489	375	220	83	44	113
2016	23862	5313	19711	7538	1665	2736	433	1349	937	1104	588	331	296	228	135	51	98
2017	5109	18771	4178	15469	5849	1252	1959	296	900	621	731	390	220	198	153	91	101
2018	14280	4019	14762	3279	12011	4414	907	1371	203	616	425	501	268	151	136	106	133
2019	10007	11233	3161	11595	2557	9177	3259	646	956	141	427	295	348	187	106	95	167
2020	8226	7872	8834	2482	9032	1952	6783	2331	454	668	98	298	206	244	131	74	185
2021	21536	6470	6190	6933	1932	6888	1440	4837	1630	315	463	68	207	144	170	91	182
2022	21527	16941	5088	4858	5399	1476	5095	1029	3386	1133	219	322	48	145	100	119	192
2023	21527	16934	13322	3993	3784	4125	1093	3650	723	2364	790	153	225	33	101	70	219

Table 20. Bss.27.4bc7ad–h: Final sea bass 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	0.018	0.037	0.062	0.086	0.103	0.113	0.119	0.121	0.122	0.123	0.123	0.123	0.123	0.122
1986	0.000	0.002	0.008	0.021	0.043	0.072	0.099	0.120	0.133	0.140	0.144	0.145	0.146	0.146	0.146	0.146	0.145
1987	0.000	0.003	0.010	0.027	0.055	0.091	0.125	0.153	0.171	0.183	0.189	0.192	0.193	0.193	0.193	0.193	0.192
1988	0.000	0.002	0.008	0.022	0.046	0.077	0.105	0.127	0.140	0.148	0.151	0.153	0.153	0.153	0.153	0.152	0.151
1989	0.000	0.002	0.008	0.022	0.047	0.078	0.106	0.128	0.141	0.148	0.152	0.153	0.154	0.153	0.153	0.153	0.151
1990	0.000	0.002	0.008	0.023	0.048	0.079	0.108	0.130	0.144	0.151	0.154	0.156	0.156	0.156	0.155	0.155	0.153
1991	0.000	0.002	0.009	0.026	0.055	0.091	0.124	0.149	0.165	0.173	0.178	0.179	0.180	0.179	0.179	0.178	0.175
1992	0.000	0.002	0.010	0.026	0.054	0.089	0.122	0.148	0.166	0.176	0.181	0.183	0.184	0.184	0.184	0.183	0.182
1993	0.000	0.002	0.009	0.025	0.052	0.086	0.118	0.143	0.158	0.167	0.172	0.174	0.175	0.175	0.174	0.174	0.172
1994	0.000	0.002	0.008	0.023	0.049	0.083	0.112	0.132	0.144	0.150	0.153	0.153	0.153	0.152	0.151	0.150	0.147
1995	0.000	0.002	0.009	0.025	0.054	0.090	0.121	0.144	0.158	0.165	0.168	0.169	0.168	0.168	0.167	0.166	0.162
1996	0.000	0.003	0.012	0.033	0.068	0.113	0.156	0.190	0.213	0.227	0.234	0.237	0.238	0.238	0.237	0.237	0.234
1997	0.000	0.003	0.011	0.031	0.066	0.108	0.149	0.180	0.200	0.212	0.218	0.220	0.221	0.220	0.220	0.219	0.216
1998	0.000	0.003	0.011	0.030	0.062	0.104	0.144	0.175	0.195	0.207	0.213	0.215	0.216	0.216	0.216	0.215	0.213
1999	0.000	0.003	0.011	0.031	0.065	0.110	0.154	0.189	0.211	0.223	0.230	0.233	0.233	0.233	0.233	0.232	0.230
2000	0.000	0.003	0.011	0.030	0.062	0.102	0.141	0.172	0.193	0.205	0.211	0.214	0.215	0.215	0.215	0.215	0.212
2001	0.000	0.003	0.011	0.030	0.062	0.103	0.142	0.173	0.194	0.206	0.212	0.215	0.216	0.216	0.215	0.215	0.212
2002	0.000	0.003	0.011	0.030	0.062	0.103	0.142	0.173	0.192	0.203	0.209	0.211	0.212	0.212	0.211	0.210	0.207
2003	0.000	0.003	0.013	0.035	0.071	0.117	0.163	0.199	0.223	0.238	0.246	0.249	0.251	0.251	0.250	0.250	0.247
2004	0.000	0.003	0.014	0.036	0.073	0.121	0.167	0.204	0.230	0.245	0.253	0.257	0.258	0.258	0.258	0.257	0.254
2005	0.000	0.004	0.016	0.041	0.083	0.135	0.187	0.230	0.259	0.278	0.288	0.293	0.295	0.296	0.295	0.295	0.292
2006	0.000	0.004	0.016	0.042	0.084	0.138	0.190	0.232	0.262	0.281	0.291	0.296	0.298	0.298	0.298	0.297	0.294
2007	0.000	0.004	0.015	0.039	0.080	0.131	0.181	0.220	0.247	0.264	0.273	0.277	0.278	0.278	0.278	0.277	0.274
2008	0.000	0.004	0.015	0.039	0.081	0.132	0.181	0.219	0.246	0.262	0.270	0.274	0.275	0.275	0.274	0.273	0.269

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2009	0.000	0.004	0.014	0.038	0.078	0.128	0.175	0.212	0.237	0.252	0.261	0.264	0.265	0.265	0.264	0.263	0.259
2010	0.000	0.004	0.017	0.044	0.089	0.146	0.201	0.245	0.276	0.295	0.305	0.310	0.311	0.311	0.311	0.310	0.306
2011	0.000	0.004	0.015	0.041	0.084	0.138	0.189	0.230	0.258	0.274	0.283	0.287	0.288	0.288	0.287	0.286	0.282
2012	0.000	0.004	0.017	0.045	0.094	0.154	0.210	0.253	0.282	0.300	0.309	0.313	0.314	0.313	0.312	0.310	0.304
2013	0.000	0.005	0.020	0.052	0.108	0.177	0.241	0.292	0.327	0.348	0.360	0.364	0.365	0.365	0.363	0.362	0.355
2014	0.000	0.003	0.015	0.046	0.100	0.164	0.216	0.251	0.273	0.284	0.288	0.288	0.285	0.282	0.279	0.276	0.264
2015	0.000	0.001	0.005	0.026	0.079	0.156	0.223	0.256	0.266	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	0.045	0.094	0.141	0.165	0.172	0.172	0.169	0.166	0.163	0.160	0.156	0.153	0.139
2017	0.000	0.000	0.002	0.013	0.042	0.082	0.117	0.135	0.139	0.140	0.138	0.137	0.135	0.133	0.131	0.129	0.120
2018	0.000	0.000	0.002	0.009	0.029	0.063	0.100	0.120	0.126	0.127	0.125	0.124	0.122	0.120	0.118	0.116	0.107
2019	0.000	0.000	0.002	0.010	0.030	0.062	0.095	0.113	0.119	0.120	0.119	0.117	0.116	0.114	0.113	0.112	0.105
2020	0.000	0.000	0.002	0.011	0.031	0.064	0.098	0.118	0.124	0.125	0.125	0.123	0.122	0.120	0.118	0.117	0.110
2021	0.000	0.000	0.002	0.010	0.029	0.061	0.096	0.117	0.124	0.124	0.124	0.122	0.120	0.119	0.117	0.116	0.109
2022	0.000	0.000	0.002	0.010	0.029	0.060	0.093	0.113	0.119	0.120	0.119	0.118	0.116	0.115	0.113	0.112	0.105

Table 21. Bss.27.4bc7ad–h: Final sea bass 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	73	845	1616	17475	23548	29621	0.076	0.105	0.133	0.037	0.067	994		1805
1986	444	2474	4504	15236	20676	26116	0.090	0.123	0.157	0.056	0.067	1318		1629
1987	15256	21485	27713	13597	18453	23309	0.117	0.161	0.205	0.093	0.068	1979		1483
1988	10046	17453	24860	12390	16773	21155	0.095	0.130	0.164	0.062	0.067	1239		1379
1989	77066	91611	106156	12037	16131	20224	0.095	0.131	0.166	0.063	0.067	1161		1274
1990	2299	7473	12647	10900	14781	18662	0.095	0.133	0.170	0.065	0.067	1064		1145
1991	9164	15253	21342	9312	12937	16561	0.108	0.152	0.197	0.085	0.067	1226		1051
1992	15810	22918	30026	8019	11343	14667	0.111	0.154	0.198	0.087	0.068	1186		1080
1993	4109	8728	13347	8662	11734	14805	0.111	0.147	0.184	0.080	0.067	1256		1258
1994	24023	33595	43167	11448	14392	17337	0.104	0.132	0.160	0.065	0.067	1370		1509
1995	39062	49919	60776	15069	18140	21211	0.116	0.145	0.173	0.078	0.067	1835		1689
1996	439	3098	5757	16829	20106	23383	0.159	0.199	0.24	0.131	0.068	3022		1696
1997	45385	57563	69740	15914	19238	22562	0.148	0.186	0.22	0.119	0.067	2620		1605
1998	8077	17359	26640	14693	17959	21225	0.144	0.181	0.22	0.114	0.068	2390		1548
1999	43207	56539	69871	14129	17294	20458	0.155	0.196	0.24	0.128	0.068	2670		1548
2000	15205	24448	33691	14243	17344	20444	0.142	0.180	0.22	0.113	0.067	2407		1601
2001	15583	27663	39742	15126	18291	21456	0.143	0.181	0.22	0.113	0.068	2500		1685
2002	29093	43952	58812	15860	19104	22348	0.142	0.178	0.21	0.111	0.067	2622	17	1782
2003	31677	44557	57436	16936	20273	23611	0.166	0.21	0.25	0.141	0.068	3459	16	1863
2004	23632	34542	45451	17564	20983	24402	0.171	0.21	0.26	0.147	0.068	3731	59	1908
2005	15013	22954	30896	17970	21463	24956	0.193	0.24	0.30	0.177	0.068	4430	96	1900
2006	16792	24375	31958	17413	20960	24506	0.194	0.25	0.30	0.179	0.068	4377	53	1869
2007	18778	27594	36410	16965	20480	23996	0.183	0.23	0.28	0.164	0.068	4064	50	1866

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	7808	14288	20769	17351	20777	24203	0.183	0.23	0.28	0.163	0.068	4107	8	1878
2009	8008	12667	17325	17764	21094	24425	0.177	0.22	0.27	0.155	0.067	3889	151	1852
2010	358	2540	4723	17664	20881	24098	0.21	0.26	0.31	0.192	0.068	4562	148	1751
2011	7043	10543	14042	16262	19302	22342	0.193	0.24	0.29	0.174	0.067	3858	22	1605
2012	2254	4553	6853	14974	17820	20666	0.21	0.26	0.32	0.197	0.067	3987	157	1440
2013	9896	15618	21340	13153	15851	18549	0.24	0.31	0.37	0.24	0.067	4137	53	1222
2014	21989	31873	41758	10498	13113	15728	0.189	0.25	0.31	0.182	0.066	2682	25	1008
2015	2353	6754	11155	8449	11021	13593	0.169	0.23	0.29	0.176	0.055	2066	40	690
2016	14033	23862	33692	6586	9113	11641	0.102	0.15	0.191	0.127	0.0189	1295	199	209
2017	1797	5109	8422	5837	8337	10838	0.083	0.121	0.160	0.103	0.0185	984	271	206
2018	6000	14280	22560	5833	8401	10969	0.073	0.107	0.142	0.095	0.0127	948	482	150
2019	3225	10007	16789	6569	9386	12202	0.070	0.102	0.135	0.082	0.021	972	464	284
2020	1392	8226	15059	7675	10947	14220	0.072	0.107	0.142	0.076	0.031	1042	325	468
2021		10875^		8417	12173	15928	0.070	0.106	0.141	0.075	0.031	1126	412	499
2022		10875^		8743	12924	17105	0.066	0.102	0.138	0.071	0.031	1126	196	509
2023		10875^		8656	13159	17661								

*** Incomplete for some fleets 2002–2008.**

****Geometric mean recruitment 2011–2020.**

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 2021–2022 (years with no recruit deviations estimated) with the long-term GM, adjusted for natural mortality.

age	Stock numbers 2023	weight in stock	Proportion mature (female)	H.Cons retained mean F (2022)	H.Cons Discarded mean F (2022)	H.Cons retained mean weights	H.Cons discarded mean weights	H.Cons proportion retained	Recreational F	Recreational removals mean weight	M
0	10875	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.24
1	8554	0.024	0.000	0.000	0.000	0.117	0.117	0.000	0.000	0.079	0.24
2	6727	0.096	0.000	0.000	0.000	0.236	0.236	0.003	0.002	0.191	0.24
3	3993	0.210	0.000	0.001	0.004	0.384	0.385	0.027	0.005	0.341	0.24
4	3784	0.369	0.093	0.007	0.012	0.583	0.561	0.183	0.011	0.530	0.24
5	4125	0.571	0.297	0.026	0.016	0.809	0.752	0.547	0.019	0.749	0.24
6	1093	0.807	0.578	0.058	0.011	1.014	0.967	0.824	0.027	0.991	0.24
7	3650	1.072	0.797	0.079	0.004	1.243	1.220	0.941	0.032	1.249	0.24
8	723	1.357	0.914	0.086	0.001	1.511	1.505	0.981	0.035	1.525	0.24
9	2364	1.657	0.965	0.087	0.000	1.803	1.805	0.994	0.036	1.818	0.24
10	790	1.964	0.985	0.086	0.000	2.105	2.112	0.998	0.036	2.122	0.24
11	153	2.274	0.993	0.085	0.000	2.408	2.418	0.999	0.036	2.429	0.24
12	225	2.582	0.997	0.083	0.000	2.708	2.721	1.000	0.036	2.734	0.24
13	33	2.885	0.998	0.082	0.000	3.000	3.016	1.000	0.036	3.033	0.24
14	101	3.179	0.999	0.080	0.000	3.284	3.302	1.000	0.036	3.323	0.24
15	70	3.464	0.999	0.079	0.000	3.556	3.577	1.000	0.036	3.602	0.24
16	219	4.157	1.000	0.077	0.000	4.225	4.909	1.000	0.036	3.869	0.24

Age 0,1,2 over-written as follows:

2023 yc **2023 age 0 replaced by 20011–2020 LTGM (10xxx);**

2022 yc **2023 age 1 from SS3 survivor estimate at-age 1, 2023 * LTGM / SS3 estimate of age 0 in 2022;**

2021 yc **2023 age 2 from SS3 survivor estimate at-age 2, 2023 * LTGM / SS3 estimate of age 0 in 2021.**

Table 23. Bss.27.4bc7ad–h: Management options table.

Basis	Total removals* (2024)	F_{total} (2024)	SSB (2025)	% SSB change**	% advice change ***
ICES advice basis					
MSY approach: $F = F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$	2432	0.154	11975	-7.7	-4.3
EU MAP^: $F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$	2432	0.154	11975	-7.7	-4.3
EU MAP^: $F_{MSY\ upper} \times SSB_{2024}/MSY\ B_{trigger}$	2432	0.154	11975	-7.7	-4.3
EU MAP^: $F_{MSY\ lower} \times SSB_{2024}/MSY\ B_{trigger}$	2042	0.128	12304	-5.2	-19.7
$F = F_{MSY}$	2683	0.171	11764	-9.4	5.5
F = 0	0	0	14040	8.2	-100
F_{pa}	3132	0.203	11387	-12.3	23.2
F_{lim}	3825	0.254	10807	-16.7	50.5
$SSB_{2025} = B_{lim}$	4418	0.30	10313	-20.5	73.8
$SSB_{2025} = B_{pa}$					
$SSB_{2025} = MSY\ B_{trigger}$					
$F = F_{2023}$	1698	0.105	12595	-3.0	-33.2
$SSB_{2025} = SSB_{2024}$	1247	0.076	12978	0	-50.9

* Includes commercial catch and recreational removals (taking mortality of released fish into account, estimated at approximately 5%).
** SSB 2025 relative to SSB 2024.
*** Advice value for 2024 relative to the MSY value for 2023 (2542 tonnes).
^ MAP multiannual plan (EU, 2019).

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 sea bass landings by gear (France –top- and UK –bottom).

Figure 3. Bss.27.4bc7ad–h: Length composition for the combined French fleet from 2000 onwards.

1985
N adj.=4.3
1989
N adj.=11.8
1993
N adj.=20.5
1997
N adj.=22.3
1986
N adj.=6.5
1990
N adj.=7.9
1994
N adj.=37.8
1998
N adj.=16.2
1987
N adj.=14.2
1991
N adj.=8.4
1995
N adj.=30.6
1999
N adj.=16.1
1988
N adj.=9.2
1992
N adj.=6.7
1996
N adj.=22.8
2000
N adj.=19.2
Proportion
Length (cm)

2001
N adj.=20.3
2005
N adj.=8.8
2009
N adj.=14.2
2013
N adj.=16.4
2002
N adj.=38.9
2006
N adj.=8.4
2010
N adj.=12.3
2014
N adj.=14.1
2003
N adj.=35.8
2007
N adj.=8
2011
N adj.=12.9
2015
N adj.=13.3
2004
N adj.=23.3
2008
N adj.=12.3
2012
N adj.=14.3
2016
N adj.=21.7
Proportion
Length (cm)

Figure 4. Bss.27.4bc7ad–h: Length composition of UK bottom trawls and nets fleet landings from 1985 onwards.

1985
N adj.=2.9
1989
N adj.=3.9
1993
N adj.=18.7
1997
N adj.=20.8
1986
N adj.=4.7
1990
N adj.=3.3
1994
N adj.=23.5
1998
N adj.=16.8
1987
N adj.=10.5
1991
N adj.=8
1995
N adj.=16.2
1999
N adj.=22.6
1988
N adj.=8
1992
N adj.=16.8
1996
N adj.=16.1
2000
N adj.=9.9
Proportion
Length (cm)

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 sea bass 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 sea bass over the survey series.

Figure 9. Bss.27.4bc7ad–h: Comparison of French commercial LPUE index for European sea bass 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.

Ending year selectivity for UKOTB_Nets
Selectivity, Retention, Mortality
Length (cm)
Selectivity
Retention
Discard mortality
Keep = Sel*Ret
Dead = Sel*(Ret+(1-Ret)*Mort)
Discard = Sel*(1-Ret)

Ending year selectivity for Lines
Selectivity
Length (cm)

Ending year selectivity for UKMWT
Selectivity
Length (cm)

Ending year selectivity for French
Selectivity, Retention, Mortality
Length (cm)
Selectivity
Retention
Discard mortality
Keep = Sel*Ret
Dead = Sel*(Ret+(1-Ret)*Mort)
Discard = Sel*(1-Ret)

Ending year selectivity for Other
Selectivity
Length (cm)

Ending year selectivity for RecFish
Selectivity
Length (cm)

Ending year selectivity for AutBass
Selectivity
Length (cm)

Ending year selectivity for CGFS1
Selectivity
Length (cm)

Figure 11. Bss.27.4bc7ad–h: Final sea bass update assessment: Fitted length-based and age-based selectivity curves.

Figure 12. Bss.27.4bc7ad–h: Final sea bass update assessment: Fitted time-series of length-based and age-based selectivity and retention curves for fleets with blocks.

1985 N adj.=4.3 N eff.=16.9
1989 N adj.=11.8 N eff.=24.2
1993 N adj.=20.5 N eff.=19.3
1997 N adj.=22.3 N eff.=66.9
1986 N adj.=6.5 N eff.=43.6
1990 N adj.=7.9 N eff.=69.8
1994 N adj.=37.8 N eff.=31
1998 N adj.=16.2 N eff.=43
1987 N adj.=14.2 N eff.=39.6
1991 N adj.=8.4 N eff.=34.9
1995 N adj.=30.6 N eff.=24.5
1999 N adj.=16.1 N eff.=37.5
1988 N adj.=9.2 N eff.=25.1
1992 N adj.=6.7 N eff.=15.1
1996 N adj.=22.8 N eff.=19.5
2000 N adj.=19.2 N eff.=40.3
Proportion
Length (cm)

2001 N adj.=20.3 N eff.=32.6
2005 N adj.=8.8 N eff.=19.8
2009 N adj.=14.2 N eff.=34.2
2013 N adj.=16.4 N eff.=60.2
2002 N adj.=38.9 N eff.=40.8
2006 N adj.=8.4 N eff.=21.1
2010 N adj.=12.3 N eff.=33.7
2014 N adj.=14.1 N eff.=85.3
2003 N adj.=35.8 N eff.=41.1
2007 N adj.=8 N eff.=47.6
2011 N adj.=12.9 N eff.=77
2015 N adj.=13.3 N eff.=65.2
2004 N adj.=23.3 N eff.=49.1
2008 N adj.=12.3 N eff.=21.9
2012 N adj.=14.3 N eff.=32.2
2016 N adj.=21.7 N eff.=335.2
Proportion
Length (cm)

2017 N adj.=21.2 N eff.=140.4
2021 N adj.=47.8 N eff.=43.7
2018 N adj.=14.3 N eff.=161.5
2022 N adj.=51.2 N eff.=244.1
2019 N adj.=14.9 N eff.=53.8
2020 N adj.=13.1 N eff.=23.5
Proportion
Length (cm)

-150
50
150
Length (cm)
Year

Figure 13. Bss.27.4bc7ad–h: Final sea bass 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.

1985 N adj.=2.9 N eff.=11.2
1989 N adj.=3.9 N eff.=2
1993 N adj.=18.7 N eff.=65
1997 N adj.=20.8 N eff.=82.8
1986 N adj.=4.7 N eff.=44.3
1990 N adj.=3.3 N eff.=215.4
1994 N adj.=23.5 N eff.=18.5
1998 N adj.=16.8 N eff.=236.1
1987 N adj.=10.5 N eff.=68
1991 N adj.=8 N eff.=44.4
1995 N adj.=16.2 N eff.=21.4
1999 N adj.=22.6 N eff.=338.3
1988 N adj.=8 N eff.=14.9
1992 N adj.=16.8 N eff.=66.7
1996 N adj.=16.1 N eff.=43.5
2000 N adj.=9.9 N eff.=183
Proportion
Length (cm)

2001 N adj.=17.3 N eff.=277.4
2005 N adj.=3.8 N eff.=129.4
2009 N adj.=2.9 N eff.=324.6
2013 N adj.=6.4 N eff.=233.1
2002 N adj.=22 N eff.=98.4
2006 N adj.=10.2 N eff.=204.8
2010 N adj.=6.2 N eff.=33.1
2014 N adj.=11.1 N eff.=285.8
2003 N adj.=13.6 N eff.=358.3
2007 N adj.=4.7 N eff.=163.1
2011 N adj.=8.5 N eff.=234.9
2015 N adj.=12 N eff.=284.6
2004 N adj.=10.5 N eff.=189.9
2008 N adj.=4.5 N eff.=97.5
2012 N adj.=15.2 N eff.=156.7
2016 N adj.=16.7 N eff.=758.2
Proportion
Length (cm)

2017 N adj.=25.9 N eff.=53
2021 N adj.=33.8 N eff.=233.7
2018 N adj.=18.7 N eff.=118.6
2022 N adj.=34.7 N eff.=82.6
2019 N adj.=15.6 N eff.=424.9
2020 N adj.=14.4 N eff.=369.7
Proportion
Length (cm)

Figure 14. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of UK lines length-composition data for the retained catch components.

Figure 15. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of UK midwater trawl fishery length-composition data for the retained catch components.

2000
N adj.=7.8
N eff.=278.8
2004
N adj.=15.4
N eff.=107.4
2008
N adj.=24.5
N eff.=174.6
2012
N adj.=37.6
N eff.=423.2
2001
N adj.=12.8
N eff.=293
2005
N adj.=10.4
N eff.=211.8
2009
N adj.=48.7
N eff.=579
2013
N adj.=24.3
N eff.=349.3
2002
N adj.=10.1
N eff.=200.9
2006
N adj.=15.3
N eff.=167.9
2010
N adj.=25
N eff.=291.5
2014
N adj.=25.5
N eff.=82.4
2003
N adj.=16.3
N eff.=153.8
2007
N adj.=23.5
N eff.=154.5
2011
N adj.=36.7
N eff.=212.9
2015
N adj.=39.2
N eff.=31.6
Proportion
Length (cm)

2016
N adj.=29.2
N eff.=144.7
2020
N adj.=9.1
N eff.=108.5
2017
N adj.=10.7
N eff.=41.8
2021
N adj.=17.3
N eff.=90.2
2018
N adj.=5.7
N eff.=35.6
2022
N adj.=30
N eff.=210.8
2019
N adj.=1.6
N eff.=16.9
Proportion
Length (cm)

-2
0.1
2
Length (cm)
Year

Figure 16. Bss.27.4bc7ad–h: Final sea bass 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 sea bass update assessment: Fit and residuals of recreational length compositions data.

Figure 18. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of Channel groundfish survey length compositions.

Figure 19. Bss.27.4bc7ad–h: Final sea bass 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 sea bass 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 sea bass update assessment: Fit and residuals of age composition data for the combined UK lines fleet.

Figure 22. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of age composition data for the UK mid-water trawl fleet.

Figure 23. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of age composition data for the combined French fleets.

Figure 24. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of age composition data for the Solent Autumn bass survey.

Figure 25. Bss.27.4bc7ad–h: Final sea bass update assessment: Fit and residuals of UK fleets age compositions, aggregated across time.

Figure 26. Bss.27.4bc7ad–h: Final sea bass 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 sea bass update assessment: Fit to Channel groundfish survey total abundance index, accounting for length-based selectivity.

Figure 28. Bss.27.4bc7ad–h: Final sea bass 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 sea bass update assessment: Top: time-series of log-recruit deviations (deviations for 1965–1984 precede the period of input catch data). Below: stock–recruit scatter (model is fitted assuming Beverton–Holt stock–recruit model and steepness = 0.999).

Figure 30. Bss.27.4bc7ad–h: Retrospective analysis of stock trends from final update assessment, based on Stock Synthesis run final year set to 2022 and peeling back five years (for the final run, terminal F is for 2021 and SSB and total biomass terminate in 2022).

Figure 31. Bss.27.4bc7ad–h: Stock trends from final update assessment, based on Stock Synthesis run final year set at 2022 to give 2023 numbers and biomass and 2022 F. Recruitment in 2021–2023 is the geometric mean 2011–2020. Recruitment, F and SSB are shown with 95% confidence intervals.

Figure 32. Bss.27.4bc7ad–h: Comparison between recreational catch time-series from this year's final update assessment and last year 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 Sea bass (*Dicentrarchus labrax*) in divisions 6.a, 7.b, and 7.j (West of Scotland, West of Ireland, eastern part of southwest of Ireland)

Type of assessment

There is no assessment for this stock component.

ICES advice applicable to 2024, 2025 & 2026

ICES advises that when the precautionary approach is applied, commercial landings should be no more than 2 tonnes in each of the years 2024, 2025, and 2026. ICES cannot quantify total catches.

30.1 General

Stock description and management units

At IBP-NEW (2012a), it was agreed that sea bass in the North Sea (4.b&c) and in the Irish Sea, Channel and Celtic Sea (7.a, d, e,f,g&h) would be treated as a functional stock unit as there is no clear basis from fishery data, tagging and genetics studies to subdivide the populations in the Irish Sea, Celtic Sea, Channel and North Sea into independent stock units. It was proposed based on previous ICES bass study group reports to allocate sea bass in 6.a, 7.b and 7.j to a separate stock, although it is recognised that sea bass in Irish coastal waters of 7.g and 7.a are likely to be from the same stock as in 7.j. As there are negligible commercial fishery catches of sea bass in Irish coastal waters due to the moratorium on commercial fishing for bass by Irish vessels, the splitting of the stock between 7.g and is not likely to have any impact on the bass assessment in 4.b,c and 7.a,d–h. Supporting information can be found in the IBP-NEW (ICES, 2012a) report.

In 2022, a workshop for WKSEA BASS met to review evidence and propose plausible stock structure scenarios for the ICES sea bass benchmark in 2023. Conclusion mentioned that "although this meeting exclusively examined the northern and southern sea bass stock units, future studies must extend this effort to investigate evidence of boundaries and/or connectivity with other areas. ICES advice is currently provided for divisions 8.a-b (northern and central Bay of Biscay), as well as divisions 4.b–c, 7.a and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel and Celtic Sea (de Pontual *et al.*, 2019). Additionally, two stocks are recognised but no advice is provided by ICES: divisions 8.c-9.a (Iberian), and divisions 6.a, 7.b, 7.j (West of Scotland and Ireland) (de Pontual *et al.*, 2019). Due to the high degree of connectivity revealed by this report, it is highly unlikely that the Iberian and West of Scotland/Ireland sea bass are isolated components. Therefore, additional genomics, tagging, pelagic connectivity and microchemistry will need to be undertaken to reveal how sea bass within these regions link to existing stock units."

Management applicable

Sea bass are not subject to EU TACs and quotas. A moratorium on commercial fishing for sea bass has been in place for Irish vessels fishing in areas 6 and 7 since 1990.

For recreational fisheries, European Sea Bass legislation was first introduced to Ireland in 1990 after the stock collapsed. It has been followed by various statutory instruments and byelaws which make it illegal to take more than a certain number of European Sea Bass from Irish territorial waters. Bass legislation changes annually. In 2022, in Northern Atlantic waters (ICES divisions 4b, 4c, 6a and 7a to 7k), only catch-and-release is allowed in January, February and December. From March until November, the bag limit of two fish per day and per angler was applied, with a minimum size which remains at 42 cm.

Fishery in 2022

Landings data used by the WG are given in Table 30.2.1. Due to the Irish sea bass moratorium, landings are close to 0 from 2012 onwards (source: official landings).

30.2 Data

Commercial landings data

Landings data are given in Table 30.2.1. No other data for sea bass in this area were provided to WGCSE.

Commercial discards

No estimates of sea bass discards are available.

Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development and are described by the ICES Working Group on Recreational Fishery Surveys (ICES, 2012b). A survey was conducted in Ireland in 2010 and 2011 (O'Reilly and Roche, 2012). Domestic shore bass anglers are estimated at 11 600 individuals and these anglers harvested and estimates of 30 t and 44 t of bass in 2010 and 2011. The 2010 estimate was considered to be more robust. In addition, between 75% and 80% of bass caught were returned to the water. The survey doesn't disaggregate the angling catch estimates by ICES division.

More recently, The Irish Marine Recreational Angling (IMREC) done a pilot study (2019–2021) to develop and test methods to produce robust estimates of participation, effort and catches of nominated species by sea anglers' resident in Ireland O'Reilly Data streams are currently being reviewed and refined.

Biological data

Data on growth and maturity for this stock component were not reviewed by WGCSE.

Survey data

No survey data were available to WGCSE for this stock.

Other relevant data

None.

30.3 Assessment model, diagnostics and retrospectives

ICES advises that when the precautionary approach is applied, commercial landings should be no more than 2 tonnes in each of the years 2024, 2025, and 2026. ICES cannot quantify total catches. Without clear information on the stock status, the precautionary buffer was last applied in 2021 for the 2022 and 2023 advice and has therefore been considered this year.

The reduction in advice (-33%) compare to the previous years is due to the application of the precautionary buffer and rounding.

30.4 Historical stock development

No information is available for this stock area.

30.5 Management plans

There are no existing management plans for European sea bass.

30.6 Management considerations

Sea bass grow slowly, do not mature until 4–7 years of age, and have been recorded at up to 28 years of age. Juvenile bass up to three years of age, occupy nursery areas in estuaries whilst adults undertake seasonal migrations from inshore habitats to offshore spawning sites. After spawning, sea bass tend to return to the same coastal sites each year. The combination of slow growth, late maturity, spawning aggregation and strong site fidelity, increase the vulnerability of sea bass to overexploitation and localized depletion.

Management of sea bass fisheries needs to consider the distinctive characteristics and economic value of the different fisheries. Sea bass is of high social and economic value to sea angling in Ireland, which contributes substantially to local economies.

The current stock structure assumptions are pragmatic, and need further evaluation. Further studies are needed to determine if the sea bass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds.

30.7 Data needs

Time-series of relative abundance indices need to be developed throughout the range of the stock, for both the adult and pre-recruit components of the stock.

There is a need to develop a time-series of recreational fishery catch, effort, and catch composition.

Further studies using tagging, genetics, and other stock and individual markers are needed to more accurately define stock boundaries suitable for assessment and management purposes. A tagging programme has been undertaken by the Marine Institute of Ireland to investigate the distribution of the European sea bass in Irish waters. This project is being carried out in conjunction with the Beaufort Scientific Group and University College Cork. A total of 12 adult European sea bass *Dicentrarchus labrax* were tagged with pop-off satellite archival tags (PSAT) in Irish coastal waters and in offshore waters in the northeast Celtic Sea between 2015 and 2016. Archived data were successfully recovered from five of the 12 tags deployed, three from fish

released in inshore Irish waters and two from fish released offshore in the eastern Celtic Sea. All three fish tagged in inshore waters were found to undertake migrations into the open ocean coinciding with the spawning period. These fish also exhibited fidelity to inshore sites post-migration, returning to the same general location (within approximately 73 km, which is roughly the predicted mean accuracy of the method) of their original release site. Although the number of tracks obtained here was limited, some degree of aggregation between inshore and offshore tagged fish in the eastern Celtic Sea was noted during the expected spawning period suggesting PSATs can provide new information on specific spawning locations of European sea bass (O'Neill *et al*., 2018).

Studies are needed to document the survival of recreationally caught and released sea bass. IBP-NEW (ICES, 2012a) noted that a range of studies on striped bass in the USA indicated hooking mortalities of around 20% on average, although a lower value of around 9% from one specific study is currently considered most appropriate for inclusion in the assessments.

30.8 References

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Ryan, D. K., Leonard, E., Casserly, C. M. and Roche. W. 2021. Marine Recreational Angling Catches in Ireland. Pilot Study Report (2019–2021). Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

Table 30.2.1. European sea bass in Divisions 6.a, 7.b and 7.j. Official landings: all countries (predominantly France).

Year	Official landings
2000	1
2001	4
2002	4
2003	2
2004	8
2005	4
2006	2
2007	5
2008	5
2009	4
2010	9
2011	7
2012	1
2013	0
2014	2
2015	0.8
2016	0.1
2017	0
2018	1
2019	0.04
2020	0.002
2021*	0.039
2022*	0.095

*Preliminary. Source Official landings.

31 Sole (*Solea solea*) in Division 7.a (Irish Sea)

Type of assessment in 2023

This assessment is an update assessment.

ICES advice applicable to 2023

ICES advises that when the MSY approach is applied, catches in 2023 should be zero 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, EU legislation). In addition, beam trawlers, fishing with mesh sizes equal to or greater than 80 mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Council Regulation (EC) N°254/2002 and the Stock Annex.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the western and eastern Irish Sea. Since then, closure has been mainly in the western part whereas the sole fishery takes place mainly in the eastern part of the Irish Sea (Liverpool Bay and Cardigan Bay). No direct impact on the sole stock is expected from this closure.

For 2009, Council Regulation (EC) N°43/2009 allocates different amounts of kW*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The areas are Kattegat, part of 3.a not covered by Skagerrak 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.

Sole in the Irish Sea is fully under the landing obligation since 2020 ((EU) 2019/2239). There is a *de minimis* exemption in place which allow for discarding of undersized sole in Division 7.a, for vessels using trammel and gillnets (maximum 3% of annual catches) and using TBB gear with a mesh size of 80–119 mm equipped with the Flemish panel (max. 3% of annual catches).

Management applicable to 2022 and 2023

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		

The TAC and the national quotas by country for 2023.

Species:	Common sole *Solea solea*		Zone:	7a (SOL/07A.)
Belgium		270	Analytical TAC	
France		3	Article 3 of Regulation (EC) No 847/96 shall not apply	
Ireland		94	Article 4 of Regulation (EC) No 847/96 shall not apply	
Netherlands		86		
Union		453		
United Kingdom		140		
TAC		605		

Fishery in 2023

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, 632 t in 2021 and 685 t in 2022.

In 2022, the WG estimated landings are 685 t, of which Belgium landed 79% (540 t), Ireland 10% (69 t), 8% (58 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 87% of the agreed TAC in 2022 (787 t) and last year's forecast.

The WG estimate of the 2021 landings was slightly revised upwards (629 t → 632 t).

In 2022, 90% of the landings were taken by beam trawls, 9.3% by otter trawls and 1% by other gears.

31.2 Data

Landings

Age compositions for 2022 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 2022 (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 2022 were taken from the combined age–weight key (Table 31.4).

Stock weights-at-age for 2000–2022 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.

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 12.8% (average 2019–2022). The highest discard rate was noted for 2022 with 16.3%. Belgian beam trawl length distributions of retained and discarded catches of sole in 2022 (Figure 31.3) indicate that predominantly 2 and 3-year old fish are discarded.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2020–2022 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 74%, 75% and 79% for 2020, 2021 and 2022 respectively. Assuming that discard rates do not change from the average of the last three years (2020–2022) and a fixed proportion of discards survive, a discard rate of around 12.5% (of the catch) could be assumed for this stock at the moment.

Biological

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years, details of which can be found in the Stock Annex Section B2.

Surveys

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; 2021–2022) (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 2020 no information is available and for the following two years a value of 63.6 kg/100 Km fished and 71.4 kg/100 Km fished was noted respectively.

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 (2013–2022) and the UK (E&W) otter trawlers (2014–2022) 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 2022, the effort dropped again to half the value of 2021. 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 2019–2022, effort further increased to the level recorded in 2008–2012. 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 since 2020. 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 2020–2022 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 (47.7 kg/hour). In 2022 the LPUE decreased again to 40.95 kg/hour fished. The Irish beam trawl LPUE shows a gradually diminishing trend over the whole time-series. After the slight increase in 2013, it fell back to a record low level in 2016–2018. Since 2019 there's an 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 2022, the LPUE dropped again to half the value of 2021. In 2012–2016, the LPUE of Irish otter trawlers is fluctuating at a lower level. In 2017–2022 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. Since 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.

ASSESSMENT YEAR	2011 WKFLAT 2011	2012-2023
Assessment Model	XSA	XSA
Fleets		
BEL-CBT	omitted	omitted
UK-CBT	omitted	omitted
UK(E&W)-BTS-Q3	1988-assessment year-1 (ages 2-7)	1988-assessment year-1* (ages 2-7)
UK(E&W)-BTS-Q1	omitted	omitted
Time Ser. Wts	uniform	uniform
Power Model	none	none
Q plateau	4	4
Shk se	1.5	1.5
Shk Age-yr	5 yrs	5 yrs
	3 ages	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. Since 2021, the assessment is performed without tuning data for 2020. In 2021, the recruitment estimate for 2020 was considered uncertain and was replaced by the geometric mean of recruitment (GM, 2015–2019). Last year, with the addition of the 2021 catch data and the 2021 UK(E&W)-BTS-Q3 tuning information, the 2020 recruitment (7051 thousand fish) was estimated to be higher than the geometric mean of recruitment (2931 thousand fish, GM, 2015–2019). This year, the 2020 recruitment was again revised upwards (7612 thousand fish). Both the age 3 catch numbers in 2021 and age 4 catch numbers in 2022 (Figure 31.1) as well as the age 3 UK(E&W)-BTS-Q3 index of 2021 and the age 4 UK(E&W)-BTS-Q3 index of 2022 indicate that 2018 is a strong year class.

Adding the 2022 data to the time-series did not cause any additional anomalies compared to last year. The log catchability residual pattern showed no trends apart from the year effect in 2016. The positive residuals (higher estimates from the UK(E&W)-BTS-Q3 fleet compared to the VPA estimates) in 2016 are likely due to the fact that the age composition in the catch is flattened.

The survivor estimates and fishing mortality estimates are almost entirely determined by the UK(E&W)-BTS-Q3 survey as it gets a high weighting (>93%) at all ages.

A Mohn's rho analysis was conducted based on the XSA stock assessment results, i.e. the last data year (2022) 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	0.070	-0.092	-0.153

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 2021 recruitment (1405 thousand fish) and 2020 recruitment estimates (7051 thousand fish) in last year's assessment, were revised upwards by 27% (1788 thousand fish) and 8% (7612 thousand fish) respectively in this year's assessment. In last year's assessment, F and SSB for 2021 were estimated to be 0.259 and 3385 t respectively; this year's estimates for 2021 are 0.276 and 3424 t, an upward revision of 7% for F and 1% 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 31.12a. 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 (858 t), SSB gradually increased but remains below just below $MSYB_{trigger}$ in 2021 (3424 t). In 2022, SSB dropped to 2712 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} and to above F_{lim} in 2022. Since 2001, recruitment has been well below the mean (5356 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (631 thousand fish). The 2016 recruitment (3904 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 (7612 thousand 2 year old fish) is estimated to be highest recorded in the last 20 years, followed by the weaker 2019 year class (1788 thousand 2 year old fish) and 2020 year class (1745 thousand 2 year old fish).

31.4 Short-term projections

Last year's forecast assumptions

A comparison of the estimates of this year's assessment and forecast with last year's is given in Figure 31.12b.

The 2011–2014 recruitments have been the lowest in the time-series. Higher recruitment was observed from 2015 onwards. However, the 2020 year class ((2022 recruitment) is now estimated at 1745 thousand fish at age 2 (Table 31.12), which is 10% lower than the short term GM (2012–2020) (1937 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 and 2022 UK(E&W)-BTS-Q3 abundance index for age 2 (0.74 and 0.82 respectively) are around the same level of 2017 (0.8).

In last year's assessment the 2022 SSB (3588 t) was estimated to be just above MSY $B_{trigger}$; however, this year, the 2022 SSB is revised downwards by 24% (2712 t). An F of 0.217 was assumed for the intermediate year in last year's forecast, this value (F in 2022) is now estimated to be 63% higher (0.353).

This year's forecast assumptions

Figure 31.13 shows three different targets for the intermediate year: F_last ($F = F_{2022}$ or status quo), F_average ($F = F_{average\ 2020–2022}$), and TAC. F estimates decreased slightly in 2020 compared to 2019 but increased in 2021.

The F in 2022 (0.353) is substantially higher than in previous years (F_{2021}=0.276, F_{2020}=0.154) and the assumed 2023 landings using a status quo fishing mortality scaled to 2022 (757 t) are much higher than the 2023 TAC (catch = 605 t; landings = 530 t). Landings and catch (discards calculated based on an overall discard rate) have been slightly above the international TAC for 2022 (Figure 31.14), whereas in 2011 catch and/or landings were below the TAC. The latter could possibly be allocated to the Brexit and the fact that the 2021 TAC was available at a later stage during the year. The assumed landings for 2023 (584 t), using an F average (2020–2022) (0.261) are slightly higher than the 2023 TAC (catch = 605 t; landings = 530 t) and in line with last year's slight overshoot of the TAC. Therefore, unlike previous years, the working group agreed to use an F average (2020–2022) for the intermediate year (2023).

As input for the forecast fishing mortality was calculated as the mean of 2020–2022 (0.261). Catch and stock weights-at-age were also averages for the years 2020–2022. Population numbers at the start of 2023 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 (2020–2022, 12.5%).

The input for the short-term catch predictions and sensitivity analysis is given in Table 31.13.

MSY forecast

The stock is predicted to be below B_{lim} in 2024 (2340 t) because of a reduction in stock weights and numbers in older age classes (Figure 31.15). There are no catch scenarios following the MSY approach (Table 31.14), that will bring the stock above B_{lim} by 2025 and therefore ICES advises zero catch.

Table 31.15 and Figure 31.16 show a detailed output of the forecast targeting F = 0 for 2024–2025 and Figure 31.17 shows the year classes contributing to the forecast SSB. The assumed short-term GM recruitments accounts for about 28% of the 2025 SSB.

Implementing the MSY approach with F = 0, leads to an SSB just above B_{lim} in 2025 (2677 t).

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 2015–2022, 82%–97% of the TAC has been taken. As the discard fraction is increasing in recent years, this should be taken into account for a more realistic comparison between the TAC and the uptake (=catch).

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%), 2020 (12%), 2021 (9%). The most recent discard information indicates an increase in 2022 to 16%. It is 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 2019–2022 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.

This stock is scheduled for a benchmark in 2024, and will aim to include discard estimates in the assessment and estimating historical discards. An alternative assessment model such as a state–space stock assessment model (SAM) will be tested as this 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 31.18).

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 the 2019–2021. However in 2022, SSB has decreased again. 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_{lim} in 2022.

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

Connolly, P.L., Kelly, E., Dransfeld, L., Slattery, N., Paramor, O.A.L., and Frid, C.L.J. 2009. MEFEPO North Western Waters Atlas. Marine Institute.

ICES. 2014a. Report of the Workshop to consider reference points for all stocks (WKMSYREF2), 8–10 January 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014/ACOM:47. 91 pp.

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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.

[1] **1989 onwards: N. Ireland included with England & Wales.**

Year	Belgium	France	Ireland	Netherlands	UK (E+W)	UK (Isle of Man)	UK (N. Ireland)[1]	UK (Scotland)	Officially reported	Unallocated	Total used by WG	TAC
1973	793	12	27	281	258	-	46	11	1428	0	1428	
1974	664	54	28	320	218	-	23	-	1307	0	1307	
1975	805	59	24	234	281	-	24	15	1442	-1	1441	
1976	674	72	74	381	195	-	49	18	1463	0	1463	
1977	566	39	84	227	160	-	49	21	1146	1	1147	
1978	453	65	127	177	189	-	57	30	1098	8	1106	
1979	779	48	134	247	290	-	47	42	1587	27	1614	
1980	1002	41	229	169	367	-	44	68	1920	21	1941	
1981	884	13	167	186	311	-	41	45	1647	20	1667	
1982	669	9	161	138	277	-	31	44	1329	9	1338	
1983	544	3	203	224	219	-	33	29	1255	-86	1169	
1984	425	10	187	113	230	-	38	17	1020	38	1058	
1985	589	9	180	546	269	-	36	28	1657	-511	1146	
1986	930	17	235	-	637	1	50	46	1916	79	1995	
1987	987	5	312	-	599	3	72	63	2041	767	2808	2100
1988	915	11	366	-	507	1	47	38	1885	114	1999	1750
1989	1010	5	155	-	613	2	-	38	1823	10	1833	1480
1990	786	2	170	-	569	10	-	39	1576	7	1583	1500
1991	371	3	198	-	581	44	-	26	1223	-11	1212	1500
1992	531	11	164	-	477	14	-	37	1234	25	1259	1350
1993	495	8	98	-	338	4	-	28	971	52	1023	1000
1994	706	7	226	-	409	5	-	14	1367	7	1374	1500
1995	675	5	176	-	424	12	-	8	1300	-34	1266	1300
1996	533	5	133	149	194	4	-	5	1023	-21	1002	1000
1997	570	3	130	123	189	5	-	7	1027	-24	1003	1000
1998	525	3	134	60	161	3	-	9	895	16	911	900
1999	469	<1	120	46	165	1	-	8	810	53	863	900
2000	493	3	135	60	133	1	-	8	833	-15	818	1080
2001	674	4	135	-	195	+	-	4	1012	41	1053	1100
2002	817	4	96	-	165	+	-	3	1085	5	1090	1100
2003	687	4	103	-	217	+	-	3	1014	0	1014	1010
2004	527	1	77	-	106	+	-	1	712	-3	709	800
2005	662	3	85	-	103	+	-	1	854	1	855	960
2006	419	1	85	-	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	480	<1	81	-	74	<1	-	-	635	-3	632	768
2022	542	<1	69	-	75	<1	-	-	687	-2	685	787

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
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	605	412	439	203	293	70	52	23	18	12	13	11	27	2198
2022	113	364	1053	379	298	170	171	68	35	15	15	7	16	13	2716

Table 31.3. Sol.27.7a - Annual length distributions by country (2022).

Length (cm)	UK (England & Wales) All gears	Belgium All gears	Ireland All gears
21		97	
22		742	
23		13437	
24	608	118856	166
25	3075	320574	1407
26	11941	348093	2631
27	23378	289241	4447
28	40508	295280	11706
29	43685	231446	12341
30	24180	201488	13219
31	17766	124993	19207
32	21613	91132	18814
33	10633	67428	20401
34	2948	51330	17769
35	5668	38771	19729
36	1594	20361	11990
37	1233	14806	6363
38	645	11527	5939
39	1061	7615	5651
40	473	4645	3401
41	122	2220	890
42	122	1242	2049
43		1308	557
44		213	103
45		281	0
46		0	15
47		178	
48		0	
49		111	
Total	211253	2257415	178795

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
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	0.344
2022	0.172	0.205	0.239	0.268	0.297	0.283	0.324	0.252	0.272	0.239	0.28	0.308	0.269	0.384

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
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	0.366	0.433	0.336	0.463	0.424	0.345
2022	0.15	0.195	0.233	0.261	0.31	0.302	0.329	0.282	0.302	0.3	0.342	0.335	0.357	0.384

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	458.492	16.929	0	44.624
	2022	520.081	19.987	0	101.957
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	–
	2022	44.433	8.983	4.491	0.934
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	–
	2022	48.796	20.476	0.156	–

	total L	L corresponding with discard info	% coverage of L	total D	rate
2012	286.44	227.01	0.79	17.22	0.071
2013	142.74	107.35	0.75	8.54	0.074
2014	91.93	45.74	0.50	4.09	0.082
2015	71.88	42.89	0.60	3.74	0.080
2016	32.61	21.08	0.65	0.64	0.029
2017	30.38	18.99	0.63	0.64	0.033
2018	34.02	22.50	0.66	0.97	0.041
2019	392.31	351.42	0.90	55.31	0.136
2020	396.45	293.32	0.74	41.00	0.123
2021	612.44	458.49	0.75	44.62	0.089
2022	667.40	529.06	0.79	102.89	0.163
average 20–22					0.125

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
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	9.6	-	222.6	-	193.6	13.2	8.9
2022	12.7	-	117.6	-	133.1	13.0	6.0

[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
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	47.70	-	1079.7	-	192.7	63.60	-	0.72	5.79
2022*	40.95	-	1416.1	-	101.9	71.43	-	1.18	8.59

[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									
1988	2022								
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
103.768	201	**85**	**65**	**186**	**37**	**35**	**8**	33	8

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 2023-04-19 14:17:13

CPUE data from indices

Catch data for 53 years. 1970 to 2022. Ages 2 to 8.

            fleet first age last age first year last year alpha beta
1 UK (E&W)-BTS-Q3         2        7       1988      2022  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   2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  2013  2014  2015  2016  2017  2018  2019  2020  2021  2022
  2 0.039 0.017 0.009 0.000 0.001 0.001 0.018 0.013 0.011 0.070
  3 0.146 0.098 0.057 0.012 0.012 0.016 0.196 0.124 0.098 0.273
  4 0.247 0.109 0.090 0.039 0.015 0.015 0.253 0.204 0.238 0.221
  5 0.181 0.166 0.067 0.039 0.032 0.012 0.119 0.223 0.298 0.319
  6 0.153 0.082 0.096 0.025 0.017 0.021 0.090 0.093 0.385 0.302
  7 0.099 0.127 0.054 0.046 0.018 0.011 0.187 0.097 0.181 0.569
  8 0.099 0.127 0.054 0.046 0.018 0.011 0.187 0.097 0.181 0.569
```

XSA population number (Thousand)

year \ age	2	3	4	5	6	7	8
2013	635	768	361	675	579	380	916
2014	770	553	601	255	510	450	493
2015	1699	685	453	487	195	425	1496
2016	3904	1523	585	375	412	161	757
2017	1633	3531	1361	509	326	364	788
2018	3609	1475	3156	1213	446	290	967
2019	2875	3262	1314	2812	1085	395	505
2020	7612	2556	2425	923	2259	897	1474
2021	1788	6797	2044	1790	668	1862	1433
2022	1745	1601	5574	1457	1202	412	819

Estimated population abundance at 1st Jan 2023

year \ age	2	3	4	5	6	7	8
2023	0	1471	1103	4042	958	804	211

Fleet: UK (E&W)-BTS-Q3

Log catchability residuals.

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.041	0.024	0.409	0.507	-0.053	-0.276	0.161	0.173	-0.282	0.097	0.448	-0.148	-0.001	-0.044	-0.905	0.136
3	0.567	0.350	-0.143	-0.308	0.456	-0.290	-0.061	0.279	-0.696	-0.091	0.099	-0.002	-0.220	-0.239	-0.241	-0.192
4	-0.017	0.045	-0.262	-0.947	0.431	-0.120	-0.309	0.030	-0.265	-0.188	-0.788	0.308	0.311	-0.501	0.050	0.218
5	-0.403	-0.037	0.949	-0.629	-0.034	-0.326	0.014	-0.598	-0.234	0.022	-0.775	0.322	-0.125	-0.145	-0.395	0.194
6	-0.245	-0.245	0.292	-0.209	0.162	-0.075	0.537	-0.023	-0.183	-0.161	-0.281	0.347	0.148	-0.095	0.078	0.005
7	-0.124	0.088	0.198	-0.181	-0.188	-0.061	0.202	-0.324	-0.137	0.293	0.214	0.197	-0.105	-0.005	-0.006	-0.223

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2	0.038	0.001	0.274	-0.232	0.019	0.006	-0.588	-0.158	-0.146	0.301	-0.191	0.261	0.336	-0.101	0.107	0.143	NA
3	0.403	-0.381	0.137	0.234	0.015	0.037	-0.121	0.035	-0.260	0.048	-0.153	0.222	0.214	0.009	0.026	0.177	NA
4	-0.121	-0.235	-0.109	0.252	0.029	0.195	-0.081	0.370	0.294	0.476	0.367	0.074	0.179	-0.056	0.047	0.363	NA
5	0.434	-0.082	0.708	0.256	0.386	0.460	-0.195	0.258	-0.165	0.249	0.353	0.123	0.253	0.093	-0.331	0.159	NA
6	0.038	0.173	0.244	-0.033	0.123	0.368	-0.386	-0.104	-0.455	-0.227	0.212	-0.466	0.329	0.057	0.083	-0.183	NA
7	0.363	-0.017	-0.197	-0.018	-0.196	-0.075	-0.516	0.007	0.153	0.305	0.160	-0.178	0.189	-0.563	-0.342	-0.310	NA

age \ year	2021	2022
2	-0.267	-0.090
3	-0.111	0.201
4	-0.135	0.094
5	-0.491	-0.101
6	0.016	0.022
7	-0.350	-0.169

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	-7.4371	-7.7486	-7.8788	-7.8788	-7.8788	-7.8788
S.E_Logq	0.2901	0.2901	0.2901	0.2901	0.2901	0.2901

Table 31.10. Sol.27.7a - Fishing mortality.

year/age	2	3	4	5	6	7	8+	Fbar(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	0.365	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	0.437
1984	0.045	0.181	0.243	0.38	0.433	0.353	0.353	0.352
1985	0.01	0.135	0.361	0.321	0.328	0.337	0.337	0.337
1986	0.006	0.276	0.423	0.553	0.338	0.439	0.439	0.438
1987	0.059	0.181	0.567	0.765	1.263	0.869	0.869	0.866
1988	0.01	0.173	0.372	0.565	0.738	1.119	1.119	0.699
1989	0.044	0.3	0.452	0.541	0.637	0.711	0.711	0.585
1990	0.113	0.401	0.684	0.669	0.62	0.684	0.684	0.664
1991	0.116	0.354	0.488	0.4	0.506	0.654	0.654	0.512
1992	0.08	0.289	0.415	0.615	0.422	0.698	0.698	0.538
1993	0.014	0.149	0.356	0.425	0.552	0.938	0.938	0.568
1994	0.025	0.297	0.431	0.478	0.532	0.566	0.566	0.502
1995	0.072	0.236	0.528	0.528	0.567	0.435	0.435	0.515
1996	0.026	0.346	0.477	0.502	0.595	0.554	0.554	0.532
1997	0.105	0.418	0.62	0.518	0.507	0.775	0.775	0.605
1998	0.026	0.312	0.47	0.718	0.404	0.417	0.417	0.502
1999	0.063	0.207	0.35	0.549	0.738	0.271	0.271	0.477
2000	0.027	0.242	0.243	0.249	0.523	0.858	0.858	0.468
2001	0.057	0.285	0.321	0.275	0.31	0.52	0.52	0.356
2002	0.069	0.291	0.529	0.473	0.328	0.223	0.223	0.388
2003	0.163	0.583	0.491	0.474	0.319	0.177	0.177	0.365
2004	0.091	0.489	0.45	0.31	0.296	0.211	0.211	0.317
2005	0.213	0.46	0.705	0.688	0.419	0.43	0.43	0.561
2006	0.093	0.397	0.509	0.458	0.607	0.324	0.324	0.474
2007	0.102	0.423	0.328	0.32	0.317	0.409	0.409	0.344
2008	0.055	0.28	0.373	0.276	0.313	0.312	0.312	0.318
2009	0.044	0.303	0.411	0.483	0.27	0.4	0.4	0.391
2010	0.015	0.2	0.249	0.355	0.365	0.207	0.207	0.294
2011	0.029	0.182	0.344	0.269	0.298	0.517	0.517	0.357
2012	0.021	0.33	0.364	0.372	0.255	0.231	0.231	0.305
2013	0.039	0.146	0.247	0.181	0.153	0.099	0.099	0.17
2014	0.017	0.098	0.109	0.166	0.082	0.127	0.127	0.121
2015	0.009	0.057	0.09	0.067	0.096	0.054	0.054	0.077
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	0.016	0.015	0.012	0.021	0.011	0.011	0.015
2019	0.018	0.196	0.253	0.119	0.09	0.187	0.187	0.162
2020	0.013	0.124	0.204	0.223	0.093	0.097	0.097	0.154
2021	0.011	0.098	0.238	0.298	0.385	0.181	0.181	0.276
2022	0.07	0.273	0.221	0.319	0.302	0.569	0.569	0.353

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	2828	29446
1975	6679	5288	9588	1475	2699	504	3220	29455
1976	3857	5795	4087	6406	822	1642	2221	24830
1977	15771	3462	4887	2432	3581	509	2192	32834
1978	9039	14060	2737	3193	1464	2227	2042	34762
1979	8846	8117	11811	1859	1930	905	1713	35182
1980	5069	7902	6368	7423	894	1140	2536	31332
1981	4495	4409	6256	3889	3808	313	2365	25535
1982	2459	4001	3438	4074	2111	1885	1163	19130
1983	5554	2217	3291	1930	2451	1233	2094	18769
1984	15444	4990	1849	2029	1025	1498	1961	28796
1985	16206	13355	3768	1312	1255	602	2702	39199
1986	23652	14517	10563	2377	861	818	2495	55283
1987	3450	21267	9964	6261	1237	556	1451	44186
1988	3486	2942	16059	5112	2636	317	797	31349
1989	4360	3124	2240	10015	2628	1141	524	24031
1990	5537	3775	2093	1290	5277	1257	984	20212
1991	12629	4473	2288	955	598	2568	999	24511
1992	4936	10175	2840	1271	579	326	1930	22058
1993	6164	4121	6894	1697	622	343	1175	21016
1994	5219	5499	3213	4369	1004	324	1269	20897
1995	2002	4606	3698	1889	2451	534	1039	16220
1996	2490	1686	3293	1973	1009	1257	853	12561
1997	8311	2196	1079	1849	1080	504	1029	16049
1998	6820	6769	1307	525	997	589	1298	18305
1999	5214	6012	4481	740	232	602	1025	18305
2000	6930	4432	4422	2857	387	100	466	19595
2001	4533	6101	3148	3139	2015	207	702	19845
2002	2326	3873	4153	2066	2158	1337	1139	17052
2003	3048	1964	2620	2214	1166	1406	2224	14642
2004	3626	2343	992	1452	1247	767	994	11420
2005	2938	2996	1300	572	963	839	1102	10710
2006	1316	2149	1711	581	260	573	1436	8025
2007	1858	1084	1307	931	333	128	929	6569
2008	1942	1518	643	852	611	219	819	6605
2009	2255	1663	1038	401	585	404	514	6860
2010	1595	1953	1112	623	224	404	885	6795
2011	631	1422	1447	784	395	141	316	5136
2012	867	554	1073	928	542	265	586	4816
2013	635	768	361	675	579	380	916	4314
2014	770	553	601	255	510	450	493	3631
2015	1699	685	453	487	195	425	1496	5441
2016	3904	1523	585	375	412	161	757	7717
2017	1633	3531	1361	509	326	364	788	8512
2018	3609	1475	3156	1213	446	290	967	11157
2019	2875	3262	1314	2812	1085	395	505	12249
2020	7612	2556	2425	923	2259	897	1474	18146
2021	1788	6797	2044	1790	668	1862	1433	16383
2022	1745	1601	5574	1457	1202	412	819	12809

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	4888	1463	0.300	0.427
1977	15771	5509	4490	1147	0.260	0.370
1978	9039	6244	5092	1106	0.220	0.358
1979	8846	6887	5684	1614	0.280	0.475
1980	5069	6428	5513	1941	0.350	0.637
1981	4495	5907	5164	1667	0.320	0.481
1982	2459	4744	4329	1338	0.310	0.441
1983	5554	4914	4093	1169	0.290	0.437
1984	15444	6779	4598	1058	0.230	0.352
1985	16206	7843	5631	1146	0.200	0.337
1986	23652	9492	6937	1995	0.290	0.438
1987	3450	8525	7138	2808	0.390	0.866
1988	3486	5961	5486	1999	0.360	0.699
1989	4360	5140	4594	1833	0.400	0.585
1990	5537	4245	3586	1583	0.440	0.664
1991	12629	4433	3150	1212	0.380	0.512
1992	4936	4419	3417	1259	0.370	0.538
1993	6164	3827	3200	1023	0.320	0.568
1994	5219	4932	4006	1374	0.340	0.502
1995	2002	3916	3476	1266	0.360	0.515
1996	2490	3043	2675	1002	0.370	0.532
1997	8311	3405	2468	1003	0.410	0.605
1998	6820	4194	2981	911	0.310	0.502
1999	5214	4265	3270	863	0.260	0.477
2000	6930	3864	3081	818	0.270	0.468
2001	4533	4255	3511	1053	0.300	0.356
2002	2326	3956	3515	1090	0.310	0.388
2003	3048	3548	3150	1014	0.320	0.365
2004	3626	2739	2259	709	0.310	0.317
2005	2938	2480	2044	855	0.420	0.561
2006	1316	1861	1613	569	0.350	0.474
2007	1858	1631	1374	492	0.360	0.344
2008	1942	1562	1311	332	0.250	0.318
2009	2255	1333	1062	325	0.310	0.391
2010	1595	1442	1181	277	0.230	0.294
2011	631	1242	1084	330	0.300	0.357
2012	867	1273	1141	298	0.260	0.305
2013	635	1181	1071	148	0.140	0.170
2014	770	946	858	99	0.120	0.121
2015	1699	1479	1273	76	0.060	0.077
2016	3904	1581	1179	35	0.030	0.037
2017	1633	2159	1774	34	0.020	0.020
2018	3609	2918	2462	36	0.010	0.015
2019	2875	3156	2661	400	0.150	0.162
2020	7612	4007	3272	404	0.120	0.154
2021	1788	3976	3424	632	0.180	0.276
2022	1745	3012	2712	685	0.250	0.353

Table 31.13. Sol.27.7a – Input for catch forecast and F_{MSY} analysis.

Input:	F 2023–2025: mean (2020–2022)
	Catch and stock weights in 2023–2025: mean (2020–2022)
	Recruits age 2 in 2023–2025: GM(13–21)

2023								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2086	0.1	0.38	0	0	0.132	0.0315	0.176
3	1471	0.1	0.71	0	0	0.198	0.165	0.217
4	1103	0.1	0.97	0	0	0.238	0.2211	0.256
5	4042	0.1	0.98	0	0	0.288	0.2803	0.309
6	958	0.1	1	0	0	0.33	0.2601	0.332
7	804	0.1	1	0	0	0.346	0.2824	0.329
+gp	630	0.1	1	0	0	0.358	0.2824	0.344
FBAR 4–7							0.261	

2024								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2086	0.1	0.38	0	0	0.132	0.0315	0.176
3	1829	0.1	0.71	0	0	0.198	0.1650	0.217
4	1129	0.1	0.97	0	0	0.238	0.2211	0.256
5	800	0.1	0.98	0	0	0.288	0.2803	0.309
6	2764	0.1	1	0	0	0.33	0.2601	0.332
7	668	0.1	1	0	0	0.346	0.2824	0.329
+gp	978	0.1	1	0	0	0.358	0.2824	0.344
FBAR 4–7							0.261	

2025								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2086	0.1	0.38	0	0	0.132	0.0315	0.176
3	1829	0.1	0.71	0	0	0.198	0.1650	0.217
4	1403	0.1	0.97	0	0	0.238	0.2211	0.256
5	819	0.1	0.98	0	0	0.288	0.2803	0.309
6	547	0.1	1	0	0	0.33	0.2601	0.332
7	1928	0.1	1	0	0	0.346	0.2824	0.329
+gp	1123	0.1	1	0	0	0.358	0.2824	0.344
FBAR 4–7							0.261	

Table 31.14. Sol.27.7a - Management option table.

F 2023–2025: mean (2020–2022)
Catch and stock weights in 2023–2025: mean (2020–2022)
Recruits age 2 in 2023–2025: GM(13–21)
Fbar age range: 4–7

Input units are thousands and kg - output in tonnes.

2023			
SSB	F_{Mult}	F_{bar}	Landings
2525	1.0	0.261	584

2024				**2025**
SSB	F_{Mult}	F_{bar}	Landings	SSB
2340	0.0	0.000	0	2677
2340	0.1	0.026	57	2620
2340	0.2	0.052	113	2565
2340	0.3	0.078	167	2510
2340	0.4	0.104	220	2457
2340	0.5	0.130	272	2406
2340	0.6	0.157	322	2355
2340	0.7	0.183	371	2306
2340	0.8	0.209	419	2258
2340	0.9	0.235	466	2212
2340	**1.0**	**0.261**	**512**	**2166**
2340	1.1	0.287	557	2122
2340	1.2	0.313	600	2078
2340	1.3	0.339	643	2036
2340	1.4	0.365	684	1995
2340	1.5	0.391	725	1954
2340	1.6	0.418	764	1915
2340	1.7	0.444	803	1877
2340	1.8	0.470	841	1839
2340	1.9	0.496	878	1803
2340	2.0	0.522	914	1767

Basis	catch_ 2024	landings_ 2024	discards_ 2024	fbar_ 2024	SSB_ 2025	ssb_ change	TAC_ change	advice_ change
F0	0	0	0	0.000	2677	14.42	-100.00	-100.00
FMSY_lower_rescal	257	225.013	32.061	0.107	2452	4.80	-57.51	-57.51
FMSY_rescal	317	277.831	39.586	0.134	2400	2.54	-47.53	-47.53
Blim	203	177.317	25.265	0.083	2500	6.83	-66.52	-66.52
Bpa*								
Btrigger*								
FMSY_lower	375	328.466	46.801	0.160	2349	0.38	-37.97	-37.97
Bintplus1	385	337.422	48.077	0.165	2340	0.00	-36.28	-36.28
FMSY	461	403.186	57.447	0.200	2274	-2.80	-23.86	-23.86
Fpa	502	439.514	62.624	0.220	2238	-4.35	-17.00	-17.00
FMSY_upper	543	475.172	67.704	0.240	2203	-5.87	-10.27	-10.27
Fint	585	511.886	72.935	0.261	2166	-7.43	-3.34	-3.34
Flim	641	561.469	80.000	0.290	2117	-9.54	6.03	6.03
Flast	759	664.604	94.695	0.353	2014	-13.93	25.50	25.50

Table 31.15. Sol.27.7a - Detailed output of the short-term forecast (MSY approach: F = 0). Input units are thousands and kg - output in tonnes.

Year:	2023						
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.03149	62	11	2086	275	793	105
3	0.16495	213	46	1471	291	1045	206
4	0.22113	209	53	1103	262	1070	255
5	0.28029	942	291	4042	1163	3961	1140
6	0.26010	209	70	958	316	958	316
7	0.28244	189	62	804	278	804	278
8	0.28244	148	51	630	226	630	226
Total		1972	584	11094	2811	9260	2525
F_{bar}4–7	0.26099						

Year:	2024						
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.00000	0	0	2086	275	793	105
3	0.00000	0	0	1829	362	1299	257
4	0.00000	0	0	1129	269	1095	261
5	0.00000	0	0	800	230	784	225
6	0.00000	0	0	2764	911	2764	911
7	0.00000	0	0	668	231	668	231
8	0	0	0	978	350	978	350
Total		0	0	10254	2628	8380	2340
F_{bar}4–7	0						

Year:	**2025**						
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos**	**SSB**
2	0.00000	0	0	2086	275	793	105
3	0.00000	0	0	1887	373	1340	265
4	0.00000	0	0	1655	394	1605	382
5	0.00000	0	0	1021	294	1001	288
6	0.00000	0	0	724	239	724	239
7	0.00000	0	0	2501	866	2501	866
8	0.00000	0	0	1490	533	1490	533
Total		0	0	11364	2974	9453	2677
F_{bar}4–7	0						

Figure 31.1. 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. 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).

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 31.5. Sole in 7.a - Mean standardised effort and LPUE for the commercial beam 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 31.6. Sole in 7.a - Mean standardised effort and LPUE for the commercial otter trawl fleets.

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 31.12a. - Sol.27.7a - comparison with last year's assessment.

Figure 31.12b. - Sol.27.7a - comparison with last year's assessment – short-term forecast assumptions.

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 - comparison with last year's assessment – short-term forecast: the numbers at age and mean stock weights.

Figure 31.16. Sol.27.7a - Output for the short-term forecast under the MSY approach (MSY approach: F = 0).

Figure 31.17. Sol.27.7a - Year-class sources and contributions for the short-term forecast (MSY approach: F = 0).

Figure 31.18. Sol.27.7a – Stock–recruitment plot.

32 Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)

Type of assessment in 2023

There is no assessment for this stock. Advice is provided on a triennial basis (and is provided this year for 2024, 2025 and 2026) according to the approach outlined below.

In 2023, the updated advice followed the agreed procedures for category 6 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.

32.1 General

32.1.1 Advice

The advice for 2021, 2022 and 2023 was for catches of no more than 15 tonnes (Table 32.1).

ICES framework for category 6 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was last applied in 2020 (for the 2021–2023 advice), and with no new information available to support the current level of catches the precautionary buffer is applied for the 2024 advice. Discarding is considered negligible.

Table 32.1. Sole in divisions 7.b and 7.c. The basis for the catch scenarios.*

Advised catches (2021–2023)	**19 tonnes**	
Discard rate	Negligible	
Precautionary buffer	Applied	0.8
Catch advice **	15 tonnes	
% advice change ***	-20	

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

**** [Recent advised catch] × [precautionary buffer].**

***** Advice value for 2024 relative to the advice value for 2023.**

32.1.2 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.

32.1.3 Data

The time-series of official landings is presented in Table 32.2 and Figure 32.1a and b. In recent years, the official landings differ from the ICES estimates due to confidentiality of data reported to Eurostat. The ICES estimated landings are presented in Figure 32.2.

The time-series of otter-trawl landings effort and LPUE since 1995 are shown in Figure 32.3. 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.

32.1.4 Historical stock development

No analytical assessment was performed.

Table 32.1. Sole in divisions 7.b and 7.c. History of official landings presented by country; ICES unallocated and estimated values. All weights are in tonnes.

Year	Official landings					ICES estimates
	France	UK	Ireland	Other countries	Total	
1908	0	1	37	0	38	
1909	0	0	32	0	32	
1910	0	0	28	0	28	
1911	0	1	22	0	23	
1912	0	1	22	0	23	
1913	0	1	25	0	26	
1914	0	1	43	0	44	
1915	0	1	12	0	13	
1916	0	0	14	0	14	
1917	0	0	6	0	6	
1918	0	0	7	0	7	
1919	0	0	6	0	6	
1920	0	9	5	0	14	
1921	0	10	9	0	19	
1922	0	4	9	0	13	
1923	0	2	10	0	12	
1924	0	15	64	0	79	

Year	Official landings					ICES estimates
	France	UK	Ireland	Other countries	Total	
1925	0	11	18	0	29	
1926	7	10	18	0	35	
1927	47	11	19	0	77	
1928	49	8	16	0	73	
1929	74	11	18	0	103	
1930	52	5	22	0	79	
1931	82	9	29	0	120	
1932	122	10	27	0	159	
1933	411	10	10	0	431	
1934	217	10	13	0	240	
1935	40	7	11	0	58	
1936	43	20	9	0	72	
1937	32	25	14	0	71	
1938	44	21	7	0	72	
1939	0	0	13	0	13	
1940	0	0	19	0	19	
1941	0	0	14	0	14	
1942	0	0	8	0	8	
1943	0	0	11	0	11	
1944	0	0	16	0	16	
1945	0	0	20	0	20	
1946	0	12	10	0	22	
1947	0	6	8	15	29	
1948	0	11	14	0	25	
1949	41	12	12	0	65	
1950	24	9	6	0	39	
1951	27	7	6	0	40	
1952	40	2	6	0	48	

Year	Official landings					ICES estimates
	France	UK	Ireland	Other countries	Total	
1953	99	2	4	0	105	
1954	116	1	7	0	124	
1955	66	1	9	0	76	
1956	161	1	6	0	168	
1957	94	1	4	0	99	
1958	163	2	6	0	171	
1959	327	1	8	0	336	
1960	80	1	9	0	90	
1961	110	1	12	0	123	
1962	100	0	8	0	108	
1963	172	0	19	0	191	
1964	159	1	24	0	184	
1965	95	5	24	0	124	
1966	0	1	11	0	12	
1967	78	0	11	0	89	
1968	121	0	8	0	129	
1969	86	1	9	0	96	
1970	3	0	8	0	11	
1971	0	2	5	0	7	
1972	4	0	13	0	17	
1973	0	0	12	0	12	
1974	25	0	12	0	37	
1975	7	0	19	0	26	
1976	6	0	44	0	50	
1977	3	0	14	0	17	
1978	3	0	16	0	19	
1979	6	0	13	0	19	
1980	9	0	24	0	33	

Year	Official landings					ICES estimates
	France	UK	Ireland	Other countries	Total	
1981	6	0	47	0	53	
1982	5	1	55	0	61	
1983	9	0	40	0	49	
1984	3	0	17	0	20	
1985	6	0	44	0	50	
1986	8	0	29	0	37	
1987	2	0	39	0	41	
1988	2	1	34	0	37	
1989	0	0	38	0	38	
1990	0	0	41	0	41	
1991	5	0	46	0	51	
1992	2	0	43	0	45	
1993	1	0	59	0	60	60
1994	1	0	60	0	61	70
1995	2	0	59	0	61	59
1996	2	0	52	0	54	57
1997	3	1	51	0	55	55
1998	0	0	49	0	49	66
1999	0	0	68	0	68	72
2000	12	0	65	0	77	68
2001	7	0	53	0	60	60
2002	14	0	50	0	64	61
2003	19	0	50	0	69	64
2004	18	0	49	0	67	69
2005	7	0	38	0	45	44
2006	12	0	31	0	44	43
2007	7	0	34	0	42	42
2008	7	0	32	0	39	40

Year	Official landings					ICES estimates
	France	UK	Ireland	Other countries	Total	
2009	5	0	46	0	50	51
2010	8	0	35	0	44	43
2011	5	0	22	0	27	22
2012	7	0	38	0	45	43
2013	3	0	30	0	33	33
2014	3	0	24	0	28	27
2015	3	<1	31	0	35	34
2016	6	<1	36	0	42	42
2017	5	<1	22	0	27	27
2018	2	<1	16	0	18 [c]	18
2019	3	0	0[c]	<1	4 [c]	18
2020	2	<1	0[c]	1	3[c]	17
2021 *	2	<1	14	<1	17	18
2022 *	1	0	22	<1	24	26

***Preliminary official landings.**

[c] **Incomplete/missing, as part of the data is unavailable under data confidentiality clauses.**

***Preliminary official landings.**

[c] **Incomplete/missing, as part of the data is unavailable under data confidentiality clauses.**

Figure 32.1a. Landings of Sole in 7.bc as officially reported to ICES (1908–2022). Data in some years effected by confidentiality, see Table 32.1.

Figure 32.1b. Landings of Sole in 7.bc as officially reported to ICES (2010–2022). Data in some years effected by confidentiality, see Table 32.1.

Figure 32.2. Sole in divisions 7.b and 7.c. ICES estimated landings.

Figure 32.3. Sole in 7.b Irish otter trawl landings (top) effort (middle) and landings per Unit of effort (LPUE; bottom) from 1995–2022.

33 Sole (*Solea solea*) in Division 7.e (western English Channel)

Type of assessment in 2021

Last year's assessment report is available at:

http://doi.org/10.17895/ices.pub.19863796

ICES advice applicable to 2022

Last year's advice is available at https://doi.org/10.17895/ices.advice.19453826 and stated:

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 1394 tonnes.

33.1 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 (please note, access to these repositories is so far restricted to ICES and members of WGCSE). The current WGCSE 2023 assessment is available from https://github.com/ices-taf/2023_sol.27.7e_assessment.

All changes since last year's assessment can be accessed with the following link: https://github.com/ices-taf/2023_sol.27.7e_assessment/compare/a74dd04...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.

33.2 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 33.1.

Official landings in 2022 were 1407 t, a 22% undershoot of the 2022 TAC (1810 t).

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	1111		
TAC	1810		

(Source: Council Regulation (EU) 2022/515, EU, 2022).

The TAC and the national quotas by country for 2023

Species	**Sole** ***Solea solea***	**Zone:**	**7e** **(Sol/07E.)**
Belgium	46		Analytical TAC
France	487		
Union	533		
United Kingdom	861		
TAC	1394		

(Source: Council Regulation (EU) 2023/194, EU, 2023).

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 allowed 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.

33.3 Data

InterCatch

International catch data are collated using the ICES InterCatch platform. For 2022, data for Belgium, France, Ireland, and the United Kingdom (England, Scotland and the Channel Island Jersey) were uploaded into InterCatch (Figures 33.1 and 33.2). All submitted age samples are presented in Figure 33.8 and length samples in Figure 33.9. The raising procedure is described in the Stock Annex.

Landings

Landings of sole in Division 7.e have been increasing in recent years and were 1409 t in 2022.

The UK, France and Belgium provided age-structured landings samples in InterCatch (Figure 33.8).

Total international landings numbers-at-age (Table 33.2 and Figure 33.5) and landings and stock weights-at-age (Tables 33.3 and 33.4 and Figure 33.6), 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 92.5% of the 2022 total international landings, based on the InterCatch level (year, country, fleet, and quarter), up from 85.1% for 2021 and 84.8% for 2019.

Discards

Discards for this stock are very low and not included in the assessment.

For 2022, 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 Q1.

Discards data are only available from InterCatch since 2012. In general, the discard rates are low (Figure 33.3). 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 (2020–2022) discard rate is 0.40%. 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 33.4 (shown are only discards submitted to InterCatch, discards are not raised).

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

An error was discovered for the age sample data submitted by England which affected 2017 and 2018 data. The weights-at-age 11 were lower than the weights for older and younger fish (Figures 33.10 and 33.11) which led to the numbers-at-age 11 to be artificially inflated (Figures 33.12 and 33.13). Furthermore, there was a large peak for the number of fish at age 3. Data for 2017 and 2018 was re-processed to correct these mistakes and was resubmitted to InterCatch in 2023. The International catch data was then raised again for these two years in InterCatch. The resulting catch-at-age data are compared to the previously used data in Figure 33.14.

Figures 33.15–33.21 show the impact of the revised data on the XSA assessments conducted by WGCSE in 2018–2023. In the earlier years, the impact was larger and the non-revised data led to an overestimation of spawning–stock biomass (SSB) and an underestimation of fishing mortality (F). However, the difference between the assessments using the revised and non-revised data weakens over time when more data years are added. The difference in the 2023 assessment is negligible (Figure 33.21).

The working group decided to use the revised data for the stock assessments starting in 2023 because (1) the revision is a correction to data, and (2) the influence on the current assessment is negligible.

Biological data

Natural mortality was assumed to be constant over all ages and years at 0.1. The maturity ogive used for this stock was originally borrowed 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 33.7). For 2022 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 33.6 and shown in Figures 33.22–33.25, and internal consistencies in Figures 33.26–33.28. 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*., 2023) conducted another survey of sole and plaice abundance in the Western English Channel in 2022. The survey uses two 4 m beam trawls with 80 mm nominal codend mesh and focuses on the area around the English coast. 89 out of 90 tows were completed in 2022. 411 sole otoliths were collected for ageing in 2022.

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 33.29) and that many cohorts contribute to the stock. The total CPUE decreased since 2019 and is at its lowest value of the time-series in 2022. The index is mainly driven by ages 3, 4, and 6. 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.

The 2022 survey was disrupted and only 55 out of 81 planned tows were fished (Figure 33.30). The main reasons for this disruption where (1) the vessel could initially only use one of two engines, (2) the delayed permission to enter the French exclusive economic zone, and (3) disruptions to the survey due to a health and safety review of lifting operations.

The disruption meant that the survey coverage was severely reduced, and the fished stations are mainly located around the English coast whereas in previous years the survey covered the entire Division 7.e. The survey index derived from the Q1SWBeam survey is the product of a modelling approach. Due to the missing stations in 2022, it was not possible to provide index values for 2022 consistent with the time-series. Two alternative versions of the survey index were provided to WGCSE (Figure 33.21). However, these index time-series use a reduced set of stations for the entire time-series and would consequently require a revision of the entire survey index time-series. Figure 33.32 shows a comparison of the XSA assessment without 2022 Q1SWBeam data and the two version of the survey index including 2022 data.

The working group decided to exclude the 2022 Q1SWBeam index data because (1) no values consistent with the previous time-series were available, (2) the inclusion of 2022 data would lead to loss of survey coverage for all historical years, and (3) the survey has only a minor influence on the XSA assessment and mediocre cohort tracking whereas the other indices (FSP-7e and commercial tuning indices) have a higher influence.

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 33.22). 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 and has exceeded the long-term average in recent years. When the effort of all UK beam trawl vessels is combined, the effort stayed relatively constant since the early 2000s with a slight increase in recent years.

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 33.5 and 33.6 and plotted in Figures 33.23–33.25.

33.4 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 and a revision to 2017 and 2018 catch data.

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 2023 assessment.

The landings numbers-at-age 3 were high in 2017 and continue as age 4 into 2018. 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 33.6.

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 2021	WGCSE 2022	WGCSE 2023
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	2006–2020 Ages 2–11 (non-offset)	2006–2021 Ages 2–11 (non-offset)	2006–**2021** Ages 2–11 (non-offset)
UK-FSP	2014–2020 Ages 2–11	2014–2021 Ages 2–11	2014–2022 Ages 2–11
UK combined beam (late)	2003–2020 Ages 3–11	2003–2021 Ages 3–11	2003–2022 Ages 3–11
UK otter trawl	1988–2016 Ages 3–11	1988–2016 Ages 3–11	1988–2016 Ages 3–11
Time taper	Yes	Yes	Yes
Power model	Tricubic	Tricubic	Tricubic
Taper range	15 years	15 years	15 years
P shrinkage	No	No	No
Q plateau age	7	7	7
F shrinkage S.E	0.5	0.5	0.5
Number of years	3	3	3
Number of ages	5	5	5
Fleet S.E.	0.4	0.4	0.4

Figure 33.33 shows the results from the final XSA model fit, Figure 33.34 the model residuals, Figure 33.35 a comparison of the current assessment with last years' assessments, Figure 33.36 XSA survivor weightings for the last two years and Figure 33.37 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 with five peels was conducted based on the XSA stock assessment results, i.e. the last data year (2022) 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	-0.010	0.047	0.180

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.

XSA diagnostic of the final assessment are presented in Table 33.7, stock numbers-at-age in Table 33.8, fishing mortalities-at-age in Table 33.9 and an assessment summary in Table 33.10.

Consistency of the stock assessment

The comparison of historical stock assessment results (historical retro, Figure 33.35) and the analytical retrospective analysis (Figure 33.37) show slightly different retrospective patterns. It is worth noting that the historical comparison (Figure 33.35) 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 33.37) 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.
- The 2017 and 2018 catch data were revised in 2023, which would have led to lower estimates of SSB and higher estimates of F in recent years (Figures 33.15-33.21).

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 33.10 and plotted in Figure 33.33. The SSB is in a desirable state above all biomass reference points. However, F has increased and now exceeds F_{MSY}.

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.

33.5 Short-term projections

Forecast assumptions

Figure 33.38 shows three different targets for the intermediate year: status quo ($F = F_{2022}$), average ($F = F_{average\ 2020–2022}$), and TAC.

Landings have been below the international TAC and the advised catch in previous years (Figure 33.39). However, landings have been increasing and the TAC has decreased in recent years. Landings in 2022 (1409 t) were similar to the TAC for 2023 (1394 t). Anecdotal information from England (the main country fishing in this area) suggests that the TAC is becoming restrictive for some fleets. This indicates that the TAC for 2023 of 1394 t is likely to be taken by the fishery. Using the most recent F (F_{sq}) or a three-year average F ($F_{average\ 2020–2022}$) would lead to a reduction in the intermediate year catch compared to 2022, which is considered unlikely given the available information. Consequently, the working group decided to select the option corresponding to the TAC for the intermediate year (2023). Because the assessment is based on landings only, the TAC of 1394 t was corrected for the assumed discard rate (average of 2020–2022, 0.40%), and a landings value of 1388 t was used for the intermediate year in the short-term forecast.

Weights-at-age were calculated as the average of the last three historical years, as in previous years.

Recruitment estimates do not indicate periods of consistent high or low recruitment periods in recent years. Consequently, the long-term average (geometric mean of 1969–2022) of the recruitment was used for the intermediate year and advice year, following the Stock Annex.

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 (2020–2022, 0.40%).

The input data for the short-term forecast are shown in Table 33.11.

MSY forecast

Table 33.12 shows a detailed output of the forecast targeting F_{MSY} for 2024–2025, and Table 33.13 the year classes contributing to the forecast yield and SSB.

Figure 33.40 shows the forecast results for F_{MSY}, and Figure 33.41 the forecast, including F_{MSY} ranges.

Implementing the MSY approach with F_{MSY}=0.29 leads to a total catch of 1055 t in 2024 (1051 t of landings, 4 t of discards), and an SSB of 3500 t in 2025 in the short-term forecast.

A management options table is provided in Table 33.14, and Table 33.15 shows additional options.

The advice is a reduction of 24% compared to the advice for 2023. The following report section describes the changes in the advice.

Explanation of the change in advice

The perception of the stock changed this year (SSB lower than previously estimated, F higher than previously estimated, Figure 33.41) because of (1) a revision of historical (2017 and 2018) catch age samples from England because an error was found in the data and (2) the addition of an additional year of data to the assessment. The data revision would have had a larger impact

in previous years (WGCSE 2018/2019/2020) and potentially led to lower catch advice in these years. The impact of the revisions on this year's terminal SSB/F estimates and the short-term forecast is considered negligible.

This year's advice is a reduction to the previously advised catch value because (1) F is estimated to be above F_{MSY} and needs to be reduced in the short-term forecast and (2) the SSB is declining and expected to decline further in the short-term forecast.

Figure 33.43 shows a comparison of this year's values-at-age (stock numbers, stock weight, stock biomass, selectivity) for the assessment and forecast and the corresponding values from last year's analysis.

Figure 33.44 illustrates the contribution of cohorts to the SSB and the catch from this years assessment and short-term forecast. Figure 33.45 shows the same but for numbers.

33.6 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 ≥ B_{lim} with 95% probability.	ICES (2016, 2017)
Previous management plan	SSB_{MGT}	Not defined		
	F_{MGT}	0.27		EU (2007)

33.7 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.

33.8 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 <1% of the total international catch weight in the past years. 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 2023 assessment is consistent with the previous assessments conducted in recent years. Temporal trends in SSB and F estimates were virtually identical.

33.9 Recommendation for the next benchmark

There is no urgent 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.

Age samples for 2017 and 2018 catches from England were revised in 2023 due to an error found in the data. The data for remaining years should also be checked if similar issues occurred in other years.

33.10 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.

33.11 Ecosystem considerations and changes in the environment

See Stock Annex.

33.12 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).

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33.14 Tables

Table 33.1. 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	926	1182	1185	4
2020	58	194	< 1		969	1222	1219	< 1
2021*	103	243	< 1	< 1	1048	1395	1392	13
2022*	132	231		<1	1044	1407	1409	3

*** Preliminary.**

Table 33.2. Sole in Division 7.e. Landings numbers-at-age (thousands). Data years 2017 and 2018 were revised at WGCSE 2023 and are denoted by *.

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1969	89	322	80	148	210	21	50	26	20	9	63	1037
1970	53	232	322	90	83	112	13	35	52	22	113	1127
1971	51	200	246	198	65	80	156	10	35	54	113	1207
1972	146	412	167	115	112	14	25	134	38	54	106	1323
1973	71	396	433	89	99	120	17	52	30	4	136	1446
1974	45	349	220	178	71	80	43	32	24	55	106	1202
1975	82	567	170	199	115	28	53	26	22	24	171	1456
1976	167	419	472	161	135	92	46	58	51	14	213	1830
1977	426	318	384	206	102	70	74	10	24	32	159	1804
1978	250	1123	347	214	189	103	72	77	38	27	203	2644
1979	227	803	811	250	229	174	103	90	104	28	290	3108
1980	175	559	497	630	126	183	140	65	56	130	342	2902
1981	245	806	651	467	389	179	126	76	58	55	211	3262
1982	128	1451	916	553	352	240	136	113	81	61	294	4324
1983	91	753	1573	583	351	267	294	119	73	37	262	4401
1984	333	663	826	758	325	204	129	152	54	28	255	3727
1985	287	1700	756	469	585	179	97	103	85	29	125	4414
1986	246	1618	971	421	321	336	84	75	90	74	127	4363
1987	487	808	1090	427	204	224	229	47	50	41	162	3770
1988	443	1438	596	728	374	153	162	109	39	50	171	4262
1989	390	871	1233	497	509	225	110	107	113	48	214	4316
1990	341	902	581	553	244	264	143	103	75	85	235	3525
1991	450	415	482	289	220	93	111	68	37	31	145	2341
1992	316	1434	417	297	115	112	61	74	26	23	90	2964
1993	209	704	1107	350	219	151	78	60	56	31	79	3045
1994	97	657	558	558	112	106	49	57	44	50	99	2388
1995	95	308	629	427	411	131	101	61	33	18	142	2356
1996	365	445	364	298	235	257	68	61	49	37	143	2321

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12+	TOTAL
1997	216	831	724	325	180	194	173	44	20	40	88	2835
1998	265	606	536	336	209	151	80	127	35	34	162	2543
1999	280	915	500	398	255	114	103	54	107	25	123	2874
2000	307	599	751	367	229	107	53	68	51	88	91	2710
2001	145	1401	531	497	268	178	100	55	43	42	159	3419
2002	332	1251	843	387	322	129	105	94	33	18	85	3599
2003	598	835	953	645	130	74	50	58	63	14	61	3482
2004	398	1080	448	445	526	164	116	61	54	35	85	3412
2005	258	468	834	449	366	293	113	80	45	24	96	3027
2006	500	786	472	606	250	224	185	85	56	31	87	3282
2007	201	852	755	293	362	179	130	110	55	27	99	3062
2008	281	752	678	376	163	184	105	71	67	39	89	2805
2009	166	540	385	333	202	66	74	37	50	35	65	1955
2010	68	348	394	329	204	127	49	71	20	34	78	1723
2011	91	499	476	405	233	156	80	39	34	28	93	2136
2012	31	227	525	400	355	231	137	67	44	39	124	2180
2013	120	324	483	595	280	214	147	98	48	23	110	2441
2014	198	320	466	426	410	168	112	79	61	27	97	2364
2015	177	329	395	336	261	206	115	78	45	30	82	2054
2016	92	420	469	276	249	242	189	67	50	33	107	2194
2017*	134	747	561	288	238	196	142	130	83	64	124	2708
2018*	130	375	768	429	203	209	155	98	95	73	156	2691
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
2022	356	505	937	648	845	311	213	107	55	55	194	4226

Table 33.3. Sole in Division 7.e. Landings weights-at-age (kg). Data years 2017 and 2018 were revised at WGCSE 2023 and are denoted by *.

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

year\age	2	3	4	5	6	7	8	9	10	11	12+
1997	0.186	0.244	0.300	0.354	0.406	0.455	0.503	0.548	0.592	0.633	0.734
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*	0.209	0.264	0.315	0.364	0.409	0.451	0.490	0.527	0.56	0.59	0.664
2018*	0.237	0.289	0.338	0.383	0.425	0.463	0.498	0.529	0.558	0.582	0.666
2019	0.18	0.233	0.284	0.333	0.379	0.423	0.464	0.503	0.54	0.574	0.682
2020	0.188	0.235	0.28	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
2022	0.144	0.207	0.266	0.322	0.375	0.424	0.47	0.512	0.551	0.586	0.665

Table 33.4. Sole in Division 7.e. Stock weights-at-age (kg). Data years 2017 and 2018 were revised at WGCSE 2023 and are denoted by *.

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

year\age	2	3	4	5	6	7	8	9	10	11	12+
1997	0.156	0.215	0.272	0.327	0.380	0.431	0.480	0.526	0.570	0.612	0.717
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	0.59	0.617	0.714
2017*	0.181	0.237	0.290	0.340	0.387	0.430	0.471	0.509	0.543	0.575	0.655
2018*	0.210	0.264	0.314	0.361	0.404	0.444	0.481	0.514	0.544	0.570	0.660
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
2022	0.111	0.176	0.237	0.295	0.349	0.400	0.447	0.491	0.532	0.569	0.656

Table 33.5. 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	1.10
	1996	1999	106	52.99	0.88
	1997	1991	132	66.30	1.10
	1998	2357	99	42.12	0.70
	1999	2518	115	45.70	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	0.30
	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	0.70
	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	1.15
	2021	5354	399	74.5	1.24
	2022	6059	377	62.21	1.03
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	51.50	1.07
	1995	4917	257	52.30	1.09
	1996	5592	178	31.84	0.66
	1997	5377	199	37.10	0.77
	1998	4945	164	33.19	0.69
	1999	4512	141	31.32	0.65
	2000	5237	151	28.84	0.60
	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	0.20
	2005	6684	236	35.27	0.73
	2006	6595	236	35.79	0.74
	2007	5594	196	35.10	0.73
	2008	4924	154	31.36	0.65
	2009	3523	115	32.66	0.68

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2010	3064	94	30.64	0.64
	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	0.68
	2016	4064	166	40.79	0.84
	2017	4556	207	45.41	0.93
	2018	4116	231	56.17	1.16
	2019	4329	313	72.36	1.49
	2020	4335	321	74.07	1.52
	2021	4505	354	78.56	1.62
	2022	5320	349	65.59	1.35
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	0.70
	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

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	2004	10612	132	12.46	0.23
	2005	9990	427	42.70	0.80
	2006	9873	460	46.57	0.87
	2007	9621	421	43.75	0.82
	2008	9552	367	38.42	0.72
	2009	7563	300	39.70	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	0.90
	2014	8769	413	47.05	0.88
	2015	9298	411	44.17	0.82
	2016	10178	521	51.19	0.96
	2017	11114	606	54.57	1.02
	2018	10482	617	58.90	1.10
	2019	10396	711	68.35	1.28
	2020	9978	714	71.55	1.34
	2021	9859	753	76.35	1.42
	2022	11379	726	63.79	1.19
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

Fleet	Year	Effort [days]	Landings [tonnes]	Lpue [tonnes/1000 days]	means standardised lpue
	1998	2699	11	4.22	0.89
	1999	2486	13	5.16	1.09
	2000	2681	11	4.11	0.87
	2001	2732	13	4.90	1.04
	2002	2448	9	3.66	0.78
	2003	2273	8	3.31	0.70
	2004	2334	6	2.46	0.52
	2005	1762	12	6.86	1.45
	2006	1699	8	4.57	0.97
	2007	1917	9	4.90	1.04
	2008	1750	7	4.26	0.90
	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	0.67
	2017	2398	15	6.10	0.58
	2018	1986	17	8.42	0.80
	2019	1548	14	9.33	0.89
	2020	1076	15	14.17	1.35
	2021	1369	20	14.7	1.40
	2022	1246	17	13.92	1.32

Table 33.6. 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 2021
106
UK-CBT-late
2003 2022
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
  11.37885     314.31     614.77     308.96     431.39     155.16       97.7      53.51
28.48      22.69      18.32      11.57      14.03
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
```

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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
Q1SWBeam-nonoffset-V1
2006 2022
1 1 0.1 0.25
1 27
1           0           10.2831     14.4378     7.2725      14.4377     5.5961
            7.13        6.861       2.90702     2.82859     3.60271
            0.64983     1.18363     0.42807     0.658       6.79316
            0.83462     0.39699     0           0           0           0
            0           0           0           0           0
1           0.16687     9.8812      27.8597     10.5167     1.6884      5.7311
            2.0168      2.1298      3.72043     2.51892     3.10315
            0.11374     1.15808     0.96954     0.33416     0
            0.63993     0.28599     0           0           0
            0.40667     0           0           0.09932     0           0
1           0           10.8269     22.4315     19.0395     8.8652      6.4496
            2.5605      6.4218      6.18206     3.83386     1.82804     1.542
            1.64694     0.84895     0.4194      0.09932     0.87867
            1.39078     2.27897     0           0           0           0
            0           0           0           0
1           0           2.7029      18.4684     14.3973     9.4283      5.5118
            1.9591      2.4189      0.89228     3.0406      3.50273
            0.66769     0.63782     0.14701     0.72372     0
            1.16367     1.29584     1.49235     0           0           0
            0           0           0.10455     1.05699     1.05699
1           0           17.4225     17.8979     19.3542     13.2345     8.318
            7.1591      1.6078      1.65577     1.39785     0.81183
            1.18174     0.71617     0.66769     0.51741     0
            0.49475     0           0.66245     0           0.66769     0
            0           0           0           0           0
1           0           9.6518      17.797      14.2866     10.5999     4.6691
            2.7641      2.5717      1.47053     0.22467     1.24853
            0.77389     0.31664     0.3873      0.12102     0.09459     0.3333
            0           0.11919     0           0           0.09459     0
            0           0           0           0
1           0           1.7917      16.9977     18.5256     7.7153      6.3403
            8.0401      4.0948      2.86418     0.13376     1.0617
            1.84127     0.33928     0.98069     0.09932     0.44749     0
            0.09932     0.66245     0           0           0
            0.33416     0           0           0           0
1           0           3.0941      10.5562     18.2857     17.3685
            11.5663     9.7466      6.5411      6.14901     5.15539
            0.85402     4.97234     0.82806     3.43062     0.7629      0
            0           0           0           0           0
            1.88505     0.66831     0           0           0           0
1           0.7539      3.9292      20.2852     24.4269     9.9905
            14.2817     10.2697     18.9533     5.81383     2.3858
            3.74314     1.0254      1.32124     0.7671      1.01737
            0.92041     1.23376     0           0           0.92041
            0.21026     0           0           0           0           0
            0
1           0.56543     4.112       8.5863      8.7851      7.6517      7.4502
            8.6561      5.0026      5.03134     2.451       1.65758
            0.81713     1.80827     1.7988      0           2.41582
            0.27347     0.92815     0.14558     0.178       1.25309     0
            0           0           0           0           0
1           0.20429     10.1608     22.8495     9.7784      10.0088     7.0214
            6.1444      10.0515     1.77202     1.58774     3.13678
            1.70091     0.90133     0.06207     0           0.33416     0
            0           0           0.79506     0           0.1204      0
            0           0           0           0
1           1.3311      4.2408      13.9577     12.7983     7.3733      5.7578
            4.9765      2.1543      1.76602     1.74008     1.29402
```

```
            3.12057     0.99117     0.94877     0.1442      0.24464     0
            0           0.95282     0.31664     0.19391     0           0
            0           0           0           0
1           0           9.7449      15.9118     22.0253     16.018      5.515
            7.3314      5.4841      4.63405     4.26519     1.04742
            3.18642     3.36517     3.81071     0.83888     0           0
            0           0           0.32885     0           0           0
            0           0           0           0
1           0.35174     14.1628     35.5258     15.708      15.9896     8.4814
            2.9977      2.5971      2.60269     1.74875     4.73319
            0.12722     2.11464     1.22713     2.10488     0           0
            0.34295     0           0.22567     0           0
            0.66769     0           0           0           0
1           0.23884     13.4637     18.2356     21.9305     11.0805     8.2492
            5.533       3.5814      2.3138      1.46077     3.42926     2.0927
            0.66215     0.66769     0.15604     0           0           0
            0           0           0           0.18073     0           0
            0           0           0
1           0.18772     5.0725      37.1815     20.8599     32.7296
            11.1961     9.7452      14.9424     1.95381     3.94729
            2.14387     0.17896     0.338       1.96585     0           0
            1.85926     0           0           0           0.1093      0
            0.11083     0           0           0           0
1           0.27394     10.2775     11.6372     17.2343     14.7067
            19.2967     8.2653      1.9945      4.08389     6.22742
            1.93206     1.88248     1.19079     1.98107     1.39072     0
            0           0.18058     0           0           0
            0.19917     0           0           0           0           0
Q1SWBeam-nonoffset-V2
2006 2022
1 1 0.1 0.25
1 27
1           0           7.4957      15.6942     8.1629      13.7659     4.4601
            7.9809      8.215       2.62088     2.51538     1.57293
            0.82974     0.4043      0.54659     0.84017     1.06569
            1.06569     0.5069      0           0           0           0
            0           0           0           0           0
1           0.21306     10.2549     31.4907     12.2649     2.1559      4.3041
            0.8773      1.2674      4.20114     1.436       2.5228
            0.14522     0.27269     1.23796     0.42667     0
            0.26777     0.36517     0           0           0
            0.51926     0           0           0.12682     0           0
1           0           9.3517      23.8653     20.1224     8.2276      3.6036
            1.304       4.8368      6.33696     3.49147     0.92676     0
            0.69907     0.52245     0.53552     0.12682     0.12682
            1.77583     0.66379     0           0           0           0
            0           0           0           0
1           0           2.7636      19.9221     16.0533     8.4327      6.3502
            2.5015      3.0886      1.13932     2.17751     4.47249
            0.85255     0.12682     0.18771     0.92409     0
            1.48584     1.6546      1.21793     0           0           0
            0           0           0.13349     1.34963     1.34963
1           0           9.5466      13.8703     13.751      10.7131     8.1091
            8.2953      2.053       0.2491      1.18322     1.03659
            0.24546     0.91445     0.85255     0.05902     0           0
            0           0           0           0.85255     0           0
            0           0           0           0
1           0           9.65        17.9112     14.1607     11.9302     4.0463
            2.9946      1.3119      0.80808     0.28687     1.5942
            0.39706     0.4043      0.49453     0.15452     0.12078
            0.42558     0           0.15219     0           0
            0.12078     0           0           0           0           0
1           0           2.2877      16.9141     16.4274     5.7525      6.8735
            7.6574      4.308       2.53409     0.17079     1.35564
            1.78951     0.43321     0.40635     0.12682     0           0
            0.12682     0           0           0           0
            0.42667     0           0           0           0
1           0           2.6872      13.4787     20.9267     19.3299
            12.0266     11.1816     6.0313      4.37694     4.57779
            1.09046     4.02821     0           2.26578     0.97412     0
            0           0           0           0           0
            1.34963     0.85334     0           0           0           0
1           0           3.0597      20.7032     23.3555     11.6462
            14.6996     10.1758     14.9904     5.60804     2.57641
            4.77945     0.53997     1.68704     0.50956     0.28828
            1.17524     1.57534     0           0           1.17524
            0.26848     0           0           0           0           0
            0
1           0           3.7494      7.3555      7.7897      7.8567      5.0884
            7.9526      4.1062      3.74846     2.34338     1.05168
            0.86287     1.54893     2.01486     0           2.90416
            0.34918     0.83272     0.18588     0.22728     1.60002     0
            0           0           0           0           0
1           0.26085     8.4082      25.468      11.2763     9.5         7.5862
            6.2108      11.0859     1.74748     1.17007     3.24943
            1.32674     1.15087     0.07926     0           0.42667     0
```

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                0           0           0.50004     0           0.15374     0
                0           0           0           0
1               1.69962     4.9716      15.5316     14.1659     8.9935      6.9308
                6.3543      2.7507      2.25495     2.22184     1.65228
                2.29232     1.26558     1.21145     0.18412     0.31237     0
                0           1.21661     0.4043      0.24759     0           0
                0           0           0           0
1               0           12.4429     17.5788     25.9583     19.3736     6.3741
                7.2578      6.1332      5.24925     4.77826     1.04061
                3.42202     3.02701     3.97536     1.07113     0           0
                0           0           0.4199      0           0           0
                0           0           0           0
1               0.44913     18.0839     42.2028     20.0569     19.6795
                10.8296     3.7224      3.3161      3.32326     2.2329
                6.04361     0.16244     2.48952     1.56688     2.47706     0
                0           0.4379      0           0.28815     0           0
                0.85255     0           0           0           0
1               0.30497     15.0253     20.9944     27.5791     12.3362     9.2041
                4.8866      4.5729      2.9544      1.8652      3.95576
                2.67208     0.84547     0.85255     0.19925     0           0
                0           0           0           0           0.23077     0
                0           0           0           0
1               0.2397      5.8924      35.2822     24.1483     36.88
                13.0749     10.5003     18.4375     1.77277     3.8191
                2.01545     0.22851     0.43158     2.5101      0           0
                0           0           0           0           0.13955     0
                0.14151     0           0           0           0
1               0.27394     10.2775     11.6372     17.2343     14.7067
                19.2967     8.2653      1.9945      4.08389     6.22742
                1.93206     1.88248     1.19079     1.98107     1.39072     0
                0           0.18058     0           0           0
                0.19917     0           0           0           0           0
FSP-UK
2003 2022
1 1 0.7 0.75
1 27
1               0.0005996525 0.1640287001 0.3331577428 0.3421042854 0.3077896855
                0.0276877607 0.0434349878 0.0011901644 0.0608211293 0.0451846307
                0.0762401028 0.0041715647 0.0044611431 0.0017225891 0.0002409318
                0.0014310962 0            0            0.0001204659 0.0001204659 0
                0.0002409318 0.0001204659 0            0.0001204659 0            0
1               0.0001289088 0.1508839894 0.5403144168 0.3152059396 0.2604647275
                0.1293730848 0.0581589456 0.0852368551 0.0346906115 0.0160847022
                0.0172630837 0.0102386751 0.0065656453 0.0069292813 0.004461108
                0.0014047561 0.0011386869 0.0007995095 0.0034532307 0.0013999214
                0.0004645713 0.0013823569 0.002375134  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               0.0039622611 0.1530302961 0.3381459769 0.1553909058 0.2150083739
                0.0964564671 0.1165659253 0.1314613194 0.0263429885 0.0257418516
                0.0180397302 0.0143442058 0.0090569562 0.0018010876 0.0041838598
                0.0038007209 0.003544814  0.0026229604 0.0019664864 0.0012697642
                0.0005627501 0.0007545149 0.0005711703 0.0012697642 3.29809e-05
                3.29809e-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               2.19509e-05  0.2195312571 0.3064662987 0.2655858799 0.2476263144
                0.0431096001 0.0375100475 0.0146102064 0.0570111676 0.0329417363
                0.0020477989 0.0103748736 0.0052148939 0.0003398419 0.0019273659
                0.0012345973 0.0002575085 0.0023031566 0.0017533753 0.0001128858
                0.0019527171 0.001458163  4.01443e-05  0.0001032939 0.001601874
                1.01841e-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
                0.0841717658 0.0489667592 0.0045366621 0.0133353383 0.0073015942
                0.0107249114 0.0123980674 0.0133018554 0.0012425358 0.0037484892
                7.66997e-05  0.0047445182 4.60198e-05  0.0012271959 1.53399e-05
```

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                3.06799e-05   6.13598e-05   3.06799e-05   1.53399e-05   1.53399e-05
                0.0034484612  0
1               0             0.0462429317  0.3661074051  0.3751123378  0.171327639
                0.1173729434  0.0335259216  0.0444019076  0.0276687794  0.0030709031
                0.0064301999  0.0001226115  0.0090535148  0.0102454045  0.0064329549
                0.0063234365  0.0019806469  0             6.13057e-05   6.13057e-05
                0.0012992471  0.0001226115  6.13057e-05   0             6.13057e-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
                0.1366900268  0.0642090392  0.039600374   0.0304428769  0.0543766714
                0.0184043047  0.0425608914  0.0141064564  0.0039886845  0.0064464231
                0.0041454309  0.0024767799  0.0012224282  0.0001198868  2.39774e-05
                0.0022751972  0.0053210793  4.79547e-05   2.39774e-05   2.39774e-05
                2.39774e-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
1               0.0004082631  0.0787689915  0.1276190299  0.2410221235  0.0760166774
                0.1630496915  0.0575661026  0.0266004609  0.02003413    0.014412702
                0.012570426   0.0060156309  0.0056956075  0.014770917   0.0034451973
                0.0089231969  0.0020651531  0.0037530185  1.98648e-05   3.9729628e-06
                0.0011283214  1.19189e-05   0.0014991313  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 33.7. Sole in Division 7.e. Detailed XSA survivor diagnostics.

```
FLR XSA Diagnostics 2023-05-02 09:04:55

CPUE data from indices

Catch data for 54 years 1969 to 2022. Ages 2 to 12.

               fleet first age last age first year last year alpha beta
1        UK-CBT-late         3       11       2003      2022  <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      2022  <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
     year
age    2013 2014  2015 2016  2017  2018  2019  2020  2021 2022
  all 0.482 0.61 0.725 0.82 0.893 0.944 0.976 0.993 0.999    1


 Fishing mortalities
    year
age   2013  2014  2015  2016  2017  2018  2019  2020  2021  2022
  2  0.040 0.067 0.045 0.018 0.030 0.016 0.023 0.024 0.044 0.091
  3  0.116 0.127 0.136 0.128 0.176 0.099 0.126 0.132 0.141 0.242
  4  0.220 0.217 0.203 0.260 0.225 0.247 0.225 0.226 0.215 0.207
  5  0.267 0.274 0.214 0.191 0.225 0.239 0.295 0.301 0.326 0.285
  6  0.264 0.266 0.240 0.218 0.224 0.219 0.308 0.308 0.453 0.363
  7  0.279 0.223 0.185 0.326 0.238 0.279 0.307 0.310 0.351 0.418
  8  0.299 0.206 0.209 0.231 0.287 0.268 0.337 0.320 0.318 0.358
  9  0.269 0.232 0.195 0.161 0.220 0.292 0.313 0.248 0.465 0.296
  10 0.296 0.240 0.178 0.165 0.278 0.222 0.311 0.271 0.358 0.351
  11 0.300 0.240 0.160 0.174 0.290 0.368 0.284 0.211 0.262 0.395
  12 0.300 0.240 0.160 0.174 0.290 0.368 0.284 0.211 0.262 0.395


 XSA population number (Thousand)
       age
year      2    3    4    5    6    7   8   9  10  11  12
  2013 3254 3120 2571 2668 1272  924 596 436 199  92 445
  2014 3221 2830 2515 1867 1848  884 632 400 302 134 478
  2015 4257 2726 2256 1832 1284 1282 640 466 287 215 585
  2016 5470 3683 2154 1666 1338  914 964 470 347 217 704
  2017 4772 4863 2933 1503 1245  973 597 693 362 266 515
  2018 8725 4190 3689 2120 1085  900 694 405 503 248 533
  2019 5370 7770 3435 2607 1511  789 616 480 274 365 665
  2020 7595 4750 6199 2481 1757 1005 525 398 318 182 874
  2021 2845 6712 3767 4473 1662 1168 667 345 281 219 811
  2022 4306 2465 5273 2749 2923  956 744 439 196 178 621


 Estimated population abundance at 1st Jan  2023
      age
year   2    3    4    5    6    7   8   9  10  11  12
  2023 0 3557 1750 3880 1871 1840 570 470 295 125 108


 Fleet:  UK-CBT-late

 Log catchability residuals.

    year
age    2003   2004   2005   2006   2007   2008   2009   2010   2011   2012
```

```
  3  -0.427 -0.634  0.426  0.622  0.739  0.401  0.129 -0.708 -0.037 -0.453
  4  -0.628 -1.285  0.163  0.231  0.233  0.185 -0.008 -0.178 -0.430 -0.173
  5  -0.845 -1.450 -0.139  0.272  0.066 -0.107  0.071  0.013 -0.054 -0.386
  6  -1.771 -1.026  0.011 -0.164 -0.090  0.018  0.125 -0.127 -0.116 -0.140
  7  -1.386 -2.090  0.072  0.107 -0.104 -0.016 -0.329 -0.074 -0.144 -0.154
  8  -1.460 -1.240 -0.766  0.323 -0.007  0.177 -0.213 -0.084 -0.217 -0.136
  9  -0.789 -1.444  0.069 -0.048  0.053 -0.084 -0.323 -0.068 -0.349 -0.134
  10 -1.315 -1.126  0.134  0.144 -0.492  0.119 -0.417 -0.528  0.104  0.047
  11 -1.413 -1.283  0.310  0.097  0.063 -0.111 -0.320 -0.087 -0.021  0.097
    year
age    2013   2014   2015   2016   2017   2018   2019   2020   2021   2022
  3  -0.798 -0.385 -0.198  0.061  0.263 -0.303  0.147  0.160  0.120  0.582
  4   0.031 -0.135 -0.213 -0.032  0.041  0.133  0.102  0.039  0.146 -0.024
  5   0.081 -0.091 -0.001 -0.231 -0.090  0.016  0.158  0.235  0.162 -0.135
  6  -0.026  0.005 -0.095 -0.060 -0.204 -0.209  0.136  0.093  0.272  0.094
  7  -0.065  0.022 -0.267  0.062 -0.118  0.022  0.059  0.248  0.282  0.214
  8   0.128 -0.043 -0.139 -0.188  0.007 -0.156 -0.098  0.304  0.199 -0.024
  9  -0.066 -0.004 -0.185 -0.235 -0.286 -0.006 -0.057 -0.102  0.218 -0.128
  10  0.145 -0.076 -0.078 -0.011 -0.157 -0.298  0.065 -0.306  0.218  0.073
  11  0.091  0.085 -0.230 -0.292 -0.253  0.102 -0.125 -0.518 -0.004 -0.036


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

                3       4       5       6       7       8       9      10
Mean_Logq -4.9071 -4.4076 -4.2969 -4.2168 -4.2168 -4.2168 -4.2168 -4.2168
S.E_Logq   0.4570  0.3568  0.3963  0.4567  0.5662  0.4639  0.3583  0.4199
               11
Mean_Logq -4.2168
S.E_Logq   0.4386


 Fleet:  UK-COT

 Log catchability residuals.

    year
age    1988   1989   1990   1991   1992   1993   1994   1995   1996   1997
  3   1.112  0.752  1.024  0.750  0.717  0.675  0.907  0.352  0.794  1.125
  4   0.641  0.457  0.456  0.002 -0.041  0.196  0.451  0.532  0.520  0.331
  5   0.525  0.405  0.291 -0.270 -0.429  0.260  0.189  0.180  0.298  0.341
  6   0.336  0.293  0.453 -0.576 -1.357 -0.122 -0.133 -0.256  0.005 -0.029
  7  -0.367  0.150  0.061 -0.847 -0.999 -0.214  0.074 -0.002 -0.224  0.209
  8  -0.176 -0.118 -0.127 -0.802 -1.218 -0.486 -0.517 -0.073 -0.034 -0.387
  9  -0.558  0.124  0.090 -1.163 -1.321 -0.010  0.000 -0.518 -0.102 -0.230
  10 -1.284 -0.165 -0.094 -0.877 -1.750 -0.593  0.584 -0.617 -0.257 -0.937
  11 -0.394  0.400 -0.459 -1.133 -2.104 -0.152  0.065 -0.355 -0.206 -0.529
    year
age    1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  3   0.793  0.891  0.459  0.841  0.519  0.244  0.169  1.150  0.861  0.938
  4   0.340  0.239  0.318 -0.042 -0.354 -0.088 -0.582  0.728  0.308  0.335
  5   0.016  0.274  0.080  0.123 -0.446 -0.276 -0.785  0.296  0.283  0.179
  6   0.147 -0.024 -0.130 -0.005  0.001 -0.993 -0.389  0.384 -0.282 -0.010
  7  -0.112  0.171 -0.577  0.023 -0.174 -0.652 -1.517  0.423 -0.065 -0.045
  8  -0.405  0.407 -0.397 -0.369 -0.294 -0.700 -0.728 -0.378  0.234  0.086
  9  -0.506 -0.220  0.267  0.169 -1.073 -0.203 -0.883  0.479 -0.152  0.112
  10 -0.457 -0.076 -0.112  0.361 -0.490 -0.718 -0.562  0.474 -0.032 -0.366
  11 -0.062  0.259 -0.182  0.098  0.306 -0.433 -0.670  0.856 -0.105 -0.029
    year
age    2008   2009   2010   2011   2012   2013   2014   2015
  3   0.615  0.843 -0.360  0.322  0.158 -0.320 -0.062  0.093
  4   0.165  0.254  0.016 -0.365  0.228  0.125  0.000 -0.100
  5  -0.186  0.145  0.096 -0.091 -0.058  0.182  0.005 -0.092
  6  -0.099  0.079 -0.074 -0.245  0.115  0.026  0.042 -0.025
  7  -0.069 -0.360 -0.013 -0.281 -0.017 -0.071  0.077 -0.213
  8   0.105 -0.054  0.000 -0.562  0.056  0.221  0.071 -0.164
  9  -0.087 -0.173  0.037 -0.509  0.070  0.004  0.181 -0.189
  10  0.133 -0.176 -0.316 -0.127  0.274  0.341  0.187  0.113
  11  0.034 -0.002  0.107 -0.293  0.444  0.345  0.308 -0.124


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

                  3        4        5        6        7        8        9
Mean_Logq -14.2911 -13.6758 -13.5329 -13.3893 -13.3893 -13.3893 -13.3893
S.E_Logq    0.4203   0.3105   0.2947   0.3792   0.4072   0.3622   0.4443
                 10       11
Mean_Logq -13.3893 -13.3893
S.E_Logq    0.5339   0.5528


 Fleet:  Q1SWBeam-nonoffset

 Log catchability residuals.
```

```
    year
age    2006   2007   2008   2009   2010   2011   2012   2013   2014   2015
  2   0.732  0.700  0.280 -0.441  0.773  0.692 -1.177 -0.517 -0.150 -0.190
  3  -0.028  0.529  0.430  0.247  0.040 -0.067  0.405 -0.333  0.559 -0.212
  4  -0.226 -0.238  0.720  0.108  0.661 -0.122 -0.090  0.379  0.527 -0.637
  5   0.570 -1.484  0.265  0.479  0.529 -0.361 -0.426  0.007 -0.548 -0.355
  6   0.578 -0.321  1.111  0.354  0.415 -0.616 -0.512  0.184  0.072  0.179
  7   0.638 -0.602 -0.027 -0.792  1.050 -1.077  0.098  0.319  0.396  0.503
  8   0.722 -0.510  0.938 -0.019 -0.962  0.034  0.126  0.538  1.401  0.662
  9   1.304  0.654  1.425 -1.752 -0.182  0.233  0.599  0.735  0.382  0.842
  10  1.746  1.035  0.845  1.046  0.264 -1.495     NA  1.331 -0.074  0.471
  11  2.017  1.073  1.040  1.411  0.707  0.967 -1.751  0.290  0.843  0.796
    year
age    2016   2017   2018   2019   2020   2021
  2   0.330 -0.241 -0.368  0.669  0.237  0.066
  3   0.279 -0.536 -0.243  0.029  0.011  0.269
  4  -0.144  0.013  0.182 -0.018 -0.307  0.187
  5   0.033 -0.098  0.424  0.220 -0.187  0.365
  6  -0.133 -0.162  0.144  0.138 -0.191  0.154
  7   0.241 -0.166  0.618 -0.373  0.119  0.320
  8   0.470 -0.469  0.391 -0.456 -0.049  1.330
  9  -0.384 -0.968  0.744 -0.308  0.288 -0.336
  10  0.048 -0.402  0.556 -0.079  0.277  0.788
  11  0.911 -1.560 -0.027  0.607  1.497  0.609


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

                2       3       4       5       6       7       8       9
Mean_Logq -6.0822 -4.8267 -4.6852 -4.5647 -4.5179 -4.5179 -4.5179 -4.5179
S.E_Logq   0.5641  0.3208  0.3694  0.5311  0.4245  0.5660  0.6729  0.8297
               10      11
Mean_Logq -4.5179 -4.5179
S.E_Logq   0.7890  0.9970


 Fleet:  FSP-UK

 Log catchability residuals.

    year
age   2004   2005  2006  2007   2008   2009   2010   2011   2012   2013   2014
  2  0.908  0.140 0.423 0.313  0.867  0.035  0.030 -0.271 -0.579 -0.416  0.305
  3  0.529  0.140 0.293 0.478  0.185  0.071 -0.306  0.075  0.306  0.297  0.268
  4  0.618  0.100 0.278 0.196  0.293  0.438  0.073 -0.831  0.191  0.672  0.631
  5  0.575  0.077 0.559 0.097  0.922  0.217  0.271  0.063  0.180  0.551  0.789
  6  0.063  0.497 0.423 0.251 -0.007 -0.084  0.291 -0.179  0.105  0.532  0.392
  7  0.062  0.643 0.640 0.431 -0.130  0.260 -0.247 -0.353 -0.711  0.244  0.520
  8  1.037 -0.031 0.992 0.164 -0.438 -0.041 -0.079 -1.969 -0.103  0.137  0.313
  9  0.611  0.451 0.061 1.138  0.683 -0.019  0.340 -0.213  0.206  0.088  0.076
  10 0.430  0.154 0.855 0.115  0.439 -0.145  0.411 -0.606 -1.249 -0.873  0.573
  11 0.653  0.860 0.840 1.249 -1.643  1.145  0.444  0.301 -0.266  0.000 -1.675
    year
age    2015   2016   2017   2018   2019   2020   2021   2022
  2   0.107 -0.189  0.145 -0.260  0.516  0.523 -0.364 -0.200
  3   0.050  0.396  0.207 -0.210  0.321 -0.173 -0.480 -0.408
  4   0.562 -0.154  0.280  0.296 -0.382 -0.224 -0.199 -0.635
  5   0.217  0.049 -0.229  0.383 -0.266  0.007  0.051 -1.024
  6   0.217  0.125 -0.158  0.030 -0.246  0.023 -0.183 -0.270
  7   0.015  0.130 -0.068 -0.006 -0.242 -0.172 -0.188 -0.154
  8   0.379  0.277 -0.164  0.529 -0.006  0.000 -0.412 -0.718
  9   0.406 -0.278  0.049 -0.140  0.028 -0.037 -0.043 -0.519
  10 -0.010  0.491 -0.338  0.406  0.285  0.784 -0.462 -0.003
  11  0.319 -0.215 -0.511  0.716  0.359  0.218  0.306 -0.009


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

                 2       3       4       5       6       7       8       9
Mean_Logq -10.5706 -9.2124 -9.1357 -9.1927 -9.1886 -9.1886 -9.1886 -9.1886
S.E_Logq    0.4203  0.2948  0.4254  0.4297  0.2522  0.3546  0.6456  0.3842
               10      11
Mean_Logq -9.1886 -9.1886
S.E_Logq   0.5627  0.7921


 Terminal year survivor and F summaries:

 ,Age 2 Year class =2020

source
       scaledWts survivors yrcls
FSP-UK     0.851      2913  2020
fshk       0.149     11131  2020
```

```
 ,Age 3 Year class =2019

source
            scaledWts survivors yrcls
UK-CBT-late     0.454      3133  2019
FSP-UK          0.454      1164  2019
fshk            0.093      3369  2019

 ,Age 4 Year class =2018

source
            scaledWts survivors yrcls
UK-CBT-late     0.526      3789  2018
FSP-UK          0.371      2056  2018
fshk            0.103      3574  2018

 ,Age 5 Year class =2017

source
            scaledWts survivors yrcls
UK-CBT-late     0.545      1635  2017
FSP-UK          0.339       672  2017
fshk            0.116      1711  2017

 ,Age 6 Year class =2016

source
            scaledWts survivors yrcls
UK-CBT-late     0.448      2022  2016
FSP-UK          0.448      1405  2016
fshk            0.103      1872  2016

 ,Age 7 Year class =2015

source
            scaledWts survivors yrcls
UK-CBT-late     0.446       706  2015
FSP-UK          0.446       488  2015
fshk            0.108       775  2015

 ,Age 8 Year class =2014

source
            scaledWts survivors yrcls
UK-CBT-late     0.556       459  2014
FSP-UK          0.316       229  2014
fshk            0.127       525  2014

 ,Age 9 Year class =2013

source
            scaledWts survivors yrcls
UK-CBT-late     0.451       260  2013
FSP-UK          0.451       176  2013
fshk            0.097       249  2013

 ,Age 10 Year class =2012

source
            scaledWts survivors yrcls
UK-CBT-late     0.593       134  2012
FSP-UK          0.272       125  2012
fshk            0.135       142  2012

 ,Age 11 Year class =2011

source
            scaledWts survivors yrcls
UK-CBT-late     0.620       104  2011
FSP-UK          0.232       107  2011
fshk            0.147       122  2011
```

Table 33.8. 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	1959	1329	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	22153
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	19553
1984	5968	3412	3005	3087	1058	806	629	635	192	110	982	19884
1985	6981	5083	2456	1934	2073	648	535	446	430	123	532	21241
1986	3765	6044	2982	1504	1303	1319	417	392	306	309	529	18869
1987	5847	3173	3930	1774	960	874	874	297	283	191	754	18958
1988	3877	4827	2102	2519	1199	675	578	573	224	208	713	17496
1989	3735	3087	3000	1335	1587	729	465	369	415	166	743	15631
1990	2817	3009	1965	1542	736	952	445	316	232	268	739	13021
1991	7159	2224	1864	1225	869	434	609	267	189	139	656	15636
1992	3901	6050	1618	1228	833	577	304	446	177	136	528	15798
1993	3349	3229	4110	1068	828	645	416	217	334	136	344	14676
1994	2377	2832	2253	2666	633	541	440	302	140	249	487	12917
1995	3450	2058	1937	1507	1881	466	389	351	218	84	646	12988
1996	3937	3031	1569	1154	958	1311	297	256	259	166	649	13589
1997	3328	3215	2320	1073	762	643	942	204	174	188	412	13261

year\age	2	3	4	5	6	7	8	9	10	11	12+	total
1998	4393	2805	2119	1411	662	518	397	688	143	138	647	13921
1999	3588	3723	1962	1407	956	400	325	284	501	97	477	13720
2000	6482	2981	2499	1300	895	623	253	196	205	352	365	16150
2001	5394	5573	2127	1546	827	591	461	179	113	137	514	17465
2002	3823	4743	3711	1420	927	494	366	322	109	62	285	16261
2003	5367	3143	3101	2556	917	532	324	231	202	68	301	16743
2004	2859	4287	2050	1900	1699	705	411	246	154	123	296	14729
2005	3962	2208	2852	1428	1296	1037	482	261	165	88	347	14127
2006	4590	3340	1553	1787	865	825	660	328	160	107	298	14513
2007	3899	3678	2274	956	1040	545	534	421	216	92	340	13995
2008	4083	3337	2517	1340	587	597	323	359	277	143	322	13885
2009	3656	3428	2304	1633	855	376	365	192	257	186	344	13597
2010	4928	3151	2587	1718	1161	581	277	260	138	185	429	15417
2011	3500	4395	2520	1966	1242	856	404	204	168	106	349	15710
2012	3480	3080	3501	1827	1394	902	626	290	148	119	383	15750
2013	3254	3120	2571	2668	1272	924	596	436	199	92	445	15576
2014	3221	2830	2515	1867	1848	884	632	400	302	134	478	15110
2015	4257	2726	2256	1832	1284	1282	640	466	287	215	585	15830
2016	5470	3683	2154	1666	1338	914	964	470	347	217	704	17928
2017	4772	4863	2933	1503	1245	973	597	693	362	266	515	18722
2018	8725	4190	3689	2120	1085	900	694	405	503	248	533	23092
2019	5370	7770	3435	2607	1511	789	616	480	274	365	665	23882
2020	7595	4750	6199	2481	1757	1005	525	398	318	182	874	26083
2021	2845	6712	3767	4473	1662	1168	667	345	281	219	811	22950
2022	4306	2465	5273	2749	2923	956	744	439	196	178	621	20849

Table 33.9. 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	0.12	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	0.13	0.185	0.075	0.083	0.147	0.051	0.181	0.108	0.108	0.131
1976	0.065	0.185	0.291	0.158	0.166	0.072	0.176	0.216	0.122	0.151	0.151	0.180
1977	0.071	0.152	0.23	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	0.287	0.316	0.293	0.156	0.229	0.237	0.191	0.167	0.196	0.196	0.244
1993	0.068	0.26	0.333	0.423	0.326	0.283	0.221	0.341	0.194	0.274	0.274	0.313
1994	0.044	0.279	0.302	0.248	0.206	0.230	0.126	0.223	0.405	0.239	0.239	0.231
1995	0.029	0.171	0.418	0.354	0.261	0.349	0.318	0.202	0.171	0.261	0.261	0.296
1996	0.103	0.168	0.280	0.316	0.298	0.231	0.275	0.289	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	0.398	0.383	0.285	0.382	0.214	0.254	0.132	0.254	0.254	0.319
1998	0.066	0.257	0.309	0.289	0.404	0.366	0.237	0.216	0.295	0.305	0.305	0.297
1999	0.086	0.299	0.312	0.353	0.329	0.358	0.403	0.224	0.255	0.315	0.315	0.325
2000	0.051	0.237	0.38	0.352	0.314	0.200	0.247	0.450	0.302	0.303	0.303	0.311
2001	0.029	0.307	0.305	0.412	0.416	0.380	0.260	0.392	0.508	0.392	0.392	0.353
2002	0.096	0.325	0.273	0.337	0.455	0.321	0.360	0.366	0.376	0.377	0.377	0.348
2003	0.125	0.328	0.390	0.308	0.162	0.159	0.176	0.306	0.399	0.241	0.241	0.261
2004	0.158	0.308	0.261	0.282	0.393	0.281	0.353	0.300	0.463	0.359	0.359	0.311
2005	0.071	0.252	0.367	0.401	0.352	0.352	0.284	0.388	0.336	0.343	0.343	0.342
2006	0.122	0.284	0.385	0.441	0.363	0.336	0.349	0.318	0.455	0.365	0.365	0.354
2007	0.056	0.279	0.429	0.388	0.455	0.424	0.296	0.320	0.315	0.363	0.363	0.37
2008	0.075	0.270	0.333	0.349	0.345	0.391	0.418	0.234	0.296	0.342	0.342	0.334
2009	0.049	0.181	0.193	0.241	0.286	0.204	0.240	0.228	0.229	0.222	0.222	0.225
2010	0.015	0.123	0.175	0.225	0.204	0.262	0.206	0.337	0.169	0.212	0.212	0.219
2011	0.028	0.127	0.222	0.244	0.220	0.213	0.232	0.224	0.242	0.327	0.327	0.212
2012	0.009	0.081	0.172	0.262	0.312	0.314	0.262	0.279	0.374	0.415	0.415	0.240
2013	0.040	0.116	0.220	0.267	0.264	0.279	0.299	0.269	0.296	0.300	0.300	0.245
2014	0.067	0.127	0.217	0.274	0.266	0.223	0.206	0.232	0.240	0.240	0.240	0.221
2015	0.045	0.136	0.203	0.214	0.240	0.185	0.209	0.195	0.178	0.160	0.160	0.197
2016	0.018	0.128	0.26	0.191	0.218	0.326	0.231	0.161	0.165	0.174	0.174	0.216
2017	0.030	0.176	0.225	0.225	0.224	0.238	0.287	0.22	0.278	0.290	0.290	0.228
2018	0.016	0.099	0.247	0.239	0.219	0.279	0.268	0.292	0.222	0.368	0.368	0.235
2019	0.023	0.126	0.225	0.295	0.308	0.307	0.337	0.313	0.311	0.284	0.284	0.273
2020	0.024	0.132	0.226	0.301	0.308	0.310	0.320	0.248	0.271	0.211	0.211	0.264
2021	0.044	0.141	0.215	0.326	0.453	0.351	0.318	0.465	0.358	0.262	0.262	0.324
2022	0.091	0.242	0.207	0.285	0.363	0.418	0.358	0.296	0.351	0.395	0.395	0.310

Table 33.10. 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	6981	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	3877	5119	4043	1444	0.36	0.333
1989	3735	4317	3442	1390	0.40	0.409
1990	2817	4222	3286	1315	0.40	0.404
1991	7159	4218	2990	852	0.28	0.273
1992	3901	4099	2936	895	0.30	0.244
1993	3349	3578	2809	904	0.32	0.313
1994	2377	3784	3052	800	0.26	0.231
1995	3450	3874	3066	856	0.28	0.296
1996	3937	4150	3052	833	0.27	0.265

Year	Recruitment Age 2 [thousands]	TSB [tonnes]	SSB [tonnes]	Landings [tonnes]	Yield/SSB	F_{bar} (Ages 3–9)
1997	3328	3828	2918	949	0.33	0.319
1998	4393	3937	2907	880	0.30	0.297
1999	3588	3943	2827	957	0.34	0.325
2000	6482	4290	2861	914	0.32	0.311
2001	5394	4490	2887	1069	0.37	0.353
2002	3823	4167	2996	1106	0.37	0.348
2003	5367	4377	3268	1078	0.33	0.261
2004	2859	3998	3079	1075	0.35	0.311
2005	3962	3933	3063	1039	0.34	0.342
2006	4590	3656	2691	1023	0.38	0.354
2007	3899	3736	2716	1015	0.37	0.370
2008	4083	3743	2644	908	0.34	0.334
2009	3656	3812	2888	701	0.24	0.225
2010	4928	4326	3335	698	0.21	0.219
2011	3500	4649	3481	801	0.23	0.212
2012	3480	4474	3644	872	0.24	0.240
2013	3254	4414	3572	883	0.25	0.245
2014	3221	4686	3806	885	0.23	0.221
2015	4257	4825	3872	774	0.20	0.197
2016	5470	5793	4360	913	0.21	0.216
2017	4772	5599	4110	998	0.24	0.228
2018	8725	7009	4671	1075	0.23	0.235
2019	5370	6273	4564	1185	0.26	0.273
2020	7595	6812	4974	1219	0.25	0.264
2021	2845	5972	4837	1392	0.29	0.324
2022	4306	5536	4720	1409	0.30	0.310

Table 33.11. Sole in Division 7.e. Input data for the short-term forecast.

Age	N2023	N2024	N2025	M	Mat	PF	PM	SWt	Sel	CWt
2	4036	4036	4036	0.1	0.1400	0	0	0.135	0.055	0.163
3	3557	3437	3470	0.1	0.4500	0	0	0.191	0.178	0.218
4	1750	2641	2632	0.1	0.8800	0	0	0.245	0.224	0.270
5	3880	1235	1938	0.1	0.9800	0	0	0.296	0.315	0.319
6	1871	2475	832	0.1	1.0000	0	0	0.343	0.388	0.366
7	1840	1100	1557	0.1	1.0000	0	0	0.388	0.373	0.410
8	570	1100	702	0.1	1.0000	0	0	0.430	0.344	0.450
9	470	352	722	0.1	1.0000	0	0	0.469	0.349	0.488
10	295	289	230	0.1	1.0000	0	0	0.505	0.338	0.523
11	125	183	190	0.1	1.0000	0	0	0.539	0.300	0.554
12	487	396	396	0.1	1.0000	0	0	0.625	0.300	0.633

Table 33.12. 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 = 2023, F_{bar} = 0.346							
2	0.061	226	37	4036	543	565	76
3	0.198	609	133	3557	681	1601	306
4	0.249	367	99	1750	428	1540	377
5	0.35	1093	349	3880	1147	3803	1124
6	0.431	626	229	1871	642	1871	642
7	0.414	596	244	1840	715	1840	715
8	0.382	173	78	570	245	570	245
9	0.388	144	70	470	221	470	221
10	0.376	88	46	295	149	295	149
11	0.333	34	19	125	67	125	67
12	0.333	132	83	487	304	487	304
Total	NA	4089	1388	18881	5142	13167	4226
Year = 2024, F_{bar} = 0.290							
2	0.051	191	31	4036	543	565	76
3	0.167	502	110	3437	658	1546	296
4	0.209	475	129	2641	646	2324	569
5	0.294	300	96	1235	365	1210	358
6	0.363	719	263	2475	849	2475	849
7	0.349	309	127	1100	427	1100	427
8	0.322	289	130	1100	473	1100	473
9	0.326	93	46	352	165	352	165
10	0.317	75	39	289	146	289	146
11	0.28	43	24	183	99	183	99
12	0.28	92	59	396	248	396	248
Total	NA	3090	1052	17243	4619	11541	3705

Age	F	Catch.No	Yield	Stock.No	Biomass	SSNo	SSB
Year = 2025, F_{bar} = 0.290							
2	0.051	191	31	4036	543	565	76
3	0.167	507	111	3470	664	1561	299
4	0.209	474	128	2632	644	2317	567
5	0.294	472	151	1938	573	1899	562
6	0.363	242	89	832	286	832	286
7	0.349	438	179	1557	605	1557	605
8	0.322	184	83	702	302	702	302
9	0.326	192	94	722	338	722	338
10	0.317	59	31	230	116	230	116
11	0.28	44	25	190	103	190	103
12	0.28	92	59	396	248	396	248
Total	NA	2896	979	16706	4421	10972	3500

Units are thousands (for numbers) and tonnes (for weights).

Table 33.13. Sole in Division 7.e. Year-class sources and contributions for the short-term forecast (in percent).

cohort	Yield 2023	Yield 2024	SSB 2023	SSB 2024	SSB 2025
2011	6.0		7.2		
2012	1.3	5.6	1.6	6.7	
2013	3.3	2.3	3.5	2.7	7.1
2014	5.1	3.7	5.2	3.9	2.9
2015	5.6	4.3	5.8	4.5	3.3
2016	17.6	12.4	16.9	12.8	9.7
2017	16.5	12.0	15.2	11.5	8.6
2018	25.2	25.0	26.6	22.9	17.3
2019	7.2	9.1	8.9	9.7	8.2
2020	9.6	12.2	7.2	15.3	16.0
2021	2.7	10.4	1.8	8.0	16.2
2022		3.0		2.1	8.5
2023					2.2

Table 33.14. Sole in Division 7.e. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2024)	Projected landings (2024)	Projected discards (2024)	$F_{projected\ landings}$ (2024)	SSB (2025)	% SSB change **	% TAC change***	% advice change^
ICES advice basis								
MSY approach: F_{MSY}	1057	1052	4	0.29	3500	-5.5	-24	-24
Other options								
EU MAP^^: F_{MSY}	1057	1052	4	0.29	3500	-5.5	-24	-24
F = MAP^^ $F_{MSY\ lower}$	620	618	2	0.160	3924	5.9	-56	-56
F = MAP^^ $F_{MSY\ upper}$	1210	1205	5	0.34	3351	-9.5	-13.2	-13.2
F = 0	0	0	0	0	4529	22	-100	-100
F_{pa}	1357	1351	5	0.39	3210	-13.4	-2.7	-2.7
F_{lim}	1496	1490	6	0.44	3075	-17	7.3	7.3
$SSB_{2025} = B_{lim}$	2623	2613	11	0.97	2000	-46	88	88
Rollover TAC	1394	1388	6	0.40	3174	-14.3	0	0
$SSB_{2024} = B_{pa}$ = MSY $B_{t\ rigger}$	1678	1672	7	0.51	2900	-22	20	20
$SSB_{2025} = SSB_{2024}$	846	842	3	0.23	3705	0	-39	-39

*** Total catch derived from the projected landings and the assumed discard rate.**

**** SSB 2025 relative to SSB 2024.**

***** Total catch in 2024 relative to TAC 2023 (1394 tonnes).**

^ Advice value for 2024 relative to the advice value for 2023 (1394 tonnes).

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

Table 33.15. 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^
F=0	0	0	0	0	4529.273	22.25725	-100	-100
$F_{MSY\ lower}$	620.126	617.6272	2.498758	0.16	3924.067	5.921122	-55.5146	-41.9358
F=0.17	655.7186	653.0764	2.642176	0.17	3889.428	4.986137	-52.9614	-52.9614
F=0.18	690.9623	688.1781	2.784188	0.18	3855.141	4.060628	-50.4331	-50.4331
F_{sq}*0.6	711.7015	708.8337	2.867755	0.185931	3834.97	3.516158	-48.9454	-48.9454
F=0.19	725.8608	722.936	2.924809	0.19	3821.201	3.144494	-47.9296	-47.9296
F=0.2	760.4176	757.3536	3.064054	0.2	3787.604	2.237633	-45.4507	-45.4507
F=0.21	794.6365	791.4345	3.201936	0.21	3754.348	1.339947	-42.9959	-42.9959
F=0.22	828.5209	825.1824	3.338472	0.22	3721.427	0.451336	-40.5652	-40.5652
SSB_{stable}	845.7357	842.3279	3.407838	0.225118	3704.707	2.22E-14	-39.3303	-39.3303
F=0.23	862.0745	858.6008	3.473674	0.23	3688.84	-0.4283	-38.1582	-38.1582
F=0.24	895.3007	891.6931	3.607557	0.24	3656.581	-1.29905	-35.7747	-35.7747
F_{sq}*0.8	921.3458	917.6333	3.712504	0.247908	3631.302	-1.98139	-33.9063	-33.9063
F=0.25	928.203	924.4629	3.740134	0.25	3624.648	-2.16101	-33.4144	-33.4144
F=0.26	960.7848	956.9134	3.871421	0.26	3593.036	-3.01428	-31.0771	-31.0771
MP	993.0495	989.0481	4.001429	0.27	3561.744	-3.85895	-28.7626	-28.7626
F=0.27	993.0495	989.0481	4.001429	0.27	3561.744	-3.85895	-28.7626	-28.7626
F=0.28	1025	1020.87	4.130174	0.28	3530.767	-4.69511	-26.4706	-26.4706
F_{MSY}	1056.641	1052.383	4.257667	0.29	3500.101	-5.52285	-24.2008	-24.2008

Basis	Total catch* (2023)	Projected landings (2023)	Projected discards (2023)	$F_{projected\ landings}$ (2023)	SSB (2024)	% SSB change **	% TAC change***	% advice change^
F=0.3	1087.974	1083.59	4.383923	0.3	3469.744	-6.34227	-21.9531	-21.9531
F=0.31	1119.004	1114.495	4.508954	0.31	3439.692	-7.15345	-19.7271	-19.7271
F=0.32	1149.733	1145.1	4.632773	0.32	3409.942	-7.95648	-17.5228	-17.5228
F=0.33	1180.164	1175.408	4.755394	0.33	3380.491	-8.75145	-15.3398	-15.3398
TAC*0.85	1184.9	1180.126	4.774478	0.331565	3375.908	-8.87515	-15	-15
MP2	1184.9	1180.126	4.774478	0.331565	3375.908	-8.87515	-15	-15
$F_{MSY\ upper}$	1210.3	1205.424	4.876827	0.34	3351.336	-9.53844	-13.1779	-41.5031
F_{sq}	1224.018	1219.085	4.9321	0.344584	3338.068	-9.89655	-12.1939	-12.1939
F_{pa}	1356.675	1351.208	5.466634	0.39	3209.881	-13.3567	-2.67755	-2.67755
TAC	1394	1388.383	5.617033	0.403147	3173.853	-14.3292	0	0
F_{lim}	1496.139	1490.111	6.028597	0.44	3075.356	-16.9879	7.327075	7.327075
TAC*1.15	1603.1	1596.64	6.459588	0.480048	2972.361	-19.768	15	15
B_{pa}	1678.35	1671.587	6.762801	0.509174	2900	-21.7212	20.3981	20.3981
$B_{trigger}$	1678.35	1671.587	6.762801	0.509174	2900	-21.7212	20.3981	20.3981
B_{lim}	2623.326	2612.755	10.57052	0.965685	2000	-46.0146	88.18694	88.18694

*** Total catch derived from the projected landings and the assumed discard rate.**

**** SSB 2025 relative to SSB 2024.**

***** Total catch in 2024 relative to TAC 2023 (1394 tonnes).**

^ Advice value for 2024 relative to the advice value for 2023 (1394 tonnes).

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34 Sole (*Solea solea*) in Division 7.f and 7.g (Bristol Channel, Celtic Sea)

Type of assessment in 2023

This assessment is an update assessment.

ICES advice applicable to 2023

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 1338 tonnes.

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Celtic Sea were reported.

34.1 General

Stock description and management units.

Red Boxes - TAC/Management Areas
Blue Shading - Assessment Area

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 2022 and 2023 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

Management applicable to 2022 and 2023

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		

The TAC and the national quotas by country for 2023.

Species:	Common sole *Solea solea*	Zone:	7f and 7g (SOL/7FG.)
Belgium	777	Analytical TAC	
France	78	Article 7(2) of this Regulation applies	
Ireland	39		
Union	894		
United Kingdom	421		
TAC	1 338		

Fishery in 2022

An overview of the landings and discard data provided and used by the Working Group (WG) is shown in Table 34.1 and Figure 34.1. 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 72 t in 2022.

In 2022, the WG estimated landings are 1300 t, of which Belgium landed 64.3% (836 t), UK (England and Wales) 27.2% (353 t), France 5.2% (68 t), Ireland 2.4% (31 t) and the remainder by Northern Ireland and Spain. Discards were estimated to be at 72 t. This catch figure (1372 t) corresponds to an international overshoot of 3% of the agreed TAC in 2022 (1337 t).

The WG estimate of the 2021 landings were slightly revised (1336 t → 1343 t).

In 2022, 87% of the landings and discards were taken by beam trawls, 13% by otter trawls and <1% by other gears.

34.2 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 2022 were available for landing numbers and weight-at-age, for most of the

Belgian, Irish and UK fleets. These comprise 87% of the international landings. Discard weights were available for 62% 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%, 71% and 6.3% 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 2022 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 2022, the proportion of landings covered for age composition is respectively 29%, 99% and 13% 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%, 71%, 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 2022 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. 34.2 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 34.2 and weights-at-age in the catch are given in Table 34.3. Age compositions are plotted in Figures 34.3ab. The standardised catch proportion-at-age is presented in Figure 34.4.

Length-compositions

Annual length compositions for 2022 are given by fleet in Table 34.4 Length distributions of the total Belgian and UK(E&W) landings for the last 23 years are plotted in Figure 34.5. Belgian vessels generally land a greater proportion of small fish compared to the UK(England and Wales).

The length distributions for 2022 of retained and discarded catches of sole by the Belgium beam trawl fleet are presented in Figure 34.6 from The Belgian beam trawl fleet mainly discarded fish of 22 and 23 cm. According to the Belgian age–length samples, these fish were mainly age 2.

Biological

The stock weights (Table 34.5) 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 2023 Celtic Sea sole stock assessment used one scientific survey index: UK(E&W)-BTS-Q3 (1988–2022), 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 34.6 and Figure 34.7. 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 34.8).

After the peak in 2000 (228.46 kg/100 Km fished, Figure 34.9 and Table 34.8), 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. In 2022, the LPUE slightly increased to 124.67 kg/100 Km fished.

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 34.7–34.8 and Figure 34.10.

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. It remains at that level in 2022, after a slight decrease 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 lower value of 22.7 kg/hour was recorded in 2021 and 18.72 kg/hour in 2022.

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 2020–2022.

The LPUE of the UK otter trawlers is relatively stable at a lower level, but increased in recent years in area 7f.

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 34.9, 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–recent 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–recent, 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 34.11a shows the evolution through time of the commercial biomass tuning series. The Belgian BE_CBT_2006–2021 and the UK(E&W)-CBT_2006–2022 tuning series show a relatively similar increasing trend during the last years. However, it should be noted that the 2022 index of the BE_CBT is excluded from the plot as this index could not be calculated due to issues with the input data. Changes in the database system used for the on-board registration of electronic logbook data by fishers, resulted in an unrealistic allocation of fishing hours and/or landings to the ICES statistical rectangles. As this level of detail is important to account for the spatial variation and as it is still unclear what changes have been implemented in the data processing, it was decided to exclude the 2022 input data from the model. In addition, there was a minor update of the 2021 input data, resulting in a minor change compared to last year's BE_CBT_2006–2021 tuning series (Figure 34.11b).

Other relevant data

Reports from UK industry suggest that the main issues affecting the fishery in 7.f and 7.g were displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W (Trebilcock and Rozarieux, 2009).

No additional information was received from the Belgian, French and Irish industries.

34.3 Stock assessment

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)[1] 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.

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

[1] 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).

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 34.10.

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
σ^2 F parameters-at-age	1 = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
σ^2 N parameters-at-age	2 = 0, 1, 1, 1, 1, 1, 1, 1, 1, 1
σ^2 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
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)	-

***2022 data were excluded.**

This year's assessment

The SAM model fitting diagnostics and survey catchabilities are shown in Table 34.11, the fishing mortalities in Table 34.12, the stock numbers in Table 34.13 and the assessment summary in Table 34.14 and Figure 34.12.

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 2019–2021 estimates around the same high level. The 2022 estimate is slightly lower than the estimates of the previous three years. Fishing mortality has been below F_{MSY} since 2017. 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 34.13. There may be some indications of a trend in the UK beam trawl fleet (UK(E&W)-CBT_2006–2022) 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 34.14. 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 (2022) 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	-0.0674	0.0825	0.1079

Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figures 34.15ab. Trends in fishing mortality, SSB and recruitment are very similar. The 2019, 2020 and 2021 recruitment were revised downwards by 3.6%, 15.8% and 9.4% respectively in this year's assessment. In last year's assessment, F and SSB for 2021 were estimated to be 0.250 and 5894 t respectively; this year's estimates for 2021 are 0.246 and 6004 t, a downward revision of 1.6% for F and an upward revision of 1.9% for SSB.

State of the stock

Trends in catch, SSB, F_{bar}(3–8) and recruitment are presented in Table 34.14 and Figure 34.12.

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} since 2017.

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 (13 566 thousand fish). Recruitment has been above average (5856 thousand fish) since 2015, and the recruitment of 2017 is estimated to be the highest of the time-series (14 251 thousand fish).

SSB has declined almost continuously from the highest value of 6676 t in 1971 to the lowest observed in the time-series in 1997 (2192 t). The exceptional year class of 1998 has increased SSB to above the long-term average (3916 t) in 2002. 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 t) is at its highest level since 1973. The SSB in 2022 is again slightly lower (5710 t).

34.4 Short-term projections

Last year's forecast assumptions

A comparison of the estimates of this year's assessment and forecast with last year's is given in Figure 34.15b.

Higher recruitment was observed from 2015 onwards. However, the 2021 year class (2022 recruitment) is now estimated at 7894 thousand fish at age 1 (Table 34.14), which is 54% higher than the median resampled recruitment from the years 1971–2019 (5111 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 2022 UK(E&W)-BTS-Q3 abundance index for age 1 (11.0) is the second highest of the time series and close to the 2017 index value but the 2022 recruitment estimate is much lower than the record high 2017 recruitment estimate.

In last year's assessment the 2022 SSB was estimated to be 6234 t, this year the 2022 SSB is revised downwards by 8.4% (5710 t). An F of 0.246 was assumed for the intermediate year in last year's forecast, this value (F in 2022) is now estimated to be around the same level (0.244).

This year's forecast assumptions

The F in 2022 (0.244) is slightly lower than the mean F over the last three years ($F_{average\ 2020–2022}$ = 0.246) and using this F to project the stock into 2023, would result in slightly lower catches (1245 t) than the 2023 TAC (1338 t). Similar amount of catches (1258 t) is resulting from assuming that the F in 2023 will be equal to the mean F over the last three years. As recent catches have been close to the TAC (2021) or slightly above the TAC (2022) (Figure 34.16), the working group decided to use a TAC constraint for the intermediate year (2023). Assuming a TAC constraint for 2023 of 1338 t, implies a fishing mortality in 2023 of 0.264. This results in an SSB of 5850 t in 2024.

As input for the forecast fishing mortality was calculated as the mean of 2020–2022, scaled to 2022 (0.244). Catch and stock weights-at-age were also averages for the years 2020–2022. Population numbers at the start of 2023 for ages 3 and older, were taken from the SAM output. The long-term median resampled recruitment (1971–2020) as estimated by a stochastic projection (SAM, 5156 thousand fish) was assumed for recruitment in 2023 and (SAM, 5140 thousand fish) for recruitment in 2024.

There are no known specific environmental drivers known for this stock.

MSY forecast

Table 34.15 and Figure 34.17 show the output of the forecast targeting F = F_{MSY} for 2024–2025 and the slight decrease in advice compared to last year's advice is due to a reduction in biomass at

the beginning of 2024. The latter is a combination of a reduction in stock weights and stock numbers (Figure 34.18).

Figure 34.19 shows the year classes contributing to the forecast yield and SSB. The assumed long-term median resampled recruitment (1971–2020) accounts for about 3.5% of the landings in 2024 and 17.04% of the 2025 SSB.

Implementing the MSY approach with $F = F_{MSY} = 0.251$ leads to a total yield of 1267 t in 2024, and an SSB of 5659 t in 2025.

Additional options

A management options table is provided in Table 34.15.

34.5 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; $B_{lim} \times 1.4$
	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).**

34.6 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.

34.7 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.

34.8 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

34.9 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 34.20). 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).

34.10 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.

34.11 References

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Table 34.1. 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
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

Year	Belgium	Denmark	France	Ireland	UK(E.&W, NI)	UK(Scotland)	Spain	Other	Total-Official	Unallocated	Used by WG	TAC	Discards**
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 ^	858	-	61	48	395	-	2	-	1364	-21	1343	1337	62
2022 ^	840	-	67	31	354	-	7	-	1299	1	1300	1338	72

^Landings are preliminary.

*** including 7.g–k.**

**** Discards estimated by ICES.**

Table 34.2. 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	129	692	1084	1955	948	363	127	63	171	5532
2022	11	616	562	818	757	1586	599	180	65	201	5395

Table 34.3. 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	0.126	0.17	0.212	0.252	0.26	0.35	0.412	0.494	0.537
2022	0.103	0.116	0.175	0.224	0.258	0.281	0.297	0.416	0.456	0.469

Table 34.4. - Sol.27.7fg - Annual landings length distributions by fleet.

	UK (England & Wales)	Belgium	Ireland
Length (cm)		Beam trawl	
17			
18			
19			
20		188	
21	8	202	
22	57	951	
23	1318	6437	81
24	5600	67285	27
25	22981	315889	67
26	48329	410790	450
27	56352	432984	1104
28	63577	433706	1590
29	66182	298414	2033
30	70996	273029	2085
31	69498	200227	2872
32	82553	163916	3461
33	75295	123311	3599
34	73919	100472	2665
35	56814	88468	2206
36	51085	63523	2051
37	39289	43728	1275
38	32303	33015	958
39	25387	20442	655
40	16051	13434	484
41	11666	11493	173
42	7412	7173	94
43	3963	3733	101
44	3334	3085	34
45	1560	1614	13
46	1460	877	
47	906	599	
48	569	0	
49	76	210	
50	20	388	
51	26		
52	23		
53			
54			
55			
Total	888609	3119583	28078

Table 34.5. 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	0.364	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	0.164	0.232	0.292	0.346	0.397	0.444	0.487	0.599
1975	0.041	0.089	0.165	0.24	0.31	0.37	0.426	0.477	0.522	0.649
1976	0.041	0.083	0.165	0.236	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	0.117	0.185	0.266	0.334	0.395	0.451	0.503	0.549	0.694
1979	0.041	0.093	0.178	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	0.428	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	0.266	0.34	0.404	0.464	0.517	0.565	0.682
1983	0.041	0.096	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	0.736
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	0.518	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	0.506	0.602
1996	0.041	0.091	0.169	0.252	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	0.178	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	0.39	0.419	0.522	0.571	0.668
2006	0.041	0.125	0.17	0.234	0.297	0.372	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	0.324	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	0.65
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	0.17	0.222	0.288	0.357	0.415	0.463	0.479	0.596
2016	0.041	0.149	0.164	0.22	0.266	0.326	0.391	0.434	0.486	0.6
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	0.248	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	0.453	0.544
2022	0.041	0.118	0.149	0.195	0.234	0.266	0.278	0.381	0.434	0.488

Table 34.6. 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
2022	121	1100	168	48	28	25	23	5	8	0
Mean	26.98	522.73	338.88	76.51	25.05	12.65	7.41	4.08	2.86	2.38

Table 34.7. 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

	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]
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	547	28	102	-	35.45	83.91	14.80	31.57
2022	90	1275	4	207	36	77	-	42.27	64.45	14.30	22.50

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 34.8. 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	88.53	156.87	6.41	78.38	9.80	136.10	-	22.70	0.34	0.02	0.54
2022*	124.67	108.90	113.46	28.44	131.02	0.00	103.38	-	18.72	0.33	0.02	0.53

[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 34.9. 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-CBT3-2006-2022	Belgium Beam trawl (Biomass tuning index)		
2006	2022		
1	1	0	0
1	-1		
1	2.384		
1	2.165		
1	2.088		
1	1.901		
1	2.313		
1	2.693		
1	2.676		
1	2.314		
1	2.902		
1	2.733		
1	2.614		
1	2.842		
1	3.417		
1	4.126		
1	4.242		
1	5.067		
1	NA*		

*** the 2022 data are excluded from the BE-CBT_06-22 tuning series.**

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_2022		UK(E+W) Beam trawl (Biomass tuning index)	
2006	2022		
1	1	0	0
1	-1		
1	132.78		
1	221.04		
1	243.98		
1	211.11		
1	235.68		
1	284.79		
1	252.24		
1	215.16		
1	300.22		
1	238.72		
1	204.26		
1	207.64		
1	255.74		
1	235.96		
1	295.15		
1	347.47		
1	351.87		

UK(E&W)-BTS-Q3										
UK(E+W) 7.f Corystes (automated indices since 1995). Ages used in the assessment are in bold										
1988	2022									
1	1	0.75	0.85							
0	9									
74.120	22	**60**	**242**	**36**	**14**	**4**	0	0	0	0
91.909	132	**204**	**304**	**162**	**18**	**14**	6	4	2	2
69.858	21	**269**	**219**	**35**	**11**	**3**	5	2	0	0
123.410	40	**297**	**638**	**83**	**21**	**18**	5	0	3	2
125.078	5	**493**	**325**	**174**	**37**	**23**	12	1	2	1
127.672	6	**207**	**436**	**52**	**28**	**3**	2	2	1	1
120.816	1	**424**	**430**	**133**	**23**	**11**	9	0	0	3
114.886	31	**142**	**255**	**60**	**13**	**7**	14	1	1	1
118.592	3	**178**	**251**	**64**	**27**	**7**	3	4	1	3
114.886	37	**498**	**207**	**21**	**13**	**14**	5	3	6	0
114.886	104	**885**	**472**	**58**	**11**	**9**	5	2	1	5
118.592	29	**2922**	**297**	**38**	**16**	**7**	4	5	1	0
118.592	16	**1086**	**1608**	**37**	**26**	**6**	0	2	1	1
118.592	26	**449**	**711**	**307**	**23**	**9**	6	2	0	2
118.592	9	**786**	**283**	**151**	**121**	**14**	7	2	3	0
118.592	14	**465**	**628**	**55**	**30**	**56**	9	3	3	0
114.886	64	**860**	**434**	**99**	**15**	**22**	42	4	3	0
118.592	44	**407**	**267**	**38**	**16**	**7**	5	17	1	2
118.592	13	**324**	**238**	**47**	**16**	**8**	0	2	12	0
118.592	108	**424**	**128**	**51**	**16**	**8**	7	3	4	13
118.592	6	**1232**	**124**	**15**	**18**	**7**	9	4	3	5
118.592	1	**604**	**377**	**29**	**8**	**10**	4	3	3	2
118.592	21	**101**	**558**	**144**	**20**	**2**	5	9	4	2
118.592	21	**595**	**62**	**164**	**82**	**8**	2	7	3	0
118.592	16	**643**	**274**	**9**	**63**	**28**	1	1	1	3
118.592	11	**331**	**614**	**51**	**16**	**29**	18	1	6	1
118.592	40	**289**	**305**	**90**	**16**	**6**	27	9	1	1
118.592	33	**885**	**57**	**52**	**37**	**8**	4	16	7	0
118.592	31	**680**	**426**	**14**	**32**	**15**	8	4	6	9
118.592	7	**1240**	**206**	**80**	**15**	**19**	20	5	4	13
118.592	32	**515**	**1074**	**331**	**53**	**20**	11	18	13	5
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
118.592	143	**1305**	**199**	**57**	**33**	**30**	27	6	10	0

Table 34.10. Sol.27.7fg – Configuration.

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[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
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$corFlag
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[4        ]  5  -1  -1  -1  -1  -1  -1  -1  -1  -1
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Levels: ID AR US

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$fbarRange
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Levels: LN ALN

$fixVarToWeight
[1] 0

$fracMixF
[1] 0

$fracMixN
 [1] 0 0 0 0 0 0 0 0 0 0

$fracMixObs
[1] 0 0 0 0 0 0 0

$constRecBreaks
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$predVarObsLink
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[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

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[1          ]  NA   NA   NA   NA   NA   NA   NA   NA   NA   NA

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$keyMatureMean
 [1] NA NA NA NA NA NA NA NA NA NA

$mortalityModel
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$keyMortalityMean
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$keyMortalityObsVar
 [1] NA NA NA NA NA NA NA NA NA NA

$keyXtraSd
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$logNMeanAssumption
[1] 0 0

$initState
[1] 0
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Table 34.11. Sol.27.7fg – Diagnostics.

Name	Type	Years	Ages	LogQ _age1	Sd _age1	LogQ _age2	Sd _age2	LogQ _age3	Sd _age3	LogQ _age4	Sd _age4	LogQ _age5	Sd _age5
UK-BTS-Q3	age-based	1988-2022	1-5	-7.17	0.101	-7.416	0.099	-8.618	0.098	-9.243	0.065	-9.243	0.065
BE-CBT_71-83	biomass	1971-1983	-1	-5.112	0.065	NA	NA	NA	NA	NA	NA	NA	NA
BE-CBT_84-96	biomass	1984-1996	-1	-5.245	0.055	NA	NA	NA	NA	NA	NA	NA	NA
BE-CBT_06-22	biomass	2006-2022	-1	-7.243	0.052	NA	NA	NA	NA	NA	NA	NA	NA
UK-CBT_84-05	biomass	1984-2005	-1	-3.826	0.076	NA	NA	NA	NA	NA	NA	NA	NA
UK-CBT_06-22	biomass	2006-2022	-1	-2.801	0.072	NA	NA	NA	NA	NA	NA	NA	NA

log(L)	#par	AIC
-255.635	24	559.2709

Table 34.12. Sol.27.7fg - Fishing mortality.

year/age	1	2	3	4	5	6	7	8	9	10+	Fbar(3-8)
1971	0.003	0.090	0.281	0.329	0.329	0.329	0.291	0.291	0.269	0.269	0.308
1972	0.003	0.084	0.261	0.303	0.303	0.303	0.267	0.267	0.247	0.247	0.284
1973	0.003	0.079	0.246	0.283	0.283	0.283	0.248	0.248	0.230	0.230	0.265
1974	0.003	0.075	0.234	0.268	0.268	0.268	0.236	0.236	0.219	0.219	0.252
1975	0.003	0.074	0.229	0.262	0.262	0.262	0.230	0.230	0.213	0.213	0.246
1976	0.003	0.085	0.264	0.301	0.301	0.301	0.265	0.265	0.243	0.243	0.283
1977	0.003	0.077	0.240	0.273	0.273	0.273	0.240	0.240	0.219	0.219	0.257
1978	0.003	0.071	0.219	0.249	0.249	0.249	0.217	0.217	0.198	0.198	0.233
1979	0.003	0.075	0.233	0.265	0.265	0.265	0.230	0.230	0.209	0.209	0.248
1980	0.003	0.085	0.265	0.302	0.302	0.302	0.260	0.260	0.235	0.235	0.282
1981	0.003	0.095	0.298	0.341	0.341	0.341	0.295	0.295	0.265	0.265	0.318
1982	0.004	0.100	0.313	0.360	0.360	0.360	0.312	0.312	0.279	0.279	0.336
1983	0.004	0.105	0.329	0.380	0.380	0.380	0.331	0.331	0.293	0.293	0.355
1984	0.004	0.105	0.331	0.386	0.386	0.386	0.334	0.334	0.295	0.295	0.360
1985	0.004	0.112	0.353	0.417	0.417	0.417	0.358	0.358	0.316	0.316	0.387
1986	0.004	0.121	0.383	0.459	0.459	0.459	0.394	0.394	0.348	0.348	0.425
1987	0.004	0.118	0.374	0.454	0.454	0.454	0.389	0.389	0.344	0.344	0.419
1988	0.004	0.115	0.363	0.446	0.446	0.446	0.381	0.381	0.337	0.337	0.411
1989	0.004	0.109	0.344	0.424	0.424	0.424	0.359	0.359	0.317	0.317	0.389
1990	0.004	0.114	0.360	0.445	0.445	0.445	0.375	0.375	0.332	0.332	0.408
1991	0.004	0.110	0.347	0.430	0.430	0.430	0.361	0.361	0.322	0.322	0.393
1992	0.004	0.108	0.340	0.421	0.421	0.421	0.352	0.352	0.316	0.316	0.384
1993	0.004	0.116	0.364	0.453	0.453	0.453	0.379	0.379	0.342	0.342	0.413
1994	0.004	0.125	0.394	0.493	0.493	0.493	0.411	0.411	0.372	0.372	0.449
1995	0.005	0.137	0.433	0.543	0.543	0.543	0.453	0.453	0.409	0.409	0.495
1996	0.005	0.139	0.438	0.549	0.549	0.549	0.457	0.457	0.414	0.414	0.500
1997	0.005	0.141	0.446	0.559	0.559	0.559	0.467	0.467	0.423	0.423	0.509
1998	0.005	0.133	0.419	0.525	0.525	0.525	0.439	0.439	0.399	0.399	0.479
1999	0.004	0.119	0.372	0.464	0.464	0.464	0.387	0.387	0.352	0.352	0.423
2000	0.004	0.104	0.323	0.404	0.404	0.404	0.338	0.338	0.310	0.310	0.368
2001	0.004	0.101	0.314	0.396	0.396	0.396	0.332	0.332	0.308	0.308	0.361
2002	0.004	0.102	0.318	0.405	0.405	0.405	0.341	0.341	0.317	0.317	0.369
2003	0.004	0.110	0.343	0.442	0.442	0.442	0.374	0.374	0.350	0.350	0.403
2004	0.004	0.113	0.353	0.458	0.458	0.458	0.389	0.389	0.367	0.367	0.417
2005	0.004	0.109	0.339	0.443	0.443	0.443	0.379	0.379	0.362	0.362	0.405
2006	0.004	0.104	0.321	0.424	0.424	0.424	0.366	0.366	0.353	0.353	0.388
2007	0.004	0.098	0.300	0.400	0.400	0.400	0.351	0.351	0.340	0.340	0.367
2008	0.003	0.090	0.273	0.369	0.369	0.369	0.328	0.328	0.320	0.320	0.340
2009	0.003	0.085	0.257	0.352	0.352	0.352	0.317	0.317	0.309	0.309	0.324
2010	0.003	0.081	0.244	0.338	0.338	0.338	0.307	0.307	0.300	0.300	0.312
2011	0.003	0.081	0.244	0.343	0.343	0.343	0.314	0.314	0.308	0.308	0.317
2012	0.003	0.086	0.257	0.365	0.365	0.365	0.336	0.336	0.332	0.332	0.338
2013	0.003	0.085	0.256	0.367	0.367	0.367	0.340	0.340	0.337	0.337	0.339
2014	0.003	0.084	0.252	0.364	0.364	0.364	0.338	0.338	0.338	0.338	0.337
2015	0.003	0.077	0.229	0.330	0.330	0.330	0.306	0.306	0.306	0.306	0.305
2016	0.003	0.070	0.207	0.298	0.298	0.298	0.275	0.275	0.274	0.274	0.275
2017	0.002	0.063	0.187	0.270	0.270	0.270	0.249	0.249	0.248	0.248	0.249
2018	0.002	0.059	0.174	0.253	0.253	0.253	0.233	0.233	0.233	0.233	0.233
2019	0.002	0.060	0.177	0.257	0.257	0.257	0.238	0.238	0.236	0.236	0.237
2020	0.002	0.062	0.184	0.270	0.270	0.270	0.251	0.251	0.247	0.247	0.249
2021	0.002	0.062	0.182	0.268	0.268	0.268	0.247	0.247	0.242	0.242	0.246
2022	0.002	0.061	0.180	0.264	0.264	0.264	0.244	0.244	0.239	0.239	0.244

Table 34.13. 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	8647	5307	1793	4720	2048	1508	1818	2670	1476	4871	34859
1972	4529	8277	4358	1387	2807	1268	997	1155	1729	4021	30527
1973	3412	3952	7340	2932	1094	1738	782	711	766	3822	26547
1974	3521	2991	3193	5005	2010	805	1139	541	534	3070	22809
1975	3562	3184	2428	2299	3417	1406	555	765	405	2396	20416
1976	5271	3104	2686	1819	1746	2359	975	369	604	1965	20899
1977	4879	4965	2492	1661	1314	1126	1751	669	216	1796	20869
1978	5197	4346	4353	1719	1027	997	767	1273	476	1302	21457
1979	3786	4857	3656	3342	1150	717	784	606	957	1277	21133
1980	4918	3240	4159	2683	2185	808	496	554	466	1678	21187
1981	5095	4529	2552	2908	1677	1362	524	417	385	1546	20994
1982	5090	4610	3829	1537	1929	1088	827	331	330	1366	20937
1983	6480	4488	3768	2475	967	1233	697	517	209	1247	22082
1984	5767	6037	3633	2374	1599	604	838	452	289	1103	22696
1985	5571	5160	5087	2309	1541	951	396	535	299	984	22832
1986	4003	5159	4133	3179	1376	908	555	274	335	903	20825
1987	5661	3389	4245	2421	1804	777	503	323	188	778	20088
1988	4621	5364	2554	2836	1278	1049	451	265	203	675	19297
1989	4913	4358	4533	1664	1737	699	593	295	145	562	19499
1990	7368	4387	3675	3002	969	1074	403	355	189	501	21925
1991	5003	7250	3437	2381	1732	547	618	240	205	494	21906
1992	5063	4431	6156	2120	1389	958	320	376	150	439	21402
1993	4738	4575	3493	3759	1167	764	533	209	261	378	19879
1994	4340	4436	3642	2138	2135	675	461	292	136	427	18681
1995	3819	3898	3600	2275	1116	1159	361	278	182	348	17037
1996	4407	3488	3046	2150	1132	593	586	203	155	329	16089
1997	6405	4029	2778	1698	1093	588	314	322	120	295	17641
1998	8032	5857	3225	1605	866	538	296	174	175	249	21019
1999	13566	6932	4598	1971	772	460	296	152	106	241	29095
2000	9171	12684	5384	2641	1111	383	270	179	92	234	32151
2001	5775	8180	10377	3258	1513	689	246	177	110	242	30566
2002	7146	4912	6572	7233	1901	921	402	169	125	234	29615
2003	5482	6641	3809	4263	4539	1029	591	266	106	267	26994
2004	4829	4876	5442	2450	2652	2386	540	359	171	266	23971
2005	4300	4379	3802	3216	1450	1497	1290	318	218	291	20761
2006	3553	3921	3566	2327	1912	817	871	762	204	330	18263
2007	3923	3178	3231	2264	1357	1173	489	546	513	338	17011
2008	7329	3339	2562	2093	1372	820	732	302	369	559	19476
2009	6747	6979	2650	1800	1332	844	542	469	192	637	22193
2010	3162	6356	6583	2033	1192	875	552	363	322	554	21993
2011	5371	2556	5610	5220	1386	877	583	391	235	648	22876
2012	6361	4900	1994	4002	3490	973	598	384	261	640	23604
2013	5156	5786	4044	1533	2451	2011	651	386	244	602	22864
2014	4025	4780	4803	2862	1030	1471	1209	416	259	576	21430
2015	7818	3298	4038	3550	1765	660	921	678	278	486	23493
2016	8443	7334	2659	2774	2313	1145	455	574	449	441	26588
2017	14251	7069	6449	2046	1831	1480	770	326	367	578	35167
2018	6881	14210	5892	5044	1491	1250	944	554	248	630	37145
2019	6780	6180	13264	4483	3595	1181	822	628	445	615	37993
2020	5140	5859	5437	10787	3883	2428	883	566	448	798	36231
2021	7311	4400	4891	4521	8086	3284	1594	604	379	932	36001
2022	7894	6587	3609	3667	3154	5861	2445	1048	399	973	35638

Table 34.14. Sol.27.7fg - Summary ('Catch' refers to model estimate).

year	R (age1) low	R (age1) value	R (age1) high	TSB low	TSB value	TSB high	SSB low	SSB value	SSB high	Catch low	Catch value	Catch high	Fbar (3-8) low	Fbar (3-8) value	Fbar (3-8) high
1971	5764	8647	12972	6199	7231	8435	5668	6676	7863	1381	1700	2093	0.247	0.308	0.386
1972	3146	4529	6522	5344	6221	7243	4917	5765	6760	1186	1400	1652	0.233	0.284	0.346
1973	2368	3412	4917	5440	6315	7331	5048	5890	6873	1195	1407	1657	0.218	0.265	0.322
1974	2445	3521	5071	4985	5794	6735	4682	5470	6391	1050	1240	1465	0.206	0.252	0.307
1975	2466	3562	5144	4586	5328	6190	4301	5026	5873	957	1131	1337	0.201	0.246	0.301
1976	3681	5271	7550	4237	4913	5696	3898	4551	5313	914	1091	1303	0.231	0.283	0.346
1977	3415	4879	6971	4180	4819	5557	3748	4348	5044	829	973	1142	0.211	0.257	0.311
1978	3615	5197	7470	4230	4874	5617	3799	4405	5107	770	922	1103	0.188	0.233	0.289
1979	2611	3786	5491	4319	4967	5712	3961	4579	5295	869	1030	1222	0.203	0.248	0.303
1980	3445	4918	7021	4296	4932	5661	3969	4582	5290	1007	1186	1397	0.235	0.282	0.338
1981	3570	5095	7273	4029	4598	5247	3658	4202	4826	961	1136	1342	0.267	0.318	0.38
1982	3562	5090	7275	4030	4569	5181	3612	4119	4698	1044	1229	1447	0.283	0.336	0.4
1983	4520	6480	9291	4023	4547	5140	3566	4054	4608	1066	1257	1483	0.3	0.355	0.421
1984	4021	5767	8271	4204	4739	5343	3726	4214	4767	1094	1287	1514	0.304	0.36	0.425
1985	3886	5571	7987	3849	4341	4894	3462	3921	4440	1149	1358	1606	0.329	0.387	0.455
1986	2787	4003	5749	3996	4514	5098	3594	4068	4606	1224	1457	1736	0.358	0.425	0.503
1987	3992	5661	8027	3543	3995	4503	3166	3585	4060	1113	1317	1558	0.355	0.419	0.495
1988	3292	4621	6487	3282	3692	4154	2914	3293	3720	979	1158	1371	0.349	0.411	0.483
1989	3503	4913	6889	3146	3528	3956	2764	3111	3502	845	1002	1187	0.33	0.389	0.459
1990	5224	7368	10393	2970	3327	3728	2571	2895	3260	939	1110	1312	0.344	0.408	0.482
1991	3589	5003	6975	3257	3686	4172	2833	3211	3640	953	1139	1360	0.332	0.393	0.465
1992	3651	5063	7022	3287	3722	4216	2883	3276	3723	896	1084	1310	0.322	0.384	0.459
1993	3406	4738	6591	3083	3466	3898	2703	3050	3441	908	1082	1290	0.351	0.413	0.487
1994	3128	4340	6021	2858	3203	3590	2511	2823	3173	916	1086	1287	0.384	0.449	0.525
1995	2732	3819	5339	2776	3106	3476	2443	2740	3073	965	1147	1362	0.422	0.495	0.58
1996	3153	4407	6159	2526	2824	3157	2209	2476	2776	886	1045	1232	0.427	0.5	0.585
1997	4597	6405	8922	2311	2592	2908	1946	2192	2470	834	990	1176	0.431	0.509	0.602
1998	5721	8032	11276	2656	3010	3411	2132	2414	2734	812	969	1155	0.405	0.479	0.566
1999	9553	13566	19264	3109	3543	4037	2351	2677	3047	785	944	1135	0.357	0.423	0.501
2000	6598	9171	12748	3154	3587	4081	2556	2914	3322	893	1099	1352	0.305	0.368	0.444
2001	4122	5775	8090	4391	5050	5808	3765	4341	5006	1123	1369	1668	0.303	0.361	0.431
2002	5137	7146	9940	4403	5032	5751	3872	4450	5116	1225	1479	1787	0.312	0.369	0.437
2003	3960	5482	7589	4141	4699	5333	3670	4185	4771	1247	1500	1804	0.343	0.403	0.474
2004	3513	4829	6638	4118	4644	5237	3640	4115	4652	1220	1455	1736	0.354	0.417	0.492
2005	3148	4300	5875	3722	4174	4680	3319	3734	4201	1108	1311	1550	0.343	0.405	0.477
2006	2592	3553	4870	3290	3673	4100	2942	3292	3684	879	1031	1209	0.329	0.388	0.457
2007	2862	3923	5379	3059	3424	3832	2708	3037	3405	826	966	1129	0.31	0.367	0.435
2008	5231	7329	10269	3119	3523	3980	2645	2986	3372	737	860	1004	0.285	0.34	0.405
2009	4905	6747	9282	3285	3781	4352	2700	3097	3552	626	735	864	0.273	0.324	0.386
2010	2250	3162	4444	3424	3874	4384	2977	3373	3822	721	848	996	0.262	0.312	0.371
2011	3926	5371	7348	3649	4101	4609	3244	3662	4133	877	1030	1210	0.267	0.317	0.376
2012	4650	6361	8702	3669	4126	4639	3180	3592	4057	857	1014	1199	0.283	0.338	0.403
2013	3761	5156	7068	3587	4029	4526	3106	3497	3937	851	1000	1176	0.282	0.339	0.408
2014	2894	4025	5598	3695	4174	4717	3289	3727	4223	936	1102	1297	0.277	0.337	0.41
2015	5684	7818	10753	3631	4106	4643	3122	3555	4047	786	925	1088	0.25	0.305	0.372
2016	6208	8443	11483	3867	4384	4971	3183	3617	4109	694	817	962	0.225	0.275	0.337
2017	10179	14251	19954	4401	4998	5676	3513	3993	4539	704	830	978	0.203	0.249	0.306
2018	4980	6881	9507	5299	6044	6894	4430	5045	5744	812	967	1152	0.189	0.233	0.288
2019	4854	6780	9469	5812	6601	7498	5165	5884	6703	1004	1186	1400	0.192	0.237	0.292
2020	3473	5140	7607	5752	6570	7505	5260	6026	6905	1137	1359	1624	0.199	0.249	0.313
2021	4282	7311	12484	5618	6611	7779	5080	6004	7095	1115	1336	1601	0.192	0.246	0.317
2022	3967	7894	15708	5183	6373	7837	4649	5710	7013	1023	1240	1503	0.183	0.244	0.325

Table 34.15. Sol.27.7fg – Short-term forecast.

Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 3–8}$ (2023)	0.264	Based on a catch of 1338 tonnes for 2023
SSB(2024)	5850	Short-term forecast; in tonnes.
$R_{age\ 1}$ (2023)	5156	Median recruitment, resampled from the years 1971–2020; in thousands.*
$R_{age\ 1}$ (2024)	5140	Median recruitment, resampled from the years 1971–2020; in thousands.*
Catch (2023)	1338	TAC for 2023; in tonnes.
Projected landings (2023)	1263	Assuming average landings ratio by age 2020–2022; in tonnes.
Projected discards (2023)	75	Assuming average discard ratio by age 2020–2022; in tonnes.

Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2024)	Projected landings* (2024)	Projected discards** (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change ***	% TAC change ^	% advice change^^
ICES advice basis										
MSY approach: F = F_{MSY}	1267	1198	69	0.251	0.24	0.0160	5659	-3.3	-5.3	-5.3
EU MAP^^^: F_{MSY}	1267	1198	69	0.251	0.24	0.0160	5659	-3.3	-5.3	-5.3
EU MAP^^^: $F_{MSY\ lower}$	724	685	39	0.136	0.127	0.009	6226	6.4	-46	-46
EU MAP^^^ : $F_{MSY\ upper}$	2121	1999	122	0.462	0.431	0.031	4762	-18.6	59	59
F = 0	0	0	0	0	0	0	6982	19.4	-100	-100
F= F_{pa}	1895	1787	108	0.402	0.375	0.027	5002	-14.5	42	42
F= F_{lim}	2405	2266	139	0.543	0.507	0.036	4466	-24	80	80
$SSB_{2025} = B_{lim}$	4625	4326	299	1.547	1.444	0.103	2184	-63	250	250
$SSB_{2025} = B_{pa}$ = MSY $B_{trigger}$	3765	3533	232	1.047	0.978	0.069	3057	-48	181	181
F = F_{2023}	1324	1251	73	0.264	0.246	0.0180	5600	-4.3	-1.05	-1.05
$SSB_{2025} = SSB_{2024}$	1082	1023	59	0.211	0.197	0.0140	5850	0	-19.1	-19.1

*** Marketable landings, assuming recent discard rate.**

**** Including BMS landings (EU stocks), assuming recent discard rate.**

***** SSB 2025 relative to SSB 2024.**

^ Total catch in 2024 relative to TAC 2023 (1338 tonnes).

^^ Advice value for 2023 relative to the advice value for 2023 (1338 tonnes).

^^^ EU multiannual plan (MAP) for the Western Waters and adjacent waters (EU, 2019).

Figure 34.1. Sol.27.7fg - Landings and discards estimates by weight, as used by the WG.

Figure 34.2. Sol.27.7fg - InterCatch landings and discard data by year, country and gear.

Figure 34.3a. Sol.27.7fg - Age composition of the catch.

Figure 34.3b. Sol.27.7fg - Age composition of the catch.

Figure 34.4. Sol.27.7fg - Standardized catch proportion.

Figure 34.5. Sol.27.7fg - Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings.

Figure 34.6. Sol.27.7fg - Belgian length distributions of discarded and retained fish from discard sampling studies.

Figure 34.7a. Sol.27.7.fg - Mean-standardised indices.

Figure 34.7b. Sol.27.7.fg - Mean-standardised indices.

Figure 34.8. Sol.27.7fg - Consistency plot UK(E&W)-BTS-Q3 survey.

Figure 34.9. Sol.27.7fg – Mean standardized LPUE UK(E&W)-BTS-Q3 survey (kg/100 km fished).

Figure 34.10a. Sol.27.7fg - Mean standardised Effort (fishing hours (BE-CBT and IR-CBT), days fished (UK-CBT)).

Figure 34.10b. Sol.27.7fg - Mean standardised LPUE (kg/hour (BE-CBT and IR-CBT), kg/day (UK-CBT)).

Figure 34.11a. Sol.27.7fg - Commercial biomass tuning indices.

Figure 34.11b. Sol.27.7fg – Comparison between the Belgian Commercial biomass tuning series (BE-CBT-06-21) used in last year's assessment and the one used in this year's assessment.

Figure 34.12. Sol.27.7fg - Summary plots.

Figure 34.13. Sol.27.7fg - One Step Ahead residuals for the final SAM run (the 2022 data are excluded from the BE-CBT_06-22 tuning series).

Figure 34.14. Sol.27.7fg - Retrospective analysis.

Figure 34.15a. Sol.27.7fg - Comparison with last year's assessment.

Figure 34.15b. - Sol.27.7fg - comparison with last year's assessment – short-term forecast assumptions.

Figure 34.16. Sol.27.7fg - Comparison of international TAC, catch and landings.

Figure 34.17. Sol.27.7fg - SAM forecast assuming TAC constraint in the intermediate year followed by targeting F_{MSY} in subsequent years.

Figure 34.18. Sol.27.7fg - comparison with last year's assessment – short-term forecast: the numbers-at-age and mean stock weights,

Figure 34.19. Sol.27.7fg - Year-class sources and contributions for the short-term forecast.

Figure 34.20. Sol.27.7fg – Stock–recruitment plot.

35 Sole *(Solea solea*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Type of assessment in 2023

There is no assessment for this stock. Advice is provided on a triennial basis (and is provided this year for 2024, 2025 and 2026). In 2023, the updated advice followed the agreed procedures for category 5 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.

ICES advice applicable to 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.

https://ices-library.figshare.com/articles/report/Sole_Solea_solea_in_divisions_7_h_k_Celtic_Sea_South_southwest_of_Ireland_/19453832?backTo=/collections/ICES_Advice_2022/5796935

35.1 General

Advice

The advice for 2024, 2025 and 2026 is for catches of no more than 170 tonnes (Table 35.1).

ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. Discarding is considered negligible. The precautionary buffer was last applied in 2020 (for the 2021 advice), and with no new information available to support the current level of catches the precautionary buffer is applied for the 2024, 2025 and 2026 advice.

Table 1. Sole in divisions 7.h–k. The basis for the catch options.

Advised catch for 2023	213 tonnes	
Discard rate	Negligible	
Precautionary buffer	Applied	0.8
Catch advice (2024 -2026)	170 tonnes	
% advice change	-20	

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 35.1). 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 35.1 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 35.1. 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	
France		36	Article 8(2) of this Regulation applies	
Ireland		95		
Netherlands		28		
Union		177		
United Kingdom		36		
TAC		213		

Landings obligation

In 2016, the landings obligation will apply to this stock for the first time. According to the regulation (EC, 2015) vessels where more than 5% of their landings using beam trawls were sole during the reference years (2013 and 2014) in ICES divisions 7.b, 7.c and 7.f–7k will be covered by the Landings Obligation. The landings obligation will also apply to all catches of sole with trammelnets or gillnets. These vessels will have to land all sole in 2016. However, a *de minimis* exemption will also apply allowing for up to a maximum of 3% of the annual catch to be discarded. Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice given.

35.2 Data

35.2.1 Landings and discards

The official and ICES estimates of landings are presented in Table 35.1. 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.

35.3 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 is caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings. The catches are taken in a mixed-fisheries and should be managed as such. Constraining the landings by TAC will not constrain the catches. The TAC is currently not restrictive, but for some countries, the quota appears to have become restrictive.

35.4 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 35.1. 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	
1976	638	19	11	152	33	853	
1977	519	103	12	126	140	900	

Year	Official landings						ICES landings
	Belgium	France	UK	Ireland	Other countries	Total	
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
2004	157	102	79	111	0	449	454
2005	90	93	112	97	0	392	375

Year	Official landings						ICES landings
	Belgium	France	UK	Ireland	Other countries	Total	
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	97	33	61[c]	0	288[c]	235
2019	75	98	48	55[c]	14	291[c]	308
2020	90	109	50	38	10	297	299
2021*	48	128	47	75	16	313	336
2022*	40	78	41	62	41	263	264

*** Preliminary official landings.**

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

36 Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)

Type of assessment in 2023

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, 2021), 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.

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 36.4).

ICES advice applicable to 2023

"*ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 4155 tonnes.*"

https://ices-library.figshare.com/articles/report/Whiting_Merlangius_merlangus_in_Division_6_a_West_of_Scotland_/19457426?backTo=/collections/ICES_Advice_2022/5796935

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://ices-library.figshare.com/articles/report/Whiting_Merlangius_merlangus_in_Division_6_a_West_of_Scotland_/18639074

Following the benchmark in 2021, the perception of stock status changed substantially and therefore new advice was issued in 2021 for 2022 (replacing the advice issued in 2020 for 2021 and 2022).

36.1 General

Stock description

General information is presented in the Stock Annex.

Management applicable to 2022 and 2023

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 2023 and 2022 is shown below.

TAC for 2023

Species:	Whiting *Merlangius merlangus*		Zone:	6; United Kingdom and International waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	7	(1)	Analytical TAC	
France	135	(1)	Article 8 of this Regulation applies	
Ireland	802	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
Union	944	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	1 692	(1)		
TAC	2 636	(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) 2023/194 of 30 January 2023).

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 Council Regulation (EU) 2022/109 of 27 January 2022).

Fishery in 2022

A description of the fisheries in the West of Scotland is given in the Stock Annex.

The year 2022 was the fourth year in a row during which the landing obligation was applied in full force. The overall increase in TAC in 2019–2022 following the introduction of the landing obligation has resulted, in general, in an increase in landings.

Total landings (nominal landings, ICES statistics) in 2022 were 621 t, down by 27% from 2021 (Table 36.1). They were, however, the second highest in the last 19 years. The majority were landed by Scottish and Irish vessels, and smaller amounts, by French and Danish vessels. The UK landings in Division 6.a in 2022 constituted a third of the quota for the UK, while Ireland used roughly half of its quota. Total landings in 2022 constituted 34% of the TAC for that year.

The total estimated international catch of all age groups in 2022 was 751 t, of which 123 t were discards (Table 36.2). Of the discards, 48% 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 2022 (all ages) were lower (by 53%) than those in 2021 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 second lowest in the time-series (Table 36.2).

36.2 Data

Landings

Total landings, as officially reported to ICES, are shown in Figure 36.1 (in 1965–2022) and Table 36.2 (in 1981–2022).

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, 2021) 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 2022 in the Scottish fleet (taking the majority of the catch) were different compared to 2021. Only two trips of the demersal trawl fleet were sampled for landings last year. For discards, the sampling level increased in 2022 and this was particularly the case in the *Nephrops* fleet. The number of primary sampling units (PSU = number of trips sampled) in the area from 2018 to 2022 is shown in the table below:

Year	UK (Scotland)				Ireland			
	Landings		Discards		Landings		Discards	
	TR1	TR2	TR1	TR2	TR1	TR2	TR1	TR2
2022	2	0	13	11	39	0	36	0
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

Landings uploaded to InterCatch by métier and country for 2022 are shown in Figure 36.2. As in previous assessments, age distributions were estimated from market samples. Total catch (including landings) by métier for 2022 is shown in Figure 36.3. Catch numbers-at-age (in different catch categories) in 2022 are shown in Figure 36.4. Overall, these were very low which contrasted with relatively high catch numbers (especially of young fish) observed in earlier years (Figure 36.5).

Annual numbers-at-age in the landings are given in Table 36.3. Annual mean weights-at-age in the landings are given in Table 36.6 and shown in Figure 36.6. Overall, the mean weights-at-age

in the landings have been variable in recent years mainly due to the variability associated with low sample sizes. Efforts to increase sampling in these fisheries are being pursued.

Estimates of mean weights-at-age in 2022 landings were considered particularly unreliable, due to reduced sampling of the demersal trawl fleet in that year.

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 2022 are shown in Figure 36.2.

Annual numbers-at-age in the discards are given in Table 36.4. Annual mean weights-at-age in the discards are given in Table 36.7 and shown in Figure 36.6.

Biological

Annual numbers-at-age in the total catch are given in Table 36.5. Annual mean weights-at-age in the total catch are given in Table 36.8 and shown in Figure 36.6.

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, 2021) 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 to estimate size-dependent natural mortality-at-age, and one to be used as stock weights-at-age input into the SAM stock assessment model to calculate SSB. The latter weights (obtained by smoothing with a General Additive Model, GAM) are shown in Table 36.9 and Figure 36.6.

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, 2021).

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 36.7. The estimated natural mortality-at-age is shown in Table 36.10 and Figure 36.8.

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, 2021). The analysis provided coefficients of the logistic model (being time-invariant, with data up to 2020). The estimated proportions of mature whiting were given then as follows:

Age	0	1	2	3	4	5	6	7+
Maturity ogive	0	0.254	0.984	1	1	1	1	1

The method for calculating the maturity ogive for this stock was corrected this year; it was applied now more strictly in accordance with the calculation procedure originally set out at WKMOG 2008 (ICES, 2008). The maturity ogive re-estimation (with the same raw data) resulted in derivation of the following coefficients: -4.690 (intercept) and 4.225 (slope). The midpoint of the revised maturity ogive, A50, was estimated to be 1.110 (±0.013) years. The re-estimated proportions of mature whiting are shown in the table below:

Age	0	1	2	3	4	5	6	7+
Maturity ogive	0	0.386	0.977	1	1	1	1	1

The re-estimation revealed that considerable proportion of fish at age 1 (39%) and nearly all fish at age 2 (98%) were mature. There was little variability in the data. Also, correcting the calculation procedure resulted in relatively narrow confidence intervals, considerably narrower compared to those for the previous ogive (Figure 36.9).

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, G1179): all ages 1 and older, years 1985–2010;
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4, G4299): 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, G4748): all ages 1 and older, years 2011–2023 (excluding 2022);
- Scottish fourth-quarter west coast groundfish survey (UK-SCOWCGFS-Q4, G4815): all ages including age 0, years 2011–2022.

The distribution and densities of whiting at-age (standardised as CPUE) in the Q1 and Q4 surveys in 2018–2023 are shown in Figure 36.10. 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, 12 years of data are currently available in the time-series for the Q1 survey and 11 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, G7212): all ages including age 0, years 2003–2022.

The distribution and densities of whiting at-age in the two Q4 surveys, UK-SCOWCGFS-Q4 and IGFS-WIBTS-Q4 in 2017–2022 are shown in Figure 36.11 (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, 2022).

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 and covering the period 1996 onwards (ICES, 2021). 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 36.12. 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.

36.3 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, 2021). 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 0 between 1981 and 2002, and landings mean weights-at-age 0 for the entire modelled time period, were equal to the average of mean weights-at-age 0 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 0 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 36.13–36.15).

The log catch curves for the commercial catch and for the surveys in the current assessment are shown in Figure 36.13. 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 in the later part of the time-series are more noisy and have a strong 'hook', especially at age 0 (from 2003 onwards).

The plots of mean standardised catch proportions at age by year (Figure 36.14) demonstrate general consistency in the estimates of year-class strength across age groups. They indicate strong year classes in recent years (e.g. 2009 and 2014 year classes), but also markedly weak year classes (e.g. 2012 and 2017 year classes). A strong year effect can be seen for ages 1+ in 2008 and to a lesser extent in 2007 and 2012 in the combined survey series.

The within-survey correlation plots generally show high correlations between adjacent age groups (i.e. between age 1 and age 2, between age 2 and age 3 etc.; Figure 36.15). Also here, there is general consistency with regard to year-class strength across age groups, with the points being more scattered for old age groups.

The three indices used as tuning series in the current assessment are shown in Table 36.11.

Final assessment

Model used: SAM

Software used: stockassessment package in R; stockassessment.org

Input data types and characteristics:

- Catch numbers-at-age: ages 1–7+, 1981–2022 (excluding age 1 in 2021, see below); age 0, 2003–2022 (excluding 2020 and 2021, see below)
- Landings fraction at age, ages 0–7+, years 1981–2022,
- Catch weights-at-age: ages 1–7+, 1981–2022; age 0, 2003–2022 (excluding 2020, see below)
- Landings weights-at-age, ages 0–7+, years 1981–2022 (excluding age 1 in 2021, see below),
- Discards weights-at-age: ages 1–7+, years 1981–2022; age 0, 2003–2022 (excluding 2020, see below),
- ScoGFS-WIBTS-Q1, ages 1–6, years 1985–2010,
- UK-SCOWCGFS-Q1, ages 1–6, years 2011–2023 (excluding 2022, see below),
- Modelled Q4 index, Comb-WCGFS-Q4, fitted to data from ScoGFS-WIBTS-Q4, UK-SCOWCGFS-Q4, and IGFS-WIBTS-Q4; ages 0–7+ with variance estimates, 1996–2022.

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-0 discards are treated as missing in 2020 (as in the years before 2003). Missing catch weights-at-age 0 are assumed equal to the average of 2003–2019. There were no age-1 fish recorded in the landings in 2021, therefore landings weight-at-age 1 for 2021 is a three-year average value (2018–2020). Catch numbers-at-age 0 and 1 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. The UK-SCOWCGFS-Q1 index was not available in 2022 as there was no survey carried out due to vessel maintenance.

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 36.12. 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 0, 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 36.13 shows the SAM parameter estimates for the assessment model. Table 36.14 shows the population numbers-at-age estimated in SAM, and estimated F-at-age is shown in Table 36.15. A summary of the full model output is detailed in Table 36.16. The summary plots for the final assessment are shown in Figure 36.16.

The fits of the model to observations (catch and survey indices on a log scale) are shown in Figure 36.17. The fits to the ScoGFS-WIBTS-Q1 appear to overestimate ages 1 and 2 in the early part of the time-series, and for ages 3 and 4 some of the trends in the time-series are not fully captured. Fits to Comb-WCGFS-Q4 are also generally good, although there is a tendency towards overestimation of age 0 individuals for part of the time-series, and some overestimation and deficiency in tracking the variability of age 7+. 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 7+. particularly from 2000 onwards.

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, and a retrospective peel analysis. One observation ahead residuals-at-age for catch and survey indices are shown in Figure 36.18. 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 2 and 4, where the fishery shifted from being directly targeted to bycatch. There is some tendency towards negative residuals in the oldest age group of the Q4 survey index, occasionally interspersed with positive residual values. Otherwise, there are no obvious problematic trends, either in magnitude or direction.

The model leave-one-out analysis is shown in Figure 36.19. 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 2009. Excluding ScoGFS-WIBTS-Q1 results in higher estimates of $\bar{F}$ for much of the time-series from 2000 onwards, while excluding 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 36.20. Retrospective bias in SSB is not substantial, with some downward revision with the addition of new data in recent years. This year's model shows a slight upward revision on last year's model's recent estimates of SSB, but a declining trend in SSB in the final year. The Mohn's rho values are as follows:

SSB	$\bar{F}$	Recruitment
0.11	0.22	0.44

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.

The SAM stock–recruit plot is presented in Figure 36.21 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 (ICES, 2021), 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 around 2010, although this trend has slowed or levelled off since 2018. Average recruitment between 2010 and 2020 was higher than in the previous 10 years, but has been low since 2020.

Comparison with last year's assessment

This year, the WG estimates from SAM are as follows:

$\bar{F}_{(1–3)}$ in 2022 = 0.017

SSB in 2023 = 24 858 t

The estimated fishing pressure continued to be very low. The stock biomass was estimated to decrease slightly in 2023. The estimates of SSB from this year's assessment are similar to 2022 with slight upwards revision (Figure 36.22). There are downward revisions in $\bar{F}$ and recruitment, but these remain at relatively low levels.

SURBAR analysis

An alternative exploratory assessment conducted using SURBA (Needle, 2015) was presented at the WKNSEA benchmark (ICES, 2021) and the following two assessments by WGCSE. 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 36.9). 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 and 2023;
- Comb-WCGFS-Q4 for the period 1996–2022.

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 36.23. The stock summary plots show rather variable estimates of mean Z being generally lower from the mid-1990s 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. The increase between 2019 and 2021 can be explained by relatively high recruitments in 2018–2019. Recruitment between 2005 and 2013 was on a very low level. It increased in the following years but remained rather low in the last three years.

The assessment with SURBAR shows similar trends to those seen in the SAM runs (Figure 36.24).

State of the stock

The spawning–stock biomass (SSB) in 2023 is estimated to be below MSY $B_{trigger}$. It increased between 2010 and 2020, and levelled off since then at estimates consistent with those for the late 1990s (Figure 36.25). $\bar{F}$ declined almost continuously from 2000–2008, and has been below F_{MSY} since 2005. Recruitment was at historically low levels in the mid-2000s, and from around 2014 to 2020 has been variable around relatively low values. Recruitment estimates have remained low in recent years.

36.4 Short-term projections

The WG conducted a forecast using SAM in the form of short-term stochastic projections. A total of 1×10^5 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 (2023) was taken as the SAM estimate, equal to the estimate of recruitment for 2022. The estimate of recruitment for the forecast year(s) was resampled from 2014–2023, to reflect recent levels of recruitment.

Fishing mortality in the intermediate year (2023) was taken as a five-year average over 2018 to 2022 (Figure 36.26) of the exploitation pattern rescaled to the 2022 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 36.27, the observed proportion discarded at-age shows a significant decline in the proportion of discards for ages three to five between 2019 and 2021, with a decline in proportion of discards-at-age two from 2020 onwards. For the forecast, total catch is partitioned into landings and discards on the

basis of the mean discard proportions-at-age between 2020 and 2022 (rather than the 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 2023 and 2024.

The observed mean weights-at-age 0 and 1 in the 2021 discard data were considered unreliable due to limited sampling of fleets discarding whiting (COVID-19 pandemic related sampling issue, see Section 36.2 for further details). For the purpose of forecasting, the mean value for those ages in 2021 were replaced with the average of the equivalent values across 2019 and 2020. Estimates of mean weights-at-age in 2022 the landings were considered unreliable, due to reduced sampling of the demersal trawl fleet in that year. For the short-term forecast, these values were replaced with averages calculated across the preceding three years (2019–2021).

Variable	Value	Notes
$F_{ages\ 1–3}$ (2023)	0.0166	$F = F_{average\ (2017-2021)}$ rescaled to F_{2021}
SSB (2024)	23 794	Short-term forecast; Tonnes
$R_{age\ 0}$ (2023)	143 462	Assessment estimate in 2023, in thousands
$R_{age\ 0}$ (2024)	237 915	Median recruitment, resampled from the years 2014–2023, in thousands
Catch (2023)	611	Short-term forecast; tonnes
Projected landings (2023)^	509	Short-term forecast; assuming average landings ratio by age 2020–2022; tonnes
Projected discards (2023)^	102	Short-term forecast; assuming average discard ratio by age 2020–2022; tonnes

^ Due to inadequate discard sampling coverage of the fishery in 2021, average landings and discards weights from 2019–2020 were used for ages 0 and 1.

Under the forecast assumption of *status quo* F, landings in 2023 are predicted to be 509 t and discards to be 102 t. The SSB in 2024 is forecast to be 23 794 t, which is above B_{lim} and below MSY $B_{trigger}$. A summary of the forecast run under different catch scenarios for 2023 is shown in Table 36.17 (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 2024 (3879 t) shows a decrease in SSB in 2025 (Figure 36.28). Figure 36.29 shows the contribution by recruitment year to SSB in 2025 and catch in 2024 (when fished at $F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$). The assumption regarding recruitment in 2023 and 2024 contribute approximately 22% and 13% to the forecast 2025 SSB, and 20% and 14% to the forecast 2024 catch, respectively.

There is a 6.6% reduction in advice compared to last year which is attributable to lower stock numbers-at-age and biomass-at-age compared to those projected in 2022 (Figures 36.30 and 36.31), despite a continued decline in fishing pressure, due to successive low recruitments.

36.5 MSY and biological reference points

The reference points for this stock were updated at WKNSEA 2021 (ICES, 2021), 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<B_{lim} in stochastic simulation (EqSim). Uses segmented regression recruitment with breakpoint=B_{lim} (S–R pairs from 1985 onwards).
F_{pa}	0.18	0.19	0.21	$F_{p.05}$; the F that leads to SSB ≥ B_{lim} with 95% probability.
F_{MSY}	0.22	0.23	0.21	$F_{p.05}$ (F_{MSY} uncapped = 0.23)
F_{MSY} upper	0.34	0.32	0.21	$F_{p.05}$ (F_{MSY} 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 $F_{p.05}$).

36.6 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).

36.7 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 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.

Estimates of mean weights-at-age in the landings in 2022 were considered unreliable (due to reduced sampling of the demersal trawl fleet in that year), but using a three-year average in the short-term forecast seems a reasonable choice in this case.

36.8 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 considered to estimate stock mean weights. Currently, they are smoothed with a GAM independently in each age group. As a result, two adjacent age groups may occasionally show different trends, which is quite unlike and which makes such stock weight 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.

36.9 Management considerations

SSB in 2023 is estimated to be below 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 three last years was estimated to be lower. The third non-zero advice in a row has been given this year. 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 (16% in 2022). 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 2023 and 2024.

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.

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Table 36.1. Whiting in Division 6.a. Nominal landings (in tonnes) as officially reported to ICES in 1989–2022.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
France	199	180	352	105	149	191	362	202	108	82	300	48	52	21	11	6	9	7	6	1
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+	1	-
Ireland	1 315	977	1 200	1 377	1 192	1213	1 448	1 182	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.)	6 109	4 819	5 135	4 330	5 224	4 149	4 263	5 021	4 638	3 369	3 046	2 258	1 654	1 064	751	444	103	178	424	
UK (total)																				370
Total landings	7 669	6 026	6 908	6 010	6 751	5 786	6 278	6 642	6 178	4 657	4 677	3 203	2 543	1 735	1 365	819	289	383	488	441

Table 36.1. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021*	2022*
Belgium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	2	56	10	-	4
Faroe Islands	-	+	1	1	-	-	-	-	-	-	-	-	-	-
France	1	3	+	+	1	1	+	5	3	2	7	10	35	9
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	125	99	149	96	97	97	88	77	53	72	**	126	161	236
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	371
Total landings	482	349	230	301	214	181	221	232	169	189	327**	537	851	621

*** Preliminary.**

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

+ <0.5 t.

Table 36.2. Whiting in Division 6.a. Landings, discards and catch estimates for 1981–2022, as used by the WG. Values are totals for ages 1 to 7+ (in 1981–2002) and for ages 0 to 7+ (in 2003–2022). 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	12 203	2 132	14 335	15
1982	13 871	5 485	19 356	28
1983	15 970	6 294	22 264	28
1984	16 458	4 017	20 475	20
1985	12 893	4 840	17 733	27
1986	8 454	2 669	11 123	24
1987	11 544	11 918	23 462	51
1988	11 352	8 132	19 484	42
1989	7 531	5 876	13 407	44
1990	5 643	4 530	10 173	45
1991	6 660	4 883	11 543	42
1992	6 004	9 249	15 253	61
1993	6 872	4 759	11 631	41
1994	5 901	3 455	9 356	37
1995	6 076	5 771	11 847	49
1996	7 156	7 940	15 096	53
1997	6 285	5 251	11 536	46
1998	4 631	9 216	13 847	67
1999	4 613	3 975	8 588	46
2000	3 010	13 285	16 295	82
2001	2 438	4 263	6 701	64
2002	1 709	2 851	4 560	63
2003	1 331	1 984	3 316	60
2004	798	2 887	3 686	78
2005	335	972	1 307	74
2006	378	746	1 124	66
2007	481	366	847	43

Year	Landings	Discards	Total	Discard rate (%)
2008	441	156	598	26
2009	480	826	1 305	63
2010	345	1091	1 436	76
2011	231	630	861	73
2012	300	742	1 042	71
2013	215	1 172	1 387	85
2014	181	745	926	80
2015	221	1 458	1 679	87
2016	227	1 040	1 266	82
2017	168	1 331	1 498	89
2018	189	666	855	78
2019	484	960	1 444	66
2020	541	834	1 375	61
2021	852	261	1 114	23
2022	628	123	751	16
Min	168	123	598	15
Mean	4 431	3 566	7 997	54
Max	16 458	13 285	23 462	89

Table 36.3. Whiting in Division 6.a. Landings-at-age (thousands).

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0	3 593	24 395	11 297	4 611	1 518	452	201
1982	0	2 991	5 783	29 094	6 821	2 043	803	348
1983	0	3 418	7 094	8 040	22 757	6 070	1 439	540
1984	0	7 209	12 765	8 221	4 387	14 825	1 953	858
1985	0	4 139	19 520	8 574	3 351	1 997	4 764	822
1986	0	2 674	14 824	9 770	2 653	532	291	529
1987	0	6 430	13 935	13 988	5 442	837	330	259
1988	0	1 842	20 587	9 638	6 168	1 949	290	207
1989	0	2 529	5 887	11 889	4 767	1 266	468	71
1990	0	3 203	8 028	2 393	4 009	1 326	204	37
1991	0	3 294	8 826	10 046	1 208	1 391	286	51
1992	0	2 695	9 440	4 473	4 782	396	373	106
1993	0	1 051	10 179	6 293	2 673	2 738	163	147
1994	0	909	4 889	9 158	3 607	712	715	69
1995	0	215	4 322	6 516	5 654	1 397	376	282
1996	0	990	5 410	7 675	5 052	2 461	583	157
1997	0	877	3 658	8 514	4 316	1 441	338	106
1998	0	840	3 504	4 277	3 698	1 442	338	288
1999	0	1 013	6 131	4 546	2 040	1 774	355	112
2000	0	484	2 952	4 211	1 570	485	328	89
2001	0	461	3 271	2 630	1 567	401	131	16
2002	0	62	1 624	3 018	799	227	23	13
2003	0	98	652	1 309	1 481	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
2022	0	2	79	439	279	144	206	2

Table 36.4. 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).

	Age							
Year		1	2	3	4	5	6	7+
1981	NA	1 128	10 415	1 397	201	27	12	0
1982	NA	19 511	3 421	12 683	1 197	187	4	0
1983	NA	21 690	6 748	2 909	5 372	158	8	0
1984	NA	34 330	2 400	909	371	811	73	1
1985	NA	17 615	9 858	3 273	672	205	363	40
1986	NA	6 159	9 823	1 962	185	1	0	10
1987	NA	97 611	17 427	1 763	154	0	0	0
1988	NA	28 057	38 019	2 239	467	11	0	0
1989	NA	31 079	5 598	8 570	223	13	5	0
1990	NA	20 952	11 176	71	23	3	0	0
1991	NA	23 211	7 540	7 355	266	236	56	0
1992	NA	50 665	16 729	2 810	954	0	0	0
1993	NA	14 057	11 139	2 903	588	431	0	1
1994	NA	12 700	6 859	3 872	1 152	189	150	4
1995	NA	21 974	21 786	3 416	484	7	1	1
1996	NA	33 621	18 625	5 086	1 535	13	1	20
1997	NA	22 422	9 632	3 806	540	71	2	1
1998	NA	53 742	16 058	3 553	847	177	31	8
1999	NA	7 928	17 097	1 402	503	275	44	0
2000	NA	158 913	5 254	2 238	154	16	41	0
2001	NA	5 666	23 084	715	172	0	0	0
2002	NA	11 055	8 531	2 428	415	175	9	3
2003	5 678	9 448	2 489	1 775	375	25	7	1
2004	10 577	14 941	5 095	1 011	660	125	4	2
2005	7 873	3 246	2 298	769	60	22	8	4
2006	5 866	4 691	528	637	169	29	6	2
2007	1 259	1 016	966	283	88	38	3	0
2008	840	630	144	114	31	37	4	0
2009	9 685	6 880	114	66	44	15	4	0
2010	5 903	17 678	1 581	264	37	54	6	16

Year	Age	1	2	3	4	5	6	7+
2011	13 306	2 047	998	122	7	2	0	0
2012	1 434	7 810	429	547	94	19	1	0
2013	3 188	16 415	1 578	172	255	8	2	2
2014	6 261	9 831	51	55	27	30	8	3
2015	17 740	7 930	909	287	112	18	17	0
2016	3 745	5 506	1 910	268	16	12	4	2
2017	8 518	7 563	788	889	65	160	2	0
2018	1 777	2 371	962	469	276	21	5	0
2019	2 188	10 379	526	413	232	34	0	0
2020	NA	23 481	807	59	29	10	3	0
2021	2 579	156	467	80	44	89	0	0
2022	581	198	64	139	34	8	6	0

Table 36.5. Whiting in Division 6.a. Total catch-at-age (thousands).

	Age							
Year	0	1	2	3	4	5	6	7+
1981	NA	4 721	34 810	12 694	4 812	1 545	464	201
1982	NA	22 502	9 204	41 777	8 018	2 230	807	348
1983	NA	25 108	13 842	10 949	28 129	6 228	1 447	540
1984	NA	41 539	15 165	9 130	4 758	15 636	2 026	859
1985	NA	21 754	29 378	11 847	4 023	2 202	5 127	862
1986	NA	8 833	24 647	11 732	2 838	533	291	539
1987	NA	104 041	31 362	15 751	5 596	837	330	259
1988	NA	29 899	58 606	11 877	6 635	1 960	290	207
1989	NA	33 608	11 485	20 459	4 990	1 279	473	71
1990	NA	24 155	19 204	2 464	4 032	1 329	204	37
1991	NA	26 505	16 366	17 401	1 474	1 627	342	51
1992	NA	53 360	26 169	7 283	5 736	396	373	106
1993	NA	15 108	21 318	9 196	3 261	3 169	163	148
1994	NA	13 609	11 748	13 030	4 759	901	865	73
1995	NA	22 189	26 108	9 932	6 138	1 404	377	283
1996	NA	34 611	24 035	12 761	6 587	2 474	584	177
1997	NA	23 299	13 290	12 320	4 856	1 512	340	107
1998	NA	54 582	19 562	7 830	4 545	1 619	369	296
1999	NA	8 941	23 228	5 948	2 543	2 049	399	112
2000	NA	159 397	8 206	6 449	1 724	501	369	89
2001	NA	6 127	26 355	3 345	1 739	401	131	16
2002	NA	11 117	10 155	5 446	1 214	402	32	16
2003	5 678	9 546	3 141	3 083	1 856	439	100	3
2004	10 577	14 990	5 794	1 556	1 176	745	78	35
2005	7 873	3 272	2 571	1 229	205	129	57	10
2006	5 866	4 773	663	1 023	445	96	93	27
2007	1 259	1 209	1 156	578	449	190	33	53
2008	840	632	421	500	366	187	58	25
2009	9 685	6 988	370	324	462	123	53	14
2010	5 903	17 729	1 662	414	185	196	49	68
2011	13 306	2 048	1 254	267	101	29	26	8

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2012	1 434	7 823	469	920	298	72	17	9
2013	3 188	16 419	1 619	247	523	82	21	7
2014	6 261	9 844	77	185	127	130	31	14
2015	17 740	7 937	983	343	269	90	90	30
2016	3 745	5 525	2003	415	92	98	23	30
2017	8 518	7 580	825	1 056	134	212	41	10
2018	1 777	2 371	1 035	557	475	81	13	8
2019	2 188	10 402	580	840	486	293	48	5
2020	NA	23 488	1 116	317	339	166	42	3
2021	2 579	156	785	754	419	456	67	37
2022	581	201	142	578	312	153	211	2

Table 36.6. 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

	Age							
Year	**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
2022	0.035	0.347	0.417	0.465	0.476	0.694	0.685	0.526

*** 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 36.7. 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

	Age							
Year	**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
2022	0.063	0.101	0.208	0.276	0.320	0.302	0.323	NA

*** For age 0 in 1981–2002 and 2020, mean weights-are assumed to be the average for 2003–2019.**

Table 36.8. 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
2022	0.063	0.104	0.323	0.420	0.459	0.672	0.675	0.526

*** For age 0 in 1981–2002 and 2020, mean weights-are assumed to be the average for 2003–2019.**

Table 36.9. 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	0.152	0.271	0.373	0.477	0.551	0.644
1982	0.037	0.048	0.152	0.271	0.373	0.477	0.551	0.644
1983	0.037	0.048	0.152	0.271	0.373	0.477	0.551	0.644
1984	0.037	0.048	0.152	0.271	0.373	0.477	0.551	0.644
1985	0.037	0.048	0.152	0.271	0.373	0.477	0.551	0.644
1986	0.037	0.048	0.152	0.268	0.369	0.471	0.549	0.638
1987	0.037	0.048	0.152	0.265	0.365	0.466	0.547	0.633
1988	0.037	0.048	0.153	0.263	0.361	0.46	0.545	0.627
1989	0.036	0.048	0.152	0.26	0.358	0.455	0.542	0.621
1990	0.036	0.049	0.152	0.258	0.356	0.45	0.54	0.614
1991	0.036	0.049	0.15	0.256	0.354	0.446	0.538	0.608
1992	0.036	0.049	0.149	0.254	0.353	0.442	0.535	0.601
1993	0.036	0.049	0.147	0.252	0.352	0.44	0.533	0.595
1994	0.035	0.049	0.145	0.25	0.35	0.438	0.531	0.589
1995	0.035	0.049	0.143	0.249	0.349	0.437	0.53	0.583
1996	0.035	0.049	0.141	0.248	0.347	0.435	0.529	0.578
1997	0.035	0.049	0.14	0.248	0.344	0.433	0.528	0.573
1998	0.035	0.05	0.138	0.247	0.341	0.431	0.527	0.569
1999	0.034	0.05	0.137	0.248	0.337	0.428	0.527	0.565
2000	0.034	0.05	0.136	0.249	0.334	0.426	0.527	0.562
2001	0.034	0.05	0.136	0.25	0.332	0.424	0.528	0.56
2002	0.034	0.05	0.136	0.252	0.331	0.424	0.529	0.559
2003	0.034	0.05	0.137	0.255	0.332	0.427	0.532	0.559
2004	0.033	0.05	0.138	0.259	0.338	0.433	0.535	0.561
2005	0.033	0.051	0.14	0.264	0.347	0.442	0.539	0.564
2006	0.033	0.051	0.143	0.269	0.359	0.454	0.544	0.568
2007	0.033	0.051	0.145	0.274	0.375	0.467	0.55	0.574
2008	0.033	0.051	0.148	0.28	0.393	0.482	0.557	0.581
2009	0.033	0.051	0.151	0.286	0.41	0.496	0.564	0.588
2010	0.033	0.051	0.155	0.292	0.426	0.509	0.571	0.597

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2011	0.034	0.052	0.157	0.298	0.439	0.52	0.579	0.607
2012	0.034	0.052	0.16	0.303	0.449	0.53	0.587	0.617
2013	0.034	0.052	0.162	0.307	0.455	0.537	0.594	0.628
2014	0.034	0.052	0.164	0.311	0.458	0.542	0.602	0.639
2015	0.034	0.052	0.165	0.315	0.459	0.545	0.608	0.65
2016	0.035	0.053	0.165	0.318	0.457	0.547	0.615	0.661
2017	0.035	0.053	0.164	0.321	0.455	0.547	0.622	0.673
2018	0.035	0.053	0.162	0.324	0.451	0.547	0.628	0.683
2019	0.036	0.053	0.16	0.327	0.447	0.546	0.634	0.694
2020	0.036	0.053	0.158	0.33	0.441	0.544	0.64	0.704
2021	0.037	0.054	0.155	0.332	0.435	0.543	0.646	0.715
2022	0.037	0.054	0.152	0.335	0.428	0.541	0.652	0.725
2023	0.037	0.054	0.149	0.337	0.421	0.539	0.658	0.735

Table 36.10. Whiting in Division 6.a. Natural mortality.

	Age							
Year	0	1	2	3	4	5	6	7+
1981	1.050	1.012	0.713	0.591	0.539	0.500	0.478	0.460
1982	1.050	1.012	0.713	0.591	0.539	0.500	0.478	0.460
1983	1.050	1.012	0.713	0.591	0.539	0.500	0.478	0.460
1984	1.050	1.012	0.713	0.591	0.539	0.500	0.478	0.460
1985	1.050	1.012	0.713	0.591	0.539	0.500	0.478	0.460
1986	1.052	0.996	0.710	0.593	0.541	0.502	0.479	0.461
1987	1.054	0.981	0.708	0.595	0.543	0.504	0.480	0.462
1988	1.055	0.966	0.705	0.596	0.544	0.507	0.481	0.463
1989	1.057	0.953	0.702	0.598	0.546	0.510	0.483	0.465
1990	1.059	0.941	0.700	0.599	0.547	0.512	0.484	0.466
1991	1.060	0.929	0.697	0.600	0.547	0.514	0.485	0.467
1992	1.062	0.918	0.695	0.601	0.548	0.515	0.486	0.469
1993	1.064	0.908	0.692	0.601	0.548	0.515	0.488	0.470
1994	1.066	0.898	0.689	0.602	0.547	0.514	0.489	0.472
1995	1.067	0.889	0.687	0.601	0.547	0.512	0.490	0.473
1996	1.069	0.880	0.684	0.601	0.547	0.510	0.491	0.475
1997	1.071	0.873	0.681	0.600	0.547	0.510	0.492	0.476
1998	1.073	0.866	0.678	0.598	0.547	0.510	0.493	0.477
1999	1.075	0.860	0.675	0.597	0.548	0.513	0.494	0.478
2000	1.077	0.854	0.673	0.596	0.548	0.517	0.495	0.479
2001	1.079	0.850	0.670	0.594	0.549	0.522	0.495	0.480
2002	1.081	0.846	0.667	0.592	0.549	0.526	0.495	0.480
2003	1.082	0.842	0.665	0.589	0.549	0.529	0.494	0.480
2004	1.084	0.839	0.662	0.587	0.547	0.529	0.493	0.480
2005	1.085	0.837	0.660	0.583	0.543	0.526	0.491	0.480
2006	1.086	0.834	0.658	0.580	0.538	0.520	0.489	0.479
2007	1.087	0.833	0.655	0.576	0.533	0.513	0.486	0.478
2008	1.087	0.831	0.653	0.572	0.526	0.505	0.484	0.476
2009	1.086	0.829	0.652	0.568	0.521	0.497	0.481	0.475
2010	1.085	0.828	0.650	0.565	0.515	0.491	0.478	0.473
2011	1.084	0.826	0.648	0.562	0.511	0.486	0.476	0.471

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2012	1.082	0.824	0.647	0.560	0.509	0.483	0.473	0.469
2013	1.080	0.822	0.646	0.558	0.507	0.481	0.471	0.466
2014	1.077	0.820	0.645	0.557	0.506	0.480	0.469	0.464
2015	1.074	0.818	0.645	0.556	0.506	0.481	0.468	0.462
2016	1.072	0.816	0.644	0.555	0.507	0.482	0.466	0.459
2017	1.069	0.815	0.644	0.555	0.508	0.483	0.465	0.457
2018	1.066	0.813	0.644	0.555	0.509	0.484	0.464	0.455
2019	1.063	0.811	0.644	0.556	0.511	0.486	0.463	0.453
2020	1.060	0.810	0.644	0.557	0.514	0.489	0.463	0.451
2021	1.056	0.808	0.644	0.558	0.517	0.492	0.462	0.449
2022	1.053	0.807	0.645	0.559	0.520	0.495	0.461	0.447
2023	1.050	0.806	0.645	0.561	0.524	0.498	0.461	0.445

Table 36.11. 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	3 140	1 792	380	85	23	156	18
1986	10	1 456	1 525	403	68	10	9	10
1987	10	6 938	1 054	584	142	36	2	1
1988	10	567	3 469	654	189	42	5	1
1989	10	910	505	586	237	48	3	0
1990	10	1 818	571	122	216	61	4	1
1991	10	3 203	276	299	22	39	9	1
1992	10	4 777	1 597	410	517	56	18	0
1993	10	5 532	6 829	644	91	30	11	2
1994	10	6 614	2 443	1 487	174	56	15	6
1995	10	5 598	2 831	1 160	370	70	17	32
1996	10	9 385	2 237	635	341	135	30	4
1997	10	5 663	2 444	1 531	355	102	17	4
1998	10	9 851	1 352	294	195	50	14	1
1999	10	6 125	4 952	489	103	16	1	0
2000	10	12 862	471	152	34	10	11	0
2001	10	4 653	1 955	242	41	8	1	1
2002	10	5 542	1 028	964	89	15	1	1
2003	10	6 934	746	436	300	32	2	4
2004	10	5 887	1 566	189	131	44	9	1
2005	10	1 308	723	183	35	8	11	2
2006	10	1 441	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	3 523	340	108	52	40	4	3

Table 36.11. 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	1 884	397	64	37	45	12	6 431	150 861	5 654	209	80	133	11
2012	10	3 441	293	738	72	14	5	7	600 264	8 104	18 380	184	9	2	3
2013	10	552	1 031	302	463	61	7	3	62 915	46 672	50 56	15 023	443	7	1
2014	10	5 805	125	246	110	74	7	1	2 230 995	556	2 133	657	333	2	0
2015	10	2 545	760	285	259	65	58	8	144 266	46 202	8 599	4 562	305	352	10
2016	10	3 226	3 485	576	148	84	42	25	397 138	1 880 448	28 776	691	260	95	48
2017	10	4 970	1 981	1 707	203	49	32	5	2 335 667	309 373	227 966	2 958	172	99	3
2018	10	1 960	1 827	1 069	1 142	132	14	2	763 992	330 295	91 346	108 990	2 138	70	0
2019	10	3 231	666	577	191	99	25	0	345 197	29 689	21 447	1 786	536	30	0
2020	10	3 795	2 263	711	572	178	110	27	1 369 852	699 830	68 242	27 213	3 694	1 736	415
2021	10	774	1 679	703	272	140	24	11	29 371	129 127	23 776	3 259	1 173	30	10
2022	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2023	10	1 408	809	670	563	98	29	21	152 501	105 577	37 319	34 070	622	114	119

Table 36.11. Continued.

Comb-WCGFS-Q4 – Combined Scottish and Irish Groundfish Survey – numbers-at-age per hour									
Index									
Year	Effort (hours)	Age 0	1	2	3	4	5	6	7+
1996	1	8 781.0	439.2	100.2	30.5	8.0	3.1	0.5	0.0
1997	1	1 977.7	689.3	159.0	34.8	10.8	2.3	0.4	0.1
1998	1	637.1	621.6	201.3	21.4	9.3	2.1	0.4	0.7
1999	1	2 375.7	216.6	97.6	14.7	4.6	2.1	0.1	0.3
2000	1	2 912.0	1 025.5	162.8	25.5	1.4	1.1	0.2	0.4
2001	1	294.2	390.5	400.7	30.9	4.9	2.5	0.3	0.1
2002	1	2 312.5	272.5	110.5	57.9	4.2	1.2	0.5	0.2
2003	1	629.7	475.8	73.7	32.8	10.7	2.2	0.4	0.2
2004	1	235.3	195.1	75.1	7.7	4.7	3.1	0.2	0.2
2005	1	188.4	67.3	43.6	10.7	1.1	0.4	0.1	0.1
2006	1	138.4	49.4	27.4	12.0	3.3	0.7	0.1	0.0
2007	1	123.8	58.3	39.0	11.4	4.6	2.5	0.3	0.1
2008	1	19.8	40.5	19.3	16.3	4.3	3.1	0.5	0.1
2009	1	1 670.9	22.5	16.6	5.2	2.6	0.8	0.4	0.4
2010	1	80.7	307.8	35.9	9.1	2.6	1.1	0.2	0.3
2011	1	473.5	32.3	157.5	20.5	7.2	2.4	1.4	0.4
2012	1	95.4	234.7	51.2	70.7	17.0	2.4	0.7	0.3
2013	1	2 311.9	37.7	91.6	28.2	30.4	4.9	0.6	0.1
2014	1	8 568.2	237.3	46.1	38.9	10.4	8.1	2.0	0.3
2015	1	891.1	758.8	119.5	28.3	19.2	4.4	2.8	0.2
2016	1	611.2	305.4	292.6	40.6	9.0	10.5	1.6	2.2
2017	1	641.3	158.1	113.0	120.6	19.0	2.6	1.3	0.6
2018	1	3 194.3	130.1	93.0	37.5	20.4	2.9	0.1	0.3
2019	1	3 187.2	432.7	46.9	22.6	9.6	3.5	0.6	0.1
2020	1	1 198.4	416.8	165.4	24.0	12.1	4.0	2.1	0.2
2021	1	1 694.8	127.5	157.4	36.1	6.8	4.0	2.1	0.2
2022		355.2	248.1	99.2	70.5	16.2	3.3	0.6	0.4

Table 36.11. 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	15 962 759.1	36 188.4	1 424.1	102.0	6.8	1.1	0.0	0.0
1997	1	613 224.2	55 772.1	2 372.5	86.4	8.3	0.4	0.0	0.0
1998	1	69 527.6	49 655.5	3 773.1	40.0	7.2	0.4	0.0	0.0
1999	1	902 727.5	6 118.3	1 003.3	18.6	2.2	0.6	0.0	0.0
2000	1	1 088 049.9	91 796.0	1 675.1	47.5	0.2	0.1	0.0	0.0
2001	1	13 046.9	11 799.0	10 984.1	63.7	1.6	0.4	0.0	0.0
2002	1	608 018.9	4 936.0	597.7	171.0	0.7	0.1	0.0	0.0
2003	1	36 058.1	12 293.8	229.5	34.4	3.2	0.2	0.0	0.0
2004	1	5 409.6	1 863.6	209.9	2.3	0.8	0.3	0.0	0.0
2005	1	3 016.3	225.0	76.9	3.9	0.1	0.0	0.0	0.0
2006	1	2 908.4	133.2	37.1	4.7	0.4	0.0	0.0	0.0
2007	1	1 531.3	161.2	59.3	4.5	0.7	0.2	0.0	0.0
2008	1	83.7	96.6	17.8	10.4	0.7	0.3	0.0	0.0
2009	1	216 834.7	30.2	11.7	1.1	0.3	0.0	0.0	0.0
2010	1	1 701.1	9 724.2	126.9	7.2	1.0	0.2	0.0	0.0
2011	1	26 943.7	67.1	1071.5	15.6	1.6	0.2	0.1	0.0
2012	1	1 520.3	2 657.9	112.8	191.8	8.9	0.2	0.0	0.0
2013	1	774 389.8	111.9	489.0	36.4	37.6	1.0	0.0	0.0
2014	1	6 557 958.9	3213.2	96.4	51.6	3.4	1.8	0.1	0.0
2015	1	61 732.7	27 874.4	590.3	29.9	13.7	0.6	0.2	0.0
2016	1	38 479.2	4 286.0	3519.2	46.7	2.6	3.2	0.1	0.1
2017	1	43 927.4	1 652.8	575.5	516.6	12.6	0.2	0.1	0.0
2018	1	993 378.2	932.5	351.9	56.7	13.4	0.2	0.0	0.0
2019	1	762 140.2	9 557.5	97.1	17.2	3.2	0.4	0.0	0.0
2020	1	150 844.4	9 794.8	1245.2	22.6	5.5	0.5	0.1	0.0
2021	1	245 486.9	802.1	1089.4	52.1	2.0	0.6	0.2	0.0
2022		13 952.4	3 162.4	434.8	204.4	8.6	0.4	0.0	0.0

Table 36.12. 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 36.13. Whiting in Division 6.a. Parameter estimates from the updated SAM assessment model.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-5.924	0.158	0.003	0.002	0.004
logFpar_1	-5.963	0.159	0.003	0.002	0.004
logFpar_2	-6.123	0.163	0.002	0.002	0.003
logFpar_3	-6.243	0.172	0.002	0.001	0.003
logFpar_4	-6.916	0.193	0.001	0.001	0.001
logFpar_5	-5.870	0.236	0.003	0.002	0.005
logFpar_6	-5.713	0.248	0.003	0.002	0.005
logFpar_7	-5.480	0.245	0.004	0.003	0.007
logFpar_8	-5.710	0.257	0.003	0.002	0.006
logFpar_9	-6.346	0.255	0.002	0.001	0.003
logFpar_10	-4.668	0.226	0.009	0.006	0.015
logFpar_11	-5.172	0.186	0.006	0.004	0.008
logFpar_12	-5.167	0.183	0.006	0.004	0.008
logFpar_13	-5.583	0.188	0.004	0.003	0.005
logFpar_14	-6.003	0.205	0.002	0.002	0.004
logFpar_15	-6.370	0.245	0.002	0.001	0.003
logFpar_16	-7.234	0.277	0.001	0.000	0.001
logSdLogFsta_0	-0.963	0.139	0.382	0.289	0.504
logSdLogN_0	-0.549	0.161	0.577	0.418	0.797
logSdLogN_1	-1.796	0.265	0.166	0.098	0.282
logSdLogObs_0	-0.206	0.202	0.814	0.543	1.220
logSdLogObs_1	-0.973	0.082	0.378	0.321	0.445
logSdLogObs_2	-0.430	0.154	0.650	0.478	0.886
logSdLogObs_3	-0.333	0.066	0.717	0.628	0.818
logSdLogObs_4	-0.451	0.095	0.637	0.526	0.771
logSdLogObs_5	0.998	0.146	2.714	2.027	3.634
logSdLogObs_6	0.814	0.137	2.257	1.715	2.970
logSdLogObs_7	1.226	0.098	3.406	2.798	4.146
transfIRARdist_0	3.596	9 098.548	36.443	0.000	Inf
transfIRARdist_1	-0.935	0.298	0.393	0.216	0.713
transfIRARdist_2	3.300	1 280.194	27.110	0.000	Inf
itrans_rho_0	1.489	0.192	4.434	3.021	6.507

*** 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 36.14. Whiting in Division 6.a. SAM estimated population numbers-at-age (thousands).

	Age							
Year	0	1	2	3	4	5	6	7+
1981	763 412	193 790	475 359	81 297	22 271	6 971	2 124	1 927
1982	797 726	259 978	71 777	211 546	35 877	9 605	3 072	2 014
1983	1 042 771	264 439	79 079	31 330	88 931	14 556	3 868	2 307
1984	874 799	360 259	79 844	26 930	11 288	31 285	4 669	2 390
1985	757 054	288 289	111 307	26 761	7 642	3 293	8 673	2 258
1986	1 300 200	235 629	96 837	36 224	7 107	1 664	704	2 559
1987	501 712	490 357	89 284	37 121	12 529	2 181	491	1 302
1988	750 989	145 389	155 741	32 143	11 298	3 421	533	656
1989	652 450	250 628	39 453	45 492	10 167	2 713	736	371
1990	858 446	202 578	88 768	11 481	13 098	3 014	628	332
1991	1 135 809	280 865	65 904	38 919	4 178	4 472	1 001	378
1992	791 810	391 675	98 851	24 513	16 111	1 534	1 480	562
1993	802 797	251 080	136 524	36 351	9 009	6 252	556	856
1994	770 037	266 089	91 486	52 297	13 698	3 267	2 276	647
1995	691 052	256 081	103 407	38 126	19 250	4 967	1 187	1 234
1996	648 757	224 601	92 815	38 496	13 923	6 197	1 663	1 039
1997	661 438	200 857	67 864	33 105	11 981	3 941	1 587	1 029
1998	423 291	219 825	63 665	20 992	11 122	3 367	1 117	1 111
1999	865 111	121 292	65 234	16 067	5 507	2 945	724	839
2000	339 589	309 653	39 808	17 140	3 529	1 292	686	594
2001	211 962	97 124	89 013	11 970	3 820	871	294	456
2002	281 186	63 966	34 358	27 343	3 854	1 173	261	345
2003	218 771	89 246	17 323	12 754	8 209	1 421	468	295
2004	123 089	72 645	27 883	5 436	4 328	3 029	546	408
2005	112 730	36 359	21 564	8 751	1 650	1 424	1 104	489
2006	71 315	37 163	12 923	8 575	3 525	747	708	896
2007	64 685	21 610	14 395	5 836	3 700	1 712	378	927
2008	106 003	20 621	7 988	7 078	2 743	1 908	826	751
2009	306 918	36 117	9 299	4 041	3 652	1 405	1 017	905
2010	100 902	115 359	14 928	4 717	2 028	2 049	736	1 145

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2011	205 320	27 604	43 826	7 567	2 465	1 018	1 180	1 037
2012	109 963	72 536	11 897	19 909	4 741	1 220	581	1 236
2013	240 008	33 751	26 482	6 971	10 563	2 482	710	1 069
2014	442 144	79 134	10 194	11 497	4 164	5 191	1 438	1 118
2015	310 278	149 164	26 782	6 490	6 829	2 410	3 293	1 591
2016	268 345	97 593	64 852	13 085	3 628	3 866	1 441	2 964
2017	207 485	92 470	37 476	33 211	7 029	2 093	2 140	2 378
2018	410 469	62 143	37 448	19 265	15 866	3 768	1 091	2 408
2019	460 578	147 145	24 051	18 495	10 031	7 424	2 096	1 909
2020	177 775	171 906	55 272	12 796	10 649	5 169	3 985	2 142
2021	138 700	55 957	65 471	24 851	7 560	6 598	2 827	3 429
2022	143 462	44 241	23 546	32 984	12 862	4 465	4 125	3 209
2023	143 462	50 205	19 606	12 567	18 448	7 252	2 554	4 580

Table 36.15. Whiting in Division 6.a. SAM estimates for F-at-age.

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.023	0.06	0.126	0.219	0.277	0.313	0.333	0.16
1982	0.035	0.095	0.193	0.313	0.374	0.414	0.436	0.207
1983	0.049	0.137	0.29	0.47	0.557	0.622	0.648	0.297
1984	0.057	0.162	0.362	0.601	0.731	0.815	0.861	0.384
1985	0.06	0.171	0.416	0.71	0.924	1.044	1.117	0.477
1986	0.047	0.129	0.307	0.488	0.633	0.725	0.802	0.342
1987	0.073	0.212	0.45	0.634	0.791	0.906	0.988	0.399
1988	0.087	0.259	0.529	0.697	0.876	1.027	1.083	0.424
1989	0.078	0.23	0.474	0.63	0.767	0.913	0.936	0.358
1990	0.058	0.166	0.327	0.429	0.519	0.605	0.596	0.231
1991	0.057	0.164	0.33	0.437	0.514	0.574	0.544	0.211
1992	0.055	0.159	0.319	0.425	0.491	0.527	0.49	0.193
1993	0.045	0.126	0.265	0.387	0.485	0.537	0.495	0.192
1994	0.041	0.114	0.239	0.361	0.461	0.508	0.468	0.178
1995	0.053	0.151	0.308	0.446	0.552	0.597	0.526	0.194
1996	0.072	0.215	0.418	0.598	0.721	0.775	0.632	0.219
1997	0.073	0.218	0.411	0.582	0.666	0.709	0.554	0.183
1998	0.099	0.306	0.564	0.794	0.867	0.941	0.736	0.227
1999	0.095	0.293	0.551	0.826	0.922	0.968	0.774	0.22
2000	0.11	0.345	0.562	0.832	0.958	0.925	0.722	0.192
2001	0.08	0.243	0.395	0.569	0.677	0.625	0.452	0.116
2002	0.083	0.254	0.363	0.481	0.525	0.443	0.284	0.073
2003	0.079	0.243	0.319	0.429	0.46	0.373	0.231	0.059
2004	0.102	0.313	0.357	0.484	0.496	0.379	0.233	0.064
2005	0.06	0.173	0.164	0.219	0.227	0.174	0.113	0.034
2006	0.054	0.155	0.127	0.181	0.21	0.175	0.123	0.039
2007	0.041	0.123	0.095	0.139	0.176	0.154	0.112	0.037
2008	0.033	0.102	0.069	0.102	0.137	0.122	0.088	0.03
2009	0.049	0.163	0.085	0.111	0.139	0.119	0.081	0.028
2010	0.064	0.22	0.098	0.116	0.136	0.117	0.079	0.027

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2011	0.04	0.137	0.049	0.053	0.06	0.052	0.035	0.012
2012	0.048	0.181	0.057	0.06	0.067	0.059	0.038	0.013
2013	0.059	0.24	0.064	0.062	0.065	0.058	0.037	0.012
2014	0.031	0.119	0.031	0.033	0.037	0.038	0.025	0.008
2015	0.034	0.132	0.04	0.047	0.05	0.052	0.032	0.01
2016	0.027	0.105	0.033	0.04	0.04	0.043	0.025	0.007
2017	0.026	0.107	0.035	0.044	0.045	0.051	0.026	0.007
2018	0.018	0.078	0.028	0.037	0.038	0.039	0.019	0.004
2019	0.02	0.09	0.033	0.048	0.052	0.053	0.025	0.005
2020	0.017	0.075	0.027	0.04	0.046	0.048	0.022	0.004
2021	0.012	0.047	0.02	0.038	0.054	0.065	0.033	0.005
2022	0.005	0.02	0.009	0.021	0.033	0.045	0.025	0.004

Table 36.16. 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	442 010	763 412	1 318 519	78 366	110 258	155 129	12 194	2 132	0.088	0.135	0.207
1982	486 781	797 726	1 307 297	69 660	93 759	126 195	13 880	5 485	0.139	0.2	0.288
1983	640 909	1 042 771	1 696 606	53 537	68 865	88 580	15 962	6 294	0.213	0.299	0.42
1984	538 631	874 799	1 420 776	39 350	49 075	61 203	16 459	4 017	0.27	0.375	0.521
1985	459 217	757 054	1 248 059	31 721	39 777	49 879	12 879	4 840	0.315	0.432	0.593
1986	783 929	1 300 200	2 156 473	26 653	33 880	43 067	8 458	2 669	0.221	0.308	0.43
1987	304 044	501 712	827 892	31 101	38 864	48 565	11 542	11 918	0.318	0.432	0.585
1988	444 520	750 989	1 268 747	31 569	40 781	52 682	11 349	8 132	0.366	0.495	0.668
1989	401 679	652 450	1 059 777	21 998	27 834	35 218	7 523	5 876	0.321	0.445	0.616
1990	532 759	858 446	1 383 231	20 394	26 539	34 534	5 642	4 530	0.219	0.307	0.432
1991	702 749	1 135 809	1 835 736	22 919	29 176	37 141	6 657	4 883	0.223	0.311	0.432
1992	491 894	791 810	1 274 591	28 185	35 519	44 763	6 004	9 249	0.215	0.301	0.421
1993	500 672	802 797	1 287 236	31 614	40 245	51 232	6 871	4 759	0.184	0.26	0.366
1994	484 356	770 037	1 224 216	31 037	38 882	48 710	5 900	3 455	0.168	0.238	0.336
1995	435 942	691 052	1 095 449	31 405	39 022	48 485	6 078	5 771	0.217	0.302	0.419
1996	409 012	648 757	1 029 030	28 780	35 589	44 008	7 158	7 940	0.3	0.41	0.562
1997	423 230	661 438	1 033 720	23 032	28 547	35 383	6 291	5 251	0.293	0.404	0.557
1998	267 333	423 291	670 230	19 742	24 475	30 343	4 628	9 216	0.407	0.554	0.755
1999	546 688	865 111	1 369 001	15 113	19 029	23 959	4 613	3 975	0.405	0.557	0.765
2000	215 417	339 589	535 338	14 272	17 958	22 596	3 011	13 285	0.426	0.579	0.788
2001	127 516	211 962	352 331	14 271	18 743	24 615	2 439	4 263	0.284	0.402	0.571
2002	177 604	281 186	445 179	11 296	14 794	19 376	1 768	2 851	0.247	0.366	0.541
2003	141 656	218 771	337 865	8 323	11 039	14 642	1 331	1 987	0.215	0.33	0.507

Year	Recruitment age 0			SSB			Landings*	Discards*	Fishing mortality ages 1-3		
	Low	Value	High	Low	Value	High			Low	Value	High
2004	78 381	123 089	193 300	7 265	9 865	13 397	799	2 889	0.241	0.385	0.614
2005	71 469	112 730	177 813	5 669	8 048	11 425	335	971	0.116	0.185	0.296
2006	44 492	71 315	114 308	5 165	7 343	10 438	378	748	0.099	0.154	0.242
2007	40 114	64 685	104 306	4 883	6 991	10 010	481	367	0.076	0.119	0.186
2008	64 707	106 003	173 653	4 465	6 437	9 279	441	156	0.058	0.091	0.144
2009	184 779	306 918	509 792	4 557	6 539	9 384	480	826	0.077	0.12	0.187
2010	60 081	100 902	169 458	6 206	8 919	12 818	338	1 094	0.091	0.145	0.23
2011	124 679	205 320	338 119	8 228	12 455	18 856	229	631	0.048	0.08	0.132
2012	64 436	109 963	187 657	8 724	13 227	20 055	304	772	0.06	0.099	0.166
2013	141 076	240 008	408 317	9 188	14 241	22 074	216	1 225	0.069	0.122	0.215
2014	263 221	442 144	742 689	8 448	13 099	20 310	181	748	0.035	0.061	0.105
2015	182 593	310 278	527 250	10 863	16 840	26 106	223	1 457	0.043	0.073	0.124
2016	158 945	268 345	453 043	14 679	23 230	36 763	226	1 038	0.034	0.059	0.102
2017	118 653	207 485	362 823	16 397	25 832	40 696	178	1 326	0.036	0.062	0.107
2018	240 689	410 469	700 011	16 052	24 987	38 893	190	648	0.028	0.047	0.081
2019	266 076	460 578	797 260	15 651	24 009	36 829	502	925	0.034	0.057	0.097
2020	96 980	177 775	325 883	18 087	27 838	42 846	544	826	0.027	0.047	0.082
2021	69 113	138 700	278 351	19 648	30 481	47 286	873	262***	0.02	0.035	0.064
2022	62 272	143 462	330 507	17 936	28 405	44 985	613	123	0.009	0.017	0.031
2023	34 514	143 462	596 324	15 395	24 858	40 137					

*** 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 (2013–2022).**

***** Underestimate due to reduced discard sampling from the *Nephrops* fleet.**

Table 36.17. Whiting in Division 6.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change *	% Advice change **
ICES advice basis									
MSY approach = F_{MSY} × SSB (2024) /MSY $B_{trigger}$	3 879	2 612	1 267	0.195	0.064	0.131	19 777	-16.9	-6.6
Other scenarios									
MSY approach: $F_{MSY\ lower}$ × SSB (2024) /MSY $B_{trigger}$	3 245	2 185	1 060	0.16	0.053	0.107	20 391	-14.3	-22
MSY approach: $F_{MSY\ upper}$ × SSB (2024) /MSY $B_{trigger}$	3 879	2 612	1 267	0.195	0.064	0.131	19 777	-16.9	-6.6
F = 0	0	0	0	0	0	0	23 671	-0.52	-100
F= F_{MSY}	4 158	2 799	1 359	0.21	0.069	0.141	19 512	-18	0.07
F= $F_{MSY\ lower}$	3 482	2 345	1 137	0.173	0.057	0.116	20 159	-15.3	-16.2
F= F_{pa}	4 158	2 799	1 359	0.21	0.069	0.141	19 512	-18	0.07
F= F_{lim}	5 878	3 950	1 928	0.31	0.102	0.21	17 923	-25	41
SSB (2025) = B_{lim}	6 582	4 421	2 161	0.35	0.116	0.24	17 286	-27	58
SSB (2025) = B_{pa} = MSY $B_{trigger}$ ***									
SSB (2025) = SSB (2024) ***									
F = F_{2022}	361	243	118	0.017	0.005	0.012	23 292	-2.10	-91

*** SSB 2025 relative to SSB 2024.**

**** Advice value for 2024 relative to the corresponding 2023 value (4155 tonnes).**

***** These options were left blank because they cannot be achieved in 2025, even with zero catch in 2024.**

Figure 36.1. 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 36.2. Whiting in Division 6.a. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2022 as entered into InterCatch.

Figure 36.3. 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 36.4. 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 36.5. Whiting in Division 6.a. Catch numbers-at-age by year.

Figure 36.6. Whiting in Division 6.a. Mean weight-at-age in the landings, discards, catch and stock.

Figure 36.7. 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 36.8. 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 36.9. Whiting in Division 6.a. The re-estimated maturity ogive (solid black line) with the corresponding 95% confidence interval shown (grey bands). The previous maturity ogive (estimated at WKNSEA 2021) is also shown here (solid blue line) with the corresponding 95% confidence intervals (dashed blue line). The midpoints of the two maturity ogives (A50%) are indicated in the respective colours.

Figure 36.10. 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 2018–2023. Numbers are standardised to 30 minutes towing.

Figure 36.11. 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 2017–2022. Numbers are standardised to 30 minutes towing.

Figure 36.12. 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.

Figure 36.13. 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 2003–2022 for the catch data.

Figure 36.14. 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 36.15. 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 36.16. Whiting in Division 6.a. Summary of the SAM assessment model estimates (orange line) with 95% confidence intervals (yellow polygon).

Figure 36.17. 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 36.18. 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 36.19. Whiting in Division 6.a. Leave-one-out sensitivity analysis of the SAM assessment model.

Figure 36.20. Whiting in Division 6.a. Retrospective patterns for the SAM assessment model.

Figure 36.21. Whiting in Division 6.a. The SAM assessment model Stock–Recruit relationship.

Figure 36.22. Whiting in Division 6.a. Comparison of 2023 SAM assessment estimates (solid lines) with revised 2022 SAM assessment estimates (dotted lines).

Figure 36.23. 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 36.24. Whiting in Division 6.a. Comparison of the Recruitment and SSB estimates by SAM and SURBAR (the run with three tuning series).

Figure 36.25. Whiting in Division 6.a. ICES Standard Graphs for the SAM assessment. The assumed recruitment value for 2023 is shaded in a lighter colour.

Figure 36.26. Whiting in Division 6.a. The SAM assessment model estimated F-at-age.

Figure 36.27. Whiting in Division 6.a. Proportion of catch discarded-at-age, from SAM landing fraction input file.

Figure 36.28. Whiting in Division 6.a. SAM forecast in the intermediate year followed by F_{MSY} (the proposed advice) in subsequent years.

Figure 36.29. Whiting in Division 6.a. Contribution of recruitment years to projected 2024 catch and 2025 SSB under an F_{MSY} catch scenario.

Figure 36.30. Whiting in Division 6.a. Comparison of numbers-at-age: data (circles), intermediate year assumptions (triangles), and median forecast estimates (squares) from 2022 (orange) and 2023 (blue) assessment models.

Figure 36.31. Whiting in Division 6.a. Comparison of stock biomass-at-age: data (circles), intermediate year assumptions (triangles), and median forecast estimates (squares) from 2022 (orange) and 2023 (blue) assessment models.

37 Whiting (*Merlangius merlangus*) in Division 6.b (Rockall)

Type of assessment in 2023

No assessment was performed in 2023.

ICES advice applicable to 2022–2024

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://ices-library.figshare.com/articles/report/Whiting_Merlangius_merlangus_in_Division_6_b_Rockall_/18639044

37.1 General

Stock description

There is an absence of information on whiting stock structure in this region and whiting caught at Rockall may potentially be part of the adjacent 6.a stock.

Management applicable to 2022 and 2023

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 2023 and 2022 is shown below.

TAC for 2023

Species:	Whiting *Merlangius merlangus*		Zone:	6; United Kingdom and International waters of 5b; international waters of 12 and 14 (WHG/56-14)
Germany	7	(1)	Analytical TAC	
France	135	(1)	Article 8 of this Regulation applies	
Ireland	802	(1)	Article 3 of Regulation (EC) No 847/96 shall not apply	
Union	944	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
United Kingdom	1 692	(1)		
TAC	2 636	(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) 2023/194 of 30 January 2023).

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 Council Regulation (EU) 2022/109 of 27 January 2022).

Fishery in 2022

No specific information is available for 2022. Whiting at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

37.2 Data

Landings data for whiting in 27.6.b are shown by nation in Table 37.1 and Figure 37.1. Total officially reported landings were 13 t in 2022, of which 11 t were reported by the UK and 2 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 2022 (Figure 37.2). Total catch by category (including raised discards) is shown in Figure 37.3. All the landings and discards were from the TR1 fleet. The overall discard rate was 63%. In addition to catch, some landings and discards age compositions (only from the Scottish fleet) were also uploaded to InterCatch. Catch numbers-at-age (in different catch categories) are shown in Figure 37.4. The overview of catch data (including raised discards) by country and catch category is shown below:

Country	Landings(tonnes)	Discards (tonnes)	Total (tonnes)
Ireland	2.1	0.7	2.7
UK (Scotland)	10.7	20.8	31.2
Total	12.8	21.4	34.2

Survey catch rates of whiting at Rockall are extremely low (Table 37.2) 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.

37.3 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 37.2 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.

37.4 Management considerations

Rockall whiting is managed under a TAC for the combined divisions 6.a and 6.b and therefore cannot be effective in limiting catches in Rockall.

Table 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***	**2022***		
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
France	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-		
Ireland	16	23	4	2	3	-	+	6	6	9	7	9	24	13	6	2		
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	11		
Total	17	31	16	18	9	1	3	29	52	33	40	43	89	38	17	13		

* Preliminary.

+ < 0.5 t

Table 37.2. 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 hours									
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
2022	10	1.737	21.121	0.986	0	0	0	0	0

Figure 37.1. Whiting in Division 27.6.b. Official landings of whiting in 27.6.b by nation.

Figure 37.2. Whiting in Division 27.6.b. Landings (left panel) and discards (right panel) by metier (kg) in 2022 as entered into InterCatch.

Figure 37.3. Whiting in Division 27.6.b. Landings (sampled and unsampled, in grey), sampled discards (in black) and raised unsampled discards (in red) after allocations within InterCatch.

Figure 37.4. Whiting in Division 27.6.b. Catch numbers-at-age by sampled and unsampled landings, and sampled and raised (unsampled) discards, after allocations within InterCatch.

38 Whiting in 7.a

2023 Assessment and advice

WGCSE 2023 updated the assessment with 2022 data. The advice for this stock is biennial and advice is issued in 2023 for each of the years 2024 and 2025.

This is a category 1 stock where a full analytical assessment and forecast is carried out.

Type of assessment

SPALY update of ASAP assessment.

ICES advice applicable to 2023 (and 2022)

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

Technical Service 2022

EU DGMARE has requested that ICES evaluate the following:

For bycatch and for target stocks where ICES is advising zero TACs but the stock is caught in mixed-fisheries with other species where non-zero catches are advised, where possible ICES will provide the EU with illustrative catch scenarios that are consistent with the advice for the main target species in the fishery.

As a result the advice given for whiting in Division 7.a is that forecasted bycatch levels in 2023 are 1125 tonnes, using a model of whiting bycatch in the *Nephrops* fishery and assuming 8476 tonnes of *Nephrops* catches in 2023. This is expected to result in a 1% increase in SSB in 2024.

https://doi.org/10.17895/ices.advice.20170970.v2

38.1 General

Stock description and management units

The stock and the management unit are both ICES Division 7.a (Irish Sea). Whiting landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the 7.b,c,e–k whiting stock since 2003.

Management applicable to 2022

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 and 2023, the TAC was set at 721 t, with slightly differing country quotas between the two years.

Official landings as reported to ICES in 2022 were 78 t, a decrease from 149 t in 2021.

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)		
Union	299	(1)	Article 4 of Regulation (EC) No 847/96 shall not apply	
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.

TAC 2023

Species:	Whiting *Merlangius merlangus*		Zone:	7a (WHG/07A.)
Belgium	2	(1)	Analytical TAC	
France	21	(1)	Article 8 of this Regulation applies	
Ireland	269	(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	293	(1)		
United Kingdom	428	(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 2022

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

The fishery in 2022 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 finfish 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 is a bycatch. Figure 38.2 shows the contribution of catch by fleet.

Table 38.1 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 38.2. In recent years the values provided to the WG are very similar to officially reported landings.

Belgium and UK(NI) submitted discard estimates for 2022. However, there were no OTB_CRU discard estimates from Ireland. This métier constitutes on average 17% of the overall OTB_CRU discards for the stock. In order to determine an estimate from this component of the catch for 2022, a linear model was applied to the total weight of whiting discards and effort from the Irish OTB_CRU fleet from 2010-2021 weighted by the number of trips. This resulted in an estimate of 211t for the Irish OTB_CRU fleet for 2022.

Total discards were estimated to be 986 t in 2022.

No BMS landings or logbook registered discards were submitted to ICES for 2022.

The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, was continued in 2022 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 2022 catches by main gear types is presented below.

Catch	Landings*			Discards	
1043 tonnes	Finfish-directed otter trawls	*Nephrops*-directed otter trawls	1043 tonnes	Finfish-directed otter trawls	*Nephrops*-directed otter trawls
	89.8%	1.2%		89.8%	1.2%
	57 tonnes			986 tonnes	

***Landings from statistical rectangles 33E2 and 33E3 reallocated to whiting landings in divisions 27.7b-ce-k.**

38.2 Information from the Industry

There was no information on the whiting stock from the industry.

38.3 Data

Data were provided by all countries according to the data call.

For WGCSE (2023) 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 38.1 and indicate the declining trend since the start of the time-series. In 2022, there was a decrease in landings from 91 t to 57 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 (Table 38.3).

Fishery discards

Discard estimates are available from Northern Ireland, Irish 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 38.4. 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 2022, 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 2022, discard sampling numbers-at-age were available from Northern Ireland and Ireland (OTB_DEF fleet only).

Discard number-at-age are given in Table 38.5. 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, 2 and 3 discarded later in time-series (Figure 38.4).

The length frequency of discards of national sampled fleets in 2019 is given in Figure 38.3 This information has not been updated for 2022. 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 38.5 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 38.6 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). There was no new information available for the NI MIK (I9826) survey in 2022. Previous sensitivity analysis has shown that missing data from this survey have little impact on the overall assessment.

Figure 38.6 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.

38.4 Historical stock development

Model used: ASAP

Software used: ASAP V3.0.17 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

FLR with R version 3.6.1 (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 38.7 shows the ASAP input data.

Final update assessment

The final assessment was run using the same settings as described in WKIRISH, 3. These final settings are described in the Stock Annex. The exception to this is the CV of 0.3 used for catch numbers-at-age for 2020.

Figure 38.7 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 38.8 shows the model estimates.

The observed and predicted index CPUE values are shown in Figure 38.8. There is poor fit to the Northern Irish groundfish survey indices in the first half of the series but it improves in recent years.

The observed and predicted catches are shown in Figure 38.9. 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 38.10 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern. 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. In some years, recruitment appears to be overestimated in the assessment.

A Mohn's rho analysis was conducted based on the ASAP stock assessment results, i.e. the last data year (2022) 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	0.136	-0.149	0.30

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 38.9 shows the estimated fishing mortality-at-age and Table 38.10 shows the stock numbers-at-age. The stock summary is given in Table 38.11 and Figure 38.11.

The present stock size is extremely low. SSB has declined since the start of the time-series and has been well below B_{lim} since the mid-1990s. Recruitment has been low since the early 1990s 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.

38.5 Short-term predictions

Short-term projections were performed using FLR libraries. Recruitment for 2023–2024 was estimated at 121079 (GM 2000–2021: thousands). As the retrospective pattern has shown an overestimate of recruitment for some years, the terminal year was excluded from the GM for the WGCSE, 2023 assessment. Three year averages (2020–2022) were used for F (unscaled) and weights-at-age.

Input data for the short-term forecast are given in Table 38.12. The single-option output is given in Table 38.13, Table 38.14 and Table 38.15 gives the management options.

Estimates of the relative contribution of recent year classes to the 2024 landings and 2025 SSB are shown in Figure 38.12. The 2020–2021 year-class estimates from ASAP accounts for 81% of the projected landings in 2024. The 2023 GM assumption contributes considerably to the estimated SSB in 2024 as does the 2021 and 2022 ASAP assessment.

38.6 Medium-term projection

There is no analytical assessment for this stock.

38.7 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock at 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
	B_{lim}	10 000 t	Below 10 000 t recruitment is impaired
Precautionary	B_{pa}	16 300 t	B_{lim} combined with the assessment error
Approach	F_{lim}	0.37	F with 50% probability of SSB less than B_{lim}
	F_{pa}	0.22	$F_{p.05}$; 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.

38.8 Management plans

No management plan has been agreed or proposed.

38.9 Uncertainties and bias in assessment and forecast

This stock was benchmarked in January 2017. The result of the benchmark was that the stock was elevated from a category 3 stock (trend-based assessment) to a category 1 stock (analytical assessment). The assessment includes information from the commercial fishery, including both landings and discards, and takes into account selectivity changes that have occurred in 1995. Three survey series are used within the assessment. Natural mortality parameters were updated to reflect current stock dynamics. The highly fluctuating estimates of fishing mortality in recent years (2002–present) are likely to be the result of variability in the sampling data and discard

estimates. Despite this inherent uncertainty, it is clear from the assessment and additional information from surveys that the stock remains extremely low.

It was noted at WGCSE 2023 that the partitioning of landings and discards used for the forecast may not be representative as it is not reflective of recent catches where by on average over the last ten years ~95% of the catch is discarded. There are a considerable number of age 3 (100 t) and 4 (100 t) year olds contributing to the landing forecast of 275 t in 2024. The forecast is assuming that 81% of the catch is discarded in 2024.

38.10 Recommendations for next benchmark assessment

This stock was benchmarked in 2017 as part of the WKIRISH process. A number of recommendations for future work were made and these are listed below. Given the current stock status and issues outlined below there is a recommendation by WGCSE to benchmark this stock in 2024/2025.

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.

Maturity estimate are available from Northern Ireland. This was explored at WGCSE 2023 where the NI maturity estimates were used in alternative assessment run. It had little impact on the overall stock status but it more likely better estimated as it is derived from real data.

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.

Dietary and genetic analysis

AFBI have recently undertaken a project looking at the genetic and dietary status of whiting in the Irish Sea, the results of which will help life-history parameters of the whiting stock.

Ecosystem models

There are several ecosystem models developed for the Irish Sea, the most recent of which looks at foodweb interactions. Incorporating ecosystem models into the assessment and advice process will better inform on sustainable fisheries management and species conservation.

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.

38.11 Management considerations

Discarding in the *Nephrops* fishery is the main management issue. Despite the implementation of several technical measures, which experimentally reduce whiting catches, as part of the cod long-term management plan and the full implementation of the landings obligation in 2019, the discards estimates still remain high, approximately 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.

38.12 References

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38.13 Tables

Table 38.1. 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
2,015	1	<0.5	49		8					59
2,016	1	<0.5	44		5		<0.1			50
2,017	2	<0.5	32		17		<0.1			50
2018	1		44		19		<0.5			63
2019	4		129		63		<0.1			196
2020	5	<0.1	56		42		<0.1			102
2021*	2	<0.1	109		38					149
2022*	4	0.1	34		40					78

* Preliminary

Table 38.2. 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]	UK (NI) [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

Year	Discards by Country/Fleet					Discards	Landings	Catch
	Nephrops fishery [b]	IR-OTB fleet[ce]	UK (NI) [d]	Belgium	UK (E&W) fleet			
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
2022		213[g]	721	49	4	986	57	1,043

b Based on UK(N.Ireland) and Ireland data.

c Based on data from Ireland.

d Based on data from Northern Ireland.

e Raised using Days.

f Average IR-OTB discards (2017–2019).

g Of which 211 is based on LM (2010–2021).

*** Preliminary (and rounded).**

Table 38.3. Whiting landings taken or reported in ICES rectangles 33E2, 33E3 and 33E4 have been reassigned to the 7.e–k whiting stock since 2003.

Year	Official landings	ICES landings	ICES Discards	ICES catch	Landings taken or reported in rectangles 33E2 and 33E3
1988	11,492	10,245	1,611	11,856	
1989	11,328	11,305	2,103	13,408	
1990	8,183	8,212	2,444	10,656	
1991	7,411	7,348	2,598	9,946	
1992	7,094	8,588	4,203	12,791	
1993	5,977	6,523	2,707	9,230	
1994	5,637	6,763	1,173	7,936	
1995	5,465	4,893	2,151	7,044	
1996	5,581	4,335	3,631	7,966	
1997	4,472	2,277	1,928	4,205	
1998	3,355	2,229	1,304	3,533	
1999	1,989	1,670	1,092	2,762	
2000	1,130	762	2,118	2,880	
2001	1,066	733	1,012	1,745	
2002	714	747	740	1,487	
2003	554	517	480	996	159
2004	204	133	905	1,038	51
2005	164	125	272	397	33
2006	85	64	1,773	1,837	22
2007	197	35	1,512	1,547	161
2008	84	37	1,169	1,206	44
2009	100	39	1,321	1,360	63
2010	121	30	1,154	1,184	91
2011	118	31	946	977	75
2012	86	60	1,339	1,399	43
2013	68	33	948	981	33
2014	73	23	1,951	1,974	50
2015	59	28	1,521	1,549	34

Year	Official landings	ICES landings	ICES Discards	ICES catch	Landings taken or reported in rectangles 33E2 and 33E3
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
2022	78	57	986	1,043	21

***this includes the ICES estimate of 102 t for IR-OTB discards.**

Table 38.4. Whiting7.a. Landings numbers-at-age.

Year	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

Year	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
2022	0	0	16	83	58	11	1

Table 38.5. Whiting7.a. Discard numbers-at-age.

Year	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

Year	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
2022	2837	18777	1468	270	67	12	1

Table 38.5. Whiting in 7.a. Survey data available.

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey

1993	2022					
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

1993	2022					
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
1	1900.5	503.1	119.9	4.2	1.8	0.4

NIGFS-WIBTS-Q4: Northern Ireland October Groundfish Survey

1993	2022						
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
1	1934.2	1178.4	174.9	33.7	1.6	0.9	0.00

NIMIK : Northern Ireland MIK Net Survey

1994	2021			
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	2022		
1	1	0.75	0.79
0	1		
1	96	26	1988
1	93	21	1989
1	99	33	1990
1	216	25	1991
1	405	206	1992
1	253	95	1993
1	205	125	1994
1	1949	87	1995
1	169	194	1996
1	409	254	1997
1	893	199	1998
1	550	137	1999
1	320	122	2000
1	585	195	2001
1	280	96	2002
1	456	229	2003
1	917	330	2004
1	849	294	2005
1	1010	228	2006
1	339	89	2007
1	780	72	2008
1	389	371	2009
1	324	33	2010
1	1002	341	2011
1	442	426	2012
1	1535	228	2013
1	261	113	2014
1	211	112	2015
1	666	213	2016
1	489	230	2017
1	662	380	2018
1	307	186	2019
1	N/A	N/A	2020
1	340	132	2021
1	379	226	2022

Eastern Irish Sea FSP: Isadale 2005–2013: Numbers of fish per hour towed

2005	2013					
1	1	0.16	0.20			
1	6					
1	0.22	11.06	21.12	5.28	0.98	0
	0.69					
1	8.69	46.65	15.22	1.85	0.53	0.013
	0					
1	4.24	10.77	5.55	1.01	0.28	0.02
	0					
1	3.7	10.29	8.58	1.99	0.38	0.29
	0					
1	27.3	84.91	48.67	3.61	0.33	0
	0					
1	4.54	57.92	43.5	4.95	0.16	0.05
	0.02					
1	2.22	8.42	31.85	5.13	0.96	0.02
	0					
1	5.15	80.9	29.75	22.08	1.24	0.13
	0					
1	4.21	47.35	26.43	3.13	1.72	0.01
	0					

Table 38.6. Whiting 7.a. ASAP input data.

```
# ASAP VERSION 3.0
# Irish Sea Whiting
#
# ASAP GUI 15 AUG 2012
#
# Number of Years
43
# 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
# 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
```

0.026	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
0.02	0.04	0.105	0.2	0.369	0.445	0.559

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	0.0275	0.06	0.1337	0.2251	0.3284	0.3758
0	0.0296	0.0603	0.1346	0.2462	0.3417	0.4099
0	0.0326	0.0655	0.1346	0.2582	0.356	0.4141
# 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
2
2
2
2
2
# Selectivity Options for each block 1=by age, 2=logisitic, 3=double logistic
2  2
# Selectivity Block #1 Data
0	1	0	0.25
0.5	1	0	0.25
0.9	1	0	0.25
1	-1	0	0.25
1	-1	0	0.25
1	-1	0	0.25
1	-1	0	0.25
```

```
3 1 0 1
0.5 1 0 1
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
# Selectivity Block #2 Data
0.2 1 0 0.5
1 -1 0 0
1 -1 0 0
1 -1 0 0
1 -1 0 0
1 -1 0 0
1 -1 0 0
2 1 0 1
0.5 1 0 1
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
# Fleet Start Age
1
# Fleet End Age
7
# Age Range for Average F
2 4
# Average F report option (1=unweighted, 2=Nweighted, 3=Bweighted)
1
# Use Likelihood constants? (1=yes)
1
# Release Mortality by Fleet
1
# Catch Data
# Fleet-1 Catch Data
12786 46838 28699 6533 2574 350 621 16737
9865 36138 38173 16166 2622 821 339 21331
4088 13916 18658 19359 6108 813 400 17969
23847 12214 11979 9109 4530 1165 321 12405
26394 52154 14250 5268 2571 1045 402 14999
12380 42001 37183 8696 996 675 372 18169
28364 27417 18303 10842 1877 285 270 12129
16594 50747 23438 6968 1943 242 111 14270
6922 24941 27708 6989 1513 396 197 11856
17247 32346 16505 13037 3645 490 177 13408
4216 41312 20957 4806 1477 318 128 10656
20451 36760 22229 5975 994 311 84 9946
1497 69831 32311 8056 1374 462 93 12791
12677 16721 39175 7753 937 135 27 9230
3731 15308 8795 20211 1830 208 50 7936
7118 18737 17110 3512 4678 233 21 7044
12861 41299 14330 9408 1344 1082 135 7966
8163 26107 9591 3256 1936 87 79 4205
6096 27460 5580 5277 932 261 95 3533
20852 8018 4923 2835 776 161 121 2762
7321 39242 5758 1566 354 115 25 2880
16940 12742 4338 1108 181 53 20 1745
8538 13480 2336 1710 408 48 42 1487
12389 4685 1252 606 199 0 0 996
19699 14938 362 176 150 17 0 1038
643 5797 448 232 98 21 3 397
15764 20624 654 109 39 9 1 1837
17436 24343 787 82 10 3 0 1547
10645 20032 742 41 5 1 0 1206
6622 27513 1220 22 4 1 0 1360
3946 15120 2894 75 4 0 0 1184
25982 8198 675 373 15 3 0 977
```

```
6637 31023 819 116 61 12 1 1399
8501 12026 649 24 5 1 1 981
13467 27555 2450 284 21 1 1 1974
3883 23595 2613 267 15 1 1 1549
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
4272 18880 6527 514 80 46 6 1662
2837 18777 1468 270 67 12 1 1043
# 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
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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
# 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
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```

```
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
# 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 50
2022 2530 0.3 0 0.751 0.199 0.047 0.002 0.001 0 50
# Index-2 Data
1980 0 0 0 0 0 0 0 0 0 0
1981 0 0 0 0 0 0 0 0 0 0
1982 0 0 0 0 0 0 0 0 0 0
1983 0 0 0 0 0 0 0 0 0 0
1984 0 0 0 0 0 0 0 0 0 0
1985 0 0 0 0 0 0 0 0 0 0
1986 0 0 0 0 0 0 0 0 0 0
1987 0 0 0 0 0 0 0 0 0 0
1988 0 0 0 0 0 0 0 0 0 0
1989 0 0 0 0 0 0 0 0 0 0
1990 0 0 0 0 0 0 0 0 0 0
1991 0 0 0 0 0 0 0 0 0 0
1992 0 0 0 0 0 0 0 0 0 0
1993 2309 0.3 0.309 0.451 0.206 0.029 0.004 0.001 0 50
1994 2829 0.3 0.393 0.467 0.074 0.053 0.012 0.001 0 50
1995 3841 0.3 0.813 0.124 0.043 0.008 0.009 0.001 0 50
1996 3103 0.3 0.743 0.191 0.043 0.017 0.003 0.002 0 50
1997 3889 0.3 0.675 0.174 0.128 0.016 0.005 0.001 0.001 50
1998 3566 0.3 0.803 0.131 0.043 0.02 0.002 0.001 0 50
1999 3851 0.3 0.644 0.28 0.05 0.013 0.011 0.001 0 50
2000 3631 0.3 0.654 0.299 0.035 0.006 0.005 0.002 0.001 50
2001 7322 0.3 0.868 0.09 0.037 0.004 0.001 0 0 50
2002 4331 0.3 0.622 0.305 0.062 0.01 0.001 0 0 50
2003 7017 0.3 0.631 0.224 0.131 0.011 0.002 0 0 50
2004 5545 0.3 0.804 0.126 0.048 0.021 0.001 0 0 50
2005 3066 0.3 0.775 0.159 0.06 0.005 0 0 0 50
2006 3050 0.3 0.934 0.047 0.015 0.003 0.001 0 0 50
```

2007	3296	0.3	0.656	0.291	0.045	0.005	0.001	0.001	0	50
2008	6315	0.3	0.773	0.208	0.018	0.001	0	0	0	50
2009	2838	0.3	0.791	0.18	0.025	0.003	0.001	0	0	50
2010	2855	0.3	0.797	0.109	0.091	0.003	0	0	0	50
2011	4053	0.3	0.872	0.086	0.034	0.006	0.001	0	0	50
2012	1894	0.3	0.703	0.213	0.071	0.01	0.003	0	0	50
2013	7680	0.3	0.929	0.046	0.02	0.004	0	0	0	50
2014	5157	0.3	0.873	0.098	0.026	0.002	0	0	0	50
2015	3816	0.3	0.734	0.234	0.03	0.002	0	0	0	50
2016	3817	0.3	0.712	0.225	0.053	0.008	0	0	0	50
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
2022	3324	0.3	0.582	0.355	0.053	0.01	0	0	0	50

Index-3 Data

1980	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	778	0.5	0	0	0	0	0	0	0	0
1995	225	0.5	0	0	0	0	0	0	0	0
1996	397	0.5	0	0	0	0	0	0	0	0
1997	205	0.5	0	0	0	0	0	0	0	0
1998	59	0.5	0	0	0	0	0	0	0	0
1999	91	0.5	0	0	0	0	0	0	0	0
2000	40	0.5	0	0	0	0	0	0	0	0
2001	167	0.5	0	0	0	0	0	0	0	0
2002	19	0.5	0	0	0	0	0	0	0	0
2003	148	0.5	0	0	0	0	0	0	0	0
2004	101	0.5	0	0	0	0	0	0	0	0
2005	135	0.5	0	0	0	0	0	0	0	0
2006	118	0.5	0	0	0	0	0	0	0	0
2007	82	0.5	0	0	0	0	0	0	0	0
2008	99	0.5	0	0	0	0	0	0	0	0
2009	173	0.5	0	0	0	0	0	0	0	0
2010	78	0.5	0	0	0	0	0	0	0	0
2011	122.2	0.5	0	0	0	0	0	0	0	0
2012	123.9	0.5	0	0	0	0	0	0	0	0
2013	197.6	0.5	0	0	0	0	0	0	0	0
2014	54.9	0.5	0	0	0	0	0	0	0	0
2015	59.5	0.5	0	0	0	0	0	0	0	0
2016	6.7	0.5	0	0	0	0	0	0	0	0
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
2022	0	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
2022 379 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
2022 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
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
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1
1
1
1
1
1
1
1
1
1
1
1
```

```
1
1
1
1
1
1
1
1
1
1
1
# Lambdas by Index
1  1  1  1  1
# Lambda for Total Catch in Weight by Fleet
1
# Lambda for Total Discards-at-Age by Fleet
0
# Catch Total CV by Year and Fleet
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.3
0.2
0.2
# Discard Total CV by Year and Fleet
0
0
0
0
```

0
0
0

```
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
10
# Discard Effective Sample Size by Year and Fleet
0
0
0
```

```
0
# 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
2023
# Projection Data by Year
2023     -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 38.7. Whiting 7.a. Selectivity of the catches and indices.

Age	Catch	NI-Q1	NI-Q4	NI-MIK
0	0.110	0	0.654	1.00
1	0.833	0.470	0.748	0.00
2	0.995	1.00	1.00	0.00
3	1.000	1.00	1.00	0.00
4	1.000	1.00	1.00	0.00
5	1.000	1.00	1.00	0.00
6	1.000	1.00	1.00	0.00

Table 38.8. Whiting 7.a Fishing mortality- (F) -at age.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1980	0.026	0.176	0.422	0.492	0.501	0.501	0.502
1981	0.031	0.211	0.508	0.593	0.603	0.604	0.604
1982	0.035	0.234	0.563	0.657	0.668	0.669	0.669
1983	0.035	0.238	0.571	0.666	0.678	0.679	0.679
1984	0.043	0.288	0.693	0.808	0.822	0.824	0.824
1985	0.052	0.352	0.846	0.987	1.004	1.006	1.006
1986	0.041	0.275	0.66	0.77	0.783	0.785	0.785
1987	0.043	0.291	0.698	0.815	0.829	0.83	0.831
1988	0.037	0.248	0.596	0.696	0.708	0.709	0.709
1989	0.052	0.349	0.838	0.977	0.994	0.996	0.996
1990	0.044	0.298	0.716	0.836	0.85	0.852	0.852
1991	0.045	0.304	0.731	0.853	0.868	0.869	0.869
1992	0.075	0.506	1.217	1.42	1.444	1.447	1.447
1993	0.06	0.405	0.973	1.135	1.155	1.157	1.157
1994	0.062	0.42	1.008	1.176	1.197	1.199	1.199
1995	0.101	0.763	0.911	0.916	0.916	0.916	0.916
1996	0.109	0.828	0.989	0.993	0.994	0.994	0.994
1997	0.095	0.72	0.86	0.865	0.865	0.865	0.865
1998	0.134	1.015	1.213	1.218	1.219	1.219	1.219
1999	0.106	0.803	0.959	0.964	0.964	0.964	0.964
2000	0.137	1.042	1.244	1.25	1.251	1.251	1.251
2001	0.112	0.847	1.011	1.016	1.016	1.016	1.016
2002	0.153	1.159	1.384	1.391	1.391	1.391	1.391
2003	0.077	0.581	0.693	0.697	0.697	0.697	0.697
2004	0.215	1.628	1.944	1.954	1.954	1.954	1.954
2005	0.059	0.446	0.533	0.535	0.535	0.535	0.535
2006	0.189	1.429	1.707	1.715	1.716	1.716	1.716
2007	0.149	1.127	1.346	1.353	1.353	1.353	1.353
2008	0.121	0.917	1.095	1.1	1.1	1.1	1.1

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	0.137	1.035	1.236	1.242	1.242	1.242	1.242
2010	0.143	1.084	1.294	1.3	1.3	1.3	1.3
2011	0.107	0.814	0.972	0.976	0.977	0.977	0.977
2012	0.141	1.072	1.28	1.286	1.286	1.286	1.286
2013	0.082	0.621	0.742	0.745	0.745	0.745	0.745
2014	0.187	1.418	1.693	1.701	1.701	1.701	1.701
2015	0.122	0.926	1.105	1.111	1.111	1.111	1.111
2016	0.07	0.529	0.631	0.634	0.635	0.635	0.635
2017	0.056	0.424	0.507	0.509	0.509	0.509	0.509
2018	0.056	0.424	0.506	0.509	0.509	0.509	0.509
2019	0.094	0.715	0.854	0.858	0.858	0.858	0.858
2020	0.098	0.743	0.888	0.892	0.892	0.892	0.892
2021	0.112	0.848	1.013	1.018	1.018	1.018	1.018
2022	0.059	0.445	0.531	0.534	0.534	0.534	0.534

Table 38.9. 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	637848	390251	125022	21069	7469	1025	1829
1981	322277	211449	146684	39999	7013	2602	1030
1982	284242	106267	76678	43055	12040	2205	1183
1983	883137	93407	37664	21303	12155	3547	1033
1984	633451	290068	32994	10379	5957	3546	1384
1985	514593	206497	97402	8051	2518	1504	1289
1986	872880	166165	65053	20389	1633	530	608
1987	473896	285128	56566	16405	5141	429	309
1988	485038	154430	95517	13725	3954	1290	192
1989	593444	159063	53979	25666	3727	1120	434
1990	512451	191725	50283	11394	5258	792	342
1991	656864	166811	63755	11986	2690	1291	288
1992	229474	213624	55130	14974	2781	649	395
1993	211702	72416	57673	7965	1971	377	146
1994	182972	67826	21641	10636	1394	357	98
1995	336920	58492	19972	3852	1786	242	82
1996	201392	103665	12216	3916	839	411	77
1997	170310	61438	20293	2217	789	179	108
1998	166238	52698	13391	4187	508	191	72
1999	207222	49475	8552	1942	674	86	46
2000	109117	63421	9925	1598	403	148	30
2001	191446	32361	10022	1395	249	66	30
2002	79127	58259	6217	1778	275	52	21
2003	120737	23107	8189	760	241	39	11
2004	93249	38055	5793	1997	206	69	15
2005	105733	25597	3347	404	154	17	7
2006	153551	33923	7342	958	129	52	8
2007	103390	43269	3639	650	94	13	6
2008	148324	30320	6279	462	91	14	3

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
2009	92255	44720	5430	1025	84	17	3
2010	91885	27385	7116	769	161	14	4
2011	150538	27101	4151	952	114	25	3
2012	78489	46010	5381	766	195	25	6
2013	160731	23186	7058	730	115	31	5
2014	195177	50390	5582	1640	189	31	10
2015	122041	55085	5469	501	163	20	5
2016	80729	36754	9779	883	90	31	5
2017	101936	25619	9704	2537	255	27	11
2018	106389	32798	7508	2851	830	88	14
2019	210853	34232	9615	2207	933	287	36
2020	108016	65289	7501	1996	509	227	82
2021	189741	33321	13907	1506	445	120	75
2022	93382	57730	6393	2464	296	93	42
2023	121079	29965	16576	1833	787	100	47

Table 38.10. 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	16692.17	61818.2	33212.8	0.330324	637848.4	0.327	0.363	0.322
1981	18267	3064	21331	21137.38	60346.23	43747.48	0.247831	322276.8	0.425	0.437	0.295
1982	17167	801	17969	17941.94	44077.58	35151.13	0.270276	284242	0.446	0.485	0.332
1983	10577	1829	12405	12358.34	30305.03	22365.43	0.348659	883136.9	0.254	0.492	0.390
1984	11619	3380	14999	14736.93	38144.92	15229.5	0.415667	633451.1	0.314	0.596	0.355
1985	15525	2644	18169	17960.03	37339.27	22946.43	0.296739	514592.8	0.345	0.728	0.326
1986	10063	2066	12129	12074.45	29049.43	18365	0.324792	872879.5	0.263	0.568	0.351
1987	10411	3859	14270	14064.17	33402.18	16351.51	0.339889	473896.3	0.347	0.601	0.324
1988	10245	1611	11856	11793.37	30163.93	20635.6	0.280612	485038	0.323	0.513	0.327
1989	11305	2103	13408	13391.85	26757.45	17102.32	0.307888	593444.2	0.267	0.721	0.322
1990	8212	2444	10656	10632.25	24357.78	12700.87	0.328521	512451.4	0.251	0.616	0.305
1991	7348	2598	9946	9909.769	22709.32	13618.14	0.261805	656864.1	0.169	0.629	0.253
1992	8588	4203	12791	12552	21804.74	11550.81	0.209968	229474.1	0.152	1.048	0.182
1993	6523	2707	9230	6709.433	12549.57	9196.695	0.151641	211702.3	0.130	0.837	0.166
1994	6763	1173	7936	4952.799	8414.206	5280.661	0.158982	182971.5	0.136	0.868	0.172
1995	4893	2151	7044	4507.709	6582.718	3816.05	0.161182	336919.8	0.118	0.863	0.168
1996	4335	3631	7966	4352.365	6979.874	2625.931	0.184788	201391.6	0.128	0.937	0.146
1997	2277	1928	4205	2985.603	5143.876	2889.097	0.149749	170309.9	0.139	0.815	0.163
1998	2229	1304	3533	2872.109	4085.6	2388.74	0.158653	166238.1	0.130	1.149	0.163
1999	1670	1092	2762	2234.409	2954.707	1406.152	0.196252	207221.5	0.127	0.909	0.174
2000	762	2118	2880	2342.641	3361.912	1383.173	0.188928	109116.8	0.138	1.179	0.150
2001	733	1012	1745	1609.876	2171.084	1222.911	0.171664	191446	0.130	0.958	0.180
2002	747	740	1487	1880.711	2779.182	1089.664	0.193674	79127.25	0.136	1.311	0.153
2003	517	480	996	1276.163	1744.573	1095.262	0.169539	120736.8	0.148	0.657	0.233
2004	133	905	1038	2050.542	2259.313	1163.336	0.196203	93248.97	0.124	1.842	0.159
2005	125	272	397	509.7517	1289.594	462.8021	0.255055	105733.4	0.138	0.505	0.274
2006	64	1773	1837	2550.414	2083.015	960.1652	0.215619	153550.7	0.125	1.617	0.177
2007	35	1512	1547	1512.002	2028.585	505.5068	0.270896	103390.2	0.130	1.275	0.164
2008	37	1169	1206	1279.128	1594.071	651.1271	0.206319	148324	0.124	1.037	0.188

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
2009	39	1321	1360	1488.997	2141.411	661.1674	0.212911	92254.71	0.133	1.171	0.170
2010	30	1154	1184	1443.395	1637.422	744.6759	0.190942	91885.26	0.127	1.226	0.183
2011	31	946	977	975.4042	1388.209	539.9333	0.22938	150538.4	0.125	0.921	0.193
2012	60	1339	1399	1426.047	2085.015	612.6853	0.211675	78488.82	0.134	1.213	0.166
2013	33	948	981	1033.977	1525.797	751.3763	0.1964	160730.6	0.140	0.703	0.218
2014	23	1951	1974	2621.538	2709.268	849.8597	0.210835	195177.3	0.118	1.604	0.171
2015	28	1521	1549	1732.704	2463.053	595.6615	0.251619	122041.4	0.115	1.047	0.173
2016	15	765	780	818.5359	1991.175	859.1587	0.178826	80729.45	0.126	0.598	0.199
2017	36	668	704	697.0648	1831.432	1047.479	0.161578	101935.6	0.122	0.480	0.210
2018	46	853	899	877.2282	2094.879	1107.665	0.166449	106389.3	0.138	0.480	0.208
2019	172	1089	1261	1434.669	2210.934	1218.21	0.164446	210852.9	0.136	0.809	0.223
2020	88	1030	1118	1278.594	2732.421	936.9809	0.221189	108016.2	0.147	0.841	0.237
2021	91	1571	1662	1758.435	2209.142	1222.825	0.188498	189740.9	0.153	0.959	0.217
2022	57	986	1043	1069.651	2759.25	877.2369	0.253295	93382.28	0.279	0.503	0.298
2023*	NA	NA	NA	NA	NA	1517.032	NA	121079	NA	0.768	NA

Table 38.11. 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.

2023										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	121079	1.078	0	0	0	0	0	0	0.089	0.022
1	29965	0.803	0	0	0	0.03	0.069	0.147	0.61	0.037
2	16576	0.718	1	0	0	0.062	0.331	0.261	0.48	0.084
3	1833	0.608	1	0	0	0.134	0.583	0.3	0.231	0.134
4	787	0.554	1	0	0	0.243	0.741	0.341	0.073	0.205
5	100	0.518	1	0	0	0.342	0.797	0.413	0.018	0.143
6	47	0.518	1	0	0	0.4	0.805	0.454	0.009	0
2024										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	121079	1.078	0	0	0	0	0	0	0.089	0.022
1	37671	0.803	0	0	0	0.03	0.069	0.147	0.61	0.037
2	6809	0.718	1	0	0	0.062	0.331	0.261	0.48	0.084
3	3595	0.608	1	0	0	0.134	0.583	0.3	0.231	0.134
4	442	0.554	1	0	0	0.243	0.741	0.341	0.073	0.205
5	200	0.518	1	0	0	0.342	0.797	0.413	0.018	0.143
6	39	0.518	1	0	0	0.4	0.805	0.454	0.009	0
2025										
Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	121079	1.078	0	0	0	0	0	0	0.089	0.022
1	37671	0.803	0	0	0	0.03	0.069	0.147	0.61	0.037
2	8561	0.718	1	0	0	0.062	0.331	0.261	0.48	0.084
3	1477	0.608	1	0	0	0.134	0.583	0.3	0.231	0.134
4	867	0.554	1	0	0	0.243	0.741	0.341	0.073	0.205
5	112	0.518	1	0	0	0.342	0.797	0.413	0.018	0.143
6	63	0.518	1	0	0	0.4	0.805	0.454	0.009	0

Table 38.12. Whiting 7.a. Single-option output of the short-term forecast (F = mean F 2020–2021). Numbers in thousands, weights in tonnes.

2023										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	Dyield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.089	6397	139	121079	0	0	0
1	0.069	0	0	0.61	10607	396	29965	896	0	0
2	0.331	166	43	0.48	6718	564	16576	1027	16576	1027
3	0.583	338	102	0.231	458	61	1833	246	1833	246
4	0.741	302	103	0.073	47	10	787	191	787	191
5	0.797	42	18	0.018	3	0	100	34	100	34
6	0.805	21	10	0.009	0	0	47	19	47	19
Total	0.328	869	276	0.44	24230	1170	170387	2413	19343	1517
2024										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.089	6397	139	121079	0	0	0
1	0.069	0	0	0.61	13335	498	37671	1126	0	0
2	0.331	68	18	0.48	2760	232	6809	422	6809	422
3	0.583	664	199	0.231	898	120	3595	483	3595	483
4	0.741	170	58	0.073	26	5	442	107	442	107
5	0.797	85	35	0.018	5	1	200	68	200	68
6	0.805	17	8	0.009	0	0	39	15	39	15
Total	0.328	1004	318	0.44	23421	995	169835	2221	11085	1095
2025										
Age	F (lan)	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0.089	6397	139	121079	0	0	0
1	0.069	0	0	0.61	13335	498	37671	1126	0	0
2	0.331	86	22	0.48	3470	291	8561	530	8561	530
3	0.583	273	82	0.231	369	49	1477	198	1477	198
4	0.741	333	113	0.073	52	11	867	211	867	211
5	0.797	48	20	0.018	3	0	112	38	112	38
6	0.805	28	13	0.009	0	0	63	25	63	25
Total	0.328	768	250	0.44	23626	988	169830	2128	11080	1002

Table 38.13. Whiting 7.a. Management options table. Weights in tonnes.

Fmult	Catch24	Land24	Dis24	FCatch24	FLand24	FDis24	SSB25	dSSB	dTac
0	0	0	0	0	0	0	2111	92.61%	-100%
0.1	169	43	126	0.077	0.0122	0.065	1959	78.74%	-76.56%
0.2	329	83	246	0.154	0.024	0.129	1818	65.88%	-54.51%
0.3	479	120	358	0.23	0.037	0.194	1688	54.02%	-33.70%
0.4	620	155	465	0.31	0.049	0.26	1567	42.97%	-14.15%
0.5	753	187	565	0.38	0.061	0.32	1454	32.66%	4.16%
0.6	878	217	661	0.46	0.073	0.39	1350	23.18%	21.64%
0.7	996	245	751	0.54	0.085	0.45	1253	14.33%	38.00%
0.8	1108	271	837	0.61	0.097	0.52	1163	6.11%	53.40%
0.9	1213	295	918	0.69	0.11	0.58	1080	-1.46%	67.96%
1	1313	318	995	0.77	0.122	0.65	1003	-8.49%	81.83%
1.1	1407	339	1068	0.84	0.134	0.71	931	-15.06%	94.87%
1.2	1496	359	1137	0.92	0.146	0.78	865	-21.08%	107.21%
1.3	1581	377	1204	1	0.158	0.84	803	-26.73%	118.86%
1.4	1661	394	1267	1.08	0.171	0.9	746	-31.93%	129.96%
1.5	1737	410	1327	1.15	0.183	0.97	692	-36.86%	140.50%
1.6	1809	425	1384	1.23	0.195	1.03	643	-41.33%	150.49%
1.7	1877	439	1438	1.31	0.21	1.1	597	-45.53%	159.92%
1.8	1942	452	1491	1.38	0.22	1.16	555	-49.36%	168.93%
1.9	2005	464	1540	1.46	0.23	1.23	515	-53.01%	177.53%
2	2064	476	1588	1.54	0.24	1.29	479	-56.30%	185.71%
2.1	2120	486	1634	1.61	0.26	1.36	445	-59.40%	193.62%
2.2	2174	496	1678	1.69	0.27	1.42	413	-62.32%	200.97%
2.3	2225	506	1720	1.77	0.28	1.49	384	-64.96%	208.18%
2.4	2274	515	1760	1.84	0.29	1.55	356	-67.52%	214.98%
2.5	2321	523	1799	1.92	0.3	1.62	331	-69.80%	221.50%

Table 38.14. Whiting 7.a. Management options Advice table. Weights in tonnes.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F total (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change*	% advice change^^
MSY approach: F = 0	0	0	0	0	0	0	2111	93	-
Other scenarios									
$F_{MSY} = F_{pa}$	457	115	342	0.22	0.035	0.184	1706	56	-
F = 0	0	0	0	0	0	0	2111	93	-
$F_{MSY\ lower}$	338	85	252	0.158	0.025	0.133	1811	65	-
$F_{MSY\ upper}$	457	115	342	0.22	0.035	0.184	1706	56	-
$F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$	33	9	25	0.0147	0.0023	0.0124	2081	90	-
$F_{MSY\ lower} \times SSB_{2024}/MSY\ B_{trigger}$	24	6	18	0.0106	0.00169	0.0089	2089	91	-
$F_{MSY\ upper} \times SSB_{2024}/MSY\ B_{trigger}$	33	9	25	0.0147	0.0023	0.0124	2081	90	-
F_{lim}	729	182	548	0.37	0.059	0.31	1474	34	-
$SSB_{2025} = B_{lim}$^									
$SSB_{2025} = B_{pa} = MSY\ B_{trigger}$^									
$SSB_{2025} = SSB_{2024}$	1193	291	902	0.68	0.107	0.57	1096	0	-
$SSB_{2025} = SSB_{2024} \times 1.2$	920	227	693	0.49	0.077	0.41	1315	20	-
$F = F_{2023}$	1313	318	995	0.77	0.122	0.65	1003	-8.5	-

*** SSB 2025 relative to SSB 2024.**

^ The B_{lim}, B_{pa}, and MSY $B_{trigger}$ options were left blank because B_{lim}, B_{pa}, and MSY $B_{trigger}$ cannot be achieved in 2025, even with zero catch.

^^ This is not provided as catch advice for 2022 and 2023 was 0.

38.14 Figures

Figure 38.1. Whiting 7.a Working group estimates of International landings and discards.

Figure 38.2. Whiting 7.a Landings and discards by fleet.

Figure 38.3. 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, 2022.

Figure 38.4. Whiting 7.a Proportion of discards by age (left) and year (right).

Figure 38.5. Whiting 7.a Smoothed Stock Weights (Three year running average).

Figure 38.3. Whiting 7.a. Log Standardized indices of tuning fleets by cohort.

Figure 38.7. Whiting 7.a. Selectivity-at-age in the Catch.

Figure 38.8. Whiting 7.a. Observed and Predicted index CPUE.

Figure 38.9. Whiting 7.a. Observed and Predicted catch.

Figure 38.4. Whiting 7.a. Retrospective analysis of the final ASAP run with Mohn's Rho calculation. Image shows >5 peels but calculation is based on 5 peels only.

Figure 38.11. 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 38.12. 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.

39 Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)

Type of assessment in 2023

The stock assessment is a stochastic State–Space Assessment Model (SAM) and detailed in the Stock Annex. The model input data were updated with commercial catch, sampling and survey data as in previous years.

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 2023

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 1715 tonnes.

39.1 General

Stock description and management units

The TAC for whiting is set for divisions 7.b, 7.c, 7.d, 7.e, 7.f, 7.g, 7.h, 7.j and 7.k. The assessment area does not correspond to the TAC area. Since the 2014 Benchmark (WKCELT), Whiting in 7.b,c are now assessed as part of 7.bc, e–k, while whiting in 7.d remain part of the WGNSSK assessment of the North Sea stock. Any management measures implemented for this stock should be consistent with the assessment area.

Red Boxes-TAC/Management Areas Blue Shading-Assessment Area.

The TAC for whiting 7.bc, e–k decreased from 19 184t (2019) to 3877t (2023). ICES official landings for whiting 7.bc, e–k in 2022 are 5115 t and estimated catch of 7577 t and a TAC in that year of 8352 t. Thus, the 2023 TAC (3877 t) for whiting catches in the 7.b-ce-k stock area is now likely to be restrictive.

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, and are assessed by ICES to have increased in 2022 to 32% from 13% in 2019. This may in part be due to a recent partial shift in the fishery towards seiners and away from the more traditional otter trawl fishing. 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.

39.2 The fishery in 2022

ICES officially reported landings for divisions 7.b-ce–k and landings as used by the Working Group are given in Table 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.

39.3 Data

Catch

Data are 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 standardized across the cod, haddock and whiting stocks using the same R markdown template and editing only where necessary as developed during the 2020 benchmark (ICES, 2020).

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 aggregated into to either: GNS_DEF, OTB_CRU, OTB_DEF, TBB_DEF, SSC_DEF, PTM_SPF 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, 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 – 27cm).

While poorly represented in the survey data, 0-group fish are incorporated into the assessment to allow inclusion of 0-group indices, although catches at this age are 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 year old corrected weights are relatively stable. There

[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

was a notable increase in the 0-group stock in 2021 and drop in 1-group so they appear to overlap. This is not apparent in the 2022 mean weights-at-age.

Discards

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 have been available through InterCatch since the benchmark and are included in the assessment. 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 2003–2022 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 (2022) 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. There is evidence of increased discarding again however in 2022.

Biological

Rivard corrected mean stock and catch weights-at-age data are calculated following the methodology described in the stock annex. Natural mortality is based on Lorenzen's model and a power function of mean catch weights-at-age from the IBTS surveys is used.

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. The approach adopted 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 c80% for ages 2:3 (Figure 7). However, following evaluation with different survey age ranges during assessment model fitting at the benchmark, the survey index was truncated to and remains 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 bycatch 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 approximately 45% of the landings it is ostensibly concentrated around the 7d Channel area and eastern Celtic Sea.

39.4 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.

Final update assessment

The final assessment was run as per https://www.stockassessment.org/setStock.php?stock=whg.7b-ce-k_WGCSE22_RevRec_2023.

Final model inputs and settings were:

- Full time-series of catch data(1999 to 2022, ages 0 to 7+)
- SAM Model-filled discards for ages 5–7+ in 1999–2002
- VAST Model index for ages 0–2 from IGFS:EVHOE 2003–2022
- French Commercial biomass index in Kg/Hr for 2000–2022
- 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).

[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

Fishing mortality-at-age and stock numbers-at-age are presented in Table 10 and Table 11 respectively. Summary plots for SSB, F_{bar} 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 the 2013 cohort.

Model fits to the data are presented in Figure 10. The overall fit to catch data is 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 residual patterns are presented in Figure 11 with 0 group observations appearing significantly below the model prediction.

Comparison with previous assessments

The assessment continues to show retrospective bias, highlighted by the Mohn's Rho values (Figure 12). Spawning–stock biomass being 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}) has increased since 2012, but is assessed to be just above all reference points. SSB is estimated to be increasing slowly, but still below agreed reference points.

39.5 Short-term projections

The short-term projections were carried out in SAM (stockassessment.org) as described in the stock annex. However, given the ongoing bias a revision to the recruitment assumption was used span only the recent recruitment time-series ≥2015, rather than including the more productive historic figures. This removes 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.

The median resampled recruitment then from 2015–2022 in 000ies is estimated as 387 753. This was used as 0-group numbers in the forecast for 2023–2024.

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 67% likelihood of being below B_{lim} with a spawning–stock biomass forecast of 33 995 t. The assumed recruitment in 2023 and 2024 used in the forecast, constitutes to be a significant part (52.9%) of the projected SSB in 2025 (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 from MixedFish was used as the F assumption until WGCSE 2022, but revised as part of the ADG and ACOM review

process to F status quo. The resulting F_{sq} (0.763) is unscaled and the average $F_{2020–2023}$ used as the F assumption for the intermediate year (2023).

39.6 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	$F_{p.05}$
Bl_{im}	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}

39.7 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 MSY approach. Catch scenarios consistent with the MAP F_{MSY} ranges are provided.

39.8 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 2002–2022 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. That may no longer the case from 2022 data year onward however.

39.9 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.

39.10 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. Highgrading 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 become more reliable (for a summary of issues see http://www.discardless.eu/media/results/Celtic_Sea_Year2.pdf).

39.11 References

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39.12 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						[b]Rectangles	Used by WG			7.bc,e–k Catch +	
Year	BEL	FRA	IRL	UK_EW	Others	Total	33E2 & 33E3	WG Total	Dicards	Catch 7b-k Est	7.d Landings	TAC
1998	479	11748	5549	1853	81	19710	-	-	-	-		
1999[a]	448	16418	6013	1354	27	24260	-	20178	5420	25598	31401	
2000	194	9184	5358	1279	15	16030	-	15645	4400	20045	26117	
2001	171	7317	5365	963	16	13832	-	13192	9877	23070	29684	
2002	149	7546	5718	860	22	14295	-	13640	7336	20977	26338	
2003	129	5989	4516	772	12	11418	-	11097	10337	14656	21661	
2004	180	4870	4350	594	125	10119	-	10189	19522	16670	21953	
2005	218	5886	5774	482	136	12496	-	12211	13598	18911	23812	
2006	128	4711	4570	413	129	9951	-	9660	5098	21691	25440	
2007	127	3575	4864	575	86	9227	-	9087	8439	17543	20934	19900
2008	122	3072	2406	619	35	6254	-	5860	3760	8740	11933	19900
2009	87	2815	2798	829	25	6554	-	6513	4281	10614	17183	16950
2010	101	3464	4331	796	86	8778	-	8588	5346	11596	17729	14407
2011	100	4390	5433	754	179	10856	-	9484	3750	11438	16902	16658
2012	170	3766	7006	781	147	11870	32	10188	5116	12637	16234	19053

	Official ICES Landings						[b]Rectangles	Used by WG			7.bc,e–k Catch +	
2013	226	4055	8218	927	97	13523	34	11931	4026	14443	18700	24500
2014	222	4982	8122	1085	41	14452	49	12847	4672	16824	19954	19162
2015	152	5676	7156	831	101	13916	32	13174	6528	19275	19954	17742
2016	186	6334	8390	896	41	15847	40	15179	8259	22457	26187	22778
2017	102	5293	7014	608	34	13051	20	11693	2791	17098	17780	27500
2018	103	3684	5103	596	875	10361	18	8773	2139	10268	12625	22213
2019	73	3241	2344	487	136	6281	24	5542	970	6294	9393	19184
2020	82	2674	2656	335	143	5890	14	5931	1266	7197	1970	10863
2021*	83	2666	2915	352	66	6082	59	6153	1224	7377	2454	12259
2022*	75	2750	1977	347	14	5163	21	7577	2462	9534	1957**	8352

***Provisional data.**

****ICES preliminary landings.**

a French Official landings not available, not updated.

B Landings re-allocated from 7a to 7b–ce-k WG Landings.

Table 2. Whiting in Divisions 7.b–ce–k. Landings (t) by fleet.

LANDINGS	Others	OTB	SSC	TBB	Total	%
BEL	0	20	1	54	74	1%
FRA	101	2655	0	0	2756	54%
IRL	18	983	948	15	1964	38%
UK	34	177	12	60	284	6%
Others	3	26	7	0	36	1%
Total	156	3862	968	128	5115	100%
	3%	76%	19%	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	2022						
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
77.7	5989.0	7120.2	5525.3	3878.4	513.3	71.4	9.4

Table 4. Whiting in divisions 7.bc,e–k. Catch weights-at-age (Tons).

1999	2022						
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
7.1	997.9	1758.2	2300.8	2094.1	352.9	56.9	9.7

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
2022	0.0911	0.1666	0.2469	0.4164	0.5399	0.6874	0.7960	1.0251

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	0.01666	0.04324	0.17128	0.29605	0.41522	0.49054	0.50546	0.53966
2000	0.01666	0.04324	0.17128	0.29605	0.41522	0.49054	0.50546	0.53966
2001	0.01800	0.05920	0.11307	0.28856	0.45753	0.56578	0.65413	0.67176
2002	0.01277	0.05513	0.14812	0.25488	0.44811	0.61169	0.72289	0.87756
2003	0.02386	0.05796	0.13646	0.24372	0.37481	0.52812	0.69262	0.70572
2004	0.00888	0.08287	0.15001	0.21767	0.30021	0.39264	0.44557	0.53789
2005	0.02189	0.04965	0.17401	0.24175	0.32003	0.35639	0.40736	0.44489
2006	0.01810	0.07821	0.18191	0.26893	0.41229	0.48660	0.40155	0.51652
2007	0.02814	0.06663	0.16793	0.28266	0.37405	0.50066	0.50894	0.35856
2008	0.01974	0.07532	0.16400	0.23209	0.35283	0.43133	0.58582	0.62434
2009	0.04512	0.07214	0.16020	0.26545	0.35639	0.53931	0.54035	0.74693
2010	0.02006	0.10108	0.18610	0.28131	0.40949	0.50489	0.65564	0.58114
2011	0.01753	0.08418	0.18915	0.30089	0.45605	0.58317	0.63073	0.77257
2012	0.03555	0.05711	0.19619	0.30905	0.44307	0.63344	0.72017	0.82641
2013	0.02627	0.09181	0.14758	0.28466	0.47513	0.58788	0.79348	0.76382
2014	0.03067	0.07960	0.19432	0.28924	0.44625	0.63448	0.70429	0.91734
2015	0.03730	0.07648	0.18154	0.31354	0.46211	0.63345	0.70137	0.74435
2016	0.02352	0.08282	0.16007	0.29182	0.46064	0.60495	0.72574	0.70617
2017	0.02459	0.07882	0.17025	0.28982	0.44206	0.63130	0.77912	0.80794
2018	0.03146	0.07309	0.16901	0.29608	0.48862	0.64827	0.80488	0.94954
2019	0.03837	0.09459	0.20738	0.30519	0.48142	0.68629	0.80404	0.97773
2020	0.00894	0.10166	0.22530	0.42281	0.54384	0.66306	0.78664	0.88352
2021	0.02815	0.04190	0.21818	0.37900	0.58214	0.69800	0.71020	0.91686
2022	0.02515	0.07938	0.21695	0.36900	0.53580	0.68245	0.76696	0.92603

Table 7. Whiting in divisions 7.e–k. Summary of landings and discard data for 2022 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

Weight in tonnes										
Number in 000's										
Discards	Country		1	2	3	4	5	6	7	Grand Total
	Belgium	1.7	123.3	71.5	34.3	23.0	2.7	0.0	0.0	256.5
	France	66.9	3710.0	2091.0	988.7	665.8	78.0	1.2	0.0	7601.6
	Ireland	0.0	359.2	503.1	266.9	240.4	28.6	0.0	0.0	1398.2
	UK (England)	0.0	621.5	1902.8	520.7	43.0	1.9	0.1	0.0	3090.0
	Other	0.3	407.5	144.6	43.9	24.0	2.7	0.0	0.0	622.9
	Total	68.8	5221.5	4713.0	1854.4	996.1	114.0	1.4	0.0	12969.2
Landings	Belgium	0.1	10.4	36.4	51.4	41.8	6.5	1.2	0.2	147.9
	France	8.8	711.0	1787.9	2064.3	1003.8	106.4	16.6	5.6	5704.4
	Ireland	0.0	0.8	425.4	1228.4	1670.3	266.4	48.7	2.9	3642.9
	UK (England)	0.0	41.8	133.9	300.2	150.8	18.3	3.3	0.6	649.0
	Other	0.0	3.5	23.5	26.6	15.7	1.7	0.3	0.0	71.4
	Total	8.9	767.5	2407.2	3670.9	2882.3	399.3	70.1	9.4	10215.6

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/Km^2).

IGFSEVHOE No/Hr			
	Age		
		1	2
2003	41270	39916	12317
2004	131662	32539	8215
2005	38903	34262	6130
2006	67750	23150	8276
2007	211447	28688	4538
2008	155973	41778	9361
2009	232200	69648	11642
2010	21352	50983	21622
2011	71548	16397	25517
2012	38559	17874	10724
2013	180756	12131	7837
2014	29128	39439	7027
2015	66531	14326	18272
2016	69179	19511	11478
2017	65705	9475	4680
2018	84584	6602	2563
2019	53168	23827	3519
2020	44318	8793	4531
2021	53157	21168	7581
2022	11885	16342	504

Table 9. Whiting in divisions 7.bc,e–k. FRA-OTB commercial biomass index (Kg/Hr).

Kg/Hr	
2000	38.1036
2001	20.7203
2002	19.7279
2003	15.0461
2004	15.0812
2005	24.6578
2006	24.1190
2007	14.6645
2008	11.0597
2009	11.1447
2010	14.6829
2011	13.0133
2012	10.4575
2013	13.1697
2014	19.6047
2015	20.3092
2016	25.6908
2017	25.0667
2018	22.2050
2019	22.4371
2020	18.5756
2021	16.4738
2022	18.2615

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	0.097	0.425	0.655	0.944	1.191	1.579	1.579
2000	0.008	0.092	0.389	0.626	0.966	1.237	1.756	1.756
2001	0.008	0.090	0.362	0.579	1.046	1.551	2.346	2.346
2002	0.008	0.078	0.292	0.405	0.704	1.091	1.896	1.896
2003	0.009	0.092	0.334	0.386	0.607	0.988	1.563	1.563
2004	0.014	0.157	0.622	0.697	0.701	0.868	1.312	1.312
2005	0.012	0.150	0.602	0.786	0.789	0.850	1.322	1.322
2006	0.006	0.075	0.278	0.547	0.742	1.042	1.585	1.585
2007	0.007	0.103	0.487	1.032	1.361	1.749	2.131	2.131
2008	0.004	0.060	0.279	0.631	0.844	1.039	1.257	1.257
2009	0.003	0.047	0.221	0.530	0.788	1.008	1.189	1.189
2010	0.002	0.040	0.177	0.438	0.676	0.855	1.023	1.023
2011	0.002	0.035	0.142	0.326	0.543	0.727	0.900	0.900
2012	0.002	0.039	0.154	0.299	0.483	0.683	0.853	0.853
2013	0.002	0.039	0.160	0.302	0.501	0.723	0.900	0.900
2014	0.002	0.042	0.172	0.333	0.568	0.775	0.978	0.978
2015	0.003	0.061	0.252	0.437	0.663	0.882	1.149	1.149
2016	0.004	0.080	0.350	0.636	0.870	1.114	1.429	1.429
2017	0.003	0.077	0.356	0.639	0.890	1.125	1.465	1.465
2018	0.003	0.079	0.395	0.767	1.075	1.377	1.780	1.780
2019	0.002	0.054	0.282	0.693	1.071	1.367	1.755	1.755
2020	0.002	0.048	0.243	0.637	1.071	1.508	1.955	1.955
2021	0.001	0.037	0.193	0.528	0.935	1.411	1.865	1.865
2022	0.001	0.035	0.177	0.457	0.801	1.199	1.581	1.581

Table 11. Whiting in divisions 7.b, c, e–k. Stock number-at-age ('000).

	0	1	2	3	4	5	6	7+
1999	2002018	291381	95313	37283	17440	14779	9868	2520
2000	1670339	600441	111624	31876	11681	4459	2985	1777
2001	1405898	488574	236853	39522	9883	2860	892	570
2002	1252362	408002	189409	90137	13586	2176	393	97
2003	1003041	371067	160025	75850	38111	4344	506	49
2004	865620	295718	145053	62138	36477	13848	1007	80
2005	758102	241368	107430	40262	18044	13638	3996	201
2006	818807	222558	79476	29511	10927	5113	4578	770
2007	1019549	232975	87120	35080	10171	3386	1158	759
2008	1217047	300827	84793	27830	7760	1677	384	157
2009	1266036	363167	117186	32619	8805	2203	405	106
2010	644934	392388	140192	48679	11601	2572	533	108
2011	621732	190097	164849	58822	18320	3808	736	159
2012	577033	184102	80712	77939	25333	6610	1236	250
2013	1167025	158223	76328	36304	37276	10359	2180	436
2014	533085	383555	63289	34525	16640	15587	3340	727
2015	502674	156518	174351	28653	15302	5964	4971	1052
2016	326715	146613	63603	75721	11854	5218	1648	1317
2017	286223	90118	54518	22308	24064	3364	1152	489
2018	485022	77444	33284	19197	7120	6338	749	262
2019	387753	146537	28663	10894	5349	1605	1061	117
2020	489419	112581	56802	10900	3071	1161	279	140
2021	395703	146926	46436	23740	3428	665	170	41
2022	240196	121988	58323	19662	8487	870	107	22

Table 12. Whiting in divisions 7.b, c, e–k. Summary table.

Year	Recruitment			SSB			Landings	Discards	F		
	Low Recruitment	Midpoint Recruitment	High Recruitment	Low SSB	Midpoint	High SSB			Low	Midpoint	High
	thousands			tonnes			tonnes	tonnes			
1999	1337548	2002018	2996584	48381	54359	61076	20180	5420	0.69	0.80	0.94
2000	1145754	1670339	2435106	45630	52323	59998	15644	4400	0.69	0.81	0.93
2001	1026375	1405898	1925757	50965	60851	72655	13196	9877	0.76	0.89	1.03
2002	925888	1252362	1693953	58918	69983	83127	13640	7336	0.52	0.62	0.74
2003	739432	1003041	1360625	59421	68113	78076	11788	10337	0.48	0.58	0.70
2004	636246	865620	1177687	57394	65074	73782	10321	19522	0.61	0.72	0.85
2005	559835	758102	1026585	41418	46503	52212	12575	13598	0.65	0.76	0.88
2006	594248	818807	1128226	36492	41000	46066	9908	5098	0.55	0.65	0.78
2007	753743	1019549	1379091	34237	39087	44624	9424	8439	1.00	1.16	1.34
2008	896908	1217047	1651456	32136	36860	42278	6080	3760	0.59	0.70	0.83
2009	872545	1266036	1836979	40388	46557	53669	6574	4281	0.53	0.64	0.77
2010	473116	644934	879149	58839	68321	79330	9570	5346	0.44	0.54	0.66
2011	461205	621732	838131	58020	67151	77720	10084	3750	0.35	0.44	0.54
2012	421962	577033	789093	53334	60835	69390	10834	5116	0.33	0.41	0.50
2013	727971	1167025	1870883	48607	54807	61798	12131	4026	0.34	0.42	0.52
2014	394940	533085	719553	52491	59982	68543	12983	4672	0.38	0.46	0.56
2015	368748	502674	685242	53583	60675	68706	13110	6528	0.47	0.56	0.66
2016	218673	326715	488138	42873	48990	55981	15201	8259	0.64	0.74	0.87
2017	192715	286223	425102	29574	33064	36966	12377	2791	0.65	0.75	0.88
2018	352647	485022	667088	20284	22589	25155	9007	2139	0.78	0.90	1.04
2019	278302	387753	540248	19029	21834	25053	6588	970	0.73	0.85	0.99
2020	340870	489419	702705	22287	26214	30834	5931	1266	0.73	0.87	1.02
2021	251543	395703	622482	20107	24565	30010	6153	1224	0.59	0.77	1.00
2022	108813	240196	530215	23230	29946	38603	5115	2462	0.40	0.66	1.09
2023	240196	387753	502674	21020	29740	41713					
Average	572809	812963	1154910	41146	47577	55095	10767	5859	0.58	0.69	0.84

*** Median resampled (2015–2022).**

Table 13. Whiting in divisions 7.b, c, e–k. Management options table.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ (2024)	$F_{projected\ discards}$ (2024)	SSB (2025)	% SSB change *	% advice change **	% probability of being below B_{lim} in 2025
ICES advice basis										
MSY approach: zero catch	0	0	0	0	0	0	33995	29	-100	67
Other scenarios										
MSY and precautionary considerations: F = 0	0	0	0	0	0	0	33995	29	-100	67
EU MAP^^: $F_{MSY\ upper} \times SSB_{2024}$/ MSY $B_{trigger}$	2852	2431	421	0.20	0.161	0.034	31307	19	66	81
EU MAP^^: $F_{MSY} \times SSB_{2024}$/MSY $B_{trigger}$	2852	2431	421	0.195	0.161	0.034	31307	19	66	81
EU MAP^^: $F_{MSY\ lower} \times SSB_{2024}$/ MSY $B_{trigger}$	2433	2075	358	0.163	0.135	0.028	31690	20	42	79
$F = F_{MSY} = F_{pa}$	5063	4290	773	0.38	0.31	0.065	29327	11	195	88
SSB_{2025} = Blim^										
$SSB_{2025} = B_{pa} = B_{trigger}$^										
$F = F_{2023}$	8797	7374	1423	0.76	0.63	0.133	26026	-1	413	96
$SSB_{2025} = SSB_{2024}$	8415	7063	1352	0.72	0.59	0.126	26361	0	391	95

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
$F_{ages\ 2–5}$ (2023)	0.763	$F_{sq} = F_{average}$ (2020–2022), unscaled
SSB (2024)	26361	Short-term forecast; in tonnes.
Recruitment age 0 (2023–2024)	387753	Median resampled (2015–2022); in thousands
Catch (2023)	9817	Short-term forecast; in tonnes.
Projected landings (2023)	8180	Short-term forecast assuming average 2020–2022 landings pattern; in tonnes
Projected discards (2023)	1637	Short-term forecast assuming average 2020–2022 discard pattern; in tonnes

Input units are thousands and kg output in tonnes.

39.13 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 raw 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 (2003–2022).

Figure 6. Proportion of landings (upper panel) and discards (lower panel) for Celtic Sea whiting (2003–2022).

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_{bar} 2–5 (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.

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WGCSE Meeting 1 – 3-12 May

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WGCSE Meeting 2 – 25-27 September

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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 in the ICES Library under the Content Type "Stock Annexes". Use the search facility to find a particular Stock Annex by species or ICES Expert Group, refining your search in the left-hand column to include the *year* and *ecoregion* (in Categories).

Stock ID	Stock name	Last up-dated	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	https://doi.org/10.17895/ices.pub.18622049
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	https://doi.org/10.17895/ices.pub.18623210
cod.27.7e–k	Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)	October 2020	https://doi.org/10.17895/ices.pub.18622229
cod.27.7a	Cod (*Gadus morhua*) in Division 7.a (Irish Sea)	October 2023	https://doi.org/10.17895/ices.pub.24495970
cod.27.6b	Cod (*Gadus morhua*) in Division 6.b (Rockall)	May 2023	https://doi.org/10.17895/ices.pub.23501778
gug-celt	Grey gurnard in Subarea 6 and Divisions 7.a–c and e–k	March 2014	https://doi.org/10.17895/ices.pub.18622463
had.27.7b–k	Haddock (*Melanogrammus aeglefinus*) in divisions 7.b–k (southern Celtic Seas and English Channel)	October 2020	https://doi.org/10.17895/ices.pub.18622523
had.27.7a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)	June 2021	https://doi.org/10.17895/ices.pub.18622511
had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	May 2020	https://doi.org/10.17895/ices.pub.18622496
lez.27.4a6a	Megrim (*Lepidorhombus* ssp.) in divisions 4.a and 6.a (northern North Sea, West of Scotland)	June 2021	https://doi.org/10.17895/ices.pub.18622778

Stock ID	Stock name	Last up-dated	Link
nep.fu.11	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 11 (West of Scotland, North Minch)	May 2016	https://doi.org/10.17895/ices.pub.18622844
nep.fu.12	Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)	May 2023	https://doi.org/10.17895/ices.pub.24448741
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	https://doi.org/10.17895/ices.pub.18622859
nep.fu.14	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 14 (Irish Sea, East)	May 2023	https://doi.org/10.17895/ices.pub.24448771
nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a, Functional Unit 15 (Irish Sea, West)	May 2018	https://doi.org/10.17895/ices.pub.18622871
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	https://doi.org/10.17895/ices.pub.18622910
nep.fu.17	Norway lobster (*Nephrops norvegicus*) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)	May 2016	https://doi.org/10.17895/ices.pub.18622874
nep.fu.19	Norway lobster (*Nephrops norvegicus*) in divisions 7.a, 7.g, and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of southwest of Ireland)	October 2019	https://doi.org/10.17895/ices.pub.18622907
nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20 and 21 (Celtic Sea)	October 2019	https://doi.org/10.17895/ices.pub.18622925
nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)	May 2018	https://doi.org/10.17895/ices.pub.18622919
ple.27.7bc	Plaice (*Pleuronectes platessa*) in divisions 7.b–c (West of Ireland)	April 2013	https://doi.org/10.17895/ices.pub.18622979
ple.27.7h–k	Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)	May 2021	https://doi.org/10.17895/ices.pub.18622994
ple.27.7fg	Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2022	https://doi.org/10.17895/ices.pub.20170799
ple.27.7e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)	May 2022	https://doi.org/10.17895/ices.pub.20170745
ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	June 2021	https://doi.org/10.17895/ices.pub.18622958
sol.27.7bc	Sole (*Solea solea*) in divisions 7.b and 7.c (West of Ireland)	April 2013	https://doi.org/10.17895/ices.pub.18623267

Stock ID	Stock name	Last up-dated	Link
sol.27.7h–k	Sole (*Solea solea*) in divisions 7.h–k (Celtic Sea South, Southwest of Ireland)	May 2020	https://doi.org/10.17895/ices.pub.18623288
sol.27.7fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	May 2023	https://doi.org/10.17895/ices.pub.23501748
sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	June 2021	https://doi.org/10.17895/ices.pub.18623264
sol.27.7a	Sole (*Solea solea*) in Division 7.a (Irish Sea)	May 2023	https://doi.org/10.17895/ices.pub.23501700
whg.27.7b–ce–k	Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)	May 2023	https://doi.org/10.17895/ices.pub.23501757
whg.27.7a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)	May 2017	https://doi.org/10.17895/ices.pub.18623552
whg.27.6b	Whiting (*Merlangius merlangus*) in Division 6.b (Rockall)	May 2013	https://doi.org/10.17895/ices.pub.18623543
whg.27.6a	Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)	June 2022	https://doi.org/10.17895/ices.pub.20177060

Annex 3: Working documents

The following working documents were presented to WGCSE in spring 2023. They are found in full in the following pages:

WD1: Reducing uncertainty & assessing Biases in estimates of *Nephrops norvegicus* population size; Niall G. Fallon.

WD2: Results on haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangius*) and Norway lobster (*Nephrops norvegicus*) from the 2022 Porcupine Bank Survey (NE Atlantic); O. Fernández-Zapico, S. Ruiz-Pico, M. Blanco, F. Velasco and F. Baldó.

Working Paper: Reducing uncertainty & assessing Biases 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 *white* areas within the main patch are unsuitable for *Nephrops* burrowing as they consist of mixed gravel sediments, and are thus not considered when estimating abundances.

The current sampling scheme for FU 12 is stratified across three sediment types (muddy sand, sandy mud and mud, following the Folk sediment classification; Cooper *et al.*, 2013) with fixed proportions of sampling effort relative to the coverage of each sediment type being allocated across three areal strata (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 (Table 1). Due to logistic disruptions, the 2022 survey had to be carried out on an ad hoc, two-part basis. Samples were collected as close to representing areal allocations as was possible under those constraints.

Figure 2. Proportionate sample allocations by stratum 2007-2022.

Table 1. Proportions of UWTV survey effort allocated to each area/sediment stratum in old and revised sampling schemes.

Stratum	Old Allocations	Allocations from 2021 onward
S. Sandy Mud	0.025	0.041
S. Muddy Sand	0.075	0.107
W. Sandy Mud	0.225	0.195
W. Muddy Sand	0.25	0.324
W. Mud	0	0.01
E. Sandy Mud	0.25	0.167
E. Muddy Sand	0.125	0.118
E. Mud	0.05	0.038

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. Abundance estimates based on kriging may also provide insight into model related biases in abundance estimates. 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

2007-2022 (*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. Omnidirectional 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 2021 abundance estimates to kriging grid size and variogram lag 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 caused by survey sample allocation, 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.

Across the time-series, kriged burrow density surfaces generally predicted higher density in the inshore areas of FU 12, with lower burrow densities in the western and southern parts of the main sediment patch (Fig. 6). Kriged estimates of mean abundance were significantly lower than the estimates using the current method (Fig. 7; $F_{(2, 45)} = 6.8$, $p < 0.01$). 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 ($F_{(2, 45)} = 6.8$, $p = 0.34$). The percentage deviation of 2021 and 2022 resample-based estimates from their equivalent standard estimates had the third and fourth lowest percentage deviations (1.5% and 1.8%, respectively) across the time series.

Figure 6. Time series estimates of kriged *Nephrops* burrow density distribution surfaces for FU 12. Darker *red* pixels represent areas of higher estimated *Nephrops* burrow density, and lighter *yellow* pixels represent areas of lower estimated density.

Figure 7. 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*; semi-transparent to show overlap of CIs), 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 > 0.94), suggesting generally good agreement between the trends observed across methods (Fig. 8). Compared to the standard method, there was a mean reduction of 31.6% in coefficient of variation using kriging (Fig. 9).

Figure 8. 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 9. Time series of coefficients of variation for standard (*blue line*) and kriged (*orange line*) estimates of FU 12 *Nephrops* abundance.

Following discussions at WGNEPS 2022, an MSY $B_{trigger}$ reference point for the new abundance time-series was estimated based on the method used for FU 19 and FU 22 (ICES, 2016). A normal distribution with mean and standard deviation equal to those of the time-series of kriged abundance estimates was randomly generated, and the 5% quantile of that distribution (770 million) was taken as MSY $B_{trigger}$ (rounded to the nearest 10 million individuals; Fig. 10). The new MSY $B_{trigger}$ value is 24.5% lower than the former value of 1020 million individuals.

Figure 10. 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*). MSY $B_{trigger}$ values based on the standard and kriged estimates are shown in *blue* and *orange*, respectively.

2021 abundance estimates showed little sensitivity to changes in kriging grid size (Fig. 11) and variogram lag distances (Fig. 12).

Figure 11. FU 12 *Nephrops* kriged abundance estimates with 95% CIs calculated using a range of grid sizes.

Figure 12. 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 methods 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, in the context of abundance estimates based on a standard stratified arithmetic-mean-based approach. Regardless, it would be favourable to correct the minor discrepancies in proportionate sample allocations for future surveys. Comparison of the arithmetic mean based approaches with the kriged estimates does suggest that the standard estimates are upward biased due to the influence of large sample values.

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Working Document to be presented to the Working Group for the Celtic Seas Ecoregion
ICES WGCSE, 5th - 12th May 2023, Ostend, Belgium

Results on haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangius*) and Norway lobster (*Nephrops norvegicus*) from the 2022 Porcupine Bank Survey (NE Atlantic)

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Abstract

This working document presents the results on haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangius*) and Norway lobster (*Nephrops norvegicus*) caught in the Porcupine Spanish Groundfish Survey (SP-PORC-Q3) in 2022. Biomass, abundance, distribution and length frequency were analyzed. The biomass of these two fishes increased compared to the previous year. No signs of recruits were found for neither of the two species. In addition, the incidental species *Pleuronectes platessa* and *Solea solea* were not found in 2022 and *Pollachius pollachius* has never been caught in the time series. The crustacean *N. norvergicus* has increased strongly in this last survey and has done so for all the groups of sizes, thought more markedly in those smaller than 21 mm. However, the mean individual weight was slightly lower than in previous years.

Introduction

The Spanish Bottom Trawl Survey on the Porcupine Bank (ICES Divisions 7c and 7k) has been carried out annually in the third-quarter (September) since 2001 to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES, 2017).

The aim of this working document is to update the results (biomass and abundance indices, length frequency and geographic distributions) of the species *Melanogrammus aeglefinus* (haddock), *Merlangius merlangius* (whiting) and *Nephrops norvegicus* (Norway lobster) on the Porcupine bottom trawl surveys after the results presented previously (Ruiz-Pico *et al* 2018, 2019, 2020; Fernández-Zapico *et al*. 2021, 2022).

Material and methods

The Spanish Ground Fish Survey on the Porcupine Bank (SP-PORC-Q3) has been carried out annually since 2001 on board the R/V "*Vizconde de Eza*", a stern trawler of 53 m and 1800 Kw. The area covered extends from longitude 12° W to 15° W and from latitude 51° N to 54° N, following the standard methodology for the IBTS North Eastern Atlantic surveys (ICES, 2017). The sampling design was random stratified to the area (Velasco and Serrano, 2003) with two

geographical sectors (Northern and Southern) and three depth strata (<300 m, 300-450 m and 450-800 m) (Figure 1). Hauls allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley et al., 2004) to avoid the selection of adjacent 5×5 nm rectangles. More details on the survey design and methodology are presented in ICES (2017).

The tow duration is 20 min since 2016, but the results were extrapolated to 30 min of trawling time to keep up the time series.

Results and discussion

In 2022, 80 valid standard hauls and 11 additional hauls were carried out. Among the additional hauls, five of them have been carried out into the standard stratification, to improve coverage in the gaps left by random sampling and six of them, between 1032 and 1492 m, to explore the continuity of the fish community in Porcupine Seabight (Figure 1).

The total stratified catch per haul increased significantly in 2022 compared to the previous year, reaching the highest value in the time series (Figure 2). Fish represented 95% of the total catch and the species analyzed in this report represented only a small percentage of the total fish catch: haddock (0.51%) and whiting (0.05%). However, Norway lobster represented 16.7% of the total crustacean catch.

In 2022, the biomass of these two fishes increased strongly compared to the previous year, reaching high values in the time series both of them.

No signs of recruits were found for neither of the two species.

The biomass and abundance of the crustacean *N. norvergicus* has increased strongly in this last survey and it did for all the groups of sizes, thought more markedly in those smaller than 21 mm. However, the mean individual weight was slightly lower than in previous years.

Melanogrammus aeglefinus (haddock)

In 2022 this species increased strongly in terms of biomass, reaching the third highest value in the time series. However, it increased marginally in terms of abundance, remaining among the low values of the time series (Figure 3).

The species *M. aeglefinus* was distributed on the Irish shelf, as usual. In this last survey, the points with the highest biomass were found in the northeastern part of the study area (Figure 4).

The recruitment for this species fell again after the strong increase of the previous year. The sizes ranged among 24 and 78 cm, with a mode in 37 cm (Figure 5).

Merlangius merlangius (whiting)

Biomass and abundance of *M. merlangius* have increased strongly, so that this species nearly fourfolded in terms of biomass, reaching the highest value in the time series, and it nearly threefolded in terms of abundance, reaching the second highest value in the overall time series, after the peak in 2020 (Figure 6).

All the specimens were found in just a single haul at 233 m depth, in the Irish shelf (Figure 7). They ranged from 30 to 48 cm, losing the small sign of recruitment from the previous year and showing a mode in 39 cm (Figure 8).

Nephrops norvegicus (Norway lobster)

This species has increased strongly in the last survey, especially in abundance terms, returning to the high values of the time series, prior to the sharp fall of 2020 (Figure 9).

The muddy slope of the Porcupine Seabight is where both adults and recruits of *N. norvegicus* dwell. *Nephrops* remained concentrated in and around the closed area. In 2022, 7 positive catches, representing 42% of the total biomass, were found in the closed area and 14 out and around the area, representing 52%. Only 6% of the biomass was found in 14 hauls in the rest of the study area (Figure 10 and Figure 11).

In 2022 an increase in specimens of all sizes can be observed compared to previous years, especially those smaller than 21mm (Figure 12). However, the mean individual weight was slightly lower than in the four previous years (around 24g) (Figure 13). Recruits were concentrated mainly in the northern part of the closed area, as usual, with a especially big point of biomass in this last survey, and also several points were found out of the closed area, in the north-eastern part of the study area (Figure 14). The length distribution (Figure 15) showed a predominance of adults around 30 mm in this last survey, similar to the previous years.

Acknowledgements

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Ruiz-Pico, S., Blanco, M., Fernández-Zapico, O., Velasco, F., Baldó, F. 2018. Results on haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangius*), cod (*Gadus morhua*) and Norway

lobster (*Nephrops norvegicus*) from the Porcupine Bank Survey (NE Atlantic). Working Document presented to ICES WGCSE 2018. 19 pp.

Velasco, F. and Serrano, A., 2003. Distribution patterns of bottom trawl faunal assemblages in Porcupine Bank: implications for Porcupine surveys stratification design. WD presented to the ICES IBTSWG, Lorient, France 25-28 March 2003. 19 pp.

Velasco, F.; Baldó, F. & González Herraiz, I. 2018. Reporto n Nephrops results from Porcupine Bank 2018 bottom Trawl Survey. WD presented to the ICES ADGNEPH, ICES HQ, Copenhagen, Oct. 2018. 5 pp.

Figures

Figure 1. Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. Grey area in the middle of Porcupine bank corresponds to a large non-trawlable area not considered for area measurements and stratification. Right: hauls performed in 2022

Figure 2. Evolution of the total catch in Porcupine surveys (2001-2022)

Figure 3. Evolution of *Melanogrammus aeglefinus* biomass and abundance indices in Porcupine surveys (2001-2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

Figure 4. Geographic distribution of *Melanogrammus aeglefinus* catches (kg×30 min haul^{-1}) in Porcupine surveys (2013-2022)

Figure 5. Mean stratified length distributions of *Melanogrammus aeglefinus* in Porcupine surveys (2013-2022)

Figure 6. Evolution of *Merlangius merlangus* biomass and abundance indices in Porcupine surveys (2001-2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

Figure 7. Geographic distribution of *Merlangius merlangus* catches (kg×30 min haul^{-1}) in Porcupine surveys (2013-2022)

Figure 8. Mean stratified length distribution of *Merlangius merlangus* in Porcupine surveys (2013-2022)

Figure 9. Evolution of *Nephrops norvegicus* biomass and abundance indices in Porcupine surveys (2001-2022). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

Figure 10. Geographic distribution of *Nephrops norvegicus* catches (kg×30 min haul-1) in Porcupine surveys (2013-2022)

Figure 11. a) *Nephrops norvegicus* catches in Porcupine survey 2022 showing hauls performed inside and outside the area closed to trawling (red line). b) boxplot showing the differences in catches inside an outside the closed area (only hauls with *Nephrops* catches are considered)

Figure 12. Abundance of small *Nephrops* (<21 mm), juveniles between 21-26 mm and adults (>26 mm) in Porcupine survey 2001-2022

Figure 13. Mean individual weight in Porcupine survey 2001-2022

Figure 14. Geographic distribution of *Nephrops norvegicus* recruits (< 21 mm) in Porcupine surveys (2013-2022)

Figure 15. Mean stratified length distributions and length density plots of *Nephrops norvegicus* in Porcupine surveys (2015-2022)

Annex 4: Audits

Audit of Cod 27a.6b

Auditor: Pia Schuchert 22/05/2023

General

For single stock summary sheet advice:

1. Assessment type: SALY
2. Assessment: none no assessment, advice follows the agreed procedures for category 6.2.0 of ICES RGLIFE data-limited stock (DLS) advice rules
3. Forecast: not presented
4. Assessment model: no assessment, advice follows the agreed procedures for category 6.2.0 of ICES RGLIFE data-limited stock (DLS) advice rules
5. Data issues: all data available, however general issues with the data and reporting are known and the Rockall component of the SIAMISS survey was not carried out in 2020 or 2022, and in 2021 only a single fish was caught. This index therefore can no longer be used to justify an increasing biomass for the purposes of category 6 data limited advice.
6. Consistency: The last time advice was given, WG decided to use survey data to not apply the precautionary buffer as it was assumed the stock was in a better condition. In the current year the survey data was not deemed sufficient to provide an index suggesting increasing biomass. Therefore, the precautionary buffer was applied.
7. Stock status: Stock status is unknown
8. Management Plan: EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019) takes bycatch of this species into account, however there is no agreed shared management plan with UK for this stock.

General comments

- Advice follows the Stock annex under the data-limited stock advice rules
- Advice given triennial

Technical comments

Advice given according to Stock Annex

Conclusions

No assessment has been conducted.

Audit of Cod.27.7e–k

Auditor: Paul Bouch 26/05/23

General

ICES advises for zero catch in 2024. Fishing pressure is above F_{MSY} and F_{pa} and spawning–stock size is below all relevant reference points.

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: Minor potential confusion in Table 8 whether the data are official landings or ICES estimates. Queried with the co-ordinator.
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 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 in the Celtic Sea (had.27.6b)

Auditor: Jonathan White 19 June 2023

General

Had.27.6b is a category 3 data-limited stock with no advice update in 2023.

For single-stock summary sheet advice

None.

General comments

Data updates are available in R with associated data in the data folder for "GCSE 2023."

Technical comments

None.

Conclusions

The data update has been performed correctly.

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

Auditor: Andrzej Jaworski 02/06/2023

General

ICES provides annual catch advice for this stock based on the MSY approach. A full analytical assessment and forecast were performed in 2023 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. **Data issues:** The NI-MIK survey was not carried out in 2022. There was an issue with lower sampling levels for some fleets that discard haddock. Using recent discard rates to estimate unsampled catches showed to have minimal impact on the assessment outcomes.
6. **Consistency**: There is close agreement of the stock trends in the current assessment and the benchmark assessment.
7. **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).
8. **Management 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 audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? **Yes**
- Is the assessment according to the stock annex description? **Yes**
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? **No**
- 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)]

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 short and does not give details about how to perform it.

The stock assessment method (a Schaefer surplus production model) has been 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 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, 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 and forecast 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 Norway lobster (*Nephrops norvegicus)* in Division (nep.fu.11)

Auditor: Jennifer Doyle 05/10/2023

General

Assessment basis as in table below with updated TV abundance and fishery statistics.

ICES stock data category	1 (ICES, 2023a)
Assessment type	Underwater TV survey (ICES, 2023b)
Input data	One survey index (UWTV-FU11[U6028]); commercial catches (international landings, length frequencies from Scottish catch sampling); fixed maturity parameters from survey data; fixed natural mortalities. Discard survival rate.
Discards and by-catch	Included in the assessment since 1990; data series from the majority of the main fleets covering all landings
Indicators	Size structure, mean size, and sex ratio of catches
Other information	The latest benchmark (based on the UWTV survey) was performed in 2013 (ICES, 2013)
Working group	Working Group for the Celtic Seas Ecoregion (WGCSE)

For single stock summary sheet advice:

1. Assessment type: SALY
2. Assessment: category 1 assessment.
3. Forecast: No forecast but catch scenarios.
4. Assessment model: As above
5. Data issues: Sampling effort in 2022 was at a similar level to that seen in 2019. However, sampling is low in quarter two; this is due to staffing issues. In 2022, a co-sampling programme was established whereby fishers submitted catch samples at port for measurement by MSS.
6. In 2023, the UWTV survey was carried out as planned with 100% of planned stations being sampled.
7. Consistency: consistent with last year's assessment.
8. Stock status: B > MSY Btrigger since 1998. F < FMSY since 2013.
9. Management Plan: ICES is aware of the EU multiannual management plan (MAP) that has been agreed for this stock (EU, 2019) and considers it to be precautionary when implemented at the functional unit level. There is no agreement with UK regarding this plan, and it is not used as the basis of the advice for this stock. ICES provides catch scenarios consistent with the F_{MSY} ranges in the MAP.
10. General comments

Well documented, well ordered and considered section. It was easy to follow and interpret.

Technical comments

Some minor edits to be checked off in the WG report section – have emailed the stock assessor with these.

Conclusions

The assessment has been performed correctly.

Audit of Norway lobster (*Nephrops norvegic*us) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)

Auditor: Mikel Aristegui Ezquibela 06/10/2023

General

For single stock summary sheet advice:

Based on a combination of examining trends in fishery indicators and abundance estimated by underwater TV survey. Updated fishery data (quantities landed and discarded, fishing effort and length distributions) for 2022, and updated abundance estimate by UWTV Survey 2023. Following benchmark WKNEPH 2009

1) **Assessment type:** Updated abundance estimation methodology to kriging, improving its precision and reducing uncertainty. Updated abundance estimates and HR since 2007. As a result, MSY $B_{trigger}$ has been re-estimated.
2) **Assessment**: Analytical. UWTV assessment, Category 1
3) **Forecast**: Presented catch scenarios for 2024
4) **Assessment model**: UWTV based approach
5) **Data issues:** All data and R scripts included
6) **Consistency:** The assessment is consistent with last year's. Updated abundance estimation methodology.
7) **Stock status**: $F < F_{MSY}$ since 2013
   $B >$ MSY $B_{trigger}$ since 2013
8) **Management Plan**: ICES is aware of the EU multiannual management plan (MAP) that has been agreed for this stock (EU, 2019) and considers it to be precautionary when implemented at the FU level. There is no agreement with the UK regarding this plan, and it is not used as the basis of the advice for this stock. ICES provides catch scenarios consistent with the F_{MSY} ranges in the MAP.

General comments

Well documented and easy to follow.

- New methodology: https://community.ices.dk/ExpertGroups/wgcse/2023%20Meeting%20Documents/04.%20Working%20documents/Fallon_2022_Nephrops_TV_Uncertainty_Bias_v4.2.docx
- Data and R scripts: https://community.ices.dk/ExpertGroups/wgcse/2023%20Meeting%20Documents/06.%20Data/nep.fu.12.zip

Technical comments

Harvest rate SAG needs to be updated with the new HR values. The values are correct in Table 9, but wrong in the Figure.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- **Has the EG answered those TORs relevant to providing advice?**
  Yes
- **Is the assessment according to the stock annex description?**
  Yes. But it uses an updated and improved abundance estimate methodology.
- **If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?**
  ICES is aware of the EU multiannual management plan (MAP) that has been agreed for this stock (EU, 2019) and considers it to be precautionary when implemented at the FU level. There is no agreement with the UK regarding this plan, and it is not used as the basis of the advice for this stock. ICES provides catch scenarios consistent with the FMSY ranges in the MAP.
- **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 <u>major</u> 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 Norway lobster (Nephrops norvegicus) in Division 6.a, Functional Unit 13 (West of Scotland, the Firth of Clyde and Sound of Jura) [nep.fu.13]

Auditor: Jennifer Doyle 09/10/2023

General

Assessment basis as in table below with updated TV abundance and fishery statistics.

ICES stock data category	1 (ICES, 2023a)
Assessment type	Underwater TV survey (ICES, 2023b)
Input data	One survey index (UWTV-FU13 [U6028]); commercial catches (international landings, length frequencies from Scottish and Northern Ireland catch sampling); fixed maturity parameters (from survey data); fixed natural mortalities. Discard survival rate.
Discards and by-catch	Included in the assessment since 1990; data series from the majority of the main fleets covering all landings
Indicators	Size structure, mean size, and sex ratio of catches
Other information	The latest benchmark (based on the UWTV survey) was performed in 2009 (ICES, 2009)

For single stock summary sheet advice:

1) **Assessment type:** SALY
2) **Assessment**: category 1 assessment.
3) **Forecast**: No forecast but catch scenarios.
4) **Assessment model**: As above
5) **Data issues:** Sampling effort of commercial catches been reduced since 2020. No representative discard samples in 2022. Estimation method been same since 2020 – averaging over all qtrs from 2017-2019.
   In 2023, the UWTV survey was carried out as planned with 100% of planned stations being sampled.
6) **Consistency**: consistent with last year's assessment.
7) **Stock status**: Clyde: B > MSY $B_{trigger}$ since start of time series. F < F_{MSY} in 2022.
   Sound of Jura: B > MSY $B_{trigger}$ since start of time series. Same values as Clyde: F < F_{MSY} in 2022.
8) **Management Plan**: ICES is aware of the EU multiannual management plan (MAP) that has been agreed for this stock (EU, 2019) and considers it to be precautionary when implemented at the functional unit level. There is no agreement with UK regarding this plan, and it is not used as the basis of the advice for this stock. ICES provides catch scenarios consistent with the F_{MSY} ranges in the MAP.
9) **General comments**

Well documented, well ordered and considered section. It was easy to follow and interpret.
Data, report, advice sheet available for checking. Did not run code but checked final inputs for assessment (Table 9).

Technical comments

Some minor edits to be checked off in the WG report section – have emailed the stock assessor with these.

Conclusions

The assessment has been performed correctly.

Audit of Norway lobster (Nephrops norvegicus) in Division 7.a, Functional Unit 15 (Irish Sea, West) [nep.fu.15]

Auditor: Chris Firmin 08/10/2023

General

This assessment is based on UWTV approach outlined in WKNEPH 2009 and 2013 and using parameters in the 2009 stock annex, last updated in 2018. This year's assessment has been updated based on 2022 catch data and the results of the 2023 UWTV survey.

For single stock summary sheet advice:

1) **Assessment type:** Update (SALY)
2) **Assessment**: Analytical. UWTV assessment, Category 1
3) **Forecast**: advice provided based on MSY approach for 2024; catch scenarios also presented for upper / lower F_{MSY} ranges and based on F_{2020-2} and F_{2022}
4) **Assessment model**: UWTV approach
5) **Data issues:**
    - UWTV survey carried out by two vessels this year (Corystes in NI waters, Tom Crean in ROI waters).
    - Recent changes in camera system (from 2021) have resulted in increased field of view. The effects of this change on the bias correction factor used in the assessment has yet to be evaluated

6) **Consistency**: The assessment approach is consistent with last year.
7) **Stock status**: Fishing pressure on the stock is below F_{MSY} since 2016; stock size has been above $MSY_{Btrigger}$ for the entire time series (since 2003)
8) **Management Plan**: EU multiannual plan – catch scenario provided according to ranges.

General comments

Advice sheet clear and data checked by correspondence. UWTV calculations checked along-side FU14 at WGCSE 2023. Consistent with ICES survey protocol (2021). WGNEPS to look into the estimation of UWTV survey reference points for this stock for the provision of next years' advice.

Technical comments

- Catch options checked for consistency within advice sheet and are consistent.

Conclusions

The assessment has been performed correctly according to stock annex.

Audit of Norway lobster (Nephrops norvegicus) in Division 7.b – c and 7.j – k, Functional Unit 16 (west and southwest of Ireland, Porcupine Bank) [nep.fu.16]

Auditor: Ruth Kelly 08/10/2023

General

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 2022 catch data and the results of the 2023 UWTV survey.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical. UWTV assessment, Category 1
3) **Forecast**: Catch scenarios for 2024
4) **Assessment model**: UWTV approach
5) **Data issues:**
    - No Irish at-sea sampling available for this area, since 2019 (pre-covid). Catch sampling program commenced by Ireland in 2020, which has been the source of commercial sampling data in 2020, 2021 and 2022.

    - There is insufficient catch sampling to quantify discards in this fishery, although discarding has been observed recently. The current advice assumes that all catches will be landed in 2023.

6) **Consistency**: The assessment approach is consistent with last year.
7) **Stock status**: Fishing pressure on the stock is above FMSY, and no reference points for stock size have been defined for this stock.
8) **Management Plan**: EU multiannual plan – advice provided according to ranges.

General comments

Advice sheet clear, code and data available on sharepoint. WKNEPS to look into the estimation of stock-size reference points for this stock for the provision of next years' advice.

Technical comments

- Catch options checked against pdf code outputs and are correct.

Conclusions

The assessment has been performed correctly according to stock annex.

Audit of Norway lobster (Nephrops norvegicus) in Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)

Auditor: Ailsa Ellis 09/10/2023

General

For single stock summary sheet advice:

Assessment based on updated fishery data (quantities landed and discarded, fishing effort and length distributions) for 2022, and updated abundance estimate by UWTV Survey 2023.

1) **Assessment type:** update
2) **Assessment**: Analytical: UWTV assessment, Category 1.
3) **Forecast**: Presented as catch scenarios for 2024.
4) **Assessment model**: UWTV-based approach.
5) **Data issues:** All data updated and included in assessment.
6) **Consistency**: The data inputs and assessment procedure are consistent with last year. Harvest rate for 2022 is calculated using a linear interpolation of abundance, due to no survey taking place in 2022.
7) **Stock status**: Fishing pressure on the stock has been above F_{MSY} since 2021, and stock size has been below MSY $B_{trigger}$ since 2016.
8) **Management Plan**: 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 F_{MSY} range for the stock. ICES considers the MAP to be precautionary when implemented at the FU level.

General comments

- The assessment is well documented and ordered.
- Advice sheet, scripts, data, draft WGCSE report section, and draft survey report are available via ICES SharePoint.

Technical comments

- Data work-up and assessment carried out in accordance with the Stock Annex (updated 2016)
- Assessment outputs checked for consistency with report section and advice sheet
- Some minor edits to be made in the Advice sheet and WG report section. The stock assessor had been informed.

Conclusions

The assessment has been performed correctly

Audit of 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)

Auditor: Chris Firmin 10/10/2023

General

This assessment is based on UWTV approach outlined in WKNEPH 2009 and 2013 and using parameters in the 2014 stock annex, last updated in 2019. This year's assessment has been updated based on 2022 catch data and the results of the 2023 UWTV survey.

For single stock summary sheet advice:

1) **Assessment type:** Update (SALY)
2) **Assessment**: Analytical. UWTV assessment, Category 1
3) **Forecast**: advice provided based MSY approach with EU multiannual plan (MAP) upper / lower ranges for 2024; stock below $MSY_{Btrigger}$ and advised harvest rate adjusted according to ratio of UWTV abundance and $MSY_{Btrigger}$. Other catch scenarios presented for upper / lower F_{MSY} ranges without adjustment and based on F_{2020-2} and F_{2022}
4) **Assessment model**: UWTV approach
5) **Data issues:** Intercatch and National Expert data sources updated. Both sources compared and presented; National Expert catch data used in assessment where both sources available. BMS landings and logbook discards data available but no used to maintain consistency with assessment approach (SALY).
6) **Consistency**: The assessment approach is consistent with last year.
7) **Stock status**: Fishing pressure on the stock is below F_{MSY} since 2014; stock size has been below $MSY_{Btrigger}$ since 2018
8) **Management Plan**: EU multiannual plan – advice provided according to ranges.

General comments

Assessment uploaded onto TAF. Advice sheet clear and checked with one minor edit. UWTV survey consistent with ICES survey protocol (2021).

Technical comments

- Catch options checked for consistency within advice sheet and are consistent.

Conclusions

The assessment has been performed correctly according to stock annex.

Audit of Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h, functional units 20–21 (Celtic Sea)

Auditor: Chris Firmin 11/10/2023

General

This assessment is based on UWTV approach outlined in WKNEPH 2009 and 2013 and using parameters in the 2014 stock annex, last updated in 2021. This year's assessment has been updated based on 2022 catch data and the results of the 2023 UWTV survey.

For single stock summary sheet advice:

1) **Assessment type:** Update (SALY)
2) **Assessment**: Analytical. UWTV assessment, Category 1
3) **Forecast**: advice provided based on MSY approach for 2024; catch scenarios also presented for upper / lower FMSY ranges and based on $F_{2020\text{-}2022}$ and F_{2022}
4) **Assessment model**: UWTV approach
5) **Data issues:** Minor revision to 2021 landings applied to advise sheet at WGCSE
6) **Consistency**: The assessment approach is consistent with last year.
7) **Stock status**: Fishing pressure on the stock is below F_{MSY} since 2020; stock size has been below $MSY_{Btrigger}$ since 2013
8) **Management Plan**: EU multiannual plan – catch scenarios provided according to ranges.

General comments

Assessment uploaded onto TAF. Advice sheet clear and checked with one minor comment. UWTV survey consistent with ICES survey protocol (2021).

Technical comments

- Catch options checked for consistency within advice sheet and are consistent.

Conclusions

The assessment has been performed correctly according to stock annex.

Audit of Norway lobster (*Nephrops norvegicus*) in divisions 7.f and 7.g, Functional Unit 22 (Celtic Sea, Bristol Channel)

Auditor: Paul Bouch 28/09/2023

General

For single stock summary sheet advice:

1) **Assessment type: SALY**
2) **Assessment**: Analytical: UWTV assessment, Category 1.
3) **Forecast**: Presented as catch scenarios for 2024, assuming recent discards.
4) **Assessment model**: UWTV-based approach.
5) **Data issues:** All data updated and included in assessment, as per stock annex. Survey completed successfully with a decrease in estimated abundance compared to last year. Mean landings and discard rates were very slightly down.
6) **Consistency**: The data inputs and assessment procedure are similar and consistent with last year
7) **Stock status**: Fishing pressure on the stock has been below F_{MSY} since 2019, and stock size has been below MSY $B_{trigger}$ since 2020.
8) **Management Plan**: ICES is aware of the EU multiannual management plan (MAP) that has been agreed for this stock and considers it to be precautionary when implemented at the FU level. There is no agreement with the UK regarding this plan, and it is not used as the basis of the advice for this stock. ICES provides catch scenarios consistent with the F_{MSY} ranges in the MAP.

General comments

- The assessment is well available on the ICES TAF GitHub and is logically arranged and explores the data thoroughly. Advice, presentations, report and github assessment are consistent.

Technical comments

- Data work-up and assessment carried out in accordance with the Stock Annex
- Assessment outputs checked for consistency with report section and advice sheet

Conclusions

No issues with the assessment were found.

Audit of Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea) ple 27.7a

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: Age-based analytical assessment (SAM; Nielsen and Berg, 2014; ICES, 2023b) that uses landings and discards in the model and in the forecast. Commercial catch-at-age data; three survey indices UK (E&W)-BTS-Q3 (B6596), NIGFS-WIBTS-Q1 (G7144), and NIGFS-WIBTS-Q4 (G7655); fixed maturity ogive; natural mortality constant over the years and different across the ages.
5. Consistency: Same approach as in previous years. The Mohn's rho values for this assessment are 1.5% for recruitment, 0.9% for SSB and -1.6% for F_{bar}.
6. 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}.
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.

Technical comments

Low F and recruitment have led to an increasing proportion of the stock being contained within the modelled plus group (47% in the last five years is age 8+). Consequently, the assessment and forecast have increased uncertainty, and a pattern of retrospective downscaling of SSB is seen in the recent history of the assessment.
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.

Conclusions

The assessment and forecast for plaice in 7.a could be reproduced and were performed correctly.

Audit of Plaice (*Pleuronectes platessa*) in divisions 7.b and 7.c (West of Ireland)

Auditor: Gianfranco Anastasi 01/06/2023

General

Assessment was not performed since no information on abundance or exploitation are available to date. Therefore, for this stock ICES advises that when the precautionary approach is applied, landings should be no more than 15 tonnes in each of the years 2024, 2025, and 2026.

For single stock summary sheet advice:

1. Assessment type: update
2. Assessment: Not presented.
3. Forecast: Not presented.
4. Assessment model: Catches in this area are too low to support the collection of the necessary information for an analytic assessment of the stock status.
5. Data issues: No issues identified for the advice.
6. Consistency: The advice is consistent with the previous advice.
7. Stock status: Unknown. Landings since 2000 have been low. Discarding is known to take place in the area, however discarding patterns are unknown.
8. Management Plan: No management plan.

General comments

A short document easy to follow.

Technical comments

Figure 23.1a Landings of plaice in 7.bc as officially reported to ICES (2003–2022) seems to have a mismatch between the bars and the x axis (years).

Two plots have the same name "Figure 23.1a" consider to used Figure 23.1a and Figure 23.1b.

Conclusions

Low catches to provide the necessary information to perform an analytic assessment to determine the stock status. Discarding is known to take place in the area, however discarding patterns are unknown.

Audit of plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)

Reviewers: Niall G. Fallon

General

WGCSE provides advice for ple.27.7e as a category 3 data-limited stock using the rfb rule. Advice was provided in 2022 for 2023 and 2024, so this year's report represents a data update. The stock is recommended for benchmark, and there are a number of issues associated with this stock on the ICES SID issue list. The stock coordinator has indicated that the existing category 3 assessment approach is likely to be best (most precautionary) for this stock, given the current state of knowledge.

For single-stock summary sheet advice

ple.27.7e

Short description of the assessment as follows:

1. Assessment type: update (data only)
2. Assessment: not presented
3. Forecast: not presented
4. Assessment model: In 2022, according to ICES guidelines for category 2 and 3 stocks, WGCSE agreed to provide advice for this stock based on the application of the rfb rule, based on the data-limited nature of the stock, and the estimated individual growth rate of the population.
5. Consistency: last year's assessment was accepted for the provision of advice for 2023 and 2024.
6. Stock status: The fishing pressure proxy on the stock is above F_{MSY} proxy, and the stock-size index is above MSY $B_{trigger}$ ($I_{trigger}$).
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

- From the report: "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."
- The need to further investigate the stock structure (e.g. mixing during spawning period; update to current assumed mixing rate) has been added to the rolling issues list for this stock, but migration and mixing are considered less problematic for the derivation of category 3 empirical harvest control rules than for the application of analytical stock assessment models.

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."
- This excerpt was highlighted in the previous audit, and also relates to the tagging-derived mixing rate assumption.
- Recently published work (Fischer *et al*., 2023) suggests that a category 3 assessment may be the most appropriate means of providing advice for this stock. Due to uncertainties, a full analytical assessment is unlikely to capture the dynamics of this stock; i.e. a category 1 assessment which might be considered an improvement in method, would likely provide advice with an implicitly higher risk to stock sustainability. The current method can be tuned for the stock, and has an associated MSE framework.

Conclusions

The report section for this stock has been updated, and minor comments were added by the auditor. R code for assessments and data updates are available on TAF.

Fischer, S. H., De Oliveira, J. A. A., Mumford, J. D., and Kell, L. T. 2023. Risk equivalence in data-limited and data-rich fisheries management: An example based on the ICES advice framework. Fish and Fisheries, 24: 231–247. https://doi.org/10.1111/faf.12722.

Audit of ple.27.7.fg Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)]

Auditor: Claire Moore 05/06/2023

General

No assessment conducted in 2023

For single stock summary sheet advice:

1. Assessment type: No assessment
2. Assessment: trends (2022)
3. Forecast: presented in 2022, no update
4. Assessment model: Survey biomass trend applying the rfb rule for advice. The UKBTS survey (1988–2021) alone was used as the index of abundance. This survey covers the main habitat of the stock and has similar trends as the Irish groundfish survey. Commercial landings and discards, one survey index (UK [E&W]-BTS-Q3 [B6596]), length frequencies of the entire catch (landings + discards).
5. Data issues: No known data issues.
6. Consistency: Advice was not provided.
7. Stock status: The fishing pressure proxy on the stock is above F_{MSY} proxy, and the stock-size index is below MSY $B_{trigger}$ proxy ($I_{trigger}$)
8. Management Plan: No relevant management plan applicable.

General comments

The report is well-structured and clear. Information is well-visualised including relevant mapping.

Technical comments

The assessment has not been performed this year.

Conclusions

The assessment has not been performed this year.

Audit of ple.27.7.hk Plaice (*Pleuronectes platessa*) in divisions 7h–k (Celtic Sea South, southwest of Ireland)

Auditor: Vladimir Laptikhovsky 01/06/2023

General

No assessment conducted in 2023

For single stock summary sheet advice:

1. Assessment type: No assessment
2. Assessment: trends (2022)
3. Forecast: presented in 2022, no update
4. Assessment model: The Vector Autoregressive Spatiotemporal model (VAST) survey biomass index based on the seven fisheries-independent surveys. The LBI-estimated values of the ratio *Lmean/LF=M* are used to estimate exploitation status relative to the proxy MSY reference point.
5. Data issues: No known data issues.
6. Consistency: Advice was not provided.
7. Stock status: SSB is high and stable in recent years. Estimated F was below F_{MSY} from 2004, and is now at the lowest point in the time-series.
8. Management Plan: No relevant management plan applicable.

General comments

The report is well-structured and clear. Information is well-visualised including relevant mapping.

Technical comments

The assessment has not been performed this year.

Conclusions

The assessment has not been performed this year.

Audit of Pol.27a.67

Auditor: Pia Schuchert 25/05/2023

General

The advice and assessment were done correctly following the RFB rule for category 3 data-limited stocks.

The WG decided not to go ahead with the benchmarked SPiCT assessment due to high uncertainty and the uncertainty of the index which does not adequately cover the fishing area. However, the index was used for the RFB rule.

The advice has a decline of 83% with regard to the previous one as a new assessment method was implemented.

For single stock summary sheet advice:

1. Assessment type: update
2. Assessment: trends
3. Forecast: not presented
4. Assessment model: RFB rule applied to survey biomass trend. Biomass index is VAST using five surveys
5. Data issues:
6. Consistency: The stock was benchmarked in 2023 with a SPiCT model, which was subsequently deemed inadequate for providing advice. Now based on empirical RFB rule
7. Stock status: B<MSY $B_{trigger}$ since 2021, fishing pressure proxy is at $F_{MSYproxy}$
8. Management Plan: Agreed 2019: when the F_{MSY} ranges are not available, fishing opportunities should be based on the best available advice. There is no agreed shared management plan with the UK for this stock, and ICES provides advice according to ICES MSY approach.

General comments

It is a well written advice and report, easy to follow and all the information presented.

Technical comments

The assessment method was changed during the working group, the stock annex is currently being adjusted accordingly.

Conclusions

The assessment has been performed correctly as agreed by the WG.

Audit of Sea bass (*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)

Auditor: Tim Earl 31/5/2023

General

For single stock summary sheet advice:

1. Assessment type: SALY
2. Assessment: analytical
3. Forecast: presented
4. Assessment model: SS3
5. Data issues: No data issues
6. Consistency: No inconsistencies with last year
7. Stock status: F below F_{MSY}, B between B_{lim} and B_{pa} (=MSY $B_{trigger}$)
8. Management Plan: EU MAP applies, but not agreed by UK, so MSY advice provided.

General comments

This stock is currently undergoing a benchmark process including reviewing the stock identity and mixing with adjacent areas. Recreational catches are significant and remain relatively poorly sampled (the series is based on a single estimate for 2012, scaled by the assumed effects of management measures subsequently). Modelled discards are a significant underestimate. None of these issues are new.

Technical comments

It is possible to rerun the assessment using the files presented on the SharePoint and get the same results, but having the R files used to call SS3 and compile outputs would be helpful too.

In the report section on Mohn's Rho, it appears that the text refers to percentages, while the table is given as decimals. It would make it clearer if these numbers were presented in the same way.

Conclusions

The assessment has been performed correctly.

Audit of bss.6a7bj

Auditor: Gwladys Lambert 22/05/2023

General

For single stock summary sheet advice:

1. Assessment type: SALY
2. Assessment: no assessment, category 6 stock
3. Forecast: none
4. Assessment model: none
5. Data issues: recreational removals are not quantified
6. Consistency: no issue
7. Stock status: unknown
8. Management Plan: none

General comments

Advice follows category 6 under the data -limited stock advice rules.

Advice given triennially.

Technical comments

None

Conclusions

No assessment has been conducted. Stock ID may be an issue with stock not having been considered during 2022 stock ID workshop that included northern (47) and southern (Biscay) stock units.

Audit of sol.27.7a Sole (*Solea solea*) in Division 7.a (Irish Sea)

Reviewers: Simon Fischer 18/05/2023

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, fairly consistent, some rescaling in historical assessment output but mainly caused by intermediate year estimates
6. Stock status: SSB has been declining is now (2023) at around B_{lim} and expected to decrease further; F has been increasing and has now exceeded above all F reference points.
7. Management plan: None

General comments

The stock is on a concerning/poor trajectory and a zero-catch advice is recommended by WGCSE.

Discards are not used in the assessment (but considered in the advice) and have been increasing recently (~12.5% in recent year). This means that the stock status is likely more optimistic than reality, and the stock is likely in a worse condition than estimated by ICES. This is a further justification for providing zero catch advice.

Technical comments

None

Conclusions

The assessment and forecast options for sole in 7.a could be reproduced and were performed correctly.

Audit of Sole in 27.7bc

Auditor: Paul Bouch 25/05/23

General

The catches are too low to support the collection of the data that would be needed to assess the stock. The precautionary category 6 framework was applied, and after application of the precautionary buffer, ICES advises that catches should be no more than 15 tonnes in each of the years 2024, 2025, and 2026.

For single stock summary sheet advice:

1. Assessment type: update
2. Assessment: Not possible
3. Forecast: NA
4. Assessment model: Precautionary category 6 framework approach
5. Data issues: Insufficient catches to provide the data for an assessment
6. Consistency: Same approach as in 2020
7. Stock status: Unknown
8. Management Plan: The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019) takes bycatch of this species into account.

General comments

Well written and concise summary of the stock.

Technical comments

Minor inconsistencies in historic official landings between table.

Conclusions

No assessment is possible due to the paucity of data.

Audit of sol.27.7e Sole (*Solea solea*) in Division 7.e (western English Channel)

Reviewers: Sofie Nimmegeers, 23/05/2023

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). The UK-Q1SWBeam was disrupted in 2022 and the index data from that year were not used in the stock assessment. This survey has only a minor influence on the stock assessment.
5. Consistency: Same approach as in previous years; 2017 and 2018 catch-at-age data from England were revised which had a negligible impact on the current stock assessment. The Mohn's rho values for this assessment are well within the ICES WKFORBIAS thresholds (+0.20, -0.15), i.e. the retrospective analysis indicates that the assessment is sufficiently consistent for advice purposes.
6. Stock status: SSB is well above MSY $B_{trigger,}$, B_{PA} and B_{lim} (highest value of the time-series in 2020); F has been increasing and is now above F_{MSY}, but below F_{pa} and F_{lim}
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.

Technical comments

Discards are not used in the assessment (but considered in the advice). As discards are low (average discard rate of 2020–2022 = 0.40%), 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 sol.27.7fg Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea)]

Auditor: Alessandra Bielli 26/05/2023

General

The assessment and forecast were performed correctly.

For single stock summary sheet advice:

1. Assessment type: update
2. Assessment: analytical - accepted
3. Forecast: presented - accepted
4. Assessment model: Age-based analytical assessment (SAM) - landings, ages and length frequencies from catch sampling + 1 survey index (UK[E&W]-BTS-Q3) + five commercial biomass indices (BE and UK).
5. Data issues: The 2022 tuning data (Belgium commercial LPUE) were excluded from the model as explained in the Tuning data section of the report
6. Consistency: Since the benchmark in 2020, the current assessment has shown good consistency
7. Stock status: the stock is just below F_{MSY}; similarly to recent years, 2022 spawning–stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}
8. Management Plan: EU MAP, but not accepted by all clients.

General comments

The report is well organised and clear. It was easy to follow and interpret. Further details about the tuning data to be provided in the report (see technical comments).

Technical comments

- The 2022 tuning data (Belgium commercial LPUE) were excluded from the model as explained in the Tuning data section of the report. I suggest providing some further details in the text for clarity (see comments in report). Stock annex will have to be updated
- 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”.

Conclusions

The assessment and forecast could be reproduced and have been performed correctly.

Audit of Sol 7h–k

Auditor: Tim Earl 26/05/2023

General

- The Working Group was requested to produce annual advice for this stock. With limited data available to assess the stock, the Working Group considered that a 3-year cycle (every time the precautionary buffer should be considered) was more appropriate.
- The advice area does not correspond well with stock boundaries. Most of the catch sampling data is inshore in 7j, while the catches are predominantly from 7h
- Survey data are very limited and insufficient to derive a robust stock index
- LBIs were considered for the stock but do not provide information to avoid applying the precautionary buffer.

For single stock summary sheet advice:

1. Assessment type: Same as 2021
2. Assessment: not presented – category 5 data-limited
3. Forecast: Not applicable
4. Assessment model: Category 5 data-limited rule
5. Data issues: No issues with the catch data, sampling and survey data remain poor
6. Consistency: The approach is consistent with 2021
7. Stock status: Unknown
8. Management Plan: The EU MAP applies to this stock, but is not agreed with the UK.

General comments

The report covers all the information used to provide the advice, but it would be helpful to include sections summarizing the discussions on the suitability of the combined survey indices, and length-based indicators, to record all the information that was considered by the Working Group.

Technical comments

- Official catches from 2018–2020 don't match between the advice sheet (and report) and the downloaded csv/xlsx. This appears to be because France reported the same landings in both 7.j and 7.j1, so they are being double counted.

Conclusions

The assessment has been performed correctly, but a check of the official landings (not directly used in the assessment) is needed before the ADG.

Audit of Whiting 27.7a

Auditor: Ruth Kelly 02/05/2023

General

For single stock summary sheet advice:

1. Assessment type: SPALY
2. Assessment: Analytical
3. Forecast: Presented
4. Assessment model: ASAP using NI Q1 and Q4 GFS, and miknet. Forecast using FLR
5. Data issues: There were no data available for the NIMIK net survey in 2022 and discard estimates in 2022 for some of the Irish *Nephrops* fleets that commonly discard whiting are based on a modelled estimate. Sensitivity analyses have shown that these have had minimal impact on the perception of the stock status.
6. Consistency: Apart from the lack of NIMIK net data and the modelled estimate used for discard estimates for Irish OTB_CRU fleets, the assessment is performed as per stock annex.
7. Stock status: SSB very low (below B_{lim} since 1990s). Fishing mortality high (above F_{lim} since 1980) and variable between years.
8. Management Plan: MSY approach used for providing advice. Stock is under EU MAP with no shared agreement with the UK. Zero catch advice for two years as the stock remains below B_{lim} even with no catch in 2022.

General comments

The report contained the expected information in a clear manner.

There was discussion at the working group meeting about the discard-landings split being estimated in the model forecast. Investigation showed that the assessment model may overestimate the older ages (3 plus) in the stock and lead to an overestimation of stock biomass and landings in the forecast. There is also uncertainty with the ratio of landings/discards split used in the forecast. This stock is recommended for benchmark in 2024–2025.

Technical comments

Report, data and code are available on SharePoint.

Conclusions

The assessment has been performed correctly.

Audit of whg.27.7bce–k

Auditor: Helen Dobby 1/6/2023

General

For single stock summary sheet advice:

1. Assessment type: update/SALY
2. Assessment: analytical age-based in SAM
3. Forecast: presented – short-term stochastic projections
4. Assessment model: SAM with catch and survey data plus a commercial LPUE.
5. Data issues: No major data issues
6. Consistency: Assessment and forecast follows approach documented in the Stock Annex and is the same approach as last year.
7. Stock status: $B<B_{lim}$ for a while, $F_{lim}<F<F_{pa}$, R uncertain, seem to be high recent years
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

In general, the report is well written and easy to follow – some minor typos/comments on the report for the stock assessor to address. 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. In addition, it would be helpful to provide an explanation of the 33E2/33E3 rectangle issue (and the landings for these) in the WG report.

The assessment shows major retrospective patterns with significant revisions in SSB and F occurring with the addition of extra years of data (resulting in overoptimistic assessment of SSB). It would probably not be accepted as the basis for providing non-zero catch advice but given that no catch option results in a high probability of > B_{lim} the advice is for zero catch.

The survey internal consistency looks reasonable for older ages – suggest to consider extending the age range included in the assessment. May help with model performance.

Technical comments

The SA.org configuration is as per the stock annex and the SA.org input data are as given in the individual text files. The assessment results and forecast can both be reproduced on SA.org.

The main issue appears to be discrepancies between landings and discards in some of the advice sheet tables and Table 1 in WG report:

Advice sheet Table 7 – Landings for 1999–2002 do not match those in Table 10 of the advice sheet. For 1999 onwards, the values do not match those in Table 1 of the WG report.
Advice sheet Table 7 – Discards for 2003 to 2019 do not match those in Table 1 of the WG report.
Advice sheet Table 9 – discrepancies between French values and totals in this table and Table 1 of the WG report.
The reference points are consistent in the WG report and advice sheet but not in the Stock Annex.

Conclusions

The assessment has been performed correctly.

Some cross-checking of landings and discard totals across tables in the advice sheet and Table 1 in the WG report is required.

Annex 5: Irish Sea cod (cod.27.7a) assessment review (benchmarking report)

Cod.27.7a Assessment Review (Benchmarking report)

ICES Working Group for the Celtic Seas Ecoregion (WGCSE)

Pia Schuchert

25/8/2023

Following the WGCSE assessment meeting in May 2023 it was agreed to verify an error that had occurred in the benchmark of the Irish Sea cod in February 2022.

It was identified that there was a mismatch between selectivity blocks for the commercial fleet, with one block starting in 1972 to 2000, and the other block incorporating the year 1968 to 1971 and 2001 onwards. The first period (1968 to 1971) should be assigned the same selectivity level as the following period (1972 to 2000), giving two distinct selectivity periods: 1968 to 2000 and 2001 to 2022 (Figure 8). The correction of this error was initially discussed as it was a typing error, however two further issues emerged during the WGCSE working group in May 2022 and 2023, which should be taken further into consideration:

- In the working group meeting in 2023 a potential issue regarded the use of weightings of the age-composition. There was a strong desire at the May 2023 meeting to investigate the incorporation of Francis or Ianelli weighting (NOAA 2020) into the model to improve model fit.
- Another issue that has been dealt with in the WGCSE meeting in 2022 and will be briefly mentioned here is the inclusion of the recreational catches in the model. The benchmark report (ICES 2023) included the recreational catches with the commercial catches, but also agreed on an option to exclude the recreational catches. In May 2022 WGCSE was made aware of the fact that the values for the recreational fleet provided for the benchmark were wrong and indeed larger than the commercial catches; there was a lot of uncertainty around the values for the recreational fleet and it was agreed (ICES 2022) to run the model without recreational catches.

The proposed model has the start of the first commercial selectivity block set to 1968, thereby correcting the error. Additionally all the recreational catches were removed from the model. In a next step the model was thoroughly tested with weightings following Ianelli and Francis (Francis 2011, NOAA 2020). While both weightings considerably improved the fit of the model to the data, there were considerable issues with an increase in the SSB. Both Ianelli and Francis weightings were run with 10 iterations to get the best possible values for the two weightings. Additionally, a model with the effective sample sizes of the commercial fleet set to 50 rather than 100 since 1990 was tested, given the only sampling in earlier years from the commercial fleet and the sampling being lower during later years where cod were encountered infrequently, different vessels were used as well as a range of gears and selectivity devices. This had originally been proposed by Ianelli in the WKIRISH 3 Benchmark (ICES 2017) and was the previously agreed Benchmarked setting, set up in this way in the ASAP model (hence the name "ASAP" for the run as used in this review).

Impacts of Ianelli and Francis weightings were reviewed and considered. It was agreed with the chairs of WGCSE and Hans Gerritsen (Chair of(ICES 2017)) that the ASAP option would be preferable to the Ianelli or Frances weighting; both Frances and Ianelli weightings reduced the weighting of the commercial fleet in age distribution to approximately 20% giving the surveys a considerably higher weighting resulting in a considerable uplift of the SSB in the 2000s.

We propose the "ASAP" option as a mid-way, improving the fit and accounting for the sampling shortcomings in a commercial fleet, however, we propose to not use either Francis or Ianelli weighting due to their high survey Coefficient of Variances (CV). The model as benchmarked (and going forward) also uses Dirichlet weightings.

The model used in the figures as the "old" model is the model that was benchmarked with the added data for 2021 and 2022 but excluding the recreational removals, which were not available in 2022 and wrong for the prior years.

Table 1 shows the model fit of the proposed model.

The model diagnostics show that the proposed model has good fits to the data and the trend is similar to the model previously used. It is evident that the proposed model has a lower virgin SSB and a higher SSB throughout the last 15 years, however this is due to initially the selectivity block used for the years from 2001 to present also used the initial 4 years of data to estimate it; this is an error that needs to be corrected.

The proposed is a better approximation to the sampling effort, the range of vessels, the different selectivity devices and gear we are proposing to take the proposed model forward.

The reference point estimations model can be seen in Table 2, showing small updates resulting from updating the commercial fleet selectivity blocks and the implementation of setting effective sample sizes of the commercial fleet to 50 rather than 100 since 1990. The full estimation of the reference points is available in the added document.

Changes:

- Set commercial selectivity block from 1968 to 2000 and 2001 to current
- Set effective sample size for commercial fleet from 1968 to 1989 to 100, and from 1990 to 50
- Removal of recreational catches from total catch for the years 2016-2020 and going forward.

Table 1: fits of the proposed models

	Model
Mohns Rho F	-0.09
Mohns Rho SSB	0.03
Total Likelihood	963
Survey	21.0
Age-composition	925.7
Recruitment	12.9
SR_LN(R0)	12.159

Table 2: Comparison of reference points estimated for the two models using eqsim. Feco is not estimated as it will be estimated on an annual basis.

	Model	Model proposed
MSY $B_{trigger}$	11538	12595
F_{msy}	0.222	0.177
$F_{msyLower}$	0.168	0.143
$F_{msyUpper}$	0.273	0.222
B_{lim}	8303	9064
B_{pa}	11538	12595
F_{lim}	0.43	0.33
F_{pa}	0.25	0.18

Comparison plots for results and some of the diagnostics

Figure 1: SSB with 95% confidence interval

Figure 2; Fbar ages 2-4 with 95% confidence ratio

Figure 3: Recruitment with uncertainty

Figure 4: Log Index fit to NIGFS Q1

Figure 5: Log Index fit to NIGFS Q4

Figure 6: Log Fit to FSP survey index

Figure 7: Density distribution of virgin SS biomass

Figure 8: proposed model commercial selectivities

Figure 8: Runs test for the proposed model

Figure 10: Age composition residuals

Figure 11: Stock Recruitment curve

Figure 12: Mohns Rho for SSB and F; the values in brackets are the forecast Mohns Rho which SS3 estimates as well.

References

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Annex 6: Review of the Irish Sea cod (cod.27.7a) assessment review

Overview of the assessment

Irish Sea cod was benchmarked in 2022 and moved from category 3 stock to category 1. The new assessment model accepted in 2022 was a SS3 model. The model both used commercial catches and recreational catches. In 2022 WGCSE meeting it discovered that the recreational catches agreed upon in the benchmark were incorrect and in 2022 WGCSE meeting the model was run without recreational catches. In 2023 WGCSE meeting it was found out that the selectivity blocks used for commercial catches were wrongly specified.

Problems concerning the assessment:

1. The updated assessment configuration was supposed to address the issues of wrongly specifying the selectivity blocks. This specification has been updated and corresponds to what was intended (two separate selectivity blocks, 1968-2000 and 2001-present).
2. The model has set up as such that it uses Dirichlet multinomial assumption on sample size for data weighting.
    a. In the working document it is said that different weighting following Ianelli and Francis were tested, however no documentation on the process and results were provided. Making it impossible to test if final decisions on data weighting were justified or not. The final model agreed upon uses Dirichlet weightings.
    b. The model settings for Dirichlet weightings are shown in Table 1. SS3 manual suggests using a normal N(0,1.813) prior for the ln(DM_parm) parameters. It can be seen from the Table 1 that this was intended, however the column values were mixed and therefore wrong settings given to the model. This caused the model to give an warning " Number_of_active_parameters_on_or_near_bounds: 2" and from the estimated parameters table it is seen that these are flagged:

Estimated parameters (excluding deviation parameters)
Any parameter with a gradient value with an absolute value above 0.001 or a parameter on bounds is colored in red.
file: parameterchecks.html

Parameter	Value	Phase	Min	Max	Init	Status	Parm_StDev	Gradient	Pr_type	Prior	Pr_SD	Pr_Like	Afterbound
SR_LN(R0)	12.159400	1	8.000	40	20.000000	OK	0.0900991	-0.00000185425	No_prior	NA	NA	NA	OK
SR_regime_BLK1repl_2002	-1.418810	1	-5.000	5	-2.312080	OK	0.2313590	-0.0000001575	No_prior	NA	NA	NA	OK
InitF_seas_1_flt_1Commercial	0.127820	1	0.001	1	0.050000	OK	0.0300348	0.0000000589018	No_prior	NA	NA	NA	OK
AgeSel_P3_Commercial(1)	1.354290	5	-5.000	9	1.000000	OK	0.1203710	-0.000000170224	No_prior	NA	NA	NA	OK
AgeSel_P4_Commercial(1)	-0.512920	5	-5.000	9	0.200000	OK	0.1379770	0.000000129261	No_prior	NA	NA	NA	OK
AgeSel_P3_NIGSQ1(2)	1.150710	5	-5.000	9	2.200560	OK	0.0555320	-0.000000124899	No_prior	NA	NA	NA	OK
AgeSel_P3_UKFSP(4)	4.199100	5	-5.000	9	4.039870	OK	1.3281200	-0.0000000096206	No_prior	NA	NA	NA	OK
AgeSel_P4_UKFSP(4)	1.883010	5	-5.000	9	1.674880	OK	0.1682180	-0.000000234558	No_prior	NA	NA	NA	OK
AgeSel_P5_UKFSP(4)	-0.362280	5	-5.000	9	-0.100000	OK	0.1398540	0.0000000735092	No_prior	NA	NA	NA	OK
AgeSel_P6_UKFSP(4)	-1.022300	5	-5.000	9	0.000000	OK	0.2248430	-0.0000000615465	No_prior	NA	NA	NA	OK
ln(DM_theta)_2	4.962250	6	-5.000	5	-0.917833	HI	1.1724800	0.00000000302303	Normal	1.813	99	0.0005060	OK
ln(DM_theta)_3	0.998121	6	-5.000	5	-3.264890	OK	72.1179000	0.000000200716	Normal	1.813	99	0.0000339	OK
ln(DM_theta)_4	4.991360	6	-5.000	5	1.066030	HI	0.2750340	0.000000014233	Normal	1.813	99	0.0005154	OK
AgeSel_P2_Commercial(1)_BLK2repl_1968	4.668210	5	-25.000	25	3.000000	OK	0.1957510	0.0000000245639	No_prior	NA	NA	NA	OK
AgeSel_P3_Commercial(1)_BLK2repl_1968	1.442940	5	-5.000	9	1.000000	OK	0.0680164	0.0000000395867	No_prior	NA	NA	NA	OK
AgeSel_P4_Commercial(1)_BLK2repl_1968	0.133457	5	-5.000	9	1.500000	OK	0.0784470	0.00000000983355	No_prior	NA	NA	NA	OK

Table 1. Parameters specified for the Dirichlet weightings.

LO	HI	Init	PR	PR_SD	PR_type	PHASE	Env-var	Use_dev	Dev_mnvr	Dev_mxyr	Dev_PH	Block	Blk_fxn	Parm_name
# Dirichlet parameters														
#_multiple_fleets_can_refer_to_same_parm;_but_list_cannot_have_gaps														
-5	5	0.1	1.813	99	6	-3	0	0	0	0	0	0	0	ln(DM_theta)_1
-5	5	-0.917833	1.813	99	6	6	0	0	0	0	0	0	0	ln(DM_theta)_2
-5	5	-3.26489	1.813	99	6	6	0	0	0	0	0	0	0	ln(DM_theta)_3
-5	5	1.06603	1.813	99	6	6	0	0	0	0	0	0	0	ln(DM_theta)_4

c. In addition, as seen from Table 1, it is defined that ln(DM_theta)_1 (for commercial fleet) the theta parameter is not estimated but defined "Init" values is used instead (this criteria is set by having negative phase value). It is unclear if the parameter estimation was turned off intentionally or not. If this is what was aimed, there is no documentation on how the "Init" value was chosen and how sensitive the model is for this "Init" value.

d. The Dirichlet parameters are defined for 4 fleets (1 commerical and 3 surveys). However, there is no age composition presented for survey 3 (NIGSQ4) but a Dirichlet parameter (ln(DM_theta)_3) is specified. The model estimates a theta parameter for this survey but in diagnostics it is flagged that this parameter has no correlation with any other parameters, indicating that uncorrelated parameters may not be playing a significant role in the model. The reviewer thinks that there shouldn't be any theta parameter for the NIGSQ4 fleet.

Issues brought out in point 2 were relayed to the stock assessor and immediate actions were taken. The ln(DM_theta) parameter specifications were adjusted according to the SS3 manual. However, the reasoning behind ln(DM_theta)_1 values were not explained, in addition not enough material were not provided to the reviewer to determine if the choice of method for data weighting was justified. After fixing the ln(DM_theta) parameter priors the stock assessor rerun the model and compared the results with previous model run output. No major differences were observed.

In light of the mistake made in SS3 control file where parameters are specified, it is suggested to take a careful look that there are no other misspecifications due to mixing up the column meanings. The SS3 control, starter and data file are set up differently compared to the usually used files (e.g., XSA, SAM). It is imperative that these files are set up with care and understanding so that unnecessary mistakes are not made. At this reviewing process some mistakes were picked up easily, but this doesn't rule out that there might be some other misspecifications/mistakes in there which were not easily seen and identified.

At this stage with the fixes in the assessment model, no other major discrepancies were identified. However, it is my strong suggestion that the stock assessors looks closely over the SS3 control file to be sure that no other misspecification is present. With the updates done in the model, output can be used to calculate reference points.

Review of the reference points

The following review on the reference points is done based on the analysis that was conducted using the assessment output which does not yet include the updates mentioned in some of the ln(DM_theta) parameters (point 2 in above section). However, based on the knowledge that the assessment results were not strongly affected by those adjustments, initial review of the process of the reference point calculations can be given.

Blim is an important reference point from which other precautionary reference points are derived.

- The Irish Sea cod was categorised as Type 1 stock, spasmodic stock with occasional large year classes. This classification can be considered acceptable.
- For Type 1 stock it is specified that Blim is based on the lowest SSB where large recruitment is observed. In case of Irish Sea cod there is indicated that there was ecological regime shift sometime in the end on 90s/beginning of 2000's. Clearer clarification on this topic is missing in the documents provided. Due to the regime shift only years 1995-2021 were included in the estimate of Blim.
- Blim was taken as SSB which produced the highest recruitment in years 1995-2021, this corresponded to year 1996 SSB.
- Bpa was estimated according to ICES guidelines using the formula:
  *Bpa = Blim * exp(1.645*sigmaB),* where sigmaB was set equal to 0.2.

Assumptions for Fmsy estimation

- To estimate Fmsy model averaged stock recruit relationship of segmented regression, Ricker and Beverton Holt were used. The stock-recruitment relationship was calculated based on the whole timeseries.

The reviewer's opinion is that it is contradictive that for estimating Blim shortened time-series is used (due to regime shift) but when estimating Fmsy the whole time-series is used to fit a SRR which is used in the Fmsy calculation. As the nature of the regime shift and its affects to the Irish Sea cod are not discussed in any documents provided for the reviewer, it is difficult to understand the justification of such cutting of time series for one thing but not for other. When looking at the stock-recruitment pairs for the whole timeseries it is seen that there is no clear relationship presented. Unfortunately, this is rather common for many stocks, and it makes fitting any SRR function to the data difficult and subjective. In addition, it is mentioned that Irish Sea cod recruitment is affected by the environment (hence the usage of Feco), meaning that the recruitment success is more driven by the changes in temperature not by changes in SSB.

As there is no apparent SRR, reviewer suggests investigating YPR and SPR reference points alternatively, even just as an indication where would the F_{max}, $F_{30\%SPR}$, $F_{35\%SPR}$, and $F_{40\%SPR}$ values lie in comparison to the currently estimated Fmsy value.

At this stage to approve the reference points more information and explanation about the choices concerning the choices of cutting timeseries to calculate Blim is needed (at the same time using whole timeseries for estimating Fmsy). Exploration of YPR and SPR reference points would provide additional information as the Fmsy calculation is sensitive to the assumed SRR.

It is recommended that the whole code of calculating reference points is tidied up, as currently it is confusing to always understand which choices were made in calculations (e.g., I have written that sigmaB=0.2 as this is what corresponds to the Bpa value shown in the document, however there is also references in the R code that maybe sigmaB=0.3 is used instead).