REPORT OF THE WORKING GROUP ON ELASMOBRANCH FISHES (WGEF)

VOLUME 06 | ISSUE 75

ICES SCIENTIFIC REPORTS

RAPPORTS SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371

ICES Scientific Reports

Volume 06 | Issue 75

REPORT OF THE WORKING GROUP ON ELASMOBRANCH FISHES (WGEF)

Recommended format for purpose of citation:

ICES. 2024. Report of the Working Group on Elasmobranch Fishes (WGEF).
ICES Scientific Reports. 06:75. 994 pp. https://doi.org/10.17895/ices.pub.26935504

Editors

Sophy McCully Phillips • Teresa Moura

Authors

Aurelien Delaval • Barbara Serra Pereira • Catarina Maia • Christopher Griffiths • Cristina Rodríguez-Cabello • Damian Villagra Villanueva • Graham Johnston • Guzman Diez • Inigo Martinez • Jaylene Mbararia • Jim Ellis • Joana Silva • José De Oliveira • Jurgen Batsleer • Katinka Bleeker • Klara Jakobsdottir • Loïc Baulier • Matthias Schaber • Nana Afranewaa • Noémie Deleys • Pascal Lorance • Rebecca Holt • Régis Souza Santos • Ross O'Neill • Sophy McCully Phillips • Tanja Miethe • Teresa Moura • Thomas Barreau • Tobias Mildenberger

ICES CIEM International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Contents

i Executive summary

ICES WGEF is responsible for providing assessments and advice on the state of the stocks of sharks, skates, and rays throughout the ICES area. In 2024, WGEF provided advice for 31 stocks of skates and rays distributed in the Celtic Seas and Bay of Biscay/West Iberia ecoregions and two stocks of sharks distributed in the Northeast Atlantic.

Models were revised in a benchmark process for three stocks of skates: thornback ray and cuckoo ray in Division 9.a (Atlantic Iberian waters) and thornback ray in Division 8.c (Cantabrian Sea).The advice resulting from the new assessment method (stochastic surplus production model in continuous time – SPiCT) recommend larger catches than previously for cuckoo ray in Division 9.a (+83%) and thornback ray in Division 8.c (+110%), despite the 15th percentile of removals at F_{MSY} being used to advise of catch which was considered more precautionary than the standard 35th percentile. The advice remained at similar values for thornback ray in Division 9.a (-3.2%).

Spurdog in the Northeast Atlantic was assessed again at Category 1, and a further six stocks were assessed at Category 2 level for the second time, with one stock (porbeagle shark in the Northeast Atlantic) having a roll-over of advice with no new assessment, given the lack of new biomass data. WGEF applied for the second time the empirical methods for stock assessment and catch advice developed by WKLIFE X. These methods were applied to eight category 3 stocks to provide advice within the ICES MSY framework. The 15 category 5 and 6 stocks were not quantitatively assessed and advice was provided using the precautionary approach.

Discard estimates continue to remain uncertain due to the fact that elasmobranchs are primarily caught as bycatch in a variety of fisheries. Achieving precise and unbiased estimates would require a high level of sampling effort. However, the group has made diligent efforts to collate and harmonize discard data (since 2009) categorized by country, fleet segment, and stock code. This has enabled the inclusion of discard data in this report for comprehensive presentation. Nevertheless, for most stocks, advice is provided in terms of landings.

No benchmark assessments have been proposed for 2025.

ii Expert group information

Expert group name	Working Group on Elasmobranch Fishes (WGEF)
Expert group cycle	Annual
Year cycle started	2024
Reporting year in cycle	1/1
Chair(s)	Sophy McCully Phillips, UK
	Teresa Moura, Portugal
Meeting venue(s) and dates	5-6 June 2024, Online (data prep), 8 participants
	18-27 June, Online and Lisbon, Portugal, 29 participants

1 Introduction

1.1 Terms of Reference

2023/AT/FRSG14 The **Working Group Elasmobranch Fishes** (WGEF), chaired by Sophy McCully Phillips (UK) and Teresa Moura* (Portugal), will meet:

online 5–6 June 2024 to:

a) Compile the catch and length data for all elasmobranch stocks;

and in Lisbon, Portugal, from 18–27 June 2024 to:

b) Address generic ToRs for Regional and Species Working Groups.
c) Update the description of elasmobranch fisheries for deep-water, pelagic and demersal species in the ICES area and compile landings, effort and discard statistics by ICES Subarea and Division, and catch data by NEAFC regulatory areas. Describe and prepare a first Advice draft of any emerging elasmobranch fishery with the available data on catch/landings, fishing effort and discard statistics at the finest spatial resolution possible in the NEAFC RA and ICES area(s);
d) Evaluate the stock status for the provision of biennial advice due in 2024 for: (i) spurdog in the NE Atlantic; and (ii) skates in the Celtic Seas and Bay of Biscay and Iberian Coast ecoregions;
e) Collate landings and discard data from countries and fleets according to the ICES data call to follow recommendations from WKSHARK5 to: (i) address the following issues: data quality and onboard coverage; raising factors; discard retention patterns between fleets and countries; discard survival; (ii) advise on how to include discard information in the advisory process; and (iii) develop a coherent data-base for landings/discard information used in the assessments.
f) Follow the outcomes of WKSKATE and make the best use of survey indices in the assessments where appropriate.
g) Work intersessionally to draft/update stock annexes and then develop a procedure and schedule for subsequent reviews.

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. The assessments must be available for audit on the first day of the meeting.
Material and data relevant for the meeting as specified in the 2024 ICES data call must be available to the group no later than 14 days prior to the starting date.

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 Background and history

The Study Group on Elasmobranch Fishes (SGEF), having been first established in 1989 (ICES, 1989), was re-established in 1995 and had meetings or met by correspondence in subsequent years (ICES, 1995–2001). Assessments for elasmobranch species had been hampered by a lack of data. The 1999 meeting was held concurrently with an EC-funded Concerted Action Project meeting (FAIR CT98-4156) allowing greater participation from various European institutes (ICES, 1999).

Exploratory assessments were carried out for the first time at the 2002 SGEF meeting (ICES, 2002), covering eight of the nine case-study species considered by the EC-funded DELASS project (CT99-055). The success of this meeting was due largely to the DELASS project, a three-year collaborative effort involving 15 fisheries research institutes and two subcontractors (Heessen, 2003). Though much progress was made on methods, there was still much work to be done, with the paucity of species-specific landings data a major data issue.

In 2002, SGEF recommended the group be continued as a working group on Elasmobranch Fishes (WGEF). The medium-term remit of this group being to extend the methods and assessments for elasmobranchs prepared by the EC-funded DELASS project; to review and define data requirements (fishery, survey and biological parameters) for stock identification, analytical models and to carry out such assessments as are required by ICES customers. Since 2003 WGEF meets annually to continue the work on stock assessment and to support the advisory process. Further details on the history and achievements of WGEF can be found in an earlier report (ICES, 2021a).

In 2020 and 2021, WGEF met online due to COVID-19 restrictions. For the 2020 working group, data submission and processing had been altered to reduce issues in terms of data call interpretation as well as the delivery of non-uniform data sets. The WGEF 2020 data were submitted to InterCatch for the first time, extracted and processed using R-code available in TAF. Next landings data are collated to the landings spreadsheet containing the historical landings data. This process was repeated in 2021 and 2022. The incorporation of a two-day data preparatory meeting in 2023 was pivotal in the advancement of the harmonisation of fleet names, stock codes and species codes of the historic landings data. This meeting had three focus groups: 1) landings data, 2) discards data and 3) length data. Each group retrieved data submitted through InterCatch and Accessions and collated them using existing, and by developing new, code. Data were checked, missing data were identified and chased up, resulting in three data tables holding all submitted data in one place (see Section 27.4). This meant for the first time in 2023, the working group started the assessment meeting with (near) final data sets with which to run their assessments – something which was crucial in the management of workload. The incorporation of a data-preparatory meeting will remain as standard for this group going forward and was equally successfully implemented in 2024.

WGEF in 2024 was a full assessment meeting with updates for 31 stocks, of which three were benchmarked between 2023–2024. The elasmobranch benchmark (WKBELASMO3 2024) was held as a hybrid meeting from 26 February to 1 March 2024 to evaluate the appropriateness of data and methods to assess and provide short-term forecast of three rays stocks: thornback ray in Atlantic Iberian waters (rjc.27.9a); cuckoo ray in Atlantic Iberian waters (rjn.27.9a); and blonde ray in Atlantic Iberian waters (rjh.27.9a). A SPiCT assessment was accepted for the thornback and cuckoo ray stocks resulting in them becoming category 2 stocks for 2024 (see ICES 2024 for the full benchmark report, and Sections 19.9.3 and 19.9.6). The blonde ray stock failed to be accepted as a SPiCT assessment and thus the stock remained in category 3 and advice given according to the *rfb* rule in 2024. One further stock; thornback ray in the Cantabrian Sea (rjc.27.8c) was benchmarked as part of the WKBMSYSPiCT2 workshop which was held online from 9–13 January 2023. The SPiCT assessment was accepted and thus this stock became a category 2 stock for 2024 (see ICES, 2023 for the full benchmark report, and Section 19.9.2). The remaining 28 stocks considered the empirical methods for stock assessment and catch advice developed by WKLIFE X (ICES, 2021b), with eight category 3 stocks employing the rfb or rb-rule for the second time to provide advice within the ICES MSY framework.

1.3 Planning of the work of the group

Given the large number of stocks that WGEF addresses, WGEF and the ICES Secretariat have developed the following timeframe for advice.

In 2023, the following species and stocks were assessed and advice drafted (Table 1.1). These stocks will be addressed again in 2025:

- Skates and rays (Rajidae) in the Greater North Sea, (including Skagerrak, Kattegat and eastern Channel) (four ICES assessment units excluding 'other rays and skates' and blonde ray in Subarea 6 and Division 4.a (North Sea and West of Scotland));
- Skates and rays (Rajidae) in the Azores and Mid-Atlantic Ridge (mainly *R. clavata*);
- Smooth-hounds in the Northeast Atlantic;
- Catshark stocks in the Northeast Atlantic (seven ICES stock assessment units);

In 2023, the following species and stocks with quadrennial advice were addressed (Table 1.2). These stocks will be addressed again in 2027:

- Common skate in the greater North Sea ecoregion
- Starry ray in the greater North Sea ecoregion
- Leafscale gulper shark in the Northeast Atlantic;
- Kitefin shark in the Northeast Atlantic;
- Portuguese dogfish in the Northeast Atlantic;
- Angel shark in the Northeast Atlantic;
- Basking shark in the Northeast Atlantic;
- Thresher sharks in the Northeast Atlantic;
- White skate in the Northeast Atlantic.
- Tope in the Northeast Atlantic;
- Blonde ray in Subarea 6 and Division 4.a (North Sea and West of Scotland)
- Other rays and skates (Rajidae) in Subarea 4 and in divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and eastern English Channel).

In 2024, the following species and stocks were assessed and advice drafted (Table 1.3). These stocks will be addressed again in 2026:

- Seven category 2 and 3 stock of skates and rays (Rajidae) from the Celtic Seas ecoregion:
  - Thornback ray in Subarea 6 (West of Scotland)
  - Thornback ray in divisions 7.a,f-g (Irish Sea, Bristol Channel, Celtic Sea North).
  - Small-eyed ray in divisions 7.f and 7.g (Bristol Channel, Celtic Sea North)
  - Spotted ray in Subarea 6 and divisions 7.b and 7.j (West of Scotland, west and southwest of Ireland)
  - Spotted ray in divisions 7.a and 7.e-h (southern Celtic Seas and western English Channel)
  - Cuckoo ray in subareas 6-7 and divisions 8.a-b and 8.d (West of Scotland, southern Celtic Seas, and western English Channel, Bay of Biscay)

    - Undulate ray in divisions 7.d and 7.e (English Channel)

- Seven category 2 and 3 stocks of skates and rays (Rajidae) from the Biscay and Iberia ecoregion:
    - Thornback ray in divisions 8.a-b and 8.d (Bay of Biscay)
    - Thornback ray in Division 8.c (Cantabrian Sea)
    - Thornback ray in Division 9.a (Atlantic Iberian waters)
    - Blonde ray in Division 9.a (Atlantic Iberian waters)
    - Spotted ray in Subarea 8 (Bay of Biscay)
    - Cuckoo ray in Division 8.c (Cantabrian Sea)
    - Cuckoo ray in Division 9.a (Atlantic Iberian waters)

- As well as two widely distributed stocks:
    - Spurdog in Subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)
    - Porbeagle in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters).

Additionally, in 2024, the following species and stocks were addressed and advice drafted (Table 1.), but these category 5 or 6 stocks will now move to quadrennial advice (instead of biennial as previously) and thus will be addressed again in 2028:

- Other rays and skates (Rajiformes) in Subarea 6 and divisions 7.a-c and 7.e-k (Rockall, West of Scotland, Celtic Sea and western English Channel)
- Other rays and skates (Rajidae) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)
- Common skate complex (Blue skate (Dipturus batis) and flapper skate (Dipturus intermedius) in Subarea 6 and divisions 7.a–c and 7.e–k (Celtic Seas and western English Channel)
- Common skate complex (Blue skate (Dipturus batis) and flapper skate (Dipturus intermedius) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)
- Thornback ray (Raja clavata) in Division 7.e (western English Channel)
- Small-eyed ray (Raja microocellata) in divisions 7.d and 7.e (English Channel)
- Shagreen ray (Leucoraja fullonica) in subareas 6-7 (West of Scotland, southern Celtic Seas, English Channel)
- Blonde ray (Raja brachyura) in divisions 7.a and 7.f-g (Irish Sea, Bristol Channel, Celtic Sea North)
- Blonde ray (Raja brachyura) in Division 7.e (western English Channel)
- Sandy ray (Leucoraja circularis) in subareas 6-7 (West of Scotland, southern Celtic Seas, English Channel)
- Spotted ray (Raja montagui) in Division 9.a (Atlantic Iberian waters)
- Undulate ray (Raja undulata) in divisions 7.b and 7.j (west and southwest of Ireland)
- Undulate ray (Raja undulata) in divisions 8.a-b (northern and central Bay of Biscay)
- Undulate ray (Raja undulata) in Division 8.c (Cantabrian Sea)
- Undulate ray (Raja undulata) in Division 9.a (Atlantic Iberian waters)

Table 1.1. Elasmobranch stocks with biennial assessments and advice carried out in 2023.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
raj.27.1012	Rays and skates (mainly thornback ray) in the Azores and Mid-Atlantic Ridge	Widely distributed and migratory stocks	2021	Biennial
rjc.27.3a47d	Thornback ray (*Raja clavata*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat and eastern English Channel)	North Sea	2021	Biennial
rjh.27.4bc7d	Blonde ray (*Raja brachyura*) in Divisions 4.b, 4.c and 7.d (Central and southern North Sea and eastern English Channel)	North Sea	2021	Biennial
rjm.27.3a47d	Spotted ray (*Raja montagui*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2021	Biennial
rjn.27.3a4	Cuckoo ray (*Leucoraja naevus*) in Subarea 4 and Division 3.a (North Sea and Skagerrak and Kattegat)	North Sea	2021	Biennial
sdv.27.nea	Starry smooth-hound (*Mustelus* spp.) in the Northeast Atlantic	Widely distributed and migratory stocks	2021	Biennial
sho.27.67	Black-mouth dogfish (*Galeus melastomus*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2021	Biennial
sho.27.89a	Black-mouth dogfish (*Galeus melastomus*) in in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2021	Biennial
syc.27.3a47d	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2021	Biennial
syc.27.67a-ce-j	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 6 and Divisions 7.a–c. e–j (Celtic Seas and west of Scotland)	Celtic Seas	2021	Biennial
syc.27.8abd	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions 8.a,b,d (Bay of Biscay)	Bay of Biscay and Iberian seas	2021	Biennial
syc.27.8c9a	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions 8.c and 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2021	Biennial
syt.27.67	Greater-spotted dogfish (*Scyliorhinus stellaris*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2021	Biennial

Table 1.2. Elasmobranch stocks with quadrennial assessments and advice carried out in 2023.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
rjb.27.3a4	Common skate (*Dipturus batis*-complex) in Subarea 4 and Division 3.a (North Sea and Skagerrak)	North Sea	2019	Quadrennial
rjr.27.23a4	Starry ray (*Amblyraja radiata*) in Subareas 2, 3.a and 4 (Norwegian Sea, Skagerrak, Kattegat and North Sea)	North Sea	2019	Quadrennial
agn.27.nea	Angel shark (*Squatina squatina*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
bsk.27.nea	Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
cyo.27.nea	Portuguese dogfish (*Centroscymnus coelolepis*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
guq.27.nea	Leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
rja.27.nea	White skate (*Rostroraja alba*) in the Northeast Atlantic	Widely distributed	2019	Quadrennial
sck.27.nea	Kitefin shark (*Dalatias licha*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
thr.27.nea	Thresher sharks (*Alopias* spp.) in Subareas 10, 12, Divisions 7.c-k, 8.d-e, and Subdivisions 5.b.1, 9.b.1, 14.b.1 (Northeast Atlantic)	Widely distributed	2019	Quadrennial
gag.27.nea	Tope (*Galeorhinus galeus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2021	Biennial
raj.27.3a47d	Other skates and rays in the North Sea ecoregion (Subarea 4, and Divisions 3.a and 7.d)	North Sea	2021	Biennial
rjh.27.4a6	Blonde ray (*Raja brachyura*) in Division 4a and Subarea 6 (Northern North Sea and west of Scotland)	North Sea	2021	Biennial

Table 1.3. Elasmobranch stocks with biennial assessments and advice carried out in 2024.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
dgs.27.nea	Spurdog (Squalus acanthias) in Subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	Widely distributed	2024	Biennial
por.27.nea	Porbeagle (Lamna nasus) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	Widely distributed	Roll-over	TBC
rjc.27.6	Thornback ray (Raja clavata) in Subarea 6 (West of Scotland)	Celtic Seas	2024	Biennial
rjc.27.7afg	Thornback ray (Raja clavata) in divisions 7.a and 7.f-g (Irish Sea, Bristol Channel, Celtic Sea North)	Celtic Seas	2024	Biennial
rjc.27.8abd	Thornback ray (Raja clavata) in divisions 8.a-b and 8.d (Bay of Biscay)	Bay of Biscay and Iberian seas	2024	Biennial
rjc.27.8c	Thornback ray (Raja clavata) in Division 8.c (Cantabrian Sea)	Bay of Biscay and Iberian seas	2024	Biennial
rjc.27.9a	Thornback ray (Raja clavata) in Division 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Biennial
rje.27.7fg	Small-eyed ray (Raja microocellata) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea North)	Celtic Seas	2024	Biennial
rjh.27.9a	Blonde ray (Raja brachyura) in Division 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Biennial
rjm.27.67bj	Spotted ray (Raja montagui) in Subarea 6 and divisions 7.b and 7.j (West of Scotland, west and southwest of Ireland)	Celtic Seas	2024	Biennial
rjm.27.7ae-h	Spotted ray (Raja montagui) in divisions 7.a and 7.e-h (southern Celtic Seas and western English Channel)	Celtic Seas	2024	Biennial
rjm.27.8	Spotted ray (Raja montagui) in Subarea 8 (Bay of Biscay)	Bay of Biscay and Iberian seas	2024	Biennial
rjn.27.678abd	Cuckoo ray (Leucoraja naevus) in subareas 6-7 and divisions 8.a-b and 8.d (West of Scotland, southern	Celtic Seas	2024	Biennial

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
	Celtic Seas, and western English Channel, Bay of Biscay)			
rjn.27.8c	Cuckoo ray (Leucoraja naevus) in Division 8.c (Cantabrian Sea)	Bay of Biscay and Iberian seas	2024	Biennial
rjn.27.9a	Cuckoo ray (Leucoraja naevus) in Division 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Biennial
rju.27.7de	Undulate ray (Raja undulata) in divisions 7.d and 7.e (English Channel)	Celtic Seas	2024	Biennial

Table 1.4. Elasmobranch stocks with quadrennial assessments and advice carried out in 2024.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
raj.27.67a-ce-k	Other rays and skates (Rajiformes) in Subarea 6 and divisions 7.a-c and 7.e-k (Rockall, West of Scotland, Celtic Sea and western English Channel)	Celtic Seas	2024	Quadrennial
raj.27.89a	Other rays and skates (Rajidae) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Quadrennial
rjb.27.67a-ce-k	Common skate complex (Blue skate (Dipturus batis) and flapper skate (Dipturus intermedius) in Subarea 6 and divisions 7.a–c and 7.e–k (Celtic Seas and western English Channel)	Celtic Seas	2024	Quadrennial
rjb.27.89a	Common skate complex (Blue skate (Dipturus batis) and flapper skate (Dipturus intermedius) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Quadrennial
rjc.27.7e	Thornback ray (Raja clavata) in Division 7.e (western English Channel)	Celtic Seas	2024	Quadrennial
rje.27.7de	Small-eyed ray (Raja microocellata) in divisions 7.d and 7.e (English Channel)	Celtic Seas	2024	Quadrennial
rjf.27.67	Shagreen ray (Leucoraja fullonica) in subareas 6-7 (West of Scotland, southern Celtic Seas, English Channel)	Celtic Seas	2024	Quadrennial
rjh.27.7afg	Blonde ray (Raja brachyura) in divisions 7.a and 7.f-g (Irish Sea, Bristol Channel, Celtic Sea North)	Celtic Seas	2024	Quadrennial
rjh.27.7e	Blonde ray (Raja brachyura) in Division 7.e (western English Channel)	Celtic Seas	2024	Quadrennial
rji.27.67	Sandy ray (Leucoraja circularis) in subareas 6-7 (West of Scotland, southern Celtic Seas, English Channel)	Celtic Seas	2024	Quadrennial
rjm.27.9a	Spotted ray (Raja montagui) in Division 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Quadrennial
rju.27.7bj	Undulate ray (Raja undulata) in divisions 7.b and 7.j (west and southwest of Ireland)	Celtic Seas	2024	Quadrennial
rju.27.8ab	Undulate ray (Raja undulata) in divisions 8.a-b (northern and central Bay of Biscay)	Bay of Biscay and Iberian seas	2024	Quadrennial
rju.27.8c	Undulate ray (Raja undulata) in Division 8.c (Cantabrian Sea)	Bay of Biscay and Iberian seas	2024	Quadrennial
rju.27.9a	Undulate ray (Raja undulata) in Division 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2024	Quadrennial

1.4 ICES approach MSY

Most elasmobranch species are slow growing, with low population productivity. Some species (e.g. basking shark) are on several lists of 'threatened' or 'endangered' species. They may also be listed under international trade agreements such as the Convention on the International Trade on Endangered Species (CITES), which may place limitations on fishing for or trade in these species. Because of this, F_{MSY} is not believed to be an appropriate or achievable target in all cases, particularly in the short term. However, the ICES F_{MSY} methodology has evolved in recent years and ICES advice is provided under the Maximum Sustainable Yield framework (MSY).

Maximum sustainable yield is a broad conceptual objective aimed at achieving the highest possible yield over the long term (an infinitely long period of time). It is non-specific with respect to: (a) the biological unit to which it is applied; (b) the models used to provide scientific advice; and (c) the management methods used to achieve MSY.

The MSY concept can be applied to an entire ecosystem, an entire fish community, or a single fish stock. The choice of the biological unit to which the MSY concept is applied influences both the sustainable yield that can be achieved and the associated management options. Implementation of the MSY concept by ICES will first be applied to individual fish stocks. Further information on the background to MSY and how it is applied to fish stocks by ICES can be found in the General Context to ICES Advice.

In 2020, the Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X; ICES 2021b) developed methods for stock assessment and catch advice for stocks in ICES Categories 3 and 4, focusing on the provision of sound advice rules that are within the ICES MSY framework. WKLIFE emphasized the need to have assessment methods which accounted for the uncertainty and being more effective and precautionary compared to the two over five rule used to provide advice on elasmobranch stocks. Additional work on advice rules for stocks in Category 3 based on life-history traits (k), tested through simulation and management strategy evaluation (MSE), showed that the addition of specific multipliers based on the stock's life-history characteristics decreases the risk of the control rule´s performance. These new advice rules for category 3 stocks are implemented from 2022 onwards.

1.5 Community plan of action for sharks

An Action Plan for the Conservation and Management of Sharks (EU, 2009) was adopted by the European Commission in 2009. Further details on this plan and its relevance to WGEF can be found in an earlier report (ICES, 2009).

The utility of the Prohibited species list on TAC and quotas regulations

The list of prohibited species on the TACs and quotas regulations (e.g. Council Regulation (EU) 2023/194) is an appropriate measure for trying to protect the marine fish of highest conservation importance, particularly those species that are also listed on CITES and various other conservation conventions. Additionally, there should be sufficient concern over the population status and/or impacts of exploitation that warrants such a long-term conservation strategy over the whole management area.

There are some species that would fall into this category. For example, white shark and basking shark are both listed on CITES and some European nations have given legal protection to these species. Angel shark has also been given legal protection in the UK.

It should also be recognized that some species that are considered depleted in parts of their range may remain locally abundant in some areas, and such species might be able to support low levels of exploitation. From a fisheries management viewpoint, advice for a zero or near-zero TAC, or for no target fisheries, is very different from a requirement for 'prohibited species' status, especially as a period of conservative management may benefit the species and facilitate a return to commercial exploitation in the short term.

Additionally, there is a rationale that a list of prohibited species should not be changing regularly, as this could lead to confusion for both the fishing and enforcement communities. The STECF meeting on management of skates and rays has recommended issuing guidelines for the inclusion and removal of species on the prohibited species list (STECF, 2017).

In 2009 and 2010, undulate ray, *Raja undulata* was moved on to the prohibited species list. This had not been advised by ICES. Following a request from commercial fishers, the European Commission asked ICES to give advice on this listing. ICES reiterated that undulate ray would be better managed under local management measures and that there was no justification for placing undulate ray on the prohibited species list. The healthy status of one of the undulate ray stocks (rju.27.7de) assessed in 2022 and the corresponding advice for a rather high catch level confirms this view. There have been subsequent changes in the listing of this species. It was removed from the Prohibited Species List for Subarea 7 in 2014 (albeit as a species that cannot be retained or landed). In 2015, undulate ray was only maintained in the prohibited species list in subareas 6 and 10. Small TACs were established for stocks in the English Channel and Bay of Biscay in 2015 and for the stock in the Iberian ecoregion in 2016. In 2019, the list of prohibited species in the TACs and quota regulations was amended. An extensive list of prohibited species, including white shark, basking shark and hammerhead sharks have been taken up in the regulation on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (EU regulation 2019/1241).

1.6 Sentinel fisheries

ICES advice for several elasmobranch stocks suggests that their fisheries should, for example "*consist of an initial low* (level) *scientific fishery*". In discussions of such fisheries (e.g. rju.27.9a), WGEF would suggest that a 'sentinel fishery' is a science-based data collection fishery conducted by commercial fishing vessel(s) to gather information on a specific fishery over time using a commercial gear but with standardized survey protocols. Sentinel fisheries would:

- Operate with a standardized gear, defined survey area, and standardized index of effort;
- Aim to provide standardized information on those stocks that may not be optimally sampled by existing fishery-independent surveys;
- Include a limited number of vessels;
- Be subject to trip limits and other technical measures from the outset, in order to regulate fishing effort/mortality in the fishery;
- Carry scientific observers on a regular basis (e.g. for training purposes) and be collaborative programmes with scientific institutes;
- Assist in biological sampling programmes (including self-sampling and tagging schemes);
- Sampling designs, effort levels and catch retention policy should be agreed between stakeholders, national scientists and the relevant ICES assessment expert group.

1.7 Mixed fisheries regulations

Apart from TAC regulations, several ICES divisions have fish stocks subject to recovery plans, including the cod recovery plan, hake recovery plan, etc.

As several elasmobranch stocks, particularly skates and rays, are caught in mixed fisheries within these areas catches of elasmobranchs may be limited by restrictive effort limitations because of these plans. In general, these are not referred to within the text, but must be taken into consideration when looking at landings trends from within these areas.

1.8 Current ICES expert groups of relevance to the WGEF

1.8.1 Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Several elasmobranchs are taken in North Sea demersal fisheries, including spurdog (Section 2), tope (Section 10), various skates (Section 15) and starry smooth-hound (Section 21).

WGNSSK should note that the Greater Thames Estuary is the main part of the North Sea distribution of thornback ray *Raja clavata* and may also be an important nursery ground for some small shark species, such as tope and starry smooth-hound. Thornback ray is an important species in ICES Division 4.c, and is taken as bycatch in fisheries targeting sole (e.g. trawl and gillnet), cod (e.g. trawl, gillnet and longline), as well as in targeted fisheries.

The Wash may also be an area of ecological importance for some elasmobranchs, including thornback ray and tope.

1.8.2 Working Group for the Celtic Seas Ecoregion (WGCSE)

Several elasmobranchs are taken in the waters covered by WGCSE, including spurdog (Section 2), tope (Section 10), various skates and rays (Section 18) and starry smooth-hound (Section 21).

WGCSE should note that common skate *Dipturus batis*-complex, which has declined in many inshore areas of northern Europe, may be locally abundant in parts of ICES Division 6.a and the deeper waters of the Celtic Sea (Division 7.h-j). Thornback ray is abundant in parts of the Irish Sea, especially Solway Firth, Liverpool Bay and Cardigan Bay. The Lleyn Peninsula is an important ground for greater-spotted dogfish *Scyliorhinus stellaris*. WGSCE should also note that the Bristol Channel is of high local importance for small-eyed ray *Raja microocellata*, as well as being an important nursery ground for some small sharks (e.g. starry smooth-hound and tope) and various skates.

Angel shark (Section 22) was formerly abundant in parts of Cardigan Bay, the Bristol Channel and Start Bay, and is now observed very rarely. Similarly, white skate (Section 23) was historically present in this ecoregion and may be near-extirpated from most parts of the ecoregion.

1.8.3 Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)

In 2008, WGEF met in parallel with WGDEEP in order to assess and provide advice on deep-water sharks (see sections 3–5). In February 2010, WGDEEP held a benchmark assessment of deep-water stocks (WKDEEP; ICES, 2010). Two WGEF members attended in order to carry out an assessment of the deep-water shark species *Centrophorus squamosus* and *Centroscymnus* *coelolepis*. Considerable progress was made in robust construction of a plausible catch and effort history for both species. A novel approach to assessing such species as deep-water sharks was presented at the meeting using a subset of the data on Portuguese dogfish and was agreed by WKDEEP to be a highly promising approach, pending the acceptable reconstruction of the aforementioned catch and effort data. Further development and possible future application of the method is to be encouraged. Several members of WGEF also attend WGDEEP, so facilitating the exchange of knowledge between the two expert groups.

1.8.4 International Bottom-trawl Survey Working Group (IBTSWG) and Working Group on Beam Trawl Surveys (WGBEAM)

IBTSWG continue to provide maps of the distribution of a variety of demersal elasmobranchs from the IBTS surveys in the North Sea and western areas. WGEF consider that these plots provide useful information and hope that IBTSWG will continue to provide these plots as routine outputs in the future. WGBEAM carries out some analysis of catch rates and distribution of certain skate species from beam trawl surveys in the North Sea and Celtic Seas ecoregions. Such analyses are very useful for WGEF.

There are some inaccuracies in the identifications of some skates in various trawl surveys, as well as some recent taxonomic revisions. Hence, more collaborative studies and exchange between WGEF and WGBEAM to address such issues is encouraged.

1.8.5 Workshop on the Inclusion of Discard Survival in Stock Assessments (WKSURVIVE)

The first workshop met in February 2021. Important objectives of this Workshop for WGEF is to explore the incorporation of discard survival estimates in stock assessments as well as to review the various approaches taken to integrate discard estimates in current assessments in the context of applying discard survival estimates.

One of the recurring issues in WGEF is the uncertainty in discard data as a result of the high number of discrepancies between years and inconsistent or missing data when these data are raised. Raising procedures not standardized among member states and thus are often deemed too unreliable for inclusion, despite having had two dedicated workshops on the use of discard data in stock assessments (WKSHARK 3 (ICES, 2017) and WKSHARK5 (ICES, 2020a)). However, with the transition of ten stocks from a Category 3 to Category 2, discard data are now included in some SPiCT models and therefore the advice given for selected stocks since 2022. Given the expected high survival of elasmobranchs, catch data (i.e. landings and estimated discards) will not equal dead removals. Hence the importance to understand the survival rate of discarded elasmobranchs in order to obtain separate estimates for dead and surviving discards.

WKSURVIVE pointed out that discard and discard survival are a major concern in many elasmobranch stocks and their inclusion should be evaluated in all assessments of skate and ray stocks and suggested to develop data-limited assessment frameworks that can accommodate the explicit inclusion of discards and discard survival.

1.9 Other meetings of relevance to WGEF

1.9.1 ICCAT

WGEF have conducted joint-meetings and assessments with ICCAT in 2008 (Madrid) and 2009 (ICES headquarters). These meetings were useful in pooling information on highly migratory pelagic shark species, including porbeagle, blue shark and shortfin mako. It is intended that these collaborations continue to usefully assess and update knowledge of pelagic shark species.

In 2022, WGEF hosted a joint ICCAT-ICES meeting on porbeagle. The meeting focused on the Northeast Atlantic stock, and discussed the benchmark and new advice outcome, as well as the process and timeline of advice provision within ICES and similarly within ICCAT. The timelines to provide final advice, and management programmes of both organisations differ. In addition, ICCAT scientists question the approach of applying a generic Harvest Control Rule (HCR) to assess elasmobranch stocks as the rule has not been tested on long-lived species. As a result this has led to inconsistent perceptions of the stock status and any associated catch advice. Consistency between the advice from each organisation is important and future alignment of process and outcomes. Therefore in 2024, this SPiCT assessment was not updated and a roll-over of the 2022 advice provided. Further information on the 2022 joint meeting on porbeagle is found in section 6 of this report.

WGEF considers that further collaborative meetings with the ICCAT Shark Species Group should continue. There are ongoing studies analysing the genetics, tagging of several shark species and modelling approaches. Both organisations should invest time and effort to collaborate in sharing these data and knowledge in order to improve our understanding of stock structure and status of several shark species. Such collaboration may be facilitated by an MoU between ICES and ICCAT.

1.9.2 General Fisheries Commission for the Mediterranean (GFCM)

WGEF consider that ICES and the GFCM would benefit from improved interaction due to the overlap in the distribution of certain stocks, and also in comparing stock assessment methods for data-limited stocks. Further information on collaboration between ICES and GFCM can be found in an earlier report (ICES, 2021a).

1.10 Relevant biodiversity and conservation issues

ICES work on elasmobranch fish is becoming increasingly important as a source of information to various multilateral environmental agreements concerning the conservation status of some species. Table 1.5 lists species occurring in the ICES area that are considered within these fora. An increasing number of elasmobranchs are 'prohibited' species in European fisheries regulations (EU 2019/1241, EU 2023/194), and these are summarised in Table 1.6.

Additionally, whilst not forming the basis of a legal instrument, the International Union for Conservation of Nature (IUCN) conduct Red List assessments of many species, including elasmobranchs, which has been undertaken at global (e.g., Dulvy *et al*., 2021), North-East Atlantic (Gibson *et al*., 2008), Mediterranean (Cavanagh and Gibson, 2007; Abdul Malak *et al*., 2011) and European scales (Nieto *et al*., 2015). IUCN listings are summarised in the relevant species sections.

1.10.1 OSPAR Convention

The OSPAR Convention (www.ospar.org) guides international cooperation on the protection of the marine environment of the Northeast Atlantic. It has 15 Contracting Parties and the European Commission represents the European Union. The OSPAR list of Threatened and/or Declining Species and Habitats, developed under the OSPAR Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area, provides guidance on future conservation priorities and research needs for marine biodiversity at risk in the region. To date, eleven elasmobranch species are listed (Table 1.5), either across the entire OSPAR region or in areas where they were perceived as declining.In 2020, ICES was requested to review and update OSPAR status assessments for stocks of listed shark, skates and rays in support of the OSPAR Quality Status Report 2023 (QSR2023) (WKSTATUS, ICES, 2020b).

1.10.2 Convention on the Conservation of Migratory Species (CMS)

CMS recognizes the need for countries to cooperate in the conservation of animals that migrate across national boundaries, if an effective response to threats operating throughout a species' range is to be made. The Convention actively promotes concerted action by the range states of species listed on its Appendices. The CMS Scientific Council has determined that 35 shark and ray species, globally, meet the criteria for listing in the CMS Appendices (Convention on Migratory Species, 2007). Table 1.5 lists Northeast Atlantic elasmobranch species that are currently included in the Appendices.

CMS Parties should strive towards strict protection of endangered species on Appendix I, conserving or restoring their habitat, mitigating obstacles to migration and controlling other factors that might endanger them. The range states of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international cooperation) are encouraged to conclude global or regional agreements for their conservation and management.

CMS now has a Sharks MOU, comprising an Advisory Committee (AC) and Intercessional Working Group (IWG).

1.10.3 Convention on International Trade in Endangered Species (CITES)

CITES was established in recognition that international cooperation is essential to the protection of certain species from overexploitation through international trade. It creates an international legal framework for the prevention of trade in endangered species of wild fauna and flora, and for the effective regulation of international trade in other species which may become threatened in the absence of such regulation.

Species threatened with extinction can be listed on Appendix I, which basically bans commercial, international trade in their products. Appendix II includes "*species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival*". Trade in such species is monitored closely and allowed if exporting countries can provide evidence that such trade is not detrimental to wild populations of the species.

Resolution Conf. 12.6 encourages parties to identify endangered shark species that require consideration for inclusion in the Appendices if their management and conservation status does not improve. Decision 13.42 encourages parties to improve data collection and reporting of catches, landings and trade in sharks (at species level where possible), to build capacity to manage their shark fisheries, and to take action on several species-specific recommendations from the Animals Committee (CITES, 2009).

1.10.4 Convention on the Conservation of European Wildlife and Natural Habitats (Bern convention)

The Bern Convention is a regional convention that provides a binding, international legal instrument that aims to conserve wild flora, fauna and natural habitats. Appendix II (or III) lists strictly protected (or protected) species of fauna (sometimes identified for the Mediterranean Sea only). Contracting Parties should "*take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II*" and "*protection of the wild fauna species specified in Appendix III*".

Table 1.5. Elasmobranch species listed by Multilateral Environmental Agreements. Source; OSPAR (http://www.ospar.org/), CITES (https://cites.org/), CMS (http://www.cms.int/) and Bern Convention (http://www.coe.int/t/dg4/cultureheritage/nature/bern/default_en.asp).

Family	Species	Multinational Environmental Agreement			
		OSPAR	CMS	CITES	Bern
Squalidae	Spurdog *Squalus acanthias*	✓	App II (northern hemisphere populations)		
Triakidae	Tope *Galeorhinus galeus*		App II		
Centrophoridae	Gulper shark *Centrophorus granulosus*	✓			
	Leafscale gulper shark *Centrophorus squamosus*	✓			
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	✓			
Squatinidae	Angel shark *Squatina squatina*	✓	App I & II		App III (Med)
Rhincodontidae	Whale shark *Rhincodon typus*		App I & II	App II	
Alopiidae	Pelagic thresher *Alopias pelagicus*		App II	App II	
	Bigeye Thresher *Alopias superciliosus*		App II	App II	
	Common Thresher *Alopias vulpinus*		App II	App II	
Cetorhinidae	Basking shark *Cetorhinus maximus*	✓	App I and II	App II	App II (Med)
Lamnidae	White shark *Carcharodon carcharias*		App I and II	App II	App II (Med)
	Shortfin mako shark *Isurus oxyrinchus*		App II		App III (Med)
	Longfin mako shark *Isurus paucus*		App II		
	Porbeagle shark *Lamna nasus*	✓	App II	App II	App III (Med)
Carcharhinidae	Silky shark *Carcharhinus falciformis*		App II	App II	
	Oceanic white-tip *Carcharhinus longimanus*		App I	App II	
	Blue shark *Prionace glauca*		App II	App II	App III (Med)
Sphyrnidae	Scalloped hammerhead *Sphyrna lewini*		App II	App II	
	Great hammerhead *Sphyrna mokarran*		App II	App II	
	Smooth hammerhead *Sphyrna zygaena*		App II	App II	

Table 1.5. (continued). Elasmobranch species listed by Multilateral Environmental Agreements.

Family	Species	Multinational Environmental Agreement			
		OSPAR	CMS	CITES	Bern
Pristidae	Sawfish *Pristidae*		App I and II	App I	
Rhinobatidae	Common Guitarfish *Rhinobatos rhinobatos*		App II	App II	
Glaucostegi-dae	Blackchin Guitarfish Glaucostegus cemiculus			App II	
Rajidae	Common skate (*Dipturus batis*) complex	✓			
	Thornback ray *Raja clavata*	✓ ICES Divi-sion 2			
	Spotted ray *Raja montagui*	✓ North Sea			
	White skate *Rostroraja alba*	✓			App III (Med)
Mobulidae	Reef manta ray *Manta alfredi*		App I and II		
	Giant manta ray *Manta birostris*		App I and II	App II	
	Manta rays *Manta* spp.			App II	
	Longhorned mobula *Mobula eregoodootenkee*		App I and II	App II	
	Lesser devil ray *Mobula hypostoma*		App I and II	App II	
	Spinetail mobula *Mobula japanica*		App I and II	App II	
	Shortfin devil ray *Mobula kuhlii*		App I and II	App II	
	Giant devil ray *Mobula mobular*		App I and II	App II	App II (Med)
	Munk's (or pygmy) devil ray *Mobula munkiana*		App I and II	Ap II	
	Lesser Guinean devil ray *Mobula rochebrunei*		App I and II	App II	
	Chilean (or sicklefin) devil ray *Mobula tarapacana*		App I and II	App II	
	Smoothtail mobula *Mobula thurstoni*		App I and II	App II	

Table 1.6. Elasmobranch taxa listed as Prohibited Species on EU fisheries regulations*. It is prohibited for EU vessels "… *to fish for, to retain on board, to tranship or to land …*" these species in certain areas within EU waters (Article 13) or, for certain species listed in Article 22, within the ICCAT Convention area. Adapted from EU (2019/1241; 2023/194).

Family	Species	Area
Centrophoridae	Leafscale gulper shark *Centrophorus squamosus*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
	Birdbeak dogfish *Deania calcea*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Etmopteridae	Smooth lantern shark *Etmopterus pusillus*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1, 5–8, 12 and 14
	Great lantern shark *Etmopterus princeps*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Dalatiidae	Kitefin shark *Dalatias licha*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Squatinidae	Angel shark *Squatina squatina*	EU waters
Alopiidae	Bigeye thresher shark *Alopias superciliosus*	ICCAT convention area
Cetorhinidae	Basking shark *Cetorhinus maximus*	All waters
Lamnidae	White shark *Carcharodon carcharias*	All waters
	Porbeagle shark *Lamna nasus*	All waters
	Shortfin mako shark *Isurus oxyrinchus*	All waters
Triakidae	Tope *Galeorhinus galeus*	When taken by longline in EU waters of Division 2.a and subarea 4, and EU and international waters of subareas 1, 5–8, 12 and 14.
Carcharhinidae	Silky shark *Carcharhinus falciformis*	ICCAT convention area
	Oceanic whitetip shark *Carcharhinus longimanus*	ICCAT convention area
	Hammerheads (Sphyrnidae), except for *Sphyrna tiburo*)	ICCAT convention area
Pristidae	Narrow sawfish *Anoxypristis cuspidata*	All waters
	Dwarf sawfish *Pristis clavata*	All waters
	Smalltooth sawfish *Pristis pectinata*	All waters
	Largetooth sawfish *Pristis pristis*	All waters
	Green sawfish *Pristis zijsron*	All waters
Rhinobatidae	All members of family	EU waters of subareas 1–12

Table 1.6. (continued). Elasmobranch taxa listed as Prohibited Species on EU fisheries regulations.

Family	Species	Area
Rajidae	Starry ray *Amblyraja radiata*	EU waters of Divisions 2.a, 3.a, 7.d and subarea 4
	Common skate (*Dipturus batis*) complex (*Dipturus cf. flossada and Dipturus cf. intermedia*)	EU waters of Division 2.a and sub-areas 3–4, 6–10.
	Norwegian skate *Dipturus nidarosiensis*	EU waters of subarea 6 and Divisions 7.a-c and 7e–h and 7.k
	Thornback ray *Raja clavata*	EU waters of Division 3.a
	Undulate ray *Raja undulata*	EU waters of subareas 6 and 10
	White skate *Rostroraja alba*	EU waters of subareas 6-10
Mobulidae	Reef manta ray *Manta alfredi*	All waters
	Giant manta ray *Manta birostris*	All waters
	Longhorned mobula *Mobula eregoodootenkee*	All waters
	Lesser (or Atlantic) devil ray *Mobula hypostoma*	All waters
	Spinetail mobula *Mobula japanica*	All waters
	Shortfin devil ray *Mobula kuhlii*	All waters
	Giant devil ray *Mobula mobular*	All waters
	Munk's (or pygmy) devil ray *Mobula munkiana*	All waters
	Lesser Guinean devil ray *Mobula rochebrunei*	All waters
	Chilean (or sicklefin) devil ray *Mobula tarapacana*	All waters
	Smoothtail mobula *Mobula thurstoni*	All waters

* excluding 15 species/families of deep-water sharks as listed in Annex I, Part D of EU 2023/194, prohibited in United Kingdom, Union and international waters of ICES subareas 6 to 9; United Kingdom and international waters of 5; Union and international waters of ICES subarea 10; Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2; and international waters of ICES subarea 12 (see sections 3 and 5 for further details).

1.11 Data availability

1.11.1 General considerations

WGEF members agree that future meetings of WGEF should continue to meet in June, as opposed to meeting earlier in the year, as (a) more refined landings data are available; (b) meeting outside the main spring assessment period should provide national laboratories with more time to prepare for WGEF, (c) it will minimize potential clashes with other assessment groups (which could result in WGEF losing the expertise of stock assessment scientists) and (d) given that there are not major year-to-year changes in elasmobranch populations (cf. many teleost stocks), the advice provided would be valid for the following year.

The group agreed that survey data should be provided as disaggregated raw data, and not as compiled indices or data. The group agreed that those survey abundance estimates that are not currently in the DATRAS database are also provided as raw data by individual countries. It is recommended to have the data and code to calculate the survey indices to be made available on TAF.

WGEF recommends that Member States provide detailed explanations of how national data for species and length compositions are raised to total catch, especially when there may be various product weights reported (e.g. gutted or dressed carcasses and livers and/or fins).

1.11.2 ICES Data Call

Landings data for years 2005 and later come from Data Calls (see above). WGEF uses some landings data extracted from ICES catch statistics, for time-series going back in time further than 2005. These data were mostly collated before 2005 although this task was hampered by the use by many countries of “nei” (not elsewhere identified) categories. Although strongly improving over time, for all years, the Working Group’s best estimates are still considered inaccurate for a number of reasons:

i. Quota species may be reported as elasmobranchs to avoid exceeding quota, which would lead to over-reporting;
ii. Fishers may not take care when completing landings data records, for a variety of reasons;
iii. Administrations may not consider that it is important to collect accurate data for these species;
iv. Some species could be underreported to avoid highlighting that bycatch is a significant problem in some fisheries;
v. Some small inshore vessels may target (or have a bycatch of) certain species and the landings of such inshore vessels may not always be included in official statistics.

A Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2) was held in January 2016 (ICES, 2016), and following this, the 2016 Data Call requested a standardised approach to data submission, including for a longer period. Since 2016 data were submitted to the accessions folder using a common InterCatch format. This still resulted in considerable issues with data collation, formatting and QA that had to be addressed in the early stages of the meetings.

During the 2019 meeting, continuing issues with how the Data Call is interpreted, the non-uniformity of the dataset and as well as the many issues with species coding and stock allocations were discussed at length. A dedicated group met with the ICES Data Centre prior to the 2020 Data Call to explore options to facilitate the process of rendering a by the group accepted landings table before the start of WGEF. The group developed a more automated process using InterCatch and an R-coding procedure available in the Transparent Assessment Framework (TAF). The procedure to obtain the landings data is described in the 2020 WGEF report (ICES, 2020c). The issue list, stock allocation file and R-code is available on github: https://github.com/ices-taf/WGEF_catches.

Since 2020, the data call requested nations to upload landings and discard data into InterCatch. The use of InterCatch facilitates data processing, improve transparency and allow members to conduct initial assessments prior to the meeting, removing a serious time-constraint.

1.11.3 Discards data

The EU requires Member States to collect discard data on elasmobranchs. This discarding may include both regulatory discarding, when quota is limited, as well as the discarding of smaller and less marketable individuals. Whilst WGEF want to make progress from ‘landings’ to ‘catch’-based advice, data from discard observer programmes has suffered from quality issues often related to the variety of raising procedures employed by Member States. However, to-date eight stocks now include discard data in their assessment and provision of catch advice, as they have transitioned from a Category 3 to Category 2 assessment using surplus production models.

EU countries have implemented national on-board observer programs to estimate discards of abundant commercially important species (e.g. hake, *Nephrops*, cod, sole, and plaice). The adopted sampling designs have been defined considering the métiers, seasons and areas relevant for those species. As a consequence, national sampling programmes might not be optimal for estimating precise and unbiased discards for elasmobranchs.

In 2017 and 2019, workshops were held to address the issues surrounding the use of discards in the elasmobranch assessments (ICES, 2017; 2020a). WKSHARK3 reviewed i) the suitability of national sampling programs to estimate elasmobranch discards (including rare species), ii) the discard information available and iii) the procedures/methods to calculate population level estimates of discards removals for different countries (ICES, 2017). WKSHARK5 investigated i) the raising method for elasmobranch fishes, ii) the data quality and onboard coverage, and iii) proposed method on how to include the data in the advisory process (ICES, 2020a).

In 2021, discard data over the period 2009 to 2020 were collected and merged into a single spreadsheet in Excel. Since 2022 those discard data has been added, making discard data available and easily accessible from 2009 onwards. It was noted that for many stocks the discard data were incomplete for many of the years. In addition, raising to national catch levels is uncertain and procedures are not standardized. Particularly problematic are the cases of species which are not landed, i.e. being either not commercial or being subject to conservation measures (e.g. zero TAC).

Overall, the main issues concerning the estimation of elasmobranch total discards are presented in the 2021 WGEF report (ICES, 2021a).

1.11.4 Discard survival

Owing to the apparent high survival of some elasmobranchs after capture it is important to obtain separate estimates for dead and surviving discards. As a proportion of the discards would be alive, catch data (landings and estimated discards) do not equate with “dead removals” in terms of population dynamics. Understanding the survival rates of discarded individuals is therefore fundamental for informing potential exemptions from the EU landings obligation.

To date there have been only limited scientific studies on the discard survival of skates and catsharks in European fisheries, and data on the immediate, short-term survival and longer-term discard survival of these species are lacking for most fisheries. A summary of those studies was compiled in WKSHARK3 (ICES, 2017). To inform discussions on the future EU landing obligation and to improve the quantification of dead discards, WGEF recommend the need to implement scientific studies to better assess and quantify the discard survival of the main commercial skates caught by the trawl fleets, especially otter trawlers operating in the Bay of Biscay and Iberian waters, beam trawl and flyshoot fleets operating in northern Europe and for gill- and trammel net fisheries used by the inshore polyvalent fleet.

1.11.5 Length data

In 2022, there was a recommendation to change the way ICES provides advice for data limited stocks (DLS) using WKLIFE X methods (ICES, 2021b). A data call was put out, requesting supporting information on life history parameters and length compositions for landings and discards as far back in time as possible. The data have been submitted to InterCatch. Before WGEF convenes, the data coordinator request ICES to extract all length data submitted as requested by the WKLIFE X Data Call. In addition, missing data were looked up in the WGEF accessions folders. All data were collated to produce a large overview table containing length data on landings and discards by country, year, species, fishing area, and fleet. Data were checked and assigned to an ICES stock code using an automated process derived from the way the WGEF landings table is constructed. The same approach was followed in 2023 and 2024.

1.11.6 Stock structure

This report presents the status and advice of various demersal, pelagic and deep-water elasmobranchs by individual stock component. The identification of stock structure has been based upon the best available knowledge to date (see the stock-specific sections for more details). However, it has to be emphasized that overall, the scientific basis underlying the identity of many of these stocks is currently weak. In most cases, stock identification is based on the distribution and relative abundance of the species, current knowledge of movements and migrations, reproductive mode, and consistency with management units.

WGEF considers that the stock definitions proposed in the report are limited for many species, and in some circumstances advice may refer to 'management units'.

WGEF recommends that increased research effort be devoted to clarifying the stock structure of the different demersal and deep-water elasmobranchs being investigated by ICES.

1.11.7 Taxonomic problems

Incorrect species identifications or coding errors affect many relevant data sets, including commercial data and even some scientific survey data. WGEF consistently attempt to correct and report these errors when they are found. The FAO produced an updated guide to the chondrichthyan fish of the North Atlantic (Ebert and Stehmann, 2013).

1.12 Methods and software

Many elasmobranchs are data-limited, and the paucity of data can extend to:

- Landings data, which are often incomplete or aggregated;

- Life-history data, as most species are poorly known with respect to age, growth and reproduction;
- Commercial and scientific datasets that are compromised by inaccurate species identification (with some morphologically similar species having very different life-history parameters);
- Lack of fishery-independent surveys for some species (e.g. pelagic species) and the low and variable catch rates of demersal species in existing bottom-trawl surveys.

Hence, the work undertaken by WGEF often precludes the formal stock assessment process that is used for many commercial teleost stocks. The analysis of survey, biological and catch data are used in most cases to evaluate the status of elasmobranch species/stocks. This limitation may be eased by new data-poor assessment approaches, which have the potential to allow some ray stocks to be moved from assessment Category 3 to Category 2. To date, ten stocks have been through a benchmark and now use a Surplus Production model such as SPiCT and a State-Space Bayesian Model to provide advice. Since 2022, ACOM has recommended the use of the WKLIFE X Empirical approaches to assess category 3 stocks within the MSY framework (ICES, 2021b).

1.13 InterCatch

Since 2022, InterCatch was used to submit landings and discard data. InterCatch is solely used as a database to store official landings and discard data. Landings figures are supplied by individual members, after data formatting undertaken by WGEF (e.g. allocation to stock, quality assurance, reallocation of misidentified species). These corrected data are considered to be more accurate than official statistics as regional laboratories can better provide information on local fisheries and interpretation of nominal records of various species (including errors in species coding). In the last two years landings and discard data, including length data, were requested in the InterCatch SI format and were requested to be submitted to InterCatch. However, not all nations have followed up on the data call and submitted the data to data.call@ices.dk. As such, part of the landings data were retrieved from the Accessions folder.

1.14 References

Abdul Malak, D., Livingstone, S.R., Pollard, D., Polidoro, B.A., Cuttelod, A., Bariche, M., Bilecenoglu, M., Carpenter, K.E., Collette, B.B., Francour, P., Goren, M., Hichem Kara, M., Massutí, E., Papaconstantinou, C. and Tunesi, L. 2011. *Overview of the Conservation Status of the Marine Fishes of the Mediterranean Sea*. Gland, Switzerland and Malaga, Spain: IUCN. vii + 61pp.

Cavanagh, R.D. and Gibson, C. 2007. *Overview of the Conservation Status of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea*. IUCN, Gland, Switzerland and Malaga, Spain. vi + 42 pp.

CITES. 2009. Conservation and management of sharks and stingrays. AC24 WG5 Doc. 1. http://www.cites.org/common/com/AC/24/wg/E–AC24–WG05.pdf.

Convention on Migratory Species. 2007. Report of the Fourteenth Meeting of the Scientific Council of the Convention on the Conservation of Migratory Species of Wild Animals. http://www.cms.int/bodies/ScC/Reports/Eng/ScC_report_14.pdf.

Dulvy, N.K., Pacoureau, N., Rigby, C.L., Pollom, R.A., Jabado, R.W., Ebert, D.A., Finucci, B., Pollock, C.M., Cheok, J., Derrick, D.H., Herman, K.B., Sherman, C.S., VanderWright, W.J., Lawson, J.M., Walls, R.H.L., Carlson, J.K., Charvet, P., Bineesh, K.K., Fernando, D., Ralph, G.M., Matsushiba, J.H., Hilton-Taylor, C., Fordham, S.V. and Simpfendorfer, C.A. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. Current Biology 31: 1-15 https://doi.org/10.1016/j.cub.2021.08.06.

Ebert, D.A. and Stehmann, M.F.W. 2013. Sharks, batoids, and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes. No. 7. Rome, FAO. 523 pp.

EU. 2009. Communication from the Commission to the European parliament and the council on a European Community action plan for the conservation and management of sharks. COM (2009) 40.

Gibson, C., Valenti, S.V., Fordham, S.V. and Fowler, S.L. 2008. *The Conservation of Northeast Atlantic Chondrichthyans: Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop*. viii + 76 pp.

Heessen, H.J.L. (Ed.) 2003. Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 605 pp.

ICES. 1989. Report of the Study Group on Elasmobranch Fisheries, 26–28 April 1989, Dublin, Ireland. ICES Document CM 1989/G: 54, 37 pp.

ICES. 1999. Report of the Study Group on Elasmobranch Fishes, 23–27 March 1999, Santander, Spain. ICES Document CM 1999/G: 11, 18 pp.

ICES. 2002. Report of the Study Group on Elasmobranch Fishes, 6–10 May 2002, Copenhagen, Denmark. ICES Document CM 2002/G: 08, 119 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 424 pp.

ICES. 2010. Report of the Benchmark Workshop on Deep-water Species (WKDEEP). 17–24 February, Copenhagen, Denmark. ICES CM 2010/ACOM:38, 247 pp.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40, 69 pp.

ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20-24 February 2017, Nantes, France . ICES CM 2017/ACOM:38. 119 pp.

ICES, 2018. French request for updated advice on Undulate ray (*Raja undulata*) in divisions 7.d–e and 8.a–b. 13 July 2018. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, sr.2018.13.

ICES. 2020a. Workshop on incorporating discards into the assessments and advice of elasmobranch stocks (WKSHARK5, outputs from 2019 meeting). ICES Scientific Reports. 2:87. 94 pp. http://doi.org/10.17895/ices.pub.7494

ICES. 2020b. Workshop to review and update OSPAR status assessments for stocks of listed shark, skates and rays in support of OSPAR (WKSTATUS). ICES Scientific Reports. 2:71. 152 pp. http://doi.org/10.17895/ices.pub.7468

ICES. 2020c. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 2:77. 789 pp. http://doi.org/10.17895/ices.pub.7470

ICES, 2021a. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 3:59. 822 pp. https://doi.org/10.17895/ices.pub.8199

ICES. 2021b. 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. 2022 Benchmark Workshop for selected elasmobranch stocks (WKELASMO). ICES Scientific Reports.

ICES. 2023. Benchmark workshop 2 on development of MSY advice using SPiCT (WKBMSYSPiCT2). ICES Scientific Reports. 5:65. 472 pp. https://doi.org/10.17895/ices.pub.23372990

ICES. 2024. Benchmark Workshop 3 on Selected Elasmobranch Stocks (WKBELASMO3). ICES Scientific Reports. 6:74. 321 pp. https://doi.org/10.17895/ices.pub.26935492Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., García Criado, M., Allen, D.J., Dulvy, N.K., Walls, R.H.L., Russell, B., Pollard, D., García, S., Craig, M., Collette, B.B., Pollom, R., Biscoito, M., Labbish Chao, N., Abella, A., Afonso, P., Álvarez, H., Carpenter, K.E., Clò, S., Cook, R., Costa, M.J., Delgado, J., Dureuil, M., Ellis, J.R., Farrell, E.D., Fernandes, P., Florin, A-B., Fordham, S., Fowler, S., Gil de Sola, L., Gil Herrera, J., Goodpaster, A., Harvey, M., Heessen, H., Herler, J., Jung, A., Karmovskaya, E., Keskin, C., Knudsen, S.W., Kobyliansky, S., Kovačić, M., Lawson, J.M., Lorance, P., McCully Phillips, S., Munroe, T., Nedreaas, K., Nielsen, J., Papaconstantinou, C., Polidoro, B., Pollock, C.M., Rijnsdorp, A.D., Sayer, C., Scott, J., Serena, F., Smith-Vaniz, W.F., Soldo, A., Stump, E. and Williams, J.T. 2015. *European Red List of marine fishes.* Luxembourg: Publications Office of the European Union, iv + 81 pp.

OSPAR Commission. 2010. *Report of the OSPAR workshop on defining actions and measures for the OSPAR list of threatened and/or declining species and habitats*. OSPAR Commission, 131 pp.

STECF (Scientific, Technical and Economic Committee for Fisheries) 2017. Long-term management of skates and rays (STECF-17-16). Publications Office of the European Union, Luxembourg. 85 pp.

Contents

2 Spurdog in the Northeast Atlantic

2.1 Stock distribution

Spurdog or the piked dogfish, *Squalus acanthias* has a worldwide distribution in temperate and boreal waters, and occurs mainly in depths of 10–200 m. In the NE Atlantic, this species is found from Iceland and the Barents Sea southwards to the coast of Northwest Africa (McEachran and Branstetter, 1984).

WGEF considers that there is a single NE Atlantic stock ranging from the Barents Sea (Subarea 1) to the Bay of Biscay (Subarea 8), and that this is the most appropriate unit for assessment and management within ICES. Spurdog in Subarea 9 may be part of the NE Atlantic stock, but catches from this area are likely to consist of a mixture of *Squalus* species, with increasing numbers of *Squalus blainville* further south.

Genetic microsatellite analyses conducted by Verissimo *et al.* (2010) found no differences between east and west Atlantic spurdog. The authors suggested this could be accomplished by transatlantic migrations of a very limited number of individuals. Further information on the stock structure and migratory pattern of Northeast Atlantic spurdog can be found in the Stock Annex. Nonetheless, recent studies undertaken by Thorburn *et al*. (2018) suggest subpopulations across the UK.

2.2 The fishery

2.2.1 History of the fishery

Spurdog has a long history of exploitation in the Northeast Atlantic (Pawson *et al.*, 2009) and WGEF estimates of total landings are shown in Figure 2.1 and Table 2.1a. Spurdog has historically been exploited by France, Ireland, Norway and the UK (Table 2.2). The main fishing grounds for the NE Atlantic stock of spurdog are the North Sea (Subarea 4), West of Scotland (Division 6.a) and the Celtic Seas (Subarea 7) and, during the decade spanning the late 1980s to 1990s, the Norwegian Sea (Subarea 2) (Table 2.3). Outside these areas, landings have generally been low. In recent years, the fishery has changed significantly in line with restrictive management measures, which have included more restrictive quotas, a maximum landing length and bycatch regulations.

Further details of the historical development of the fishery are provided in the Stock Annex. General information on the mixed fisheries exploitation of this stock and changes in effort can be found in ICES (2009a, b) and STECF (2009).

2.2.2 The current fishery

The zero TAC for spurdog for EU vessels, introduced in 2011, has resulted in a major change in the magnitude and spatial distribution of reported landings (Figure 2.1). Between 2005 and 2017, landings declined across all ICES subareas, slightly increasing in 2018-2022. Following the introduction of a non-zero TAC in 2023, landings increased substantially to 2317 tonnes.

In 2010-2022 Norwegian landings were significantly higher than landings from other countries, and have been fluctuating between 217–540 tonnes. Since 2019, the Norwegian landings have remained stable within 321-409 tonnes.

Since 2016, UK reported landings have greatly increased from 30 tonnes in 2016 to 120 tonnes in 2022. For UK, traditionally one of the major fishing countries of spurdog (prior to 2009), this was a major increase from a level close to zero since the zero TAC was introduced in 2011. With implementation of a non-zero TAC in 2023, landings have increased further to 446 tonnes.

Other countries have also increased their landings in 2023 following the introduction of the non-zero TAC, particularly France with 904 tonnes and Ireland with 422 tones. Further details of spurdog landings by country are listed in Table 2.2.

Discard estimates are available from some countries from 2005 (Table 2.1b) and are highly variable across years and countries with between 20 and 4781 tonnes between 2005 and 2023; a maximum of 4090 tonnes was reported by the UK England in 2017.

Commercial fishermen in various areas, including the southern North Sea, the Celtic Sea, and in the south- and mid-Norwegian coastal areas, continue to report that spurdog can be seasonally abundant on their fishing grounds.

Catches in the NEAFC area are negligible for this stock.

2.2.3 ICES advice applicable

In 2022, ICES advised that "*when the MSY approach is applied, catches in 2023 and 2024 should be no more than 17 353 tonnes and 17 855 tonnes respectively. Any possible provision for the landing of bycatch should be part of a management plan, including close monitoring of the stock and fisheries*".

2.2.4 Management applicable

The following table summarises ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2023.

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC NE Atlantic	TAC (2a (EC) and 4) (tonnes)	TAC 3a , 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	TAC 3a(EC) (tonnes)	TAC 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
2000	No advice	-		9470				15 890
2001	No advice	-		9070	-	-	-	16 693 (1)
2002	No advice	-		7300	-	-	-	11 170
2003	No advice	-		5840	-	-	-	12 246
2004	No advice	-		4672	-	-	-	9365
2005	No advice	-		1236	-	-	-	7092
2006	F=0	Stock depleted and in danger of collapse		1051	-	-	-	3996
2007	F=0	Stock depleted and in		841 (2)	2828	-	-	2892

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC NE Atlantic	TAC (2a (EC) and 4) (tonnes)	TAC 3a , 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	TAC 3a(EC) (tonnes)	TAC 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
		danger of collapse						
2008	No new advice	No new advice		631 [2,3]	-	-	2004 [2]	1791
2009	F=0	Stock depleted and in danger of collapse		316 [3,4]	-	104 [4]	1002 [4]	1968
2010	F=0	Stock depleted and in danger of collapse		0 [5]		0 [5]	0 [5]	886
2011	F=0	Stock depleted and in danger of collapse		0 [6]		0	0 [6]	427
2012	F=0	Stock below possible reference points		0 [6]		0	0 [6]	447
2013	F=0	Stock below possible reference points		0		0	0	331
2014	F=0	Stock below possible reference points		0		0	0	381
2015	F=0	Stock below possible reference points		0		0	0	257
2016	F=0	Stock below possible reference points		0		0	0 (270[7])	371
2017	F-0	Stock below possible		0		0	270[7]	294

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC NE Atlantic	TAC (2a (EC) and 4) (tonnes)	TAC 3a , 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	TAC 3a(EC) (tonnes)	TAC 1, 5, 6, 7, 8, 12 and 14 (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
		reference points						
2018	F-0	Stock below possible reference points		0		0	270(7)	362
2019	F=0	Stock below possible reference points		0		0	270(7)	455
2020	F=0	Stock below possible reference points		0		0	270(7)	526
2021	F=0	Stock below possible reference points		0		0	270(7)	539
2022	F=0	Stock below possible reference points		0		0	270(7)	474
2023	F=0	Above MSY Btrigger, Bpa, and Blim	17 353					2317
2024	F=0	Above MSY Btrigger, Bpa, and Blim	17 855					

(1) The WG estimate of landings in 2001 may include some misreported deep-sea sharks or other species. (2) Bycatch quota. These species shall not comprise more than 5% by live weight of the catch retained on board. (3) For Norway: including catches taken with longlines of tope shark (*G. galeus*), kitefin shark (*D. licha*), bird beak dogfish (*D. calcea*), leafscale gulper shark (*C. squamosus*), greater lantern shark (*E. princeps*), smooth lanternshark (*E. spinax*) and Portuguese dogfish (*C. coelolepis*). This quota may only be taken in zones 4, 6 and 7. (4) A maximum landing size of 100 cm (total length) shall be respected. (5) Bycatches are permitted up to 10% of the 2009 quotas established in Annex Ia to Regulation (EC) No. 43/2009 under the following conditions: catches taken with longlines of tope shark (*G. galeus*), kitefin shark (*D. licha*), bird beak dogfish (*D. calceus*), leafscale gulper shark (*C. squamosus*), greater lantern shark (*E. princeps*), smooth lantern shark (*E. pusillus*) and Portuguese dogfish (*C. coelolepis*) and spurdog (*S. acanthias*) are included (Does not apply to 3a); a maximum landing size of 100 cm (total length) is respected; the bycatches comprise less than 10% of the total weight of marine organisms on board the fishing vessel. Catches not complying with these conditions or exceeding these quantities shall be promptly released to the extent practicable. (6) Catches taken with longlines of tope shark (*G. galeus*),

kitefin shark (*D. licha*), bird beak dogfish (*D. calcea*), leafscale gulper shark (*C. squamosus*), greater lanternshark (*E. princeps*), smooth lanternshark (*E. pusillus*), Portuguese dogfish (*C. coelolepis*) and spurdog (*S acanthias*) are included. Catches of these species shall be promptly released unharmed to the extent practicable. (7) Spurdog shall not be targeted in the areas covered by this TAC. When accidentally caught in fisheries where spurdog is not subject to the landing obligation, specimens shall not be harmed and shall be released immediately, as required by Articles 12 (13 in 20180 and 41 (45 in 2018) of this Regulation. By derogation from Article 12 of this Regulation, a vessel engaged in the by-catch avoidance programme, a small TAC was introduced (see conditions in section 2.2.4 text below).

In 2022, ICES advised that when the MSY approach is applied, catches in 2023 and 2024 should be no more than 17 353 tonnes and 17 855 tonnes, respectively. This is the first spurdog non-zero quota advice since 2009.

In all EU regulated areas, a zero TAC for spurdog was retained for 2019. In July 2016, an in-year amendment to EU quota regulations (Council Regulation (EU) 2016/1252 of 28 July 2016) introduced a small TAC (270 t) for Union and international waters of subareas 1, 5–8, 10 and 12, with this TAC being allocated to vessels participating in bycatch avoidance programmes. This regulation states that "*a vessel engaged in the by-catch avoidance programme that has been positively assessed by the STECF may land not more than 2 tonnes per month of picked dogfish that is dead at the moment when the fishing gear is hauled on board. Member States participating in the by-catch avoidance programme shall ensure that the total annual landings of picked dogfish on the basis of this derogation do not exceed the amounts indicated below. They shall communicate the list of participating vessels to the Commission before allowing any landings. Member States shall exchange information about avoidance areas*".

This derogation was not denoted for TAC areas for EU waters of 3.a or EU waters of 2.a and 4. In these areas, no EU landings were permitted.

In 2007, Norway introduced a general ban on target fisheries for spurdog in the Norwegian economic zone and in international waters of ICES subareas 1–14, with the exception of a limited fishery for small coastal vessels. Bycatch could be landed and sold as before. All directed fisheries were banned from 2011, although there is still a bycatch allowance. From October 2011, bycatch should not exceed 20% of total landings on a weekly basis. Since 4 June 2012, bycatch must not exceed 20% of total landings over the period 4 June–31 December 2012. From 1 January 2013, bycatch must not exceed 15% of total landings on a half calendar year basis. Live specimens can be released, whereas dead specimens must be landed. From 2011, the regulations also include recreational fisheries. Norway has a 70 cm minimum landing size (first introduced in 1964).

Since 1 January 2008, fishing for spurdog with nets and longlines in Swedish waters has been forbidden. In trawl fisheries, there is a minimum mesh size of 120 mm, and the species may only be taken as a bycatch. In fisheries with hand-held gear only one spurdog was allowed to be caught and kept by each angler during a 24-hour period.

Many of the mixed fisheries that caught spurdog in the North Sea, West of Scotland and Irish Sea were subject to effort restrictions under the cod long-term plan (EC 1342/2008).

2.3 Catch data

2.3.1 Landings

Total annual landings of NE Atlantic spurdog are given in Table 2.1a and illustrated in Figure 2.1. Preliminary estimates of landings for 2023 were 2317 t. Total landings split by nation are given in Table 2.2.

2.3.2 Discards

Discards from some countries have been provided following the data call for the WKNSEA benchmark in 2021 (ICES, 2021 and associated WDs) and also for the WGEF data call in 2021-2023. Total discards from 2005-2023 can be found in Table 2.1b.

Further information on discards can be found in the Stock Annex and in the WKNSEA benchmark report (ICES, 2021 and associated WDs).

2.3.3 Discard survival

Low mortality has been reported for spurdog caught by trawl when tow duration was < 1 h, with overall mortality of about 6% (Mandelman and Farrington, 2007; Rulifson, 2007), with higher levels of mortality (ca. 55%) reported for gillnet-caught spurdog (Rulifson, 2007).

Only limited data on at-vessel mortality is available for European waters (Bendall *et al.*, 2012), and there are no published data on post-release mortality.

2.3.4 Quality of the catch data

In addition to the problems associated with obtaining estimates of the historical total landings of spurdog, due to the use of generic dogfish landings categories, anecdotal information suggests that widespread misreporting by species may have contributed significantly to the uncertainties in the overall level of spurdog landings.

Underreporting may have occurred in certain ICES areas when vessels were trying to build up a track record of other species, for example deep-water species. It has also been suggested that over-reporting may have occurred with other elasmobranch stocks with highly restrictive quotas being recorded as spurdog. It is not possible to quantify the amount of under and over-reporting that may have occurred. The introduction of UK and Irish legislation requiring registration of all fish buyers and sellers should mean that such misreporting problems have declined since 2006.

It is not known whether the 5% bycatch ratio limit (implemented in 2008) or the maximum landing length (implemented in 2009) led to misreporting (although the buyers and sellers legislation should deter this) or increased discarding.

Given the zero or very small TAC from 2011 to 2022, catch data in these years are highly uncertain. Whilst data from discard observer programmes may allow catches to be estimated, estimation of dead discards will be more problematic.

Some nations may now be reporting landings of spurdog under more generic codes (e.g. *Squalus* sp., Squalidae and Squaliformes) as well as for *Squalus acanthias*.

With introduction of the non-zero TAC in 2023, it is expected that data availability will improve.

2.4 Commercial catch composition

2.4.1 Length composition

Since 2005, two gear groupings were selected as representing the two main types of fishing activity, namely “trawls & other” and “nets & hooks”. The catch length frequencies which formed the basis of the “trawls & other” fleet are shown by country in Figure 2.2a; these length frequencies were combined by first expressing them as proportions by length category (according to the established life-stage-based length bins used for spurdog), and then combining them by using weighted averaging using the relative contribution by country to the fleet (Table 2.4 gives an example of these weights for the years 2022-2023). For the current assessment (2022-2023), new length frequency data were received and used from countries that hadn't submitted data previously, e.g. U.K Northern Ireland and France (Figure 2.2a, Table 2.4). As part of the assessment process, length frequency data by nation were either included or excluded following a decision based on data quality as per benchmark (2021) protocol for such data. For example, U.K England data were submitted for 2022 but were not included in the assessment as the data were of a very low sample size and had a discontinuous length distribution. Similarly, Ireland submitted length frequency data for 2022, it was not included in the assessment for the aforementioned reasons as well as direct information on its unsuitability (Per comms Graham Johnston, WGEF 2024). For the "nets & hooks" fleet, catch length frequencies from gillnet, trammel nets, hooks and lines were combined with equal weighting (Figure 2.2b). The resulting commercial proportions by length category for males and females combined as used in the assessment are listed in Table 2.9.

2.4.2 Sex ratio

No new data is available; a sex ratio of 0.5 is assumed in the assessment (see Stock Annex).

2.4.3 Quality of data

Length frequency samples prior to 2005 are only available for UK landings and these are aggregated into broader length categories and have been used in previous assessments. Prior to 2005, no data were available from Norway, France or Ireland who were the other main exploiters of this stock. The availability of length data from 2005 onwards has improved following the Data Call associated with the 2021 WKNSEA benchmark (ICES, 2021).

2.5 Commercial catch-effort data

No commercial CPUE is used in the assessment (see Stock Annex).

2.6 Fishery-independent information

2.6.1 Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. Beam trawl surveys are not considered appropriate for this species, due to the low catchability of spurdog in this gear type.

The international bottom trawl surveys (IBTS) have higher catchability and the gears are considered suitable for this species. The spatial coverage of the North and Celtic Seas IBTS represents a large part of the stock range, as shown for an example year, 2013, in Figure 2.3. For further details of these surveys and gears used see ICES (2010). A description of the current groundfish surveys included in the spurdog assessment can be found in the Stock Annex and in ICES 2021. In addition, bottom trawl data on spurdog from the Norwegian Shrimp survey (NO-shrimp-Q1) is available and used (details in Stock Annex and ICES 2021). Its coverage is shown in Figure 2.4. All survey data are combined per quarter for the assessment (Q1, Q3 andQ4), see Stock Annex for further details.

Additional Norwegian data on spurdog include the annual bottom trawl Coastal survey (from 1995 and ongoing) and a longline survey (from 2021 and ongoing). The NOcoast-Aco-Q4 covers the areas from 62°N to the Russian border in the north in October–November (Q4). The target species are coastal cod, saithe and haddock, but data is also collected for other demersal fish, elasmobranchs and deep-water shrimps (Mehl et al. 2017). Spurdog is mainly caught south of 66°N. A Campelen Shrimp trawl with 40 mm mesh size was used from 1995–1998, whereas mesh size was 20 mm for later years. More details can be found in Vollen (2014) and Junge *et al*. (2020).

The spurdog longline survey in Norwegian waters covers 58-65 °N and started in October 2021 (again in Sep/Oct 2022). This survey is specifically designed for spurdog and covers its distribution area along the Norwegian coast. The pilot survey in 2021 consisted of 280 successful longline stations each with 180 hooks. Spurdog was caught between 20 and 300 m at 34% of stations (Figure 2.5). The length-weight relationship per sex from the 2021 survey is shown in Figure 2.6 (Vollen et al. 2021, survey report IMR; Andrade et al. presentation to WGEF in 2022).

Spurdog survey data are typically characterised by highly variable catch rates due to occasional large hauls and a significant proportion of zero catches. All survey data are combined per quarter for the assessment (Q1, Q3 andQ4), see Stock Annex.

Future studies of survey data could utilise sex-specific and juvenile abundance trends. In the absence of accurate catch data, fishery-independent trawl surveys will be increasingly important to monitor stock development.

2.6.2 Length–frequency distributions

Proportions by length category and sex for the three combined survey indices included in the assessment are shown in Figure 2.7.

Previously presented length frequencies are displayed in the Stock Annex, in the WGEF report 2022 (ICES 2022) and the WKNSEA report (ICES 2021).

2.6.3 Statistical modelling

Statistical modelling of survey data is carried out with the ‘surveyIndex’ R package (Berg, et al. 2014) using the delta-lognormal approach with the full model (for both the presence-absence and positive parts of the model) defined as follows:

$$g(\mu_i) = Year_i + Gear_i + U(Ship_i) + s_1(\text{lon}_i, \text{lat}_i) + s_2(\text{depth}_i) + s_3(\text{timeofday}_i) + \log(\text{HaulDur}_i)$$

where g is the logit link function for the binomial model (1/0 response), and the lognormal for the positive observations (implemented by log-transforming the response variable and using a normal distribution with identity link function). The model includes an offset to account for the effects of haul duration. Further details of the modelling approach, including the final models used for each of the combined survey indices (Q1, Q3 and Q4) and the surveys included in these combined indices, can be found in the Stock Annex and the 2021 benchmark report (ICES 2021; see also WD1 to this benchmark report).

Figure 2.8 shows biomass maps for the combined surveys by quarter. Figure 2.9 shows the estimated biomass indices based on the delta-lognormal modelling approach by quarter, with 95% confidence bounds, as compared to indices used for the 2022 assessment (ICES, 2022). For Q1 surveys, the estimated distribution map shows the highest biomass to be to the north and west of Scotland, with some indication of higher biomass in the coastal waters of Norway and the central North Sea (Figure 2.8), while the estimated index shows a steep decline at the start of the time series with a gradual increase since the mid-2000s (Figure 2.9). For the Q3 survey, the estimated distribution map shows areas of highest biomass to be in the central and northwestern North Sea, in addition to along the Swedish coastline (no coverage west of Scotland, Figure 2.8), while the estimated index shows no obvious temporal trend, although it perhaps reaches a minimum in the early 2000s and maxima in the late 1990s and in recent years (Figure 2.9). For the Q4 surveys, the estimated distribution map shows high biomass to the west of Scotland, but also in the Irish Sea and to the south in the Celtic Sea (no coverage of the North Sea, Figure 2.8), while the estimated index shows a significant and sharp increase since around 2015 (Figure 2.9).

For the year 2022 in Q1, there were no hauls for SCOWCGFS survey in subarea 6.a and a slightly reduced number of stations in NS-IBTS. The delta GAM modelling approach used to estimate the combined Q1 survey index includes a spatial effect to account coverage issues. As expected, the uncertainty in Q1 index is slightly higher in 2022 than for other recent years (Table 2.7). Also, the sample size for length distributions is reduced in Q1 of 2022 (Table 2.8a). Survey indices and CVs as well as survey proportions at length and sample sizes are used as input to the assessment model.

2.7 Life-history information

The biological parameters currently used in the assessment can be found in the Stock Annex.

2.8 Exploratory assessments and previous analyses

2.8.1 Previous assessments

Exploratory assessments undertaken in 2006 included the use of a delta-lognormal GLM-standardized index of abundance and a population dynamic model. This has been updated at subsequent meetings. The results from these assessments indicate that spurdog abundance had declined, and that the decline was driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation (ICES, 2006). More recent assessments have indicated that spurdog biomass is increasing again (e.g. ICES, 2020a, ICES, 2022).

2.8.2 Simulation of effects of maximum landing length regulations

Earlier demographic studies on elasmobranchs indicate that low fishing mortality on mature females may be beneficial to population growth rates (Cortés, 1999; Simpfendorfer, 1999). Hence, measures that afford protection to mature females may be an important element of a management plan for the species. As with many elasmobranchs, female spurdog attain a larger size than males, and larger females are more fecund.

Preliminary simulation studies of various Maximum Landing Length (MLL) scenarios were undertaken by ICES (2006) and suggested that there are strong potential benefits to the stock by protecting mature females. However, improved estimates of discard survivorship from various commercial gears are required to better examine the efficacy of such measures.

2.9 Stock assessment

2.9.1 Introduction

An initial benchmark assessment of the model was carried out in 2011. A summary of reviewer comments and responses are provided in Appendix 2a of the 2011 WGEF report (ICES, 2011), and is reproduced in an Appendix to the Stock Annex. The model is described in detail in the Stock Annex, and in De Oliveira *et al*. (2013).

In 2011, WGEF updated the model based on the benchmark assessment. Subsequent update assessments were carried out in 2014, 2016, 2018 and 2020. A second benchmark was held in early 2021 (ICES, 2021), and the assessment model presented here adopts the configuration approved during the 2021 benchmark.

The assessment was carried out in 2022 following the benchmark settings with updated data. No assessment was carried out in 2023 (the stock is assessed on a biennial basis), sections below summarize the 2024 assessment.

2.9.2 Updates since the benchmark in 2021

2.9.2.1 Summary of benchmark

In February 2021, a benchmark for spurdog was held as part of WKNSEA (ICES 2021).

The spurdog assessment is currently the only elasmobranch ICES category 1 assessment, with an integrated age–length-based assessment that includes catch data back to 1905. Survey indices included in the assessment prior to the benchmark in 2021 only covered a relatively small part (primarily divisions 6.a and 4.a) of the entire stock distribution area. Therefore, it was one of the main aims of the benchmark to improve spatial coverage by including a number of eligible surveys in the assessment. Furthermore, the inclusion of new fecundity data along with improved information on growth was on the issue list. Finally, inclusion of fleet-based data (including length distributions), and better catch information since 2010 was to be addressed and a data-call was set up to request this information. Four main topics were considered in this benchmark (i) catch data (landings, discards and commercial size and sex composition), (ii) survey indices (biomass indices and size and sex composition), (iii) biological parameters, and (iv) reference points.

Based on the discussion on spatial and temporal coverage of the various surveys in DATRAS and those made available as part of the data call, the workshop agreed to derive three separate biomass indices, one per quarter (Q1, Q3 andQ4). Data extraction and manipulation made use of the 'DATRAS' R package while statistical modelling has been carried out using the 'surveyIndex' R package (Berg et al., 2014). It implements a GAM modelling framework allowing for a variety of different model assumptions including 'delta' models with lognormal and gamma distributions for positive observations. In addition to the modelled survey indices (and estimated CVs), the number of individuals by sex (sample size) and proportion at length by year (and sex) were calculated for use in the stock assessment. Details on the input data, analysis and results are found in the WD by Dobby (2021). This results in the following indices to be used in the assessment:

- A modelled biomass Q1 index, based on four survey time-series: NO-shrimp, NS-IBTS, SWC-IBTS, SCOWCGFS [1985–present]. Proportions at length by year and sex from the Q1 surveys and sample sizes.

- A modelled biomass Q3 index, based on a single survey: NS-IBTS [1992–present]. Proportions at length by year and sex from the Q3 survey and sample sizes.
- A modelled Q4 index, based on five survey time-series: SWC-IBTS, SCOWCGFS, NIGFS, IE-IGFS, EVHOE [2003–present]. Proportions at length by year and sex from the Q4 surveys and sample sizes.

Fecundity data used to inform the model were improved from having two data years (1960, 2005) to include 14 data years covering the period 1921–2020.

Commercial catch length data were requested as part of the data-call for the benchmark, and this resulted in the definition of two commercial fleet types from 2005 onwards ("nets & hooks" and "trawls & other"), with commercial proportions by length category data compiled from 2007 onwards and used to estimate the selectivity for these two fleet types. The commercial fleet types prior to 2005 were kept as before ("target" and "non-target"), with associated data (as before) to estimate selectivities for these. The model has therefore been extended to reflect four commercial selectivity types, as described above.

For reference points, B_{lim} was set to 20% of B_0 because the model goes back to 1905 when reporting of landings were relatively low and well before the high exploitation in the 1950s and onwards. For detailed descriptions, please see the benchmark report (ICES, 2021).

2.9.2.2 Issues encountered during WGEF 2022

When preparing data for the assessment presented below, some errors were discovered with input data preparation for the 2021 benchmark assessment. These are summarised as follows:

a. unraised sampling data were erroneously included when preparing the fishery length composition data for both the "nets & hooks" and "trawls & other" categories from 2007 onwards – these unraised data have now been removed;
b. when preparing the "trawls & other" fishery length composition data, a misalignment of years occurred due to missing years of data from Sweden, which meant that length compositions were incorrectly combined and allocated to the wrong years – this has now been corrected;
c. when preparing the discards data for 2007 onwards, a formatting issue in Excel meant that some discards data (e.g. for England and Wales) were omitted – these data have now been included.

In addition to these issues, there was an effort to update landings and discards data for elasmobranchs from 2005 onwards during the WKSHARK series of meetings (see e.g. ICES, 2020b). The decision from the 2021 benchmark was to use updated data from 2007 onwards, given information available at the time, but for the assessment presented below, updated landings and discards were included from 2005 onwards to be consistent with the work done within WKSHARK. However, length composition data used in the assessment were not updated to include 2005 and 2006, but these should be considered for inclusion during a future benchmark.

When preparing the discard data, it was clear that there were substantial gaps in the discard data for UK (England & Wales): there were no discard data for gillnets and trammel nets for the years 2011, 2013-2015, while surrounding years had anything from 683 t (2016) to 4472 t (2012). It was therefore decided to fill these gaps by allocating the average UK (England & Wales) discards for gillnets and trammel nets for the years 2010, 2012, 2016-19 (2425 t) to these missing years, and this was included in the assessment.

A comparison was made between the results of the 2021 benchmark ("benchmark21") and a subsequent update to account for the issues mentioned above (corrections to input data, updated data for 2005 onwards, infilling for missing data: "update21"). Figure 2.10 indicates a markedly different likelihood profile for benchmark21 and update21 for the parameter Q_{fec}, which reflects the extent of density-dependence in the stock-recruit relationship, and hence productivity – update21 has a higher optimum Q_{fec} value, indicating that the stock is more productive than previously thought. These runs showed quite a different perception, where during the benchmark the stock was still thought to be below the biomass reference points, but with subsequent updates, the perception is somewhat different, with the stock above biomass reference points. Although Q_{fec} is estimated, the other fecundity parameters (a_{fec} and b_{fec}) are not, and the approach used was to set these to their update21 values (since that would have been the equivalent of the benchmark had there not been the data issues), and this is the approach adopted (Figure 2.11). The fixed values of a_{fec} and b_{fec} used in the current assessment are given in Table 2.11b.

2.9.2.3 Issues encountered during WGEF 2024

Reference points for spurdog are estimated as part of the assessment model and are updated with each new assessment. Although the values are updated within each assessment, the basis should remain unchanged. However, during WGEF 2024 the basis for calculating MSY $B_{trigger}$ and HR_{pa} were discussed following the ICES guidelines and updated.

Due to the harvest rate having been well below the MSY reference point since 2005 (Table 2.13, Figure 2.21b), the basis for calculating MSY $B_{trigger}$ was updated. Following the ICES guidelines, the WG rejected setting MSY $B_{trigger}$ to B_{pa} (339 490 t), which was selected in the last benchmark, and was considered to be too low. Also, the 5th percentile of current stock biomass (530 764 t) was rejected. Since the stock biomass is currently increasing, the 5^{th} percentile is likely to increase over time, when reference points are revised in the future. Instead, the current MSY $B_{trigger}$ is now set to the 5th percentile of B_{MSY} (650 770 t) which is considered a precautionary and more stable estimate. The 5^{th} percentile is based on a CV (11.9%) taken from the last 10 years (2015-2024) of total biomass estimates from the 2024 assessment. This results in a MSY $B_{trigger}$ set at about 76% of B_{MSY} (Figure 2.12a).

HR_{pa} was previously calculated as $HR_{lim}/1.4$, and this was updated to an HR that has a no-more-than 5% probability of driving the stock to B_{lim}. This calculation can be done either with or without the ICES advice rule. Without the ICES advice rule it is a more straightforward calculation, where it is the harvest rate that leads to a total biomass equal to $B_{lim}/(1\text{-}2\times CV)$ (with "observed CV" of 11.9% taken from the last 10 years (2015-2024) of total biomass estimates from the 2024 assessment); i.e. the 5th percentile of the total biomass distribution is at B_{lim}. With the ICES advice rule, this calculation is more complicated, and has been done with a long-term projection, shown in Figure 2.12b. It became apparent that including the ICES advice rule when calculating HR_{pa} leads to a harvest rate (0.134) that, when subsequently applied without the ICES advice rule, will crash the stock. This is likely due to the much higher MSY $B_{trigger}$ proposed for this stock. WGEF is not comfortable with putting forward a harvest rate that crashes the stock, and we therefore propose that HR_{pa} is calculated without the ICES advice rule (0.064).

Reference points	Technical basis	Value
MSY $B_{trigger}$	A proxy for the 5th percentile of the B_{MSY} distribution is used (assuming CV for last 10 years of estimates of total biomass, 2015-2024). Equilibrium-based calculation; in tonnes	650 770
B_{lim}	0.2 × B_0, where B_0 is the virgin total biomass. Equilibrium-based calculation; in tonnes	242 493
B_{pa}	1.4 × B_{lim}; in tonnes	339 490
HR_{MSY}	Harvest rate (ages 5-30) that maximises yield and leads to B_{MSY}. Equilibrium-based calculation.	0.043
HR_{pa} without ICES Advice Rule	Harvest rate that leads to the 5th percentile of total biomass equal to B_{lim} (assuming CV for last 10 years of estimates of total biomass, 2015-2024), where the ICES advice rule is not included. Equilibrium-based calculation.	0.064
HR_{lim}	Harvest rate that leads the B_{lim}. Equilibrium-based calculation.	0.067
HR_{crash}	Harvest rate that crashes the population. Equilibrium-based calculation.	0.073
HR_{pa} with ICES Advice Rule	Harvest rate that leads to the 5th percentile of total biomass equal to B_{lim} (assuming CV for last 10 years of estimates of total biomass, 2015-2024), where the ICES advice rule is included. From long-term projection (Figure 2.12b)	0.134*

***This value is an approximation, based on a multiplier on HR_{MSY}, where the ICES Advice Rule is based on MSY $B_{trigger}$ = 650 770 tonnes (the purple dot in Figure 2.12a). The realised HR in a long-term projection, using this HR and including the advice rule, is 0.065, which is close to HR_{pa} without the ICES Advice Rule. The equivalent value to this approximation when the ICES Advice Rule is based on MSY $B_{trigger}$ = 530 764 tonnes (the blue dot in Figure 2.12a) is at least 0.107 (so still greater than HR_{crash}), with a corresponding realized HR of at least 0.064.**

2.9.3 Life-history parameters and input data

Calculation of the life-history parameters M_a (instantaneous natural mortality rate), l_a^s (mean length-at-age for animals of sex *s*), w_a^s (mean weight-at-age for animals of sex *s*), and P_a'' (proportion females of age *a* that become pregnant each year) are summarised in Table 2.5, and described visually in Figure 2.13.

Catch data used in the assessment are given in Tables 2.6a and b. The assessment requires the definition of fleets with corresponding exploitation patterns, and the only information currently available to provide this comes from Scottish and English & Wales data for the period up to (and including) 2004 (Table 2.7a), and from Swedish, Scottish and Irish bottom trawl data, and England & Wales gillnet and trammel net data for the period 2005 onwards (Table 2.6b). Four fleets are therefore defined: two operating up to (and including) 2004 and allocated to landings data, namely a "non-target" fleet (Scottish data), and a "target" fleet (England & Wales data); two operating from 2005 onwards and allocated to catch data, namely a "trawls & other" fleet (Swedish, Scottish and Irish bottom trawl data), and a "nets & hooks" fleet (England & Wales gillnet and trammel net data). Several targeting scenarios were explored in order to show the sensitivity of model results to these allocations (ICES, 2011), and these results can be found in previous reports (e.g. ICES, 2020a). In order to take the model back to a virgin state, the average proportion of the first two fleets for 1980–1984 were used to split landings data prior to 1980.

Three abundance indices (biomass catch rate) were derived on the basis of applying a delta-lognormal GLM model to several surveys (following WKNSEA, 2021), and these are given in Table 2.7 along with the corresponding CVs. The proportions-by-length category data derived from these surveys, along with the actual sample sizes these data are based on, are given in Tables 2.8a-c separately for females and males.

Table 2.9 lists the proportion-by-length-category data for the four commercial fleets considered in the assessment, along with the raised sample sizes or catch (see Table caption for details). Because these raised sample sizes/catch do not necessarily reflect the actual sample sizes the data are based on (as they have been raised to landings), these sample sizes have been ignored in the assessment (by setting $n_{pcom,j,y} = \bar{n}_{pcom,j}$ in equation 10b of the Stock Annex); a sensitivity test conducted in ICES (2010) showed a lack of sensitivity to this assumption.

The fecundity data (see Ellis and Keable, 2008, and the 2021 benchmark report, ICES, 2021, for sampling and other details) are given as pairs of values reflecting length of pregnant female and corresponding number of pups, and are listed in Tables 2.10a-p for the several periods (1921, 1960, 1978, 1987, 1988, 1997, 2005, 2009, 2010, 2014, 2016, 2017, 2018, 2019, 2020, 2023).

2.9.4 Summary of recent assessment model runs

The starting point for the 2024 baseline assessment is the 2022 assessment, which is the equivalent of the 2021 benchmark assessment, but with updates to some of the input data to deal with corrections, updates, and missing data (see section 2.9.2.2-3). Furthermore, the values for the parameters a_{fec} and b_{fec} are kept constant at the values used in the 2022 assessment (Figure 2.11; see Table 2.11b), and the model fitted, including estimation of Q_{fec}.

Category	Description	Figures	Tables
Base case run	Results for baseline assessment, including model fits and estimation.	2.14-2.21	2.11–13
Retrospective	A 6-year retrospective analysis, using the baseline assessment and omitting one year of data each time	2.22	
Projections	Projections under different harvest rate scenarios	2.27	2.14
Comparison	Comparison of the baseline assessment with the previous assessment (WGEF 2022).	2.26	
Sensitivity			
Q_{fec}	A comparison with an alternative Q_{fec} values that fall within the 95% probability interval of Figure 2.23	2.23	
Leave-out runs	A comparison of the baseline assessment with an assessment (“Q1 only”) that omits the Q3 and Q4 survey indices, keeping only the Q1 index, along with likelihood profiles for the “Q1 only” assessment to highlight difference with the “update21” assessment profiles (Figure 2.23) on which the baseline assessment is based	2.24-2.25	

2.9.5 Results of the 2024 baseline assessment

Model fits

Fecundity data available for several periods present an opportunity to estimate the extent of density-dependence in pup-production (Q_{fec}). However, estimating this parameter along with the fecundity parameters a_{fec} and b_{fec} was not possible because these parameters are confounded. The approach therefore was to plot the likelihood surface for a range of fixed a_{fec} and b_{fec} input values, while estimating Q_{fec}, and the results are shown in Figure 2.10 for the "update21" assessment. The likelihood profiles were not repeated for the baseline assessment because they result in unrealistically high Q_{fec} values (optimum around 10, compared to around 3 from the "update21" assessment; results not shown), implying a highly productive resource, and likely resulting from conflicts in the underlying data. The periods of fecundity data are essential for the estimation of Q_{fec}, and further information that would help with the estimation of this parameter would be useful. Figure 2.11d indicates a near-linear relationship between Q_{fec} and $MSYR$ (defined in terms of the biomass of all animals $\geq l^{f}_{mat00}$), so additional information about $MSYR$ levels typical for this species could be used for this purpose (but has not yet been attempted).

The value of Q_{fec} estimated for the baseline assessment (3.030) corresponds to the optimum shown in Figures 2.23a and b for a_{fec} and b_{fec}, respectively. Lower Q_{fec} values correspond to lower productivity, and vice-versa, higher values to higher productivity.

Figure 2.14 shows the model fits to the Q1, Q3 and Q4 survey indices; the Q4 index shows a much steeper increase compared to the Q1 and Q3 indices, a sharp increase that the model struggles to deal with, and this is likely driving the perception of a more productive stock than previously thought. Figures 2.15 shows the model fits to the four sets of commercial proportion-by-length-category data (one for each commercial fleet) as well as multinomial residuals. Figures 2.15 shows the three sets of survey proportion-by-length-category data (one for each survey index), the survey data fitted separately for females and males. Model fits to the survey index and commercial proportion data appear to be reasonable, with a close fit to the average proportion-by-length-category for the commercial fleets, but also with a poorer fit to the survey data, and some very high residuals. The difference between observed or estimated proportion at length are high in Q3 and Q4 for the plus group (Table 2.8b-c, Figure 2.16)

The model fits to the fecundity data are shown in Figures 2.17, showing marked changes in fecundity over time, which is related to value estimated for Q_{fec}. Figures 2.18 compare the deterministic and stochastic modelled recruitment and plot the estimated normalised recruitment residuals; the latter shows predominantly positive residuals (particularly for 2016), which is likely linked to the attempts of the model to fit to the steep recent increase in the Q4 survey index.

Estimated parameters

Model estimates of the total number of pregnant females in the virgin population ($N_0^{f,preg}$), the extent of density-dependence in pup production (Q_{fec}), survey catchability for each survey (q_{sur}), and current (2024) total biomass levels relative to 1905 and 1955 (B_{depl05} and B_{depl55}), are shown in Table 2.11a (for the "base case" and alternative Q_{fec} estimates) together with estimates of precision. Estimates of the natural mortality parameter M_{pup}, the fecundity parameters a_{fec} and b_{fec}, B_0, B_{lim}, MSY-related estimates (HR_{MSY}, MSY, B_{MSY}, MSY $B_{trigger}$ and $MSYR$), and other harvest rates of interest (HR_{pa}, HR_{lim}) are given in Table 2.11b. Table 2.12 provides a correlation matrix for some of the key estimable parameters (only the last five years of recruitment deviations are shown). Correlations between estimable parameters are generally low, apart from those associated with scale (strongly negative between $N_0^{f,preg}$ and Q_{fec}, and between Q_{fec} and q_{sur}, and positive between $N_0^{f,preg}$ and q_{sur}) and among some selectivity parameters.

Estimated commercial- and selectivity-at-age patterns are shown in Figures 2.19, and reflect the differing proportions of animals of different size categories in the survey data when compared to the commercial catch data (e.g. a general tendency to select smaller animals in surveys and larger animals in commercial catches), and amongst the commercial fleets and surveys themselves (see also Figures 2.15-16). It should be noted that females grow to larger lengths than males, so that females are able to grow out of the second highest length category, whereas males, with an L_∞ of < 85 cm (Table 2.5) are not able to do so (hence the commercial selectivity remains unchanged for the two largest length categories for males). The divergence of survey selectivity for females compared to males is a reflection of the separate selectivity parameters for females/males in the largest length category (70+ for surveys).

A plot of recruitment vs. the number of pregnant females in the population, effectively a stock–recruit plot, is given in Figure 2.18b together with the replacement line (the number of recruiting pups needed to replace the pregnant female population under no harvesting). This plot illustrates the importance of the Q_{fec} parameter in the model: a Q_{fec} parameter equal to 1 would imply the expected value of the stock–recruit point lies on the replacement line, which implies that the population is effectively incapable of replacing itself. A further exploration of the behaviour of Q_y and $N_{pup,y}$ (equations 2a and b in the Stock Annex) is shown in Figure 2.20.

Time-series trends

Model estimates of total biomass (B_y), recruitment (R_y) and mean fishing proportion ($HR_{5\text{-}30,y}$) are shown in Figure 2.21, together with approximate 95% probability intervals; observed annual catch ($C_y = \sum_j C_{j,y}$) is also shown. They indicate a strong decline in spurdog total biomass, particularly since the 1950s, to a low around the early- to mid-2000s (20% of pre-exploitation levels), which appears to be driven by relatively high exploitation levels, given the biological characteristics of spurdog. $HR_{5\text{-}30,y}$ appears to have declined in recent years, with B_y increasing again to 57.5% of pre-exploitation levels in 2024 (B_{depl05} in Table 2.11a). The fluctuations in recruitment towards the end of the time-series are driven by information in the proportion-by-length-category data. Table 2.13 provides a stock summary (recruitment, total biomass, catches and $HR_{5\text{-}30,y}$).

2.9.6 Retrospective analysis

A six-year retrospective analysis (the baseline model was re-run, each time omitting a further year in the data) was performed and is shown in Figure 2.22 for the total biomass (B_y), mean fishing proportion ($HR_{5\text{-}30,y}$) and recruitment (R_y). Mohn's rho values are given in the top right of each of these plots. The retrospective bias on $HR_{5\text{-}30,y}$ is relatively low, while the retrospective bias has increased for total biomass and recruitment. The Mohn's rho for total biomass is below the threshold of 20% and recent peels are inside the confidence interval (black hashed lines) of the full data line (2023).

2.9.7 Sensitivity analyses

Two sets of sensitivity analyses were carried out, as listed in the text table above.

a) Q_{fec}

The a_{fec} and b_{fec} values that provided the optimum for the "update21" assessment (Q_{fec}=3.030; plots a-c in Figures 2.11) was selected for the baseline assessment. This sensitivity test compares it to the runs for which the a_{fec} and b_{fec} input values provide the lower bound of the 95% probability interval (Q_{fec}=2.267) and upper bound (Q_{fec}=3.758). Model results are fairly sensitive to these options (Figures 2.23, Tables 2.11a–b), which is unsurprising because Q_{fec} reflects the productivity of the stock.

b) Leave-out runs

The leave-out runs tests the impact of only including the Q1 survey, to be similar to the assessment prior to the benchmark. Figure 2.24 indicates a large impact of including the Q3 and Q4 surveys (compare "include all" and "Q1 only"), with the "Q1 only" indicating only a very minor recovery in the stock in recent years, and "include all" showing a much stronger recovery. A big driver for this is the estimation of Q_{fec}, which is much lower for the former compared to the latter (compare Figure 2.11 and Figure 2.25).

2.9.8 Projections

The baseline assessment (see Tables 2.11) is used as a basis for future projections under a variety of catch options. These are based on:

- HR_{MSY}, which assumes a harvest rate set at that $HR_{MSY} = 0.043$;
- Zero catch (for comparison purposes);
- HR_{sq}, which assumes a harvest rate set at the same harvest rate as 2023 (0.0092) and that assumed for the intermediate year, 2024;
- HR_{pa}, which assumes a harvest rate set at $HR_{pa} = 0.064$;
- HR_{lim}, which assumes a harvest rate set at $HR_{lim} = 0.067$.

Results are given in Tables 2.14 , expressed as total biomass in future relative to the total biomass in 2024, and are illustrated in Figures 2.27. All scenarios result in increasing stock size, albeit at different rates, apart from fishing at HR_{lim}.

2.9.9 Conclusion

A benchmark for spurdog was held in 2021, during which there was a substantial improvement in data available for the assessment, including survey indices and associated length compositions covering a much larger area of the stock distribution, fecundity data spanning a much wider timeframe, fleet-based length data covering more countries than just the UK, and improved catch information since 2005. However, mistakes in the input data, subsequent updates to landings and discards data, including infilling for missing discards data (see Section 2.9.2.2) meant that the benchmark assessment had to be re-run. This was the basis for the baseline assessment in 2022. The 2024 assessment was based on the 2022 assessment and includes updates with recent survey, catch and fecundity data. A comparison of the 2024 assessment with the 2022 assessment results is provided in Figure 2.26 and shows an upward trend in recruitment and total biomass in recent years.

Sensitivity tests show the model to be sensitive to the range of Q_{fec} values that fall within the 95% probability interval for corresponding fecundity parameters (Figure 2.23). The leave-out runs also highlight the influence of especially the Q4 survey index on the perception of productivity of the stock (Figure 2.24), leading to a substantially higher estimate of Q_{fec} (and hence higher productivity) compared to past assessment. Summary plot of the final assessments (the baseline assessment), showing catches and estimates of recruitment, mean fishing proportion (with $HR_{MSY} = 0.043$, $HR_{pa} = 0.064$, $HR_{lim} = 0.067$) and total biomass (with $B_{lim} = 242\,493$ t , $B_{pa} = 339\,490$ t, $MSY\ B_{trigger} = 650\,770$ t and B_{MSY}) are given in Figure 2.28 and Table 2.14.

Results from the current model confirm that spurdog abundance has declined in the historic period, and that the decline is driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation. The assessment also confirms that the stock is recovering from a low in the early- to mid-2000s, and is now above $MSY\ B_{trigger}$.

2.10 Quality of assessments

Whilst the current assessment model has been benchmarked twice (ICES, 2011, 2021) and published (De Oliveira et al. 2013), there are a number of issues to consider regarding input data and the assessment mode itself, as summarised below.

2.10.1 Catch data

The WG has provided estimates of total landings of NE Atlantic spurdog, and from 2005 onwards estimates of discards, and has used these together with length frequency distributions in the assessment of this stock. However, there are still concerns over the quality of these data as a consequence of:

- uncertainty in the historical level of catches because of landings being reported by generic dogfish categories;
- uncertainty over the accuracy of the landings data because of species misreporting;
- missing discards data for some countries and métiers (e.g. for UK-England & Wales gillnets and trammel nets).

2.10.2 Survey data

Survey data are particularly important indicators of abundance trends in commercial fish stocks. However, it should be highlighted that

- spurdog survey data are difficult to interpret because of the typically highly skewed distribution of catch-per-unit effort.
- annual survey length frequency distribution data (aggregated over all hauls) may be dominated by data from single large hauls.
- differences in survey index trends between quarters, which may be affected by the difference in spatial coverage (Q3 and Q4 vs Q1).
- high proportion of individuals in the plus group 70+ in recent years

These problems can be dealt with by adopting appropriate statistical modelling approaches when analysing survey data (see above). In a future benchmark, a combined survey for Q3 and Q4 could be investigated. The identification of appropriate length bins and statistical models of length groups could improve the survey input data for the assessment.

2.10.3 Biological information

As well as good commercial and survey data, the analytical assessments require good information on the biology of NE Atlantic spurdog. In particular, the WG would like to highlight the need for:

- updated and validated growth parameters, in particular for larger individuals;
- better estimates of natural mortality.

An area of future improvement for the spurdog model is including variation in the age-length relationship in the model. The lack of progress in this regard during the 2021 benchmark (given the need to focus on other areas considered of higher priority, such as the substantial improvement in the data now included in the model) meant that it was not possible to explore sensitivity to alternative growth parameterisations. This was because the alternative growth models proposed meant that there were no longer animals in the smallest length classes, leading to zero values which were not possible to deal with during this benchmark. The growth parameters used for the final model therefore remain at the values used in the previous assessment and reported in Table 1 (see also De Oliveira et al., 2013).

2.10.4 Assessment

As with any stock assessment model, the exploratory assessment relies heavily on the underlying assumptions, particularly with regard to life-history parameters (e.g. natural mortality and growth), and on the quality and appropriateness of input data. The inclusion of several periods of fecundity data has provided valuable information that allows estimation of Q_{fec}, and projecting the model back in time is needed to allow fecundity data sets to be fitted. Nevertheless, the likelihood surface does not have a well-defined optimum, and additional information, such as on appropriate values of MSYR for a species such as spurdog, would help with this problem. Further refinements of the model are possible, such as including variation in growth or considering alternative definitions of the plus groups. Selectivity curves also cover a range of gears over the entire catch history, and more appropriate assumptions (depending on available data) could be considered.

In summary, the model may be appropriate for providing an assessment of spurdog, though it could be further developed if the following data were available:

- further refinements of selectivity parameters disaggregated by gear for the main fisheries (i.e. for various trawl, long line and gillnets);
- improved estimates for biological data (e.g. growth parameters, reproductive biology and natural mortality);
- information on likely values of MSYR for a species such as spurdog.

2.11 Reference points

The spurdog model is an integrated assessment model that includes a function that relates pup production to mature females, and it is therefore possible to estimate reference points (such as B_{MSY}) from within the model (in much the same way that is done for biomass dynamic models) without relying on an approach such as EqSim. Furthermore, the model commences in 1905, when reported landings were relatively low, and well before the period of high exploitation experienced from the 1950s onwards, and so the model is considered to provide a reasonably reliable estimate of B_0 (the virgin total biomass level). Reference points are directly based on assessment outputs, which means that reference points are updated every time the assessment is rerun. The basis for current reference points, including the equations for how some of them are derived, generally remain unchanged and are detailed in the Stock Annex.

During WGEF 2024, it was noted that the MSY $B_{trigger}$ and HR_{pa} are not calculated according to the ICES guidelines. Due to the harvest rate having been well below the MSY reference point since 2005 (Table 2.13), the MSY $B_{trigger}$ was updated. Instead of being set at B_{pa}, the current MSY $B_{trigger}$ is now set to the 5th percentile of B_{MSY} which is considered a precautionary and stable estimate for this stock with increasing total biomass. Furthermore, at the benchmark HR_{pa} was simply calculated as $HR_{lim}/1.4$, and during WGEF 2024 this was updated to an HR that has a no-more-than 5% probability of driving the stock to B_{lim} without application of the advice rule. For the calculation, the 5^{th} percentile is based on a CV taken from the last 10 years of total biomass estimates from the assessment (for the 2024 assessment, this is 2015-2024). Further details can be found in section 2.9.2.3.

For current estimates of reference points, please see Table 2.11b.

2.12 Conservation considerations

In 2007, the IUCN Red List of Threatened Species categorized spurdog globally as 'Vulnerable' (Finucci et al. 2020), although an assessment of spurdog in European waters from 2015 lists spurdog as 'Endangered' (Ellis et al. 2015; Nieto *et al*., 2015).

2.13 Management considerations

Perception of state of stock

All analyses presented in previous reports of WGEF have indicated that the NE Atlantic stock of spurdog declined over the second half of the 20th century, but now appears to be increasing. The current stock size is thought to be ca. 57.5% of virgin biomass (Tables 2.11).

Although spurdog are less frequently caught in groundfish surveys than in the past, there is some suggestion that spurdog are now being more frequently seen in survey hauls, and survey catch rates are starting to increase (Figure 2.9).

Stock distribution

Spurdog in the ICES area are considered to be a single stock, ranging primarily from Subarea 1 to Subarea 8, although landings from the southern end of its range may also include other *Squalus* species.

Biological considerations

Spurdog is a long-lived and slow growing species which has a high age-at-maturity and is particularly vulnerable to high levels of fishing mortality. Furthermore, females are thought to have restricted movement (Thorburn *et al*., 2015). Population productivity is low, with low fecundity and a protracted gestation period. In addition, they form size- and sex-specific shoals and therefore aggregations of large fish (i.e. mature females) are easily exploited by target longline and gillnet fisheries.

Updated age and growth studies are required. For Norwegian waters, see Albert *et al*., 2019 and Section 2.14.

Fishery and technical considerations

Those fixed gear fisheries that capture spurdog should be reviewed to examine the catch composition, and those taking a large proportion of mature females should be strictly regulated.

During 2009 and 2010, a maximum landing length (MLL) was established in EC waters to deter targeting of mature females (see Section 2.10 of ICES, 2006 for simulations on MLL). Those fisheries taking spurdog that are lively may have problems measuring fish accurately, and investigations to determine an alternative measurement (e.g. pre-oral length), that has a high correlation with total length and is more easily measured on live fish, are required. Dead spurdog may also be more easily stretched on measuring, and understanding such post-mortem changes is required to inform on any levels of tolerance, in terms of enforcement.

There is limited information on the distribution of gravid females with term pups and new-born spurdog pups, though they have been reported to occur in Scottish waters, in the Celtic Sea and off Ireland. The lack of accurate data on the location of pupping and nursery grounds, and their importance to the stock, precludes spatial management for this species at the present time.

2.14 Additional recent information

2.14.1 Developing an abundance index for spurdog in Norwegian waters

In Norwegian waters, from where a high proportion of the landings originated in recent years, there is now a dedicated annual longline survey for spurdog since 2021 and the development of an abundance index is ongoing (Figure 2.5-6). In addition, bycatch data (until 2022) from the Norwegian Reference fleet is available.

2.14.2 Recent life-history information

The most recent update of biological data for *S. acanthias* in the Northeast Atlantic are from Norwegian waters (Albert *et al*., 2019). A total of 3948 bycaught individuals were sampled throughout the period from 2014–2018, within the ICES divisions 2.a, 4.a, and 3.a. Overall, females accounted for 56% of the samples, but the sex compositions of individual catches were highly skewed.

The sampled spurdog varied in length from 41 to 95 cm and 53 to 121 cm for males and females, respectively. The mean lengths of both males and females were larger in the northern area of the study.

The age composition was similar for both sexes, observed from the age of 3 up to the mid-30s with dominance of individuals <15 years of age. Median age for both sexes was 11 years, with an interquartile range of 9–14 and 8–17 for females and males, respectively.

The youngest and smallest mature females were 7 years and 68 cm, while the oldest and largest immature ones were 26 years and 100 cm. Mean age of late gravid females was 15.3 years, with an interquartile range of 12–16 years; estimated 50% maturity was 9.5 years and 77.8 cm. For males, very few immatures were recorded making estimation of 50% maturity uncertain.

Near-term females had a range of 1–19 pups and a mean of 7.2 pups. Difference between left and right uteri was a maximum of two pups for 92% of the near-term females. Mean pup length of near-term females was 24 cm, with 10 and 90 percentiles of 19 and 27 cm, respectively. Both the number and mean size of pups of near-term females increased with maternal length.

2.15 References

Albert, O.T. and Vollen, T. 2012. Plan for a Norwegian sentinel fishery for spurdog. Working document for the ICES Elasmobranch Working Group (WGEF) 2012.

Albert, O.T. and Vollen, T. 2015. Spurdog in Norwegian waters: Recent trends in occurrence and composition in surveys and commercial catches. Working document for the ICES Elasmobranch Working Group (WGEF) 2015.

Albert, O.T. 2016. Update on occurrence of Spurdog in Norwegian catches. Working document for the ICES Elasmobranch Working Group (WGEF) 2016.

Albert, O. T., Junge, C., and Myrlund, M. K. 2019. Young mums are rebuilding the spurdog stock (*Squalus acanthias L.*) in Norwegian waters. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsz15

Bedford, B.C., Woolner, L.E, and Jones, B.W. 1986. Length–weight relationships for commercial fish species and conversion factors for various presentations. Data Report, MAFF Directorate of Fisheries Research Lowestoft, 10: 41pp.

Bendall, V. A., Hetherington, S. J., Ellis, J. R., Smith, S. F., Ives, M. J., Gregson, J. and Riley, A. A. 2012. Spurdog, porbeagle and common skate bycatch and discard reduction. Fisheries Science Partnership 2011–2012, Final Report; 88 pp.

Berg, C. W., Nielsen, A., and Kristensen, K., 2014. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. Fisheries Research 151, 91-99.

Cortés, E. 1999. A stochastic stage-based population model of the sandbar shark in the Western North Atlantic. In Life in the slow lane: Ecology and conservation of long-lived marine animals. Ed. by J.A. Musick. American Fisheries Society Symposium, 22: 115–136.

Coull, K. A., Jermyn, A. S., Newton, A. W., Henderson, G. I and W. B. Hall. 1989. Length–weight relationships for 88 species of fish encountered in the North East Atlantic. Scottish Fisheries Research Report Number 43.

De Oliveira, J. A. A., Ellis, J. R., and Dobby, H. 2013. Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias*. ICES Journal of Marine Science, 70: 1341–1353.

Dobby, H. 2021. Survey indices for Northeast Atlantic spurdog. Working Document for the Benchmark Workshop on North Sea Stocks (WKNSEA 2021), February 22–26, 2021; 23 pp.

Dobby, H., Beare, D, Jones, E.and MacKenzie, K. 2005. Comparison of trends in long-term survey data for *Squalus acanthias* with a preliminary stock assessment for this species. ICES CM 2005/N:01.

Ellis, J.R. and Keable, J. 2008. The fecundity of Northeast Atlantic spurdog (*Squalus acanthias* L., 1758). ICES Journal of Marine Science, 65: 979–981.

Ellis, J.R., Doran, S., Dunlin, G., Hetherington, S., Keable, J., and Skea, N. 2010. Spurdog in the Irish Sea. Cefas, Lowestoft, Fisheries Science Partnership; 2009; Programme 9, Final Report, 28 pp. (available electronically at https://webarchive.nationalarchives.gov.uk/20150204060540/http://www.cefas.defra.gov.uk/publications-and-data/scientific-series/fisheries-science-partnership-reports.aspx.

Ellis, J., Soldo, A., Dureuil, M. & Fordham, S. 2015. *Squalus acanthias*. The IUCN Red List of Threatened Species 2015: e.T91209505A48910866.

Finucci, B., Cheok, J., Chiaramonte, G.E., Cotton, C.F., Dulvy, N.K., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. & Walker, T.I. 2020. *Squalus acanthias*. The IUCN Red List of Threatened Species 2020: e.T91209505A124551959. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T91209505A124551959.en.

Ford, E. 1921. A contribution to our knowledge of the life-histories of the dogfishes landed at Plymouth. Journal of the Marine Biological Association of the UK, 12: 468–505.

Gauld, J. A. 1979. Reproduction and fecundity of the Scottish Norwegian stock of spurdogs, *Squalus acanthias* (L.). ICES Document CM 1979/H: 54. 15 pp.

Holden, M. J., and Meadows, P. S. 1964. The fecundity of the spurdog (*Squalus acanthias* L.). Journal du Conseil Permanent International pour l'Exploration de la Mer, 28: 418–424.

ICES. 2006. Report of the Working Group on Elasmobranch Fishes (WGEF), 14–21 June 2006, ICES Headquarters. ICES CM 2006/ACFM:31. 291 pp.

ICES. 2009a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak - Combined Spring and Autumn (WGNSSK), 6–12 May 2009, ICES Headquarters, Copenhagen. ICES CM 2009/ACOM:10. 1028 pp.

ICES. 2009b. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 13–19 May 2009, ICES Headquarters, Copenhagen.

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 558 pp.

ICES. 2011. Report of the Working Group on Elasmobranch Fishes (WGEF), 20–24 June 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:19. 492 pp.

ICES. 2014. 2nd Interim Report of the International Bottom Trawl Survey Working Group (IBTSWG), 31 March–4 April 2014, Hamburg, Germany. ICES CM 2014/SSGESST:11. 177 pp.

ICES. 2016. Report of the Working Group on Elasmobranch Fishes (WGEF), 15–24 June 2016, Lisbon, Portugal. ICES CM/ACOM:20. 26 pp.

ICES. 2017. ICES fisheries management reference points for category 1 and 2 stocks. ICES Advice Technical Guidelines, ICES Advice 2017, Book 12, Section 12.4.3.1. Published 20 January 2017: 19pp. DOI: 10.17895/ices.pub.3036.

ICES. 2018. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–28 June 2018, Lisbon, Portugal. ICES CM 2018/ACOM:16. 1306 pp.

ICES. 2020a. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 2:77. 789 pp. http://doi.org/10.17895/ices.pub.7470

ICES. 2020b. Workshop on incorporating discards into the assessments and advice of elasmobranch stocks (WKSHARK5, outputs from 2019 meeting). ICES Scientific Reports. 2:87. 94 pp. http://doi.org/10.17895/ices.pub.7494

ICES. 2021. Benchmark Workshop on North Sea Stocks (WKNSEA). ICES Scientific Reports. 3:25. 756 pp. https://doi.org/10.17895/ices.pub.7922

ICES. 2022. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.21089833.v1

Junge, C., Lo, N. C., Jacobson, L. D. and Squire, J. L. 1992. Indices of relative abundance for fish spotter data based on delta-lognormal models. Canadian Journal of Fisheries and Aquatic Sciences, 49: 2515–2526.

Mandelman, J. W. & Farrington, M. A. 2007. The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*). Fisheries Research 83, 238–245.

McEachran, J. D., and Branstetter, S. 1984. Squalidae. In Fishes of the Northeastern Atlantic and the Mediterranean Vol. 1, pp 128–147. Ed. by P. J. P.Whitehead, M.-L.Bauchot, J.-C.Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris.

Mehl et al. 2017. Acoustic abundance of saithe, coastal cod and haddock Finmark-Møre. Institute of Marine Research. 30 pp.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., García Criado, M. et al. 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

Pawson, M. J., Ellis, J. and Dobby, H. 2009. The evolution and management of spiny dogfish (spurdog) fisheries in the Northeast Atlantic. In V. F. Gallucci, G. A. McFarlane & G. C. Bargamann (eds), Biology and Management of Spiny Dogfish Sharks, American Fisheries Society, Bethesda, MD.

Rulifson, R. A. 2007. Spiny dogfish mortality induced by gill-net and trawl capture and tag and release. North American Journal of Fisheries Management 27, 279–285.

Silva, J. F., Ellis, J. R., Catchpole, T. L. and Righton, D. 2013. Bycatch and discarding patterns of dogfish and sharks taken in commercial fisheries around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal. 17–21 June 2013. 31 pp.

Silva, J. F. and Ellis, J. R. 2015. Recent observations on spurdog *Squalus acanthias* life-history parameters in the North-East Atlantic. Working document to the Working group presented at the Working group on Elasmobranch Fishes 2015, 12 pp.

Simpfendorfer, C. A. 1999. Demographic analysis of the dusky shark fishery in Southwestern Australia. In Life in the slow lane: Ecology and conservation of long-lived marine animals, pp 149–160. Ed. by J. A.Musick. American Fisheries Society Symposium, 22.

STECF. 2009. STECF Report of the SGMOS-09-05 Working Group on Fishing Effort Regimes Regarding Annex IIA of TAC & Quota Regulations and Celtic Sea.

Stefansson, G. 1996. Analysis of groundfish survey abundance data: combining the GLM and delta approaches. ICES Journal of Marine Science, 53: 577–588.

Søvik G and Thangstad TH. 2021. Shrimp survey in the Norwegian Deep and Skagerrak January 2020. Toktrapport/Havforskningsinstituttet/ISSN 15036294/Nr. 3–2021.

Thorburn, J., Neat, F., Bailey, D. M., Noble, L. R., Jones, C. S. 2015. Winter residency and site association in the critically endangered North Easter Atlantic spurdog *Squalus acanthias*. Marine Ecology Progress Series. 526: 113-124

Thorburn, T., Jones, R., Neat, F., Pinto, C., Bendall, V., Hetherington, S., Bailey, D. M., Leslie, N., Jones, C. 2018. Spatial versus temporal structure: Implications of inter-haul variation and relatedness in the North-east Atlantic spurdog *Squalus acanthias*. Aquatic Conservation: Marine and Freshwater Ecosystem 28: 1167- 1180.

Veríssimo, A., McDowell, J. R., and Graves, J. E. 2010. Global population structure of the spiny dogfish *Squalus acanthias*, a temperate shark with an antitropical distribution. Molecular Ecology, 19: 1651–1662.

Vollen, T. 2014. Data on spurdog from two Norwegian surveys; the Shrimp survey and the Coastal survey updated with new data in 2014. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–26 June 2014; 2014/25.

Vollen, T. and Albert, O.T. 2016. Spurdog in two Norwegian surveys. Working document for the ICES Elasmobranch Working Group (WGEF) 2015.

Vollen, T., Andrade Rodriguez, H. A., and Albert, O. T. 2021. Pigghåtokt – Toktrapport nr. 19 – 2021. IMR Survey Report series, ISSN 15036294/Nr. 19-2021 (in Norwegian).

2.16 Tables and Figures

Table 2.1a. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1905-2023).

Year	Landings (tonnes)	Year	Landings (tonnes)	Year	Landings (tonnes)
1905	7 248	1945	6 776	1985	38 674
1906	2 200	1946	10 895	1986	30 910
1907	1 428	1947	16 893	1987	42 355
1908	1 409	1948	19 491	1988	35 569
1909	2 022	1949	23 010	1989	30 278
1910	1 563	1950	24 750	1990	29 906
1911	1 957	1951	35 301	1991	29 562
1912	3 199	1952	40 550	1992	29 046
1913	4 050	1953	38 206	1993	25 636
1914	2 641	1954	40 570	1994	20 851
1915	2 602	1955	43 127	1995	21 318
1916	534	1956	46 951	1996	17 294
1917	339	1957	45 570	1997	15 347
1918	451	1958	50 394	1998	13 919
1919	2 659	1959	47 394	1999	12 384
1920	4 396	1960	53 997	2000	15 890
1921	5 321	1961	57 721	2001	16 693
1922	5 401	1962	57 256	2002	11 170
1923	5 655	1963	62 288	2003	12 246
1924	6 355	1964	60 146	2004	9 365
1925	6 719	1965	49 336	2005	7 092
1926	7 277	1966	42 713	2006	3996
1927	8 395	1967	44 116	2007	2 892
1928	9 522	1968	56 043	2008	1 791
1929	9 320	1969	52 074	2009	1 968
1930	11 914	1970	47 557	2010	886
1931	11 838	1971	45 653	2011	427

Year	Landings (tonnes)	Year	Landings (tonnes)	Year	Landings (tonnes)
1932	16 726	1972	50 416	2012	447
1933	20 244	1973	49 412	2013	331
1934	20 378	1974	45 684	2014	381
1935	22 266	1975	44 119	2015	257
1936	20 925	1976	44 064	2016	371
1937	23 930	1977	42 252	2017	294
1938	18 196	1978	47 235	2018	362
1939	20 119	1979	38 201	2019	455
1940	9 428	1980	40 968	2020	526
1941	8 740	1981	39 961	2021	539
1942	10 625	1982	32 402	2022	474
1943	8 181	1983	37 046	2023	2317
1944	8 151	1984	35 193		

Table 2.1b. Northeast Atlantic spurdog. WG estimates of discards of NE Atlantic spurdog (2005–2023).

Year	Discards (tonnes)
2005	20
2006	22
2007	34
2008	46
2009	96
2010	1523
2011	2597
2012	4757
2013	2939
2014	2915
2015	3016
2016	1580
2017	4781

Year	Discards (tonnes)
2018	2371
2019	3165
2020	942
2021	639
2022	967
2023	1891

Table 2.2. Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2023); "-" = no data available, "." = zero catch, "+" = <0.5 tonnes Data from 2005 onwards revised during WKSHARK2. From 2005 Scottish landings data are combined with those from Northern Ireland, England and Wales, and presented as UK (combined).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	1097	1085	1110	1072	1139	920	1048	979	657	750	582	393	447	335	396	391
Denmark	1404	1418	1282	1533	1217	1628	1008	1395	1495	1086	1364	1246	799	486	212	146
Faroe Islands	0	22	0	0	0	0	0	0	0	9	2	3	25	137	203	310
France	17 514	19 067	12 430	12 641	8356	8867	7022	11 174	7872	5993	4570	4370	4908	4831	3329	1978
Germany	43	42	39	25	8	22	41	48	27	24	26	6	55	8	21	100
Iceland	36	22	14	25	5	9	7	5	4	17	15	53	185	108	97	166
Ireland	108	476	1268	4658	6930	8791	5012	8706	5612	3063	1543	1036	1150	2167	3624	3056
Netherlands	217	268	183	315	0	0	0	0	0	0	0	0	0	0	0	0
Norway	5925	3941	3992	4659	4279	3487	2986	3614	4139	5329	8104	9633	7113	6945	4546	3940
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Country	Portugal	Russia	Spain	Sweden	UK (E&W)	UK (Sc)	Total
1980	2	0	0	399	9229	4994	40 968
1981	0	0	0	308	9342	3970	39 961
1982	0	0	8	398	8024	3654	32 402
1983	0	0	653	300	6794	4371	37 046
1984	0	0	0	256	8046	4957	35 193
1985	0	0	0	360	7841	6749	38 674
1986	1	0	0	471	7047	6267	30 910
1987	5	0	0	702	7684	8043	42 355
1988	3	0	0	733	6952	8075	35 569
1989	2	0	0	613	5371	8024	30 278
1990	128	0	0	390	5414	7768	29 906
1991	188	0	0	333	3770	8531	29562
1992	250	0	0	230	4207	9677	29046
1993	323	0	0	188	3494	6614	25636
1994	190	0	0	95	3462	4676	20851
1995	256	0	0	104	2354	8517	21318

Table 2.2 (continued). Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2023); "-" = no data available, "." = zero catch, "+" = <0.5 tonnes Data from 2005 onwards revised during WKSHARK2. * From 2005 Scottish landings data are combined with those from Northern Ireland, England and Wales, and presented as UK (combined)

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	430	443	382	354	400	410	23	11	13	21	17	11	12	7	1	0	0	0	-	-
Denmark	142	196	126	131	146	156	256	232	219	150	121	76	78	82	14	26	30	19	10	27
Faroe Islands	51	218	362	486	368	613	340	224	295	-	-	-	-	-	-	-	-	-	-	-
France	1607	1555	1286	998	4342	4304	2569	1705	1062	945	700	504	368	412	164	84	34	13	19	2
Germany	38	21	31	54	194	304	121	98	138	140	7	3	5	2	1	1	1	0	1	+
Iceland	156	106	80	57	107	199	276	200	142	76	82	43	68	102	62	53	51	6	19	8
Ireland	2305	2214	1164	904	905	1227	1214	1416	1076	1022	859	651	137	175	26	13	37	34	18	2
Netherlands	0	0	0	0	28	39	27	10	25	31	23	25	18	5	7	1	4	3	0	1
Norway	2748	1567	1293	1461	1643	1424	1091	1119	1054	1016	790	615	711	543	540	247	285	250	313	217
Poland	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-

Country	Portugal	Russia	Spain	Sweden	UK (E&W), UK(com-bined)*	UK (Scot-land)*	Total
1996	120	0	0	154	2670	6873	17 294
1997	100	0	0	196	3066	5665	15 347
1998	46	0	28	140	4480	4501	13 919
1999	21	0	95	114	4461	3248	12 384
2000	2	0	372	123	3654	3606	15 890
2001	3	0	363	238	4516	2897	16 693
2002	4	0	306	0	2823	2120	11 170
2003	4	0	135	275	3109	3708	12 246
2004	9	0	17	244	1729	3342	9365
2005	-	-	41	169	3481	-	7092
2006	-	-	40	147	1209	-	3996
2007	-	-	71	93	799	-	2892
2008	-	-	39	75	280	-	1791
2009	-	-	14	80	546	-	1968
2010	-	-	2	5	64	-	886
2011	-	-	2	0	1	-	427
2012	-	-	3	-	3	-	447
2013	-	-	0	-	6	-	331
2014	-	-	-	-	0	-	381
2015	-	-	-	-	-	-	257

Table 2.2 (continued). Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2023); "-" = no data available, "." = zero catch, "+" = <0.5 tonnes. Data from 2005 onwards revised during WKSHARK2. * From 2005 Scottish landings data are combined with those from Northern Ireland, England and Wales, and presented as UK (combined).

Country	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	-	-	-	-	-	-	-	5
Denmark	24	27	19	21	32	20	23	129
Faroe Islands	-	-	-	-	-	-	-	-
France	1	3	1	-	-	-	-	904
Germany	2	+	1	+	-	+	+	+
Iceland	8	4	2	1	3	1	2	2
Ireland	34	1	24	11	3	-	9	422
Netherlands	1	1	6	+	+	-	-	2
Norway	270	222	271	370	409	367	321	351
Poland	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-
Spain	-	.	.	-	+	-	-	3
Sweden	+	+	+	+	-	+	+	52
UK (combined)*	30	37	38	52	79	151	120	446
UK (Scotland)*								
Total	371	294	362	455	526	539	474	2317

Table 2.3. Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2023). Data from 2005 onwards revised during WKSHARK2

Subarea or Division	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Baltic	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0	0	0	0
1 and 2	138	20	28	760	40	120	137	417	1559	2808	4296	6614	5063	5102	3124	2725	1853	582
3 and 4	20 544	16 181	11 965	11 572	10 557	11 136	8986	11 653	10 800	10 423	11 497	9264	10 505	6591	4360	7347	5299	4977
5	45	27	18	27	5	22	9	41	6	73	182	133	336	335	364	484	217	320
6	4590	4011	5052	7007	8491	12422	8107	9038	7517	6406	5407	6741	6268	5927	5622	5164	4168	3412
7.a	2722	4013	4566	4001	6336	6774	6458	7305	5569	3389	2801	2527	2669	2700	2313	1185	1650	1534
7.b-c	704	925	424	1777	2178	1699	1197	2401	1579	893	369	293	316	2009	1175	1004	603	450
7.d-f	6693	8210	5989	4664	2450	1280	1644	2892	2120	1634	1339	1122	852	785	800	760	852	646
7.g-k	4793	5479	3881	6924	4902	4965	3864	8106	6175	4477	3736	2495	2622	1745	2680	2034	2229	2984
8	739	1095	479	312	234	257	507	497	242	174	273	367	406	435	406	602	408	418

Subarea or Division	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
9	0	0	0	0	0	0	1	4	1	2	4	4	2	5	7	5	2	2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	12
14	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0
Other or unspecified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	12	10
Total	40 968	39 962	32 402	37 046	35 194	38 674	30 910	42 356	35 569	30 279	29 906	29 563	29 046	25 637	20 851	21 318	17 295	15 348

Table 2.3 (continued) Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2023). Data from 2005 onwards revised during WKSHARK2. Excludes landings from 8.c, 9.a, and 10.a (due to mixed landings with *S. blainville*).

Subarea or Division	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baltic	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 and 2	607	779	894	462	357	440	423	682	499	312	337	230	190	93	131	74	122	105
3 and 4	3895	2705	2475	2516	1904	2395	2163	1177	789	628	642	635	400	183	189	198	203	140

Subarea or Division	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
5	442	545	879	1406	808	583	677	244	204	161	86	103	63	53	51	6	28	8
6	2831	2715	5977	5624	3169	3398	2630	1581	830	619	169	263	69	3	1	0	0	+0
7.a	1771	2153	1599	1878	1529	2021	938	589	413	272	73	97	3	1	10	4	2	+
7.b-c	854	1037	1028	816	527	588	432	332	268	299	48	97	7	1	1	0	0	0
7.d-f	443	411	438	555	295	268	278	285	168	172	124	196	78	71	33	17	8	+
7.g-k	2656	1822	2161	2846	2130	2339	1739	2005	746	386	245	288	63	14	29	30	16	2
8	308	171	405	469	269	134	56	135	79	44	68	59	13	9	3	3	2	1
9	2	3	19	8	11	5	14	0	0	0	0	0	0	0	0	0	0	0
10	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	104	22	14	41	22	74	12	4	1	0	0	0	0	0	0	0	0	0
14	0	0	0	63	0	0	0											

Subarea or Division	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Other or un-specified	6	4	1	2	149	1	4	58	0	0	0	0	0	0	0	0	0	0
Total	13 919	12 385	15 891	16 693	11 170	12 247	9366	7092	3996	2892	1791	1968	886	427	447	331	381	257

Table 2.3 (continued) Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2023). Data from 2005 onwards revised during WKSHARK2.

Subarea or Division	2016	2017	2018	2019	2020	2021	2022	2023
Baltic	0	0	0	0	0	0	0	0
1 and 2	150	127	164	183	280	277	203	206
3 and 4	165	123	128	208	156	110	140	450
5	8	4	2	0	3	1	2	2
6	5	1	3	0	5	+	6	103
7.a	2	0	+	+	+	-	+	46
7.bc	2	0	0	0	0	-	-	23
7.d-f	1	14	19	14	29	26	17	227
7.g-k	36	24	45	49	53	125	107	1197
8	1	1	+	0	+	+	+	63
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-
14	-	-	1	-	-	-	-	-
Other or unspecified	-	-	-	-	-	-	-	-
Total	373	294	362	455	526	539	474	2317

Table 2.4. Northeast Atlantic spurdog. Relative proportion (by tonnage) from Sweden, Ireland, UK, Denmark, France and Spain catches of spurdog taken by bottom trawls. These relative proportions are used as weights when combining the bottom trawl length composition data.

	Sweden	Ireland	GBR	UK (Scot.)	Den-mark	France	Spain	UK (Engl +Wales)	UK (NI)
2007	7%	35%	57%						
2008	14%	40%	46%						
2009	7%	19%	74%						
2010	7%	43%	51%						
2011	6%	46%	48%						
2012	10%	31%	59%						

	Sweden	Ireland	GBR	UK (Scot.)	Den-mark	France	Spain	UK (Engl +Wales)	UK (NI)
2013	12%	21%	67%						
2014	28%	12%	59%						
2015	4%	20%	76%						
2016	6%	28%	66%						
2017	21%	41%	37%						
2018	2%	40%	59%						
2019	9%	18%	73%						
2020	0%	51%	49%						
2021	0%	3%	97%						
2022	8%	0%		52%	9%	0%	11%	0%	5%
2023	2%	6%		26%	0%	34%	11%	9%	5%
Average 2022-2023	5%	3%		39%	5%	17%	11%	5%	5%

Table 2.5. Northeast Atlantic spurdog. Description of life-history equations and parameters.

Parameters	Description/values	Sources
M_a	Instantaneous natural mortality at age *a*: $M_a = \begin{cases} M_{pup} e^{-a \ln(M_{pup}/M_{adult})/a_{M1}} & a < a_{M1} \\ M_{adult} & a_{M1} \le a \le a_{M2} \\ M_{til}/[1+e^{-M_{gam}(a-(A+a_{M2})/2)}] & a > a_{M2} \end{cases}$	
a_{M1} , a_{M2}	4, 30	expert opinion
M_{adult} , M_{til} , M_{gam}	0.1, 0.3, 0.04621	expert opinion
M_{pup}	Calculated to satisfy balance equation	supplementary material of De Oliveira et al. 2013
l_a^s	Mean length-at-age a for animals of sex *s* $l_a^s = L_\infty^s (1 - e^{-\kappa^s (a - t_0^s)})$	
L_∞^f , L_∞^m	110.66, 81.36	average from literature
κ^f , κ^m	0.086, 0.17	average from literature
t_0^f , t_0^m	-3.306, -2.166	average from literature
w_a^s	Mean weight at age *a* for animals of sex *s* $w_a^s = a^s (l_a^s)^{b^s}$	
a^f , b^f	0.00108, 3.301	Bedford *et al*. (1986)
a^m , b^m	0.00576, 2.89	Coull *et al*. (1989)

Parameters	Description/values	Sources
l^f_{mat00}	Female length at first maturity 70 cm	average from literature
P''_a	Proportion females of age a that become pregnant each year $P''_a = \frac{P''_{\max}}{1+\exp\left[-\ln(19)\frac{l^f_a - l^f_{mat50}}{l^f_{mat95}-l^f_{mat50}}\right]}$ where $P''_{\max}$ is the proportion very large females pregnant each year, and l^f_{matx} the length at which *x*% of the maximum proportion of females are preg-nant each year	
$P''_{\max}$	0.5	average from literature
l^f_{mat50}, l^f_{mat95}	80 cm, 87 cm	average from literature

Table 2.6a. Northeast Atlantic spurdog. Landings used in the old assessment (1905-2004), with the allocation to "Non-target" and "Target". Estimated Scottish selectivity (based on fits to proportions by length category data for the period 1991–2004) is assumed to represent "non-target" fisheries, and estimated England and Wales selectivity (based on fits to proportions by length category data for the period 1983–2001) "target" fisheries. The allocation to "Non-target" and "Target" shown below is based on categorising each nation as having fisheries that are "non-target", "target" or a mixture of these from 1980 onwards. An average for the period 1980–1984 is assumed for the "non-target"/"target" split prior to 1980, while all landings from 2008 onwards are assumed to come from "non-target" fisheries. Landings are used as catch in the assessment.

Year	Non-target	Target	Total	Year	Non-target	Target	Total	Year	Non-target	Target	Total
1905	3503	3745	7248	1939	9723	10396	20119	1973	23880	25532	49412
1906	1063	1137	2200	1940	4556	4872	9428	1974	22078	23606	45684
1907	690	738	1428	1941	4224	4516	8740	1975	21322	22797	44119
1908	681	728	1409	1942	5135	5490	10625	1976	21295	22769	44064
1909	977	1045	2022	1943	3954	4227	8181	1977	20420	21832	42252
1910	755	808	1563	1944	3939	4212	8151	1978	22828	24407	47235
1911	946	1011	1957	1945	3275	3501	6776	1979	18462	19739	38201
1912	1546	1653	3199	1946	5265	5630	10895	1980	20770	20198	40968
1913	1957	2093	4050	1947	8164	8729	16893	1981	20953	19009	39962
1914	1276	1365	2641	1948	9420	10071	19491	1982	16075	16327	32402
1915	1258	1344	2602	1949	11120	11890	23010	1983	17095	19951	37046
1916	258	276	534	1950	11961	12789	24750	1984	15047	20147	35194
1917	164	175	339	1951	17060	18241	35301	1985	17048	21626	38674
1918	218	233	451	1952	19597	20953	40550	1986	15138	15772	30910
1919	1285	1374	2659	1953	18464	19742	38206	1987	19558	22798	42356
1920	2125	2271	4396	1954	19607	20963	40570	1988	17292	18277	35569
1921	2572	2749	5321	1955	20843	22284	43127	1989	15355	14924	30279
1922	2610	2791	5401	1956	22691	24260	46951	1990	14390	15516	29906
1923	2733	2922	5655	1957	22023	23547	45570	1991	14034	15529	29563
1924	3071	3284	6355	1958	24355	26039	50394	1992	15711	13335	29046

Year	Non-target	Target	Total	Year	Non-target	Target	Total	Year	Non-target	Target	Total
1925	3247	3472	6719	1959	22905	24489	47394	1993	12268	13369	25637
1926	3517	3760	7277	1960	26096	27901	53997	1994	9238	11613	20851
1927	4057	4338	8395	1961	27896	29825	57721	1995	12104	9214	21318
1928	4602	4920	9522	1962	27671	29585	57256	1996	10026	7269	17295
1929	4504	4816	9320	1963	30103	32185	62288	1997	9158	6190	15348
1930	5758	6156	11914	1964	29068	31078	60146	1998	8509	5410	13919
1931	5721	6117	11838	1965	23843	25493	49336	1999	7233	5152	12385
1932	8083	8643	16726	1966	20642	22071	42713	2000	9283	6608	15891
1933	9784	10460	20244	1967	21320	22796	44116	2001	9513	7180	16693
1934	9848	10530	20378	1968	27085	28958	56043	2002	6169	5001	11170
1935	10761	11505	22266	1969	25166	26908	52074	2003	7167	5080	12247
1936	10113	10812	20925	1970	22983	24574	47557	2004	5718	3648	9366
1937	11565	12365	23930	1971	22063	23590	45653				
1938	8794	9402	18196	1972	24365	26051	50416				

Table 2.6b. Northeast Atlantic spurdog. Catch from 2005 onwards used in the assessment, with the allocation to "Trawls & other" and "Nets & hooks". Estimated selectivity for "Trawls & other" is based on fits to proportions by length category data for available Scottish, Swedish and Irish bottom trawl data for the period 2007-present, and estimated selectivity for "Nets & hooks" is based on fits to proportions by length category data for available England and Wales gillnets and trammel nets data for the period 2007-present (although in this case, the year 2021 is omitted due to the lack of sufficient samples for that year). The allocation to "Trawls & other" and "Nets & hooks" shown below is based on assigning gears to these two broad categories for all landings and discards data. Note that infilling was required for the years 2011, 2013-2015 due to missing discards data for gillnets and trammel nets for England and Wales (average of 2010, 2012, 2016-2019 used for the missing years, equating to 2425 t discards added for England and Wales in each of the missing years), but this only affects "Nets & hooks".

Year	Trawls & other	Nets & hooks	Total
2005	2890	4222	7112
2006	2186	1832	4018
2007	1562	1363	2925
2008	975	862	1837
2009	1203	861	2064
2010	675	1734	2409
2011	302	2722	3024
2012	399	4805	5204
2013	598	2672	3270
2014	536	2759	3295
2015	638	2635	3273
2016	984	967	1951
2017	726	4349	5075
2018	699	2034	2733
2019	795	2826	3621
2020	746	722	1468
2021	673	505	1178
2022	620	820	1441
2023	2888	1320	4208

Table 2.7. Northeast Atlantic spurdog. Delta-lognormal GLM-standardised index of abundance (with associated CVs), based on combined surveys for Q1, Q3 and Q4.

Year	Q1 index	CV	Q3 index	CV	Q4 index	CV
1985	6755	0.23				
1986	4706	0.21				
1987	4024	0.22				
1988	3000	0.24				
1989	2996	0.26				
1990	5742	0.25				
1991	3957	0.23				
1992	1196	0.31	2523	0.31		
1993	1752	0.24	2686	0.31		
1994	2064	0.26	575	0.40		
1995	1996	0.31	463	0.50		
1996	2608	0.28	990	0.41		
1997	1378	0.34	4043	0.36		
1998	1201	0.31	1697	0.38		
1999	2058	0.32	1324	0.36		
2000	625	0.36	739	0.48		
2001	1849	0.31	1158	0.48		
2002	1561	0.30	362	0.57		
2003	1017	0.30	316	0.65	7612	0.13
2004	811	0.41	443	0.53	6493	0.13
2005	1010	0.31	972	0.49	6865	0.13
2006	1418	0.31	456	0.48	6895	0.14
2007	1060	0.28	750	0.42	5766	0.13
2008	956	0.30	841	0.40	6680	0.14
2009	464	0.31	1847	0.44	5509	0.15
2010	557	0.31	988	0.40	7473	0.22
2011	1256	0.30	1384	0.37	6092	0.16
2012	759	0.32	1004	0.42	9921	0.14
2013	2085	0.24	742	0.43	6408	0.17
2014	1840	0.24	962	0.40	10189	0.14
2015	742	0.29	2228	0.30	10835	0.13
2016	1796	0.27	1608	0.34	20366	0.11
2017	1975	0.25	1077	0.31	26402	0.13
2018	1635	0.27	1248	0.34	17995	0.13
2019	1695	0.23	789	0.33	26259	0.10
2020	2457	0.24	994	0.28	31396	0.11
2021	2862	0.22	1534	0.31	42150	0.10
2022	2600	0.30	4775	0.26	59023	0.09
2023	4627	0.21	2007	0.27	69949	0.09

Table 2.8a. Northeast Atlantic spurdog. Scottish survey proportions-by-length category for females (top) and males (bottom) for the Q1 combined index, with the actual sample sizes given in the second column.

	$n_{psur,y}$	16–31	32–54	55–69	70+
Females					
1985	244	0.0721	0.1934	0.0930	0.0352
1986	212	0.0406	0.0657	0.1546	0.1315
1987	101	0.0304	0.0761	0.1167	0.0439
1988	1894	0.0012	0.5886	0.0032	0.0010
1989	351	0.0466	0.3616	0.0150	0.0451
1990	516	0.0278	0.2170	0.1250	0.0176
1991	963	0.0992	0.2044	0.0495	0.0103
1992	119	0.1233	0.2651	0.0437	0.0271
1993	84	0.0923	0.2935	0.0730	0.0430
1994	1606	0.0287	0.3199	0.0215	0.0093
1995	2210	0.2164	0.2731	0.0041	0.0032
1996	174	0.0718	0.2656	0.0635	0.0263
1997	16	0.1013	0.2025	0.1013	0.0253
1998	216	0.0662	0.3080	0.0728	0.0372
1999	134	0.0894	0.2336	0.0547	0.0615
2000	33	0.0787	0.3148	0.0197	0.0787
2001	43	0.0123	0.2441	0.0862	0.0615
2002	54	0.0609	0.2348	0.1304	0.1566
2003	189	0.0277	0.3117	0.0554	0.0492
2004	24	0.0426	0.2340	0.0851	0.0639
2005	39	0.1250	0.2059	0.0882	0.0588
2006	39	0.0795	0.1324	0.1192	0.1457
2007	71	0.1124	0.2469	0.0787	0.1181
2008	135	0.1229	0.2610	0.0330	0.0454
2009	163	0.0968	0.3226	0.0183	0.0244
2010	3491	0.0087	0.3560	0.1972	0.0013
2011	164	0.0353	0.1666	0.0801	0.0690
2012	700	0.0101	0.3414	0.0070	0.0035
2013	99	0.1028	0.2202	0.0635	0.1178
2014	413	0.0359	0.1302	0.0969	0.0182
2015	54	0.0516	0.2628	0.0317	0.0238
2016	198	0.1018	0.1925	0.0762	0.1384
2017	655	0.1005	0.2863	0.0260	0.0292
2018	93	0.0360	0.3030	0.0924	0.0672
2019	520	0.0721	0.3289	0.0811	0.0532
2020	295	0.2103	0.1135	0.0554	0.1357
2021	1654	0.0330	0.0951	0.2696	0.3707
2022	62	0.0969	0.1254	0.0239	0.0479
2023	995	0.0541	0.1366	0.0429	0.4848
Males					
1985	1841	0.0432	0.1324	0.1909	0.2398
1986	654	0.0288	0.0957	0.3372	0.1458
1987	714	0.0406	0.0457	0.1316	0.5149
1988	1135	0.0010	0.3948	0.0082	0.0021
1989	431	0.0489	0.3917	0.0391	0.0520
1990	978	0.0427	0.1541	0.2111	0.2048
1991	1445	0.0787	0.2017	0.2168	0.1394
1992	127	0.1477	0.1808	0.0407	0.1717
1993	71	0.0959	0.2691	0.0344	0.0988
1994	2380	0.0268	0.5444	0.0184	0.0311
1995	1857	0.1588	0.3405	0.0026	0.0013
1996	218	0.0657	0.3734	0.0942	0.0394
1997	22	0.1899	0.1266	0.0759	0.1772
1998	219	0.0355	0.3431	0.0692	0.0680
1999	200	0.1401	0.2683	0.0479	0.1045
2000	36	0.0393	0.2525	0.0787	0.1377
2001	92	0.0246	0.1538	0.1087	0.3087
2002	36	0.0783	0.1696	0.0522	0.1174
2003	216	0.0216	0.3674	0.1259	0.0411
2004	32	0.0426	0.2340	0.0638	0.2341

	$n_{psur,y}$	16–31	32–54	55–69	70+
2005	47	0.1250	0.1912	0.0588	0.1470
2006	57	0.0132	0.2252	0.1192	0.1655
2007	66	0.0675	0.1462	0.1162	0.1141
2008	146	0.1460	0.2653	0.0495	0.0770
2009	207	0.0897	0.3437	0.0308	0.0737
2010	2487	0.0063	0.2986	0.1150	0.0167
2011	273	0.0294	0.1995	0.2491	0.1709
2012	897	0.0198	0.5993	0.0088	0.0101
2013	86	0.1088	0.1451	0.0816	0.1602
2014	1013	0.0394	0.1567	0.3290	0.1937
2015	116	0.0436	0.2727	0.0947	0.2189
2016	215	0.0936	0.1813	0.1178	0.0984
2017	844	0.0918	0.3600	0.0471	0.0592
2018	163	0.0144	0.2497	0.1036	0.1336
2019	526	0.0534	0.2484	0.0886	0.0743
2020	383	0.2431	0.0826	0.0588	0.1006
2021	812	0.0287	0.0911	0.0676	0.0440
2022	187	0.0770	0.1169	0.0884	0.4237
2023	609	0.0582	0.1011	0.0482	0.0741

Table 2.8b. Northeast Atlantic spurdog. Scottish survey proportions-by-length category for females (top) and males (bottom) for the Q3 combined index, with the actual sample sizes given in the second column.

	$n_{psur,y}$	16–31	32–54	55–69	70+
Females					
1992	32	0.00001	0.0118	0.1118	0.4824
1993	13	0.0294	0.0294	0.0882	0.3235
1994	15	0.0864	0.1481	0.0494	0.1975
…	…	…	…	…	…
2008	48	0.0685	0.2785	0.0183	0.0182
2009	28	0.0276	0.0552	0.1380	0.3671
2010	16	0.0303	0.2730	0.0910	0.00002
2011	47	0.0658	0.1343	0.0987	0.1534
2012	31	0.1177	0.0941	0.0244	0.1359
2013	52	0.0688	0.0854	0.0142	0.5124
2014	26	0.0046	0.0107	0.0076	0.0137
2015	53	0.0765	0.1756	0.1778	0.0810
2016	25	0.0882	0.1730	0.0799	0.1531
2017	92	0.0915	0.2063	0.0819	0.0546
2018	64	0.0210	0.0374	0.0187	0.1560
2019	51	0.0539	0.3695	0.0551	0.0368
2020	92	0.1072	0.2403	0.0277	0.0920
2021	208	0.0265	0.0718	0.1242	0.2376
2022	536	0.0728	0.1416	0.1767	0.1052
2023	323	0.0186	0.0654	0.0719	0.3094
Males					
1992	31	0.00001	0.0941	0.0588	0.2411
1993	19	0.00001	0.0882	0.1471	0.2941
1994	18	0.0494	0.2716	0.0741	0.1235
…	…	…	…	…	…
2008	71	0.0731	0.4201	0.0274	0.0959
2009	18	0.0276	0.0819	0.0267	0.2760
2010	25	0.0607	0.2118	0.1213	0.2118
2011	92	0.0658	0.1316	0.0987	0.2517
2012	56	0.1088	0.1314	0.1181	0.2697
2013	26	0.0488	0.0569	0.0712	0.1424
2014	725	0.0046	0.0122	0.0948	0.8517
2015	58	0.0720	0.1708	0.1351	0.1111
2016	34	0.0333	0.1065	0.0799	0.2862
2017	102	0.0819	0.2245	0.0546	0.2048
2018	302	0.0327	0.0491	0.0397	0.6452
2019	53	0.0613	0.2769	0.0546	0.0919
2020	85	0.1265	0.2543	0.0647	0.0872

	$n_{psur,y}$	16–31	32–54	55–69	70+
2021	255	0.0198	0.0743	0.1064	0.3393
2022	928	0.0469	0.1216	0.1992	0.1359
2023	318	0.0234	0.0752	0.1069	0.3293

Table 2.8c. Northeast Atlantic spurdog. Scottish survey proportions-by-length category for females (top) and males (bottom) for the Q4 combined index, with the actual sample sizes given in the second column.

	$n_{psur,y}$	16–31	32–54	55–69	70+
Females					
2003	266	0.0308	0.1273	0.0958	0.3883
2004	139	0.0083	0.1312	0.1240	0.2768
2005	611	0.0161	0.1193	0.3550	0.1340
2006	227	0.0403	0.1498	0.1032	0.3193
2007	213	0.0411	0.1706	0.1018	0.2493
2008	1247	0.0058	0.0273	0.0240	0.8685
2009	135	0.0181	0.1726	0.1498	0.1878
2010	386	0.0325	0.1685	0.0381	0.4706
2011	170	0.0224	0.1020	0.0704	0.1534
2012	1207	0.0234	0.0670	0.0448	0.6601
2013	399	0.0183	0.1314	0.1651	0.4121
2014	601	0.0622	0.2164	0.0530	0.2263
2015	302	0.0673	0.1489	0.0862	0.1924
2016	1469	0.0555	0.1795	0.1270	0.1671
2017	1090	0.0607	0.3170	0.0551	0.1115
2018	1761	0.0375	0.3582	0.0711	0.1058
2019	2319	0.0372	0.2077	0.0828	0.2354
2020	1743	0.0425	0.1890	0.1109	0.2149
2021	2564	0.0670	0.2131	0.0728	0.1841
2022	3268	0.0677	0.1942	0.0790	0.1907
2023	4869	0.0353	0.2230	0.0633	0.1428
Males					
2003	322	0.0668	0.1017	0.0810	0.1083
2004	261	0.0083	0.1494	0.1336	0.1686
2005	457	0.0221	0.0794	0.2021	0.0719
2006	221	0.0229	0.1178	0.1342	0.1125
2007	313	0.0178	0.1836	0.1154	0.1206
2008	332	0.0036	0.0280	0.0143	0.0285
2009	251	0.0331	0.1452	0.1023	0.1910
2010	268	0.0118	0.1554	0.0400	0.0830
2011	458	0.1189	0.1837	0.1541	0.1950
2012	593	0.0102	0.0682	0.0426	0.0838
2013	312	0.0133	0.0691	0.0755	0.1152
2014	619	0.0511	0.2332	0.0485	0.1092
2015	378	0.0416	0.1726	0.1079	0.1831
2016	1713	0.0504	0.1850	0.1172	0.1185
2017	1432	0.0338	0.2648	0.0529	0.1042
2018	1620	0.0218	0.2510	0.0668	0.0879
2019	2112	0.0303	0.2146	0.0701	0.1219
2020	1730	0.0420	0.1825	0.1096	0.1085
2021	2949	0.0683	0.1978	0.0728	0.1240
2022	3547	0.0605	0.2086	0.0802	0.1189
2023	7226	0.0417	0.2618	0.0953	0.1369

Table 2.9. Northeast Atlantic spurdog. Commercial proportions-by-length category (males and females combined), for each of the two fleets ("Non-target", "target", "Trawls & other", "Nets & hooks), with raised sample sizes given in the second column, except for "Trawls & other" which gives the combined catch tonnage (landings + discards) associated with Swedish, Scottish and Irish bottom trawl length compositions.

	$n_{pcom,j,y}$	16–54	55–69	70–84	85+
Non-target (Scottish) commercial proportions					
1991	6167824	0.0186	0.4014	0.5397	0.0404
1992	6104263	0.0172	0.1844	0.7713	0.0272
1993	4295057	0.0020	0.2637	0.7106	0.0236
1994	3257630	0.0301	0.3322	0.5857	0.0520
1995	5710863	0.0112	0.2700	0.6878	0.0309
1996	2372069	0.0069	0.4373	0.5416	0.0142
1997	3769327	0.0091	0.3297	0.5909	0.0702
1998	3021371	0.0330	0.4059	0.5286	0.0325
1999	1869109	0.0145	0.3508	0.5792	0.0556
2000	1856169	0.00001	0.1351	0.7683	0.0967
2001	1580296	0.0021	0.2426	0.7022	0.0531
2002	1264383	0.0529	0.3106	0.5180	0.1186
2003	1695860	0.0011	0.2673	0.5729	0.1587
2004	1688197	0.0106	0.2292	0.6893	0.0708
Target (England & Wales) commercial proportion					
1983	243794	0.0181	0.4010	0.4778	0.1030
1984	147964	0.0071	0.2940	0.4631	0.2359
1985	97418	0.0015	0.1679	0.6238	0.2068
1986	63890	0.0004	0.1110	0.6410	0.2476
1987	116136	0.0027	0.1729	0.5881	0.2362
1988	168995	0.0085	0.0973	0.5611	0.3332
1989	109139	0.0011	0.0817	0.5416	0.3757
1990	39426	0.0168	0.1349	0.5369	0.3115
1991	42902	0.0013	0.1039	0.5312	0.3637
1992	23024	0.0003	0.1136	0.4847	0.4013
1993	15855	0.0012	0.1741	0.4917	0.3331
1994	14279	0.0026	0.2547	0.3813	0.3614
1995	48515	0.0007	0.1939	0.4676	0.3378
1996	16254	0.0082	0.3258	0.4258	0.2402
1997	22149	0.0032	0.1323	0.4082	0.4563
1998	21026	0.0007	0.1075	0.4682	0.4236
1999	9596	0.0037	0.1521	0.5591	0.2851
2000	10185	0.0001	0.0729	0.4791	0.4480
2001	17404	0.0024	0.1112	0.4735	0.4128
Trawls & other (Swedish, Scottish and Irish bottom trawls) commercial proportion					
2007	288	0.0820	0.3020	0.4960	0.1200
2008	204	0.3310	0.1652	0.3852	0.1186
2009	534	0.2118	0.1760	0.5050	0.1074
2010	404	0.1884	0.2028	0.4630	0.1456
2011	140	0.4566	0.2406	0.2440	0.0588

	$n_{pcom,j,y}$	16–54	55–69	70–84	85+
2012	316	0.7264	0.0514	0.1210	0.1010
2013	264	0.3764	0.3558	0.1602	0.1076
2014	446	0.1554	0.3448	0.4128	0.0870
2015	456	0.2336	0.3402	0.3596	0.0668
2016	212	0.5084	0.2288	0.1734	0.0892
2017	648	0.3818	0.2236	0.3270	0.0676
2018	564	0.4158	0.1584	0.3608	0.0650
2019	708	0.4262	0.2306	0.2724	0.0708
2020	358	0.0948	0.3430	0.4916	0.0706
2021	396	0.1658	0.4044	0.3680	0.0618
2022	486	0.2500	0.3952	0.2180	0.1368
2023	2322	0.2458	0.2062	0.3542	0.1938
	Nets & hooks (England & Wales gillnets and trammel nets) commercial proportion				
2007	187	0.00001	0.0838	0.5411	0.3751
2008	232	0.0092	0.1416	0.5585	0.2906
2009	2841	0.0041	0.0201	0.8979	0.0779
2010	514	0.0167	0.2994	0.5655	0.1183
2011	405	0.00001	0.1191	0.6006	0.2802
2012	796	0.00001	0.0148	0.8659	0.1192
2013	381	0.00001	0.0223	0.5456	0.4321
2014	305	0.0424	0.0214	0.2066	0.7296
2015	186	0.00001	0.1716	0.5764	0.2520
2016	5979	0.0011	0.0480	0.6472	0.3037
2017	1224	0.0045	0.0887	0.5272	0.3797
2018	2689	0.0106	0.1307	0.4225	0.4361
2019	967	0.0010	0.0468	0.5506	0.4015
2020	1002	0.0010	0.0459	0.4473	0.5058
2021	...	...	...	...	...
2022	991	0.0063	0.0758	0.4630	0.4549
2023	211	0.0000	0.1185	0.4001	0.4814

Table 2.10a. Northeast Atlantic spurdog. Fecundity data for 1921, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 81.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
72	2	77	2	77	3	77	5	82	2	82	4	82	6	87	2	87	3	87	4	92	3	97	2
72	3	77	2	77	3	77	5	82	2	82	4	82	7	87	2	87	3	87	5	92	3	97	3
72	3	77	2	77	3	82	1	82	2	82	4	82	7	87	2	87	3	87	6	92	4	97	7
72	3	77	2	77	3	82	1	82	3	82	5	87	1	87	2	87	3	87	7	92	4	97	11
72	4	77	2	77	4	82	2	82	3	82	5	87	2	87	2	87	3	87	7	92	5		
72	4	77	2	77	4	82	2	82	4	82	5	87	2	87	2	87	3	92	3	92	7		
77	2	77	2	77	4	82	2	82	4	82	6	87	2	87	3	87	3	92	3	92	8		

Table 2.10b. Northeast Atlantic spurdog. Fecundity data for 1960 (Ellis and Keable, 2008), given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 783.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
73	3	84	4	86	3	87	7	88	3	89	4	90	1	91	7	93	3	94	5	96	10	101	11
73	3	84	6	86	3	87	8	88	5	89	4	90	3	91	8	93	4	94	5	96	10	101	7
75	3	84	6	86	3	87	9	88	5	89	5	90	3	91	8	93	5	94	6	96	7	102	5
77	3	84	3	86	4	87	2	88	6	89	7	90	5	91	3	93	5	94	6	96	7	102	10
78	3	84	3	86	4	87	5	88	6	89	8	90	6	91	4	93	5	94	7	96	8	102	3
79	2	84	4	86	4	87	5	88	6	89	8	90	8	91	4	93	5	94	8	97	4	103	14
79	3	84	4	86	4	87	5	88	7	89	5	90	5	91	7	93	5	94	8	97	4	103	9
79	4	84	4	86	5	87	5	88	8	89	6	90	6	91	4	93	6	94	8	97	7	103	15
79	4	84	5	86	5	87	6	88	6	89	6	90	6	91	5	93	8	94	9	97	2	103	9
79	3	84	6	86	5	87	5	88	6	89	8	90	7	91	7	93	9	94	9	97	3	103	15
80	4	84	6	86	5	87	5	88	8	90	1	90	7	91	7	93	5	94	9	97	3	105	11
80	3	84	4	86	6	87	6	88	9	90	2	90	9	91	8	93	5	94	11	97	3	110	8
80	4	84	4	86	2	87	7	89	3	90	3	90	10	92	2	93	5	94	3	97	4	117	9
80	5	84	6	86	3	87	7	89	3	90	3	91	2	92	4	93	6	94	3	97	4		
80	2	84	6	86	4	87	7	89	4	90	3	91	3	92	5	93	6	94	8	97	4		
80	3	84	6	86	4	87	8	89	4	90	3	91	4	92	7	93	6	94	9	97	5		
80	3	84	6	86	5	87	9	89	4	90	5	91	5	92	2	93	8	94	9	97	6		
80	5	84	3	86	5	88	2	89	6	90	5	91	5	92	2	93	9	94	9	97	6		
81	1	84	4	86	5	88	2	89	2	90	5	91	6	92	2	93	9	94	11	97	7		
81	3	84	4	86	5	88	2	89	2	90	6	91	6	92	2	93	4	95	3	97	3		
81	3	84	4	86	6	88	4	89	3	90	7	91	7	92	2	93	6	95	6	97	5		
81	3	84	6	86	6	88	4	89	3	90	1	91	2	92	2	93	6	95	6	97	6		
81	6	84	6	86	7	88	5	89	3	90	2	91	2	92	3	93	6	95	8	97	7		
81	3	84	6	86	5	88	5	89	3	90	2	91	2	92	3	93	7	95	3	97	4		
81	3	84	6	86	6	88	5	89	3	90	3	91	2	92	3	93	9	95	4	97	6		
82	3	85	3	86	7	88	5	89	3	90	3	91	2	92	3	93	9	95	4	97	8		
82	4	85	3	86	7	88	6	89	4	90	3	91	3	92	3	93	9	95	4	97	9		
82	4	85	4	86	7	88	1	89	4	90	3	91	3	92	4	93	9	95	5	97	9		
82	4	85	5	86	8	88	2	89	4	90	4	91	4	92	4	93	9	95	7	97	4		
82	5	85	5	86	1	88	3	89	4	90	4	91	4	92	5	93	10	95	7	97	6		
82	6	85	5	86	2	88	3	89	4	90	4	91	4	92	5	93	11	95	7	97	7		
82	1	85	5	86	2	88	3	89	4	90	4	91	4	92	6	93	1	95	9	97	7		
82	4	85	5	86	3	88	3	89	4	90	4	91	4	92	6	93	4	95	6	97	9		
82	4	85	7	86	4	88	3	89	4	90	4	91	4	92	6	93	7	95	9	97	6		
82	6	85	1	86	5	88	3	89	4	90	5	91	4	92	6	93	4	95	7	97	8		
82	6	85	3	86	6	88	4	89	4	90	5	91	5	92	7	93	6	95	8	97	9		
82	5	85	3	86	7	88	4	89	5	90	5	91	5	92	7	93	6	95	10	98	1		
82	6	85	3	86	7	88	4	89	5	90	5	91	5	92	8	93	6	95	11	98	5		
82	5	85	4	86	7	88	4	89	5	90	5	91	5	92	9	93	7	95	11	98	6		
82	6	85	4	86	8	88	5	89	5	90	6	91	6	92	4	93	9	95	11	98	9		
82	5	85	4	87	2	88	5	89	5	90	6	91	6	92	5	93	9	95	4	98	9		
83	3	85	5	87	3	88	5	89	5	90	6	91	6	92	6	93	9	95	7	98	8		
83	2	85	5	87	4	88	5	89	6	90	8	91	6	92	6	93	9	95	8	98	8		
83	2	85	3	87	5	88	5	89	6	90	9	91	6	92	6	93	10	95	11	98	9		
83	3	85	4	87	6	88	5	89	6	90	4	91	7	92	7	93	11	95	11	98	12		
83	4	85	4	87	3	88	5	89	6	90	4	91	7	92	8	94	5	95	11	98	8		
83	5	85	5	87	4	88	5	89	6	90	4	91	7	92	6	94	6	96	4	98	8		
83	4	85	5	87	4	88	6	89	6	90	5	91	7	92	6	94	6	96	4	98	9		
83	4	85	5	87	4	88	6	89	7	90	5	91	4	92	7	94	6	96	9	99	6		
83	5	85	6	87	5	88	6	89	4	90	5	91	4	92	10	94	7	96	4	99	6		
83	5	85	6	87	5	88	6	89	4	90	6	91	4	92	3	94	9	96	5	99	8		
83	5	85	6	87	5	88	6	89	4	90	6	91	4	92	3	94	3	96	5	99	4		
83	6	85	7	87	7	88	6	89	4	90	6	91	4	92	4	94	3	96	5	99	8		
83	4	85	4	87	3	88	4	89	4	90	6	91	5	92	5	94	3	96	5	99	15		
83	4	85	5	87	4	88	5	89	4	90	7	91	6	92	6	94	4	96	6	99	8		
83	4	85	7	87	5	88	5	89	5	90	7	91	6	92	6	94	4	96	6	100	6		
83	6	85	8	87	5	88	5	89	5	90	7	91	6	92	7	94	4	96	6	100	9		
83	4	85	3	87	5	88	6	89	6	90	7	91	6	92	7	94	5	96	6	100	10		
83	4	85	4	87	6	88	6	89	6	90	9	91	6	92	7	94	5	96	8	100	14		
83	4	85	5	87	6	88	6	89	6	90	9	91	7	92	10	94	5	96	5	100	7		
83	6	85	6	87	7	88	5	89	6	90	5	91	7	92	6	94	6	96	5	100	10		

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
84	3	85	7	87	7	88	5	89	7	90	6	91	7	93	1	94	6	96	6	100	14		
84	3	85	4	87	7	88	6	89	3	90	6	91	8	93	4	94	6	96	6	101	4		
84	3	86	2	87	5	88	6	89	5	90	6	91	8	93	5	94	7	96	8	101	6		
84	4	86	3	87	5	88	6	89	6	90	7	91	8	93	6	94	7	96	8	101	6		
84	6	86	3	87	5	88	6	89	6	90	7	91	8	93	7	94	7	96	7	101	10		
84	3	86	4	87	6	88	7	89	8	90	8	91	4	93	8	94	7	96	7	101	7		
84	3	86	5	87	6	88	8	89	8	90	9	91	5	93	1	94	7	96	8	101	9		
84	3	86	2	87	7	88	8	89	3	90	10	91	7	93	2	94	8	96	10	101	11		
84	4	86	2	87	7	88	9	89	3	90	1	91	7	93	2	94	4	96	10	101	9		

Table 2.10c. Northeast Atlantic spurdog. Fecundity data for 1978, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 58.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
74	4.9	78	5.9	83	6.9	86	6.1	88	7.1	91	6.4	93	9.6	96	10.4	99	9.7	101	12.6	104	12.9	107	13.2
75	5.9	79	4.1	84	6.7	86	7.4	89	5.2	91	9.2	94	9.4	97	10.3	99	11	102	11.5	104	13.1	108	12.9
76	5.9	80	7.9	84	7.5	87	5.8	89	7.1	92	7.2	94	9.5	97	10.7	100	9.9	102	12.4	105	13.2	108	13.9
77	5.9	81	6.9	85	6	87	7.5	90	7	92	10.9	95	11	98	10.4	100	11.7	103	11.2	106	12.9		
78	3.9	82	6.3	85	7.4	88	6.5	90	8.6	93	8.6	96	7.3	98	10.5	101	11.5	103	12.2	106	14.2		

Table 2.10d. Northeast Atlantic spurdog. Fecundity data for 1987, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 126.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
71.5	5	75	4	76.5	5	77.5	5	79	4	80	7	82	5	84	9	86	5	88	7	91.5	9	101	17
72	4	95	4	95	8	95	11	79	5	80	9	82	6	84.5	5	86	8	88	7	92	6	101	17
72	5	95	4	95	8	96	4	79	5	80.5	5	82	6	84.5	8	86.5	4	89	7	92	9	101.5	12
72	6	95	5	95	8	96	4	79	6	80.5	6	82	7	85	2	86.5	7	89	8	92.5	6	105	12
72.5	4	95	6	95	9	96	4	79	6	81	4	82.5	5	85	4	87	2	89.5	6	92.5	11	106	14
72.5	6	95	6	95	9	96	5	79	7	81	5	82.5	8	85	5	87.5	4	89.5	7	93.5	8		
73.5	4	95	6	95	10	96	5	79.5	4	81	6	82.5	8	85	10	87.5	6	90	4	94	10		
73.5	5	95	7	95	11	96	5	79.5	6	81	8	83	5	85.5	4	87.5	8	90	6	94.5	8		
73.5	6	95	7	95	11	96	5	80	3	81.5	3	83	7	85.5	7	88	5	90	7	94.5	10		
74	4	95	7	95	11	96	5	80	5	81.5	6	83	8	85.5	8	88	6	91	6	99.5	13		
74.5	5	95	7	95	11	96	5	80	6	82	4	83.5	7	86	4	88	6	91	8	100	11		

Table 2.10e. Northeast Atlantic spurdog. Fecundity data for 1988, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 25.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
77	5	87	4	92	3	95	11	97	10
82	4	87	5	92	6	95	12	98	4
86	6	88	5	92	7	96	3	101	12
87	3	89	2	92	9	96	9	104	7
87	3	92	1	93	10	97	6	106	9

Table 2.10f. Northeast Atlantic spurdog. Fecundity data for 1997, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 111.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
72	6	79	4	82	4	84.5	5	87	5	87	7	92	4	92	7	93	4	97	7	102	5	108	15
77	1	79	5	82	5	84.5	7	87	5	87	7	92	4	92	7	93	7	97	8	102	8		
77	3	80	4	82	5	86.5	5	87	5	87.5	6	92	4	92	7	94.5	5	97	9	102	8		
77	3	80.5	5	82	5	87	1	87	5	88	5	92	5	92	8	94.5	7	97	9	102	9		
77	4	82	1	82	6	87	2	87	5	89	6	92	5	92	8	95	7	97	9	102	10		
77	4	82	2	82	6	87	4	87	6	90	5	92	5	92	8	95	8	97.5	8	102	10		
77	4	82	3	82	6	87	4	87	6	90.5	9	92	6	92	8	97	4	97.5	10	102	13		
77	5	82	4	82	6	87	5	87	6	91	9	92	6	92	10	97	5	98	9	106	12		
77	6	82	4	82	9	87	5	87	6	91.5	8	92	6	92	11	97	6	100	11	106.5	10		
77.5	5	82	4	84.5	3	87	5	87	6	92	3	92	7	92.5	6	97	7	100.5	7	107	8		

Table 2.10g. Northeast Atlantic spurdog. Fecundity data for 2005 (Ellis and Keable, 2008), given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 179.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
84	6	92	5	94	11	97	7	98	11	100	7	101	10	102	13	103	14	105	11	107	12	109	15
87	8	92	8	95	7	97	8	98	12	100	8	101	12	102	13	103	15	105	12	107	12	109	16
89	3	92	8	95	9	97	8	98	12	100	9	101	13	102	13	103	16	105	13	107	12	109	18
89	5	92	9	95	10	97	12	98	12	100	9	101	13	102	13	103	16	105	15	107	15	110	10
89	5	92	9	95	11	97	12	98	12	100	9	101	14	102	15	104	11	105	15	107	16	110	13
89	6	93	3	96	7	97	12	98	12	100	10	101	14	102	16	104	12	105	15	107	17	110	15
89	6	93	4	96	7	97	14	98	13	100	11	101	17	102	17	104	13	105	16	108	12	111	19
89	8	93	5	96	10	97	14	98	13	100	12	102	3	102	17	104	14	105	16	108	13	112	12
90	4	93	9	96	10	98	5	98	16	100	12	102	5	103	11	104	14	105	17	108	14	112	16
90	7	93	11	96	11	98	7	99	8	100	12	102	10	103	11	104	14	105	19	108	14	112	17
90	9	94	5	96	11	98	7	99	10	100	14	102	12	103	11	104	14	106	7	108	16	113	15
90	9	94	6	97	5	98	7	99	11	101	6	102	12	103	11	104	15	106	14	108	16	113	21
91	6	94	8	97	6	98	8	99	11	101	9	102	12	103	13	104	17	106	16	109	10	114	14
91	6	94	9	97	7	98	10	99	11	101	10	102	13	103	14	105	5	106	16	109	13	116	16
92	3	94	9	97	7	98	10	99	12	101	10	102	13	103	14	105	8	107	11	109	13		

Table 2.10h. Northeast Atlantic spurdog. Fecundity data for 2009, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 116.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
102	16	107	13	98	11	97	10	104	10	101	9	91	8	98	8	83	7	106	7	95	6	87	5
103	16	102	12	96	11	106	10	107	10	100	9	92	8	97	8	88	7	84	7	91	6	88	5
104	16	97	12	106	11	104	10	106	10	106	9	93	8	88	8	91	7	85	7	92	6	91	4
109	16	101	12	101	10	106	10	105	10	95	9	107	8	94	8	93	7	94	7	100	6	88	4
108	16	101	12	100	10	103	10	98	9	97	9	98	8	97	8	103	7	92	7	94	6	91	3
108	16	105	12	105	10	105	10	97	9	98	9	100	8	104	8	98	7	91	6	91	6	91	2
105	15	99	12	88	10	101	10	102	9	102	9	94	8	99	8	110	7	93	6	97	5		
106	15	96	11	97	10	106	10	94	9	97	9	99	8	84	8	99	7	95	6	93	5		
108	14	98	11	95	10	102	10	97	9	101	9	83	8	94	8	94	7	105	6	88	5		
100	13	95	11	97	10	104	10	101	9	90	8	82	8	95	7	97	7	83	6	88	5		

Table 2.10i. Northeast Atlantic spurdog. Fecundity data for 2010, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 1.

l^f	P'
98	10

Table 2.10j. Northeast Atlantic spurdog. Fecundity data for 2014, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 109.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
86	3	93	8	98	2	100	4	102	6	103	5	104	4	105	16	107	11	109	12	111	13
89	7	94	6	98	3	100	6	102	7	103	7	104	10	106	1	107	12	109	12	111	17
90	7	94	7	98	4	100	7	102	8	103	8	104	11	106	5	107	15	109	14	111	19
90	7	95	7	98	8	100	11	102	10	103	10	104	14	106	8	107	15	109	17	113	17
91	2	95	7	98	9	101	6	102	11	103	10	104	15	106	8	108	5	110	4	114	15
91	4	96	2	98	9	101	8	102	12	103	11	104	16	107	2	108	8	110	12	115	12
92	3	96	8	98	10	101	9	102	13	103	12	104	17	107	3	108	8	110	13	116	7
92	5	97	8	99	8	101	11	102	15	103	12	105	8	107	4	108	13	111	1	116	7
92	6	97	11	99	12	101	14	103	2	103	12	105	12	107	10	109	2	111	7	122	14
92	6	98	1	99	12	102	3	103	4	103	15	105	14	107	11	109	11	111	10		

Table 2.10k. Northeast Atlantic spurdog. Fecundity data for 2016, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 92.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
75	3	79	6	82	6	83	8	87	4	89	3	90	3	93	1	94	6	98	8	102	7	107	13
76	5	79	7	82	6	84	5	87	6	89	6	91	6	93	2	95	4	99	15	103	7	111	9
76	6	80	1	82	6	85	8	87	8	89	6	91	9	93	5	95	7	100	12	103	10	112	12
77	4	81	5	82	6	85	9	88	5	89	6	91	9	93	6	95	12	100	12	103	11	114	19

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
78	4	81	5	83	2	86	3	88	5	89	6	92	2	93	6	96	2	101	9	103	13		
78	4	81	5	83	3	86	6	88	5	89	7	92	4	93	9	96	7	101	10	104	7		
78	5	81	6	83	5	86	9	88	9	89	8	92	7	94	2	96	8	102	6	104	10		
78	6	81	7	83	7	87	2	89	3	89	9	92	9	94	3	96	9	102	7	107	11		

Table 2.10l. Northeast Atlantic spurdog. Fecundity data for 2017, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 297.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
72	3	79	4	83	4	85	6	87	4	88	9	91	4	93	6	95	10	97	10	100	8	107	9
72	4	79	6	83	5	85	6	87	4	89	2	91	5	93	6	95	11	97	10	100	9	107	11
73	2	80	2	83	6	85	8	87	4	89	5	91	5	93	6	95	11	97	11	100	9	107	12
73	4	80	5	83	7	85	9	87	5	89	5	91	6	93	7	95	12	97	13	100	11	107	13
75	3	80	5	84	3	86	3	87	5	89	6	91	6	93	7	95	15	97	13	100	13	108	1
75	5	80	5	84	3	86	3	87	5	89	6	91	7	93	8	96	3	98	2	101	5	108	7
75	5	80	5	84	4	86	3	87	6	89	6	91	7	93	9	96	4	98	5	101	7	108	10
75	7	81	2	84	4	86	3	87	6	89	6	91	7	93	9	96	4	98	5	101	7	108	14
76	3	81	3	84	4	86	4	87	6	89	6	91	7	93	13	96	6	98	5	101	7	108	14
76	3	81	4	84	5	86	4	87	7	89	8	91	7	94	6	96	7	98	7	101	10	108	14
76	4	81	4	84	5	86	5	88	2	89	8	91	7	94	6	96	7	98	8	101	14	108	15
77	1	81	5	84	5	86	5	88	3	89	8	91	7	94	6	96	7	98	10	102	5	109	6
77	3	81	7	84	5	86	6	88	4	89	10	91	8	94	6	96	7	98	11	102	7	110	1
77	3	82	3	84	5	86	6	88	4	90	3	91	8	94	7	96	7	98	14	102	10	110	12
77	4	82	3	84	6	86	6	88	4	90	5	91	9	94	8	96	9	98	14	102	12	110	13
77	4	82	5	84	6	86	7	88	5	90	5	92	2	94	8	96	9	99	7	102	13	112	12
77	5	82	5	84	6	86	7	88	5	90	5	92	3	94	8	96	9	99	8	102	14	112	13
77	6	82	5	84	6	86	8	88	5	90	6	92	3	94	12	96	10	99	9	103	12	112	15
78	4	82	5	84	7	87	2	88	6	90	6	92	5	95	4	96	11	99	9	105	12	112	16
78	5	82	5	84	7	87	3	88	6	90	6	92	6	95	5	97	6	99	10	105	12	113	3
78	5	83	2	84	7	87	3	88	6	90	6	92	7	95	7	97	6	99	10	105	12	113	19
79	2	83	3	84	8	87	4	88	6	90	6	92	8	95	8	97	6	99	12	105	13	121	14
79	3	83	3	85	3	87	4	88	7	90	8	92	8	95	8	97	8	100	7	105	16		
79	4	83	3	85	4	87	4	88	8	90	9	92	9	95	8	97	8	100	8	106	11		
79	4	83	4	85	5	87	4	88	9	90	13	92	9	95	10	97	9	100	8	106	14		

Table 2.10m. Northeast Atlantic spurdog. Fecundity data for 2018, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 43.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
81	4	85	3	89	6	90	6	91	9	93	8	94	10	99	6	101	10
81	5	85	6	89	7	91	6	92	3	93	8	95	7	99	7	102	10
82	5	86	5	89	8	91	6	92	7	93	9	96	7	100	7	112	13
84	2	86	5	90	5	91	7	92	9	94	6	97	11	100	9		
84	6	87	6	90	6	91	8	93	5	94	9	99	2	100	11		

Table 2.10n. Northeast Atlantic spurdog. Fecundity data for 2019, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 25.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
88	5	95	5	98	6	102	15	105	13
89	9	95	6	100	9	102	15	105	15
90	8	96	6	101	11	103	13	106	13
93	10	97	8	101	14	105	12	108	18
95	2	97	13	102	10	105	12	109	17

Table 2.10o. Northeast Atlantic spurdog. Fecundity data for 2020, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 26.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
92	5	99	10	101	12	104	11	106	12	109	11
95	11	100	10	103	13	104	14	106	15		
97	9	100	12	104	4	105	13	107	12		
97	12	101	6	104	7	106	11	107	15		
99	8	101	11	104	8	106	11	109	8		

Table 2.10p. Northeast Atlantic spurdog. Fecundity data for 2023, given as length of pregnant female (l^f) and number of pups (P'). Total number of samples is 3.

l^f	P'
96	11
102	9
84	7

Table 2.11a. Northeast Atlantic spurdog. Estimates of key model parameters, with associated Hessian-based estimates of precision (CV expressed as a percentage) for the baseline assessment, and two sensitivity tests for alternative estimates for Q_{fec}.

	Q_{fec} = 3.030 Baseline assessment		Q_{fec} = 2.267		Q_{fec} = 3.758	
$N_0^{f,preg}$	71611	1.5%	87132	1.3%	61840	1.6%
Q_{fec}	3.030	1.8%	2.267	1.5%	3.758	1.6%
Q1 q_{sur}	0.0080	13%	0.0081	13%	0.0087	11%
Q3 q_{sur}	0.0077	13%	0.0077	14%	0.0085	11%
Q4 q_{sur}	0.0579	16%	0.0733	15%	0.0517	23%
B_{depl05}	0.575	13%	0.422	13%	0.635	11%
B_{depl55}	0.659	12%	0.514	13%	0.683	10%

Table 2.11b. Northeast Atlantic spurdog. Estimates of other estimates of interest for the baseline assessment, and two sensitivity tests for alternative estimates for Q_{fec}.

	Q_{fec} = 3.030 Baseline assessment	Q_{fec} = 2.267	Q_{fec} = 3.758
M_{pup}	0.516	0.658	0.406
a_{fec}	-6.010	-7.739	-4.892
b_{fec}	0.0969	0.1246	0.0790
B_{lim}	242493	296744	208538
MSY $B_{trigger}$	650770	714206	613950
B_{MSY}	853443	936635	805156
B_0	1212460	1483720	1042690
HR_{msy}	0.0427	0.0288	0.0547
HR_{pa}	0.0427	0.0288	0.0547
HR_{lim}	0.0667	0.0456	0.0841
MSY	27517	21399	31634
MSYR	0.0322	0.0228	0.0393
$-\ln L_{tot}$	5485	5508	5468

Table 2.12. Northeast Atlantic spurdog. Baseline assessment. Correlation matrix for some key estimable parameters for the base-case.

	lnNfpr	Sc1	Sc1	Sc1	Sc1	Sc2	Sc2	Sc2	Sc2	Sc3	Sc3	Sc3	Sc3	Ss1	Ss1	Ss1	Ss2	Ss2	Ss2	Ss3	Ss3	Ss3	Ss4	Ss4	Ss4	Qfec	epsRy	epsRy	epsRy	epsRy	epsRy	qsur	qsur	qsur
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	71	72	73	74	75	560	561	562
1 lnNfpreg0	1																																	
2 Sc1	-0.18	1																																
3 Sc1	-0.03	0.01	1																															
4 Sc1	-0.05	0.00	0.00	1																														
5 Sc1	-0.01	0.00	0.00	0.01	1																													
6 Sc2	-0.49	0.36	0.02	0.00	0.00	1																												
7 Sc2	-0.23	0.03	0.08	0.01	0.00	0.08	1																											
8 Sc2	-0.05	0.00	0.00	0.75	0.01	0.00	0.005	1																										
9 Sc2	-0.04	0.00	0.00	0.04	0.07	0.00	0.00	0.05	1.00																									
10 Sc3	-0.60	0.38	0.02	0.01	0.00	0.85	0.11	0.00	0.00	1																								
11 Sc3	-0.47	0.09	0.10	0.01	0.00	0.22	0.53	0.01	0.01	0.27	1																							
12 Sc3	-0.04	0.01	0.00	0.76	0.01	0.01	0.01	0.75	0.03	0.02	0.02	1																						
13 Sc3	-0.05	0.01	0.00	0.05	0.11	0.02	0.01	0.06	0.39	0.02	0.03	0.06	1																					
14 Ss1	0.10	-0.03	0.00	0.00	0.00	-0.07	-0.04	0.00	0.00	-0.08	-0.07	-0.01	-0.01	1																				
15 Ss1	0.02	-0.01	0.00	0.01	0.00	-0.02	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	0.02	1																			
16 Ss1	0.08	-0.04	-0.01	0.02	0.00	-0.10	-0.05	0.02	0.02	-0.10	-0.07	0.02	0.03	0.03	0.01	1																		
17 Ss2	0.10	-0.03	-0.01	0.01	0.00	-0.09	-0.05	0.01	0.01	-0.09	-0.07	-0.01	-0.01	0.65	0.01	0.04	1																	
18 Ss2	0.01	-0.01	0.00	0.02	0.01	-0.02	-0.01	0.00	0.00	-0.02	-0.01	-0.01	-0.02	0.02	0.26	0.00	0.02	1																
19 Ss2	0.10	-0.05	-0.01	0.03	0.01	-0.13	-0.07	0.04	0.04	-0.13	-0.09	0.03	0.05	0.04	0.01	0.64	0.05	-0.01	1															
20 Ss3	0.05	-0.02	0.00	0.02	0.01	-0.06	-0.04	0.02	0.02	-0.06	-0.05	0.00	0.00	0.58	0.00	0.03	0.74	0.01	0.05	1														
21 Ss3	-0.01	-0.01	0.00	0.02	0.01	-0.01	-0.01	0.02	0.01	-0.01	-0.01	-0.01	-0.02	0.01	0.24	-0.02	0.02	0.36	-0.02	0.02	1													
22 Ss3	0.12	-0.05	-0.01	0.03	0.00	-0.15	-0.08	0.04	0.04	-0.14	-0.10	0.04	0.06	0.03	0.01	0.63	0.05	-0.01	0.81	0.05	-0.04	1												
23 Ss4	0.08	-0.01	0.00	-0.02	0.00	-0.04	-0.02	-0.02	-0.01	-0.04	-0.03	-0.02	-0.02	0.46	0.00	0.01	0.59	0.00	0.01	0.51	0.00	0.01	1											
24 Ss4	0.04	-0.01	0.00	-0.01	0.00	-0.02	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.02	0.01	0.23	0.01	0.01	0.32	0.01	0.01	0.31	0.01	0.01	1										
25 Ss4	0.12	-0.05	-0.01	-0.01	0.00	-0.12	-0.07	-0.02	-0.01	-0.13	-0.11	-0.03	-0.03	0.02	0.00	0.43	0.02	0.02	0.57	0.01	0.03	0.53	0.01	0.00	1									
26 Qfec	-0.73	0.06	0.01	0.07	0.02	0.18	0.14	0.08	0.06	0.21	0.21	0.05	0.07	-0.10	-0.02	-0.04	-0.09	0.00	-0.04	-0.03	0.02	-0.06	-0.09	-0.04	-0.08	1								
71 epsRy	0.01	0.00	0.00	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.06	0.02	0.01	0.01	-0.03	0.00	0.00	0.00	-0.02	1							
72 epsRy	0.02	0.00	0.00	-0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.11	0.02	0.01	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.09	1						
73 epsRy	0.01	0.00	0.00	-0.03	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.07	-0.05	-0.01	-0.01	-0.10	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	-0.02	-0.06	-0.13	1					
74 epsRy	0.01	0.00	0.00	-0.03	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.17	-0.03	-0.01	-0.03	-0.02	0.00	0.00	0.01	0.00	0.00	-0.01	-0.01	0.00	-0.07	-0.06	1				
75 epsRy	0.00	0.00	0.00	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.07	-0.06	0.00	-0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.03	1			
560 qsur	0.39	-0.02	-0.01	-0.04	-0.01	-0.08	-0.10	-0.04	-0.03	-0.09	-0.13	-0.04	-0.05	0.27	0.01	0.03	0.51	0.02	0.04	0.13	0.01	0.04	-0.02	0.04	0.06	-0.63	-0.02	-0.02	-0.02	-0.03	0.00	1		
561 qsur	0.34	0.01	0.00	-0.06	-0.02	0.00	-0.06	-0.06	-0.05	-0.01	-0.06	-0.03	-0.03	0.06	-0.19	0.01	0.05	-0.31	0.00	0.00	-0.39	0.01	0.07	-0.57	0.05	-0.65	-0.01	0.00	0.01	0.02	0.02	0.55	1	
562 qsur	0.41	-0.03	-0.01	-0.01	-0.01	-0.12	-0.11	-0.01	0.00	-0.13	-0.14	0.01	0.03	0.09	0.01	0.25	0.10	-0.02	0.28	0.05	-0.06	0.55	0.07	0.04	-0.08	-0.61	-0.05	-0.04	-0.03	0.01	0.02	0.51	0.51	1

Table 2.13. Northeast Atlantic spurdog. Baseline assessment. Summary table of estimates: recruitment (thousands of pups), total biomass (t) and fishing proportion or harvest rate (with selectivity averaged over ages 5–30); and WG estimates of catch (t) used in the assessment. The final recruitment value is taken directly from the estimated stock-recruit relationship.

	R (thousand pups)	B_{tot} (t)	Catch (t)	HR (5–30)
1980	137574	502041	40968	0.1329
1981	119714	486801	39962	0.1333
1982	110190	471468	32402	0.1133
1983	105315	462391	37046	0.1330
1984	107084	447510	35194	0.1316
1985	99019	432778	38674	0.1470
1986	94850	413030	30910	0.1194
1987	99424	400140	42356	0.1692
1988	72104	373321	35569	0.1504
1989	74044	352407	30279	0.1320
1990	79816	336303	29906	0.1360
1991	94583	320906	29563	0.1395
1992	84924	305147	29046	0.1403
1993	80109	289374	25637	0.1342
1994	64592	275974	20851	0.1164
1995	92163	268827	21318	0.1177
1996	65305	259941	17295	0.0989
1997	67343	254918	15348	0.0896
1998	68755	251647	13919	0.0820
1999	72639	249763	12385	0.0740
2000	73475	249325	15891	0.0944
2001	64146	244596	16693	0.1015
2002	69103	239117	11170	0.0712
2003	69663	239102	12247	0.0770
2004	71152	238010	9366	0.0585
2005	74979	239953	7112	0.0406
2006	65501	243488	4018	0.0217
2007	69027	250023	2926	0.0153
2008	92610	258812	1837	0.0093
2009	124999	270839	2064	0.0098
2010	87119	281070	2409	0.0119
2011	140205	294209	3024	0.0150
2012	127149	307173	5204	0.0251
2013	115896	318351	3270	0.0150
2014	131987	333289	3295	0.0147
2015	234387	355412	3273	0.0141
2016	638464	405548	1951	0.0074

	R (thousand pups)	B_{tot} (t)	Catch (t)	HR (5–30)
2017	188261	440221	5076	0.0202
2018	155248	471205	2733	0.0101
2019	166258	506880	3621	0.0128
2020	199181	545789	1468	0.0043
2021	194165	588458	1178	0.0031
2022	205581	630167	1441	0.0038
2023	159888	666555	4208	0.0092
2024	157684	696838		

Table 2.14. Northeast Atlantic spurdog. Baseline assessment. Assessment projections under different future catch options. Estimates of begin-year total biomass relative to the total biomass in 2024 are shown, assuming that the catch in 2024 is 4720 tonnes (status quo HR). Point estimates are given in the upper third of the table with corresponding lower and upper values (reflecting ±2 standard deviations) given in the middle and bottom third of the table. The "+x yrs" in the first column is relative to 2024 (so "+3 yrs" indicates 2027).

	Medium-term projections				
	HRmsy	zero	HRsq	HRpa	HRlim
average catch*	24550	0	7527	30558	31007
Point estimates					
+ 3 yrs	1.06	1.12	1.11	1.02	1.02
+ 5 yrs	1.07	1.20	1.17	1.00	1.00
+ 10 yrs	1.08	1.37	1.30	0.95	0.94
+ 30 yrs	1.15	1.82	1.69	0.82	0.79
Point estimates -2 standard deviations					
+ 3 yrs	1.04	1.10	1.09	1.00	1.00
+ 5 yrs	1.03	1.16	1.13	0.96	0.96
+ 10 yrs	1.00	1.29	1.23	0.87	0.86
+ 30 yrs	0.97	1.36	1.37	0.68	0.66
Point estimates +2 standard deviations					
+ 3 yrs	1.08	1.14	1.13	1.05	1.04
+ 5 yrs	1.11	1.23	1.20	1.05	1.04
+ 10 yrs	1.16	1.46	1.37	1.03	1.01
+ 30 yrs	1.34	2.27	2.02	0.96	0.93

*** "average catch" is the average for the projection period 2025–2053**

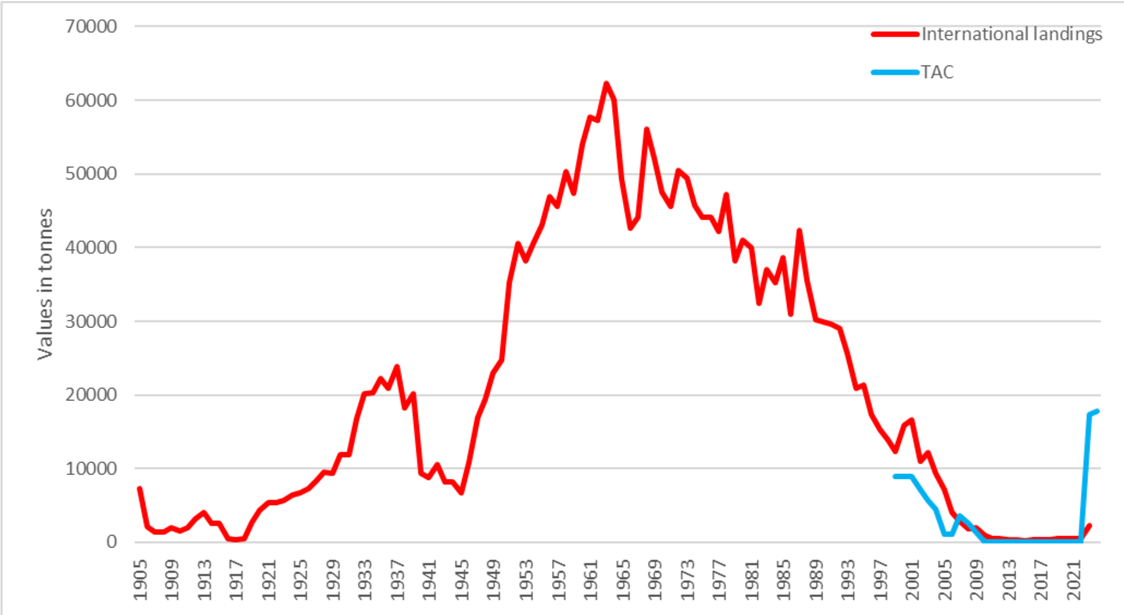
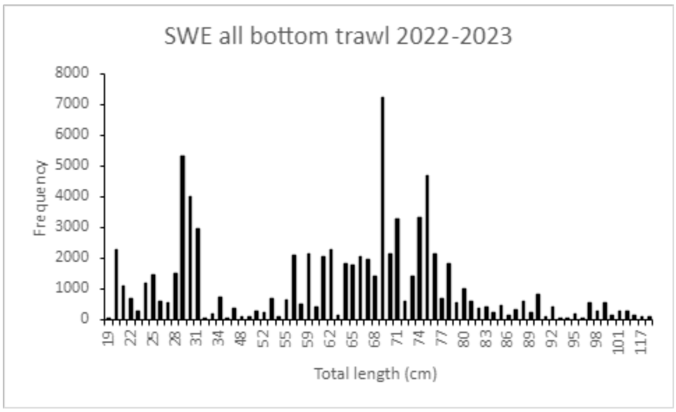
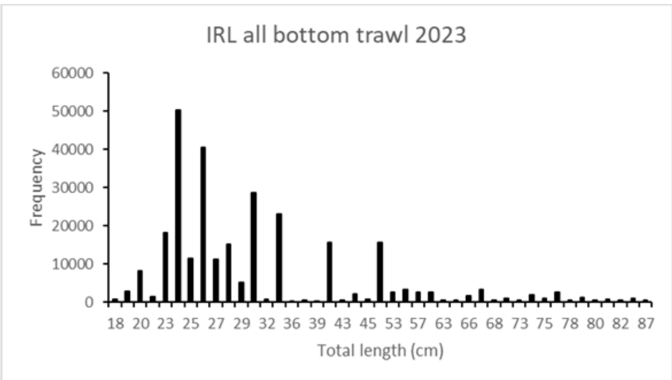
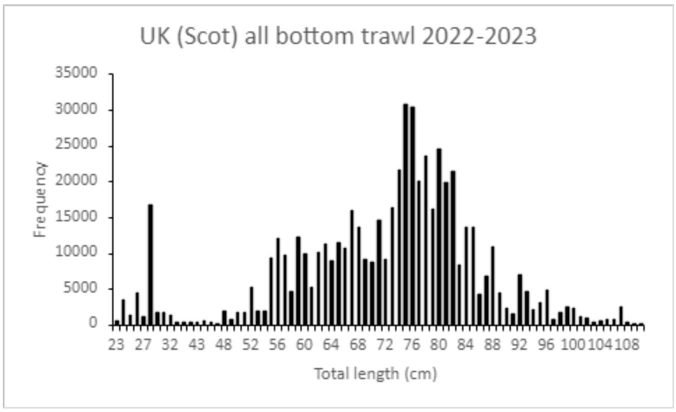
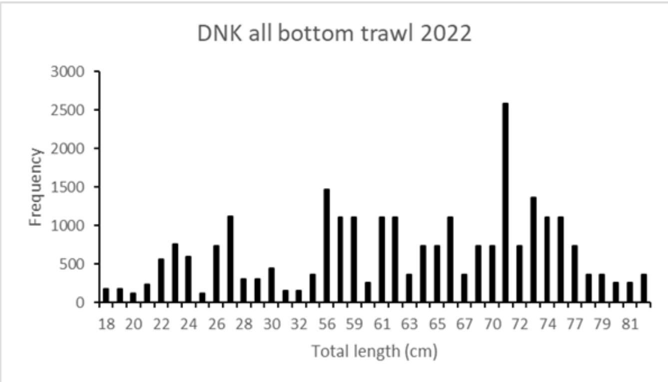


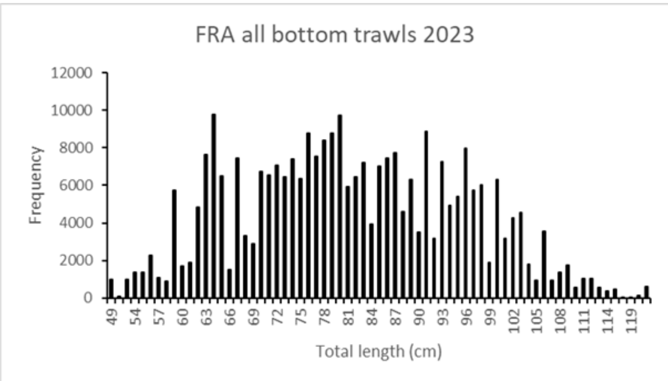
Figure 2.1. Northeast Atlantic spurdog. WG estimates of total international landings of NE Atlantic spurdog (1905–2023, red line) and TAC (blue line). Restrictive management (e.g. through quotas and other measures) is only thought to have occurred since 2007.

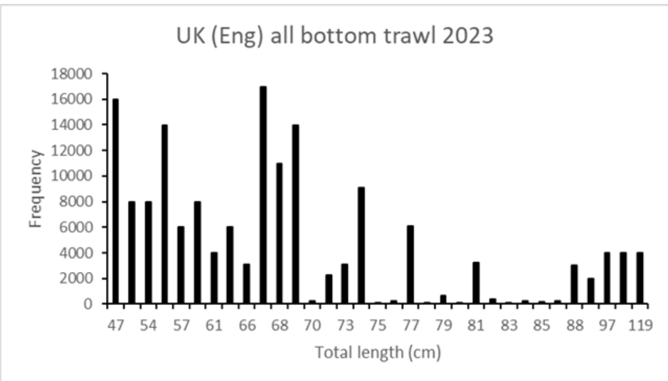





UK (Scot) all bottom trawl 2022-2023
Frequency
Total length (cm)


DNK all bottom trawl 2022
Frequency
Total length (cm)


FRA all bottom trawls 2023
Frequency
Total length (cm)


UK (Eng) all bottom trawl 2023
Frequency
Total length (cm)

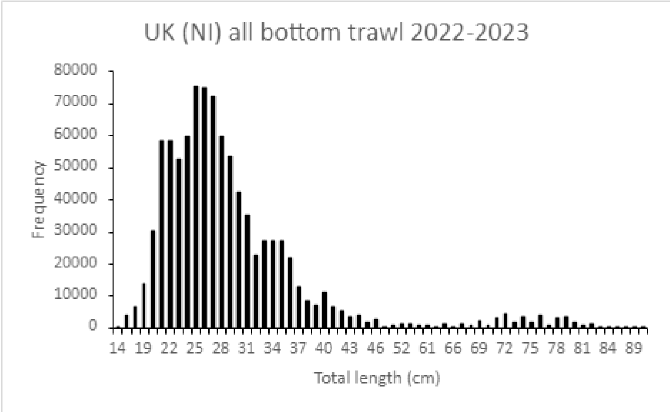


Figure 2.2a. Northeast Atlantic spurdog catches, 2022-2023. Length frequency information by country used as a basis for compiling the proportion by length category data for the "all bottom trawls" gear category.

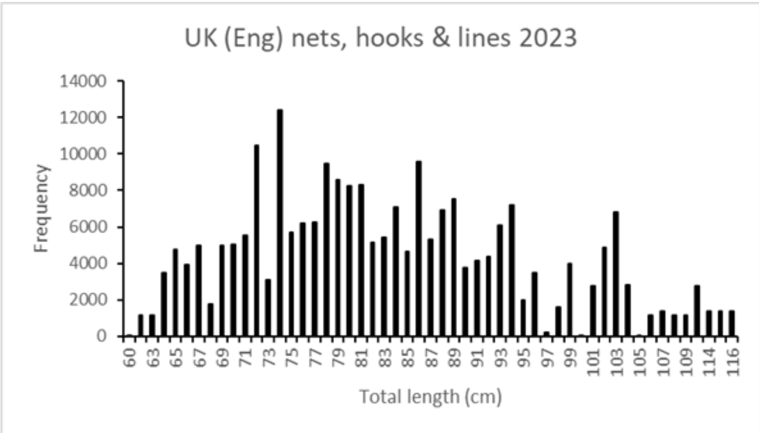


Figure 2.2b. Northeast Atlantic spurdog catches. Length frequency information for UK (England) 2023 used as a basis for compiling the proportion by length category data for the "nets, hooks & lines" gear category. These data were simply combined with equal weighting.

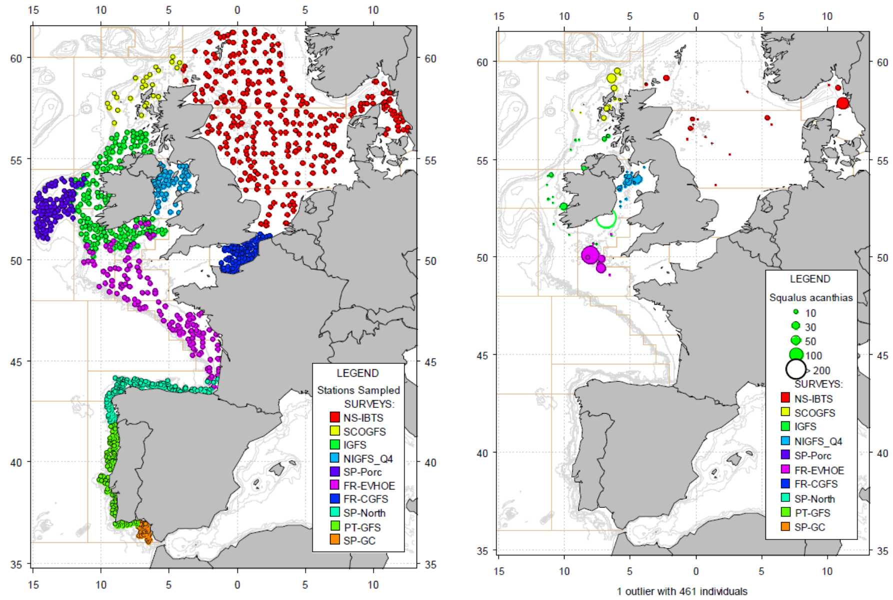


Figure 2.3. Northeast Atlantic spurdog. Overall spatial coverage of the IBTS (left) all surveys combined and (right) captures of spurdog (number per hour, bottom) as reported in the 2013 summer/autumn IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore, the map does not reflect proportional abundance in all the areas but within each survey (From ICES, 2014).

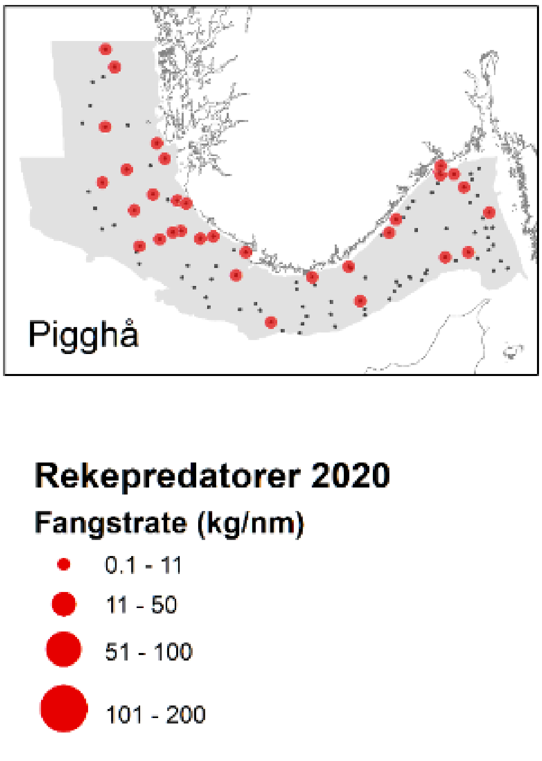


Figure 2.4. Northeast Atlantic spurdog. Map of survey area on Norwegian south coast (Norwegian Deep and Skagerrak) with stations for 2020 for the Shrimp ("Reke") survey Red circles indicate catches of spurdog ("pigghå"; circle area is proportional to catch rate, that is kg per nautical mile. Source: Søvik G and Thangstad TH. 2021.

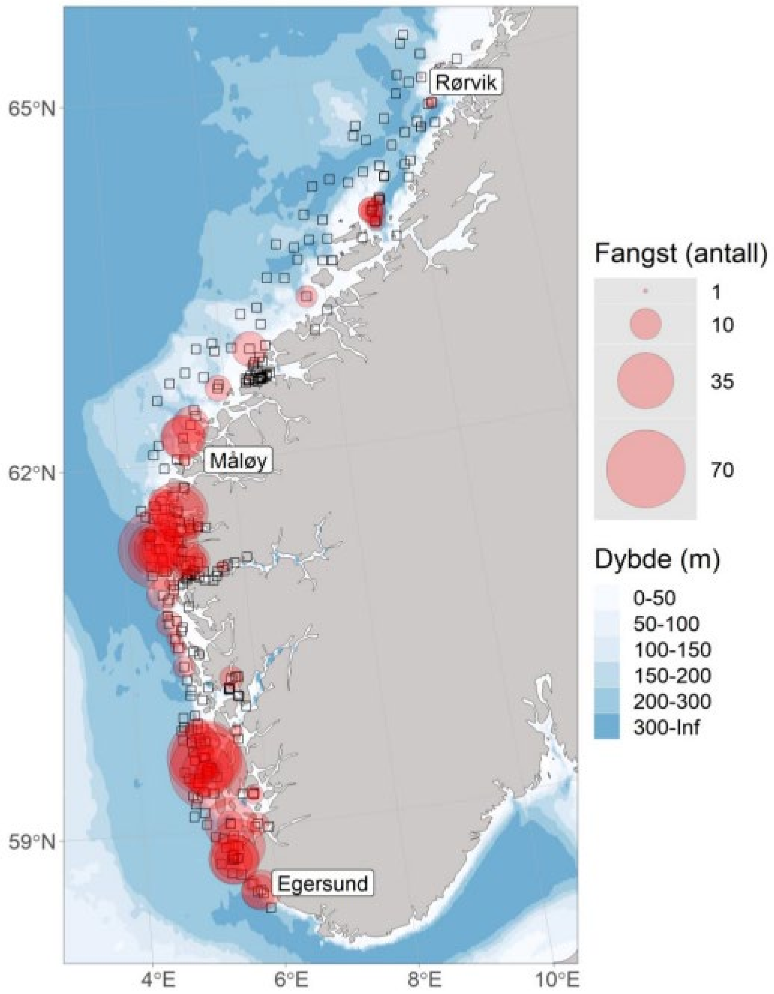


Figure 2.5. North East Atlantic spurdog. Survey coverage and spurdog catches in the 2021 Norwegian longline spurdog survey. Black squares are stations, red bubbles are spurdog catches with the area representing number of individuals caught per station.

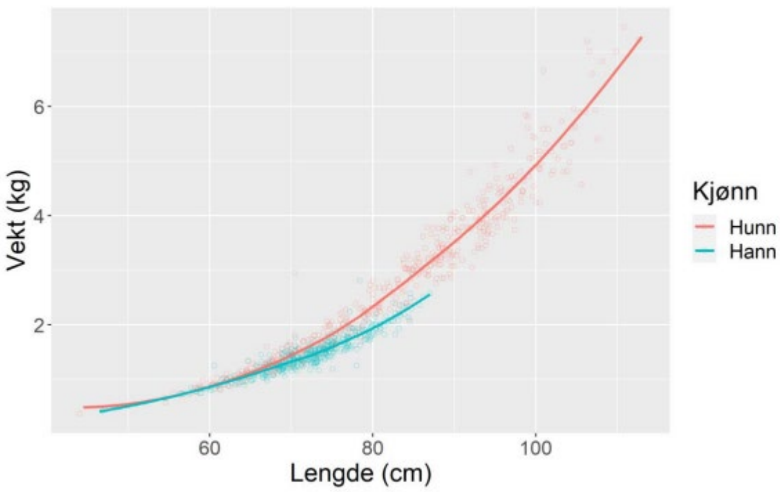


Figure 2.6. North East Atlantic Spurdog. The length-weight relationship of spurdog caught in the 2021 Norwegian longline spurdog survey. Red line is females, blue line is males.

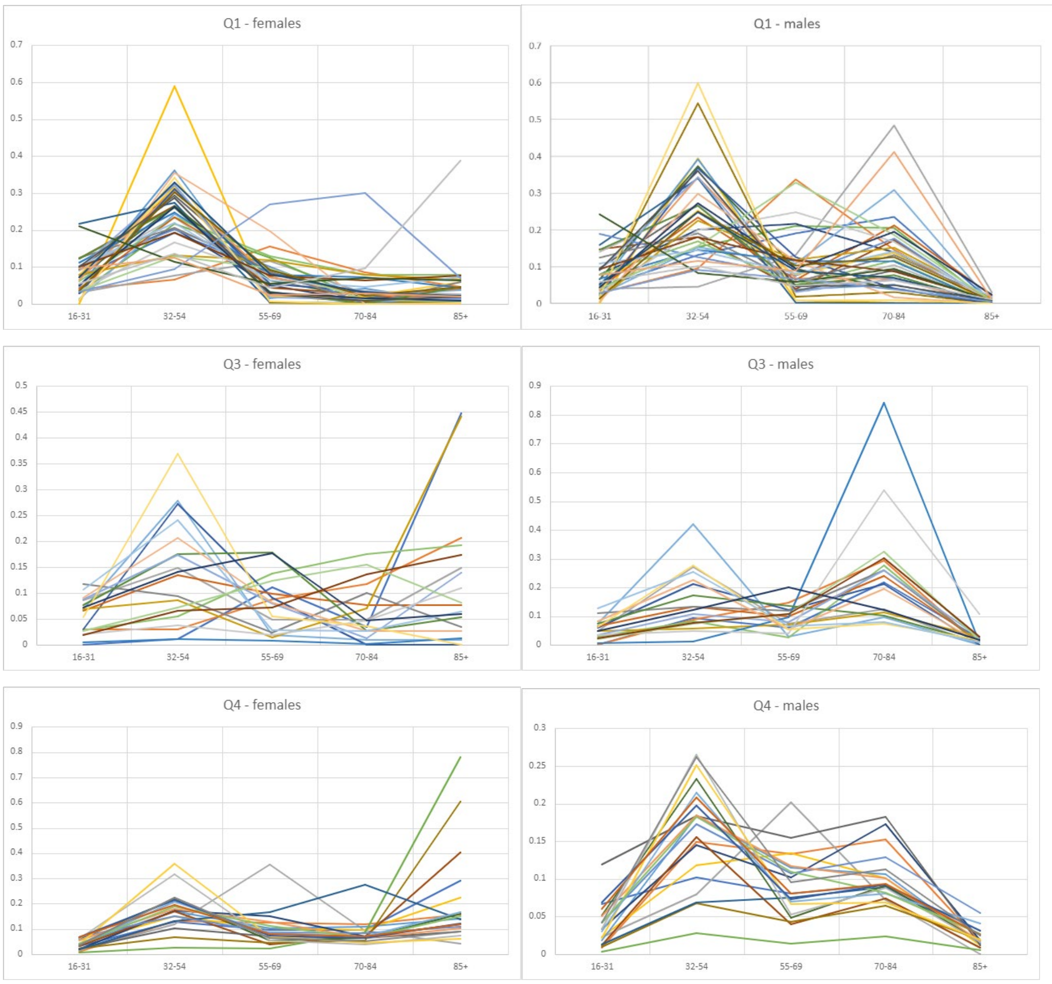
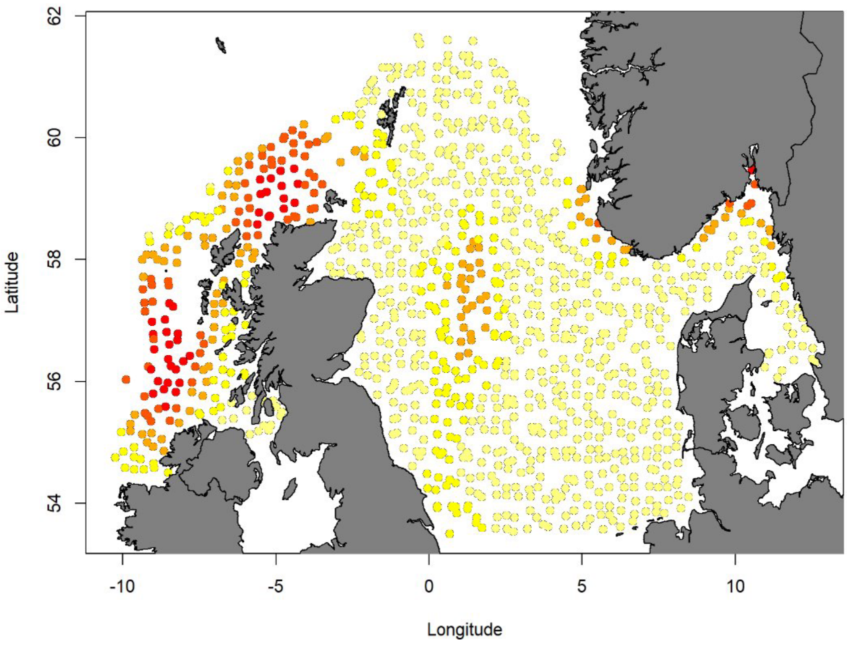


Figure 2.7. Northeast Atlantic spurdog. Proportions by length-category for three combined survey indices (top row: Q1 1985-2023, middle row: Q3 1992-1994, 2008-2023, and bottom row: Q4 2003-2023) for females (left) and males (right).



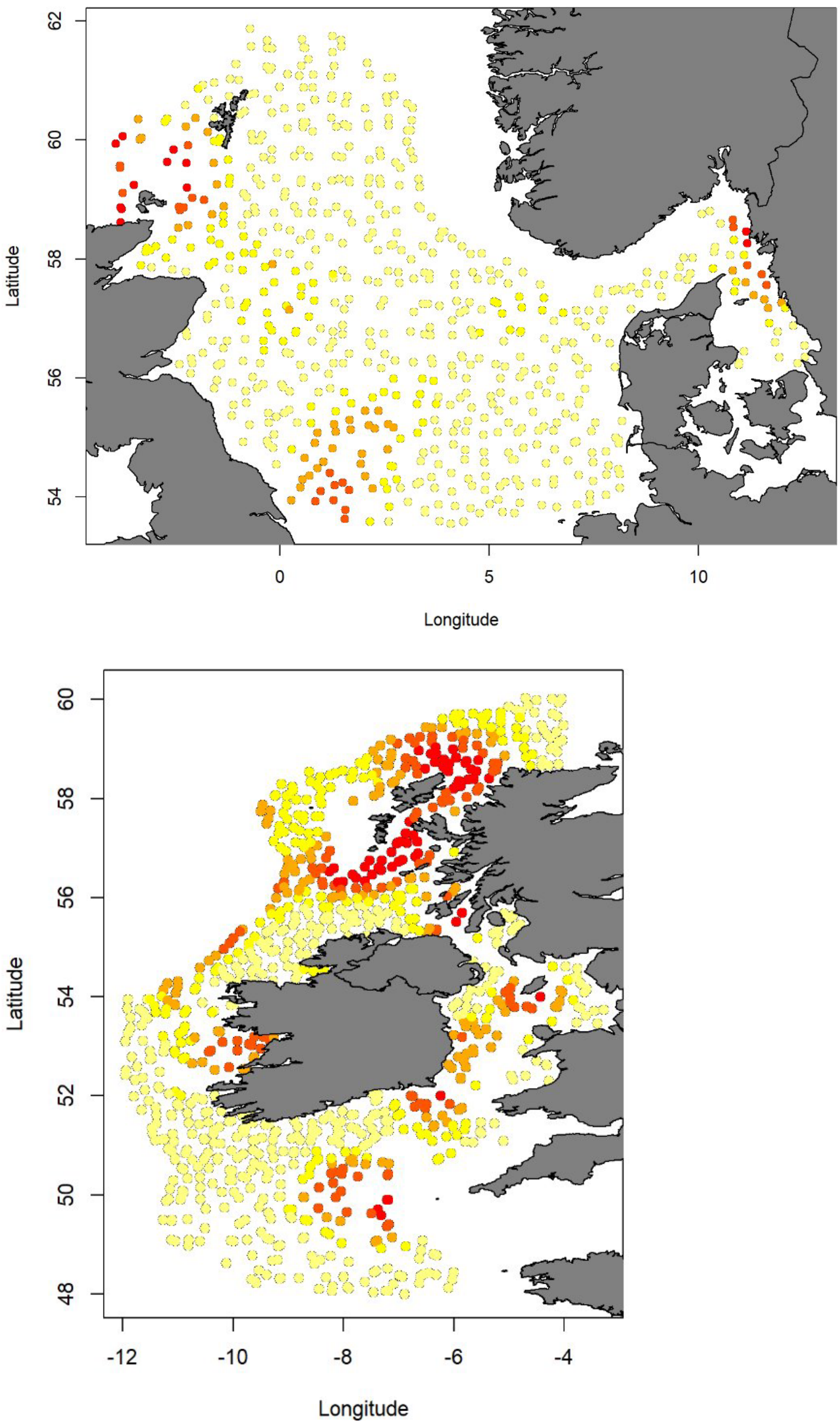


Figure 2.8. Northeast Atlantic spurdog. Modelled survey biomass maps (top-Q1, middle-Q3, bottom-Q4), where the biomass is predicted within each grid cell at the haul nearest to the centroid of the cell, using spatial effect from the respective delta-lognormal modelling approach.

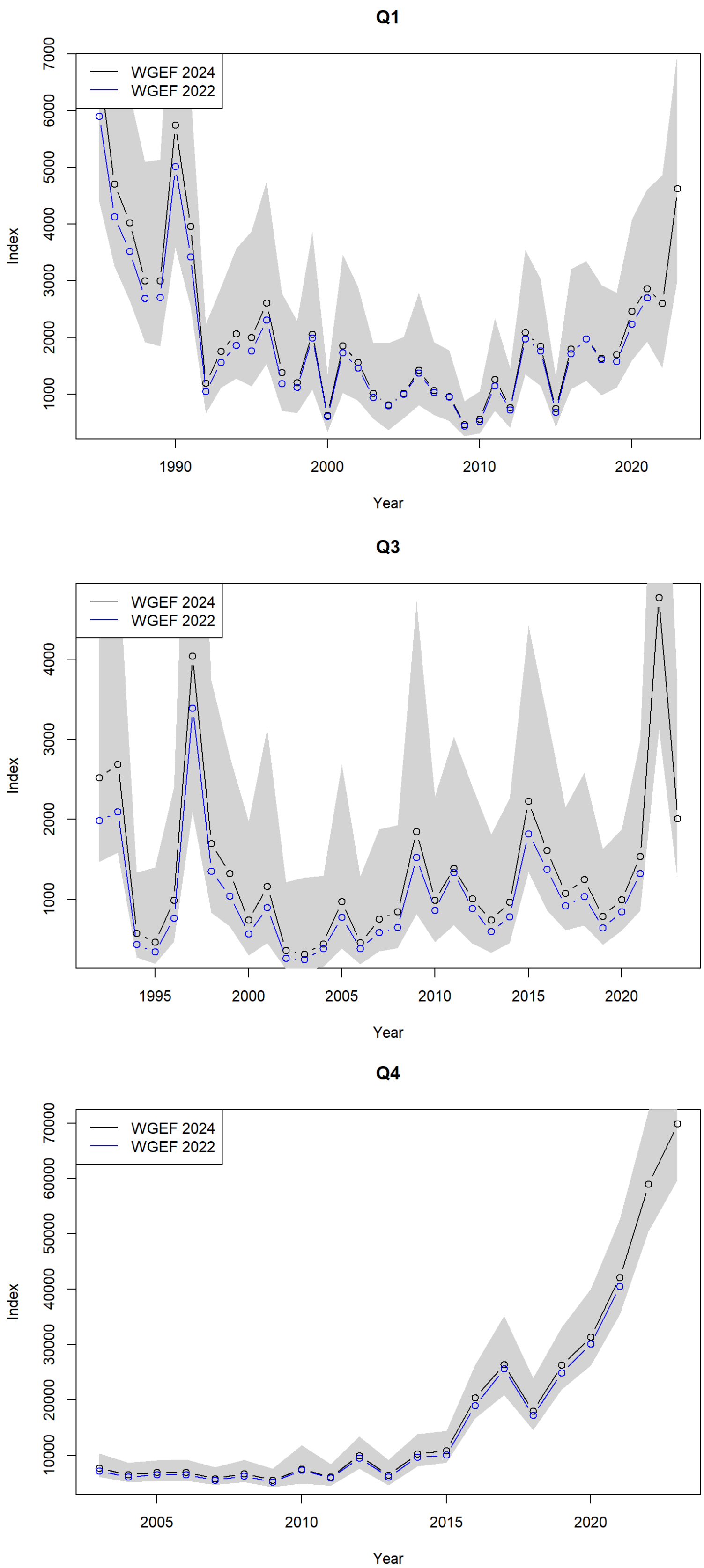


Figure 2.9. Northeast Atlantic spurdog. Indices of biomass with 95% confidence bounds for the three combined survey indices (top-Q1, middle-Q3, bottom-Q4) estimated using a delta-lognormal modelling approach. In blue, for comparison, survey indices estimated during WGEF 2022.

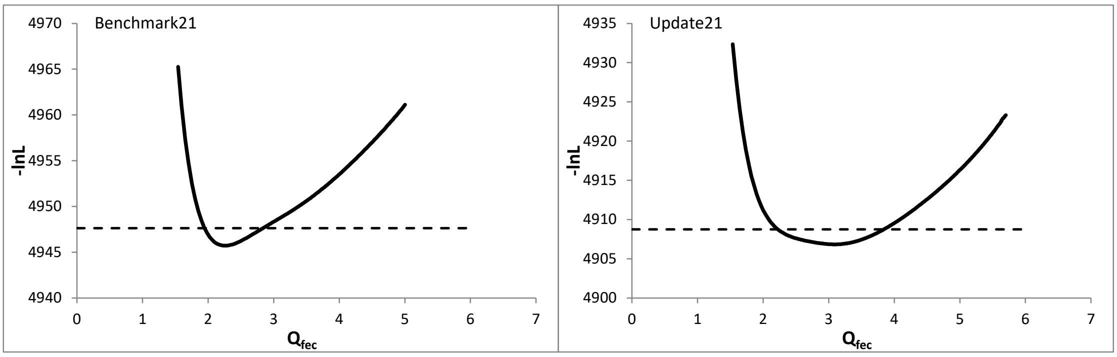


Figure 2.10. Northeast Atlantic spurdog. Comparison of the likelihood profile on Q_{fec} from the 2021 benchmark (left) and including corrections and updates for input data and infilling of missing discard data (right).

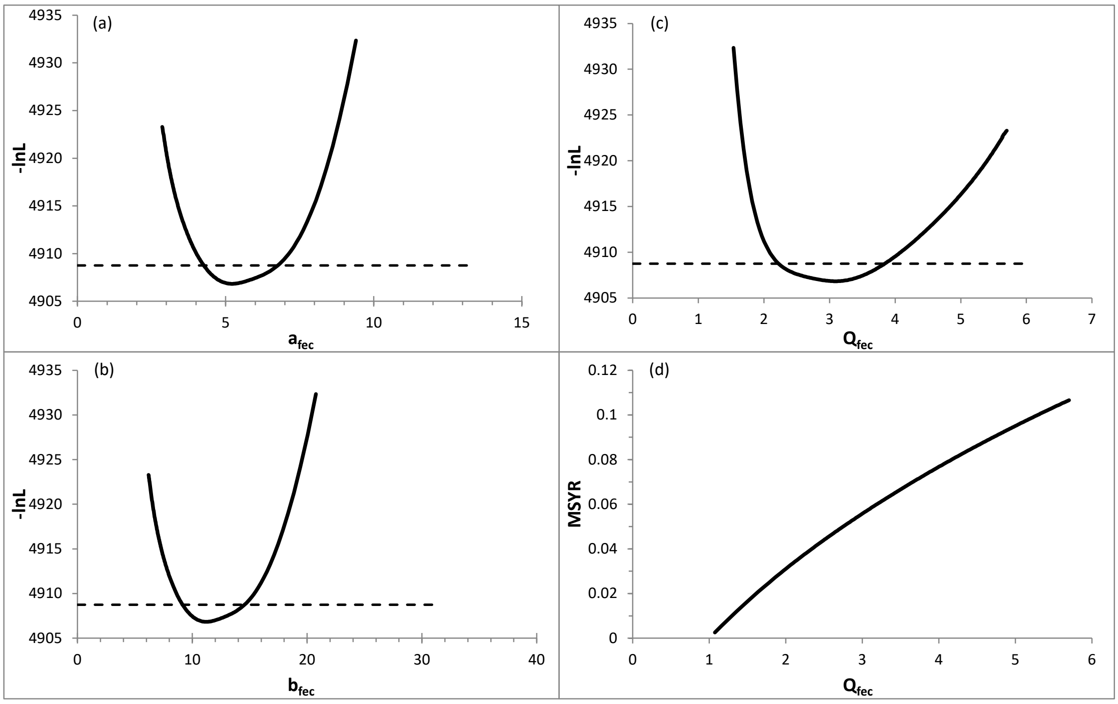


Figure 2.11. Northeast Atlantic spurdog. "Update21" assessment negative log-likelihood (-ln*L*) for a range of (a) a_{fec} and (b) b_{fec} values, with (c) corresponding Q_{fec}. Plot (d) shows MSYR (MSY/B_{MSY}) vs. Q_{fec}. Using the likelihood ratio criterion, the hashed line in plots (a)–(c) indicate the minimum –ln*L* value + 1.92, corresponding to 95% probability intervals for the corresponding parameters for values below the line. Plot (c) is identical to the plot on the right of Figure 2.20.

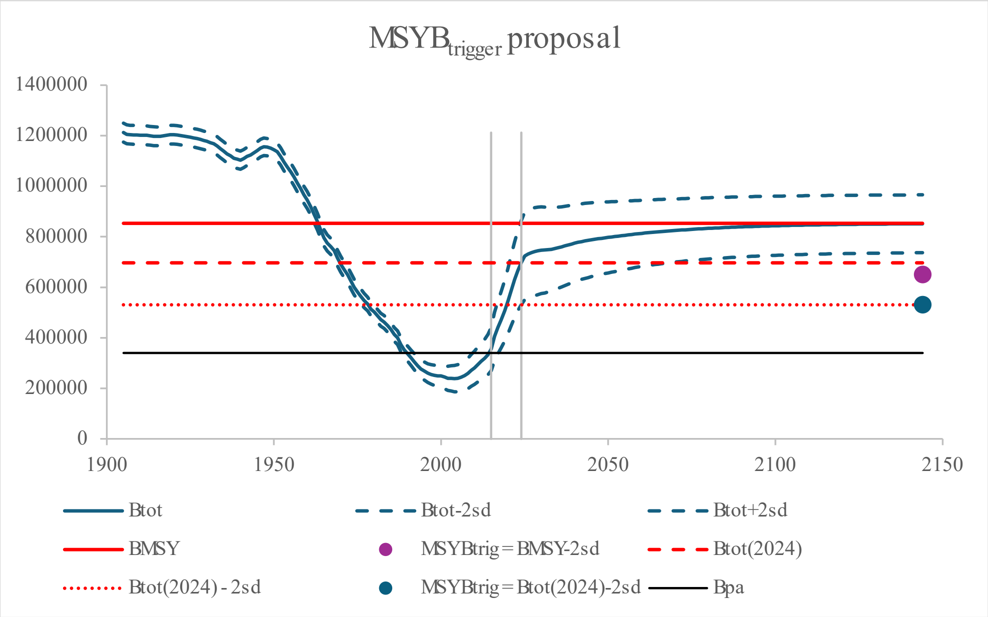


Figure 2.12a. Northeast Atlantic spurdog. Long-term projection (120 years) when fishing at HR_{MSY}. The solid blue line and hashed lines either side of it reflect total biomass (B_{tot}) and ±2 standard deviations, given in tonnes. The solid horizontal red line indicates B_{MSY}, the hashed horizontal red line the value of B_{tot} in 2024, the dotted horizontal red line, the value of B_{tot} in 2024 less 2 standard deviations, and the solid horizontal black line B_{pa}. The two vertical grey lines indicate the final 10 years of the assessment estimates of B_{tot} (2015-2024), and is the period used for the calculation of the "observed CV" (i.e. this estimate of the CV reflects real data; value for the 2024 assessment of 11.9%). The purple dot (the higher of the large two dots) is the WGEF-preferred estimate of MSY $B_{trigger}$, and is B_{MSY} less 2 standard deviations, where the standard deviations are based on the afore-mentioned "observed CV". The blue dot (the lower of the large two dots) is an alternative calculation of MSY $B_{trigger}$, based on the 2024 estimate of B_{tot} less 2 standard deviations.

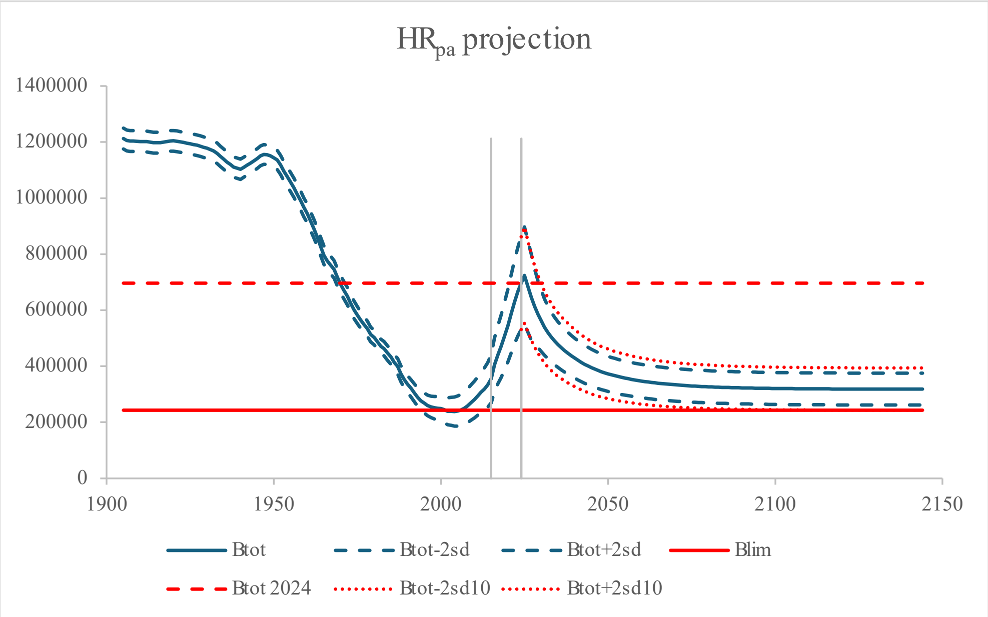


Figure 2.12b. Northeast Atlantic spurdog. Long-term projection (120 years) when fishing at HR_{pa} with ICES Advice Rule. The solid blue line and hashed blue lines either side of it reflect total biomass (B_{tot}) ±2 standard deviations, given in tonnes. The solid horizontal red line indicates B_{lim} and the hashed horizontal red line the value of B_{tot} in 2024. The dotted red lines on either side of B_{tot} in the projection period (to the right of the second vertical grey line) indicate B_{tot} ±2 standard deviations, where the standard deviations are based on the "observed CV" (11.9%; see Figure 3 caption for explanation of this and vertical grey lines). The projection aims to find the HR that leads to the bottom red dotted line (B_{tot} less 2 standard deviations based on the "observed CV") coinciding with the solid horizontal red line (B_{lim}) at the end of the projection period.

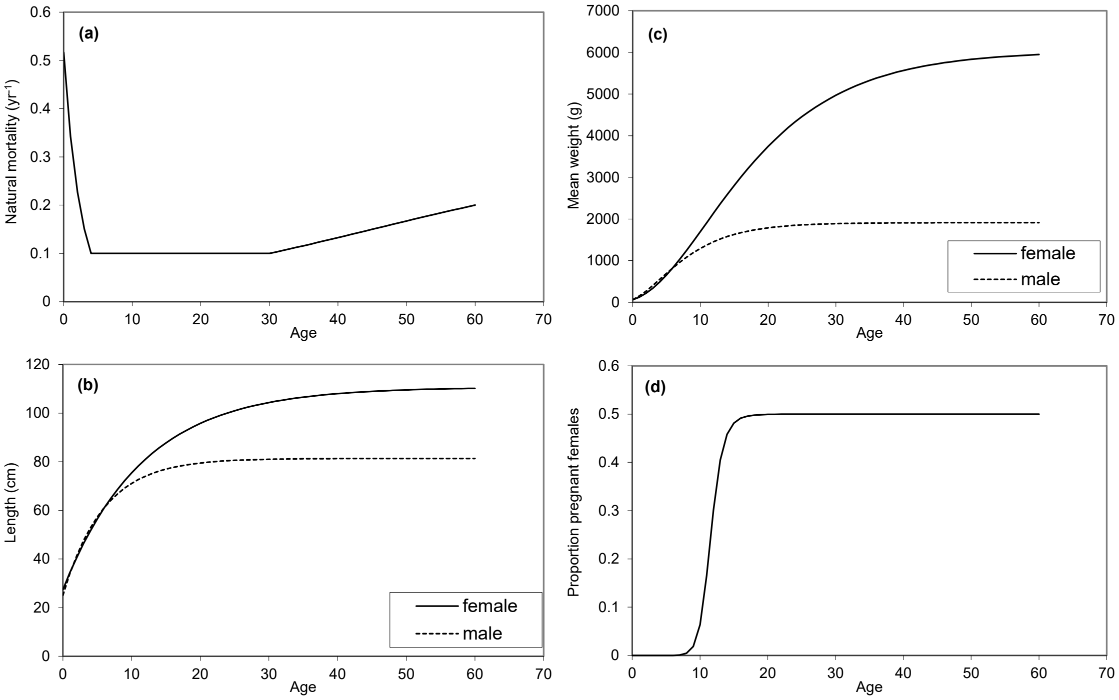


Figure 2.13. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.5. [Note, the value of natural mortality-at-age 0 is a parameter derived from the assessment.]

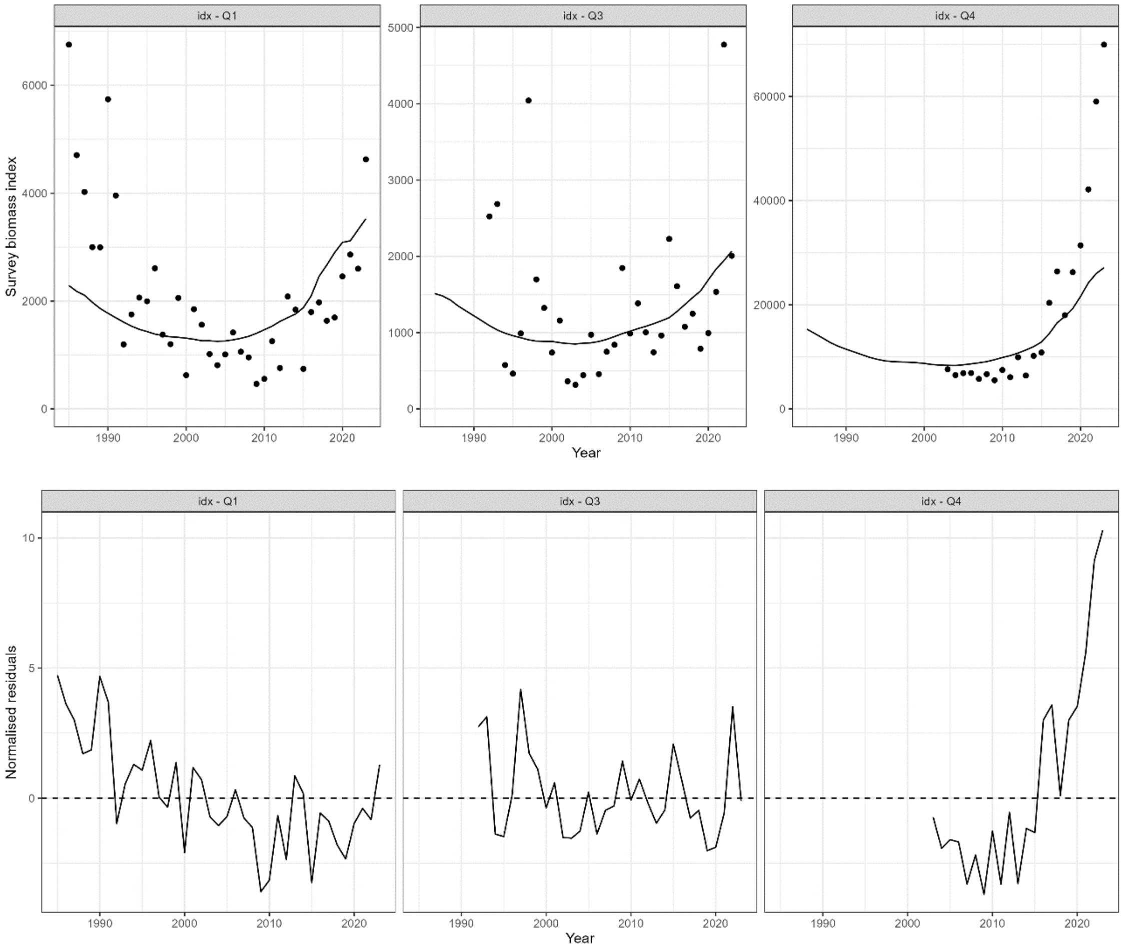
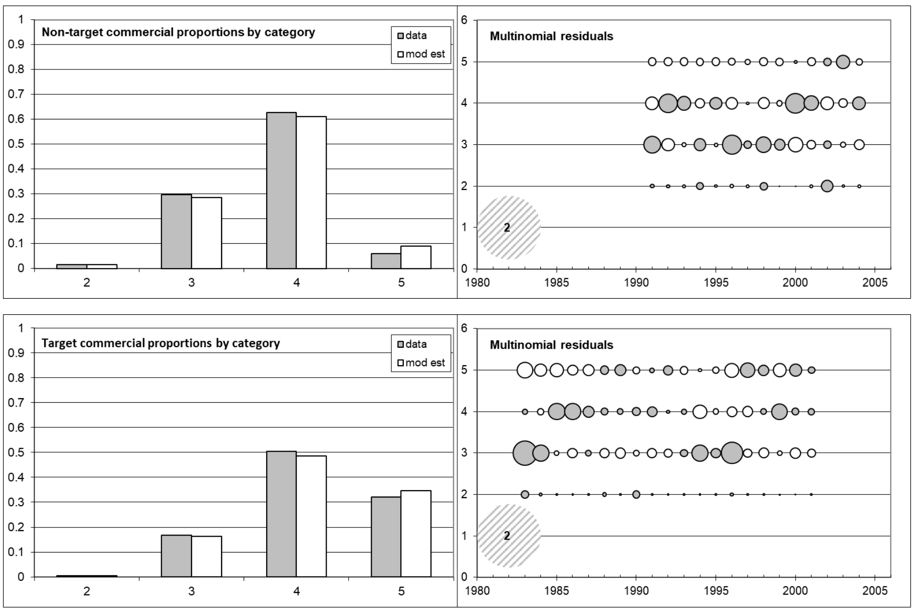


Figure 2.14. Northeast Atlantic spurdog. Baseline assessment. Model fits to the three surveys indices (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in Stock Annex equation 9b) (bottom).



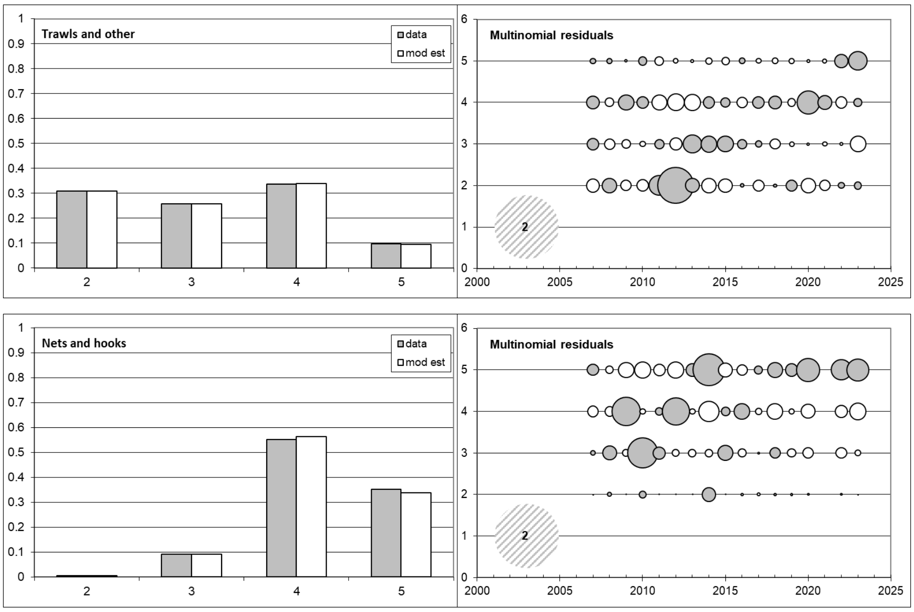
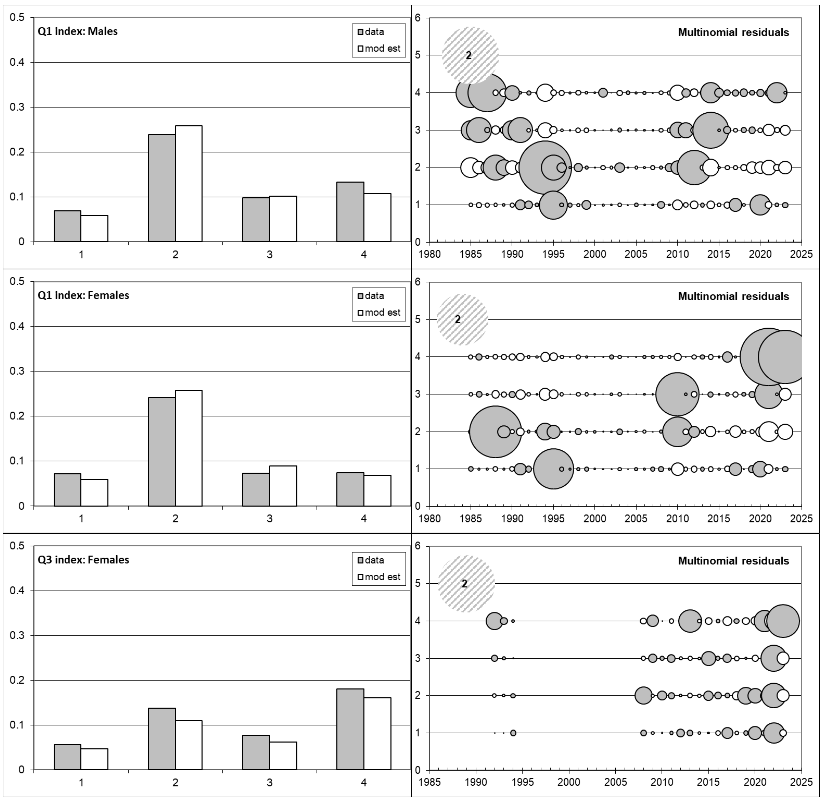


Figure 2.15. Northeast Atlantic spurdog. Baseline assessment. Model fits (bar plots, left) and associated residuals (bubble plots, right) for the four commercial fleets. The bar plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The bubble plots show multinomial residuals ($\varepsilon_{pcom,j,y,L}$ in Stock Annex equation 10b), with grey bubbles indicating positive residuals, bubble area being proportional to the size of the residual (see legend for reference), and length category indicated on the vertical axis. The length categories considered are, for the commercial data, 2: 16–54 cm; 3: 55–69 cm; 4: 70–84 cm; 5: 85+ cm.



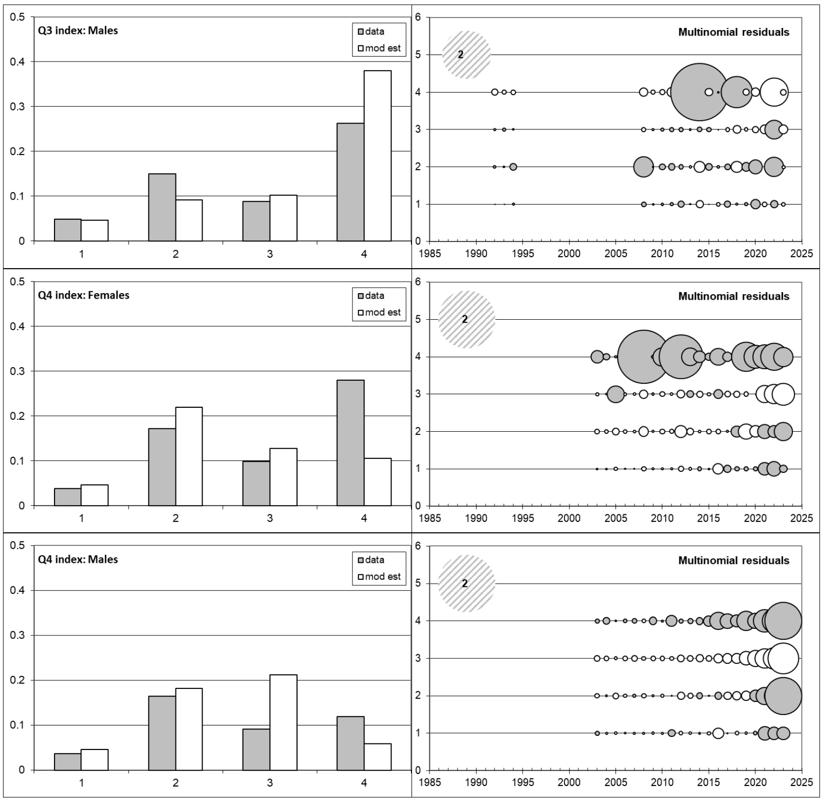
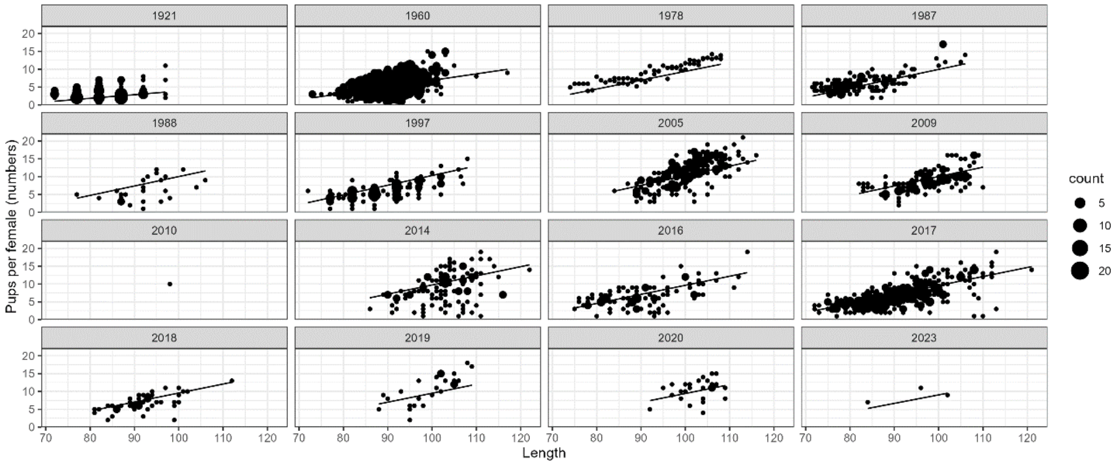


Figure 2.16. Northeast Atlantic spurdog. Baseline assessment. Model fits (bar plots) and associated residuals (bubble plots) for three survey indices by sex. The bar plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The bubble plots show multinomial residuals ($\varepsilon_{pcom,j,y,L}$ in Stock Annex equation 10b), with grey bubbles indicating positive residuals, bubble area being proportional to the size of the residual (see legend for reference), and length category indicated on the vertical axis. The length categories considered are for the surveys, 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70+ cm.

A) Fits to fecundity data



B) Normalised residuals

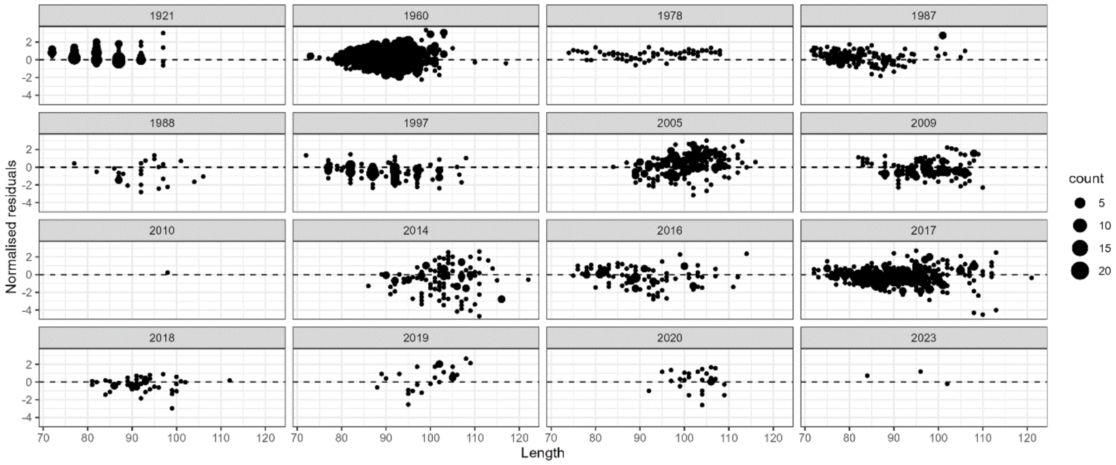


Figure 2.17. Northeast Atlantic spurdog. Baseline assessment. Fit to fecundity data from several periods (a), with associated normalised residuals ($\varepsilon_{fec,k,y}$ in Stock Annex equation 11b) (b). For (a), the black lines reflect the model estimates for the given points. For all plots, the diameter of each point is proportional to $\sqrt{n}$, where *n* is the number of samples with the same number of pups for a given length.

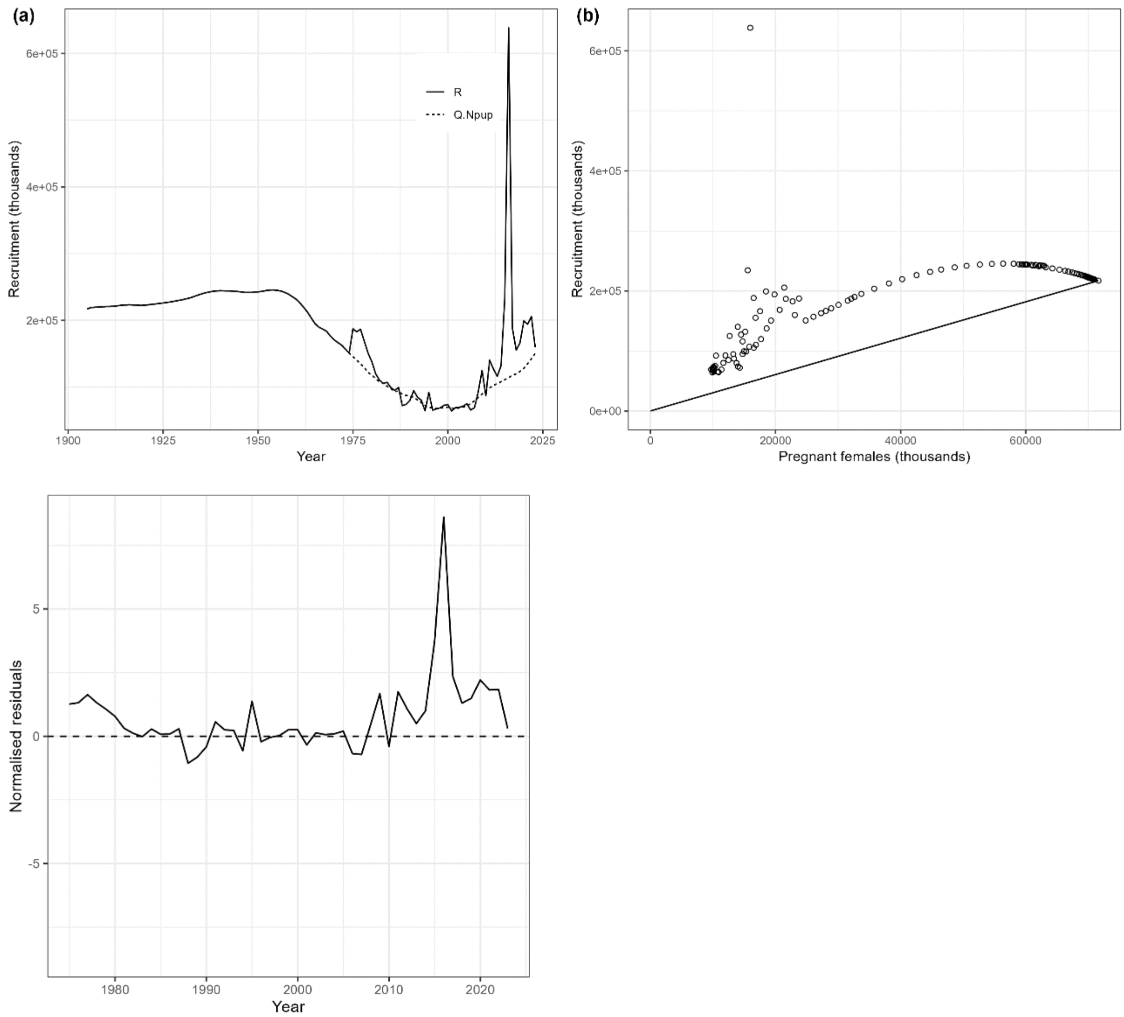


Figure 2.18. Northeast Atlantic spurdog. Baseline assessment. (a) A comparison of the deterministic (N_{pup}) and stochastic (R) versions of recruitment (Stock Annex equations 2a–c) with (c) normalised residuals ($\varepsilon_{r,y}/\varepsilon_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model); and (b) a plot of recruitment (R) vs. number of pregnant females (in thousands; open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).

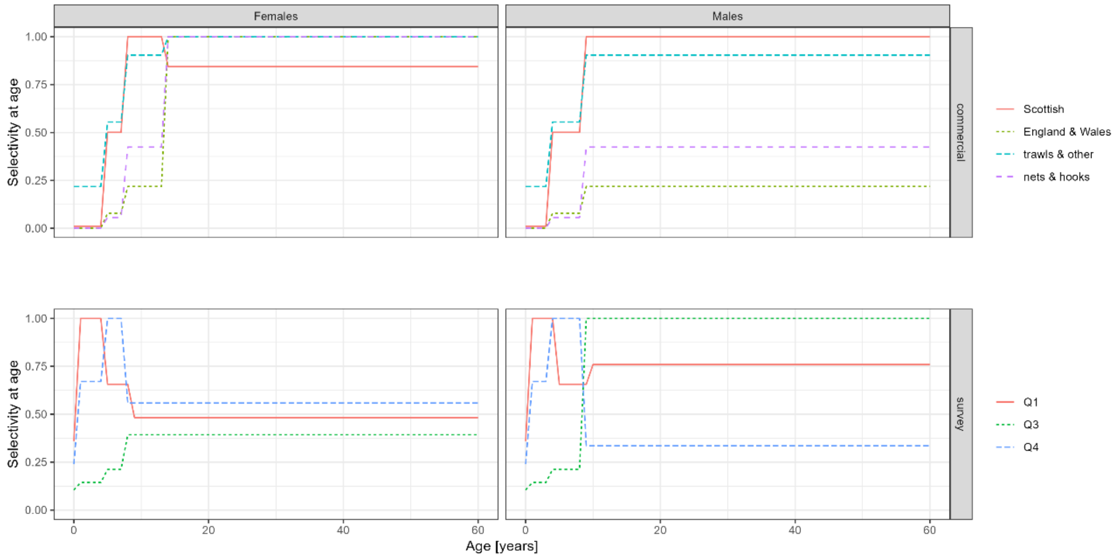


Figure 2.19. Northeast Atlantic spurdog. Baseline assessment. Estimated selectivity-at-age curves for females (left plots) and males (right plots). The four commercial fleets considered (top row) have non-target (Scottish), target (England & Wales), "trawls & other", and "nets & hooks" selectivity, which differ by sex because of the life-history parameters for males and females (Table 2.5). The survey selectivity-at-age curves for the three indices are given in the bottom row.

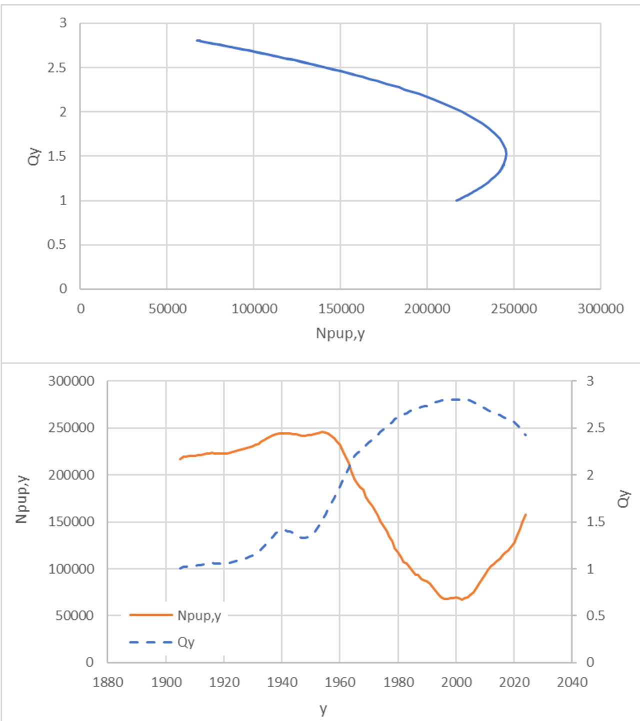


Figure 2.20. Northeast Atlantic spurdog. Baseline assessment. A plot of the density-dependent factor Q_y (Stock Annex equation 2b) against the number of pups $N_{pup,y}$ (top), and both plotted against time (bottom; orange line for $N_{pup,y}$, and blue hashed line for Q_y).

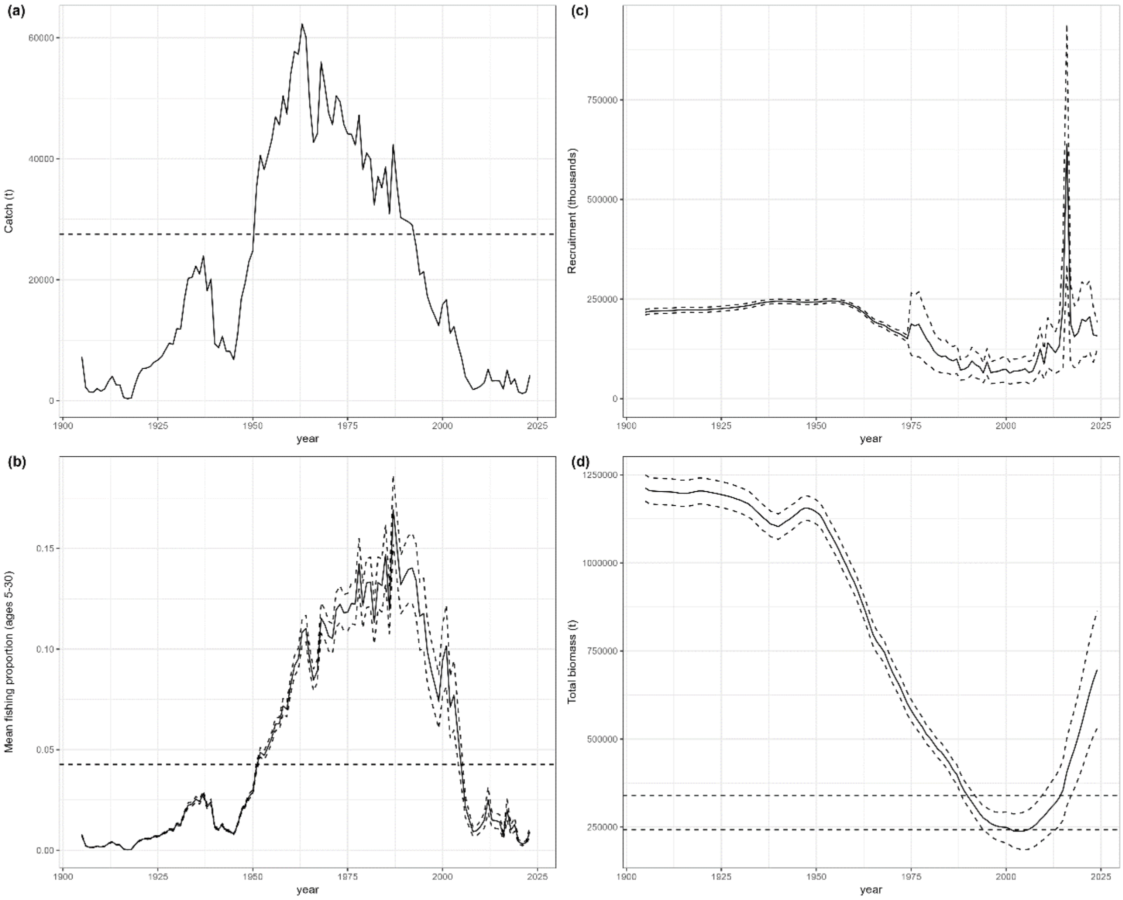
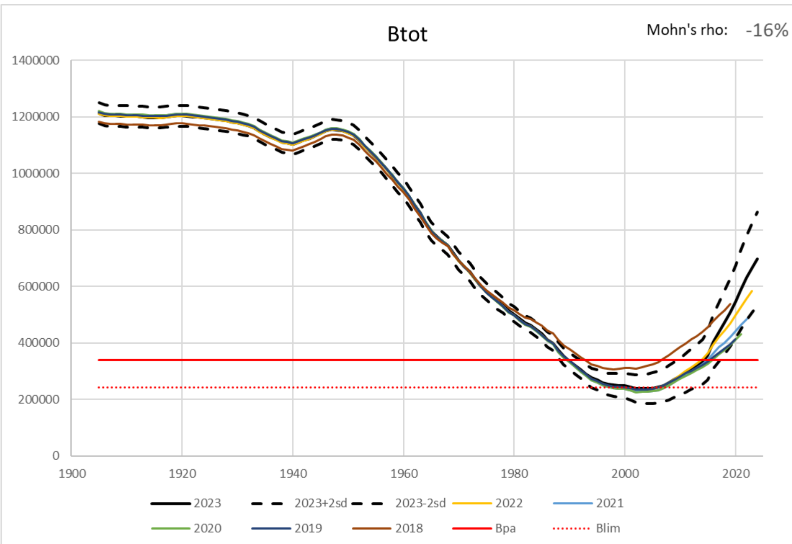


Figure 2.21. Northeast Atlantic spurdog. Baseline assessment. Summary four-plot showing long-term trends in catch (tons; hashed horizontal line = *MSY*), recruitment (thousands of pups), mean fishing proportion (harvest rate, average over ages 5–30; hashed horizontal line = HR_{MSY}) and total biomass (tons; top hashed horizontal line = B_{pa}; bottom hashed horizontal line = B_{lim}). Hashed lines reflect estimates of precision (±2 standard deviations).



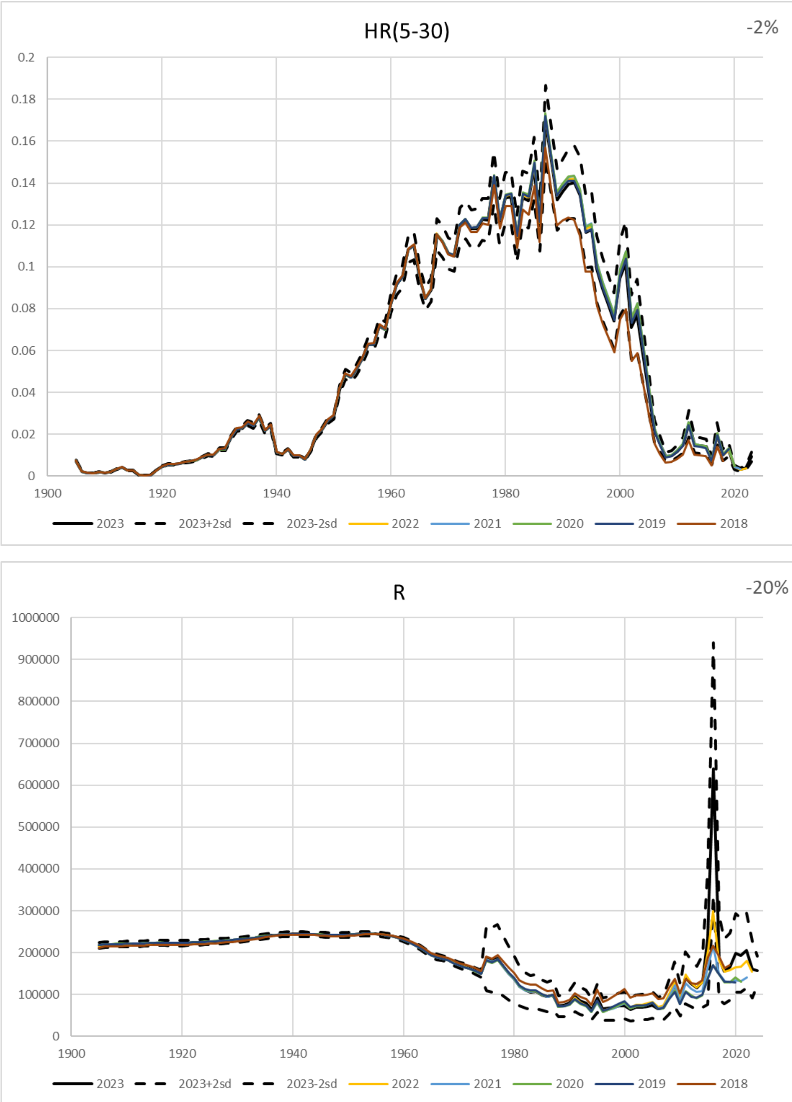


Figure 2.22. Northeast Atlantic spurdog. Baseline assessment. Six-year retrospective plots (the model was re-run, each time omitting a further year in the data). Mohn's rho is given in the top-right of each plot, and confidence bounds (hashed black curves; ±2 sd) for the 2023 line (black curve).

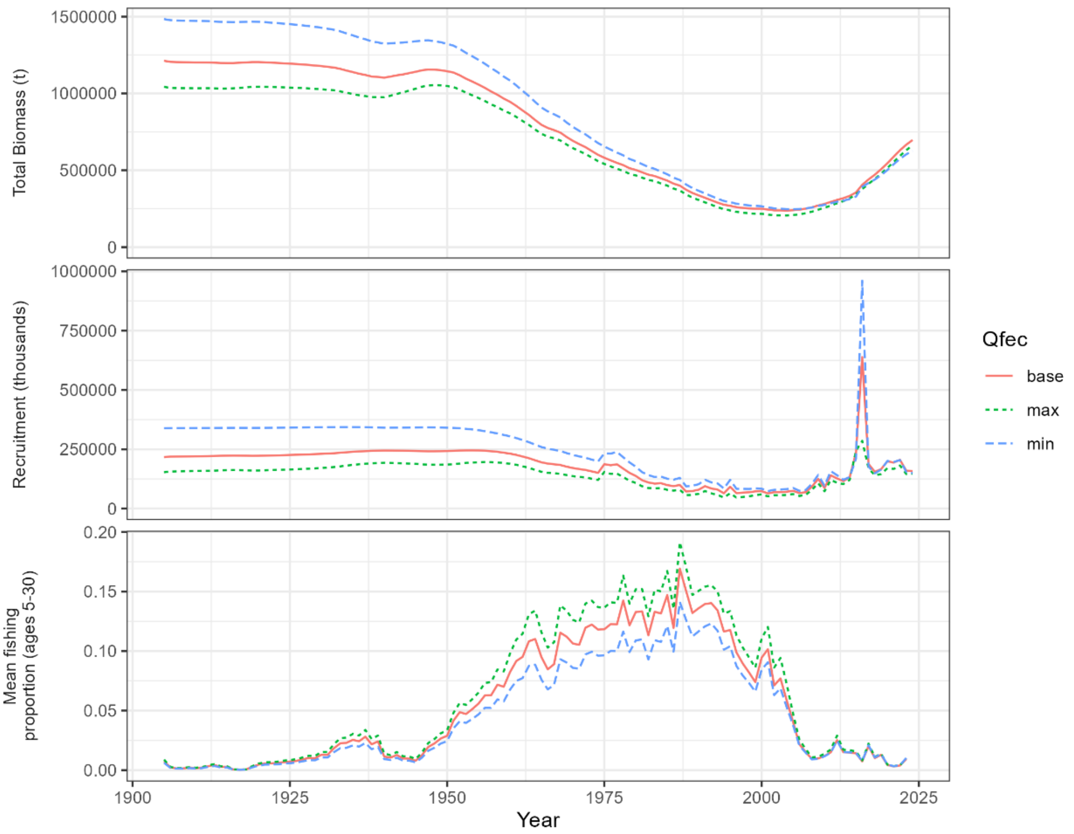


Figure 2.23. Northeast Atlantic spurdog. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production (Q_{fec}). Three alternative values are considered, related to the optimum (in terms of lowest –ln*L*), smallest, and largest values for parameters a_{fec} and b_{fec} that are within the 95% probability intervals for the baseline assessment. The estimated Q_{fec} associated with these are base = 3.030 (baseline assessment), max = 3.758, min = 2.267, respectively.

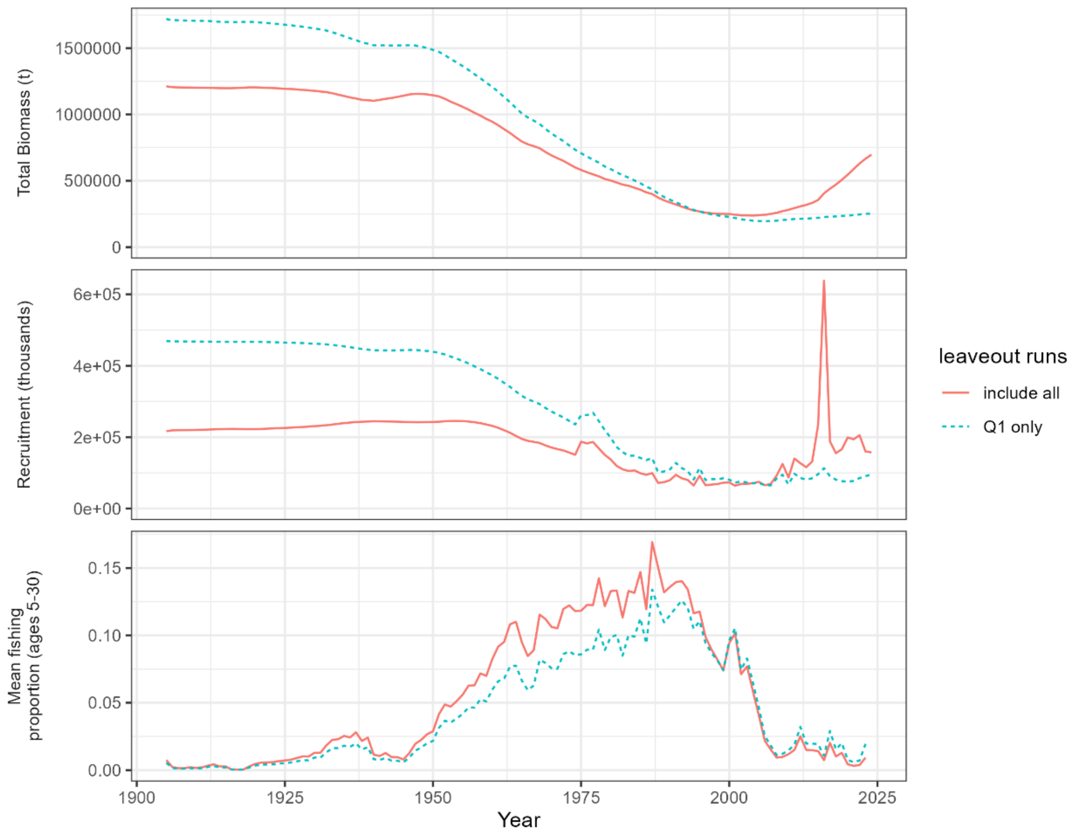


Figure 2.24. Northeast Atlantic spurdog. A sensitivity analysis omitting all surveys indices except the Q1 index ("Q1 only") compared to the baseline assessment ("include all").

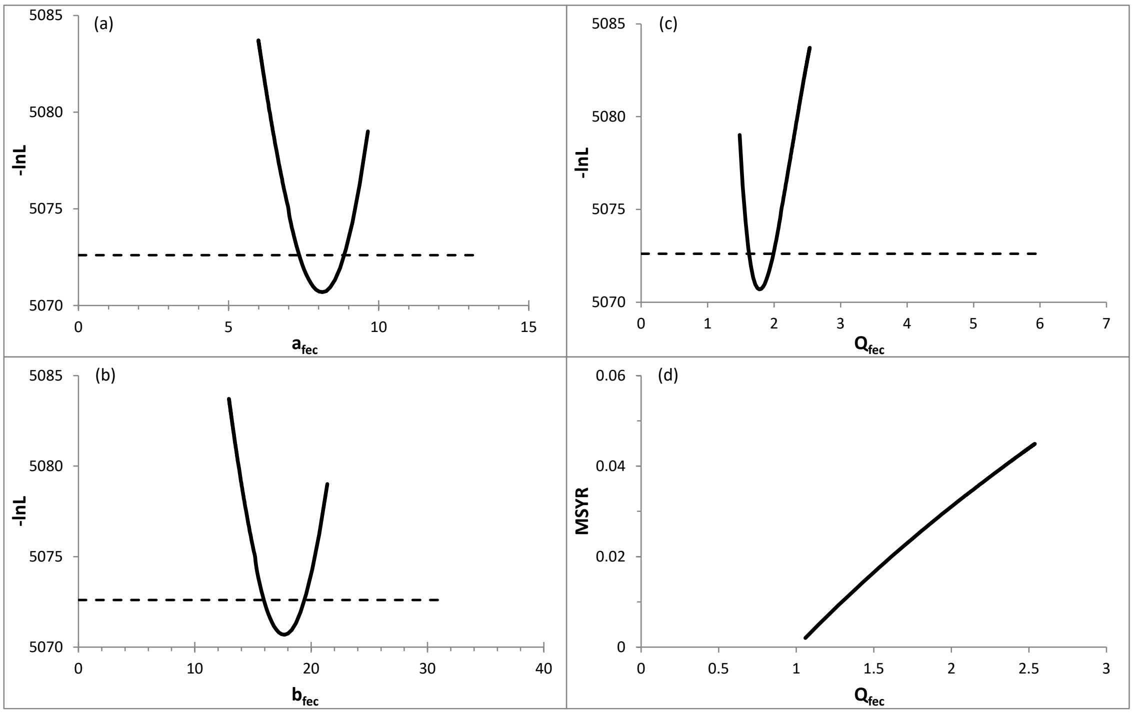


Figure 2.25. Northeast Atlantic spurdog. Q1 only assessment. See caption to Figure 2.13 for relevant details.

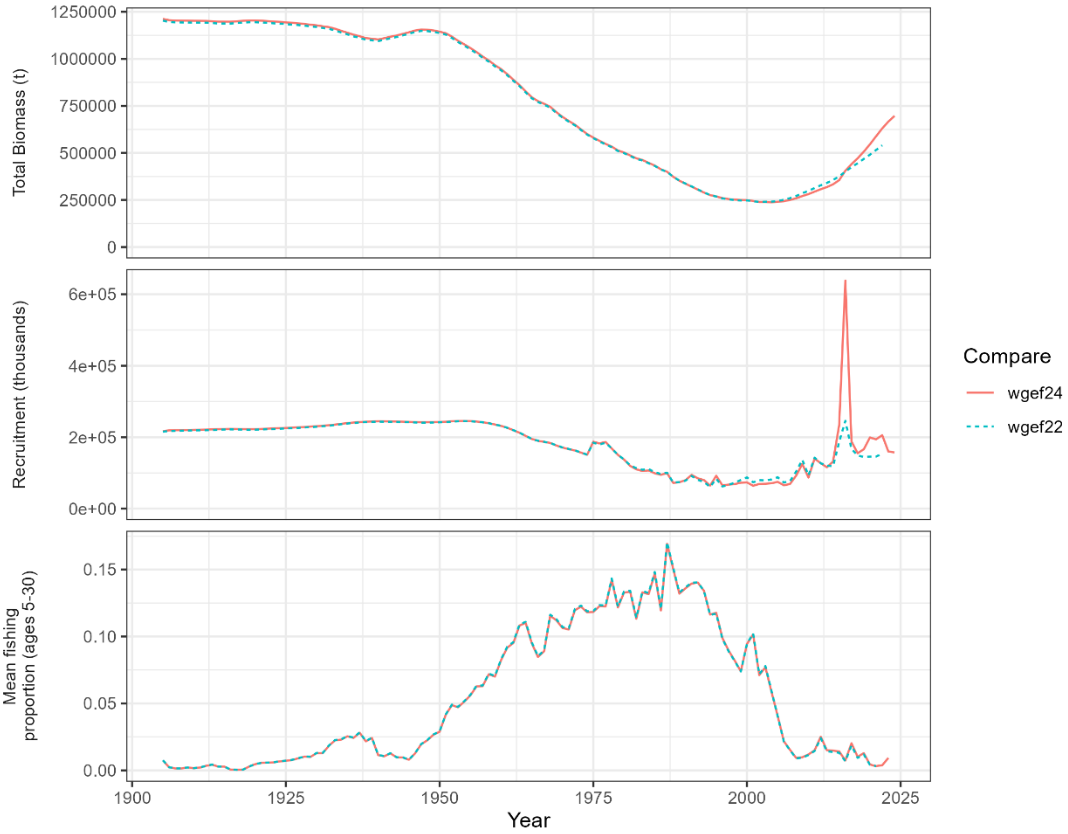


Figure 2.26. Northeast Atlantic spurdog. Comparison of summary plots from WGEF 2022 assessment (dashed blue) and current 2024 assessment (solid red).

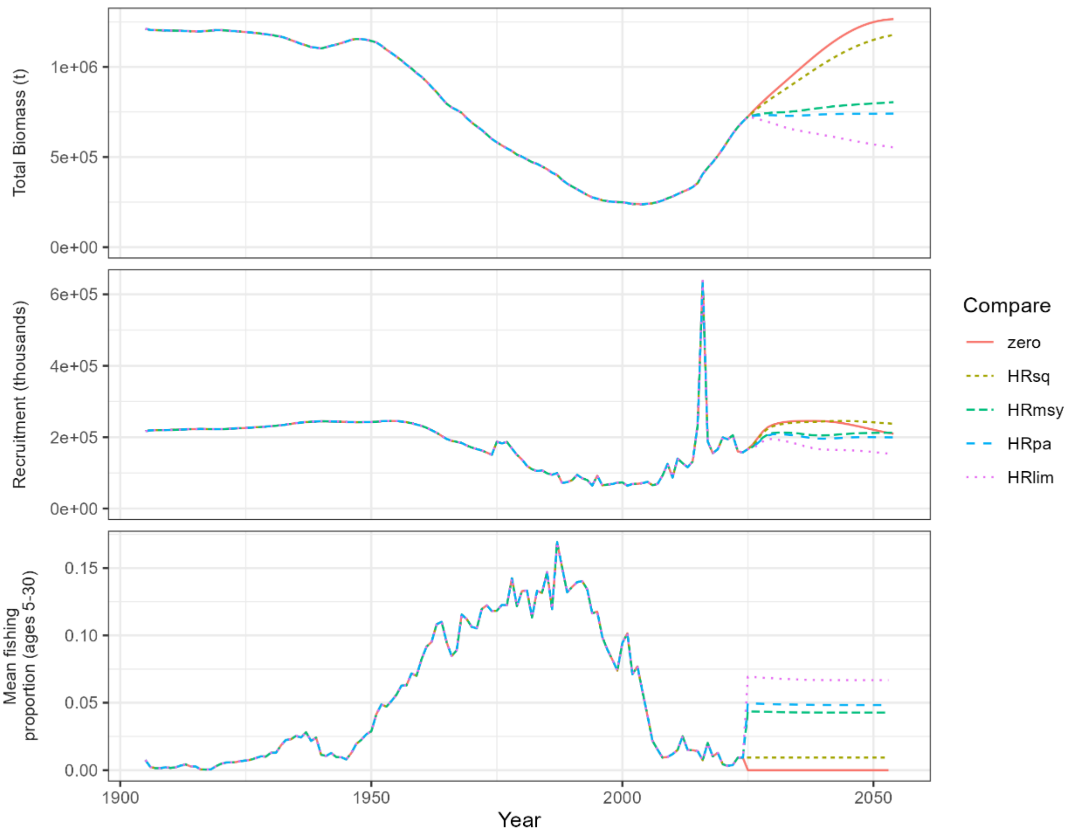


Figure 2.27. Northeast Atlantic spurdog. Baseline assessment. 30-year projections for different levels of future catch, including zero catch for reference.

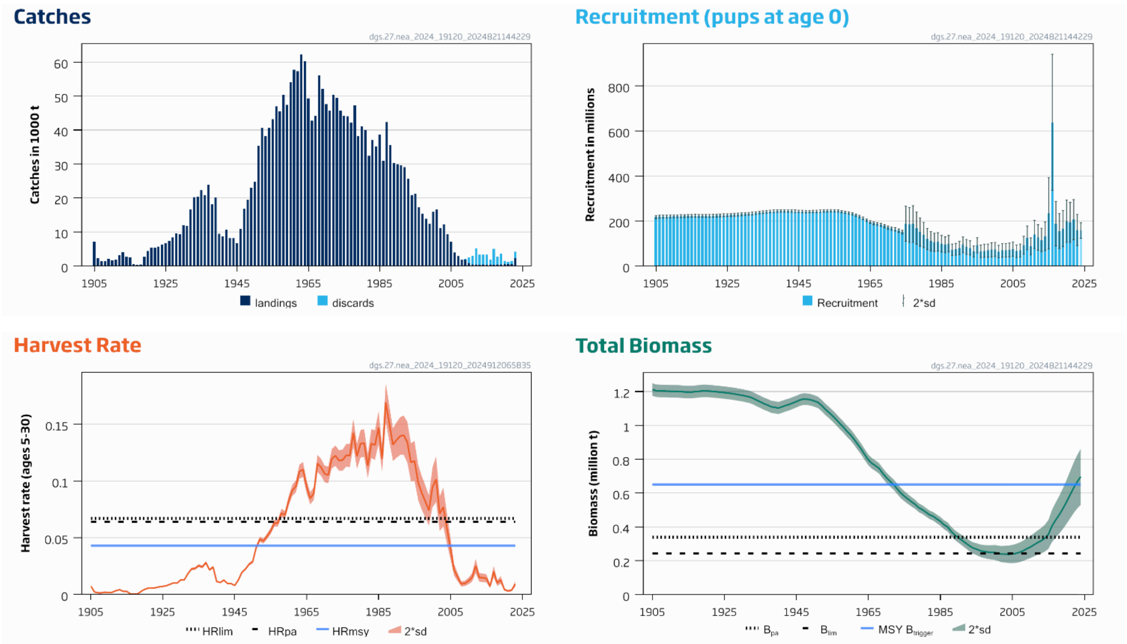


Figure 2.28. Northeast Atlantic spurdog. Baseline assessment. Summary four-plot showing long-term trends in catches (1000 tonnes), recruitment (millions of pups), mean fishing proportion (harvest rate, average over ages 5–30) and total biomass (million tonnes). Reference points are indicated as coloured lines.

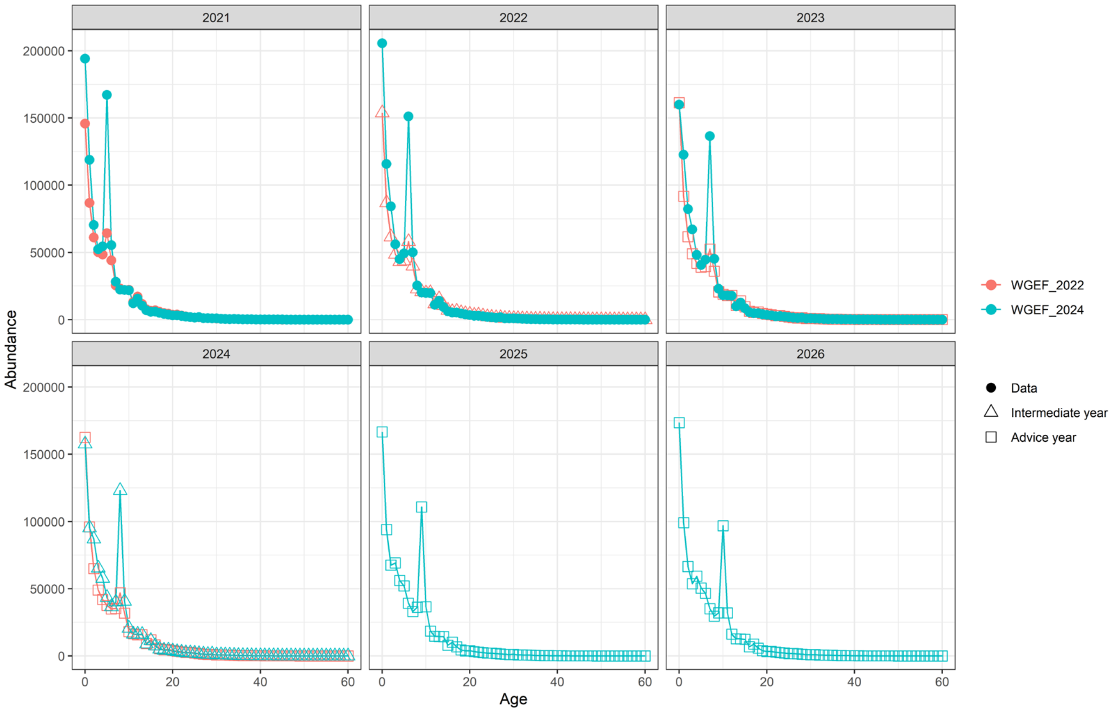


Figure 2.29. Northeast Atlantic spurdog. Summary six-plot showing abundance at age comparison between the 2022 assessment (WGEF 2022) and the current assessment (WGEF 2024).

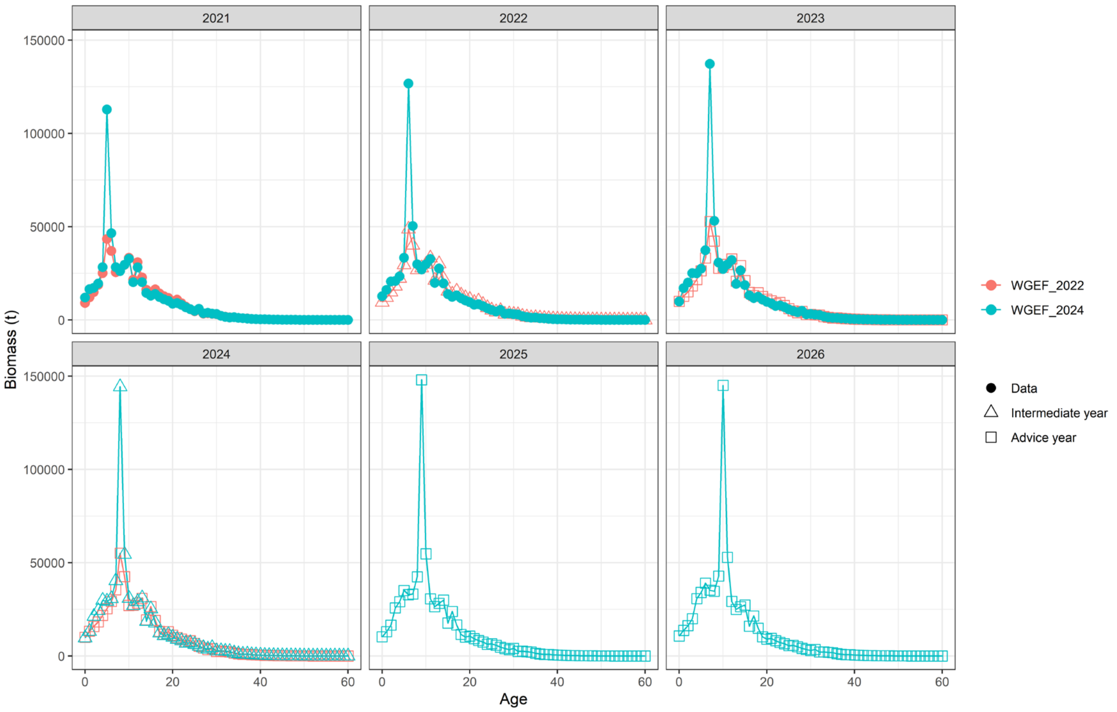


Figure 2.30. Northeast Atlantic spurdog. Summary six-plot showing biomass (tonnes) at age comparison between the 2022 assessment (WGEF 2022) and the current assessment (WGEF 2024).

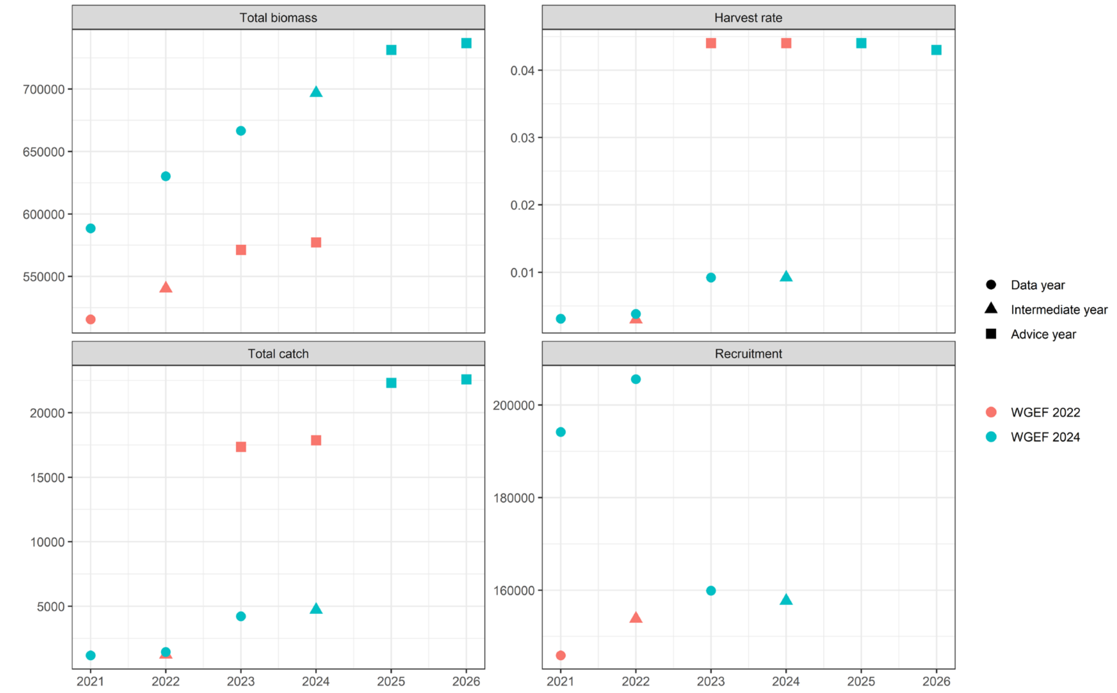


Figure 2.31. Northeast Atlantic spurdog. Summary four-plot comparing total biomass (tonnes), harvest rate (average over ages 5–30), total catch (tonnes), and recruitment (thousands of pups) between the 2022 assessment (WGEF 2022) and the current assessment (WGEF 2024).

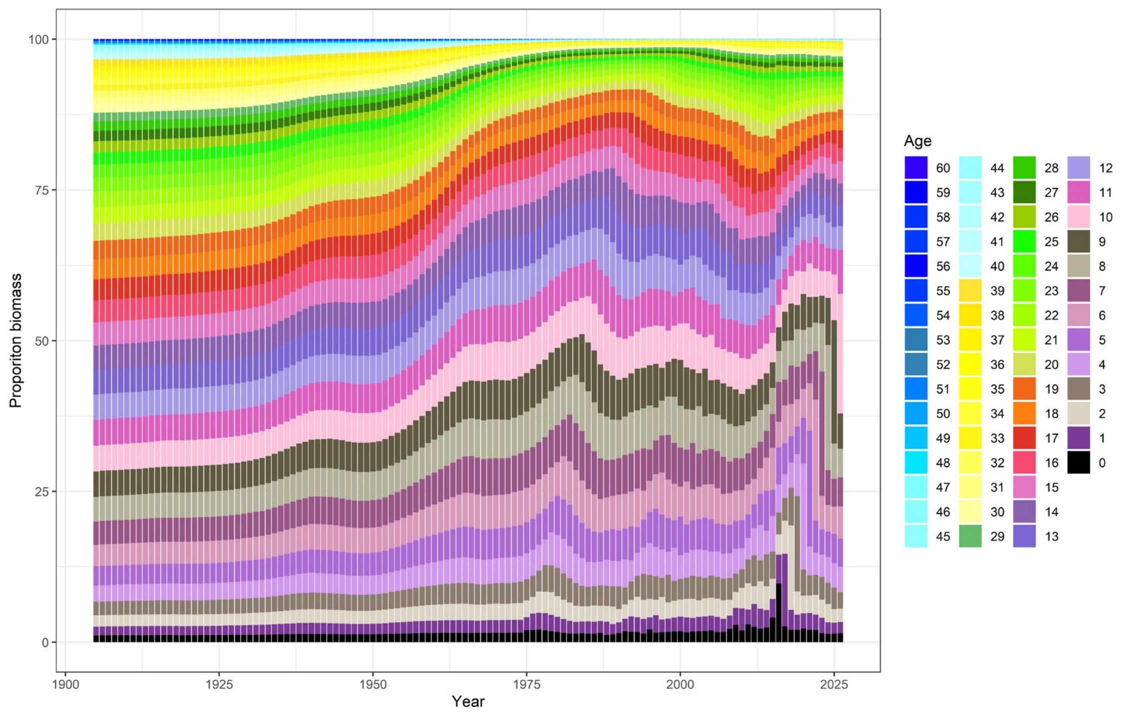


Figure 2.32. Northeast Atlantic spurdog. Historical proportion biomass (1905-2026) by age (0-60) from the current assessment and forecast (WGEF 2024).

Contents

3 Deep-water sharks; leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14)

3.1 Stock distribution

A number of species of deep-water sharks have been exploited in the ICES area. This section deals with leafscale gulper shark *Centrophorus squamosus* and Portuguese dogfish *Centroscymnus coelolepis*, which have been the two species of greatest importance to commercial fisheries.

In the past in some of European fisheries, landings data for the two species were combined for most of the period since the beginning of the fishery, under a generic term "siki".

3.1.1 Leafscale gulper shark

The leafscale gulper shark has a wide distribution in the Northeast (NE) Atlantic, from Iceland and Atlantic slopes south to Senegal, Madeira and the Canary Islands. On the Mid-Atlantic Ridge, it is distributed from Iceland to the Azores (Hareide and Garnes, 2001). The species can be demersal on the continental slopes (at depths of 230–2400 m) or have a more pelagic behaviour, occurring in the upper 1250 m of oceanic areas with seafloor around 4000 m (Compagno and Niem, 1998).

Available information suggests that this species is highly migratory (Clarke *et al.*, 2001; 2002; Moura *et al.*, 2014; Rodríguez-Cabello *et al.*, 2016). In the NE Atlantic, the distribution pattern formerly assumed considered the existence of a large-scale migration, where females would give birth off the Madeira Archipelago, as there were reports of pregnant females (Severino *et al.*, 2009) in that region. Geo-referenced data show that pregnant females also occur off Iceland, indicating another potentially important reproductive area in the northern part of the NE Atlantic (Moura *et al.*, 2014). Juveniles are only caught rarely. Segregation by sex, size and maturity seems to occur, likely linked to factors such as depth and temperature. Post-natal and mature females tend to occur in relatively shallower sites. Pregnant females are distributed in warmer waters compared to the remaining maturity stages, particularly immature females, which are usually found at greater depths and lower temperatures (Moura *et al.*, 2014). Although based on a small sample size, tagging studies have observed movements from the Cantabrian Sea to the Porcupine Bank (Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello *et al.*, 2016) and north to the Faroes Islands (Rodríguez-Cabello, personal comm.).

Results from a molecular study, using six nuclear loci, did not reject the null hypothesis of genetic homogeneity among NE Atlantic samples (Veríssimo *et al.*, 2012). The same study showed that females are less dispersive than males and possibly philopatric. In the absence of clearer information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

3.1.2 Portuguese dogfish

The Portuguese dogfish is distributed widely in the NE Atlantic. Stock structure and spatial dynamics are poorly understood. Specimens below 70 cm have been recorded rarely. The absence of small fishes in the NE Atlantic may be a consequence of their concentration in nurseries outside the sampling areas, movement to pelagic or deeper waters, gear selectivity or to different habitat and/or prey choices, with juveniles being more benthic (Moura *et al.*, 2014). Consistent results among different studies show that females move to shallower waters for parturition (Girard and Du Buit, 1999; Clarke *et al*., 2001; Moura and Figueiredo, 2012 WD; Moura *et al*., 2014). Similar size ranges and different maturity stages exist in both the northern and southern European continental slopes. The occurrence of all adult reproductive stages within the same geographical area and, in many cases in similar proportions among different areas, suggests that this species is able to complete its life cycle within these areas (Moura *et al*., 2014).

Population structure studies developed so far using microsatellites and mitochondrial DNA show no evidence of genetic population structure among collections in the NE Atlantic (Moura *et al*., 2008 WD; Veríssimo *et al*., 2011; Catarino *et al*., 2015). In the absence of clearer information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

3.2 The fishery

3.2.1 History of the fishery

Fisheries taking leafscale gulper shark or Portuguese dogfish are described in their respective stock annexes.

Since 2010, EU TACs for deep-water sharks have been set at zero, and, consequently, reported landings for each of the two species have been very low or zero.

The EU fixed, for 2017-2020, a restrictive by-catch allowance, permitting limited landings of unavoidable by-catches of deep-sea sharks in directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). Since 2021, both species are prohibited by several regulations and cannot be retained on board, transhipped, relocated or landed in a great extent of the NE Atlantic. Discards are known to occur but were not quantified. See section 3.2.5 (Management applicable) for more details.

3.2.2 Species distribution and spatial overlap with fisheries

Geostatistical studies (Veiga *et al*., 2013; Veiga *et al*., 2015 WD) using deep-water longline black scabbardfish fishery data (vessel monitoring systems, logbooks and official daily landings) were conducted with the aim of evaluating the spatial distribution and spatial overlap between i) black scabbardfish and leafscale gulper shark and between ii) black scabbardfish and Portuguese dogfish taken by the longline fishery operating off mainland Portugal (Division 9.a). Results obtained indicated that in fishing grounds where black scabbardfish is more abundant and where fishing takes place, the relative occurrence of both deep-water shark species was reduced. These differences on the relative occurrence have implications for alternative management measures to be adopted in the deep-water longline black scabbardfish fishery, particularly in what concerns the minimization of deep-water shark bycatch. The existence of differences in the deep-water sharks' abundance between fishing grounds for black scabbardfish and deeper fishing grounds was further supported by results from a short-duration pilot survey on board commercial fishing vessels belonging to the Portuguese mainland black scabbard fishery in 2014 (Veiga, 2015 WD). Under this survey, ten fishing hauls were carried out by five vessels, each vessel performing one haul at the fishing grounds exploited by the black scabbardfish fleet (BSF fishing grounds) and other located at deeper areas adjacent to these fishing grounds, using the same gear, hook size and fishing practices. For all vessels, the proportions of each shark species (~ quotient between the caught weight of the deep-water shark under analysis and the sum of the caught weight of black scabbardfish and of that deep-water shark) was significantly smaller in hauls performed at the BSF fishing grounds and those located deeper.

In addition to the conclusions drawn by these studies, an analysis of onboard data collected at commercial vessels belonging to the Portuguese deep-water longline fishery that takes place in ICES Subarea 9 suggested that *C. squamosus* and *D. calceus* have a larger spatial overlap with the fishery for black scabbardfish than *C. coelolepis* (Figueiredo and Moura, 2019 WD). Worth to mention that *C. squamosus* and *D. calceus* have a widespread distribution and undertake migrations associated to reproduction (despite those from the *D. calceus* being less understood).

As a reaction of the restrictive EU management measures adopted for deep-water sharks, fishing vessels also tend to avoid fishing grounds where deep-water sharks are more likely to be caught. No survival of sharks when returned to the sea is expected. See section 3.3.4. for more information on discard survival.

3.2.3 The fishery in 2023

No new information.

3.2.4 ICES advice applicable

Leafscale gulper shark: in 2023, ICES advised that "*when the precautionary approach is applied there should be zero catches in each of the years 2024–2027*".

Portuguese dogfish: in 2023, ICES advised that "*when the precautionary approach is applied there should be zero catches in each of the years 2024–2027*".

3.2.5 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters for different ICES subareas are summarized below.

Year	ICES subareas		
	5–9	10	12 (includes also *Deania histricosa*[5] and *Deania profondorum*)
2005 and 2006	6763	14	243
2007	2472[1]	20	99
2008	1646[1]	20	49
2009	824[1]	10[1]	25[1]
2010	0[2]	0[2]	0[2]
2011	0[3]	0[3]	0[3]
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10[4]	10[4]	0
2018	10[4]	10[4]	0
2019	7[4]	7[4]	0
2020	7[4]	7[4]	0
2021[6]	---	---	---

Year	ICES subareas		
	5–9	10	12 (includes also *Deania histricosa*(5) and *Deania profondorum*)
2022(6)	---	---	---
2023(6)	---	---	---
2024(6)	---	---	---

(1) Bycatch only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatch of up to 10% of 2009 quotas is permitted.

(3) Bycatch of up to 3% of 2009 quotas is permitted.

(4) Exclusively for bycatch in longline fishery targeting black scabbardfish. No directed fishery shall be permitted.

(5) Recent studies demonstrated that there is not enough scientific support to discriminate *Deania hystricosa* from its congener *Deania calceus*; they are likely the same species (Rodríguez-Cabello *et al*., 2020; Stefanni *et al*., 2021)

(6) Species included in the prohibited list of the TAC regulations

Since 2013, the deep-sea shark category includes the following species (Council regulation (EC) No 1182/2013): Deep-water catsharks *Apristurus* spp., frilled shark *Chlamydoselachus anguineus*, gulper sharks *Centrophorus* spp., Portuguese dogfish *Centroscymnus coelolepis*, longnose velvet dogfish *Centroselachus crepidater*, black dogfish *Centroscyllium fabricii*; birdbeak dogfish *Deania calceus*; kitefin shark *Dalatias licha*; greater lantern shark *Etmopterus princeps*; velvet belly *Etmopterus spinax*; mouse catshark *Galeus murinus*; six-gilled shark *Hexanchus griseus*; sailfin roughshark *Oxynotus paradoxus*; knifetooth dogfish *Scymnodon ringens* and Greenland shark *Somniosus microcephalus*.

Since 2013, under NEAFC Recommendation, 7 it was required that Contracting Parties prohibit vessels flying their flag in the Regulatory Area from directed fishing for deep-sea sharks on the following list: *Centrophorus granulosus, Centrophorus squamosus, Centroscyllium fabricii, Centroscymnus coelolepis, Centroselachus crepidater, Dalatias licha, Etmopterus princeps, Apristurus spp, Chlamydoselachus anguineus, Deania calceus, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

Since 2015, the leafscale gulper shark and the Portuguese dogfish, have been included on the EU prohibited species list for Union waters of Division 2.a and Subarea 4 and in all waters of Subareas 1 and 14 (Council Regulation (EC) No 2015/104, Art. 12:1(g)).

A bycatch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. According to this Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 and 7 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2 in 2017–2018 and 2019–2020, respectively. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

Since 2021 there is a prohibition to fish, to retain on board, to tranship, to relocate or to land some deep-water sharks species (including leafscale gulper shark and Portuguese dogfish) in United Kingdom and Union waters of ICES subarea 4; United Kingdom waters of division 2a;

international waters of ICES subareas 1 and 14; United Kingdom, Union and international waters of ICES subareas 6 to 9; United Kingdom and international waters of 5; Union and international waters of ICES subarea 10; Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2; and international waters of ICES subarea 12 (Council Regulation (EU) 2023/194).

EU regulations on some deep-water fisheries also contributed to the reduction of the deep-water sharks fishing mortality. In 2005, the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas was banned (Council Regulation (EC) No 1568/2005). In 2007, the use of gillnets by Community vessels at depths greater than 600 m in ICES divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12 was banned while a maximum bycatch of deep-water shark of 5% in hake and monkfish gillnet catches was allowed (Council Regulation (EC) No 41/2007). Since 2009, the "rasco (gillnet)" fishing gear was banned at waters deeper than the 600 m isobath (EC Regulation 43/2009). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from NEAFC waters by 1 February 2006.

Since 2016, and in order to mitigate the potential damaging impacts of bottom trawling, fishing with bottom trawls was ban at depths deeper than 800 metres (EU Regulation 2016/2336).

3.3 Catch data

3.3.1 Landings

Landings of leafscale gulper shark and Portuguese dogfish have historically been included by many countries in mixed landings categories (e.g. sharks 'nei' and dogfish 'nei'). Figure 3.1 shows the Working Group estimates of combined landings of the two species by country and by ICES area.

During WKSHARK2, landing data provided by country was revised in relation to data quality (including taxonomic categories). Protocols to better document the decisions to be made when estimating WG landings were developed (ICES, 2016). For the years before 2005, it was not possible to determine identity to species level for some countries and hence the landings presented here are of "siki" sharks. "Siki" landings are a mixed category comprising mainly *C. squamosus* and *C. coelolepis* but also including unknown quantities of other species (Table 3.1). Landings estimates from 2005 onwards were revised following WKSHARK2 and are presented by species (Figure 3.2; Tables 3.2 and 3.3).

Landings have declined from around 10 000 t in 2001–2004 to one tonne in 2012. The recent decrease in landings is mostly related to the imposition of the EU TAC, which has been set at zero catch since 2010. From 2017 to 2020, landings were reported in division 9a due to the deep-water sharks by-catch allowance in the black scabbard longline fisheries. In 2021 and 2022, and due to the regulations in place since 2021, there were no landings of Portuguese dogfish. In the case of leafscale gulper shark, Portugal reported landings of 59 kg and 7 kg, respectively.

3.3.2 Discards

Given the restrictive EU TACs for deep-water sharks, it was admitted that the discarding in deep-water fisheries had increased. However, with the several EU regulations in place, particularly the ban of gillnet, entangle and trammel net fisheries at depths >600 m and trawl deep-water fisheries at depths >800 m, the potential bycatch and subsequent discarding of Portuguese dogfish and leafscale gulper shark is now thought to be relatively low. Since 2010, that discard information is limited to some years and countries (Tables 3.4 and 3.5).

Portugal. The IPMA on-board sampling programme of Portuguese commercial vessels that operate deep-water longlines to target black scabbardfish (métier LLD_DWS_0_0_0), started in mid-2005. Sampling effort was fixed at three trips per quarter and sampled trips and vessels were selected in a quasi-random sampling (Fernandes *et al*., 2011 WD). However, it is considered that spatial coverage by the sampling is insufficient to allow discards to be raised to the whole fleet (Prista *et al*., 2014 WD).

To evaluate the level of shark bycatch and discards, and to increase knowledge of the fishery, a pilot study on the Portuguese trammel net fishery targeting anglerfish in Division 9.a (200–600 m deep) took place, under the PNAB/DCF from 2012–2014 (Moura *et al*., 2015 WD). Results showed that the fishery targeting anglerfish at depths of 200–600 m had a low frequency of occurrence of Portuguese dogfish. No specimens of leafscale gulper shark were ever sampled. Despite these results, higher frequencies are likely to be observed at depths >600 m.

Spain. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES subareas 6–7 and divisions 8.c and 9.a started in 1988; however, it did not have annual coverage until 2003. The sampling strategy and the estimation methodology used follows the "Workshop on Discard Sampling Methodology and Raising Procedures" guidelines (ICES, 2003) and more details of this applied to this area were explained in Santos *et al*. (2010 WD).

Estimated discards of leafscale gulper shark in 2021 were 5.5 tonnes.

Discards estimates of *C. squamosus* from the Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES Subareas 6, 7, 8c and North 9a in the period 2003-2013 are presented in Table 3.6. It should be noted that the CVs from these estimates are very high (>50%) (Santos et al., 2010 WD), which can be related with the sampling not being stratified to account for the depth effect (*C. squamosus* generally distributes at high depths). The results presented in Table 3.6 can therefore not be considered reliable estimates of the quantities discarded. They are included in this report as indicative that some discarding of the species occurred in the period considered.

France. French bycatch of Portuguese dogfish and leafscale gulper shark occurs mainly, if not only, in the deep-water fishery to the West of Scotland. Estimates for the period 2005–2014 are available in Table 3.7. It was previously shown that estimated discards may vary strongly with the auxiliary variable used for raising observed discards to the French fleet. Available auxiliary variables are fishing time, number of trips, number of fishing operations, number of fishing days and total landings of all species caught. Raising to the landings of the same species is not suitable as these sharks are not landed. Raising to available variables returned different discard estimates, which range from 13–200 tonnes of Portuguese dogfish and from 40–700 tonnes of leafscale gulper shark. Estimated discards for recent years (2020-2022) were not scrutinized by WGEF.

Ireland. Discard data from Ireland is available from 2009 to 2017 and 2023 for the Portuguese dogfish from the trawl fleet operating in ICES divisions 27.6.a and 27.7.bgj. Although 4.3 t were reported in 2023, discards are considered negligible as values estimated are <1 tonne in most of the years.

3.3.3 Quality of the catch data

Historically, very few countries have provided landings data disaggregated by species. Portugal has supplied species-specific data for many years. Since 2003 onwards, other countries have increased species-specific reporting of landings but some of these data may contain misidentifications.

It is believed that immediately prior to the introduction of quotas for deep-water species, in 2001, some vessels may have reported deep-water sharks as other species (and vice versa) in an effort to build up track record for other deep-water species (or deep-water sharks). It was also likely that, before the introduction of quotas for deep-water sharks, some gillnetters may have reported monkfish as sharks.

Misreporting is likely to have increased as a reaction to the EU restrictive measures adopted for deep-water sharks. As an example, the data from the DCF landing sampling programme at Sesimbra landing port in 2009 and 2010 revealed the existence of misidentification problems (Lagarto *et al*., 2012 WD). In 2014, sampling data derived from 13 trips on deep-water longliners (a small proportion of the total number of trips) indicated that nearly 50% of the sampled specimens landed as *Galeorhinus galeus* corresponded to leafscale gulper shark and Portuguese dogfish. Misidentification issues persisted until 2016.

3.3.4 Discard survival

No information is available. Scientific studies have recently tagged leafscale gulper sharks caught by longline at depths of 900–1100 m, indicating that they are capable of surviving after capture and release (Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello and Sánchez, 2017). In these studies, at-vessel mortality (proportion of fish that are dead when the fish are brought on board) for *C. squamosus* and *C. coelolepis* was low: 1.2%, and 4.5%, respectively. However, if including also specimens scored in poor condition, at vessel mortality increased to 18.9% and 38.6%, respectively.

It is important to remark that in these studies, the soaking times were restricted to 2–3 hours and the fishing gear was hauled in at a much slower speed (0.4–0.5 m s^{-1}) than under normal fishing practices.

3.4 Commercial catch composition

3.4.1 Species composition

No new information.

Past efforts made by WGEF to assign mixed landings by species are described in the Stock Annex. Briefly, the benchmarked procedure agreed by WKDEEP 2010 was further explored by a dedicated workshop on splitting of deep-water shark historical catch data in 2011 (ICES, 2011a). Results from this meeting indicated that the ratio between leafscale gulper shark and Portuguese dogfish varied considerably both temporally and spatially. Data from 2005 onwards was revised in WKSHARK2.

3.4.2 Length composition

No new information is available.

3.4.3 Quality of catch and biological data

Despite past efforts to improve the quality of the data, particularly on species composition, considerable uncertainties persist on historical data (ICES, 2011a; ICES, 2016).

Since the reduction of EU TACs to zero, significant quantities of the two deep-water shark species under consideration are likely to be discarded by deep-water fisheries. Despite some sampling effort on discards has been undertaken, the sampling effort is clearly insufficient to estimate the quantities caught by species and size composition.

3.5 Commercial catch-effort data

Information on past commercial catch-effort data is presented in the stock annex. No new information is available.

3.6 Fishery-independent surveys

Since 1996, Marine Scotland Science has been conducting a monitoring deep-water survey in Subarea 6 at depths ranging from 300–2040 m [G6642]. This survey can be considered to be standardised in terms of depth coverage since 1998. More information on this survey is presented below.

In September, from 2006 to 2008, and in December 2009, Ireland carried out annual deep-water surveys in subareas 6 and 7. Fishing hauls were performed off north-western Ireland and west of Scotland, and the Porcupine Bank area to the west of Ireland at depth strata: 500 m, 1000 m, 1500 m and 1800 m. The Irish deep-water survey and other surveys were part of a planned coordinated survey in the ICES area, through the Planning Group on Northeast Atlantic Continental Slope Surveys (WGNEACS).

A new Irish trawl survey (IAMS) began trawling deep-water stations in 2018, but data have not yet been analysed.

From 2015 to 2023, AZTI conducted a deep-water longline survey (PALPROF) along the Basque Coast, Bay of Biscay (ICES Division 8.c), onboard a commercial longliner [L4398]. More information on this survey is presented below.

The WGNEACS (ICES, 2011b) was dedicated mainly to the design of a longline survey in Bay of Biscay and Iberian waters. One of its main objectives would be to clarify the distribution of all the deep-water sharks and to provide data to monitor their stock status, in the absence of commercial fisheries data.

3.7 Life-history information

Information on life history is presented in the corresponding stock annexes. No new information is available.

3.8 Exploratory assessments

3.8.1 Scottish deep-water survey data (ICES Subarea 6)

Survey indicators from the Scottish deep-water survey have been investigated since 2012 (Campbell, 2018WD; ICES, 2019). The survey takes place every two years, and the most recent information refers to 2023. In 2024, species mean weight and numbers per tow (for the hauls at 500 – 1800m and 700 – 1900m, respectively) were submitted to WGEF (Figures 3.3 and 3.4). Portuguese dogfish shows an increasing trend in both indicators since 2012, with relatively high values since 2019. Although not so evident as for the Portuguese dogfish, the leafscale gulper shark also shows higher values in the last four years, with the mean value in 2021 being the highest of the series (but with relatively high error values associated).

3.8.2 PALPROF survey (ICES Division 8c)

New information from the PALPROF survey in the Bay of Biscay was presented, updating the data presented previously (see Diez *et al.*, 2023WD and Diez *et al.* 2021 for details). The PALPROF survey has been conducted annually since 2015 in a commercial longliner with the main objective of estimating and assessing the inter-annual variation of the abundance and biomass indices of the deep-water sharks and other ichthyofauna. The surveyed area is located 10.5 km North of the Cape Matxitxako (ICES 27.8.c east) close to a narrow canyon of about 28 km length, where the bottom depth progressively increases from 500 to 2500 m. Based on canyon valley depth profile, and for a depth range from 650 m to 2400 m, 400 m depth interval strata were considered. Six fishing hauls were performed each year, at the same position and time, in order to get homogeneous and comparable data.

To minimize the mortality of deep-water sharks, the number of hooks of a former commercial deep-water-sharks longline was reduced to 300 (Figure 3.5). Depth, temperature and salinity are continuously monitored through CTD sensors (every 30 s).

Data on status of the hook were recorded during the hauling and the recovering of the long line. The categories considered were: i) **E** - Hook with bait; ii) **C** - Hook with bait partially eaten; iii) **R** - Broken-Tangled hook; iv) **V** - Empty hook (no catch, no bait); v) **P** - Hook with catch and vi) **N.O.** - Hook status not Observed/recorded during recovering of the line.

On board, all fish specimens caught were sorted and species identified to the lowest taxonomic level possible. Also, each specimen was measured (cm), sexed and the condition (dead or alive) recorded. Individual body weight was estimated based on species length/weight relationships. The effective fishing effort performed in each stratum (EFFORTst) corresponded to the number of hooks able to fish during the haul, i.e. P + E + C divided by the total of hooks and multiplied by the soaking time (minutes):

EFFORTst: ((P + E + C) / total hooks) x soak time (minutes)

For each *stratum* the CPUE of species **i** was calculated as the ratio of catch of i^{th} species (kg) and EFFORTst.

In the estimates presented to WGEF in 2023, the catch per unit of effort (CPUE) was adapted to the units usually used in the assessments based in survey trends. Therefore, the CPUE was raised to 60 min and the biomass and abundance indices were calculated in kg/h and n/h, respectively.

During the eight years of the survey, 13 different species of sharks and two chimaeras were caught. Sharks and chimaeras were less frequently caught in the floating sections of the fishing gear than at the bottom sections. The highest CPUE values were recorded for *C. coelolepis*. CPUE values for this species showed no major trends until 2020, decreased in 2021-2022 but increased again in 2023 (Figure 3.6). The CPUE values for *C. squamosus* increased over time but with oscillations (the maximum value was reported for 2018). Abundance of *C. coelolepis* is highest in the 1451–1850 strata whereas *C. squamosus* presented similar percentage of abundance in the 1051–1450 m and in the 1451–1850 strata.

3.8.3 On-board Portuguese data (ICES Division 9a)

IPMA analysed the onboard data collected under Data Collection Framework (PNAB/DCF) for the deep-water sharks *Centroscymnus coelolepis*, *Centrophorus squamosus* and *Deania calceus* (Figueiredo and Moura, 2019WD). The analysis covered a period from 2009 to 2018 during which data on deep-water sharks was collected by onboard observers of the deep-water longline fishery targeting the black scabbardfish (LLD-DWS *métier*) in Division 9.a. Details and results have been provided in previous reports (ICES, 2019).

The initial objective of this analysis was to estimate the level of by-catch of the main deep-water sharks by year and by area (see section 3.2.2) in addition to evaluate any potential trend during this time period, to compare with catch levels prior to 2007 (when the TAC started to restrict landings). However, the sampling effort achieved is considered insufficient to provide reliable information on the abundance or biomass trend of deep-water shark species. The spatial locations of the fishing hauls are heterogeneously dispersed along time (Figure 3.7) and the vessels sampled also changed. It should be noted that given the vessel site fidelity, there is a confounding effect between the fishing vessel and the fishing grounds and with the distribution patterns of each species, difficult to disentangle. The results obtained from the onboard analysis are presents below, by species.

Portuguese dogfish. The relative occurrence of *C. coelolepis* at the sampled fishing hauls, by year, varied between 33 and 100%. The number of specimens caught varied, not only among years, but also among vessels. The highest number of specimens caught by fishing haul were consistently recorded in some places (Figure 3.8). The geographic information of the catches of *C. coelolepis* supports previous studies where it was concluded that the black scabbardfish fishery operate at locations of lower abundance of *C. coelolepis* (Veiga *et al.*, 2015 WD).

Leafscale gulper shark. *Centrophorus squamosus* was quite frequently caught but its relative occurrence by fishing haul and by year varied between 17 and 100%. Also, the number of specimens caught per fishing haul varied not only among years but also among vessels. The data available were considered insufficient to estimate the level of by-catch and did not put in evidence any temporal trend. This fact might be associated with the spatial changes of the sampled fishing hauls along time (Figure 3.9).

3.9 Stock assessment

No new assessments were undertaken in 2023.

3.10 Quality of the assessments

Several regulations on catch opportunities and fisheries operations are in place in the NE Atlantic since 2005 to protect deep-water sharks' populations (or with effect on their protection), being recognized that fishing effort to these species has been reduced in a great extent (see Section 3.3.5). However, data to evaluate the impact of those management measures and current stock status of these species are deficient. Despite not being conducted yearly, the Scottish deep-water survey provides a meaningful time-series of species-specific data, but this started after the fishery being established, and only covers part of the stock range for both the leafscale gulper shark and the Portuguese dogfish. The PALPROF survey in the Bay of Biscay provides new fishery-independent data since 2015, but also covers a small area. Fishery-independent data from other areas of the stock range are limited or lacking.

Fishery dependent data are lacking. The data derived from discards sampling is not adequate to estimate the quantities caught or needs further investigation.

Therefore, a major scientific investment is required to gain a full understanding of the spatial and temporal population dynamics of deep-water sharks to enable estimates of sustainable exploitation levels.

Several strategies to be adopted to monitor species abundance and evaluate fishing impact on their populations by the different deep-water fisheries have been discussed in previous meetings and included the: i) increase of close monitoring of deep water shark populations; ii) development of specific studies to assess the distribution patterns of species and estimate the spatial overlap with fisheries; iii) evaluate the effect on the bycatch of deep water sharks of modifications in deep water fishing operations (Figueiredo and Moura, 2016 WD).

Many countries formerly reported landings of Portuguese dogfish and leafscale gulper shark combined with other deep-water sharks in categories such as "siki sharks". Unless suitable data can be found to enable splitting of the catch data, historical catch levels by species will remain uncertain.

3.10.1 Historical assessments

In 2010, an exploratory assessment method was proposed for the Portuguese dogfish stock (cyo.27.nea) (ICES, 2010). The demographic model proposed is a state-space model that divides the population system dynamics into two processes running in parallel: an unobserved process that describes the female sharks' population abundance in number, and an observational model, annual catches, that allows establishing the connection between the unknown states (ICES, 2010). However, the application of the model requires catch data discriminated by species from the different areas within the stock NE Atlantic. Such data is deficient, as historical data is not split by species and current catch estimates are also not quantified.

3.11 Reference points

There are no reference points for these stocks.

3.12 Conservation considerations

The Red List of European marine fish considered both leafscale gulper shark and Portuguese dogfish to be Endangered (Nieto *et al*., 2015).

Recent IUCN assessments for a group of deep-water sharks classified the Portuguese dogfish as globally Near Threatened with signs of increase in the population inhabiting the NE Atlantic (Finucci *et al.*, 2020a). The leafscale gulper shark was classified as globally Endangered, with signs of reduction of the population in the NE Atlantic (Finucci *et al*. 2020b).

Both species are included in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) List of Threatened and/or Declining Species & Habitats (OSPAR, 2021).

3.13 Management considerations

Some species of deep-water shark are considered to have very low population productivity.

Whilst the zero TAC for deep-water sharks has prevented targeted fisheries for deep-water sharks, these species can still be a bycatch in some deep-water fisheries. The level of bycatch in these fisheries is uncertain but is now assumed to be relatively low given the EU regulations adopted for deep-water fisheries (see Section 3.3.5).

3.14 References

Campbell, N. 2018. Analyses of Scottish deep-water survey data. Working Document presented in the ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, June 2018. 12pp.

Catarino, D., Knutsen, H., Veríssimo, A., Olsen, E. M., Jorde, P. E., Menezes, G., Sannaes, H., Stankovi, D., Company, J.B., Neat, F., Danovaro, R., Dell'Anno, A. Rochowski, B., Stefanni, S. (2015). The Pillars of Hercules as a bathymetric barrier to gene flow promoting isolation in a global deep-sea shark (*Centroscymnus coelolepis*). Molecular Ecology, 24: 6061-6079.

Clarke, M.W., Connolly, P.L. and Bracken, J.J. 2001. Aspects of reproduction of deep-water sharks *Centroscymnus coelolepis* and *Centrophorus squamosus* from west of Ireland and Scotland. Journal of the Marine Biological Association of the United Kingdom, 81: 1019–1029.

Clarke, M.W., Connolly, P.L. and Bracken, J.J. 2002. Age estimation of the exploited deep-water shark *Centrophorus squamosus* from the continental slopes of the Rockall Trough and Porcupine Bank. Journal of Fish Biology, 60: 501–514.

Compagno, L. J. V. and Niem, V. H. 1998. Squalidae. In FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 2. Cephalopods, crustaceans, holothurians and sharks, pp 1213–1232. Ed. by K.E. Carpenter and V.H. Niem. FAO, Rome.

Diez, G., Basterretxea, M., Cuende, E., Oyarzabal, I., Pedrajas, A. (2023). Abundance, biomass and CPUE of deep-water sharks in the longline survey (PALPROF) in the Bay of Biscay (ICES 8c). Update from 2015 to 2022. Working Document presented to the Working Group on Elasmobranch Fishes. 11 p.

Diez G, Arregi L, Basterretxea M, Cuende E, Oyarzabal I (2021). Preliminary observations on abundance and distribution of fish fauna in a canyon of the Bay of Biscay (ICES Division 8c). Journal of the Marine Biological Association of the United Kingdom, 101, 169-178, https://doi.org/10.1017/S0025315420001265

Fernandes, A. C., Prista, N., Jardim, E., Silva, D. and Ferreira, A., P. 2011. Results from the 2010 Portuguese onboard sampling programme of the deepwater longline fleet with an emphasis on elasmobranch species. Working Document presented in the ICES Working Group on Elasmobranch Fishes (WGEF), Copenhagen, June 2011.

Figueiredo, I., Moura, T. 2016. The Portuguese black scabbardfish longline fishery in ICES division IXa: data needed to assess the by-catch of deep-water sharks and to develop advice on possible mitigation measures to reduce the by-catches. Working Document for the ICES Working Group on Elasmobranch Fishes, Lisbon, 15-24 June 2016. 13 pp.

Figueiredo, I., Moura, T. 2019. Onboard sampling information for deep-water sharks in Portuguese mainland waters (2009-2018). Working Document presented in the ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 18-27th June. 21 pp.

Finucci, B., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020a. *Centroscymnus coelolepis*. The IUCN Red List of Threatened Species 2020: e.T41747A2955293. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41747A2955293.en.

Finucci, B., Bineesh, K.K., Cheok, J., Cotton, C.F., Dharmadi, Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020b. *Centrophorus squamosus*. The IUCN Red List of Threatened Species 2020: e.T41871A68614964. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41871A68614964.en.

Girard M., Du Buit M. H. 1999 Reproductive biology of two deep-water sharks from the British Isles, *Centroscymnus coelolepis* and *Centrophorus squamosus* (Chondrichthyes: Squalidae). Journal of the Marine Biological Association of the UK, 79: 923–931.

Hareide, N. R. and Garnes, G. 2001. The distribution and catch rates of deep-water fish along the Mid-Atlantic Ridge from 43 to 61 N. Fisheries Research, 519: 297–310.

ICES. 2003. Report of ICES Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2–4 September 2003.

ICES. 2010. Report of the Benchmark Workshop on Deep-water Species (WKDEEP), 17–24 February 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:38. 247 pp

ICES. 2011a. Report of the Workshop on splitting of deep-water shark historical catch data 2011 (WKSHARK). 17th June 2011, Copenhagen, Denmark. ICES 2010/2/ACOM36; 25 pp.

ICES. 2011b. ICES Advisory Committee on Fishery Management. Report of the Working Group for Northeast Atlantic Continental Slope Survey (WGNEACS). Archimer, archive institutionnelle de l'Ifremer, ID : 10670/1.dbyb7u

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARKS), 19–22 January 2016, Lisbon, Portugal . ICES CM 2016/ACOM:40. 69 pp.

ICES. 2019. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 1:25. 964pp. http://doi.org/10.17895/ices.pub.5594

Lagarto, N., Moura, T., Farias, I., and Figueiredo, I. 2012. Sampling information from deep-water sharks caught in the black scabbardfish fishery from mainland Portugal. Working Document to ICES WGEF; 5 pp.

Moura, T., and Figueiredo, I. 2012. Reproductive strategy and population structure of *Centroscymnus coelolepis*. Working Document to ICES WGEF; 6 pp.

Moura, T., Figueiredo, I. and Gordo, L. 2008. Analysis of genetic structure of the Portuguese dogfish *Centroscymnus coelolepis* caught in the Northeast Atlantic using mitochondrial DNA (Control Region)-Preliminary results. Working Document to ICES WGEF.

Moura, T., Jones, E., Clarke, M.W., Cotton, C.F., Crozier, P., Daley, R.K., Diez, G., Dobby, H., Dyb, J.E., Fossen, I., Irvine, S.B., Jakobsdottir, K., López-Abellán, L.J., Lorance, P., Pascual-Alayón, P., Severino, R.B., and Figueiredo, I. 2014. Large- scale distribution of three deep-water squaloid sharks: integrating data on sex, maturity and environment. Fisheries Research, 157: 47–61.

Moura, T., Fernandes, A., Figueiredo, I., Alpoim, R., Azevedo, M. 2015. Results from the pilot study on the Portuguese trammel nets fishery targeting anglerfish in ICES Division IXa. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; 7 pp.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., Garcia Criado, M., *et al*. 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union.

OSPAR. 2021 Status assessment 2021 - leafscale gulper shark. https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-assesments/leafscale-gulper-shark/

Prista, N., Fernandes, A.C., Maia, C., Moura, T., and Figueiredo, I. 2014 WD. Discards of elasmobranchs in the Portuguese fisheries operating in ICES Division XIa: Bottom otter trawl, deepwater set longlines, set gillnet and trammel net fisheries (2004–2013). Working Document ICES WGEF. 18 pp.

Rodríguez-Cabello, C., and Sánchez, F. 2014. Is *Centrophorus squamosus* a highly migratory deep-water shark? Deep Sea Research Part I, 92: 1–10.

Rodríguez-Cabello, C., González-Pola, C., and Sánchez, F. 2016. Migration and diving behaviour of *Centrophorus squamosus* in the NE Atlantic. Combining electronic tagging and Argo hydrography to infer deep ocean trajectories. Deep Sea Research Part I, 115: 48–62.

Rodríguez-Cabello, C., and Sánchez, F. 2017. Catch and post-release mortalities of deep-water sharks caught by bottom longlines in the Cantabrian Sea (NE Atlantic) (in press). Journal of Sea Research, 130: 248-255.

Rodríguez-Cabello, C., Pérez, M. and Grasa, I. 2020. Taxonomic research on *Deania calcea* and *Deania profundorum* (Family: Centrophoridae) in the Cantabrian Sea (Northeast Atlantic) with comments on Deania hystricosa. Regional Studies in Marine Science 37. https://doi.org/10.1016/j.rsma.2020.101321

Santos J., H. Araújo, I. Salinas and N. Pérez. 2010. Elasmobranches Results from Spanish Discard Sampling Programme. Working Document presented to WGEF 2010.

Stefanni, S., Catarino, D., Ribeiro, P.A., Freitas, M., Menezes, G.M., Neat, F. and Stankovic´, D. 2021. Molecular Systematics of the Long-Snouted Deep Water Dogfish (Centrophoridae, Deania) With Implications for Identification, Taxonomy, and Conservation. Front. Mar. Sci. 7:588192. doi: 10.3389/fmars.2020.588192

Severino, R., Afonso-Dias, I., Delgado, J., and Afonso-Dias, M. 2009. Aspects of the biology of the leaf-scale gulper shark *Centrophorus squamosus* (Bonnaterre, 1788) off Madeira archipelago. Arquipélago-Life and Marine Sciences, 26: 57–61.

Veiga, N. 2015 WD. Onboard data from the Portuguese deep-water longliners: study of the spatial overlap between deep-water sharks and the black scabbardfish. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; 4 pp.

Veiga, N., Moura, T., and Figueiredo, I. 2013. Spatial overlap between the leafscale gulper shark and the black scabbardfish off Portugal. Aquatic Living Resources, 26: 343–353.

Veiga, N., Moura, T. and Figueiredo, I. 2015 WD. Spatial overlap between Portuguese dogfish and the black scabbardfish off Portugal. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; 18 pp.

Veríssimo, A., McDowell, J.R., and Graves, J.E. 2011. Population structure of a deep-water squaloid shark, the Portuguese dogfish (*Centroscymnus coelolepis*). ICES Journal of Marine Science, 68: 555–563.

Veríssimo, A., McDowell, J.R., and Graves, J.E. 2012. Genetic population structure and connectivity in a commercially exploited and wide-ranging deepwater shark, the leafscale gulper (*Centrophorus squamosus*). Marine and Freshwater Research, 63: 505–512.

3.15 Tables and Figures

Table 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) by ICES area from 1998 to 2004. Landings by species not available in these years, UA, unknown area.

	4.a	5.a	5.b	6	7	8	9	10	12	14	UA	Total
1988	0	0	0	0	0	0	560	0	0	0		560
1989	12	0	0	8	0	0	507	0	0	0		527
1990	8	0	140	6	0	6	475	0	0	0		635
1991	10	0	75	1013	265	70	1075	0	1	0		2509
1992	140	1	123	2013	1171	62	1114	0	2	0		4626
1993	63	1	97	2781	1232	25	946	0	7	0		5152
1994	98	0	198	2872	2087	36	1155	0	9	0		6455
1995	78	0	272	2824	1800	45	1354	0	139	0		6512
1996	298	0	391	3639	1168	336	1189	0	147	0		7168
1997	227	0	328	4135	1637	503	1311	0	32	9		8182
1998	81	5	552	4133	1038	605	1220	0	56	15		7705
1999	55	0	469	3471	895	531	972	0	91	0		6484
2000	1	1	410	3455	892	361	1049	0	890	0		7059
2001	3	0	475	4459	2685	634	1130	0	719	0		10105
2002	10	0	215	3086	1487	669	1198	0	1416	12		8093
2003	16	0	300	3855	3926	746	1180	0	849	4		10876
2004	5	0	229	2754	3477	674	1125	0	767	0		9031

Table 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of landings of Portuguese dogfish (t) by ICES area. FAO34, FAO area 34, UA, unknown area. 0 = landings <0.5 t.

	27.2	27.4	27.5	27.6	27.7	27.8	27.9	27.10	27.12	27-UA	TOTAL	FAO34
2005	0	2	149	414	392	92	541	0	8	60	1657	256
2006	0	1	138	244	214	106	537		0		1240	25
2007	0	2	133	186	14	29	143				507	0
2008		0	121	145	7	361	86				394	0
2009		0	27	47	3	4	33				114	
2010		0	31	24	2	0	1				58	0
2011			1		1		1				2	
2012			4				0				4	
2013			2				0				2	0
2014			5								5	0
2015		0				0	0				1	
2016					0	0					0	
2017							3*				3	
2018						0	2*				2	
2019							11*				11	
2020						0	9*				9	
2021												
2022												
2023												

*** Landings from the deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025).**

Table 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of landings of leafscale gulper shark (t) by ICES area. FAO34, FAO area 34; UA, unknown area. 0 = landings <0.5 t.

	27.2	27.4	27.5	27.6	27.7	27.8	27.9	27.10	27.12	27-UA	TOTAL	FAO34
2005	0	0	32	189	249	154	457	0	1	64	1147	565
2006		0	47	158	95	50	508		0		858	50
2007	0	0	44	28	26	2	231				331	0
2008		0	41	43	15	3	87				190	7
2009		0	50	83	4	1	26				165	13
2010		0	58	59	12	0	4				134	5
2011					3		1				3	3
2012					1		1				2	5
2013							0				0	4
2014			32		0		0				33	3
2015		1	9			0	0				10	
2016							0				0	
2017							7*				7	9*
2018							2*				2	9*
2019							17*				17	11*
2020		0					4*				4	8*
2021							0				0	
2022							0				0	
2023												

*** Landings from the deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025).**

Table 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Discards of Portuguese Dogfish available in the period 2010-2023.

Year	Ireland - all other bottom trawls		France - all other bottom trawls				France - set nets
	27.6.a	27.7.b.g.j	27.7.h		27.6.a	27.5.b	27.8.b
2010	0.13						
2011	0.44						
2012	0.12						
2013	0.04						
2014		1.51					
2015	0.03						
2016	0.41						
2017	0.12						
2018			4.18	165.60	1.79	0.06	4.18
2023		4.29					

Table 3.5. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Discards of leafscale gulper shark available in the period 2010-2021.

Year	Spain - all other bottom trawls		Spain - set nets	
	27.8c	27.9a	27.8c	27.9a
2018	12.49	6.39		
2019	0.26	0.13		
2021			4.93	0.59

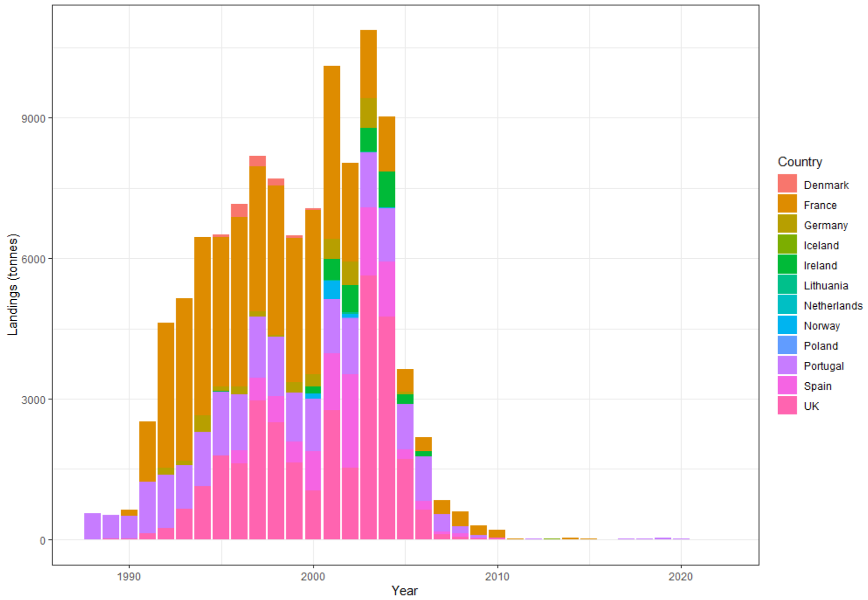
Table 3.6. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Spanish discard data for Leafscale gulper shark. Numbers of sampled trips and total trips are not available for the years 2010 onward.

Year	Celtic Sea (subareas 6–7)			Iberian Waters (divisions 8.c–9.a))		
	Sampled trips	Total trips	Raised discards (t)	Sampled trips	Total trips	Raised discards (t)
2003	9	1172	0	51	18 036	0
2004	11	1222	0	53	20 819	0
2005	10	1194	0	97	11 693	4.5
2006	13	1152	3.2	75	18 352	4.1
2007	12	1233	0	95	17 750	0
2008	11	1206	67.3	103	15 114	0
2009	15	1304	61.1	116	14 486	85.9
2010			0			29.2
2011			0			0.9
2012			173.4			0.7
2013			0			0

Table 3.7. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Total number of fishing trips, number of hauls and number of hauls with catch of Portuguese dogfish and leafscale gulper shark in French on-board observations (2005–2014).

Year	Country	Total number of:		Portuguese dogfish (positive hauls)		Leafscale gulper shark (positive hauls)	
		Trips	Hauls	Number	Proportion	Number	Proportion
2005	France	18	212	26	0.12	9	0.04
2006	France	9	106	18	0.17	1	0.01
2007	France	6	15	1	0.07	35	0.14
2008	France	18	245	12	0.05	143	0.24
2009	France	42	605	89	0.15	120	0.24
2010	France	48	504	93	0.18	71	0.16
2011	France	29	443	67	0.15	93	0.21
2012	France	32	449	35	0.08	79	0.18
2013	France	36	447	27	0.06	72	0.20

Year	Country	Total number of:		Portuguese dogfish (positive hauls)		Leafscale gulper shark (positive hauls)	
		Trips	Hauls	Number	Proportion	Number	Proportion
2014	France	31	365	34	0.09	9	0.04



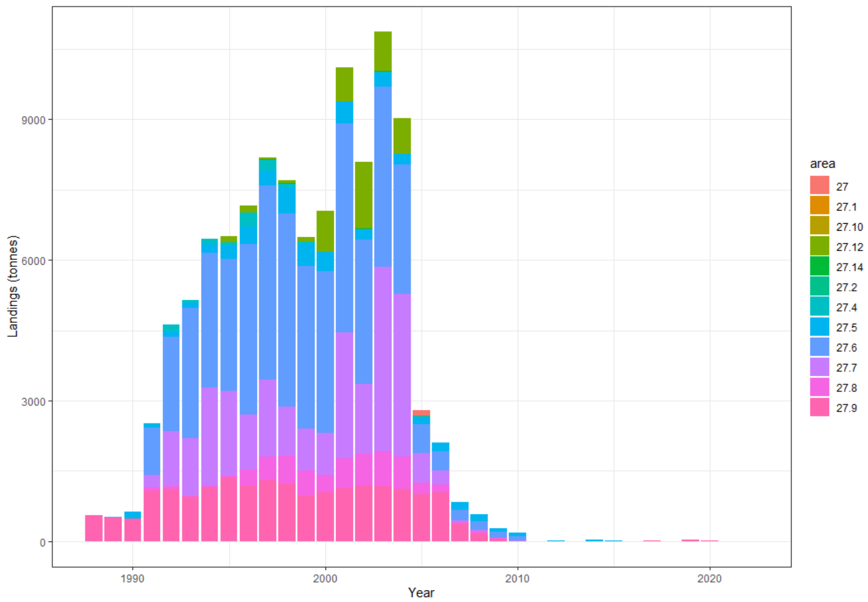


Figure 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimates of combined landings of the two species, by country (top) and by ICES Subarea (bottom).

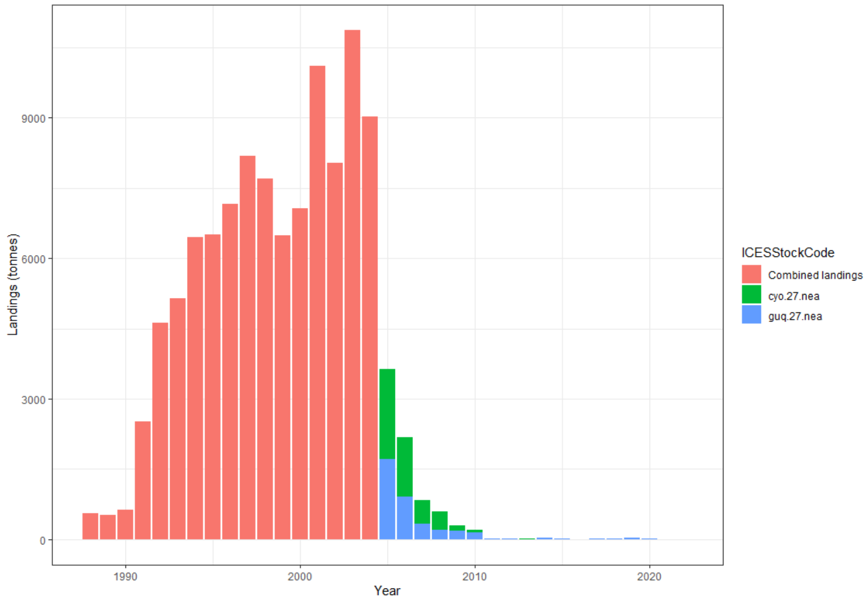


Figure 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimates of landings (combined landings from 1988 to 2004; by species from 2005 to 2023).

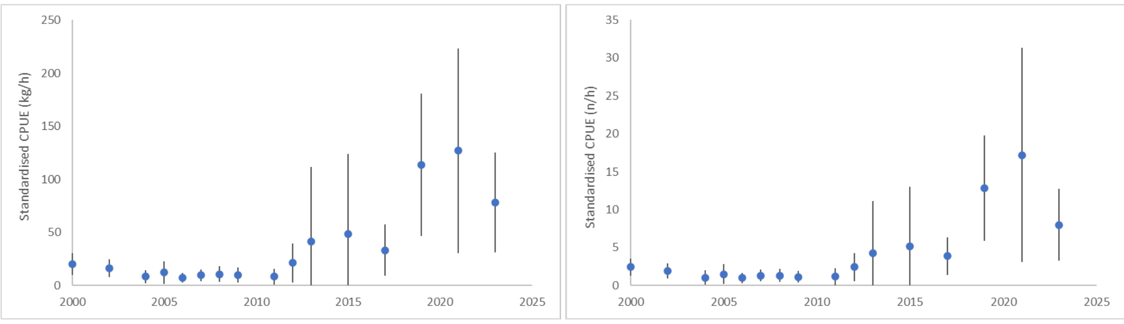


Figure 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Mean weight and number of Portuguese dogfish per tow in Scottish deep-water surveys 2000 to 2023.

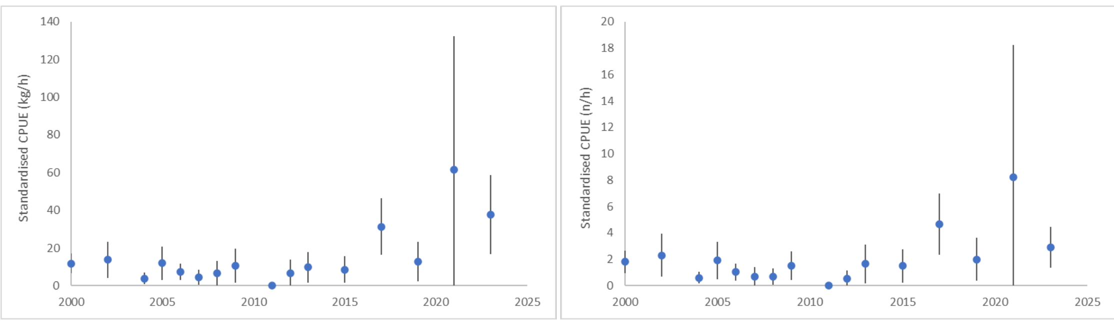


Figure 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Mean weight and number of leafscale gulper shark per tow in Scottish deep-water surveys 2000 to 2021.

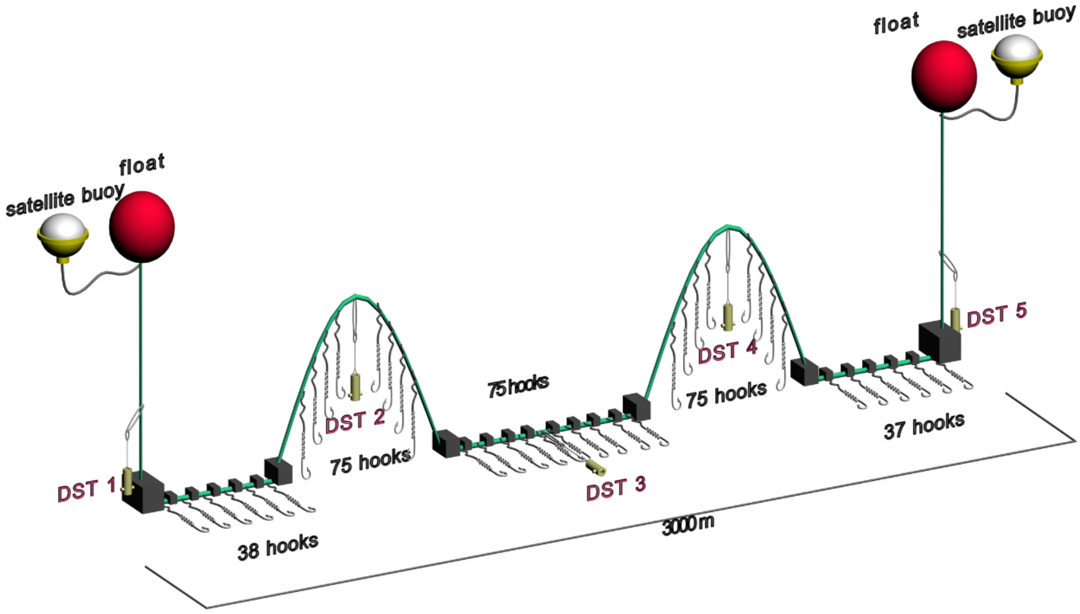


Figure 3.5. Deep-water sharks - Scheme of the final design of long-line fishing gear used in the PALPROF survey (from WD01 - Diez *et al.*, 2020).

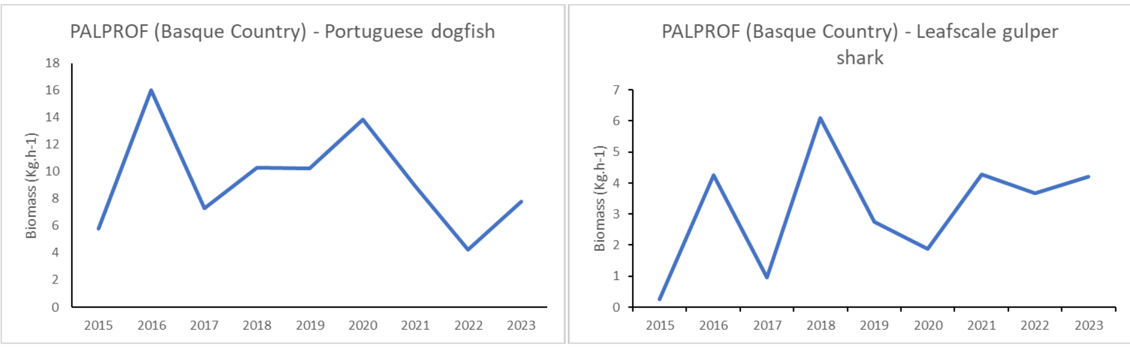


Figure 3.6 Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14)–CPUE (kg hook^{-1} min^{-1}) estimates for *C. coelolepis* and *C. squamosus* in the PALPROF survey (2015–2023).

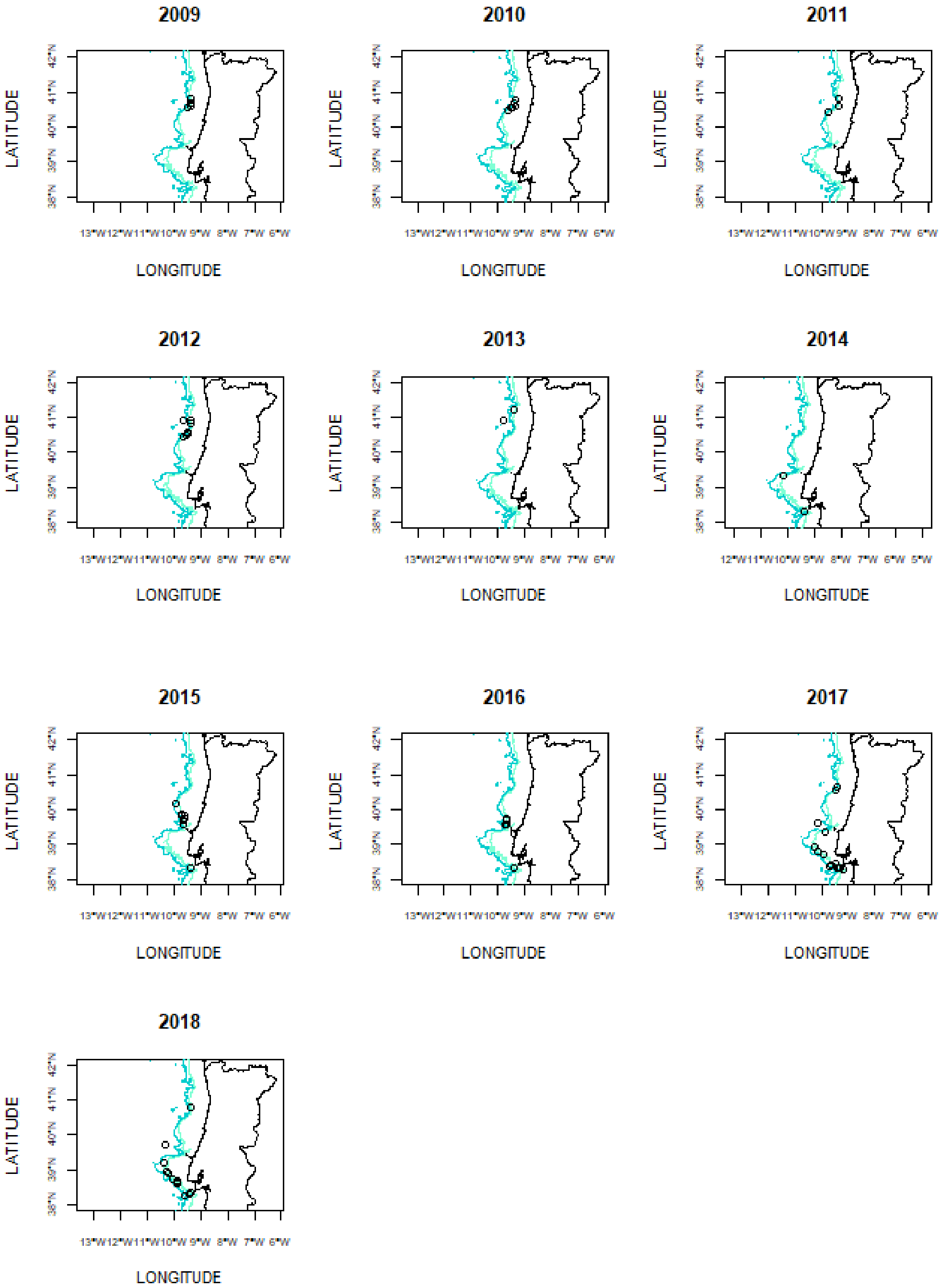


Figure 3.7. Deep-water sharks – Geographic locations of the LLS-DWS métier fishing hauls annually sampled by IPMA from 2009 to 2018.

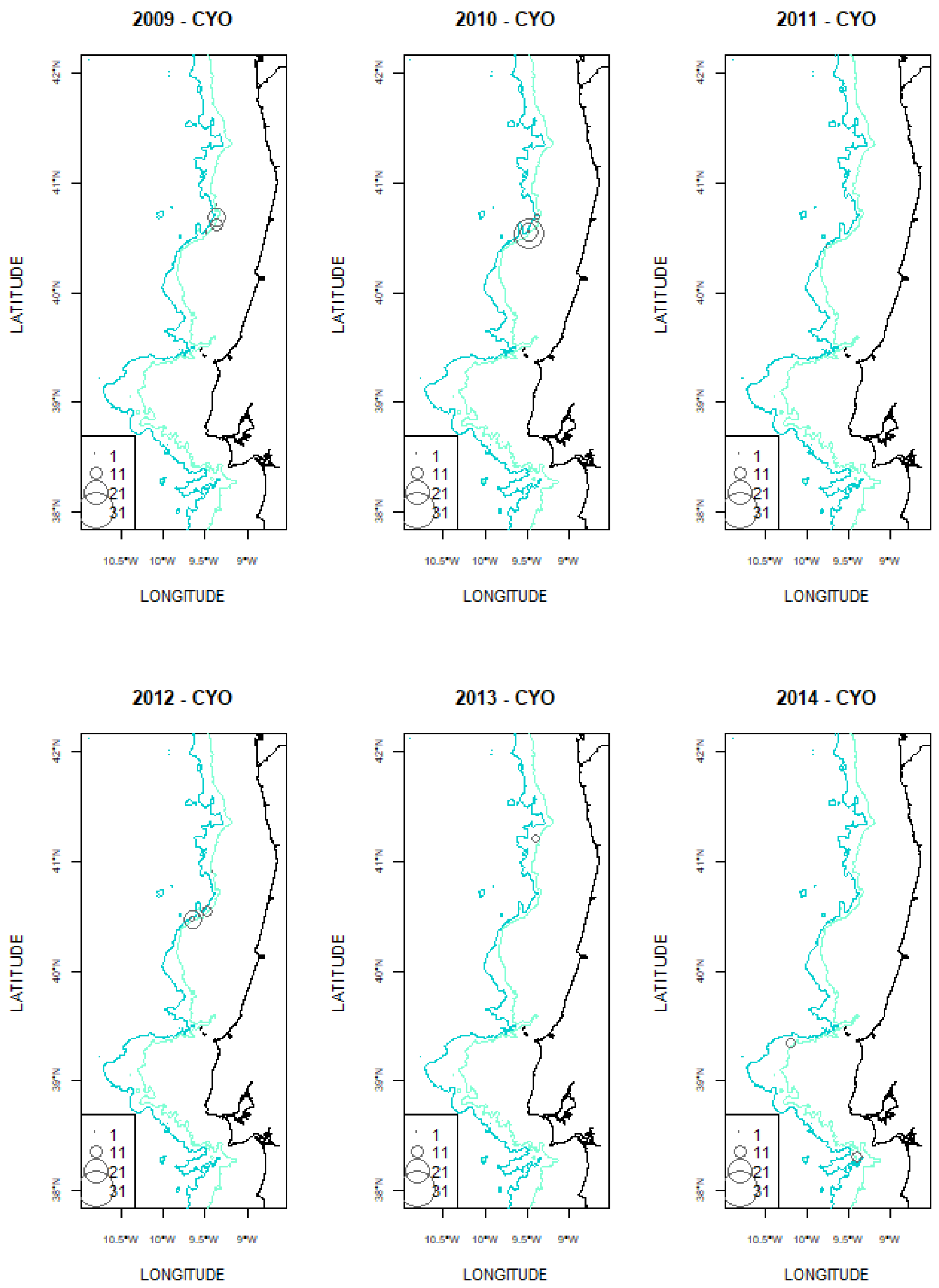


Figure 3.8. Deep-water sharks – Geographic location and number of specimens of *C. coelolepis* caught per fishing haul for the period 2009 to 2018.

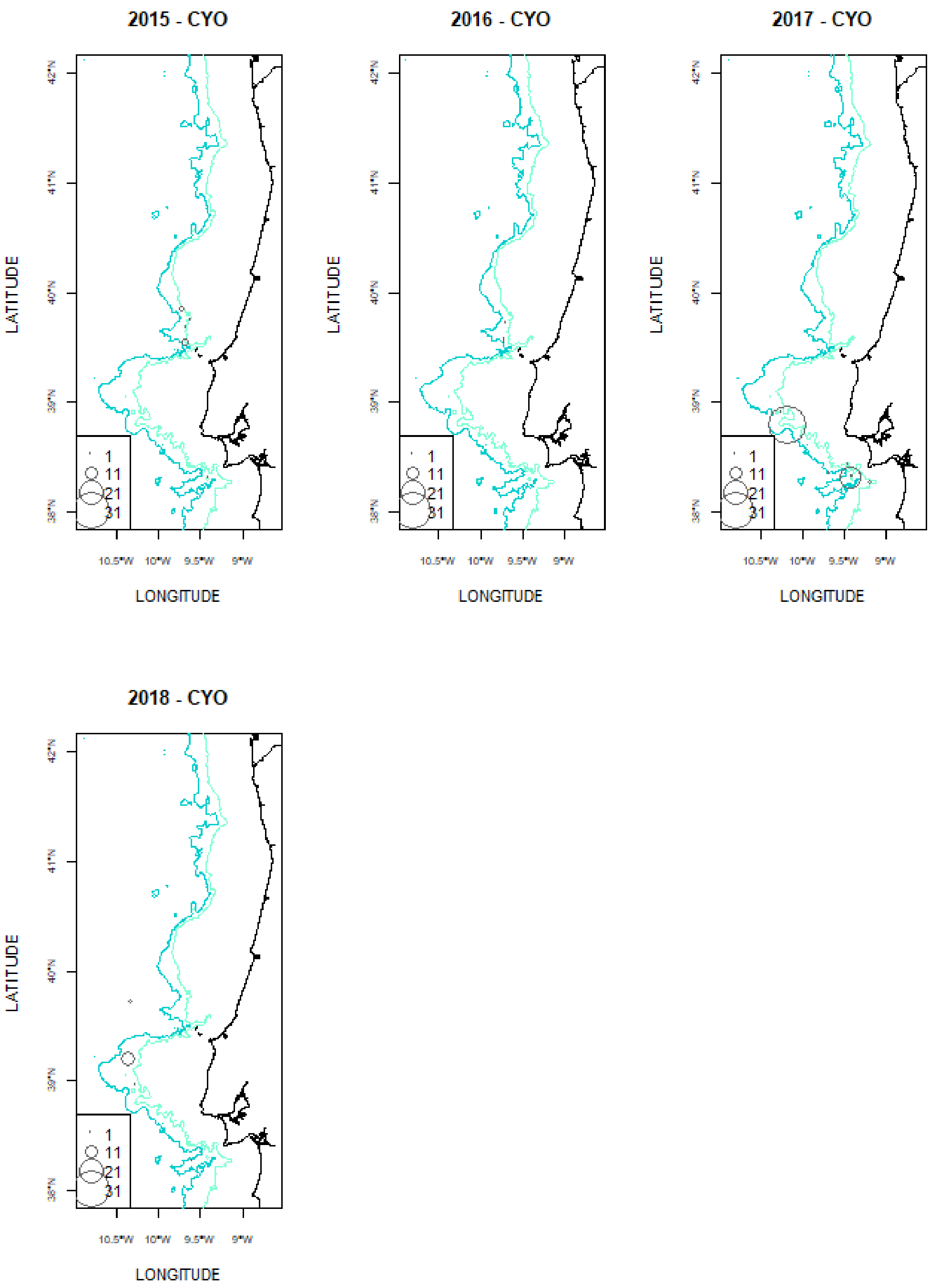


Figure 3.8 ***continued*** **Deep-water sharks – Geographic location and number of specimens of** ***C. coelolepis*** **caught per fishing haul for the period 2009 to 2018.**

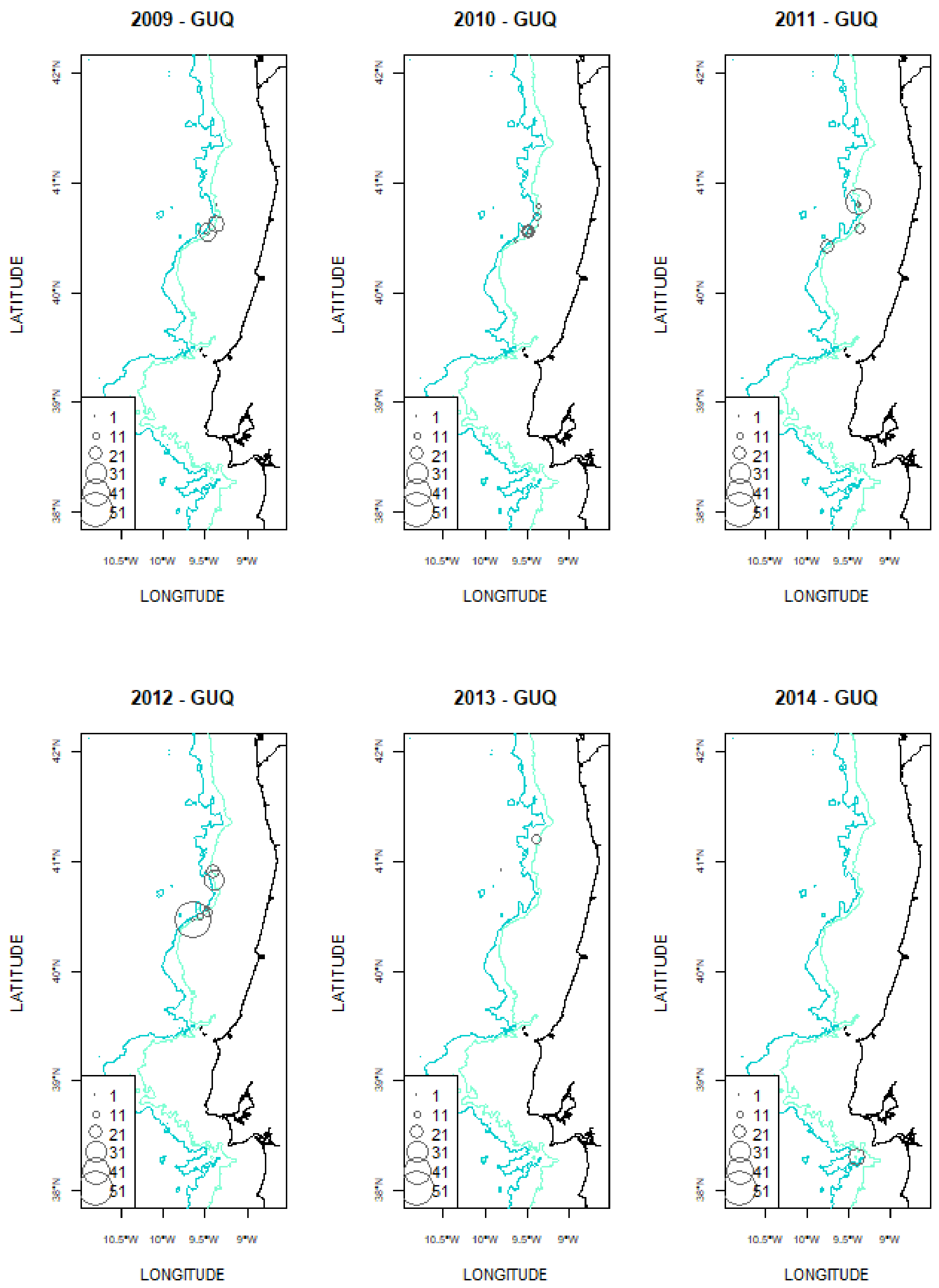


Figure 3.9. Deep-water sharks – Geographic location and number of specimens of *C. squamosus* caught per fishing haul for the period 2009 to 2018.

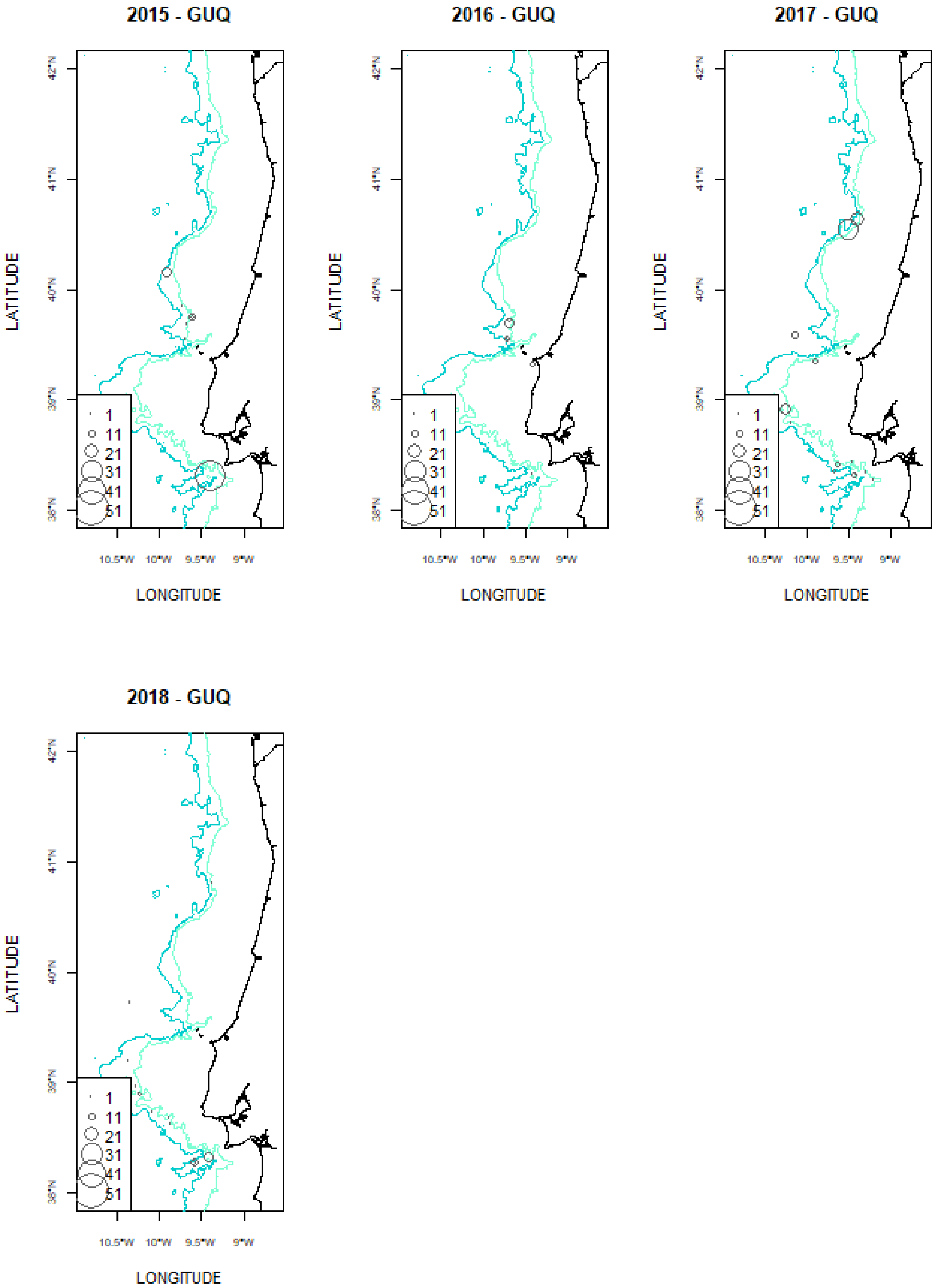


Figure 3.9. ***continued*** **Deep-water sharks – Geographic location and number of specimens of** ***C. squamosus*** **caught per fishing haul for the period 2009 to 2018.**

Contents

4 Kitefin shark in the Northeast Atlantic (entire ICES Area)

4.1 Stock distribution

Kitefin shark *Dalatias licha* is distributed widely in the deeper waters of the northeast Atlantic, from Norway to northwest Africa and the Gulf of Guinea, including the Mediterranean Sea and NW Atlantic.

The stock identity of kitefin shark in the NE Atlantic is unknown. However, the species seems to be more abundant in the southern area of the Mid-Atlantic Ridge (Subarea 10). Elsewhere in the NE Atlantic, kitefin shark is recorded infrequently. The species is caught as bycatch in mixed deep-water fisheries in subareas 5–7, although at much lesser abundance than the main deep-water sharks (see Section 3), and the species composition of the landings is not accurately known.

For assessment purposes, the Azorean stock (Subarea 10) is considered as a management unit. The Azores archipelago is composed of nine islands with almost no geological continental shelf, and an Exclusive Economic Zone (EEZ) with 461 identified seamounts. The Azores ecoregion (Subarea 10) lies within a much larger open ocean ecosystem, and straddles the Mid-Atlantic Ridge (ICES, 2020a).

4.2 The fishery

4.2.1 History of the fishery

A detailed description of historical fisheries can be found in Heessen (2003) and ICES (2003). The Azorean target fishery stopped at the end of the 1990s. Elsewhere in the North Atlantic, it is a bycatch in various deep-water fisheries.

Fishing in the Azores ecoregion occurs mostly around the island slopes and the numerous surrounding offshore seamounts (ICES, 2020b). Historically, Azorean landings of kitefin shark began in the early 1970s and increased rapidly to over 947 tonnes in 1981, fluctuating considerably thereafter, at least in part due to market fluctuations. Landings peaked at 937 tonnes in 1984 and 896 tonnes in 1991. In the 1990s, these landings have declined, possibly as a result of economic problems related to markets. From the early 1990s there has been some landings from other areas, which have declined from 2005 following the implementation and reduction over time of the TAC for deep-sea sharks.

4.2.2 The fishery in 2023

Currently there are no target fisheries for kitefin shark. Landings in the northeast Atlantic have been at low levels since 2005, with most of the catches reported from subareas 6, 7and 10 (Tables 4.1–4.6 and Figure 4.1). Small amounts are reported for other subareas but in some cases, landings may correspond to coding errors.

4.2.3 ICES advice

ICES advised that when the precautionary approach is applied, there should be zero catches in each of the years 2024–2027.

4.2.4 Management

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters in different ICES subareas are summarized in the table below (values in tonnes). The deep-sea shark category includes the kitefin shark *Dalatias licha* (Council regulation (EC) No 2285/2016).

Year	Subareas 5–9	Subarea 10	Subarea 12 (includes also *Deania histricosa* and *Deania profundorum*
2005 and 2006	6763	14	243
2007	2472(1)	20	99
2008	1646(1)	20	49
2009	824(1)	10(1)	25(1)
2010	0(2)	0(2)	0(2)
2011	0(3)	0(3)	0(3)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10(4)	10(4)	0
2018	10(4)	10(4)	0
2019	7(4)	7(4)	0
2020	7(4)	7(4)	0
2021(5)	---	---	---
2022(5)	---	---	---
2023(5)	---	---	---

(1) Bycatches only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatches of up to 10% of 2009 quotas are permitted.

(3) Bycatches of up to 3% of 2009 quotas are permitted.

(4) Bycatch only for bottom longline fisheries targeting black scabbardfish.

(5) Species included in the prohibited list of the TAC regulations.

Council Regulation (EC) No 1568/2005 banned the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas.

Council Regulation (EC) No 41/2007 banned the use of gillnets by Community vessels at depths greater than 600 m in divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12. A maximum bycatch of deep-water shark of 5% is allowed in hake and monkfish gillnet catches and 10% on the bottom longline fisheries targeting black scabbardfish.

A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from these waters by 1 February 2006.

In 2009, the Azorean Regional Government introduced new technical measures for the demersal/deep-water fisheries (Ordinance 43/2009, May 27th) including area restrictions by vessel size and gear, and gear restrictions (hook size and maximum number of hooks on the longline gear). These measures have been adapted thereafter. In Azorean waters, there is a network of closed areas (summarized in Section 20). The Condor seamount has been closed to demersal/deep-water fisheries since 2010.

Since 2015 that the kitefin shark is included on the EU prohibited species list for Union waters of Division 2.a and Subarea 4 and in all waters of Subareas 1 and 14 (Council Regulation (EC) No 2015/104, Art. 12:1(g)). In 2016 the EU established specific conditions for fishing for deep-sea stocks in the Northeast Atlantic (EU Regulation 2016/2336).

A by-catch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. According to this, Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34.2. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

Since 2021 there is a prohibition to fish, to retain on board, to tranship, to relocate or to land some deep-water sharks species (including the kitefin shark) in United Kingdom and Union waters of ICES subarea 4; United Kingdom waters of division 2a; international waters of ICES subareas 1 and 14; United Kingdom, Union and international waters of ICES subareas 6 to 9; United Kingdom and international waters of 5; Union and international waters of ICES subarea 10; Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2; and international waters of ICES subarea 12 (Council Regulation (EU) 2023/194).

4.3 Catch data

4.3.1 Landings

The annual landings reported from each country are given in Tables 4.1–4.6 and in Figure 4.1.

4.3.2 Discards

No new data were presented this year.

Discard rates of 15–85% of the kitefin shark caught per set were reported from the sampled Azorean longliners during 2004–2010 (ICES, 2012). Since 2011, discards may have increased due to management restrictions (decreasing TACs followed by prohibition), or been landed as unspecified elasmobranchs.

Sporadic and low levels of kitefin shark discards were reported from the Spanish trawl fleets operating in divisions 8.c and 9.a in 2010–2012.

4.3.3 Quality of catch data

Historic landings of deep-water sharks taken in the Azores were commonly gutted, finned, beheaded and also skinned. Only the trunks and, in some cases, the livers were landed. Misidentification problems were likely to occur with other deep-water shark species in ICES Division 10.a.

The reported Azorean landings data come exclusively from the commercial first sale of fresh fish at auctions and so landings data (Table 4.5) may be underestimated.

4.4 Commercial catch composition

No new information.

4.5 Commercial catch–effort data

No new information.

4.6 Fishery-independent surveys

Existing research surveys rarely catch kitefin shark, as the surveys are not designed for the species, and thus will not provide relevant information for the assessment.

Relative abundances of kitefin shark (ind. h^{-1}) from the Scottish deep-water trawl survey (depth range 500–1000 m) were submitted in 2016 to the group (Table 4.7). These data confirm that only low numbers are caught (<10 specimens are caught each survey). For the entire survey period, a total of 34 specimens (8 males of 60–110 cm, and 26 females of 40–140 cm) have been caught.

Relative biomass estimates of kitefin shark (kg $haul^{-1}$) from the Spanish Groundfish Survey in the Porcupine Bank were provided to WGEF (WD Fernández-Zapico *et al*., 2024). In 2023, the biomass and abundance index of *D. licha* increased (Figure 4.2). However, the mean biomass of 2022–2023 was low compared with the 2017–2021 values due to the peak in 2021 (Figure 4.3). A total of 10 hauls showed presence of this species, between 426 and 954 m deep, where individuals with sizes from 37 to 113 cm total length were found, mainly in the deepest strata in the south and west of the study area (Figure 4.4–4.5).

Relative biomass estimates of kitefin shark (kg $haul^{-1}$) from the bottom trawl survey on the Northern Spanish Shelf were submitted in 2024 to the group (WD Ruiz-Pico *et al*., 2024. One female individual sized at 61 cm was captured in one haul at 941 m depth, in the south of Galician area.

The Azorean longline survey (ARQDAÇO–L6563) has on average of 495 fishing stations per survey, covering a depth range 50–1200 m. During the period 1995–2018, a total of 102 kitefin sharks were caught, averaging about five individuals per year (Santos *et al*., 2020). Over the entire time period, specimens were caught at depths of 150–850 m and their total length ranged from 43–150 cm (Santos *et al*., 2020).

The PALPROF survey in ICES Division 8.c did not provide survey indicator for kitefin shark as the species was only caught in one out of nine years of this survey.

4.7 Life-history information

There is no new information available.

4.8 Exploratory assessment models

Exploratory kitefin shark stock assessments were conducted during the 1980s, using an equilibrium Fox production model (Silva, 1987). The stock was considered intensively exploited with the average observed total catches (809 tonnes) near the estimated maximum sustainable yield (MSY = 933 tonnes). An optimum fishing effort of 281 days fishing bottom nets and 359 trips fishing with handlines was proposed, corresponding approximately to the observed effort.

During the DELASS project (Heessen, 2003), a Bayesian stock assessment approach using the Pella-Tomlinson biomass dynamic model was applied to two fisheries, handline and bottom gillnet (ICES, 2003; 2005). Based on the probability of the Biomass 2001 be less than B_{MSY}, the stock was considered depleted.

4.9 Stock assessment

No new assessment was undertaken in 2024.

In the last assessment (2023), the ICES framework for category 6 was applied (ICES, 2012). 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.

Landings have declined after the early 1990s, which is considered to be partly due to market conditions. In line with the zero TAC, landings have been negligible since 2010 and there are no new data to assess the status of the stock.

4.10 Quality of assessments

No new assessment was undertaken.

4.11 Reference points

No reference points have been proposed for this stock.

4.12 Conservation considerations

Kitefin shark is listed as 'Vulnerable' on the IUCN Red List (Finucci *et al*., 2018).

4.13 Management considerations

Initial assessment results suggested that the stock might have been depleted to about 50% of virgin biomass (Silva, 1987). However, further analysis is required to better understand the actual status of the stock. Fisheries for kitefin shark have been affected by fluctuations in the price of shark liver oil. An analysis of liver oil prices may provide some information on historical exploitation levels of this species.

There are no adequate fishery-independent surveys to monitor the stock. WGEF recommends that the development of a fishery should not be permitted unless data on the level of sustainable catches become available. If an artisanal sentinel fishery is established, it should be accompanied by a data collection programme.

4.14 References

Heessen, H. J. L. 2003. Report of the DELASS Project.

ICES. 2003. Report of the Working Group on Elasmobranch Fishes. ICES CM 2003/G:09, 155 pp.

ICES. 2005. Report of the Working Group on Elasmobranch Fishes. ICES CM 2006/ACFM:03, 224 pp.

ICES. 2012. Report of the Working Group on Elasmobranch Fishes. ICES CM 2012/ACOM:19, 532 pp.

ICES. 2020a. Azores ecoregion – Ecosystem overview. In Report of the ICES Advisory Committee, 2020. ICES Advice 2020, Section 3.1. https://doi.org/10.17895/ices.advice.7628.

ICES. 2020b. Azores ecoregion – Fisheries overview. In Report of the ICES Advisory Committee, 2020. ICES Advice 2020, section 3.2. https://doi.org/10.17895/ices.advice.7600 .

Ruiz-Pico, S., Fernandez-Zapico, O., Blanco, M., Rodríguez-Cabello, C., Ortiz, P., González-Irusta, J.M., Punzón, A., Velasco, F. 2024. Results on main elasmobranch species captured in the 2023 Northern Spanish Shelf Groundfish Survey. Working Document presented to ICES WGEF 2024, WD; 47 pp.

Finucci, B., Walls, R.H.L., Guallart, J. & Kyne, P.M. 2018. *Dalatias licha*. The IUCN Red List of Threatened Species 2018: e.T6229A3111662. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T6229A3111662.en

Fernandez-Zapico, O., Ruiz-Pico, S., Blanco, M., Ortiz, P., Velasco, F., Rodríguez-Cabello, C., Baldó, F. 2024. Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic). Working Document presented to ICES WGEF 2024, WD; 41 pp.

Santos, R., Novoa-Pabon, A., Silva, H., Pinho, M. 2020. Elasmobranch species richness, fisheries, abundance and size composition in the Azores archipelago (NE Atlantic), *Marine Biology Research*, 16:2, 103-116. doi: 10.1080/17451000.2020.1718713

Silva, H. M. Da. 1987. An assessment of the Azorean stock of kitefin shark, *Dalatias licha*. ICES Copenhagen, ICES CM 1987/G:66, 10 pp.

4.15 Tables and Figures

Table 4.1. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from Subareas 5 and 6.

Year	5.b	6.a	TOTAL
	France	UK	
2005		19.1	19.1
2006	1.30	25	26
2007		1.84	1.84
2008			
2009			
2010			
2011			
2012			
2013			
2014			
2015			
2016			
2017			
2018			
2019			
2020			
2021			
2022			
2023			

Table 4.2. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from Subarea 7.

Year	7.b			7.c		7.e-g	7.j-k			TOTAL
	France	UK	Ireland	UK	Ireland	France	UK	Germany	Ireland	
2005		0.37	0.02	11.3	4.6		58	21	2.6	99
2006			0.36	0.34	5.3		3.7		3	12.8
2007		0.34					2.27			2.6
2008										
2009										
2010	0.085					0.0037				0.089
2011										
2012										
2013										
2014										
2015										
2016										
2017										
2018						0.3				0.3
2019										
2020										
2021										
2022										
2023										

Table 4.3. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from Subarea 8.

Year	8.a	8.b	8.c		8.d	8.e	TOTAL
	France	France	France	UK	UK	UK	
2005		1.06					1.06
2006	0.48	1.38	0.1	0.69	0.074	1.475	4.2
2007		0.95	0.0142		0.23		1.19
2008		0.85					0.5
2009	0.00125	0.18					0.181
2010		0.42					0.42
2011		0.59	0.072				0.66
2012		0.0055					0.0055
2013		0.0033					0.0033
2014	0.0057	0.023					0.028
2015							
2016	0.018	0.143					0.161
2017		0.0062					0.0062
2018	0.026	0.065					0.091
2019		0.03					0.03
2020							
2021							
2022							
2023		0.058					0.058

Table 4.4. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from Subarea 9.

Year	9.a	9.b	TOTAL
	Portugal	UK	
2005	3.2		3.2
2006	6.5	4.2	10.7
2007	2.5		2.5
2008	1.08		1.08
2009	1.1		1.1
2010	0.079		0.079
2011	0.164		0.164
2012	0.42		0.42
2013	0.003		0.003
2014	0.006		0.006
2015			
2016	0.133		0.133
2017	0.055		0.055
2018	0.062		0.062
2019	0.009		0.009
2020	0.027		0.027
2021			
2022			
2023			

Table 4.5. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from Subarea 10.

Year	10.a	Unallocated	TOTAL
	Portugal	Ireland	
2005	14.3	0.44	14.8
2006	9.6		9.6
2007	6.5		6.5
2008	9.6		9.6
2009	6.3		6.3
2010	1.92		1.92
2011			
2012			
2013			
2014			
2015			
2016			
2017			
2018			
2019			
2020			
2021			
2022			
2023			

Table 4.6. Kitefin shark in the Northeast Atlantic. Landings (tonnes) from unallocated ICES Subarea.

Year	France	TOTAL
2005		
2006		
2007		
2008		
2009		
2010	1.2	1.2
2011		
2012		
2013		
2014		
2015		
2016		
2017		
2018		
2019		
2020		
2021		
2022		
2023		

Table 4.7. Kitefin shark in the Northeast Atlantic. Relative abundance (number per hour trawling) from Scottish deep-water survey (depth range 500–1000 m: Only one fish has been caught outside this core depth range) in Subarea 6.

Year	Nº hauls	Nº positive hauls	Nº fish	Mean Nph
1998	17	2	2	0.05
2000	13	0	0	0.00
2002	16	2	4	0.13
2004	14	2	2	0.07
2005	13	1	4	0.15
2006	20	3	8	0.20
2007	15	2	7	0.23
2008	20	3	5	0.13
2009	27	1	1	0.06
2011	15	1	1	0.07
2012	18	0	0	0.00
2013	11	1	1	0.09

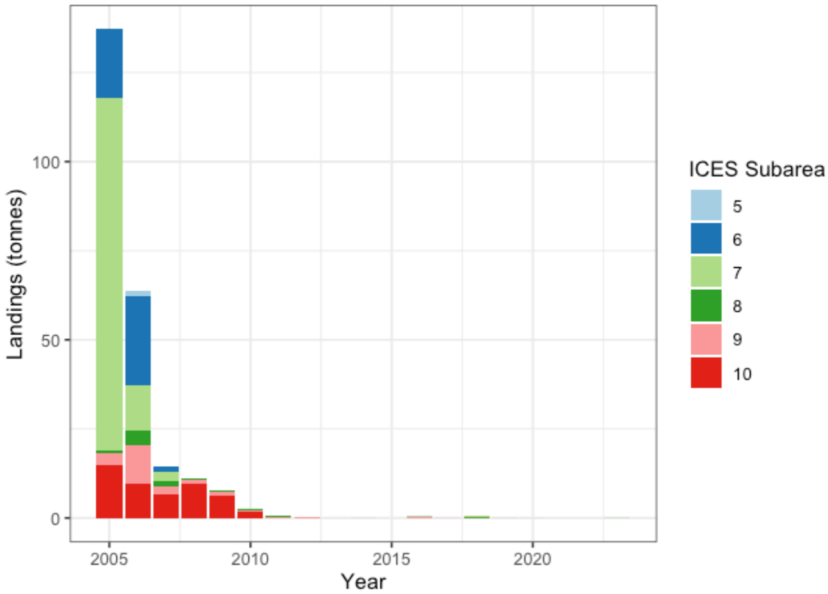


Figure 4.1. Kitefin shark in the Northeast Atlantic. Stacked barchart of reported landings (tonnes) by ICES Subarea.

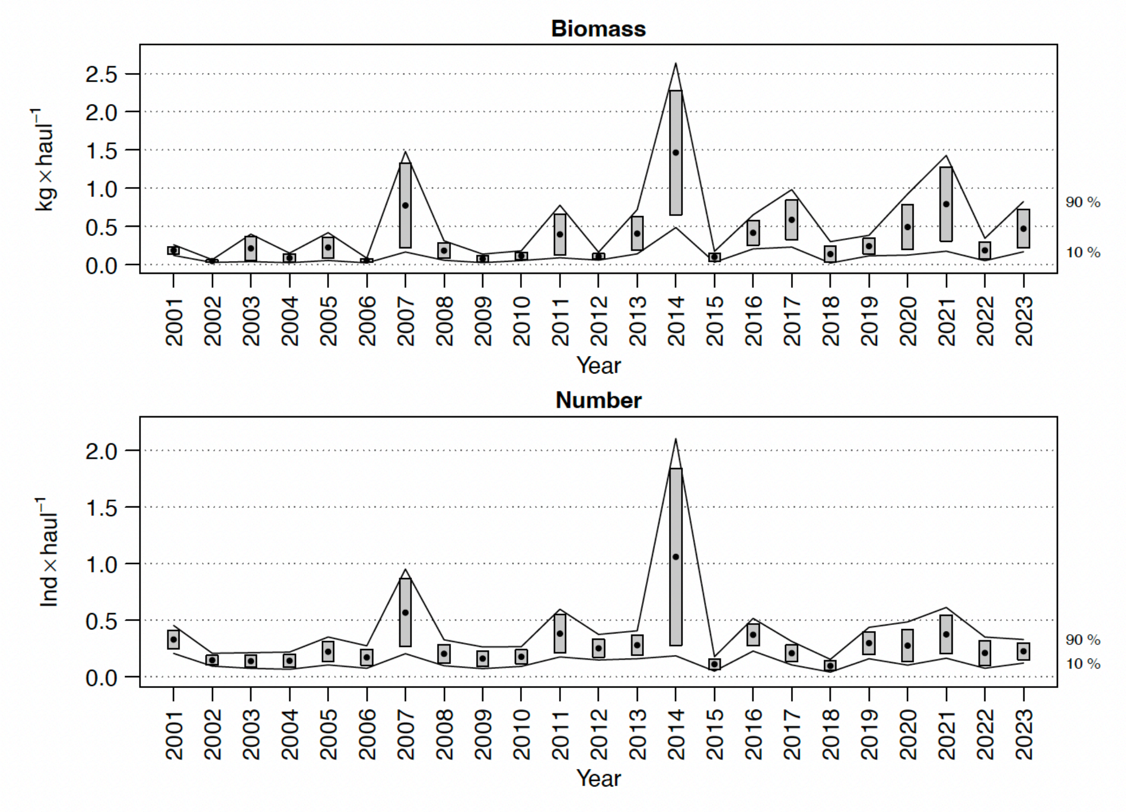


Figure 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance in weight (kg/haul) and number from the Spanish groundfish survey on the Porcupine bank. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Source: Fernández-Zapico *et al.* (2024).

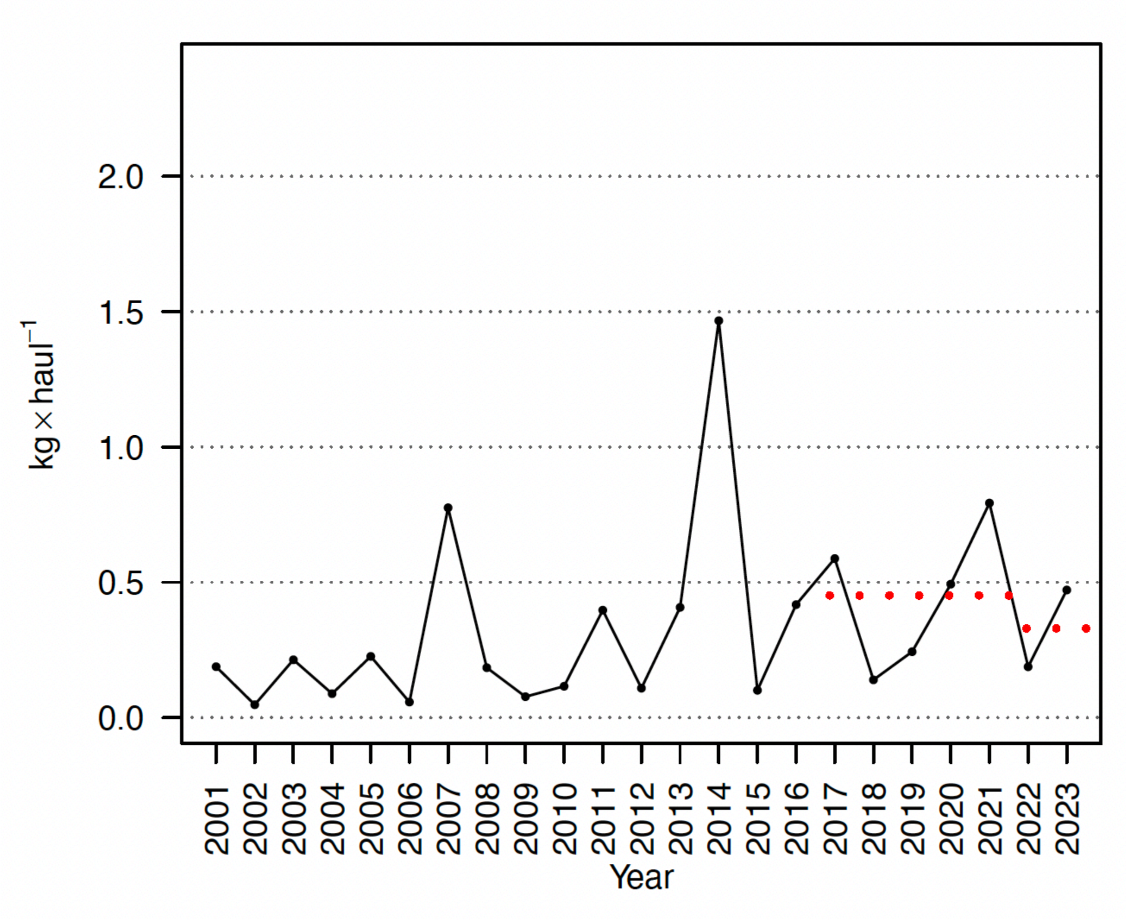


Figure 4.3. Kitefin shark in the Northeast Atlantic. Evolution of the biomass index in the Porcupine surveys (2001–2023). Dotted red lines compare mean stratified biomass in the last two years (2022–2023) with the five previous years (2017–2021). Source: Fernández-Zapico *et al.* (2024).

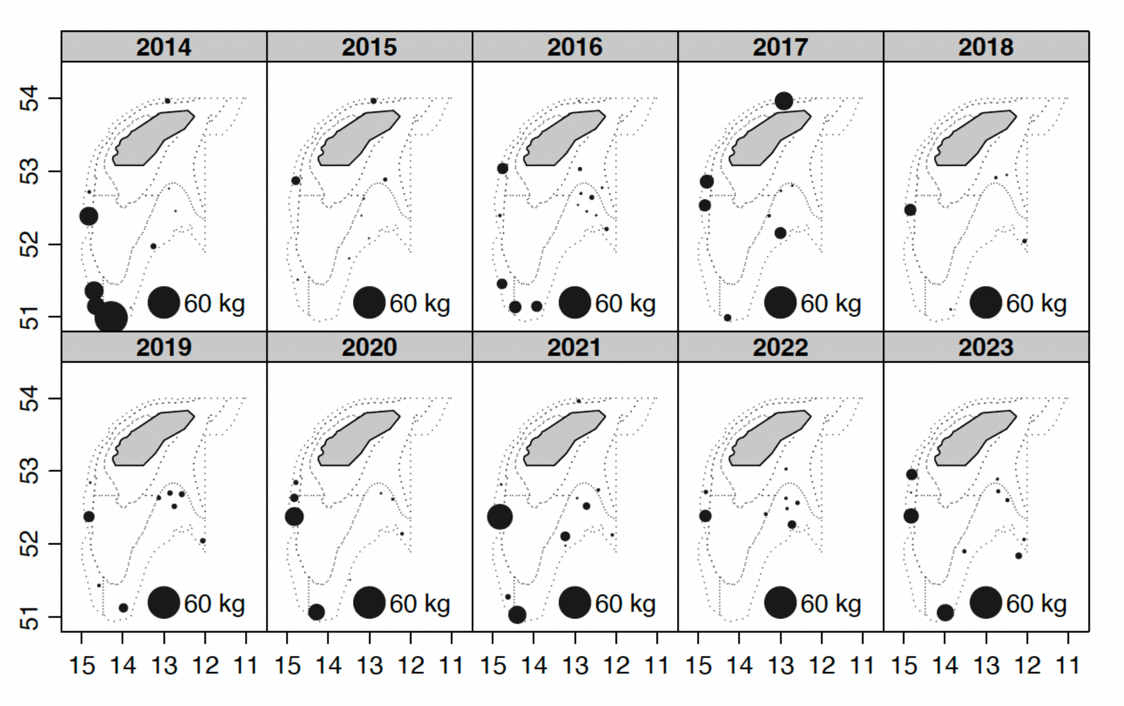


Figure 4.4. Kitefin shark in the Northeast Atlantic. Annual (2014–2023) spatial distribution (kg/30 min haul[-1]) in the Porcupine bank survey. Source: Fernández-Zapico *et al.* (2024).

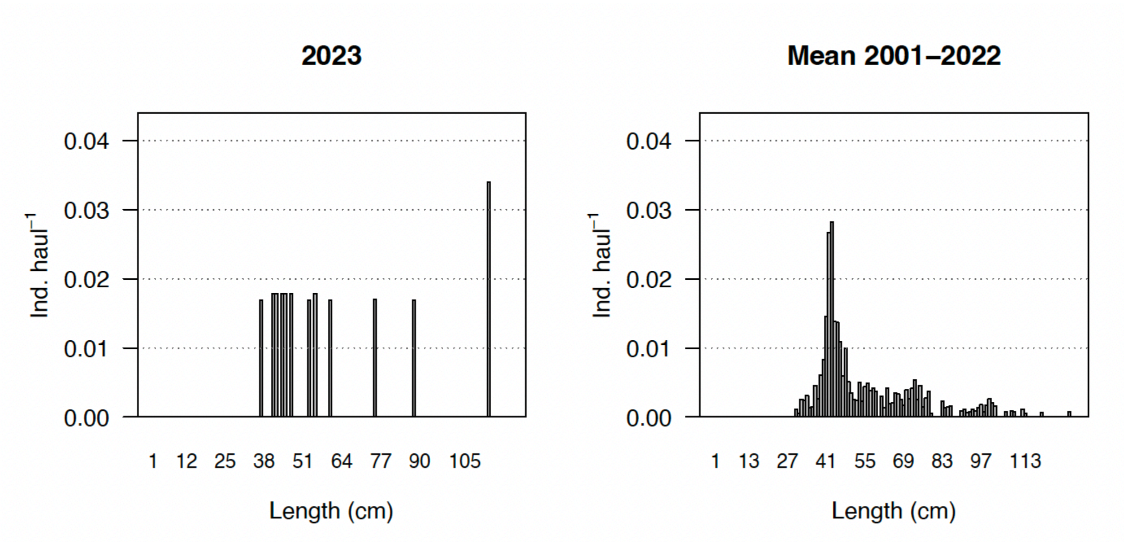


Figure 4.5. Kitefin shark in the Northeast Atlantic. Annual length composition from the Spanish groundfish survey on the Porcupine Bank. Source: Fernández-Zapico *et al.* (2024).

Contents

5 Other deep-water sharks and skates from the Northeast Atlantic (ICES subareas 4–14)

5.1 Stock distributions

This section includes information about deep-water elasmobranch species other than Portuguese dogfish and leafscale gulper shark (see Section 3), kitefin shark (see Section 4) and Greenland shark (see Section 24). Limited information exists on the majority of the deep-water elasmobranchs considered here, and the stock units for these species are unknown.

The species and generic landing categories for which data are presented are: gulper sharks *Centrophorus* spp., birdbeak dogfish *Deania calceus*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*, lanternsharks *nei Etmopterus* spp. Historical catches of knifetooth dogfish *Scymnodon ringens*, arrowhead dogfish *Deania profundorum*, bluntnose sixgill shark *Hexanchus griseus*, mouse catshark *Galeus murinus,* velvet belly lanternshark *Etmopterus spinax* and 'aiguillat noir' (which may include *C. fabricii, C. crepidater* and *Etmopterus* spp.) were also presented in the past reports (see ICES, 2018). Other deep-water sharks in the ICES area include: deep-water catsharks *Apristurus* spp., frilled shark *Chlamydoselachus anguineus*, great lanternshark *Etmopterus princeps* and sailfin roughshark (sharpback shark) *Oxynotus paradoxus.*

Fifteen species of skate (Rajidae) are known from deep water in the NE Atlantic: Arctic skate *Amblyraja hyperborea*, Jensen's skate *Amblyraja jenseni*, Krefft's skate *Malacoraja kreffti*, roughskin skate *Malacoraja spinacidermis*, deep-water skate *Rajella bathyphila*, pallid skate *Bathyraja pallida*, Richardson's skate *Bathyraja richardsoni*, Bigelow's skate *Rajella bigelowi*, round skate *Rajella fyllae*, Mid-Atlantic skate *Rajella kukujevi*, spinytail skate *Bathyraja spinicauda*, sailray *Rajella lintea*, Norwegian skate *Dipturus nidarosiensis,* blue pygmy skate *Neoraja caerulea* and Iberian pygmy skate *Neoraja iberica*.

Species such as common skate complex, shagreen skate *Leucoraja fullonica*, starry ray *Amblyraja radiata* and longnose skate *Dipturus oxyrinchus* also distributed in shallower waters down to 500 m and are not considered in this section. The electric ray *Torpedo nobiliana* may also occur in deep waters.

Eight species of rabbitfish (Chondichthyes; Holocephali), including members of the genera *Chimaera, Hariotta* and *Rhinochimaera* are a bycatch of some deep-water fisheries and are sometimes marketed. The current zero-TACs for deep-water sharks, whose livers were used to extract squalene, may have led to the increased retention of rabbitfish, particularly common chimaera *Chimaera monstrosa* in Norway to produce "ratfish oil". Catches of Chimaeridae are included in the report of the ICES Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP).

5.2 The fishery

5.2.1 History of the fishery

Most species of other deep-water shark and skate species are taken as by-catch in mixed trawl, longline and gillnet fisheries together with Portuguese dogfish, leafscale gulper shark and deep-water teleosts.

5.2.2 The fishery in 2023

Deep-water elasmobranch species are usually taken as bycatch in mixed fisheries. Regulations in place (see below) for deep-water sharks' and difficulties in monitoring limit the information available for this group of species.

5.2.3 ICES advice applicable

No species-specific advice is given for the shark and skate species considered here.

5.2.4 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters, UK waters and international waters at different ICES subareas are summarized below.

Year	ICES subareas		
	5–9	10	12 (includes also *Deania histricosa* and *Deania profondorum)* (5)
2005 and 2006	6763	14	243
2007	2472(1)	20	99
2008	1646(1)	20	49
2009	824(1)	10(1)	25(1)
2010	0(2)	0(2)	0(2)
2011	0(3)	0(3)	0(3)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10(4)	10(4)	0
2018	10(4)	10(4)	0
2019	7(4)	7(4)	0
2020	7(4)	7(4)	0
2021(6)	---	---	---
2022(6)	---	---	---
2023(6)	---	---	---
2024(6)	---	---	---

(1) Bycatch only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatch of up to 10% of 2009 quotas is permitted.

(3) Bycatch of up to 3% of 2009 quotas is permitted.

(4) Exclusively for bycatch in longline fishery targeting black scabbardfish. No directed fishery shall be permitted.

(5) Recent studies demonstrated that there is not enough scientific support to discriminate *Deania hystricosa* from its congener *Deania calceus*; they are likely the same species (Rodríguez-Cabello *et al*., 2020; Stefanni *et al*., 2021)

(6) Some species included in the prohibited list of the TAC regulations

Since 2013, the deep-sea shark category includes the following species (Council regulation (EC) No 1182/2013): Deep-water catsharks *Apristurus* spp., frilled shark *Chlamydoselachus anguineus*, gulper sharks *Centrophorus* spp., Portuguese dogfish *Centroscymnus coelolepis*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*; birdbeak dogfish *Deania calceus*; kitefin shark *Dalatias licha*; greater lantern shark *Etmopterus princeps*; velvet belly *Etmopterus spinax*; mouse catshark *Galeus murinus*; six-gilled shark *Hexanchus griseus*; sailfin roughshark *Oxynotus paradoxus*; knifetooth dogfish *Scymnodon ringens* and Greenland shark *Somniosus microcephalus*.

Since 2013, under NEAFC Recommendation 7, it was required that Contracting Parties prohibit vessels flying their flag in the Regulatory Area from directed fishing for deep-sea sharks on the following list: *Centrophorus granulosus, Centrophorus squamosus, Centroscyllium fabricii, Centroscymnus coelolepis, Centroscymnus crepidater, Dalatias licha, Etmopterus princeps, Apristurus* spp., *Chlamydoselachus anguineus, Deania calceus, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

Since 2015, the birdbeak dogfish (*D. calcea*) and the great lanternshark (*E. princeps*) have been included on the EU prohibited species list for Union waters of Division 2.a and Subarea 4 and in all waters of Subareas 1 and 14 (Council Regulation (EC) No 2015/104).

A by-catch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). According to this limited landing of unavoidable by-catches of deep-sea sharks were allowed and Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 and 7 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2 in 2017–2018 and 2019–2020, respectively. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

Since 2021 there is a prohibition to fish, to retain on board, to tranship, to relocate or to land some deep-water sharks species (including some considered in this chapter) in United Kingdom and Union waters of ICES subarea 4; United Kingdom waters of division 2a; international waters of ICES subareas 1 and 14; United Kingdom, Union and international waters of ICES subareas 6 to 9; United Kingdom and international waters of 5; Union and international waters of ICES subarea 10; Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2; and international waters of ICES subarea 12 (Council Regulation (EU) 2023/194).

EU regulations on some deep-water fisheries likely contributed to the reduction of the deep-water sharks fishing mortality. In 2005, the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas was banned (Council Regulation (EC) No 1568/2005). In 2007, the use of gillnets by Community vessels at depths greater than 600 m in ICES divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12 was banned while a maximum bycatch of deep-water shark of 5% in hake and monkfish gillnet catches was allowed (Council Regulation (EC) No 41/2007). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from NEAFC waters by 1 February 2006.

Since 2009, the "rasco (gillnet)" fishing gear was banned at depths lower than the 600 m isobath (EC Regulation 43/2009,). The regulation affected 4–6 boats in the Basque Country that used this technique. The "rasco" fleet targets anglerfish *Lophius* spp., which represents around 90% of catch weight. This métier is highly seasonal, with the highest activity occurring during winter months. Catches during these months tend to occur in deeper waters, where the nets are sunk to depths down to 1000 m.

Since 2016, fishing with bottom trawls was permitted only < 800 metres (EU Regulation 2016/2336) in order to mitigate the potential damaging impacts of bottom trawling at these depths.

5.3 Catch data

5.3.1 Landings

Landings estimates from 2005 onwards were revised following WKSHARK2 (updated in WGEF 2018). Information, by species, is presented below. Past information is presented in ICES (2018). Due to the management measures in force for deep-water sharks, their landings in 2023 continued to be low (Tables 5.1–5.7).

Gulper sharks *Centrophorus* spp. (excluding *C. squamosus*)

WGEF landings estimates of gulper sharks are presented in Tables 5.1 and 5.7.

In 2023, Portugal reported landings of approximately 48 kg of *Centrophorus* spp.

Birdbeak dogfish *Deania calceus*

WGEF landings estimates of birdbeak dogfish are presented in Tables 5.2 and 5.7.

Five European countries reported landings of birdbeak dogfish: Norway, Ireland, UK, Spain and Portugal. In 2023, landings of 142 kg were reported by Norway.

Longnose velvet dogfish *Centroscymnus crepidater*

WGEF landings estimates of longnose velvet dogfish are presented in Tables 5.3 and 5.7.

No landings were reported in 2023 for this species.

Black dogfish *Centroscyllium fabricii*

Reported landings of black dogfish are presented in Tables 5.4 and 5.7.

In 2023, Iceland reported landings of 496 kg for this species.

Lanternsharks *Etmopterus* spp.

Reported landings of velvet belly lanternshark *Etmopterus spinax* are presented in Table 5.5 until 2004. Revised landing data provided to WGEF from 2005 onwards indicates that landings assigned to *E. spinax* should be considered as *Etmopterus* spp. Those figures are provided in Tables 5.6 and 5.7. Six countries have reported landings of *Etmopterus* spp.: Denmark, Norway, UK, France, Spain and Portugal. Until 2001, highest landings were from Denmark. In 2023, Norway reported *E. spinax* landings of 282 tonnes.

Portuguese landings mainly referred to *Etmopterus spinax* and *Etmopterus pusillus*, however, only a very small proportion of the catches of these species is retained.

Catches of this species by Russian deep-water longline fisheries in the Faroese Fishing Zone and other North-eastern Atlantic areas were reported in working documents to WGEF (Vinnichenko and Fomin, 2009 WD; Vinnichenko *et al*., 2010 WD). Landings data from this fishery were not subsequently available to the working group.

Other species

There are landings information for other deep-water shark species, presented in Table 5.7. Other reported landings are sporadic and very low and thus were not presented.

5.3.2 Discards

Given the restrictive EU TACs for deep-water sharks (set to zero in 2010), it was admitted that the discarding in deep-water fisheries had increased. However, with the several EU regulations in place, particularly the ban of gillnet, entangle and trammel net fisheries at depths >600 m and trawl deep-water fisheries at depths >800 m, the potential bycatch and subsequent discarding of deep-water sharks is now thought to be relatively low. Since 2010, that discard information is limited to some years and countries.

Historical discards from Portugal (Azores and mainland) and Spain are available in ICES (2018).

Ireland: Discard data from Ireland are available from 2009 to 2020 from the trawl fleet operating in ICES divisions 27.6.a and 27.7.bgj (Table 5.8). Discards are considered negligible as values estimated are <1 tonne in most of the years.

Denmark: Discard data from *E. spinax* is available from 2009 to 2017 (Table 5.8). This species is mostly discarded by the trawl fleet from areas 27.3.a, 27.4.a and 27.4.b. Discards varied among years but has remained around 5–6 tonnes in 2016 and 2017.

Sweden: Discard data from *E. spinax* is available for 2019 (12.72 tonnes), 2022 (2.37 tonnes) and 2023 (1.46 tonnes; Table 5.8).

5.3.3 Quality of the catch data

Data provided to WGEF since 2017 followed WKSHARK2 guidelines. Despite the decisions taken regarding the assignment of landings to species or higher *taxa* some problems persist. For example, some quantities of deep-water species are maintained grouped in generic categories such as “sharks indetermined”, “unidentified deepwater sharks” or “Squaliformes”.

As a result of restrictive quotas for deep-water sharks, landings of these species may have been misreported.

5.3.4 Discard survival

No data available to the Working Group.

5.4 Commercial catch composition

No new information is available.

5.5 Commercial catch and effort data

No new information is available.

5.6 Fishery-independent surveys

5.6.1 ICES Subarea 6

The Scottish deep-water trawl survey has operated since 1996 at depths of 300–2000 m along the continental slope between approximately 55˚N and 59˚N (see Neat et al. (2010) for details). Since 2013 that the survey takes place every two years. Neat et al. (2015) analysed catches of deep-water elasmobranch species from Scottish deep-water trawl survey. This information is available in past reports (e.g., ICES, 2018).

5.6.2 ICES Subarea 7

The Spanish survey on the Porcupine Bank (SpPGFS-WIBTS-Q4) in ICES divisions 7.c and 7.k covers an area from longitude 12°W to 15°W and from latitude 51°N to 54°N following the standard IBTS methodology for the western and southern areas (ICES, 2010). A random stratified sampling design is used (Velasco and Serrano, 2003) with two geographical sectors (North and South) and three depth strata (<300 m, 300–450 m and 450–800 m). Haul 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). Results for 2023 are presented in Fernández-Zapico *et al.* (WD 2024). The most abundant deep-water shark species in biomass in these surveys were *H. griseus* (bluntnose sixgill shark), *D. calceus* (birdbeak dogfish), *S. ringens* (knifetooth dogfish), *E. spinax* (velvet belly lantern shark) and *D. licha* (kitefin shark). Length distributions for these species are presented in the working document presented to WGEF (see Fernández-Zapico *et al.*, WD 2024).

5.6.3 ICES divisions 8.c and 9.a

From 2015 to 2023, AZTI conducted a deep-water longline survey (PALPROF) along the Basque Coast (600–2400 m deep) onboard a commercial longliner, with the objective of estimating and assessing the inter-annual variation of the abundance and biomass indices of the deep-water sharks and other ichthyofauna (see details in WD - Diez *et al.*, 2023; Diez *et al.* 2021). More information is presented in Section 3.9.2. from Section 3 (3. Deep-water sharks; Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14)).

The Spanish survey in the Cantabrian Sea and Galician waters (SpGFS-WIBTS-Q4) has covered this area annually since 1983 (except 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranchs. A new vessel (R/V Miguel Oliver) is in use since 2013, but in 2021, due to the vessel breakdown the survey was also partially conducted in R/V Vizconde de Eza, using the same gear. More details on the survey design, methodology and results can be found in ICES (2017). Elasmobranchs represented 17% of the total fish caught in the survey in 2023 (WD - Ruiz-Pico *et al.*, 2024). Length distributions for the most abundant species are presented in the working document presented to WGEF (see WD - Ruiz-Pico *et al.*, 2024).

5.6.4 ICES Subarea 10

Data from the Azorean bottom longline survey (ARQDAÇO-L6563) in subdivision 10.a2 were given in Pinho and Silva (2017, WD) and Santos et al. (2020). *Deania* spp. were the most representative (abundant) species in the survey. *Centroscymnus crepidater* was common, but much less abundant. Other species occurred in very low numbers (averaging 1–4 individuals per year).

Depth ranges and length composition data are available. It should be noted that the gear configuration used is not adequate for sampling all the species (Pinho and Silva, 2017 WD).

5.7 Life-history information

See ICES (2018) for further details.

5.8 Exploratory assessments analyses of relative abundance indices

The exploratory assessments below are all based on analyses of relative abundance or biomass indices in fishery-independent surveys.

Information previously submitted to WGEF for the black dogfish *C. fabricii,* the longnose velvet dogfish *C. crepidater,* the greater lantern shark *E. princeps,* the small-eye catshark *A. microps,* the pale catshark *A. aphyodes* and other deep-water skates and rays are presented in ICES (2018).

5.8.1 Summary of occurrences and trends by species

Birdbeak dogfish *Deania calceus* and Arrowhead dogfish *Deania profundorum*

In the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) time series, these two species were traditionally registered together, but have been better separated since 2012. The biomass and abundance index of *Deania calceus* peaked in 2014 and 2016 and decreased in the following years. In 2023 the biomass value remained among the average values of the time series (Figure 5.1). The biomass and abundance of *D. profundorum* in this survey is low (WD - Fernández-Zapico *et al.*, 2024).

In the SpGFS-WIBTS-Q4 in the Cantabrian Sea and Galician waters, both species are more frequent in additional deeper hauls (>500 m) and scarce or absent on the standard hauls (70–500 m) (Figure 5.2). After two years without records, *Deania calceus* has been caught since 2019 although at low biomass values (only one individual was caught both in 2022 and 2023). The biomass caught of *D. profundorum* increased over time (WD - Ruiz-Pico *et al.*, 2024).

Deania calceus has been frequently caught in the PALPROF survey in ICES Division 8.c (2015–2021). The CPUE values are variable but show a decrease in biomass in 2022 and 2023 (Figure 5.3).

Knifetooth dogfish *Scymnodon ringens*

In SpPGFS-WIBTS-Q4, the biomass of *S. ringens* increased in 2023, although not reaching the maximum of the time series observed in 2021 (Figure 5.4) (WD - Fernández-Zapico *et al.*, 2024).

Biomass values of this species in the SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters are low. This species is mostly caught in the additional deeper hauls (Figure 5.5) (WD - Ruiz-Pico *et al.*, 2024).

Velvet belly lanternshark *Etmopterus spinax*

In the SpPGFS-WIBTS-Q4, the biomass values of *E. spinax* have been fluctuating throughout the time series without any trend (Figure 5.6; WD - Fernández-Zapico *et al.*, 2024).

In the SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters the biomass of *E. spinax* in standard hauls increased (Figure 5.7). However, the highest fraction of the biomass of this elasmobranch is usually found in hauls deeper than 500 m. In these additional deep hauls, the biomass caught by haul increased in latest years (WD - Ruiz-Pico *et al*., 2024).

Bluntnose six-gill shark *Hexanchus griseus*

This is not a frequent shark in the SpPGFS-WIBTS-Q4 and results should be considered with caution. Abundance and biomass of *H. griseus* in this survey increased in 2022 but is still among the lowest values of the time series. (Figure 5.8) (WD - Fernández-Zapico *et al*., 2024).

Hexanchus griseus is not frequent in the SpGFS-WIBTS-Q4 and results should be considered with caution. In 2023, the biomass of *H. griseus* in standard hauls decreased after attaining the highest value of the time series in 2022 (Figure 5.9). However, the values are still among the highest of the time series. Very few individuals are caught in the deep hauls (WD - Ruiz-Pico *et al*., 2024).

Other deep-water elasmobranchs

In the 2023 SpPGFS-WIBTS-Q4, there are records of *Dalatias licha, Centroscymnus crepidater, Apristurus melanoasper, Centrophorus squamosus, Centroscymnus coelolepis* and *Centroscymnus crepidater* (WD03 - Fernández-Zapico *et al*., 2024).

Centroscymnus crepidater and *Etmopterus princeps* were caught in the PALPROF survey in ICES Subdivision 8.c and CPUE data is available for the period 2015–2023 (Figure 5.3).

5.9 Stock assessment

No formal assessments are undertaken for these stocks.

5.10 Quality of assessments

No assessments undertaken.

5.11 Reference points

No reference points have been proposed for any of the species.

5.12 Conservation considerations

The European Red List of marine fishes considers *C. granulosus* to be Critically Endangered, *Echinorhinus brucus*, *D. calceus* and *D. nidarosiensis* as Endangered; and *Centrophorus uyato* and *Oxynotus centrina* as Vulnerable (Nieto *et al*., 2015).

Recent IUCN assessments for a group of deep-water sharks classified *C. crepidater*, *D. profundorum*, *D. calceus* and *H. griseus* as globally Near Threatened, *S. ringens* as globally Vulnerable, *C. granulosus*, *C. uyato* and *E. brucus* as globally Endangered. All these species were considered to have their populations stable or increasing in the NE Atlantic (Finucci *et al*. 2020a-h).

The gulper shark is included in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) List of Threatened and/or Declining Species & Habitats (OSPAR, 2008).

5.13 Management considerations

No management advice is given in 2024.

5.14 References

Diez, G., L., Basterretxea, M., Cuende, E., Oyarzabal, I., Pedrajas, A. 2023. Abundance, biomass and CPUE of deep-water sharks in the longline survey (PALPROF) in the Bay of Biscay (ICES 8.c). Update from 2015 to 2022. Working Document presented to ICES WGEF 2023, 11 pp.

Diez G, Arregi L, Basterretxea M, Cuende E, Oyarzabal I 2021. Preliminary observations on abundance and distribution of fish fauna in a canyon of the Bay of Biscay (ICES Division 8c). Journal of the Marine Biological Association of the United Kingdom , 101, 169-178, https://doi.org/10.1017/S0025315420001265

Fernandez-Zapico, O., Ruiz-Pico, S., Blanco, M., Ortiz, P., Velasco, F., Rodriguez-Cabello, C., Baldó, F. 2023. Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic). Working Document presented to ICES WGEF 2024; 41 pp.

Finucci, B., Bineesh, K.K., Cheok, J., Cotton, C.F., Dharmadi, Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020a. *Centrophorus granulosus*. The IUCN Red List of Threatened Species 2020: e.T162293947A2897883. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T162293947A2897883.en

Finucci, B., Bineesh, K.K., Cotton, C.F., Dharmadi, Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020b. *Centrophorus uyato*. The IUCN Red List of Threatened Species 2020: e.T41745A124416090. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41745A124416090.en.

Finucci, B., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020c. *Centroselachus crepidater*. The IUCN Red List of Threatened Species 2020: e.T46864A68615502. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T46864A68615502.en.

Finucci, B., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020d. *Deania calcea*. The IUCN Red List of Threatened Species 2020: e.T41798A68619155. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41798A68619155.en

Finucci, B., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020e. *Deania profundorum*. The IUCN Red List of Threatened Species 2020: e.T161551A44016720. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161551A44016720.en.

Finucci, B., Bineesh, K.K., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020f. *Echinorhinus brucus*. The IUCN Red List of Threatened Species 2020: e.T41801A2956075. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T41801A2956075.en.

Finucci, B., Barnett, A., Bineesh, K.K., Cheok, J., Cotton, C.F., Dharmadi, Graham, K.J., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020g. *Hexanchus griseus*. The IUCN Red List of Threatened Species 2020: e.T10030A495630. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T10030A495630.en.

Finucci, B., Cheok, J., Cotton, C.F., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S. and Walker, T.I. 2020h. *Scymnodon ringens*. The IUCN Red List of Threatened Species 2020: e.T161717A116739828. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161717A116739828.en.

ICES. 2018. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–28 June 2018, Lisbon, Portugal. ICES CM 2018/ACOM:16. 1306 pp.

Kingsley, M.C.S., Kanneworff, P., and Carlsson, D.M. 2004. Buffered random sampling: a sequential inhibited spatial point process applied to sampling in a trawl survey for northern shrimp *Pandalus borealis* in West Greenland waters. ICES Journal of Marine Science, 61: 12–24.

Neat, F. C., Kynoch, R.J., Drewery, J. and Burns, F. 2010. Deepwater survey manual. Marine Scotland Science: http://www.scotland.gov.uk/Resource/Doc/295194/0103756.pdf.

Neat, F. C., Burns, F., Jones, E. and Blasdale, T. 2015. The diversity, distribution and status of deep-water elasmobranchs in the Rockall Trough, north-east Atlantic Ocean. Journal of Fish Biology, 87: 1469–1488.

Nieto, A., Ralph, G. M., Comeros-Raynal, M. T., Kemp, J., Garcia Criado, M., et al. 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union.

OSPAR. 2008. Case Reports for the OSPAR List of threatened and/or declining species and habitats. Biodiversity Series. 261 p.

Pinho, M.R. and Silva, H. 2017. Resuming elasmobranchs survey data from the Azores (ICES 27.10a). Working Document presented to ICES WGEF WD2017-11; 18 pp.

Rodríguez-Cabello, C., Pérez, M. and Grasa, I. 2020. Taxonomic research on *Deania calcea* and *Deania profundorum* (Family: Centrophoridae) in the Cantabrian Sea (Northeast Atlantic) with comments on *Deania hystricosa*. Regional Studies in Marine Science 37. https://doi.org/10.1016/j.rsma.2020.101321

Ruiz-Pico, S., Fernandez-Zapico, O., Blanco, M., Rodríguez-Cabello, C., Ortiz, P., González-Irusta, J.M., Punzón, A, Velasco, F. 2024. Results on main elasmobranch species captured in the 2023 Northern Spanish Shelf Groundfish Survey. Working Document presented to ICES WGEF 2024; 47 pp.

Santos, R., Novoa-Pabon, A., Silva, H., Pinho, M. 2020. Elasmobranch species richness, fisheries, abundance and size composition in the Azores archipelago (NE Atlantic), *Marine Biology Research*, 16:2, 103-116. doi: 10.1080/17451000.2020.1718713

Stefanni, S., Catarino, D., Ribeiro, P.A., Freitas, M., Menezes, G.M., Neat, F. and Stankovic´, D. 2021. Molecular Systematics of the Long-Snouted Deep Water Dogfish (Centrophoridae, *Deania*) With Implications for Identification, Taxonomy, and Conservation. Front. Mar. Sci. 7:588192. doi: 10.3389/fmars.2020.588192

Velasco, F., and Serrano, A. 2003. Distribution patterns of bottom trawl faunal assemblages in Porcupine Bank: Implications for Porcupine surveys stratification design. Working Document presented to IBTSWG 2003; 19 pp.

Vinnichenko, V.I. and Fomin K. Yu. 2009. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2008. Working document presented to ICES WGEF 2009; 12 pp.

Vinnichenko, V.I., Dolgov, A.V. and A.S.Yurko. 2010. Russian Research and Fisheries of Sharks and Skates in the Northeast Atlantic in 2009. Working Document to ICES WGEF WD2010-14.

5.15 Tables and Figures

Table 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of gulper sharks (*Centrophorus granulosus* and *Centrophorus* spp.) in tonnes. Portuguese landings ([1]) are assigned to *Centrophorus* spp. (not *C. squamosus*) whereas Irish landings ([2]) are assigned to *C. granulosus*. Estimates from 2005 onwards were revised following WKSHARK2. Blank cells = no data; 0 = landings <0.5 t.

	UK	Portugal[1]	Spain	Ireland[2]	Total
1990		1056			1056
1991		801			801
1992		958			958
1993		886			886
1994		344			344
1995		423			423
1996		242			242
1997		291			291
1998		187			187
1999		95			95
2000		54			54
2001		96			96
2002		159	8		167
2003	643	203			846
2004	481	89			570
2005		49		14	64
2006		100			100
2007		62			62
2008		56			56
2009		17			17
2010		7			7
2011		2	0		2
2012		1			1
2013		0			0
2014		0			0
2015		0			0
2016		0			0
2017		2			2
2018		4			4
2019		0			0
2020		0.5			0.5
2021		0			0
2022		0			0
2023		0			0

Table 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of birdbeak dogfish (*Deania calceus*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2. Blank cells = no data; 0 = landings <0.5 t.

	Ireland	Spain	UK	France	Portugal	Norway	Total
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							
2000					13		13
2001			1		37		38
2002		5	+		67		72
2003			3		72		75
2004			38		157		195
2005			50		146		195
2006			22		75		96
2007					37		37
2008				5	57		62
2009				2	22		25
2010				+	3		3
2011					1		1
2012	2				1		3
2013					0	0	0
2014						0	0
2015					0	0	0
2016						0	0
2017					2	0	3
2018					1	0	1
2019					5	0	5
2020					2	0	2
2021						0	0
2022						0	0
2023						0	0

Table 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of longnose velvet dogfish (*Centroscymnus crepidater*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2. Blank cells = no data; 0 = landings <0.5 t.

	France	Ireland	UK	Portugal	Spain	Total
1990						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999	0		0			0
2000	0		0	1	85	86
2001	0		0	3	68	71
2002	13		0	4		17
2003	10		21	2		33
2004	8		7	1		16
2005	10		209	3		222
2006	4		409	7		420
2007	2	2	109	18		131
2008	4			33		37
2009	6			27		33
2010	40			0		40
2011						
2012						
2013						
2014				0		0
2015				0		0
2016	0			0		0
2017				1		1
2018				1		1
2019				1		1
2020				0		0
2021						
2022						
2023						

Table 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of black dogfish (*Centroscyllium fabricii*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2. Blank cells = no data; 0 = landings <0.5 t.

	France	Iceland	UK	Spain	Total
1990					
1991					
1992		1			
1993					
1994					
1995		1			
1996		4			
1997					
1998					
1999	0				
2000	382			85	467
2001	395			91	486
2002	47	0			47
2003	90	0	0		90
2004	49	.	0		49
2005	12		5		17
2006	3				3
2007	6				6
2008	136				136
2009	99	1			101
2010	85	10			95
2011	0	1			1
2012	1	3			3
2013	0	1			1
2014	9	0			9
2015	0	2			2
2016	0	0			0
2017					0
2018					
2019					
2020		0			0
2021		0			0
2022		0			0
2023		0.5			0.5

Table 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of velvet belly lanternshark (*Etmopterus spinax*), in tonnes. Blank cells = no data; 0 = landings <0.5 t.

	Norway	Denmark	Spain	France	Total
1990					
1991					
1992					
1993		27			27
1994		0			0
1995		10			10
1996		8			8
1997		32			32
1998		359			359
1999		128			128
2000		25			25
2001		52			52
2002			85		85
2003					
2004					

Table 5.6. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of *Etmopterus* spp., in tonnes. Estimates from 2005 onwards were revised following WKSHARK2. Blank cells = no data; 0 = landings <0.5 t.

	Denmark	Norway	France	Spain	Portugal	UK	total
1990							
1991							
1992							
1993							
1994			846		0		846
1995			2388		0		2388
1996			2888		0		2888
1997			2150		0		2150
1998			2043				2043
1999			0				0
2000			0	38	0		38
2001			0	338			338
2002			0	99			99
2003			0				0
2004			0		0		0
2005	16			2	0	9	27
2006	17			27	0		44
2007	9			87		8	103
2008	46		0	6		20	72

	Denmark	Norway	France	Spain	Portugal	UK	total
2009			1	9			9
2010	4	9	2				15
2011		4	1	1*	0	0	5
2012		13	0	2*	0		13
2013		19	0			0	19
2014		47				0	47
2015		27	1		0	0	28
2016		59	0				59
2017		129	0				129
2018		106**				4**	110
2019		163**				7**	170
2020		171**					171
2021		117**				0.52**	118
2022		136**					136
2023		282**				0.50**	283

*** assigned to *Etmopterus pusillus***
**** assigned to *Etmopterus spinax***

Table 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings by species since 2005, after revision following WKSHARK2 (in tonnes), (DWS = Unspecified deep-water sharks). Blank cells = no data; 0 = landings <0.5 t.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gulper shark	64	100	62	56	17	7	2	1	0	0	0	0	2	4	0	1	0	0	0
Centroscymnus spp.	545	514	699	537	384														
Birdbeak dogfish	195	96	37	62	25	3	1	3	0	0	0	0	3	1	5	2	0	0	0
Longnose velvet dogfish	222	420	131	37	33	40				0	0	0	1	1	1	0			
Black dogfish	17	3	6	136	101	95	1	3	1	9	2	0				0	0	0	0.5
Lanternsharks	27	44	103	72	9	15	5	13	19	47	28	59	129	110	170	171	118	136	283
Knifetooth dogfish	65	56	161	156	36	53	2	3	0	0									
Arrowhead dogfish			1		0	1	2	1			0		1						
Bluntnose sixgill shark	13	13	54	2	5	2	2	1	2	0	1	0				0			0
Mouse catshark			0	0	3	2	5	1	4	4	2	3							

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Unidentified DWS*	110	62	111	51	37	40	42	175	89	118	85	91	131	150	168	155			

*** Also allocated to "Squaliformes" and "unidentified deep-water squaloid sharks and dogfishes"**

Table 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Discards estimates from Ireland and Denmark (in tonnes). Unspec. DWS = Unspecified deep-water sharks. Blank cells = no data.

Year	Ireland						Denmark	Sweden
	C. fabricii	*E. princeps*	*H. griseus*	*E. spinax*	Unspec. DWS	*D. nidarosienesis*	*Etmopterus* spp.	*Etmopterus spinax*
2009		0.97				0.29	23.49	
2010	3.05					0.74	146.61	
2011		0.01				2.14	50.70	
2012		0.04					16.34	
2013						2.13	24.82	
2014						0.90	3.63	
2015	1.50	3.24				0.40	34.30	
2016	12.06	0.68		0.34	5.40	5.40	5.54	
2017	0.17					42.30	5.41	
2018			5.83	5.83		1.42		
2019				0.07				12.72
2020				1.07				
2021								
2022								2.37
2023								1.46

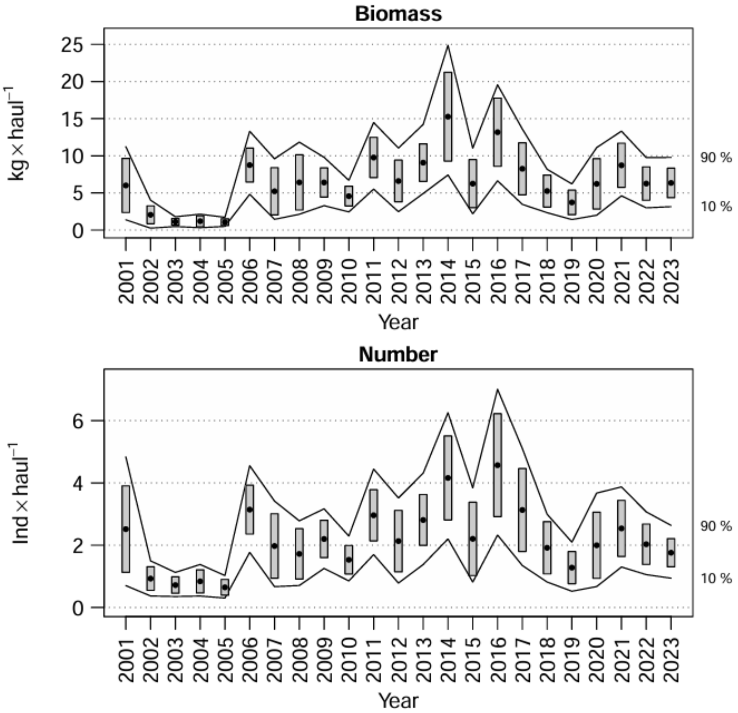


Figure 5.1. Other deep-water sharks and skates from the Northeast Atlantic. *Deania* spp., mainly birdbeak dogfish *Deania calceus* biomass index (kg haul^{-1}) from the Spanish Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2023). Boxes show parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, 2024 (WD - 2024).

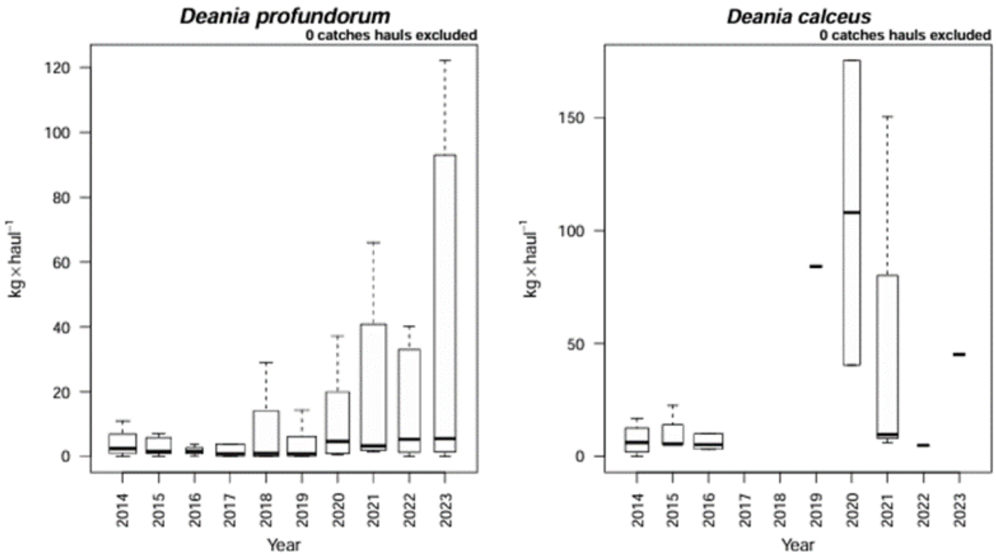


Figure 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Deania profundorum* and *Deania calceus* catches in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 2014–2023). Boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Confidence intervals are estimated only when there are two or more hauls with catch of the species. From Ruiz-Pico *et al.*, 2024 (WD - 2024).

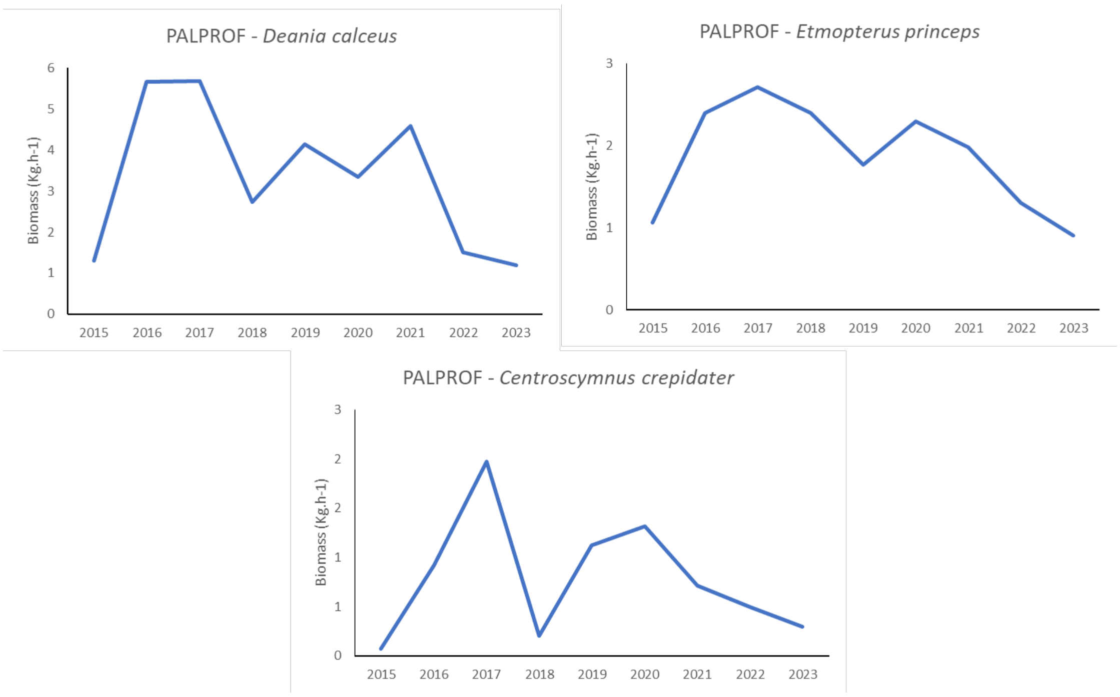


Figure 5.3. Other deep-water sharks and skates from the Northeast Atlantic. CPUE of *Deania calceus*, *Etmopterus princeps* and *Centroscymnus crepidater* caught by the PALPROF survey conducted in the coast along the Basque Country in the period 2015–2023. From Diez *et al.*, 2024 (WD - 2024).

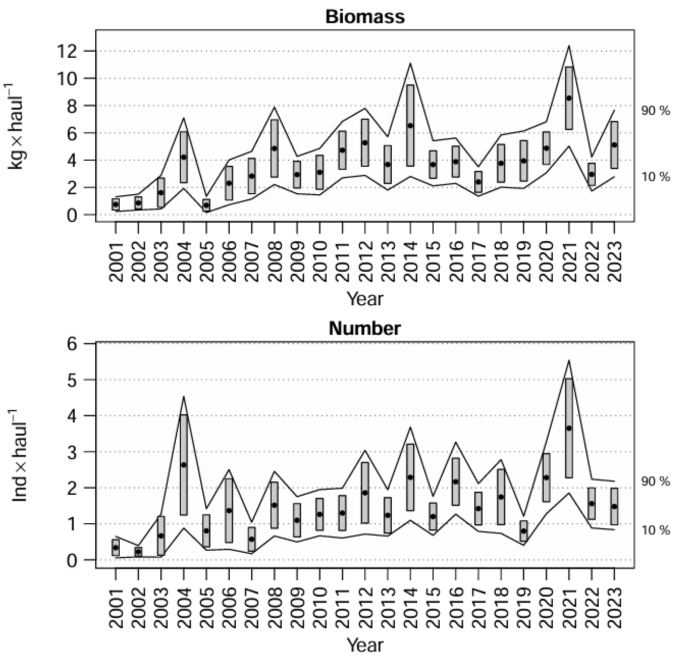


Figure 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Knifetooth dogfish *Scymnodon ringens* biomass index (top, kg haul^{-1}) and abundance index (bottom, numbers). Haul in the Spanish Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, 2024 (WD - 2024).

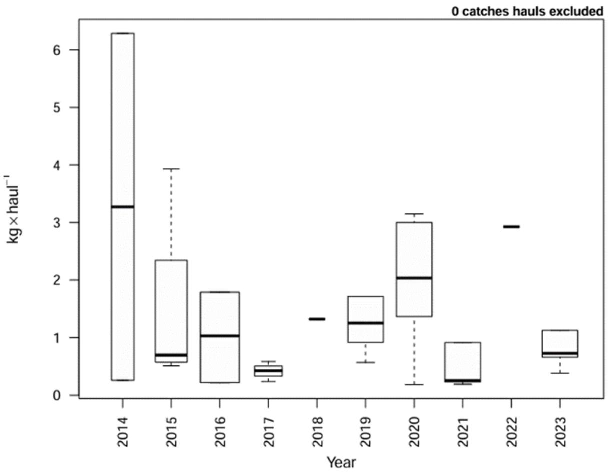


Figure 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Scymnodon ringens* catches in additional deep hauls during the North Spanish shelf bottom trawl survey (SpGFS-WIBTS-Q4, 2014–2023). Boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Confidence intervals are estimated only when there are two or more hauls with catch of the species. From Ruiz-Pico *et al.*, 2024 (WD - 2024).

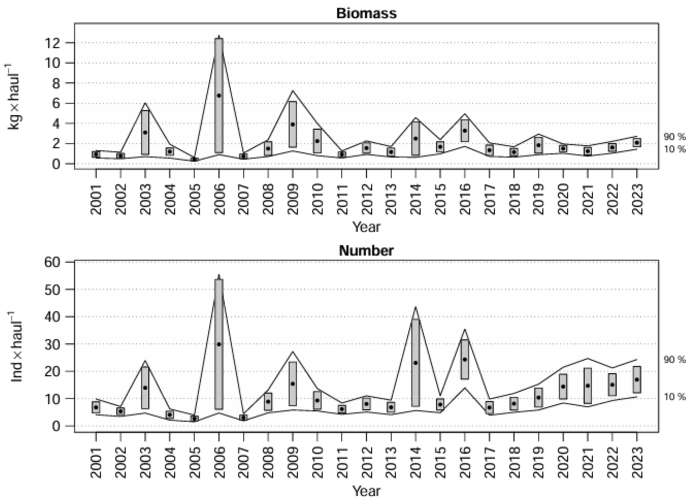


Figure 5.6. Other deep-water sharks and skates from the Northeast Atlantic. *Etmopterus spinax* biomass index (top, kg haul–1) and abundance index (bottom, numbers haul–1) during Porcupine survey time-series (SpPGFS-WIBTS-Q4,

2001–2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, 2024 (WD - 2024).

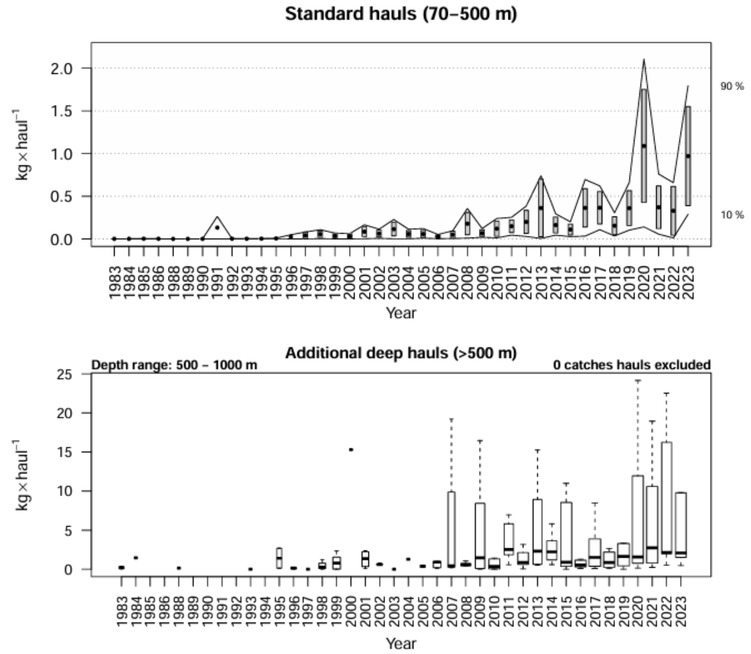


Figure 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Etmopterus spinax* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 1983–2023) covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Ruiz-Pico *et al.*, 2024 (WD - 2024).

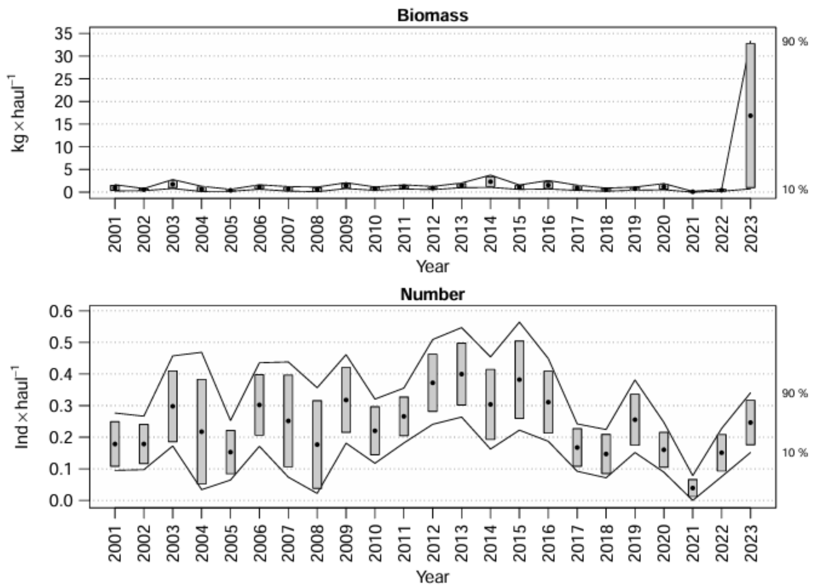


Figure 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Changes in bluntnose six-gill shark *Hexanchus griseus* biomass index (kg haul^{-1}) during Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2023). Boxes mark

parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, 2024 (WD - 2024).

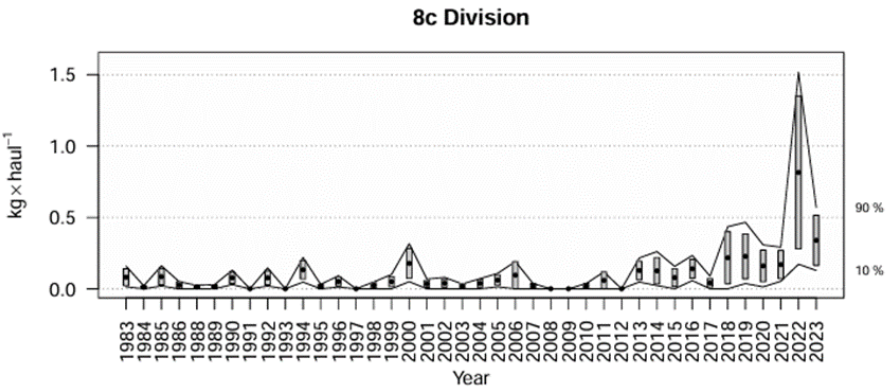


Figure 5.9. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Hexanchus griseus* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 1983–2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Ruiz-Pico *et al.*, 2024 (WD - 2024).

Contents

6 Porbeagle in the Northeast Atlantic (subareas 1–14)

6.1 Stock distribution

WGEF consider that there is a single stock of porbeagle *Lamna nasus* in the Northeast Atlantic (NEA) that occupies the entire ICES area (subareas 1–14), extending southwards to 5° N.

The supporting information is provided in the Stock Annex.

6.2 The fishery

6.2.1 History of the fishery

Porbeagle has been exploited primarily in the NEA by four directed longline fisheries with the first notable landings in 1926 until applicable management largely reduced landings in 2010 (see Section 6.2.4). Norway first developed a directed fishery from 1926 to 1986, then Denmark from 1946 to probably the 1970s or in the early 1980s, followed by the Faroe Islands from 1953 to 1960, and finally France from 1971 to 2009. All together, these four countries contributed 98% of the total landings from 1926 to 2009. A detailed history of the fishery can be found in the Stock Annex.

6.2.2 The fishery in 2023

The WGEF estimated landings are 11.6 t in 2023 and since the zero TAC was implemented in 2010, the mean (2010–2023) WGEF estimate is 18 t per year (Table 6.1). However, since 2010 data must be considered as unrepresentative of removals, as dead discards are not quantified. Discards are expected to have increased with the absence of landing opportunities.

6.2.3 ICES advice applicable

In 2022, following the WKELASMO benchmark (ICES 2022a), the stock was upgraded to assessment category 2. It was first assessed under this new status in 2022 using a surplus production model (SPiCT, Pedersen and Berg, 2017). A summary of the conclusions of WKELASMO is provided in Section 6.9.2. The 2022 advice, based on the 15th percentile of the expected catch distribution when applying F_{MSY}, led to a recommendation of catches of 219 tonnes and 231 tonnes for 2023 and 2024, respectively.

In 2024, in the absence of new biomass indices since 2019, a rollover of the 2022 advice was given, with a recommendation of catches of 231 tonnes for each of the years 2025 and 2026.

6.2.4 Management applicable

EC Regulation 1185/2003 prohibits the removal of shark fins and subsequent discarding of the body of this species. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters. In June 2023, ‘The Shark Fins Act 2023’ was passed in the UK banning the import and export of detached shark fins, including all products containing shark fins.

EC Regulation 40/2008 first established a TAC (581 t) for porbeagle taken in EC and international waters from ICES Subareas 1–12 and 14 for 2008. The TAC was reduced by 25% in 2009 and a maximum landing length of 210 cm (fork length) was implemented.

From 2010–2014, successive EC Regulations (23/2010, 57/2011, 44/2012, 39/2013 and 43/2014) had established a zero TAC for porbeagle in EU waters of the ICES area and prohibited EU vessels to fish for, to retain on board, to tranship and to land porbeagle in international waters.

Since 2015 it has been prohibited for EU vessels to fish for, to retain on board, to tranship or to land porbeagle, with this applying to all waters (Council Regulation (EU) 2015/104, 2016/72, 2017/127, 2018/120, 2019/124, 2020/123, 2021/92 and 2022/119). Fisheries consultations between the UK and the EU in 2021 and 2022 have also included porbeagle in the list of prohibited species in Union and UK waters[1]. Porbeagle has been maintained on this list despite the non-zero catch advice given by ICES in 2022.

It has been forbidden to catch and land porbeagle in Sweden since 2004; and in 2007, Norway banned all direct fisheries for porbeagle but bycatch could be landed up to 2011. Since that year, live specimens must be released, whereas dead specimens can be landed, but this is not mandatory. The species is therefore exempt from the general Norwegian landings obligation, and the payment of the sold catch is therefore withdrawn, except for 20% to cover the cost of landing.

In 2017, a regulation was issued to ban all targeted fishing in Icelandic waters for spurdog, porbeagle and basking shark and stipulating that all viable catch in other fisheries must be released.

6.3 Catch data

6.3.1 Landings

Landings of porbeagle in the Northeast Atlantic from 1926 to 2023 are shown in Table 6.1 and Figure 6.1 and 6.2.

These data were revised during the WKELASMO meeting (ICES, 2022a). The main changes from the WGEF landings tables in 2021 were: Faroe Islands landings added from 1953 to 1960 (from ICCAT database), French landings revised (mainly 1972 to 1977), conversion of Norwegian landings from gutted weight to round weight units (1926 to 1968, excepted 1958-60, and 1971), Spanish landings from 2008 (ICCAT landings series adopted). In addition to these revisions, 2021 landing figures were included (7 t) and Danish landings were updated for the years 2005, 2006, 2007 and 2009 (one tonne added each year), as these data were not previously provided in response to the 2021 WKELASMO data call. Since 2010, landings are below 50 t and mainly occur in the Faroe Islands and Norway.

More detailed information on landings is presented in the Stock Annex.

6.3.2 Discards

Because of the historically high commercial value of this species, it is likely that most specimens caught incidentally were landed prior to the zero quota from 2010. Analysis of at-sea observer programme for UK (E&W) fisheries confirms this (Silva and Ellis, 2019). Historical discards are consequently thought to be negligible.

---

[1] Fisheries: consultations between the UK and the EU in 2021

Since the EU zero TAC was introduced in 2010, discards are likely a large proportion of the catches but they are unquantified. In recent years, the only discard estimates available were provided by France in 2018 (88.7 t) and Spain in 2023 (5.4 t). However, it should be noted that these may be imprecise estimates as the underlying data relate to few observations and specimens. Porbeagle discards have been more frequently reported in log-books of French vessels in recent years (e.g. 9.2 t. in 2023). However, the observed increase in reporting frequency is not thought to reflect an increase in porbeagle discards, with the corresponding values being likely to be much lower than actual discards. Anecdotal information suggests that French pelagic trawlers and tuna long liners discard porbeagle, but their total dead discards are unknown as are seasonal discards in some métiers (e.g. in the Celtic Sea (Bendall *et al.*, 2012a, b; Ellis and Bendall, 2015)). Porbeagle is also a regular bycatch in the Norwegian pelagic trawl fishery for blue whiting in the Norwegian Sea. All specimens are reportedly dead when hauled onto the vessels.

This species is taken by recreational fishers in some areas. However, the full extent of fish captured recreationally has not been quantified. A time series of catch is only available for the UK catch and release fishery (Jones *et al.*, 2021). The porbeagle catches are largely incidental bycatch of blue shark recreational fisheries. Catches increased from zero between 1999–2011 to 333 individuals between 2015 and 2020. Other recreational fisheries are known to occur in Ireland and the Faroe Islands, but no data are available. No data are available either to estimate the post-release mortality of individuals caught and released in recreational fisheries.

More detailed information on discards is presented in the Stock Annex.

6.3.3 Quality of catch data

The quality of the catches from 1926 to 2009 can be considered good after the revisions made by the WKELASMO (ICES, 2022a).

Since the EU zero TAC / prohibited listing was introduced, discards have likely increased, but no estimates of discards are available.

More detailed information on quality of catch is presented in the Stock Annex.

6.3.4 Discard survival

Data on discard survival are too limited to estimate dead discards. Available data are presented in the Stock Annex.

6.4 Commercial catch composition

Only limited length data are available. However, length-distributions by sex are available for 2008 and 2009 for the French longline fishery that targeted porbeagle until 2009 (Hennache and Jung, 2010; Figure 6.3). These distributions are considered representative of international catches because during that period France was the major contributor to catch (Figures 6.1 and 6.2).

Catch data derived from the French longline fishery highlighted the dominance of porbeagle (89%) in the total catch. Other species included blue shark (10%), common thresher (0.6%) and tope (0.3%).

Additional information on commercial catch composition is presented in the Stock Annex.

6.4.1 Conversion factors

Length–weight relationships are available for different geographic areas and time periods (Table 6.2). Relationships between alternative length measurements with total length in porbeagle are presented in the Stock Annex.

6.5 Commercial catch and effort data

Three commercial CPUE series are available for the NEA porbeagle stock, all standardized using a GLM:

- A Norwegian longline CPUE series from 1950 to 1972, in number of fish by day, from personal logbooks of five vessels of the Norwegian directed fishery, in number of fish by day (Biais, 2022a,b);
- A French longline CPUE series from 1972 to 2009, in weight by trip, from logbooks of 19 vessels of the French directed fishery (Biais, 2022c,d);
- A Spanish longline CPUE series from 1986 to 2007, in weight per thousand hooks by trip, from the surface longline targeting swordfish (Mejuto *et al*., 2010).

They are briefly presented in the following sections. Further information can be found in the Stock Annex as well as in the report of the WKELASMO (ICES, 2022a).

6.5.1 The Norwegian longline CPUE series

The Norwegian CPUE series was obtained from logbooks for five longliners of the directed fishery. This provided daily catches in numbers per 1°x1° rectangle for the period 1950 to 1972 (years 1965-67 missing) and for an area extending from 49°N to 69°N. To avoid autocorrelations, CPUEs were selected when there were least five days between successive catches when taken in same or contiguous rectangles, based on Kendall's rank correlations (p-value<0.05).

The CPUEs were standardized comparing three GLM approaches. On the basis on five-fold cross validations, Akaike’s Information Criteria and quantile residual plots, the GLM model involving the effects of year, month and subarea and using a negative binomial error structure was selected as final model. The series of relative annual abundance indices obtained with this model shows a downward trend in the second half of the 1950s, but this trend seems to have stabilized in the early 1960s, followed by a slight increase in the late 1960s and early 1970s (Figure 6.4).

Relative biomass indices were derived from these abundance indices using mean catch weight calculated from landing weights available for most of the trips in the logbooks.

6.5.2 The French longline CPUE series

CPUEs of longliners in the French directed fishery are available from 1972 to 2009. These CPUEs are in weight per trip for a fishing area which extends mainly on the shelf edge of the Bay of Biscay, but also in the Celtic Sea. Nineteen boats with a sufficiently long presence in the fishery (at least six years over the full time-series or more than four years from 1999) were selected. CPUEs were standardized with a GLM, using a Gamma error distribution with a log link. The variables considered were the year, the month, the area (ICES divisions 7 a&f-g, 7 h-j-k and subarea 8), the vessel and their interactions. The selection of the final model was performed as for the Norwegian CPUEs. This model involves the four variables considered but not their interactions. The relative abundance index obtained decreases in the 1970s, but thereafter varies without trend (Figure 6.5).

6.5.3 The Spanish longline CPUE series

The Spanish longline CPUEs are bycatch by trip (in weight per thousand hooks) of the surface longline fishery targeting swordfish in eastern Atlantic (East 20°W from 35°N to 55°N). Data are available from 1986 to 2007. The portion of this area north of 45°N comprises about half of these catches, although it is reported that traditional longline occurs in this area only sporadically during certain years and quarters, taking advantage of local concentrations of porbeagle. CPUEs were standardized using GLM procedures assuming a delta-lognormal error distribution. The final model was selected using Akaike's Information Criterion, Bayesian Information Criterion and the likelihood ratio test (variables included: year, area, quarter, bait, year*area, year*quarter). The relative abundance index obtained (Figure 6.6) includes higher values in the 2000s, with large interannual variations.

6.6 Recreational catch and effort data

CPUE (fish by trip) of the United Kingdom recreational porbeagle catches are available from 1960 to 2020 in Division 7e (Jones *et al.*, 2021). This fishery has been conducted on a catch and release basis since 1994, largely as an occasional bycatch of blue shark recreational fisheries. The data are collated from historical records of the Shark Angling Club of Great Britain (SACGB) from 34 different boats with additional data from 13 skippers. Since 2015, resulting CPUEs have significantly increased (Figure 6.7). Available length distributions indicate that this increase has been driven by the abundance of small fish in Division 7e (median length close to 100 cm).

Further information can be found in the stock annex.

6.7 Fishery-independent surveys

A composite CPUE survey series is also available for the porbeagle stock in the NEA. This series was thus named because it combines the CPUE of a French commercial vessel, from 2000 to 2009, with the CPUE of a fishery-independent survey carried out in 2018-2019. This was done to construct a series long enough to provide information on the trend in abundance in the absence of commercial CPUEs since the zero TAC/prohibited species listing.

The survey was carried out for around 6 weeks in May-June 2018 and 2019, using a chartered longliner. The gear was a longline with 336 hooks. Two sets per day were planned in the same ICES rectangle, with one to three fishing days by statistical rectangle (but generally two) that must be at least 10 days apart. The survey area comprised 16 ICES rectangles extending along the shelf edge of the Bay of Biscay and the southern Celtic Sea (Biais, 2022e).

Combining the CPUE from this survey with a commercial CPUE was made possible by obtaining detailed data from personal logbooks provided by a vessel captain involved in the directed fishery for the years 2000 to 2009. This vessel contributed about 10% of the total French landings each year from 2000 to 2008. Sets with 252 or 336 hooks were considered comparable to the survey CPUEs (after scaling to 336 hooks when 252 hooks are deployed) because the same fishing gear and technique were used in both cases, assuming that catchability is not affected by a small difference in the number of hooks. Complementing this 2000-2009 commercial CPUE with the fishery-independent survey CPUE required a double selection for consistency. On the one hand, the commercial CPUE were selected to have independent observations of abundance, as were the survey CPUE due to the sampling plan, using the same process as for the Norwegian CPUE

(Biais, 2022f). On the other hand, the survey CPUE were selected so that the spatial distribution was comparable to that of the commercial CPUE (Biais, 2022g).

The commercial and survey CPUE thus obtained were merged (with "short" for longline type) to form a CPUE series that was supplemented with the commercial CPUEs provided based on 756 or 840 hooks (included with "long" for longline type), after scaling to the same number of hooks and selecting to have independent observation series. The resulting composite CPUE series was standardized with a GLM using a Tweedie distribution with a log link. The model involving year, type of longline and area was selected (Biais, 2022 f, g) based on five-fold cross validations, the Akaike's Information Criterion (AIC), analysis of deviance tables and quantile residual plots. The relative abundance index series obtained shows a moderate increase in abundance of porbeagle in the Bay of Biscay and the southern Celtic Sea area from 2009 to 2019 (Figure 6.8).

Relative biomass indices were derived from the abundance indices using 2008-2009 mean individual weight (from data provided by Hennache and Jung, 2010) for years 2000 to 2009, because available information supports the assumption that mean weights have not changed much in the 2000s. The 2018 and 2019 indices were calculated using the mean individual weights given by the weight-length relationship and the length distributions from survey catches.

Further information can be found in the Stock Annex.

6.8 Life-history information

Life-history information (including habitat description) is presented in the Stock Annex.

6.8.1 Movements and migrations

Migrations of three porbeagle tagged off Ireland with pop-up satellite archival tags (PSATs) in 2008 and 2009 are described by Saunders *et al.* (2011). One specimen migrated 2400 km to the northwest off Morocco, residing around the Bay of Biscay for about 30 days. The other two remained in off-shelf regions around the Celtic Sea/Bay of Biscay and off western Ireland. They occupied a vertical distribution ranging from 0–700 m and at temperatures of 9–17°C, but during the night they preferentially stayed in upper layers.

The UK (CEFAS) launched a tagging program in 2010 to address the issue of porbeagle bycatch and to further promote the understanding of porbeagle movement patterns in UK waters. Altogether, 21 PSATs were deployed between July 2010 and September 2011, and 15 tags popped up after two to six months. However, four tags failed to communicate. The tags attached to sharks in the Celtic Sea generally popped up to the south of the release positions while those to sharks off the northwest coast of Ireland popped up in diverse positions. One tag popped up in the western part of the North Atlantic, one close to the Gibraltar Straits and another in the North Sea. Several tags popped up close to the point of release (Bendall *et al*., 2012b).

From 2011 to 2019, France (IFREMER, with IRD and CEFAS in 2011; see Biais *et al*., 2017) deployed 60 PSATs that yielded 43 reconstructed tracks. They were used to map the spatiotemporal distributions by sex and length class of the exploitable fraction of the porbeagle stock present in the Bay of Biscay and the southern Celtic Sea in May-June (Biais *et al*., 2022e). Quantitative estimates of area and period occupancy were derived. Based on 21 deployments that lasted more than 11 months (336 days), an estimated 76-86% of porbeagle exhibited annual return to the Celtic Sea and Bay of Biscay after frequent migrations far into the North Atlantic Ocean.

In a recent study (Bortoluzzi *et al*., 2024), three adult females tagged off the northern coast of Ireland and off northern Norway have been shown to perform extensive movements, sometimes up to 100km in a day. The trajectories of these female porbeagle strongly differed, especially between the two individuals caught off the Irish coast, which were tagged the same day.

6.8.2 Reproductive biology

A research programme carried out by the NGO APECS (Hennache and Jung, 2010) provided information based on a large sampling (n = 1770) of the French catch in 2008–2009. Spatial sex-ratio segregations are documented and information is provided on the likelihood of a nursery ground in St. George's Channel and of a pupping area in the grounds along the western Celtic Sea shelf edge. Further evidence of parturition close to the western European shelf was provided by the captures of 9 newborn pups on the Bay of Biscay shelf break in May 2015 and July 2016 (Biais *et al*., 2017) as well as by the captures of pregnant females during the 2018 and 2019 fishery-independent survey. Historic information (Gauld, 1989) indicated that parturition might be slightly later (summer or autumn) in more northern areas such as east Scotland and the Shetland Isles.

6.8.3 Genetic information

A first study of the genetic diversity (mitochondrial DNA haplotype and nucleotide diversities) was carried out by Pade (2009). This study was based on 156 individuals caught both on the Northeast and Northwest Atlantic; the results obtained show no significant population structure across the North Atlantic. These findings were supported by another study which examined 224 specimens from eight sites across the North Atlantic and the Southern Hemisphere (Testerman, 2014). However, this study showed strong genetic difference between the North Atlantic and Southern Hemisphere, which indicates two genetically distinct populations.

Pade (2009) found also that while the mtDNA haplotype diversity was very high, sequence diversity was low, which suggests that most females display reproductive philopatry, and indicates that the stock is likely to be genetically robust.

Viricel *et al*. (2021) observed also high levels of genetic diversity at the mitochondrial DNA control region in North Atlantic, using 49 individuals caught in the Bay of Biscay from 2013 to 2019, 6 individuals from the Indian Ocean and 155 sequences obtained from Genbank from both North and South Atlantic. A significant genetic difference was found between individuals sampled in Norway and Denmark and others selected among samples from the Bay of Biscay and Celtic Sea, based on westward migrations. These results are considered preliminary, as they were obtained using a single locus and small sample sizes. They need to be complemented with Single Nucleotide Polymorphism (SNP) analysis, more robust for low sample sizes.

Further studies examining genetic structure of Mediterranean Sea porbeagle are still required.

6.9 Exploratory assessment models

6.9.1 Previous studies

The first assessment of the Northeast Atlantic stock was carried out in 2009 by the joint ICCAT/ICES meeting (ICCAT, 2009; ICES, 2009) using a Bayesian Surplus Production (BSP) model (Babcock and Cortes, 2009) and an Age-Structured Production (ASP) model (Porch *et al*., 2006).

Using the French CPUE series as well as the Spanish CPUE series, stock projections based on the BSP model demonstrated that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and that the recovery to B_{MSY} could be achieved within 25–50 years under nearly all model scenarios. More detailed results are provided in the Stock Annex.

6.9.2 Benchmark

A benchmark of the stock was conducted jointly by ICES and ICCAT in 2022. A total of 27 Surplus Production in Continuous Time (SPiCT) exploratory assessment runs (Pedersen and Berg, 2017) were submitted to WKELASMO (ICES, 2022a) with two additional JABBA exploratory assessments. For all assessments, the 1926-2020 landings, revised as part of the WKELASMO meeting, were used for the catches. Considering that discards were negligible before 2010, but unknown afterwards, the standard deviation of the observation error on catches was multiplied by 5 from 2010 onwards. The biomass indices provided by standardizing the three available commercial CPUE series and the composite CPUE survey series were used (Figure 6.9), with the ratios of their standard errors from the GLMs to their respective means (CV) as input for the relative standard deviations of indices. The biomass was assumed close to the virgin state in 1926 as all available information shows that porbeagle were only caught incidentally in limited quantities by Norwegian fisheries in the absence of a local market (median of the informative prior for initial B/K set at 0.99).

All the exploratory assessments set the median of the prior for the intrinsic rate of increase *r* to 0.059, as per the 2020 ICCAT stock assessment (Cortes and Semba, 2020), and the shape parameter of the surplus production function *n* to 2, which implies a Schaefer production model. The exploratory runs focused primarily on the effect of having informative (sd =0.2) or semi-informative (sd=0.5) priors for these parameters as well as on the inclusion of the Spanish longline biomass index in the assessment. Setting the sd of log (*n*) to 0.5, led to an average of the posterior of *n* close to 1 which was in contradiction with a low prior for *r*. Therefore, the sd was set to 0.2 for log(*n*) for further exploratory assessments. For the prior for *r*, a sd set to 0.5 was retained because the acceptance criteria for a SPiCT assessment (ICES, 2020b) are met without restriction only for this input. After several sensitivity runs with different priors for the sd of the Spanish longline biomass index, it was incorporated with a large and informative prior for its sd (median=1.1) in the final assessment, on the basis of acceptance criteria.

With respect to the comparison between the JABBA and SPiCT assessments, it should be noted that, despite some differences in model configuration, the two modelling approaches provided very similar outlooks of the status of the NEA porbeagle stock.

6.10 Stock assessment

The 2022 stock assessment was carried out using the SPiCT model with priors agreed upon during the final benchmark assessment (prior for B_{2026}/K: median=0.99, sd of log(B_{2026}/K)=0.2; prior for *n*: median=2, sd of log(*n*)=0.2; prior for *r*: median=0.059, sd of log(*r*)=0.5; priors for the sd_{Sp} of the Spanish longline biomass index: median=1.1, with sd of log(sd_{Sp})=0.1). The landings were updated but the biomass indices remained the same, because the survey was not carried out in 2020.

The posterior *n* is the same as that of the final benchmark assessment (median=1.7). The model is thus close to a Schaefer model, with an inflection point of the production curve close to B_{MSY}/K=0.5. The posterior of *r* is also the same as that of the final benchmark assessment (median=0.089). The exploited biomass decreases below B_{MSY} in the early 1950s (Figure 6.10). Despite an increase in the 2010s due to the fishing restriction in place since 2010, B/B_{MSY} was well below B_{MSY} in 2020, but above $B_{trigger}$ ($0.5 \cdot B_{MSY}$; see section 6.13). Overfishing was no longer occurring, with the low values of current *F* consistent with the landing prohibition in effect since 2010 (Figure 6.11).

The retrospective patterns are consistent although the Mohn's rho of the relative F analysis is above 0.2 (Figure 6.12). This was not observed in the retrospective analysis made at the WKELASMO for the final assessment but occurred for the 2022 assessment when using the SPiCT package 1.3.6 with the same landings as during the benchmark. However, given the very low catches in recent years, a Mohn's rho of the relative *F* analysis slightly above 0.2 cannot be considered a relevant criterion for not accepting the assessment, as was agreed during the WKELASMO for some exploratory assessments.

In 2024, new exploratory SPiCT runs were performed. Only the series of landings could be updated, as no new survey indices were available compared to the 2022 assessment. The various priors were kept identical to the ones selected in 2022. The estimated trajectories of biomass and fishing mortality were very similar to the ones obtained during the 2022 assessment. Expectedly, the posterior distributions of model parameters were virtually unaffected by this update. However, the uncertainty associated with the most recent estimates of B/B_{MSY} and F/F_{MSY} increased significantly, which caused the exploratory runs to fail to pass the SPiCT acceptance diagnostics.

6.11 Forecasts

The Benchmark Oversight Group (BOG) accepted the conclusions of the WKELASMO (ICES, 2022a). Therefore, the porbeagle stock in the NEA became an ICES Category 2 stock in 2022, as its status could be assessed with SPiCT. According to the ICES technical guidance for harvest control rules and stock assessments for stocks in category 2 (ICES, 2022b), the default rule for the catch advice is to use the fractile rule with the 35th percentile of the predicted catch distribution estimated when applying F_{MSY}.

During the meeting, catch scenarios were established for two years, considering that a four-year advice as in 2019 was justified by a zero-catch advice then, but that if this was to change, an advice every two years would be more suitable for monitoring the exploitation of the porbeagle stock. However, there were some concerns raised by ICCAT experts about the approach of applying the ICES default rule for the porbeagle catch advice when they may not have been tested on a long-lived species. This warning suggested making long-term projections (to 2053 to encompass two generations) with constant catch options to provide tables of probabilities p($B>B_{MSY}$), p($F<F_{MSY}$) and p ($B>B_{MSY}$ & $F<F_{MSY}$), as required for ICCAT advice. This was considered useful to ensure consistency between ICCAT and ICES advice, although long-term projections are not required for ICES catch advice. An online meeting was agreed upon for mid-July to review the results of these long-term projections and possible additional catch scenarios to be considered for the catch advice for 2023 and 2024. Unfortunately, the results showed some inconsistencies for the early years of the long-term forecast with constant catches that could not be resolved quickly. These were due to the way SPiCT accommodates large increase in projected catches (i.e. it produces an increase in *B* to limit the variation of *F*). However, these problems do not arise when making long-term projections for constant fishing mortalities, which are relevant for ICES advice because they allow estimation of F_{p05}, the fishing mortality that results in a less than 5% probability of $SSB < B_{lim}$ in the long term (ICES, 2022c). Probability tables for constant fishing mortalities were sent in July by the stock coordinator to WGEF members, with the addition of probabilities p($B>B_{trigger}$) and p($B>B_{lim}$) to include ICES biomass reference points (Table 6.3 a, b & c). The probability p($B>B_{MSY}$) is above 0.5 in 2053 when $F=0.7 \cdot F_{MSY}$. The probability p($B>B_{lim}$) is above 0.95 in 2053 when $F=0.3 \cdot F_{MSY}$ ($F_{p0.5}$). The latter option was included in the catch scenario tables for 2023 and 2024 of the draft for the advice.

6.12 Quality of assessments

In 2022, WGEF meeting participants included scientists involved in ICCAT shark assessments. Previously, several of them participated in WKELASMO, of which the chair of the 2020 ICCAT porbeagle assessment meeting was an external expert. Therefore, the porbeagle benchmark by the WKELASMO and the following assessment by the WGEF were conducted in cooperation with ICCAT scientists. It was the first time since the ICCAT 2009 Porbeagle Stock Assessments Meeting which was held as a joint meeting of WGEF and the ICCAT Shark species group (ICCAT, 2009; ICES, 2009). At this 2009 meeting, the lack of CPUE data for the peak fishery was highlighted as a major caveat to the quality of the assessment by a surplus production model. This issue has been resolved with the availability of the Norwegian longline CPUE series which begins in 1950, when catches were still above 3000 t.

The 2009 request for an independent survey of the fishery was also taken into account with the organisation of two fishery-independent abundance surveys in 2018 and 2019. This generated a composite survey series combining commercial and survey CPUEs, obtained after successive improvements (Biais 2022 e-g). This work greatly benefited from the participation of members of the ICCAT shark species group at WKELASMO, as did the standardization of the Norwegian and French CPUE series (Biais 2022a-d). Members of the ICCAT shark species group provided also additional assessments using JABBA, with very similar results giving the same perception of the stock as the final accepted SPiCT assessment.

Treatments to avoid autocorrelation of CPUE addressed warnings about the potential for index hyperstability that searching for concentrations generates in directed fisheries (Biais, 2022a and f). It should also be noted that the standardization of the French longline CPUE series, already used in the 2009 exploratory assessment, is now documented (Biais, 2022c and d). The validity of including the Spanish longline index in the assessment was questioned during WKELASMO, due to its large variation and the area selected to build the CPUE series. Nevertheless, this index was used, but with a large standard deviation. An examination of the possibility of increasing the quality of this index would be of interest as well as its extension beyond 2007. Furthermore, the porbeagle subgroup of the WGEF indicated that any future WKLIFE meetings could be asked to examine the assessment of a lower productivity species such as porbeagle with a surplus production model.

The quality of porbeagle assessment would benefit from improved knowledge of stock structure. While there seemed to be strong indication of site fidelity and repeated migration routes, the genetic differentiation among different regions in the Northeast Atlantic was not strong, and based on a limited number of samples (ICES, 2022a). In its porbeagle subgroup, the WGEF held discussions on ongoing genetics and tagging studies and how collaborations and the sharing of materials can be developed to improve our understanding of the stock structure in the Northeast Atlantic. Any future joint ventures or assessments would benefit from a more coordinated approach with collaborative drafting of agendas, ToR and more advanced planning to ensure that the aims, expectations and results are as aligned as possible within the operational constraints of each organisation.

6.13 Reference points

SPiCT provides relative fishing mortality (F/F_{MSY}) and relative biomass (B/B_{MSY}) reference points. F_{MSY} and B_{MSY} are estimated directly from the SPiCT assessment model and, therefore, change when the assessment is updated.

For the MSY approach, the reference points are F_{MSY} and $B_{trigger}$= 0.5 B_{MSY} (ICES, 2021).

For the precautionary approach, the reference points are F_{lim} = 1.7 × F_{MSY} (ICES, 2017) and B_{lim}= 0.3 B_{MSY} (ICES, 2021).

6.14 Conservation considerations

The porbeagle shark subpopulation of the Northeast Atlantic was listed as Critically Endangered in the IUCN red list in 2015 (Ellis *et al*., 2015). In 2019, IUCN assigned the porbeagle to the vulnerable category in a global assessment of the species (Rigby *et al*., 2019a). This review was carried out using a Bayesian state space tool for each region where data were available (Rigby *et al*., 2019b). In the NEA, the results of the 2009 ICCAT-ICES meeting were used. The median population decrease over three generations was estimated to be 56% in 2009. As a result, the global assessment is based on a NEA population classified in the endangered category.

In 2013, a renewed proposal to list porbeagle shark on Appendix II of CITES was accepted at the Conference of Parties (16) Bangkok, and it has been listed since September 2014.

6.15 Management considerations

A dedicated longline survey covering the main parts of the stock area is needed to monitor stock status appropriately in the future. The surveys carried out by France in 2018 and 2019 have shown that a fixed-station survey design can provide consistent annual indices. Continuing this spring-summer survey with an expansion to other areas within the stock distribution would be advantageous, as this would provide the necessary sampling effort to take the large distribution of porbeagle into account in order to monitor stock size. This species has low population productivity, and is thus highly susceptible to overexploitation. Consequently, WGEF considers that target fishing should not proceed without a programme to monitor stock abundance feeding into regular updates of the NEA porbeagle stock assessment. The current fishing ban renders estimates of discards difficult to obtain, but they are considered to have increased in recent years in the Bay of Biscay as well as in the northern part of the distribution area of the stock. Logbook-reported discards are currently not provided by all vessels catching porbeagle. They are most likely insufficient to derive a new biomass index, but this possibility should be reconsidered in the future when more data are expected to have been collected.

A maximum landing length (MLL) was adopted by the EC in 2009. It was considered a potentially useful management measure in targeted fisheries, as it could deter targeting areas with mature females. However, the fishery-independent survey data question both the efficacy and practicality of such a measure and, given the short time period of implementation prior to a zero TAC, the effectiveness remains unevaluated.

Studies on porbeagle bycatch should be continued to develop operational ways to reduce bycatch, to decrease at-vessel mortality and to improve the post-release survivorship of discarded porbeagle.

All fisheries-dependent data should be provided by countries having fisheries for this stock, including countries targeting other species with longlines in the stock area.

During the WGEF, discussions were initiated regarding both the process and timeline of advice provision within ICES and similarly within ICCAT. The timelines to provide final advice, and management programmes of both organisations differ, with the ICES advice released after the ICCAT meeting of the Standing Committee on Research and Statistics (SCRS). This has the potential to lead to inconsistent perceptions of the stock status and any associated catch advice. Consistency between the advice from each organisation is important and future alignment of process and outcomes may be facilitated by an MoU between ICES and ICCAT.

6.16 References

Babcock, B. A., and Cortes, E. 2009. Bayesian surplus production model applied to porbeagle catch, cpue and effort data. ICCAT, Collective Volume of Scientific Papers, SCRS/2009/068, 7 pp.

Bendall, V. A., Ellis, J. R., Hetherington, S. J., McCully, S. R., Righton, D., and Silva, J. F. 2012b. Preliminary observation on the biology and movements of porbeagle *Lamna nasus* around the British Isles. Working document to the ICES Working Group on Elasmobranch Fishes, Lisbon, 19–26 June 2012. 21 pp.

Bendall, V. A., Hetherington, S. J., Ellis, J. R., Smith, S. F., Ives, M. J., Gregson, J. and Riley, A. A. 2012a. Spurdog, porbeagle and common skate bycatch and discard reduction. Fisheries Science Partnership 2011–2012, Final Report; 88 pp.

Biais, G. 2022a. Standardized catch rates of porbeagle in the Northeast Atlantic Ocean from Norwegian longliner logbooks. ICES WKELASMO 2022 Working Document, 14 pp

Biais, G. 2022b. Standardized catch rates of porbeagle in the Northeast Atlantic Ocean from Norwegian longliner logbooks. Supplement. ICES WKELASMO 2022 Working Document, 5 pp

Biais, G. 2022c. Standardized catch rates of porbeagle in the Northeast Atlantic Ocean from French longliner data by trip. ICES WKELASMO 2022 Working Document, 10 pp.

Biais, G. 2022d. Standardized catch rates of porbeagle in the Northeast Atlantic Ocean from French longliner data by trip. Supplement. ICES WKELASMO 2022 Working Document, 4 pp.

Biais, G. 2022e. Porbeagle abundance survey in the Bay of Biscay and in the Celtic Sea in 2018 and 2019. ICES WKELASMO 2022 Working Document, 10 pp.

Biais, G. 2022f. Porbeagle abundance survey in the Bay of Biscay and in the Celtic Sea in 2018 and 2019. Supplement. ICES WKELASMO 2022 Working Document, 8 pp.

Biais, G. 2022g. Porbeagle abundance survey in the Bay of Biscay and in the Celtic Sea in 2018 and 2019. Supplement 2. ICES WKELASMO 2022 Working Document, 7 pp.

Biais, G., Coupeau, Y., Séret, B., Calmettes, B., Lopez, R., Hetherington, S., and Righton, D. 2017. Return migration patterns of porbeagle shark (*Lamna nasus*) in the Northeast Atlantic and implications for stock range and structure, ICES Journal of Marine Science, 74(5), 1268–1276. doi:10.1093/icesjms/fsw233.

Bortoluzzi, J.R., McNicholas, G.E., Jackson, A.L., Klöcker, C.A., Ferter, K., Junge, C., Bjelland, O., Barnett, A., Gallagher, A.J., Hammerschlag, N., Roche, W.K. and Payne,N.L., 2024. Transboundary movements of porbeagle sharks support need for continued cooperative research and management approaches. *Fisheries Research*, 275: 107007. https://doi.org/10.1016/j.fishres.2024.107007

Cortes E. and Semba Y, 2020. Estimates of vital rates and population dynamics parameters of interest for porbeagle shark in the Western North Atlantic and South Atlantic oceans. SCRS/2020/090. 13p.

Ellis, J. R. and Bendall, V. A. 2015. Preliminary estimates of bycatch rates of porbeagle shark *Lamna nasus* in gillnet fisheries in the Celtic Sea (ICES Divisions VIIf–h) and associated biological observations. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; WD2015-02, 9 pp.

Ellis, J., Farrell, E., Jung, A., McCully, S., Sims, D. & Soldo, A. 2015. *Lamna nasus*. The IUCN Red List of Threatened Species 2015: e.T11200A48916453. Downloaded on 03 July 2020.

Ellis, J. R., and Shackley, S. E. 1995. Notes on porbeagle sharks, *Lamna nasus*, from the Bristol Channel. *Journal of Fish Biology*, 46: 368–370.

Gauld, J. A. 1989. Records of porbeagles landed in Scotland, with observations on the biology, distribution and exploitation of the species. Scottish Fisheries Research Report No. 45. Department of Agriculture and Fisheries for Scotland. Aberdeen, UK. 15 pp.

Hennache, C., and Jung, A. 2010. Etude de la pêche palangrière de requin taupe de l'île d'Yeu. Rapport Final. Association pour l'étude et la conservation des sélaciens (APECS), http://www.asso-apecs.org/IMG/pdf/APECS_EPPARTIY_Rapport_ final_BD.pdf. 64 pp.

ICCAT. 2009. Report of the 2009 Porbeagle Stock Assessments Meeting. Copenhagen, Denmark, 22–27 June, 2009. ICCAT, Collective Volume of Scientific Papers, SCRS/2009/014. 42 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 424 pp.

ICES. 2017. ICES fisheries management reference points for category 1 and 2 stocks. ICES advice technical guidelines. 20 January 2017. https://doi.org/10.17895/ices.pub.3036

ICES. 2021. Benchmark Workshop on the development of MSY advice for category 3 stocks using Surplus Production Model in Continuous Time; SPiCT (WKMSYSPiCT). ICES Scientific Reports. 3:20. 316 pp. https://doi.org/10.17895/ices.pub.7919.

ICES. 2022a. Benchmark Workshop for selected elasmobranch stocks (WKELASMO). ICES Scientific Reports. 4:47. 136 pp. http://doi.org/10.17895/ices.pub.21025021

ICES. 2022b. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. In Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564

ICES. 2022c. Advice on fishing opportunities. *In* Report of the ICES Advisory Committee, 2022. ICES Advice 2022, section 1.1.1. https://doi.org/10.17895/ices.advice.19928060

Jones G., Alsop A., Chapman R. S., Collings M., Davis P., Faisey K. A., Forester M., Hodder L., Howell A., Malia O., Margetts D., McKie K. A., McMaster J. D., Murphy S., Rogers J., Somerfield P. J., West D., Whittaker P., Wright S., Wyatt K., Uren D. and Thomas S. F., 2021. Summary of data from the United Kingdom recreational porbeagle fishery from 1960-2020. Collect. Vol. Sci. Pap. ICCAT, 78(2): 1-15

Kohler, N. F., Casey, J. G., and Turner, P. A. 1995. Length–weight relationships for 13 species of sharks from the western North Atlantic. *Fishery Bulletin*, 93: 412–418.

Mejuto, J., and Garcés, A. G. 1984. Shortfin mako, *Isurus oxyrinchus*, and porbeagle, *Lamna nasus*, associated with longline swordfish fishery in NW and N Spain. ICES CM 1984/G:72 Demersal Fish Committee.

Mejuto, J., Ortiz, J., García-Cortés, B., Ortiz de Urbina, J., and Ramos-Cartelle, A. M. 2010. Historical data and standardized catch rates of porbeagle (*Lamna nasus*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*Xiphias gladius*) in the Atlantic Ocean. ICCAT, Collective Volume of Scientific Papers, SCRS/2009/053. 23 pp.

Pade, N. 2009. Molecular and Spatial Ecology of Porbeagle Sharks, *Lamna nasus* (Bonnaterre, 1788), in the North Atlantic Ocean. Unpublished PhD thesis, University of Aberdeen, Scotland.

Pedersen, M. W., and Berg, C. W. 2017. A Stochastic Surplus Production Model in Continuous Time. Fish and Fisheries. Wiley Online Library. doi:10.1111/faf.12174.

Porch, C. E., Eklund, A-M, and Scott, G. P. 2006. A catch-free stock assessment model with application to goliath grouper (*Epinephelus itajara*) off southern Florida. Fishery Bulletin, 104(1): 89–101.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. & Winker, H. 2019a. Lamna nasus. The IUCN Red List of Threatened Species 2019: e.T11200A500969. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T11200A500969.en. Downloaded on 07 January 2021.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. & Winker, H. 2019b. Saunders, R. A., Royer, F., and Clarke, M. W. 2011. Winter migration and diving behaviour of porbeagle shark, *Lamna nasus*, in the Northeast Atlantic. *ICES Journal of Marine Science*, 68: 166–174.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Stevens, J. D. 1990. Further results from a tagging study of pelagic sharks in the North-east Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 70: 707–720.

Testerman, C. B. 2014. *Molecular Ecology of Globally Distributed Sharks.* Doctoral dissertation. Nova Southeastern University. Retrieved from NSUWorks, Oceanographic Center. (6) http://nsuworks.nova.edu/occ_stuetd/6.

Viricel, A., Dourdin, T. S. and Biais, G. 2021. Population structure of the porbeagle shark in the Bay of Biscay inferred using molecular markers. Working Document 02 to the ICES Working Group on Elasmobranch Fishes, 2021, 7pp.

6.17 Tables and Figures

Table 6.1 Porbeagle in the Northeast Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1926–2023). Data derived from ICCAT, ICES data calls and national data. Note: blank when no catch,; '0' = < 0.5 t.

Year	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK	Japan	Total
1926								363						363
1927								595						595
1928								794						794
1929								1082						1082
1930								1957						1957
1931								1438						1438
1932								2084						2084
1933								5049						5049
1934								4714						4714
1935								2591						2591
1936								3197						3197
1937								3647						3647
1938								3553						3553
1939								2877						2877
1940								135						135
1941								368						368
1942								374						374
1943								458						458
1944								417						417
1945								1206						1206
1946	1400							1414						2814
1947	3300							3671						6971
1948	2100							2490						4590
1949	1700							1626						3326
1950	1900							1765		4				3669
1951	1600							1013		3				2616
1952	1600							789		3				2392
1953	1100	100						927		4				2131
1954	651	300						772		1				1724
1955	578	100						1167		2				1847
1956	446							1132		1				1579
1957	561	100						1426		3				2090
1958	653	300						1080		3		7		2043
1959	562	600						1183		3		9		2357

Year	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK	Japan	Total
1960	362	500						1929		2		10		2803
1961	425							1369		5		9		1808
1962	304							577		7		20		908
1963	173							157		3		17		350
1964	216							116		6		5		343
1965	165							265		4		8		442
1966	131							283		9		6		429
1967	144							397		8		7		556
1968	111							880		11		7		1009
1969	100							909		11		3		1023
1970	124							269		10		5		408
1971	311	1	550					208		11		7		1088
1972	523		1317					293		10		19		2162
1973	158	5	1350	6	2			209		12		27		1769
1974	170		967	3	2			165		9		15		1331
1975	265		1251	4	4			304		12	3	16		1859
1976	233	1	1373		3			259		9		25		1903
1977	289	5	1188		3			78		10				1573
1978	112	9	538					76		11	5			751
1979	72	25	703		1			106		8	1	1		917
1980	176	8	589		1			84		12	8	3		881
1981	158	6	451		1			93		12	5	2		728
1982	84	17	450		1			32		14	6	1		605
1983	45	12	517		1			33		28	5	2		643
1984	38	14	307		1			118		20	9	5		512
1985	72	12	200		1			79		23	10	12		409
1986	114	12	246		1			23		26	8	6		436
1987	56	33	223		1			25	3	30	5	3		379
1988	33	14	350		1			12	3	69	3	3		488
1989	33	14	357		1			27	2	42	3	15		494
1990	46	14	577		0			46	2	26	2	9		722
1991	85	7	292		0			34	1	47	2			468
1992	80	20	452		1			43	0	15	4			615
1993	91	76	632	1	3			24	1	21	3			852
1994	93	48	815		4			26	1	52	2			1041
1995	86	44	635		5			27	1	19	2	0		819
1996	72	8	442		3			28	1	41	1		3	599
1997	69	9	489		2			17	1	25	1		2	615

Year	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK	Japan	Total
1998	85	7	428	2	3			27	1	25	1	1		580
1999	107	10	306	0	3	8		32	0	18	1	6		491
2000	73	13	385	17	2	2	0	23	15	13	1	7		551
2001	76	8	380	1	4	6		17	4	24	1	10		531
2002	42	10	528	3	2	3		14	11	54		7		674
2003	21	14	443	5	0	3	0	19	4	27		25		561
2004	20	5	423	6	1	0		24	57	11	5	24		576
2005	3	18	298	5	0	3	0	12		14	0	24		378
2006	3	21	223	0	1	4		27		34		12		325
2007	2	14	369	2	0	8	0	10		8	0	26		439
2008	2	10	319	2	1	7		12		41	0	15		409
2009	4	13	291		1	3		10		77		11		410
2010		14	7		1	0	0	12						34
2011	2	18	1		1			11						33
2012	3	25	2		1			17				0		48
2013		17	1		1			9						28
2014		15	1		0			5						21
2015		7			1		0	4						12
2016	0	3			2			6						11
2017	0	1	1		1			6						9
2018		1	1		1			3						6
2019	1	1	2		3			4						11
2020	0	1			3			3						7
2021		3						5						7
2022		1	0		2			8				0		10
2023	0		0		4			7						12

Table 6.2. Porbeagle in the Northeast Atlantic. Length–weight relationships of porbeagle from scientific studies.

Stock	L-W relationship	Sex	n	Length range	Source
NW Atlantic	$W = (1.4823 \times 10^{-5})\ L_F\ 2.9641$	C	15	106–227 cm	Kohler *et al.*, 1995
NE Atlantic (Bristol Channel)	$W = (1.292 \times 10^{-4})\ L_T\ 2.4644$	C	71	114–187 cm	Ellis and Shackley, 1995
NE Atlantic (N/NW Spain)	$W = (2.77 \times 10^{-4})\ L_F\ 2.3958$	M	39		Mejuto and Garcés, 1984
	$W = (3.90 \times 10^{-6})\ L_F\ 3.2070$	F	26		
NE Atlantic (SW England)	$W = (1.07 \times 10^{-5})\ L_T\ 2.99$	C	17		Stevens, 1990
	$W = (4 \times 10^{-5})\ L_F\ 2.7316$	M	564	88–230 cm	Hennache and Jung, 2010
	$W = (3 \times 10^{-5})\ L_F\ 2.8226$	F	456	93–249 cm	

Stock	L-W relationship	Sex	n	Length range	Source
NE Atlantic (Biscay / SW England/ W Ireland)	W = (4 x 10^{-5}) L_F 2.7767	C	1020	88–249 cm	

Table 6.3 a. Porbeagle in the Northeast Atlantic. Catch per year for each fishing mortality option (upper panel), probabilities (in %) of B>B_{lim} (middle panel) and B>B_{lim} and F<F_{MSY} (lower panel) per year from 2023 to 2053 for fishing mortalities increasing from 0 to 1.2 F_{MSY}. Catch in 2022 corresponds to F status quo (8t).

Catch per F and Year	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F = 0.1 F_{MSY}	63	67	72	76	81	86	91	96	101	106	111	116	121	126	131	136	141	146	151	155	160	164	168	172	176	180	184	187	190	194	197
F = 0.2 F_{MSY}	126	133	142	150	159	167	176	185	194	203	213	222	231	240	249	258	267	276	284	292	300	308	316	323	330	337	343	350	356	361	367
F = 0.3 F_{MSY}	188	199	210	221	233	245	257	269	281	294	306	318	331	343	355	367	378	390	401	412	423	433	444	453	463	472	481	489	497	505	512
F = 0.4 F_{MSY}	250	263	277	291	305	319	333	348	362	377	392	406	421	435	449	463	477	490	503	516	529	541	553	565	576	587	597	607	617	626	635
F = 0.5 F_{MSY}	312	327	342	358	373	389	405	421	437	453	470	485	501	517	532	548	563	577	592	606	620	633	646	659	671	683	695	706	716	727	737
F = 0.6 F_{MSY}	373	390	406	423	439	456	473	490	507	524	540	557	573	590	606	622	637	653	668	682	696	710	724	737	750	762	774	786	797	808	818
F = 0.7 F_{MSY}	435	451	468	485	502	520	537	554	571	588	605	621	638	654	670	686	701	716	731	746	760	774	788	801	813	826	838	849	861	871	882
F = 0.8 F_{MSY}	496	512	529	546	563	580	596	613	630	646	662	679	694	710	726	741	756	770	784	798	812	825	838	851	863	875	887	898	909	919	929
F = 0.9 F_{MSY}	556	572	589	605	621	637	653	668	684	699	714	729	744	759	773	787	801	814	828	841	853	865	877	889	900	911	922	932	943	952	962
F = F_{MSY}	617	632	647	661	676	691	705	719	733	747	761	774	788	801	813	826	838	850	862	873	884	895	906	916	926	936	946	955	964	973	981
F = 1.1 F_{MSY}	677	690	703	716	729	742	754	766	779	790	802	814	825	836	847	857	868	878	888	898	907	916	925	934	942	951	959	966	974	981	989
F = 1.2 F_{MSY}	737	748	758	769	780	790	800	810	820	829	839	848	857	866	874	883	891	899	907	914	922	929	936	943	950	956	962	969	974	980	986

P(Bt>Blim)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	81	83	85	87	89	90	91	92	93	94	95	96	96	97	97	98	98	99	99	99	99	99	100	100	100	100	100	100	100	100	100
F = 0.1 F_{MSY}	81	83	85	86	88	89	90	91	92	93	94	95	95	96	96	97	97	98	98	98	99	99	99	99	99	100	100	100	100	100	100
F = 0.2 F_{MSY}	81	82	84	86	87	88	89	90	91	92	93	93	94	95	95	96	96	96	97	97	97	98	98	98	98	99	99	99	99	99	99
F = 0.3 F_{MSY}	81	82	84	85	86	87	88	89	90	90	91	92	92	93	93	94	94	94	95	95	95	96	96	96	96	96	97	97	97	97	97
F = 0.4 F_{MSY}	81	82	83	84	85	86	87	88	88	89	89	90	90	91	91	91	92	92	92	92	92	93	93	93	93	93	93	93	93	93	93
F = 0.5 F_{MSY}	81	82	83	84	84	85	86	86	87	87	87	88	88	88	88	89	89	89	89	89	89	89	89	89	89	89	89	89	89	88	88
F = 0.6 F_{MSY}	81	81	82	83	83	84	84	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	84	84	84	84	84	84	83	83
F = 0.7 F_{MSY}	81	81	82	82	83	83	83	83	83	83	83	83	83	83	82	82	82	82	82	81	81	81	80	80	80	80	79	79	79	79	78
F = 0.8 F_{MSY}	81	81	81	81	82	82	82	81	81	81	81	80	80	80	79	79	79	78	78	78	77	77	76	76	76	75	75	75	75	74	74
F = 0.9 F_{MSY}	81	81	81	81	81	80	80	80	79	79	78	78	77	77	76	76	76	75	75	74	74	73	73	72	72	72	71	71	71	70	70
F = F_{MSY}	81	80	80	80	79	79	79	78	77	77	76	75	75	74	74	73	73	72	71	71	70	70	70	69	69	68	68	68	67	67	67
F = 1.1 F_{MSY}	81	80	80	79	78	78	77	76	75	75	74	73	72	72	71	70	70	69	69	68	68	67	67	66	66	65	65	65	64	64	64
F = 1.2 F_{MSY}	81	80	79	78	77	76	75	74	74	73	72	71	70	69	68	68	67	67	66	65	65	65	64	64	63	63	63	62	62	62	61

P(Ft>Fmsy & Bt>Blim)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	70	72	74	76	78	80	82	83	85	86	87	88	89	90	91	91	92	92	93	93	94	94	94	95	95	95	95	95	96	96	96
F = 0.1 F_{MSY}	69	72	74	76	77	79	81	82	83	84	86	86	87	88	89	90	90	91	91	92	92	92	93	93	93	94	94	94	94	94	94
F = 0.2 F_{MSY}	68	70	72	73	75	76	77	79	80	81	82	83	84	84	85	86	86	87	87	88	88	89	89	89	89	90	90	90	90	91	91
F = 0.3 F_{MSY}	66	67	68	69	71	72	73	74	75	76	77	78	79	80	80	81	81	82	82	83	83	84	84	84	85	85	85	85	86	86	86
F = 0.4 F_{MSY}	62	63	64	65	66	68	69	70	71	71	72	73	74	74	75	76	76	77	77	77	78	78	79	79	79	79	80	80	80	80	80
F = 0.5 F_{MSY}	59	59	60	61	62	63	64	65	66	67	67	68	69	69	70	70	71	71	72	72	73	73	73	73	74	74	74	74	74	74	75
F = 0.6 F_{MSY}	55	56	56	57	58	59	60	61	61	62	63	63	64	65	65	66	66	66	67	67	67	68	68	68	68	68	68	69	69	69	69
F = 0.7 F_{MSY}	52	52	52	53	54	55	56	56	57	58	58	59	60	60	60	61	61	62	62	62	62	62	63	63	63	63	63	63	63	63	63
F = 0.8 F_{MSY}	48	48	49	50	50	51	52	53	53	54	54	55	55	56	56	56	57	57	57	57	58	58	58	58	58	58	58	58	58	58	59
F = 0.9 F_{MSY}	45	45	46	46	47	48	48	49	50	50	51	51	51	52	52	52	53	53	53	53	53	53	53	54	54	54	54	54	54	54	54
F = F_{MSY}	42	42	43	43	44	44	45	46	46	47	47	47	48	48	48	49	49	49	49	49	49	49	49	50	50	50	50	50	50	50	50
F = 1.1 F_{MSY}	39	39	40	40	41	42	42	43	43	43	44	44	44	45	45	45	45	45	45	46	46	46	46	46	46	46	46	46	46	46	46
F = 1.2 F_{MSY}	37	37	37	38	38	39	39	40	40	41	41	41	41	42	42	42	42	42	42	42	42	42	42	42	42	42	42	43	43	43	43

Table 6.3 b. Porbeagle in the Northeast Atlantic. Catch per year for each fishing mortality option (upper panel), probabilities (in %) of B>$B_{trigger}$ (middle panel) and B>$B_{trigger}$ and F< F_{MSY} (lower panel) per year from 2023 to 2053 for fishing mortalities increasing from 0 to 1.2 F_{MSY}. Catch in 2022 corresponds to F *status quo* (8t).

Catch per F and Year	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F = 0.1 F_{MSY}	63	67	72	76	81	86	91	96	101	106	111	116	121	126	131	136	141	146	151	155	160	164	168	172	176	180	184	187	190	194	197
F = 0.2 F_{MSY}	126	133	142	150	159	167	176	185	194	203	213	222	231	240	249	258	267	276	284	292	300	308	316	323	330	337	343	350	356	361	367
F = 0.3 F_{MSY}	188	199	210	221	233	245	257	269	281	294	306	318	331	343	355	367	378	390	401	412	423	433	444	453	463	472	481	489	497	505	512
F = 0.4 F_{MSY}	250	263	277	291	305	319	333	348	362	377	392	406	421	435	449	463	477	490	503	516	529	541	553	565	576	587	597	607	617	626	635
F = 0.5 F_{MSY}	312	327	342	358	373	389	405	421	437	453	470	485	501	517	532	548	563	577	592	606	620	633	646	659	671	683	695	706	716	727	737
F = 0.6 F_{MSY}	373	390	406	423	439	456	473	490	507	524	540	557	573	590	606	622	637	653	668	682	696	710	724	737	750	762	774	786	797	808	818
F = 0.7 F_{MSY}	435	451	468	485	502	520	537	554	571	588	605	621	638	654	670	686	701	716	731	746	760	774	788	801	813	826	838	849	861	871	882
F = 0.8 F_{MSY}	496	512	529	546	563	580	596	613	630	646	662	679	694	710	726	741	756	770	784	798	812	825	838	851	863	875	887	898	909	919	929
F = 0.9 F_{MSY}	556	572	589	605	621	637	653	668	684	699	714	729	744	759	773	787	801	814	828	841	853	865	877	889	900	911	922	932	943	952	962
F = F_{MSY}	617	632	647	661	676	691	705	719	733	747	761	774	788	801	813	826	838	850	862	873	884	895	906	916	926	936	946	955	964	973	981
F = 1.1 F_{MSY}	677	690	703	716	729	742	754	766	779	790	802	814	825	836	847	857	868	878	888	898	907	916	925	934	942	951	959	966	974	981	989
F = 1.2 F_{MSY}	737	748	758	769	780	790	800	810	820	829	839	848	857	866	874	883	891	899	907	914	922	929	936	943	950	956	962	969	974	980	986

P(Bt>Btrigger)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	50	55	59	63	66	69	72	75	77	80	82	83	85	87	88	90	91	92	93	94	95	96	96	97	97	98	98	99	99	99	99
F = 0.1 F_{MSY}	50	54	58	62	65	68	71	73	75	78	79	81	83	84	86	87	89	90	91	92	93	93	94	95	96	96	97	97	97	98	98
F = 0.2 F_{MSY}	50	54	58	61	64	67	69	71	74	75	77	79	80	82	83	84	85	87	88	88	89	90	91	92	92	93	93	94	94	95	95
F = 0.3 F_{MSY}	50	54	57	60	63	65	68	70	71	73	75	76	78	79	80	81	82	83	84	84	85	86	86	87	87	88	88	89	89	89	90
F = 0.4 F_{MSY}	50	54	57	59	62	64	66	68	69	71	72	73	75	76	77	77	78	79	79	80	81	81	81	82	82	82	83	83	83	83	84
F = 0.5 F_{MSY}	50	53	56	58	61	63	64	66	67	69	70	71	72	72	73	74	74	75	75	76	76	76	77	77	77	77	77	77	77	77	77
F = 0.6 F_{MSY}	50	53	55	58	59	61	63	64	65	66	67	68	69	69	70	70	71	71	71	72	72	72	72	72	72	72	72	72	72	72	72
F = 0.7 F_{MSY}	50	53	55	57	58	60	61	62	63	64	65	65	66	66	67	67	67	67	68	68	68	68	68	68	68	68	68	68	68	68	68
F = 0.8 F_{MSY}	50	52	54	56	57	59	60	61	61	62	63	63	63	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
F = 0.9 F_{MSY}	50	52	54	55	56	57	58	59	59	60	60	61	61	61	61	61	61	61	62	62	61	61	61	61	61	61	61	61	61	61	61
F = F_{MSY}	50	52	53	54	55	56	57	57	58	58	58	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	58	58	58	58
F = 1.1 F_{MSY}	50	51	52	53	54	55	55	56	56	56	56	57	57	57	57	57	57	57	57	57	57	57	57	57	56	56	56	56	56	56	56
F = 1.2 F_{MSY}	50	51	52	53	53	54	54	54	54	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	54	54	54	54	54

P(Ft>Fmsy & Bt>Btrigger)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	50	53	56	58	61	63	65	68	70	71	73	75	76	78	79	80	81	82	83	84	84	85	86	86	87	87	88	88	88	89	89
F = 0.1 F_{MSY}	50	53	55	58	60	62	64	66	68	70	71	73	74	76	77	78	79	80	81	82	82	83	84	84	85	85	86	86	87	87	87
F = 0.2 F_{MSY}	49	52	54	56	58	60	62	63	65	67	68	70	71	72	73	74	75	76	77	78	79	79	80	81	81	82	82	83	83	83	84
F = 0.3 F_{MSY}	48	50	52	53	55	57	59	60	62	63	64	66	67	68	69	70	71	72	73	74	74	75	76	76	77	78	78	79	79	79	80
F = 0.4 F_{MSY}	46	48	49	51	52	54	55	57	58	59	61	62	63	64	65	66	67	68	69	69	70	71	71	72	73	73	74	74	74	75	75
F = 0.5 F_{MSY}	44	45	46	48	49	50	52	53	54	56	57	58	59	60	61	62	63	64	64	65	66	66	67	68	68	69	69	69	70	70	70
F = 0.6 F_{MSY}	42	43	44	45	46	47	49	50	51	52	53	54	55	56	57	58	59	60	60	61	61	62	63	63	64	64	64	65	65	65	66
F = 0.7 F_{MSY}	40	40	41	42	43	44	46	47	48	49	50	51	52	53	53	54	55	56	56	57	57	58	58	59	59	59	60	60	60	61	61
F = 0.8 F_{MSY}	38	38	39	40	41	42	43	44	45	46	47	48	48	49	50	51	51	52	52	53	53	54	54	54	55	55	55	56	56	56	56
F = 0.9 F_{MSY}	35	36	36	37	38	39	40	41	42	43	44	45	45	46	47	47	48	48	49	49	50	50	50	51	51	51	51	51	52	52	52
F = F_{MSY}	33	34	34	35	36	37	38	39	40	40	41	42	42	43	44	44	45	45	45	46	46	46	47	47	47	47	47	48	48	48	48
F = 1.1 F_{MSY}	31	32	32	33	34	35	36	36	37	38	39	39	40	40	41	41	41	42	42	42	43	43	43	43	44	44	44	44	44	44	44
F = 1.2 F_{MSY}	30	30	30	31	32	33	34	34	35	36	36	37	37	38	38	38	39	39	39	39	40	40	40	40	40	40	41	41	41	41	41

Table 6.3 c. Porbeagle in the Northeast Atlantic. probabilities (in %) of B>B_{MSY} (upper panel), F<F_{MSY} (middle panel) and B>B_{MSY} and F<F_{MSY} (lower panel) per year from 2023 to 2053 for fishing mortalities increasing from 0 to 1.2 F_{MSY}. Catch in 2022 corresponds to F status quo (8t).

P(Bt>Bmsy)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	12	16	19	23	26	30	33	36	40	43	46	48	51	54	56	59	61	63	66	68	70	72	74	75	77	79	80	82	83	85	86
F = 0.1 F_{MSY}	12	15	19	22	25	29	32	35	38	41	43	46	49	51	53	55	58	60	62	64	65	67	69	70	72	73	75	76	78	79	80
F = 0.2 F_{MSY}	12	15	18	22	25	28	31	34	36	39	42	44	46	48	50	52	54	56	58	59	61	62	64	65	66	68	69	70	71	72	73
F = 0.3 F_{MSY}	12	15	18	21	24	27	30	32	35	37	40	42	44	46	48	49	51	53	54	55	57	58	59	60	61	62	63	64	65	65	66
F = 0.4 F_{MSY}	12	15	18	21	24	26	29	31	34	36	38	40	42	44	45	47	48	50	51	52	53	54	55	56	57	58	58	59	59	60	60
F = 0.5 F_{MSY}	12	15	18	20	23	26	28	30	33	35	37	39	40	42	43	45	46	47	48	49	50	51	52	53	53	54	55	55	56	56	56
F = 0.6 F_{MSY}	12	15	17	20	23	25	27	30	32	34	35	37	39	40	42	43	44	45	46	47	48	49	49	50	51	51	52	52	52	53	53
F = 0.7 F_{MSY}	12	15	17	20	22	24	27	29	31	33	34	36	38	39	40	41	43	44	44	45	46	47	47	48	48	49	49	50	50	50	51
F = 0.8 F_{MSY}	12	15	17	19	22	24	26	28	30	32	34	35	37	38	39	40	41	42	43	44	44	45	46	46	47	47	48	48	48	49	49
F = 0.9 F_{MSY}	12	15	17	19	21	23	25	27	29	31	33	34	36	37	38	39	40	41	42	43	43	44	44	45	45	46	46	46	47	47	47
F = F_{MSY}	12	14	17	19	21	23	25	27	29	30	32	34	35	36	37	38	39	40	41	41	42	43	43	44	44	45	45	45	46	46	46
F = 1.1 F_{MSY}	12	14	16	18	21	23	25	26	28	30	31	33	34	35	36	37	38	39	40	41	41	42	42	43	43	44	44	44	45	45	45
F = 1.2 F_{MSY}	12	14	16	18	20	22	24	26	28	29	31	32	34	35	36	37	38	38	39	40	40	41	42	42	42	43	43	44	44	44	44

P(Ft<Fmsy)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
F = 0.1 F_{MSY}	98	97	95	93	92	90	89	88	87	86	85	84	83	82	81	81	80	79	79	78	78	77	77	76	76	76	75	75	75	74	74
F = 0.2 F_{MSY}	93	90	88	85	83	82	80	79	78	77	76	75	75	74	73	73	72	72	71	71	70	70	70	69	69	69	68	68	68	68	67
F = 0.3 F_{MSY}	87	83	81	78	77	75	74	73	72	71	70	70	69	68	68	67	67	67	66	66	66	65	65	65	64	64	64	64	64	63	63
F = 0.4 F_{MSY}	80	77	74	73	71	70	69	68	67	66	66	65	65	64	64	63	63	63	63	62	62	62	62	61	61	61	61	61	60	60	60
F = 0.5 F_{MSY}	74	71	69	67	66	65	64	64	63	63	62	62	61	61	61	60	60	60	60	59	59	59	59	59	58	58	58	58	58	58	58
F = 0.6 F_{MSY}	68	66	64	63	62	61	61	60	60	59	59	59	58	58	58	58	57	57	57	57	57	57	56	56	56	56	56	56	56	56	56
F = 0.7 F_{MSY}	63	61	60	59	59	58	58	57	57	57	56	56	56	56	55	55	55	55	55	55	55	55	55	54	54	54	54	54	54	54	54
F = 0.8 F_{MSY}	58	57	56	56	55	55	55	54	54	54	54	54	54	54	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	52
F = 0.9 F_{MSY}	54	53	53	53	53	52	52	52	52	52	52	52	52	52	52	52	52	51	51	51	51	51	51	51	51	51	51	51	51	51	51
F = F_{MSY}	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
F = 1.1 F_{MSY}	46	47	47	48	48	48	48	48	48	48	48	48	48	48	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
F = 1.2 F_{MSY}	43	44	45	45	46	46	46	46	46	47	47	47	47	47	47	47	47	47	47	48	48	48	48	48	48	48	48	48	48	48	48

P(Bt>Bmsy & Ft<Fmsy)	Year																														
Fishing mortality	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053
F = 0	24	27	29	31	34	36	38	41	43	45	47	49	51	53	54	56	57	59	60	61	63	64	65	66	66	67	68	69	69	70	70
F = 0.1 F_{MSY}	24	27	29	31	33	35	37	39	41	43	45	47	49	50	52	54	55	56	58	59	60	61	62	63	64	65	65	66	67	67	68
F = 0.2 F_{MSY}	24	26	28	30	32	34	36	38	39	41	43	45	46	48	49	51	52	53	54	56	57	58	59	60	60	61	62	63	63	64	65
F = 0.3 F_{MSY}	24	26	27	29	31	32	34	36	37	39	40	42	43	45	46	48	49	50	51	52	53	54	55	56	57	58	59	59	60	61	61
F = 0.4 F_{MSY}	23	25	26	28	29	31	32	34	35	37	38	39	41	42	43	45	46	47	48	49	50	51	52	53	54	55	55	56	57	57	58
F = 0.5 F_{MSY}	23	24	25	26	28	29	30	32	33	34	36	37	38	40	41	42	43	44	45	46	47	48	49	50	50	51	52	53	53	54	54
F = 0.6 F_{MSY}	22	23	24	25	26	27	29	30	31	32	34	35	36	37	38	39	40	41	42	43	44	45	46	46	47	48	49	49	50	50	51
F = 0.7 F_{MSY}	21	22	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	39	39	40	41	42	43	43	44	45	45	46	46	47	47
F = 0.8 F_{MSY}	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	34	35	36	37	38	38	39	40	40	41	41	42	42	43	43	44
F = 0.9 F_{MSY}	20	20	21	21	22	23	24	25	26	27	28	29	30	31	31	32	33	34	34	35	35	36	37	37	38	38	39	39	39	40	40
F = F_{MSY}	19	19	20	20	21	22	23	24	25	26	26	27	28	29	29	30	31	31	32	32	33	33	34	34	35	35	35	36	36	36	37
F = 1.1 F_{MSY}	18	18	19	19	20	21	22	23	23	24	25	26	26	27	27	28	28	29	29	30	30	31	31	31	32	32	32	33	33	33	33
F = 1.2 F_{MSY}	17	17	18	18	19	20	21	21	22	23	23	24	24	25	25	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	30

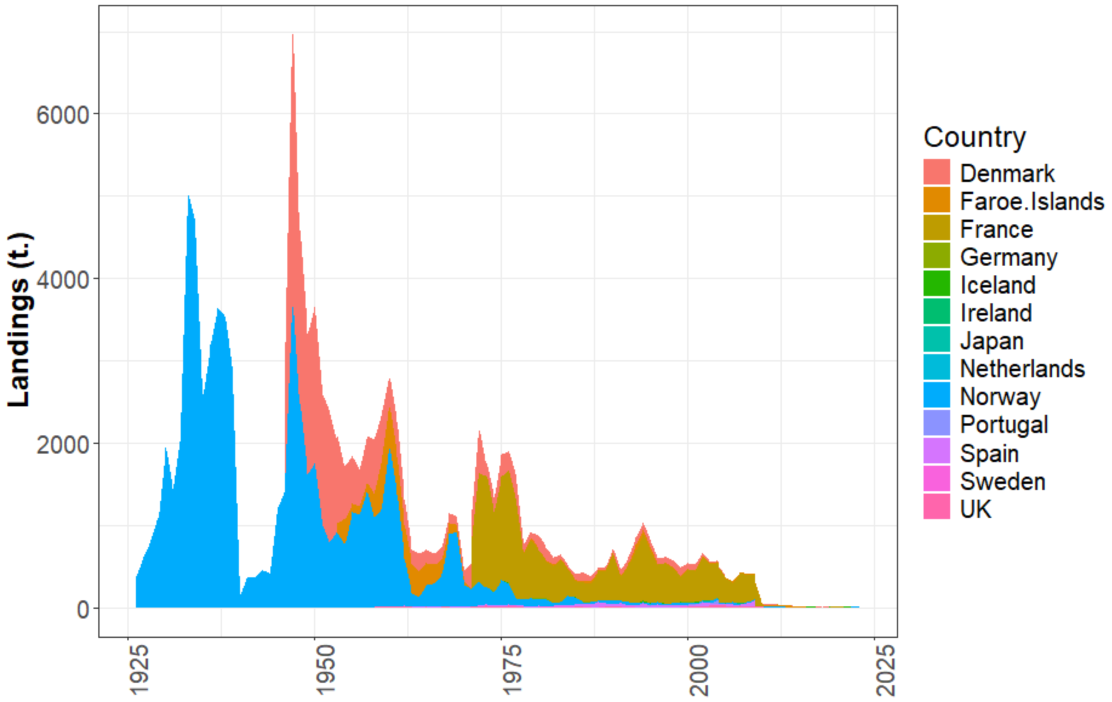


Figure 6.1. Porbeagle in the Northeast Atlantic. Working Group estimates of longer-term trend in landings of porbeagle in the Northeast Atlantic (1926–2023).

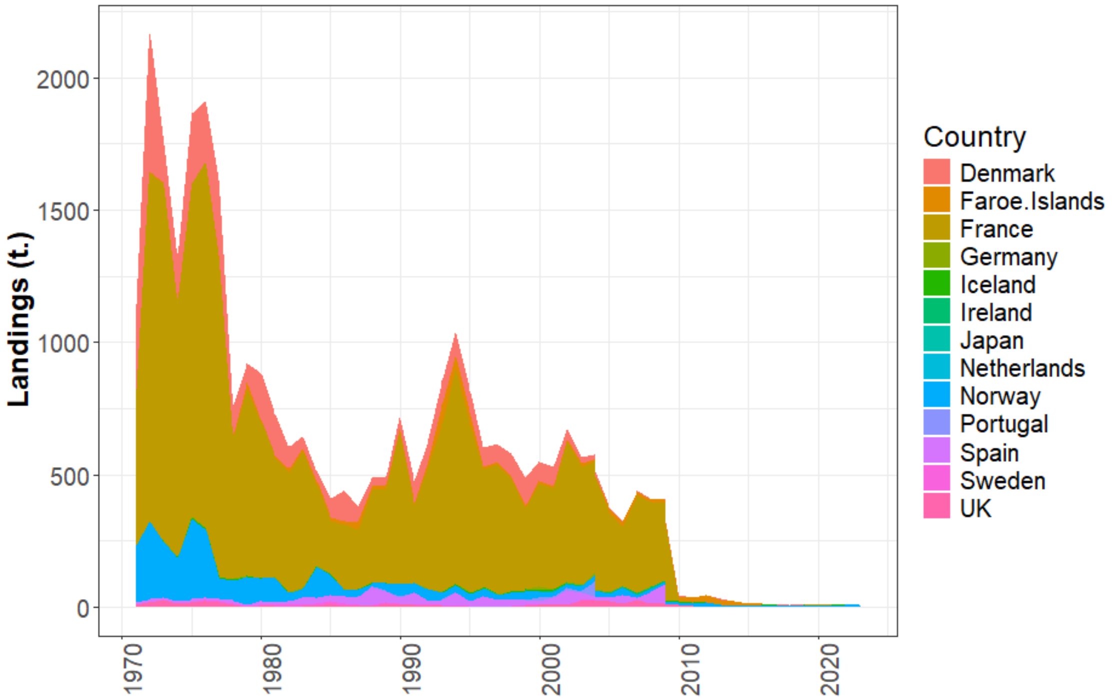


Figure 6.2. Porbeagle in the Northeast Atlantic. Working Group estimates of landings of porbeagle in the Northeast Atlantic for 1971–2023 by country.

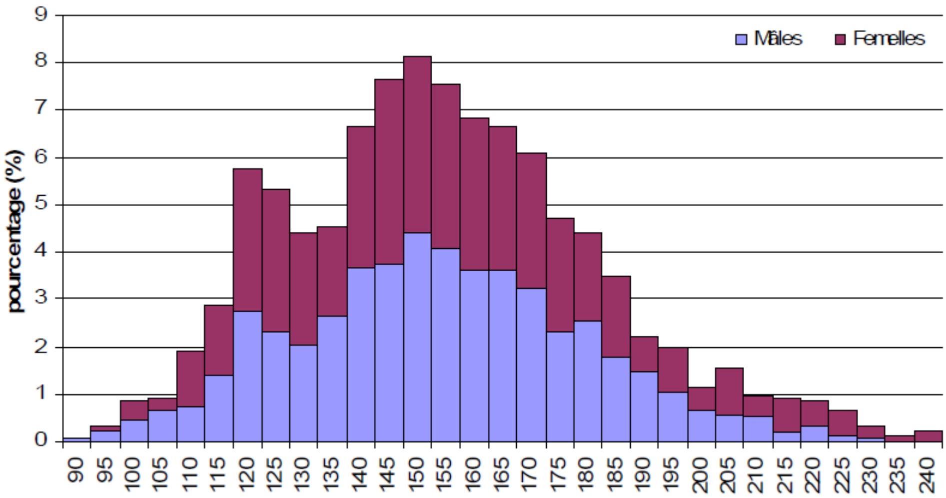


Figure 6.3. Porbeagle in the Northeast Atlantic. Length–frequency distribution of the landings of the Ile d'Yeu target fishery for porbeagle (2008–2009; n = 1769). Source: Hennache and Jung (2010).

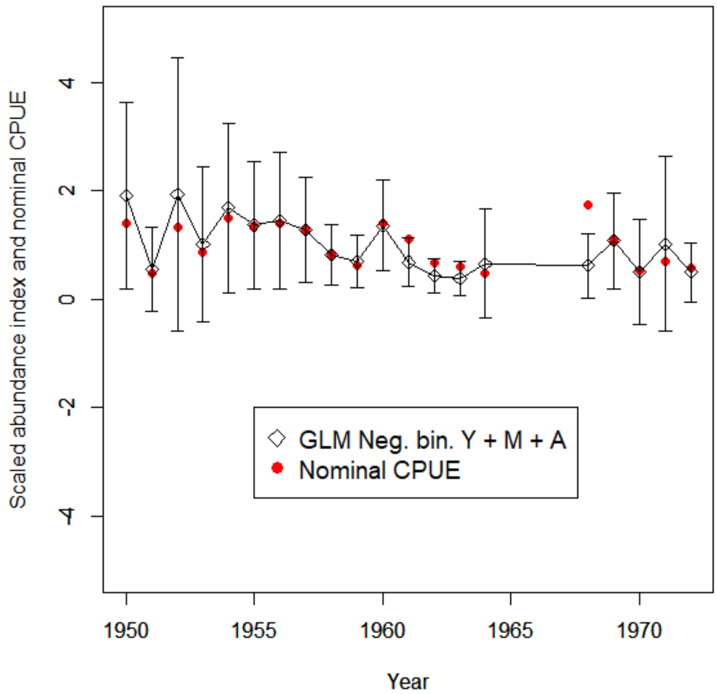


Figure 6.4. Porbeagle in the Northeast Atlantic. Relative abundance annual indices (± SE) provided by the standardization of CPUE of five longliners of the Norwegian directed fishery (with a GLM using a negative bi-nomial error distribution with a log link; variables included: year, month and area) with the nominal CPUEs (both scaled by the mean). Source: ICES 2022.

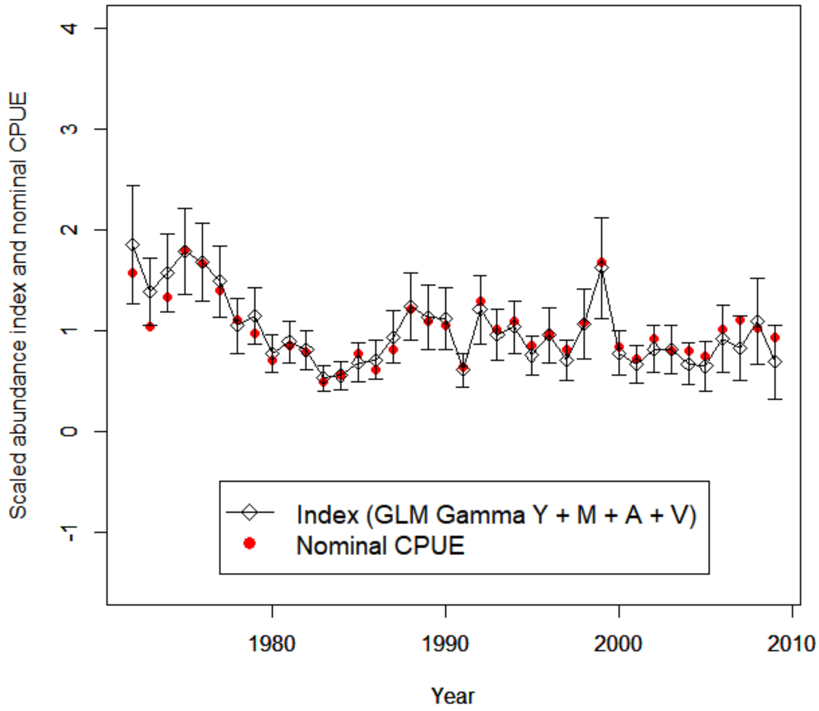


Figure 6.5. Porbeagle in the Northeast Atlantic. Relative abundance annual indices (± SE) provided by the standardization of CPUE of 19 longliners of the French directed fishery (with a GLM using Gamma error distribution with a log link; variables included: year, month, area and vessel) with the nominal CPUEs (both scaled by the mean). Source: ICES, 2022.

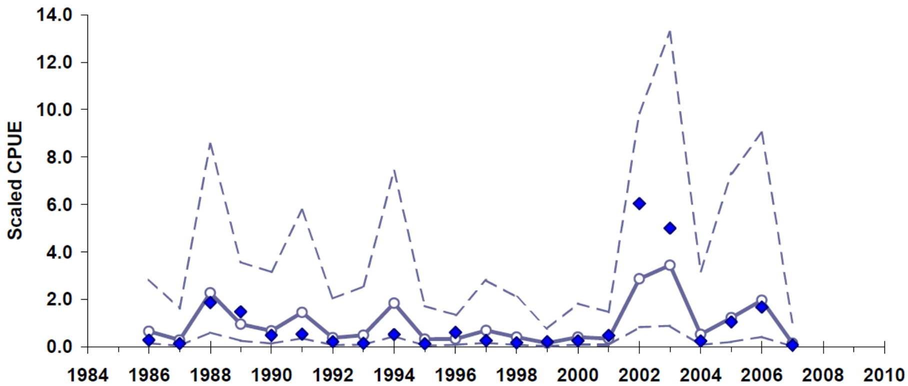


Figure 6.6. Porbeagle in the Northeast Atlantic. Relative abundance annual indices provided by the standardization of CPUE of the Spanish surface longline fishery targeting swordfish (with a GLM using delta-lognormal error distribution; variables included: year, zone, quarter, bait, year*zone, year*quarter) with confidence limits and the nominal CPUEs (blue rhombuses, scaled by the mean as the indices). Source: Mejuto *et al.*, 2010.

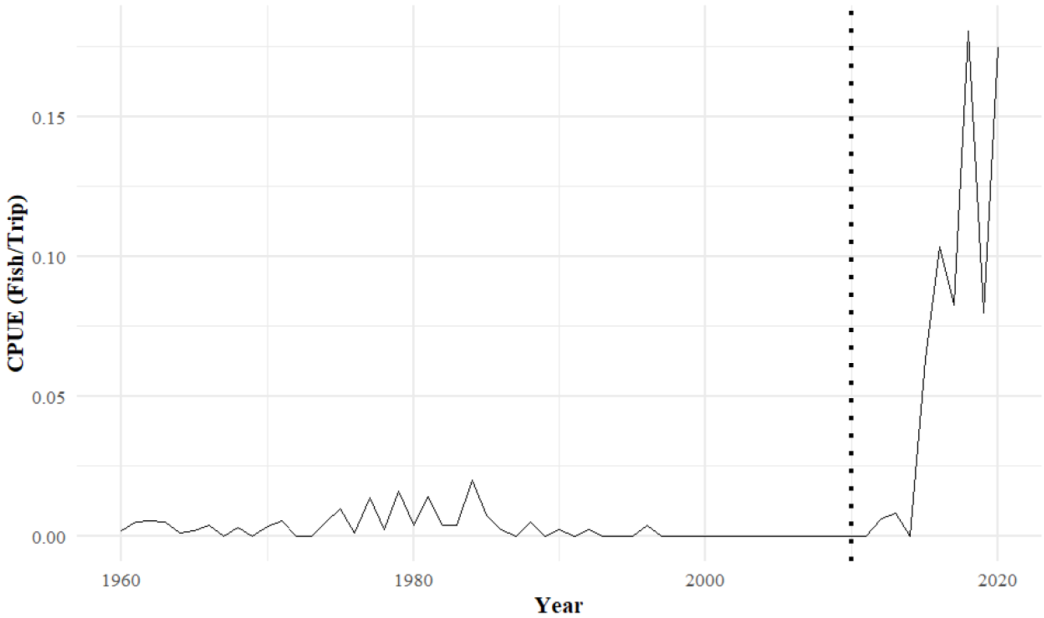


Figure 6.7. Porbeagle in the Northeast Atlantic. Temporal trends in CPUE (fish/ trip) of the UK recreational fishery in ICES Division 7e from 1960 to 2020 (n=478). Vertical dotted line represents imposition of zero TAC for the species by the EU. Source: Jones *at al.*, 2020.

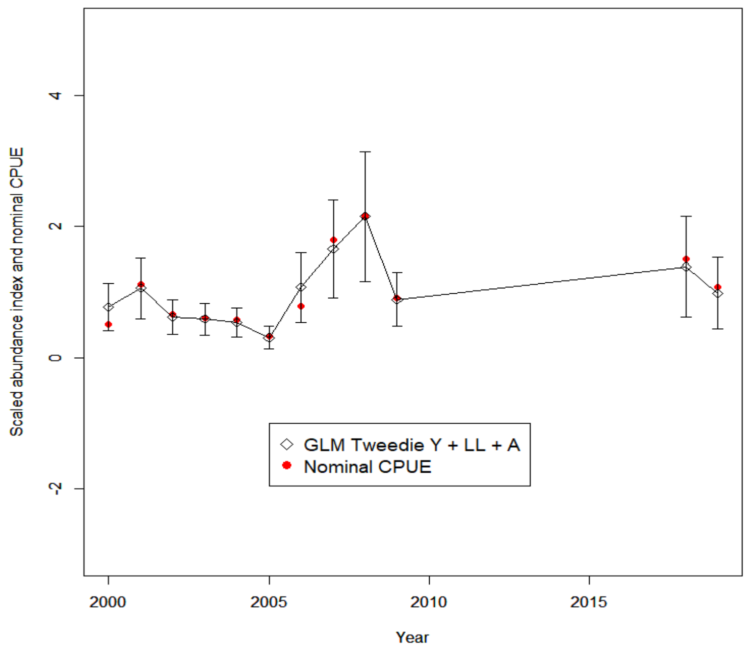


Figure 6.8. Porbeagle in the Northeast Atlantic. Relative abundance annual indices (± SE) provided by the standardization of CPUE of the composite survey CPUEs (with a GLM using Tweedie error distribution with a log link; variables included: year, type of longline and area) with the nominal CPUEs (both scaled by the mean). Source: ICES, 2022.

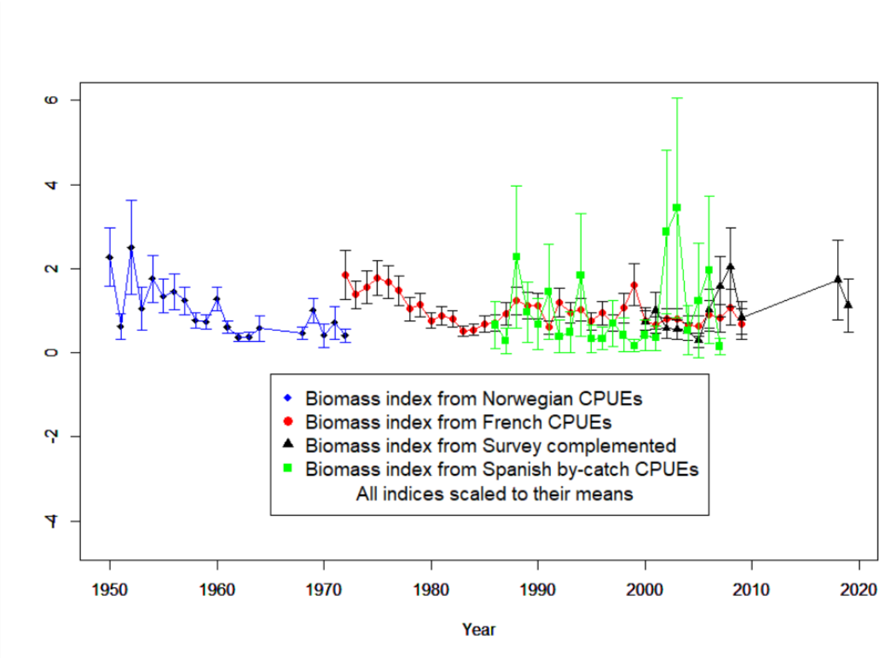


Figure 6.9: Porbeagle in the Northeast Atlantic. Relative biomass indices used in the porbeagle SPiCT assessments provided by the standardization of the four available CPUEs series. Source: ICES, 2022.

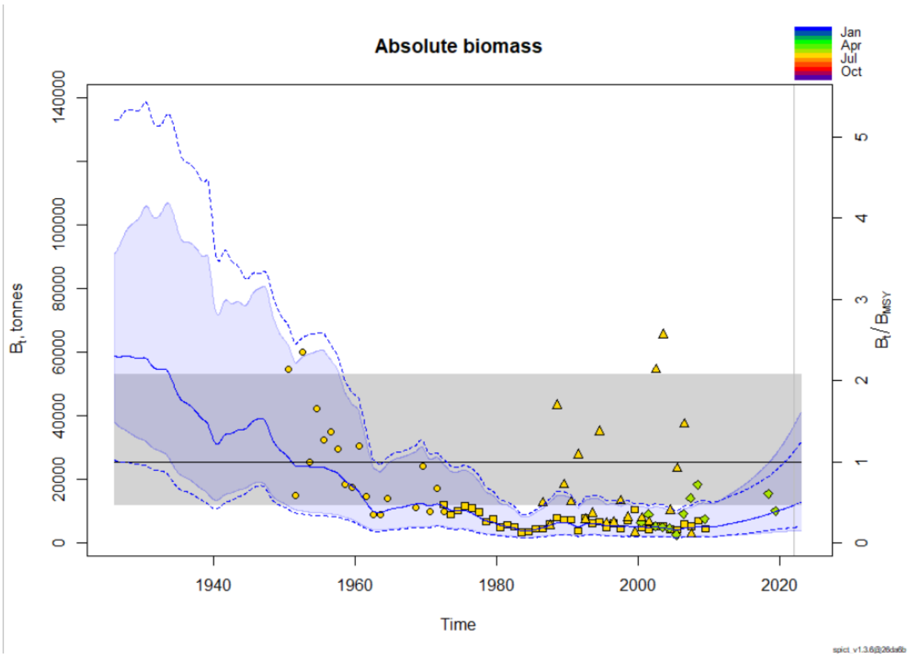


Figure 6.10: Porbeagle in the Northeast Atlantic. Absolute and relative biomasses from the 2022 SPiCT assessment.

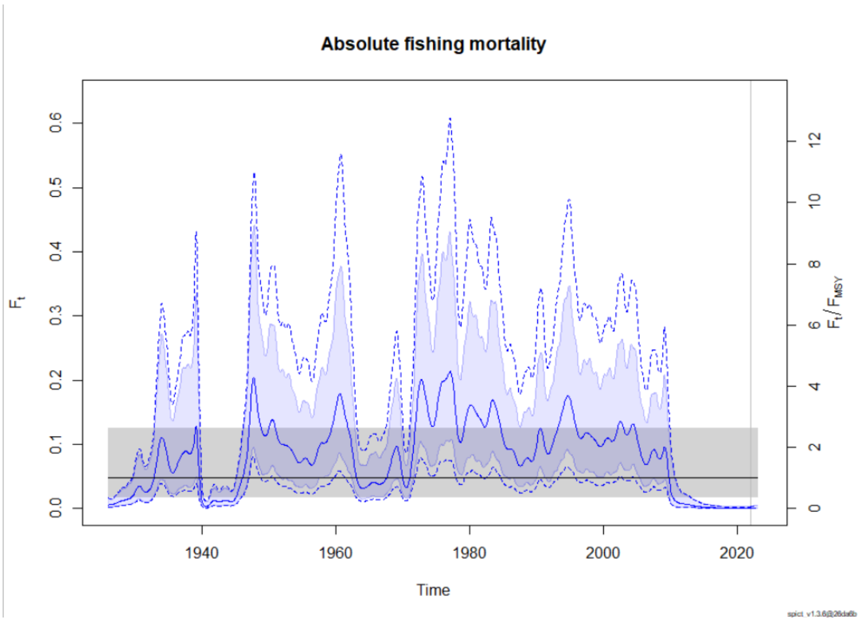


Figure 6.11: Porbeagle in the Northeast Atlantic. Absolute and relative fishing mortalities from the 2022 SPiCT assessment.

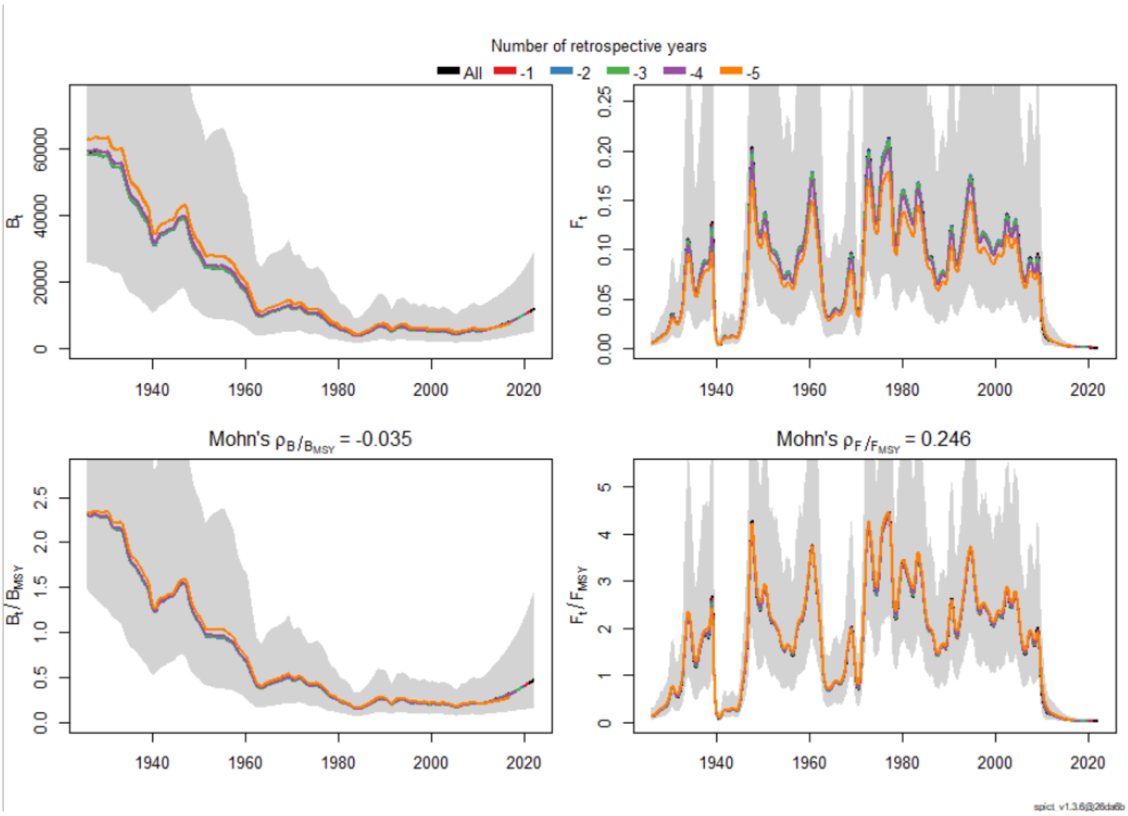


Figure 6.12: Porbeagle in the Northeast Atlantic. Retrospective plots from the 2022 SPiCT assessment.

Contents

7 Basking Shark in the Northeast Atlantic (ICES areas 1–14)

7.1 Stock distribution

In the Northeast Atlantic, basking shark *Cetorhinus maximus* is present from Iceland and the White Sea (southern Barents Sea) southwards to the Mediterranean Sea and north-west Africa (Compagno, 1984; Konstantinov and Nizovtsev, 1980), with known aggregation sites around the British Isles (Sims, 2008). WGEF considers that basking shark in the ICES area exists as a single stock and management unit. However, the WGEF is aware of tagging studies showing both transatlantic and trans-equatorial migrations, as well as movements into tropical areas and mesopelagic depths (Gore *et al*., 2008; Skomal *et al*., 2009; Braun *et al*., 2018; Dewar *et al.* 2018). A genetic study by Hoelzel *et al*. (2006) indicated no differentiation between ocean basins, whereas Noble *et al*. (2006) suggested limited gene flow between the northern and southern hemisphere.

There are two rough estimates of effective population size using genetics, one global, to take with caution, by Hoelzel *et al*. (2006), of 8200 individuals and one for the Irish Sea of 382 individuals (Lieber et al. 2020). Lieber *et al*. (2020) suggested that over 800 individuals frequented Isle of Man waters at some point during the year. A study from the west of the UK, using photo identification (Gore *et al.*, 2016), showed very few re-sightings after one year (0.5%), and satellite tracking showed that basking shark show behavioural plasticity and that most individuals use only a small fraction of the time feeding at the surface (Gore *et al.*, 2016; Doherty *et al.*, 2017). These results point to a relatively large stock, and/or that the stock size may not be adequately estimated by surface sightings.

7.2 The fishery

7.2.1 History of the fishery

The fishery for basking shark goes back as far as the middle or end of the 1700s, in Norwegian, Irish and Scottish waters (Strøm, 1762; Moltu, 1932; Parker and Stott, 1965; Myklevoll, 1968; McNally, 1976; Fairfax, 1998; See also the Stock Annex). Up to 1000 individuals may have been taken in Irish waters each year at the height of the fishery. Such intensive fisheries stopped during the mid-1800s when the species became very scarce.

The Norwegian fleet resumed the fishery in 1920. The landings increased during the 1930s as the fishery gradually expanded to offshore waters across the North Sea and south and west of Ireland, Iceland and the Faroes. During 1959–1980, landings ranged between 1266 and 4266 individuals per year, but subsequently declined (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changed markedly from year to year, possibly as a consequence of the unpredictable nature of the shark's inshore migration (Stott, 1982).

In Irish waters, the basking shark fishery started again in 1947. Between 1000 and 1800 individuals were taken each year from 1951 to 1955 (an average of 1475 per year), but there was a decline in recorded landings from 1956. Average annual landings were 489 individuals from 1956–1960, 107 individuals from 1961–1965, then about 50–60 individuals per year for the remaining years of the fishery (Parker and Stott, 1965; McNally, 1976).

The Scottish fishery started in the 1940s. In all, around 970 sharks were taken between 1946 and 1953 (during a period when Norwegian vessels were also catching basking sharks in these waters).

From 1977–2007, an estimated total of 12 347 basking sharks were landed by Norway and Scotland, and of these Norway landed 12 014 individuals with an annual maximum of 1748 individuals landed in 1979.

There is no longer any directed fishery for basking shark within the ICES area. Since 2007, the species has been listed as a prohibited species on EU fisheries regulations (Council Regulation (EC) No 41/2006), for details and currently valid regulation see Section 7.2.4. Norwegian vessels have not reported landings since 2013, though they may land dead specimens but should release live specimens. Since 2013, reported landings have been <1 t in total from all countries, with a maximum of 0.6 t landed in 2017.

7.2.2 The fishery in 2023

No new information.

7.2.3 ICES advice applicable

ICES first provided advice for basking shark in 2005, with this for a zero TAC. In 2012, ICES advised, based on the precautionary approach, that there should be no landings of basking shark and that it should remain on the Prohibited Species List. In 2023, ICES advised that "*when the precautionary approach is applied, there should be zero catches in each of the years 2024–2027*".

7.2.4 Management applicable

Article 14 of Council Regulation (EU) 2019/124 prohibits Union fishing vessels from fishing for, retaining on board, transhipping or landing basking shark in all waters. Article 50 of Council Regulation (EU) 2019/124 prohibits third-country vessels fishing for, retaining on board, transhipping or landing basking shark from EU waters.

Based on ICES advice, Norway banned all directed fisheries and landing of basking shark in 2006 in the Norwegian Economical Zone and in ICES subareas 1–14. The ban has continued since. During this period, live specimens caught as bycatch had to be released immediately, although dead or dying specimens could be landed (NFD, 2013). Since 2012, bycatch that is not landed should also be reported, and landings of basking sharks are not remunerated. Bycatch should be reported both in number of individuals and weight (since 2009).

Basking shark has been protected from killing, taking, disturbance, possession and sale in UK territorial (twelve nautical miles) waters since 1998. They are also protected in two UK Crown Dependencies: Isle of Man and Guernsey (Anon., 2002).

Sweden has forbidden fishing for or landing basking shark since 2004.

7.3 Catch data

7.3.1 Landings

Landings data within ICES subareas 1–14 from 1977–2023 are presented in Table 7.1 and Figure 7.1. Landings of basking shark peaked in 1979 at a total of 5266 t and declined rapidly towards 1988. Another peak in landings (1697 t) occurred in 1992. After the ban on directed fisheries in 2006–2007, annual landings declined to <30 t, with reported annual landings <1 t since 2013.

Reported landings data come from UK (Guernsey) in 1984 and 2020, Portugal (1991–2007, 2010–2013, 2016, 2020-2021), France (1990–2006, 2008–2010, 2014, 2017, 2020) and Norway (1977–2008, 2011–2012). Most landings are from Subarea 2 and are taken by Norway. For Portugal and France, the reported landings were between 0.01 and 1.5 t. Landings for France in 2005 were higher, at 3.5 t.

The conversion factors used for Norwegian landings (liver and fin weight to live weight) were revised during WGEF 2008. Data from the Norwegian Directorate of Fisheries revealed that the nominal value of fins increased dramatically from 1979 to 1992, was variable during 1993–2005, and decreased after 2005. Table 7.2 shows old and revised numbers.

Table 7.3 shows the proportions of landed basking sharks caught by various gears as reported to the Norwegian Directorate of Fisheries (1990–2011). During most of the 1990s, harpoon was the main gear, but remained at a relatively low level from 2000, except for 2005, which was the last year with a directed fishery. After the ban on directed fisheries in 2006, bycatch has been taken primarily in gillnets.

Further information on Norwegian landings of liver and fins, and corresponding official and revised landings in live weight and numbers are given in the Stock Annex.

7.3.2 Discards

Limited quantitative information exists on basking shark discarded bycatch. However, anecdotal information indicates that this species is an incidental bycatch in gillnet and trawl fisheries and individual basking sharks may be entangled in potting ropes. Most bycatch events occur in the summer as the species moves inshore. Total bycatch has not been estimated.

Normal discard observer programmes, such as DCMAP, may not record bycatch of large animals such as basking sharks, if they fall or are removed from gear before the catch is brought on board the vessel. Fisheries observer programmes are not designed to account for rare species (ICES, 2018).

Berrow and Heardman (1994) estimated 77–120 basking sharks were caught annually in the gillnet fishery in the Celtic Sea. These authors received 28 reports of specimens being entangled in fishing gear around the Irish coast in 1993. In the Isle of Man, bycatch in the herring fishery and the pot fishery (entanglement in ropes) was estimated at 14–20 sharks annually. Fairfax (1998) reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter. Valeiras *et al.* (2001) reported that of twelve basking sharks being incidentally caught in fixed entanglement nets in Spanish waters between 1988 and 1998, three sharks were sold at landing markets, three live sharks were released, and three dead sharks were discarded at sea. More detailed information can be found in the Stock Annex.

The French NGO APECS reported on 15 accidental catches from the Irish Sea, Atlantic Ocean and Mediterranean Sea (Jung *et al.*, 2012). More detailed information (catch location, gear, and biological data) is given in Table 7.4. This table also includes data on eleven bycatch events from the Norwegian coast, published in the Norwegian media (prior to 2013).

Accidental bycatch of three basking sharks were reported from The Smalls, Ireland (Division 7.g) in 2005. These sharks were released alive (Johnston, pers. comm. 2015). There are no other records of basking sharks in the Irish discard observer programme.

There were two records of female basking shark caught (and discarded) in the English and Welsh commercial fisheries (Silva and Ellis, 2019), which were caught by gillnet in the western English Channel in 2002 (382 cm L_T) and Bristol Channel in 2012 (378 cm L_T).

In 2009, observers from French national observer programmes reported three accidentally caught, but released, basking sharks (*ca.* 4 m long). Two basking sharks were recorded in Division 6.a and one in Division 4.a. One individual (*ca.* 8 m long) was recorded in 2010 from Division 6.a.

In April 2014, two basking sharks were stranded on south Brittany beaches: one male (5 m L_T, 650 kg) and one female (4 m L_T, 250 kg estimated). The female had a third of its dorsal body surface lacerated by a propeller wound.

Five basking sharks were caught and discarded by the Norwegian Coastal Reference Fleet in 2007–2009 (Vollen, 2010 WD). All specimens were caught in gillnets by vessels <15 m operating in ICES Subarea 2.

The requirement for EU and UK fleets to discard all basking sharks accidentally caught results in a lack of information on these catches. Similarly, for Norway, although reporting of released basking sharks is mandatory, there is currently no operative mechanism to facilitate such reporting.

A protocol for the standardised recording of bycatch and biological information from bycatch would benefit any future assessments of the stock.

7.3.3 Quality of the catch data

The official Norwegian conversion factor used to convert from liver weight and fin weight to live fish was revised in 2008 (Table 7.2). The official Norwegian landing statistics were unchanged from 1977 to 1999, but from 2000–2008 the revised landings figures are applied. Further information on the revision of the conversion factor is included in the Stock Annex.

7.3.4 Discard survival

There is limited information available, and national observer programmes could usefully collect data on the fate (released alive/released dead) of basking shark specimens caught.

7.4 Commercial catch composition

There is some information on minimum, maximum and median weights of livers and fins, and corresponding live weights of individual basking sharks landed in Norway during 1992–1997. This information is included in the Stock Annex.

7.1 Commercial catch-effort data

There are neither effort nor CPUE data available for recent years. Historical CPUE data from the Norwegian fishery (1965–1985) are given in the Stock Annex.

7.5 Fishery-independent surveys

Several countries, e.g. Norway, Denmark, and Ireland, conduct scientific whale-counting surveys. Observations of basking sharks are normally recorded on these surveys.

The Norwegian whale-counting survey observed a total of 87 basking sharks in the Norwegian Sea during the period 1995–2014. Sightings seem to be heavily dependent on weather conditions, and 82 of the 87 sightings were made within nine short time periods (hours or 1–2 d). No apparent trends could therefore be identified. A number of Norwegian commercial vessels regularly report observations of whales, and a request to report basking shark sightings might yield useful effort-related data. The Norwegian Shark Alliance (HAI Norge) has collected online public sightings of basking sharks from 2011–2014. In 2019, the Institute of Marine Research (IMR) started collecting public sighting data through an online reporting system as well as bycatch incidents from media reports.

A national sighting program also exists along French coastlines, including all scientific survey reports (managed by APECS). Between 40 and 270 sightings are recorded each year, mostly reported by sailors and fishers. Sightings occur mainly from April to June, and the major area is the southern and western coasts of Brittany. Early sightings have also been reported from off Corsica in February–March. In 2011, one basking shark was reported in Saint Pierre et Miquelon.

There are also sightings programmes in the UK (Marine Conservation Society, 2003; Southall *et al.*, 2005; and the Shark Trust, https://www.sharktrust.org/sightings-database), and in Ireland through the Irish Basking Shark Study Group and the Irish Whale and Dolphin Group.

In Scotland, the Whale and Dolphin Trust for Hebrides and North West Scotland runs a sighting programme; Sea Watch Foundation is doing so for the Northern islands and northeast Scotland coasts. Basking Shark Scotland collates public sightings data.

7.6 Life-history and other relevant information

A summary of the knowledge of basking shark habitat, reproduction, growth and maturity, food and feeding, and behaviour can be found in the Stock Annex.

Basking sharks undertake extensive horizontal and vertical movements throughout the year (Sims *et al*. 2003; Sims, 2008) with a variety of spatio-temporal movement patterns and distances (Doherty *et al*., 2017; Dolton *et al*., 2020) and seasonal patterns (Doherty *et al*., 2017). Marked interannual and intra-annual variability of basking shark sightings have been reported, with significant correlation between the duration of the sightings season in each year and environmental/climatic factors like the North Atlantic Oscillation (Couto *et al*., 2017; Witt *et al*., 2012).

The Irish and Celtic Seas are important areas and studies show important migration corridors for sharks moving between NW Scotland, Isle of Man, SW England and western France (Berrow and Johnston, 2010 WD; Stéphan *et al*., 2011, Lieber *et al*., 2020).

In a study from 2008, the Irish Basking Shark Study Group tagged two basking sharks with archival satellite tags (Berrow and Johnston, 2010 WD). Both sharks remained on the continental shelf for most of the tagging period; 'Shark A' spent most time in the Irish and Celtic Seas with evidence of a southerly movement in winter to the west coast of France, whilst the movements of 'Shark B' were more constrained, remaining off the southwest coast for the whole period with locations along the shelf edge and in the Porcupine Bight (Figure 7.2). The greatest depths recorded were 144 m and 136 m, respectively, demonstrating that although 'Shark B' was located over deep water along shelf edge, it was not diving to large depths. The sharks were within 8 m of the surface for 10% and 6% of the time. The study demonstrated that basking sharks were present and active in Irish waters throughout the winter period.

Whilst for the NW Atlantic, Skomal *et al.* (2009) shed further light on apparent winter 'disappearance' of basking shark. Through satellite archival tags and a novel geolocation technique they demonstrated that sharks tagged in temperate feeding areas off the coast of southern New England moved to the Bahamas, the Caribbean Sea, and onward to the coast of South America and into the southern hemisphere. When in these areas, basking sharks descended to mesopelagic depths (200–1000 m) and in some cases remained there for weeks to months at a time. The authors concluded that basking sharks in the western Atlantic Ocean, which is characterized by dramatic seasonal fluctuations in oceanographic conditions, migrate well beyond their established range into tropical mesopelagic waters. In the eastern Atlantic Ocean, however, only occasional dives to mesopelagic depths have been reported in equivalent tagging studies (Sims *et al.*, 2005). It is hypothesized that in this area, the relatively stable environmental conditions mediated by the Gulf Stream may limit the extent to which basking sharks need to move during winter to find sufficient food.

The NGO APECS and the Manx Basking Shark Watch tagged ten basking sharks in 2009 (Stéphan *et al.*, 2011). The sharks were tagged with pop-up archival tags (MK10PAT, Wildlife Computers). Eight tags were deployed around the Isle of Man in the Irish Sea and two in the Iroise Sea (West Brittany, France). All the sharks tagged in the Irish Sea moved south, within the Irish Sea or Celtic Sea, and one to the southern Bay of Biscay (Figure 7.3). One of the tags deployed in the Irish Sea in 2009 popped off after five days but the second after 38 days. During this short period, the shark moved quickly northwards past the west coast of Ireland to western Scotland. This study confirmed that at least some sharks are present in coastal waters during the cold season (October to March). They are then found in deeper waters, while continuing to perform daily vertical migrations. However, one particularly significant sector of winter distribution does emerge: the northwestern part of the Celtic Sea where basking sharks are notably distributed at depths of 50–100 m during the cold season (Figure 7.4). The track of one shark tagged in Brittany confirms that some sharks sighted at the entrance to the Channel can swiftly reach the waters of the Hebrides via the west of Ireland (Figure 7.3).

Since 2011, APECS have tagged two further sharks off south Brittany, a 7.5 m male in April 2011 and a 6.5 m female in June 2013. These tags popped off after 35 and 76 days, respectively. The first one moved about 150 nm west of the tagging location to the northern Bay of Biscay, and the second one in the Celtic Sea, about 40 nm south of Ireland. In May 2016, two SPOT tags were deployed on adult animals south of Brittany; the 6.5 m female showed up in May 2017 in the southern of Bay of Biscay after spending the winter off the Moroccan coast.

The Manx Whale and Dolphin Watch (and formerly Manx Basking Shark Watch) has also been collecting public sightings and deploying tags since 2005. The Irish Basking Shark Study Group also performed tagging in 2012 and 2013.

SPOT Tagging technology has been successfully applied in the Inner Hebrides (West Scotland) on basking shark since 2012: nine SPOTs were deployed in July 2012 (Witt *et al.*, 2013). Witt *et al.*, (2016) revealed various spatio-temporal patterns in habitat use, from coastal movements to movements of thousands of kilometres (Figure 7.4). Long-distance movements of three adult basking shark from the Hebridean Sea to Madeira, the Canary Islands and North African coasts were observed from SPOT and SPLASH-F tags. These represented movements of >3300 km (straight-line distance) over periods of 132–322 days. In contrast, other sharks demonstrated a degree of site fidelity to the Inner Hebrides (at various spatial scales) during the summer months (Figure 7.5). This study also highlighted the importance of the Irish and Celtic Seas and important migration corridors for sharks moving from NW Scotland to the Isle of Man and southwest England.

7.7 Exploratory assessment models

No exploratory assessments have been undertaken.

7.8 Stock assessment

No stock assessment has been undertaken.

7.9 Quality of assessments

No assessments have been undertaken.

7.10 Reference points

No reference points have been proposed for this species.

7.11 Conservation considerations

Globally, basking shark is listed as Endangered on the IUCN Red List since 2019 (Rigby *et al.*, 2021) and, in European waters since 2015 (Sims *et al, 2005*). It is also listed as Endangered on the Irish Red List (Clarke *et al.*, 2016) and on the Norwegian Red List since 2010 (Hesthagen *et al.*, 2021).

Basking shark is also listed on:

- Appendix II of the Convention on International Trade in Endangered Species since 2003 (CITES 2002).
- Appendices I and II of the Convention on the Conservation of Migratory Species (CMS) since 2005 (CMS, 2018).
- Annex I, Highly Migratory Species, of the UN Convention on the Law of the Sea (UNCLOS 1982).
- the OSPAR (Convention on the protection of the marine environment of the Northeast Atlantic) list of threatened and/or declining species since 2003 (OSPAR 2009, re-assessed in 2021).

7.12 Management considerations

The current status of the stock is unknown. At present, there is no directed fishery for this species, but the levels of incidental bycatch and mortality of discards are unknown. Improved estimations of bycatch, fate and discarding, by numbers and estimated weight are required.

Where national legislation prohibits landing of bycaught basking sharks, measures should be put in place to ensure that incidental catches are recorded by (estimated) weight and number, and carcasses or biological material made available for research.

A number of national and regional sighting schemes operate in Northeast Atlantic waters, and coordinated analyses of such data may better elucidate knowledge of spatio-temporal patterns in abundance.

The low productivity and aggregating nature of basking shark makes it particularly vulnerable to overexploitation. It is susceptible to habitat degradation through anthropogenic impacts such as coastal development, pollution as well as boat and tourism interactions.

7.13 References

Anon. 2002. Convention on International Trade in Endangered Species (CITES), 2002. Inclusion of Basking Shark *Cetorhinus maximus* in Appendix II. Proponent: United Kingdom (on behalf of the Member States of the European Community). 12th Meeting of the Conference of Parties Proposal 36.

Braun, C., Skomal, G. and Thorrold, S. 2018. Integrating archival tag data and a high-resolution oceanographic model to estimate basking shark (*Cetorhinus maximus*) movements in the western Atlantic. *Frontiers in Marine Science*, 5, p.25.

Berrow, S. D. and Heardman, C. 1994. The basking shark *Cetorhinus maximus* (Gunnerus) in Irish waters-patterns of distribution and abundance. *Proceedings of the Royal Irish Academy*, 94B: 101–107.

Berrow, S. D. and Johnston, E. 2010. Basking shark telemetry and tracking in Ireland. Working Document for ICES Elasmobranch Working Group (WGEF) 2010.

CITES. 2002. CoP12 Plen. 9. Twelfth meeting of the Conference of the Parties Santiago (Chile), 3-15 November 2002. Appendix II listing of basking shark (*Cetorhinus maximus*). Accepted. https://cites.org/sites/default/files/eng/cop/12/rep/Plen9.PDF

Clarke, M., Farrell, E.D., Roche, W., Murray, T.E., Foster, S. and Marnell, F. (2016) Ireland Red List No. 11: Cartilaginous fish [sharks, skates, rays and chimaeras]. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. Dublin, Ireland.

CMS. 2018. Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), as amended by the Conference of the Parties in 1985, 1988, 1991, 1994, 1997, 1999, 2002, 2005, 2008, 2011, 2014 and 2017. 15 pp. https://www.cms.int/sites/default/files/basic_page_documents/cms_cop12_appendices_e_0.pdf.

Compagno, L. J. V. 1984. FAO Species Catalogue. IV. Sharks of the World. 1. Hexanchiformes to Lamniformes. Food and Agriculture Organisation of the United Nations, Rome.

Couto, A., Queiroz, N., Relvas, P., Baptista, M., Furtado, M., Castro, J., Nunes, M., Morikawa, H. and Rosa, R., 2017. Occurrence of basking shark *Cetorhinus maximus* in southern Portuguese waters: a two-decade survey. *Marine Ecology Progress Series*, 564: 77–86.

Dewar, H., Wilson, S. G., Hyde, J. R., Snodgrass, O. E., Leising, A., Lam, C.H., Domokos, R., Wraith, J. A., Bograd, S. J., Van Sommeran, S. R., and Kohin, S. 2018. Basking Shark (*Cetorhinus maximus*) Movements in the Eastern North Pacific Determined Using Satellite Telemetry. Frontiers in Marine Science, 5: 163. doi: 10.3389/fmars.2018.00163

Doherty, P., Baxter, J., Gell, F. *et al.* 2017. Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic. *Science Reports* **7**, 42837; doi: 10.1038/srep42837

Dolton, H. R., Gell, F. R., Hall, J., Hall, G., Hawkes, L. A., and Witt, M. J. 2020. Assessing the importance of Isle of Man waters for the basking shark *Cetorhinus maximus*. *Endangered Species Research*, 41: 209–223.

Fairfax, D. 1998. The basking shark in Scotland: natural history, fishery and conservation. Tuckwell Press, East Linton, Scotland. 206 pp.

Gore, M., Rowat, D., Hall, J., Gell, F. R. and Ormond, R. F. 2008. Trans-Atlantic migration and deep mid-ocean diving by basking shark. *Biology Letters*, 4: 395–398.

Gore, M. A., Frey, P. H., Ormond, R. F., Allan, H. and Gilkes, G. 2016. Use of Photo-Identification and Mark-Recapture Methodology to Assess Basking Shark (Cetorhinus maximus) Populations. PLoS ONE 11(3): e0150160. doi:10.1371/journal.pone.0150160

Hesthagen, T., Wienerroither, R., Bjelland, O., Byrkjedal I, Fiske P, Lynghammar A, Nedreaas, K and Straube, N. 2021. Fisker: Vurdering av brugde Cetorhinus maximus for Norge. Rødlista for arter 2021. Artsdatabanken. https://www.artsdatabanken.no/lister/rodlisteforarter/2021/1454

Hoelzel, A. R., Shivji, M. S., Magnussen, J., and Francis, M. P. 2006. Low worldwide genetic diversity in the basking shark (*Cetorhinus maximus*). *Biology Letters*, 2: 639–642.

ICES. 2018. Report of the Working Group on Commercial Catches (WGCATCH), 6-10 November 2017, Kavala, Greec. ICES CM 2017/SSGIEOM:09. 132 pp.

Jung, A., Wargnier, A., Stéphan, E. and Lefranc, A. 2012. APECS Elasmobranch observation programs off French coasts. Working Document. ICES Working Group on Elasmobranch Fisheries. WD2012-06; 3 pp.

Konstantinov, K. G. and Nizovtsev, G. P. 1980. The basking shark *Cetorhinus maximus*, in Kandalaksha Bay of the White Sea. *Journal of Ichthyology*, 19: 155–156.

Kunzlik, P. A. 1988. The Basking Shark. Scottish Fisheries. Information Pamphlet, No. 14. Department of Agriculture and Fisheries for Scotland. Aberdeen.

Lieber, L., Hall, G., Hall, J., Berrow, S., Johnston, E., Gubili, C., Sarginson, J., Francis, M., Duffy, C., Wintner, S. P., and Doherty, P. D. 2020. Spatio-temporal genetic tagging of a cosmopolitan planktivorous shark provides insight to gene flow, temporal variation and site-specific re-encounters. *Scientific Reports*, 10(1), pp.1–17.

Marine Conservation Society. 2003. Marine Conservation Society basking shark watch report 1987–2001. Ross-on-Wye, UK: Marine Conservation Society.

McNally, K. 1976. The Sun-Fish Hunt. Blackstaff Press, Belfast.

Moltu, P. 1932. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten aktietrykk.

Myklevoll, S. 1968. Basking shark fishery. *Commercial Fisheries Review*, 30: 59–63.

Nieto, A., Ralph, G. M., Comeros-Raynal, M. T., Kemp, J., Garcia Criado, M., *et al*. 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

Noble, L. R., Jones, C. S. Sarginson, J., Metcalfe, J. D., Sims, D. W. and Pawson, M. G. 2006. Conservation Genetics of Basking Sharks. Final Report for Defra Tender CR0288. Report to Wildlife Species Conservation Division, Defra, UK.

OSPAR 2009. Background Document for Basking Shark *Cetorhinus maximus*. OSPAR Commission Report 36 pp.

Parker, H. W. and Stott, F. C. 1965. Age, size and vertebral calcification in the basking shark *Cetorhinus maximus* (Gunnerus). *Zoologische Mededelingen*, 40: 305–319.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Romanov, E. and Kyne, P.M. 2021. Cetorhinus maximus (amended version of 2019 assessment). The IUCN Red List of Threatened Species 2021: e.T4292A194720078. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T4292A194720078.en. Accessed on 21 June 2022.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980.

Sims, D. W., Southall, E. J., Richardson, A. J., Reid, P. C., and Metcalfe, J. D. 2003. Seasonal movements and behaviour of basking sharks from archival tagging: No evidence of winter hibernation. *Marine Ecology Progress Series*, 248: 187–196.

Sims, D. W., Southall, E. J., Metcalfe, J. D. and Pawson, M. G. 2005. Basking Shark Population Assessment. Report to Global Wildlife Division, Defra, UK.

Sims, D. W. 2008. Sieving a living: a review of the biology, ecology and conservation status of the plankton-feeding basking shark *Cetorhinus maximus*. Advances in Marine Biology, 54: 171–220.

Skomal, G. B., Zeeman, S. I., Chisholm, J. H., Summers, E. L., Walsh, H. J., McMahon, K. W. and Thorrold, S. R. 2009. Transequatorial migrations by basking sharks in the western Atlantic Ocean. *Current Biology*, 19: 1019–1022.

Southall, E. J., Sims, D. W., Metcalfe, J. D., Doyle, J. I., Fanshawe, S., Lacey, C., Shrimpton, J., Solandt J-L. and Speedie C. D. 2005. Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data. *Journal of the Marine Biological Association of the United Kingdom*, 85: 1083–1088.

Stéphan E., Gadenne H. and Jung A. 2011. Sur_les_traces_du_requin_pelerin. Satellite tracking of basking sharks in the North-East Atlantic Ocean. Final report. February 2011. 37pp. (http://www.asso-apecs.org/IMG/pdf/Final_report_-_Sur_les_traces_du_requin_pelerin_-_Feb_2011.pdf).

Stott, F. C. 1982. A note on catches of basking sharks, *Cetorhinus maximus* (Gunnerus), off Norway and their relation to possible migration paths. *Journal of Fish Biology*, 21: 227–230.

Strøm, H. 1762. Beskrivelse av fogderiet Søndmør. Del 1. Sorøe 1762.

Valeiras J., Lopez, A. and Garcia, M.. 2001. Geographical, seasonal occurrence, and incidental fishing capture of the basking shark *Cetorhinus maximus* (Chondrichthyes: Cetorhinidae). *Journal of the Marine Biological Association of the United Kingdom*, 81: 183–184.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working Document for ICES Elasmobranch Working Group (WGEF) 2010.

Witt, M. J., Doherty, P. D., Hawkes, L. A., Brendan J. Godley, B. J., Graham, R. T. and Henderson, S. M. 2013. Basking shark satellite tagging project: post-fieldwork report. *Scottish Natural Heritage Commissioned Report* No. 555.

Witt, M. J., Hardy, T., Johnson, L., Mcclellan, C. M., Pikesley, S. K., Ranger, S., Richardson, P. B., Solandt, J.-L., Speedie, C., Williams, R. and Godley, B. J. 2012. Basking sharks in the northeast Atlantic: spatio-temporal trends from sightings in UK waters. *Marine Ecology Progress Series*, 459: 121–134.

Witt, M. J., Doherty, P. D., Godley, B. J. Graham, R. T. Hawkes, L. A. and Henderson, S. M. 2016. Basking shark satellite tagging project: insights into basking shark (*Cetorhinus maximus*) movement, distribution and behaviour using satellite telemetry. Final Report. *Scottish Natural Heritage Commissioned Report No. 908.*

7.14 Tables and Figures

Table 7.1. Basking shark in the Northeast Atlantic. Total landings (t) of basking sharks in ICES subareas 1–14 (1977–2023)*. "+" = <0.5 t. Data for 2022 updated following Data Call.

Year	1 & 2	3 & 4	5a	5b	6	7	8	9	10	12	14	TOTAL
1977	3680											3680
1978	3349			14		278						3641
1979	5120					139	7					5266
1980	3642			83								3725
1981	1772			28								1800
1982	1970					186						2156
1983	967	734				60						1761
1984	873	1188				1						2062
1985	1465											1465
1986	1144											1144
1987	164							1				165
1988	96	10										106
1989	593							+				593
1990	781	116					1					897
1991	533	220					+	+				753
1992	1613	84					+	+				1697
1993	1374							+				1374
1994	920	157					+	1				1078
1995	604	23					1	1				629
1996	792						+	1				793
1997	425	43					2	1				471
1998	55						1					56
1999	31						1	1				33
2000	117						1	1				119
2001	80							2	1			83
2002	54	+						1				55
2003	128							1				129
2004	72							1	26			99
2005	218	+				2	1	2				223
2006	16					+	+	+				17
2007	26							+				26
2008	4						1					5
2009				1	+		+					1
2010				+	1			+				1
2011	2							+				2
2012	22							1				24
2013								+				+

Year	1 & 2	3 & 4	5a	5b	6	7	8	9	10	12	14	TOTAL
2014						+						+
2015												
2016								+				+
2017						1						1
2018												
2019												
2020						+		+				+
2021								+				+
2022												
2023**												

*** 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.**

**** 0.393 t of discards were reported in 2023.**

Table 7.2. Basking shark in the Northeast Atlantic. Norwegian landings of liver (kg) and fins (kg) of basking shark (*Cetorhinus maximus*) during 1977–2008, estimated landings in live weight (conversion factors of 4.64 for liver and 40.0 for fins), estimated numbers of landed individuals (from landings of both liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins), ICES and Norwegian official landings (applying conversion factors of 10.0 for liver (1977–1995), 100.0 fins (1996–1999), 100.0 for fins (ICES 2000–2008), and 40.0 for fins (Norway 2000–2008)), and landings recommended used by ICES WGEF 2008. In 1995 and 1997, landings of whole individuals measuring 3760 kg (one individual) and 7132 kg (two individuals), respectively, were reported. These weights are included in the official and revised landings and in the estimation of landed numbers.

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	ICES estimates (2008)
1977	793 153	0	3680.2	0.0	1223	7931.5	7931.5	3680.2
1978	784 687	0	3640.9	0.0	1210	7846.9	7846.9	3640.9
1979	1 133 477	95 070	5259.3	3802.8	1748–1330	11 334.8	11 334.8	5259.3
1980	802 756	60 851	3724.8	2434.0	1238–851	8027.6	8027.6	3724.8
1981	387 997	27 191	1800.3	1087.6	598–380	3880.0	3880.0	1800.3
1982	464 606	31 987	2155.8	1279.5	716–447	4646.1	4646.1	2155.8
1983	379 428	24 847	1760.5	993.5	585–348	3794.3	3794.3	1760.5
1984	444 171	23 505	2061.0	940.2	685–329	4441.7	4441.7	2061.0
1985	315 629	16 699	1464.5	668.0	487–234	3156.3	3156.3	1464.5
1986	246 474	12 138	1143.6	485.5	380–170	2464.7	2464.7	1143.6
1987	35 244	3148	163.5	125.9	54–44	352.4	352.4	163.5
1988	22 761	1927	105.6	77.1	35–27	227.6	227.6	105.6
1989	127 775	10 367	592.9	414.7	197–145	1277.8	1277.8	592.9
1990	193 179	18 110	896.4	724.4	298–253	1931.8	1931.8	896.4
1991	162 323	18 337	753.2	733.5	250–256	1623.2	1623.2	753.2
1992	365 761	37 145	1697.1	1485.8	564–520	3657.6	3657.6	1697.1
1993	291 042	34 360	1350.4	1374.4	449–481	2910.4	2910.4	1374.4

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	ICES estimates (2008)
1994	176 220	26 922	817.7	1076.9	272–377	1762.2	1762.2	1076.9
1995	10 450	15 571	52.2	626.6	17–219	108.3	108.3	626.6
1996	41 283	19 789	191.6	791.6	64–277	1978.9	1978.9	791.6
1997	57 184	11 520	272.5	467.9	90–163	1159.1	1159.1	467.9

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	ICES estimates (2008)
1977	793 153	0	3680.2	0.0	1223	7931.5	7931.5	3680.2
1978	784 687	0	3640.9	0.0	1210	7846.9	7846.9	3640.9
1979	1 133 477	95 070	5259.3	3802.8	1748–1330	11 334.8	11 334.8	5259.3
1980	802 756	60 851	3724.8	2434.0	1238–851	8027.6	8027.6	3724.8
1981	387 997	27 191	1800.3	1087.6	598–380	3880.0	3880.0	1800.3
1982	464 606	31 987	2155.8	1279.5	716–447	4646.1	4646.1	2155.8
1983	379 428	24 847	1760.5	993.5	585–348	3794.3	3794.3	1760.5
1984	444 171	23 505	2061.0	940.2	685–329	4441.7	4441.7	2061.0
1985	315 629	16 699	1464.5	668.0	487–234	3156.3	3156.3	1464.5
1986	246 474	12 138	1143.6	485.5	380–170	2464.7	2464.7	1143.6
1987	35 244	3148	163.5	125.9	54–44	352.4	352.4	163.5
1988	22 761	1927	105.6	77.1	35–27	227.6	227.6	105.6
1989	127 775	10 367	592.9	414.7	197–145	1277.8	1277.8	592.9
1990	193 179	18 110	896.4	724.4	298–253	1931.8	1931.8	896.4
1991	162 323	18 337	753.2	733.5	250–256	1623.2	1623.2	753.2
1992	365 761	37 145	1697.1	1485.8	564–520	3657.6	3657.6	1697.1
1993	291 042	34 360	1350.4	1374.4	449–481	2910.4	2910.4	1374.4
1994	176 220	26 922	817.7	1076.9	272–377	1762.2	1762.2	1076.9
1995	10 450	15 571	52.2	626.6	17–219	108.3	108.3	626.6
1996	41 283	19 789	191.6	791.6	64–277	1978.9	1978.9	791.6
1997	57 184	11 520	272.5	467.9	90–163	1159.1	1159.1	467.9
1998	3	1366	0.0	54.6	19	136.6	136.6	54.6
1999	20	770	0.1	30.8	11	77.0	77.0	30.8
2000	51	2926	0.2	117.0	41	292.6	117.0	117.0
2001	0	1997.5	0.0	79.9	28	199.7	79.9	79.9
2002	0	1351.5	0.0	54.1	19	135.2	54.1	54.1
2003	0	3191.5	0.0	127.7	45	319.2	127.7	127.7
2004	0	1808.3	0.0	72.3	25	180.8	72.3	72.3
2005	0	2180.5	0.0	87.2	30	218.1	87.2	87.2
2006	0	160	0.0	6.4	2	16.0	6.4	6.4

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	ICES estimates (2008)
2007	0	653	0.0	26.1	9	65.3	26.1	26.1
2008	0	98	0.0	3.9	1	9.8	3.9	3.9

Table 7.3. Basking shark in the Northeast Atlantic. Proportions (%) of landed basking sharks caught in different gears as reported to the Norwegian Directorate of Fisheries from 1990–2011.

Year	Division 2.a							Division 4.a	
	Harpoon	Gillnet	Driftnet*	Undefined nets	Bottom trawl	Danish seine	Hook and lines	Harpoon	Gillnet
1990	84.0		3.1					12.9	
1991	69.7		1.0					29.3	
1992	83.1		6.0		5.6		0.4	4.9	
1993	99.1	0.8			0.1				
1994	85.4							14.6	
1995	89.8	6.5							3.7
1996	89.1	10.3		0.2		0.4	0.1		
1997	66.7	23.7					0.5	9.1	
1998	67.2	28.5					4.4		
1999	9.1	81.8		7.8	1.3				
2000	33.4	58.7			7.8				
2001		96.0			4.0				
2002	16.3	78.5			5.2				
2003	3.4	89.7			7.2				
2004		100.0							
2005	54.1	44.5		0.5	1.4				
2006		100.0							
2007		100.0							
2008		100.0							
2009									
2010									
2011		50.0					50.0		

*** These driftnets for salmon were banned after 1992.**

Table 7.4. Basking shark in the Northeast Atlantic. Summary details of bycatch reported from France and Norway.

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
France		May	2009	Mediterra-nean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterra-nean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterra-nean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France	31	May	2009	Atlantic	47.768	4.211			2.5–3 m		Released alive	Unpublished data - APECS
France	18	Nov	2009	Atlantic	43.427	1.695			3.5–4 m		Discarded	Unpublished data - APECS
France	27	Apr	2009	Mediterra-nean	45.841	1.531	Bottom trawl	20 m			Discarded	Unpublished data - APECS
France	20	May	2009	Mediterra-nean	43.051	-3.391	Pelagic trawl	45 m	5 m		Discarded	Unpublished data - APECS
France	25	Jan	2010	Iroise Sea	48.549	5.124	Gillnet		4–5 m		Released alive	Unpublished data - APECS
France	8	May	2010	Atlanic	46.236	1.592	Gillnet		4.6 m		Discarded	Unpublished data - APECS
France	27	May	2010	Atlantic	47.247	2.964	Gillnet		3.4 m		Discarded, samples, mu-seum collec-tion	Unpublished data - APECS

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
France	30	May	2011	Mediterra-nean	43.328	-5.203	Gillnet		3–6 m		Released alive	Unpublished data - APECS
France	3	Aug	2011	Iroise Sea	48.233	4.483	Gillnet		3–6 m		Discarded, samples	Unpublished data - APECS
France	19	Apr	2011	Atlantic	47.760	4.205	Gillnet	30 m	3–6 m		Discarded, samples, im-mature	Unpublished data - APECS
France	6	May	2011	Atlantic	47.745	4.218	Gillnet		3–6 m		Released alive, genetic sample	Unpublished data - APECS
France	4	Nov.	2011	Celtic Sea					4 m		Genetic sam-ple	Obsmer data
France	17	May	2013	Atlantic	47.780	4.210	Gillnet		3.3 m		Discarded, samples, im-mature male	Unpublished data - APECS
France	15	April	2014	Atlantic	47.78	3.77			5 m	650	Discarded	Media
Norway		Dec	2006	Atlantic	59.03	9.80	Gillnet	50 m	3.5 m	350	Approx. posi-tion	Media
Norway		Sep	2006	Atlantic	58.81	9.90	Gillnet		~4 m	500	Discarded, approx. posi-tion	Media
Norway		Aug	2007	Atlantic	61.97	5.02	Gillnet		4.5 m	250	Discarded, approx. posi-tion	Media
Norway			2007	Atlantic	64.13	8.20	Gillnet		4 m	500	Approx. posi-tion	Media

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
Norway		Sep	2007	Atlantic	58.45	8.86	Gillnet		4–5 m		Approx. position	Media
Norway		July	2008	Atlantic	68.11	14.18					Approx. position	Media
Norway		July	2008	Atlantic	62.36	47.00	Gillnet				Released alive, approx. position	Media
Norway		July	2011	Atlantic	70.29	27.28	Gillnet		~10 m		Discarded, approximate position	Media
Norway		July	2011	Atlantic	71.11	23.96	Gillnet				Released alive, approx. position	Media
Norway		May	2012	Atlantic	68.78	11.86	Gillnet		~10 m	~1 t	Landed, approx. position	Media
Norway		May	2012	Atlantic	62.48	5.86	Gillnet				Landed, approx. position	Media
Norway	13	Sept	2014	Atlantic	65.60	12.10	Gillnet		12 m		Approx. position	Media

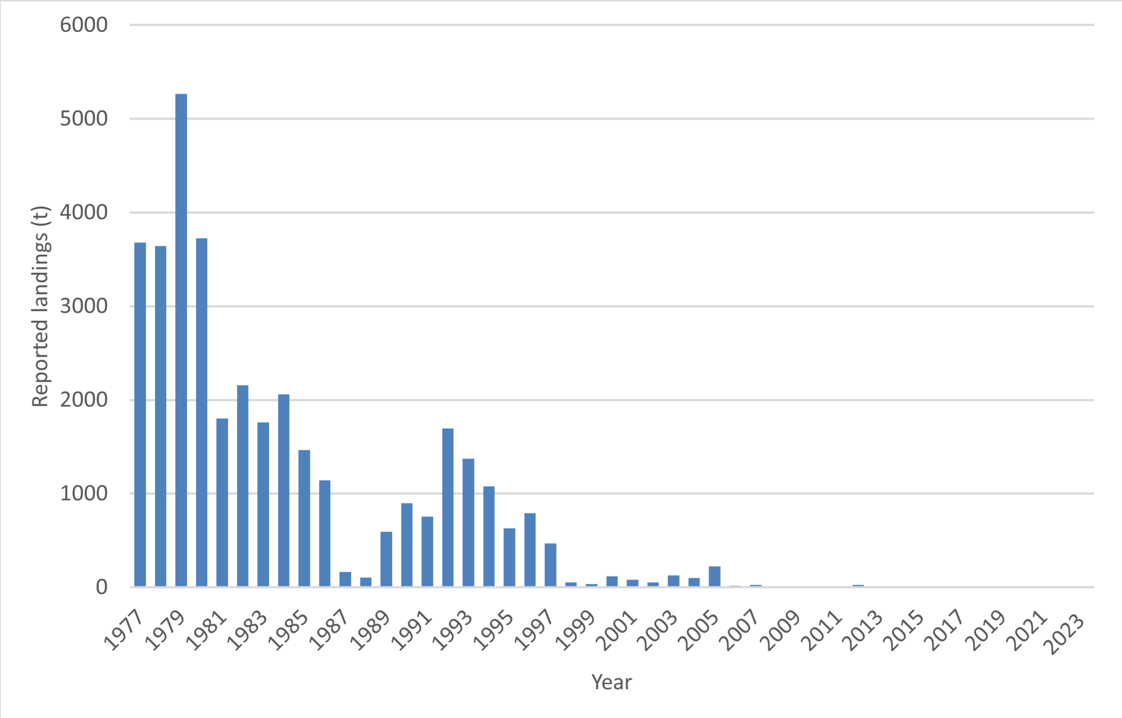


Figure 7.1. Basking shark in the Northeast Atlantic. Total landings (t) of basking sharks in ICES subareas 1–14 from 1977–2023, since 2013: < 1 t landed.

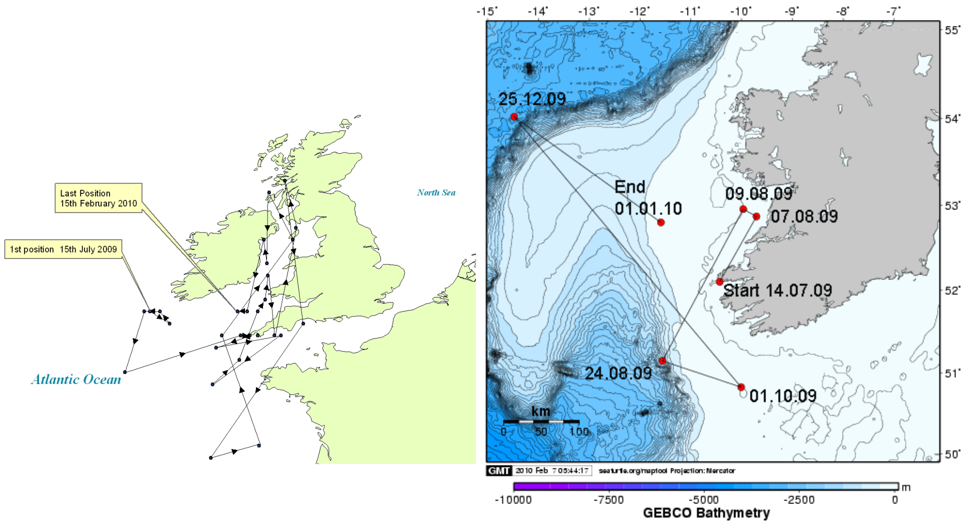


Figure 7.2. Basking shark in the Northeast Atlantic. Geolocations from basking shark A (left, sex = male) and B (right, sex = unknown). Source: Berrow and Johnston (2010 WD).

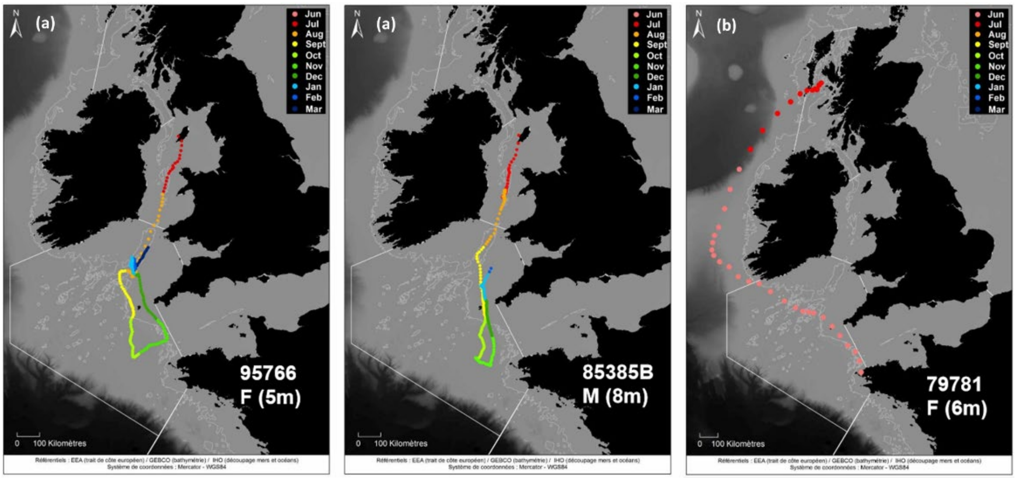


Figure 7.3. Basking shark in the Northeast Atlantic. Most probable tracks for (left) shark 95766 (5 m female) and (centre) shark 85385 (8 m male), tracked for more than 200 days and which stayed in the Irish Sea and Celtic Seas, and (right) most probable track for shark 79781 (6 m female) tracked for 38 days. Source: Stéphan *et al.* (2011).

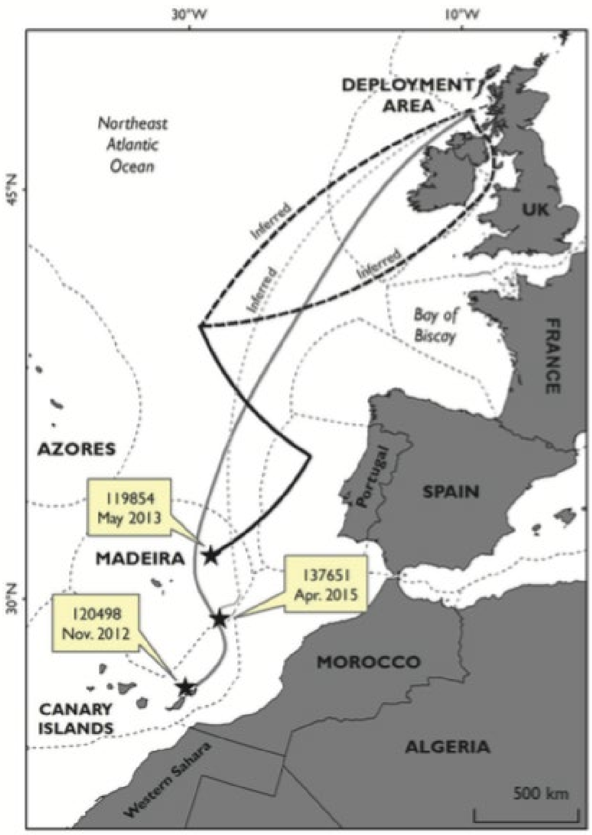


Figure 7.4. Basking shark in the Northeast Atlantic. Long-range movements of basking sharks from Scotland revealed by Argos satellite tracking. Two SPOT-tagged basking sharks in 2012 (119854, 120498) and one SPLASH-F tagged shark in 2014 (137651). Source: Witt *et al.* (2016).

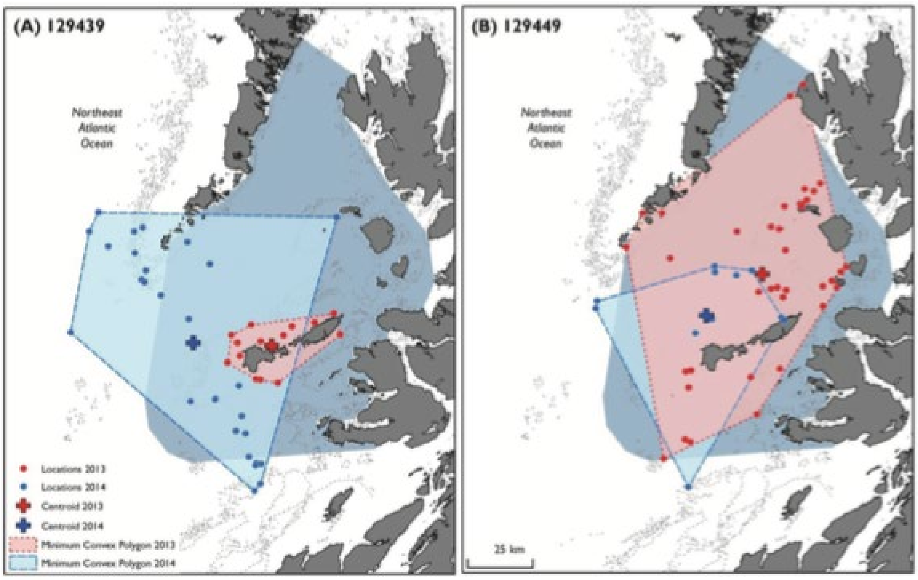


Figure 7.5. Basking shark in the Northeast Atlantic. Example distribution of two sharks showing inter-annual fidelity to the Hebridean Sea. Single highest quality Argos locations per day (red and blue circles for 2013 and 2014 respectively). Minimum convex polygons for data gathered in 2013 and 2014 (red and blue polygons respectively), geographic mean centroid of Argos locations for 2013 and 2014 (red and blue crosses respectively). Source: Witt *et al.* (2016).

Contents

8 Blue shark in the North Atlantic (North of 5ºN)

8.1 Stock distribution

There is a discrete North Atlantic stock of blue shark *Prionace glauca* (Heessen, 2003; Fitzmaurice *et al*., 2005; ICCAT, 2008), with 5°N latitude as the southern stock boundary, and a separate South Atlantic stock (ICCAT, 2008). This delineation is based on mark-recapture data (e.g. Kohler *et al.*, 2002), and oceanographic features. In addition, this division facilitates comparison with fisheries statistics for other North Atlantic stocks of tuna-like species that have the same southern stock boundary. Hence, the ICES area is only part of the stock area. The North Atlantic stock is currently considered separate to the Mediterranean Sea by ICCAT, which is also supported by a recent scientific study (Leone *et al.*, 2017).

Genetic studies on blue shark reveal genetic homogeneity across whole ocean basins in Atlantic (Verissimo *et al*., 2017) and Pacific Oceans (Ovenden *et al*., 2009; Taguchi *et al*., 2015). These are at odds with the currently assumed distinction of northern and southern stocks within each ocean basin. Much of the available evidence indicates that blue shark exhibits dispersal with gene flow over very large spatial scales, and little to no philopatry to the sampled nursery areas or to distinct ocean basins. However, in cases such as blue shark, where effective populations sizes are ~1000s, the levels of genetic divergence associated with migration rates which could lead to demographic connectivity (~10%; Hastings, 1993) may be difficult to detect using traditional molecular markers. In such cases, the precautionary approach in conservation and fisheries management would be to consider each nursery area as independent, with potentially different demographic parameters and vulnerability to fishing pressure. If each nursery area currently exchanges only a few migrant individuals per generation with other nurseries, the replenishment of each stock would be mostly dependent on recruit survival rather than on immigration from adjacent stocks.

8.2 The fishery

8.2.1 History of the fishery

There are no large-scale target fisheries for blue shark, although it is a major bycatch species in tuna and billfish fisheries and can comprise up to 70% of the total catch, thus sometimes exceeding the catch of the target species (ICCAT, 2005). Longer-term catch data are incomplete, but more data have become available in recent years.

In the North Atlantic, EU fleets (primarily Spain and Portugal) are responsible for approximately 82% of the total landings (Anon., 2015). Observer data indicates that substantially more blue sharks are caught as bycatch than reported in catch statistics.

Since 1998, there has been a seasonal (June to November) Basque artisanal longline fishery targeting blue shark and other pelagic sharks in the Bay of Biscay (Díez *et al*., 2007). Initially 3–5 vessels were involved but, as a consequence of changes in local fishing regulations, the number of vessels reduced to two after 2008.

Blue shark is also taken, in considerable numbers, in recreational fisheries, including from the Celtic Sea and western Channel (Vas, 1990; Mitchell *et al*., 2014; Thomas *et al*., 2023) and other parts of the ICES area (Campana *et al*., 2005).

In the North Atlantic, thirteen fisheries (in descending order of volume: EU-Spain, EU-Portugal, Japan, Canada, USA_LL, Chinese Taipei, EU-France, Belize, Panama, USA_SP., China PR, Korea and, Venezuela) accounted for 99% of the total removals (1990–2014). The majority (except: USA sport fishery, EU-France unclassified gear) are longline fisheries (Anon., 2015).

8.2.2 The fishery in 2023

No new information.

8.2.3 Advice applicable

ICES does not provide advice for blue shark in the North Atlantic, and assessment of this stock is considered to be the responsibility of ICCAT.

ICCAT re-assessed blue shark in 2023, with a Data Preparatory Meeting held in April 2023 (ICCAT, 2023a) and the assessment held in July 2023 (ICCAT, 2023b). The 2023 assessment updated the previous assessment conducted in 2015 (ICCAT, 2015).

ICCAT's Standing Committee on Research and Statistics (SCRS) concluded that "*While the 2022 realized catch (22,057 t) for the North Atlantic stock will maintain the stock in the green quadrant of the Kobe plot with a high probability, the Committee noted that the current TAC (39,102 t) would have a very low probability (3%) of maintaining the stock in the same quadrant by 2033. Therefore, the Committee recommends that the Commission reduces the current TAC to catch levels that will maintain the stock in the green quadrant of the Kobe plot with a high probability*" (ICCAT, 2024).

8.2.4 Management applicable

There are no measures fully regulating all the catches of blue shark in the North Atlantic.

The relevant, active ICCAT Recommendation (2023/10) gives an annual TAC of 30 000 t for North Atlantic blue shark, under which certain CPCs are subject to catch limits (EU: 24 449 t; Japan: 3012 t; Morocco: 1644 t; UK 25 t). Other CPCs were to endeavour to "*maintain their catches below the level of their highest annual catches over the last ten years*".

European regulations setting annual fishing opportunities have set an overall TAC of 39 102 t for North Atlantic blue shark (i.e., north of 5°N) since 2017. An allocation key has been included since 2020, with the allocated quotas changed slightly in recent years.

Nation	2020	2021	2022	2023	2024
Ireland	1	1	0.96	0.96	0.72
Spain	27 062	27 062	27 035.09	27 007.71	20 309.5
France	152	152	151. 70	151. 55	113.96
Portugal	5 363	5 363	5 357.67	5 352.24	4024.82
EU	32 578	32 578	32.545.42	32 512.46	24 449**
United Kingdom		(32.38)*	32.38	32.38	25
*ICCAT Circular #4088/2021 of 10 June 2021 provided details of percentage shared between the EU and UK ** After a transfer of 348 tonnes to Morocco					

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of shark fins and subsequent discarding of the body. This regulation is binding on EU vessels in all waters and non-EU vessels in EU waters. In June 2023, 'The Shark Fins Act 2023' was passed in the UK banning the import and export of detached shark fins, including all products containing shark fins.

8.3 Catch data

8.3.1 Landings

The reader is referred to ICCAT (2023a, 2023b) for the most recent appraisal of blue shark landings, with the information below not updated from the 2023 report of WGEF.

It is difficult to accurately quantify landings of blue shark in the North Atlantic, especially for the earlier parts of the time-series (Figure 8.1). ICCAT considers that reported landings of blue shark were underestimated in the early part of the time-series (prior to 1997), with official annual landings data of a more comparable magnitude since 1997 (*ca.* 20 000–44 000 t per year).

In 2015, alternative approaches to estimate catch series were discussed by ICCAT (Anon., 2015), including (i) ratios between blue shark catches and species-specific catches derived from ICCAT Task I data; (ii) catch/effort and standardised CPUE; and (iii) shark fin trade data. Figure 8.1 shows the catch series (1971–2013) for North Atlantic blue shark available for the 2008 and 2015 stock assessment meetings (SA2015), the 2008 stock assessment catches (SA2008), and the catch series obtained using shark-fin ratios (three different series, see for example Clarke *et al.,* 2006). Whilst both data series followed broadly similar trends, there were large differences in some years, and catches oscillated several times between 15 000 t and 55 000 t. The three shark-fin series showed completely different trends (continuous upward trends) with catches starting around 10 000 t in the 1980s and growing to nearly 60 000 t in 2011 (Anon., 2015).

Generally, the overall data for blue shark (and sharks in general) reported to ICCAT has improved over time, with more complete series by species and smaller quantities of unclassified sharks.

The most recently available ICCAT Task 1 data (version of 26/01/2023), including landings and dead discards, indicate that landings of the North Atlantic stock of blue shark (2000–2021) have averaged 30 232 t y^{-1} (range: 20 066–44 070 t). Following a recent peak in 2016, the reported landings have declined, averaging 25 966 t in the most recent four-year period (2018–2021). Hence, the reported catches from 2018 onwards have been lower than the TAC (Figure 8.2).

During the period 2000–2021, the majority of the reported catches of blue shark in the North Atlantic have been from billfish areas BIL94B and BIL94C (which account for ca. 90% of the catches), followed by BIL94A (8%) and with lower quantities from BIL92 and BIL93 (Table 8.1).

During this period, the main nations reporting catches of blue shark (Table 8.2) have been Spain (on average, accounting for 71% of the annual reported catch), followed by Portugal (15.3%), Japan (6.9%), Morocco (1.6%) and Canada (1.3%). Belize, Panama, China (Taipei), France and the USA have each accounted for 0.4–0.8%, and much lower proportions are reported by a range of other nations. The current Task 1 data differ slightly from those collated during the recent data preparatory meeting (ICCAT, 2023; Figure 8.2; Table 8.2), with some estimates being derived to infill those data that are considered lacking. The catch series will be finalised at the 2023 stock assessment.

8.3.2 Discards

Historically, the relative low value of blue shark meant that it was not always retained for the market, with the fins the most valuable body part. In some fisheries the fins were retained and the carcasses discarded. In 2013, the EU prohibited this practice (see Section 8.2.4).

Recent Task 1 data collated by ICCAT indicate that the quantities discarded dead is only a small proportion of the reported catch (landings and dead discards), but increasing very slightly in recent years (Table 8.3). These data, however, do not include estimates of live discards. The reported quantities being landed or discarded dead for the main fishing nations vary in their completeness for several nations (Table 8.4).

Information on elasmobranchs discards in demersal otter trawl, deep-water set longlines, set gillnet and trammel net fisheries in Division 9.a (2004–2013) showed that blue shark was caught infrequently and discarded in the longline fishery but not in the other fisheries (Prista *et al*., 2014).

8.3.3 Discard survival

Blue shark is one of the most frequent shark species captured in pelagic longline fisheries. Discard survival in such fisheries can be influenced by several factors, including hook type, hooking location, soak time and the size of shark. There are several estimates relating to capture mortality and discard survival (e.g., Boggs, 1992; Francis *et al*., 2001; Campana *et al*., 2005; Diez and Serafy, 2005). The at-vessel mortality of longline-caught blue shark ranges from about 5–35% (summarised in Ellis *et al*., 2014). Discard survival rates are estimated to be about 60% in longline fisheries and 80% in rod and reel fisheries (Campana *et al*., 2005).

One of the more comprehensive studies of the at-vessel and post-release mortality of blue shark is that of Campana *et al.* (2016). For the years 2010–2014, the at-vessel mortality was 14.7% (aggregated data; annual estimates ranged from 11.5–36.9%, averaging 19.2%). The proportion of blue shark rated as 'injured' was 25.1% (aggregated data; annual estimates ranged from 10.0–38.3%, averaging 21.8%), whilst the proportion rated as 'healthy' was 60.2% (aggregated data; annual estimates ranged from 43.1–78.5%, averaging 59.0%). Using pop-up satellite archival tags (PSATs), Campana *et al.* (2016) reported that all 'healthy' blue sharks (n = 10) survived release, although 33% post-release mortality was observed for those individuals classed as 'injured' (n = 27).

8.3.4 Quality of catch data

Catch data are incomplete, especially for those data reported before 1997. The historical use of generic shark categories is problematic, although European countries now report more species-specific data. The extent of finning (over time and by fleets) in high seas fisheries is unclear, although regulations to prohibit this practice have applied to several fleets over recent decades.

Whilst there has been improved species-specific reporting of blue shark landings, the quality and consistency for the reporting of dead (and live discards) appears to be somewhat variable, and more transparency and consistency for how such data are reported is required.

Blue shark is also taken in recreational fisheries, and more robust estimates for these fisheries are required, taking into account likely temporal changes in discard practices and post-release mortality.

8.4 Commercial catch composition

No new information.

8.4.1 Conversion factors

Information is available for length–weight relationships (Table 8.5) and various length measurements (Table 8.6a and 8.6b). Campana *et al*. (2005) calculated the conversion relationships between dressed weight (W_D) and live weight or round weight (W_R) for NW Atlantic blue shark (n = 17) to be $W_R = 0.4 + 1.22\ W_D$ and $W_D = 0.2 + 0.81\ W_R$.

For French fisheries, the proportion of gutted fish to round weight is 75.19%. There is also a factor for landed round weight to live weight (96.15%), meaning that there is a 4% reduction in weight because of lost moisture (Hareide *et al*., 2007). Various estimates of fin weight to body weight are available (Mejuto and García-Cortés, 2004; Santos and Garcia, 2005; Hareide *et al*., 2007; Santana-Garcon *et al*., 2012; Biery and Pauly, 2012).

8.5 Commercial catch and effort data

The 2015 assessment for the North Atlantic stock conducted by ICCAT used eight time-series of standardised commercial catch and effort data (US observer data, US older time series, and longline logbook data for Portugal, Spain, Venezuela, China (Taipei) and two Japanese fleets). These CPUE indices show a relatively flat trend throughout the time-series, but with high variance (Tables 8.7–8.8; Figure 8.3). The reader is referred to ICCAT (2015) for more details of these indices.

8.6 Fishery-independent surveys

No fishery-independent data are available for the NE Atlantic, although such data exist for parts of the NW Atlantic (Hueter and Simpfendorfer, 2008). A survey from 1977–1994 conducted by the US NMFS documented a decline among juvenile male blue sharks by 80%, but not among juvenile females, which also occur in fewer numbers in the study area, off the coast of Massachusetts (Hueter and Simpfendorfer, 2008). The authors concluded that vulnerability to overfishing in blue sharks is present despite their enhanced levels of fecundity relative to other carcharhinid sharks.

8.7 Life-history information

8.7.1 Life-history parameters

Various studies have compiled biological information for blue shark in the North Atlantic and other areas (see Nakano & Seki, 2003; Nakano & Stevens, 2008; da Silva *et al*., 2021; ICCAT, 2023). Relevant data are summarized in Tables 8.5 (length–weight relationships), 8.6a-b (length–length relationships), Table 8.9 (growth parameters) and Table 8.10 (other life-history parameters). Based on life-history information, blue shark is considered to be among the most productive shark species (ICCAT, 2008).

New life history inputs were obtained from data assembled at the ICCAT 2014 Intersessional Meeting of the Shark Species Group (ICCAT, 2014) and additional information provided during the 2015 blue shark data preparatory meeting (SCRS/2015/142). These included maximum population growth rates (rmax) and steepness (h) values of the Beverton–Holt stock–recruitment relationship for the North Atlantic stock, based on the latest biological information. Estimated productivity was high (rmax = 0.31–0.44 y^{-1} for the North Atlantic stock), similar to other stocks of this species. Consequently, analytically derived values of steepness were also high (h = 0.73–0.93 for the North Atlantic stock).

The influence of different biological parameters (e.g. growth coefficients, reproductive periodicity, first maturation age, natural mortality and longevity) on estimated blue shark productivity has been considered by ICCAT. Age at first maturity and growth coefficients substantially influenced the estimated productivity (e.g. a low age at first maturity and high growth coefficient results in high productivity). Reproductive periodicity also affected productivity (i.e. a longer breeding period decreased productivity). Biological parameters should be considered carefully when they are used in the stock analysis, especially when estimated productivity is inconsistent with trends in abundance indices. The level of depletion experienced by blue shark stocks may affect the productivity or population growth through density dependence, and differences in environmental water temperature may also affect growth rates (Anon., 2015).

8.7.2 Habitat

Blue shark has one of the widest ranges of all the shark species, being common in pelagic, oceanic waters in tropical and temperate oceans worldwide, as well as closer to shore (Coelho *et al.*, 2018).

8.7.3 Nursery grounds

Coelho *et al.* (2018) reported that young-of-the-year and small juvenile blue shark occurred off the Iberian Peninsula, in the Bay of Biscay, around the Azores Islands and in the central North Atlantic west of the Azores.

8.7.4 Diet

Blue shark feed primarily on small pelagic fish and squid (see Nakano & Stevens, 2008 and references therein).

8.7.5 Movements

The distribution and movements of blue shark are influenced strongly by seasonal variations in water temperature, reproductive condition and prey availability. Blue shark often occurs in large single-sex schools containing individuals of similar size.

The US National Marine Fisheries Service (NMFS) coordinates the Cooperative Shark Tagging Programme (CSTP; Kohler *et al.*, 1998; NMFS, 2006), including supplying tags to relevant bodies in the NE Atlantic. Tagging in the NE Atlantic is undertaken by various bodies, including Inshore Fisheries Ireland (formerly the Irish Central Fishing Board) Tagging Programme (Green, 2007 WD) and UK Shark Tagging Programme. There have also been other earlier European tagging studies (Stevens, 1976). The tag and release results presented by ICCAT (2012; Figure 8.4) highlights the large number of blue shark tagged to date, and the extensive horizontal movements undertaken by blue shark in the Atlantic.

In a satellite telemetry study, Queiroz *et al.* (2010) described complex and diverse types of behaviour depending on water stratification and/or depth. Females tagged in the Western Channel were able to spend up to 70 days in the shelf edge area in the Bay of Biscay; whereas tagged juveniles showed relatively extensive vertical movements away from the southern nursery areas. Results indicated that the species inhabited waters with a wide temperature range (10–20°C).

In Australian waters, blue shark exhibits oscillatory dive behaviour between the surface layers to as deep as 560–1000 m. Blue shark occupied waters of 17.5–20.0°C mainly, spending 35–58% of their time <50 m deep, and with 10–16% of their time spent at depths >300 m (Stevens *et al.*, 2010).

Adult blue sharks have no known predators, although sub-adults and juveniles are eaten by shortfin mako, white shark and sea lions. Fishing is likely to be a major contributor to adult mortality. An estimation of fishing mortality rate via satellite tagged sharks being recaptured by fishing vessels ranged from 9–33% (Queiroz *et al.*, 2010).

8.8 Exploratory assessment models

8.8.1 Previous assessments

In 2004, ICCAT completed a preliminary stock assessment (ICCAT, 2005). Although results suggested that the North Atlantic stock were above biomass in support of MSY, the assessment remained conditional on the assumptions made. These assumptions included (i) estimates of historical shark catch, (ii) the relationship between catch rates and abundance, (iii) the initial state of the stock in 1971, and (iv) various life-history parameters. It was pointed out that the data used for the assessment did not meet the requirements for proper assessment (ICCAT, 2006), and further research and better-resolved data collection was highly recommended.

In 2008, three models were used in stock assessment conducted by ICCAT (ICCAT, 2008 and references cited therein): a Bayesian surplus production model, an age-structured model that did not require catch data (catch-free model), and an age-structured production model. Results with the Bayesian surplus production model produced estimates of stock size well above MSY levels (1.5–2* B_{MSY}), and estimated F to be very low (at F_{MSY} or well below it). The carrying capacity of the stock was estimated so high that the increasing estimated catches (25–62 000 t over the time-series) generated very low F estimates. Sensitivity analyses showed that the stock size estimate was dependent on the weighting assigned to the Irish CPUE series. Equal weighting of this and the other series produced a stock size at around B_{MSY}. Other sensitivity analyses indicated similar results to the base case run, with the stock well above MSY levels.

The age-structured biomass model displayed different results with either a strong decrease in biomass throughout the series to about 30% of virgin levels, or a less pronounced decline. The prior for the virgin biomass assigned high values to a very small number of biomass values but also indicated that the range of plausible values of this parameter has a heavy tail. This is probably because there is not enough information in the data to update the model and thus provide a narrower range of plausible values and thus provide a more precise estimate of the biomass of the stock.

The age-structured model not requiring catch information estimated that F was higher than F_{MSY}, but still low and that the current SSB estimated at around 83% of virgin levels.

As a consequence of the results in 2008, ICCAT concluded that biomass was estimated to be above the level that would support MSY (ICCAT, 2008). These results agreed with earlier work (ICCAT, 2005). Stock status appeared to be close to unfished biomass levels and fishing mortality rates were well below those corresponding to the level at which MSY is reached. However, ICCAT (2008) pointed out that the results were heavily dependent on the underlying assumptions. In particular, the choice of catch data to be used, the weighting of CPUE series and various life-history parameters used as input in the model. ICCAT was unable to conduct sensitivity analyses of the input data and assumptions (ICCAT, 2008).

Owing to those weaknesses, no firm conclusions were drawn from the preliminary assessments conducted by ICCAT. ICCAT, 2008 stated that most models used predicted that this stock was not overfished but did not use these results to infer stock status and to provide management advice.

8.9 Stock assessment

The assessment for the North Atlantic blue shark stock was updated by ICCAT in 2023 using two different approaches (see ICCAT, 2023a, 2023b for more details): JABBA and Stock Synthesis.

On the basis of these assessments, ICCAT (2023b) noted "*The combined results indicate that the stock is at MSY level ($B_{2021}/B_{MSY} = 1.00$, with 95% confidence interval: 0.75-1.31) and is not experiencing overfishing ($F_{2021}/F_{MSY} = 0.70$ with a 95% confidence interval: 0.50-0.93). The Kobe phase plot indicates that there is a 49.6% probability that the stock currently falls within the yellow quadrant of the Kobe plot, a 49.7% probability that the stock falls within the green, and less than a 1% chance that it is in the red or orange quadrants*".

8.10 Quality of assessments

At the 2023 ICCAT assessment meeting, it was noted that there were conflicts in the indices of abundance that affected the performances of both models.

8.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status of this stock. These reference points are relative metrics rather than absolute values. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

8.12 Conservation considerations

The global IUCN listing for blue shark is Near Threatened (Rigby *et al.*, 2019), and it has the same listing in European waters, although is listed as Critically Endangered in the Mediterranean Sea (https://www.iucnredlist.org).

Blue shark was listed on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2017. However, it was not subsequently listed on Annex 1 of the Sharks-MoU.

In 2022, sharks in the family Carcharhinidae, thus including blue shark, were added to Appendix II of CITES, with the listing coming into effect from 25 November 2023.

8.13 Management considerations

Catch data are considered incomplete, underestimated and unreliable especially in terms of the earlier data. There have been unaccounted discards and a substantial occurrence of finning over parts of the time series. Data reported to ICES, ICCAT and FAO can vary.

Commercial CPUE series exist, and these generally show relatively flat trends over the time-series, but with high variance. There are currently no fishery-independent data available for that part of the stock in the ICES area.

For the North Atlantic stock, smaller sized blue sharks have been observed to dominate north of 30ºN, while larger sized blue sharks dominated south of 30ºN. In order to be able to account for the differences in size composition of fish in different areas, future implementations of SS3 should consider this spatial structure in the fleets. This will require estimating fleet and area specific CPUE indices, catch and size distributions. Ideally the model could also be separated by sex.

Based on the scenarios and models explored, ICCAT considered that the North Atlantic stock of blue shark was unlikely to be overfished nor subject to overfishing in their 2015 assessment. However, due to the level of uncertainty, no specific management catch recommendations were formulated.

Blue shark is considered to be one of the most productive sharks in the North Atlantic. As such, it can be expected to be more resilient to fishing pressure than other pelagic sharks. However, the high degree of susceptibility to longline fishing and the poor quality of the information available to assess the stock is a cause for concern. Given the uncertainty of the results and that this species is a significant bycatch, especially in tuna and billfish fisheries, there is a need for continued monitoring of the fisheries by observer and port sampling programmes.

With sharks in the family Carcharhinidae being listed in Appendix II of CITES, there will be a need for a non-detriment finding (NDF) for import-export, and for when landing blue shark that were caught when vessels were operating outside their area of national jurisdiction.

8.14 References

Aasen, O. 1966. Blahaien, *Prionace glauca* (Linnaeus, 1758). *Fisken og Havet*, 1: 1–15.

Anon. 2015. Report of the 2015 blue shark data preparatory meeting. Tenerife, Spain, March 23 to 27: 33 p.

Biery, L., and Pauly, D. 2012. A global review of species-specific shark fin to body mass ratios and relevant legislations. *Journal of Fish Biology*, 80: 1643–1677.

Boggs, C. H. 1992. Depth, capture time and hooked longevity of longline-caught pelagic fish. Timing bites of fish with chips. *Fishery Bulletin*, 90:642–658.

Buencuerpo, V., Ríos, S., and Morón, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin*, 96: 667–685.

Campana, S. E., Joyce, W., Fowler, M., and Showell, M. 2016. Discards, hooking, and post-release mortality of porbeagle (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), and blue shark (*Prionace glauca*) in the Canadian pelagic longline fishery. *ICES Journal of Marine Science*, 73: 520–528.

Campana, S. E., Joyce, W., and Manning, M. J. 2009. Bycatch and discard mortality in commercially caught blue sharks *Prionace glauca* assessed using archival satellite pop-up tags. *Marine Ecology Progress Series*, 387: 241–253.

Campana, S. E., Marks, L., Joyce, W. Kohler, N. 2005. Catch, by-catch, and indices of population status of blue shark (*Prionace glauca*) in the Canadian Atlantic. *ICCAT Collective Volume of Scientific Papers*, 58(3): 891–934.

Campana, S., Gonzalez, P., Joyce, W. And Marks, L. 2002. Catch, bycatch and landings of blue shark (*Prionace glauca*) in the Canadian Atlantic. Canadian Stock Assessment, Research Document, 2002/101, Ottawa.

Castro, J. I. 1983. The sharks of North American waters. Texas A&M Univ. Press, College Station, TX, 180 pp.

Castro, J. A. and Mejuto, J. 1995. Reproductive parameters of blue shark, *Prionace glauca*, and other sharks in the Gulf of Guinea. *Marine Freshwater Research*, 46: 967–973.

Clarke S. C., McAllister, M. K., Milner-Gulland, E. J., Kirkwood, G. P., Michielsens, C. G. J., Agnew, D. J., Pikitch, E. K., Nakano, H. And Shivji M. S. 2006. Global estimates of shark catches using trade records from commercial markets. *Ecology Letters*, 9: 1115–1126.

Coelho, R., Mejuto, J., Domingo, A., Yokawa, K., Liu, K.M. *et al.* 2018. Distribution patterns and population structure of the blue shark (*Prionace glauca*) in the Atlantic and Indian Oceans. *Fish and Fisheries*, 19: 90–106.

Cortés, E. 1999. Standardized diet compositions and trophic levels of sharks. *ICES Journal of Marine Science* 56: 707–717.

da Silva, T. E. F., Lessa, R. and Santana, F. M. 2021. Current knowledge on biology, fishing and conservation of the blue shark *(Prionace glauca*). *Neotropical Biology and Conservation*, 16: 71–88.

Díez G., Santurtún, M., Ruiz, J., Iriondo, A., Gonzalez. I. And Artetxe, I. 2007. The long line Basque fishery on blue shark (*Prionace glauca*) in the Bay of Biscay (1998–2006). Working Document for ICES Working Group on Elasmobranch Fishes, Galway. 22–28 June, 2007, 9 pp.

Diez, G. A., and J. E. Serafy. 2005. Longline-caught blue shark (*Prionace glauca*): factors affecting the numbers available for live release. *Fishery Bulletin* 103: 720−724.

Ellis, J. R., McCully, S. R. and Poisson, F. 2014. A global review of elasmobranch discard survival studies and implications in relation to the EU 'discard ban'. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, Portugal. June 2014. 48 pp.

Fitzmaurice, P, Green, P., Keirse, G., Kenny, M. And Clarke, M. 2005. Stock discrimination of blue shark, based on Irish tagging data. ICCAT Collective Volume of Scientific Papers, 58(3): 1171–1178.

Francis, M. P., and Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus, Isurus oxyrinchus*, and *Prionace glauca*) from New Zealand. *Fishery Bulletin* 103: 489–500.

Francis, M. P., L. H. Griggs and S. J. Baird. 2001. Pelagic shark bycatch in the New Zealand tuna longline fishery. Mar. Freshwat. Res. 52:165−178.Francis, M. P. And Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus* and *Prionace glauca*) from New Zealand. *Fishery Bulletin*, 103: 489–500.

García-Cortés, B. and J. Mejuto. 2002. Size–weight relationships of the swordfish (*Xiphias gladius*) and several pelagic shark species caught in the Spanish surface longline fishery in the Atlantic, Indian and Pacific Oceans. *ICCAT Collective Volume of Scientific Papers*, 54 (4): 1132–1149.

Green, P. 2007. Central Fisheries Board Tagging Programme 1970 to 2006. Working document to WGEF 2007 (PowerPoint display).

Hareide, N. R., Carlson, J., Clarke, M., Clarke, S., Ellis, J., Fordham, S., Fowler, S., Pinho, M., Raymakers, C., Serena, F., Seret, B. and Polti, S. 2007. European Shark Fisheries: a preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association EEA 2007, 71 pp.

Hastings, A. (1993). Complex interactions between dispersal and dynamics: Lessons from coupled logistic equations. Ecology, 74, 1362–1372.

Heessen, H. J. L. (Ed.) 2003. Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 605 pp.

Henderson, A. C., Flannery, K. And Dunne, J. 2001. Observations on the biology and ecology of the blue shark in the North-east Atlantic. *Journal of Fish Biology*, 58: 1347–1358.

Hueter, R. E. and Simpfendorfer, C. 2008. Case study: Trends in blue shark abundance in the western North Atlantic as determined by a fishery-independent survey. In: *Sharks of the Open Ocean* (M. D. Camhi, E. K. Pikitch and E. Babcock, Eds.), 236–241.

ICCAT. 2005. Report of the 2004 Inter-sessional Meeting of the ICCAT Subcommittee on Bycatches: Shark Stock Assessment. SCRS/2004/014.

ICCAT. 2006. Chapter 8.12 SHK-Sharks Report of the Standing Committee on Research and Statistics (SCRS) ICCAT. PLE-014/2006 Madrid, Spain, October 2–6, 2006. 106–113.

ICCAT. 2008. Report of the 2008 shark stock assessments meeting. Madrid, Spain, 1–5 September, 2008. SCRS/2008/017–SHK Assessment, 89 pp.

ICCAT. 2012. Chapter 4.1 Shortfin Mako Stock Assessment and Ecological Risk Assessment Meeting. Olhao, Portugal June 11–18, 2012.

ICCAT. 2014. Inter-sessional meeting of the sharks species group. Piriapolis, Uruguay, March 10–14 2014; 72 pp. (www.iccat.int/Documents/Meetings/Docs/2014_SHK_INTER-SESS_REP.pdf).

ICCAT. 2015. Report of the 2015 ICCAT blue shark stock assessment session Oceanário de Lisboa, Lisboa, Portugal July 27 to 31, 2015, 116 pp. (https://www.iccat.int/Documents/Meetings/Docs/2015_BSH%20ASSESS_original.pdf).

ICCAT. 2023a. Report of the ICCAT 2023 Blue Shark Data Preparatory Meeting (hybrid, Olhão, Portugal, 17–21 April 2023). (https://www.iccat.int/Documents/Meetings/Docs/2023/REPORTS/2023_BSH_DP_ENG.pdf).

ICCAT. 2023b. Report of the 2023 ICCAT Blue Shark Stock Assessment Meeting (17–21 July, hybrid/ Madrid, Spain).

ICCAT. 2024. Report for biennial period, 2022–23, Part II (2023), Vol. 2. Report of the Standing Committee on Research and Statistics (SCRS) (Hybrid / Madrid (Spain), 25–29 September 2023).

Kohler, N. E., Casey, J. G. and Turner, P. A. 1995. Length–weight relationships for 13 species of sharks from the western North Atlantic. *Fishery Bulletin*, 93: 412–418.

Kohler, N. E., Casey, J. G. and Turner, P. A. 1998. NMFS cooperative shark tagging programme, 1962–1993: An atlas of shark tag and recapture data. *Marine Fisheries Review*, 60: 86 pp.

Kohler, N. E., Turner, P. A., Hoey, J. J., Natanson, L. J., and Briggs, R. 2002. Tag and recapture data for three pelagic shark species: blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and porbeagle (*Lamna nasus*) in the North Atlantic Ocean. *ICCAT Collective Volume of Scientific Papers*, 54 (4): 1231–1260.

Leone, A., Urso, I., Damalas, D., Martinsohn, J., Zanzi, A., Mariani, S., Sperone, E., Micarelli, P., Garibaldi, F., Megalofonou, P. and Bargelloni, L. 2017. Genetic differentiation and phylogeography of Mediterranean-North Eastern Atlantic blue shark (*Prionace glauca*, L. 1758) using mitochondrial DNA: panmixia or complex stock structure? *PeerJ*, 5, p.e4112.

MacNeil, M. A. and Campana, S. E. 2002. Comparison of whole and sectioned vertebrae for determining the age of young blue shark (*Prionace glauca*). *Journal of Northwest Atlantic Fishery Science*, 30: 77–82.

Mejuto, J. and García-Cortés, B. 2004. Preliminary relationships between the wet fin weight and body weight of some large pelagic sharks caught by the Spanish surface longline fleet. *ICCAT Collective Volume of Scientific Papers*, 56(1): 243–253.

Mejuto, J. and García-Cortés, B. 2005. Reproductive and distribution parameters of the blue shark *Prionace glauca*, on the basis of on-board observations at sea in the Atlantic, Indian and Pacific Oceans. *ICCAT Collective Volume of Scientific Papers*, 58(3): 951–973.

Mitchell, J.D., Collins, K.J., Miller, P.I. and Suberg, L.A. 2014. Quantifying the impact of environmental variables upon catch per unit effort of the blue shark *Prionace glauca* in the western English Channel. *Journal of Fish Biology*, 85: 657–670.

Nakano, H. and Seki, M. P. 2003. Synopsis of biological data on the blue shark, *Prionace glauca* Linnaeus. *Bulletin Fisheries Research Agency Japan*, 6: 18–55.

Nakano, H. and Stevens, J.D. 2008. The biology and ecology of the blue shark, *Prionace glauca*. In: Sharks of the Open Ocean (M. D. Camhi, E. K. Pikitch and E. Babcock, Eds.); pp. 140–151.

NMFS. 2006. Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable

Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. 1600 pp.

Ovenden, J. R., Kashiwagi, T., Broderick, D., Giles, J., and Salini, J. 2009. The extent of population genetic subdivision differs among four co-distributed shark species in the Indo-Australian archipelago. BMC Evolutionary Biology, 9.

Pratt, H. L. 1979. Reproduction in the blue shark, *Prionace glauca*. *Fishery Bulletin*, 77: 445–470.

Prista, N., Fernandes, A.C., Maia, C., Moura, T. and Figuerido, I. 2014. Discards of elasmobranchs in the Portuguese fisheries operating in ICES Division XIa: Bottom otter trawl, deep-water set longlines, set gillnet and trammel net fisheries (2004–2013). Working document to ICES WGEF 2014.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M. P., Herman, K., Jabado, R. W., Liu, K. M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R. B. and Winker, H. 2019. *Prionace glauca*. The IUCN Red List of Threatened Species 2019: e.T39381A2915850. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T39381A2915850.en. Downloaded on 18 June 2021.

Queiroz, N, Humphries, N.E., Noble, L.R., Santos, A. M. and Sims, D. W. 2010. Short-term movements and diving behaviour of satellite-tracked blue sharks *Prionace glauca* in the northeastern Atlantic Ocean. *Marine Ecology Progress Series*, 406: 265–279.

Santana-Garcon, J., Fordham, S. and Fowler, S. 2012. Blue shark *Prionace glauca* fin-to-carcass-mass ratios in Spain and implications for finning ban enforcement. *Journal of Fish Biology*, 80: 1895–1903.

Santos, M. N., and Garcia, A. 2005. Factors for conversion of fin weight into round weight for the blue shark (*Prionace glauca*). *ICCAT Collective Volume of Scientific Papers*, 58(3): 935–941.

SCRS, 2019. Report of the Standing Committee on Research and Statistics (SCRS), Madrid 30 September – 4 October 2019, ICCAT Commission, 459 pp.

Skomal, G. B. and Natanson, L. J. 2002. Age and growth of the blue shark (*Prionace glauca*) in the North Atlantic Ocean. *ICCAT Collective Volume of Scientific Papers*, 54 (4): 1212–1230.

Skomal, G. B. and Natanson, L. J. 2003. Age and growth of the blue shark (*Prionace glauca*) in the North Atlantic Ocean. *Fishery Bulletin*, 101:627–639.

Skomal, G. B. 1990. Age and growth of the blue shark, *Prionace glauca*, in the North Atlantic. Master's Thesis. University of Rhode Island, Kingston, RI. 82 pp.

Smith, S. E., Au, D. W. and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. *Marine and Freshwater Research*, 49: 663–78.

Stevens, J. D., Bradford, R. W., West, G. J. 2010. Satellite tagging of blue sharks (*Prionace glauca*) and other pelagic sharks of eastern Australia: depth behaviour, temperature experience and movements. *Marine Biology*, 157: 575–591.

Stevens, J. D. 1975. Vertebral rings as a means of age determination in the blue shark (*Prionace glauca*). *Journal of the Marine Biological Association of the United Kingdom*, 55: 657–665.

Stevens, J. D. 1976. First results of shark tagging in the North-east Atlantic, 1972–1975. *Journal of the Marine Biological Association of the United Kingdom*, 56: 929–937.

Taguchi, M., King, J. R., Wetklo, M., Withler, R. E., and Yokawa, K. 2015. Population genetic structure and demographic history of Pacific blue sharks (*Prionace glauca*) inferred from mitochondrial DNA analysis. *Marine and Freshwater Research*, 66, 267–275-

Thomas, S., Alsop, A., Chapman, R. S., Collings, M., Davis, P., Faisey, K. F., Forester, M., Hodder, L., Howell, A., Malia, O., Margetts, D., McKie, K. A., McMaster, J. D., Murphy, S., Narbett, S., Newell, S., Rogers, J., Somerfield, P. J., West, D., Whittaker, P., Wright, S., Wyatt, K., Uren, D., Rudd, H. S., Vas, P. and Jones, G. 2023. Summary of data from the southwest of England blue shark fishery from 1953-2021. *ICCAT Collective Volume of Scientific Papers*, 52: 254–268.

Vas, P., 1990. The abundance of the blue shark, *Prionace glauca*, in the western English Channel. *Environmental Biology of Fishes*, 29(3), pp.209–225.

Veríssimo, A., Sampaio, Í., McDowell, J. R., Alexandrino, P., Mucientes, G., Queiroz, N., Silva, C., Jones,C. S., and Noble, L. R. 2017. World without borders—genetic population structure of a highly migratory marine predator, the blue shark (*Prionace glauca*). *Ecology and Evolution*. 1–14.

8.15 Tables and Figures

Table 8.1. Blue shark in the North Atlantic. Reported catches (t) of North Atlantic blue shark by ICCAT Statistical Area (2000-2021). Data source: ICCAT Task 1 catch data (accessed 20 June 2022; version of 26/01/2023).

Year	BIL91	BIL92	BIL93	BIL94A	BIL94B	BIL94C	Total
2000	0.8	406	43	624	12295	14776	28146
2001	9.3	106	47	581	10945	9440	21128
2002	0.5	22	35	836	10337	8835	20066
2003		10	40	349	11464	11143	23006
2004		54	12	966	8464	12245	21741
2005	0.5	26	28	1135	10044	11125	22359
2006		278	12	1098	9898	11931	23218
2007	0.1	902	20	843	12352	12810	26927
2008	0.2	639	11	145	15400	14530	30725
2009	0.1	1360	115	697	15971	17056	35200
2010	0.4	192	131	746	17143	19029	37241
2011	0.2	247	194	1885	12832	22939	38097
2012	0.7	98	209	1795	14017	20496	36616
2013	0.2	134	81	1824	13926	20850	36815
2014	0.7	91	154	961	14184	21193	36584
2015	0.7	98	158	220	18473	20680	39630
2016	0.3	213	133	9057	26301	8366	44070
2017	2.7	71	17	9806	22323	7445	39664
2018	4.1	81	6	8714	18582	6576	33964
2019	0.0	39	254	5432	16027	5445	27198
2020	0.0	193	350	3565	13038	4050	21196
2021	0.3	145	86	4006	13910	3360	21507

Table 8.2. Blue shark in the North Atlantic. Reported catches (t) of North Atlantic blue shark by nation (2000-2021). Data source: ICCAT Task 1 catch data (accessed 20 June 2022; version of 26/01/2023). Total catches reported by ICCAT (2023) also shown.

Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spain	24112	17362	15666	15975	17314	15006	15464	17038	20788	24465	26094
Portugal	2081	2110	2265	5643	2025	4027	4338	5283	6167	6252	8261
Japan	273	350	386	558	1035	1729	1434	1921	2531	2007	1763
Maroc											
Canada	624	581	836	346	965	1134	977	843	0.2	0.1	0.3
Belize										114	461
Panama							254	892	613	1575	
Chinese Taipei	165	59		171	206	240	588	292	110	73	99
France	395	207	221	57	106	120	99	167	119	84	122
USA	404	145	68	56	71	68	47	54	139	108	236
Korea Rep											
China PR		185	104	148				367	109	88	53
Venezuela	43	47	29	40	10	28	12	19	8	73	75
Senegal			456					43	134	255	56
United Kingdom	12	9.3	5.6	3.8	6.2	5.4	3.4	6.0	6.0	96	8.3
St Vincent and Grenadines											
Ireland	31	66	11	1.9	0.1	0.3		0.3	0.2	0.0	0.4
Mauritania											
Trinidad and Tobago			6.0	2.9	2.3	0.6	0.7	0.4	1.9	8.2	9.4
Costa Rica									0.4	1.1	2.6
Barbados											
Liberia											
Denmark	2.0	1.0	13	5.0	1.0						0.1
Mexico	0.1	6.1						0.1			0.3
Brazil	2.6										
Bermuda (UK)							0.2	0.1	0.1	0.2	0.2
St Pierre et Miquelon (FR)										1.0	
Netherlands									0.1	0.6	
Russian Federation											
Iceland											
Total (Task 1)	28146	21128	20066	23006	21741	22359	23218	26927	30725	35200	37241
Total (ICCAT, 2023)	28161	21151	20458	23184	22054	22660	23517	27070	30882	35354	38929

Table 8.2 (continued). Blue shark in the North Atlantic. Reported catches (t) of North Atlantic blue shark by nation (2000-2021). Data source: ICCAT Task 1 catch data (accessed 20 June 2022; version of 26/01/2023).

Nation	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spain	27988	28666	28562	29041	30078	29019	27316	21685	16314	12325	13125
Portugal	6509	3768	3694	3060	3859	7819	5664	5195	4507	3836	4300
Japan	1227	2437	1808	3287	4011	4217	4444	4111	3855	2352	1665
Maroc					873	1623	1475	1644	1524	1498	1636
Canada	0.1	1.2	0.2	0.6	5.5	16	32	71	3.9	193	173
Belize	1039	903	1216	392	4.3	5.7	201	317	369	301	349
Panama			289	153		262	0	437	242	344	84
Chinese Taipei	148	107	123	83	238	287	76	153	38	74	53
France	115	31	216	132	259	352	124	94	80	57	43
USA	279	167	160	166	114	74	67	30	36	32	34
Korea Rep	537	299	327	113	18	11	132	92	138	48	17
China PR	109	98	327		1.2	27	2.4	5.7	18	65	2.2
Venezuela	117	98	52	113	129	116	105	111	55	59	11
Senegal		4.6	12	17	13	2.9	4.3	1.5			
United Kingdom	10	8.2	10	10	12	17	11	6.3	3.3	2.7	4.0
St Vincent and Grenadines						119				2.0	
Ireland	1.3	2.9	1.9	0.8		0.0	0.4				
Mauritania						93					
Trinidad and Tobago	11	11	8.3	10	3.5	1.6	1.8	0.3	0.3	0.1	0.2
Costa Rica	5.8	14	8.3	5.2	2.8	2.1	0.5		0.1		0.2
Barbados					8.5	5.7	6.8	4.1	2.2	2.4	2.4
Liberia								7.2	10	3.3	7.6
Denmark		0.1									
Mexico	0.1	0.2	0.2	0.7	0.1	0.2	0.1	0.0	0.0	0.0	0.0
Brazil											
Bermuda (UK)	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3
St Pierre et Miquelon (FR)				0.1				0.0			
Netherlands											
Russian Federation							0.1	0.2	0.4	0.0	0.0
Iceland				0.5							
Total (Task 1)	38097	36616	36815	36584	39630	44070	39664	33964	27198	21196	21507
Total (ICCAT, 2023)	40292	38912	37813	38133	40191	44085	40004	33979	27212	21147	21848

Table 8.3. Blue shark in the North Atlantic. ICCAT Task I catch data (version of 26/01/2023) that has been allocated as 'catch', 'landings' and 'dead discards', with the latter also given as a percentage of total catch.

Year	Catch (t)	DD		Landings (t)	Total (t)
		(t)	% of catch		
2000	26461	113		1572	28146
2001	19472	106		1551	21128
2002	17896	68		2102	20066
2003	19959	55		2993	23006
2004	20518	65		1158	21741
2005	21125	66		1168	22359
2006	19879	45		3293	23218
2007	21351	54		5522	26927
2008	23596	130		7000	30725
2009	29128	103		5969	35200
2010	27231	167		9843	37241
2011		207	0.5%	37891	38097
2012		120	0.3%	36496	36616
2013		109	0.3%	36706	36815
2014		128	0.4%	36456	36584
2015		124	0.3%	39506	39630
2016		88	0.2%	43982	44070
2017		138	0.3%	39526	39664
2018		113	0.3%	33851	33964
2019		193	0.7%	27004	27198
2020		413	1.9%	20783	21196
2021		361	1.7%	21147	21507

Table 8.4. Blue shark in the North Atlantic. ICCAT Task I catch data (version of 26/01/2023) indicating the reported quantities landed (L) or discarded dead (DD) for the ten main nations exploiting the North Atlantic stock for the years 2010–2021.

Nation	Category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spain	DD							0				
	L	27988	28666	28562	29041	30078	29019	27316	21685	16314	12325	13125
	Total	27988	28666	28562	29041	30078	29019	27316	21685	16314	12325	13125
Portugal	DD											0
	L	6509	3768	3694	3060	3859	7819	5664	5195	4507	3836	4300
	Total	6509	3768	3694	3060	3859	7819	5664	5195	4507	3836	4300
Japan	DD				0	0				115	159	158
	L	1227	2437	1808	3287	4011	4217	4444	4111	3740	2193	1506
	Total	1227	2437	1808	3287	4011	4217	4444	4111	3855	2352	1665
Maroc	DD							0	0		0	0
	L					873	1623	1475	1644	1524	1498	1636
	Total					873	1623	1475	1644	1524	1498	1636
Canada	DD			0	0	5	16	32	71	4	193	173
	L	0	1	0	0	0	0	0	0	0	0	0
	Total	0	1	0	1	6	16	32	71	4	193	173
Belize	DD											
	L	1039	903	1216	392	4	6	201	317	369	301	349
	Total	1039	903	1216	392	4	6	201	317	369	301	349
Panama	DD							0				
	L			289	153		262	0	437	242	344	84
	Total			289	153		262	0	437	242	344	84
China-Taipei	DD	0	14	10	6	19	27	34	31	30	36	4
	L	148	94	113	77	220	259	42	122	8	38	49
	Total	148	107	123	83	238	287	76	153	38	74	53
France	DD							0	0	0		
	L	115	31	216	132	259	352	124	94	80	57	43
	Total	115	31	216	132	259	352	124	94	80	57	43
USA	DD	206	106	99	122	82	43	42	11	20	24	24
	L	73	61	61	44	32	31	24	19	17	8	10
	Total	279	167	160	166	114	74	67	30	36	32	34
Other	DD	0	0	0	0	18	1	29	0	25	1	1
	L	791	537	746	271	170	394	236	228	202	182	44
	Total	791	537	746	271	170	394	236	228	202	182	44
All	Total	38097	36616	36815	36584	39630	44070	39664	33964	27198	21196	21507

Table 8.5. Blue shark in the North Atlantic. Length–weight relationships for blue shark from different populations. Lengths in cm, and weights in kg unless specified in equation. W_R = round weight; W_D = dressed weight.

L (cm) W (kg) relationship	Sex	n	Length range (cm)	Source
W_D = (8.04021 x 10–7) L_F ^ 3.23189	C	354	75–250 (L_F)	García-Cortés and Mejuto, 2002
W_R = (3.1841 x 10–6) L_F ^ 3.1313	C	4529		Castro, 1983
W_R = (3.92 x 10–6) LT ^ 3.41	Male	17		Stevens, 1975
W_R = (3.184 x 10–7) L_T ^ 3.20	Female	450		Stevens, 1975
W_R = (3.2 x 10–6) L_F ^ 3.128	C	720		Campana *et al.*, 2005
W_D = (1.7 x 10–6) L_F ^ 3.205	C	382		Campana *et al.*, 2005

Table 8.6(a). Blue shark in the North Atlantic. Length–length relationships for male, female blue shark and both sexes combined from the NE Atlantic and Straits of Gibraltar (Buencuerpo *et al.*, 1998). L_S = standard length; L_F = fork length; L_T = total length; L_{UC} = upper caudal lobe length.

Females	Males	Combined
L_F = 1.076 L_S + 1.862 (n = 1043)	L_F = 1.080 L_S + 1.552 (n = 1276)	L_F = 1.079 L_S + 1.668 (n = 2319)
L_T = 1.249 L_S + 7.476 (n = 1043)	L_T = 1.272 L_S + 4.466 (n = 1272)	L_T = 1.262 L_S + 5.746 (n = 2315)
L_{UC} = 0.219 L_S + 4.861 (n = 1038)	L_{UC} = 0.316 L_S + 2.191 (n = 1264)	L_{UC} = 0.306 L_S + 3.288 (n = 2302)
L_T = 1.158 L_F + 5.678 (n = 1043)	L_T = 1.117 L_F + 2.958 (n = 1272)	L_T = 1.167 L_F + 4.133 (n = 2315)

Table 8.6(b). Blue shark in the North Atlantic. Length–length relationships for both sexes combined of blue shark from various populations and sources.

Stock	Relationship	n	Source
NW Atlantic	L_F = (0.8313) L_T + 1.3908	572	Kohler *et al.*, 1995
NE Atlantic	L_F = 0.8203 L_T –1.061		Castro and Mejuto, 1995
NW Atlantic	L_F = –1.2 +0.842 L_T	792	Campana *et al.*, 2005
NW Atlantic	L_T = 3.8 + 1.17 L_F	792	Campana *et al.*, 2005
NW Atlantic	L_{CF} = 2.1 + 1.0 L_{SF}	782	Campana *et al.*, 2005
NW Atlantic	L_{SF} = –0.8 + 0.98 L_{CF}	782	Campana *et al.*, 2005
NW Atlantic	L_F = 23.4 + 3.50 L_{ID}	894	Campana *et al.*, 2005
NW Atlantic	L_{ID} = –4.3 + 0.273 L_F	894	Campana *et al.*, 2005

Table 8.7. Blue shark in the North Atlantic. Indices of abundance for North and South Atlantic blue shark stocks. Source: ICCAT (2015).

		North Atlantic						
Year	Usobs	JPLLe	JPLLI	USOLD	PORLL	VENLL	ESPLL	CHTPLL
1957				0.98				
1958				0.48				
1959				1.11				
1960				1.18				
1961				1.13				
1962				1.5				
1963				0.7				
1964				0.87				
1965				1.55				
1966				1.27				
1967				1.43				
1968				1.31				
1969				1.96				
1970				0.97				
1971		0.87		1.08				
1972		1.46		1.93				
1973		1.12						
1974		2.62						
1975		1.85		0.88				
1976		1.07		0.75				
1977		1.89		1.82				
1978		1.58		1.06				
1979		1.3		0.860				
1980		2.21		0.830				
1981		2.19		1.050				
1982		2.08		0.780				
1983		1.81		1.010				
1984		1.22		0.680				
1985		1.51		0.740				
1986		1.52		0.480				
1987		2.13		0.500				
1988		1.21		0.440				
1989		1.51		0.800				
1990		1.34		0.940				
1991		1.26		1.220				
1992	7.455	1.9		0.63				
1993	11.076	2.43		0.95				
1994	9.717		2.33	0.98		0.047		
1995	10.17		2.1	0.73		0.073		
1996	8.208		2.05	0.47		0.017		
1997	14.439		2.05	1.25	158.14	0.154	156.83	
1998	18.408		1.72	1.16	169.02	0.216	154.45	
1999	6.663		1.89	0.76	149.83	0.117	179.91	
2000	9.541		1.58	0.78	201.44	0.151	213.05	
2001	2.306		1.71		222.14	0.133	215.63	
2002	2.277		1.37		200.86	0.074	183.94	
2003	1.876		1.97		238.77	0.044	222.88	
2004	9.503		1.79		266.16	0.034	177.27	0.749
2005	3.193		1.9		218.55	0.006	166.82	2.195
2006	4.674		2.16		212.63	0.013	177.11	1.308
2007	9.645		2.18		241.32	0.060	187.06	0.561
2008	8.512		2.48		225.68	0.088	215.80	0.495
2009	8.322		2.46		228.30	0.045	196.08	0.570
2010	13.545		2.45		276.76	0.040	209.03	0.877
2011	21.806		2.37		233.29	0.044	221.13	0.765
2012	8.128		2.6		305.53	0.107	238.00	0.668
2013	7.374		2.09		304.08	0.044	203.49	1.045

Table 8.8. Blue shark in the North Atlantic. Coefficients of variation (CVs) for North and South Atlantic blue shark stocks. Source: ICCAT (2015).

			North Atlantic					
Year	Usobs	JPLLe	JPLLl	USOLD	PORLL	VENLL	ESPLL	CHTPLL
1957				0.17				
1958				0.16				
1959				0.25				
1960				0.38				
1961				0.35				
1962				0.27				
1963				0.25				
1964				0.17				
1965				0.17				
1966				0.23				
1967				0.21				
1968				0.21				
1969				0.22				
1970				0.32				
1971		0.53		0.23				
1972		0.39		0.21				
1973		0.45						
1974		0.32						
1975		0.34		0.19				
1976		0.47		0.29				
1977		0.27		0.2				
1978		0.32		0.11				
1979		0.24		0.11				
1980		0.29		0.09				
1981		0.36		0.09				
1982		0.36		0.09				
1983		0.37		0.1				
1984		0.50		0.1				
1985		0.44		0.1				
1986		0.39		0.09				
1987		0.35		0.1				
1988		0.49		0.12				
1989		0.44		0.39				
1990		0.49		0.17				
1991		0.47		0.11				
1992	0.31	0.43		0.1				
1993	0.29	0.40		0.09				
1994	0.29		0.50	0.1		1.08		
1995	0.29		0.55	0.1		0.87		
1996	0.50		0.51	0.3		1.90		
1997	0.33		0.52	0.13	0.084	`	0.008	
1998	0.35		0.53	0.15	0.076	0.67	0.008	
1999	0.34		0.49	0.13	0.077	0.84	0.008	
2000	0.32		0.28	0.12	0.083	0.74	0.008	
2001	0.39		0.56		0.089	0.77	0.008	
2002	0.39		0.62		0.086	1.03	0.008	
2003	0.37		0.59		0.082	1.26	0.009	
2004	0.30		0.69		0.084	1.53	0.009	0.12
2005	0.35		0.71		0.087	3.88	0.010	0.19
2006	0.31		0.69		0.084	2.24	0.010	0.06
2007	0.32		0.61		0.085	1.35	0.011	0.22
2008	0.32		0.69		0.085	1.16	0.011	0.28
2009	0.31		0.64		0.086	1.56	0.012	0.17
2010	0.31		0.64		0.089	1.54	0.010	0.10
2011	0.29		0.51		0.079	1.51	0.010	0.12
2012	0.34		0.51		0.081	1.00	0.010	0.11
2013	0.31		0.21		0.085	1.84	0.011	0.14

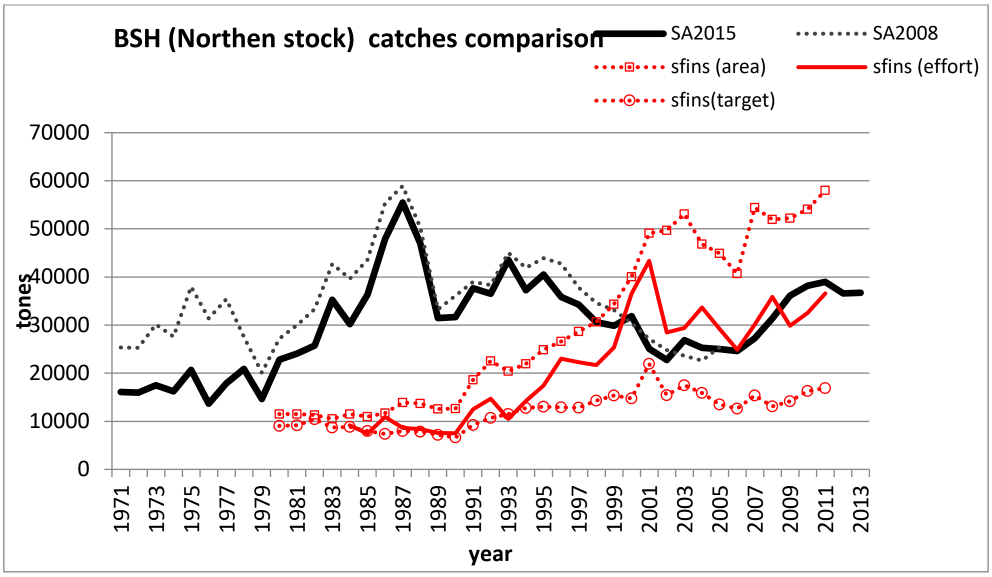
Table 8.9. Blue shark in the North Atlantic. Von Bertalanffy growth parameters (L∞ in cm (L_T), k in years^{-1}, t0 in years) from published studies.

Area	L∞	k	t0	Sex	Study
North Atlantic	394	0.133	–0.801	Combined	Aasen, 1966
North Atlantic	423	0.11	–1.035	Combined	Stevens, 1975
NW Atlantic	343	0.16	–0.89	Males	Skomal, 1990
NW Atlantic	375	0.15	–0.87	Females	Skomal, 1990
NE Atlantic	377	0.12	–1.33	Combined	Henderson *et al*., 2001
North Atlantic	282	0.18	–1.35	Males	Skomal and Natanson, 2002
North Atlantic	310	0.13	–177	Females	Skomal and Natanson, 2002
North Atlantic	287	0.17	–1.43	Combined	Skomal and Natanson, 2003
NW Atlantic	300	0.68	–0.25	Combined	MacNeil and Campana, 2002 (whole ages)
NW Atlantic	302	0.58	–0.24	Combined	MacNeil and Campana, 2002 (section ages)

Table 8.10. Blue shark in the North Atlantic. Biological parameters for blue shark.

Parameter	Values	Sample Size	Area	Reference
Reproduction	Placental viviparity			various
Litter size	25–50 (30 average)			various
Size-at-birth	30–50 cm LT			Various
Sex ratio (males: females)	1.5:1		NE Atlantic	García-Cortés and Mejuto, 2002
	1:1.44		NE Atlantic	Henderson *et al*., 2001
	1.33:1		NW Atlantic	Kohler *et al*., 2002
	1:2.13		NE Atlantic	Kohler *et al*., 2002
	1:1.07	801	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	1:0.9	158	NE Atlantic (S. coast Spain)	
	1:0.38	2187	N central Atlantic	
	1:0.53	4550	NW Atlantic	
Gestation period	9–12 months			Campana *et al*., 2002
% of females revealing fecundation signs	0.74	415	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	0	76	NE Atlantic (S. coast Spain)	
	36.27	601	N central Atlantic	
	18.15	1573	NW Atlantic	
% of pregnant females	0	415	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	0	76	NE Atlantic (S. coast Spain)	
	14.6	601	N central Atlantic	
	9.8	1573	NW Atlantic	

Parameter	Values	Sample Size	Area	Reference
Male age-at-maturity (years)	4–6			various
Female age-at-maturity (years)	5–7			various
Male length-at-maturity	180–280 cm (LF)		NW Atlantic	Campana *et al*., 2002
	190–195 cm (LF)			Francis and Duffy, 2005
	201 cm (LF; 50% maturity)		NW Atlantic	Campana *et al*., 2005
Female length-at-maturity	220–320 cm (LF)			Campana *et al*., 2002
	170–190 cm (LF)			Francis and Duffy, 2005
	> 185 cm (LF)			Pratt, 1979
Longevity (years)	16–20			Skomal and Natanson, 2003
Natural mortality (M)	0.23		Worldwide	Campana *et al*., 2005 (mean of various studies)
Productivity (R2m) estimate: intrinsic rebound	0.061 (assuming no fecundity increase)		Pacific	Smith *et al*., 1998
Potential rate of increase per year	43% (unfished)		NW Atlantic	Campana *et al*., 2005
Population doubling time TD (years)	11.4 (assuming no fecundity increase)		Pacific	Smith *et al*., 1998
Trophic level	4.1	14		Cortés, 1999



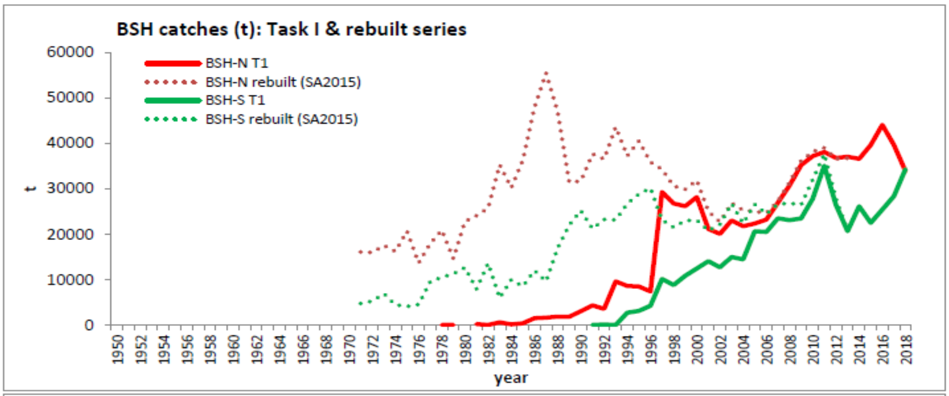


Figure 8.1. Blue shark in the North Atlantic. Top: Comparison of various catch series for the North Atlantic stock of blue shark (1971–2013). In black, the stock assessment catches from the 2008 stock assessment (dotted line) and 2015 estimations (solid line). In red, three catch series obtained using shark-fin ratios with three different approaches (area, effort, target level). Bottom: Update of catches reported to ICCAT (Task I) and estimated by SCRS (SCRS, 2019). Dotted lines are values from the 2008 assessment, solid line those of the 2015 estimates.

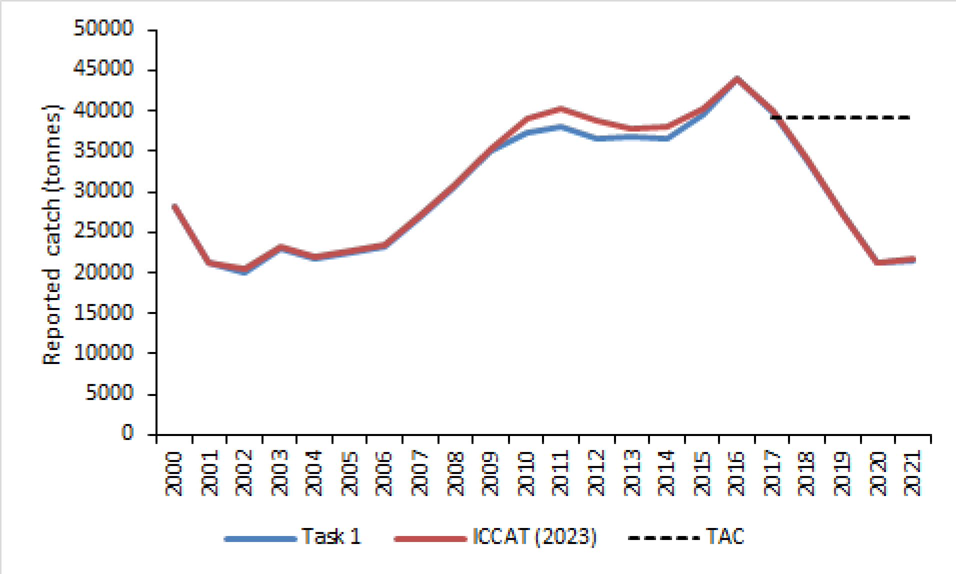


Figure 8.2. Blue shark in the North Atlantic. Reported catches of the North Atlantic stock of blue shark (2000–2021), based on the current Task 1 data (version of 26/01/2023) and the data being prepared for the 2023 stock assessment (ICCAT, 2023). The TAC is also indicated. For catch data prior to 2000, see ICCAT (2023).

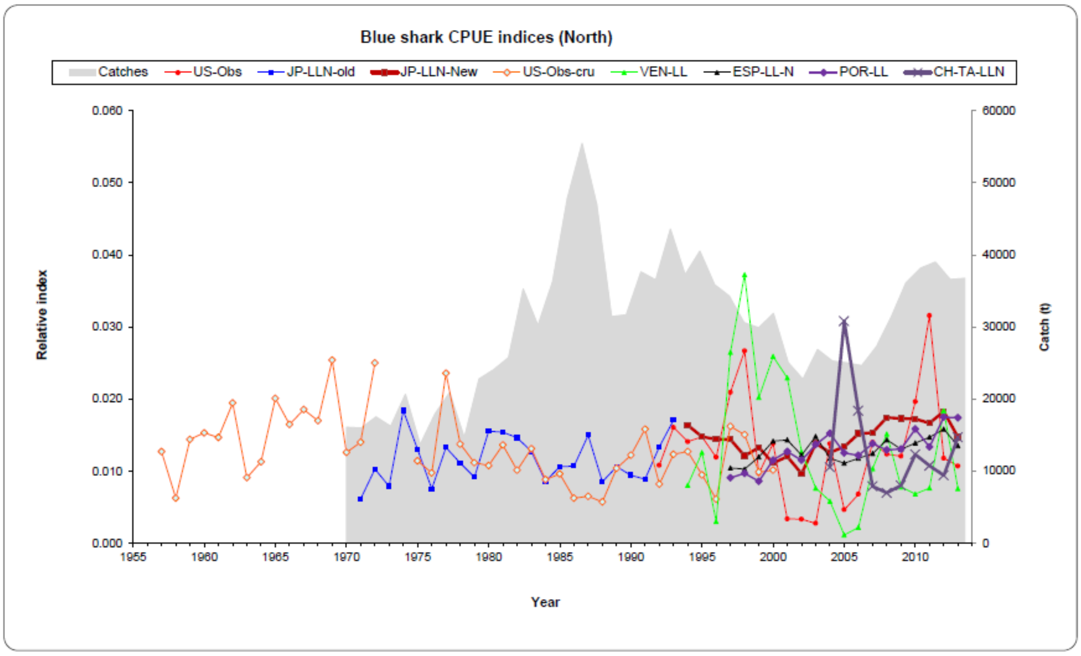


Figure 8.3. Blue shark in the North Atlantic. Indices of abundance and catches. Source: ICCAT (2019).

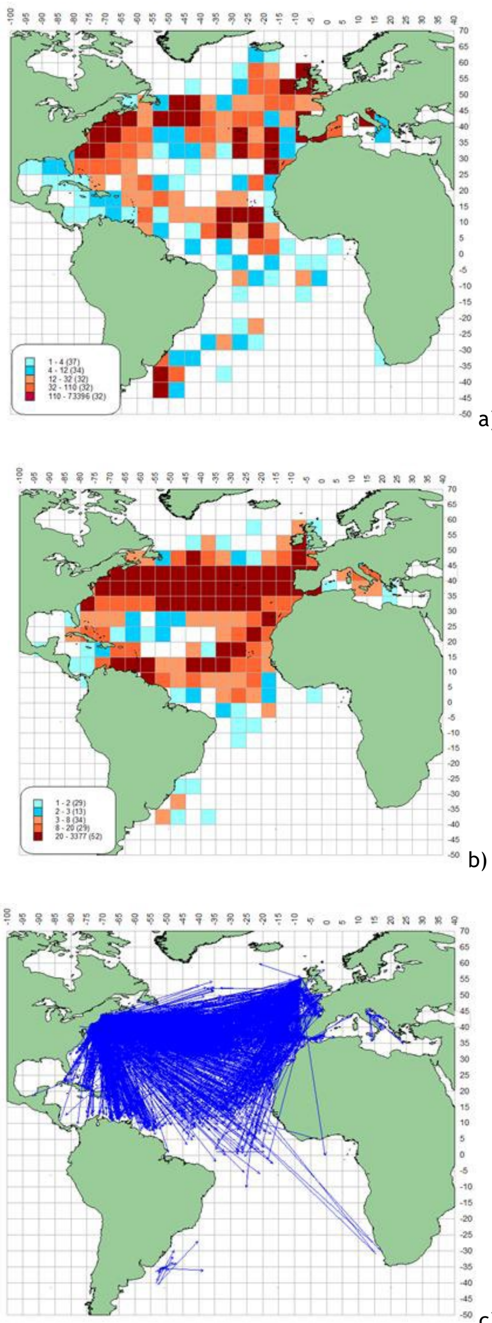


Figure 8.4. Blue shark in the North Atlantic. Blue shark tagging maps, presented by ICCAT (2012), showing (a) density of releases, (b) density of recoveries, and (c) straight line displacement between release and recovery locations.

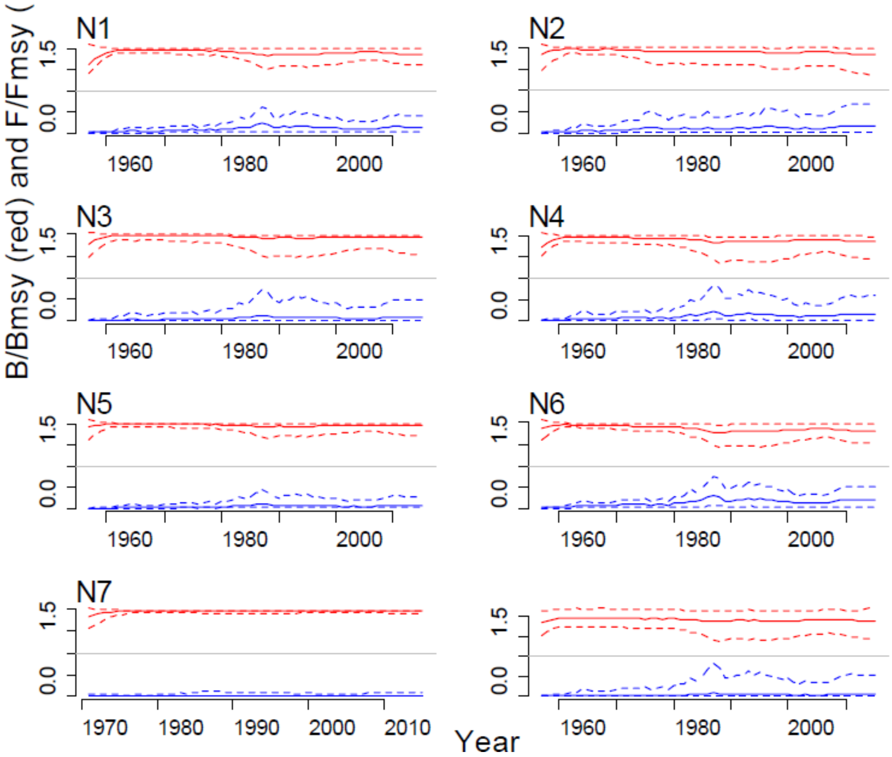


Figure 8.5. Blue shark in the North Atlantic. Estimated biomass relative to B_{MSY} (in red) and harvest rate relative to the MSY level (blue), for the BSP runs. Source: ICCAT (2015).

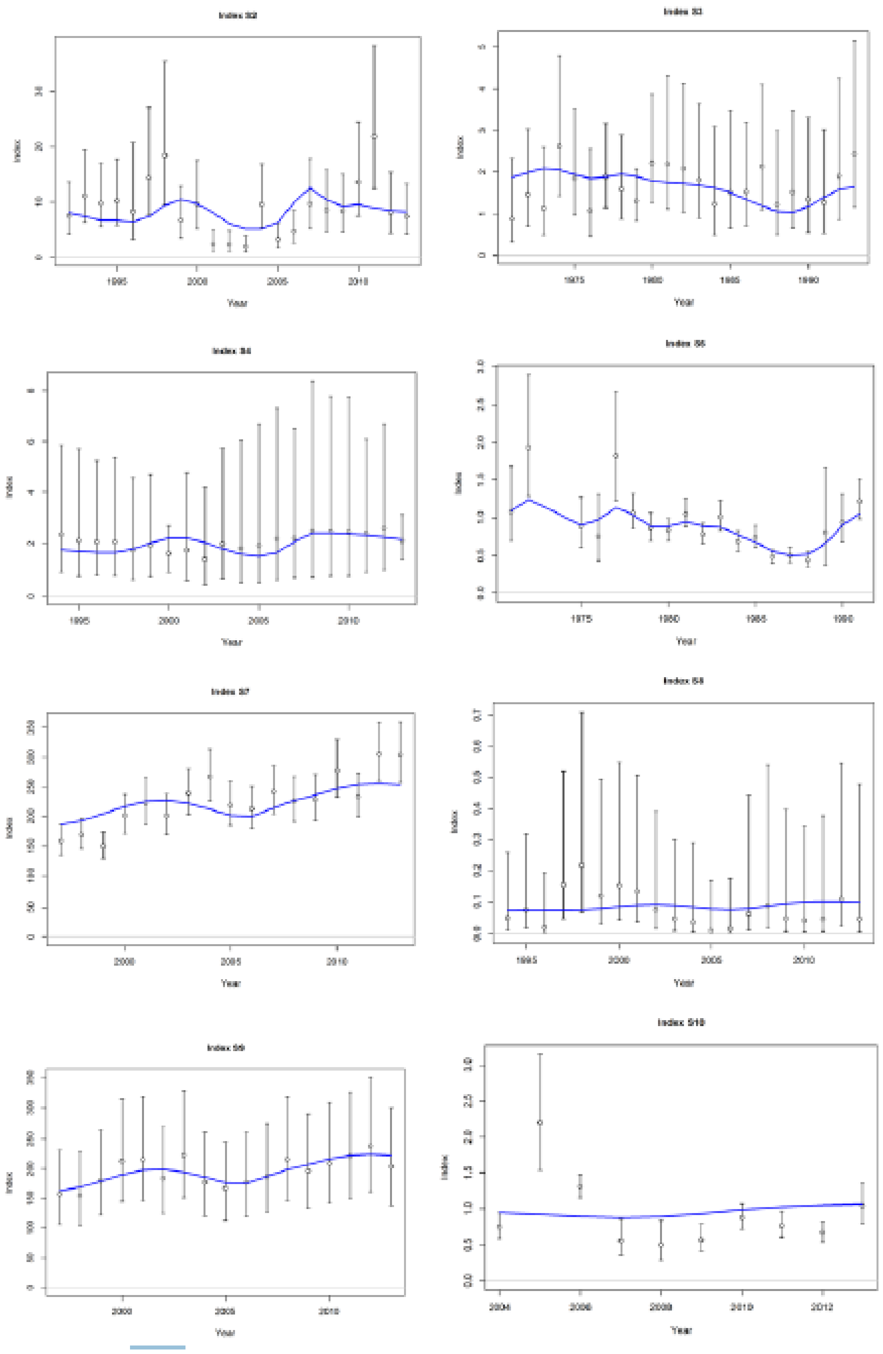


Figure 8.6. Blue shark in the North Atlantic. Preliminary Run 4 observed CPUE (open circles ± 95% confidence intervals assuming lognormal error) and model predicted CPUE (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, middle left), S6 (US-Obs-cru, middle right), S7 (POR-LL, middle left), S8 (VEN-LL, middle right), S9 (ESP-LL-N, lower left), and S10 (CTP-LL-N, lower right). Source: ICCAT (2015).

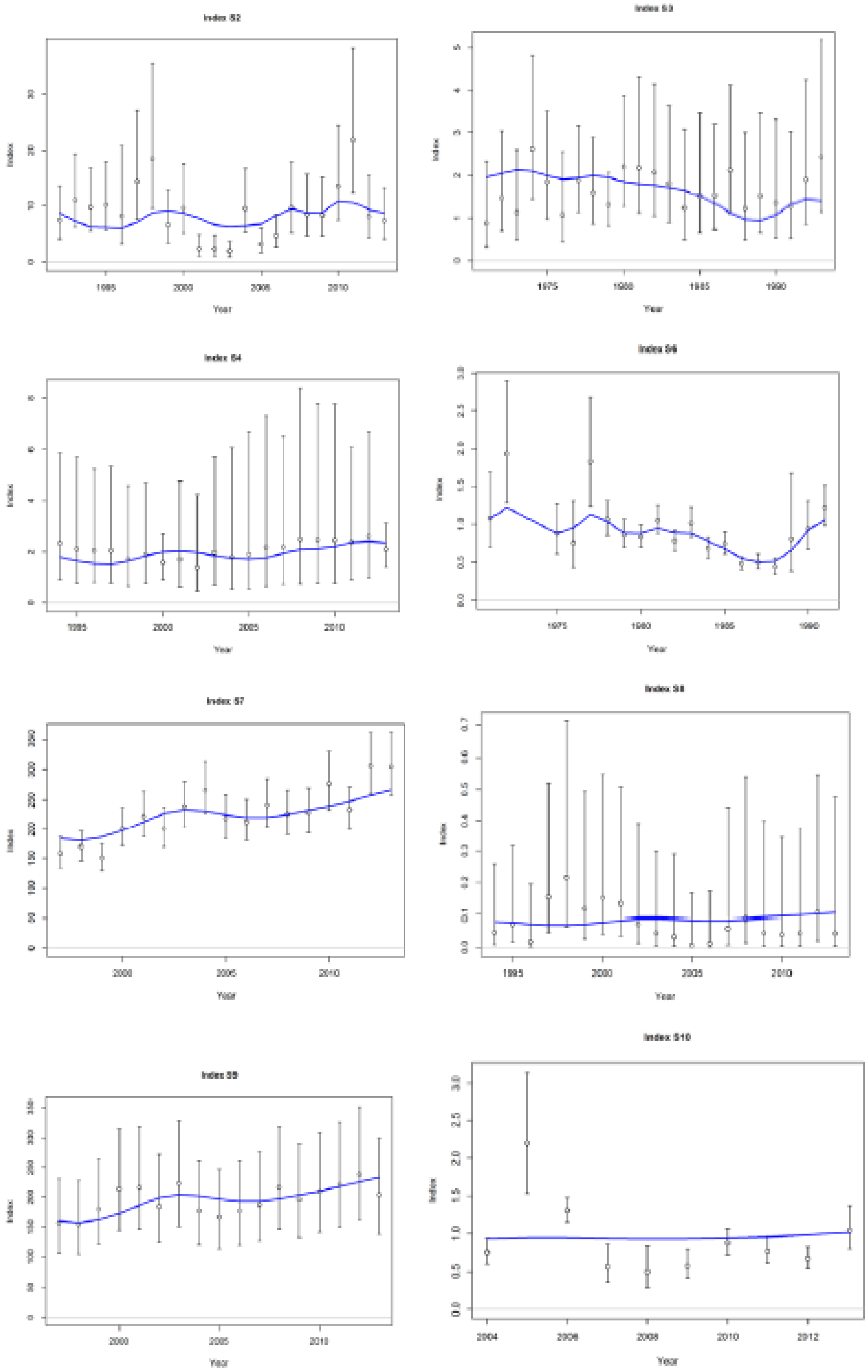
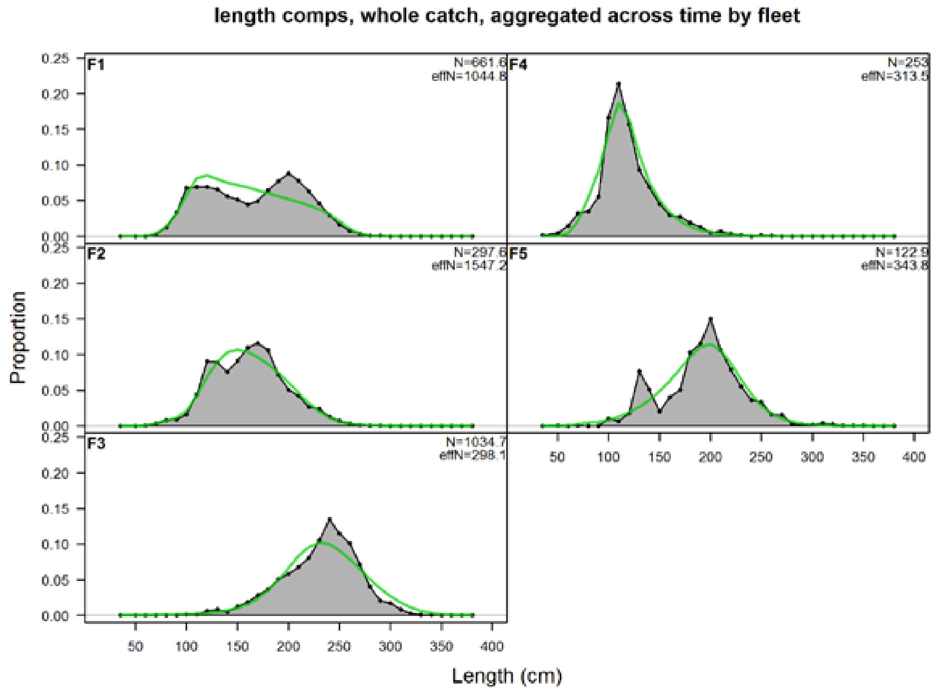


Figure 8.7. Blue shark in the North Atlantic. Preliminary Run 6 observed CPUE (open circles ± 95% confidence intervals assuming lognormal error) and model predicted CPUE (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, middle left), S6 (US-Obs-cru, middle right), S7 (POR-LL, middle left), S8 (VEN-LL, middle right), S9 (ESP-LL-N, lower left), and S10 (CTP-LL-N, lower right). Source: ICCAT (2015).



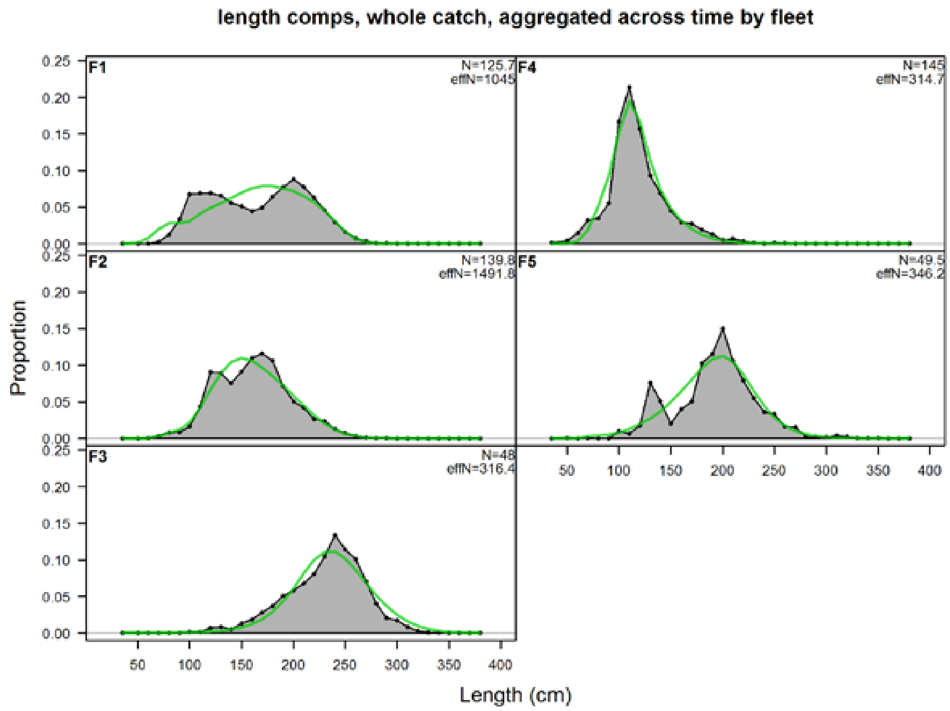


Figure 8.8. Blue shark in the North Atlantic. Model predicted (line) and observed (shaded) aggregated annual length compositions (female + male) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

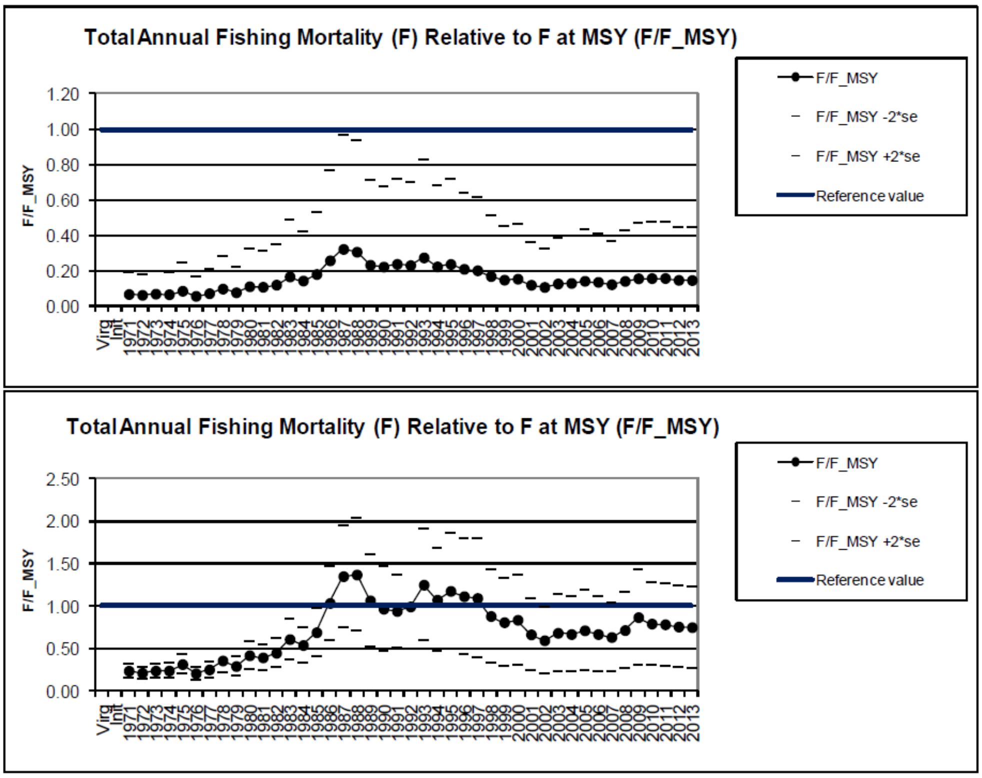


Figure 8.9. Blue shark in the North Atlantic. Estimated annual total exploitation rate in numbers (total fishing mortality for all fleets combined) relative to fishing mortality at MSY (F/F_{MSY}), obtained from Stock Synthesis output for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

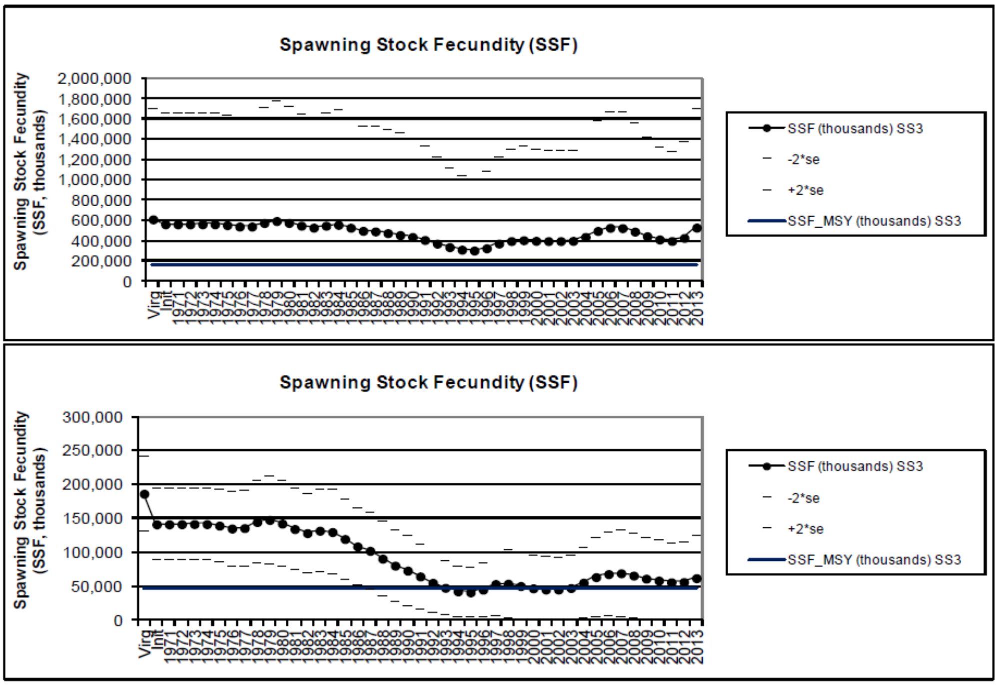


Figure 8.10. Blue shark in the North Atlantic. Estimated spawning stock size (spawning stock fecundity, SSF) along with approximate 95% asymptotic standard errors (±2*s.e.) relative to spawning stock size at MSY (SSFMSY) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

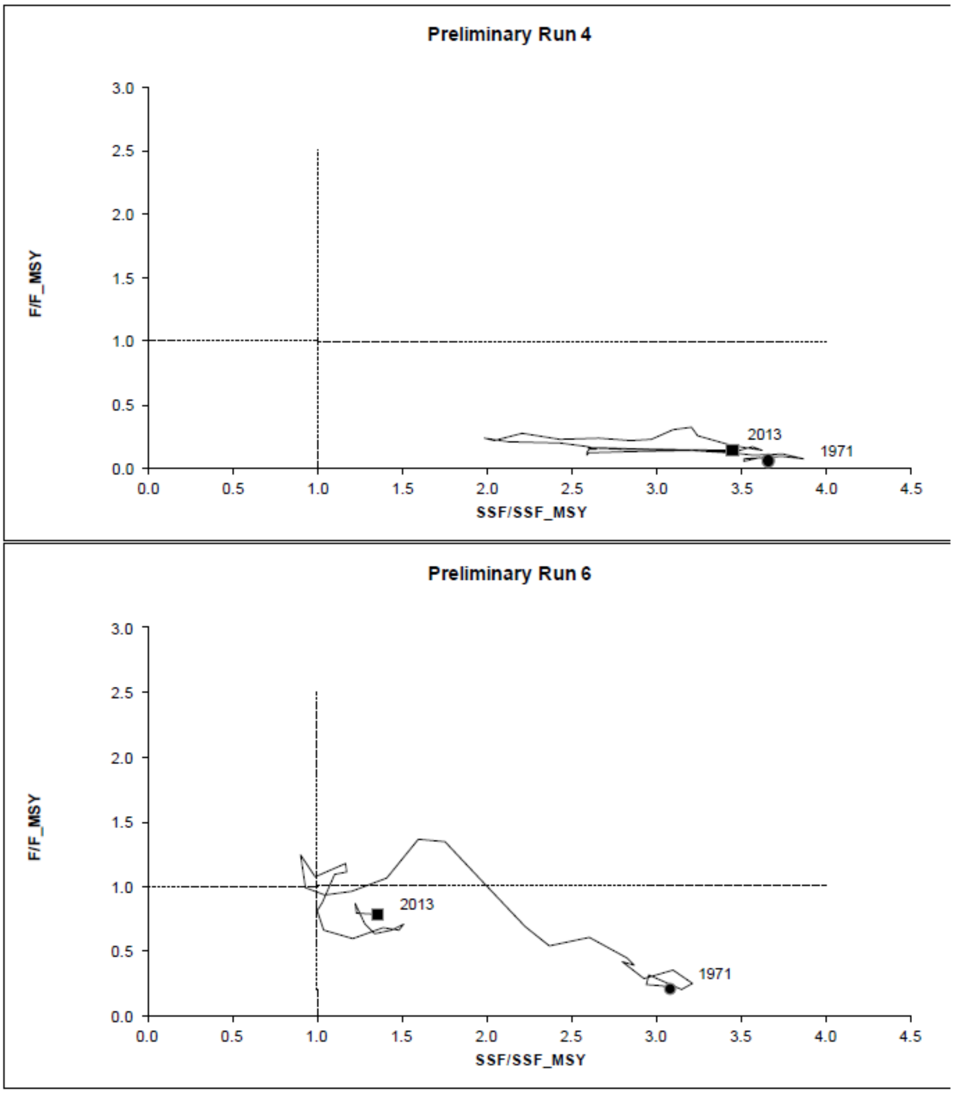


Figure 8.11. Blue shark in the North Atlantic. Kobe Phase plots for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). The circle indicates the position of the start year of the model (1971) and the square represents the end year of the model (2013). The horizontal (dotted) line identifies the fishing mortality reference at maximum sustainable yield (F_{MSY}). The vertical (dotted) line identifies the reference spawning stock fecundity at maximum sustainable yield (SSF_{MSY}). Source: ICCAT (2015).

Contents

9 Shortfin mako in the North Atlantic (North of 5°N)

Shortfin mako shark *Isurus oxyrinchus* is a large, highly mobile, pelagic predator that inhabits tropical and temperate waters circumglobally, and is taken in both recreational and commercial fisheries (Campana *et al.*, 2005).

The North Atlantic shortfin mako stock is assessed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). ICCAT conducted a stock assessment for shortfin mako in June 2017 (ICCAT, 2017b), with an update in 2019 (ICCAT, 2019). The available catch, effort and size data, and tagging data were reviewed at a prior Data Preparatory Meeting (ICCAT, 2017a), when the models to be used during the assessment and their assumptions were also discussed.

9.1 Stock distribution

Tagging data indicate that there is one stock of shortfin mako in the North Atlantic (Kohler *et al.*, 2002; Figure 9.1). Genetic studies have found no evidence to separate east and west populations in the Atlantic but indicate differences between the North Atlantic and the South Atlantic and other oceans (Heist *et al.*, 1996; Schrey and Heist, 2002). The relationship between shortfin mako in the North Atlantic and Mediterranean Sea is unclear, and the ICCAT assessment includes data from the North Atlantic only. Nevertheless, some potentially informative data are included here for the Mediterranean Sea.

Based on the oceanography of equatorial waters, and that other large pelagic species (e.g., swordfish) have a southern stock boundary of 5°N, this latitudinal extent is used as the southern boundary for the North Atlantic stock of shortfin mako. The stock area broadly equates with FAO Areas 27, 21, 31 and 34 (in part).

Preliminary results provided to ICCAT (2016) indicated that there is some stock mixing, with males moving more between regions, while the females seem to show more philopatric behaviour. Thus, further studies of the biology and population structure are required for the clarification of stock boundaries (ICCAT, 2016).

9.2 The fishery

9.2.1 History of the fishery

Shortfin mako is a highly migratory species that is a frequent bycatch in pelagic longline fisheries targeting tuna and swordfish, and in other high seas tuna fisheries. Like porbeagle, it is a relatively high-value species (cf. blue shark, which is of lower commercial value) and normally retained when permissible (Campana *et al.*, 2005).

Recreational fisheries on both sides of the North Atlantic also catch this species, with relatively large quantities reported from sport (rod and reel) fisheries reported to ICCAT (178 t in 2011). Some specimens are released alive from these fisheries.

Shortfin mako is also taken in Mediterranean Sea fisheries (STECF, 2003). For example, Tudela *et al.* (2005) observed 542 shortfin mako taken as bycatch in 4140 km of driftnets set in the Alboran Sea between December 2002 and September 2003.

9.2.2 The fishery in 2023

Reported landings of North Atlantic shortfin mako have decreased in recent years, given the introduction of more conservative management Recommendations from ICCAT (see ICCAT Recommendations 19-06 and 21-09).

ICCAT agreed a "*prohibition on retaining on board, transhipping and landing, whole or in part, North Atlantic shortfin mako caught in association with ICCAT fisheries in 2022 and 2023*" (see below), and whilst this will reduce official landings, it is unclear whether it will have resulted in changes in fishing patterns and fleet behaviour, and so how it will have affected total catch.

9.2.3 Advice applicable

ICES does not provide advice for this stock. Assessment of this stock is considered to be the responsibility of ICCAT, who coordinate Recommendations to Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (referred to as CPCs).

Following the 2017 assessment, ICCAT's Standing Committee on Research and Statistics (SCRS) recommended that "*For the North Atlantic stock of shortfin mako, the probabilities in the Kobe matrices indicate that to stop overfishing and start rebuilding, the constant annual catch should be reduced to 500 t or less. This will achieve the goal of stopping overfishing in 2018 with a 75% probability, but it only has a 35% probability of rebuilding the stock by 2040. Only a 0 t annual catch will rebuild the stock by 2040 with a 54% probability*" (ICCAT, 2018).

The SCRS also noted that "*If the Commission wishes to stop overfishing immediately and achieve rebuilding by 2040 with over a 50% probability, the most effective immediate measure is a complete prohibition of retention. Additional recommended measures that can potentially further reduce incidental mortality include time/area closures, gear restrictions, and safe handling and best practices for the release of live specimens (since post release survival can reach 70%).*" (ICCAT, 2018).

Following the subsequent assessment in 2019, SCRS recommended that "*the Commission adopt a non-retention policy without exception in the North Atlantic as it has already done with other shark species caught as bycatch in ICCAT fisheries*" (ICCAT, 2020).

9.2.4 Management applicable

ICCAT Recommendation 21-09 on the conservation of the North Atlantic stock of shortfin mako caught in association with ICCAT fisheries. This requires that "*CPCs shall implement a prohibition on retaining on board, transhipping and landing, whole or in part, North Atlantic shortfin mako caught in association with ICCAT fisheries in 2022 and 2023 as a first step in rebuilding the stock*". The Recommendation also provides an initial approach for potential levels of retention in 2023 onwards.

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters. In June 2023, 'The Shark Fins Act 2023' was passed in the UK banning the import and export of detached shark fins, including all products containing shark fins.

Shortfin mako is listed in Appendix II of CITES, and so international trade, including the retention of fish caught in international waters, now requires a Non-Detriment Finding (see Section 9.12).

9.3 Catch data

9.3.1 Landings

ICCAT's Task 1 catch data for shortfin mako in the North Atlantic are provided in Tables 9.1 and 9.2, with these data covering the period 2000–2021. Shortfin mako caught in association with ICCAT fisheries should not be retained in the years 2022–2023, and so the landing tables have not been updated this year. The reader is referred to earlier reports of WGEF and relevant ICCAT reports (e.g., ICCAT, 2022) for earlier catch data, including ICCAT's assessment reports for discussions on changes in the reported catches over time. Whilst these data include landings, dead discards and live discards, the reporting of these has been inconsistent over time. The Task 1 data currently available for this period differ only slightly from those presented in ICCAT (2022).

During the period 2000–2021, the vast majority of the reported catches of shortfin mako in the North Atlantic have been from billfish areas BIL94B, BIL94A and BIL94C and BIL92 and with much lower quantities from BIL91 and BIL93 (Table 9.1).

Whilst several nations report catches of shortfin mako, the mean annual proportion of reported catches by nation over the period 2000–2021 indicate the main nations (Table 9.2) exploiting shortfin mako have been Spain (50.2%), Portugal (19.2%), Morocco (12.8%), USA (9.7%), Japan (3.2%) and Canada (1.9%).

Over the period 2000–2021, reported annual catches of North Atlantic shortfin mako have averaged 2249 t y^{-1} (ranging from 1431–4783 t y^{-1}), but have been lower in recent years, with the mean annual catches for 2019–2021 being 1682 t y^{-1} (ranging from 1431–1886 t y^{-1}).

Comparable data for the Mediterranean Sea (Table 9.3) indicate that mean annual catches of shortfin mako have been 2.5 t y^{-1} (0–16.7 t y^{-1}) for the years 2000–2021, declining to just 0.3 t y^{-1} for 2019–2021. Whilst these data are a small fraction of the catches from the North Atlantic, these data may be under-estimated, as data for shortfin mako appear to be limited for Italy and are not reported by Greece, despite known interactions with the pelagic fleets of such nations (e.g., Megalofonou *et al.*, 2005).

9.3.2 Discards

Shortfin mako is a high value species and, over the longer time-series, many fleets would land shortfin mako gutted (usually with the head on). Although often landed for their meat in some fisheries, finning (the practice of removing the fins of a shark and returning the remainder of the carcass to the sea) may have occurred in some fleets, which may result in undocumented catches and mortality.

Discard data, as reported to ICCAT, are given in Table 9.4. The Task 1 data do not include any estimates of live discards for shortfin mako. Reported discards were low at the start of the time-series (<0.5% of the catch were discarded in the years 2010–2017), increasing slightly to ca. 1–4% (2018–2020) and then to >60% (2021). The quantities being reported as being landed or discarded dead for the six main fleets (Spain, Portugal, Morocco, USA, Japan and Canada; Table 9.5) indicate that some nations (e.g., Spain, Portugal and Morocco) are not reporting dead discards (or the reported quantities are negligible). Hence, available discards data are likely to be underestimated.

9.3.3 Quality of catch data

Historical catch data are considered underestimates for a range of reasons.

- The extent of finning in high seas fisheries is unclear, although this is expected to have declined for most fleets.
- The historical use of generic shark categories means that species-specific data are likely incomplete, although there has been improved species-specific reporting over time.
- The introduction of management measures to limit landings and associated uncertainty in the accuracy and consistency in the reporting of estimated discards means that recent catch data may be incomplete.

Despite some important recovery of historical catch series in recent years, ICCAT considers that the overall catch is underestimated, particularly before 2000. For example, earlier ICCAT assessments of shortfin mako used different approaches to estimate catches, the tuna ratio (logged observations of shark catches relative to tuna catches) and the fin trade index (shark fin trade observations from the Asian market used to calculate caught shark weights based on catch effort data; Clarke *et al*., 2006; ICCAT 2005, 2008). These figures were much higher than reported landings. However, the methods to estimate historic catches of blue shark are not considered appropriate for shortfin mako, given its higher commercial value and lower discard rates (cf. blue shark). Hence, for shortfin mako, historical estimation of catches is based on observer data, as well as other potential techniques (e.g. catch ratios). The highest priorities for such an exercise would be for Morocco, before 2011; Spain, before 1997 and Canada, before 1995 (ICCAT, 2017a, b).

There have also been observed differences in those reported catch data submitted to ICCAT, FAO and EuroStat (see earlier reports by WGEF). Updated studies to review these data sets (by fishing area, nation and year), to identify inconsistencies and, where necessary, harmonise the date sets are required.

9.3.4 Discard survival

Several studies have reported the at-vessel mortality of shortfin mako to broadly range from about 30–50% in longline fisheries (summarised in Ellis *et al.*, 2017). Discard survival in such fisheries can be influenced by several factors, including hook type, soak time and size of shark.

One of the more comprehensive studies of the at-vessel and post-release mortality of shortfin mako shark is that of Campana *et al.* (2016), who reported data for the Canadian longline fishery. For the years 2010–2014, the at-vessel mortality was 26.2% (aggregated data; annual estimates ranged from 12.2–32.4%, averaging 21.0%). The proportion of shortfin mako rated as 'injured' was 22.5% (aggregated data; annual estimates ranged from 9.3–30.9%, averaging 16.6%), whilst the proportion rated as 'healthy' was 51.3% (aggregated data; annual estimates ranged from 36.7–71.9%, averaging 62.4%). Using pop-up satellite archival tags (PSATs), Campana *et al.* (2016) reported that 30.4% of 'healthy' shortfin mako (n = 23) suffered post-release mortality, and one of the three 'injured' individuals also died.

9.4 Commercial catch composition

9.4.1 Conversion factors

Shortfin mako are landed in various forms (e.g., gutted, dressed, with or without heads). It is therefore important that appropriate conversion factors for these landings are used. FAO (based on Norwegian data) use conversion factors for fresh, gutted, and gutted and headed sharks of 87% and 77%, respectively (Hareide *et al*., 2007). Scientific estimates for various conversion factors for shortfin mako are summarised for length–weight relationships (Table 9.6) and different length measurements (Table 9.7).

9.5 Commercial catch and effort data

The ICCAT assessments use standardised indices of catch per unit effort based on commercial catch and effort data. Recent assessments have used five such series (US logbook data, and longline data from Japanese, Portuguese, Spanish and Chinese (Taipei) longline fleets in the North Atlantic.

The overall trends for the North Atlantic stock of shortfin mako is an initial decrease followed by an increase from 2000 and subsequent decline in the recent years (Figure 9.2).

Figure 9.3 presents the correlations between North Atlantic CPUE indices; the lower triangle shows the pairwise scatter plots between indices with a regression line, the upper triangle provides the correlation coefficients, and the diagonal provides the range of observations. The correlation between US observer and Chinese Taipei is high at 0.78; however, this is likely to be due to a single point, in 2009. Also, a strong correlation could be found by chance if two series only overlap for a few years.

9.6 Fishery-independent surveys

No fishery-independent data are available for shortfin mako in the northeastern Atlantic, although such data are available for the northwestern Atlantic (Simpfendorfer *et al*., 2002; Hueter and Simpfendorfer, 2008). Babcock (2010) provided an index of abundance based on of shortfin mako catch rates from the US East Coast from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS), in which a total of 711 shortfin mako were reported from 252 686 trips (1981–2010), of which about 0.2% caught at least one shortfin mako.

9.7 Life-history information

9.7.1 Life-history parameters

Various studies have provided biological information for shortfin mako (see Stevens, 2008). Relevant data are summarised in Table 9.6 (length–weight relationships), Table 9.8 (growth parameters), and Table 9.9 (other life-history parameters).

There are still uncertainties in relation to some biological parameters, and further studies are required. ICCAT Recommendation 14–06 on shortfin mako caught in association with ICCAT fisheries supports this in saying (Paragraph 3) that "*CPCs are encouraged to undertake research that* *would provide information on key biological/ecological parameters, life-history and behavioural traits, as well as on the identification of potential mating, pupping and nursery grounds of shortfin mako sharks. Such information shall be made available to the SCRS*".

The ICCAT shark subgroup coordinate various data collection programmes for relevant biological investigations. Indeed, regular updates to life-history information are provided by ICCAT's shark subgroup (e.g., ICCAT, 2014, 2016; García-Cortés *et al.*, 2021). As part of an on-going cooperative program for biological data collection, information collected by fishery observers and scientific projects from several fishing nations in the Atlantic (EU-Portugal, Uruguay, Chinese Taipei, USA, Japan, Brazil and Venezuela) were analysed at the 2017 ICCAT shortfin mako Data Preparatory Meeting (ICCAT, 2017a).

9.7.2 Habitat

Shortfin mako is a common, extremely active epipelagic species found in tropical and warm-temperate seas from the surface down to at least 500 m (Compagno, 2001). It is seldom found in waters <16°C, and in the western North Atlantic they only move onto the continental shelf when surface temperatures exceed 17°C. Observations from South Africa indicate that the species prefers clear water (Compagno, 2001).

9.7.3 Nursery grounds

Published records of potential nursery grounds are limited. Buencuerpo *et al.* (1998) suggested that the western basin of the Mediterranean Sea was a nursery area, whilst Stevens (2008) suggested that nursery areas would likely be situated close to the coast in highly productive areas, potentially off West Africa in the North Atlantic. More recently, Natanson *et al.* (2020) investigated spatio-temporal patterns in the distribution of various life- history stages, and suggested that the Gulf of Mexico and Atlantic waters off Portugal served as parturition and nursery grounds.

9.7.4 Diet

Shortfin mako feed primarily on fish, both pelagic and demersal species, and cephalopods (Compagno, 2001). Shortfin mako sampled off southwest Portugal had teleosts as the principal component of their diet (occurring in 87% of the stomachs and accounting for >90% of the contents by weight), and crustaceans and cephalopods were also relatively important, whilst other elasmobranchs were only present occasionally (Maia *et al*., 2006).

In the NW Atlantic, bluefish *Pomatomus saltatrix* is the most important prey species and comprises about 78% of the diet (Stillwell and Kohler, 1982). These authors estimated that a 68 kg shortfin mako consumes about 2 kg of prey per day, and could eat about 8–11 times its body weight per year. Stillwell (1990) subsequently suggested that shortfin mako may consume up to 15 times their weight per year.

The diet of shortfin mako in South African waters indicated that elasmobranchs could be important prey, and marine mammals can also make up a small proportion of the diet (Compagno, 2001).

9.7.5 Movements

Shortfin mako have a wide distribution and habitat use patterns (Casey and Kohler, 1992; Rogers *et al*. 2015; Vaudo *et al*. 2016). The species showed diel diving behaviour, with deeper dives occurring primarily during the daytime. A strong influence of thermal habitat on species movement behaviour suggests potentially strong impacts of rising ocean temperatures on the ecology of this highly migratory top predator. Integrating knowledge of fish movements into spatially explicit population dynamics models is being urged for improving stock assessments and management (Braccini *et al.*, 2016).

There is a large set of mark-recapture data available at ICCAT for shortfin mako. ICCAT (2016) reported that 9316 individuals had been tagged since 1962, of which 1255 specimens had been recaptured. These data, whilst supporting the stock identification, may also provide information for the estimation of growth curves (ICCAT, 2016).

Saraiva *et al.* (2023) provided information on swimming performance, after deploying tri-axial accelerometer tags on three shortfin makos caught off the Azores, with bursts in swimming speed recorded up to 3.6 m s^{-1}.

9.8 Exploratory assessment models

No new exploratory assessment was undertaken.

9.9 Stock assessment

An ICCAT assessment for shortfin mako was carried out in 2017 (ICCAT, 2017b). The models agreed that the northern stock was overfished and was undergoing overfishing. The results obtained in 2017 were not comparable with those obtained in the earlier assessment in 2012, as the input data and model structures had changed significantly.

ICCAT updated the assessment for shortfin mako in 2019. New projections were made using two Stock Synthesis model scenarios that incorporated important aspects of shortfin mako biology, which had not been available previously (ICCAT, 2019). These projections were considered by the ICCAT Shark Group as a better representation of the stock dynamics. For the North Atlantic stock, the Group stated that "it is likely the current status (2018) had a lower B/B_{MSY} and higher F/F_{MSY} than the stock status in 2015 estimated in the 2017 assessment because the population continued to decline due to high catch levels". A number of catch scenarios were given in the report, but the ICCAT Shark Group stated that "regardless of the TAC (including a TAC of 0 t), the stock will continue to decline until 2035 before any biomass increases can occur" and "although there is large uncertainty in the future productivity assumption for this stock, the Stock Synthesis projections show that there is a long lag time between when management measures are implemented and when stock size starts to rebuild" (ICCAT, 2019).

9.10 Quality of assessment

Assessments undertaken by ICCAT are conditional on several assumptions, including the estimates of historical shark catch, the relationship between catch rates and abundance, the initial state of the stock, as well as uncertainty in some life-history parameters.

9.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status. These reference points are relative metrics. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

9.12 Conservation considerations

The most recent IUCN Red List Assessment for shortfin mako is that it is Endangered (Rigby *et al.*, 2019).

In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Atlantic population of the shortfin mako as threatened (DFO, 2006).

In 2008, shortfin mako was listed in Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS).

In 2019 both shortfin mako and the related longfin mako *Isurus paucus,* were listed in Appendix II of CITES. In 2020 the CITES Scientific Review Group of the EU developed an EU-wide negative Non-Detriment Finding (NDF) for shortfin mako in the North Atlantic (https://species-plus.net/species#/taxon_concepts/98243/legal). This means that no permits will be given by any of the EU countries for international trade in wild caught individuals and those caught in waters outside national jurisdiction (‘introduction from the sea’).

9.13 Management considerations

Shortfin mako was one of the most common species in the global fin trade (Clarke *et al*. 2006) and is also a valued species for meat.

The life-history characteristics of shortfin mako confer a high risk of overexploitation (Cortés *et al*. 2010).

Longer-term catch data for pelagic sharks are considered unreliable, as many sharks are not reported on a species-specific basis, and some fisheries may have only landed fins. Data prior to 2000 should be considered as underestimates. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than more generic “*nei*” categories. The consolidation of three databases (ICCAT, FAO and EUROSTAT) by the ICCAT Secretariat should also strengthen the reliability of catch data in the future.

In 2021, ICCAT agreed a prohibition on landing shortfin mako in 2022 and 2023, and also agreed a process upon which future permissible retention shall be pursuant. Appropriate evaluation of this approach is required, including appraisal of the catch data (live and dead discards) on which the approach is predicated.

Levels of mercury (Hg) in the muscle of shortfin mako may exceed health guidelines (1.0 mg kg^{-1} wet weight), with Biton-Porsmoguer *et al.* (2018) reporting concentrations of 0.74 ± 0.56 mg kg^{-1} ww (range = 0.12–2.57) in the muscle of specimens from the northeastern Atlantic. Hg concentrations exceeding health guidelines were observed in 12 individuals over 150 cm total length and Biton-Porsmoguer *et al.* (2018) considered shortfin mako of 150–190 cm total length to be of ‘potential risk for consumers’, and 190 cm to be the size at risk.

9.14 References

Babcock, E., A. 2010. Updated index of abundance for shortfin mako sharks from the U.S. marine recreational fisheries statistics survey. ICCAT SCRS 2012/077.

Bishop, S. D. H., Francis, M. P., Duffy, C. and Montgomery, J. C. 2006. Age, growth, maturity, longevity, and natural mortality of the shortfin mako shark (*Isurus oxyrinchus*) in New Zealand waters. *Marine and Freshwater Research* 57: 143–154.

Biton-Porsmoguer, S., Bănaru, D., Boudouresque, C.F., Dekeyser, I., Bouchoucha, M., Marco-Miralles, F., Lebreton, B., Guillou, G. and Harmelin-Vivien, M. 2018. Mercury in blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*) from north-eastern Atlantic: Implication for fishery management. *Marine Pollution Bulletin*, 127: 131–138.

Braccini, M., Aires-da-Silva, A. and Taylor, I. 2016. Incorporating movement in the modelling of shark and ray populations dynamics: approaches and management implications. *Reviews in Fish Biology and Fisheries*, 26, 13–24.

Buencuerpo, V., Ríos, S. and Morón, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin* 96: 667–685.

Cailliet, G. M., Martin, L. K., Harvey, J. T., Kusher, D. and Weldon B. A. 1983. Preliminary studies on the age and growth of the blue shark, *Prionace glauca*, common thresher, *Alopias vulpinus*, and shortfin mako, *Isurus oxyrinchus*, from California waters. *In* Proceedings of the international workshop on age determination of oceanic pelagic fish: tunas, billfish, and sharks (E. D. Prince and L. M. Pulos, eds.), p. 179–188. US Dep. Commer., NOAA Tech. Rep. NMFS 8.

Campana, S. E., Joyce, W., Fowler, M. and Showell, M. 2016. Discards, hooking, and post-release mortality of porbeagle (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), and blue shark (*Prionace glauca*) in the Canadian pelagic longline fishery. *ICES Journal of Marine Science*, 73: 520–528.

Campana, S. E., Marks, L. and Joyce, W. 2004. Biology, fishery and stock status of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. Canadian Stock Assessment, Research Document 2004/094, Ottawa.

Campana, S. E., Marks, L, and Joyce, W. 2005. The biology and fishery of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. *Fisheries Research*, 73: 341–352.

Casey, J. G. and Kohler, N. E. 1992. Tagging studies on the shortfin mako shark (*Isurus oxyrinchus*) in the western North Atlantic. *Australian Journal of Marine and Freshwater Research*, 43: 45–60.

Castro, J. I., Woodley, C. M. and Brudek, R. L. 1999. A preliminary evaluation of the status of shark species. FAO Fisheries Technical Paper 380, Rome.

Clarke S. C., McAllister M. K., Milner-Gulland E. J., Kirkwood G. P., Michielsens C. G. J., Agnew D.J., Pikitch E.K., Nakano H. and Shivji M. S. 2006. Global estimates of shark catches using trade records from commercial markets. *Ecology Letters*, 9: 1115–1126.

Cliff, G., Dudley, S. F. J. and Davis, B. 1990. Sharks caught in the protective gillnets off Natal, South Africa. 3. The shortfin mako shark *Isurus oxyrinchus* (Rafinesque). *South African Journal of Marine Science*, 9: 115–126.

Compagno, L. J. V. 2001. An annotated and illustrated catalogue of shark species known to date. Volume 2 Bullhead, mackerel and carpet sharks (*Heterodontiformes*, *Lamniformes* and *Orectolobiformes*). *FAO Species Catalogue for Fishery Purposes*, 1(2): 109 pp.

Cortés, E. 1999. Standardized diet compositions and trophic levels of sharks. *ICES Journal of Marine Science*, 56: 707–717.

Cortés, E. 2000. Potential rates of increase and rates of increase per generation for three species of pelagic sharks from the Atlantic Ocean. Col. Vol. Sci. Pap. ICCAT, 51(6): 1822–1828.

Cortés, E., Arocha, F., Beerkircher, L., Carvalho, F., Domingo, A., Heupel, M., Holtzhausen, H., Santos, M.N., Ribera, M. and Simpfendorfer, C. 2010. Ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. *Aquatic Living Resources*, 23: 25–34.

DFO. 2006. Recovery Potential Assessment Report of Shortfin mako Sharks in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/051.

Di Natale A. and Pelusi P. 2000. Effetti della pesca col palangaro derivante sui grandi pelagici e sulle specie accessorie nel Mediterraneo Centrale. Rapporto al Ministero per le Politiche Agricole e Forestali, DGPA, Roma-IV Piano Triennale.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, 90: 653–722.

Francis, M. P. and Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus*, and *Prionace glauca*) from New Zealand. *Fishery Bulletin*, 103: 489–500.

García-Cortés, B. and Mejuto, J. 2002. Size–weight relationships of the swordfish (*Xiphias gladius*) and several pelagic shark species caught in the Spanish surface longline fishery in the Atlantic, Indian and Pacific Oceans. Coll. Vol. Sci. Pap. ICCAT, 54 (4): 1132–1149.

García-Cortés, B., Ramos-Cartelle, A., Mejuto-García, J., Carroceda, A. and Fernández-Costa, J. 2021. Biological Observations of Shortfin Mako Shark (*Isurus oxyrinchus*) on Spanish Surface Longline Fishery Targeting Swordfish. Collect. Vol. Sci. Pap. ICCAT, 78(4): 64–96.

Hareide, N. R., Carlson, J., Clarke, M., Clarke, S., Ellis, J., Fordham, S., Fowler, S., Pinho, M., Raymakers, C., Serena, F., Seret, B. and Polti, S. 2007. European Shark Fisheries: a preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association EEA 2007, 71 pp.

Heist, E. J., Musick, J. A. and Graves, J. E. 1996. Genetic population structure of the shortfin mako (*Isurus oxyrinchus*) inferred from restriction fragment length polymorphism analysis of mitochondrial DNA. *Canadian Journal of Fisheries and Aquatic Sciences*, 53:583–588.

Hueter, R. E. and Simpfendorfer, C. 2008. Case study: Trends in blue shark abundance in the western North Atlantic as determined by a fishery-independent survey. In: *Sharks of the Open Ocean*; M. D. Chami, E. K. Pikitch and E. Babcock (eds.) 236–241.

ICCAT. 2005. Report of the 2004 Intersessional Meeting of the ICCAT Subcommittee on Bycatches: shark stock assessment. Coll. Vol. Sci. Pap. ICCAT, 58(3): 799–890.

ICCAT. 2008. Report of the 2008 shark stock assessments meeting. Madrid, Spain, 1–5 September, 2008. SCRS/2008/017–SHK Assessment, 89 pp.

ICCAT. 2014. Inter-sessional meeting of the sharks species group. Piriapolis, Uruguay, March 10–14 2014; 72 pp. (www.iccat.int/Documents/Meetings/Docs/2014_SHK_INTER-SESS_REP.pdf).

ICCAT. 2015. Report of the Standing Committee on Research and Statistics (SCRS) Madrid Spain, 28 September – 2 October 2015. 351 pp. (http://www.iccat.int/en/meetings.asp)

ICCAT. 2016. Report of the 2016 intersessional meeting of the shark specialist group. Madeira Portugal. 25-29 April 2016. 27 pp. (http://www.iccat.org/en/meetingscurrent.htm)

ICCAT. 2017a. Report of the 2017 ICCAT Shortfin mako data preparation meeting. Madrid, Spain 28-31 March 2017.https://www.iccat.int/Documents/Meetings/Docs/2017_SMA_DATA_PREP_ENG.pdf

ICCAT. 2017b. Report of the 2017 ICCAT shortfin mako stock assessment meeting. Madrid, Spain. June 12–16, 2017. https://www.iccat.int/Documents/Meetings/Docs/2017_SMA_ASS_REP_ENG.pdf

ICCAT. 2018. Report of the Standing Committee on Research and Statistics (SCRS). Report for biennial period, 2016-17. Volume 2. https://www.iccat.int/Documents/BienRep/REP_EN_16-17_II-2.pdf

ICCAT. 2019. Report of the 2019 Shortfin mako shark stock assessment update meeting. Madrid, Spain 20-24 May 2019. https://www.iccat.int/Documents/Meetings/Docs/2019/REPORTS/2019_SMA_SA_ENG.pdf

ICCAT. 2020. Report of the Standing Committee on Research and Statistics (SCRS). Report for biennial period, 2018-19. Volume 2. https://www.iccat.int/Documents/BienRep/REP_EN_18-19_II-2.pdf.

ICCAT. 2021. Recommendation by ICCAT on the conservation of the North Atlantic stock of shortfin mako caught in association with ICCAT fisheries. https://www.iccat.int/Documents/Recs/compendiopdf-e/2021-09-e.pdf

ICCAT. 2022. Report of the 2022 ICCAT Intersessional Meeting of the Sharks Species Group. https://www.iccat.int/Documents/Meetings/Docs/2022/REPORTS/2022_SHK_ENG.pdf

Kohler, N. E., Casey, J.G. and Turner, P.A. 1995. Length–weight relationships for 13 species of sharks from the western North Atlantic. *Fishery Bulletin,* 93: 412–418.

Kohler, N. E., Turner, P. A., Hoey, J. J., Natanson, L. J. and Briggs, R. 2002. Tag and recapture data for three pelagic shark species: blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and porbeagle (*Lamna nasus*) in the North Atlantic Ocean. Col. Vol. Sci. Pap. ICCAT, 54 (4): 1231–1260.

Maia, A., Queiroz, N., Cabral, H. N., Santos, A. M. and Correia, J. P. 2007. Reproductive biology and population dynamics of the shortfin mako, *Isurus oxyrinchus* Rafinesque, 1810, off the southwest Portuguese coast, eastern North Atlantic. Journal of Applied Ichthyology, 23: 246–251.

Maia, A., Queiroz, N., Correia, J. P. and Cabral, H. 2006. *Food* habits of the shortfin mako, *Isurus oxyrinchus*, off the southwest coast of Portugal. *Environmental Biology of Fishes*, 77: 157–167.

Manday, D. G. 1975. Las pesquerias pelagico-oceanicas de corto radio de accíon en la regíon noroccidental de Cuba. Ser. Oceanol. Acad. Cienc. Cuba, 31: 1–26.

Megalofonou, P., Damalas, D. and Yannopoulos, C. 2005. Composition and abundance of pelagic shark bycatch in the eastern Mediterranean Sea. Cybium, 29(2), pp.135-140.

Mejuto, J. and Garcés, A. G. 1984. Shortfin mako, *Isurus oxyrinchus*, and porbeagle, *Lamna nasus*, associated with longline swordfish fishery in NW and N Spain. ICES CM 1984/G:72 Demersal Fish Committee.

Mollet, H. F., Cliff, G., Pratt, H. L. and Stevens, J. D. 2000. Reproductive biology of the female shortfin mako, *Isurus oxyrinchus*, Rafinesque, 1810, with comments on the embryonic development of lamnoids. *Fishery Bulletin*, 98: 299–318.

Natanson, L., Kohler, N.E., Ardizzone, D., Cailliet, G. M., Wintner, S. and Mollet, H. 2006. Validated age and growth estimates for the shortfin mako, *Isurus oxyrinchus*, in the North Atlantic Ocean. *Environmental Biology of Fishes*, 77: 367–383.

Natanson, L.J., Winton, M., Bowlby, H., Joyce, W., Deacy, B., Coelho, R. and Rosa, D. 2020. Updated reproductive parameters for the shortfin mako (*Isurus oxyrinchus*) in the North Atlantic Ocean with inferences of distribution by sex and reproductive stage. *Fishery Bulletin*, 118: 21–36.

Palma, C., Ortiz, M., de Bruyn, P., Kell L. and Pallares, P. 2012. Building a consolidated database to cross-check ICCAT Task-I nominal catch, against EUROSTAT and FAO equivalent statistics. *ICCAT SCRS 2012/078*.

Pratt, H. L. and Casey, J. G. 1983. Age and growth of the shortfin mako, *Isurus oxyrinchus*, using four methods. *Canadian Journal of Fisheries and Aquatic Sciences*, 40: 1944–1957.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. and Winker, H. 2019. *Isurus oxyrinchus*. The IUCN Red List of Threatened Species 2019: e.T39341A2903170. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T39341A2903170.en

Rogers, P.J., Huveneers, C., Page, B., Goldsworthy, S.D., Coyne, M., Lowther, A.D., Mitchell, J.G. and Seuront, L. 2015. Living on the continental shelf edge: habitat use of juvenile shortfin makos *Isurus oxyrinchus* in the Great Australian Bight, southern Australia. Fisheries Oceanography, 24, 205–218.

Saraiva, B.M., Macena, B.C., Solleliet-Ferreira, S., Afonso, P. and Fontes, J. 2023. First insights into the shortfin mako shark (*Isurus oxyrinchus*) fine-scale swimming behaviour. *Royal Society Open Science*, 10(5), p.230012.

Schrey, A., and Heist, E. J. 2002. Microsatellite markers for the shortfin mako and cross-species amplification in Lamniformes*. Conservation Genetics,* 3: 459–461.

Simpfendorfer, C. A., Hueter, R. E., Bergman, U. and Connett, S. M. H. 2002. Results of a fishery-independent survey for pelagic sharks in the western North Atlantic, 1977–1994. *Fisheries Research*, 55: 175–192.

Smith, S. E., Au, D. W. and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. *Marine and Freshwater Research,* 49: 663–78.

STECF. 2003. Report of the Subgroup on Resource Status (SGRST) of the Scientific, Technical and Economic Committee for Fisheries (STECF): Elasmobranch Fisheries. Brussels, 22–25 July 2003. Commission Staff Working Paper SEC (2003) 1427.

Stevens, J. D. 1983. Observations on reproduction in the shortfin mako *Isurus oxyrinchus*. *Copeia* 1983:126–130.

Stevens, J. D. 2008. The biology and ecology of the shortfin mako shark, *Isurus oxyrinchus*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M.D. Camhi, E.K. Pikitch and E.A. Babcock, Eds.). Blackwell Publishing, Oxford, UK, 87–94.

Stevens, J. D. and Wayte, S. E. 1999. A review of Australia's pelagic shark resources. FRDC Proj. Rep. 98/107, 64 p.

Stillwell, C. E. 1990. The ravenous mako. In: Discovering sharks. A volume honouring the work of Stewart Springer (S.H. Gruber, Ed.). Underw. Nat., Bull. American Litter. Soc., 19–20(4/1): 77–78.

Stillwell, C. E. and Kohler, N.E. 1982. Food, feeding habits, and estimates of daily ration of the shortfin mako (*Isurus oxyrinchus*) in the Northwest Atlantic. *Canadian Journal of Fisheries and Aquatic Sciences,* 39: 407–414.

Strasburg, D. W. 1958. Distribution, abundance, and habits of pelagic sharks in the Central Pacific Ocean. *Fisheries Bulletin* 138: 335–361.

Tudela, S., Kai Kai, A., Maynou, F., El Andalossi, M., and Guglielmi, P. 2005. Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). *Biological Conservation*, 121: 65–78.

Vaudo, J.J., Wetherbee, B.M., Wood, A.D., Weng, K., Howey-Jordan, L.A., Harvey, G.M. and Shivji, M.S. (2016) Vertical movements of shortfin mako sharks (*Isurus oxyrinchus*) in the western North Atlantic Ocean are strongly influenced by temperature. Marine Ecology Progress Series, 547, 163–175.

Wood, A. D., Collie, J. S. and Kohler, N. E. 2007, Estimating survival of the shortfin mako *Isurus oxyrinchus* (Rafinesque) in the north-west Atlantic from tag–recapture data. Journal of Fish Biology, 71: 1679–1695.

9.15 Tables and Figures

Table 9.1. Shortfin mako in the North Atlantic. Catch data (t) of shortfin mako (2000–2021) in the North Atlantic by billfish area as reported in ICCAT Task I catch data (version of 26/01/2023). Data include landings and dead discards. Estimated total catches from ICCAT (2022) also given.

Year	BIL91	BIL92	BIL93	BIL94A	BIL94B	BIL94C	Total	
							Task 1	ICCAT (2022)
2000	31	467	9	12	1290	785	2595	2587
2001	32	396	25	8	1580	637	2677	2677
2002	8	432	23	10	1887	1066	3426	3426
2003	19	158	28	14	2127	1642	3987	3987
2004	22	517	66	23	1928	1444	4000	4000
2005	26	767	30	29	1212	1631	3695	3695
2006	14	387	16	54	1714	1391	3574	3574
2007	20	399	20	35	2247	1436	4158	4158
2008	16	350	12	26	2099	1299	3802	3800
2009	21	405	47	67	2416	1586	4542	4541
2010	17	415	38	67	2762	1484	4783	4782
2011	26	424	28	49	1697	1498	3722	3720
2012	23	502	49	66	1908	1891	4440	4437
2013	17	369	14	150	2033	1021	3604	3603
2014	21	963	17	39	1336	1093	3469	3467
2015	8	622	12	44	1547	1049	3282	3281
2016	7	317	9	681	2041	303	3357	3356
2017	9	362	2	947	1593	206	3119	3119
2018	4	188	1	743	1175	282	2392	2373
2019	3	98	3	521	1058	203	1886	1882
2020	3	63	0	439	916	308	1729	1718
2021	4	58	0	440	688	242	1431	-

Table 9.2. Shortfin mako in the North Atlantic. Catch data (t) of shortfin mako (2000–2021) in the North Atlantic by country as reported in ICCAT Task I catch data (version of 26/01/2023). Data include landings and dead discards. Estimated total catches from ICCAT (2022) also given.

Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spain	1561	1684	2047	2068	2088	1751	1918	1814	1895	2216	2091
Portugal	318	378	415	1249	473	1109	951	1540	1033	1169	1432
Maroc				147	169	215	220	151	283	476	636
USA	422	350	372	106	477	422	353	325	306	334	352
Japan	138	105	438	267	572			82	131	98	116
Canada	78	69	78	73	80	91	71	72	43	53	41
Chinese Taipei	56	47	53	37	70	68	40	6	23	11	14
Venezuela	9	24	21	28	64	27	14	19	8.3	41	27
Belize										23	28
China PR	0.2							81	16	19	29
Senegal								7.6	17	21	
Panama	0.2						0.4	49	33	39	
Mexico	10	16		10	6.4	9.3	5.2	8.1	6.1	7.4	8.3
Korea Rep											
Trinidad and Tobago		0.8	2.0	3.0	1.5	2.1	1.0	1.1	1.3	1.2	1.1
France										15	1.7
United Kingdom	3.0	2.3	0.6	0.7	0.8	0.1	0.1	0.0	1.4	15	0.0
Costa Rica		0.1						0.2	1.4	1.3	1.0
St Pierre et Miquelon (FR)								1.4	2.0		3.8
Barbados											
Liberia											
St Vincent and Grenadines											
Bermuda (UK)							0.2	0.2	0.4	0.3	0.2
Mauritania											
Sta Lucia									0.3		0.3
Philippines									0.7		
Russia											
Curaçao											
El Salvador											
Guatemala											
Netherlands											
Total	2595	2677	3426	3987	4000	3695	3574	4158	3802	4542	4783
Total (ICCAT, 2022)	2587	2677	3426	3987	4000	3695	3574	4158	3800	4541	4782

Table 9.2 (continued). Shortfin mako in the North Atlantic. Catch data (t) of shortfin mako in the North Atlantic (2000–2021) by country as reported in ICCAT Task I catch data (version of 26/01/2023). Data include landings and dead discards. Estimated total catches from ICCAT (2022) also given.

Nation	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spain	1667	2308	1509	1481	1362	1574	1784	1165	866	870	837
Portugal	1045	1023	820	219	222	264	276	272	289	342	202
Maroc	420	406	667	624	947	1050	450	594	501	382	299
USA	341	389	368	972	580	277	306	166	58	51	42
Japan	53	56	33	69	45	74	89	20	33	28	14
Canada	37	29	35	55	85	83	109	55	64	20	22
Chinese Taipei	13	15	8	4.0	15	7.5	1.4	22	5.0	12	4
Venezuela	20	33	9.0	13	7.5	6.6	8.9	7.5	8.3	7.7	3
Belize	69	114	99	1.2	0.6	0.5	9	12	2.3		3
China PR	18	24	11	5	2	4	2		20	2.0	1
Senegal		2	0	2	2	2	68	68	26		
Panama			19	7			0				
Mexico	7.5	8.1	3.9	3.7	3.7	3.6	5.0	2.5	2.1	2.2	2
Korea Rep	27	27	15	8	3	1	3	5	4		
Trinidad and Tobago	0.5	2.2	1.0	0.8	0.6	0.8	1.6	2.3	1.2	1.2	0.9
France	0.4	0.1	0.2	0.6	1.4	2.1	1.1	0.7	1.7	0.1	1.5
United Kingdom	0.3	0.2	0.0	0.0					0.0	0.0	0.0
Costa Rica	2.3	2.3	1.4	1.7	0.8	1.0	0.5	0.5	0.2	0.4	
St Pierre et Miquelon (FR)	0.2		4.0	0.4				0.0			
Barbados					4.3	2.9	3.5				
Liberia										9.9	
St Vincent and Grenadines					1.7				3.3		
Bermuda (UK)	0.2	0.3	0.1	0.0	0.0	0.3	0.1	0.0	0.2	0.0	0.3
Mauritania						2.1					
Sta Lucia	0.7		0.6	0.0							
Philippines											
Russia							0.1	0.0	0.2		0.0
Curaçao							0.1				
El Salvador							0.1				
Guatemala							0.0				
Netherlands							0.0				
Total	3722	4440	3604	3469	3282	3357	3119	2392	1886	1729	1431
Total (ICCAT, 2022)	3720	4437	3603	3467	3281	3356	3119	2373	1882	1718	-

Table 9.3. Shortfin mako in the North Atlantic. Catch data (t) of shortfin mako from the adjacent Mediterranean Sea (2000–2021) by country as reported in ICCAT Task I catch data (version of 26/01/2023). Data include landings and dead discards. Estimated total catches from ICCAT (2022) also given.

Year	Portugal	Spain	Cyprus	Italy	Japan	France	Maroc	Total	Total (ICCAT, 2022)
2000	1.2	2.9						4.1	4
2001	5.3	1.8						7.1	7
2002		1.7						1.7	2
2003	0.2	2.1						2.2	2
2004		1.8						1.8	2
2005	14.9	1.7						16.7	17
2006	5.0	3.7	1.3					9.9	10
2007		0.8	1.5					2.2	2
2008		0.2	0.5		0.2			0.9	1
2009		0.2	0.3		0.0	0.1		0.6	1
2010	0.3	0.9	0.5					1.7	2
2011		1.6	0.9				0.0	2.4	2
2012		1.5					0.1	1.6	2
2013		0.0			0.0		0.0	0.0	0
2014		0.2			0.0		0.0	0.2	0
2015		0.2			0.0			0.2	0
2016								0.0	0
2017					0.0			0.0	0
2018				0.9	0.0			0.9	1
2019				0.0	0.0	0.0		0.0	0
2020					0.0	0.0		0.0	0
2021		0.7				0.0		0.7	

Table 9.4. Shortfin mako in the North Atlantic. ICCAT Task I catch data (version of 26/01/2023) that has been allocated as 'catch', 'landings' and 'dead discards', with the latter also given as a percentage of total catch.

Year	Catch	Dead discards		Landings	Total catch
	(t)	(t)	% total catch	(t)	(t)
2000	1803	8		784	2595
2001	2131			547	2677
2002	2708			718	3426
2003	3260			727	3987
2004	3109	0		892	4000
2005	2872			822	3695
2006	2426			1148	3574
2007	2705	7		1446	4158
2008	2868	10		924	3802
2009	3247	20		1275	4542
2010		2	0.04%	4781	4783
2011		9	0.24%	3713	3722
2012		19	0.44%	4420	4440
2013		5	0.14%	3599	3604
2014		12	0.33%	3457	3469
2015		10	0.32%	3271	3282
2016		8	0.23%	3349	3357
2017		5	0.17%	3114	3119
2018		26	1.07%	2367	2392
2019		57	3.03%	1829	1886
2020		66	3.79%	1664	1729
2021		881	61.56%	550	1431

Table 9.5. Shortfin mako in the North Atlantic. ICCAT Task I catch data (version of 26/01/2023) indicating the reported quantities landed (L) or discarded dead (DD) for the six main nations exploiting the North Atlantic stock for the years 2010–2021.

Nation	Category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Canada	DD				0		0	1	0	2	1	20	22
	L	41	37	29	35	55	85	82	109	53	63	1	0
	Total	41	37	29	35	55	85	83	109	55	64	20	22
Spain	DD								0				837
	L	2091	1667	2308	1509	1481	1362	1574	1784	1165	866	870	0
	Total	2091	1667	2308	1509	1481	1362	1574	1784	1165	866	870	837
Portugal	DD											1	
	L	1432	1045	1023	820	219	222	264	276	272	289	342	202
	Total	1432	1045	1023	820	219	222	264	276	272	289	342	202
Japan	DD					0	0				30	28	14
	L	116	53	56	33	69	45	74	89	20	4	0	0
	Total	116	53	56	33	69	45	74	89	20	33	28	14
Maroc	DD					0		0	0	0		0	0
	L	636	420	406	667	624	947	1050	450	594	501	382	299
	Total	636	420	406	667	624	947	1050	450	594	501	382	299
USA	DD	2	9	18	5	11	8	6	4	2	1	3	3
	L	350	332	371	363	961	572	271	302	165	57	48	39
	Total	352	341	389	368	972	580	277	306	166	58	51	42
Other	DD		0	1	0	0	2	1	1	22	26	14	5
	L	114	159	228	173	48	39	34	104	98	49	21	10
	Total	114	159	229	173	49	41	34	104	120	75	35	16
Total	Catch	4783	3722	4440	3604	3469	3282	3357	3119	2392	1886	1729	1431

Table 9.6. Shortfin mako in the North Atlantic. Length–weight relationships for *Isurus oxyrinchus* (sexes combined) from different populations. Lengths in cm, and weights in kg unless specified in equation. W_R = round weight; W_D = dressed weight.

Stock	L (cm) W (kg) relationship	n	Length range (cm)	Source
Central Pacific	log W (lb) = –4.608 + 2.925 x log L_T			Strasburg, 1958
Cuba	W = 1.193 x 10–6 x L_T 3.46	23	160–260 (L_T)	Manday, 1975
Australia	W = 4.832 x 10–6 x L_T 3.10	80	58–343 (L_T)	Stevens, 1983
South Africa	W = 1.47 x 10–5 x L_{PC} 2.98	143	84–260 (L_{PC})	Cliff *et al.*, 1990
NW Atlantic	W_R = (5.2432 x 10–6) L_F 3.1407	2081	65–338 (L_F)	Kohler *et al.*, 1995.
NW Atlantic	W = 7.2999 x L_T (m) 3.224	63	2.0–3.7 m (L_T)	Mollet *et al.*, 2000
Southern hemisphere	W = 6.824 x L_T (m) 3.137	64	2.0–3.4 m (L_T)	Mollet *et al.*, 2000
NE Atlantic	W_D = (2.80834 x 10–6) L_F 3.20182	17	70–175 (L_F)	García-Cortés and Mejuto, 2002
Tropical east Atlantic	W_D = (1.22182 x 10–5) L_F 2.89535	166	95–250	García-Cortés and Mejuto, 2002
Tropical central Atlantic	W_D = (2.52098 x 10–5) L_F 2.76078	161	120–185	García-Cortés and Mejuto, 2002

Stock	L (cm) W (kg) relationship	n	Length range (cm)	Source
Southwest Atlantic	W_D = (3.1142 x 10–5) L_F 2.7243	97	95–240	García-Cortés and Mejuto, 2002

Table 9.7. Shortfin mako in the North Atlantic. Length–length relationships for male, female and sexes combined from the NE Atlantic and Straits of Gibraltar (L_S = standard length; L_F = fork length; L_T = total length; L_{UC} = upper caudal lobe length). Source: Buencuerpo *et al.* (1998).

Females	Males	Combined
L_F = 1.086 L_S + 1.630 (n=852)	L_F = 1.086 L_S + 1.409 (n=911)	L_F = 1.086 L_S + 1.515 (n=1763)
L_T = 0.817 L_S + 0.400 (n=852)	L_T = 1.209 L_S + 0.435 (n=681)	L_T = 1.207 L_S + 0.971 (n=1533)
L_{UC} = 3.693 L_S + 13.094 (n=507)	L_{UC} = 3.795 L_S + 10.452 (n=477)	L_{UC} = 3.758 L_S + 11.640 (n=1054)
L_T = 1.106 L_F + 0.052 (n=853)	L_T = 1.111 L_F – 0.870 (n=911)	L_T = 1.108 L_F – 0.480 (n=1746)

Table 9.8. Shortfin mako in the North Atlantic. Published growth parameters, assuming two vertebral bands formed annually. Data give von Bertalanffy growth parameters (Gompertz growth function) used, t_0 in cm. L_∞ in cm (Fork Length), k in years^{-1}.**

Area	L∞	k	t_0	L_0^*	Sex	Study
Northwest Atlantic	302	0.266	–1	-	Male	Pratt and Casey, 1983
Northwest Atlantic	345	0.203	–1	-	Female	Pratt and Casey, 1983
Atlantic	373.4	–0.203	1.0		Female	Cortés, 2000
Northwest Atlantic	253	0.125	-	71.6	Male	Natanson *et al*., 2006**
Northwest Atlantic	366	0.087	-	88.4	Female	Natanson *et al*., 2006**

***: size-at-birth**

Table 9.9. Shortfin mako in the North Atlantic. Life-history information available from the scientific literature.

Parameter	Values	Sample Size	Area	Reference
Reproduction	Ovoviviparous with oophagy			Campana *et al*., 2004
Litter size	4–25	35	Worldwide	Mollet *et al*., 2000
	12–20			Castro *et al*., 1999
Size at birth (L_T)	70 cm	188+	Worldwide	Mollet *et al*., 2000
Sex ratio (males: females)	1:1	2188	NW Atlantic	Casey and Kohler, 1992
	1:0.4		NE Atlantic (Spain, Azores)	Mejuto and Garces, 1984
	1:0.9		NE, N central Atlantic and Med	Buencuerpo *et al*., 1998
	1.0:1.4	17	NE Atlantic	García-Cortés and Mejuto, 2002
Gestation period	15–18	26	Worldwide	Mollet *et al*., 2000
Male age-at-first maturity (years)*	2.5			Pratt and Casey, 1983
	9			Cailliet *et al*., 1983

Parameter	Values	Sample Size	Area	Reference
Male age-at-median maturity (years)	7	145	New Zealand	Bishop *et al.*, 2006
Female age-at-first maturity (years)*	5			Pratt and Casey, 1983
Female age maturity (years)	19	111	New Zealand	Bishop *et al.*, 2006
	7			Pratt and Casey, 1983
Male length-at-first maturity (T_L)	195 cm			Stevens, 1983
Male length-at-maturity (T_L)	197–202 cm (median)	215	New Zealand	Francis and Duffy, 2005
	180 cm (L_F)		NE Atlantic (Portugal)	Maia *et al.*, 2007
	200–220		Worldwide	Pratt and Casey, 1983; Mollet *et al.*, 2000
Female length-at-first maturity (T_L)	265–280 cm			Cliff *et al.*, 1990
Female length-at-maturity (T_L)	301–312 (median)	88	New Zealand	Francis and Duffy, 2005
	270–300 cm (L_T)		Worldwide	Pratt and Casey, 1983; Mollet *et al.*, 2000
Age-at-recruitment (year)	0–1			Stevens and Wayte, 1999
Male maximum length (L_T)	296 cm			Compagno, 2001
Female maximum length (L_T)	396 cm 408 cm (estimated)			Compagno, 2001
Lifespan (years)	11.5–17 (oldest aged)			Pratt and Casey, 1983
	45 (estimated longevity)			Cailliet *et al.*, 1983
Natural mortality (M)	0.16		Pacific	Smith *et al.*, 1998
Annual survival estimate	0.79 (95% C.I. 0.71–0.87)			Wood *et al.* 2007
Growth parameters	61.1 cm year–1 first year 40.6 cm year–1 second year 5.0 cm month–1 in summer 2.1 cm month–1 in winter	262	NE Atlantic (Portugal)	Maia *et al.*, 2007
Maximum age (estimated from von Bertalanffy growth eqn.)	28			Smith *et al.*, 1998
Productivity (R2m) estimate: intrinsic rebound	0.051 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Potential rate of increase per year	8.5%		Atlantic	Cortés, 2000
Population doubling time T_D (years)	13.6 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Generation time (years)	~ 9		Atlantic	Cortés, 2000
Trophic level	4.3	7		Cortés, 1999

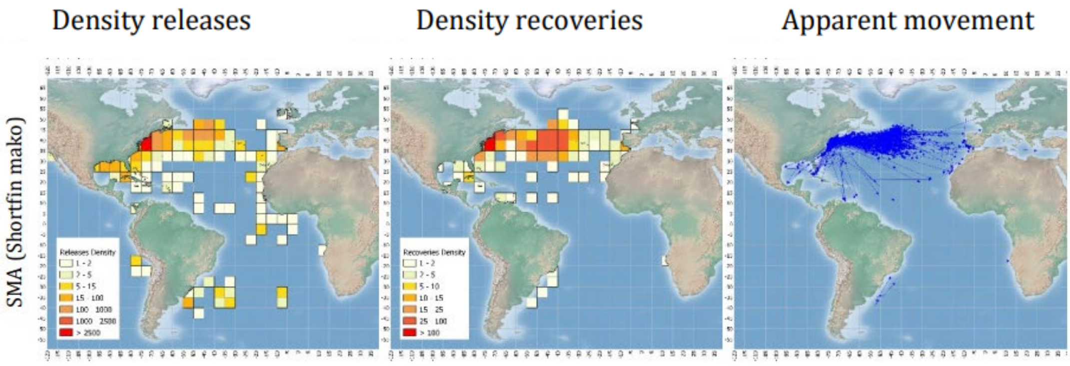


Figure 9.1. Shortfin mako in the North Atlantic. Tag and release distributions for shortfin mako in the Atlantic Ocean showing (a) density of releases in a 5x5 grid, (b) density of recoveries in a 5x5 grid, and (c) the apparent movement (straight line from the release to the recovery locations. Recaptures were 13.4%. Source: ICCAT (2022).

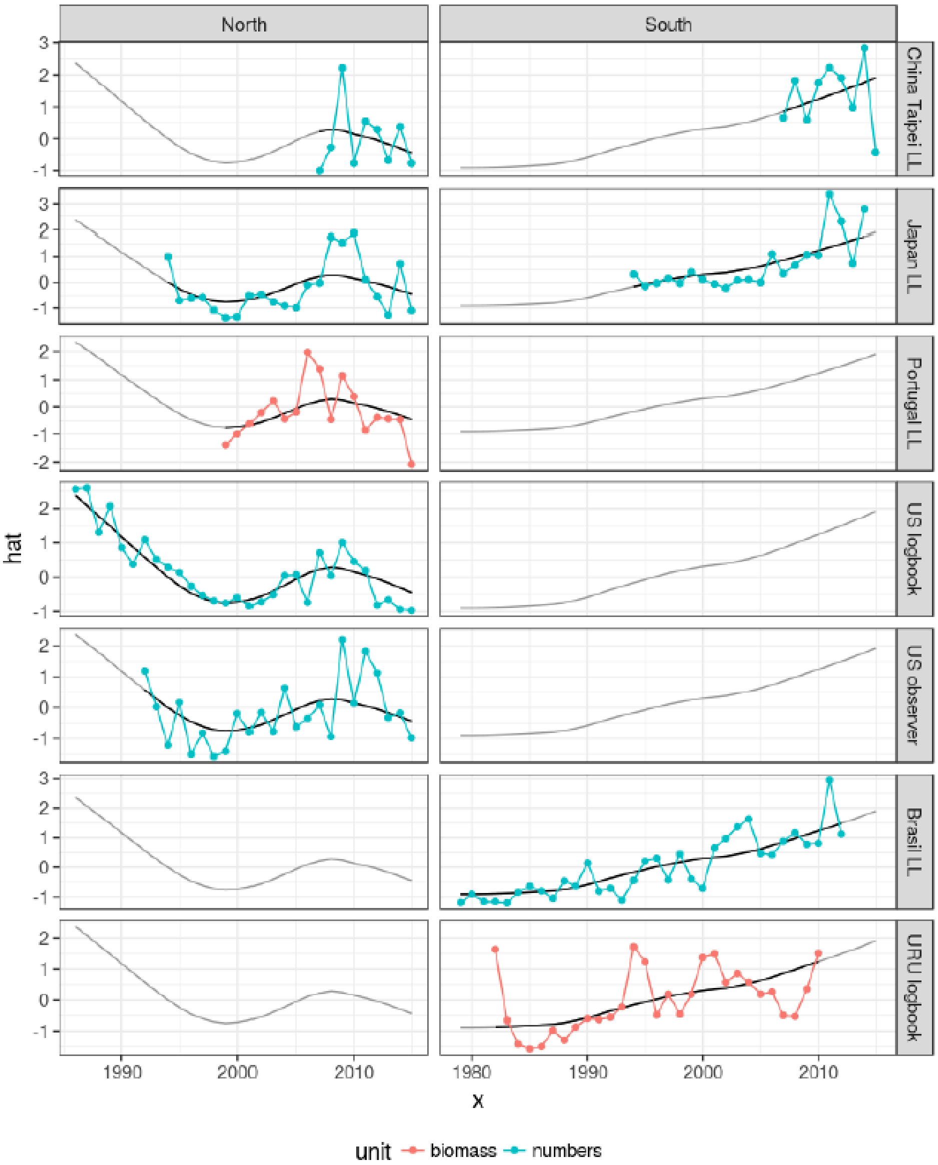


Figure 9.2. Shortfin mako in the North Atlantic. Time-series of agreed CPUE indices for the North Atlantic (left panel) and South Atlantic (right panel), points are the standardised values, continuous black lines are a loess smoother showing the average trend by area (i.e. fitted to year for each area with series as a factor). X-axis is time, Y-axis are the scaled indices. Source: ICCAT.

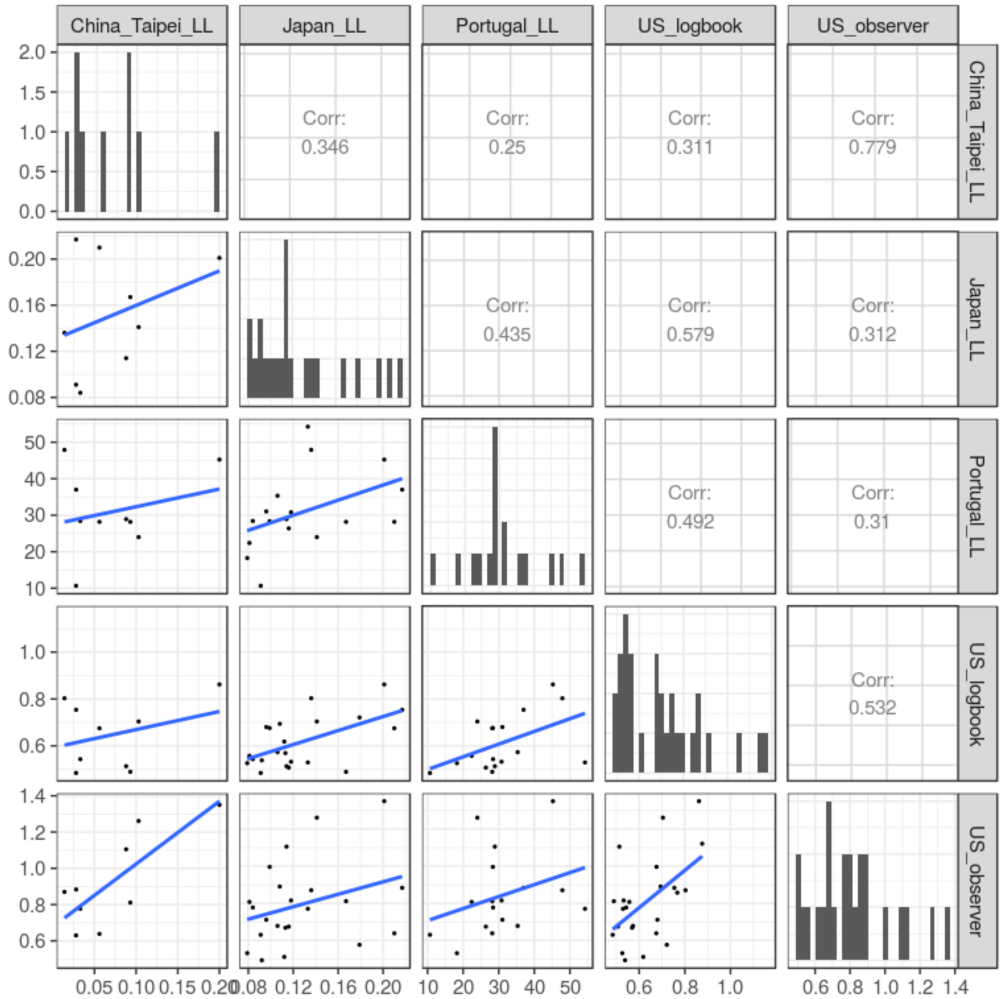


Figure 9.3. Shortfin mako in the North Atlantic. Pairwise scatter plots for agreed indices used for the North Atlantic stock of shortfin mako. X- and Y-axis are scaled indices. Source: ICCAT.

Contents

10 Tope in the Northeast Atlantic

10.1 Stock distribution

WGEF considers there to be a single stock of tope (or school shark) *Galeorhinus galeus* in the ICES area. This stock is distributed from Scotland and southern Norway southwards to the coast of Northwest Africa and the Mediterranean Sea. The stock area covers ICES subareas 2–10 (where subareas 4 and 6–10 are important parts of the stock range, and subareas 2, 3 and 5 areas where tope tend to be an occasional vagrant). The stock extends into the northern part of the CECAF area and the Mediterranean Sea (Subareas I–III). The information used to identify the stock unit is summarized in the stock annex (ICES, 2009).

10.2 The fishery

10.2.1 History of the fishery

Currently there are no targeted commercial fisheries for tope in the NE Atlantic. Tope is discarded in some fisheries but landed as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic static gears.

Tope is also an important target species for recreational sea angling in several areas, with anglers, angling clubs and charter boats often having catch and release protocols.

The impact of the COVID-19 pandemic on fishing activity remains unquantified, however, it is assumed based on national and/or local restrictions to have resulted in reduced fishing effort in 2020 and 2021.

10.2.2 The fishery in 2023

No changes to the fishery were observed in 2023.

10.2.3 ICES Advice applicable

ICES provided advice for this stock for the first time in 2012, stating "*Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 20%. Because the data for catches of tope are not fully documented and considered unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result. Measures to identify pupping areas should be taken*".

In 2023, ICES advised that "*when the precautionary approach is applied, landings should be no more than 241 tonnes in each of the years 2024–2027. ICES cannot quantify the corresponding catches*". This advice has moved to quadrennial advice until more catch and survey data are made available to ICES.

10.2.4 Management applicable

In 2015, EC regulations for fishing opportunities first prohibited EU vessels from fishing for, retaining on board, transhipping or landing tope when captured on longlines in European Union waters of ICES Division 2.a and Subarea 4 and in Union and international waters of ICES subareas 1, 5–8, 12 and 14 (Council Regulation (EU) 2015/104). These prohibitions on longline-caught tope continue to apply in UK waters.

The UK's Department for Environment, Food and Rural Affairs (DEFRA) introduced a Statutory Instrument in 2008 (SI Number 2008/691, "The Tope (Prohibition of Fishing) Order") that banned fishing for tope other than by rod and line (with anglers fishing using rod and line from boats not allowed to land their catch) and established a tope bycatch limit of 45 kg per day in commercial fisheries. In Scotland, vessels are prohibited from fishing for tope other than by rod and line or hand-line, trans-shipment of tope caught by rod and line or hand-line (wherever caught), and landing tope (wherever caught) as per Statutory Instrument in 2012 (SI Number 2012/63, "The Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order 2012").

10.3 Catch data

10.3.1 Landings

No accurate estimates of historical catch are available, as many nations that land tope report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). In other cases, misidentification/misreporting of other species as tope may have taken place.

Reported species-specific landings, which commenced in 1978 for French fisheries, are given in Table 10.1, based on data collated by WGEF up to and including 2004. Prior to, and at WGEF 2016, landings from 2005–2015 were reassessed, and where possible, erroneous or generic species categories or figures were reassigned following WKSHARK2 (ICES, 2016a).

Recent estimated landings data from 2005–2022 for tope are shown by fishing area (Table 10.2) and by nation (Table 10.3), following the procedure from WKSHARK2. Overall, landings data appear relatively stable in recent years, with a decrease observed in 2019 and 2020 (Figure 10.1; Table 10.2; Table 10.3). The 2020 estimated landings were the lowest observed in the last decade, however, these should be viewed with care as the COVID-19 pandemic may have contributed to a reduction on fishing activity and thus on reported landings. Since 2021, estimated landings are at similar levels as those observed in 2016–2018. Despite the current management restrictions applicable using hooks and lines in Subareas 7 and 8, landings of this fleet in these Subareas accounted for 53% in 2022, with the remaining 47% from Subareas 9 and 10 where no current restrictions are in place on this fleet.

France is one of the main nations landing tope, accounting for 77% during 2019–2022 and 76% in 2023, with the English Channel and Celtic Seas remaining important fishing grounds. UK fisheries also land tope, although species-specific data are lacking for the earlier years, and reported landings have declined since precautionary management measures (trip limits of no more than 45 kg per day) were introduced.

Since 2001, Ireland, Portugal and Spain have also declared species-specific landings. However, it is believed that some of the Portuguese landings recorded as tope may also include unknown proportions of other sharks, including smooth-hounds and deep-water sharks. Portuguese tope landings for 2017 were examined by IPMA scientists and have been corrected in 2019, which explains values for this year to be less than declared previously. The main Portuguese landings of tope are recorded from areas around the Azores. Landings for the Azores in 2021–2022 are estimates and not officially reported data.

The introduction of management restrictions in 2015 applicable to Subarea 7 and 8 (see Section 10.2.4) may have, alongside with unavailable data from FAO areas 34 and 37, contributed to the decrease in 2015–2023 landings reported by Spain (Table 10.3).

Limited species-specific catch data for the Mediterranean Sea and off northwest Africa are available. The degree of possible misreporting or underreporting is not known.

10.3.2 Discards

Though some discard information is available from various nations, data are limited for most nations and fisheries.

Data analysis from the UK (E&W) observer programme (Silva and Ellis, 2019) suggested that the introduction of the Tope (Prohibition of Fishing) Order 2008, may have influenced the discard-retention patterns (Figure 10.2). This change was more evident on tope caught in drift and static gillnet fisheries where the proportion of discards increased from 11% (2002–2007) to 67% (2008–2016). No apparent change was observed by otter trawlers, with similar levels for both time periods (ca. 77%).

The small number of tope recorded in some discard observer programmes may be an artefact of limited coverage on those vessels that may encounter them, and the occasional and seasonal occurrence of tope in some areas. Sporadic records of tope in observer data indicate that appropriate methods of raising such discard data to fleet need to be evaluated if catch advice is to be developed.

In 2017, ICES held a workshop (WKSHARK3) to compile and refine catch and landings of elasmobranchs (ICES, 2017). National data were examined for UK (England), Ireland, France and Spain (Basque country) for two main gear categories: otter trawl and gillnet.

Discard data were also provided as part of the 2017–2023 Data Call. However, data available were insufficient to draw a more comprehensive interpretation of any discard/retention patterns.

10.3.3 Quality of catch data

Catch data are of poor quality, and biological data are not collected under the Data Collection Regulations. Some generic biological data are available (see Section 10.7).

10.3.4 Discard Survival

Ellis *et al.* (2014 WD; 2017) provided references for discard survival of shark species worldwide. Discard survival of members of the Triakidae family appears to be quite variable. Whilst quantitative data are limited in European waters, Fennessy (1994) reported at-vessel mortality (AVM) of 29% for Arabian smooth-hound *Mustelus mosis* taken in a prawn trawl fishery. AVM ranged from 57–93% for three triakid sharks taken in an Australian gillnet fishery, despite the soak times being < 24 hours (Braccini *et al*., 2012). Lower AVM of triakids has been reported in longline fisheries (Frick *et al*., 2010; Coelho *et al*., 2012). Investigations on post-release survival of mature and lively tope caught with automatic demersal longlines in the Great Australian Bight showed a high resilience to capture, precautious handling and release (Rogers *et al*., 2017).

10.4 Commercial catch composition

Tope is one of the main elasmobranch species caught by the Azorean bottom longline fleet (Morato *et al*., 2003) and was reported in 29% of the trips, representing up to 2% of the total catch landed along the studied period (Figure 10.3) (Santos *et al.* 2018 WD).

10.5 Commercial catch and effort data

Standardized CPUE series for tope from the Azorean bottom longline fleet (1990–2017) are shown in Figure 10.4 (see Table.10.4 in ICES, 2020; Santos *et al.* 2020 WD), with data no longer available from 2018 onwards. The trends from the nominal and standardized index differed substantially; indeed, the nominal CPUE oscillated over time, with peaks in 1999, 2000 and 2017; while the standardized index gave a more stable trend since 1994. According to Ortiz (2017), it is not necessary that the nominal and standardized trends follow the same trend.

10.6 Fishery-independent information

10.6.1 Availability of survey data

Although several fishery-independent surveys operate in the stock area, data are limited for most of these. Analyses of catch data need to be undertaken with care, as tope is a relatively large-bodied species (up to 200 cm L_T in the NE Atlantic), and adults are strong swimmers that forage both in pelagic and demersal waters. Tope are not sampled effectively in beam trawl surveys because of low gear selectivity. They are caught occasionally in GOV trawl and other (high-headline) otter trawl surveys in the North Sea and westerly waters, though survey data generally include a large number of zero hauls.

The discontinued UK (England and Wales) Q4 IBTS survey in the Celtic Seas ecoregion recorded small numbers of tope, which were tagged and released where possible (ICES, 2008). UK surveys in this area generally caught larger tope at the southern entrance to St George's Channel, and in 2011 several juveniles were caught in the Irish Sea.

Southern and western IBTS surveys may cover a large part of the stock range, and more detailed and updated analyses of these data are required.

The western waters beam-trawl survey in the English Channel and Celtic Sea did not catch any tope (Silva *et al*., 2020 WD) which is known to occur in the area. However, tope occurs higher up in the water column and is rarely captured by beam trawls.

Data from the Azorean demersal spring bottom longline survey (ARDAÇO[1]) were examined by Santos *et al.* (2020), where tope was frequently observed during 1995–2018.

10.6.2 Trends in survey abundance

Data for five trawl surveys were examined by WGEF, as summarised below.

NS-IBTS-Q1: Data for the IBTS-Q1 in the North Sea showed a low abundance (and biomass) across countries over the time-series examined (1992–2022), with this survey excluded from further analysis.

NS-IBTS-Q3: The mean CPUE (numbers and biomass) were calculated for the IBTS-Q3 in the North Sea IBTS for the years 1992–2022, with updated estimates provided in 2023 for the whole times series. During this period, there were large differences in abundance and biomass in earlier years compared to recent years (Figure 10.5). The frequency of occurrence for the years 1992–2016 has increased since 2002 (Figure 10.6 in ICES, 2022), but such investigations are needed for the more recent years.

---

[1] This survey may also be referred to as 'ARQDAÇO(P)-Q1' in other ICES-related documents.

More detailed investigations of NS-IBTS-Q3 data on DATRAS were undertaken by WGEF in 2023 in terms of the length and spatial distribution by nations (Figure 10.6 and 10.7). Length-frequency distributions indicate that data for *Galeorhinus galeus* and *Mustelus* spp. may have been confounded, with this most evident for Danish survey data (See Section 21.6). It is likely that some tope have been attributed to *Mustelus* in some years, and so until further analyses of these data are undertaken, the temporal trends in catch rates shown in Figure 10.5 exclude Danish data to be consistent with the approach applied for smooth-hounds (see Section 21.9). These values may also differ due to changes in the DATRAS product, which are mostly related to previously allocated data to Sweden now reallocated to Denmark. Further analyses on the quality of these data are required.

Furthermore, WGEF note that the apparent 'peak' in tope in 1992 in driven by a single large catch at one station (*RV* "Thalassa" in 35F1, haul number 15 with CPUE of 182 ind/hr). Further examination of these data are required.

IE-IGFS-WIBTS-Q4: Abundance and biomass estimates were calculated for all individuals for the time series 2005–2022 (Figure 10.8) and shows an increasing trend from 2012, with a slight decrease in 2017 and 2018, a sharp increase in 2020, followed by a decrease since 2021. This survey usually catches small numbers of tope, although one haul (40E2, Division 6.a) in 2006 yielded 59 specimens (Figure 10.8). The peak in 2020 relates to larger specimens (>80 cm total length) being caught in one single haul (33E3, 16 min tow, Division 7.a). Most tope caught are now tagged and released. Survey indices for the whole time series were updated in 2019 and, values may differ from the previous survey indices as values were scaled to the survey area rather than the ecoregion. No further updates have been conducted, with more recent estimates following the same methodology.

EVHOE-WIBTS-Q4: Swept area biomass estimates were calculated for total and exploitable biomass (individuals ≥50 cm total length) for the time series 1997–2022 (Figure 10.9) and fluctuate without trend. Abundance estimates were calculated for individuals <50 cm total length (Figure 10.9), which show that this GOV survey catches mostly larger specimens. Estimates were calculated using DATRAS data and were updated in 2023 for the whole time-series. This survey did not occur in 2017.

The spatial distribution across the time-series (1997–2014) (Figure 10.4 in ICES, 2016b), showed similar locations reported during UK surveys, with the majority of individuals found at the entrance to St George's Channel and outer Bristol Channel.

ARDAÇO**:** Additional information on the Azorean demersal spring bottom longline survey ARDAÇO on the relative abundance index for 1995–2018 is shown in Figure 10.10 (Santos *et al.*, 2020). Biomass estimates (kg per 1000 hooks) by area are shown in Figure 10.11, with additional estimates for 2019 and 2021. However, estimates for 2021 should be viewed with caution as there was a reduction in survey spatial coverage compared to previous years. A crew strike in 2022 resulted in the cancellation of the survey. Abundance (and biomass) are highly variable over time, with no consistent trend. This may relate to the gear used being of low catchability and to the survey sampling design.

Summary: WGEF consider that any trend analysis should be viewed with care, due to the low catchability in fishery-independent surveys. Given the low and variable catch rates, WGEF do not consider that catch rates are wholly appropriate for quantitative advice on stock status. The proportion of stations at which tope are captured may be an alternative metric for consideration and could be further investigated for more surveys covering the stock area.

10.6.3 Length distributions

In 2009, data were presented on length distributions found in the Celtic Seas ecoregion during fisheries-independent surveys conducted by England and Ireland in Q4 (Figure 10.7 in ICES, 2016b). Irish surveys recorded 145 tope (2003–2009), of which 110 (76%) were male. English surveys recorded 90 tope (56 (62%) males and 34 (38%) females). These specimens were 40–163 cm L_T. The length–frequency distributions found between the surveys were noticeably different, with more large males found in the Irish survey; 75% of the males were greater than 130 cm. The English surveys had a more evenly distributed length range.

Length distributions of tope caught in various UK surveys in 2004–2009 were analysed in 2016 (see Figure 10.8 in ICES 2016b). In the beam trawl survey (Figure 10.8a in ICES, 2016b), two peaks were observed, at 30–54 cm L_T and 70–84 cm L_T respectively. In the North Sea survey (Figure 10.8b in ICES, 2016b) a wide range (30–164 cm L_T) was observed, with a main peak at 30–44 cm L_T. Wide ranges were also observed in the Celtic Sea survey (44–164 cm L_T; Figure 10.8c in ICES, 2016b) and in the western IBTS survey (70–120 cm L_T; Figure 10.8d in ICES, 2016b).

In the Azorean demersal spring bottom longline survey ARDAÇO, records also show a wide length range of 25–185 cm L_T, with fish caught at depths up 650 m during 1995–2018. Smaller fish were caught in higher numbers in shallow waters, with an increase in length range observed in deeper waters while decreasing in abundance (Figure 10.12, Santos *et al.*, 2020).

10.6.3.1 Recreational length distributions

During 2009–2013, a Scottish recreational fishery in the Mull of Galloway recorded sex, length and weight of captured tope. While the number of tope tagged has declined, the number of mature fish of both sexes appears to have disproportionally declined (see Figure 10.11 in ICES, 2020). This area is thought to be a breeding ground for tope (James Thorburn, pers. Comm., 2014), so the lack of mature animals is a cause for concern.

10.6.4 Tagging information

A total of 159 tope were tagged and released by CEFAS over the period 1961–2013, predominately in the Irish Sea and Celtic Sea (Figure 10.10 in ICES 2016b; Burt *et al.*, 2013). Fish were also tagged in the western English Channel and North Sea but in lower numbers (n = 9). Tope were tagged over a wide length range (41–162 cm L_T), the majority being males, with a male to female sex ratio of 1.5:1. A total of four tope were recaptured, and were, on average, at liberty for 1195 days, with a maximum recorded time at liberty of 2403 days. Over the period individual fish had travelled relatively large distances (112–368 km), and all had moved from one ICES division to another. For example, the fish that was at liberty the longest was released in Cardigan Bay (Division 7.a) in November 2003, was later captured in June 2010 just to the east of the Isle of Wight. It is also noted that a tag from a tope was returned to CEFAS from southern Spain, and although release information could not be located, it is thought it may have been tagged in the 1970s.

Mark and recapture data from three tagging programmes around the UK (Scottish Shark Tagging Program, the Glasgow Museum Tagging Program, the UK Shark Tagging Program) are available. From 2,043 tagged tope, 138 recapture records were analysed. Connectivity between UK waters and the Azores, the Canary Islands and the Mediterranean where shown (Thorburn *et al.*, 2019). Site fidelity and annual migrations were also suggested due to the closeness of tope recaptures to tagging sites throughout the year; however, seasonal patterns of movement are thought to be confounded by partial migration behaviour in the species (Thorburn *et al.*, 2019). Only mature individuals were found off the shelf and there is a relationship between maximum distance of recapture and body size in females with larger individuals undertaking the biggest movements into southerly regions, these are assumed to be in relation to parturition. There was no relationship between maximum distance and body size in males (Thorburn *et al.*, 2019). Electronic tag data from four tope from Scotland showed extensive summer use of shelf waters, but a movement into oceanic waters over winter months with tope diving to 826 m. PSAT tag track reconstruction showed a male tope moving from Scottish waters, around the North and west of Ireland to Porcupine Seabight (Thorburn *et al.*, 2019).

The Irish Marine Sportfish Tagging Programme has tagged tope off the Irish coast since 1970. Four fish have been recaptured in the Mediterranean Sea (Inland Fisheries Ireland, pers comm. 2013; Fitzmaurice, 1994; cf. nicematin.com, 29 May 2013, "Le long périple d'un requin hâ, de l'Irlande à la Corse). A tope tagged on 30 July 2001 off Greystones (Ireland) as part of this programme, was caught on 9 May 2013 off Bastia, Corsica (Mediterranean Sea), showing a movement of 3900 km in twelve years. One tope tagged off Ireland was recaptured in May 2018, again off the west of Ireland, after 9046 days.

An ongoing tagging project of the German Thünen-Institute of Sea Fisheries (HTTP – Helgoland Tope Tagging Project) has been tagging tope in the southern North Sea (German Bight) around Helgoland Island during annual aggregations of mostly adult sharks in the summer months. As of June 2024, 22 tope (18 females, four males, length range 103–164 cm L_T) have been tagged with Wildlifecomputers MiniPAT pop-up satellite archival tags and conventional tags. Preliminary results showed overwintering of the tope in the western English Channel and partial migration of both female and male specimens into oceanic habitats of the Northeast Atlantic, including long-distance, southward migrations of the female sharks towards the western part of the Strait of Gibraltar and as far south as Madeira. Tope that migrated into oceanic areas exhibited extensive diel vertical migratory behaviour, with a clear association with mesopelagic habitat features (deep scattering layers). The sharks followed the diel vertical migration of mesopelagic organisms staying at depths of around 500 m during daytime and ascending to surface layers during night-time, while remaining in layers with highest densities of cephalopod prey (Schaber *et al.*, 2022).

Long-distance migrations of tope from the Northeast Atlantic to the Mediterranean Sea have also been reported by Colloca *et al*. (2019), with two females tagged and released in the Irish Sea being recaptured by Sicilian artisanal fishers using trammel nets. One tope tagged off Luce Bay (West Scotland) in June 2009 was recaptured at a depth of 35 m off Talbot Bank (south-west coast of Sicily) in November 2014, after 1967 days. The second female tope at 153 cm total length tagged off Carlingford Bay (East Ireland) in June 2015, was recaptured at ca. 30 cm depth off Selinunte harbour (South Sicily) in April 2017, after 648 days.

10.7 Life-history information

Much biological information is available for tope in European seas and elsewhere in the world, which are summarized in the stock annex (ICES, 2009).

Genetic studies on five geographically isolated populations (Africa, Australia, North America, South America, Western Europe) showed that there is little to no gene flow between these populations, indicating a lack of population connectivity and mixing (Chabot and Allen, 2009; Chabot, 2015). A Northeast Atlantic and Mediterranean genetic study showed gene flow throughout the region but did observe unique haplotypes in some areas, with outlying genotypes observed in the Mediterranean (Thorburn, in prep). Further genetic assessment is recommended to explore connectivity with the Mediterranean.

The following relationships and ratios were calculated by Séret and Blaison (2010):

$L_T = 0.0119\ W^{2.7745}$ (n = 10; length range of 60–140 cm L_T; weight in g);

Live weight / eviscerated weight = 1.28 (s.d. 0.05);
Live weight / dressed weight (eviscerated, headed, skinned) = 2.81 (s.d. 0.13);
Smallest mature male = 110 cm L_T, smallest mature female 130 cm L_T, fitting with the ranges 120–135 and 134–140 cm L_T observed for other populations.

Additional data from French surveys were presented by Ramonet *et al.* (2012 WD).

The length-weight relationship from tope sampled on UK (E&W) surveys (Silva *et al.,* 2013) was used to convert individual numbers at length to biomass when assessing the North Sea IBTS survey index (Q1 and Q3).

$L_T = 0.0038\ W^{3.0331}$ (n = 43; length range of 39–155 cm L_T; weight in g)

10.7.1 Parturition and nursery grounds

Pups (24–45 cm L_T) are caught occasionally in groundfish surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas (see Figure 10.5 of ICES, 2007). Most of the pup records in UK surveys are from the southern North Sea (Division 4.c), though they have also been recorded in the northern Bristol Channel (Division 7.f). The updated locations of pups caught in fisheries-independent surveys across the ICES region could usefully be collated.

A recent study suggests the maximum depth associated with tope may be related to their body size, with specimens under 50 cm L_T being found in waters less than 50 m deep, suggesting small juvenile tope will be restricted to specific areas (Thorburn *et al.*, 2019). A combination of angler data and survey data showed areas where small tope (26–46 cm L_T) were found in the Southern North Sea, the Severn estuary, Cardigan Bay and Liverpool Bay (Figure 10.13; Thorburn *et al.*, 2019).

The lack of more precise data on the location of pupping and nursery grounds, and their importance to the stock, precludes spatial management for the Northeast Atlantic population of this species at the present time.

10.8 Exploratory assessment models

Various assessment methods have been developed and applied to the South Australian tope stock (e.g. Punt and Walker, 1998; Punt *et al.*, 2000; Xiao and Walker, 2000).

A preliminary capture-recapture model was developed in 2015 using data from the Irish Marine Sportfish Tagging Programme (Bal *et al.*, 2015 WD). This approach was re-applied as an exploratory assessment by WGEF in 2016 including additional Irish tagging records from 2014 and 2015. The approach, results and a discussion of the current state of the model are summarized in the WGEF 2020 report (Figures 10.12–10.17 in ICES, 2020).

10.9 Stock assessment

Catch data (see Section 10.3) and survey data (see Section 10.6) are currently too limited to allow for a quantitative stock assessment of NE Atlantic tope. In the latest advice 2023, tope was treated as a Category 5 stock, with advice based on recent estimated landings.

Whilst not used in quantitative advice, WGEF note that available survey trends indicate that catch numbers have been relatively stable or variable in recent years depending on the survey considered.

10.10 Quality of the assessment

The low catchability of tope in current surveys can lead to variability in catch rates. Trawl surveys are not designed to capture larger pelagic species like tope, and therefore survey catches may not accurately represent population size.

Current surveys do cover a large part of the stock area in northern European waters, but data for other areas are unavailable. The spatial and bathymetric distribution of tope may be influenced by the availability of pelagic prey as well as by far ranging migrations that could be conceivably related to reproduction, which may lead to further variability in catch rates in surveys.

In the absence of any other data sources, surveys with high headline trawls may be the most appropriate species-specific data currently available.

10.11 Reference points

No reference points have been proposed for this stock.

10.12 Conservation considerations

According to the latest IUCN Red List Assessments, tope is listed as Vulnerable in Europe (McCully *et al.*, 2015) and in the Mediterranean (McCully *et al.*, 2016), though listed globally as Critically Endangered (Walker *et al.*, 2020).

Tope have been added to Appendix II of the Convention of Migratory Species of Wild Animals (CMS) during the 13th Conference of Parties in February 2020 (CMS, 2020).

10.13 Management considerations

Tope is considered highly vulnerable to overexploitation, as this species has low population productivity, relatively low fecundity and a protracted reproductive cycle. Unmanaged targeted fisheries elsewhere in the world have resulted in stock collapse (e.g. off California and South America).

Tope is an important target species in recreational fisheries; though there are insufficient data to examine the relative economic importance of tope in the recreational angling sector, this may be high in some regions.

Tope is, or has been, a targeted species elsewhere in the world, including Australia/New Zealand, South America and California. Evidence from these fisheries (see stock annex and references cited therein) suggests that any targeted fisheries would need to be managed conservatively, exerting a low level of exploitation.

Australian fisheries managers have used a combination of legal minimum and maximum lengths, legal minimum and maximum gillnet mesh sizes, closed seasons and closed nursery areas. These technical measures may have less utility in the ICES area as tope is taken here mainly in mixed fisheries. Spatio-temporal measures would require further information on e.g. pupping and nursery grounds prior to assessing their suitability across the ICES area.

Following the publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Workshop on Stock Assessment of selected species of Elasmobranchs in the GFCM area in 2011, WGEF believes that collaboration should continue between ICES and the GFCM. This will encourage the sharing of information and aid the better understanding of elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

10.14 References

Bal, G., Johnston G., Roche W., O'Reilly S., Green P., Fitzmaurice P. and Clarke M. 2015. Estimating the yearly size of the population of tope shark off the coast of Ireland. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; WD2015-18; 9 pp.

Braccini, M., Van Rijn, J., and Frick, L. 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS One*, 7(2), e32547: 1–9.

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V. A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal, 17–21 June 2013. 12 pp.

Chabot, C. L. 2015. Microsatellite loci confirm a lack of population connectivity among globally distributed populations of the tope shark *Galeorhinus galeus* (Triakidae). *Journal of Fish Biology*, 87: 371-385. doi:10.1111/jfb.12727

Chabot, C. L. and Allen, L. G. 2009. Global population structure of the tope (*Galeorhinus galeus*) inferred by mitochondrial control region sequence data. *Molecular Ecology*, 18: 545–552.

CMS. 2020. Convention on the Conservation of Migratory Species of Wild Animals, Notification to the Parties: Amendments to the Appendices of the Convention. Notification 2020/003. https://www.cms.int/sites/default/files/003_amendments%20to%20the%20appendices_0.pdf

Coelho, R., Fernandez-Carvalho, J., Lino, P.G. and Santos, M.N. 2012. An overview of the hooking mortality of elasmobranchs caught in a swordfish pelagic longline fishery in the Atlantic Ocean. *Aquatic Living Resources*, 25: 311–319.

Colloca, F., Scannella, D., Geraci, M. L., Falsone, F., Batista, G., Vitale, S., Di Lorenzo, M. and Bovo, G. 2019. British sharks in Sicily: records of long-distance migration of tope shark (*Galeorhinus galeus*) from north-eastern Atlantic to Mediterranean Sea. *Mediterranean Marine Science*, 20(2): 309-313. https://doi.org/10.12681/mms.18121.

Ellis, J.R., McCully, S.R. and Poisson, F. 2014. A global review of elasmobranch discard survival studies and implications in relation to the EU 'discard ban'. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, June 2014, 48 pp.

Ellis, J.R., McCully, S.R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, 90: 653-722.

Fennessy, S.T. 1994. Incidental capture of elasmobranchs by commercial prawn trawlers in the Tugela Bank, Natal, South Africa. South African Journal of Marine Science, 14: 287–296.

Fitzmaurice, P. 1994. Tagging studies of blue sharks and tope off the Irish coast. In: S. L. Fowler and R. C. Earll (Eds.) Proceedings of the Second European Shark and Ray Workshop,15–16 February 1994, p. 17.

Frick, L.H., Reina, R.D. and Walker, T.I. 2010. Stress related changes and post-release survival of Port Jackson sharks (*Heterodontus portusjacksoni)* and gummy sharks (*Mustelus antarcticus)* following gill-net and longline capture in captivity. *Journal of Experimental Marine Biology and Ecology*, 385: 29–37.

ICES. 2007. Report of the Working Group on Elasmobranch Fishes. ICES CM 2007/ACFM:27.

ICES. 2008. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 31 March–4 April 2008, Vigo, Spain. ICES CM 2008 RMC:02; 228 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 424 pp.

ICES. 2016a. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40, 69 pp.

ICES. 2016b. Report of the Working Group on Elasmobranch Fishes (WGEF), 15–24 June 2016, Lisbon, Portugal. ICES CM/ACOM:20. 26 pp.

ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20–24 February 2017, Nantes, France. ICES CM 2017/ACOM:38. 119 pp.

ICES. 2020. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 2:77. 789 pp. http://doi.org/10.17895/ices.pub.7470.

ICES. 2022. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 4:74. 848 pp. http://doi.org/10.17895/ices.pub.21089833

McCully, S., Dureuil, M. and Farrell, E. 2015. *Galeorhinus galeus*. *The IUCN Red List of Threatened Species* 2015: e.T39352A48938136. Downloaded on 24 June 2020.

McCully, S., Dureuil, M. and Farrell, E.D. 2016. *Galeorhinus galeus*. *The IUCN Red List of Threatened Species* 2016: e.T39352A16527949. Downloaded on 24 June 2020.

Morato, T., Solà, E., Grós, M.P. and Menezes, G. 2003. Diets of thornback ray (*Raja clavata*) and tope shark (*Galeorhinus galeus*) in the bottom longline fishery of the Azores, northeastern Atlantic. *Fishery Bulletin*, 101: 590-602.

Ortiz, M. 2017. Standardized catch rates for simulated longline data SAM WG 2017. ICCAT Collective Volume of Scientifics Papers 74, 479–497.

Punt, A. E. and Walker, T. I. 1998. Stock assessment and risk analysis for the school shark (*Galeorhinus galeus*) off southern Australia. *Marine and Freshwater Research*, 49: 719–731.

Punt, A. E., Pribac, F., Walker, T. I., Taylor, B. L. and Prince, J. D. 2000. Stock assessment of school shark *Galeorhinus galeus* based on a spatially-explicit population dynamics model. *Marine and Freshwater Research*, 51: 205–220.

Ramonet M., Jung, A., Salaun M., Pawlowski, L., Bellail, R., Mahé, J-C., Poisson, F. and Biseau, A. 2012. Elasmobranch morphometric relationship and sexual maturity stages from EVHOE scientific survey in Northeast Atlantic Ocean from 2007 to 2011 campaigns. WGEF WD, June 2012, 26 pp.

Rogers, P.J., Knuckey, I., Hudson, R.J., Lowther, A.D. and Guida, L. 2017. Post-release survival, movement, and habitat use of school shark *Galeorhinus galeus* in the Great Australian Bight, southern Australia. *Fisheries Research*, 187: 188-198.

Santos, R V.S., Novoa-Pabon, A.M., da Silva, H.M., Pereira, J.G. and Pinho, M.R. 2018 WD. Standardized catch rates for tope (lsk.27.10a2) from the Azorean bottom longline fleet (1990-2016).

Santos, R., Medeiros-Leal, W. and Pinho, M. 2020 WD. Updated standardized CPUE for *Galeorhinus galeus* caught by bottom longline fleet in the Azores (ICES Subdivision 27.10.a.2), 1990-2017. Working Document to the Working Group on Elasmobranch Fisheries, June 16–25 2020, 11pp.

Santos, R., Novoa-Pabon, A., Silva, H. and Pinho, M. 2020. Elasmobranch species richness, fisheries, abundance and size composition in the Azores archipelago (NE Atlantic), *Marine Biology Research*, 16:2: 103-116. https://doi.org/10.1080/17451000.2020.1718713.

Schaber, M., Gastauer, S., Cisewski, B., Hielscher, N., Janke, M., Peña, M., Sakinan, S. and Thorburn, J. 2022. Extensive mesopelagic habitat use of a migratory continental shark species. *Scientific Repo ts*, 12 : 2074 . https://doi.org/10.1038/s41598-022-05989-z

Séret, B. and Blaison A. 2010. Requins et raies des pêches françaises. Axe 2. Facteurs de conversion. Convention DPMA / IRD. Rapport, 31 pp.

Silva J. F., Ellis J. R. and Ayers R. A. 2013. Length-weight relationships of marine fish collected from around the British Isles. Sci. Ser. Tech. Rep., Cefas Lowestoft, 150: 109 pp.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Silva, J. F., Ellis, J. R. and Kupschus, S. 2020. Demersal elasmobranchs in the western Channel (ICES Division 7.e) and Celtic Sea (ICES Divisions 7.f-j). Working Document to the ICES Working Group on Elasmobranch Fishes, June 16–25 2020; 40 pp.

Thorburn, J., Neat F., Burrett I., Henry, L., Bailey, D. M., Jones, C. S. and Noble L. R. 2019. Ontogenetic Variation in Movements and Depth Use, and Evidence of Partial Migration in a Benthopelagic Elasmobranch. Frontiers in Ecology and Evolution, 7 (353), 14 pp.

Walker, T.I., Rigby, C.L., Pacoureau, N., Ellis, J., Kulka, D.W., Chiaramonte, G.E. and Herman, K. 2020. *Galeorhinus galeus*. *The IUCN Red List of Threatened Species* 2020: e.T39352A2907336..

Xiao, Y. and Walker, T. I. 2000. Demographic analysis of gummy shark (*Mustelus antarcticus*) and school shark (*Galeorhinus galeus*) off southern Australia by applying a generalized Lotka equation and its dual equation. *Canadian Journal of Fisheries and Aquatic Sciences*, 57: 214–222.

10.15 Tables and Figures

Table 10.1. Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2004. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and are limited for Northwest African waters.

ICES Area	ICES Division	Denmark	France	Netherlands	Sweden	UK (E&W)	UK (Scotland)
1975		-	na		-	na	
1976		-	na		-	na	
1977		-	na		-	na	
1978		-	32		-	na	
1979		-	22		-	na	
1980		-	na		-	na	
1981		-	Na		-	Na	
1982		-	26		-	8	
1983		-	26		-	10	
1984		-	13		-	31	
1985		-	31		-	36	
1986		-	13		-	94	
1987		-	14		-	28	
1988		-	18		-	22	
1989		-	12		-	18	
1990		-	17		-	14	-
1991		-	16		-	21	-
1992		-	10		-	15	-
1993		-	11		-	15	-
1994		-	12		-	19	-
1995		-	8		-	25	-

ICES Subarea	Subtotal	UK (Scotland)	UK (E&W)	Spain	Spain	Netherlands	Ireland	France	ICES Subarea	Subtotal	ICES Area
			na	-	na		na	na		0	**1975**
			na	-	na		na	na		0	**1976**
			na	-	na		na	na		0	**1977**
	522		na	-	na		na	522		32	**1978**
	2076		na	-	na		na	2076		22	**1979**
	0		na	-	na		na	na		0	**1980**
	0		Na	-	Na		Na	Na		0	**1981**
	1051		63	-	na		na	988		34	**1982**
	1631		51	-	na		na	1580		36	**1983**
	374		28	-	na		na	346		44	**1984**
	362		23	-	na		na	339		67	**1985**
	1162		21	-	na		na	1141		107	**1986**
	512		21	-	na		na	491		42	**1987**
	642		21	-	na		na	621		40	**1988**
	462		55	-	na		na	407		30	**1989**
	402		45	-	na		na	357		31	**1990**
	438		47	-	na		na	391		37	**1991**
	288		53	-	na		na	235		25	**1992**
	288		48	-	na		na	240		26	**1993**
	284		49	-	na		na	235		31	**1994**
	303		38	-	na		na	265		33	**1995**

ICES Area	France	Spain	Spain	UK (E&W)	UK Scotland	Subtotal	ICES Subarea	Spain	Subtotal	ICES Subarea	Portugal
1975	na	na	-	-				na			18
1976	na	na	-	-				na			na
1977	na	na	-	-				na			na
1978	na	na	-	+		0		na			24
1979	237	na	-	+		237		na			15
1980	na	na	-	+		0		na			51
1981	Na	Na	-	+		0		Na			77
1982	na	na	-	+		0		na			42
1983	63	na	-	+		63		na			24
1984	119	na	-	+		119		na			29
1985	52	na	-	+		52		na			24
1986	103	na	-	1		104		na			24
1987	97	na	-			97		na			24
1988	66	na	-			66		na			34
1989	39	na	-			39		na			23
1990	34	na	-			34		na			56
1991	38	na	-			38		na			81
1992	34	na	-			34		na			80
1993	40	na	-			40		na			115
1994	54	na	-			54		na			116
1995	44	na	-	0		44		na			124

TOTAL LAND-	Portugal	CECAF area	UK (E&W)	France	Other/Un-	Subtotal	ICES Area
18	-		-	-		18	1975
0	-		-	-			1976
0	-		-	-			1977
578	-		-	-		24	1978
2350	-		-	-		15	1979
51	-		-	-		51	1980
77	-		-	-		77	1981
1127	-		-	-		42	1982
1754	-		-	-		24	1983
567	-		-	-		29	1984
505	-		-	-		24	1985
1397	-		-	-		24	1986
675	-		-	-		24	1987
782	-		-	-		34	1988
554	-		-	-		23	1989
523	-		-	-		56	1990
593	-		-	-		81	1991
427	-		-	-		80	1992
469	-		-	-		115	1993
485	-		+	-		116	1994
504	-		+	-		124	1995

Table 10.1. (continued). Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2004. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and are limited for Northwest African waters.

ICES Area and Nation	1996	1997	1998	1999	2000	2001	2002	2003	2004
ICES Division 3.a, 4									
Denmark	-	.	.	3	8	4	5	5	5
France	11	5	11		11	11	6	6	3
Netherlands									
Sweden	-	.	.	.	.	.	.	.	.
UK (E&W)	14	22	12	14	13	10	13	11	8
UK (Scotland)	-	.	.	.	.	.	.	.	.
Subtotal	25	27	23	17	32	25	24	22	16
ICES Subareas 6–7									
France	314	409	312		368	394	324	284	209
Ireland	na	na	na	na	na	4	1	6	4
Netherlands		.	.	.	.	.	.	.	.
Spain	na	na	na	na	na	+	242	3	na
Spain (Basque country)	-	.	.	.	.	+	+	3	15
UK (E&W)	39	34	41	62	98	72	60	55	65
UK (Scotland)									
Subtotal	353	443	353	62	466	470	627	351	293
ICES Subarea 8									
France	78	40	46	+	71	58	49	60	16
Spain	na	na	na	na	na	9	13	10	na
Spain (Basque country)	-	.	.	.	.	9	6	10	10
UK (E&W)	0	0	0	0		1		3	8
UK Scotland									
Subtotal	78	40	46	0	71	77	68	83	34
ICES Subarea 9									
Spain	na	na	na	na	na	na	na	na	76
Subtotal									
ICES Subarea 10									
Portugal	80	104	128	129	142	82	77	69	51
Subtotal	80	104	128	129	142	82	77	69	51
Other/Unknown									
France	-	.	.	386	.	2	.	.	.
CECAF area									
Portugal	-	.	.	.	2	1	2	98	na
TOTAL LANDINGS	**536**	**615**	**551**	**593**	**713**	**656**	**798**	**622**	**394**

Table 10.2. Tope in the Northeast Atlantic. ICES estimates of tope landings (tonnes) by area 2005–2023 following WKSHARK2 (ICES, 2016a). Blank = no data reported; 0.0 < 0.1 tonnes.

Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
27.2	0.0	0.0	0.0	0.0		0.0	0.0		0.0		0.0			0.0	0.1	0.1	0.1	0.3	0.1
27.3	1.1	1.3	0.0	0.1		1.0	1.0			1.0	0.4	0.1	0.8	0.2	0.7	0.9	0.4	0.3	0.4
27.4	24.2	26.8	15.6	13.2	9.5	9.2	15.5	6.8	6.4	5.6	6.3	9.2	16.2	6.5	3.3	3.2	3.7	3.8	1.6
27.5b	0.0	0.0	0.5	0.1	0.0	0.0			0.0	0.0	0.0	0.0	0.0			0.0			
27.6	3.4	4.0	6.7	5.6	8.0	1.3	0.6	0.7	1.2	1.1	6.2	0.5	0.7	0.2	0.2	0.4	0.1	0.5	0.3
27.7	417.8	445.8	366.7	359.9	348.6	311.1	262.6	277.8	279.5	245.5	301.2	233.8	267.5	302.3	253.4	207.0	288.4	298.8	276.1
27.8	113.1	110.9	102.9	123.4	145.8	80.0	85.1	54.6	60.9	52.8	64.5	90.8	67.1	79.6	82.5	68.7	95.8	84.7	76.9
27.9	37.9	54.0	47.3	48.2	72.6	59.7	53.9	45.0	48.8	54.4	51.1	34.2	37.2	23.4	29.8	37.6	49.8	57.3	57.4
27.10	44.7	45.2	42.5	46.6	33.9	41.3	43.6	47.4	45.7	65.4	71.0	84.9	69.8	41.4	27.0	21.4	26.9	22.7	17.6
27.12			0.0				0.0			0.0	0.0								

Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
27.14							0.0	0.0											
27/(unspecified, incl. BIL94B)	0.2	0.2	0.0	0.0		0.1	0.1	0.0		0.0									
34*	5.0	10.7	3.2	11.1	5.5	28.4	8.0	5.3	2.4	3.6	0.0	0.3	0.8	2.9	2.9	1.0			
37*/BIL95	20.3	16.3	15.6	12.8	25.9	32.4	41.2	28.4	38.4	33.0									
Total	**667.7**	**715.2**	**601.3**	**621.1**	**649.9**	**564.4**	**511.5**	**466.1**	**483.3**	**462.4**	**500.8**	**453.7**	**460.2**	**456.7**	**399.9**	**340.2**	**465.2**	**468.4**	**430.3**

Table 10.3. Tope in the Northeast Atlantic. ICES species-specific estimates of tope landings (tonnes) 2005–2023 following WKSHARK2 (ICES, 2016a). Blank = no data reported; 0.0 < 0.1 tonnes.

Nation	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium												0.1	0.0	0.0	0.0	0.0	5.6	0.8	0.1
Denmark	7.0	6.0	2.0	3.0	2.0	2.0	3.0	1.0		3.0	1.4	0.9	2.2	1.8	1.2	1.6	0.6	1.3	0.5
France	347.8	383.2	301.9	365.1	353.8	319.7	291.4	282.5	308.9	261.1	349.8	302.7	312.9	355.8	319.6	257.6	359.7	346.5	327.9
Germany													0.4		0.0	0.1	0.1	0.3	0.1

Total	UK	Sweden	Spain	Portugal	Norway	Netherlands	Ireland	**Nation**
667.7	80.8	0.1	181.7	44.7			5.5	**2005**
715.2	91.9	0.3	181.8	45.2			6.8	**2006**
601.3	49.4	0.0	202.9	42.5			2.6	**2007**
621.1	41.1	0.1	163.1	46.6			2.1	**2008**
649.9	23.3		234.0	33.9			2.9	**2009**
564.4	16.8		179.4	41.3	0.1	2.1	3.1	**2010**
511.5	17.0		138.1	43.5	0.2	17.7	0.6	**2011**
466.1	16.1		94.0	47.4		24.8	0.3	**2012**
483.3	17.1		100.3	45.7	0.0	11.2		**2013**
462.4	20.4		101.1	65.4		11.4		**2014**
500.8	17.0		55.7	71.0	0.0	5.8		**2015**
453.7	19.8		36.8	85.2		8.2		**2016**
460.2	13.8		41.3	70.8		18.7		**2017**
456.7	12.6		30.5	44.3	0.0	11.6		**2018**
399.9	15.6		32.9	30.0	0.1	0.5		**2019**
340.2	13.6		44.3	22.5	0.1	0.4		**2020**
465.2	14.1		56.9	27.4	0.1	0.6		**2021**
468.4	16.0		79.1	22.7	0.3	1.3		**2022**
430.3	16.5		67.0	17.6	0.1	0.3	0.2	**2023**

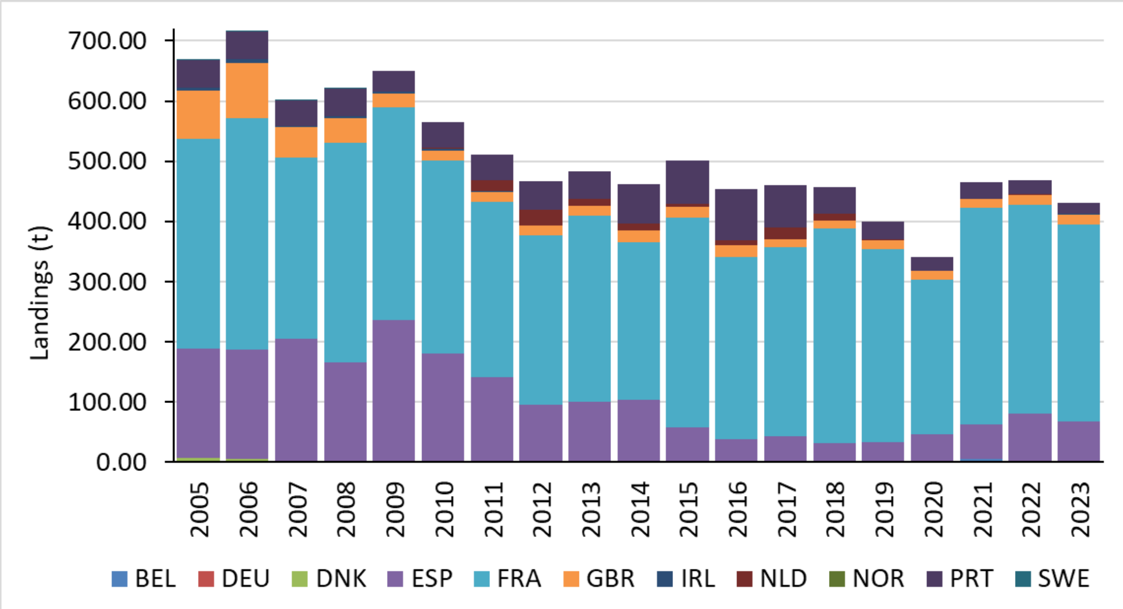


Figure 10.1. Tope in the Northeast Atlantic. ICES species-specific estimated landings by country for 2005–2023.

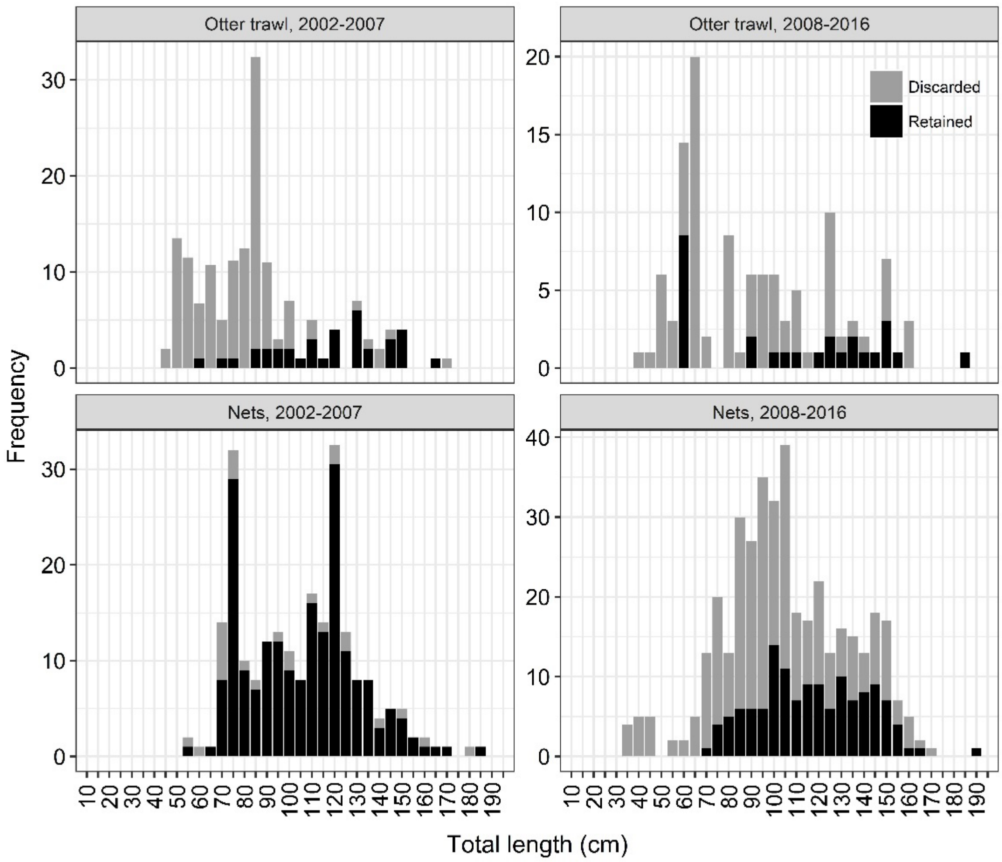


Figure 10.2. Tope in the Northeast Atlantic. Length–frequency of discarded and retained tope *Galeorhinus galeus* (5 cm length classes) caught by otter trawl and gill nets during the periods 2002–2007 and 2008–2016, as recorded in the Cefas observer programme. Source: Silva and Ellis (2019).

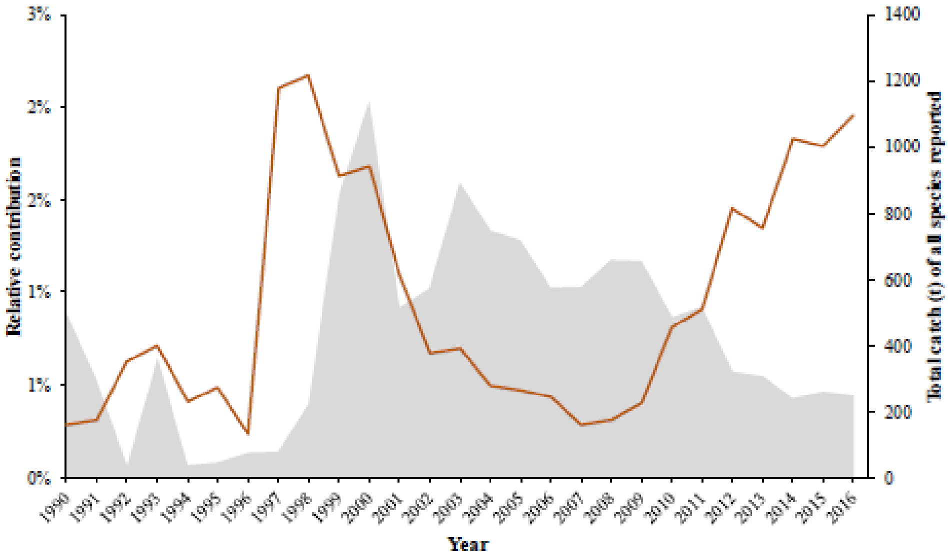


Figure 10.3. Tope in the Northeast Atlantic. Total catch of all species (■) and relative contribution of tope *Galeorhinus galeus* to all species (—) landed by the Azorean bottom longline fleet and sampled by the DCF inquiries. Source: Santos *et al.* 2018 WD.

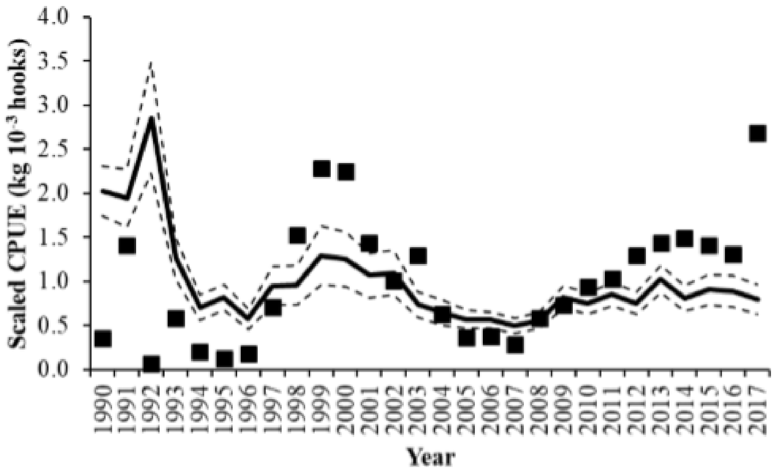


Figure 10.4. Tope in the Northeast Atlantic. Nominal (■) and standardized (—) CPUE (kg 10^{-3} hooks) for tope *Galeorhinus galeus* from the Azorean bottom longline fishery, 1990–2017. Dotted lines represent 95% confidence intervals for the standardized CPUE. Source: Santos *et al.* 2020 WD.

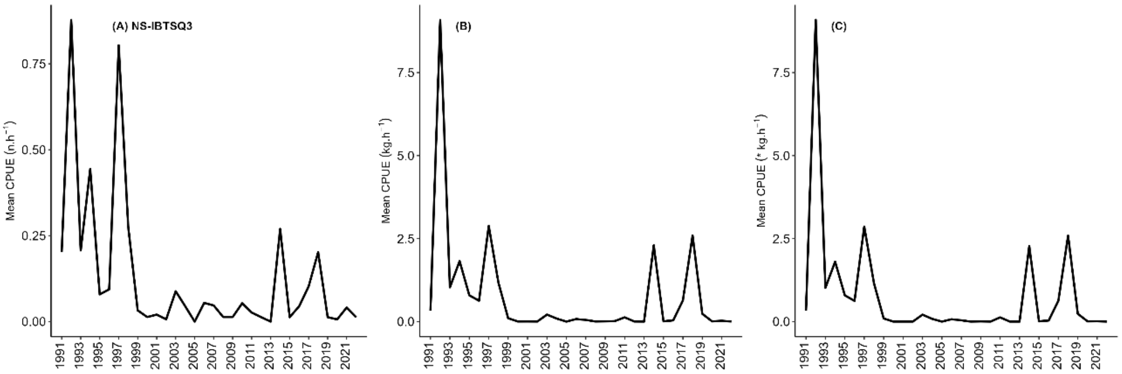


Figure 10.5. Tope in the Northeast Atlantic. Mean catch rates in terms of (A) total abundance (n.h-1), (B) total biomass (kg.h-1) and (C) exploitable biomass for individuals ≥50 cm total length (*kg.h-1) during the NS-IBTS-Q3 (1992–2022). Note: The large catch in 1992 is largely due to a large catch reported in one haul, and these data should be verified. Some catches of tope are considered to have been reported as *Mustelus* on DATRAS, consequently this time-series does not provide a robust abundance trend. Danish data have been excluded from NS-IBTS-Q3 (see further details in Section 21.6). Updated results in 2023 for whole time series.

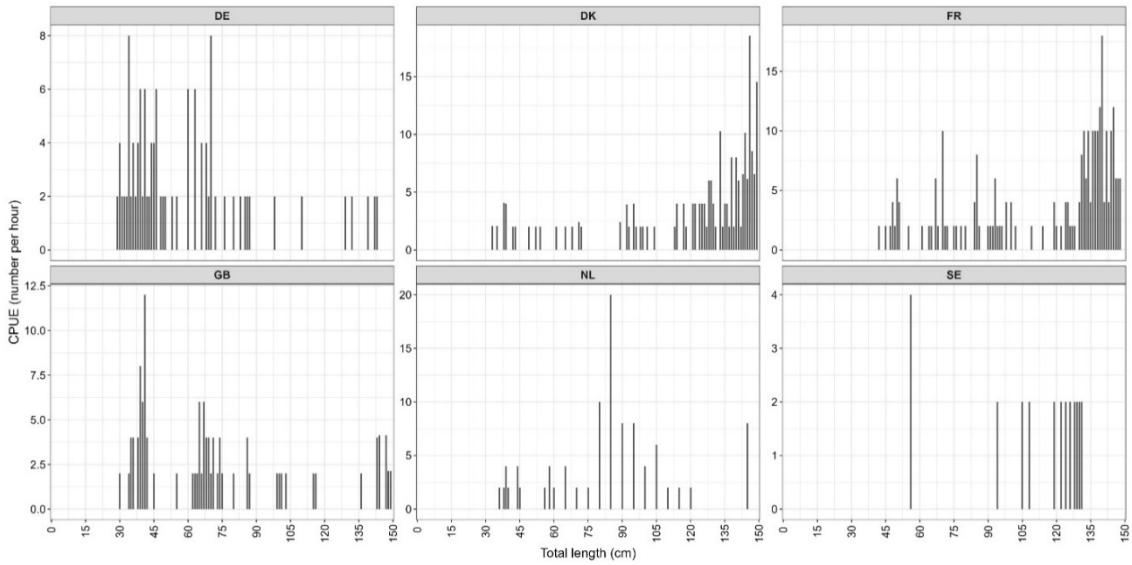


Figure 10.6. Tope in the Northeast Atlantic. Length-frequency distribution of tope by country in the NS-IBTS-Q3 (1992–2022). Note: DE - Germany, DK - Denmark, FR - France, GB - England, NL - The Netherlands and SE - Sweden. Scottish records not shown as data are limited.

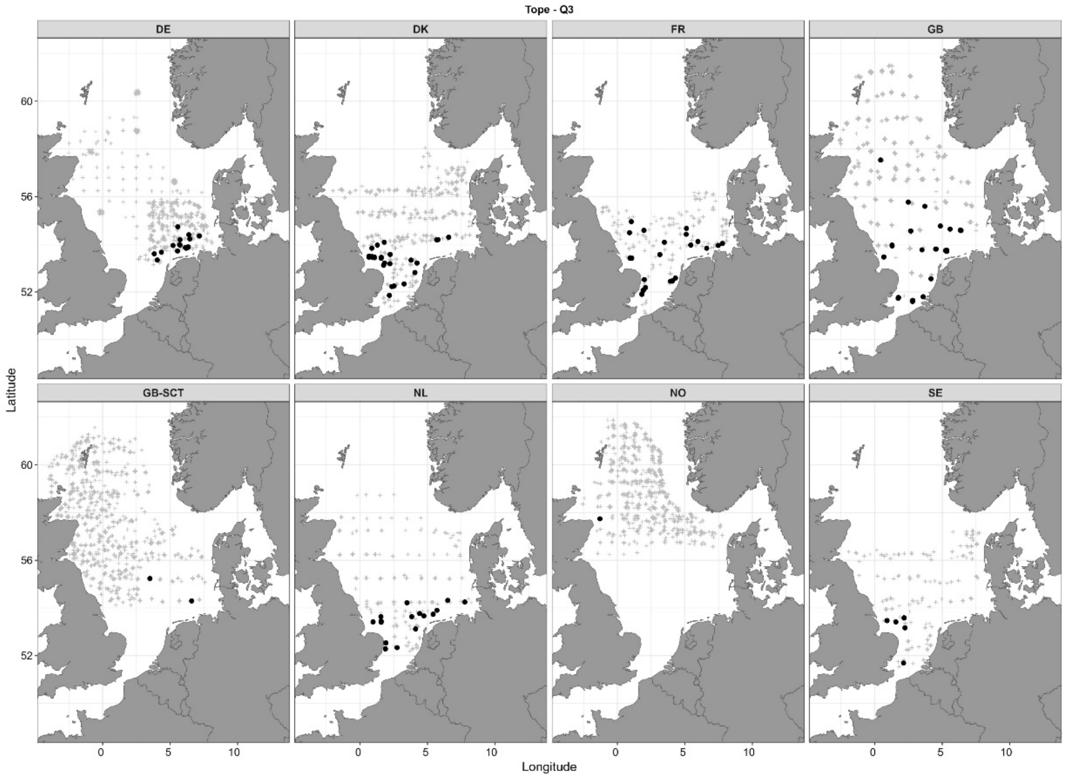


Figure 10.7. Tope in the Northeast Atlantic. Spatial distribution of tope by country in the NS-IBTS-Q3 (1992–2022) (black dots = positive hauls; grey dots = negative hauls). Note: DE - Germany, DK - Denmark, FR - France, GB - England, GB-SCT - Scotland, NL - The Netherlands, NO - Norway and SE - Sweden.

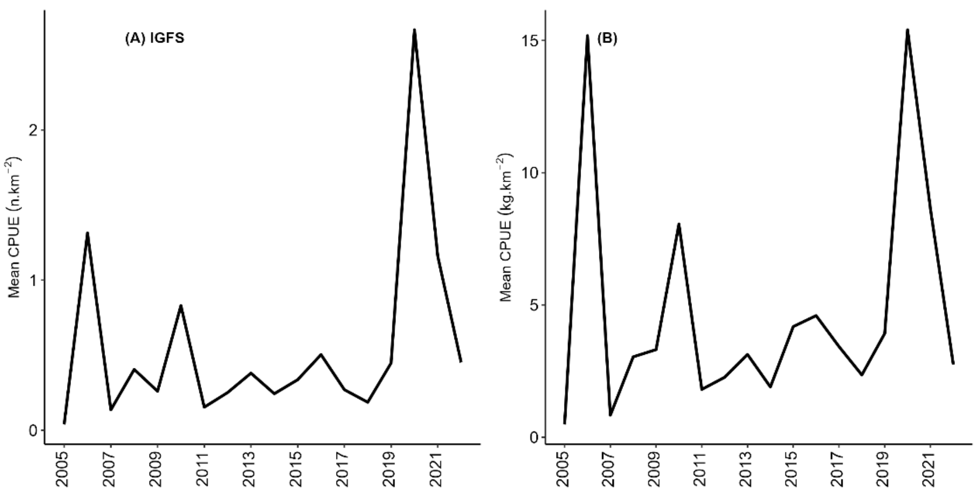


Figure 10.8. Tope in the Northeast Atlantic. Mean catch rates in terms of (A) total abundance (n.km^{-2}) and (B) total biomass (kg.km^{-2}) for all individuals during the IE-IGFS-WIBTS-Q4 (2005–2022). Note: All fish recorded are above 50 cm L_T.

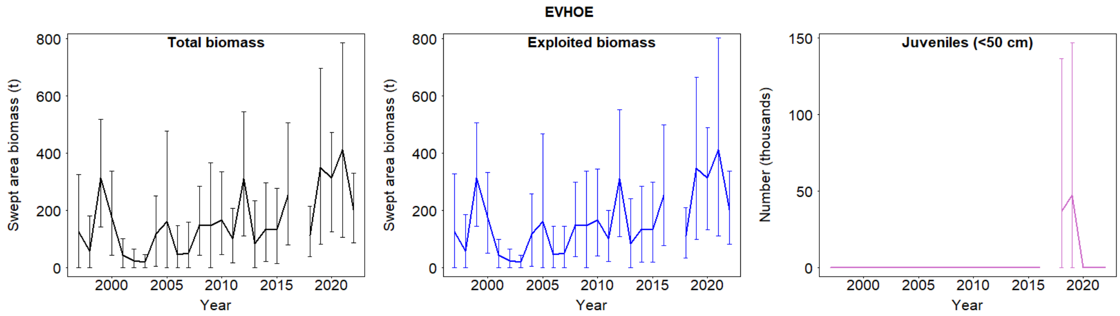


Figure 10.9. Tope in the Northeast Atlantic. Swept area biomass for total (t, all individuals) and exploitable biomass (t, individuals ≥50 cm total length) and, abundance in terms of numbers of juvenile fish (thousands, individuals <50 cm total length) during the EHVOE-WIBTS-Q4 (1997–2022). Associated confidence intervals (95% CI) calculated using bootstrap. Updated results in 2023 for whole time series.

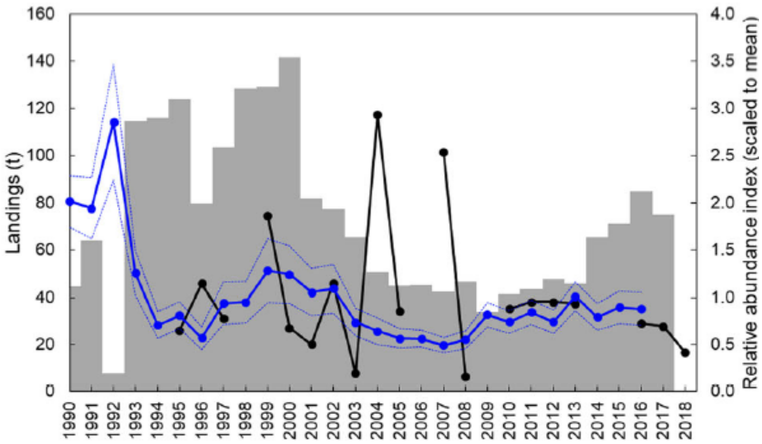


Figure 10.10. Tope in the Northeast Atlantic. Landings (bars) and relative abundance index from the Azorean demersal spring bottom longline survey (black colour) and derived from commercial catch and effort (standardized CPUE) data (blue colour) in the Azores archipelago. Dotted lines represent 95% confidence intervals for the standardized CPUE. Note: Historical landings may differ from data in Table 10.1–10.3 so for ICES landings estimates used in advice please refer to Table 10.2 and 10.3. Source: Adapted from Santos *et al*. (2020).

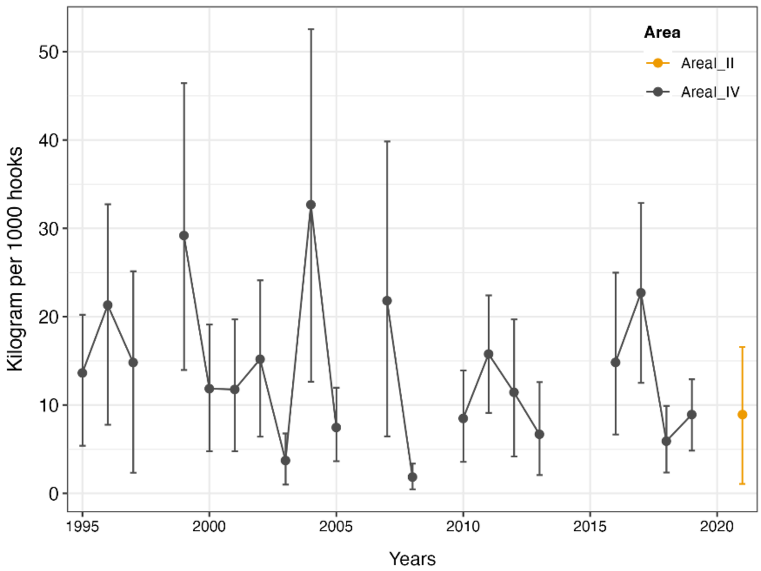


Figure 10.11. Tope in the Northeast Atlantic. Biomass estimates (kg per 1000 hooks) by area from the Azorean demersal spring bottom longline survey (1995–2021). Note: Estimates for 2021 should be viewed with caution as survey spatial coverage was reduced comparatively to previous years. Survey did not occur in 2022.

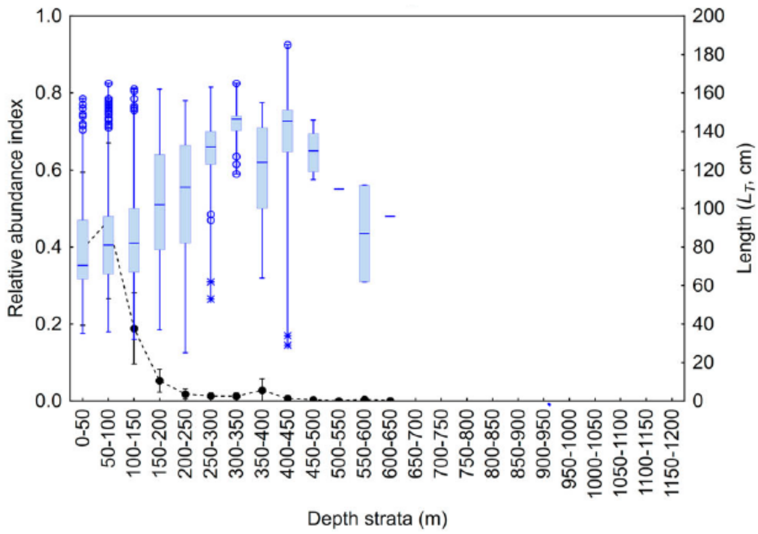


Figure 10.12. Tope in the Northeast Atlantic. Relative abundance index (mean ± 0.95 confidence interval) and boxplot of length (L_T, cm) by stratum from the Azorean demersal spring bottom longline survey (1995–2018). Boxes show the quartiles (25–75%), horizontal lines inside each box show the median, and the limits are shown with whiskers. Empty-circle symbols identify outliers and asterisks are extreme outliers. Source: Adapted from Santos *et al*. (2020).

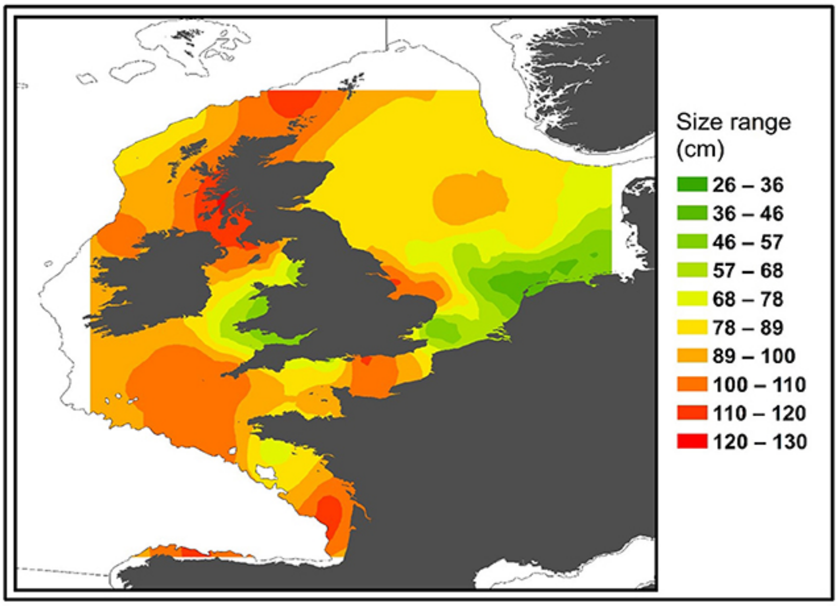


Figure 10.13. Tope in the Northeast Atlantic. Distribution of all immature tope (max length = 130 cm L_T) based on mark and recapture and International Bottom Trawl Survey (IBTS) data sets. Colour represents smallest sized (based on L_T) animal predicted to occur in that area. Source: Adapted from Thorburn *et al*. (2019).

Contents

11 Thresher sharks in the Northeast Atlantic and Mediterranean Sea

11.1 Stock distribution

Two species of thresher occur in the ICES area: common thresher, *Alopias vulpinus* and bigeye thresher, *A. superciliosus.* Of these species, *A. vulpinus* is the main species encountered on the continental shelf of the ICES area.

There is little information on the stock identity of these species, which have a near circumglobal distribution in tropical and temperate waters. WGEF assumes there to be a single stock of *A. vulpinus* in the NE Atlantic and Mediterranean Sea, with this stock extending into the CECAF area. The presence of a nursery ground in the Alboran Sea provides the rationale for including the Mediterranean Sea within the stock area. Further information on stock identity is given in the Stock Annex drafted in 2009 (ICES, 2009). This stock annex requires future revision in particular as a consequence of landings data revision carried out in recent years by WGEF.

The results from the analysis of sequences of mitochondrial DNA showed no significant differences between populations of *A. superciliosus* from southern Atlantic and the Indian Ocean further suggesting the existence of a high dispersal of this species (Morales *et al*., 2018).

11.2 The fishery

11.2.1 History of the fishery

There are no target fisheries for thresher sharks in the NE Atlantic. Both species are a bycatch in longline fisheries for tuna, swordfish and blue shark (Parra *et al*., 2023), and would have been taken in earlier pelagic drift net fisheries. Common thresher is an occasional bycatch in gillnet fisheries. Fisheries data for the ICES area are limited and unreliable. It is likely that some commercial data for the two species are confounded.

In the Mediterranean Sea, where the two thresher sharks species occur, there are no fisheries targeting either of these species. In this area the two species are bycatches in various fisheries, including the Moroccan driftnet fishery in the southwest Mediterranean. Both species are also caught in industrial and semi-industrial longline fisheries and artisanal gillnet fisheries operating in the area.

11.2.2 The fishery in 2023

No new information.

11.2.3 ICES Advice applicable

ICES advice for thresher sharks is given in every four years, and the first to be provided was in 2015, stating that "*ICES advises that when the precautionary approach is applied for common thresher shark Alopias vulpinus and bigeye thresher shark Alopias superciliosus in the Northeast Atlantic, fishing mortality should be minimized and no targeted fisheries should be permitted. This advice is valid for 2016 to 2019".* The latest advice provided by ICES for this stock was in 2019 stating that "*ICES advises* *that when the precautionary approach is applied, there should be zero catch in each of the years 2020–2023."*

11.2.4 Management applicable

Since 2009, the EU regulations regarding thresher sharks are in the annual TAC regulations in the section on the ICCAT convention area and stipulates that thresher sharks of the *Alopias* genus should not be the objects of directed fishing and that bigeye thresher sharks should not be retained on board or transhipped (see Council regulation 2023/194 of 30 January 2023).

Council Regulation No. 1185/2003 prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters. In June 2023, 'The Shark Fins Act 2023' was passed in the UK banning the import and export of detached shark fins, including all products containing shark fins.

11.3 Catch data

11.3.1 Landings

Landings of thresher sharks are reported irregularly and are variable; from 4–266 t in the North and Eastern Atlantic and Mediterranean Sea from 1997 to 2022 (ICCAT and national data; tables 11.1–11.2). There can be large inter-annual variation in reported landings, as well as differences in values reported to ICCAT (tables 11.1–11.2) and ICES (Table 11.3). For example, in 2021 there was a steep increase in reported landings by Algeria in the Mediterranean (Table 11.2). Further studies to review landings data for thresher sharks are required and should be included in the proposed joint meetings with the ICCAT shark subgroup.

Historically, an unknown proportion of landings was reported as generic 'sharks'. In recent years, overall quantities reported to ICES as generic sharks reduced from an average of 85 tonnes between 2005 and 2010 to 51 tonnes in 2020–2022. Based on the fishing area and reporting countries of these landings, WGEF considered they mostly included Scyliorhinidae, Triakidae and Squalidae. Catches of thresher sharks are expected to represent a small proportion (if any) of these landings.

Historically, the main European countries reporting landings of thresher sharks were Portugal, Spain and France, although the large quantities reported by Portugal to ICCAT in 2006 and 2007 require a further verification..

As well as being caught and landed from fisheries for tuna and tuna-like species, thresher sharks are also a bycatch in continental shelf fisheries in the ICES area, including subareas 4, 6–9.

11.1.1 Discards

Limited data are available.

11.1.2 Quality of catch data

Thresher sharks have not been reported consistently, either at species-specific or generic level. There are also some discrepancies between some data sources. Landings of thresher shark in coastal waters are most likely to represent *A. vulpinus*, but some of these landings may also be reported as 'sharks nei'. This issue seems to be minor in recent years. For year 2015-2022, the bulk of landings attributed to thresher sharks by WGEF was reported as *Alopias vulpinus*.

11.3.2 Discard survival

There is limited information on discard survival from European fisheries, but there have been several studies elsewhere in the world. Braccini *et al.* (2012) found that about two thirds of thresher shark captured in gillnets were dead, even with a short soak time, although this was based on a small sample size. Moderate to high levels of mortality have been reported in pelagic longline fisheries, with most studies indicating that about half of the thresher sharks captured are in poor condition or dead (see Ellis *et al.*, 2017 and references therein). Immediate mortality of bigeye thresher shark (*A. superciliosus*) caught in swordfish longline fisheries in the Pacific has been estimated between 7% (Aalbers *et al.*, 2021) and 25% (Musyl *et al.*, 2011). In a Hawaiian deep-set fishery targeting bigeye tuna, the projected survival of bigeye thresher shark has been estimated after one month at 34% (Hutchinson *et al*., 2021).

11.4 Commercial catch composition

Length–frequency distributions for *A. vulpinus* were collected under the Data Collection Regulation (DCR) programme by observers on board French vessels (see ICES, 2015). Given the potential problems of how thresher sharks are measured (standard length, fork length, total length), improved standardisation of length-based information is required.

11.5 Commercial catch and effort data

Limited data on landing and effort are available for the ICES area. ICES and ICCAT should cooperate to collate and interpret commercial catch data from high seas and shelf fisheries.

11.6 Fishery-independent surveys

No fishery-independent data are available for the NE Atlantic.

11.7 Life-history information

Various aspects of the life history, including conversion factors, for these species are included in the drafted Stock Annex (ICES, 2009).

The common thresher and bigeye thresher are distributed circumglobally in the Atlantic, Pacific, and Indian Oceans and in the Mediterranean (Smith *et al*., 2008; Clo *et al*., 2008; Corsini-Foka and Sioulas, 2008). Threshers are active, strong-swimming sharks occurring in oceans and shelf seas in tropical and temperate seas. They are found from the surface to 500 m depth (deepest record 723 m). Threshers are mostly epipelagic, but may stay at 200–500 m depth over the continental slope during the day and in open waters at 80–130 at night.

Alopias vulpinus

In the NE Atlantic, *A. vulpinus* has been recorded from Norway to the Mediterranean Sea and the Black Sea, and off Madeira and the Azores. Quigley *et al*., 2008 and Ellis, 2004 have provided information on the occurrence of *A. vulpinus* in Irish and North Sea waters, respectively.

There have been a few recent published studies on *A. vulpinus*. Cartamil *et al.* (2016) and Kinney *et al*. (2020) examined the movements of *A. vulpinus* along the western coast of the USA and

Mexico; Natanson *et al.* (2016) provided revised growth curves for *A. vulpinus*, in the NW Atlantic; and Finotto *et al.* (2016) commented on the occurrence of *A. vulpinus* in the northern Adriatic Sea.

Relevant information from these studies should be reviewed for future work by WGEF.

11.7.1 Movements and migrations

The "Alop" Project tagged two specimens in the Gulf of Lions. The behaviour of one female (135 cm L_T) was recorded for 200 days. Horizontal movements within a restricted area of the Gulf of Lions were observed; the female stayed in coastal shelf areas from July to September, moving to deeper waters afterwards, probably as a response to the seasonal drop in sea surface temperature. Another specimen (120 cm L_T) stayed mostly at depths of 10–20 m with occasional dives to 800 m.

Cao *et al.* (2012) provided data for *A. superciliosus* and *A. vulpinus* around the Marshall Islands (Pacific, West Central), where they occurred at depths of 240–360 m and 160–240 m, temperatures of 10–16°C and 18–20°C and salinities of 34.5–34.7 and 34.5–34.8, respectively.

A. superciliosus

Nakano *et al*. (2003) conducted an acoustic telemetry study to identify the short-term horizontal and vertical movement patterns of two immature female *A. superciliosus* in the eastern tropical Pacific Ocean (summer 1996). Distinct crepuscular vertical migrations were observed; specimens often occurring at 200–500 m depth during the day and at 80–130 m depth at night, with slow ascents and relatively rapid descents during the night, the deepest dive being 723 m. The estimate of the mean swimming speed over the ground ranged from 1.32–2.02 km h^{-1}.

Weng and Block (2004) studied diel vertical migration patterns of two *A. superciliosus* that were caught and tagged with pop-up satellite archival tags in the Gulf of Mexico and near Hawaii. Both showed strong diel movement patterns, spending most of the day below the thermocline (waters of 10°C at 300–500 m and 400–500 m) and occurring in warmer (> 20°C) surface mixed layers above the thermocline (10–50 m) at night.

Carlson and Gulak (2012) provided results from a tagging programme with archival tags deployed on *A. superciliosus*. One specimen exhibited a diurnal vertical diving behaviour, spending most of their time between 25 and 50 m depth in waters between 20 and 22°C while the other dove down to 528 m. Deeper dives occurred more often during the day, and by night they tended to stay above the thermocline.

In the tropical northeast Atlantic fifteen bigeye threshers were tagged with pop-up satellite archival tags (PSATs) in 2012 and 2014, with successful transmissions received from 12 tags for a total of 907 tracking days. Marked diel vertical movements were recorded on all specimens, with most of the daytime spent in deeper colder water and nighttime spent in warmer water closer to the surface. The operating depth of the pelagic longline gear was measured and it was concluded that there is spatial overlap between the fishery and the habitat particularly during the night and overlap is higher for juveniles (Coelho *et al.*, 2015).

A recent study on the movement and post-capture survival of the big-eye thresher off the west coast of the USA, showed that individuals tagged near San Francisco exhibited long-range (1235 ± 235 km) south/south-westward movements (Aalbers *et al*., 2021). The authors suggest a potentially relevant migratory corridor for large pelagic sharks. Post-release survival rate was around 93% (Aalbers *et al.*, 2021)

A. vulpinus

Kinney *et al.* (2020) studied the seasonal movements of 25 tagged common thresher sharks off the west coast of North America. They provided evidence for movements driven by the biological state (body size, sex) and environmental drivers, with younger individuals mostly remaining in an identified nursery area: the Southern California Bight, while larger individuals frequently moved out of the bay in spring and winter.

Based on catch data and data collected by onboard observers along the eastern coast of the US, Kneebone *et al.* (2020) found evidence for seasonal changes in distribution, with individuals found at more northern latitudes in the summer. Young of the year were almost exclusively found in continental shelf waters north of 33.5°N, mostly in shallow waters, and seemed to display reduced migrations compared to older individuals. No evidence for differences in movements of males and females was found.

11.7.2 Nursery grounds

A. superciliosus

Nursery areas for *A. superciliosus* occur off the southwestern Iberian Peninsula and Strait of Gibraltar (Moreno and Moron, 1992).

A. vulpinus

Juvenile *A. vulpinus* are known to occur in the English Channel and southern North Sea (Ellis, 2004). The capture of newborn individuals in northern Adriatic Sea supports the presence of a nursery in this area (Finotto *et al*. 2016). Moreno and Moron (1992) also observed aggregations of gravid females of *A. vulpinus* in the Strait of Gibraltar.

11.7.3 Diet

Both *A. vulpinus* and *A. superciliosus* feed mostly on small pelagic fish, including mackerel and clupeids, as well as squid and octopus (e.g. Preti *et al*., 2012).

A. superciliosus

This species is found to eat a wider range of prey items, with pelagic and demersal fish and squid, making up the largest proportion (Fitch and Craig, 1964; Bass *et al*., 1975; Stillwell and Casey, 1976; Gruber and Compagno, 1981; Castro, 1983). Bowman *et al*., 2000 found from analysis of 24 stomachs from Northwest Atlantic animals, that six were empty, and the remaining contained 83.5% pelagic and demersal fish (scorpionfish, Scorpaenidae being most abundant at 53.8%) and 15% squid (Northern shortfin squid, *Illex illecebrosus* was most abundant making up 11.9%).

A. vulpinus

This species is found to feed on small schooling species such as anchovy, hake, mackerel, sardine and squid (Gubanov, 1972; Stick and Hreha, 1989; Bedford, 1992; Preti *et al*., 2001, 2004). Bowman *et al*., 2000 found that in 19 stomachs analysed from the Northwest Atlantic, seven were empty, and the remaining contained 97% fish (66.3% Northern sand lance, *Ammodytes dubius*) and 3% squid (2.2% Northern shortfin squid, *Illex illecebrosus*).

11.8 Exploratory assessments

Both *A. vulpinus* and *A. superciliosus* were included in a Productivity-Susceptibility Analysis (PSA) for the pelagic fish assemblage (ICCAT, 2009a). However, the lack of reliable landing data, and absence of fishery-independent data hampered the assessment of the two thresher stocks. A bycatch per unit effort (BPUE) was derived for bigeye thresher shark caught by the Portuguese longline fleet between 2008 and 2016 (ICCAT, 2020).

Along the west coast of North America, *A. vulpinus* is assumed to be a single, well-mixed stock. This assumption is supported by genetics, tagging data, and seasonal movements. This stock was assessed with Stock Synthesis modelling platform (v3.24U). The results obtained included the estimation of management quantities for eight fishing fleets operating in USA and Mexico waters (Teo *et al*., 2018).

A Bayesian population modelling tool integrating separable virtual population analysis, per-recruit models and age-structured demographic analysis was developed for the *A. superciliosus* population in an area subset of the western North Pacific. The results from the risk analysis revealed that only low levels of fishing pressure (10% of the current fishing pressure) over a wide range of ages could maintain a relatively low risk of population decline for bigeye threshers. Sensitivity testing indicated that the model is robust to prior specification (Tsai *et al*., 2019).

11.9 Stock assessment

In 2019, ICES advice for *A. vulpinus* and *A. superciliosus* was given according to the ICES framework for category 6 (ICES, 2012). ICES considered that for stocks without information on abundance or exploitation, as is the case of these two stocks, 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.

11.10 Quality of assessments

At the Northeast Atlantic level, there is no stock assessment for common thresher or bigeye thresher. However, in 2012, ICCAT conducted an Ecological Risk Assessments for elasmobranchs to evaluate the biological productivity of these stocks and a susceptibility analysis to assess their propensity to capture and mortality in pelagic longline fisheries (McCully *et al.*, 2013).

Historically, landing data for the entire stock area is uncertain for both common thresher and bigeye thresher. Some historical commercial catch-per-unit-effort data are available for parts of the stock area, but data for the two species may be confounded. It is unclear as to how representative CPUE data would be for informing on trends in the two stocks' abundance.

Species-specific landings are required, and future quantitative assessments should be undertaken in collaboration with ICCAT.

11.11 Reference points

No reference points have been proposed for these species.

11.12 Conservation considerations

In 2015, a revision of the Red List for European Marine Fishes classified both *Alopias vulpinus* and *A. superciliosus* as Endangered (Nieto *et al.*, 2015).

At global level, all three species of thresher sharks were listed in Appendix II of CITES on 02/01/2017 (Entry into effect delayed by 12 months, i.e. until 04 October 2017). The species covered are the bigeye thresher *A. superciliosus,* and the look-alike species common thresher *A. vulpinus* and pelagic thresher *A. pelagicus*, which occurrence in the Atlantic Ocean is unconfirmed. The three *Alopias* species have also been listed in Appendix II of CMS since 2014.

11.13 Management considerations

There is limited knowledge of the stock structure or the exploitation status of these two species of thresher shark occurring in the NE Atlantic.

Liu *et al.* (1998) considered *Alopias* spp. to be particularly vulnerable to overexploitation; requiring a close monitoring because of their high vulnerability resulting from low fecundity and relatively high age of sexual maturity.

The 2008 Ecological risk assessments (ERA) undertaken by ICCAT for eleven pelagic sharks indicated that the bigeye thresher has the lowest productivity and highest vulnerability with a productivity rate of 0.010. In this study common thresher was ranked 10th, with a productivity rate of 0.141 (ICCAT, 2009a). The ERA was then updated and expanded notably with the addition of five species and the consideration of interactions between stocks and fisheries in 2012. This new ERA led to similar conclusions to the previous one, with bigeye thresher appearing as the most vulnerable species whereas common thresher gets an intermediate rank within the 20 stocks considered (Cortés *et al.*, 2015).

In 2009, the International Commission for the Conservation of Atlantic Tuna (ICCAT, 2009b) recommended the following:

1. "CPCs (The Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities) shall prohibit, retaining on board, transhipping, landing, storing, selling, or offering for sale any part or whole carcass of bigeye thresher sharks (*Alopias superciliosus*) in any fishery with exception of a Mexican small-scale coastal fishery with a catch of less than 110 fish;
2. CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, bigeye thresher sharks when brought along side for taking on board the vessel;
3. CPCs should strongly endeavour to ensure that vessels flying their flag do not undertake a directed fishery for species of thresher sharks of the genus *Alopias* spp.;
4. CPCs shall require the collection and submission of Task I and Task II data for *Alopias* spp. other than *A. superciliosus* in accordance with ICCAT data reporting requirements. The number of discards and releases of *A. superciliosus* must be recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements;
5. CPCs shall, where possible, implement research on thresher sharks of the species *Alopias* spp. in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate."

Some of these recommendations appear to have been acted on by the EU (see Section 11.2.4). In 2010, the General Fisheries Commission for the Mediterranean (GFCM) adopted ICCAT's thresher shark Recommendation (banning retention of bigeye threshers *A. superciliosus*).

11.14 References

Aalbers, S.A., Wang, M., Villafana, C., Sepulveda, C.A. 2021. Bigeye thresher shark *Alopias superciliosus* movements and post-release survivorship following capture on linked buoy gear. *Fisheries Research*, 236: 105857.

Bass, A.J., D'Aubrey, J.D. and Kistnasamy, N. 1975. Sharks of the East coast of southern Africa. 4. The *Families Odontaspididae, Scapanorhynchidae, Isuridae, Cetorhinidae, Alopiidae, Orectolobidae* and *Rhiniodontidae*. Report No. 39. Oceanographic Research Institute, Durban, South Africa, pp. 102.

Bedford, D. 1992. Thresher shark. *In*: California's Living Marine Resources and Their Utilization (Eds. S. Leet, C.M. Dewees and C.W. Haugen). Publication UCSGEP-92–12. California Sea Grant, Davis, CA, pp. 49–51.

Bowman R.E., Stillwell C.E., Michaels W.L. and Grosslein M.D. 2000. Food of Northwest Atlantic fishes and two common species of squid. *NOAA Technical Memorandum* NMFS-NE; 155, 138 pp.

Braccini, M., Van Rijn, J., and Frick, L. 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS One*, 7(2), e32547, 1–9.

Cao, D-M., Song, L-M., Zhang, Y., Lv, K-K., and Hu, Z-X. 2012. Environmental preferences of *Alopias superciliosus* and *Alopias vulpinus* in waters near the Marshall Islands. *New Zealand Journal of Marine and Freshwater Research*, 45: 103–119.

Carlson, J.K., and Gulak, S.J.B. 2012. Habitat use and movements patterns of oceanic whitetip, bigeye thresher and dusky sharks based on archival satellite tags. SCRS/2011/099.

Cartamil, D., Wraith, J., Wegner, N.C., Kacev, D., Lam, C.H., Santana-Morales, O., Sosa-Nishizaki, O., Escobedo-Olvera, M., Kohin, S., Graham, J.B. and Hastings, P. 2016. Movements and distribution of juvenile common thresher sharks *Alopias vulpinus* in Pacific coast waters of the USA and Mexico. *Marine Ecology Progress Series*, 548: 153–163.

Castro J. 1983. *The Sharks of North American Waters*. Texas A&M University: Texas A&M University Press, 192 pp.

Clo, S., Bonfil, R. and De Sabata, E. 2008. Additional records of the bigeye thresher shark, *Alopias superciliosus*, from the central and eastern Mediterranean Sea. *JMBA2 Biodiversity Records*, 2 pp.

Coelho, R., Fernandez-Carvalho, J., Santos, M.N. 2015. Habitat use and diel vertical migration of bigeye thresher shark: overlap with pelagic longline fishing gear. *Marine Environmental Research*, 112: 91–99. https://doi.org/10.1016/j.marenvres.2015.10.009

Corsini-Foka, M. and Sioulas, A. 2008. On two old specimens of *Alopias superciliosus* (Chondrichthyes: Alopiidae) from the Aegean waters. *JMBA2 Biodiversity Records*, 4 pp.

Cortés, E., Domingo, A., Miller, P., Forselledo, R., Mas, F. *et al.* 2015. Expanded ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Collect. Vol. Sci. Pap. ICCAT 71, 2637–2688

Ellis, J. R. 2004. The occurrence of thresher shark off the Suffolk coast. *Transactions of the Suffolk Naturalists' Society*, 40: 73–80.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Bio*logy, 90: 653–722.

Finotto, L., Barausse, A. and Mazzoldi, C. 2016. In search of prey: the occurrence of Alopias vulpinus (Bonnaterre, 1788) in the northern Adriatic Sea and its interactions with fishery. *Acta Adriatica*, 57: 295–304.

Fitch, J.E. and Craig, W.L. 1964. First records for the bigeye thresher (*Alopias superciliosus*) and slender tuna (*Allothunnus fallai*) from California, with notes on eastern Pacific scombrid otoliths. *California Fish and Game Quarterly*, 50: 195–206.

Gruber, S. H and Compagno, L.J.V. 1981. Taxonomic status and biology of the bigeye thresher, *Alopias superciliosus*. *Fishery Bulletin*, 79(4), 617–640.

Gubanov, Y.P. 1972. On the biology of the thresher shark [*Alopias vulpinus* (Bonnaterre)] in the Northwest Indian Ocean. *Journal of Ichthyology*, 12: 591–600.

Hutchinson, M., Siders, Z., Stahl, J., and Bigelow, K. 2021. Quantitative estimates of post-release survival rates of sharks captured in Pacific tuna longline fisheries reveal handling and discard practices that improve survivorship. PIFSC data report, DR-21-001. 56 pp.

ICCAT. 2009a. Report for biennial period 2008–2009; Part I (2008). Vol. 2. SCRS. 271 pp.

ICCAT. 2009b. Recommendation Rec.09-07 by ICCAT on the conservation of thresher sharks caught in association with fisheries in the ICCAT convention area.

ICCAT. 2020. Report for biennial period, 2018-19 PART II (2019). Vol. 2. SCRS. 462 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16, 424 pp.

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

ICES. 2015. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–23. June 2015, Lisbon, Portugal. ICES CM 2015/ACOM:19. 711 pp

Kinney, M.J., Kacev, D., Sippel, T., Dewar, H., and Eguchi, T. 2020. Common thresher shark *Alopias vulpinus* movement: Bayesian inference on a data-limited species. *Marine Ecology Progress Series*, 639: 155–167.

Kneebone, J., Bowlby, H., Mello, J.J., McCandless, C.T., Natanson, L.J., Gervelis, B., Skomal, G.B., Kohler, N., Bernal, D. 2020. Seasonal distribution and habitat use of the common thresher shark (*Alopias vulpinus*) in the western North Atlantic Ocean inferred from fishery-dependent data. *Fishery Bulletin*, 118(4): 399–412.

Liu, K.-M., Chiang, P.-J., and Chen, C.-T. 1998. Age and growth estimates of the bigeye thresher shark, *Alopias superciliosus*, in Northeastern Taiwan waters. Fishery Bulletin, 96: 482–491.

McCully, S.R., Scott, F., Ellis, J. R., and Pilling, G. M. 2013. Productivity and susceptibility analysis: application and suitability for data poor assessment of elasmobranchs in northern European seas. SCRS/2012/079. *Collective Volume of Scientific Papers ICCAT*, *69*(4), 1679–98.

Morales, M.J.A., Mendonça, F.F., Magalhães, C.O., Oliveira, C., Coelho, R., Santos, M.N., Cruz, V.P., Piercy, A., Burgess, G., Hazin, F.V., and Foresti, F. 2018. Population genetics of the bigeye thresher shark *Alopias superciliosus* in the Atlantic and Indian Oceans: implications for conservation. *Reviews in Fish Biology and Fisheries*, 28(4): 941–951.

Moreno, J., and Moron, J. 1992. Reproductive biology of the bigeye thresher shark, *Alopias superciliosus* (Lowe, 1839). *Australian Journal of Marine and Freshwater Research*, 43: 77–86.

Musyl, M.K., Brill, R.W., Curran, D.S., Fragoso N.M., McNaughton, L.M., Nielsen, A., Kikkawa, B.S., Moyes C.D. 2011. Postrelease survival, vertical and horizontal movements, and thermal habitats of five species of pelagic sharks in the central Pacific Ocean. *Fishery Bulletin*, 109(4):341–368.

Nakano, H., Matsunaga, H., Okamoto, H., and Okazaki, M. 2003. Acoustic tracking of bigeye thresher shark *Alopias superciliosus* in the eastern Pacific Ocean. *Marine Ecology Progress Series*, 265: 255–261.

Natanson, L.J., Hamady, L.L. and Gervelis, B.J. 2016. Analysis of bomb radiocarbon data for common thresher sharks, *Alopias vulpinus*, in the northwestern Atlantic Ocean with revised growth curves. *Environmental Biology of Fishes*, 99: 39–47.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J. *et al.* 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

Parra, H., Pham, C. K., Machete, M., Santos, M., Bjorndal, K. A., and Vandeperre, F. 2023. The Portuguese industrial pelagic longline fishery in the Northeast Atlantic: Catch composition, spatio-temporal dynamics of fishing effort, and target species catch rates. *Fisheries Research*, *264*: 106730.

Preti A., Smith SE. and Ramon D.A. 2001. Feeding habits of the common thresher shark (*Alopias vulpinus*) sampled from the California-based drift gill net fishery, 1998–1999. *Reports of California Cooperative Oceanic Fisheries Investigations*, 42: 145–152.

Preti A., Smith S.E. and Ramon D.A. 2004. Diet differences in the thresher shark (*Alopias vulpinus*) during transition from a warm-water regime to a cool-water regime off California- Oregon, 1998–2000. *Reports of California Cooperative Oceanic Fisheries Investigations*, 45, 118–125.

Preti, A., Soykan, C.U., Dewar, H., Wells, R.J.D., Spear, N., Kohin, S. 2012. Comparative feeding ecology of shortfin mako, blue and thresher sharks in the California Current. *Environmental Biology of Fishes*, 95: 127–146.

Quigley, D.T.G., Hannon, G. and Flannery, K. 2008. Thresher Shark *Alopias vulpinus* (Bonnaterre, 1788) in Irish waters: further records and a review of Irish records. *Irish Naturalists' Journal*, 29(1): 7–12.

Smith, S.E., Rasmussen, R.C., Ramon, D.A. and Cailliet, G.M. 2008. The biology and ecology of thresher sharks (Alopiidae). *In*: Sharks of the Open Ocean: Biology, Fisheries & Conservation (M.D.Camhi, E.K.Pikitch and E.A.Babcock, Eds). Blackwell Publishing, Oxford, UK. pp. 60–68.

Stick, K.C. and Hreha, L. 1989. *Summary of the 1988 Washington/Oregon experimental thresher shark gill net fishery*. Progress Report 275. Washington Department of Fish and Wildlife, Olympia, WA, pp.40.

Stillwell, C. and Casey, J.G. 1976. Observations on the bigeye thresher, *Alopias superciliosus*, in the western North Atlantic. *Fishery Bulletin*, 74: 221–225.

Teo, S., Garcia Rodriguez, E. and Sosa-Nishizaki. O. 2018. Status of Common Thresher Sharks, *Alopias vulpinus*, Along the West Coast of North America: Updated Stock Assessment Based on Alternative Life History. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-595. https://doi.org/10.7289/V5/TM-SWFSC-595.

Tsai, W.-P., Chang, Y.-J. and Liu, K.-M. 2019. Development and testing of a Bayesian population model for the bigeye thresher shark, *Alopias superciliosus*, in an area subset of the western North Pacific. Fisheries Management and Ecology. 26. 10.1111/fme.12347.

Weng, K. C., and Block, B. A. 2004. Diel vertical migration of the bigeye thresher shark (*Alopias superciliosus*), a species possessing orbital *Retia mirabilia*. *Fishery Bulletin*, 102: 221–229.

11.15 Tables and Figures

Table 11.1. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported catches of thresher sharks (1997 to 2022; ICCAT data, version of 31 January 2024). An unknown proportion of thresher sharks are reported in combined sharks. Areas are ADRI: Adriatic Sea; AZOR: Azores; IONIA: Ionian Sea; MDRA: Madeira; MEDI: Mediterranean Sea; NE: Northeast Atlantic; and S.SIC: Strait of Sicily. Note: 0 = values < 0.1. Considered reported catch type data as C (Catches), L (Landings) and DD (Discards – dead).

Flag	Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Algeria	MEDI																		
China (Taipei)	NE															0.2	2	1.2	0.1
Curaçao	NE																		
El Salvador	NE																		
Denmark	NE																		
Spain	MEDI	3.5	7.2	6.7	9.2	9	25.3	0.4	1.1			2.5	2.7	0.2					
	NE	190.33	167.4	49.6	42.1	109	48.6	26.1	63.2			43.9	70.4	77.7					
France	MEDI											5.7	9.6	5.7	1.6	1	0.5	1.4	
	NE								23.3	18.5		31.2		26	25.3	40.6	6.7	30.9	
Ireland	NE				0.1			0	0.1		0.3								

Flag	Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Italy	MEDI											7.4	5.5	13.9	4.1			21.3	
	ADRI																		2
	IONIA																		0
	S.SIC																		0.7
Malta	MEDI	0.1	0.7	0.2	1.4							0.2	0.1	0.3	0.1	0.1			
Portugal	AZOR									8.1	11.9	16.4	7.5	21.3	0.6				
	MDRA									0.1	1	3.1		0.1					
	MEDI						0.5				0.1								
	NE		0	1.3	1.8	1.6	21.2	17.5	20.9		94.5	81.3	45.8	43.1	15		0.6	1.4	
UK	NE										0	1.1	0.8	0.7	1.6	1.3	0.8	1.1	2

Flag	Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Guatemala	NE																		
Korea	NE																	0.3	
Liberia	NE																		
Mauritania	NE																		
Panama	NE																		
Russian Fed.																			
Senegal	NE												2.5	9					
TOTAL		193.8	175.3	57.8	54.6	119.6	95.7	44.1	108.6	26.7	107.8	192.8	144.9	198	48.5	43.3	10.6	57.6	4.9

Table 11.1 cont'. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported landings of thresher sharks (1997 to 2022; ICCAT data, version of 31 January 2024). An unknown proportion of thresher sharks are reported in combined sharks. Areas are ADRI: Adriatic Sea; AZOR: Azores; IONIA: Ionian Sea; MDRA: Madeira; MEDI: Mediterranean Sea; NE: Northeast Atlantic; and S.SIC: Strait of Sicily. Note: 0 = values < 0.1. Considered reported catch type data as C (Catches), L (Landings) and DD (Discards – dead)

Flag	Area	2015	2016	2017	2018	2019	2020	2021	2022
Algeria	MEDI	0.4			0.9	18.7	24.2	195.1	1.8
China (Taipei)	NE	0.8	1	0.2	0.4	0.2	0.1		0.1
Curaçao	NE			0					
El Salvador	NE			0					
Denmark	NE					0.4	0.2	0.2	0.4
Spain	MEDI								
	NE			0.1					
France	MEDI	2.5				0.6	1.7	1.0	0.4
	NE	38.8	35.2	55.9	44.6	47.2	62.4	66.2	39.2

Flag	Area	2015	2016	2017	2018	2019	2020	2021	2022
Ireland	NE								
Italy	MEDI		0.5	2.5	1.2	1.5	0.7	3.6	1.4
	ADRI								
	IONIA								
	S.SIC								
Malta	MEDI							0.2	
Portugal	AZOR								
	MDRA								
	MEDI								
	NE						0.6	0.2	0.3
UK	NE	2.5	3		0.6	0.6	0.7		0.3

Flag	Area	2015	2016	2017	2018	2019	2020	2021	2022
Guatemala	NE			0					
Korea	NE	0.5							
Liberia	NE				0.5				
Mauritania	NE		13.2						
Panama	NE			0					
Russian Fed.	NE					0			
Senegal	NE								
TOTAL		45.6	52.9	58.8	48.3	69.1	90.6	266.4	43.9

Table 11.2. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported catches of thresher shark by species and nation for EU and UK (ICCAT data, version of 31 January 2024). An unknown proportion of thresher sharks are reported in combined sharks. ALV = *Alopias vulpinus*, BTH = *Alopias superciliosus*, THR = *Alopias* spp. Note: 0 = values < 0.1. Considered reported catch type data as C (Catches), L (Landings) and DD (Discards – dead).

Year	Denmark	Spain			France			Ireland	Italy	Malta	Portugal			United Kingdom
	ALV	THR	BTH	ALV	THR	BTH	ALV	ALV	ALV	ALV	THR	BTH	ALV	THR
1997		25.2	138.4	30.1						0.1				
1998		26.9	103.8	43.9						0.7		0.0		
1999		56.3								0.2			1.3	
2000		22.6	21.0	7.7				0.1		1.4	1.8			
2001		61.6	35.4	21.0							1.6			
2002		24.5	38.0	11.4									21.7	
2003		1.3	17.5	7.7				0.0					17.5	
2004		10.8	37.4	16.1			23.3	0.1					20.9	
2005							18.5						8.1	
2006								0.3					107.5	0.0
2007			32.1	14.3			36.9		7.4	0.2	2.8	0.3	97.7	1.1
2008		73.1					9.6		5.5	0.1		0.6	52.7	0.8
2009			50.1	27.7			31.7		13.9	0.3			64.4	0.7
2010							27.0		4.1	0.1		0.7	15.0	1.6
2011					0.2	0.1	41.3			0.1				1.3
2012							7.2						0.6	0.8
2013							32.3		21.3			0.1	1.3	1.1
2014									2.7					2.0
2015							41.3							2.5
2016							35.2		0.5					3.0
2017			0.1				55.9		2.5					
2018							44.6		1.2					0.6
2019	0.4						47.8		1.5					0.6
2020	0.2						64.2		0.7				0.6	0.7
2021	0.2						67.2		3.6	0.2			0.2	
2022	0.4						39.6		1.4				0.3	0.3
TOTAL	0.7	302.4	473.7	180.0	0.2	0.1	584.1	0.5	64.8	3.4	6.2	1.7	409.5	16.9

Table 11.3. Thresher sharks in the Northeast Atlantic and Mediterranean Sea (FAO areas 27 and 37). Reported landings of thresher shark (*Alopias* spp.) for the period 2005–2022 (Data following the 2016–2023 data calls). Data are considered preliminary and more dedicated studies to refine a time series of thresher shark landings is required.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Denmark													<0.1		0.3	0.2	0.2	0.4	
France	33.1	36.2	42.1	26.5	38.7	28.0	51.3	34.0	33.6	42.9	38.8	70.3	55.9	44.6	47.2	62.4	66.2	38.7	47.5
Ireland		0.3																	0.1
Netherlands			0.1									<0.1							
Portugal	49.4	78.9	54.8	22.9	27.2	12.7	3.3	0.6	1.3	0.2	0.9	0.6	1.0	0.3	0.2	0.5	0.2	0.2	0.4
Slovenia																		0.1	
Spain	4.1	2.9	4.8	3.3	2.5	0.2	<0.1	0.1											
UK	0.4	<0.1	1.1	0.8	0.7	1.6	1.3	0.8	1.1	2.0	2.5	3.0		0.6	0.6	0.7	9.3	0.3	0.5
Total	87.0	118.3	102.9	53.4	69.1	42.6	56.0	35.5	36.0	45.1	42.3	73.9	56.8	45.6	48.2	63.8	75.8	39.7	48.4

Contents

12 Other pelagic sharks in the Northeast Atlantic

12.1 Ecosystem description and stock boundaries

In addition to the pelagic species discussed previously (Sections 6–11), several other pelagic sharks and rays occur in the ICES area (Table 12.1).

Many of these taxa, including hammerhead sharks (*Sphyrna* spp.) and requiem sharks (*Carcharhinus* spp.), are tropical to warm temperate species, and often coastal pelagic species. There are limited data with which to examine the stock structure of these species, and the ICES area would only be the northern extremes of their Northeast Atlantic distribution range.

Other species, including long-fin mako, silky shark and oceanic white-tip are truly oceanic and likely to have either North Atlantic or Atlantic stocks, although data to confirm the exact stocks boundaries are limited. These species are found mostly in the southern and southwestern parts of the ICES areas (subareas 9–10), though some may occasionally range further north into the Bay of Biscay (Subarea 8). Some of these species also occur in the Mediterranean Sea.

In October 2011, a whale shark *Rhincodon typus* was reported from southern Portugal (Rodrigues *et al.*, 2012), and the northern limits of this species also extend to the Azores (Afonso *et al.*, 2014).

12.1.1 Taxonomic changes

A recent treatise on batoids (Last *et al.*, 2016) considers all eight species of manta ray and devil ray to be in a single genus *Mobula,* with two of these species (giant manta ray *Mobula birostris* and giant devil ray *Mobula mobular* shown as occurring in the southernmost part of the ICES area (Subarea 9). Both these species also occur around the Azores (Subarea 10; Santos *et al.*, 1997), with Sobral and Afonso (2014) also indicating that Chilean devil ray *Mobula tarapacana* also occurred as far north as the Azores.

12.2 The fishery

12.2.1 History of the fishery

Pelagic sharks and rays are an incidental catch in tuna and billfish fisheries (mainly longline, but also purse seines) and a very occasional bycatch in other pelagic fisheries. Some, like hammerhead and requiem sharks, may constitute a noticeable component of the bycatch and were traditionally landed, whilst others are only recorded sporadically (e.g., white shark, tiger shark and *Mobula* spp.). Some of these pelagic species (e.g., silky shark and oceanic whitetip) are a regular bycatch in high seas fisheries, whilst others (e.g. various requiem sharks and hammerhead sharks) may be caught in continental shelf seas in the southern parts of the ICES area.

12.2.2 The fishery in 2023

No new information is available.

12.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

12.2.4 Management applicable

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of fins of these shark species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters. In June 2023, 'The Shark Fins Act 2023' was passed in the UK banning the import and export of detached shark fins, including all products containing shark fins.

Article 10 of Council Regulation (EU) 2019/1241 states the prohibition of for Union vessels to fish for, retain on board, tranship, land, store, sell, display or offer for sale the species listed in Annex I or species for which fishing is prohibited under other Union legal acts, and includes the following pelagic elasmobranchs relevant here:

- White shark *Carcharodon carcharias* in all waters;
- Mobulid rays (*Mobula* spp.) in all waters

Article 18 of Council Regulation (EU) 2023/194 lists prohibited species which, if caught accidentally, should not be harmed and should be released promptly. It is prohibited for EU vessels to fish for, to retain on board, to tranship or to land species listed in this Article, which include the following pelagic elasmobranch:

- Whale shark *Rhincodon typus* in all waters.

Article 25 of Council Regulation (EU) 2023/194 also lists prohibited species in relation to fisheries operating in the ICCAT Convention area. The species prohibited include hammerhead sharks (Family Sphyrnidae, except for *Sphyrna tiburo*), oceanic whitetip *Carcharhinus longimanus*, silky shark *Carcharhinus falciformis*, North Atlantic shortfin mako *Isurus oxyrinchus*, and bigeye thresher *Alopias superciliosus*.

The listings on Article 25 of Council Regulation (EU) 2023/194 are in support of ICCAT recommendations that Contracting Parties "prohibit, retaining on board, transhipping, landing, storing, selling, or offering for sale any part or whole carcass" of silky shark *Carcharhinus falciformis* (Recommendation 2011–08), oceanic whitetip shark *Carcharhinus longimanus* (Recommendation 2010–07), bigeye thresher *Alopias superciliosus* and all hammerhead sharks (Family Sphyrnidae, except bonnethead shark *Sphyrna tiburo*; Recommendation 2010–08). In addition, "It shall be prohibited to engage in directed fishery for species of thresher sharks of the *Alopias* genus".

In 2023 ICCAT agreed Recommendation 2023/12 that prohibits "*flagged fishing vessels from retaining on board, transhipping, or landing, in whole or in part, any specimen of whale shark (*Rhincodon typus*) caught in ICCAT fisheries*", and Recommendation 2023/14 for which CPCs "*shall prohibit retaining onboard, transhipping, landing or storing any part or whole carcass of all species of mobulid rays (family Mobulidae) taken in the Convention area in association with ICCAT fisheries*". Both recommendations will be effective no later than 1 July 2025, but only if there is a consensus on advice from SCRS that these taxa are "*of the greatest biological vulnerability and conservation concern for which there are very few data*", for which advice should be provided in 2024.

12.3 Catch data

12.3.1 Landings

No reliable estimates of landings or catches are available for these species, as many nations that land various species of pelagic sharks have often recorded them under generic landings categories. There can also be differences in the data reported to ICES, ICCAT and FAO, and so the most accurate data sources need to be verified. Historical species-specific landings reported to ICES were summarised in earlier WGEF reports.

Data (landings and dead discards) reported to ICCAT are given in Table 12.2, with the data presented here restricted to the years 2000–2021 and from ICCAT Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic (i.e., including the ICES area and extending southwards into the central eastern Atlantic (to 5°N), but excluding the Mediterranean Sea). Spain and Portugal are the main European nations reporting 'other pelagic shark species' from the Northeast Atlantic. Catch data were not updated during the 2024 meeting of WGEF.

The data that have been presented in the present report are shown by nation and year, and are shown for the various carcharhinid sharks (Tables 12.2a-b), hammerhead sharks (Tables 12.2c-d), lamniform sharks, other pelagic sharks and pelagic stingray (Table 12.2e), and mobulid rays (Table 12.2f).

12.3.2 Discards

No data are available. Some species were usually retained, but other species, such as the pelagic stingray, were usually discarded. There are now EU regulations to prohibit the retention of some of the species considered here, but discard data for these species are likely incomplete.

12.3.3 Quality of catch data

Landings/catch data have been reported inconsistently. For example, data for mobulid rays only appeared in the ICCAT time-series in 2017 (Table 12.2f), largely relating to reporting of dead discards. Some of the catch data that have been reported are known to be associated with coding errors (e.g. some of the reported landings of 'tiger shark' by the Netherlands, Table 12.2b), or suspected coding errors (e.g. the reported landings of white shark by Morocco, which were 92 t for 2011).

More dedicated effort to compile an appropriate time-series of landings is required, especially in relation to longfin mako (given that data for this species could usefully be appraised in relation to shortfin mako) and smooth hammerhead (given this species is one of the more frequent of the 'other pelagic sharks' in the ICES area).

Overall, catch data are of poor quality (see above), except for some occasional studies of the Spanish Atlantic swordfish longline fishery (e.g. Castro *et al*., 2000; Mejuto *et al*., 2002) and of Portuguese pelagic longline fishery in the Atlantic Ocean (e.g. Santos *et al*., 2014).

Biological data are not collected under the Data Collection Regulations, although some generic biological data are available (see Section 12.7). Species-specific identification in the field is problematic for some genera, notably for *Carcharhinus* spp., *Sphyrna* spp. and mobulid rays.

12.3.4 Discard survival

There have been several studies on the at-vessel mortality of pelagic sharks in longline fisheries, although more limited data are available for purse-seine fisheries. These studies were reviewed by Ellis *et al.* (2017).

12.4 Commercial catch composition

No data on the species and length composition of these species were available to WGEF.

12.5 Commercial catch and effort data

No CPUE data are available to WGEF for these pelagic sharks in the ICES area. ICCAT is the main source for appropriate catch and effort data for pelagic sharks.

12.6 Fishery-independent data

No fishery-independent data are available for these species in the ICES area.

12.7 Life-history information

The overall biology of several species has been reviewed, including white shark (Bruce, 2008), silky shark (Bonfil, 2008), oceanic whitetip (Bonfil *et al.*, 2008; Young & Carlson, 2020) and pelagic stingray (Neer, 2008). Other biological information is available in a range of sources (e.g. Branstetter, 1987, 1990; Stevens and Lyle, 1989; Shungo *et al.*, 2003; Piercy *et al.*, 2007). The main biological parameters are summarised in Table 12.3.

There is limited information on nursery or pupping grounds. Silky shark is thought to use the outer continental shelf as primary nursery ground (Springer, 1967; Yokota and Lessa, 2006), and young oceanic whitetip have been found offshore along the Southeast coast of the USA, suggesting offshore nurseries over the continental shelf (Seki *et al.*, 1998). Scalloped hammerhead nurseries are usually in shallow coastal waters.

In relation to *M. mobular*, Fortuna *et al.* (2014) estimated the size of the population of *M. mobular* in the Adriatic Sea as 3255 adults, from 60 field observations and available biological parameters. It was reported that several hundred specimens of *M. mobular* (estimates varied from 200–500) were caught by fishermen of the Gaza Strip on 27 February 2013.

Given the quantities of reported landings of longfin mako *Isurus paucus* and hammerhead sharks, of which *Sphyrna zygaena* is the main species occurring in the ICES area, further information is provided here for these two species.

12.7.1 Longfin mako *Isurus paucus*

Longfin mako is a pelagic species that is distributed widely in warm-temperate to tropical waters of the Atlantic, Indian and Pacific Oceans. Whilst most records of this species have been from the western Atlantic, including Cuba (Dodrill & Gilmore, 1979; Hueter *et al.*, 2017; Ruiz-Abierno *et al.*, 2021), it also occurs around the Azores, as far north as 44.8°N (Moreno & Moron, 1992; Queiroz *et al.*, 2008; Mucientes *et al.*, 2013) and occasional individuals have also been reported from the Mediterranean Sea (Hemida & Capapé, 2008).

Biological data for this species are limited. Typical of other lamnid sharks, it has a low fecundity (2–8 pups), which are born at about 97–120 cm (Gilmore, 1983; Compagno, 2001). The length at 50% maturity for males and females has been estimated at 215 cm and 230 cm total length, respectively (Ruiz-Abierno *et al.*, 2021). The smallest mature and largest immature females observed in that study were 220 cm and 257 cm, respectively, whilst the smallest mature and largest immature males were 208 cm and 224 cm, respectively (Ruiz-Abierno *et al.*, 2021).

Hueter *et al.* (2017) satellite tagged two individuals, which moved from the Gulf of Mexico into the oceanic waters of the western North Atlantic. These individuals also undertook vertical migrations, moving into surface waters at night, and spent most time at depths shallower than 600 m, with occasional dives into deeper (to 1767 m) waters.

Ellis *et al.* (2022) give a more detailed overview of the available data relating to longfin mako,

12.7.2 Smooth hammerhead *Sphyrna zygaena*

Smooth hammerhead is the more frequently recorded hammerhead shark occurring in both the ICES area and Mediterranean Sea (Celona & De Maddalena, 2005). Whilst this species has a global distribution, the Atlantic population(s) appears to be distinct to the Indo-Pacific (Miller, 2016). It appears to prefer warm (>23°C) surface waters. In the eastern Atlantic, it is more abundant in the warmer waters west of Africa, though the distribution extends up into Division 9.a (Couto *et al.*, 2018; Santos & Coelho, 2019), with very occasional records as far north as the British Isles (Southall & Sims, 2008).

The biology of the species in the Atlantic is little known, though there are studies from elsewhere in the world (Miller, 2016). Growth parameters for smooth hammerhead caught in the eastern Atlantic have been estimated by Coelho *et al.* (2011), based on 139 specimens of 136–233 cm fork length (L_F). The estimated VBGP were L_{inf} = 272 cm L_F, K = 0.06, t_0 = –9.4 (males) and L_{inf} = 285 cm L_F, K = 0.07, t_0 = –7.3 (females). A subsequent study with increased sample size (n = 304; 126–253 L_F) estimated the growth parameters as L_{inf} = 285 cm L_F, K = 0.09 and L_{inf} = 294 cm L_F, K = 0.09 for males and females, respectively (Rosa *et al.*, 2017).

The length-at-maturity (L50%; based on samples from the Pacific) is estimated at 194 cm L_T and 200 cm L_T for males and females, respectively (Nava Nava & Márquez-Farías, 2014), with higher estimates (L50% = 239.3 cm L_T (females) and 263.7 cm L_T (males)) provided by López-Martínez *et al.* (2020).

The oceanic movements of smooth hammerhead in the Atlantic were described by Santos & Coelho (2018), with neonates and juveniles occurring in shallow, coastal waters, and larger individuals making more oceanic movements (Diemer *et al.*, 2011; Francis, 2016; Santos & Coelho, 2018, 2019). Whilst based on studies in the eastern Pacific, Félix-López *et al.* (2019) suggested that smooth hammerhead displayed philopatric behaviour. The diet of smooth hammerhead has been described for many parts of the geographical range (Smale, 1991; Smale & Cliff, 1998; Gonzalez-Pestana *et al.*, 2017; Dicken *et al.*, 2018; Estupiñán-Montaño *et al.*, 2019).

12.8 Exploratory assessments

No assessments have been made of these stocks in the NE Atlantic. Cortés *et al.* (2010) undertook a level 3 quantitative Ecological Risk Assessment (ERA) for eleven pelagic elasmobranchs (blue shark, shortfin and longfin mako, bigeye and common thresher, oceanic whitetip, silky, porbeagle, scalloped and smooth hammerhead, and pelagic stingray). Of these species, silky shark was found to be high risk (along with shortfin mako and bigeye thresher sharks), and oceanic whitetip and longfin mako sharks were also considered to be highly vulnerable.

McCully *et al*. (2012) undertook a level 2, semi-quantitative ERA for pelagic fish in the Celtic Sea area, and of the 19 species considered (eight of which were elasmobranchs), porbeagle and shortfin mako were found to be at the highest risk in longline and setnet fisheries, followed by common thresher. A comparable analysis examining the pelagic ecosystem for the Northeast Atlantic could usefully be considered.

12.9 Stock assessment

No stock assessments have been undertaken.

12.10 Quality of the assessment

No stock assessments have been undertaken.

12.11 Reference points

No reference points have been proposed for these stocks.

12.12 Conservation considerations

The recent European Red List of European marine fish (Nieto *et al*., 2015) listed white shark *Carcharodon carcharias* as Critically Endangered (CR), and giant devil ray *Mobula mobular*, oceanic white-tip *Carcharhinus longimanus* and sandbar shark *Carcharhinus plumbeus* as Endangered (EN) in European seas. Many other pelagic sharks are listed as Data Deficient (DD) in European waters, including silky shark *Carcharhinus falciformis,* blacktip shark *C. limbatus,* dusky shark *C. obscurus,* tiger shark *Galeocerdo cuvier,* scalloped hammerhead *Sphyrna lewini,* great hammerhead *S. mokarran,* smooth hammerhead *S. zygaena* and longfin mako *Isurus paucus.* Pelagic stingray *Pteroplatytrygon violacea* is listed as Least Concern (LC).

Globally, many of the species considered here are listed as Threatened on the IUCN Red List (https://www.iucnredlist.org; consulted 16 June 2022), including *C. longimanus, S. lewini* and *S. mokarran* (CR), *I. paucus, R. typus, C. obscurus, C. plumbeus, C. signatus, M. mobular* and *M. birostris* (EN) and *C. carcharias, C. brachyurus, C. brevipinna, C. falciformis, C. limbatus* and *S. zygaena* (Vulnerable, VU), with *G. cuvier* listed as Near Threatened (NT) and *P. violacea* as LC.

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) lists several elasmobranchs on Appendix I (i.e. Contracting Parties that are a Range State should prohibit the taking of such species) including whale shark *Rhincodon typus, Carcharodon carcharias* and *Mobula* spp. These species are also listed on Appendix II of CMS (i.e. species that require international agreements for their conservation and management), with *Isurus paucus, Carcharhinus falciformis, Carcharhinus obscurus, Sphyrna lewini* and *S. mokarran* also listed on Appendix II. In 2020, *Sphyrna zygaena* was also added to Appendix II of CMS.

Carcharodon carcharias, Rhincodon typus, Carcharhinus falciformis, C. longimanus, Sphyrna lewini, S. mokarran, S. zygaena and *Mobula* spp. are also listed on Appendix II of CITES.

In 2022, all sharks in the family Carcharhinidae, thus including *Carcharhinus* spp., were added to Appendix II of CITES, with the listing coming into effect from 25 November 2023.

12.13 Management considerations

There is a paucity of fishery data for many of the species considered here, and this hampers the provision of management advice.

Some of the species considered in this section are included in various conservation initiatives, including CMS and CITES (see above), with some protected in the Mediterranean Sea, through their listing on Appendix II of the Barcelona Convention.

With sharks in the family Carcharhinidae being listed in Appendix II of CITES, there will be a need for a non-detriment finding (NDF) for import-export, and for when landing relevant species that were caught when vessels were operating outside their area of national jurisdiction.

In 2012, a consortium of scientific institutions (AZTI, IEO, IRD and IFREMER) obtained a contract from the EC to review the fishery and biological data for the main pelagic sharks and rays. The aim was to identify the gaps that could be filled within the framework of the EU's Action Plan for the Conservation and Management of Sharks ("Community Action Plan"), in order to improve the monitoring of these species taken in pelagic fisheries in the Atlantic, Indian and Pacific Oceans. The consortium reviewed and prioritised data and knowledge gaps, and potential research to fill gaps and to support the formulation of scientific advice for managers. The main gaps concerned fishery statistics, which are often not broken down by species, a lack of size–frequency data and limited regional biological/ecological information. The final report was given to the DG-Mare of the EU in May 2013 (DG-Mare, 2013).

A subsequent project updated this work, providing updated information on the occurrence of pelagic, oceanic sharks and rays in different fisheries, updated information on data collection and methodological approaches for assessing their status, a critical review of existing Conservation and Management Measures (CMMs) for sharks, summaries of their current conservation status, and identified approaches to improve and/or provide alternative options for conservation and fisheries managers. The final report (Coelho *et al.*, 2019) is available at https://publications.europa.eu/en/publication-detail/-/publication/bb27e867-6185-11e9-b6eb-01aa75ed71a1/language-en.

In 2013, the shark species group of ICCAT proposed the framework of a Shark Research and Data Collection Program (SRDCP) to fill gaps in knowledge on oceanic and pelagic sharks that are responsible for much of the uncertainty in stock assessments and have caused constraints to the provision of scientific advice (ICCAT, 2013).

In October 2019, STECF conducted a dedicated expert working group aiming to review the implementation of the shark finning regulation and to assess the impact of the 2009 European Community Action Plan for the Conservation and Management of sharks. A review of the fisheries potentially involved in catching sharks and in particular marketing shark fins was conducted for the EU nations with the main fishing fleets. This included finning of oceanic sharks, such as smooth hammerhead and silky shark, which have been reported in the fin trade (Fields *et al.*, 2017). The final report provided an overview of progress in fisheries management relating to elasmobranch during the 10 years subsequent to the implementation of the Community Action Plan, and proposed actions for improvements (STECF, 2019).

12.14 References

Afonso, P., McGinty, N. and Machete, M. 2014. Dynamics of whale shark occurrence at their fringe oceanic habitat. *PLoS One*, 9(7), p.e102060.

Bonfil, R. 2008. The biology and ecology of the silky shark, *Carcharhinus falciformis*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M. D. Camhi, E. K. Pikitch and E. A. Babcock, Eds). Blackwell Publishing, Oxford, UK, 114–127.

Bonfil, R., Clarke, S. and Nakano, H. 2008. The biology and ecology of the oceanic whitetip shark, *Carcharhinus longimanus*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M. D. Camhi, E. K. Pikitch and E. A. Babcock, Eds). Blackwell Publishing, Oxford, UK, 128–139.

Branstetter, S. 1987. Age, growth and reproductive biology of the silky shark, *Carcharhinus falciformis* and the scalloped hammerhead, *Sphyrna lewini*, from the Northwestern Gulf of Mexico. *Environmental Biology of Fishes*, 19: 161–173.

Branstetter, S. 1990. Early life-history implications of selected Carcharinoid and Lamnoid sharks of the Northwest Atlantic. *NOAA Technical Report NMFS*, 90: 17–28.

Bruce, B. D. 2008. The biology and ecology of the white shark, *Carcharodon carcharias*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M. D. Camhi, E. K. Pikitch and E. A. Babcock, Eds). Blackwell Publishing, Oxford, UK, 69–81.

Brum, J.M.M. and Azevedo, J.M.N. 1995. First record of the Galapagos shark *Carcharhinus galapagensis* (Snodgrass & Heller, 1905)(Carcharinidae) on the Azores. *Boletim do Museu Municipal do Funchal*, Supl. No. 4: 139–143.

Castro, J., de la Serna, J.M., Macias, D., and Mejuto J. 2000. Estimaciones centificas preliminares de los desembarcos de especies asociadas realizados por la flota española de palange de superficie en 1997 y 1998. ICCAT SCRS/1999/082, Collection of Scientific Papers, 51(6): 1882–1893.

Celona, A. and De Maddalena, A. 2005. Occurrence of hammerhead sharks (Chondrichthyes: Sphyrnidae) in waters off Sicily (central Mediterranean): historical and recent data. *Annales: Series Historia Naturalis*, 15: 57–64.

Coelho, R., Apostolaki, P., Bach, P., Brunel, T., Davies, T., Díez, G., Ellis, J., Escalle, L., Lopez, J., Merino, G., Mitchell, R., Macias, D., Murua, H., Overzee, H., Poos, J. J., Richardson. H., Rosa, D., Sánchez, S., Santos, C., Séret, B., Urbina, J. O. and Walker, N. 2019. Improving scientific advice for the conservation and management of oceanic sharks and rays. Final Report, Specific Contract No 1, Framework Contract EASME/EMFF/2016/008; 658 pp.

Coelho, R., Fernandez-Carvalho, J., Amorim, S. and Santos, M. N. 2011. Age and growth of the smooth hammerhead shark, *Sphyrna zygaena*, in the Eastern Equatorial Atlantic Ocean, using vertebral sections. *Aquatic Living Resources*, 24: 351–357.

Compagno, L.J.V. 2001. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). *FAO Species Catalogue for Fishery Purposes*. No. 1, Vol. 2. Rome: FAO; 269 pp.

Cortés, E. Arocha, F. Beerkircher, L. Carvalho, F. Domingo, A. Heupel, M., Holtzhausen, H. Santos, M.N., Ribera, M. and Simpfendorfer C. 2010. Ecological Risk Assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. *Aquatic Living Resources*, 23: 25–34.

Couto, A., Queiroz, N., Ketchum, J. T., Sampaio, E., Furtado, M., Cid, A. A., Castro, J. and Rosa, R. 2018. Smooth hammerhead sharks (*Sphyrna zygaena*) observed off the Portuguese southern coast. *Environmental Biology of Fishes*, 101: 1261–1268.

DG-Mare. 2013. Studies for Carrying out the Common Fisheries Policy (Reference: Mare/2010/11) LOT 2: Provision of scientific advice for the purpose of the implementation of the EUPOA sharks. Final report for the Directorate-General for Maritime Affairs and Fisheries. AZTI, IRD, Ifremer, IEO, 31st May 2013, 474 pp.

Dicken, M. L., Winker, H., Smale, M. J. and Cliff, G. 2018. Sharks caught in the KwaZulu-Natal bather protection programme, South Africa. 14. The smooth hammerhead shark *Sphyrna zygaena* (Linnaeus). *African Journal of Marine Science*, 40: 157–174.

Diemer, K. M., Mann, B. Q. and Hussey, N. E. 2011. Distribution and movement of scalloped hammerhead *Sphryna lewini* and smooth hammerhead *Sphyrna zygaena* sharks along the east coast of southern Africa. *African Journal of Marine Science*, 33: 229–238.

Dodrill, J.W. and Gilmore, R.G. 1979. First North American continental record of the longfin mako (*Isurus paucus* Guitart Manday). *Florida Scientist*, 42: 52–58.

Domingo, A., Coelho, R., Cortes, E., Garcia-Cortes, B., Mas, F., Mejuto, J., Miller, P., Ramos-Cartelle, A., Santos, M.N. and Yokawa, K. 2016. Is the tiger shark *Galeocerdo cuvier* a coastal species? Expanding its distribution range in the Atlantic Ocean using at-sea observer data. *Journal of Fish Biology*, 88: 1223–1228.

Ebert, D.A. and Stehmann, M.F.W. 2013. Sharks, batoids, and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes. No. 7. Rome, FAO. 523 pp.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. (2017). A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, 90: 653–722.

Ellis, J. R., Reeves, S. and McCully Phillips, S.R. (2022). Longfin mako *Isurus paucus*: the forgotten cousin. *Collective Volume of Scientific Papers ICCAT*, 79(4): 183–202.

Estupiñán-Montaño, C., Cedeño-Figueroa, L., Estupiñán-Ortiz, J. F., Galván-Magaña, F., Sandoval-Londoño, A., Castañeda-Suarez, D. and Polo-Silva, C. J. 2019. Feeding habits and trophic level of the smooth hammerhead shark, *Sphyrna zygaena* (Carcharhiniformes: Sphyrnidae), off Ecuador. *Journal of the Marine Biological Association of the United Kingdom*, 99: 673–680.

Félix-López, D. G., Bolaño-Martinez, N., Díaz-Jaimes, P., Oñate-González, E. C., Ramírez-Pérez, J. S., García-Rodríguez, E., Corro-Espinosa, D., Osuna-Soto, J. E. and Saavedra-Sotelo, N. C. 2019. Possible female philopatry of the smooth hammerhead shark *Sphyrna zygaena* revealed by genetic structure patterns. *Journal of Fish Biology*, 94: 671–679.

Fields, A.T., Fischer, G.A., Shea, S.K.H., Zhang, H., Abercrombie, D.L., Feldheim, K.A., Babcock, E.A. & Chapman, D.D. (2017). Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. *Conservation Biology*, 32, 376–389.

Fortuna, C., Kell, L., Holcer, D., Canese, S., Filidei, E., Mackelworth, P. and Donavan, G. 2014. Summer distribution and abundance of the giant devil ray *(Mobula mobular*) in the Adriatic Sea: Baseline data for an iterative management framework. *Scientia Marina*, 78: 227–237.

Francis, M. P. 2016. Distribution, habitat and movement of juvenile smooth hammerhead sharks (*Sphyrna zygaena*) in northern New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 50: 506–525.

Gilmore, R.G. 1983. Observations on the embryos of the longfin mako, *Isurus paucus*, and the bigeye thresher, *Alopias superciliosus*. *Copeia* 1983(2): 375–382.

Gonzalez-Pestana, A., Acuna-Perales, N., Coasaca-Cespedes, J., Cordova-Zavaleta, F., Alfaro-Shigueto, J., Mangel, J.C. and Espinoza, P., 2017. Trophic ecology of the smooth hammerhead shark (*Sphyrna zygaena*) off the coast of northern Peru. *Fishery Bulletin*, 115: 451–459.

Hemida, F. and Capapé, C. 2008. On the occurrence of the longfin mako, *Isurus paucus* (Chondrichthyes: Isuridae) off the Algerian coast (southwestern Mediterranean). *Acta Adriatica*, 49: 185–189.

Hueter, R. E., Tyminski, J. P., Morris, J. J., Ruiz Abierno, A. and Angulo Valdes, J. 2017. Horizontal and vertical movements of longfin makos (*Isurus paucus*) tracked with satellite linked tags in the northwestern Atlantic Ocean. *Fishery Bulletin*, 115: 101–116.

ICCAT. 2013. Report of the 2013 inter-sessional meeting of the shark species group. Mindelo, Cape Verde, April 8–12, 2013. 81 pp.

Last, P. R., White, W. T., de Carvalho, M. R., Séret, B., Stehmann, M. F. W. and Naylor, G. J. P. 2016. Rays of the World. CSIRO Publishing & Cornell University Press, Comstock Publishing Associates, vii + 790 pp.

López-Martínez, J., Cabanilla-Carpio, C., Ruiz Choez, W. and Arzola-Sotelo, E.A., 2020. Interannual variability of distribution, abundance and population dynamics of the smooth hammerhead *Sphyrna zygaena* (Linnaeus, 1758) in the central-southeast Pacific Ocean. *Journal of Fish Biology*, 97: 341–353.

McCully, S. R., Scott, F., Ellis, J. R. and Pilling, G. M. 2012. Productivity and susceptibility analysis: Application and suitability for data poor assessment of UK elasmobranchs. ICCAT SCRS/2012/079.

Mejuto, J., Garcia-Cortes, B., and de la Serna, J. M. 2002. Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea. ICCAT SCRS/2001/049, Collection of Scientific Papers, 54(4): 1150–1163.

Miller, M. H. 2016. Endangered Species Act status review report: Smooth hammerhead shark (*Sphyrna zygaena*). Report to National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, 167 pp.

Moreno, J. and Moron, J. 1992. Comparative study of the genus *Isurus* (Rafinesque, 1810), and description of form ("Marrajo Criollo") apparently endemic to the Azores. *Australian Journal of Marine and Freshwater Research*, 43: 109–122.

Mucientes, G., Bañon, R. and Queiroz, N. 2013. Updated distribution range of longfin mako *Isurus paucus* (Lamniformes: Lamnidae) in the North Atlantic. *Journal of Applied Ichthyology*, 29: 1163–1165.

Nava Nava, P. and Márquez-Farías, J.F. 2014. Talla de madurez del tiburón martillo, *Sphyrna zygaena*, capturado en el Golfo de California. *Hidrobiológica*, 24: 129–135.

Neer, J. A. 2008. The biology and ecology of the pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832). In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M. D. Camhi, E. K. Pikitch and E. A. Babcock. Eds). Blackwell Publishing, Oxford, UK, 152–159.

Nieto, A. *et al.* 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

Piercy, A. N, Carlson, J. K, Sulikowski, J. A., and Burgess, G. H. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrna lewini*, in the Northwest Atlantic Ocean and Gulf of Mexico. *Marine and Freshwater Research*, 58: 34–40.

Queiroz, N., Araújo, S., Ribeiro, P.A., Tarroso, P., Xavier, R. and Santos, A.M. 2008. A first record of longfin mako, *Isurus paucus*, in the mid-North Atlantic. *Marine Biodiversity Records*, 1.

Rodrigues, N.V., Correia, J.P.S., Graça, J.T.C., Rodrigues, F., Pinho, R. and Hirofumi, M. 2012. First record of a whale shark *Rhincodon typus* in continental Europe. *Journal of Fish Biology*, 81: 1427–1429.

Rosa, D., Coelho, R., Fernandez-Carvalho, J. and Santos, M.N. 2017. Age and growth of the smooth hammerhead, *Sphyrna zygaena*, in the Atlantic Ocean: comparison with other hammerhead species. *Marine Biology Research*, 13: 300–313.

Ruiz-Abierno, A., Márquez-Farías, J.F., Trápaga-Roig, M. and Heuter, R.E. 2021. Length at maturity of two pelagic sharks (*Isurus paucus* and *Carcharhinus longimanus*) found off northern Cuba. *Bulletin of Marine Science*, 97: 77–88.

Santos, C. C. and Coelho, R. 2018. Migrations and habitat use of the smooth hammerhead shark (*Sphyrna zygaena*) in the Atlantic Ocean. *PloS one*, 13(6), p.e0198664.

Santos, C. C. and Coelho, R., 2019. Distribution patterns and indicators of the smooth hammerhead shark (*Sphyrna zygaena*) in the Atlantic Ocean. *Fisheries Research*, 212: 107–113.

Santos, M. N., Coelho, R., Lino, P. G., and Fernandez-Carvalho, J. 2014. Preliminary observations on elasmobranchs by-catch-at-size and sex ratios on the pelagic longline fishery in the Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 70(5), 2416-2432.

Santos, R. S., Porteiro, F. M. and Barreiros, J. P., 1997. Marine fishes of the Azores: annotated checklist and bibliography. *Arquipélago* (Life and Marine Sciences) Supplement 1: xxiii + 242 pp.

Scientific, Technical and Economic Committee for Fisheries (STECF). 2019. Review of the implementation of the shark finning regulation and assessment of the impact of the 2009 EU action plan on sharks (STECF-19-17). Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11287-7, doi: 10.2760/487997, PUBSY No JRC119051.

Seki, T., Taniuchi, T., Nakano, H., and Shimizu, M. 1998. Age, growth and reproduction of the oceanic whitetip shark from the Pacific Ocean. *Fisheries Sciences*, 64: 14–20.

Shungo, O., Hideki, N. and Sho, T. 2003. Age and growth of the silky shark *Carcharhinus falciformis* from the Pacific Ocean. *Fisheries Sciences*, 69(3): 456.

Smale, M. J. 1991. Occurrence and feeding of three shark species, *Carcharhinus brachyurus, C. obscurus* and *Sphyrna zygaena*, on the Eastern Cape coast of South Africa. *South African Journal of Marine Science*, 11: 31–42.

Smale, M. J. and Cliff, G. 1998. Cephalopods in the diets of four shark species (*Galeocerdo cuvier, Sphyrna lewini, S. zygaena* and *S. mokarran*) from KwaZulu-Natal, South Africa. *South African Journal of Marine Science*, 20: 241–253.

Sobral, A. F. and Afonso, P. 2014. Occurrence of mobulids in the Azores, central North Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 94: 1671–1675.

Southall, E. J. and Sims, D. W. 2008. A smooth hammerhead shark (*Sphyrna zygaena*) from south-west England. *Marine Biodiversity Records*, 1, 2pp.

Springer, S. 1967. Social organizations of shark populations. *In*: Gilbert P.W. (ed.) Sharks, Skates and Rays. John Hopkins Press, Baltimore, 149–174.

Stevens, J. D., and Lyle, J. M. 1989. Biology of three hammerhead sharks (*Eusphyrna blochii, Sphyrna mokarran* and *S. lewini*) from northern Australia. *Australian Journal of Marine and Freshwater Research*, 40: 129–146.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C. Nielsen, J. T., and Tortonese, E. (Eds) 1989. Fishes of the North-eastern Atlantic and the Mediterranean. 510 pp.Yokota, L. and Lessa, R. P. 2006. A nursery area for sharks and rays in Northeastern Brazil. *Environmental Biology of Fishes*, 75: 349–360.

Young, C. N. and Carlson, J. K. 2020. The biology and conservation status of the oceanic whitetip shark (*Carcharhinus longimanus*) and future directions for recovery. *Reviews in Fish Biology and Fisheries*, 30: 293–312.

12.15 Tables and Figures

Table 12.1. Other pelagic sharks in the Northeast Atlantic. Summary of the distribution of pelagic elasmobranchs in the ICES area. Species that are resident or caught frequently in an area are denoted ●, species that may occur as occasional vagrants denoted ⦿ and species that have not been recorded in an area are denoted ○. Adapted from Whitehead *et al.* (1989) and Ebert & Stehmann (2013).

Family	Common name	Scientific name	ICES Subarea					Notes
			7	8	9	10	12	
Lamnidae	White shark	*Carcharodon carcharias*	○	⦿	⦿	⦿	⦿	[1]
	Longfin mako	*Isurus paucus*	○	○	⦿	●	⦿	
Pseudocar-charidae	Crocodile shark	*Pseudocarcharias kamoharai*	○	○	○	?	○	
Rhincodontidae	Whale shark	*Rhincodon typus*	○	○	⦿	⦿	○	
Carcharhinidae	Bronze whaler	*Carcharinus brachyurus*	○	○	?	○	○	
	Spinner shark	*Carcharhinus brevipinna*	○	○	⦿	○	○	
	Silky shark	*Carcarhinus falciformis*	○	○	⦿	⦿	○	
	Galapagos shark	*Carcharhinus galapagensis*	○	○	○	⦿	○	[2]
	Blacktip shark	*Carcharhinus limbatus*	○	○	⦿	○	○	
	Oceanic whitetip	*Carcharhinus longimanus*	○	⦿	⦿	⦿	?	[3]
	Dusky shark	*Carcharhinus obscurus*	○	○	⦿	?	○	
	Sandbar shark	*Carcharhinus plumbeus*	○	⦿	⦿	○	○	
	Night shark	*Carcharhinus signatus*	○	○	?	○	○	
Galeocerdonidae	Tiger shark	*Galeocerdo cuvier*	?	?	?	⦿	⦿	[4]
Sphyrnidae	Scalloped hammerhead	*Sphyrna lewini*	○	○	?	?	○	
	Great hammerhead	*Sphyrna mokarran*	○	○	?	○	○	
	Smooth hammerhead	*Sphyrna zygaena*	⦿	⦿	⦿	⦿	?	
Dasyatidae	Pelagic stingray	*Pteroplatytrygon violacea*	⦿	⦿	●	⦿	?	[5]
Mobulidae	Giant devil ray	*Mobula mobular*	⦿	⦿	⦿	⦿	○	[6]
	Giant manta ray	*Mobula birostris*	○	○	⦿	⦿	○	
	Sicklefin devil ray	*Mobula tarapacana*	○	○	○	⦿	○	
	Bentfin devil ray	*Mobula thurstoni*	○	○	○	?	○	

[1] Three records from the Bay of Biscay; [2] see Brum and Azevedo (1995); [3] One individual stranded in Swedish waters; [4] Some unconfirmed sightings in northern Europe, see also Domingo *et al.* (2016); [5] Two specimens recorded from the North Sea; [6] Individual specimens reported from the Bay of Biscay (capture) and Celtic Sea (stranding).

Table 12.2a. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Species code	Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
C. albimarginatus	ALS	FRA											0.0	0.1										
C. brachyurus	BRO	ESP									0.5	0.4												
C. brevipinna	CCB	FRA										0.0												
C. falciformis	FAL	TAI							1.0	1.0	0.8	2.6		0.0	0.3			0.0				0.0		
		CUW																		4.2				
		SLV																		17.4				
		ESP		0.8		0.1	4.3			62.7		21.8								43.5				
		FRA																4.0	0.3	29.4	6.1	2.2	2.8	0.8
		PRT										0.3	0.0	55.7	0.4	0.0								0.0
		GTM																		0.4				
		LBR																			11.9	25.1	15.7	0.0
		MRT																	0.3					
		PAN																		4.0				
		USA							0.1		0.1	0.4												
C. galapagensis	CCG	ESP										1.2												
C. leucas	CCE	FRA										0.0												
C. limbatus	CCL	ESP		0.0									4.8											
		FRA										0.0												
		PRT												0.2		0.0								
C. longimanus	OCS	TAI												0.0	0.0				0.0					
		CUW																		0.0				
		SLV																		0.0				
		ESP	0.0	3.8	0.1	0.1				3.8		20.1	66.9							0.0				
		FRA										0.7								0.1	0.0			
		PRT						0.4	0.1		1.2	1.2	18.5											
		KOR																0.0						
		PAN																		0.0				
		USA									0.3	1.0	0.0											
C. obscurus	DUS	FRA										0.8	0.1	0.2										
		NLD									0.2	0.9		0.3	0.1									
		MAR												6.0	0.6	3.0								
		USA								0.3														

Table 12.2b. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Species code	Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
C. plumbeus	CCP	ESP										4.2	0.1											
		PRT						0.1					0.1		0.2	0.9								
		SEN								0.4						0.4								
		USA							0.1			0.1												
C. signatus	CCS	ESP		0.0			0.1						2.0											
		SEN														6581.0								
		USA									0.1													
R. acutus	RHA	SEN	20.0	138.0	11.0	23.0	1.0	11.0	16.0	5.0		68.0		6.0	3.0									
Carcharhinidae	RSK	CUW																		0.0				
		SLV																		0.1				
		ESP		119.5	93.5	108.2	127.9				31.9			66.3	7.8	5.8				0.1				
		FRA									506.7	1.5	0.4	2.9										
		PRT				168.8		24.3	23.3	494.9			0.2											
		MAR															238.0	921.8		89.3				
		PAN																		0.0				
		SEN	1714.0	1806.0	1045.0	1387.0	1651.0	5401.0	1035.0	1221.0	1253.0	375.0	426.0	898.0	3649.6		727.6	320.9	524.1	55.6	65.6	27.6	109.3	48.2
G. cuvier	TIG	ESP	8.2	4.7	3.5	2.7	4.7			2.7		2.4	0.8	3.3	0.1	0.0								
		NLD								37.0	30.0	32.2		49.5	14.9									
		LBR																					0.9	
		BMU	4.0																					
		USA									0.2													

Table 12.2c. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Species code	Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
S. lewini	SPL	TAI																0.0						
		CUW																		0.4				
		SLV																		0.6				
		ESP		0.1		0.1	2.2			0.3		0.5								3.1				
		FRA										0.1						0.0	0.0	1.5	0.1	0.0		0.0
		GBR										11.5	0.3											
		GTM																		0.1				
		KOR																0.1						
		MAR												1.0	0.4									
		PAN																		0.3				
		RUS																		0.0				
S. mokarran	SPK	CUW																		0.0				
		SLV																		0.2				
		ESP																		0.8				
		FRA																			0.1			
		GTM																		0.0				
		LBR																			1.2			
		PAN																		0.3				
S. zygaena	SPZ	TAI																	0.1		0.0			
		CUW																		0.1				
		SLV																		0.0				
		ESP	1.6	4.8	1.7	0.6	12.6			2.0		0.2								0.3				
		FRA																		0.8	0.4	9.9	2.0	
		PRT				2.0		3.9	10.2	10.6	0.1	1.1	5.9		0.7	0.7	0.2						0.2	
		GBR													0.0	0.0			0.0	0.1			0.0	
		GTM																		0.0				
		KOR												0.8	1.0		0.1							
		MAR												153.0	155.0									
		PAN																		0.0				
		RUS																		0.1	0.0	0.1		
		SEN						7.0							1.4	438.7		2.3						

Table 12.2d. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Species code	Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sphyrna spp.	SPN	ESP	369.2	303.9	429.0	287.1	446.5			130.5		126.7		0.1										
		FRA												0.1										
		PRT	0.2	0.3		8.6	16.9	26.1	25.4	20.9	24.4	15.1	44.9		0.1	0.3								
		SEN	57.0	1464.0	36.0	71.0	168.0	318.0	173.0	154.0	110.0	101.0	56.0	51.0	101.0		112.5	166.9					87.2	91.7
		USA							0.1															
Sphyrnidae	SPY	TAI												0.0	0.2									
		CUW																		0.0				
		SLV																		0.1				
		ESP									138.6									0.3				
		FRA												0.1										
		GTM																		0.0				
		PAN																		0.0				
		SEN													1.0				238.7	28.8	35.8	243.2		

Table 12.2e. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Spe-cies code	Na-tion	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
R. typus	RHN	FRA											0.2	0.2										
C. taurus	CCT	FRA										0.1	0.5	3.1										
		NLD													3.2									
		SEN									48.9													
C. carcharias	WSH	TAI												0.0	0.1	0.1								
		FRA												0.1										
		PRT						5.9								0.0								
		MAR												92.0	11.0	24.8	7.0							
		SEN											17.6											
		USA						0.3	0.0															
I. paucus	LMA	ESP	16.0	38.1	52.6	52.0	47.3			40.2		64.6	37.3	42.8	90.5	94.0	63.6	34.4	42.3	33.2	77.9	80.6	6.3	
		PRT											1.0	0.0	4.5	1.0	1.1							
		LBR																			19.1			
		USA									0.4	0.8	0.9											
Lamnidae	MSK	ESP	139.1								39.5													
		FRA										3.7												
		IRL										0.1												
		SEN										4.0												
P. kamoharai	PSK	KOR																1.4						
P. violacea	PLS	CUW																		0.0				
		SLV																		0.0				
		ESP																		0.0				
		FRA																0.0			0.0	0.0	0.0	
		GTM																		0.0				
		KOR																0.0						
		PAN																		0.0				

Table 12.2f. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (2000–2021) as reported to ICCAT (Task 1 Nominal catch data; downloaded 20/06/2023; ICCAT version of 26/01/2023, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Species	Species code	Nation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
M. birostris	RMB	CUW																		0.1				
		SLV																		0.0				
		ESP																		0.2				
		GTM																		0.0				
		PAN																		0.0				
M. japanica	RMJ	CUW																		0.3				
		SLV																		0.2				
		ESP																		1.4				
		FRA																		0.1				
		GTM																		0.0				
		PAN																		0.1				
M. mobular	RMM	CUW																		0.2				
		SLV																		1.2				
		ESP																		2.6				
		FRA																		0.2	1.4	4.2		0.1
		GTM																		0.0				
		PAN																		0.2				
M. tarapacana	RMT	FRA																				0.2	1.2	
M. thurstoni	RMO	FRA																						0.4
Mobulidae	MAN	CUW																		0.4				
		SLV																		0.1				
		ESP																		1.3				
		GTM																		0.0				

Table 12.3. Other pelagic sharks in the Northeast Atlantic. Preliminary compilation of life-history information for NE Atlantic sharks.

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
White shark *Carcharodon carcharias*	Cosmopolitan 0–1280 m	720	Ovovivip-arous+ ooph-agy	372–402	8–10	?	7–14	120–150	36	L∞ = 544 K= 0.065 T0 = −4.40	4.42–4.53
Longfin mako *Isurus paucus*	Cosmopolitan	417	Ovovivip-arous	230 F 215 M			2–8	97–120			4.5
Spinner shark *Carcharhinus brevipinna*	Circumtropi-cal 0–100 m	300	Viviparous	176–212	7.8–7.9	10–12	Up to 20	60–80		L∞ = 214 FL K= 0.210 T0 = −1 .94	4.2–4.5
Silky shark *Carcharhinus falciformis*	Circumtropi-cal 0–500 m	350	Viviparous	210–220 M 225 F	6–7 7–9	12	2–15	57–87	25	L∞ = 291/315 K= 0.153 / 0.1 T0 = −2.2 / − 3.1	4.4–4.52
Oceanic whitetip *Carcharhinus longimanus*	Cosmopolitan 0–180 m	396	Viviparous	175–189	4–7	10–12	1–15	60–65	22	L∞ = 245 / 285 K= 0.103 / 0.1 T0 = 2.7 / −	4.16–4.39
Dusky shark *Carcharhinus obscurus*	Circumglobal	420	Viviparous	220–280	14–18	22–24	3–14	70–100	40	L∞ = 349 / 373 K= 0.039/ 0.038	4.42–4.61
Sandbar shark *Carcharhinus plumbeus*	Circumglobal 0–1800 m	250	Viviparous	130–183	13–16	12	1–14	56–75	32	L∞ = 186 FL K= 0.046 T0 = −6.45	4.23–4.49
Night shark *Carcharhinus signatus*	Atlantic 0–600 m	280	Viviparous	185–200	8–10	~12	4–12	60		L∞ = 256 / 265 K= 0.124 / 0.114	4.44–4.5
Tiger shark *Galeocerdo cuvier*	Circumglobal 0–350 m	740	Ovovivip-arous	316–323	8–10	13–16	10–82	51–104	50	L∞ = 388 / 440 K= 0.18 / 0.107	4.54–4.63
Scalloped hammerhead *Sphyrna lewini*	Cosmopolitan 0–512 m	430	Viviparous	140–250	10–15	9–10	13–31	45–50	35	L∞ = 320 / 321 K= 0.249 / 0.222	4.0–4.21

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
Great hammerhead *Sphyrna mokarran*	Circumglobal 1–300 m	610	Viviparous	250–292		11	13–42	60–70		L∞ = 264 / 308 (FL) K= 0.16 / 0.11 T0 = -1.99 / -	4.23–4.43
Smooth hammerhead *Sphyrna zygaena*	Circumglobal 0–200 m	500	Viviparous	210–265		10–11	20–50	50–60			4.32–4.5
Pelagic stingray *Pteroplatytrygon violacea*	Cosmopolitan 37–238	160	Ovoviviparous	35–40 DW	2–3	2–4	4–9	15–25 DW	~10	L∞ = 116 DW K= 0.0180	4.36
Gian devilray *Mobula mobular*	NE Atl. + Med. epipelagic	520	Ovoviviparous			25	1	≤ 166 DW			3.71

Contents

13 Demersal elasmobranchs in the Barents Sea

13.1 Ecoregion and stock boundaries

The ecology of the Barents Sea ecosystem (ICES Subarea 1, extending into the eastern parts of Subarea 2) has been described comprehensively by Jakobsen and Ozhigin (2012).

Lynghammar *et al*. (2013) reviewed the occurrence of chondrichthyan fishes in the Barents Sea ecoregion. The skate species reported from the offshore areas of this ecoregion include thorny skate *Amblyraja radiata*, Arctic skate *Amblyraja hyperborea*, round skate *Rajella fyllae*, spinytail skate *Bathyraja spinicauda*, common skate complex (*Dipturus batis* and/or *D. intermedius*, but see Section 26), long-nosed skate *Dipturus oxyrinchus,* sailray *Rajella lintea*, shagreen ray *Leucoraja fullonica* and thornback ray *Raja clavata* (Andriashev, 1954; Dolgov, 2000; Dolgov *et al*., 2005a; Wienerroither *et al*., 2011; Knutsen *et al*., 2017 WD), but few occur at high abundance. All skate species occurring in offshore areas also occur in more coastal areas, with the exception of *A. hyperborea, D. oxyrinchus* and *R. lintea* (Williams *et al*., 2008). The spatial distribution of chondrichthyan fishes in the Barents Sea, as observed in recent surveys, has been described by Wienerroither *et al*. (2011, 2013).

The stock boundaries are not known for the skates in this area, nor the potential movements of species between coastal and offshore areas. Further investigations are necessary to determine potential movements and migrations between elasmobranch populations within this ecoregion and with adjacent areas.

Amblyraja radiata is the dominant skate species, comprising 96% by number and about 92% by biomass of skates caught in surveys or as bycatch. The next most abundant species are *A. hyperborea* and *R. fyllae* (3% and 2% by number, respectively), and the remaining species are scarce (Dolgov *et al*., 2005a; Drevetnyak *et al*., 2005).

The species composition of skates caught in the Barents Sea differs from those recorded in the Norwegian Deep and northeastern Norwegian Sea (Skjaeraasen and Bergstad, 2000, 2001). Although *A. radiata* is the dominant species in both areas, the proportion of warmer-water species (*B. spinicauda* and *R. lintea*) is lower, and the proportion of cold-water species (*A. hyperborea*) is higher in the Barents Sea.

In terms of other elasmobranchs, sharks known to occur in the Barents Sea include spurdog (Section 2), velvet belly lanternshark (Section 5), porbeagle shark (Section 6), Greenland shark (Section 24) and, in the southern part of the area, blackmouth catshark (Section 25). One chimaeroid (*Chimaera monstrosa*) also occurs.

13.2 The fishery

13.2.1 History of the fishery

All skate species known to occur in the ecoregion may be taken as bycatch in demersal fisheries, but there are at present no fisheries targeting skates in the Barents Sea. Detailed data on catches of skates from the Barents Sea are available from bycatch records and surveys, as shown for the periods 1996–2001 and 1998–2001, respectively, by Dolgov *et al.* (2005a, 2005b). Bottom-trawl fisheries targeting cod *Gadus morhua* and haddock *Melanogrammus aeglefinus*, and longline fisheries targeting cod, blue catfish *Anarhichas denticulatus* and Greenland halibut *Reinhardtius hippoglossoides* have skate bycatch, and only large individuals are thought to be landed.

Dolgov *et al.* (2005b) estimated the total catch of skates taken by the Russian fishing fleet operating in the Barents Sea and adjacent waters in 1996–2001, and found that it ranged from 723 to 1891 tonnes (average of 1250 tonnes per year). *Amblyraja radiata* accounted for 90–95% of the total skate bycatch. *Amblyraja radiata* is also the predominant skate species in catches of the Norwegian Reference Fleet operating in ICES Subarea 1, and accounts for around 90% of the catches (Albert *et al.*, 2016 WD).

13.2.2 The fishery in 2023

No new information. Since 2012, reported Norwegian skate landings have been increasing, with landings consistently >500 tonnes each year since 2017, reaching a maximum of 1084 tonnes in 2022 (Table 13.1; Figure 13.1). The reason for this increase is unknown. Germany reported between <0.1-5 tonnes landed for the years 2013–2018, but none since.

13.2.3 ICES advice applicable

ICES does not provide advice on the status of skate stocks in this ecoregion.

13.2.4 Management applicable

There are no TACs for any of the skate species in this ecoregion. Norway has a general ban on discarding. Since 2010, all dead or dying skates and other fish in the catches should be landed, whereas live specimens can be released (discarded).

13.3 Catch data

13.3.1 Landings

For ICES Subarea 1, landings data are limited and only available for all skate species combined (Table 13.1). Landings from the most westerly parts of the Barents Sea ecoregion fall within Subarea 2 (see Section 14). Since 1973, Russia and Norway are the main countries landing skates from the Barents Sea (Figure 13.1). However, Russian landings are not available since 2011.

Elasmobranch landings from ICES Subarea 1 are low, but there have been large fluctuations in Russian landings. The peak in Russian landings in the 1980s corresponded to an experimental fishery for skates, where the bycatch (mainly comprised of *A. radiata*) was landed (Dolgov, personal communication, 2006).

Based on data from the Norwegian Reference fleets, and the expert judgement detailed in Albert *et al*. (2016 WD), Norwegian landings by species and species groups from ICES Subarea 1 were estimated for the period 2012-2015 (Table 13.2). Landings tend to be restricted to the larger specimens of *R. clavata*, *B. spinicauda* and *A. hyperborea*.

13.1.1 Discards

Based on interviews of the Norwegian Reference Fleet and landing sites, the expected discards of skates varied extensively between species and is assumed to be almost 100% for specimens <50 cm total length. For *R. fyllae* and *A. radiata,* nearly all specimens are probably discarded, whereas the discards of *R. clavata* by the coastal fleet is expected to be negligible (Albert *et al*., 2016 WD).

13.3.2 Quality of catch data

Recent reported data on skate catches and landings from the Barents Sea are almost exclusively from Norway, and species information from the Norwegian Reference Fleet (Table 13.2) may be indicative of the species composition of total catch and landings. The estimation of total skate catches and landings by species relied on some strong assumptions, e.g. that data from the Coastal and Oceanic Reference Fleets operating in the Barents Sea are representative for vessels below and above 21 m respectively, and that the relative species composition of skate catches in these two reference fleets has been stable over the last ten years. These assumptions were made due to limited availability of data. With increased data and extended time series, these assumptions should be relaxed by including running averages over shorter time periods, e.g. 3–5 years.

For years 2012-2015, even after allocating skate landings to species based on data from the Reference Fleet, the generic “Skates and rays” category still accounted for more than 50% of the total skate landings (Table 13.2). In 2023, about 77% of skate landings were still reported as Rajidae, the rest being reported as *A. radiata* (22%), *R. clavata* (<1%), or *B. spinicauda* (<1%).

In addition, the splitting of catches by species should be validated by independent surveys. The best way to do this is probably to include skates on the list of species to sample from selected landing ports. Skates are mostly landed as wings in Norway, which can make conventional species identification more difficult (although skate identification could be confirmed with genetic barcoding). Programmes for market sampling of skate landings could usefully be undertaken.

13.3.3 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

13.4 Commercial catch composition

Generally, larger skates are more often caught in longline fisheries than in trawl fisheries (Dolgov *et al*., 2005b).

Vinnichenko *et al.* (2010 WD) reported that catches of skates in Russian trawl and longline bottom fisheries in 2009 (60–400 m depths) were dominated by *A. radiata* (90–95%). Information on length and sex composition can be found in ICES (2014). Other species occurring were *R. fyllae*, *A. hyperborea*, *B. spinicauda* and *R. lintea*. These findings are supported by data from the Norwegian Reference Fleet (Vollen, 2010 WD; Albert *et al*., 2016 WD).

Dolgov *et al.* (2005b) reported the mean length and the sex ratio for four species of skates in the Barents Sea. The sex ratio was 1:1 in commercial catches for all skate species except *A. hyperborea*, of which males dominated in the longline fishery (see ICES, 2007 for further information).

13.5 Commercial catch and effort data

Some CPUE data are available for *A. radiata*, *A. hyperborea*, *R. fyllae* and the common skate complex in trawl and longline fisheries, respectively (Norwegian Institute of Marine Research). Total catches of skates in Russian fisheries in the Barents Sea and adjacent areas for the years 1996–2001 were summarized in ICES (2007).

Catch data from other nations are limited and analyses of more recent Russian data are required.

13.6 Fishery-independent surveys

13.6.1 Russian bottom trawl survey (RU-BTr-Q4)

For the offshore areas, data from October–December surveys (RU-BTr-Q4) were available for the years 1996–2003 (Dolgov *et al.*, 2005b; Drevetnyak *et al.*, 2005; summarized in ICES, 2007). These studies described the distribution and habitat utilization of skates (*A. radiata*, *A. hyperborea*, *R. fyllae*, *D. batis* complex, *B. spinicauda* and *R. lintea*) in the Barents Sea.

Vinnichenko *et al.* (2010 WD) reported on catches of *A. radiata* from the 2009 Russian bottom-trawl survey in October–December (RU-BTr-Q4). The overall length range was 8–61 cm total length (TL). The mean length of males (41.6 cm TL) was larger than that of females (38.8 cm TL), and the sex ratio was about 1.02:1.

13.6.2 Norwegian coastal survey (NOcoast-Aco-Q4)

The distribution and diversity of elasmobranch species in the northern Norwegian coastal areas were assessed by Williams *et al.* (2008). The results were summarized in ICES (2007, 2008). New data from the Norwegian coastal survey should be analysed and presented to the WGEF when sufficient data becomes available.

13.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from 3185 deep trawl hauls (400–1400 m) spanning 30 research surveys along the continental slope (62–81°N) between 2003-2009. The area investigated covered the Norwegian Sea ecoregion, as well as the border between the Norwegian Sea and Barents Sea ecoregions (see Section 14 of ICES, 2009).

13.6.4 Joint Russian-Norwegian surveys (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea. These surveys run in February (BS-NoRu-Q1 (BTr)), in the southern Barents Sea northwards to the latitude of Bear Island, and August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)), covering the whole Barents Sea area including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but data on elasmobranchs are missing for some years. The August–September survey started in 2003. Both surveys are still ongoing. All skate species are recorded during these surveys, and length data are collected. Some biological data are also collected on Russian vessels. However, due to initial species misidentification, species-specific data should only be used from the years 2006–2007 onwards (applies also to Norwegian data).

Vinnichenko *et al.* (2010 WD) analysed data on elasmobranch species from the joint surveys in 2009. The results were reported in Section 13 of ICES (2014). Wienerroither *et al*. (2011, 2013) used data from the August–September (Q3) survey (2004–2009) and February (Q1) survey (2007–2012) to describe the spatial distribution of chondrichthyan fishes in the Barents Sea. For some species, length composition data are also available. The information on the main skate species is summarized below. It should be noted that length distributions are not directly comparable between the two surveys due to differences in sampling design and spatio-temporal coverage.

A. radiata: The most common skate species in the Barents Sea. Widely distributed in the surveyed area (Figure 13.2). Size distribution was similar in the two surveys, ranging from 5–65 cm (Figure 13.3). Based on a simple swept area model utilizing the Q3 data, the stock appeared to vary in both biomass and number of individuals, without showing any apparent trend (Knutsen, *et al*., 2017 WD).

A. hyperborea: The species was found in deeper waters along the shelf edge towards the Norwegian Sea and Polar basin, and in the deeper parts of the eastern Barents Sea (Figure 13.2). The length range was 6 to 85 cm. Only few specimens <38 cm were caught during the Q1 survey, although this size class was very numerous in the Q3 survey (Figure 13.3). The stock increased in biomass and numbers between 2007 and 2014. For subsequent years, estimates were at a similar level as before 2007 (Knutsen *et al*. 2017 WD).

B. spinicauda: During the Q1 survey, the species was found in larger parts of the central basin. During the Q3 survey, the distribution was more towards the western part of the surveyed area (Figure 13.2). Recorded lengths ranged from 6 to 183 cm (Figure 13.3). The largest specimen exceeded the reported maximum length of 172 cm. Fewer small and more large individuals were caught in the Q1 survey than in the Q3 survey. Generally, the stock appeared to be relatively stable in terms of biomass and number of individuals (Knutsen *et al*., 2017 WD).

R. fyllae: The species was found in warm-water areas in the southwestern part of the surveyed area and along the slope west of Svalbard/Spitsbergen (Figure 13.2). The length distribution ranged from 6–60 cm, with two peaks around 10–15 and 46–50 cm (Figure 13.3). Although there were some annual fluctuations in number of individuals in the Barents Sea, the general trend was stable, as was the trend for biomass (Knutsen *et al*., 2017).

13.6.5 Quality of survey data

Species identification for skates is a major issue, especially with some of the earlier data. Williams (2007) gave a detailed description of identification issues between *A. radiate* and *R. clavata* in the Norwegian Sea ecoregion.

Furthermore, the reported occurrence of the common skate complex (which is possibly confused with *B. spinicauda*) adds to potential identification errors (see Section 26), and the occurrence of *L. fullonica* in the Barents Sea has been questioned by Lynghammar *et al.* (2014), as no specimens could be obtained for genetic analyses since 2007. Consequently, appropriate quality checks of these survey data are required prior to their use in assessments.

In order to improve the quality of current survey data, better identification practices using appropriate identification literature needs to be put in place. Ongoing work to improve future sampling at the Institute of Marine Research includes workshops to educate staff as well as improved field guides and keys used for species identification. A workshop series in 2019 established the basis for an updated identification guide to be used for surveys and by the reference fleet.

13.7 Life-history information

Length data for *A. radiata*, *A. hyperborea*, *R. fyllae*, common skate complex and *B. spinicauda* are available in Dolgov *et al.* (2005a; 2005b) and Vinnichenko *et al.* (2010 WD; see ICES, 2007; 2010). Some biological information is available in the literature (e.g. Berestovskii, 1994). Sampling of elasmobranch egg cases has been included in Norwegian trawl surveys from mid-2009, and may provide future information on egg-laying (spawning) grounds.

13.8 Exploratory assessment models

No exploratory assessments have been conducted, due to the limited data available. Analyses of survey trends may allow to evaluate the status of the more frequent species, although species identification issues need to be addressed first.

13.9 Exploratory assessment models

No assessments have been conducted.

13.10 Quality of assessments

No assessments have been conducted.

13.11 Reference points

No reference points have been proposed.

13.12 Conservation considerations

The International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species) global listings for species reportedly occurring in this area include (species assessed as "Least Concern" not considered):

- "Critically Endangered": Common blue skate (*Dipturus batis*; Ellis et al., 2024a) and flapper skate (*Dipturus intermedius*; Ellis et al., 2024b), however the occurrence of the common skate complex in the Barents Sea has been questioned.
- "Endangered": *Leucoraja circularis* (McCully et al., 2015a)
- "Vulnerable": *Leucoraja fullonica* (McCully et al., 2015b), *Amblyraja radiata* (Kulka et al., 2020)
- "Near threatened": *Bathyraja spinicauda* (Pollom et al., 2020), *Dipturus oxyrinchus* (Ellis et al., 2015c) and *Raja clavata* (Ellis, 2016).

The Norwegian Red List (Hesthagen *et al.*, 2021) lists *Dipturus intermedius* and *Leucoraja fullonica* as "Critically Endangered". All other species are listed as "Least Concern".

13.13 Management considerations

Landings of skates in this ecoregion have steadily increased in recent years, with high levels (>800 tonnes) since 2021. There are no TACs for any of the demersal skate stocks in this region.

The elasmobranch fauna of the Barents Sea comprises relatively few species. The most abundant skate in the area is *A. radiata*, which is widespread and abundant in this ecoregion and adjacent waters. This species dominated the large historical Russian landings, but is otherwise generally discarded.

Data from the Norwegian Reference Fleet indicate that the most commonly landed skates today are larger specimens of *R. clavata*, *B. spinicauda* and *A. hyperborea.* These are not abundant in the Barents Sea and the information on stock status is limited.

Further studies are required, particularly for the larger-bodied skates, which may be more vulnerable to overfishing.

13.14 References

Albert, O.T., Vollen, T., Bjelland, O., Otterå, H., and Nedreaas, K.H., 2016. Norwegian catches and landings of skates by species. Working document for the ICES Elasmobranch Working Group (WGEF) 2016.

Andriashev, A. P. 1954. Fishes of the Arctic seas of the USSR. Guide to identification of USSR fauna of the Zoological Institute of the USSR Academy of Science, Acad. Sci. Press, No. 53. 566 pp. (in Russian).

Berestovskii, E. G. 1994. Reproductive biology of skates of the family Rajidae in the seas of the far north. *Journal of Ichthyology*, 34: 26–37.

Dolgov, A. V. 2000. New data on composition and distribution of the Barents Sea ichthyofauna. ICES C.M. 2000/Mini:12. 13 pp.

Dolgov, A. V., Drevetnyak, K. V. and Gusev, E. V. 2005a. The status of skate stocks in the Barents Sea. *Journal of Northwest Atlantic Fisheries Science*, 35: 249–260.

Dolgov, A. V., Grekov, A. A., Shestopal, I. P. and Sokolov, K. M. 2005b. By-catch of skates in trawl and long-line fisheries in the Barents Sea. *Journal of Northwest Atlantic Fisheries Science,* 35: 357–366.

Drevetnyak, K. V., Dolgov, A. V., Sokolov, K. M., Gusev, E. V. and Grekov, A. A. 2005. Skates in the Barents Sea: stock status and catch by fishing fleet. ICES CM 2005/ N:11. 14 pp.

Ellis, J.R., McCully-Philips, S.R., Sims, D., Derrick, D., Cheok, J. and Dulvy, N.K. 2024a. *Dipturus batis* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2024: e.T203364219A256580832. Accessed on 17 September 2024.

Ellis, J.R., McCully-Philips, S.R., Sims, D., Walls, R.H.L., Cheok, J., Derrick, D. and Dulvy, N.K. 2024b. *Dipturus intermedius* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2024: e.T18903491A256581177. Accessed on 17 September 2024.

Ellis, J., Abella, A., Serena, F., Stehmann, M.F.W. and Walls, R. 2015. *Dipturus oxyrinchus*. The IUCN Red List of Threatened Species 2015: e.T63100A48908629. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T63100A48908629.en. Accessed on 17 September 2024.

Ellis, J. 2016. *Raja clavata*. The IUCN Red List of Threatened Species 2016: e.T39399A103110667. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T39399A103110667.en. Accessed on 17 September 2024.

Hesthagen, T., Wienerroither, R., Bjelland, O., Byrkjedal, I., Fiske, P., Lynghammar, A., Nedreaas, K. and Straube, N. 2021. Rødlista for arter 2021. Artsdatabanken. http://www.artsdatabanken.no/lister/rodlisteforarterICES. 2007. Report of the Working Group Elasmobranch Fishes (WGEF), 22–28 June 2007, Galway, Ireland. ICES CM 2007/ACFM:27; 318 pp.

ICES. 2008. Report of the Working Group Elasmobranch Fishes (WGEF), 3–6 March 2008, Copenhagen, Denmark. ICES CM 2008/ACOM:16; 332 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16; 424 pp.

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19; 519 pp.

ICES. 2014. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–26 June 2014, Lisbon, Portugal. ICES CM 2014/ACOM:19; 671 pp.

Jakobsen, T. and Ozhigin, V. K. (Eds.) 2012. Barents Sea: Ecosystem, resources, management - half a century of Russian/Norwegian cooperation. Tapir Academic Press; 832 pp.

Knutsen, M., Thangstad, T.H., Søvik, G. and Albert, O.T. 2017. Survey trends of skates in Norwegian waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2017.

Kulka, D.W., Ellis, J., Anderson, B., Cotton, C.F., Derrick, D., Pacoureau, N. and Dulvy, N.K. 2020. *Amblyraja radiata*. The IUCN Red List of Threatened Species 2020: e.T161542A124503504. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161542A124503504.en. Accessed on 17 September 2024.

Lynghammar, A., Christiansen, J. S., Mecklenburg, C. W., Karamushko, O. V., Møller, P. R. and Gallucci, V. F. 2013. Species richness and distribution of chondrichthyan fishes in the Arctic Ocean and adjacent seas. *Biodiversity*, 14: 57–66.

Lynghammar, A., Christiansen, J. S., Griffiths, A. M., Fevolden, S-E., Hop, H. and Bakken, T. 2014. DNA barcoding of the northern Northeast Atlantic skates (Chondrichthyes, Rajidae), with remarks on the widely distributed starry ray. *Zoologica Scripta*, 43: 458–495.

McCully, S., Ellis, J., Walls, R. and Fordham, S. 2015a. *Leucoraja circularis*. The IUCN Red List of Threatened Species 2015: e.T161464A48938919. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T161464A48938919.en. Accessed on 17 September 2024.

McCully, S. and Walls, R. 2015b. *Leucoraja fullonica*. The IUCN Red List of Threatened Species 2015: e.T161461A48938639. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T161461A48938639.en. Accessed on 17 September 2024.

Pollom, R., Kulka, D.W., Derrick, D., Pacoureau, N. and Dulvy, N.K. 2020. *Bathyraja spinicauda*. The IUCN Red List of Threatened Species 2020: e.T161366A124472535. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161366A124472535.en. Accessed on 17 September 2024.

Skjaeraasen, J. E. and Bergstad, O. A. 2000. Distribution and feeding ecology of *Raja radiata* in the northeastern North Sea and Skagerrak (Norwegian Deep). *ICES Journal of Marine Science*, 57: 1249–1260.

Skjaeraasen, J. E. and Bergstad, O. A. 2001. Notes on the distribution and length composition of *Raja linteus, R. fyllae, R. hyperborea* and *Bathyraja spinicauda* (Pisces: Rajidae) in the deep northeastern North Sea and on the slope of the eastern Norwegian Sea. *ICES Journal of Marine Science*, 58: 21–28.

Vinnichenko, V. I., Dolgov, A. V., Yurko, A. S., Zhivov, B. D. and Safronov, A. M. 2010. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2009. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Vollen, T. 2009. Distribution of chondrichthyan species in Norwegian deep-sea waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2009.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Wienerroither, R., Johannesen, E., Dolgov, A., Byrkjedal, I., Bjelland, O, Drevetnyak, K., Eriksen, K. B., Høines, Å., Langhelle, G., Langøy, H., Prokhorova, T., Prozorkevich, D. and Wenneck, T. 2011. Atlas of the Barents Sea Fishes. IMR/PINRO Joint Report Series 1-2011. ISSN 1502-8828.

Wienerroither, R., Johannesen, E., Dolgov, A., Byrkjedal, I., Aglen, A., Bjelland, O., Drevetnyak, K., Eriksen, K. B., Høines, Å., Langhelle, G., Langøy, H., Murashko, P., Prokhorova, T., Prozorkevich, D., Smirnov, O. and Wenneck, T. 2013. Atlas of the Barents Sea Fishes based on the winter survey. IMR-PINRO Joint Report Series 2-2013. ISSN 1502-8828. 220 pp.

Williams, T. 2007. Cartilaginous fishes along the North-Norwegian coast. Distributions and densities with regard to fishing and sea temperature. Master thesis in International Fisheries Management. Norwegian College of Fishery Science. University of Tromsø. 62 pp. http://www.ub.uit.no/munin/handle/10037/975.

Williams, T., Helle, K. and Aschan, M. 2008. The distribution of chondrichthyans along the north coast of Norway. *ICES Journal of Marine Science*, 65: 1161–1174.

13.15 Tables and Figures

Table 13.1. Demersal elasmobranchs in the Barents Sea. Total landings (t) of skates from ICES Subarea 1 (1973–2023); "n.a." = no data available, "." = zero catch, "+" = <0.5 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	.	.	.	1	.	.	.	.	.	.	.	.	.	.
France	.	.	.	81	49	44	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	1	3	4	8	2	2	2	1	10	11	3
Portugal	.	.	100	11	1	.	.	+	.	.	.	.	.	.
USSR/Russian Fed.	n.a.	n.a.	n.a.	n.a.	n.a.	1126	168	93	3	1	n.a.	563	619	2137
Spain	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK(E&W)	78	46	49	33	70	9	8	4	+	1	.	+	+	+
UK(Scotland)	.	.	1	2	2	.	.	.	.	.	.	.	.	.
Total	78	46	150	129	125	1183	184	99	5	4	1	573	630	2140

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	1	.	.	+	1	.	.	4
Norway	14	7	4	1	5	24	29	72	9	27	3	13	21	12
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	2364	2051	1235	246	n.a.	399	390	369	n.a.	n.a.	399	790	568	502
Spain	.	.	.	.	.	.	.	.	7	.	.	.	.	.
UK(E&W)	2	.	+	.	.	.	.	.	.	.	.	.	+	.
UK(Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	2380	2058	1239	247	5	423	420	443	16	27	403	803	589	518

Table 13.1 (continued). Demersal elasmobranchs in the Barents Sea. Total landings (t) of skates from ICES Subarea 1 (1973–2022); "n.a." = no data available, "." = zero catch, "+" = <0.5 tonnes.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	+	.	.	+	.	.	+	+	5
Iceland	.	.	.	3	3	.	.	.	.	.	.	1	8	.	.
Norway	30	26	2	1	4	13	4	72	15	9	31	109	172	157	369
Portugal	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	218	173	38	69	37	48	24	6	2	1	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK(E&W)	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
UK(Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	248	199	40	73	44	61	28	78	17	10	31	110	180	157	374

	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.
Germany	2	+	2	.	.	.	.	.
Iceland	.	.	.	.	.	.	.	.
Norway	374	704	582	849	670	821	1084	909
Portugal	.	.	.	.	.	.	.	.
USSR/Russian Fed.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	n.a
Spain	.	.	.	.	.	.	.	.
UK(E&W)	.	.	.	.	.	.	.	.
UK(Scotland)	.	.	.	.	.	.	.	.
Total	376	704	584	849	670	821	1084	909

Table 13.2. Demersal elasmobranchs in the Barents Sea. Estimated Norwegian landings (t) of skates and rays by species in ICES Subarea 1. Source: Albert *et al.* (2016 WD).

Species	2012	2013	2014	2015
Amblyraja hyperborea	10	17	2	14
Bathyraja spinicauda	13	22	3	19
Dipturus oxyrinchus	1	1	0	1
Raja clavata	10	13	25	50
Rajidae indet.	76	116	127	285
Total	108	170	157	368

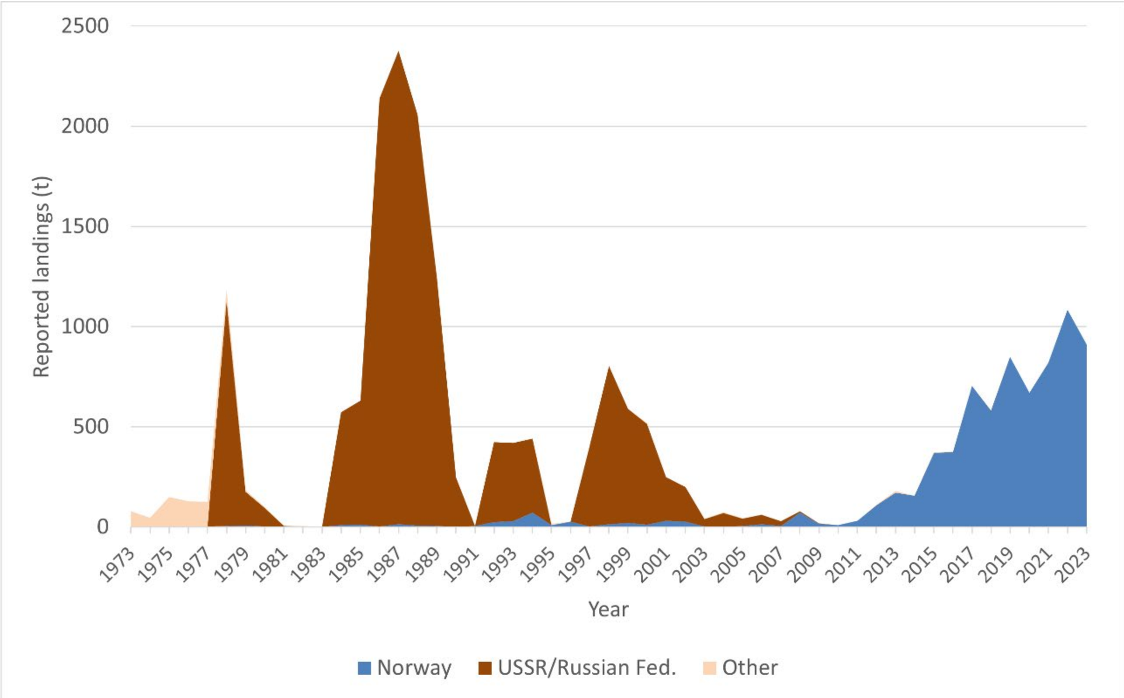


Figure 13.1. Demersal elasmobranchs in the Barents Sea. Reported landings (t) of skates from ICES Subarea 1 (1973–2023).

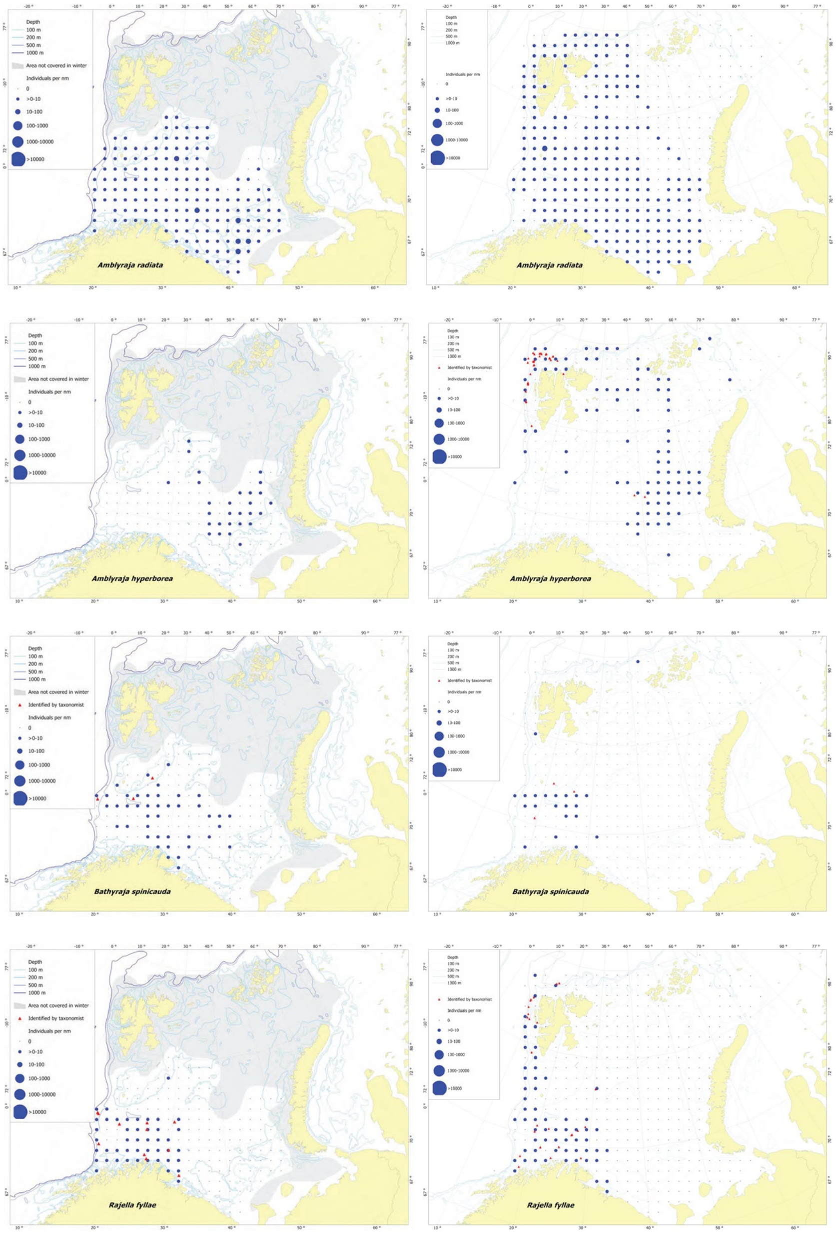


Figure 13.2. Demersal elasmobranchs in the Barents Sea. Spatial distribution of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Source: Wienerroither *et al*. (2011, 2013).

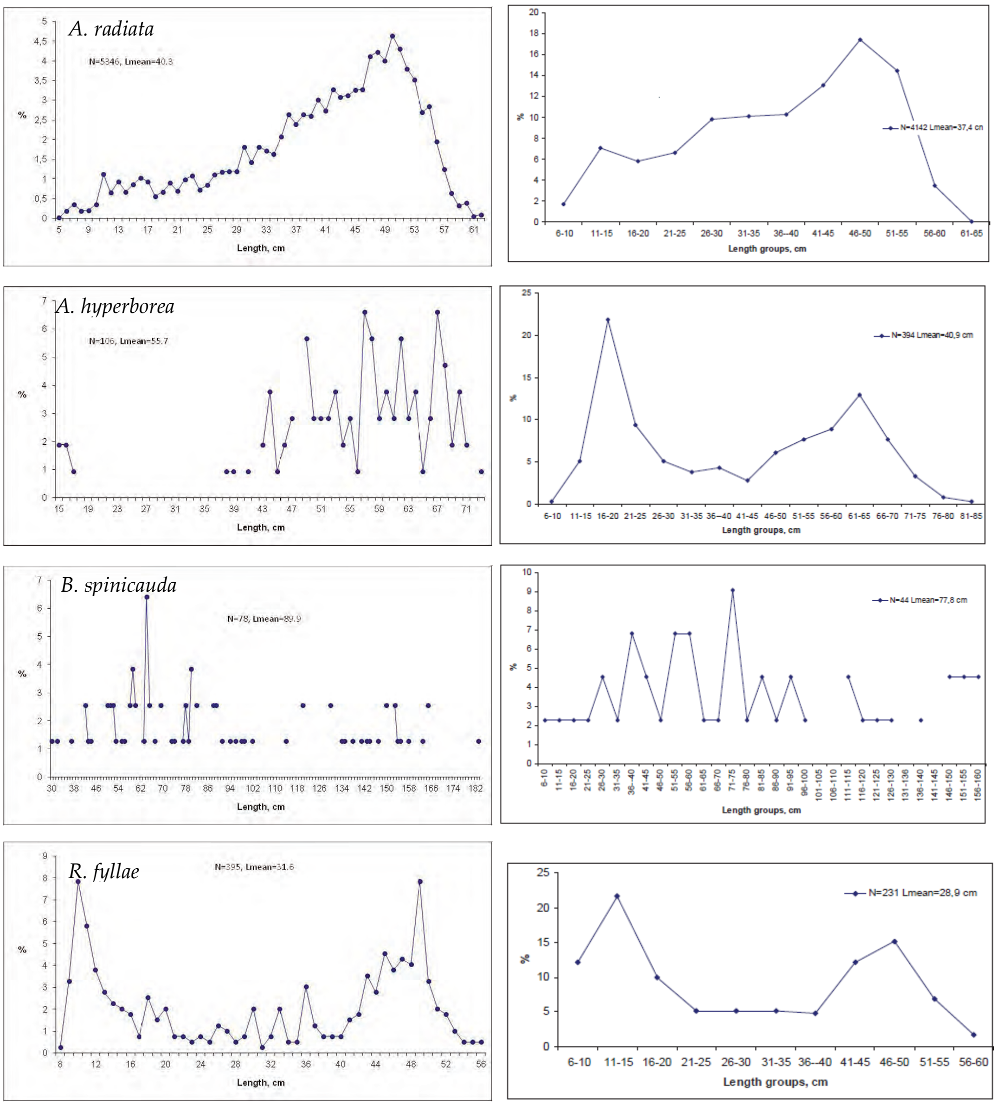


Figure 13.3. Demersal elasmobranchs in the Barents Sea. Length distributions of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Note that length distributions are not directly comparable between the two surveys. Source: Wienerroither *et al*. (2011, 2013).

Contents

14 Demersal elasmobranchs in the Norwegian Sea

14.1 Ecoregion and stock boundaries

The Norwegian Sea connects with the Celtic Seas and Faroes ecoregions to the south-west, and with Icelandic waters and the Greenland Sea ecoregions to the west. To the south it borders the shallower North Sea along the 62°N parallel between Norway and the Faroe Islands, and to the northeast with the shallower Barents Sea (ICES 2019). It comprises ICES Divisions 2.a-b.

The occurrence of chondrichthyan species in the Norwegian Sea ecoregion was reviewed by Lynghammar *et al*. (2013). In coastal areas, thorny skate *Amblyraja radiata* is the most abundant skate species (Williams *et al*., 2008). While more abundant in the north, this species is common at all latitudes along the Norwegian coast.

Other species that have been confirmed in the coastal area are thornback ray *Raja clavata,* common skate complex (most likely flapper skate *Dipturus intermedius* (Lynghammar *et al*., 2014; C. Junge, pers. obs.)), Norwegian skate *Dipturus nidarosiensis,* Long-nose skate *Dipturus oxyrinchus,* sailray *Rajella lintea,* sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica,* round skate *Rajella fyllae*, arctic skate *Amblyraja hyperborea* and spinytail skate *Bathyraja spinicauda*. *Dipturus oxyrinchus* is distributed mainly along the southern section of the coastline, south of latitude 65°N. Records of blonde ray *R. brachyura* and spotted ray *R. montagui* need to be confirmed by voucher specimens, although they are present in catch statistics (Lynghammar *et al*., 2014).

In deeper areas of the Norwegian Sea, *A. radiata* and *A. hyperborea* are the two most abundant species, but *B. spinicauda* and *R. fyllae* also occur regularly, particularly north of 70°N (Skjaeraasen and Bergstad, 2001; Vollen, 2009 WD).

Sharks in the Norwegian Sea ecoregion include spurdog *Squalus acanthias* (Section 2), velvet belly lanternshark *Etmopterus spinax* (Section 5), porbeagle *Lamna nasus* (Section 6), basking shark *Cetorhinus maximus* (Section 7), Greenland shark *Somniosus microcephalus* (Section 24), black-mouth catshark *Galeus melastomus*, and lesser-spotted dogfish *Scyliorhinus canicula* (Section 25). One chimaera, the rabbitfish *Chimaera monstrosa*, is also found in the Norwegian Sea.

Stock boundaries of skates and rays in the Norwegian Sea are not known, and neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

14.2 The fishery

14.2.1 History of the fishery

There are no fisheries targeting skates or sharks in the Norwegian Sea, though they are caught in various demersal fisheries targeting teleost species. All skate species in the ecoregion may be taken as bycatch, with only larger individuals thought to be landed (see Section 14.3).

14.2.2 The fishery in 2023

No new information.

14.2.3 ICES advice applicable

ICES does not provide advice for the skate stocks in this ecoregion, although some stocks of North Sea skates may extend into the southern parts of the Norwegian Sea.

14.2.4 Management applicable

There are no TACs for any of the skate stocks in this ecoregion.

Norway has a general ban on discarding. Since 2010, all dead or dying skates in the catches should be landed, whereas live specimens can be discarded.

14.3 Catch data

14.3.1 Landings

Landings data for skates are provided for the years 1973–2023 (Table 14.1). For ICES Subarea 2, landings data are limited and, for skates, aggregated across all species. This Subarea covers all of the Norwegian Sea ecoregion, but also includes the most westerly parts of the Barents Sea ecoregion (Section 13).

Overall landings throughout time have been low, ca. 200–500 t per year for all fishing countries, with moderate fluctuations. This is with the exception of a peak in the late 1980s, which resulted from Russian fisheries landing over 1900 t of skates in 1987 as a consequence of an experimental fishery when skate bycatch was landed, whereas normally they are discarded (Dolgov, pers. comm.). Russia and Norway are the main countries landing skates from the Norwegian Sea and Figure 14.1 shows their landings from 1973 to 2023.

Landings data (usually not discriminated at species level) since 2010 have been provided by Norway (2010–2023), France (2010–2013), Germany (2010, 2013–2019), the UK (2010–2011, 2013, 2015–2016, 2021, 2023), Spain (2010, 2012–2014), the Netherlands (2015), and Denmark (2021). Russian landings have not been available since 2010.

Based on data from the Norwegian Reference fleets, and the expert judgement detailed in Albert *et al*. (2016 WD), Norwegian landings by species and species groups from ICES Subarea 2 were estimated (Table 14.2). The main species landed tend to be larger specimens of *D. oxyrinchus*, *B. spinicauda* and *R. clavata.*

14.3.2 Discard data

Based on interviews of the Norwegian Reference Fleet and landing sites, the expected discards of skates vary extensively between species and is assumed to be almost 100% for specimens <50 cm TL. For *R. fyllae* and *A. radiata,* nearly all specimens are probably discarded, whereas the discarding of *Raja clavata* by the coastal fleet is expected to be negligible (Albert *et al*., 2016 WD).

14.3.3 Quality of catch data

Catch data are not species disaggregated.

Recent data on skate catch and landings in the Norwegian Sea are almost exclusively from Norway, and species information from the Norwegian Reference Fleet (Table 14.2) may be indicative of the species composition of total catch and landings. The estimation of total skate catches and landings by species relied on some strong assumptions, e.g., that data from the Coastal and

Oceanic Reference Fleets operating in the Norwegian Sea are representative of vessels below and above 21 m, respectively. Also, that the relative species composition of skate catches in either of these two reference fleets has been stable over the last ten years. These assumptions were made due to limited data availability.

Even after allocating skate landings to species based on data from the Reference Fleet, the generic "Skates and rays" category still accounted for about 30% of the total skate landings (Table 14.2). A further reduction of this proportion should, however, be achievable in the future. Work on improving species identification by arranging workshops for reference fleet crew and education during visits at sea is ongoing.

As mentioned here since 2016, in addition, the splitting by species should also be validated by independent surveys. The best way to do this is probably to include skates on the list of species sampled from selected landing ports. Skates are mostly landed as wings in Norway, which can make conventional species identification more difficult (although skate identification could be confirmed with genetic barcoding). Programmes for market sampling of skate landings could usefully be undertaken.

14.3.4 Discard survival

No data is available to WGEF for the fisheries in this ecoregion.

14.1 Commercial catch composition

14.3.5 Species and size composition

In 2009, Russian landings of skates were taken as bycatch during the longline and trawl demersal fisheries at depths ranging from 50–900 m deep in February–November. The main skate caught was *A. radiata*, with A. *fyllae*, *A. hyperborea*, and *B. spinicauda* found in minor quantities (Vinnichenko *et al.*, 2010 WD).

Amblyraja radiata (27–58 cm L_T) were recorded in the commercial bottom-trawl catches, comprising mostly males of 41–55 cm and females of 36–50 cm (Figure 14.2a). The proportion of small individuals was lower than in the Barents Sea. The mean length of females (43.7 cm) was smaller than that of males (45.0 cm). Males were slightly more abundant in catches (sex ratio of 1.1:1).

Vinnichenko *et al.* (2010 WD) presented data on *A. radiata* compiled from samples taken by scientific observers on commercial fishing vessels, the Russian survey, and the joint Russian–Norwegian surveys. These are presented in Section 14.6.

14.3.6 Quality of the data

Information on the species composition of commercial catches is required.

Data from the Norwegian Reference Fleet demonstrated that elasmobranch catches in ICES Subarea 2 were dominated by *A. radiata* and *R. clavata* (Table 14.2; Vollen, 2010 WD), although misidentification problems may exist.

For vessels in the Oceanic Reference Fleet, elasmobranch bycatch differed among bottom trawl, bottom gillnet and longline. Whereas *A. radiata* made up the majority of trawl and longline catches (55% and 79% by numbers, respectively), *R. clavata* dominated in gillnet catches (82%). This was probably influenced by the dominance of trawl and longline vessels further north, and more southerly fishing grounds for gillnetters, but potential misidentification issues should also be investigated. Catches of *A. radiata* were higher in Subarea 2 than in Subarea 1 for trawl catches (61 kg per 100 trawl hours for Subarea 2; 43 kg per 100 trawl hours for Subarea 1), but lower for longline catches (119 kg per 10 000 hooks vs. 135 kg per 10 000 hooks, respectively).

Data from the Coastal Reference Fleet indicated that the common skate complex (most likely misidentified) and unidentified skates dominated the landings in this area (39% and 33% by weight, respectively). Discards were dominated by unidentified skates (32% by weight). As opposed to the Oceanic Reference Fleet, *A. radiata* was only sporadically recorded in this area.

14.4 Commercial catch and effort data

Limited data available (but see above).

14.5 Fishery-independent surveys

14.5.1 Russian bottom trawl survey (RU-BTr-Q4)

Vinnichenko *et al.* (2010 WD) reported that catches from the 2009 survey were dominated by *A. radiata* (10–56 cm L_T; Figure 14.2b). In the size distribution, different size/age classes were distinguishable. The mean length of males (37.7 cm) and females (37.4 cm) were similar, and males predominated slightly (sex ratio = 1.05:1).

A. hyperborea (17–91 cm L_T) were recorded in the catches (Figure 14.2d; specimens > 131 cm were not considered here as they are thought to be typing errors or species misidentifications). The mean length of males (65.1 cm) and females (65.8 cm) were similar, and mostly males were caught (sex ratio = 5:1).

14.5.2 Norwegian coastal survey (NOcoast-Aco-4Q)

The distribution and diversity of elasmobranchs in northern Norwegian coastal areas, based on survey data from 1992–2005, were summarized by Williams *et al.* (2008). The southern portion of the coastal area studied was incorporated within the Norwegian Sea ecoregion, and the Barents Sea was defined as the border between Norwegian Directorate of Fisheries Statistical Areas 04 and 05 (https://portal.fiskeridir.no/portal/apps/webappviewer/index.html?id=ea6c536f760548fe9f56e6edcc4825d8).

Thirteen skate species and four species of shark were recorded from the coastal region (Table 14.3). Regularly occurring skates were *A. radiata, A. hyperborea,* common skate complex (most likely *Dipturus intermedius* (Junge/Lynghammar, pers. comm)), *D. nidarosiensis, D. oxyrinchus, R. clavata, R. fyllae* and *L. fullonica*. Occasional or single observations were made of *B. spinicauda*, *R. lintea* and *L. circularis* (*R. montagui* and *R. brachyura* were also nominally recorded, but see Section 14.6.5). Four species of shark were identified: *E. spinax, G. melastomus* and *S. acanthias*, as well as one specimen of *S. microcephalus.*

Amblyraja radiata appeared to fluctuate in both biomass and numbers, but the stock had an increasing trend in 2008–2016 (Knutsen *et al*., 2017 WD). *Dipturus oxyrinchus* also fluctuated in biomass, but only slightly in numbers, indicating variance in size composition of the survey catch between years. However, the overall trends in biomass and numbers were positive. The estimates of biomass and abundance of *R. fyllae* were stable over the time-series (2003–2016) (Knutsen *et al*., 2017 WD).

Although no clear shifts in abundance over time were detected for any species, more robust assessments are necessary to better identify temporal abundance trends.

14.5.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from 3185 deep trawl hauls (400–1400 m) spanning 30 research surveys along the continental slope (62–81°N) from the Barents Sea to the Skagerrak. Data were combined from multiple deep-water surveys during the period 2003–2009. Data from the Skagerrak are excluded in this section, whereas parts of the Barents Sea ecoregion are included. Overall, nine species (six skates and three sharks) were recorded. *Amblyraja radiata* and *A. hyperborea* were the dominant species north of 62°N (ICES Subarea 2), whereas *E. spinax* was most numerous in the Norwegian Deep (Division 3.a). *Bathyraja spinicauda* and *R. fyllae* also occurred frequently in the catches in all areas. Reports of *R. clavata* were considered to be misidentifications of other species. Results were reported in more detail in ICES (2009).

14.5.4 Joint Russian-Norwegian survey (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea: one during February (BS-NoRu-Q1 (BTr)) in the southern Barents Sea northwards to the latitude of Bear Island, and another in August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)) covering much of the Barents Sea, including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but data on elasmobranchs are missing for some years. The August–September survey started in 2003. Both surveys are still ongoing. All skates are recorded during these surveys, and data on length distributions as well as some biological data (on board Russian vessels) are collected. As a result of initial problems with species identification, species-specific data should only be used from the years 2006–2007 onwards (for Norwegian data). Analyses of data from these surveys are not complete, but some data from the 2009 surveys are presented in Vinnichenko *et al.* (2010 WD).

Amblyraja radiata was the dominant species in the August–September survey. The length range was 5–61 cm total length (TL), with most specimens in the range 33–37 cm (Figure 14.2c; Vinnichenko *et al.*, 2010 WD).

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for samples collected by scientific observers on commercial fishing vessels, the Russian survey, and the joint Russian–Norwegian surveys. Males prevailed in these samples (1.7:1). Most males and females (over 70%) were immature, the rest were in developing stages or were mature. Unlike in the Barents Sea, no individuals at the active stage were reported in the area. The main prey (by weight) were crustaceans (spider crab *Hyas* spp.: 33%; northern shrimp *Pandalus borealis*: 14%; amphipods: 6%), fish (capelin *Mallotus villosus*: 14%; Atlantic hookear sculpin *Artediellus atlanticus*: 12%; unidentified fish remains: 6%) and polychaete worms.

14.5.5 Quality of survey data

The difficulties associated with identifying skate species are a concern when considering the validity of the data used for any assessment. Identification problems between *A. radiata* and *R. clavata* were highlighted by Williams (2007) and summarized in ICES (2007). Despite sampling since 2007, Lynghammar *et al.* (2014) did not catch any specimens of common blue skate *Dipturus batis*, *R. brachyura* or *R. montagui* in the Norwegian Sea: giving more credence to suspected misidentifications in earlier years. Indeed, a record of *R. montagui* from central Norway was known from a museum specimen, but Lynghammar *et al.* (2014) identified it as *R. clavata*. *D. intermedius* may occur in small numbers in the Norwegian Sea. There were also no contemporary records of *L. fullonica*, though this species was reported in historical accounts.

To achieve a better quality of survey data, it is important to improve the identification practices and use appropriate identification literature. Ongoing work to improve sampling at the Institute of Marine Research includes workshops to educate staff as well as improved guides and keys used for species identification, including a new simplified guide for commercial longliners since January 2021. A workshop series in 2019 established the basis for an updated complete identification guide that is to be used for surveys and by the reference fleet.

14.6 Life-history information

Some length data are available for *A. radiata* and *A. hyperborea* (Vinnichenko *et al.*, 2010 WD; ICES, 2010). Some biological information is also available in the literature (e.g., Berestovskii, 1994). Sampling of elasmobranch egg-cases was included in Norwegian trawl surveys from mid-2009 until 2020 (from 2021: egg cases are still recorded but only sampled when caught in large numbers per station), which may provide future information on nursery grounds.

14.7 Exploratory assessment models

Due to limited data availability, no exploratory assessments have been conducted. Analyses of survey trends may allow evaluation of the status of more frequently caught species, although species identification issues need to be addressed first.

14.8 Stock assessment

No assessments have been conducted.

14.9 Quality of assessments

No assessments have been conducted.

14.10 Reference points

No reference points have been proposed for any of these skate stocks.

14.11 Conservation considerations

The International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species) global listings for species reportedly occurring in this area include (assessment year in parentheses, excluding species assessed as "Least Concern"):

- "Critically Endangered": Common blue skate (*Dipturus batis*; Ellis et al., 2024a) and flapper skate (*Dipturus intermedius*; Ellis et al., 2024b), however the occurrence of the common blue skate in the Norwegian Sea has not been confirmed.
- "Endangered": *Leucoraja circularis* (McCully et al., 2015a), *Dipturus nidarosiensis* (Finucci et al., 2024)
- "Vulnerable": *Leucoraja fullonica* (McCully et al., 2015b), *Amblyraja radiata* (Kulka et al., 2020)

- "Near threatened": *Bathyraja spinicauda* (Pollom et al., 2020), *Dipturus oxyrinchus* (Ellis et al., 2015c) and *Raja clavata* (Ellis, 2016).

The Norwegian Red List (Hesthagen *et al*., 2021) lists *Dipturus intermedius* and *Leucoraja fullonica* as "Critically Endangered", and *Dipturus nidarosiensis* as "Vulnerable". All other species are listed as "Least Concern".

14.12 Management considerations

There are no TACs for any of the skates in this ecoregion. The demersal elasmobranch fauna of the Norwegian Sea comprises several species that also occur in the Barents Sea (Section 13) and/or the North Sea (Section 15). Further investigations are required and could offer valuable information for the management of these neighbouring ecoregions.

14.13 References

Albert, O.T., Vollen, T., Bjelland, O., Otterå, H., and Nedreaas, K.H., 2016. Norwegian catches and landings of skates by species. Working document for the ICES Elasmobranch Working Group (WGEF) 2016.

Berestovskii, E. G. 1994. Reproductive biology of skates of the family Rajidae in the seas of the far north. *Journal of Ichthyology*, 34: 26–37.

Ellis, J.R., McCully-Philips, S.R., Sims, D., Derrick, D., Cheok, J. and Dulvy, N.K. 2024a. *Dipturus batis* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2024: e.T203364219A256580832. Accessed on 17 September 2024.

Ellis, J.R., McCully-Philips, S.R., Sims, D., Walls, R.H.L., Cheok, J., Derrick, D. and Dulvy, N.K. 2024b. *Dipturus intermedius* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2024: e.T18903491A256581177. Accessed on 17 September 2024.

Ellis, J., Abella, A., Serena, F., Stehmann, M.F.W. and Walls, R. 2015. *Dipturus oxyrinchus*. The IUCN Red List of Threatened Species 2015: e.T63100A48908629. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T63100A48908629.en. Accessed on 17 September 2024.

Ellis, J. 2016. *Raja clavata*. The IUCN Red List of Threatened Species 2016: e.T39399A103110667. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T39399A103110667.en. Accessed on 17 September 2024.

Finucci, B., Lynghammar, A. and Charles, R. 2024. *Dipturus nidarosiensis*. The IUCN Red List of Threatened Species 2024: e.T161729A124534517. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T39399A103110667.en. Accessed on 17 September 2024.

Hesthagen, T., Wienerroither, R., Bjelland, O., Byrkjedal, I., Fiske, P., Lynghammar, A., Nedreaas, K. and Straube, N. 2021. Rødlista for arter 2021. Artsdatabanken. http://www.artsdatabanken.no/lister/rodlisteforarter

ICES. 2007. Report of the Working Group Elasmobranch Fishes (WGEF), 22–28 June 2007, Galway, Ireland. ICES CM 2007/ACFM:27. 318 pp.

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 424 pp.

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 558 pp.

ICES. 2019. ICES Fisheries Overviews: Norwegian Sea ecoregion. Advice. https://doi.org/10.17895/ices.advice.5707

IUCN. 2017. IUCN Red List of Threatened Species. Version 2017.3. http://www.iucnredlist.org>. Downloaded on 26 June 2018.

Knutsen, M., Thangstad, T. H., Søvik, G. and Albert, O.T. 2017. Survey trends of skates in Norwegian waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2017.

Kulka, D.W., Ellis, J., Anderson, B., Cotton, C.F., Derrick, D., Pacoureau, N. and Dulvy, N.K. 2020. *Amblyraja radiata*. The IUCN Red List of Threatened Species 2020: e.T161542A124503504. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161542A124503504.en. Accessed on 17 September 2024.

Lynghammar, A., Christiansen, J. S., Mecklenburg, C. W., Karamushko, O. V., Møller, P. R. and Gallucci, V. F. 2013. Species richness and distribution of chondrichthyan fishes in the Arctic Ocean and adjacent seas. *Biodiversity*, 14(1): 57–66.

Lynghammar, A., Christiansen, J. S., Griffiths, A. M., Fevolden, S-E., Hop, H. and Bakken, T. 2014. DNA barcoding of the northern Northeast Atlantic skates (Chondrichthyes, Rajidae), with remarks on the widely distributed starry ray. *Zoologica Scripta*, 43: 458–495.

McCully, S., Ellis, J., Walls, R. and Fordham, S. 2015a. *Leucoraja circularis*. The IUCN Red List of Threatened Species 2015: e.T161464A48938919. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T161464A48938919.en. Accessed on 17 September 2024.

McCully, S. and Walls, R. 2015b. *Leucoraja fullonica*. The IUCN Red List of Threatened Species 2015: e.T161461A48938639. https://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T161461A48938639.en. Accessed on 17 September 2024.

Pollom, R., Kulka, D.W., Derrick, D., Pacoureau, N. and Dulvy, N.K. 2020. *Bathyraja spinicauda*. The IUCN Red List of Threatened Species 2020: e.T161366A124472535. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161366A124472535.en. Accessed on 17 September 2024.

Skjaeraasen, J. E. and Bergstad, O. A. 2001. Notes on the distribution and length composition of *Raja linteus, R. fyllae, R. hyperborea* and *Bathyraja spinicauda* (Pisces: Rajidae) in the deep northeastern North Sea and on the slope of the eastern Norwegian Sea. *ICES Journal of Marine Science*, 58: 21–28.

Vinnichenko, V. I., Dolgov, A. V., Yurko, A. S., Zhivov, B. D. and Safronov, A. M. 2010. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2009. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Vollen, T. 2009. Distribution of chondrichthyan species in Norwegian deep-sea waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2009.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Williams, T. 2007. Cartilaginous fishes along the North-Norwegian coast. Distributions and densities with regard to fishing and sea temperature. Master thesis in International Fisheries Management. Norwegian College of Fishery Science. University of Tromsø, 62 pp., http://www.ub.uit.no/munin/handle/10037/975.

Williams, T., Aschan, M. and Helle, K. 2007. Distribution of Chondrichthyan species along the North-Norwegian coast. Working Document for the ICES Elasmobranch Working Group (WGEF) 2007.

Williams, T., Helle, K. and Aschan, M. 2008. The distribution of chondrichthyans along the north coast of Norway. *ICES Journal of Marine Science*, 65: 1161–1174.

14.14 Tables and Figures

Table 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (and Division 2.a and 2.b) from 1973–2023. "n.a." = no data available, "." = means zero catch, "+" = < 0.5 tonnes. Countries with only occasional catches are not included by country in the landings table: Denmark (1994, 2021), Belgium (1 tonne 1975), Sweden (+ in 1975), Netherlands (1979, 2015), Iceland (2001, 2011), Estonia (2002, 2005), and Ireland (2007, 2009). Species included are: *A. radiata, D. licha, D. pastinaca, D. spp., L. circularis, L. fullonica, L. naevus, M. aquila, R. brachyura, R. clavata, R. montagui, R. alba, T. marmorata*, Rajiformes (indet).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Faroe Islands	.	.	.	5	2	1	1	.	.	.	.	.	.	4
France	.	.	1	68	61	18	2	1	12	109	2	6	5	11
Germany	+	1	52	12	59	114	84	85	53	7	2	112	124	102
Norway	201	158	89	34	99	82	126	191	137	110	96	150	104	133
Portugal	.	.	.	34	39	.	.	.	.	.	.	.	.	.
USSR/Russ. Fed.	.	.	.	.	.	302	99	39	.	.	.	537	261	1633
Spain	.	.	.	.	.	.	.	.	.	.	28		17	5
UK – E, W & NI	65	18	14	20	90	10	6	2	+	+	.	5	1	2
UK – Scotland	2	1	.	+	1	+	.	.	.	.	.	.	+	+
Other	.	.	1	.	.	.	2	.	.	.	.	.	.	.
Total	268	178	157	173	351	527	320	318	202	226	128	810	512	1890
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Faroe Islands	.	15	.	42	.	2	.	.	.	.	.	.	.	.
France	21	42	8	56	11	15	9	7	8	6	8	5	.	5
Germany	95	76	32	52	.	+	.	.	.	.	.	.	.	2
Norway	214	112	148	216	235	135	286	151	239	198	169	214	239	244
Portugal	.	.	.	.	.	.	22	11	.	10	28	46	10	6
USSR/Russ. Fed.	1921	1647	867	208	n.a.	181	112	257	n.a.	n.a.	77	139	247	400
Spain	.	9	.	.	.	.	.	.	3	.	3	15	6	.
UK - E, W & NI	4	.	2	1	+	1	+	+	1	4	.	+	1	+
UK – Scotland	2	+	+	+	+	+	+	.	+	+	+	+	1	1
Other	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Total	2257	1902	1057	575	246	334	429	426	251	218	285	419	504	658

Table 14.1 cont'. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (and Division 2.a and 2.b) from 1973–2023. "n.a." = no data available, "." = means zero catch, "+" = < 0.5 tonnes. Countries with only occasional catches are not included by country in the landings table: Denmark (1994,2021), Belgium (1 tonne 1975), Sweden (+ in 1975), Netherlands (1979, 2015), Iceland (2001, 2011), Estonia (2002, 2005), and Ireland (2007, 2009). Species included are: *A. radiata, D. licha, D. pastinaca, D. spp., L. circularis, L. fullonica, L. naevus, M. aquila, R. brachyura, R. clavata, R. montagui, R. alba, T. marmorata*, Rajiformes (indet).

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Faroe Islands	.	.	2	12	15	13	9	13	4	3	n.a.	.	n.a.	n.a.
France	4	7	2	7	9	7	2	5	3	5	1	1	+	+
Germany	.	2	2	7	1	.	.	.	+	1	.	.	1	2
Norway	233	118	111	142	133	146	189	259	258	250	198	121	147	105
Portugal	3	.	8	2	1	14	13	2	.	.	.	.	.	.
USSR/Russ. Fed.	113	38	6	50	20	16	20	.	8	2	n.a.	n.a.	n.a.	n.a.
Spain	7	11	32	.	1	.	.	.	.	+	.	+	1	+
UK - E, W & NI*		.	.	.	2	4	1	1	+	+	+	.	1	.
UK – Scotland*	1	3	3	.	.	.	.	.	.	.	.	.	.	.
Other	4	5	.	.	.	.	1	.	+	.	.	.	.	.
Total	365	184	166	220	182	200	235	280	273	261	199	122	150	108

	2015	2016	2017	2018	2019	2020	2021	2022	2023
Faroe Islands	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.
Germany	2	1	1	6	+	.	.	.	.
Norway	112	198	111	213	275	328	180	192	205
Portugal	.	.	.	.	.	.	.	.	.
USSR/ Russ. Fed.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	.	.	.	.
UK (combined)*	2	+	.	.	.	.	+	.	1
Other	+	.	.	.	.	.	+	.	.
Total	115	200	112	219	276	328	180	192	206

Table 14.2. Demersal elasmobranchs in the Norwegian Sea. Estimated Norwegian landings (tonnes) of skates and rays by species in ICES Subarea 2. Source: Albert *et al*. (2016 WD).

	2012	2013	2014	2015

Amblyraja hyperborea	9	11	7	10
Bathyraja spinicauda	23	28	19	23
Common skate complex (most likely *Dipturus intermedius*)	7	9	7	7
Dipturus oxyrinchus	23	28	23	20
Leucoraja circularis	2	2	2	2
Leucoraja fullonica	1	1	1	1
Raja clavata	14	17	14	12
Rajella lintea	6	7	5	6
Rajidae indet.	36	43	27	32
Total	121	146	104	112

Table 14.3. Catch data (number of individuals per species) for the Norwegian Sea ecoregion from the Annual Autumn Bottom-trawl Surveys of the North Norwegian Coast, from 1992 to 2005. Adapted from Williams *et al.* (2007 WD).

Species	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total catch**	**Total % of positive samples**	**Catch rate (No. per survey)**
Amblyraja radiata	7	44	23	15	8	41	9	16	9	6	10	10	19	9	226	11%	17.4
Bathyraja spinicauda	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0%	0.1
Rajella fyllae	0	4	0	0	0	1	0	0	0	0	5	6	4	0	20	1%	1.5
Raja clavata	0	4	15	1	0	2	3	6	0	0	0	0	2	0	33	2%	2.5
Common skate complex (most likely *Dipturus in-*	0	2	0	1	3	7	7	1	1	1	1	0	0	0	24	1%	1.8
Leucoraja fullonica	0	0	0	0	0	0	0	4	3	9	3	0	0	1	20	1%	1.5

Species	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total catch	Total % of positive samples	Catch rate (No. per survey)
Leucoraja circularis	0	0	0	0	0	0	0	0	1	0	1	9	5	7	23	1%	1.8
*Raja montagui**	0	0	0	0	0	0	0	2	1	0	1	0	1	0	5	<1%	0.4
Dipturus oxyrinchus	0	0	54	3	2	30	2	0	0	1	2	6	4	2	106	5%	8.2
Dipturus nidarosiensis	0	0	0	0	1	1	0	0	0	3	1	0	1	0	7	<1%	0.5
Amblyraja hyperborea	0	0	1	0	0	0	0	0	0	0	4	0	1	0	6	<1%	0.5
*Raja brachyura**	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	<1%	0.3
Rajella lintea	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	<1%	0.1
Galeus melastomus	0	24	1883	1197	105	1269	189	480	258	812	1196	275	640	48	8376	24%	644.3
Etmopterus spinax	0	829	8453	473	1061	2733	584	3881	1485	1401	2417	785	2305	1369	27 776	33%	2136.6
Squalus acanthias	0	21	51	26	20	5	106	168	12	68	43	21	104	17	662	8%	50.9
Somniosus microcephalus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	<1%	0.1

Species	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total catch	Total % of positive samples	Catch rate (No. per survey)
Number of samples	17	163	106	77	74	96	78	81	76	56	78	65	77	63			

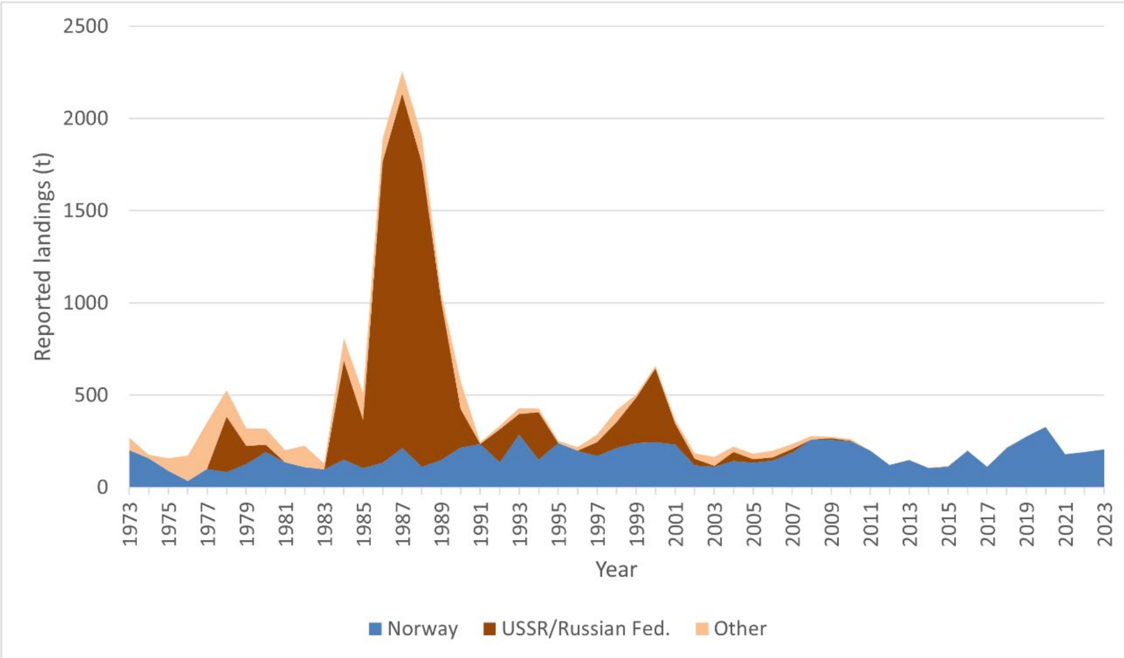


Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (1973–2023).

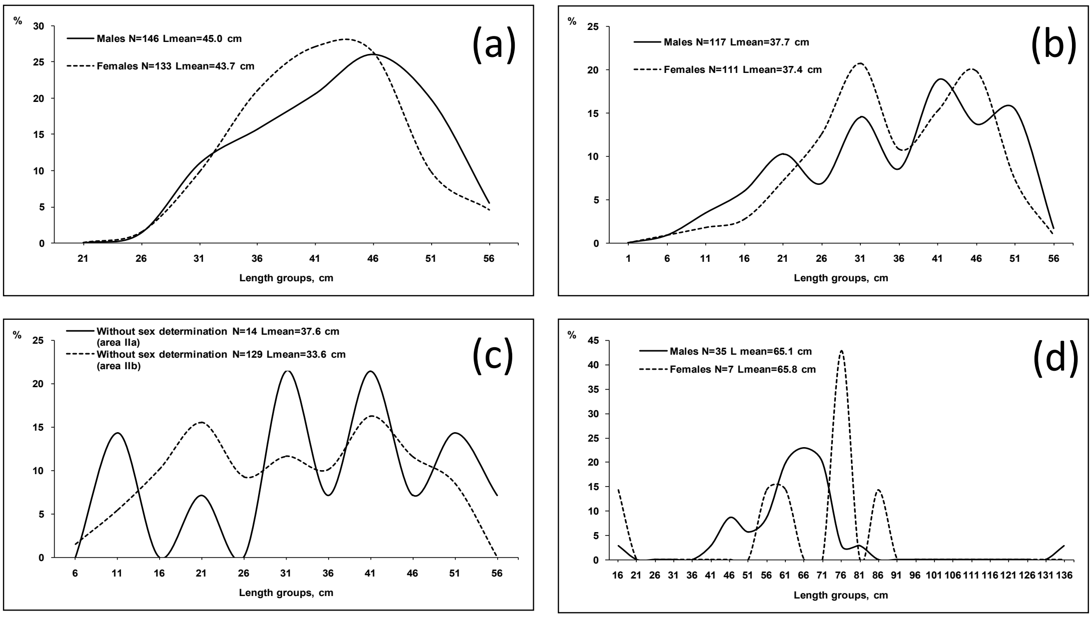


Figure 14.2. Demersal elasmobranchs in the Norwegian Sea showing the length composition of *A. radiata* in (a) commercial bottom-trawl catches in the Norwegian Sea in 2009, (b) Russian demersal survey (October–December 2009) and (c) the Norwegian Sea based on data from the joint Russian–Norwegian ecosystem survey (August–September 2009); and (d) length composition of *A. hyperborea* in the Norwegian Sea (Division 2.b) from the Russian demersal survey (October–December 2009). Specimens exceeding 131 cm are probably typing errors or misidentifications. Source: Vinnichenko *et al*. (2010 WD).

Contents

15 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel

15.1 Ecoregion and stock boundaries

In the North Sea, about ten skate and ray species occur, as well as about ten demersal shark species (Daan *et al.*, 2005). Thornback ray *Raja clavata* is the most important skate for commercial fisheries. *R. clavata* in the Greater Thames Estuary (southern part of Division 4.c) is known to move into the eastern English Channel (Walker *et al.*, 1997; Ellis *et al.*, 2008b). Bird *et al*. (2020) compiled and reviewed 50 years of tagging data, including release and return information, for several skate and ray species. Thornback ray is the most frequently tagged ray species in European waters and from individuals tagged in the North Sea, 99% of tag returns came from within the current stock unit. Though there is a clear exchange of thornback ray within divisions 4.b-c and 7.d, information on the exchange with divisions 3.a and 4.a is very limited.

For Blonde ray *R. brachyura*, the stock boundaries are not well known and currently there are two stock units defined in this ecoregion (rjh.27.4a6 and rjh.27.4bc7d). The southern stock (rjh.27.4bc7d) was benchmarked in 2023 and during this process Division 4.b was included in the stock unit definition (for details see ICES 2023a).

Spotted ray *R. montagui* has limited information on stock structure. Tagging studies showed recaptures within the stock unit of release (Bird *et al*., 2020). However, no information is available to confirm the inclusion of Division 4.a in the stock unit. More information on stock identity of rjc.27.3a47d, rjh.27.4bc7d and rjm.27.3a47d can be found in their respective stock annexes.

For most other demersal ray species in the North Sea ecoregions, stock boundaries are not well known. Cuckoo ray *Leucoraja neavus* (rjn.27.3a4) and the northern blonde ray stock (rjh.27.4a6) probably extend into the waters west of Scotland (Ellis *et al.*, 2015). Starry ray *Amblyraja radiata* (rjr.27.23a4), is mostly distributed to the north-east (between UK and Sweden) and is rarely found below the 54°N parallel (ICES 2023b).

Dipturus batis, frequently referred to as common skate, has been confirmed to comprise of two species, which were erroneously assumed to be one species in the 1920s (Iglésias *et al*., 2010; Griffiths *et al*., 2010). The smaller species (previously described as *Dipturus flossada* by Iglésias *et al*., 2010) is the common blue skate (*Dipturus batis* (FAO code RJB)) and the larger species may refer to the flapper skate (*Dipturus intermedius* (FAO code DRJ)). The member of the common skate complex present in the northern North Sea is *Dipturus intermedius*, which is generally considered the more vulnerable to fishing pressure. Both species were accepted by Last *et al*. (2016) and are now also accepted in the Catalog of Fishes (Fricke *et al*., 2021) and WoRMS. The distribution and stock boundaries of the two species are uncertain. The larger-bodied flapper skate occurs in the north-western North Sea, and this stock is likely the same as occurs of North-west Scotland. The presence and geographical extent of blue skate in this region is uncertain, but this species may have occurred in the southern North Sea historically. Further information on *Dipturus* species is presented in Section 26.

This section focuses primarily on skates (Rajidae). For the main demersal sharks in this ecoregion, the reader is referred to the relevant chapters for spurdog (Section 2), tope (Section 10), smooth-hounds (Section 21) and lesser-spotted dogfish and other catsharks (Section 25).

15.2 The fishery

15.2.1 History of the fishery

Demersal elasmobranchs are caught as a bycatch in the mixed demersal fisheries for roundfish and flatfish. A few inshore vessels target skates and rays with tangle nets and longlines. For a description of the demersal fisheries see the fisheries overview for the Greater North Sea Ecoregion (ICES, 2022a).

In 2007, the EC brought in a 25% bycatch ratio (see also Section 15.2.4, footnote 1) for vessels over 15 m. This has restrained some fisheries and may have resulted in misreporting, both of area and species composition.

15.2.2 The fishery in 2023

The landings peaked in the middle of the 1980s and declined steadily thereafter in the North Sea (Figure 15.3.1). Since 2008, the TAC appears to have been restrictive for the fisheries in the North Sea (Subarea 4), with landings ranging between approximately 1300–1600 t since 2010. A similar trend is observed for Division 7.d although since 2015, landings have increased by >50% to ~1700 t.

15.2.3 ICES Advice

Stock-specific advice for several species/stocks in this region was provided in 2023, see table below (and Section 15.9). Note that for most of stocks ICES provides biennial advice, however, for common skate complex, blonde ray (in Subarea 6 and Division 4.a) and starry ray quadrennial advice is provided. Three North Sea ray stocks were benchmarked in 2023 and their ICES Data Category was updated from a Category 3 to a Category 2 (ICES, 2023a)

ICES stock code	Stock description	ICES Data Category	Advice basis	ICES advice
rjb.27.3a4	Common skate *Dipturus batis-complex* Subarea 4 and Division 3.a	6.3.0	Precautionary approach	Zero catch in each of the years 2024-2027.
rjc.27.3a47d	Thornback ray *Raja clavata* Subarea 4 and divisions 3.a and 7.d	2	MSY approach	5274 t in 2024 5307 t in 2025
rjh.27.4a6	Blonde ray *Raja brachyura* Subarea 6 and Division 4.a	5.2	Precautionary approach	7 t in each of the years 2024-2027
rjh.27.4bc7d	Blonde ray *Raja brachyura* divisions 4.b, 4.c and 7.d	2	MSY approach	1262 t in 2024 1209 t in 2025
rjm.27.3a47d	Spotted ray *Raja montagui* Subarea 4 and divisions 3.a and 7.d	2	MSY approach	1517 t in 2024 1415 t in 2025
rjn.27.3a4	Cuckoo ray *Leucoraja naevus* Subarea 4 and Division 3.a	3.2	MSY approach	79 t in 2024 and 2025
rjr.27.23a4	Starry ray *Amblyraja radiata* Subareas 2, 4 and Division 3.a	3.1.5	Precautionary approach	Zero catch in each of the years 2024-2027

ICES stock code	Stock description	ICES Data Category	Advice basis	ICES advice
raj.27.3a47d	Other skates and rays Subarea 4 and divisions 3.a and 7.d	6.2.0	Insufficient data to provide advice	NA

15.2.4 Joint request 2024

Three North Sea stocks were benchmarked in 2023: thornback ray (rjc.27.3a47d), blonde ray (rjh.27.4bc7d) and spotted ray (rjm.27.3a47d). Following the benchmark process, all stocks were allowed to be assessed as category 2. A SPiCT (Pedersen and Berg, 2017) assessment is used for all three stocks and catch advice is given as total dead catch and estimated relative to reference points. The ICES catch advice is based on the 15th percentile of the predicted catch distribution, which was considered more precautionary than the 35th percentile. However, the advice for all three stocks for 2024 and 2025 was substantially higher than the previous advice and it cannot be quantified how this increase will impact discard rates for these stocks.

During WGEF 2024, a joint request from the UK and EU was considered. For those stocks where a robust discard rate exists (i.e. undulate ray in the English Channel, rju.27.7de) the 2024 advice sheets have been updated and implied landings have been added to the catch scenarios tables.

The three North Sea stocks included in the request will be assessed in 2025, thus for the current advice (i.e. catch advice for 2025), implied landings are not provided in the advice. Since the in-crease in advice for these stocks in 2024 and 2025, resulting in an increase in the TAC in 2024 in the Greater North Sea ecoregion, it is expected that the contribution of landings to the total dead catch might change accordingly. This has for example been seen in undulate ray in the English Channel where the contribution of landings to the total dead catch have increased from 21% (average of 2018-2022) to 78% in 2023.

There will not be a re-issue of the 2024 and 2025 advice for the three North Sea stocks. Therefore, WGEF 2024 has explored several options of historic dead discards rates for this special request. This will be helpful in translating the 2025 catch advice to implied landings for these stocks. In the 2025 assessment with catch advice being given for 2026 and 2027, the implied landings will be provided in the catch scenarios table.

X shows the average dead discard rates for the three North Sea stocks: thornback ray, blonde ray and spotted ray. The averages were calculated on several time frames: full time series (2009 – 2022), 10 years (2013 – 2022), 5 years (2018 - 2022) and 3 years (2020 – 2022). Unlike for undulate ray in the English Channel, the average dead discard rate does not vary much for all three stocks in the last 10 years. Spotted ray (Figure X.c) shows an increasing trend in dead discards rates in the time series.

The working group concluded that the historic 5-year average dead discard rate can be used to estimate the implied landings for 2025 for these stocks (table X).

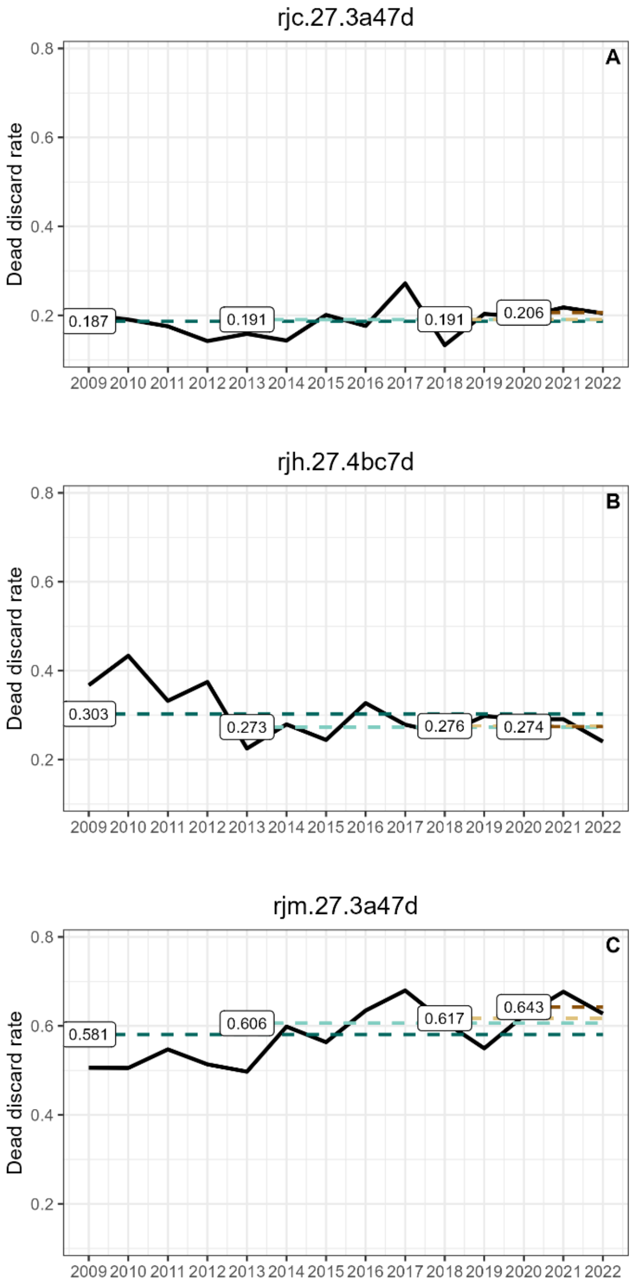


Figure X. Dead discard rate from 2009 – 2022 for thornback ray (A), blonde ray (B) and spotted ray (C) with the average dead discard rates displayed (from the left to the right) for: the whole time series, 10 years, 5 years and 3 years.

Table X. Average dead discard rates for North Sea thornback ray, blonde ray and spotted ray calculated for the periods 3 last years, 5 last years, 10 last years and the whole available time series.

Year	Full time series	(2009 – 2022), 10 years	(2013 – 2022), 5 years	(2020 – 2022), 3 years
Rjc.27.3a47d	0.187	0.191	0.191	0.206
Rjh.27.4bc7d	0.303	0.273	0.276	0.274
Rjm.27.3a47d	0.581	0.606	0.617	0.643

15.2.5 Management applicable

Since 1999, the EC have also used a common TAC for skates and rays in the North Sea. This was extended to three ecoregions in 2009 and is now applied in the Celtic Seas (ICES subarea 6 and divisions 7.a-c and 7.e-k; SRX/67AKXD), Biscay and Iberian waters (ICES subareas 8 and 9; SRX/89-C) and Greater North Sea (ICES subarea 4 and divisions 2.a, 3.a and 7.d) (STECF, 2022). The latter has been separated into three TAC areas: Union waters of Division 3.a (SRX/03A-C); UK and Union waters of Division 2.a and subarea 4 (SRX/2AC4-C); and UK and Union waters of Division 7.d (SRX/07D). Furthermore, from 2008 onwards, the EC has obliged Member States to provide species-specific landings data for the major North Sea species: *R. clavata*, *R. montagui*, *R. brachyura*, *L. naevus*, *A. radiata* and the common skate complex.

The TACs (Council Regulation (EU) 2024/257) for skates and rays in 2024 are: 3197 t for EU waters of Division 2.a and Subarea 4; 2120 t for Division 7.d; and 88 t for Division 3.a. Some transfer (5%) between the Division 7.d TAC area and the Celtic Seas ecoregion is allowed, which may account for some quota overshoot of the TAC in 7.d.

In 2015, a separate species-specific precautionary TAC for undulate ray (*Raja undulata*) was set within the overall skate TAC for Division 7.d. A special condition applied that up to 5% may be fished in Union waters of 7.e and reported under the following code: (RJU/*67AKD). However, in 2018 France requested ICES to update the advice for undulate ray in divisions 7.d–e and 8.a–b (ICES, 2018). The outcomes of that request contributed to a separate TAC for undulate ray in divisions 7.d and 7.e from 2019 onwards.

The list of prohibited species on EU fisheries regulations (Council Regulation (EU) 2016/72) included the following species within the North Seas ecoregion: white skate *Rostroraja alba* (Union waters of ICES subareas 6–10), thornback ray *Raja clavata* (Union waters of Division 3.a), starry ray *Amblyraja radiata* (Union waters of divisions 2.a, 3.a and 7.d and subarea 4) and common skate complex in Union waters of Division 2.a and ICES subareas 3, 4, 6–10.

Year	TAC*	TAC for 2.a and 4	TAC for 7.d	TAC for RJU 7.d-e	TAC for 3.a	Landings**
1999	6060	6060				3997
2000	6060	6060				3992
2001	4848	4848				4011
2002	4848	4848				3904
2003	4121	4121				3797
2004	3503	3503				3237
2005	3220	3220				3239 (3030)
2006	2737	2737				2928 (2845)
2007	2190	2190 (1)				3145 (3141)
2008	1643	1643 (2)				3177 (3025)
2009	2755	1643 (3,4,5)	1044 (i, ii)		68 (a, b)	2974 (3192)
2010	2342	1397 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2853 (2951)
2011	2342	1397 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2684 (2672)
2012	2340	1395 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2800 (2738)
2013	2106	1256 (3,4,5)	798 (ii, iii, iv)		52 (c,d)	2967 (3000)
2014	2101	1256 (4,6,7)	798 (iii,v,vi)		47 (e,f)	2836(2603)
2015	2227	1382 (4,6,7)	798 (iii, vii, viii)		47 (e)	2542

2016	2326	1313 (6,8,9)	966 (iii, vii, ix)		47 (e)	2685
2017	2488	1378 (6,8,9)	1063 (iii, vii, ix)		47 (e)	2813
2018	2977	1654 (6,8,9,10)	1276 (v,x,xi,xii)		47 (e)	3497
2019	3105	1654(6,8,9,10)	1404(v,x,xi,xiii)	234(1a)	47 (e)	3514
2020	3258	1737(6,8,9,10)	1474(v,x,xi,xiii)	234(1a)	47(e)	3315
2021	3095	1650(6,8,9,10)	1400(v,x,xi,xiii)	234(1a)	45(e)	3350
2022	3309	1764(6,8,9,10)	1497(v,x,xi,xiii)	234(1a)	48(e)	2994
2023	3349	1764(6,8,9,10)	1537(v,x,xi,xiii)	3192(1a)	48(e)	3318
2024	5405	3197	2120	3974	88	

***TAC does not include TAC for rju.27.7de.**

****Data from 2005 onwards revised following, 2022 benchmark data call, with previous estimates in brackets. Data contain those species that are part of the TAC (raj.27.3a47d, rjc.27.3a47d, rjm.27.3a47d, rjh.27.4a6, rjh.27.4c7d and rjn.27.3a4) and include landings for *Raja undulata* and *Raja microocellata* declared by Member States in 7.d.**

1) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board.

2) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, starry ray *Amblyraja radiata* and common skate *Dipturus batis* to be reported separately.

3) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

4) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board. This condition applies only to vessels over 15 m length overall.

5) Does not apply to common skate *Dipturus batis*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

6) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura* and spotted ray *Raja montagui* to be reported separately.

7) Shall not apply to common skate *Dipturus batis* complex and starry ray *Amblyraja radiata* . When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

8) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board per fishing trip. This condition applies only to vessels over 15 metres' length overall. This condition applies only to vessels over 15 m LOA. This provision shall not apply for catches subject to the landing obligation as set out in Article 15(1) of Regulation (EU) No 1380/2013.

9) Shall not apply to blonde ray *Raja brachyura* in Union waters of 2.a and small-eyed ray *Raja microocellata* in Union waters of 2.a and 4. When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species

10) Special condition: of which up to 10 % may be fished in Union waters of 7.d (SRX/*07D2.), without prejudice to the prohibitions set out in Articles 13 and 45 of this Regulation for the areas specified therein. Catches of blonde ray (*Raja brachyura*) (RJH/*07D2.), cuckoo ray (*Leucoraja naevus*) (RJN/*07D2.), thornback ray (*Raja clavata*) (RJC/*07D2.) and spotted ray (*Raja montagui*) (RJM/*07D2.) shall be reported separately. This special condition shall not apply to small-eyed ray (*Raja microocellata*) and undulate ray (*Raja undulata*).

(i) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

(ii) Does not apply to common skate *Dipturus batis* and undulate ray *Raja undulata*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(iii) Of which up to 5% may be fished in EU waters of 6.a-b, 7.a-c and 7.e-k

(iv) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, small-eyed ray *Raja microocellata* and starry ray *Amblyraja radiata* to be reported separately.

(v) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and small-eyed ray *Raja microocellata* to be reported separately.

(vi) Does not apply to common skate complex *Dipturus batis*, undulate ray *Raja undulata* and starry ray *Amblyraja radiata*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(vii) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, small-eyed ray *Raja microocellata* and undulate ray *Raja undulata* to be reported separately.

(viii) Undulate ray not to be targeted, with a trip limit of 20 kg live weight per trip, and catches to remain under an overall quota of 11 t

(ix) Undulate ray not to be targeted, with a trip limit of 40 kg live weight per trip, and to remain under an overall quota of 12 t

(x) of which up to 5 % may be fished in Union waters of 6.a, 6.b, 7.a-c and 7.e-k. This special condition shall not apply to small-eyed ray *Raja microocellata* and to undulate ray *Raja undulata*.

(xi) of which up to 10 % may be fished in Union waters of 2a and 4. This special condition shall not apply to small-eyed ray *Raja microocellata*.

(xii) Undulate ray not to be targeted. The catches shall remain under an overall quota of 19 t.

(xiii) Not applicable to undulate ray *Raja undulata*

1a) This species shall not be targeted in the areas covered by this TAC. This species may only be landed whole or gutted. The former provisions are without prejudice to the prohibitions set out in Articles 14 (16 in 2020 regulations) and 50 (52 in 2020 regulations) of this Regulation for the areas specified therein.

---

a) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

b) Does not apply to common skate *Dipturus batis*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

c) Catches of cuckoo ray *Leucoraja naevus*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

d) Does not apply to common skate *Dipturus batis* and thornback ray *Raja clavata*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

e) Catches of cuckoo ray *Leucoraja naevus*, blonde ray *Raja brachyura* and spotted ray *Raja montagui* to be reported separately.

f) Does not apply to common skate complex *Dipturus batis*, thornback ray *Raja clavata* and starry ray *Amblyraja radiata*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

Within the North Sea ecoregion, some of the UK's Inshore Fisheries and Conservation Authorities (IFCAs), formerly Sea Fisheries Committees, have a minimum landing size of 40 cm disc width for skates and rays.

In 2013, Dutch Producer Organisations introduced a minimum landings size of 55 cm (total length) for skates and rays. In addition, to keep landings within the national quota, the POs have implemented landing restrictions, which may vary throughout the year to control the quota uptake. Restrictions can vary between 40 and 250 kg dead weight. Since 2019, the weekly landings were capped to 160 kg rays per trip. Similarly, Belgium implements a minimum landing size of 50 cm (total length) for skates and rays.

Since 2009, Norway has had a discard ban that applies to skates and sharks, as well as other fish, in the Norwegian Economic Zone. Whilst some discarding of skates is likely to have continued, the precise quantity is unknown.

15.3 Catch data

15.3.1 Landings

The landings tables for all rays and skates combined (Tables 15.3.1–15.3.3) were updated in 2024. Since 2008, EC member states are required to provide species-specific landings data for the main species of rays and skates and these are collated by stock (Table 15.3.4). These data were all based on data submitted in the 2022 Data Call, with appropriate corrections made, following the recommendations of WKSHARK2 (ICES, 2016). During the 2023 WGEF data preparation meeting, historic data in the landings table were further harmonized and corrections were applied to certain stocks (i.e. re-assigning certain landings to the correct stock), including those that were benchmarked (ICES, 2023a). Data is be added to the WGEF landings table on an annual basis.

Figure 15.3.1 shows the total international landings of rays and skates from Division 3.a, Subarea 4, and Division 7.d since 1973. The figure also includes the combined landings from Division 3.a and Subarea 4 plus the TAC for recent years. Data from 1973 onwards are WGEF estimates.

Up to the early 1990s, landings of skates in Division 7.d have been relatively stable around 1500 t, thereafter decreasing with lowest levels reported in the early 2000s (<1000 t). During 2007–2017, landings fluctuated around 1300 t. In 2020, landings were over 50% larger compared to 2015 (ca. 1808 t). Historically, estimated landings in Division 7.d have been much lower compared to landings in subarea 4. However, in recent years landings in Division 7.d have increased and are higher than those estimated for the North Sea.

Landings of skates in Division 3.a (Skagerrak and Kattegat) are low compared to both other areas. Before the early 2000s, landings have been relatively stable around 150 t. Since 2005 landings largely decreased (<50 t) with recent years showing similar levels to earlier years.

15.3.2 Discards

Information on discards in the different demersal fisheries is being collected by several Member States and is submitted to WGEF annually. In 2020, all discard data available in the WGEF accessions folders were collated into a single discard table. Since 2020, submitted discard data (both InterCatch and accessions) are added to the table annually. In 2023, the discard table was further harmonized and where applicable, corrections were made (i.e. adding blonde ray discards from Division 4.b to the in 2023 updated stock unit rjh.27.4bc7d). Whilst discard data are shown per stock from 2009 to 2022 (Table 15.3.5), these should be viewed with caution as further work is required in terms of QA/QC procedures prior to use in the assessments (see Section 1.14).

The estimation of elasmobranch total discards has raised concerns. This is because raising to national catch levels is uncertain, with raising procedures not standardized among member states. Consequently, discard data were deemed unreliable and were not included in the 2021 advice of the skates within the North Sea ecoregion. The main issues concerning discards data are summarised in Section 1.14 of this report.

With the transition of *R. clavata, R. brachyura* and *R. montagui* from a Category 3 to Category 2 stocks, discard data is now included in the SPiCT models and the advice given in 2023. Further information on the discard processing, reconstruction and inclusion in the models can be found in their respective stock annexes.

15.3.3 Discard survival

Skates and rays were due to come under the European Landing Obligation (LO) from 1 January 2019 onwards, and given the disparity in quota and actual landings, they were expected to become "choke" species in certain fisheries. As stated in STECF 2014 "Article 15 paragraph 2(b)", exemptions from the LO are possible for species for which "scientific evidence demonstrates high survival rates". There have since been exemptions made for skates and rays in the North Sea such that discarding has been allowed to occur until the end of 2023. During this period, additional data and information have been collected on survivability.

Ellis *et al.* (2017) provided a review of discard survival studies. Skates taken in coastal fisheries using trawls, longlines, gillnets and tangle nets generally show low at-vessel mortality (Ellis *et al.*, 2008a, 2018), though it should be noted that the inshore fleet generally have limited soak times and haul durations. Studies for beam trawlers indicate that just over 70% of skates may survive (Depestele *et al*., 2014).

The SUMARiS project funded by the INTERREG 2 Seas Programme (2014–2020) provided further information on the vitality, reflex impairment, injury and survival probability of skates discarded in the English Channel and North Sea after being captured on-board commercial fishing vessels using active (beam trawl, otter trawl) or passive (gillnets, trammel nets) fishing gears. A total of 31 trips were organized on-board of French, English and Belgian commercial vessels. The discard survival probability (using immediate and delayed survival estimates (monitored in captivity for 21 days)) for thornback ray and blonde ray discarded by beam trawlers were 54% and 67%, respectively. Meanwhile otter trawlers showed overall survival estimates for thornback and blonde ray of 72% and 86%, respectively. For spotted ray and undulate ray by beam trawlers, the overall discard survival estimates were 27% and 58%, respectively (Van Bogaert *et al.*, 2020).

A Dutch study quantitatively estimated the longer-term discard survival probability of thornback ray. Discard survival was assessed during nine trips with commercial pulse-trawlers, monitoring survival in captivity for 15–18 days (Schram and Molenaar, 2018). The discard survival probability estimates varied among sea trips, resulting in a survival probability estimate of 53% (95% CI 40–65%). Also, during two trips, discard survival probabilities were estimated for spotted ray, resulting in survival probabilities of 21% and 67%. Given the limited numbers of observations per species, estimates should be considered and treated as a first indication of the actual discard survival probability for these species in the 80 mm pulse-trawl fisheries. Further quantitative estimates of longer-term survival are required for a variety of elasmobranchs captured in various European fisheries (Ellis *et al.*, 2018).

A more recent study combined available discard survival data for thornback ray, blonde ray and spotted ray from the SUMARiS project, FROM NORD (French flyshoot study) and Wageningen Marine Research (Villagra *et al.*, 2023). Discard survival was calculated for beam trawls, other bottom trawls, flyshoot gears and netters (when applicable). The results from this study were used during the 2023 benchmark to calculate the dead discards for each of the three benchmarked stocks (ICES, 2023).

15.4 Commercial landings composition

15.4.1 Length data of the catch

Length-frequency distributions of retained and discarded elasmobranchs were provided through the WKLIFE data-call in 2022 and in the WGEF data-call in 2023. In 2022, during the WGEF meeting, length data for all stocks were collected from both InterCatch and the accessions folder and collated into a single length data table. Since 2022, additional data following WGEF data calls is added on an annual basis.

15.4.2 Quality of data

Length data may have insufficient samples in a single year to be used annually and as a consequence length data is often pooled. For those stocks that were assessed following the *rfb* rule, length data were presented during the WGEF meeting and for each stock, it was decided whether data were sufficient to be used in the assessment. COVID-19 also reduced sampling levels in 2020 and 2021.

15.5 Commercial catch-effort data

There are no effort data specifically for North Sea skates and rays.

15.6 Fishery-independent surveys

Time-series of abundance and biomass indices for the most relevant species are available and are based on North Sea IBTS, BTS, and CGFS-Q4 surveys. Data were extracted from the DATRAS database or supplied by national laboratories. A description of the surveys is given below. Additional information on all these surveys was collated during WKSKATE (ICES, 2021).

15.6.1 International Bottom Trawl Survey North Sea Q1 (IBTS-Q1) and Q3 (IBTS-Q3)

Fishery-independent data are available from the International Bottom Trawl Survey (IBTS), in winter (Q1) and summer (Q3). An overview of IBTS survey data for North Sea elasmobranchs is presented in Daan *et al.* (2005), with further information collated during WKSKATE on all skates and rays encountered during these surveys (ICES, 2021).

Daan *et al.* (2005) also analysed the time-series of abundance for the major species caught for the period 1977–2004 (see Figure 12.3 of ICES, 2006). *A. radiata* appears to have increased from the late 1970s to the early 1980s, followed by a decline. The reasons for this decline are unknown, but could include changing environmental conditions, multi-species interactions (including with other skates), fishing impacts, or even improved species identification. The same patterns seem to apply to *L. naevus* and *R. montagui*, however, these species have also shown an increase in the most recent ten years in both the Q1 and Q3 surveys. The 'common skate complex' showed an overall decline, supporting the findings of ICES (2006). Since 2009, an increase of the 'common skate complex' has been observed (Figure 15.6.5). *R. clavata* has been stable, with one outlier in 1991 owing to a single exceptionally large catch (confirmed record) but shows an increasing trend in most recent years (Figure 15.6.3).

15.6.2 Channel groundfish survey

Martin *et al.* (2005) analysed data from the Channel Groundfish Survey (CGFS-Q4) and the Eastern Channel Beam Trawl Survey (UK (BTS-Q3)) for the years 1989–2004. Migratory patterns related to spawning and nursery areas were postulated, with the coast of southeast England an important habitat for *R. clavata*. Updated analyses for this survey were recently published by Martin *et al*. (2010, 2012). CGFS-Q4 continued in 2013, where high indices were noted for *R. clavata* and *R. undulata*. While most species fluctuate without a clear trend, *R. clavata* has increased in the last ten years. Information on *R. undulata* is presented in Section 18, as the main part of the stock is considered to occur in Division 7.e. For further information see also the 2021 WKSKATE report (ICES, 2021).

15.6.3 Beam trawl surveys

The UK beam trawl survey in quarter 3 (BTS-Eng-Q3) started in the late 1980s, although the survey grid was not standardized until 1993 (see Ellis *et al*., 2005a, b and Parker-Humphreys, 2005 for a description of the survey, ICES, 2021). The primary target species for the survey are commercial flatfish (plaice *Pleuronectes platessa* and sole *Solea solea*) and so most sampling effort occurs in relatively shallow water. *Raja brachyura*, *R. clavata*, *R. montagui* and *R. undulata* are all sampled during this survey.

The Dutch beam trawl survey in quarter 3 consists of two parts: the BTS-ISIS-Q3 started in the late 1980s, and the NL BTS Tridens or BTS-TRI-Q3 started in the 1990s. The primary target species for these surveys are commercial flatfish (plaice and sole). The BTS ISIS fishes in the Southern North Sea and the BTS Tridens fishes in the Southern and central North Sea. For more detailed information see also WKSKATE report (ICES, 2021).

Data from the German beam trawl survey in quarter 3 (BTS-GFR-Q3) has also been available since the late 2000s (ICES, 2021). Catch rates are generally lower than for the other BTS surveys, with the exception of *A. radiata*.

Data from the Belgian beam trawl survey in quarter 3 (BTS-BEL-Q3) have been uploaded to DATRAS for the following years 2010–2022. Historical data (prior to 2010) are being prepared for uploading to DATRAS. This North Sea survey is organized yearly at the end of August and beginning of September since 1985 on-board of the *RV* Belgica and covers an important area in the south-western part of the North Sea (i.e. Greater Thames estuary and the Wash). The most abundant skate species observed in the survey are thornback ray *Raja clavata* and spotted ray *Raja montagui*. Figure 15.6.8 shows the distribution plots for these species from all BTS surveys in the central-southern North Sea and shows that the highest concentrations (numbers per km^2) are covered by the Belgian BTS. Other elasmobranchs such as lesser-spotted dogfish (*Scyliorhinus canicula*) are caught in large numbers, while smooth-hounds *Mustelus sp.* and blonde ray *Raja brachyura* are also caught, though in smaller numbers. For more detailed information see also WKSKATE report (ICES, 2021).

15.6.4 Index calculations

Survey data for the IBTS Q1 and Q3, as well as BTS-ISI-Q3, BTS-TRI-Q3 and BTS-GFR-Q3 were downloaded from DATRAS in June 2022 as CPUE per length per haul. For the CGFS-Q4 and BTS-Eng-Q3, exchange data were downloaded from DATRAS, while the BTS-BEL-Q3 survey data refer to data held within the national database.

For IBTS and BTS, starting from the CPUE (in numbers per hour) per length per haul, indices were calculated for n. hr^{-1}, biomass hr^{-1}, and exploitable biomass h^{-1}. Data for exploitable biomass relate to individuals ≥50 cm total length. This was done by first combining observations for *Dipturus batis* (including for the junior synonym *Dipturus flossada*) and *Dipturus intermedius* as "common skate complex", and then by splitting the observations for *Raja brachyura* for areas 4.a and 4.c. Only IBTS roundfish areas 1–7 were used when calculating indices for the IBTS-Q1 and IBTS-Q3. Data included in the calculations relate to successfully fished (valid) hauls.

Zero observations were added for all length-haul combinations. The average CPUE per length per ICES statistical was then calculated from the CPUE per length per haul. The CPUE per length per ICES statistical rectangle data was combined with the life history information to obtain CPUE per length per ICES statistical rectangle in numbers per hour and in weight per hour. These were summed across lengths to obtain the overall CPUE per ICES statistical rectangle (numbers and biomass).

For each survey, the annual index value was calculated for the mean catch rate by abundance (mean n.h^{-1}), total biomass (mean kg.h^{-1}) and exploitable biomass (kg.h^{-1}) with associated confidence intervals (95% CI). These values were obtained through the method of bootstrapping (1000 replicates) using '*boot*' R package (Davison and Hinkley, 1997; Canty and Ripley, 2021). Input data were the total number (abundance), total biomass and exploitable biomass per statistical rectangle and year (including zero catches), thus obtaining an annual mean value with a lower and upper confidence limit.

For the BTS-Eng-Q3, survey indices for the whole time series were updated following recommendations from WKSKATE (ICES, 2021). Additionally, calculations are now based on DATRAS exchange data as per ICES (2021) and this is contrary to the indices used in the 2019 assessments, with the latter previously described in Silva and Ellis (2019).

The CGFS-Q4 indices were calculated using a swept area approach (km^{-2}) for the total abundance, total and exploitable biomass, following the methodology developed during WKSKATE

(ICES, 2021). Catches in weight per haul were calculated using a length-weight relationship from McCully *et al.* (2012).

The abundance indices in n. h^{-1} for the different species are presented in Tables 15.6.1–15.6.7. The biomass indices in kg.h^{-1} are presented in Tables 15.6.8–15.6.14. The exploitable biomass indices in kg.h^{-1} are presented in Tables 15.6.15–15.6.21. CGFS-Q4 results are per km^2 instead of per hour in all the Tables. It is important to note that while CGFS-Q4 2020 data are shown in this report, these should be viewed with caution as survey spatial coverage was reduced due to the lack of dispensation to fish in ICES rectangles 29F1 and 30E9. All indices including the 95% CIs are also given in Figures 15.6.1–15.6.7.

15.7 Life-history information

Elasmobranchs are not routinely aged, although techniques for ageing are available (e.g. Walker, and Hislop, 1998; Serra-Pereira *et al.*, 2005). Limited numbers of species have been aged in dedicated studies.

Updated length–weight conversion factors and lengths-at-maturity are available for nine skate species (McCully *et al.*, 2012; Silva *et al.*, 2013). The length-weight conversions used for the calculations of the fisheries independent biomass indices are given in Table 15.7.1. Three species had conversion factors specific to the North Sea ecoregion, with the lengths at maturity for both sexes of *L. naevus*, and female *R. clavata*, being significantly smaller in the North Sea than the Celtic Seas ecoregion.

Demographic modelling requires more accurate life-history parameters, in terms of age or length and fecundity. An overview of the life-history parameters for North Sea stocks of *R. clavata, R. brachyura* and *R. montagui* was provided by Ellis et al. (2023a) and included information on the length-weight relationship, length-at-maturity, growth rates and annual fecundity. This overview provided initial proposals for values that could be used in the benchmark assessment process. Further information on life-history parameters for these stocks can be found in their respective stock annexes.

With the development of the *rfb* rules by ICES, knowledge of the growth parameter *k* and L_{inf} is needed. Ellis *et al.* (2023b) provided a working document summarising available data on the growth rate from the published literature for some of the main species of skate and catsharks.

15.7.1 Ecologically important habitats

Ecologically important habitats for the skates include (a) oviposition (egg-laying) sites (b) nursery grounds; (c) habitats of the rare species, as well as other sites where there can be large aggregations (e.g. for mating or feeding).

Little is known about the presence of egg-laying grounds, although parts of the southern North Sea (e.g. the Thames area) are known to have large numbers of juvenile *R. clavata* (Ellis *et al.*, 2005a) and egg laying is thought to occur in both the inshore grounds of the Outer Thames estuary and the Wash.

Trawl surveys could provide useful information on catches of (viable) skate egg cases. This recommendation has therefore been put into the offshore and inshore manuals of the trawl surveys (ICES, 2011). The Netherlands already collects data on viable elasmobranch egg cases.

Surveys may be able to provide information on the locations of nursery grounds and other juvenile habitats, and these should be further investigated to identify sites where there are large numbers of 0-groups and where these life-history stages are found on a regular basis.

Little is known about the habitats of the rare elasmobranch species, and further investigations on these are required (e.g. Martin *et al*., 2010; 2012; Ellis *et al*., 2012).

15.8 Exploratory assessment models

Different methods have been explored to assess the stock status of several skate species. Early assessments methods as conducted under the DELASS project (Heessen, 2003) and the SPANdex approach were used to examine changes in abundance and distribution of the four main skate species in the North Sea (*A. radiata*, *L. naveus*, *R. clavata* and *R. montagui*). These have been extensively discussed in previous ICES reports (ICES, 2002 and 2007). In 2017, SPiCT was trialled for two North Sea stocks (*R. clavata* and *L. naevus).* While the model performed reasonably well, these were not further developed until 2023. In 2023, SPiCT was explored and accepted for three North Sea stocks (ICES, 2023a).

The ICES Workshop on the Development of Quantitative Assessment Methodologies based on life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE) has worked on further developing methods for stock assessment and catch advice for Category 3 and 4 stocks. Within these workshops, methods (i.e. *rfb* rule) for data-limited stocks have been explored and evaluated resulting in the application of these empirical rules for North Sea elasmobranch stocks.

15.9 Stock assessment

The stocks listed below were assessed in 2023. For Category 5 and 6 stocks there were no changes to the assessment methods. Category 3 stocks were assessed using the ICES framework (*rfb* rule, method 2.1, ICES, 2022b).

Following the new *rfb* methodology also means that average comparisons of indices has changed from the mean values of the previous two years over the preceding five years (2/5 rule) to the mean values of the previous two years over the preceding three years (2/3 rule).

Three stocks were benchmarked in 2023 and are now assessed as Category 2 stocks. This means they are assessed using a Surplus Production model in Continuous Time (SPiCT, Pedersen and Berg 2017).

15.9.1 Blonde ray in Subarea 6 and Division 4.a

Raja brachyura has a patchy distribution in Subarea 6. It is not encountered in sufficient numbers in surveys to derive trends in abundance/biomass. The stock is considered to extend into the north-western North Sea (Division 4.a) and may also extend along the west coast of Ireland. This Subarea 6 and Division 4.a stock was assessed in North Sea biennial advice years (2021, 2023 etc.) previously, but the decision was made in 2023 that this stock will now be assessed and advice drafted quadrennially. It was last assessed as a Category 5 stock in 2023, using landings data only. WKSKATE (ICES, 2021) examined this stock as a case-study and determined that there was no suitable survey or combination of surveys that could be used in a Category 3 assessment.

15.9.2 Blonde ray in divisions 4.b, 4.c and 7.d

Raja brachyura has a patchy distribution and the stock boundaries have previously not been well defined. Currently there are two stock units in the North Sea ecoregion (rjh.27.4a6 and rjh.27.4bc7d). The latter stock unit formerly included only divisions 4.c and 7.d. However, studies using tagging data and analysis of survey data showed a spill-over from the north of 4.c to the south of 4.b in recent years. This has led to the inclusion of Division 4.b in the stock unit in 2023.

In previous assessments, only the French Channel Groundfish Survey (FR-CGFS-Q4) was used to obtain an exploitable biomass index (individuals ≥50 cm). Catch rates are variable, though there is a clear sign of improving status in recent years. This survey mainly covers Division 7.d. Catch rates in both International Bottom Trawl Surveys (NS-IBTS-Q1 and NS-IBTS-Q3) are highly variable, with a large number of zero hauls recorded. As the NS-IBTS-Q1 and NS-IBTS-Q3 cover a broader range of the stock unit, it was decided to include these surveys for the index calculations (ICES, 2023a). A Generalized Additive Model (GAM) with a Delta-lognormal distribution was used to obtain an exploitable biomass index. The combined index is presented in Figure 15.9.1 and shows that exploitable biomass is low in earlier years of the time series. In years 1990, 1991 and 1996, the numbers of records were too low to estimate exploitable biomass. Since 2012, there is an increase in exploitable biomass and a wider spatial distribution in divisions 4.c and 7.d.

15.9.2.1 Benchmark assessment

A benchmark assessment of this stock took place in 2023 (WKBELASMO 2023). The results are outlined in the benchmark report (ICES, 2023a) and the stock annex.

The application of a new SPiCT model allowed the estimation of relative reference points. The assessment of the stock indicates that F is below F_{MSY} and B is above B_{MSY}. ICES catch advice is based on the 15th percentile of predicted catch distribution, which is considered more precautionary than the 35th percentile (the default method in SPiCT). The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years.

15.9.3 Common skate complex (Blue skate *Dipturus batis* and flapper skate *D. intermedius*) in Subarea 4 and Division 3.a

The common skate complex is known to comprise two species, the common blue skate and the flapper skate. Available information suggests that flapper skate occurs in the northern parts of the stock area, where it likely merges with the neighbouring population in subareas 6 and 2. The distribution extends into the west of Scotland and the Norwegian Sea (based on comparisons of historical and temporary trawl survey data). Common skate has long been considered depleted however, in the last 10 years, catch rates have increased in both IBTS surveys.

No landings of these species have been allowed in UK and EU waters since 2009 and both have been on the prohibited species list since 2010. Nevertheless, ICES estimates of landings are available in Subarea 4 and Division 3.a, with the majority of these landings coming from Denmark. Denmark states that these landings are occurring in Norwegian waters.

In 2023, ICES was requested to provide advice for this stock unit. Given the lack of robust survey data over the stock range, and lack of landings data, a Category 6 assessment was applied to this stock. WGEF considers that trends in stock size or indicator cannot be evaluated.

15.9.4 Cuckoo ray in Subarea 4 and Division 3.a

Cuckoo ray is a small-bodied skate with a widespread distribution. Within the Greater North Sea ecoregion it is found mainly in the northern areas of the North Sea (Division 4.a). The combined exploitable biomass (individuals ≥50 cm) index (kg h^{-1}) used in the assessment is calculated using the NS-IBTS-Q1 and NS-IBTS-Q3 surveys for years 1991-2022. The stock has shown a decreasing trend in the last years of time series, with an increase in 2022. The 2/3 rule resulted in a decrease of 18%.

In 2023, the stock was assessed using the ICES *rfb*-rule. Length-data is available from 2016-2022, for which the last 4 years (2019-2022) are considered to have sufficient coverage. For 2019, no length data were available, therefore years 2020-2022 were used to calculate the length-based reference points. Full details of the input parameters for the *rfb* assessment can be found in Appendix 1 of this chapter.

15.9.5 Spotted ray in Subarea 4 and divisions 3.a and 7.d

Spotted ray is a small-bodied skate species with a widespread distribution in the North-east Atlantic. There is limited information available on the stock structure; there is evidence of movement between divisions 4.c and 4.b and between divisions 7.d and 4.c, however, there is no information available to confirm the inclusion of Division 4.a in the stock unit. The stock was benchmarked in 2023 (ICES, 2023a).

The inclusion of surveys for this stock unit was assessed in WKSKATE in 2020 (ICES, 2021). A combined exploitable biomass (individuals ≥50 cm) index (kg h^{-1}) for the NS-IBTS-Q1 and NS-IBTS-Q3 has been used with a design-based approach to combine the surveys. In 2023, a modelled-based approach was used for combining different relevant surveys. This led to the inclusion of five more surveys (FR-CGFS-Q4, BTS-BEL-Q3, BTS-Eng-Q3, BTS-NL-TRI-Q3 and BTS-NL-ISI-Q3). A Generalized Additive Model (GAM) with a Delta-lognormal distribution was used to model two separate indices splitting the different surveys based on seasonality. The NS-IBTS-Q1 and FR-CGFS-Q4 were combined with consecutive years. All surveys carried out in Q3 were combined into a second index. Furthermore, a biomass index of individuals ≥30 cm was chosen, instead of exploitable biomass. The indices are presented in Figure 15.9.2 and follow the same trend. In summary, biomass has been stable from the beginning of the time series and shows a slight increasing trend since 2006.

15.9.5.1 Benchmark assessment

A benchmark assessment of this stock took place in 2023 (WKBELASMO 2023). The results are outlined in the benchmark report (ICES, 2023a) and the stock annex.

The application of a new SPiCT model allowed the estimation of relative reference points. The assessment of the stock showed that F is currently below F_{MSY} and B is above B_{MSY}. ICES catch advice is based on the 15th percentile of predicted catch distribution, which is considered more precautionary than the 35th percentile (the default method in SPiCT). The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years.

15.9.6 Starry ray in Subarea 2 and 4 and Division 3.a

This small-bodied skate is distributed mainly in the Northern parts of the North Sea. It is listed on the prohibited species list and has a zero catch advice. The combined abundance index (n h^{-1}) used in the assessment is calculated using the NS-IBTS-Q1 and NS-IBTS-Q3 surveys for years 1991-2022 and is considered to cover most of the stock area. The stock has been decreasing since 2001 and the 2/3 rule resulted in an *r* of 0.75. Length information is limited and derived purely from the discarded proportion of the catch (i.e., no length data from landings data is available). Only the years 2019 and 2022 are considered to have sufficient coverage to facilitate the calculation of the length-based reference points. Full details of the input parameters for the *rfb* assessment can be found in Appendix 2 of this chapter. The catch advice resulting from the 2023 assessment is zero t.

15.9.7 Thornback ray in Subarea 4 and divisions 3.a and 7.d

Thornback ray is the most common skate species in the Greater North Sea ecoregion. The population structure has been studied using both genetics and tagging. Genetic studies have shown that within the ecoregion, there are few genetic differences between individuals sampled from the different divisions. Furthermore, based on available tagging data it was found that there is a clear exchange of thornback ray within divisions 4.b-c and 7.d. Information on the exchange with divisions 3.a and 4.a is limited.

There has been no update to the surveys used to indicate the stock status. Currently included surveys are NS-IBTS-Q1, NS-IBTS-Q3, FR-CGFS-Q4, BTS-BEL-Q3 and BTS-Eng-Q3. During the benchmark process, the index calculation process has changed from a design-based to a modelled-based approach. Furthermore it was decided to use a biomass index (individuals ≥30 cm), instead of an exploitable biomass index. A Generalized Additive Model (GAM) with a Delta-lognormal distribution was used to model two separate indices splitting the different surveys based on seasonality. The NS-IBTS-Q1 and FR-CGFS-Q4 were combined with consecutive years. All surveys carried out in Q3 were combined into a second index. The combined indices are presented in Figure 15.9.3 and show that biomass is low during the earlier years of the time series. Since 2012, there is a notable increase in biomass up until 2020. In more recent years, biomass has been decreasing. Highest numbers are found in the English Channel (Division 7.d).

15.9.7.1 Benchmark assessment

A benchmark assessment of this stock took place in 2023 (WKBELASMO 2023). The results are outlined in the benchmark report (ICES, 2023a) and the stock annex.

The application of a new SPiCT model allowed for the estimation of relative reference points. The assessment of the stock showed that F is currently below F_{MSY} and B is above B_{MSY}. ICES catch advice is based on the 15th percentile of predicted catch distribution, which is considered more precautionary than the 35th percentile (the default method in SPiCT). The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years.

15.9.8 Other rays and skates in Subarea 4 and divisions 3.a and 7.d

This advice unit relates to those skates (order *Rajiformes*) not specified elsewhere in the ICES advisory process. It includes skate stocks in the Greater North Sea ecoregion but does not refer to stingrays or electric rays. The skate species considered here include Arctic skate *Amblyraja hyperborea*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, sailray *Rajella lintea*, and occasional records for species occurring outside of their allocated stock units (e.g. blonde ray in Division 3.a). Blonde ray catches in Division 4.b have now been allocated to rjh.27.4bc7d stock. Some of the generic skate landings are likely to be commercial species for which ICES provides species-specific advice. The species composition of the catch is mostly unknown. The decrease in generic landings is due to the introduction and improvement in species-specific recording of the main commercial skate and ray species since 2009. The majority of landings submitted as unspecified rays and skates are from divisions 3.a and 4.a. In 2023, the ICES framework for category 6 stocks was applied. Due to the lack of sufficient survey and catch, catch advice on this stock could not be provided.

15.10 Quality of assessments

There are several issues that influence the evaluation of stock status:

1. Length data may have insufficient samples in a single year and therefore length data are often pooled.
2. The stock identity for many species is not accurately known (although there have been some tagging and genetic studies to inform on some species).
3. The identification of skate species is considered to be reliable for recent surveys, although occasional misidentifications may still occur.

For the three benchmarked stocks (rjh.27.4bc7d, rjm.27.3a47d and rjc.27.3a47d) SPiCT has been adopted as the assessment method. The use of new assessment methods resulted in stocks moving from the ICES stock Category 3 to Category 2. It also led to a changed perception of the stock and a major increase in advised catch.

Increased advice following a stock category change is somewhat expected. This is because as advice under the precautionary approach (ICES category 3) is calculated using a method that is explicitly designed to be precautionary and to prevent stock depletion in the absence of sufficient data to support a quantitative assessment. In comparison, advice for Category 2 stocks is given under the MSY approach.

15.11 Reference points

No official reference points have been adopted for any stock that has not been through the benchmark process. The three benchmark stocks now have F_{MSY} and B_{MSY} reference points. Proxy length-based reference points are now also calculated for Category 3 stocks that use the ICES *rfb* method.

15.12 Conservation considerations

Both members of the 'common skate complex' are considered 'Critically Endangered' by the IUCN, and '*D. batis*', *R. montagui*, and *R. clavata* are all on the OSPAR list of Threatened and Declining species. However, WKSTATUS considered that both *R. montagui* and *R. clavata* do not continue to justify inclusion in the OSPAR list (ICES, 2020).

Various elasmobranchs are contained in the Swedish Red List (Gärdenfors, 2010), with *R. lintea* considered Near Threatened, *R. clavata* considered Endangered, and '*D. batis*' considered Regionally Extirpated.

The Norwegian Red List (Gjøsæter *et al.*, 2010) includes various skates. '*D. batis*' (complex) is considered Critically Endangered, and *B. spinicauda*, *D. nidarosiensis* and *L. fullonica* are all considered Near Threatened.

15.13 Management considerations

Skates are usually caught in mixed fisheries for demersal teleosts, although some inshore longline and gillnet fisheries target *R. clavata* in seasonal fisheries in the south-western North Sea. *Raja brachyura* may be locally and seasonally important for some inshore fisheries.

Up to 2008, skates were traditionally landed and reported in mixed categories such as "skates and rays". For assessment purposes, species-specific landings data are essential. Species-specific reporting for the main skate species has been required since 2008. An increasing proportion of skate landings are now reported to species and, whilst there are some inconsistencies, the overall proportions broadly correspond with what would be expected, given survey information. Nevertheless, some doubt exists as to the quality of some of the data provided, particularly the distinction between *R. montagui* and *R. brachyura.* Continued species-specific reporting is required, and further scientific sampling of commercial catches (to validate species-specific landings) and training are required.

A TAC for skates was first established for Union waters of Division 2.a and Subarea 4 (combined) in 2009. Since 2009, there have been three separate TAC areas in this ecoregion: Union waters of Division 2.a and Subarea 4 (combined); Division 3.a; and Division 7.d.

Landings have been at or above the TAC since 2006 (but slightly above in Division 7.d, possibly due to transfer between 7.d and 7.e) (Figure 15.3.1) and may now be restrictive for some fisheries. Since its introduction, the TAC has gradually been reduced, which may have induced regulatory discarding. In recent years (2016–2020), the TAC has increased slightly.

Recent work has shown that the use of common TACs can lead to the overexploitation of certain skate and ray species (Batsleer *et al*., 2024). In the North Sea, landings of *R. brachyura* (allocated to rjh.27.4a6 and rjh.27.4bc7d) have exceeded ICES single stock advice in almost all years between 2016 and 2022. In comparison, landings of *R. clavata* (rjc.27.3a47d) often fall below ICES single stock advice. Such findings provide support for the ICES advice that 'management of catches under a common TAC prevents effective control of single-stock exploitation rates and could lead to over-exploitation of some species.

Current TAC regulations have a condition so that "*up to 5%* [of the TAC for Union waters of 6.a-b, 7.a–c and 7.e–k] *may be fished in Union waters of 7.d*". Whilst it is pragmatic allowing vessels in the English Channel (7.d–e) to transfer quota between these divisions, further studies to examine the implications of this needs to be evaluated. For example, 5% of the overall 2014 quota for 6.a-b, 7.a–c and 7.e–k (8032 t) is 401.6 t, which is more than half of the 2014 TAC for 7.d (798 t). Whilst this is a theoretical maximum and unlikely to be realised, further studies of this issue are required.

At-vessel mortality is low for inshore trawlers in the south-western North Sea, as tow duration tends to be relatively short and longline fisheries also have low at-vessel mortality (Ellis *et al*., 2008a, b, 2018). At-vessel mortality in gillnets may also be low, depending on soak-time. A study on survival from beam trawlers indicated survival of >70% for skates (Depestele *et al.*, 2014). Discard survival probability varies significantly according to species and gear combination and ranged between 27% and 86%. Fish condition, individual length and sorting time strongly affected both short and medium-term survival (Van Bogaert *et al.*, 2020). In pulse-trawlers the long-term discard survival probability for thornback ray was estimated to be 53% (Schram and Molenaar, 2018).

Effort restrictions and high fuel prices have resulted in reduced effort but can also result in using different gears with different catchabilities for skates. Also, some fisheries may redirect effort to fishing grounds closer to port, which may affect more coastal species, such as *R. clavata* in the Thames estuary and in the Wash in the south-western North Sea.

15.14 References

Batsleer, J., Griffiths, C.A., Bleeker, K., Johnston, G., Cardinale, M. and Lorance, P. 2024. Comparisons of landings to scientific advice indicate overshooting within the common TAC for skates and rays in the Northeast Atlantic, ICES Journal of Marine Science, 81 (3): 470–479.

Daan, N., Heessen, H.J.L., and ter Hofstede, R. 2005. North Sea Elasmobranchs: distribution, abundance and biodiversity. ICES CM 2005/N:06.

Depestele, J., Desender, M., Benoît, H. P., Polet, H., and Vincx, M. 2014. Short-term survival of discarded target fish and non-target invertebrate species in the "eurocutter" beam trawl fishery of the southern North Sea. Fisheries Research, 154: 82–92.7

Deschamps, G., Giret, M., Liorzou, B., Tetard, A. 1981. Étude halieutique de projet de site PENLY (Seine-maritime) – Rapport sur deux cycles annuels II ème Partie – Pêche et Biologie des espèces Vol.I & II. http://archimer.ifremer.fr/doc/00045/15662/.

Ellis, J.R., Burt, G.J. and Cox, L.P.N. 2008a. Thames ray tagging and survival. Cefas Fisheries Science Partnership 2007/2008, Programme 19, Final Report, 54 pp.

Ellis, J.R., Burt, G.J., Cox, L.P.N., Kulka, D.W, and Payne, A.I.L. 2008b. The status and management of thornback ray Raja clavata in the southwestern North Sea. ICES CM 2008/K:13, 45 pp.

Ellis, J. R., Burt, G. J., Grilli, G., McCully Phillips, S. R., Catchpole, T. L. and Maxwell, D. L. 2018. At-vessel mortality of skates (Rajidae) taken in coastal fisheries and evidence of longer-term survival. Journal of Fish Biology, 92: 1702–1719.

Ellis, J. R., Cruz-Martinez, A., Rackham, B. D. and Rogers, S. I. 2005a. The distribution of chondrichthyan fishes around the British Isles and implications for conservation. Journal of Northwest Atlantic Fishery Science, 35: 195–213.

Ellis, J.R., Dulvy, N.K., Jennings, S., Parker-Humphreys, M. and Rogers, S.I. 2005b. Assessing the status of demersal elasmobranchs in UK waters: a review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Ellis, J. R., Heessen, H. J. L. and McCully Phillips, S. R. 2015. Skates (Rajidae). In 'Fish atlas of the Celtic Sea, North Sea, and Baltic Sea' (Heessen, H. J. L., Daan, N. and Ellis, J. R., Eds.). Wageningen Academic Publishers / KNNV Publishing, 96–124.

Ellis, J.R., McCully, S.R. and Brown, M.J. 2012. An overview of the biology and status of undulate ray Raja undulata. Journal of Fish Biology, 80: 1057–1074.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. Journal of Fish Biology, 90: 653–722.

Ellis, J.R., Silva, J.F., McCully, S.R., Evans, M. and Catchpole, T. 2010. UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10.

Ellis, J. R., Silva, J. F., McCully Phillips, S. R., Bleeker, K. and Batsleer, J. 2023a. An overview of the life-history parameters for North Sea stocks of thornback ray *Raja clavata* (rjc.27.3a47d), spotted ray *R. montagui* (rjm.27.3a47d) and blonde ray *R. brachyura* (rjh.27.4bc7d). Working Document to the ICES Benchmark Workshop for selected elasmobranch stocks (WKBELASMO), 20–24 March 2023; 22 pp.

Ellis, J. R., Silva, J. F. and McCully Phillips, S. R. 2023b. An overview of the growth parameters of demersal elasmobranchs in the ICES area and adjacent waters. Working Document to the ICES Working Group on Elasmobranch Fishes, June 20–June 29, 2023; 32 pp.Fricke, R., Eschmeyer, W. N. & R. van der Laan (eds). 2021. ESCHMEYER'S CATALOG OF FISHES: GENERA, SPECIES, REFERENCES. (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Electronic version accessed 28 07 2021.

Gärdenfors, U. (Ed.). 2010. Rödlistade arter i Sverige 2010- The 2010 Red List of Swedish Species. Artdatbanken, SLU, Uppsala. Available via: http://www.slu.se/Global/externwebben/centrumbildningar-projekt/artdatabanken/Dokument/R%c3%b6dlistan/Artgrupper/Rodlista2010-fiskar.pdf.

Gjøsæter, J., Hesthagen, T., Borgstrøm, R., Brabrand, Å., Byrkjedal, I., Christiansen, J. S., Nedreaas, K., Pethon, P., Uiblein, F., Vøllestad, L. A. And Wienerroither, R. 2010. Fisker "Pisces". In Kålås, J. A., Viken, Å., Henriksen, S. And Skjelseth, S. (eds.) 2010. The Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Norway.

Griffiths, A. M., Sims, D. W., Cotterell, S. P., El Nagar, A., Ellis, J. R., Lynghammar, A., McHugh, M., Neat, F. C., Pade, N. G., Queiroz, N., Serra-Pereira, B., Rapp, T., Wearmouth, V. J. and Genner, M. J. 2010.

Molecular markers reveal spatially segregated cryptic species in a critically endangered fish, the common skate (*Dipturus batis*). Proceedings of the Royal Society, B – Biological Sciences, 277: 1497–1503.

Heessen, H.J.L. (Ed.) 2003. Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 605 pp.

ICES. 2002. Report of the Working Group on Elasmobranch Fishes (WGEF), 6–10 May, Copenhagen, Denmark. ICES CM 2002/G:08, 119 pp.

ICES. 2006. Report of the Working Group on Elasmobranch Fishes (WGEF), 14–21 June 2005, Copenhagen, Denmark. ICES CM 2006/ACFM:31, 291 pp.

ICES. 2007. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–28 June, Galway, Ireland. ICES CM 2007/ACFM:27, 318 pp.

ICES. 2011. Report of the Working Group on Beam Trawl Surveys (WGBEAM). ICES CM 2011/SSGESST:14.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARKS), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40. 69 pp.

ICES. 2018. Report on the French request for updated advice for Undulate ray (*Raja undulata*) in Divisions 7.d-e and 8.a-b. Annex 8 in Report of the Working Group on Elasmobranch Fishes, 19-28 June 2018, Lisbon, Portugal. ICES CM 2018/ACOM:16. Available separately in the ICES library.

ICES. 2020. Workshop to review and update OSPAR status assessments for stocks of listed shark, skates and rays in support of OSPAR (WKSTATUS). ICES Scientific Reports. 2:71. 152 pp. http://doi.org/10.17895/ices.pub.7468

ICES. 2021. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948.

ICES 2022a. Greater North Sea ecoregion – fisheries overview. ICES Advice: Fisheries Overviews. Report. https://doi.org/10.17895/ices.advice.21641360.v1

ICES. 2022b. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. In Report of ICES advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564

ICES. 2023a. Benchmark Workshop on selected elasmobranch stocks (WKBELASMO). ICES Scientific Reports. 5:45. 117 pp. http://doi.org/10.17895/ices.pub.22760042

ICES. 2023b. Working Group on Beam Trawl Surveys (WGBEAM). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.22726112.v1

Iglésias, S. P., Toulhout, L. and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquatic Conservation Marine and Freshwater Ecosystems, 20: 319–333.

Last, P., White, W., Carvalho, M.R. de, Séret, B., Stehmann, M. and Naylor, G.J.P. 2016. Rays of the World. Victoria: CSIRO Publishing.

Martin C.S., Vaz, S., Ellis, J.R., Coppin, F., Le Roy, D. and Carpentier, A. 2010. Spatio-temporal patterns of demersal elasmobranchs in trawl surveys in the eastern English Channel (1988–2008). Marine Ecology Progress Series, 417: 211–228.

Martin, C.S., Vaz, S., Ellis, J.R., Lauria, V., Coppin, F., and Carpentier, A. 2012. Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. Journal of Experimental Marine Biology and Ecology, 418/419: 91–103.

Martin, C.S., Vaz, S., Ernande, B., Ellis, J.R., Eastwood, P.D., Coppin, F., Harrop, S., Meaden, G.J., and Carpentier, A. 2005. Spatial distributions (1989–2004) and preferential habitats of thornback ray and lesser-spotted dogfish in the eastern English Channel. ICES CM 2005/N:23, 27 pp.

McCully, S.R., Scott, F., and Ellis, J.R. 2012. Lengths-at-maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES Journal of Marine Science, 69:

1812–1822.Parker-Humphreys, M. 2005. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Eastern English Channel (ICES Division VIId) and the southern North Sea (ICES Division Ivc) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 124, 92 pp.

Pedersen, M. W., & Berg, C. W. (2017). A stochastic surplus production model in continuous time. Fish and Fisheries, 18(2), 226-243.

Schlaich, I., Antajan, E., Baehr, A., Devreker, D., Francoise, S., Loots, C., Rabiller, E., Schapira M. 2014. Surveillance écologique et halieutique du site électronucléaire de Penly. Année 2013 – Rapport scientifique annuel. http://archimer.ifremer.fr/doc/00188/29912/.

Schram, E. and Molenaar, P. (2018). Discards survival probabilities of flatfish and rays in North Sea pulse-trawl fisheries. Wageningen, Wageningen Marine Research (University & Research centre). Wageningen, Wageningen Marine Research report C037/18.: 39 pp.

Serra-Pereira, B., Figueiredo, I., Bordalo-Machado, P., Farias, I., Moura, T., and Serrano Gordo, L. 2005. Age and growth of Raja clavata Linnaeus, 1758-evaluation of ageing precision using different types of caudal denticles. ICES CM 2005/N:17.

Silva J. F., Ellis J. R. and Ayers R. A. 2013. Length-weight relationships of marine fish collected from around the British Isles. Sci. Ser. Tech. Rep., Cefas Lowestoft, 150: 109 pp..

Silva, J.F. and Ellis, J.R. 2019. New updated survey index for elasmobranchs caught in the English beam trawl survey of the eastern English Channel (ICES Division 7.d) and southern North Sea (ICES Division 4.c). Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, June 18 – June 27, 2019.

Tetard A., Schlaich I., Goascoz N., Cochard M.-L. 2015. Raja clavata indices observed during the pluri-annual surveys of the flatfish nursery of Bay of Somme, VIId (1980–2014). Unpublished data.

Van Bogaert, N., Ampe, B., Uhlmann, S., Torreele, E. 2020. Discard survival estimates of commercially caught skates of the North Sea and English Channel. SUMARiS report.

van Overzee, H.M.J, Poos, J.J.,Batsleer, J. & Molenaar, P., 2019. Starry ray in the ottertrawl and flyshoot fishery. Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report. 38 pp.Walker, P.A. 1999. Fleeting images: Dynamics of North Sea Ray populations. PhD Thesis, University of Amsterdam, the Netherlands, 145 pp.

Walker P. Hislop J.R.G. 1998. Sensitive skates or resilient rays? Spatial and temporal shifts in ray species composition in the central and north-western North Sea between 1930 and the present day. ICES J.Mar. Sci. 55, 392–402.

Walker, P., Howlett, G. and Millner, R. 1997. Distribution, movement and stock structure of three ray species in the North Sea and eastern English Channel. ICES Journal of Marine Science, 54: 797–808.

15.15 Tables and Figures

Table 15.3.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division 3.a (in tonnes). Note blank = no data reported; that "0" indicates landings <0.5.

Year	DK	DE	NL	NOR	SE	Total
1999	11			208	2	221
2000	41			123	2	166
2001	56			154	12	222
2002	22			159	13	194
2003	36			163	9	208
2004	129			85	20	234
2005	65	0		94	10	170
2006	25	0.5	0	51	18	95
2007	8	0	0	13	11	33
2008	4	0		23	6	33
2009	12			33	2	47
2010	12			24	10	45
2011	43	0		25	3	71
2012	16	0		28	3	47
2013	18	0		50	6	74
2014	14	0		39	3	56
2015	27	0	0	32		60
2016	40		0	50	0	90
2017	72	0		55	0	128
2018	157	0	0	52	0	209
2019	122		0	34	2	159
2020	108		2	31	0	141
2021	122		0.8	41	0	164
2022	100		0.5	31	0	132
2023	43		0	22	0	65

Table 15.3.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea 4 (in tonnes). Note: blank = no data reported; "0" indicates landings <0.5. Data include accepted lower quantities of landings for *Raja microocellata* and *Raja undulata* declared by Member States in 4.c.

Year	BEL	DK	FRA	DE	IRL	NLD	NOR	SE	GBR	Total
1999	336	45	41	16		515	152		1583	2688
2000	332	93	31	23		693	161		1376	2709
2001	370	65	61	11		834	173		1298	2812
2002	436	34	62	22		805	83		1353	2794
2003	323	33	36	21		686	113		1278	2490
2004	276	25	37	17		561	77		1062	2055
2005	350	25	60	28		493	87	0	833	1876
2006	346	28	77	16		530	98	0	732	1826
2007	261	29	66	17		659	71	0	704	1807
2008	387	24	72	29		506	97	0	762	1878
2009	302	30	80	22		379	121	0	666	1600
2010	288	30	95	32		390	105	0	663	1604
2011	237	38	63	19		212	56	0.5	788	1412
2012	188	21	49	17		431	69	0	662	1438
2013	214	45	51	25		312	74	0	804	1526
2014	199	45	53	32		225	88	0	778	1422
2015	246	40	25	25		274	62		666	1338
2016	188	41	40	50		281	69	0	665^	1334
2017	181	40	38	42		287	91	0	702^	1382
2018	178	56^	37^	55		362	118	0	810^	1617^
2019	148	70^	48^	53		320	128	0	767^	1533^
2020	95	34	57^	52		372	106	0	577^	1292^
2021	172	72	30^	12		321	72		675^	1354^
2022	123	59	17	19	2	336	86		514	1156
2023	200	86	20	24		379	93		581	1383

^ Data revised in 2024.

Table 15.3.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division 7.d (in tonnes). Note: blank = no data reported; "0" indicates landings <0.5. Data include landings of *Raja microocellata* and *Raja undulata* declared by Member States in 7.d.

Year	BEL	DE	FRA	IRL	NLD	UK	Total
1999	93		558			437	1088
2000	69		693			355	1117
2001	79		729			169	977
2002	113		725			140	978
2003	153		796			186	1135
2004	96		695			157	948
2005	100		940	0	9	144	1193
2006	113		738		12	144	1007
2007	158		926		18	204	1305
2008	171		880		12	209	1272
2009	119		1185		10	164	1327
2010	88		1033		10	139	1203
2011	106		966		12	152^	1201
2012	105		931		14	172	1315
2013	131		1024		4	193	1368
2014	112		1040		6	194^	1358
2015	115		879		3	147^	1143
2016	137		916		8	201^	1261
2017	142		917		9	237^	1304
2018	166		1182		25	302^	1674
2019	183		1303		31	309^	1826
2020	207		1321		43	313^	1884
2021	182		1304	2	33	313	1833
2022	202	0.7	1161	0.9	54	289	1706
2023	193		1360	2	55	259	1870

Table 15.3.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings per stock and country in the North Seas ecoregion (Subarea 4 and divisions 3.a and 7.d) (in tonnes). Note: blank = no data reported; "0" indicates landings <0.5;

raj.27.3a47d										
Year	BEL	DE	DK	FRA	GBR	IRL	NLD	NOR	SE	Total
2005	450.1	28.3	90.0	754.9	977.2	0.1	501.5	181.0	10.4	2993.4
2006	458.4	16.6	53.0	675.1	876.2		541.8	149.2	17.7	2788.0
2007	417.2	17.6	37.0	735.4	907.8		677.1	84.3	11.2	2887.5
2008	183.1	29.3	28.0	806.7	720.5		64.1	119.6	6.4	1957.7
2009	126.9	22.1	40.0	578.1	408.9		2.2	153.6	2.0	1333.8
2010	134.1	32.4	39.0	444.7	202.4		4.2	128.9	9.5	995.2
2011	92.1	19.0	77.0	378.7	134.1		5.1	80.5	2.8	789.4
2012	37.6	16.8	37.0	248.9	102.6		19.8	97.1	1.6	561.4
2013	6.8	25.1	60.0	107.1	95.4		9.0	123.6	4.2	431.3
2014	3.0	32.2	49.0	40.5	78.0		7.7	127.3	3.2	341.0
2015	2.4	25.1	62.6	17.5	28.9		2.2	94.7		233.4
2016	11.2	11.6	74.8	19.9	24.3		0.5	119.1	0	261.4
2017	1.1	8.3	88.2	25.5	30.6		0.7	146.0		300.4
2018	4.3	9.8	169.8	21.0	29.5			169.4		403.8
2019	0.7	2.3^	117.3	9.7	45.4			162.3	2.6	340.3
2020	1.1		74.4	10.0	18.8			137.1	0.4	241.8
2021	6.0		135.1	13.9	29.0			112.3	0	296.3
2022	0		105.2	10.8	17.7			116.9		251.1
2023	1.3		43.6	26.7	22.1			115.1		208.8

rjb.27.3a4								
Year	BEL	DE	DK	FRA	GBR	NLD	SE	Total
2005				0.7				0.7
2006				0.1			0.4	0.5
2007				0.1			0	0.1
2008	0			0.2	0.5	0		0.8
2009			2.0	0.2	7.0			9.2
2010	0		2.0	0.5	0.7		0.5	3.7
2011			1.0	0.1	4.2	0	0.7	6.0
2012					1.8	0.5	1.4	3.7
2013				0.0	1.0		1.9	2.9
2014				0.0	0.3			0.3
2015			0.7		0.3			1.0
2016			2.0		0.3	0	0	2.4
2017			15.7	0.1	0.7	0	0	16.5
2018	0		25.3		0.4^	0.5		26.0
2019			14.8		0	0.2	0	15.1

rjb.27.3a4								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2020		0	7.3		0.7	0.5	0	8.6
2021			5.1		0	0.1		5.2
2022		0	12.1		0.1			12.3
2023			0.9		0			0.9

rjc.27.3a47d										
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**IRL**	**NLD**	**NOR**	**SE**	**Total**
2005				196.4	0			0.8		197.2
2006				107.8					0	107.9
2007	0.6			155.3	0				0	155.9
2008	214.2			90.1	208.9		196.6	0.0		709.7
2009	153.9		0.3	458.9	335.6		178.1			1126.6
2010	163.0		1.2	546.2	410.0		203.1			1323.4
2011	163.9		1.0	530.1	486.2		97.0		0	1278.5
2012	154.3		0.3	764.2	478.6		186.3		0	1583.8
2013	200.7		2.1	926.6	573.8		149.0			1852.3
2014	205.9		8.7	987.8	571.6		130.8			1904.7
2015	219.1		3.7	833.0	448.3		160.6			1664.7
2016	197.3	33.8	2.7	869.9	519.3		185.2		0	1808.1
2017	174.8	27.6	1.1	824.5	598.3		162.6		0	1789.3
2018	193.3	33.0	1.7	1115.5	665.3		209.8		0	2218.8
2019	192.2	36.9	0.1	1197.9	592.4		193.6		0	2213.1
2020	169.1	41.5	3.7	1256.3	489.8		282.7			2243.0
2021	175.7	10.4	18.7	1239.4	561.7	1.7	230.9			2238.7
2022	177.2	15.6	29.3	1101.4	436.9	0.4	204.5		0	1965.3
2023	241.0	20.2	61.2	1150.1	482.5	1.5	202.7		0	2159.2

rjm.27.3a47d							
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**Total**
2005				41.9	0.0		41.9
2006				25.9			25.9
2007	0.1			93.4	0.0		93.5
2008	38.7			46.2	9.4	240.4	334.7
2009	34.4			28.0	28.5	199.7	290.8
2010	24.0			33.9	56.5	182.3	296.8
2011	31.2			29.4	91.3	108.0	259.9
2012	10.0			25.2	82.5	180.0	297.8
2013	11.6			30.0	127.4	119.4	288.6
2014	4.3		1.0	34.2	107.0	66.4	213.2

rjm.27.3a47d							
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**Total**
2015	9.4		0.1	16.1	124.0	76.9	226.4
2016	9.9	4.1		16.0	117.6	76.3	223.8
2017	15.7	5.9		36.9	114.2	87.4	260.1
2018	27.1	11.8		16.0	189.1	112.2	356.1
2019	40.9	12.5	0.1	22.9	170.5	92.6	339.5
2020	17.0	9.7	0.7	25.1	117.4	86.8	256.7
2021	42.0	1.8	7.7	14.7	137.3	71.6	275.1
2022	35.1	2.9	4.0	8.6	108.7	79.4	238.7
2023	41.2	3.4	6.7	6.8	117.3	100.6	276.7

rjh.27.4bc7d								
Year	BEL	DE	DK	FRA	GBR	IRL	NLD	Total
2005								
2006								
2007	0.2							0.2
2008	115.8				22.4		14.6	152.8
2009	104.9			10.7	39.2		8.2	163.0
2010	48.5			19.8	46.8		11.0	1126.1
2011	46.8			28.0	68.9		13.5	157.2
2012	85.7			22.2	50.4		58.6	216.8
2013	118.3		0	21.2	74.5		38.8	252.8
2014	91.3		0	27.6	61.0		26.1	206.1
2015	119.1		0	28.0	40.8		37.5	225.3
2016	97.0	0		34.2	24.9		26.7	182.9
2017	114.8	0	0	49.8	31.2		45.0	240.8
2018	107.8	0.2		47.9	34.2		64.6	254.8
2019	83.4	1.1		75.4	28.4		64.8	253.1
2020	101.1	0.5	1.7	59.6	33.7		46.4	243.1
2021	129.6	0.2	13.0	45.7	57.8	0	52.4	298.9
2022	110.9	0.9	8.4	32.0	66.9	2.8	106.0	328.0
2023	92.4	0.8	17.1	30.0	43.1	0	130.5	314.2

rjh.27.4a6							
Year	BEL	DK	ES	FRA	GBR	IRL*	Total
2005							
2006							
2007							
2008					6.8		6.8
2009	0		0	0.9	5.2	0	6.4
2010	0				6.7	3.7	10.4
2011					16.6	0.9	17.5
2012					4.0	1.4	5.4
2013					0.5	23.6	24.1
2014				0.6	0.7	8.6	10.0
2015		0		0.8	3.4	9.3	13.6
2016				0.6	2.3	10.9	13.8
2017				0	1.1	5.4	6.8
2018				1.2	2.8	23.0	27.0
2019				0.7	1.5^	33.2	35.4
2020	0			0.6	0	20.4	21.5
2021		0		0	0.7	13.6	14.7

rjh.27.4a6							
Year	BEL	DK	ES	FRA	GBR	IRL*	Total
2022		0		0	1.7	3.2	5.4
2023		0		0	2.2	2.3	4.8

***Landings of Ireland are declared coming out of Subarea 6.**

rjn.27.3a4							
Year	BEL	DE	DK	FRA	GBR	NLD	Total
2005							
2006							
2007							
2008	2.5			0	0	0	3.3
2009	1.0			1.1	4.6	0	7.1
2010	3.7			1.0	81.2	0	86.3
2011	5.0		2.0	1.0	143.1		151.1
2012	1.1			0.5	115.5		117.1
2013	0.6		1.0	0	122.6	0	124.4
2014	0.5			0	151.7	0	152.5
2015	3.1		0	0	169.0		172.5
2016	0		1.4	0	167.6	0	169.7
2017	0		7.4	0	154.3		162.4
2018	0		14.6	0	179.6		194.5
2019	0		56.8	1.1	201.6		259.7
2020	0		53.8	0	176.1		230.5
2021			14.7	0	167.6		182.4
2022				0	136.0		136.1
2023				0	134.7		134.8

rjr.27.23a4								
Year	BEL	DE	DK	FRA	GBR	NLD	SE	Total
2005								
2006								
2007								
2008	0							0.1
2009					0			0.1
2010					0			0
2011				1.2			0	1.3
2012					0	0		0.3
2013				0	0			0
2014	0			0	0			0
2015				0				0
2016				0				0
2017			0	0				0.1
2018		0	1.1	0.9	0			2.4
2019			2.6	0.6	0			3.2
2020				1.2	0	0.1		1.3
2021		0		1.5			0	1.6
2022				0.5	0			0.6
2023				0.5				0.5

Table 15.3.5 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Discards per stock and country in the North Seas ecoregion (Subarea 4 and divisions 3.a and 7.d) (in tonnes). "0" indicates discards <0.5. Values to be viewed with caution as further QA/QC procedures still required prior to use in assessment (see Section 15.3.2).

raj.27.3a47d										
Year	BEL	DE	DK	FRA	GBR	IRL	NLD	NOR	SE	Total
2009										
2010										
2011										
2012										
2013										
2014			0							0
2015										
2016				778						778
2017				827						827
2018			8.0						4.5	12.6
2019			10.9						1.7	12.5
2020			2.4							2.4
2021			3.5							3.4
2022			1.4						4.7	6.0
2023			0.6	4.1						4.7

rjb.27.3a4								
Year	BEL	DE	DK	FRA	GBR	NLD	SE	Total
2009			18.3					18.3
2010			13.3					13.3
2011			28.9					28.9
2012			100.7					100.7
2013			34.8					34.8
2014			1.6					1.6
2015			4.4					4.4
2016			8.2					8.2
2017			2.3					2.3
2018			15.3				0.6	15.9
2019			2.7				1.9	4.6
2020			5.2					5.2
2021			2.1					2.1
2022			0		0.5			0.7
2023			1.3					1.3

rjc.27.3a47d								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**NOR**	**SE**	**Total**
2009					97.7			2.0	125.1
2010					151.4			8.0	252.5
2011			2.3	199.9	90.0	166.8		3.1	462.1
2012			2.7	127.8	314.8	158.3		14.8	618.4
2013	137.7		2.4	455.8	220.2	99.0		0.7	915.9
2014	237.5		1.4	68.3	129.3	249.8		0.6	687.0
2015	183.2		8.8	390.6	197.4	174.7		9.1	963.7
2016	143.1	5.7	11.8	163.2	443.6	152.1		3.5	922.9
2017	240.2		11.2	458.1	495.1	510.2		1.8	1716.6
2018	118.7	114.3	10.0	214.6	83.3	303.0		15.0	859.0
2019	228.9	34.6	10.0	320.7	286.0	593.5		12.9	1486.5
2020	191.5	78.0	35.9	583.3	80.6	417.6		0.3	1386.9
2021	368.7	8.8	17.0	215.5	72.7	730.3		NA	1412.9
2022	170.1	0	20.5	123.7	121.7^	338.8		26.2	800.8^
2023	400.4		27.0	280.6	85.1	712.4		30	1535.5

^ Data revised in 2024

rjm.27.3a47d							
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**Total**
2009				1.7	65.9		67.6
2010				5.8	44.8		50.5
2011				33.6	37.4	384.1	455.1
2012				0	123.8	299.7	423.5
2013	7.6				141.4	285.0	434.1
2014	2.2			11.0	128.3	346.2	487.7
2015	4.4				149.8	198.0	352.2
2016	9.0			0.5	132.5	375.4	517.4
2017	11.2	0.2		10.2	98.2	804.6	924.3
2018	42.5	172.5	1.0	2.6	117.3	662.2	998.1
2019	20.9	164.2	1.8	9.4	113.7	361.2	671.1
2020	43.0	98.9	0.6	22.2	8.7	457.8	631.2
2021	58.5	47.4	0.5		11.9	826.3	944.6
2022		1.2	2.0		32.2	295.8	331.2
2023			1.1		14.6	215.8	231.5

rjh.27.4bc7d							
Year	BEL	DE	DK	FRA	GBR	NLD	Total
2009					5.6		5.6
2010				0.0	19.5		19.5
2011				0.6		123.0	123.6
2012			0	0.8	53.6		54.4
2013	16.7			1.3	2.3		20.3
2014	22.2			4.8	14.6		41.6
2015	43.7			1.2	3.7	80.2	128.7
2016	46.9		0	5.1			52.0
2017	25.1			2.8		161.1	189.0
2018	28.5			6.9		147.6	183.1
2019	28.0	0.1		1.0		240.1	269.3
2020	36.6	0.1			0.0	46.5	83.2
2021	20.3			2.1	3.1	75.0	100.5
2022	30.4			3.3	0	70.3	104.1^
2023	57.7		0	6.8	0	59.0	123.5

^ Data revised in 2024.

rjh.27.4a6							
Year	BEL	DK	ES	FRA	GBR	IRL	Total
2009						4.2	4.2
2010						2.2	2.2
2011						2.4	2.4
2012						0	0
2013						5.7	5.7
2014						0.6	0.6
2015						0.9	0.9
2016		0				0	0
2017						0	0
2018		0				3.6	3.8
2019			0			0.5	0.5
2020			0			0.6	0.6
2021							
2022			2.0				2.0
2023		0					0

rjn.27.3a4								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2009			0		11.1			11.6
2010					1.3			1.3
2011			0		5.6			5.8
2012					11.1	36.3		47.3
2013	0				5.3			5.6
2014	0		0.9		25.7	4.3		31.0
2015			1.2		22.7			23.9
2016	0		3.6		1.9	1.2		7.0
2017	1.0		0.8	7.2				8.9
2018			12.6	15.7	1.5	7.1	0	37.2
2019	0		7.2	269.6	1.9			278.9
2020			0	12.0	218.1			230.1
2021			6.5		159.8			166.3
2022					215.5^			215.5^
2023			2.3	9.8	231.2			243.4

^ Data revised in 2024.

rjr.27.23a4									
Year	**BEL**	**DE**	**DK**	**ES**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2009			3245.4						3245.4
2010			2453.7						2453.7
2011			3612.0						3612.0
2012			3548.8						3548.8
2013			1083.3						1083.3
2014			1767.3						1767.3
2015			2979.6						2979.6
2016			1317.3						1317.3
2017			1017.1		1.3		139.0		1157.4
2018			488.8		4.7		92.7	95.8	682.0
2019			622.6				66.6	122.6	811.7
2020			420.3			609	85.5		1114.9
2021			363.8				29.6^		393.4
2022			378.9	23.0		337.1	48.2	109.5	896.6
2023			613.1	4.6		520.6	12.2	174.0	1324.6

^ Discard data available for beam trawls only due to sampling coverage, while previous years for NLD have been available for both beam trawls and other bottom trawls.

Table 15.6.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Amblyraja radiata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	7.095	NA	NA	NA	NA
1988	2.670	NA	0.621	NA	NA
1989	6.612	NA	0.382	NA	NA
1990	4.891	NA	1.472	NA	NA
1991	4.171	9.449	0.447	NA	NA
1992	7.528	2.463	0.184	NA	NA
1993	12.232	1.773	0.053	NA	1.322
1994	3.913	1.994	0.045	NA	7.743
1995	8.526	1.930	0.188	NA	1.325
1996	7.111	2.227	0.118	20.452	NA
1997	5.518	1.822	0.000	16.279	11.542
1998	5.692	2.180	0.000	23.308	0.898
1999	6.473	3.134	0.143	34.191	15.780
2000	7.914	3.215	0.000	34.000	NA
2001	11.358	6.520	0.037	21.217	17.531
2002	4.353	3.307	0.031	25.459	0.865
2003	4.543	3.722	0.067	18.972	0.517
2004	3.795	2.143	0.071	20.762	0.375
2005	4.022	2.270	0.303	19.343	0.098
2006	1.992	2.499	0.179	13.729	NA
2007	3.180	3.794	0.000	14.557	17.412
2008	2.521	2.646	NA	15.174	15.396
2009	0.982	2.967	0.897	14.759	10.693
2010	0.945	1.939	0.000	15.479	9.950
2011	1.012	2.435	0.000	13.842	8.783
2012	1.502	2.014	0.091	13.239	18.278
2013	0.684	1.367	0.069	13.379	13.372
2014	1.088	1.630	0.817	12.298	1.462
2015	1.605	2.223	0.172	10.101	9.518
2016	1.137	2.059	0.469	8.315	11.737
2017	1.255	1.453	NA	4.059	8.463
2018	0.326	1.528	NA	4.293	6.158
2019	0.564	1.238	NA	6.184	5.250
2020	0.272	1.119	NA	5.531	6.240
2021	0.352	0.306	NA	12.218	16.168

Table 15.6.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Leucoraja naevus* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.131	NA	NA	NA
1988	0.526	NA	0.035	NA
1989	0.550	NA	0.000	NA
1990	0.575	NA	0.000	NA
1991	0.549	0.316	0.000	NA
1992	0.764	0.439	0.000	NA
1993	0.903	0.144	0.000	NA
1994	0.586	0.186	0.000	NA
1995	0.611	0.138	0.000	NA
1996	0.499	0.157	0.000	0.905
1997	0.262	0.235	0.000	1.302
1998	0.478	0.113	0.000	3.115
1999	0.398	0.436	0.000	3.841
2000	0.556	0.371	0.000	2.169
2001	0.332	0.589	0.000	1.478
2002	0.449	0.428	0.000	2.840
2003	0.278	0.373	0.000	3.015
2004	0.306	0.362	0.000	0.972
2005	0.308	0.433	0.000	1.659
2006	0.397	0.535	0.000	1.420
2007	0.487	0.367	0.000	2.507
2008	0.420	0.795	NA	4.400
2009	0.401	0.700	0.000	2.013
2010	0.459	0.855	0.000	0.576
2011	0.489	0.798	0.000	0.958
2012	0.464	0.920	0.000	1.013
2013	0.804	0.623	0.000	1.220
2014	0.525	0.486	0.000	1.465
2015	0.911	0.543	0.000	0.702
2016	0.545	0.541	0.000	1.333
2017	0.891	0.770	NA	1.772
2018	0.393	0.744	NA	1.827
2019	0.508	0.578	NA	1.606
2020	0.364	0.461	NA	1.615
2021	0.527	0.309	NA	1.541

Table 15.6.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for 'common skate complex' (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS-TRI-Q3 in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.013	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.026	0.007	NA
1992	0.000	0.000	NA
1993	0.019	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.020	0.000	0.000
1997	0.000	0.000	0.000
1998	0.006	0.014	0.000
1999	0.013	0.033	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.007	0.021	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.006	0.013	0.105
2006	0.000	0.005	0.000
2007	0.051	0.000	0.000
2008	0.006	0.026	0.000
2009	0.013	0.013	0.000
2010	0.044	0.000	0.000
2011	0.056	0.033	0.000
2012	0.000	0.133	0.160
2013	0.093	0.062	0.000
2014	0.039	0.067	0.086
2015	0.063	0.013	0.080
2016	0.080	0.064	0.000
2017	0.055	0.100	0.076
2018	0.157	0.030	0.000
2019	0.135	0.108	0.000
2020	0.220	0.055	0.020
2021	0.136	0.000	0.033

Table 15.6.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja clavata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.926	NA	NA	NA	NA	NA	NA	NA
1988	0.219	NA	0.023	NA	NA	NA	NA	NA
1989	0.931	NA	0.741	NA	NA	NA	NA	NA
1990	0.631	NA	0.982	NA	NA	NA	NA	NA
1991	19.181	0.457	0.000	NA	NA	NA	NA	NA
1992	1.237	0.646	0.579	NA	NA	NA	NA	NA
1993	0.355	0.571	0.000	3.060	NA	0.000	NA	15.906
1994	0.379	0.065	0.030	2.759	NA	0.000	NA	18.878
1995	0.083	0.015	0.083	1.632	NA	0.000	NA	14.909
1996	0.362	0.372	0.162	3.221	0.048	NA	NA	11.035
1997	0.593	0.140	0.825	2.553	0.000	0.000	NA	35.887
1998	0.669	0.028	0.023	2.823	0.269	0.000	NA	22.977
1999	0.211	0.052	2.057	3.895	0.000	0.000	NA	25.515
2000	0.460	0.020	0.357	3.897	0.197	NA	NA	25.818
2001	0.440	0.059	0.000	4.766	0.087	0.000	NA	27.423
2002	0.593	0.276	0.078	2.780	0.972	0.000	NA	38.587
2003	0.551	0.020	0.100	3.846	0.558	0.000	NA	36.264
2004	0.263	0.065	0.000	4.100	0.085	0.000	1.170*	36.659
2005	0.513	0.020	0.182	4.115	0.091	0.000	2.097	55.343
2006	0.610	0.277	0.000	5.444	0.181	NA	3.062*	41.059
2007	0.283	0.060	0.024	4.678	0.647	0.000	2.303	49.569
2008	1.014	0.288	NA	5.360	0.030	0.000	3.618	64.346
2009	1.164	0.283	0.000	4.573	0.091	0.000	2.767	51.369
2010	0.178	0.393	0.063	8.241	0.214	0.000	1.682*	44.525
2011	0.110	0.138	0.040	9.702	0.085	0.000	2.138*	49.518
2012	1.411	0.290	0.030	6.214	1.713	0.000	2.964*	88.805
2013	0.545	0.841	0.035	8.834	0.557	0.000	4.165*	134.990
2014	0.681	0.811	0.320	14.455	0.257	0.000	6.375	156.574
2015	0.976	1.863	0.368	12.401	0.481	0.066	4.774	123.857
2016	0.706	2.103	0.261	11.592	1.306	0.000	5.662	143.286
2017	1.369	0.351	NA	15.528	0.287	0.000	8.246	89.121
2018	0.617	1.425	NA	23.898	2.798	0.033	8.485	142.200
2019	1.265	0.748	NA	25.270	0.330	0.000	8.831	353.680
2020	1.082	0.523	NA	18.368	0.577	0.200	9.323	371.786
2021	0.825	0.388	NA	17.365	1.588	0.000	5.634	

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

***Data revised in 2022**

Table 15.6.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja montagui* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.053	NA	NA	NA	NA	NA	NA
1988	0.065	NA	0.000	NA	NA	NA	15.349
1989	0.180	NA	0.592	NA	NA	NA	6.469
1990	0.117	NA	0.278	NA	NA	NA	10.278
1991	1.210	0.172	0.579	NA	NA	NA	2.725
1992	0.188	0.200	0.184	NA	NA	NA	0.451
1993	0.223	0.221	0.637	0.349	NA	NA	3.594
1994	0.151	0.346	0.000	0.606	NA	NA	5.921
1995	0.387	0.082	0.000	0.526	NA	NA	3.099
1996	0.138	0.150	0.824	0.390	0.667	NA	3.343
1997	0.543	0.007	0.226	0.585	0.000	NA	4.29
1998	0.165	0.102	0.000	0.538	1.123	NA	3.019
1999	0.146	0.377	0.000	0.684	1.079	NA	0.567
2000	0.159	0.027	0.029	0.359	0.648	NA	1.274
2001	0.127	0.054	0.000	0.338	1.015	NA	1.285
2002	0.355	0.074	0.000	0.605	0.361	NA	0.637
2003	0.395	0.061	0.033	0.105	0.247	NA	2.596
2004	0.276	0.094	0.000	0.288	0.359	0.620*	0.261
2005	0.539	0.376	0.000	0.066	0.136	1.394	3.425
2006	0.122	0.361	0.000	0.253	0.536	1.292*	1.385
2007	0.694	0.859	0.000	0.123	0.239	1.022	1.441
2008	1.125	0.394	NA	0.333	0.167	0.522	0.229
2009	1.151	1.100	0.000	0.195	0.242	1.633*	0
2010	0.895	1.184	0.000	0.425	0.273	1.102*	0.29
2011	0.759	1.401	0.000	0.312	0.928	1.033*	4.398
2012	0.678	1.419	0.000	0.188	1.305	1.139*	2.169
2013	1.322	0.828	0.046	0.263	0.841	0.986*	2.047
2014	0.979	1.254	0.160	0.212	0.543	1.923	4.248
2015	1.242	0.521	0.058	0.313	0.550	2.580	2.514
2016	1.060	0.915	0.135	1.026	2.445	2.609	0.671
2017	0.905	0.615	NA	0.390	0.911	4.132	1.28
2018	1.052	1.026	NA	0.395	1.366	5.320	0.729
2019	1.246	1.477	NA	0.885	0.871	3.281	NA
2020	1.028	0.352	NA	0.733	1.191	2.807	NA
2021	0.846	0.223	NA	0.613	1.095	1.186	

***Data revised in 2022**

Table 15.6.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Raja brachyura* in 4.a (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.047	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.119	0.000
1993	0.035	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.022	0.000
1997	0.000	0.000
1998	0.007	0.000
1999	0.021	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.064	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.064	0.000
2007	0.429	0.077
2008	0.292	0.039
2009	0.286	0.200
2010	0.471	0.000
2011	0.137	0.340
2012	0.000	0.000
2013	0.654	0.000
2014	0.490	0.000
2015	0.039	0.000
2016	0.019	0.071
2017	0.000	0.036
2018	0.000	0.000
2019	0.061	0.000
2020	0.727	0.036
2021	0.000	0.000

Table 15.6.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja brachyura* in 4.c and 7.d (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	4.229
1990	0.000	NA	0.000	NA	NA	NA	0.458
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.308	0.000	0.000	NA	NA	NA	0.000
1993	0.160	0.000	0.000	0.159	NA	NA	0.000
1994	0.000	0.000	0.000	0.121	NA	NA	1.351
1995	0.000	0.000	0.000	0.053	NA	NA	2.103
1996	0.000	0.000	0.000	0.052	0.000	NA	0.000
1997	0.000	0.000	0.000	0.027	0.000	NA	1.132
1998	0.000	0.000	0.000	0.077	0.000	NA	2.455
1999	0.039	0.000	0.000	0.158	0.000	NA	1.586
2000	0.000	0.000	0.056	0.103	0.000	NA	1.567
2001	0.000	0.000	0.000	0.154	0.000	NA	1.741
2002	0.000	0.000	0.000	0.105	0.000	NA	4.454
2003	0.019	0.000	0.000	0.132	0.000	NA	4.111
2004	0.000	0.000	0.000	0.137	0.242	0.113*	4.139
2005	0.039	0.000	0.071	0.262	0.000	0.238	0.000
2006	0.115	0.000	0.000	0.054	0.323	0.260	2.191
2007	0.154	0.000	0.000	0.164	0.600	0.088	3.346
2008	0.423	0.000	NA	0.083	0.000	0.329	0.255
2009	0.051	0.000	0.000	0.153	0.000	0.589	3.579
2010	0.000	0.000	0.000	0.027	0.000	0.402*	1.415
2011	0.037	0.000	0.000	0.140	0.000	0.117	4.877
2012	0.154	0.095	0.071	0.082	0.000	0.377*	5.932
2013	0.111	0.000	0.000	0.187	0.000	0.588*	3.432
2014	0.995	0.000	0.000	0.291	0.000	0.417	12.208
2015	0.346	0.000	0.000	0.132	1.239	0.762	4.441
2016	0.205	0.429	0.000	0.269	0.000	0.987	6.165
2017	0.481	0.333	NA	0.524	0.000	0.579	9.015
2018	0.747	0.571	NA	0.526	0.091	0.785	5.554
2019	0.852	0.238	NA	0.423	1.000	0.862	6.851
2020	0.160	0.500	NA	0.427	1.500	0.541	2.235
2021	0.692	1.506	NA	0.987	1.636	0.793	

***Data revised in 2022**

Table 15.6.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for *Amblyraja radiata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	3.746	NA	NA	NA	NA
1988	1.451	NA	0.178	NA	NA
1989	3.325	NA	0.075	NA	NA
1990	2.423	NA	0.387	NA	NA
1991	2.040	4.158	0.124	NA	NA
1992	3.485	1.340	0.038	NA	NA
1993	6.208	0.880	0.014	NA	0.391
1994	1.898	0.940	0.023	NA	3.200
1995	4.206	0.832	0.102	NA	0.295
1996	3.493	0.980	0.237	4.493	NA
1997	2.684	0.857	0.000	4.383	4.021
1998	2.861	1.207	0.000	6.313	0.154
1999	2.352	1.312	0.059	8.558	6.100
2000	3.282	1.386	0.000	8.015	NA
2001	1.236	2.124	0.016	4.733	4.890
2002	1.573	1.123	0.035	5.947	0.179
2003	1.469	1.270	0.034	4.551	0.164
2004	1.283	0.675	0.015	5.140	0.111
2005	1.158	0.772	0.171	5.407	0.036
2006	0.741	0.899	0.112	4.089	NA
2007	1.404	1.605	0.000	5.191	6.359
2008	1.192	1.232	NA	6.182	5.996
2009	0.533	1.542	0.494	6.321	4.587
2010	0.484	1.029	0.000	6.176	3.765
2011	0.501	1.239	0.000	4.709	2.789
2012	0.641	0.848	0.051	3.467	5.721
2013	0.265	0.561	0.047	3.253	2.753
2014	0.586	0.728	0.318	3.475	0.535
2015	0.716	1.148	0.074	4.071	3.039
2016	0.527	0.941	0.165	2.700	3.112
2017	0.597	0.606	NA	1.558	2.829
2018	0.167	0.614	NA	1.236	1.956
2019	0.238	0.463	NA	1.379	1.633
2020	0.120	0.441	NA	1.317	1.407
2021	0.131	0.135	NA	3.193	2.075

Table 15.6.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for *Leucoraja naevus* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.109	NA	NA	NA
1988	0.518	NA	0.021	NA
1989	0.476	NA	0.000	NA
1990	0.558	NA	0.000	NA
1991	0.444	0.167	0.000	NA
1992	0.739	0.407	0.000	NA
1993	0.828	0.110	0.000	NA
1994	0.390	0.166	0.000	NA
1995	0.520	0.184	0.000	NA
1996	0.450	0.095	0.000	0.503
1997	0.198	0.308	0.000	0.726
1998	0.387	0.121	0.000	1.382
1999	0.342	0.322	0.000	0.944
2000	0.406	0.259	0.000	0.928
2001	0.215	0.282	0.000	0.379
2002	0.240	0.250	0.000	0.573
2003	0.170	0.214	0.000	1.080
2004	0.145	0.196	0.000	0.453
2005	0.181	0.296	0.000	0.544
2006	0.250	0.330	0.000	0.460
2007	0.286	0.225	0.000	0.854
2008	0.246	0.512	NA	1.473
2009	0.192	0.475	0.000	0.795
2010	0.296	0.630	0.000	0.258
2011	0.343	0.606	0.000	0.489
2012	0.375	0.705	0.000	0.514
2013	0.558	0.459	0.000	0.449
2014	0.376	0.315	0.000	0.564
2015	0.836	0.470	0.000	0.279
2016	0.430	0.432	0.000	0.577
2017	0.702	0.562	NA	0.798
2018	0.327	0.495	NA	0.689
2019	0.376	0.348	NA	0.424
2020	0.288	0.250	NA	0.467
2021	0.331	0.229	NA	0.481

Table 15.6.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for 'common skate complex' (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS-TRI-Q3 in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.029	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.113	0.010	NA
1992	0.000	0.000	NA
1993	0.042	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.030	0.000	0.000
1997	0.000	0.000	0.000
1998	0.015	0.028	0.000
1999	0.021	0.010	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.015	0.025	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.014	0.041	0.046
2006	0.000	0.009	0.000
2007	0.061	0.000	0.000
2008	0.004	0.059	0.000
2009	0.003	0.002	0.000
2010	0.026	0.000	0.000
2011	0.224	0.020	0.000
2012	0.000	0.249	0.130
2013	0.259	0.061	0.000
2014	0.175	0.119	0.025
2015	0.111	0.011	0.215
2016	0.254	0.157	0.000
2017	0.415	0.278	3.140
2018	0.643	0.048	0.000
2019	0.678	0.202^	0.000
2020	1.118	0.670	0.038
2021	0.341	0.000	0.007

^Data revised in 2022

Table 15.6.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja clavata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	1.569	NA	NA	NA	NA	NA	NA	NA
1988	0.223	NA	0.004	NA	NA	NA	NA	NA
1989	0.916	NA	0.418	NA	NA	NA	NA	NA
1990	0.698	NA	0.806	NA	NA	NA	NA	NA
1991	8.856	0.534	0.000	NA	NA	NA	NA	NA
1992	0.959	0.408	0.698	NA	NA	NA	NA	NA
1993	0.310	0.366	0.000	1.088	NA	0.000	NA	19.857
1994	0.218	0.036	0.008	0.974	NA	0.000	NA	45.129
1995	0.081	0.052	0.011	0.782	NA	0.000	NA	32.690
1996	0.243	0.703	0.233	1.326	0.111	NA	NA	7.437
1997	0.512	0.212	0.588	1.162	0.000	0.000	NA	50.848
1998	0.154	0.009	0.004	1.162	0.130	0.000	NA	45.941
1999	0.121	0.131	1.130	1.773	0.000	0.000	NA	36.231
2000	0.261	0.038	0.298	1.577	0.074	NA	NA	47.508
2001	0.279	0.062	0.000	1.540	0.053	0.000	NA	38.327
2002	0.356	0.260	0.088	1.061	0.831	0.000	NA	56.775
2003	0.360	0.034	0.055	1.779	0.408	0.000	NA	41.689
2004	0.177	0.044	0.000	2.475	0.058	0.000	0.652*	38.572
2005	0.393	0.027	0.471	1.557	0.094	0.000	0.395	87.306
2006	0.809	0.274	0.000	1.684	0.150	NA	0.759*	70.294
2007	0.192	0.019	0.022	2.173	0.541	0.000	0.350	92.942
2008	1.594	0.340	NA	2.924	0.014	0.000	1.951	94.537
2009	1.034	0.243	0.000	2.172	0.142	0.000	1.910*	89.228
2010	0.193	0.210	0.004	3.388	0.196	0.000	1.418*	90.478
2011	0.049	0.204	0.096	2.475	0.056	0.000	1.345*	66.975
2012	1.654	0.168	0.084	3.199	0.741	0.000	1.960*	113.665
2013	0.529	1.048	0.012	2.360	0.305	0.000	2.289*	223.638
2014	0.795	1.132	0.263	4.865	0.296	0.000	4.959	265.211
2015	1.031	1.561	0.490	4.670	0.651	0.141	2.766	211.768
2016	0.707	1.644	0.499	4.011	0.525	0.000	3.846	291.861
2017	1.637	0.629	NA	4.398	0.758	0.000	4.649	174.664
2018	0.656	1.621	NA	5.120	1.251	0.027	4.766	302.729
2019	1.415	0.631	NA	6.352	0.202	0.000	4.627	376.898
2020	1.318	0.601	NA	5.546	0.413	0.251	5.162	659.203^
2021	1.023	0.623	NA	4.248	1.193	0.000	2.756	

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

***Data revised in 2022**

Table 15.6.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja montagui* (all individuals). Information from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.066	NA	NA	NA	NA	NA	NA
1988	0.068	NA	0.000	NA	NA	NA	22.215
1989	0.136	NA	0.163	NA	NA	NA	6.007
1990	0.116	NA	0.055	NA	NA	NA	9.587
1991	0.448	0.130	1.125	NA	NA	NA	3.364
1992	0.211	0.183	0.153	NA	NA	NA	0.721
1993	0.215	0.240	0.422	0.065	NA	NA	4.426
1994	0.179	0.439	0.000	0.212	NA	NA	9.903
1995	0.567	0.091	0.000	0.197	NA	NA	3.027
1996	0.154	0.110	0.584	0.166	0.409	NA	0.653
1997	0.252	0.005	0.262	0.296	0.000	NA	4.61
1998	0.218	0.069	0.000	0.148	0.504	NA	2.767
1999	0.183	0.444	0.000	0.143	0.638	NA	0.266
2000	0.135	0.024	0.013	0.128	0.063	NA	1.586
2001	0.130	0.029	0.000	0.082	0.091	NA	1.376
2002	0.237	0.056	0.000	0.282	0.198	NA	0.447
2003	0.299	0.040	0.058	0.032	0.072	NA	1.863
2004	0.204	0.110	0.000	0.067	0.215	0.212*	0.047
2005	0.378	0.384	0.000	0.079	0.108	0.060*	2.535
2006	0.066	0.263	0.000	0.109	0.482	0.074*	2.999
2007	0.666	0.828	0.000	0.008	0.216	0.084*	1.27
2008	1.020	0.387	NA	0.121	0.118	0.165*	0.055
2009	0.677	0.903	0.000	0.088	0.103	0.514*	0
2010	0.803	1.009	0.000	0.056	0.154	0.302*	0.058
2011	0.633	1.229	0.000	0.144	0.434	0.710*	3.359
2012	0.552	1.451	0.000	0.135	0.873	0.357*	1.621
2013	0.994	0.731	0.043	0.182	0.644	0.356*	2.363
2014	1.017	1.402	0.128	0.091	0.542	0.552*	1.74
2015	1.367	0.588	0.057	0.138	0.566	0.551*	1.63
2016	1.002	1.004	0.097	0.197	0.798	0.819*	0.329
2017	0.855	0.666	NA	0.136	0.501	0.838*	5.443
2018	1.179	1.098	NA	0.208	0.391	1.131*	0.877
2019	1.091	1.584	NA	0.204	0.555	0.809*	NA
2020	1.120	0.343	NA	0.260	0.458	0.378*	NA
2021	0.731	0.123	NA	0.233	0.512	0.228	

***Data revised in 2022**

Table 15.6.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for *Raja brachyura* 4.a (all individuals). Information obtained from the IBTS-Q1 and IBTS-Q3 (roundfish areas 1–7) surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.072	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.062	0.000
1993	0.073	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.005	0.000
1997	0.000	0.000
1998	0.016	0.000
1999	0.017	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.088	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.057	0.000
2007	0.895	0.267
2008	1.076	0.142
2009	0.604	0.904
2010	1.849	0.000
2011	0.669	1.515
2012	0.000	0.000
2013	2.724	0.000
2014	1.913	0.000
2015	0.221	0.000
2016	0.092	0.410
2017	0.000	0.116
2018	0.000	0.000
2019	0.237	0.000
2020	3.200	0.054
2021	0.000	0.000

Table 15.6.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja brachyura* in 4.c and 7.d (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4, in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	1.488
1990	0.000	NA	0.000	NA	NA	NA	0.000
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.179	0.000	0.000	NA	NA	NA	0.000
1993	0.456	0.000	0.000	0.182	NA	NA	0.000
1994	0.000	0.000	0.000	0.013	NA	NA	0.342
1995	0.000	0.000	0.000	0.008	NA	NA	3.251
1996	0.000	0.000	0.000	0.006	0.000	NA	0.000
1997	0.000	0.000	0.000	0.003	0.000	NA	1.806
1998	0.000	0.000	0.000	0.008	0.000	NA	3.881
1999	0.084	0.000	0.000	0.049	0.000	NA	2.159
2000	0.000	0.000	0.025	0.012	0.000	NA	0.336
2001	0.000	0.000	0.000	0.069	0.000	NA	2.638
2002	0.000	0.000	0.000	0.076	0.000	NA	2.530
2003	0.034	0.000	0.000	0.066	0.000	NA	6.136
2004	0.000	0.000	0.000	0.045	1.316	0.108*	0.680
2005	0.102	0.000	0.062	0.118	0.000	0.104	0.000
2006	0.024	0.000	0.000	0.026	0.224	0.103*	2.322
2007	0.356	0.000	0.000	0.288	1.868	0.027	7.783
2008	0.766	0.000	NA	0.009	0.000	0.166	0.237
2009	0.071	0.000	0.000	0.068	0.000	0.147	5.765
2010	0.000	0.000	0.000	0.020	0.000	0.122*	3.251
2011	0.009	0.000	0.000	0.097	0.000	0.150	6.315
2012	0.739	0.245	0.062	0.021	0.000	0.095	19.327
2013	0.414	0.000	0.000	0.068	0.000	0.098*	4.609
2014	1.368	0.000	0.000	0.103	0.000	0.108	20.937
2015	0.587	0.000	0.000	0.046	0.129	0.169	17.310
2016	0.316	0.294	0.000	0.124	0.000	0.159	20.450
2017	1.086	0.662	NA	0.166	0.000	0.113	21.502
2018	1.835	0.442	NA	0.305	0.439	0.303	14.664
2019	2.264	0.352	NA	0.216	0.817	0.232	20.477
2020	0.492	0.638	NA	0.088	1.246	0.467	2.355^
2021	0.548	2.299	NA	0.586	3.241	0.724	

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

***Data revised in 2022**

Table 15.6.15. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Amblyraja radiata*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	0.496	NA	NA	NA	NA
1988	0.333	NA	0.000	NA	NA
1989	0.377	NA	0.000	NA	NA
1990	0.370	NA	0.000	NA	NA
1991	0.288	0.361	0.000	NA	NA
1992	0.335	0.128	0.000	NA	NA
1993	0.431	0.112	0.000	NA	0.053
1994	0.231	0.162	0.000	NA	0.679
1995	0.578	0.058	0.000	NA	0.106
1996	0.228	0.096	0.205	0.318	NA
1997	0.293	0.049	0.000	0.313	0.657
1998	0.322	0.175	0.000	0.776	0.000
1999	0.253	0.115	0.000	0.682	1.180
2000	0.363	0.108	0.000	0.419	NA
2001	0.089	0.145	0.000	0.295	0.454
2002	0.141	0.038	0.035	0.213	0.037
2003	0.152	0.067	0.000	0.194	0.000
2004	0.081	0.018	0.000	0.276	0.000
2005	0.053	0.000	0.000	0.066	0.000
2006	0.025	0.011	0.045	0.000	NA
2007	0.069	0.052	0.000	0.000	0.000
2008	0.037	0.000	NA	0.032	0.113
2009	0.012	0.014	0.000	0.038	0.215
2010	0.021	0.096	0.000	0.166	0.256
2011	0.037	0.020	0.000	0.222	0.224
2012	0.052	0.008	0.000	0.170	0.109
2013	0.014	0.014	0.000	0.000	0.000
2014	0.086	0.039	0.000	0.070	0.081
2015	0.008	0.043	0.000	0.028	0.000
2016	0.042	0.000	0.000	0.029	0.053
2017	0.030	0.007	NA	0.057	0.053
2018	0.031	0.000	NA	0.000	0.063
2019	0.000	0.007	NA	0.000	0.056
2020	0.000	0.014	NA	0.000	0.000
2021	0.000	0.000	NA	0.112	0.000

Table 15.6.16. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Leucoraja naevus*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.094	NA	NA	NA
1988	0.458	NA	0.000	NA
1989	0.352	NA	0.000	NA
1990	0.485	NA	0.000	NA
1991	0.329	0.097	0.000	NA
1992	0.639	0.326	0.000	NA
1993	0.670	0.098	0.000	NA
1994	0.245	0.154	0.000	NA
1995	0.396	0.174	0.000	NA
1996	0.362	0.068	0.000	0.392
1997	0.145	0.293	0.000	0.417
1998	0.294	0.106	0.000	0.782
1999	0.269	0.245	0.000	0.400
2000	0.328	0.174	0.000	0.380
2001	0.137	0.118	0.000	0.048
2002	0.130	0.131	0.000	0.209
2003	0.102	0.115	0.000	0.234
2004	0.055	0.070	0.000	0.180
2005	0.091	0.156	0.000	0.185
2006	0.119	0.191	0.000	0.136
2007	0.160	0.122	0.000	0.434
2008	0.130	0.305	NA	0.112
2009	0.084	0.330	0.000	0.188
2010	0.182	0.435	0.000	0.050
2011	0.209	0.437	0.000	0.190
2012	0.276	0.520	0.000	0.255
2013	0.349	0.354	0.000	0.147
2014	0.218	0.167	0.000	0.218
2015	0.691	0.391	0.000	0.097
2016	0.328	0.328	0.000	0.186
2017	0.530	0.418	NA	0.191
2018	0.252	0.360	NA	0.232
2019	0.275	0.231	NA	0.084
2020	0.205	0.159	NA	0.059
2021	0.186	0.143	NA	0.071

Table 15.6.17. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for 'common skate complex'. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS survey in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.029	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.113	0.010	NA
1992	0.000	0.000	NA
1993	0.042	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.025	0.000	0.000
1997	0.000	0.000	0.000
1998	0.016	0.028	0.000
1999	0.021	0.000	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.015	0.025	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.014	0.041	0.000
2006	0.000	0.009	0.000
2007	0.055	0.000	0.000
2008	0.000	0.059	0.000
2009	0.000	0.000	0.000
2010	0.011	0.000	0.000
2011	0.215	0.010	0.000
2012	0.000	0.229	0.130
2013	0.237	0.041	0.000
2014	0.170	0.109	0.000
2015	0.101	0.011	0.215
2016	0.249	0.151	0.000
2017	0.412	0.271	3.140
2018	0.636	0.040	0.000
2019	0.675	0.195^	0.000
2020	1.098	0.665	0.038
2021	0.331	0.000	0.000

^Data revised in 2022

Table 15.6.18. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja clavata*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	1.458	NA	NA	NA	NA	NA	NA	NA
1988	0.183	NA	0.000	NA	NA	NA	NA	NA
1989	0.734	NA	0.277	NA	NA	NA	NA	NA
1990	0.525	NA	0.601	NA	NA	NA	NA	NA
1991	3.043	0.394	0.000	NA	NA	NA	NA	NA
1992	0.634	0.202	0.610	NA	NA	NA	NA	NA
1993	0.240	0.221	0.000	0.589	NA	0.000	NA	17.828
1994	0.098	0.031	0.000	0.563	NA	0.000	NA	44.307
1995	0.069	0.053	0.000	0.562	NA	0.000	NA	31.055
1996	0.145	0.654	0.207	0.804	0.111	NA	NA	4.084
1997	0.368	0.209	0.439	0.702	0.000	0.000	NA	43.043
1998	0.018	0.000	0.000	0.565	0.045	0.000	NA	43.728
1999	0.050	0.130	0.657	1.117	0.000	0.000	NA	33.081
2000	0.131	0.033	0.186	0.908	0.031	NA	NA	43.997
2001	0.131	0.055	0.000	0.874	0.040	0.000	NA	35.328
2002	0.158	0.200	0.086	0.502	0.675	0.000	NA	50.563
2003	0.227	0.031	0.000	1.066	0.256	0.000	NA	32.726
2004	0.097	0.041	0.000	1.508	0.031	0.000	0.459*	31.837
2005	0.272	0.026	0.471	0.601	0.072	0.000	0.125	79.625
2006	0.709	0.202	0.000	0.996	0.130	NA	0.032	63.887
2007	0.129	0.013	0.022	1.357	0.374	0.000	0.000	88.975
2008	1.480	0.279	NA	1.937	0.000	0.000	1.458	86.437
2009	0.779	0.173	0.000	1.409	0.138	0.000	1.348	83.955
2010	0.171	0.104	0.000	2.170	0.146	0.000	1.156*	87.252
2011	0.034	0.176	0.096	1.267	0.028	0.000	0.976	60.191
2012	1.418	0.103	0.084	1.892	0.245	0.000	1.203*	98.224
2013	0.436	0.906	0.000	1.023	0.213	0.000	1.406*	208.965
2014	0.682	1.026	0.129	2.810	0.253	0.000	3.831	245.041
2015	0.853	1.009	0.454	2.719	0.627	0.141	1.663	198.867
2016	0.584	1.075	0.482	1.963	0.188	0.000	2.813	281.260
2017	1.410	0.608	NA	2.284	0.749	0.000	3.432	165.981
2018	0.565	1.402	NA	2.628	0.533	0.027	3.603	290.030
2019	1.168	0.467	NA	3.537	0.147	0.000	2.927	326.159
2020	1.142	0.490	NA	2.630	0.306	0.251	3.659	611.607^
2021	0.914	0.554	NA	2.328	0.828	0.000	1.554	

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

***Data revised in 2022.**

Table 15.6.19. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja montagui*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS Q4, in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.063	NA	NA	NA	NA	NA	NA
1988	0.060	NA	0.000	NA	NA	NA	0.514
1989	0.099	NA	0.049	NA	NA	NA	1.347
1990	0.102	NA	0.000	NA	NA	NA	2.123
1991	0.299	0.090	1.048	NA	NA	NA	0.84
1992	0.185	0.144	0.079	NA	NA	NA	0.205
1993	0.166	0.214	0.261	0.000	NA	NA	1.257
1994	0.163	0.405	0.000	0.106	NA	NA	2.438
1995	0.508	0.090	0.000	0.118	NA	NA	0.748
1996	0.141	0.090	0.284	0.095	0.243	NA	0
1997	0.168	0.000	0.218	0.205	0.000	NA	0.686
1998	0.206	0.014	0.000	0.035	0.383	NA	0.651
1999	0.169	0.406	0.000	0.000	0.548	NA	0
2000	0.100	0.010	0.000	0.065	0.000	NA	0.333
2001	0.110	0.007	0.000	0.044	0.000	NA	0.276
2002	0.152	0.029	0.000	0.187	0.103	NA	0.103
2003	0.221	0.026	0.058	0.000	0.000	NA	0.201
2004	0.168	0.101	0.000	0.028	0.094	0.196*	0
2005	0.209	0.324	0.000	0.079	0.060	0.000	0.669
2006	0.038	0.193	0.000	0.097	0.379	0.000	0.699
2007	0.537	0.624	0.000	0.000	0.183	0.000	0.327
2008	0.808	0.320	NA	0.087	0.058	0.133	0
2009	0.334	0.623	0.000	0.000	0.041	0.257	0
2010	0.624	0.783	0.000	0.027	0.107	0.152*	0
2011	0.457	0.889	0.000	0.110	0.196	0.523	0.796
2012	0.426	1.209	0.000	0.082	0.535	0.236*	0.08
2013	0.782	0.528	0.031	0.168	0.427	0.196*	0.716
2014	0.931	1.280	0.051	0.049	0.447	0.473	0.158
2015	1.260	0.571	0.040	0.104	0.526	0.217	0.279
2016	0.819	0.890	0.049	0.103	0.264	0.372	0
2017	0.760	0.578	NA	0.094	0.310	0.453	1.708
2018	1.056	0.982	NA	0.152	0.172	0.587	0.228
2019	0.871	1.369	NA	0.142	0.386	0.697	NA
2020	1.005	0.274	NA	0.176	0.168	0.097	NA
2021	0.555	0.063	NA	0.141	0.209	0.102	

***Data revised in 2022**

Table 15.6.20. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Raja brachyura* 4.a. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.072	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.000	0.000
1993	0.073	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.000	0.000
1997	0.000	0.000
1998	0.016	0.000
1999	0.000	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.088	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.020	0.000
2007	0.887	0.267
2008	1.076	0.142
2009	0.604	0.904
2010	1.849	0.000
2011	0.669	1.515
2012	0.000	0.000
2013	2.697	0.000
2014	1.913	0.000
2015	0.221	0.000
2016	0.092	0.410
2017	0.000	0.116
2018	0.000	0.000
2019	0.207	0.000
2020	3.184	0.054
2021	0.000	0.000

Table 15.6.21. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja brachyura* 4.c and 7.d. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS-Q4 in the period 1989–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	0.001
1990	0.000	NA	0.000	NA	NA	NA	0.000
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.055	0.000	0.000	NA	NA	NA	0.000
1993	0.449	0.000	0.000	0.161	NA	NA	0.000
1994	0.000	0.000	0.000	0.000	NA	NA	0.000
1995	0.000	0.000	0.000	0.000	NA	NA	0.003
1996	0.000	0.000	0.000	0.000	0.000	NA	0.000
1997	0.000	0.000	0.000	0.000	0.000	NA	0.002
1998	0.000	0.000	0.000	0.000	0.000	NA	0.004
1999	0.084	0.000	0.000	0.000	0.000	NA	0.002
2000	0.000	0.000	0.000	0.000	0.000	NA	0.000
2001	0.000	0.000	0.000	0.032	0.000	NA	0.003
2002	0.000	0.000	0.000	0.028	0.000	NA	0.003
2003	0.034	0.000	0.000	0.044	0.000	NA	0.006
2004	0.000	0.000	0.000	0.000	1.316	0.089*	0.001
2005	0.102	0.000	0.000	0.072	0.000	0.047	0.000
2006	0.000	0.000	0.000	0.025	0.198	0.000	0.002
2007	0.352	0.000	0.000	0.259	1.868	0.000	0.008
2008	0.739	0.000	NA	0.000	0.000	0.062	0.000
2009	0.062	0.000	0.000	0.029	0.000	0.080	0.006
2010	0.000	0.000	0.000	0.000	0.000	0.029*	0.003
2011	0.000	0.000	0.000	0.087	0.000	0.147	0.006
2012	0.740	0.245	0.000	0.000	0.000	0.040	0.019
2013	0.413	0.000	0.000	0.026	0.000	0.022*	0.005
2014	1.162	0.000	0.000	0.037	0.000	0.080	0.021
2015	0.563	0.000	0.000	0.000	0.000	0.059	0.017
2016	0.299	0.139	0.000	0.071	0.000	0.000	0.020
2017	0.963	0.590	NA	0.044	0.000	0.027*	0.022
2018	1.709	0.385	NA	0.220	0.439	0.063	0.015
2019	2.150	0.343	NA	0.178	0.677	0.070	0.020
2020	0.471	0.482	NA	0.000	0.808	0.281	0.002^
2021	0.431	2.045	NA	0.493	3.199	0.517	

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

***Data revised in 2022**

Table 15.7.1: Length-weight parameters (a and b) used to convert length to weight (values taken from Silva *et al*., 2013).

Species	a	b
Leucoraja. Naevus	0.0036	3.1399
Raja brachyura	0.0027	3.2580
Raja clavata	0.0045	3.0961
Raja microocellata	0.0030	3.2250
Raja montagui	0.0041	3.1152
Raja undulata	0.0040	3.1346
Amblyraja radiata	0.0107	2.940
‘common skate complex’	0.0038	3.1201
Scyliorhinus canicula	0.0022	3.1194
Mustelus spp	0.003	3.0349

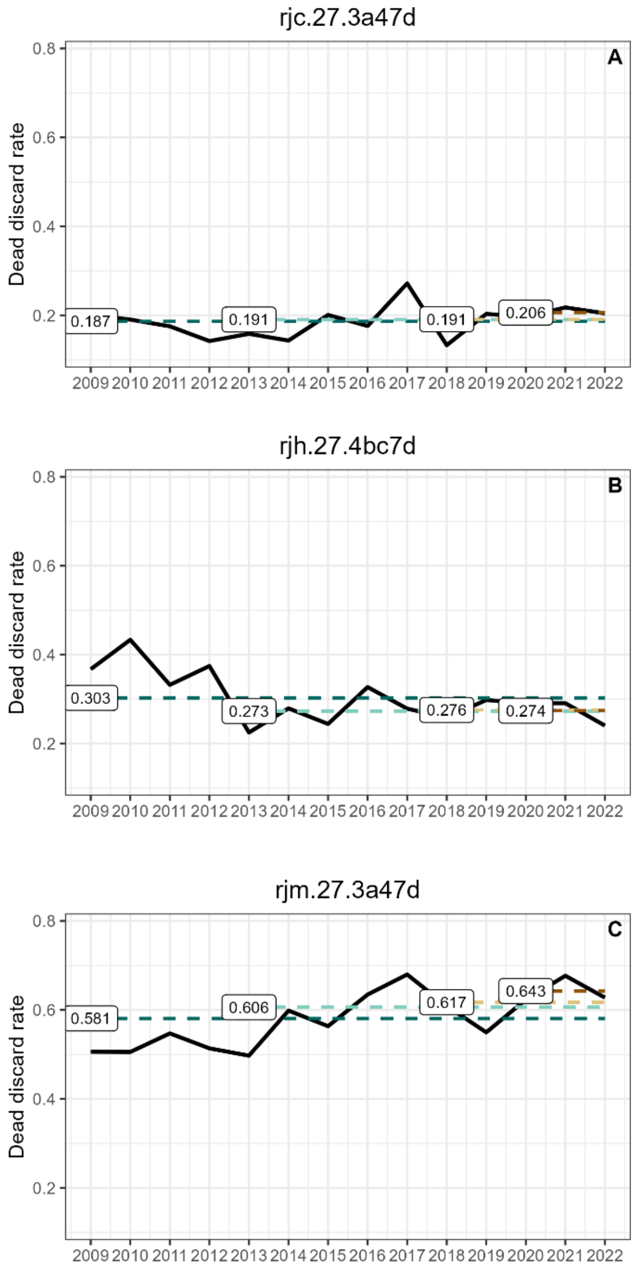


Figure 15.2.1. Dead discard rate from 2009 – 2022 for thornback ray (A), blonde ray (B) and spotted ray (C) with the average dead discard rates displayed (from the left to the right) for: the whole time series, 10 years, 5 years and 3 years.

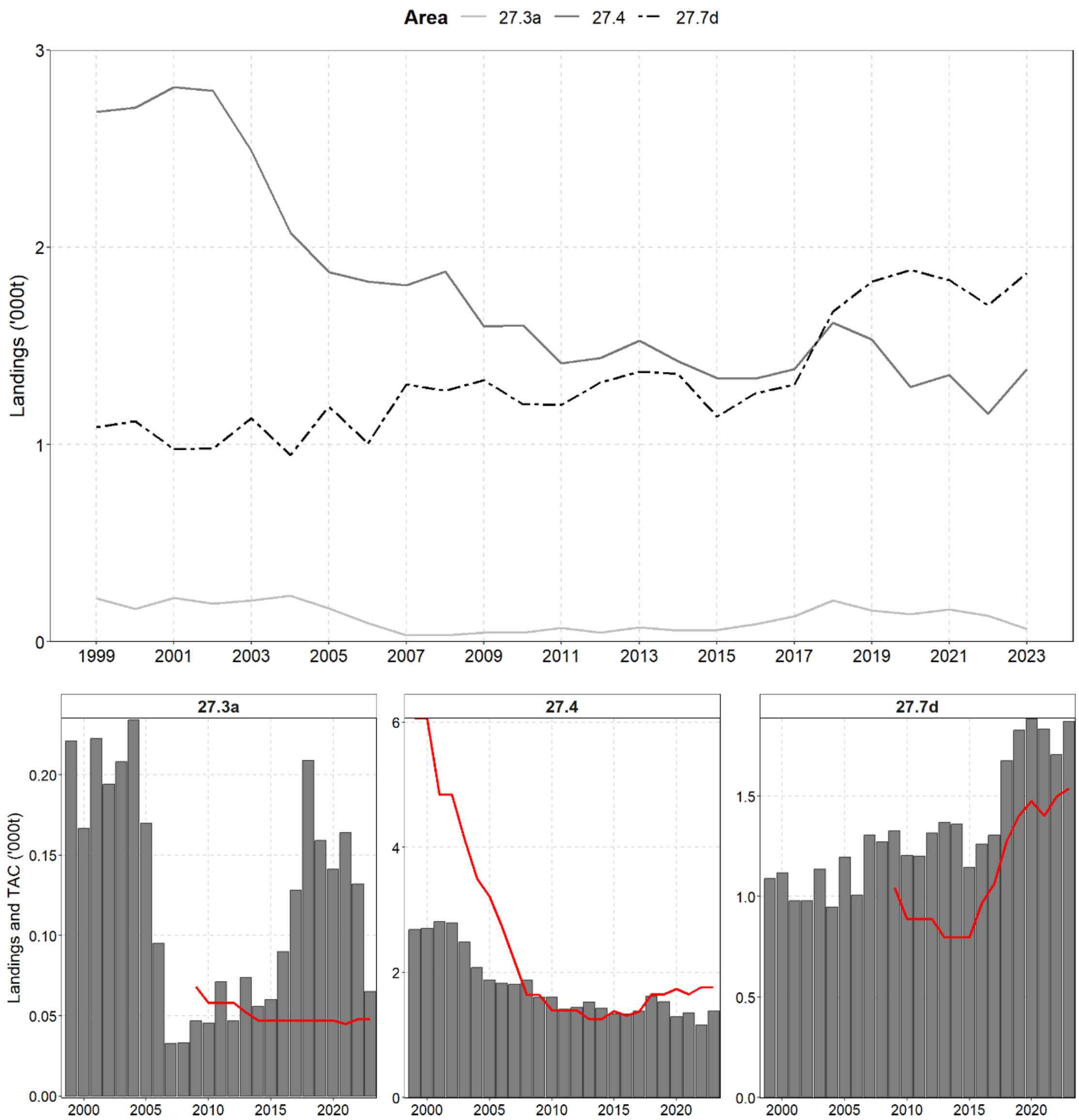


Figure 15.3.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. (top) total international landings of rays and skates in Division 3.a and Subarea 4 and Division 7.d since 1973, based on WG estimates. (bottom) Landings in Division 3.a, Subarea 4 and Division 7.d, including the TACs for the three areas (black lines) since 1999. Note: Different y-axis (bottom panel).

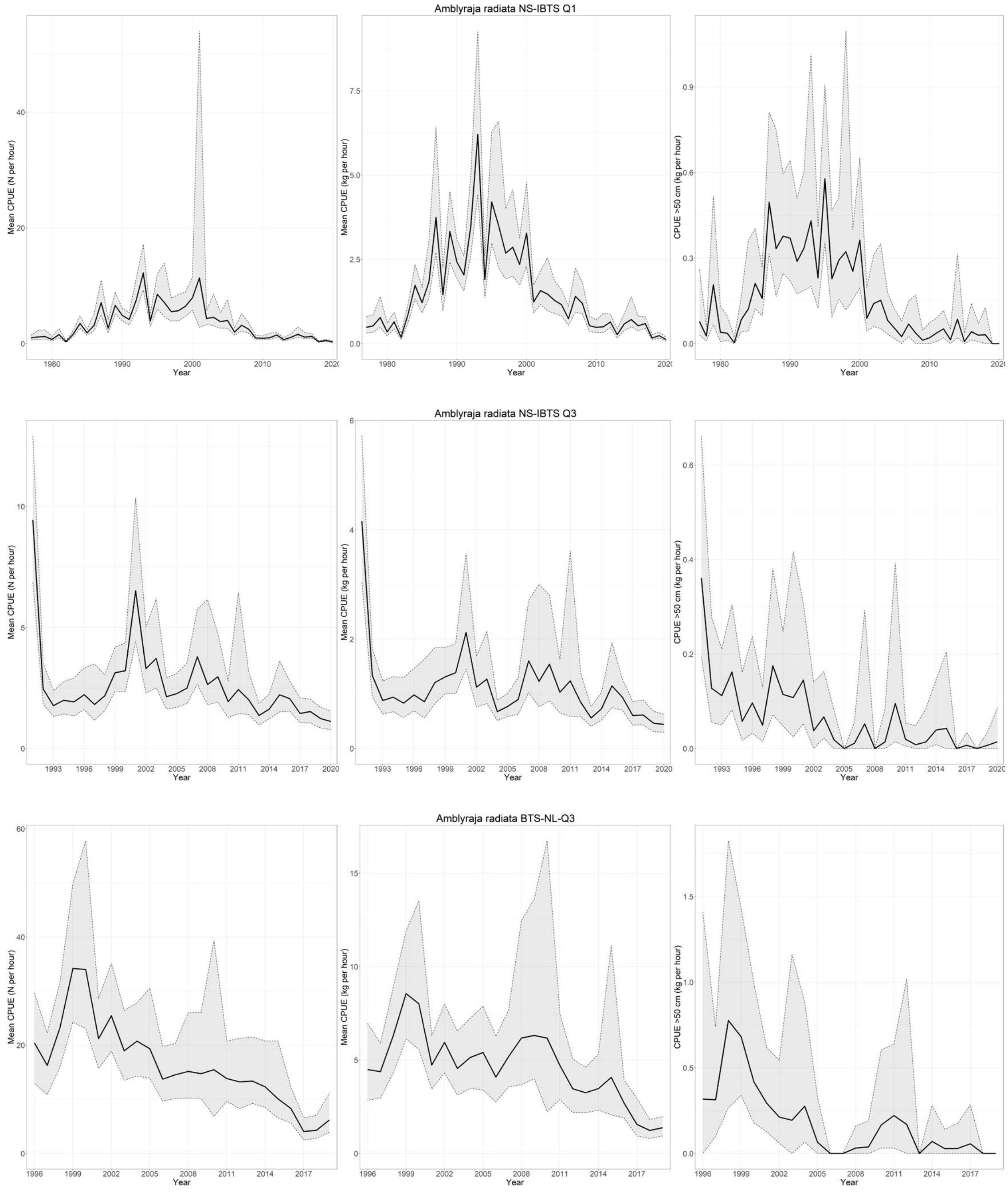


Figure 15.6.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Amblyraja radiata*. Abundance index (n. h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

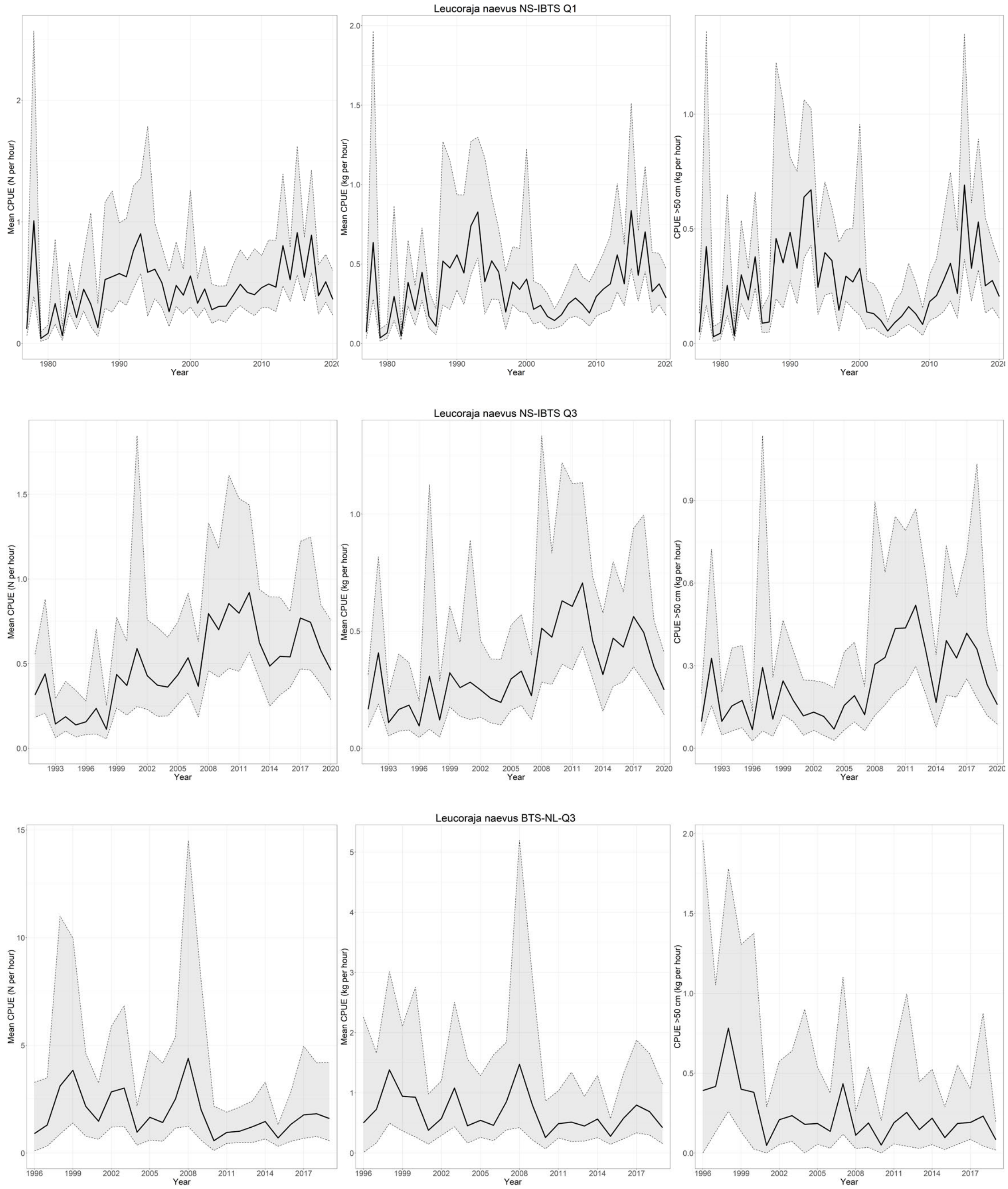


Figure 15.6.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Leucoraja naevus*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

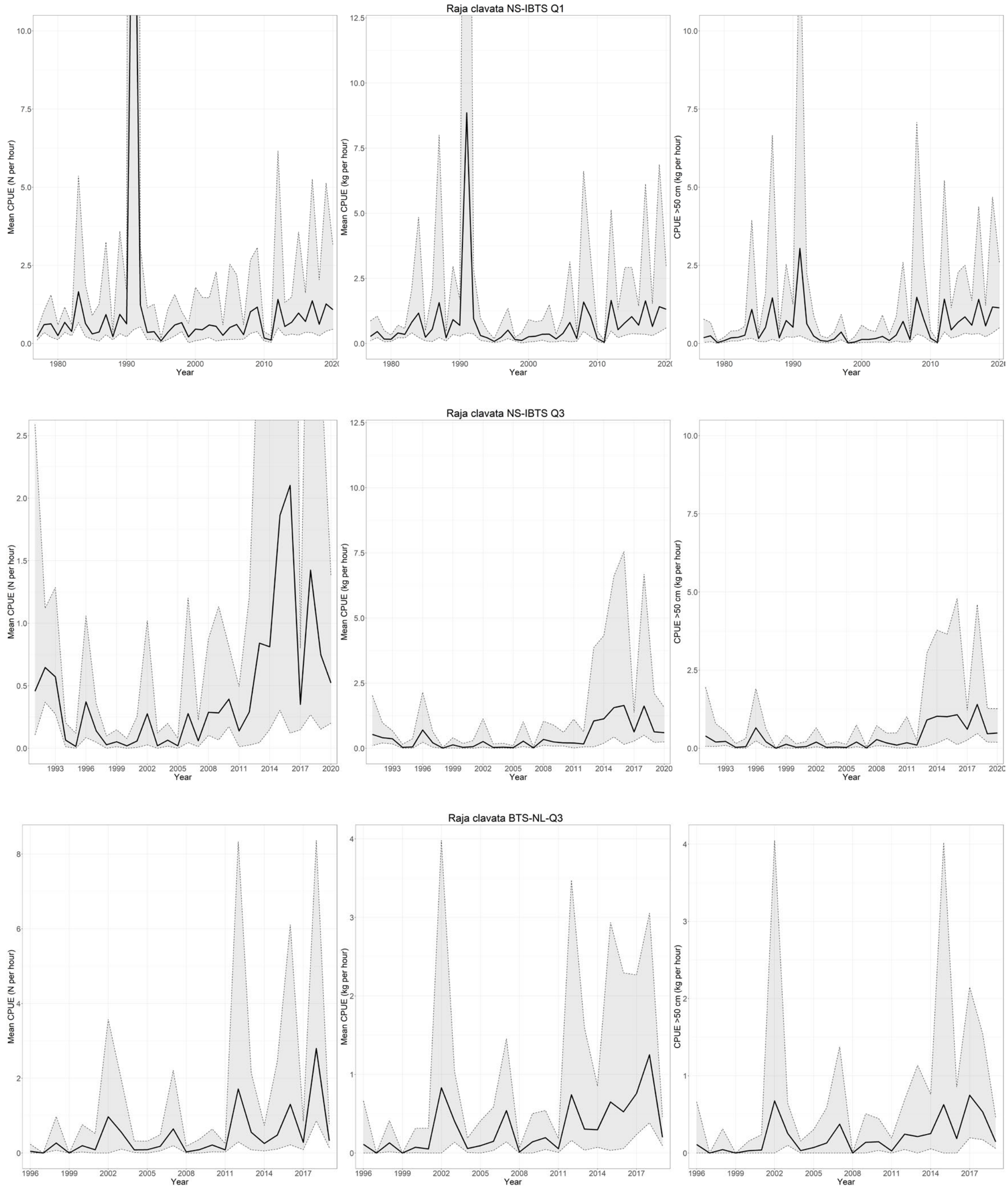


Figure 15.6.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja clavata*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

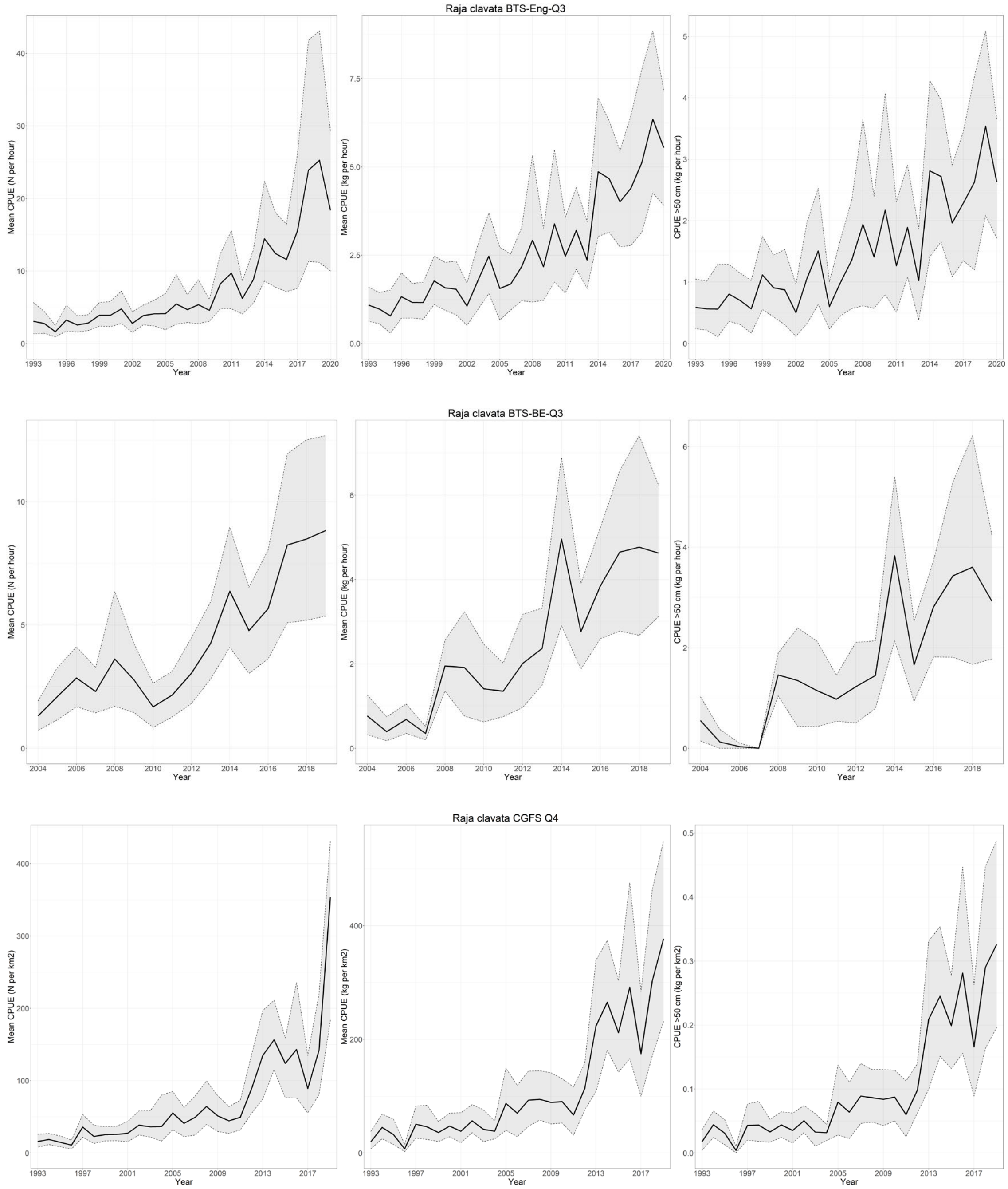


Figure 15.6.3 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja clavata*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

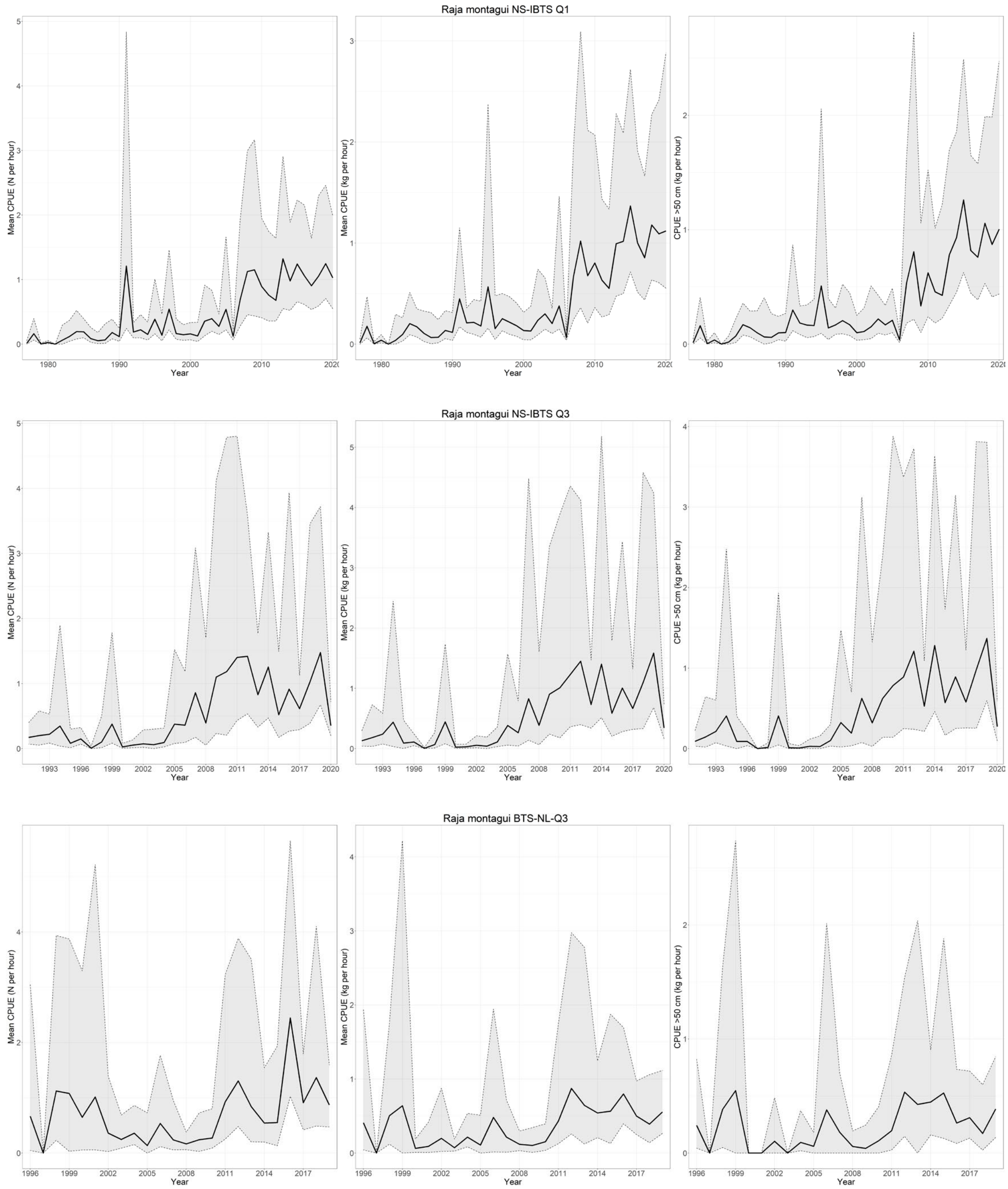


Figure 15.6.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja montagui*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

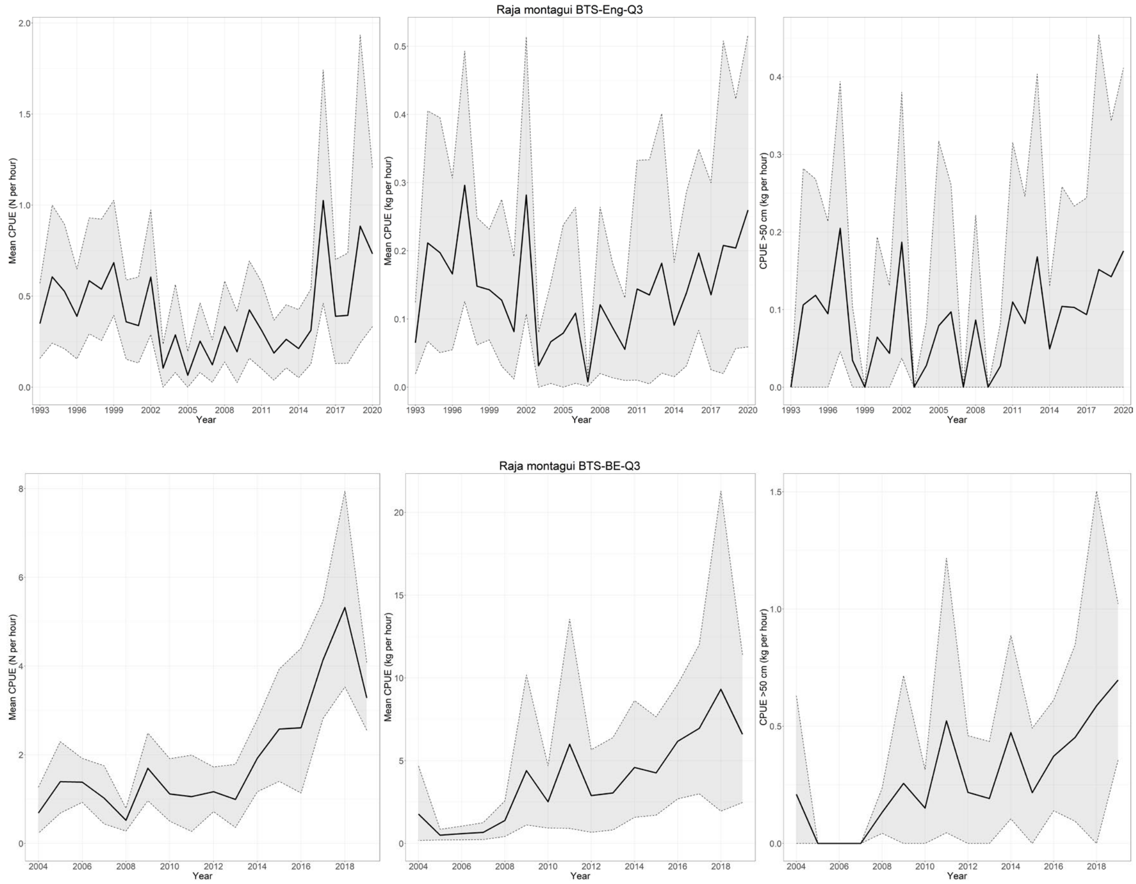


Figure 15.6.4 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja montagui*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

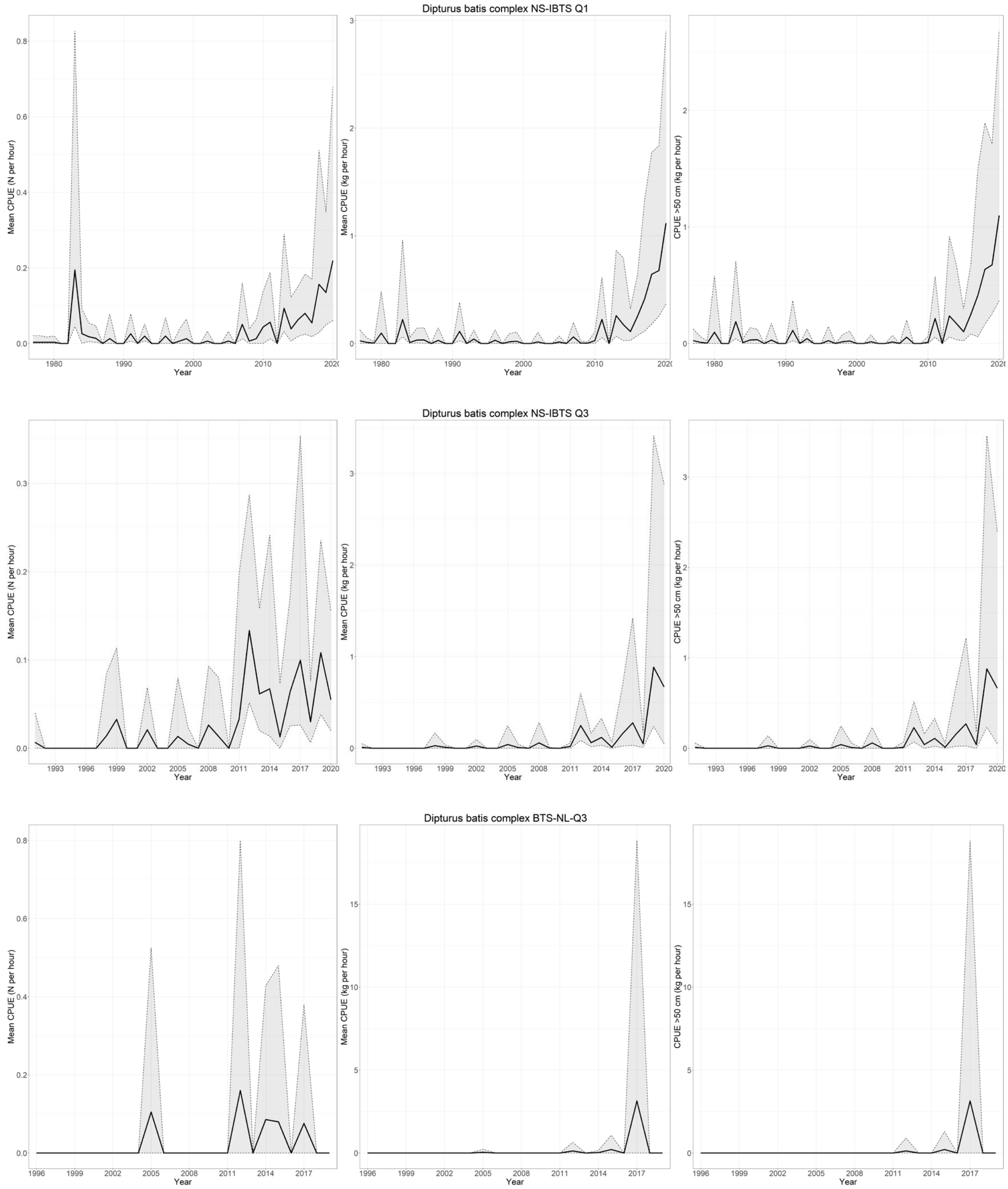


Figure 15.6.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. 'Common skate complex'. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

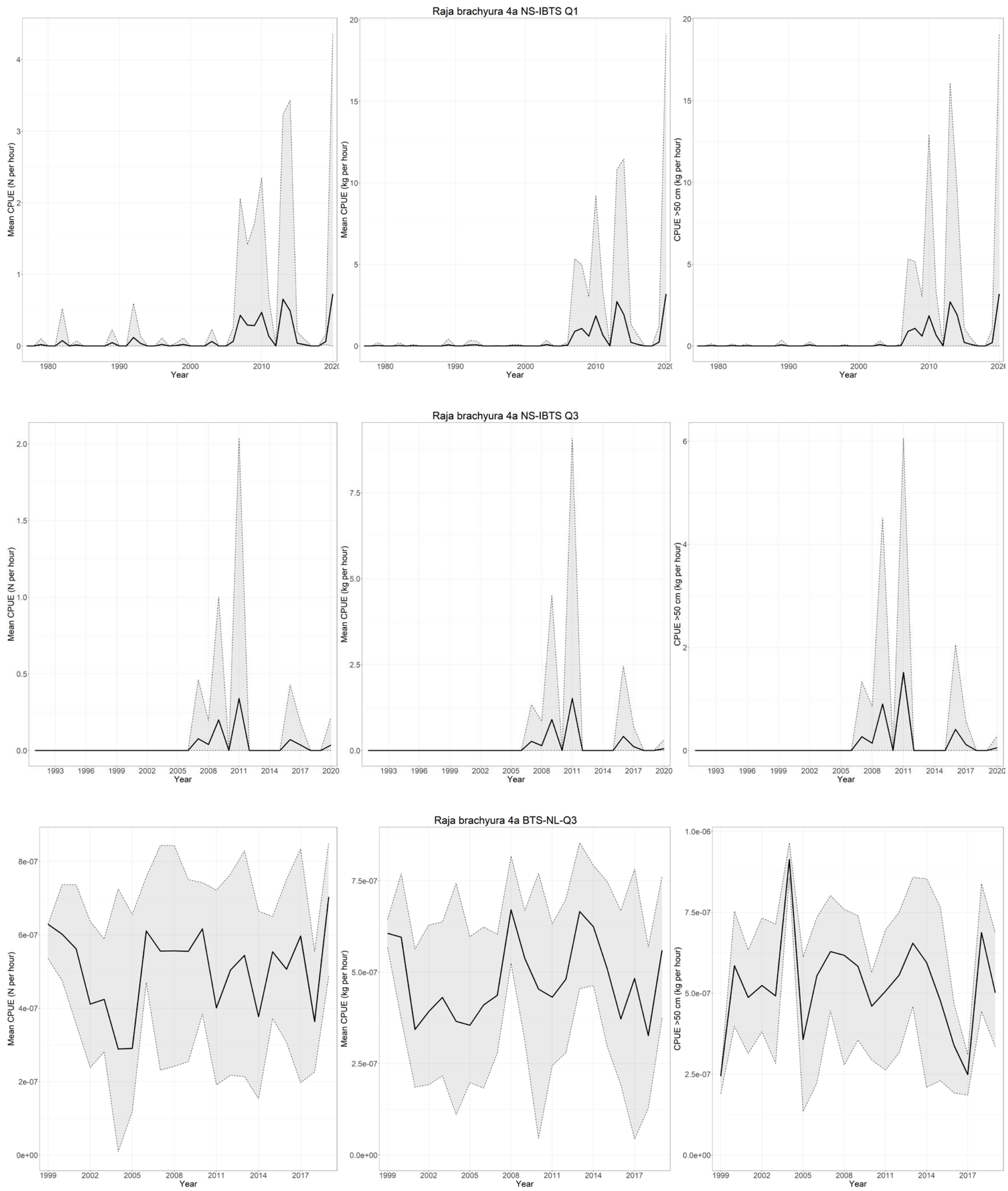


Figure 15.6.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* in 4.a. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

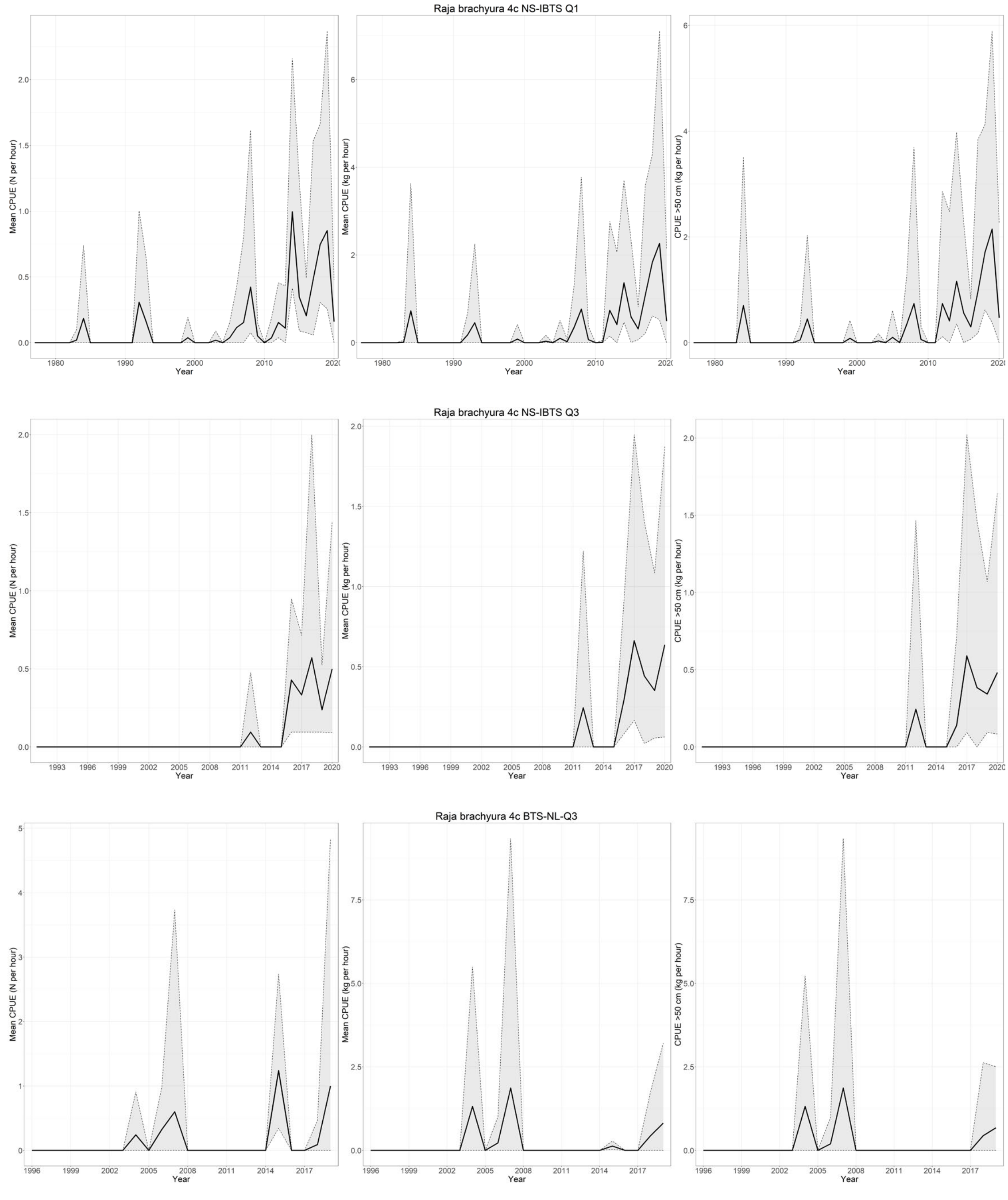


Figure 15.6.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* 4.c. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

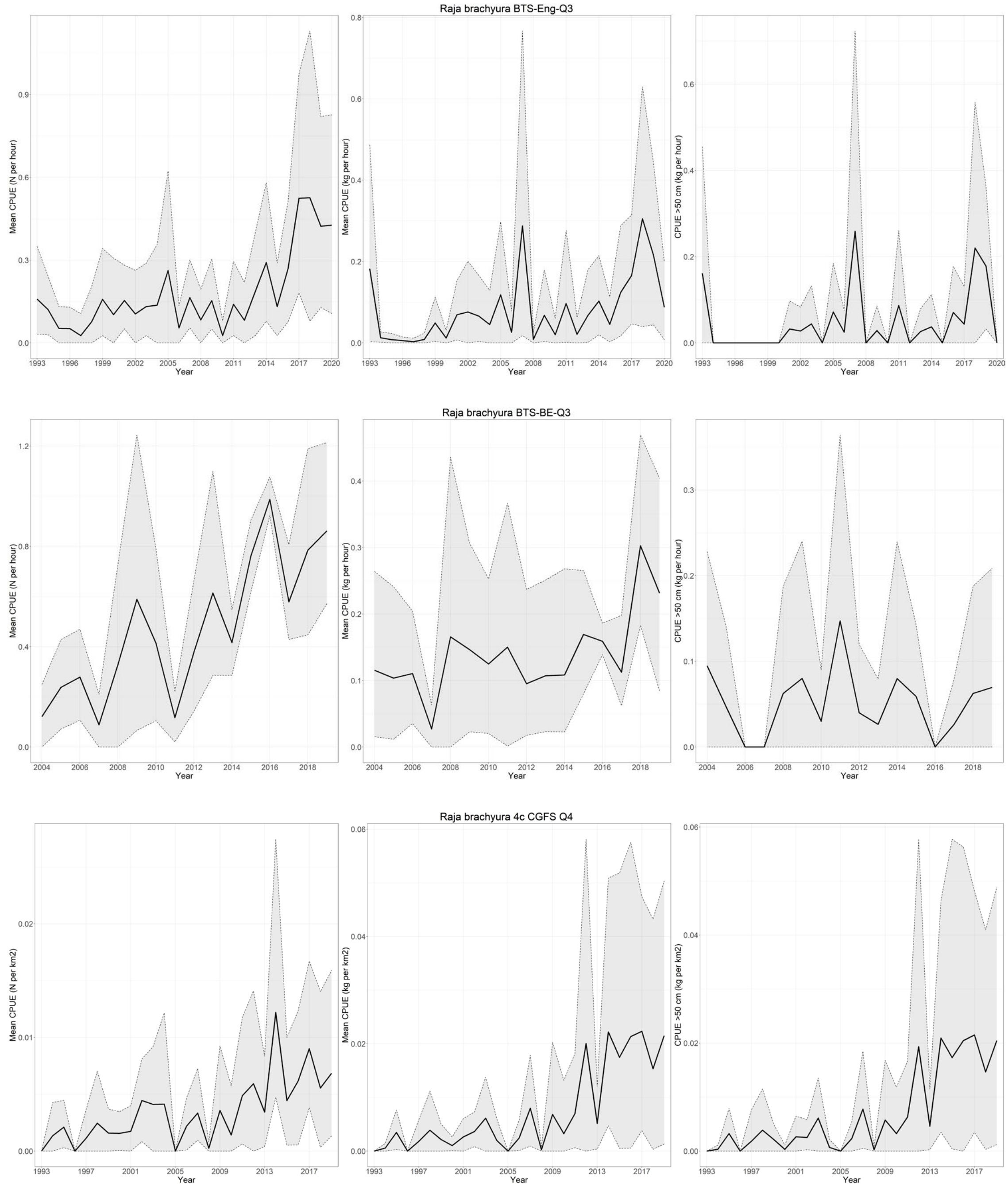


Figure 15.6.7 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* 4.c. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

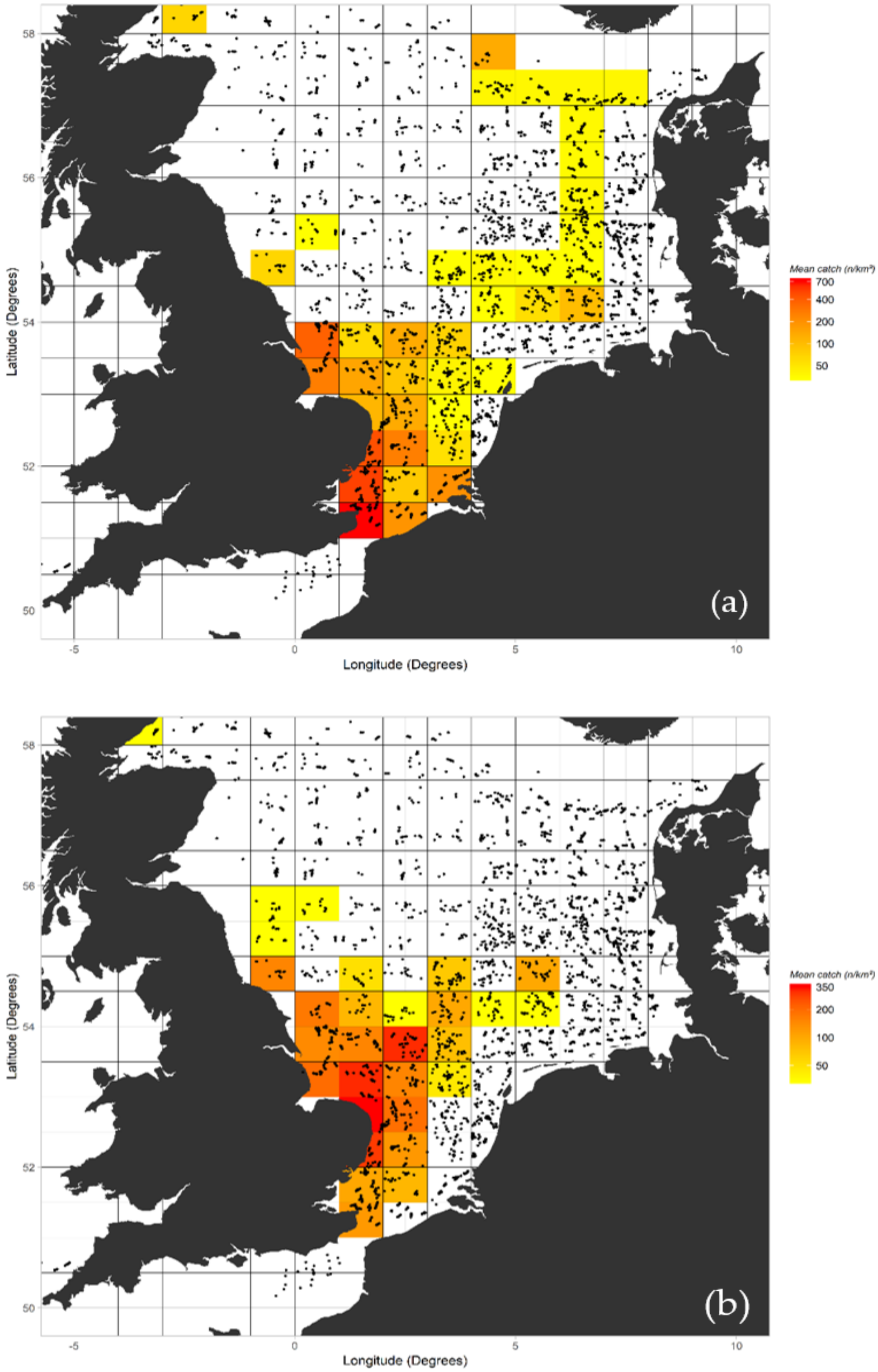


Figure 15.6.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average (a) thornback ray and (b) spotted ray catches (n.km²) from all BTS surveys (German, Dutch and Belgian) in the central-southern North Sea (ICES Areas 27.4.b and 27.4.c) for the period 2004–2018. Black dots show the different shooting positions from the survey hauls over the entire period. Data extracted from DATRAS, except for the Belgian data between 2004 and 2009, which were provided from the national database at ILVO.

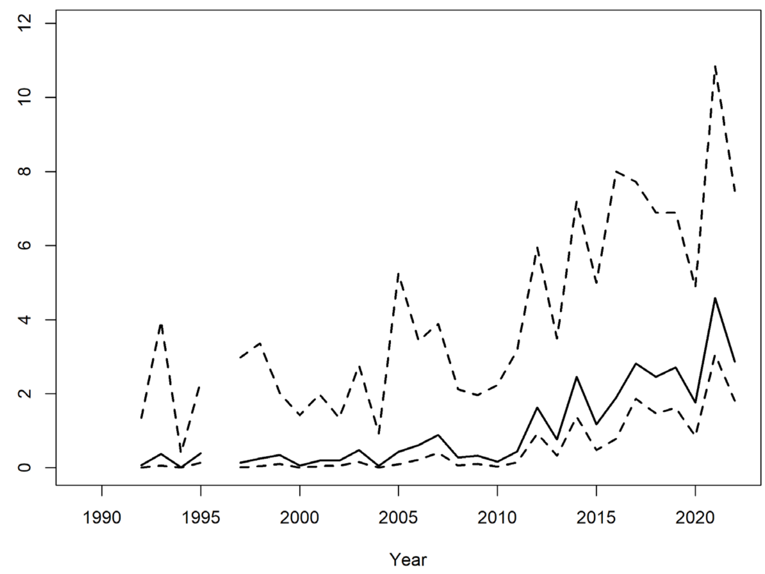


Figure 15.9.1. Blonde ray relative exploitable biomass (individuals ≥50 cm) index with 95% confidence intervals for NS-IBTS-Q1, NS-IBTS-Q3 and FR-CGFS-Q4 combined.

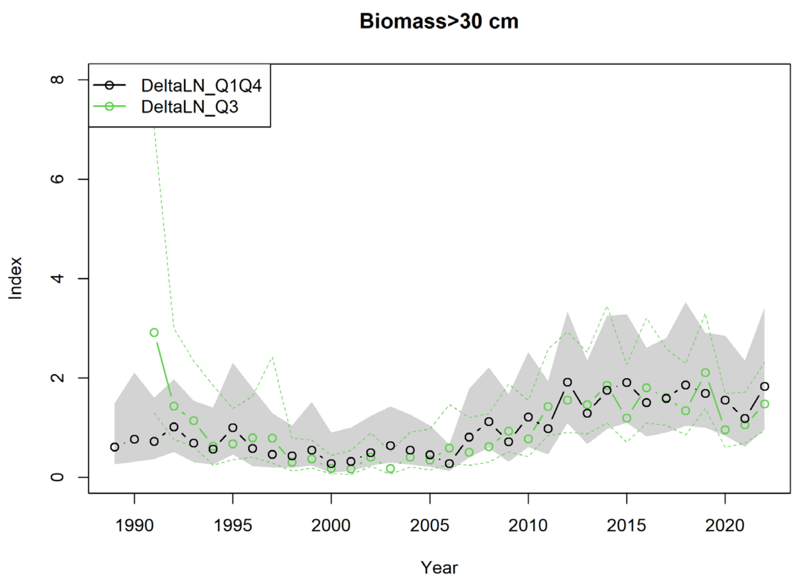


Figure 15.9.2. Spotted ray relative biomass (individuals ≥30 cm) indices with 95% confidence intervals for NS-IBTS-Q1 and FR-CGFS-Q4 combined (black line) and NS-IBTS-Q3, BTS-Eng-Q3, BTS-BEL-Q3, BTS-NL-TRI-Q3 and BTS-NL-ISI-Q3 combined (green line).

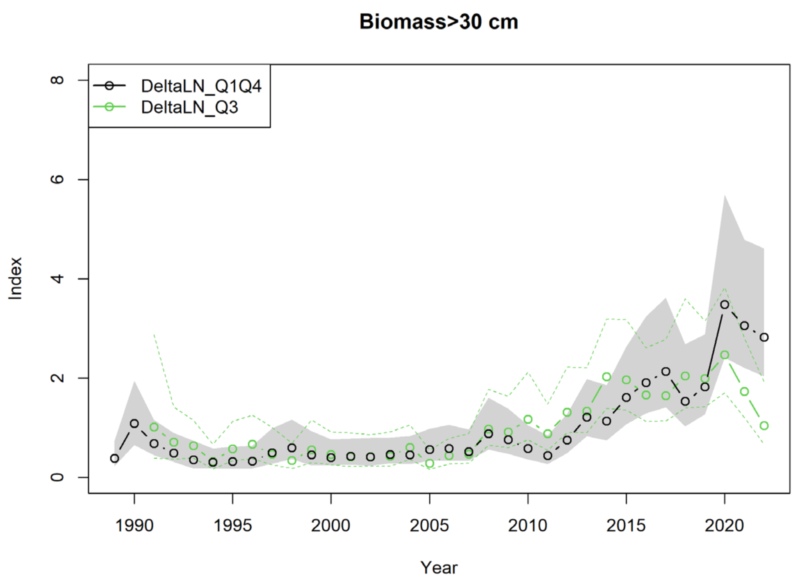


Figure 15.9.3. Thornback ray relative biomass (individuals ≥30 cm) indices with 95% confidence intervals for NS-IBTS-Q1 and FR-CGFS-Q4 combined (black line) and NS-IBTS-Q3, BTS-Eng-Q3 and BTS-BEL-Q3 combined (green line).

15.16 Appendix 1 – *rfb* method calculations by stock

15.16.1 Cuckoo ray *Leucoraja naevus* (rjn.27.3a4)

Table 1 Leucoraja naevus in Subarea 4 and Division 3.a. Estimates used in the rfb rule, with details and comments. All values have been rounded to two decimal places when appropriate. Calculations were done using unrounded values.

Variable	Estimate	Input data	Comments
r	0.82	Stock size indicator of exploitable biomass (individuals ≥50 cm) index (kg h^{-1}) from the combined NS-IBTS-Q1 and NS-IBTS-Q3, for years 1991-2022.	Index A (2021, 2022) = 0.194 Index B (2018-2020) = 0.24
b	1.00	Set to 1.00 at $I_{2022}/I_{trigger}$	I_{loss} = 0.0624 (2004) $I_{trigger}$ = 0.087 I_{2022} = 0.22
m	0.95	Set at 0.95 when a species-specific k parameter is < 0.20	k = 0.16 $year^{-1}$
f	1.13	Length data collected from commercial discards and landings from 2022 L_C, L_{mode} and $L_{F=M}$ are calculated based on pooled data from 2020 - 2022	L_C = 33 cm L_{mode} = 57 cm L_{mean} = 49 cm $L_{F=M}$ = 44 cm
A_Y	89 tonnes	ICES advice for 2022 and 2023	(ICES, 2021a)
A_{Y+1}	79 tonnes	$A_{y+1} = A_y \times r \times f \times b \times m$	

Figure 1: *Leucoraja naevus* in subarea 4 and Division 3a. Exploitable biomass (individuals ≥ 50cm) indices of the NS-IBTS-Q1 (orange) and NS-IBTS-Q3 (green) in kg h^{-1}.

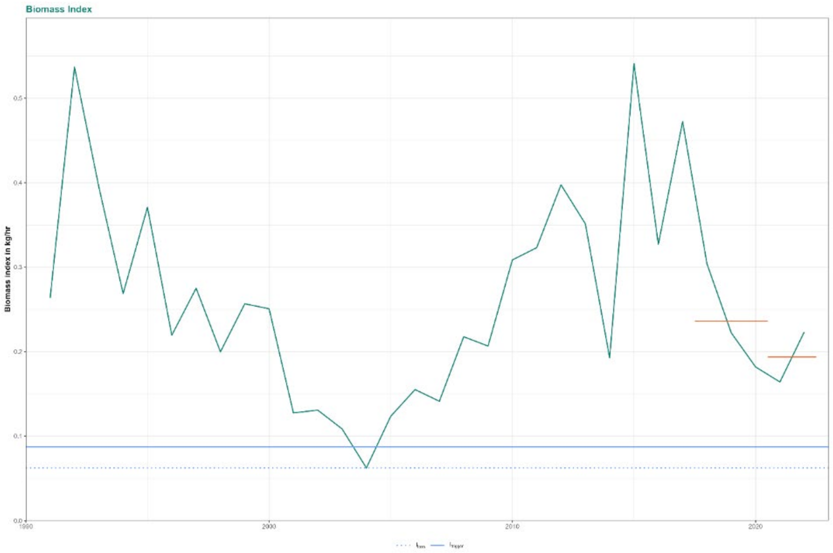


Figure 2: *Leucoraja naevus* in subarea 4 and Division 3a. Combined exploitable biomass index in kg h^{-1} for the period 1991-2022. Red horizontal lines denote the '2 over 3' rule used to calculate r, with index A (2021-2022) and index B (2018-2020). The solid and dashed blue lines show the calculated I_{loss} and $I_{trigger}$ values, respectively.

Table 2: Leucoraja naevus in subarea 4 and Division 3a. Yearly values for the exploitable biomass survey index (individuals ≥50 cm) in kg h^{-1}. Values have been rounded to three decimal places, calculations were done using unrounded values.

Year	NS-IBTS-Q1	NS-IBTS-Q3	Combined index
1991	0.329	0.199	**0.264**
1992	0.639	0.435	**0.537**
1993	0.670	0.120	**0.395**
1994	0.245	0.292	**0.269**
1995	0.396	0.346	**0.371**
1996	0.362	0.077	**0.219**
1997	0.145	0.405	**0.275**
1998	0.294	0.106	**0.200**
1999	0.269	0.245	**0.257**
2000	0.328	0.174	**0.251**
2001	0.137	0.118	**0.127**
2002	0.130	0.131	**0.131**
2003	0.102	0.115	**0.109**
2004	0.055	0.070	**0.062**
2005	0.091	0.156	**0.123**
2006	0.119	0.191	**0.155**

Year	NS-IBTS-Q1	NS-IBTS-Q3	Combined index
2007	0.160	0.122	**0.141**
2008	0.130	0.305	**0.218**
2009	0.084	0.330	**0.207**
2010	0.182	0.435	**0.309**
2011	0.209	0.437	**0.323**
2012	0.276	0.520	**0.398**
2013	0.349	0.353	**0.351**
2014	0.218	0.167	**0.193**
2015	0.691	0.391	**0.541**
2016	0.328	0.326	**0.327**
2017	0.530	0.415	**0.472**
2018	0.251	0.357	**0.304**
2019	0.275	0.170	**0.222**
2020	0.205	0.159	**0.182**
2021	0.185	0.143	**0.164**
2022	0.093	0.354	**0.223**

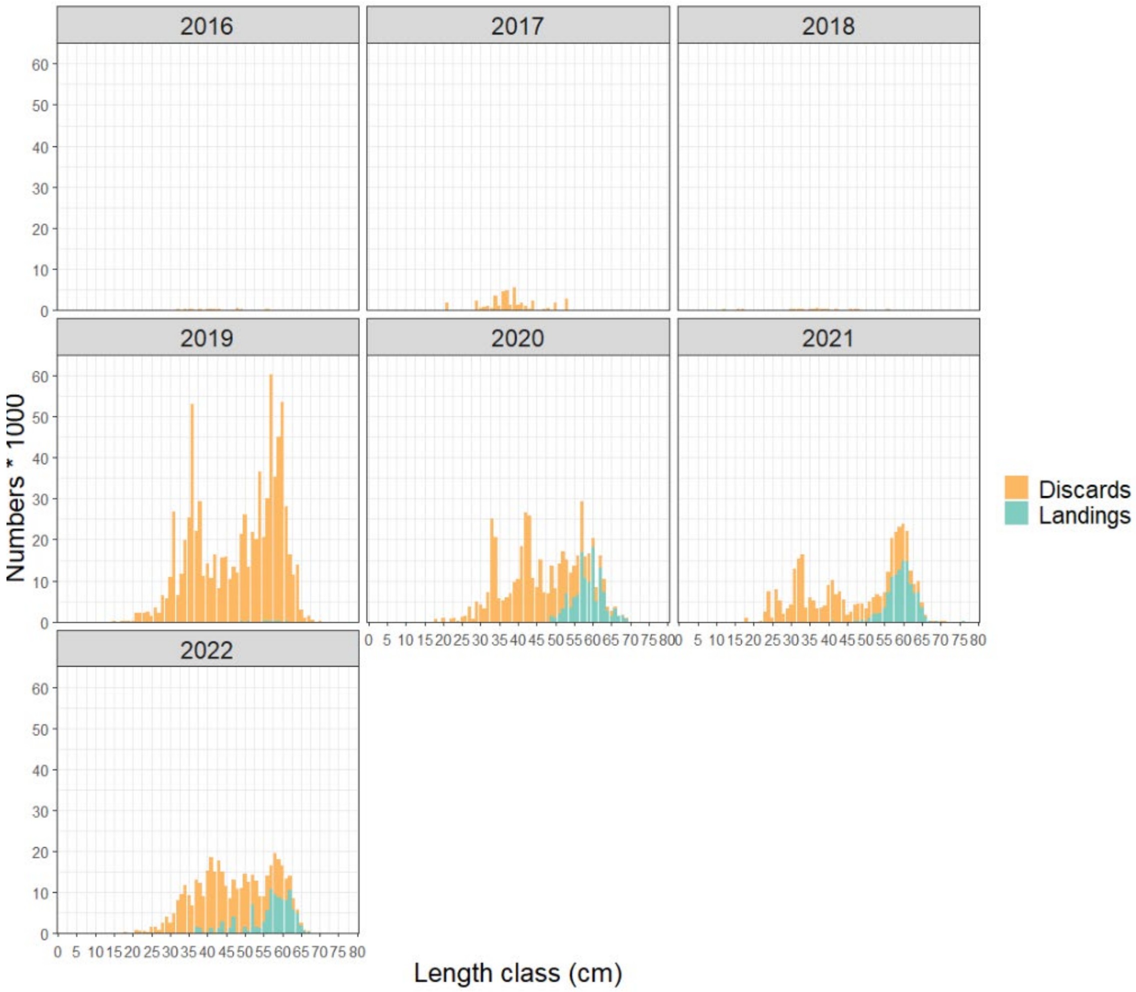


Figure 3: ***Leucoraja naevus*** **in subarea 4 and Division 3a. Length frequency distributions by year.**

15.16.2 Starry ray *Amblyraja radiata* (rjr.27.23a4)

Table 2 ***Amblyraja radiata*** **in Subarea 2 and 4 and Division 3.a. Estimates used in the rfb rule, with details and comments. All values have been rounded to two decimal places when appropriate. Calculations were done using unrounded values.**

Variable	Estimate	Input data	Comments
r	0.75	Stock size indicator (combined CPUE (number per hour) index taken from the IBTS Q1 and IBTS Q3 surveys).	Index A (2021, 2022) = 0.53 Index B (2018-2020) = 0.24
b	0.39	Set at $I_{2022}/I_{trigger}$ because I_{2022} is below $I_{trigger}$. Here $I_{trigger} * I_{loss}$ * 1.4 is set at the 20th quantile of the survey index	I_{loss} = 1.35 $I_{trigger}$ = 1.89 I_{2022} = 0.73
m	0.95	Set at 0.95 when a species-specific k parameter is < 0.20	k = 0.1 year^{-1}
f	0.95	Length data collected from commercial discards from 2022 L_C, L_{mode} and $L_{F=M}$ are calculated based on pooled data from 2019 and 2022	L_C = 33 cm L_{mode} = 40.22 cm L_{mean} = 36 cm $L_{F=M}$ = 42.48 cm

A_Y	0 tonnes	ICES advice in 2022	(ICES, 2021a)
A_{Y+1}	0 tonnes	$A_{y+1}= A_y \times r \times f \times b \times m$	By definition, an advised catch in 2022 of 0, means that product of [r × f × b × m] is multiplied by 0 and will always be equal to 0.

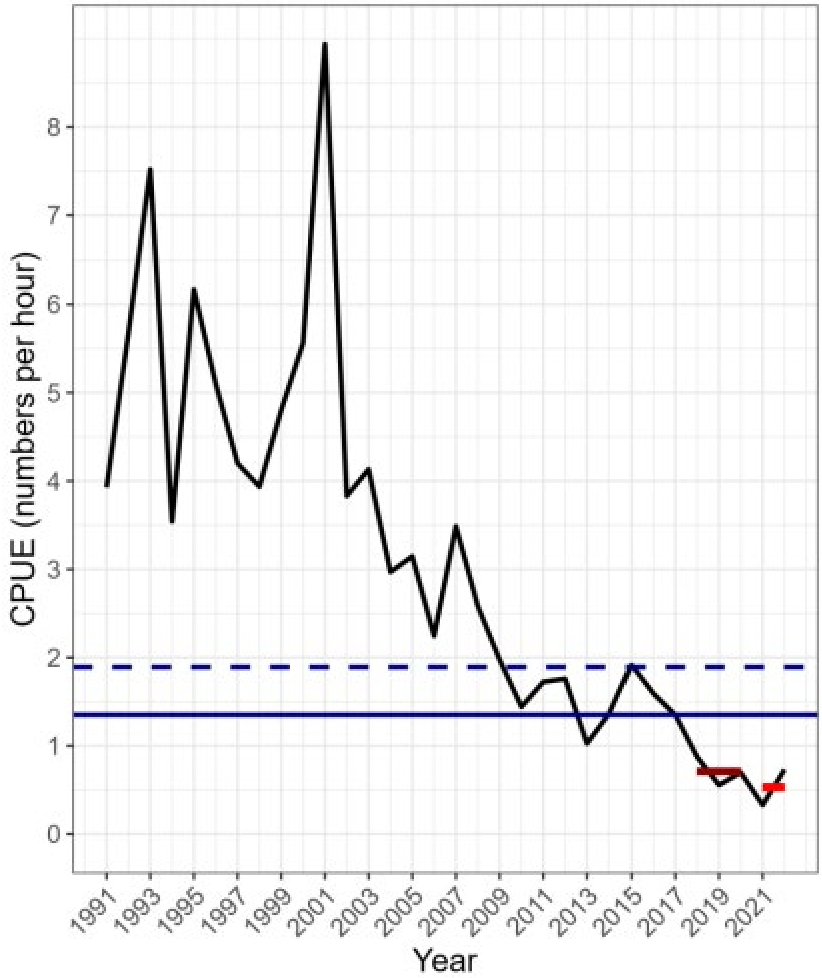


Figure 1: *Amblyraja radiata* in subareas 2 and 4 and Division 3a. Survey index through time, calculated as the combined CPUE indices from the IBTS Q1 and IBTS Q3 surveys in numbers per year. Red (2021 and 2022) and darkred (2018-2020) lines show the two parts of the '2-over-3' rule used to calculate r. The solid and dashed blue lines show the calculated I_{loss} and $I_{trigger}$ values, respectively.

Table 2 *Amblyraja radiata* in Subarea 2 and 4 and Division 3.a. Yearly values for the abundance survey index (CPUE in numbers per hour) from the IBTS Q1 and IBTS Q3, and the combined index. Values have been round to two decimal places.

Year	IBTS Q1 ($n\text{-}h^{-1}$)	IBTS Q3 ($n\text{-}h^{-1}$)	Combined index ($n\text{-}h^{-1}$)
1991	4.161	3.696	3.929
1992	7.528	3.816	5.672
1993	12.232	2.804	7.518

1994	3.913	3.173	3.543
1995	8.526	3.812	6.169
1996	7.111	3.091	5.101
1997	5.518	2.882	4.200
1998	5.692	2.180	3.936
1999	6.473	3.134	4.804
2000	7.914	3.215	5.564
2001	11.358	6.520	8.939
2002	4.353	3.307	3.830
2003	4.543	3.722	4.133
2004	3.795	2.143	2.969
2005	4.022	2.270	3.146
2006	1.992	2.499	2.245
2007	3.180	3.794	3.487
2008	2.521	2.646	2.583
2009	0.982	2.967	1.974
2010	0.945	1.939	1.442
2011	1.012	2.435	1.724
2012	1.502	2.014	1.758
2013	0.684	1.367	1.026
2014	1.088	1.630	1.359
2015	1.605	2.223	1.914
2016	1.137	2.046	1.592
2017	1.255	1.444	1.349
2018	0.228	1.519	0.873
2019	0.564	0.546	0.555
2020	0.272	1.119	0.695
2021	0.352	0.306	0.329
2022	0.445	1.017	0.731

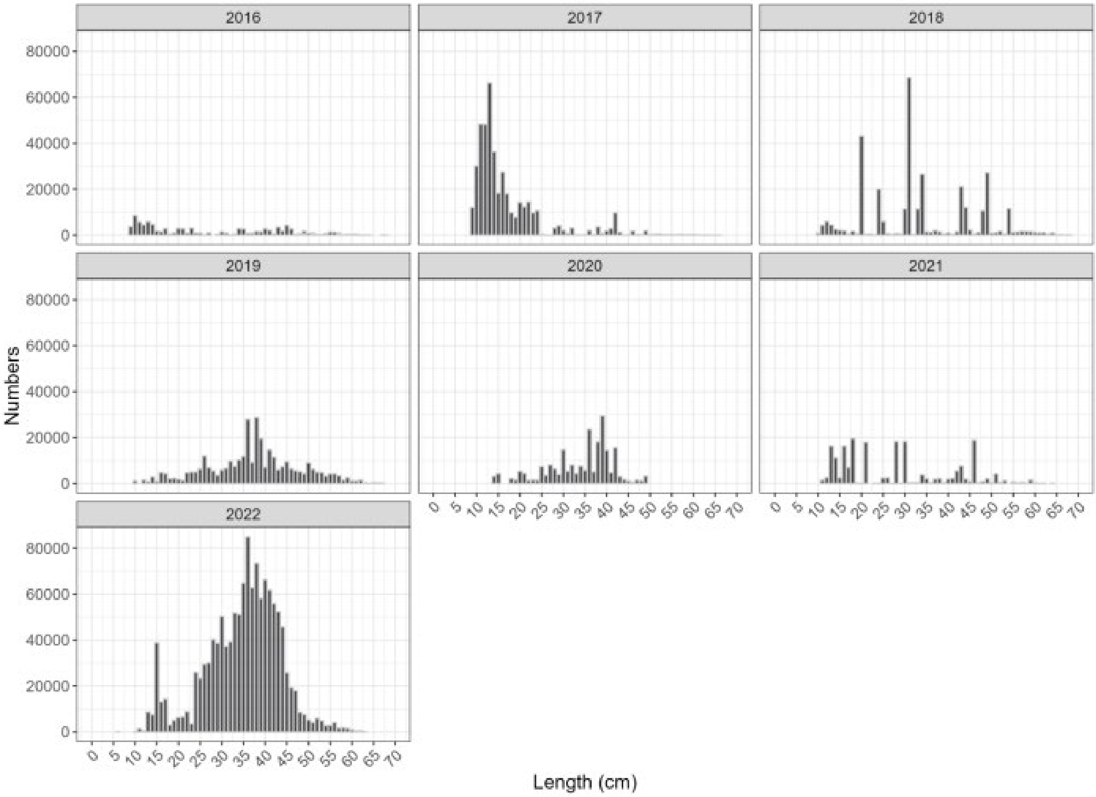


Figure 2: *Amblyraja radiata* in subareas 2 and 4 and Division 3a. Length frequency distributions by year. All length samples are taken from discards.

Contents

16 Demersal elasmobranchs - Iceland and East Greenland

16.1 Ecoregion and stock boundaries

The elasmobranch fauna off Iceland and Greenland is little-studied and comprises 15 skate and 21 shark species (with six species of chimaeroid also present). The number of species decreases as water temperature decreases, and only a few of these species are common in Icelandic and Greenland waters.

An ecosystem overview for the ecoregion of Icelandic waters has been published and is available at the ICES website (ICES, 2022a). The most abundant elasmobranch species in this ecoregion is starry ray (thorny skate) *Amblyraja radiata*.

In Icelandic waters, other skate species commonly occurring are: Common blue skate *Dipturus batis,* Arctic skate *Amblyraja hyperborea,* round skate *Rajella fyllae,* spinytail skate *Bathyraja spinicauda* and sailray *Rajella lintea* (former *D. linteus*). The remaining seven species are sporadically caught: Jensen's skate *Amblyraja jenseni,* Norwegian skate *Dipturus nidarosienis,* shagreen ray *Leucoraja fullonica*, roughskin skate *Malacoraja spinacidermis,* Krefft's skate, *Malacoraja kreffti*, deepwater ray *Rajella bathyphila* and Bigelow's skate *Rajella bigelowi.*

In Greenland waters, the commonly found skates include *R. fyllae, B. spinicauda* and *A. hyperborea,* with species such as *R. bathyphila*, *M. spinacidermis, R. lintea*, *A. jenseni* and *R. bigelowi* being less frequent (Möller *et al.*, 2010).

Dogfish and sharks in this ecoregion include spurdog *Squalus acanthias* (Section 2); Portuguese dogfish *Centroscymnus coelolepis* and leafscale gulper shark *Centrophorus squamosus* (Section 3); birdbeak dogfish *Deania calcea*, black dogfish *Centroscyllium fabricii*, great lantern shark *Etmopterus princeps*, velvet belly lanternshark *E. spinax,* longnose velvet dogfish *Centroselachus crepidater* and six gill shark *Hexanchus griseus* (Section 5); porbeagle shark *Lamna nasus* (Section 6); basking shark *Cetorhinus maximus* (Section 7); Greenland shark *Somniosus microcephalus* (Section 24); and several scyliorhinid catsharks (Iceland catshark *Apristurus laurussonii,* white ghost catshark *A. aphyodes*, small-eye catshark *A. microps* and mouse catshark *Galeus murinus*).

The distribution of demersal sharks in Icelandic waters is mainly restricted to upper slope and shelf break along the southeast to northwestern waters. The exception is *Squalus acanthias* which is found in shallower waters most commonly in the south and west but with patchy distribution also in other areas.

Chimaeras (rabbitfish *Chimaera monstrosa*, spearnose chimaera *Rhinochimaera atlantica*, large-eyed rabbitfish *Hydrolagus mirabilis*, *H. pallidus*, small-eyed rabbitfish *Hydrolagus affinis*, narrownose chimaera *Harriotta raleighana*) all occur in the area (Jakobsdóttir et al. 2020).

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

16.2 The fishery

16.2.1 History of the fishery

Skates and sharks are mainly a bycatch in fisheries, with Iceland being the main fishing nation operating in the ecoregion. Common skate complex is fished with a variety of fishing gears (Figure 16.1a). They used to be regarded as fairly common in Icelandic waters, but landings may now only be about 10% of what was landed 50 years ago. A large part of the landed catch is for local consumption, as the species within the common skate complex are traditional food in Iceland, particularly at Christmas time. The remaining catch is processed and mainly exported.

A. radiata is a bycatch in a variety of fishing gears around Iceland but was usually discarded. Increased landings since the 1990s may be related to an increased retention compensating for a lower abundance of the common skate complex. Landings are reported mainly from the longline fishery (Figure 16.1b). Reported landings have increased from low levels in 1980 to more than 1000 tonnes annually from 1995–2004. Thereafter, landings declined but have increased again to levels exceeding 1700 tonnes in 2012. From 2012 to 2016, landings have gradually reduced to approximately 1250 tonnes in 2016, followed by an abrupt decline in 2017, being ca. 600 tonnes in 2018. In 2019 and 2020, landings slightly increased again, but are not at the same level as observed before 2017. A relatively large proportion of the landings is for local consumption.

16.2.2 The fishery in 2023

No new information.

16.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

16.2.4 Management applicable

There is no TAC for demersal skates in these areas.

16.3 Catch data

16.3.1 Landings

From 1973–2023, 13 countries reported landings of skates, demersal sharks and chimaeras from Divisions 5.a (Iceland) and 14.a and 14.b (East Greenland). Iceland is the main nation fishing in these areas.

Reported landings of skates from Iceland (Division 5.a) and eastern Greenland (Subarea 14) are given in Table 16.1, with these data comprising national landings data provided to WGEF, landings statistics from the Faroese national database (www.hagstova.fo), and data from the ICES database.

Icelandic national data for estimated landings of the common blue skate (1973–2023), *A. radiata* (1977–2023), *R. lintea* (2000–2023) are available. Database entries for all species with national landings for the years 2001–2023 are available.

Prior to 1992, all skates (except *A. radiata* and common skate complex) were reported as '*Raja* rays nei'. Since 1992, when skates have been reported to the species level, *A. radiata* and *Dipturus* *batis*-complex have accounted for about 98% of the annual skate landings. Only small quantities of *L. fullonica*, *R. lintea* and *B. spinicauda* have been reported. Fishers do not usually distinguish between *L. fullonica* and *R. lintea* in Icelandic waters, and so landings of *R. lintea* are likely to be underestimated and landings of *L. fullonica* overestimated (as landings of the latter species, which is relatively rare in Icelandic waters, includes some *R. lintea*). Landings reported as *D. batis*-complex could also sometimes be *R. lintea.* Therefore, official landings on *L. fullonica* will be reported as *Raja* rays nei until this issue is locally resolved.

Reported skate landings peaked at 2500 t in 1951. Since then, the landings of the *D. batis*-complex have decreased but landings of *A. radiata* have increased in later years. Landings of *A. radiata* were under 1000 t but after 2005 increased to about 1800 t in 2012 contributing the bulk of landings of elasmobranchs in this ecoregion (Table 16.1; figures 16.2–16.3). Overall, over 95% of the skate landings came from Division 5.a. The share taken by Iceland from this area increased from <50% in the 1970s to nearly 100% from 1999 onwards.

Information on elasmobranch bycatch in East Greenland waters is unavailable, but several species are probably taken and discarded in fisheries for cod, shrimp and Greenland halibut *Reinhardtius hippoglossoides*.

16.3.2 Discards

No discard data were available.

16.3.3 Quality of catch data

The main skates landing nations in this ecoregion now provide species-specific information, but species identification needs improvement.

16.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

16.4 Commercial catch composition

No data on the length distribution or sex ratio in commercial landings were available.

16.5 Commercial catch and effort data

No data available.

16.6 Fishery-independent surveys

16.6.1 Surveys in Greenland waters

Since 1998, the Greenland surveys (GR-GHXIVB) have covered the area between 61°45'–67°N at depths of 400–1500 m, although the area between 63–64°N was not covered by the surveys, as the bottom topography was too steep and rough. The surveys are aimed at Greenland halibut, although all fish species are recorded. The surveys use an ALFREDO III trawl (wingspread ≈ 21 m; headline height ≈ 5.8 m; mesh size (cod end) = 30 mm) with rock-hopper ground gear. These data were presented to WGEF in a working paper by Jørgensen (2006) and are summarized in Table 16.2. Another source of survey data in Greenland waters is the German Greenland groundfish survey (GER (GRL)-GFS-Q4), and these data need to be examined.

16.6.2 Surveys in Icelandic waters

The Icelandic spring groundfish survey (IS-SMB) is the main source of fishery-independent data for starry ray *Amblyraja radiata* and blue skate *Dipturus batis*. The survey indices from that survey are used for an assessment of starry ray (MFRI Advice 2024).

The Icelandic autumn groundfish survey (IS-SMH) is the main source of other fishery-independent data for demersal elasmobranchs in Icelandic waters (Jakobsdóttir *et al.*, 2023). Further, data can be compiled for some species from other surveys e.g. spring groundfish survey (IS-SMB), shrimp and flatfish surveys undertaken by MFRI.

The IS-SMB survey covers the Icelandic shelf at depths of 20-500 m. The IS-SMH survey covers the Icelandic shelf and upper slope at depths of 20–1500 m. Both surveys are stratified systematic surveys with standardized fishing methods. Small-meshed bottom trawls (40 mm in the cod-end) with a rock-hopper ground gear (See Björnsson *et al.*, 2007 for a detailed description of methodology).

Catch data and frequency of occurrence for skates from IS-SMH is summarised in Table 16.3. Catch data (number of individuals per survey) of all demersal elasmobranchs, for the years 1996–2023, can be found in Jakobsdóttir *et al.* (2023).

16.7 Life-history information

Published information on life history of skates and rays in Icelandic waters is scarce.

Amblyraja radiata is by far the most abundant elasmobranch species in Icelandic waters. It has a widespread distribution over the Icelandic shelf and upper slope (Figure 16.4 and 16.6). Seasonal differences in distributional patterns have been noted, with *A. radiata* much less abundant on the shelf during autumn surveys (IS-SMH) than in spring survey (IS-SMB), and the bulk of catches in IS-SMH is taken on shelf break/slope north and east of Iceland (Figure 16.4 a and b, see also MFRI Assessment reports, 2024).

Anecdotal information suggests that *A. radiata* undertakes seasonal migrations in relation to egg-laying activity, but this is unconfirmed. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

Length–frequency distributions of *A. radiata* in IS-SMH (Figure 16.5) indicate the majority of specimens are <60 cm L_T. Data on maturity derive from autumn survey allowing for calculations of maturity ogives. Length-at-50%-maturity (L_{50}) is 42.9 cm and 41.0 cm (MFRI, Assessment reports, 2022) L_T for males and females respectively (L_{95} for males is 51.1 cm and 50 cm for females). These values are lower in comparison to adjacent waters to the NW Atlantic stock (Templeman, 1987), but larger than observed in the North Sea, where L_{50} is 36.2 and 38.4 cm L_T for males and females, respectively (McCully *et al.*, 2012).

16.8 Exploratory assessment models

Total biomass, biomass trends and probability of capture can be estimated for 5 skate species and 8 shark species frequently occurring in the Icelandic groundfish surveys using conventional standardized swept-area biomass indices. The spring survey IS-SMB provides estimates for common blue skate and starry ray. Estimates for the other skates and sharks are derived from the

Icelandic autumn survey (IS-SMH). Remaining skate and shark species from the region are only infrequently/sporadically caught int these two surveys.

Skates

Amblyraja radiata is the most widely distributed and by far the highest in biomass, the mean annual spring survey biomass estimated around 16000 t. The stock biomass in the last decade is around half that observed in the beginning of the time series (Figure 16.6). Abundance indices and biomass estimates for *A. radiata* in Icelandic waters (Va) have been calculated based on IS-SMB and IS-SMH, with a decreasing trend in large skates (>50 cm) observed (Björnsson *et al.*, 2007). Preliminary survey results indicate stable trends in major size groups in recent years after a period of decline (MFRI, Assessment reports, 2023).

In Icelandic waters *Dipturus batis* is the second most abundant skate species and its distribution is mainly within the warmer waters off South and West Iceland (MFRI, Assessment reports, 2024) The mean biomass in annual spring survey is estimated around 600 tonnes. Index shows increasing trend since 2010 with exception of this year's index (Figure 16.6).

Arctic skate *Amblyraja hyperborea* is the second most abundant skate in the IS-SMH survey. The distribution is limited to the upper shelf and slope off N and East Iceland. The mean biomass estimate is one tenth that of *Amblyraja radiata*, being around 660 t. Stock size has been relatively stable in the past two decades (Figure 16. 6) .

Spinytail skate (*Bathyraja spinicauda*) and round skate (*Rajella fyllae*) are reported in the autumn survey every year with mean estimated survey biomass of 396 t and 253 t respectively. *Bathyraja spinicauda* is most commonly found in deeper waters northwest and southeast of the island, *Rajella fyllae* being confined to the outer shelf and slope from southeast to northwestern waters. The stock size of round skate is estimated at historical low (Fig. 16.6).

Sharks

Of the 12 shark species that occur in IS-SMH *Centroscyllium fabricii* has by far the highest survey biomass estimates of 12.000 t. Interannual variability is quite high, the abundance in the last decade being higher than the first decade of this century (Figure 16.7).

Of those shark species that persistently are recorded in the autumn survey, 2 species show a decline in abundance: *Cenytoscymnus coelolepis* (mean biomass estimates of 591 t) and *Deania calcea* (mean biomass estimates of 763 t) (Figure 16.7). Another 3 species, *Etmopterus spinax* (mean biomass estimates of 1799 t), *Galeus murinus* (mean biomass estimates of 648t) and *Apristurus laurussonii* (mean biomass estimates of 622 t) show no trend in biomass over the last two decades. 3 species, *Etmopterus princeps* (mean biomass estimates of 2747 t), *Centroscymnus crepidater* (mean biomass estimates of 1927 t) and *Centrophorus squamosus* (mean biomass estimates of 535 t) show an increase in biomass (Figure 16.7).

16.9 Stock assessment

In 2020 MFRI started to publish advice for starry ray in Icelandic waters based on precautionary approach for category 3 stocks (MFRI Advice, 2022). In 2023 the first attempt was made to perform an analytical assessment of starry ray in Icelandic waters, based recommendations from ICES (2022b, MFRI Advice, 2023). The starry ray is considered a data limited stock and follows the ICES framework for such (category 3.1, ICES 2021). A stochastic surplus production model in continuous time (SPiCT; Pedersen and Berg, 2017) is one of the official assessment methods for stocks in this category. The model quantifies observation and process errors and estimates stock status and reference levels with associated confidence intervals. SPiCT estimates MSY based reference levels, which can be used to calculate quantities relevant for fisheries management and ICES recommends using the 35th percentile for all quantities (Mildenberger et al., 2022). However, starry ray is not subject to management such as TAC limitations. Only explorative assessments have been undertaken for other skates and sharks in this ecoregion.

16.10 Quality of assessments

The IS-SMB covers the main fishing grounds of starry ray. Starry ray is an abundant species in IS-SMB and the index is considered representative of stock trends.

The majority of commercial landings data are being taken by gears other than bottom trawl (Figure 16.1) and this should be considered.

16.11 Reference points

Analytical assessment has only been performed of starry ray Icelandic waters. SPiCT provides relative fishing mortality (F/FMSY) and relative biomass (B/BMSY) reference points. FMSY and BMSY are estimated directly from the SPiCT assessment model and, therefore, change when the assessment is updated. For the MSY approach, the reference points are FMSY and Btrigger= 0.5 BMSY (ICES, 2021). For the precautionary approach, the reference points are Flim = 1.7 × FMSY and Blim= 0.5 BMSY (ICES, 2021).

16.12 Conservation considerations

The common skate complex has been found to be vulnerable to exploitation and has been near-extirpated from coastal areas elsewhere in their range (e.g. parts of the Irish and North Seas). Investigation of the common skate complex in Icelandic waters indicated that the dominant species currently found in Icelandic waters is the smaller *D. batis* now currently referred to as the common blue skate (Bache-Jeffreys, 2021).

16.13 Management considerations

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species (21 sharks, 15 skates and six chimaeras). Most of the landings of skates are now reported to species.

The most abundant demersal elasmobranch in the area is *A. radiata*, which is widespread and abundant in this and adjacent waters. Negative survey trends for large size starry rays have been observed (Björnsson *et al*., 2007). Preliminary results of more recent data indicate that after a period of decline, stock trends have been stable for a few years.

16.14 References

Bache-Jeffreys, M., de Moraes, B. L. C., Ball, R. E., Menezes, G., Pálsson, J., Pampoulie, C., Stevens, J. R., & Griffiths, A. M. (2021). Resolving the spatial distributions of Dipturus intermedius and Dipturus batis—the two taxa formerly known as the 'common skate.' Environmental Biology of Fishes. https://doi.org/10.1007/S10641-021-01122-7

Björnsson, H., Sólmundsson, J., Kristinsson, K., Steinarsson, B.Æ., Hjörleifsson, E., Jónsson, E., Pálsson, J., Pálsson, Ó.K., Bogason, V., Sigurðsson, Þ. 2007. Stofnmæling botnfiska á Íslandsmiðum (SMB) 1985–2006 og stofnmæling botnfiska að haustlagi (SMH) 1996–2006. The Icelandic groundfish surveys in spring 1985–2006 and in autumn 1996–2006. In Fjölrit Hafrannsóknastofnunarinnar / MRI Reykjavík, Technical Report no. 131, 220 pp. (Available at http://www.hafro.is/Bokasafn/Timarit/fjolr.htm).

ICES. 2021. Benchmark Workshop on the development of MSY advice for category 3 stocks using Surplus Production Model in Continuous Time; SPiCT (WKMSYSPiCT). ICES Scientific Reports. 3:20. 316 pp. https://doi.org/10.17895/ices.pub.7919

ICES. 2022a. Icelandic Waters ecoregion –Ecosystem overview. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, Section 11.1, https://doi.org/10.17895/ices.advice.21731663

ICES. 2022b. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. In Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564

Jakobsdóttir, K.,Hjörleifsson, E.,Pétursson, H., Björnsson, H., Sólmundsson, J., Kristinsson, K., Bogason, V. 2022. Icelandic autumn groundfish survey 2022: Implementation and main results. In Haf og vatnarannsóknir/ MFRI. HV 2022-43. 32pp. (Available at https://www.hafogvatn.is/static/research/files/hv2022-43.pdf)

Jakobsdóttir, K. , Jónasson, J.P., Kristinsson, K. and Pálsson, J. 2020. Hámýs í stofnmælingaleiðöngrum Hafrannsóknastofnunar. In Haf og vatnarannsóknir MFRI. HV 2020-47. 47 pp. Available at https://www.hafogvatn.is/is/midlun/utgafa/haf-og-vatnarannsoknir/hamys-i-stofnmaelingaleidongrum-hafrannsoknastofnunar-hv-2020-47

Jørgensen, O. A. 2006. Elasmobranchs at East Greenland, ICES Division 14B. Working paper ICES Elasmobranch WG. June 2006.

McCully, S. R., Scott, F., and Ellis, J. R. 2012. Lengths at maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES Journal of Marine Science, 69: 1812–1822.

MFRI Assessment Reports 2024. Starry ray. *Amblyraja radiata*.. Available at https://www.hafogvatn.is/static/extras/images/12-starry-ray_techreport_en.html

MFRI Assessment Reports 2024. Blue skate. *Dipturus batis.* Available at https://www.hafogvatn.is/static/extras/images/15-skate_techreport_en.html

MFRI Advice 2023. Starry ray. 3 pp. Available at https://www.hafogvatn.is/static/extras/images/24-starryray_tindaskata1388253.pdf

MFRI Advice 2024. Starry ray. Available at https://www.hafogvatn.is/static/extras/images/12-starry-ray_advice_en.html

Möller, P. R., Nielsen, J. G., Knudsen, S. W., Poulsen, J. Y., Sunksen, K. and Jorgensen, O. A. 2010. A checklist of the fish fauna of Greenland waters. Zootaxa, 1–84.

Mildenberger, T.K., Kokkalis, A., Berg, C.W. 2022. Guidelines for the stochastic production model in continuous time (SPiCT). https://raw.githubusercontent.com/DTUAqua/spict/master/spict/inst/doc/spict_guidelines.pdf

Pedersen, M.W., Berg, C.W., 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226-243.

Templeman, W. 1987. Differences in sexual maturity and related characteristics between populatons of thorny skate (Raja radiata) in the northwest Atlantic. Journal of Northwest Atlantic Fishery Science, 7: 155–167.

Electronic references

www.hagstova.fo Accessed 19 June 2018.

ICES. 2016a. Historical Nominal Catches 1950-2010. Version 20-06-2016. Accessed 20-06-2016 via http://ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx ICES, Copenhagen.

ICES. 2021b. Official Nominal Catches 2006-2019. Version: 19-10-2021. Accessed 22-06-2022 via https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx ICES, Copenhagen.

16.15 Tables and Figures

Table 16.1. Demersal elasmobranchs - Iceland and East Greenland. Reported landings of skates from Iceland (Division 5.a) and East Greenland (Subarea 14). Data were updated with landings from ICES historic nominal landings database (ICES, 2016) and national landings data provided to the WG (June 2021). Faroese landings 1990–2015 were extracted from Faroes national statistics database available on www.hagstova.fo *1990–2015: Total catch (live weight). ** Prior to 1992 all skates nei are assumed to belong to common skate complex (see earlier reports).

Scientific name	Nation	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
common skate complex	Iceland	364	275	188	333	442	424	403	196	229	245	185	178	120	108
Amblyraja radiata	Iceland	0	0	0	0	0	0	0	0	0	9	12	46	15	44
Raja rays nei**	Belgium	59	51	62	36	41	23	27	36	28	11	15	15	19	18
	Faeroe Islands	80	56	43	35	75	27	37	21	25	23	73	24	21	0
	Germany	76	41	49	41	37	10	2	1	2	2	4	3	2	1
	Norway	1	0	63	4	2	3	2	3	6	1	10	3	5	0
	UK - England & Wales	385	187	195	106	5	0	0	0	0	0	0	0	0	0
	UK - Scotland	5	8	14	8	0	0	0	0	0	0	0	0	0	0
Total		970	618	614	563	602	487	471	257	290	291	299	269	182	171

		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
common skate complex	Iceland	130	152	152	222	304	363	274	299	245	181	118	108	80	94
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Amblyraja radiata	Iceland	125	39	100	163	286	317	294	1206	1749	1493	1430	1252	996	1076
Leucoraja fullonica	Iceland	0	0	0	0	0	0	2	12	24	19	16	12	21	27
Raja rays nei**	Belgium	22	20	22	6	9	6	3	0	0	0	0	0	0	0
	Faeroe Islands*	8	2	2	16	5	2	3	3	9	2	2	7	5	0
	Germany	0	0	0	1	3	1	2	0	9	0	0	1	0	7

Scientific name	Nation	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	Norway	0	0	0	0	0	25	8	8	7	10	2	19	8	3
	Portugal	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	UK - Eng+Wales+N. Irl.	0	0	0	0	0	1	2		4	0	0	1	2	0
Total		285	213	276	408	607	715	588	1529	2047	1705	1569	1400	1112	1210

Table 16.1. (continued). Demersal elasmobranchs - Iceland and East Greenland. Reported landings of skates from Iceland (Division 5.a) and East Greenland (Subarea 14). Data were updated with landings from ICES historic nominal landings database (ICES, 2016a) and national landings data provided to the WG. *Faroese landings 1990–2017 were extracted from Faroes national statistics database available on www.hagstova.fo. Total catch (live weight). ** Official reports on *L. fullonica* are likely misidentification and thus, from 2005, these numbers are reported to WG as rays nei.

Scientific name	Nation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
common skate complex	Iceland	82	59	120	145	166	136	123	126	128	117	125	145	153	141	165	143	147	124	194	160
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Amblyraja radiata	Iceland	1211	1781	1491	1013	657	530	496	634	866	1026	1416	1978	1847	1625	1397	1273	652	604	963	804
Rajella lintea	Iceland	0	0	10	8	1	8	7	0	8	12	9	9	7	4	11	3	5	4	5	4
***Leucoraja fullonica*	Iceland	37	32	17	23													0			
Raja rays nei	Faroe Islands*	2	1	0	8	9	16	7	11	6	5	14	5	6	4	0	8	3	3		
	Germany	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			
	France												0	0	0	0	0	0			
	Iceland	0	0	0	0	16	16	17	4	33	19	17	21	37	14	15	13	10	12	31	17
	Norway	6	5	1	0	0	7	0	1	2	4	4	0	0	0	1	1	0	0	4	
	Portugal	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Russian Federation	0	0	0	2	6	3	0	0	na	na	0	0	na	na	na	0	0	NA		
	Spain	0	0	15	0	0	0	0	0	0	0		0	0	0	0	0	0	0		

Scientific name	Nation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	UK	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
Raja clavata	France								0	0	0	1	0	0	0	0	0	0	0		
Total		1340	1878	1655	1200	855	726	650	786	1043	1183	1520	2039	1917	1788	1595	1433	817	761	1197	985

Table 16.1. (continued). Demersal elasmobranchs - Iceland and East Greenland. Reported landings of skates from Iceland (Division 5.a) and East Greenland (Subarea 14). Data were updated with landings from ICES historic nominal landings database (ICES, 2016a) and national landings data provided to the WG. *Faroese landings 1990–2017 were extracted from Faroes national statistics database available on www.hagstova.fo. Total catch (live weight). ** Official reports on *L. fullonica* are likely misidentification and thus, from 2005, these numbers are reported to WG as rays nei.

Scientific name	Nation	2021	2022	2023
common skate complex	Iceland	158	106	168
	Norway	0	0	1
	Faroe Islands			4
Amblyraja radiata	Iceland	760	249	254
Rajella lintea	Iceland	0	0	
***Leucoraja fullonica*	Iceland			
Raja rays nei	Faroe Islands*			
	Germany			
	France			
	Iceland	33	15	18
	Norway		1	1
	Portugal			
	Spain			
	UK			
Raja clavata	France			
Total		951	371	446

Table 16.2. Demersal elasmobranchs - Iceland and East Greenland. Demersal elasmobranch species captured during groundfish surveys at East Greenland (1998–2005) giving the total number, observed maximum weight (kg), depth range (m) and bottom temperature range °C and most northern position (decimal degrees). Source: Jørgensen (2006).

Species	N	Max wt (kg)	Depth range (m)	Temp range (°C)	Maximum latitude
Bathyraja spinicauda	82	61.5	548–1455	0.5–5.6	65.46°N
Rajella bathyphila	57	45.3	476–1493	0.3–4.1	65.44°N
Rajella fyllae	117	4.8	411–1449	0.8–5.9	65.46°N
Amblyraja hyperborea	12	23.4	520–1481	0.5–5.4	65.47°N
Amblyraja radiata	483	22.1	411–1281	0.8–6.6	66.21°N
Malacoraja spinacidermis	3	3.1	1282–1450	2.3–2.7	62.25°N
Apristurus laurussoni	3	0.7	836–1255	1.7–4.3	65.22°N
Centroscyllium fabricii	812	128	415–1492	0.6–5.1	65.40°N
Somniosus microcephalus	9	500	512–1112	1.4–4.9	65.35°N

Table 16.3. Demersal elasmobranchs - Iceland and East Greenland. Catch data of skates and rays in MRI annual autumn groundfish survey at Iceland (Division 5.a), giving the number of individuals caught (N) and the frequency of occurrence (percentage of stations where species was collected, %O). 2011 survey (noted with asterisk) was discontinued and therefore data are incomplete.

	2002		2003		2004		2005		2006		2007		2008		2009		2010		2011*		2012	
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O
Blue skate	3	<1	3	<1	1	<1	4	<1	6	1	7	1	7	1	9	1	4	<1	1	1	0	<1
Amblyraja radiata	1442	49	1379	49	1957	51	1678	53	1716	52	1474	52	1569	48	1590	39	1399	46	295	42	918	34
Rajella lintea	0	0	0	0	0	0	0	0	2	<1	0	0	0	0	0	0	0	0	0	0	0	0
Amblyraja hyperborea	80	8	88	8	97	9	104	8	120	10	59	10	90	9	103	9	86	10	27	8	73	7
Rajella fyllae	53	8	77	6	37	6	53	7	81	8	44	8	106	5	48	10	70	7	36	5	24	17
Bathyraja spinicauda	10	2	25	1	12	2	16	2	21	2	7	2	18	2	11	2	1	2	2	0	11	1
Rajella bathyphila	0	0	1	<1	0	0	1	<1	0	0	0	0	2	<1	0	0	0	0	0	0	0	0
Rajella bigelowi	0	0	0	0	0	0	0	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0

	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O
Blue skate	0	0	5	1	17	2	0	0	4	<1	10	1	4	1	3	<1	1	<1	3	<1	18	1
Amblyraja radiata	1142	41	1289	52	1066	49	1268	48	1026	45	1218	42	159	43	919	48	774	44	725	47	1173	48
Rajella lintea	0	0	0	0	0	0	1		0	0	0	0	-	0	2	<1	1	<1	0	-	1	<1
Amblyraja hyperborea	63	8	95	9	68	5	79	8	43	5	54	6	21	6	66	7	44	6	45	6	49	6
Rajella fyllae	35	4	71	10	30	6	46	6	33	9	41	7	26	7	36	7	19	5	39	5	20	3
Bathyraja spinicauda	4	2	11	2	5	1	4	1	5	1	7	1	0	0	2	1	4	1	0	-	4	1
Rajella bathyphila	0	0	0	0	0	0	0	0	1	<1	0	0	0	0	0	0	2	<1	0	-	0	-
Rajella bigelowi	0	0	0	0	1	<1	0	0	1	<1	0	0	0	0	0	0	0	0	0		0	
Malacoraja kreffti	0	0	0	0	2	<1	3	<1	3	<1	0	0	1	<1	2	<1	0	0	0		0	

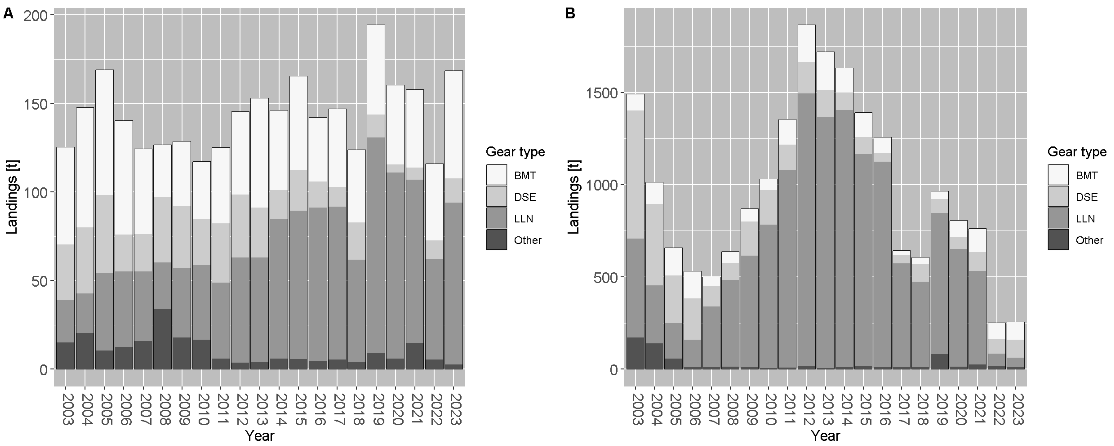


Figure 16.1. Demersal elasmobranchs - Iceland and East Greenland. Icelandic landings of (a) common blue skate and (b) starry ray *A. radiata* by fishing gear).BMT: Bottom trawl, DSE: Danish seine, LLN: Longline. Note different scales at the y-axis.

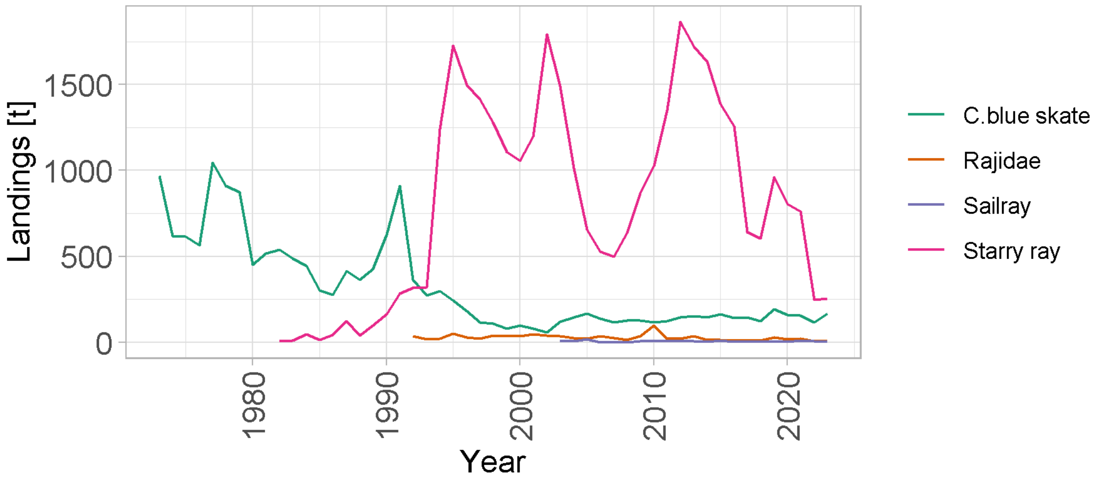


Figure 16.2. Demersal elasmobranchs - Iceland and East Greenland. Landings of skates in division 5.a. Prior to 1992, all skates nei are assumed to belong to common skate complex (see earlier reports). Data were updated with nominal landings from ICES database (ICES, 2021) for years 2006–2023 and also contain national landings data provided to the WG.

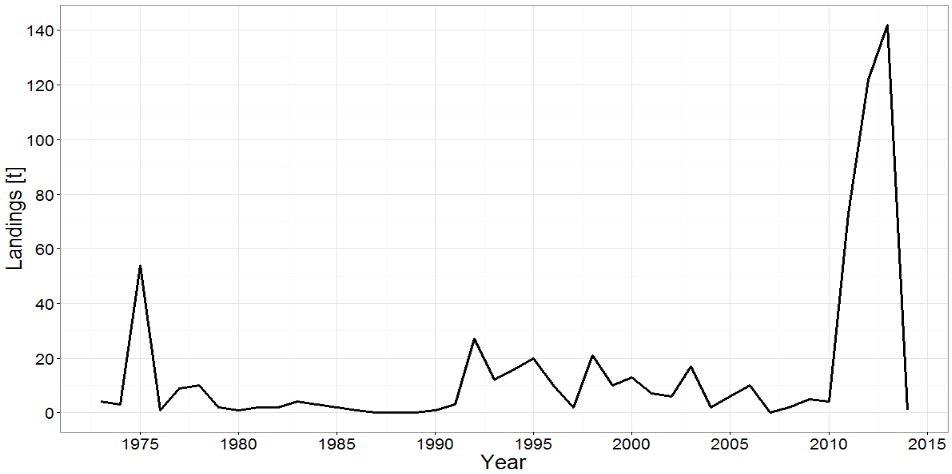


Figure 16.3. Demersal elasmobranchs - Iceland and East Greenland. Combined landings of rays and skates from East Greenland (Subarea 14). The peak landings in 2011–2013 originate from *Amblyraja radiata* (FAO Code RJR). Data from ICES (2016a, b).

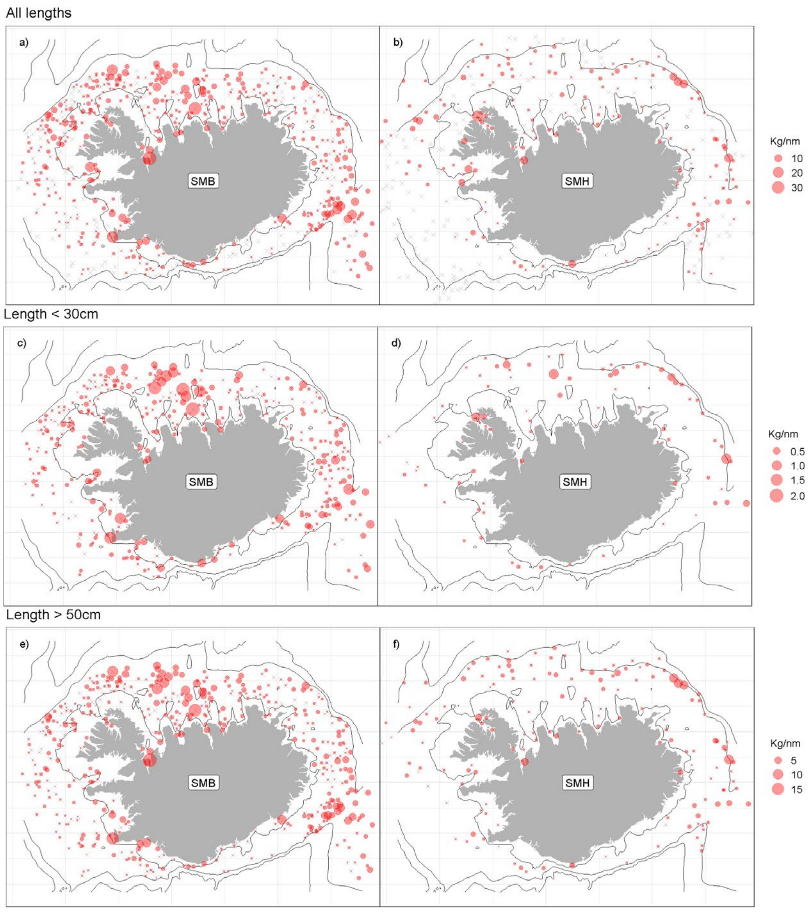


Figure 16.4. Demersal Elasmobranchs - Iceland and East Greenland. Spatial distribution of starry ray *A. radiata* in Icelandic waters (Division 5.a). Spatial distribution in IS-SMB 2024 (a, c, e) and in IS-SMH 2023 (b,d,f). The top panel shows all data, the middle panel shows individuals <30 cm, and the bottom panel shows larger individuals (>50cm). See also *MFRI Assessreports 2024*.

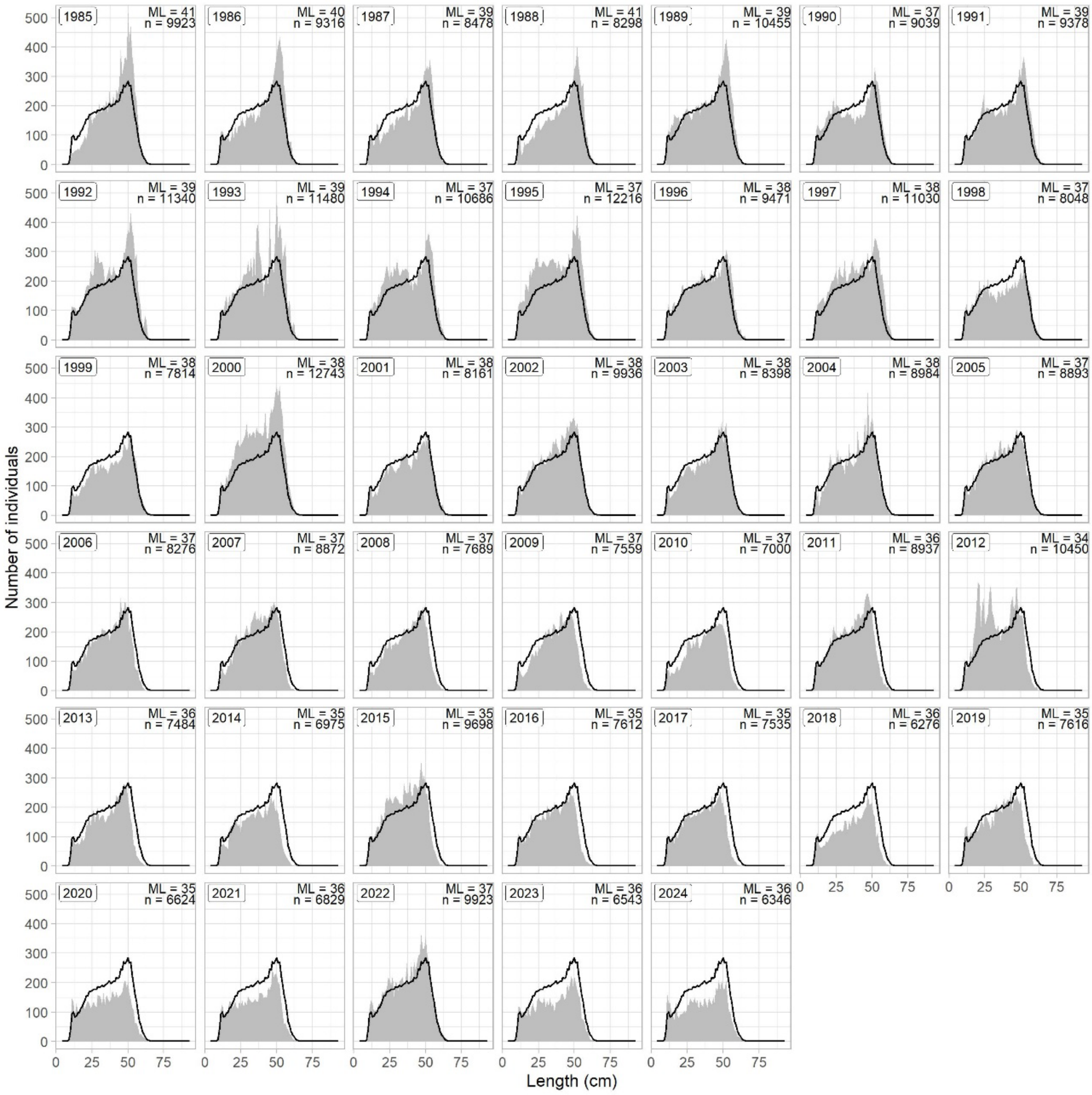


Figure 16.5. Demersal elasmobranchs - Iceland and East Greenland. Length distribution of starry ray *A. radiata* in Icelandic waters (Division 5.a) each year as observed in the annual spring survey (IS-SMB). Broken line denotes average value. Mean length each year is denoted in the upper right corner of each panel. (see also *MFRI Assessment reports 2024*)

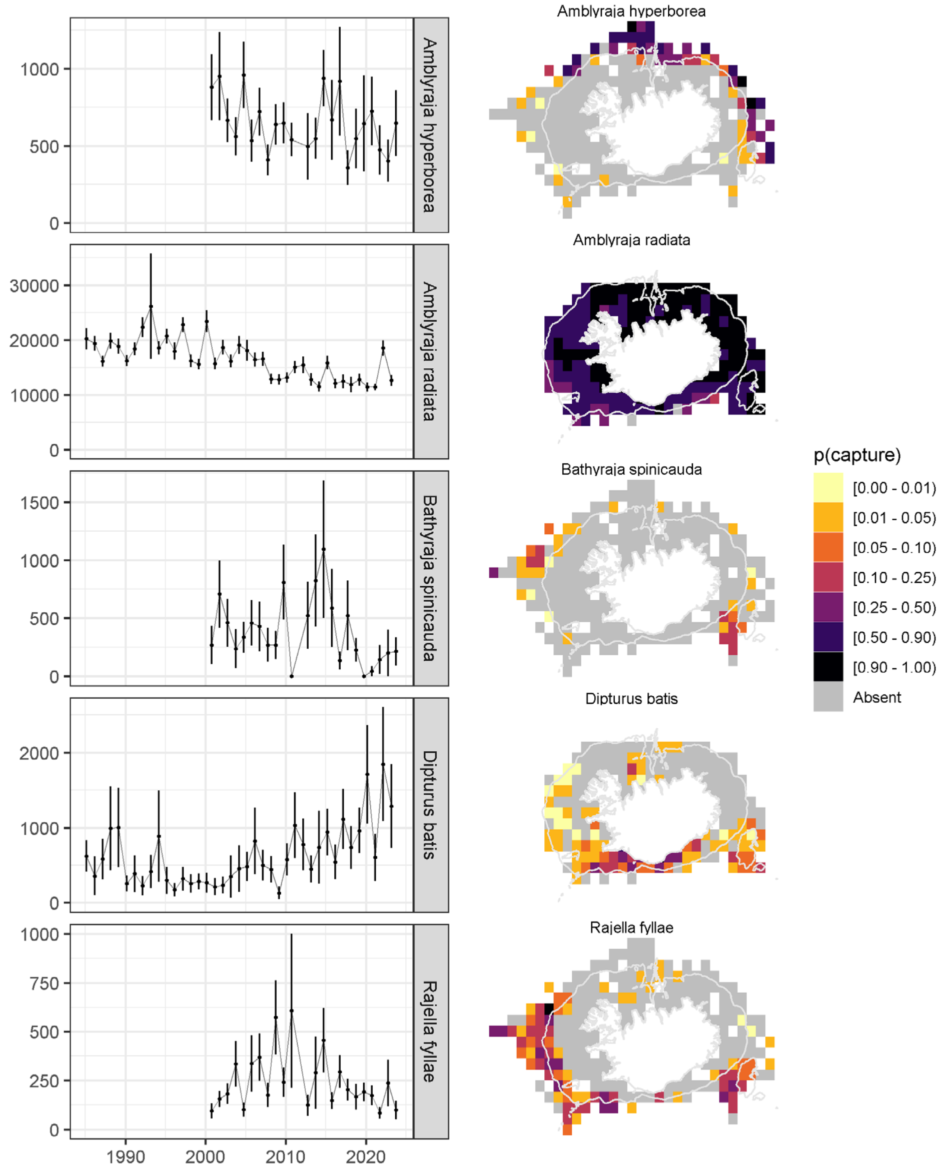
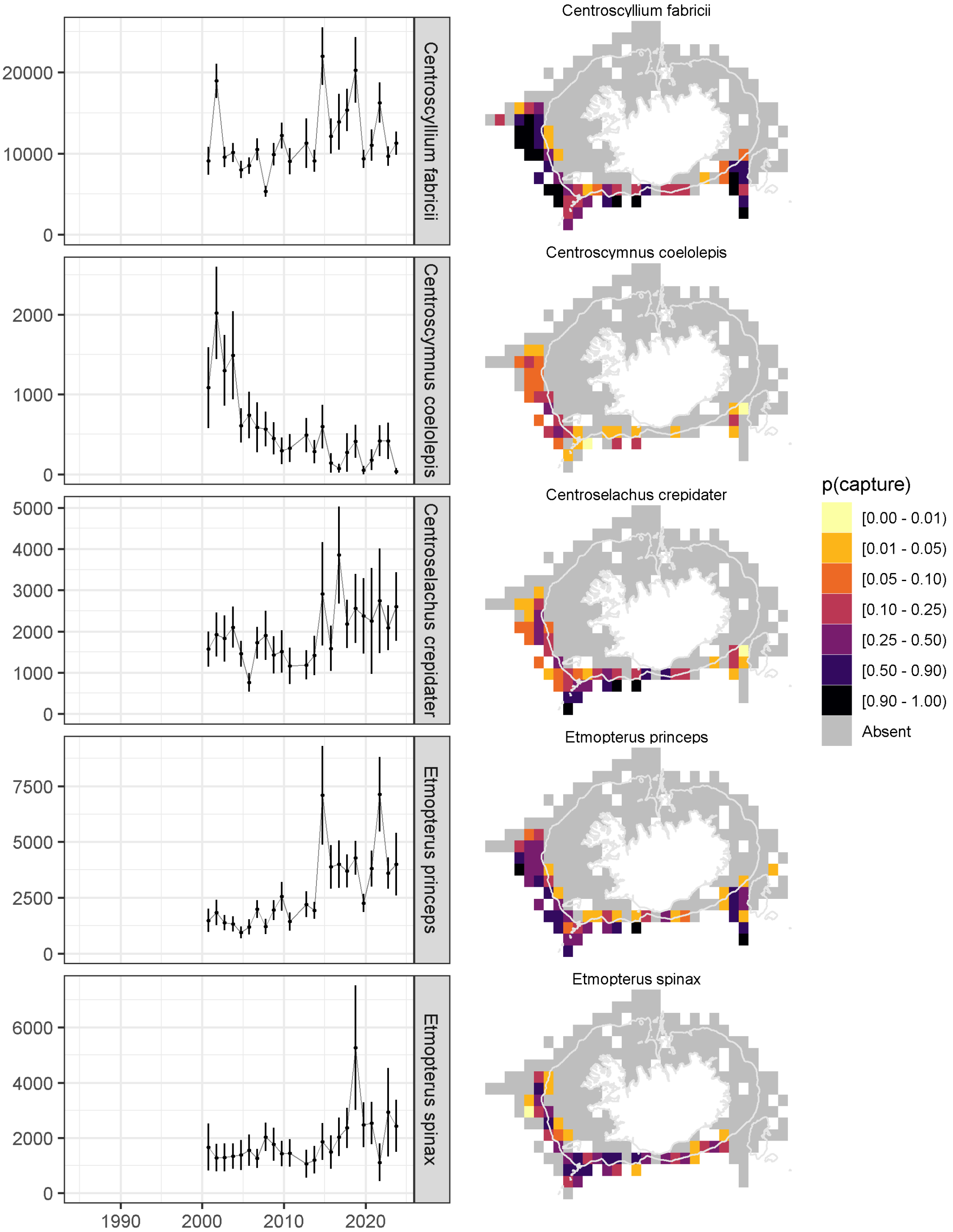


Figure 16.6. Demersal elasmobranchs - Iceland and East Greenland. Skates in Icelandic waters. Biomass estimates and probability of capture for *Amblyraja radiata* and *Dipturus batis* derived from IS-SMB survey 1985–2024. Biomass estimates for *Amblyraja hyperborea*, *Bathyraja spinicauda* and *Rajella fyllae* derived from IS-SMH survey 2000–2023.



Centroscyllium fabricii
Centroscymnus coelolepis
Centroselachus crepidater
Etmopterus princeps
Etmopterus spinax
20000
10000
0
2000
1000
5000
4000
3000
7500
5000
2500
6000
1990
2000
2010
2020
p(capture)
[0.00 - 0.01)
[0.01 - 0.05)
[0.05 - 0.10)
[0.10 - 0.25)
[0.25 - 0.50)
[0.50 - 0.90)
[0.90 - 1.00)
Absent

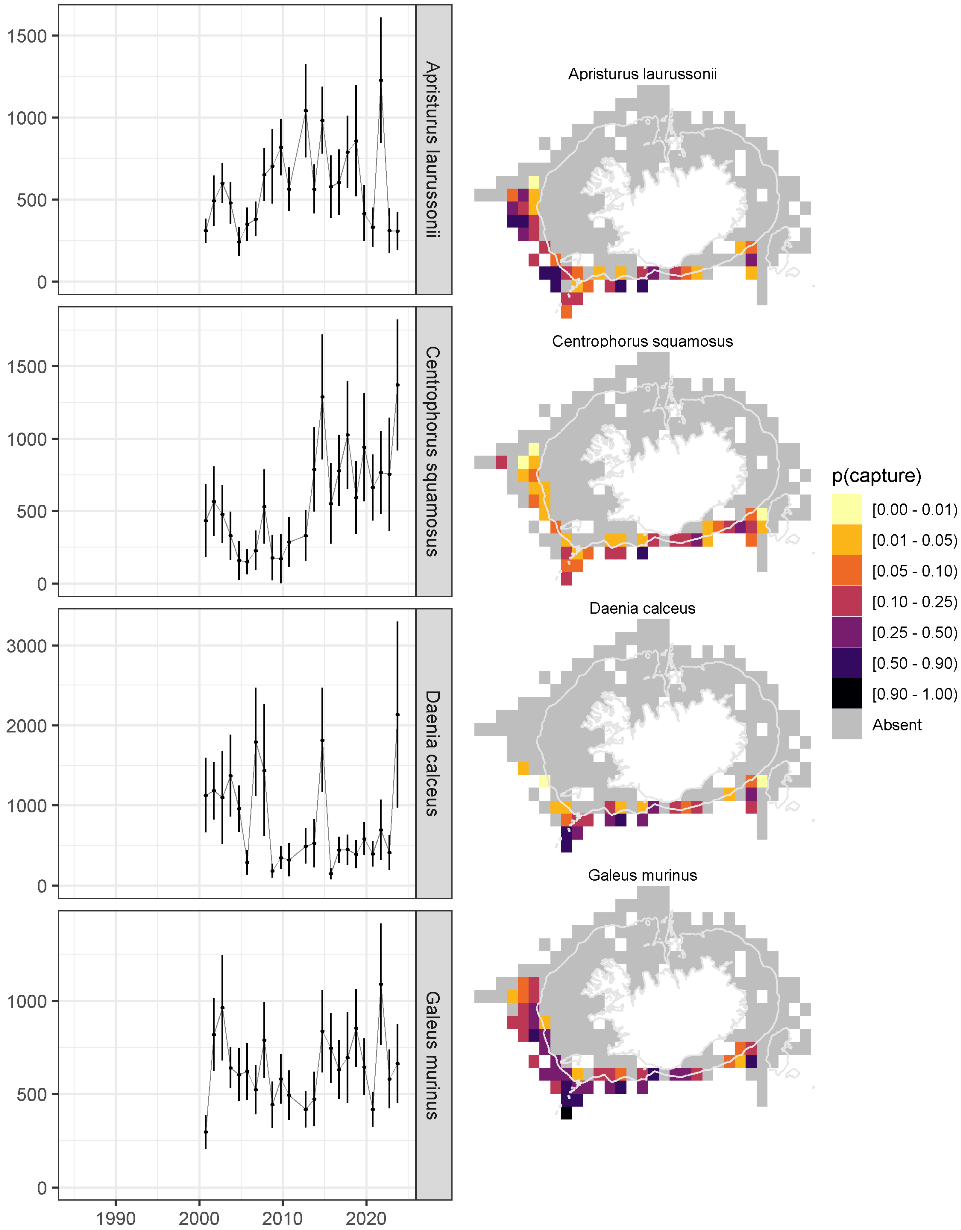


Figure 16.7. Demersal elasmobranchs - Iceland and East Greenland. Sharks in Icelandic waters. Biomass estimates and probability of capture based on annual autumn survey IS-SMH 2000–2023.

Contents

17 Demersal elasmobranchs at the Faroe Islands

17.1 Ecoregion and stock boundaries

The elasmobranch fauna off the Faroe Islands (ICES subdivisions 5.b.1 and 5.b.2) is little studied, though it is likely to be similar to that occurring in the northern North Sea and off NW Scotland and Iceland.

Skates recorded in the area include Arctic skate *Amblyraja hyperborea*, starry ray (thorny skate) *Amblyraja radiata*, common skate complex, long-nosed skate *Dipturus oxyrinchus*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, cuckoo ray *Leucoraja naevus*, spotted ray *Raja montagui*, thornback ray *Raja clavata*, round skate *Rajella fyllae* and sailray *Rajella lintea* (formerly *Dipturus linteus*).

Demersal sharks include spurdog *Squalus acanthias* (Section 2), several deep-water species eafscale gulper shark *Centrophorus squamosus*, black dogfish *Centroscyllium fabricii*, birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus* (sections 2 and 5), Greenland shark *Somniosus microcephalus* (Section 24) and various scyliorhinids, such as mouse catshark *Galeus murinus* and black-mouth catshark *Galeus melastomus* (Section 25).

Several chimaeras also occur in the area: rabbitfish *Chimaera monstrosa*, large-eyed rabbitfish *Hydrolagus mirabilis*, narrownose chimaera *Harriotta raleighana* and spearnose chimaera *Rhinochimaera atlantica*.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

17.2 The fishery

17.2.1 History of the fishery

Since 1973, seven countries have reported landings of demersal elasmobranch from Division 5.b, relating mostly to skates. Scottish vessels reported the largest portion of landings in earlier years, but Faroese vessels have reported the greatest quantities since the 1980s. These include trawlers and, to a lesser extent, longliners and gillnetters. Norwegian longliners fishing in this area target ling, tusk and cod. UK vessels include a small number of larger Scottish trawlers that occasionally obtain quota to fish in Faroese waters, and target gadoids and deeper water species. French vessels fishing in this area are probably from the same fleet that execute the mixed deep-water and shelf fishery west of the British Isles. Demersal elasmobranchs likely represent a minor to moderate bycatch in these fisheries.

In 2007, a Russian longliner fished for deep-water sharks in the Faroese Fishing Zone (FFZ) and on the Reykjanes Ridge. The total catch of the elasmobranchs in those and other NEA areas amounted to 483 t (Vinnichenko, 2008; summarised in ICES, 2010).

17.2.2 The fishery in 2023

No new information.

17.2.3 ICES advice applicable

ICES does not provide advice on the skate stocks in this area.

17.2.4 Management applicable

The majority of the area is managed by the Faroes through fishing effort-based system which restricts fishing days for demersal gadoids. Some EU vessels have been able to gain access to the Faroes EEZ where they have been managed under individual quotas for the main target species.

17.3 Catch data

17.3.1 Landings

Landings of skates, not usually identified to species level, are summarised in Table 17.1. French reported landings of common skate complex are unlikely to represent the entire catch, as an unknown quantity is included in the category of unidentified skates and rays. Total skate landings are shown in Figure 17.1.

17.3.2 Discards

The amounts of skates and demersal sharks discarded has not been estimated.

17.3.3 Quality of catch data

Species-specific information for commercial catches is incomplete.

17.3.4 Discard survival

No data available for the elasmobranchs taken in commercial fisheries in this area.

17.4 Commercial catch composition

All skates in Division 5.b, with the exception of French landings, were reported as '*Raja* rays nei' before 2008 (see Table 17.1). There were no port sampling data available to estimate species composition. It is likely that catches include common skate complex, *L. fullonica, R. clavata* and *A. radiata*. No data regarding size composition or sex ratio from commercial landings were available.

17.5 Commercial catch and effort data

No information available to WGEF.

17.6 Fishery-independent surveys

No survey data were available. Magnussen (2002) summarized the demersal fish assemblages from the Faroe Bank, based on the analysis of routine survey data collected by the RV *Magnus Heinason* since 1983. Data on elasmobranchs taken in these surveys are summarized in Table 17.2.

A more detailed analysis of the demersal elasmobranchs taken in Faroese surveys is still to be undertaken.

17.7 Life-history information

No new information. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

17.8 Exploratory assessments

No exploratory assessments have been undertaken.

17.9 Stock assessment

No assessments have been conducted due to insufficient data. Analyses of survey data may allow the general status of the more frequent species to be evaluated.

17.10 Quality of assessments

No assessments have been conducted.

17.11 Reference points

No reference points have been proposed for any of these species.

17.12 Conservation considerations

See sections 15.12 and 18.12.

17.13 Management considerations

Total international reported landings of skates declined from 1973–2003 but increased to above the average of the time-series in 2004–2006. Since then, landings declined below the long-term average again and are continuing to decrease in the most recent years. Without detailed information on the fisheries, including better separation of species, quantities discarded, sizes caught, etc., it is not possible to provide information on exploitation patterns or the status of stocks.

The elasmobranch fauna off the Faroe Islands is little studied, though it is likely to be somewhat similar to that occurring in the northern North Sea and off Iceland. Further studies to describe the demersal elasmobranch fauna of this region and to conduct preliminary analyses of fishery-independent survey data are required.

The common skate complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas, further investigation on the common skate complex and other skates in the Faroe Islands is required, including the data analysis from fishery-independent sources.

17.14 References

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 558 pp.

Magnussen, E. 2002.Demersal fish assemblages of the Faroe Bank: Species composition, distribution, biomass spectrum and diversity. *Marine Ecology Progress Series*, 238: 211–225.

Vinnichenko, V.I. 2008. Russian deep-sea investigations and fisheries in the Northeast Atlantic in 2007. Working Document for the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources, ICES, 9 pp.

Electronic references

ICES. 2021. Official Nominal Catches 2006–2019. Version 19-10-2021. http://ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx ICES, Copenhagen.

http://www.hagstova.fo Accessed 23th June 2020.

17.15 Tables and Figures

Table 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2021) for years 2006–2019 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Raja rays nei	Faroe Islands*	150	95	107	136	164	201	202	198	135	221	211	281	277
	France	0	0	30	57	159	7	3	0	4	2	0	0	0
	Germany	47	33	36	15	23	55	14	7	1	3	3	3	1
	Netherlands	0	0	1	1	0	0	0	0	0	0	0	0	0
	Norway	29	27	37	42	46	64	37	18	21	13	32	35	14
	UK	384	238	250	276	174	104	108	68	11	32	20	1	1
Common skate complex	France	0	0	0	0	0	5	0	0	0	0	0	0	0
Leucoraja naevus	France	0	0	0	0	0	0	1	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	10	0	0	1	6	23	38
	Total	610	393	461	527	566	436	375	291	172	272	272	343	331

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2021) for years 2006–2021 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Raja rays nei	Denmark	0	1	0	0	0	0	0	0	0	0	0	0	0
	Faroe Islands*	258	171	92	136	144	207	256	203	167	220	165	185	144
	France	1	6	5	8	5	0	0	0	0	1	1	2	0
	Germany	1	1	0	0	0	1	1	1	3	0	0	0	0
	Norway	22	11	29	84	96	81	37	75	20	14	60	14	45
	UK	0	2	0	1	2	1	5	13	8	7	4	11	7
Common skate complex	France	5	6	7	13	12	5	1	0	0	1	2	3	0
Leucoraja naevus	France	0	2	2	0	0	0	0	0	0	0	0	0	0
Dipturus oxyrinchus	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Raja montagui	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Dasyatis pastinaca	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja circularis	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja fullonica	France	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	287	200	135	242	259	295	300	292	198	243	232	215	196

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2021) for years 2006–2021 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Raja rays nei	Faroe Islands *	175	0	75	25	98	272	274	238	185	179	150	177	182	198	209
	France	2	0	0	1	5	10	9	20	10	7	6	0	0	0	0
	Germany	1	1	0	0	2	1	0	0	0	0	0	0	0	0	0
	Norway	45	50	21	15	5	0	12	10	16	9	4	11	0	0	0
	UK	6	35	27	12	8	20	8	2	2	2	1	3	0	0	0
Common skate complex	Norway	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0

Species	Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	France	4	2	2	2	3	5	2	3	1	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	4	5	0	0	0
Leucoraja naevus	France	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	UK	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Dipturus oxyrinchus	France	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	UK	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Raja montagui	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Dasyatis pastinaca	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja circularis	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja fullonica	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Rostroraja alba	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	233	88	128	55	121	308	305	273	214	201	168	200	182	199	214

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2021) for years 2006–2022 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight). +: <0.5 tonnes. Data for 2022 are preliminary. * Faroe Islands landings not provided for 2023.

Species	Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Raja rays nei	Faroe Islands*	150	114	126	139	138	170	182	156	151	*
	France	0	5	0	2	6	5	8	+		
	Germany	0	0	0							
	Norway	19	13	23	22	40	30	41	24	9	30
	UK	0	0	0							
Common skate complex	Norway	0	0	0							
	France	0	0	0	+	+		+			
	UK	0	1	1	5	1	1				
Leucoraja naevus	France	0	0	0	+		+	+			
	UK	0		3	2			+			

Species	Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Raja clavata	France	1	0	0	+		+	+			
	UK	0	1	1	+						
Raja montagui	France	3	5	0	1		+				
	UK				+						
Dasyatis pastinaca	France	0	0	0							
Leucoraja circularis	France	0	0	0							
Leucoraja fullonica	France	0	0	0	+	+	+	+			
	UK	0	0	0							
Rostroraja alba	France	0	0	0			+				
	Norway						7	1			
	Total	173	139	153	171	185	213	232	180	160	30

Table 17.2. Demersal elasmobranchs at the Faroe Islands. Elasmobranchs caught on the Faroe Bank during bottom-trawl surveys (1983–1996) by depth band. Symbols indicate frequency of occurrence in hauls (*: 60–100% of hauls, **: 10–60% of hauls, *: 3–10% of hauls, +: <3% of hauls). Adapted from Magnussen (2002).**

Species	Depth						Total
	<100 m	100–200 m	200–300 m	300–400 m	400–500 m	>500 m	
Galeus melastomus	–	+	*	*	**	**	*
Galeorhinus galeus	–	+	–	–	–	*	+
Squalus acanthias	–	*	*	**	*	**	*
Etmopterus spinax	–	+	–	–	*	**	*
Centroscyllium fabricii	–	–	–	–	*	–	+
Amblyraja radiata	–	–	–	–	–	**	+
Common skate complex	–	*	*	–	–	**	*
Leucoraja fullonica	–	+	+	–	–	*	+
Leucoraja circularis	–	–	*	–	–	–	+
Rajella fyllae	–	+	–	–	–	–	+
Rajella lintea	*	+	–	–	–	–	+
Raja clavata	–	+	–	–	–	–	+
Chimaera monstrosa	*	*	**	***	***	***	**

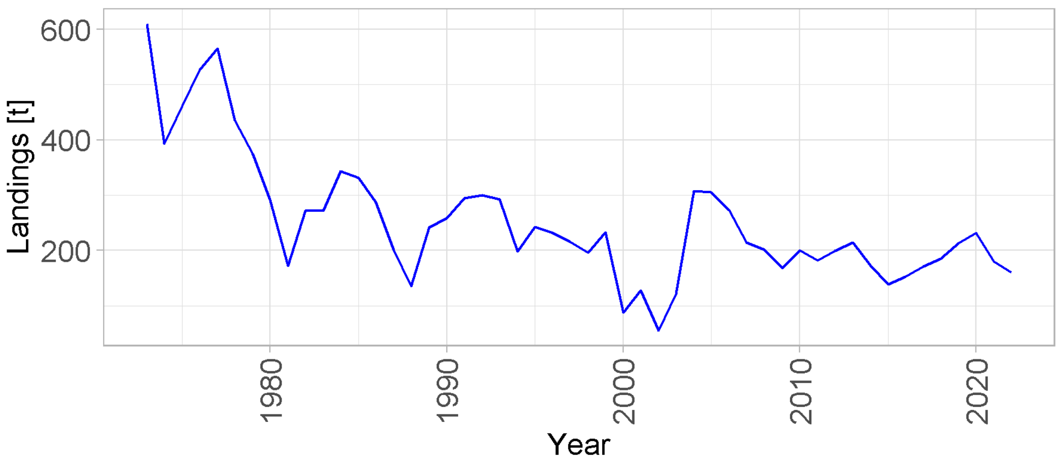


Figure 17.1. Demersal elasmobranchs at the Faroe Islands (Division 5.b). Reported landings of skates (1973–2022) based on ICES database (ICES, 2021) national landings data provided to the WG and Faroese national statistics database (www.hagstova.fo).

Contents

18 Skates and rays in the Celtic Seas (ICES subareas 6 and 7 (except Division 7.d))

18.1 Ecoregion and stock boundaries

See Stock Annex.

18.2 The fishery

18.2.1 History of the fishery

See Stock Annex.

18.2.2 The fishery in 2023

No new information available.

18.2.3 ICES advice applicable

ICES provided advice for several species/stocks in this region in 2022 (for 2023 and 2024) as summarized in Table below. Advice for most stocks is on a biennial basis. Category 5 and 6 stocks will, from 2024, be assessed on a quadrennial basis.

Stock	Stock code	Assessment category	Advice basis	Advised Landings in 2023 and 2024
Blonde ray *Raja brachyura* Divisions 7.a and 7.f-g	rjh.27.7afg	5	Precautionary approach	573 t
Blonde ray *Raja brachyura* Division 7.e	rjh.27.7e	5	Precautionary approach	213 t
Thornback ray *Raja clavata* Subarea 6	rjc.27.6	3	MSY approach	96 t
Thornback ray *Raja clavata* Divisions 7.a and 7.f-g	rjc.27.7afg	3	MSY approach	1883 t
Thornback ray *Raja clavata* Division 7.e	rjc.27.7e	5	Precautionary approach	170 t
Small-eyed ray *Raja microocellata* Bristol Channel (Divisions 7.f-g)	rje.27.7fg	3	MSY approach	86 t
Small-eyed ray *Raja microocellata* English Channel (Divisions 7.d-e)	rje.27.7de	5	Precautionary approach	32 t
Spotted ray *Raja montagui* Subarea 6 and Divisions 7.b and 7.j	rjm.27.67bj	3	Precautionary approach	36 t
Spotted ray *Raja montagui* Divisions 7.a and 7.e-h	rjm.27.7ae-h	3	MSY approach	814 t

Stock	Stock code	Assessment category	Advice basis	Advised Landings in 2023 and 2024
Cuckoo ray *Leucoraja naevus* Subareas 6–7 and divisions 8.a-b and 8.d	rjn.27.678abd	2	MSY approach	7826 t (2023) 8064 t (2024)
Sandy ray *Leucoraja circularis* Celtic Seas and adjacent areas	rji.27.67	5	Precautionary approach	27 t
Shagreen ray *Leucoraja fullonica* Celtic Seas and adjacent areas	rjf.27.67	5	Precautionary approach	134 t
Undulate ray *Raja undulata* Divisions 7.b and 7.j	rju.27.7bj	6	Precautionary approach	zero
Undulate ray *Raja undulata* Divisions 7.d-e (English Channel)	rju.27.7de	2	MSY approach	4836 t (2023) 4675 t (2024)
Common skate *Dipturus batis*-complex (flapper skate *Dipturus intermedius* and blue skate *Dipturus batis*) Subarea 6 and Divisions 7.a–c and 7.e–j	rjb.27.67a-ce-k	6	Precautionary approach.	zero
White skate *Rostroraja alba* in the north-east Atlantic*	rja.27.nea	6	Precautionary approach	zero
Other rays and skates (Rajiformes) in Subarea 6 and divisions 7.a–c and 7.e–k (Rockall, West of Scotland, Celtic Sea and western English Channel)	raj.27.67a-ce-k	6	Insufficient data to provide advice	NA

*** Advice revised in 2023**

18.2.4 Management applicable

A TAC for skates in Subarea 6 and divisions 7.a–c and 7.e–k was first established for 2009 and set at 15 748 t. Since then, the TAC has been reduced by approximately 15% (in 2010), 15% (in 2011), 13% (in 2012), 10% (in 2013) and a further 10% (in 2014). In 2017, the TAC was increased by 5%, (including separate TAC for *R. microocellata*), and in 2018, this was increased by a further 15% (including separate TAC for *R. microocellata* and *R. undulata*). In 2020, the TAC was set and reset because of negotiations between the UK and the EU. In April 2021, the TAC was set at 3882 tonnes, excluding an as yet to-be-determined UK quota. In June 2021, an agreement was reached between the EU and UK. The figures below refer to this agreement.

The history of the regulations are as follows:

Year	TAC for EC waters of 6a-b and 7a–c, and 7.e–k	Other measures	Regulation
2009	15 748 t	1,2	Council Regulation (EC) No. 43/2009 of 16 January 2009
2010	13 387 t	1,2,3	Council Regulation (EU) No. 23/2010 of 14 January 2010
2011	11 379 t	1,2,3	Council Regulation (EU) No. 57/2011 of 18 January 2011
2012	9915 t	1,2,3	Council Regulation (EU) No. 43/2012 of 17 January 2012
2013	8924 t	1,2,3	Council Regulation (EU) No. 39/2013 of 21 January 2013
2014	8032 t	1,3,4	Council Regulation (EU) No. 43/2014 of 20 January 2014
2015	8032 t	1,3,5	Council Regulation (EU) No. 2015/104 of 19 January 2015, and amended in Council Regulation (EU) No. 2015/523 of 25 March 2015
2016	8032 t	1,3,6,7	Council Regulation (EU) No 2016/72 of 22 January 2016, and amended in Council Regulation (EU) No. 2016/458 of 30 March 2016
2017	8434 t	1,3,6,8	Council Regulation (EU) No 2017/127 of 20 January 2017,

Year	TAC for EC waters of 6a-b and 7a–c, and 7.e–k	Other measures	Regulation
2018	9699 t	1,3,6,8,9	Council Regulation (EU) No 2018/120 of 23 January 2018,
2019	10 184 t	1,3,6,7,10,11	Council Regulation (EU) No 2019/124 of 30 January 2019,
2020	10 184 t	1,3,6,7,10,11	Council Regulation (EU) No 2020/123 of 27 January 2020
2021	9675 t	1,3,6,7,10,11,12,13	Council Regulation (EU) No 2021/703 of 26 April 2021, amending Council Regulations 2021/91 and 2021/92 and Written record of fisheries consultations between the United Kingdom and the European Union for 2021
2022	9482 t	1,3,6,7,14,15,16	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.
2023	9797 t	1, 17, 18, 19	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
2024	9756 t	1, 17, 18, 19	COUNCIL REGULATION (EU) 2024/257 of 10 January 2024 fixing for 2024, 2025 and 2026 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2023/194

[1] Catches of cuckoo ray *L. naevus*, thornback ray *R. clavata*, blonde ray *R. brachyura*, spotted ray *R. montagui*, small-eyed ray *R. microocellata* sandy ray *L. circularis*, shagreen ray *L. fullonica* should be reported separately.
[2] Does not apply to undulate ray *R. undulata*, common skate *D. batis*, Norwegian skate *D. nidarosiensis* and white skate *Rostroraja alba*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.
[3] Of which up to 5% may be fished in EU waters of Division 7.d.
[4] Shall not apply to undulate ray *R. undulata*, common skate *D. batis* complex, Norwegian skate *D. nidarosiensis* and white skate *Rostroraja alba*. When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.
[5] Shall not apply to undulate ray *Raja undulata*. This species shall not be targeted in the areas covered by this TAC. Bycatch of undulate ray in area 7.e exclusively may be landed provided that it does not comprise more than 20 kg live weight per fishing trip and remain under the quotas shown [TAC = 100 t]. This provision shall not apply for catches subject to the landing obligation.
[6] Shall not apply to small-eyed ray *R. microocellata*, except in Union waters of 7.f and 7.g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7.f and 7.g provided below may be taken [TAC = 188 t]
[7] Shall not apply to undulate ray *R. undulata*. This species shall not be targeted in the areas covered by this TAC. In cases where it is not subject to the landing obligation, bycatch of undulate ray in area 7.e may only be landed whole or gutted, and provided that it does not comprise more than 40 kilograms live weight per fishing trip. The catches shall remain under the quotas shown [TAC = 100 t]. Bycatch of undulate ray shall be reported separately under the following code: RJU/67AKXD.
[8] Shall not apply to undulate ray *R. undulata*. This species shall not be targeted in the areas covered by this TAC. In cases where it is not subject to the landing obligation, bycatch of undulate ray in area 7.e may only be landed whole or gutted. The catches shall remain under the quotas shown [TAC = 161 t]. Bycatch of undulate ray shall be reported separately under the following code: RJU/67AKXD (2017) RJU/07E (2018).
[9] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 154 t].
[10] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 192 t].
[11] Shall not apply to undulate ray (*Raja undulata*).

[12] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 123 t].
[**13**] Special condition: of which up to 5 % may be fished in Union waters of 7d (SRX/*07D.), without prejudice to the prohibitions set out in Articles 20 and 57 of the EU TAC and Quota Regulation 2021 and relevant prohibitions in UK law for the areas specified therein. Catches of cuckoo ray (Leucoraja naevus) (RJN/*07D.), thornback ray (Raja clavata) (RJC/*07D.), blonde ray (Raja brachyura) (RJH/*07D.), spotted ray (Raja montagui) (RJM/*07D.), sandy ray (Raja circularis) (RJI/*07D.) and shagreen ray (Raja fullonica) (RJF/*07D.) shall be reported separately. This special condition shall not apply to small-eyed ray (Raja microocellata) and undulate ray (Raja undulata).
[14] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 123 t].
[15] Shall not apply to undulate ray (*Raja undulata*). [TAC= 234t].
[16] Special condition: of which up to 5 % may be fished in 7d and reported under the following code: (RJE/*07D.). This special condition is without prejudice to the prohibitions set out in Articles 18 and 56 of this Regulation and in the relevant provisions of the United Kingdom law for the areas specified therein.

[17] Special condition: of which up to 5 % may be fished in 7d (SRX/*07D.), without prejudice to the prohibitions set out in Articles 17 and 50 of this Regulation for the areas specified therein. Catches of cuckoo ray (*Leucoraja naevus*) (RJN/*07D.), thornback ray (*Raja clavata*) (RJC/*07D.), blonde ray (*Raja brachyura*) (RJH/*07D.), spotted ray (*Raja montagui*) (RJM/*07D.), sandy ray (Leucoraja circularis) (RJI/*07D.) and shagreen ray (*Leucoraja fullonica*) (RJF/*07D.) shall be reported separately. This special condition shall not apply to small-eyed ray (*Raja microocellata*) and undulate ray (Raja undulata).

[18] Shall not apply to undulate ray (*Raja undulata*). Catches of this species in 7e shall be counted against the quantities provided for in that separate TAC (RJU/7DE). When accidentally caught in 6a, 6b, 7a-c and 7f-k, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

[19] Shall not apply to small-eyed ray (*Raja microocellata*), except in 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of these quotas, no more than the quantities of small-eyed ray in areas 7f and 7g (RJE/7FG.) provided below may be taken:

Raja microocellata in Union waters of Subarea 6 and divisions 7.a–c and 7.e–k were initially subject to strict restrictions at the start of 2016, with Council Regulation (EU) 2016/72 of 22 January 2016 stating that: "*When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species*". However, this was subsequently updated in Council Regulation (EU) 2016/458 of 30 March 2016, whereby the prohibition in landings was revoked for Union waters of 7.f–g, with a precautionary TAC of 188 t being set for this species, within the total skate and ray quota. This sub-TAC has shown an overall reduction in subsequent years (2017–2018: 154 t; 2019–2020: 192 t; 2021–2022: 1232 t; 2023–2024: 86 t).

In 2024 footnote 19 pertaining to small-eyed ray was extended to add:

[19 continued] Within the limits of the abovementioned quota, no more than 5t and 11t of small-eyed ray in 7e (RJE/07E.) may be taken by the United Kingdom and the Union respectively so as to allow for a sentinel fishery to allow fisheries-based data collection for the stock as assessed by ICES. Only vessels participating in sentinel fishery monitoring programmes for small-eyed ray in 7e may land catch of this stock. Specimens caught by other vessels shall not be harmed and shall be promptly released. Each Party shall independently determine how to allocate its quota to the vessels participating in its monitoring schemes. Each Party shall ensure that the total annual landing small-eyed ray on the basis of the monitoring allowance does not exceed the above amounts. Participating vessels will be required to collect and share data on: landings and discards, and preferably biological characteristic data of the catch (length, weight and sex).

The previous interdiction to retain skates and rays caught on the Porcupine Bank from 1 May–31 May was not continued in after 2019.

There are also mesh-size regulations for target fisheries, the EC action plan for the conservation and management of sharks (EC, 2009), and some local bylaws and initiatives, which were detailed in ICES (2010).

18.2.5 Other management issues

The requirement for EU negotiations with the UK for the first time in 2020/2021 meant that final TAC agreements were not complete at the time by mid-June 2021. A draft agreement was completed in January 2021. In 2022, initial TACs for the first part of the year were proposed, with final TACs not being agreed until April.

A high-survivability exemption to the Landings Obligation was provided for skates and rays in the Celtic Seas ecoregion until 31 December 2021, with *L. naevus* only exempted until 31 December 2019. An extension to the exemption would only be possible with additional supporting information being provided by the NWWAC. This particularly applies to *L. naevus*, which had a shorter deadline for the provision of evidence of high-survivability than the other species. Several meetings have been held by the NWWAC to discuss and advance this. Best practice guides and measures have been circulated to NWWAC members (2020). The *L. naevus* exemption has been extended to 21 December 2022 and was again extended to the end of 2024.

Alternatives to the current TAC system are being explored by the European Commission. A meeting to set Terms of Reference for an STECF request to propose alternatives was held in May 2017. This follows on from proposals by the NWWAC. A further STECF meeting (STECF 08-22) considered this aspect in 2022. ICES consider that the management of the catches of skates and rays under a combined TAC prevents effective control of single-stock exploitation rates and all advice for skates and rays stocks managed with a common TAC include this statement.

Fishermen off North Devon have a voluntary seasonal closed area over what they consider to be a nursery ground.

There are several French and English measures designed to regulate fishing for *R. undulata* in the English Channel (7.d and 7.e). These measures include: trip limits, closed seasons, minimum and maximum landings sizes.

The French regulation stipulates a minimum landing size of 45 cm for all Rajiformes and 78 cm for undulate ray.

There was a change in Belgian fisheries with the introduction of a Producer Organisation (PO) measure from 1st January 2021 to exclude landings of other species than thornback ray, blonde ray and spotted ray. This measure may have affected some stocks where Belgium is one of the main contributors in terms of a reduction in landings such as *R. microocellata* in 7.d-e and in 7.f-g. Meanwhile, landings for other stocks may have increased with fishing opportunities focusing on other species such as *R. montagui* in 7.ae-h.

18.3 Catch data

18.3.1 Landings

Landings data for skates (Rajidae) were supplied by all nations fishing in shelf waters within this ecoregion. Data for 2023 are considered provisional. Landings data prior to 2005 are considered variable and uncertain.

Landings by nation are given in Table 18.1. Landings for the entire time-series are shown in Figure 18.1a–c. Where species-specific landings have been provided they have also been included in the total for the relevant year. Although historically there have been around 15 nations involved in the skate fisheries in this ecoregion, five nations (France, United Kingdom, Belgium, Ireland, and Spain) have accounted for most landings in recent years.

18.3.2 Skate landing categories

Historically, most skate landings were reported under a generic landing category. There has been a legal requirement to report most skate landings to species-level throughout this ecoregion since 2009. Up to 99% of landings are now reported to species level, with a continuous decline in landings declared in generic categories since 2011. Earlier reports have highlighted various issues regarding the quality of these data (ICES, 2010; 2011; 2012), and this is further discussed in Section 18.4.3.

A study by Silva *et al.* (2012) examined the species-specific data recorded by the UK (England and Wales). Although there were some erroneous or potentially erroneous records, the regional species composition was broadly comparable to that recorded by scientific observers on commercial vessels, and data quality seemed to be improving. Comparable studies to critically evaluate other national data and identify potential errors are still required, to better identify where improved training and/or market sampling may improve data quality.

18.3.3 Discards

Discard data for WGEF were included in the data calls. Most countries provided raised discards. Raising methodology was considerably different, both between countries and within countries. Raised discard estimates varied by over 200% in some cases, depending on whether they were raised by vessel, fleet or landings. Therefore, discard estimates have not been calculated for most skate and ray stocks in this ecoregion.

COVID-19 affected the placing of discard observers on board commercial fishing vessels in 2020 and 2021. Social distancing regulations meant that observers could not be placed on many vessels, particularly small ones. Therefore, the number of discard samples is likely down on previous years. Fishing activity may also have decreased. In Ireland, a self-sampling scheme was put in place, where discard samples were brought ashore for analysis. Sampling levels are not back at pre-covid levels in all countries.

See Stock Annexes for historic discard discussions.

18.3.4 Discard survival

There are several recent and ongoing studies on discard survival, e.g, SUMARiS, BIM.

Cuckoo ray has shown high post-capture condition by otter-trawls in the Celtic Sea (BIM, 2019), with 84% showing 'Excellent' condition. However, studies on discard survival showed low survival rates: 11-16% in Oliver *et al*. 2021, which was highly gear-dependent, and 3.6-26% in bottom trawl fisheries (Baulier *et al*., 2024).

Although the European project INTERREG 2 Seas SUMARiS (Sustainable Management of Rays and Skates) focused mainly on the North Sea and English Channel, results from this project may be applicable to rju.27.7de which straddles Division 7.d. Survival estimates for undulate ray caught by beam trawlers were 58%.

The RAYWATCH project is examining beam trawl-caught species for discard survivability in the Celtic Sea from 2020–2022.

See Stock Annex for further information on discard survivability.

18.3.5 Quality of catch data

Although so far unquantified, COVID-19 is expected to have affected fishing activity in 2020 and 2021, with national or local restrictions on fishing activity reducing fishing effort for at least some of the year. Discard sampling was likely affected in most countries.

See Stock Annex.

18.4 Commercial catch composition

18.4.1 Size composition

The ICES rfb rule was applied to several stock assessments from this ecoregion in 2022 and 2024. See individual stock sections for further details.

18.4.2 Quality of data

See Stock Annex.

18.5 Commercial catch and effort data

A case study using French on-board observer data is provided in the Stock Annex discussing several stocks. The trend for *L. fullonica* is used as supporting information in the advice in 2020, therefore it is retained here. For all others, refer to the Stock Annex.

Shagreen ray: *Leucoraja fullonica*

rjf.27.67 (Figure 18.2): The species was caught in a relatively high proportion of OTT_DEF. The indicator suggested stability.

18.6 Fishery-independent surveys

Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance of various demersal elasmobranchs. Several fishery-independent surveys operate in the Celtic Seas ecoregion. It is noted that these surveys were not designed primarily to inform on the populations of demersal elasmobranchs, and so the gears used, timing of the surveys and distribution of sampling stations may not be optimal for informing on some species and/or life-history stages. However, these surveys provide the longest time-series of species-specific information for skates for many parts of the ecoregion. The distribution of selected skate species caught in surveys coordinated by the IBTS group (see Table 18.4 in the Stock Annex), are shown in the annual IBTS reports.

Descriptions of existing, previous and short-time-series surveys are provided in the Stock Annex.

Updated survey analyses were provided for five surveys in 2024: French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4; Figures 18.3a–d), Irish groundfish survey (IGFS-WIBTS-Q4; Table 18.4a–b; Figures 18.4a, b and f), Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4; Figures 18.5a–e), the UK (England) beam trawl survey (EngW-BTS-Q3; Figures 18.4c-e and 18.6a-e), the UK (England) Q1 Southwest ecosystem beam trawl survey (Q1SWECOS previously described as Q1SWBeam[1]; Figures 18.4f and 18.7a–e) and the UK (Scotland) West CGFS survey (IGFS-WIBTS-Q1-Q4, Figure 18.4f).

The list of fishery-independent surveys undertaken in this area include (with additional details and information on the history provided in the Stock Annex):

- French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4): 1995–present in Celtic Sea (survey did not take place in 2017).
- Irish Groundfish Survey (IGFS-WIBTS-Q4): 2003–present.
- Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4): 2001–present.
- UK (Northern Ireland) Groundfish Survey – October (NIGFS-WIBTS-Q4): 1992–present.
- UK (Northern Ireland) Groundfish Survey – March (NIGFS-WIBTS-Q1).
- Scottish West Coast Groundfish Survey Q4 (ScoGFS-WIBTS-Q4): 1990–present.
- Rockall survey (Rock-IBTS-Q3): 1991–present.

Three beam trawl surveys currently operate in this ecoregion (see Stock Annex), surveying the Irish Sea, Bristol Channel, western English Channel and the West of Ireland (additional details and information on the history are provided in the Stock Annex):

- UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3 or UK(E&W)-BTS-Q3): 1993–present. The 2020 survey data were not used in most assessments, excluding *R. microocellata* in 7.f-g, as survey coverage was limited to the Bristol Channel (divisions 7.f-g) with the Irish Sea (Division 7.a) not being sampled (Silva, 2022a). Survey index estimates provided to WGEF 2022 were revised for the entire time-series, with these now based on ICES DATRAS (contrary to previous meetings, when indices were estimated using data held on a national database) (Silva, 2022a).
- UK (England) beam trawl in the western English Channel (Q1SWECOS – previously named Q1SWBeam[1]): 2006–present. This survey extended from the western English Channel (Division 7.e) to the wider Celtic Sea (Divisions 7.f-j) in 2013. Data from the wider Celtic Sea from 2014 are used as supporting information on species spatial distribution (Silva *et al.*, 2020). It should be noted that in 2020 the survey occurred in June instead of Q1 and only covered the western Channel survey area due to the COVID-19 pandemic (Silva, 2022b). It should also be noted that the survey also did not cover strata in Division 7.e in 2022 due to logistic constraints.
- Irish monkfish beam trawl survey – IRL-IAMS surveys: 2016 onwards. This beam trawl survey for monkfish and megrim takes place in Q1 and Q2, to the west and northwest of Ireland. Elasmobranchs are caught during this survey, and in future may provide additional indices once a suitable time series is available.

Historical surveys which have been undertaken in the area and can provide past data on elasmobranchs include (with additional details and information on the history provided in the Stock Annex):

- UK (England and Wales) Western Groundfish Survey (EngW-WIBTS-Q4): 2004–2011.
- UK (England) beam trawl in Start Bay, Division 7.e (Eng-WEC-BTS-Q4): 1989–2010.
- Irish maturity survey for commercially important demersal fish: spring 2004–2009.
- Irish deep-water (500–1800 m) trawl survey to the west of Ireland: 2006–2009
- UK Celtic Sea groundfish survey using a Portuguese high headline trawl in Q1: 1982–2003.

[1] In other ICES documents also referred as 'UK-Q1-SWBeam', 'Eng-WEC-BTS-Q1' or 'BTS-UK-Q1'.

18.6.1 Temporal trends in catch rates

The statuses of skates in this ecoregion are based primarily on the evaluation of fishery-independent trawl surveys. The available survey data have been used to evaluate the status of the stocks in 2024 under the ICES approach to data-limited stocks (Section 18.9).

18.6.2 Quality of data

18.6.2.1 Species identification in surveys

There are identification problems with certain skate species that may increase uncertainty in the quality of survey data. *Raja montagui* and *R. brachyura* may be confounded occasionally, and the identification of neonatal specimens of *R. clavata*, *R. brachyura* and *R. montagui* can also be problematic. Recent data are considered more reliable.

Many recent surveys in the ecoregion have attempted to ensure that data collected for the common skate complex be differentiated. In many cases national experts have confirmed which species have been caught in recent years. However, for some past data recorded as *Dipturus batis*, it is uncertain which of the two species (*D. batis* and *D. intermedius*) was caught. It is yet unclear how to clarify for which years and surveys records as *D. batis* refer to the actual species or to the complex.

Several skate species, including some coastal species, occur sporadically in the Celtic Seas ecoregion and may have certain sites where they are locally abundant (e.g. *Raja brachyura*). These may be under-represented in existing surveys (see Stock Annex).

18.6.3 New data

No additional data were provided in 2024. See previous reports for details of ongoing projects.

18.7 Life-history information

See Stock Annex.

18.7.1 Ecologically important habitats

See Stock Annex.

Ellis *et al* (2024) shows areas around British Isles where juvenile and nursery areas may be present. These may indicate ecologically important habitats.

18.8 Exploratory assessment models

18.8.1 Productivity-Susceptibility Analysis

See Stock Annex

18.8.2 Previous assessments

See Stock Annex

18.9 Stock assessment

The following stocks were assessed in 2024. For Category 5 and 6 stocks there were no changes to the assessment methods. Until 2024, advice was given biennially for stocks in these categories. However, since 2024 skate stocks of Category 5 and Category 6 will be advised on quadrennially. The advice given in 2024 will therefore apply from 2025–2028.

As in 2022 Category 3 stocks were assessed using the ICES framework (rfb rule, method 2.1, ICES, 2022a).

18.9.1 Blonde ray *Raja brachyura* in Subarea 6 and Division 4.a

Raja brachyura has a patchy distribution in Subarea 6. It is not encountered in sufficient numbers in surveys to derive trends in abundance/biomass. The stock is considered to extend to the north western North Sea (Division 4.a) and was assessed in 2023. It may also extend along the west coast of Ireland. This Subarea 6 and Division 4.a stock is assessed in North Sea quadrennial advice years and was last assessed as a Category 5 stock, using landings data only.

18.9.2 Blonde ray *Raja brachyura* in Divisions 7.a and 7.f-g

Raja brachyura has a patchy distribution, and can be locally abundant in some parts of the Irish Sea and Bristol Channel, including off southeast Ireland. Mean catch rates in the Irish Sea and Bristol Channel (e.g. as observed in the UK beam trawl survey) are low and variable. While there was a decrease in abundance in 2015, the stock has been showing an overall increasing trend in the survey (Silva, 2022a). However, it is important to note that this survey does not sample this species effectively, and the survey is not used to provide advice for the stock.

With no reliable survey trend for this stock, it has been assessed since 2016 as a Category 5 stock using landings data. Landings were relatively stable at 1000–1200 t between 2011–2018, however there was a marked increase thereafter to 1600–1700 t (probably related to improvement in landings data quality) until 2021. Since then, landings have decreased and in 2023 were ~1000 tonnes.

18.9.3 Blonde ray *Raja brachyura* in Division 7.e

Raja brachyura has a patchy distribution in the western English Channel, and is locally abundant on certain grounds, such as sandbank habitats in and around the Channel Islands, Normano-Breton Gulf and Lyme Bay. The trawl-survey length–frequency data examined for this stock showed a peak for juvenile fish (< 25 cm L_T), with no fish recorded between 24–31 cm L_T and occasional records of larger specimens > 70 cm L_T (Silva *et al.*, 2020 WD).

Mean catch rates in a previous beam trawl survey in Great West Bay (Burt *et al.*, 2013) were low, as *R. brachyura* was caught in a relatively low proportion of tows.

With no reliable survey trend for this stock, it has been assessed since 2016 as a Category 5 stock using landings data. These reached a peak in 2015 (708 t), dropped to around 500 t per year in 2016 and 2017, but are, since 2018, over 730 t per year.

18.9.4 Thornback ray *Raja clavata* in Subarea 6

This stock was again assessed in 2024 using the rfb rule (Category 3). The stock was first assessed using the new rules in 2022. Fishing pressure is assessed as being below $F_{MSY\ Proxy}$ and the Stock size is above MSY $B_{trigger\ proxy}$ ($I_{trigger}$). Landings of this stock have declined since 2019.

18.9.5 Thornback ray *Raja clavata* in Divisions 7.a and 7.f-g

This stock was again assessed in 2024 using the rfb rule (Category 3). The stock was first assessed using this rule in 2022.

A decrease in catch of 7.3% is advised.

18.9.6 Thornback ray *Raja clavata* in Division 7.e

This stock is currently assessed as a Category 5 stock, using landings data. Landings increased steadily since 2009, peaking at 423 t in 2016, followed by a decrease to 372 t in 2017. In recent years, landings have been above the observed in 2016 and were at their highest level of 605 t in 2023.

Fishing effort time series (2014–2023) for both France and UK (E&W) as the main contributors in terms of landings of thornback ray in Division 7.e were analysed. Consistently increasing or decreasing trends (monotonic) on the fishing effort data collected over time were investigated and the non-parametric Mann-Kendall trend test was applied (https://cran.r-project.org/web/packages/Kendall/Kendall.pdf). For each nation, this test was applied to the last 10 years of the fishing effort time-series with sampling units in kW*days (Days being fishing days) and Days at sea, for UK(E&W) and France, respectively (Table 18.5 and Figure 18.13a). Fishing effort time-series suggest a downward trend and the autocorrelation in data series does not appear significant for both nations, France (Mann-Kendall trend test: tau = -0.6, p-value = 0.02) and UK(E&W) (Mann-Kendall trend test: tau = -0.467, p-value = 0.07). Following ICES guidelines, the application of the precautionary buffer was considered in 2024, however, it was not applied due to indication of increasing stock biomass based on an increasing trend in landings in a context of decreasing fishing effort for both France and UK (E&W) (Figure 18.13a-c).

The UK beam trawl survey of the western English Channel (Q1SWECOS or UK-Q1-SWBeam, 2006-present) has shown most *R. clavata* to be captured in Lyme Bay with fewer records elsewhere (Figure 18.7a). Length–frequency showed a peak in the captures of presumably 0-group fish ≤ 20 cm (Silva *et al.*, 2020 WD, WGEF 2024 data call). Although this survey could provide some preliminary estimates of total biomass for Division 7.e, these should be viewed only as 'qualitative assessments'. It shows an increasing trend over the longer time-series, with a recent decrease in 2018 and 2022–2023 following a peak in abundance (and biomass) during 2014–2017 and 2021, respectively (Figure 18.7a). These analyses were consistent with the survey random stratified design and did not consider the potential effects of catchability and selectivity towards the outputs. Therefore, exploratory analyses were conducted to better evaluate and quantify the uncertainty and risks if to use this survey for future quantitative assessment and advice (Silva, 2022b). Such analyses provided an alternative estimate for the exploitable biomass based on the approach described in Berg *et al.* (2014) using 'surveyIndex' R package (Berg, 2022). However, they were not considered in the advice process in 2022 or 2024, with further work to be undertaken and reviewed during a dedicated workshop on surveys in the Celtic Seas ecoregion following similar process of WKSKATE in 2020.

18.9.7 Small-eyed ray *Raja microocellata* in the Bristol Channel (Divisions 7.f-g)

Although occasional specimens of *R. microocellata* are caught in Division 7.a, the main concentration of this species is in Division 7.f, with larger individuals occurring slightly further offshore (Division 7.g). The youngest size class is not often taken in surveys, as 0-group fish tend to occur in very shallow water. This species may also occur in some inshore areas of southern and south-western Ireland, although data are limited for these areas.

The UK (England and Wales) beam trawl survey in the Bristol Channel (only those data from stations in 7.f–g were used) has previously indicated stable catch rates. Estimates are currently at low levels compared to earlier years, due to a decline in biomass of individuals ≥50 cm L_T (Figure 18.4e and Figure 18.6d). Although the index used in the assessment is based on biomass (kg.hr^{-1}), it is worth noting that this decline is also reflected on the decrease in numbers of individuals ≥50 cm L_T (Silva, 2022a WD). The stock index has increased by 163% (2/3 rule) and although the stock trend shows an increase comparatively to 2019–2021, it remains at low levels. Since 2022, index estimates are based on data held within DATRAS contrary to previous assessments where estimates were calculated using data held on a national database (Silva, 2022a). Since 2022, this stock has been assessed using the ICES rfb rules, with full details provided in Appendix 1 of this chapter.

Higher than expected numbers of *R. microocellata* were reported from a managed crayfish fishery in 27.7.j. (Marine Institute 2021). This may indicate that the current stock area is not correct. This issue will be further examined as part of future benchmark process.

.

18.9.8 Small-eyed ray *Raja microocellata* in the English Channel (Divisions 7.d-e)

There are also localized concentrations of *R. microocellata* in the English Channel, including around the Channel Islands (Ellis *et al.*, 2011) and Baie of Dournanenez, Brittany (Rousset, 1990), with small numbers taken elsewhere.

Preliminary analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) were provided in 2012 (See Stock Annex). The low catch rates are probably related to the patchy distribution of the species in this area. Similarly, Silva *et al.* (2020 WD) identified only a few records of this species in the western English Channel beam trawl survey, with smaller size groups likely to occur in waters shallower than can be surveyed by the research vessel.

With no adequate survey trends available, this stock is assessed under Category 5, using landings data. Landings showed a stable trend from 2009–2015, followed by a decrease in 2016 (given that they could no longer be retained in Division 7.e) that remained stable for 3 years (ca. 36 t), followed by an increase to around 50 t since 2019. Although changes in Belgian fisheries may have contributed to a decline in landings in 2021 (see Section 18.2.5), these have remained stable with the increase of landings from France relatively to 2020. This increase in French landings was also observed in 2022 leading to a further increase in the overall landings to 65 t, followed by a decline to similar levels in 2023 relatively to 2019–2021 (ca. 50 t).

Additional fisheries-dependent data collection may provide further insight to future assessments. These data are to become available through the implementation of a sentinel fishery monitoring programme for small-eyed ray in Division 7.e in 2024 (EU Council Regulation 2024/257). Data collected under such programme will include landings and discards, with biological data associated to the catch where possible (including length, weight and sex).

18.9.9 Spotted ray *Raja montagui* in Subarea 6 and Divisions 7.b and 7.j

This stock was again assessed in 2024 using the rfb rule (Category 3).The stock was first assessed using this rule in 2022.

Full details of the rfb method are provided in Appendix 1. of this chapter. The stock has remained stable in the past two years.

18.9.10 Spotted ray *Raja montagui* in Divisions 7.a and 7.e-h

This stock was again assessed in 2024 using the rfb rule (Category 3).The stock was first assessed using this rule in 2022.

Full details of the rfb method are provided in Appendix 1. of this chapter. The stock shows a minor increase by 3%.

18.9.11 Cuckoo ray *Leucoraja naevus* in subareas 6 and 7 and divisions 8.a-b and 8.d

Leucoraja naevus is a widespread and small-bodied skate that is taken in reasonable numbers in a variety of surveys in the ecoregion, especially on offshore grounds. The stock structure of this species is insufficiently known, which makes the interpretation of catch rates in the various surveys more problematic.

The combined index used in the Category 3 assessments until 2020, used the French EVHOE survey [G2527] and the Irish Groundfish Survey [G7212], and indicates that the stock increased following low stock levels in 2012–2013.

A new index integrating data from six surveys (occurring at different periods of the year) was accepted at the benchmark workshop WKELASMO 2022. Swept area indices of the exploitable biomass (individuals ≥ 50 cm total length) from the six surveys are presented in the Stock Annex and the combined index is presented in Figure 18.4f. These indices were calculated by raising swept area fished to the total sampled area, so that indices are provided in absolute values in tonnes.

18.9.11.1 Benchmark assessment

A benchmark assessment of this stock took place in 2022 (WKELASMO, 2022; ICES, 2022b). The results are outlined below and in the Stock Annex. They indicate that the stock is underexploited, with F well below F_{MSY}.

The application of the SPiCT model allowed estimation of relative reference points F_{2020}/F_{MSY} and B_{2021}/B_{MSY}. The definition of these reference points resulted in the upgrade of the stock to Category 2. Similarly, as for porbeagle in the north-east Atlantic and undulate ray in the English Channel, a more precautionary approach than the ICES default method for catch advice derivation (based on the 35th percentile of the expected catch distribution under FMSY) was adopted. The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially when advised catch are much larger than catch in the previous years.

The assessment, even at its most precautionary, indicates an underexploited stock, with low F relative to F_{MSY} and B much greater than B_{MSY}. This leads to catch advice ~2.5 times greater than in previous years (7826t in 2023 and 8064t in 2024).

18.9.11.2 Updated assessment from 2024

The 2024 assessment was conducted according to the method defined during the 2022 benchmark (WKELASMO, 2022; ICES, 2022b and see Stock Annex).

Data

Landings data used for the assessment are shown in Tables 18.1 and 18.2, except for landings from 2005 to 2008 which were reconstructed for model purposes (WKELASMO, 2022; ICES, 2022b and see Stock Annex).

The combined exploitable biomass index was calculated for the 2022 and 2023 and added to the existing data set (Figure 18.4f and Table 18.4a).

Short-term forecast

A short-term forecast is performed using SPiCT. The assumption for the intermediate year (2024) is that the fishing mortality process continues, essentially keeping status quo fishing mortality. This leads to the following short-term forecast in the intermediate year:

Variable	Value	Notes
$F(2024)/F_{MSY}$	0.21*	*Status quo* F: F_{2023}/F_{MSY}
$B(2025)/B_{MSY}$	1.76	Short-term forecast (STF)
Landings (2024)	2131	Projected landings in tonnes (STF)

* Any difference between F_{2024}/F_{MSY} in this table and F_{2023}/F_{MSY} in Table 18.6a is due to stochasticity in the projections

Results

The outputs of the assessment are shown Figure 18.10. The diagnostics of the goodness of fit of the model show some issues with autocorrelation of the residuals of the catch (landings) time series but generally the residuals are good (Figure 18.11). The retrospective plots for the assessment show good agreement with all the peels (Figure 18.12).

The summary plots of the 2024 assessment (Figure 18.10) show that fishing pressure on the stock (F) is below F_{MSY}, and biomass (B) is above MSY $B_{trigger}$ and B_{lim}. The summary of the assessment is shown in Table 18.6a.

Catch advice

Seven management scenarios were explored and the landings and relative reference points estimated for 2025 and 2026 (Tables 18.6b and 18.6c).

As in the 2022 assessment, ICES landings advice is based on the 15^{th} percentile of predicted landings distribution, which is considered more precautionary than the 35^{th} percentile (the default method in SPiCT). The choice of the 15^{th} percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years.

The landings advice for 2025-2026 (7799 t in 2025 and 7529 t in 2026) is lower than the previous advice (8064 t in 2024). The advice for 2025 corresponds to a 3.3% decrease compared to the advised catch for 2024.

18.9.12 Sandy ray *Leucoraja circularis* in the Celtic Seas and adjacent areas

Leucoraja circularis is a larger-bodied, offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division 4.a) and parts of the Bay of Biscay (Subarea 8). This species is taken only infrequently in most surveys, such as the EVHOE survey (Figure 18.3a). Some nominal records are considered unreliable.

Only the Spanish Porcupine Bank survey covers an important part of the habitat of *L. circularis* and catches this species in any quantity (Figure 18.5a). The time-series shows low and variable catch rates, with an increasing trend until 2015, followed by a decrease, until the peak of the series in 2022 (Figure 18.5b). This survey catches a broad size range, with both smaller (< 20 cm L_T) and some larger (> 100 cm L_T) specimens sampled, with the mode being much smaller (39 cm) in 2023 than average (60 cm) with more smaller individuals caught (Fernández-Zapico *et al*., 2024WD; Figure 18.5c).

Given that the only survey that samples this species effectively only covers a small proportion of the broader stock range, it is not known whether the survey index would be appropriate for the overall stock. Consequently, this stock is assessed as a Category 5 stock, using landings data. Landings of this species are at a low level and have fluctuated between highs of 77–78 t in 2009, 2016 and 2018 and lows of 36–38 t in 2019 and 2020, with values in the 50 t range thereafter.

The landings estimated by WGEF are lower than national estimates, as WGEF consider nominal landings of 'sandy ray' from outside their main range to refer to *R. microocellata.* Furthermore, the reported landings from Scotland in 2022 and 2023 of 44 and 90t respectively were reallocated to the generic Rajidae stock for the region (raj.27.67a-ce-k) after close investigation of the landings which were deemed to be highly unlikely for such an infrequently encountered species in fisheries independent surveys operating in the same area from which the landings were reported. Further scrutiny of these and historic landings would be advisable.

18.9.13 Shagreen ray *L. fullonica* in the Celtic Seas and adjacent areas

Leucoraja fullonica is a larger-bodied, offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division 4.a) and parts of the Bay of Biscay (Subarea 8).

This species is taken in small numbers in the EVHOE survey (Figure 18.3b), with catch rates declining. There is a lack of survey for most other parts of the stock area, although the increase in beam trawl surveys in the Celtic Sea may provide more data in the future.

The lack of appropriate survey coverage across the stock range and low, variable catch rates of this species means that a Category 5 assessment using landings data is currently used. Landings were at their highest of ≥250 t between 2009–2013 (peaking at 301 t in 2010) subsequently declining to 185 – 186 t in 2016, 2020 and 2021. The reported landings of 133t in 2023 were the lowest of the time-series.

18.9.14 Common skate *Dipturus batis*-complex (flapper skate *Dipturus intermedius* and blue skate *Dipturus batis*) in Subarea 6 and divisions 7.a–c and 7.e–j

Although common skate *D. batis* has long been considered depleted, on the basis of its loss from former habitat and historical decline (Brander, 1981; Rogers and Ellis, 2000), this species has recently been confirmed to comprise two species, and longer-term data to determine the extents to which the two individual species have declined are lacking. The nomenclature of the common skate complex was stabilised by Last *et al.* (2016). the smaller species (the form described as *D. flossada* by Iglésias *et al.*, 2010) is now named common blue skate, *Dipturus batis* and the larger species flapper skate, *D. intermedius.*

Common blue skate *Dipturus batis* occurs in most parts of the stock range and is the predominant member of the complex in the Celtic Sea (divisions 7.e–k) and in Rockall bank. Flapper skate shows a northern distribution, it occurs primarily in division 6.a and in the northern North Sea (Griffith *et al.*, 2010; Frost *et al.*, 2020; Fernández-Zapico *et al.*, 2024 WD; Ellis and Silva, 2021 WD; Barreau and Iglesias, 2021 WD, Baulier and Rimaud, 2022 WD).

Both species may occur in the intervening areas of divisions 7.a–c, but it is less clear as to which species predominates. In 7.c, *Dipturus batis* seems to predominate at Porcupine Bank (Figure 18.5d, Figure 18.5e; Fernández-Zapico *et al.*, 2024 WD). The documented loss of the common skate complex from parts of their former range (e.g. Division 7.a) suggested the complex to be depleted in the Celtic Sea ecoregion.

From available data, flapper skate seems to have a larger bathymetric range with individuals caught near the coast, the shallower depth being 17 m and up to 1000 m deep in 6.a. Meanwhile, the observed bathymetric range for common blue skate is from 66 m to 630 m (Pinto *et al.*, 2016; Barreau *et al.*, 2016; Barreau and Iglesias, 2021 WD).

Given that much of the data prior to 2010 refer to the species-complex, both species are currently treated together until a suitable time-series of species-specific data are available. Species distinction is improving since 2011 in scientific surveys although misidentifications may still occur (Barreau and Iglesias, 2021 WD). Number of common blue skate and flapper skate caught show an increasing trend since 2010 and some surveys may be able to provide a stock size indicator in the future such as EVHOE [G2917], IE-CGFS [G7212] or SCOROC [G4436] (Barreau and Iglesias, 2021 WD; Baulier and Rimaud, 2022 WD). The UK-Q1SWECOS survey also collects data on these species that may be useful for assessment.

Within the stock range, four species of the genus *Dipturus* can be encountered in landings. Recent prohibitions on landings of *D. batis* complex, and *D. nidarosiensis*, have resulted in increases in reported landings of *D. oxyrinchus*. Landings figures and advice refer to *Dipturus* spp., as landings of these species are believed to be confounded.

A revision of the landings table in the 2020 Working Group noted discard information from Spain in the period 2015–2017 were erroneously included in the landings. In addition, Danish landings data for 2017 and 2018 were updated. As such a noticeable change in the landings presented in the current advice and report (Table 18.1 and 18.2) occurred.

In 2022, ICES was requested to advise of this stock unit, as a complex of two species. Given the lack of robust survey data over the stock range, and lack of landings data (due to their prohibited status), a Category 6 assessment was applied to this stock, and trends in stock size or indicator cannot be evaluated.

In 2021, information about *Dipturus* species were compiled for this ecoregion and discussed under the Tor *"Evaluate available data at species-specific level within the common skate-complex (Dipturus* *spp.) stock units in order to further increase our understanding of each individual species and their current status"*. See section 26 of this report for further details.

18.9.15 Undulate ray *Raja undulata* in divisions 7.b and 7.j

This isolated stock has a very local distribution, mainly in Tralee Bay on the Southwest Irish coast.

There are no trawl surveys that can be used to assess this stock. However, data supplied by Inland Fisheries Ireland (Wögerbauer *et al.*, 2014 WD*)* shows that tag and recapture rates for *R. undulata* in Tralee Bay (Division 7.j) have significantly declined since the 1970s. Although these data do not allow for potential changes in tagging effort, it suggests that this stock is overexploited (Figure 18.8).

Given the lack of survey data over the coastal habitat for this stock, and a lack of landings data (due to management measures), a Category 6 assessment was applied to this stock, and trends in stock size or indicator cannot be evaluated.

18.9.16 Undulate ray *Raja undulata* in Divisions 7.d-e (English Channel)

ICES considers one stock unit of undulate ray in the English Channel (divisions 7.d–e), with the main part of the range extending from the Isle of Wight to the Normano-Breton Gulf. This stock is sampled by two different beam trawl surveys: the Channel beam trawl survey (see Chapter 15) and the western English Channel beam trawl survey (UK-Q1-SWBeam, Silva *et al.*, 2020 and Silva, 2022b WD), as well as the French Channel Groundfish survey FR-CGFS (see Chapter 15). The FR-CGFS and UK-Q1-SWBeam surveys provide indices of exploitable biomass for undulate ray in divisions 7.d and 7.e respectively (Table 18.4b). Both indices are considered representative for the whole stock. The spatial distribution of *R. undulata* caught in the western English Channel survey is provided in the Stock Annex. Catch rates are generally variable, partly due to the patchy distribution of this species. The surveys with the best coverage of this stock area are the French Channel Groundfish Survey (FR-CGFS) in Division 7d, and UK-Q1-SWBeam in Division 7e. Indices of exploitable biomass from both surveys suggest a rapid increase in stock biomass from the mid-2010s.

The stock of undulate ray in the English Channel is managed under a specific TAC. This formerly precautionary TAC has evolved into a TAC based on the MSY approach since 2022 following a benchmark (ICES 2022b) and the modification into a Category-2 assessment.

Between 2018 and 2022, the advice was based on catches while it was previously based on landings (see Stock Annex). The benchmark workshop WKELASMO including this stock took place in 2022 (ICES 2022b). It led to the adoption of a surplus production model (SPiCT, Pedersen and Berg, 2017) to assess this stock. The SPiCT-based assessment entailed a great increase of the advice, from 2552 tonnes (total catch) for 2021 and 2022 to 6716 and 6339 tonnes for 2023 and 2024 respectively.

18.9.16.1 Benchmarked assessment following WKELASMO in 2022

Details of input data and specification of priors on model parameters are provided in the Stock Annex.

The application of the SPiCT model allowed estimation of relative reference points F_{2020}/F_{MSY} and B_{2021}/B_{MSY}. The definition of these reference points resulted in the upgrade of the stock to Category

2. Similarly, as for porbeagle in the north-east Atlantic and cuckoo ray in subareas 6 and 7 and divisions 8.a-b and 8.d, a more precautionary approach than the ICES default method for catch advice derivation (based on the 35th percentile of the expected catch distribution under FMSY) was adopted. The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years. The stock was estimated depleted at the beginning of the longer biomass index available (1990) and survey indicators suggest it remained in such a state until the implementation of a landing ban (2009–2014). The stock biomass estimated from SPiCT reflect the same trend (Figure 18.9). The mean estimated F in 2020, was estimated around 0.010, leading to a diagnosis of under-exploitation since F_{2020}/F_{MSY}=0.086. The assessment also suggested that the stock has recovered a healthy state, as indicated by the estimated relative stock biomass in January 2021: B_{2021}/B_{MSY}=1.697.

The SPiCT-based assessment entailed a great increase in the advice, from 2552 t (total catch) for 2021 and 2022 to 4836 and 4675 t of exploitable removals (landings and dead discards ≥ 50 cm TL) for 2023 and 2024 respectively. This level of catch is unprecedented since 1990. This is due to the combination to the depleted state of the stock until the 2010s not allowing a comparable level of landings and the fishing ban followed by the very restrictive TAC set since 2015 associated with a high survival rate of discarded fish.

18.9.16.2 Updated assessment in 2024

After a peak in 2021, the exploitable biomass index of FR-CGFS-Q4 showed a decrease in 2022 and 2023, but still with higher values than for any years prior to 2019 (Table 18.4b). The 2021 index of exploitable biomass from UK-Q1-SWBeam showed a strong decrease compared to previous levels. Due to a lack of coverage of some strata, including French coastal waters of Division 7e, areas known for high densities of undulate ray (Silva, 2024WD), the 2022 value of the UK-Q1-SWBeam was excluded from the input series of the SPiCT model. The 2024 assessment led to advised catches of 4821 t and 4637 t for 2025 and 2026, respectively. As in the 2022 assessment, these advised catches are based on the 15th percentile of the expected catch distribution under F_{MSY}. The advice for 2025 corresponds to a 3.8% decrease compared to the advised catch for 2024.

The status of the stock in 2024 was similar to the one estimated in 2022 (Figure 18.9), with an estimated B_{2025}/B_{MSY} of 1.83 and an estimated F_{2024}/F_{MSY} of 0.145, indicating an underexploited stock with a biomass oved B_{MSY}.

Unlike the 2022 advice, it was possible to estimate the landings corresponding to the advised catch in 2024. Based on the contribution of landings to the total removals (landings + dead discards) in 2023, the corresponding landings were 3784 t and 3639 t for 2025 and 2026, respectively. For years 2023 and 2024, the corresponding landings could not be provided due to the unpredictable changes in fishing strategies induced by the large increase in TAC following the transition to a Category-2 assessment at that time.

18.9.17 Other skates in subareas 6 and 7 (excluding Division 7.d)

This section relates to skates not specified elsewhere in the ICES advice. This includes skates not reported to species level and some other, mainly deep-water species throughout the region. It also applies to those landings of *R. clavata, R. brachyura, R. montagui* and *R. microocellata* outside the current defined stock boundaries (Table 18.3).

It should be noted that landings were revised for 2017–2022 for France, with additional available data for species-specific landings of species outside current defined stock boundaries (Table 18.1, 18.2 and 18.3). This revision resulted in an increase in landings comparatively to 2023 report and previous advice sheet. Additionally, some estimated landings associated with sandy ray *L.*

circularis for 2022 and 2023 from Scotland are included in the raj.27.67a-ce-k until further investigations are conducted (See section 18.9.12).

Further investigations were also conducted in relation to Norwegian landings estimates, as these suggest an increase in variability in the last 3 years (2021–2023, Table 18.3). This variability may be due to little to no reported longline activity in the area in 2021 compared to previous years, with Norwegian landings only available from pelagic trawls where no skates and rays were caught. Furthermore, the decrease in fishing effort for North Sea cod in the area, with quota reduced since 2020, may have also contributed towards a decrease in landings of skates and rays in the area comparatively to previous average estimated landings (Table 18.3).

No specific assessment can be applied to this species group, and nominal landings have been shown to have declined to just 540 t in 2023, primarily because of improved species-specific reporting of the main commercial skate stocks.

18.10 Quality of assessments

Length data for many assessments have insufficient samples in a single year to be used on their own. COVID-19 reduced sampling levels in 2020 and 2021, therefore combined indices (2019–2021) were used in most assessments.

There are several other issues that influence the evaluation of stock status:

1. The stock identity for many species is not accurately known (although there have been some tagging studies and genetic studies to inform on some species, and the stocks of species with patchy distributions can be inferred from the spatial distributions observed from surveys). For inshore, oviparous species, assessments by ICES Division or adjacent divisions may be appropriate, although for species occurring offshore, including *L. naevus*, a better delineation of stock boundaries is required;
2. Age and growth studies have only been undertaken for the more common skate species, although IBTS and beam trawl surveys continue to collect maturity information. Other aspects of their biology, including reproductive output, egg-case hatching success, and natural mortality (including predation on egg-cases) are poorly known;
3. The identification of skate species is considered to be reliable for recent surveys, although there are suspected to be occasional misidentifications;
4. Although fishery-independent surveys are informative for commonly occurring species on the inner continental shelf, biomass indicators provided by these surveys are highly uncertain for lesser abundant stocks or those which distribution is not well covered by surveys as being inter-alia too coastal or having patchy distribution. This applies for example to blonde ray, which none of the three stock has a survey indicator, shagreen ray which is distributed on the offshore shelf but at low density and sandy ray, which occur mostly near the shelf break and at the upper slope.

For the two benchmarked stocks in 2022 (rju.27.7de and rjn.27.678abd) SPiCT was adopted as assessment model. These new assessments resulted in moving the two stocks from the ICES stock Category 3 to Category 2 and in a major increase in advised catch. Increased advice following the stock category change is expected as advice under the precautionary approach (ICES Category 3) are calculated with a method aiming at being precautionary to prevent stock depletion in the lack of sufficient data for a quantitative assessment. For these two stocks, the magnitude of the increase in advised catch is considerable. It is explained by the particularly precautionary previous advice and restrictive TAC adopted for undulate ray in the English Channel and the expected healthy status of cuckoo ray following the long-term increase in biomass indices and one previous study (Marandel *et al.*, 2019). Nevertheless, because of the large advice increase, a precautionary approach, similarly to that adopted for porbeagle in the north-east Atlantic, was adopted where the catch advice was derived of the 15th percentile of the catch distribution instead of the standard 35th percentile. This approach is justified by the magnitude of the change in the advice, which imply that the stock reaction to the forecast catch is uncertain and the relatively short time-series used in these assessments.

18.11 Reference points

No reference points have been adopted for any stock that has not been through the benchmark process. The two benchmark stocks have now Fmsy and Bmsy reference point. Proxy reference points are now calculated for Category 3 stocks that use the ICES rfb method.

18.12 Conservation considerations

Management measures to account for conservation aspects may exist at a national or regional level (e.g. white skate is a protected species in some UK waters).

Relevant Red List assessments for the main skate and ray species in this ecoregion are given in the table below, showing the current global IUCN assessments (https://www.iucnredlist.org/; accessed July 2023), the European Red List of Marine Fisheries (Nieto *et al.*, 2015) and Irish Red List (Clarke *et al.*, 2016). It should be noted that some of the earlier global assessments are due for updated assessments. It should also be recognised that the listings below are on regional scales that may not equate with the various stock units within the Celtic Seas ecoregion, as considered in this chapter.

Species	**Red List Category**		
	IUCN Global assessment (year of publication)	**European Red List (Nieto *et al.*, 2015)**	**Irish Red List (Clark *et al.*, 2016)**
Amblyraja radiata	Vulnerable (2020)	Least Concern	-
Dipturus batis	Critically Endangered (2021)	Critically Endangered	Critically Endangered
Dipturus intermedius	Critically Endangered (2021)		Critically Endangered
Dipturus nidarosiensis	Near Threatened (2015)	Near Threatened	Near Threatened
Dipturus oxyrinchus	Near Threatened (2015)	Near Threatened	Vulnerable
Leucoraja circularis	Endangered (2015)	Endangered	Near Threatened
Leucoraja fullonica	Vulnerable (2015)	Vulnerable	Vulnerable
Leucoraja naevus	Least Concern (2015)	Least Concern	Vulnerable
Raja brachyura	Near Threatened (2009)	Near Threatened	Near Threatened
Raja clavata	Near Threatened (2016)	Near Threatened	Least Concern
Raja microocellata	Near Threatened (2009)	Near Threatened	Least Concern
Raja montagui	Least Concern (2007)	Least Concern	Least Concern
Raja undulata	Endangered (2009)	Near Threatened	Endangered
Rajella fyllae	Least Concern (2020)	Least Concern	Least Concern
Rostroraja alba	Endangered (2006)	Critically Endangered	Critically Endangered

18.13 Management considerations

A TAC was only introduced in 2009 for the main skate species in this region. Reported landings may be slightly lower than the TAC, but this can be influenced by various issues (e.g. quota allocation and poor weather). There was evidence that quota was restrictive for some nations in some of the years after 2014, with a slight increase in TAC after this time.

Some coastal species, such as *Raja undulata* and *R. microocellata,* have been or still are subject to limited fishing opportunities, which may disproportionally impact on some inshore fleets.

Currently, fishery-independent trawl survey data provide the best time-series of species-specific information. Technical interactions for fisheries in this ecoregion are shown in the Stock Annex.

18.13.1.1 Main commercial species

Thornback ray, *Raja clavata,* is one of the most important commercial species in the inshore fishing grounds of the Celtic Seas (e.g. eastern Irish Sea, Bristol Channel). It is thought to have been more abundant in the past, and more accurate longer-term assessments of the status of this species are required.

Blonde ray, *Raja brachyura,* is a commercially valuable species. The patchy distribution of *R. brachyura* means that existing surveys have low and variable catch rates. More detailed investigations of this commercially valuable species are required.

Cuckoo ray, *Leucoraja naevus,* is an important commercial species on offshore grounds in the Celtic Sea. Further studies to better define the stock structure are required to better interpret these contrasting abundance trends.

The main stock of small-eyed ray, *Raja microocellata,* occurs in the Bristol Channel, and is locally important for coastal fisheries. Similarly, the English Channel stock of undulate ray *Raja undulata* is also important for inshore fleets.

Spotted ray, *Raja montagui,* is also commercially important, although a higher proportion of the catch of this small-bodied species is discarded in some fisheries. Commercial data for *R. brachyura* and *R. montagui* are often confounded.

18.13.1.2 Other species

Historically, species such as *L. circularis* and *L. fullonica* may have been more widely distributed on the outer continental shelf seas. These species are now encountered only infrequently in some surveys on the continental shelf, though they are still present in deeper waters along the edge of the continental shelf, and on offshore banks. Hence, studies to better examine the current status of these species in subareas 6–7 should be undertaken.

The larger-bodied species in this area are from the genus *Dipturus*, and data are limited for all species. *Dipturus batis*-complex were known to be more widespread in inner shelf seas historically, and whilst locally abundant in certain areas, have undergone a decline in geographical extent.

18.14 References

Barreau, T. and Iglésias, S.P. 2021. Knowledge available on common skate from the French National Museum of Natural History and from European research surveys to answer the ToR l) of the WGEF 2021. Working Document to the ICES Working Group on Elasmobranch Fishes, June 15–24 2021, 20 pp.

Barreau T., Caraguel J.-M., Vuillemin S. and Iglésias S. P. 2016. Programme POCHETEAUX, Rapport final. Muséum national d'Histoire naturelle, 100 p.

Baulier, L. and Rimaud, T. 2022. Recent population dynamics of *Dipturus batis* in Celtic Sea. Working Document to the ICES Working Group on Elasmobranch Fishes, June 14–23 2022, 11 pp.

Baulier, L., McHugh, M., Minto, C., Morandeau, F., Murphy, S., Sourget, Q., Oliver, M. and Morfin, M., 2024. Survivorship of discarded cuckoo ray in bottom trawl fisheries in the northern Bay of Biscay, Southern Celtic and Irish Seas. Fisheries Research, 273, p.106971.

Bendall, V. A., Hetherington, S. J., Ellis, J. R., Smith, S. F., Ives, M. J., Gregson, J. and Riley, A. A. 2012. Spurdog, porbeagle and common skate bycatch and discard reduction. Fisheries Science Partnership 2011–2012, Final Report. 88 pp.

Biseau, A. 2020. Impact of the assumption on survival and discard rates on the undulate ray advice. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF 2020) 8 pp.

BIM 2019. Post-capture condition of cuckoo ray in an Irish otter trawl fishery. Fisheries Conservation Report, March 2019. 12pp.

Brander, K. 1981. Disappearance of common skate *Raia batis* from the Irish Sea. Nature, 290: 48–49.

Brander, K. and Palmer, D. 1985. Growth rate of *Raia clavata* in the Northeast Irish Sea. ICES Journal of Marine Science, Volume 42, Issue 2, 1985, Pages 125–128, https://doi.org/10.1093/icesjms/42.2.125.

Burt G. J., Ellis J. R., Harley B. F. and Kupschus S. 2013. The FV Carhelmar beam trawl survey of the western English Channel (1989–2011): History of the survey, data availability and the distribution and relative abundance of fish and commercial shellfish. Science Series Technical Report, Cefas Lowestoft, 151: 139 pp.

Berg, C. W. 2022. surveyIndex: Calculate survey indices of abundance from DATRAS exchange data. R package version 1.09. https://github.com/casperwberg/surveyIndex

Berg, C. W., Nielsen, A. and Kristensen K. 2014. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. *Fisheries Research*, 151: 91–99. https://doi.org/10.1016/j.fishres.2013.10.005

Chevolot, M., Ellis J. R., Hoarau, G., Rijnsdorp, A. D., Stamm W. T. and Olsenm J. L. 2006. Population structure of the thornback ray (*Raja clavata*) in British waters. Journal of Sea Research, 56: 305–316.

Clarke, M., Farrell, E.D., Roche, W., Murray, T.E., Foster, S. and Marnell, F. (2016) Ireland Red List No. 11: Cartilaginous fish [sharks, skates, rays and chimaeras]. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. Dublin, Ireland.

Coelho, R. and Erzini, K. 2002. Age and growth of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal). Journal of the Marine Biological Association of the UK, 82: 987–990.

Davie, S. 2013. The Drivers and dynamics of fisher behaviour in Irish fisheries. PhD Thesis. Galway-Mayo Institute of Technology, Ireland.

Davie, S. 2014. Irish ray LPUE trends and spatial distributions. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF) 2014. 20 pp.

Davie, S., and Lordan, C. 2011. Definition, dynamics and stability of métiers in the Irish otter trawl fleet. Fisheries Research, 111: 145–158.

Dorel, D. 1986. Poissons de l'Atlantique nord-est relations taille-poids. Ifremer, Nantes. 165 pp.

Du Buit, M. H. 1976. Age et croissance de *Raja batis* et de *Raja naevus* en Mer Celtique. Journal du Conseil international pour l'Exploration del la Mer, 37: 261–265.

EC. 2009. Communication from the Commission to the European Parliament and the council on a European Community action plan for the conservation and management of sharks. Com. 2009 (40). 5th February 2009. 16 pp.

Ellis, Jim R., Cat A. Gordon, Harriet L. Allen, Joana F. Silva, Christopher Bird, Graham Johnston, Bríd O'Connor, Sophy R. McCully Phillips, and Ali Hood. "The distribution of the juvenile stages and egg-cases of skates (Rajidae) around the British Isles." Aquatic Conservation: Marine and Freshwater Ecosystems 34, no. 4 (2024): e4149.

Ellis, J. R., Bendall, V. J. and McCully, S. R. 2012a. Notes on common skate (*Dipturus batis*-complex) in the Celtic Sea. Working Document presented to the Working Group on Elasmobranch Fishes, 13 pp.

Ellis, J. R., Burt, G. J., Cox, L. P. N., Kulka, D. W. and Payne, A. I. L. 2008. The status and management of thornback ray *Raja clavata* in the southwestern North Sea. ICES CM 2008/K:13, 45 pp.

Ellis, J. R., Dulvy, N. K., Jennings, S., Parker-Humphreys, M. and Rogers, S. I. 2005. Assessing the status of demersal elasmobranchs in UK waters: A review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Ellis, J. R., McCully, S. R. and Brown, M. J. 2012b. An overview of the biology and status of undulate ray *Raja undulata*. Journal of Fish Biology, 80: 1057–1074.

Ellis, J. R., McCully, S. R. and Poisson, F. 2014. A global review of elasmobranch discard survival studies and implications in relation to the EU 'discard ban'. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, Portugal, 17–26 June 2014.

Ellis, J. R., Morel, G., Burt, G. and Bossy, S. 2011. Preliminary observations on the life history and movements of skates (Rajidae) around the Island of Jersey, western English Channel. Journal of the Marine Biological Association of the UK, 91: 1185–1192.

Ellis, J. R., Silva, J. F., McCully, S. R., Evans, M. and Catchpole, T. 2010. UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10, 38 pp.

Ellis, J. R. and Silva, J. F. 2021. Overview of data relating to *Dipturus* species. Working Document to the ICES Working Group on Elasmobranch Fishes, June 15–24 2021, 24 pp.

Ellis, J., McCully-Philipps, S.R., Sims, D., Derrick, D., Cheok, J. & Dulvy, N.K. 2021b. *Dipturus batis. The IUCN Red List of Threatened Species 2021: e.T203364219A203375487.* https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T203364219A203375487.en. Accessed on 29 July 2022

Ellis, J.R., McCully-Philipps, S.R., Sims, D., Walls, R.H.L., Cheok, J., Derrick, D. & Dulvy, N.K. 2021c. *Dipturus intermedius. The IUCN Red List of Threatened Species 2021: e.T18903491A68783461.* https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T18903491A68783461.en. Accessed on 29 July 2022.

Enever, R., Catchpole, T. L., Ellis, J. R. and Grant, A. 2009. The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research, 97: 72–76.

Fahy, E. 1989. Growth parameters of rays (Batoidei) in Irish waters, from material examined in commercial catches. ICES CM 1989/G:59, 11 pp.

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Velasco, F., Rodríguez-Cabello, C. and Baldó, F. 2024. Results on main elasmobranch species from the 2023 Spanish Groundfish Survey Porcupine Bank (NE Atlantic). Working Document presented to the Working Group on Elasmobranch Fishes (WGEF), 18–27 June, 2024, 40 pp.

Fraser, H. M., Greenstreet, S. P., and Piet, G. J. 2007. Taking account of catchability in groundfish survey trawls: implications for estimating demersal fish biomass. ICES Journal of Marine Science, 64: 1800–1819.

Frost, M., Neat, F. C., Stirling, D., Bendall, V., Noble, L. R. and Jones, C. S. 2020. Distribution and thermal niche of the common skate species complex in the north-east Atlantic. *Marine Ecology Progress Series*, 656: 65–74.

Gadenne, H. 2017. National self-sampling monitoring of Undulate Ray in France. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon 31 May–07 June 2017, 12 pp.

Gallagher, M. J. 2000. The fisheries biology of commercial ray species from two geographically distinct regions. PhD. Thesis. Trinity College, University of Dublin. 240 pp.

Gallagher, M. J., Nolan, C. P. and Jeal, F. 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. Journal of Northwest Atlantic Fishery Science, 35: 47–66.

Gerritsen, H. and Lordan, C. 2011. Integrating vessel monitoring systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES J. Mar. Sci. 68, 245–252.

Griffiths, A. M., Sims, D. W., Cotterell, S. P., El Nagar, A., Ellis, J. R., Lynghammar, A., McHugh, M., Neat, F. C., Pade, N. G., Queiroz, N., Serra-Pereira, B., Rapp, T., Wearmouth, V. J. and Genner, M. J. 2010. Molecular markers reveal spatially segregated cryptic species in a critically endangered fish, the common skate (*Dipturus batis*). *Proceedings of the Royal Society, B - Biological Sciences*, 277: 1497–1503.

Heessen, H. J. L. (Ed). 2003. Development of Elasmobranch Assessments – DELASS: DG Fish Study Contract 99/055.

ICES. 2004. Report of the Working Group on Elasmobranch Fishes. ICES CM 2004/G:11.

ICES. 2007. Report of the Working Group on Elasmobranch Fisheries (WGEF). Galway, Ireland.

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 558 pp.

ICES. 2011. Report of the Working Group on Elasmobranch Fishes (WGEF), 20–24 June 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:19. 492 pp.

ICES. 2012. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–26 June 2012, Lisbon, Portugal. ICES CM 2012/ACOM:19. 547 pp.

ICES. 2013a. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 8–12 April 2013, Lisbon, Portugal. ICES CM 2013/SSGESST:10. 272 pp.

ICES. 2013b. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–21 June 2013, Lisbon, Portugal. ICES CM 2013/ACOM:19. 649 pp.

ICES. 2015a. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–23 June 2015, Lisbon, Portugal. ICES CM 2015/ACOM:19. 711 pp.

ICES. 2015b. Report of the Fifth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history Traits, Exploitation Characteristics and other Relevant Parameters for Data-limited Stocks (WKLIFE V), 5–9 October 2015, Lisbon, Portugal. ICES CM 2015/ACOM:56. 157 pp.

ICES 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016 Lisbon, Portugal. ICES CM 2016/ACOM:40

ICES 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20–24 February 2017 Nantes, France. ICES CM 2017/ACOM:38. 119pp.

ICES. 2018. Report of the Workshop on Length-Based Indicators and Reference Points for Elasmobranchs (WKSHARK4), 6 -9 February 2018, Nantes, France. 99 pp.

ICES. 2020. Workshop on incorporating discards into the assessments and advice of elasmobranch stocks (WKSHARK5, outputs from 2019 meeting). ICES Scientific Reports. 2:87. 94 pp. http://doi.org/10.17895/ices.pub.7494.

ICES. 2021. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 183 pp. https://doi.org/10.17895/ices.pub.7948.

ICES. 2022a. ICES technical guidance for harvest control rules and stock assessments for stocks in category 2 and 3. In Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564.

ICES. 2022b. Benchmark Workshop for selected elasmobranch stocks (WKELASMO). ICES Scientific Reports. 4:47. 136 pp. http://doi.org/10.17895/ices.pub.21025021

Iglésias, S. P., Toulhaut, L. and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 319–333.

Johnston, G. and Clarke, M. 2011. A comparison of the length frequencies of two ray species in the Irish sea, 2008–2010, with the length frequencies measured in 1997. Working Document to WGEF 2011, 4 pp.

Johnston, G., Tetard, A., Santos, A.R., Kelly, E and Clarke, M. 2014. Spawning and nursery areas of selected rays and skate species in the Celtic Seas. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF 2014) 7 pp.

Leblanc, N., Tetard, A., Legrand, V., Stephan, E. and Hegron-Mace., L. 2014. RAIMOUEST: the French fishery of rays in the Western English Channel (VIIe), 2014 update. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF 2014) 29 pp.

Le Quesne, W. J., and Jennings, S. 2012. Predicting species vulnerability with minimal data to support rapid risk assessment of fishing impacts on biodiversity. Journal of Applied Ecology, 49: 20–28.

Mahé, J. C. and Poulard, J.C. 2005. Spatial distribution and abundance trends of main elasmobranch species in the Bay of Biscay and the Celtic Sea from bottom-trawl surveys. ICES CM 2005/N:04, 27 pp.

Marandel, F., P. Lorance, and V. M. Trenkel. 2019. Determining long-term changes in a skate assemblage with aggregated landings and limited species data. Fisheries Management and Ecology 26:365-373.

Marine Institute 2021. EMFAF reference here

McCully, S. R., Scott, F. and Ellis, J. R. 2012. Lengths at maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES Journal of Marine Science, 69: 1812–1822.

McCully Phillips, S. R., Scott, F. and Ellis, J. R. 2015. Having confidence in Productivity Susceptibility Analyses: A method for underpinning scientific advice on skate stocks? Fisheries Research,.In press.

McCully, S.R., Scott, F., Ellis, J.R., Pilling, G.J. 2013. Productivity Sensitivity Analysis: Application and suitability for data poor assessment of elasmobranchs in northern European Seas. Collect. Vol. Sci. Pap. ICCAT, 69(4): 1679–1698.

Miethe, T. & Dobby, H. 2018. Testing length-based reference points for an elasmobranch stock of Cuckoo ray (*Leucoraja naevus*). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, June 19–28 2018.

Moriarty, M. and Johnston, G. 2015. Distribution of four skate species in ICES Subareas VI, VII and VIII – suggesting stock structure. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015. WD2015-01.

NIEA. 2008. Position statement on sharks, skates and rays in Northern Ireland waters. Report No. BDU 2/66, 198 pp.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., García Criado, *et al.* 2015. European Red List of Marine Fishes. Published by the Euopean Commission; iv + 81 pp.

Oliver, M., McHugh, M;, Murphy, S., Minto, C., Browne, D & Cosgrove, R. 2021. An assessment of cuckoo ray (*Leucoraja naevus)* survivability inan Irish otter trawl fishery. Fisheries Conservation Report. BIM November 2021. 17pp.

Parker-Humphreys, M. 2004a. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Irish Sea (ICES Division VIIa) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 120, 68 pp.

Parker-Humphreys, M. 2004b. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Bristol Channel (ICES Division VIIf) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 123, 69 pp.

Pawson, M., Nichols, V. 1994. Recapture patterns of rays tagged in the Bristol Channel and Irish Sea. In Proceedings of the Second European Shark and Ray Workshop. Tag and Release Schemes and Shark and Ray Management Plans, 15–16 February 1994 (Fowler, S.T. and Earll, R.C., Eds.), pp. 10–13.

Pedersen, M.W., Berg, C.W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226-243

Pinto, C., Thorburn, J. A., Neat, F., Wright, P. J., Wright, S., Scott, B. E., Cornulier, T. and Travis, J. M. 2016. Using individual tracking data to validate the predictions of species distribution models. *Diversity and Distributions*, 22: 682–693.

Rogers, S. and Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. ICES Journal of Marine Science, 57: 866–881.

Rousset, J. 1990. Catches and geographical distribution of selachians on the western coast of Brittany. Journal of the Marine Biological Association of the United Kingdom, 70: 255–260.

Ruiz-Pico, S., Fernández-Zapico, O, Blanco, M, Velasco, F., Rodríguez-Cabello, C. and Baldo, F. 2020. Results on main elasmobranch species captured during the 2001–2019 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 15–25 June 2020; 34 pp.

Ryland, J. S., and Ajayi, T. O. 1984. Growth and population dynamics of three *Raja* species in Carmarthen Bay, British Isles. *ICES Journal of Marine Science*, Volume 41, Issue 2, May 1984, Pages 111–120, https://doi.org/10.1093/icesjms/41.2.111. Shephard, S., Gerritsen, H. D., Kaiser, M. J., and Reid, D. G. 2012. Spatial heterogeneity in fishing creates *de facto* refugia for endangered Celtic Sea elasmobranchs. PLOS ONE. doi:10.1371/journal.pone.0049307.

Scientific, Technical and Economic Committee for Fisheries (STECF) – Skates & Rays Management (STECF-22-08). Publications Office of the European Union, Luxembourg, 2022, https://doi.org/10.2760/627147.

Shephard, S., Johnston, G and Clarke, M. 2014. Estimation of mortality in rays and skates in the Celtic Seas, including a proposal on target F. Working Document to the ICES Working Group on Elasmobranch Fishes, 17–26th June 2014, Lisbon, Portugal. 5 pp.

Silva, J. F. 2022a. Rajidae in the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES divisions 7.f-g). Working Document to the ICES Working Group on Elasmobranch Fishes, June 14–23 2022, 23 pp.

Silva, J. F. 2022b. Rajidae in the western Channel (ICES Division 7.e). Working Document to the ICES Working Group on Elasmobranch Fishes, June 14-June 23, 2022; 30 pp.

Silva, J.F. and Ellis, J. R. 2020. Skates in the UK beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020.

Silva, J.F., Ellis, J.R. and Catchpole, T.L. 2012. Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. Journal of Fish Biology, 80: 1678–1703.

Silva, J. F., Ellis, J. R. and Kupschus, S. 2020. Demersal elasmobranchs in the western Channel (ICES Division 7.e) and Celtic Sea (ICES Divisions 7.f-j). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020.

Stephan E., C. Hennache, A. Delamare, N. Leblanc, V. Legrand, G. Morel, E. Meheust, JL. Jung. 2014a. Length at maturity, conversion factors, movement patterns and population genetic structure of undulate ray (*Raja undulata*) along the French Atlantic and English Channel coasts: preliminary results. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–26th June, 2014.

Stephan E., Gadenne H., Meheust E., Jung J.L. 2014b. Projet RECOAM : Etude de cinq espèces de raies présentes dans les eaux côtières d'Atlantique et de Manche. Rapport final. Association Pour l'Etude et la Conservation des Sélaciens et Laboratoire BioGeMME, Brest, France. 60pp. http://www.asso-apecs.org/IMG/pdf/recoam_rapport_final-2.pdf.

Walker, N. D., Bird, C., Ribeiro Santos, A., McCully Phillips, S. R. and Ellis, J. R. 2018. Length-based indicators to assess the status of skates (Rajidae). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, June 19–28 2018.

Wearmouth, V. J. and Sims, D.W. 2009. Movement and behaviour patterns of the critically endangered common skate *Dipturus batis* revealed by electronic tagging. Journal of Experimental Marine Biology and Ecology, 380: 77–87.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J., and Tortonese, E. 1984. Fishes of the North-eastern Atlantic and the Mediterranean.

Wögerbauer C., O'Reilly S., Green P. and Roche W. 2014. IFI Marine Sportfish Tagging Programme: Preliminary results for selected species, Inland Fisheries Ireland. Report No: IFI/2014/1-4231; 38 pp.

Zhou, S., Yin, S., Thorson, J. T., Smith, A. D., and Fuller, M. 2012. Linking fishing mortality reference points to life history traits: an empirical study. Canadian Journal of Fisheries and Aquatic Sciences, 69: 1292–1301.

18.15 Tables and Figures

Table 18.1. Skates and rays in the Celtic Seas. Regional total landings (ICES estimates, tonnes) of Celtic Seas skate stocks by nation. Some of these stocks extend outside the Celtic Seas ecoregion and data for these divisions are reported in relevant report chapters. *Data revised in 2024. Blank cell = no data reported; 0 = value less than 0.5.

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BEL	raj.27.67a-ce-k	1568	1328	1405	413	416	333	227	74	8	1	1	3	3	0	8	7	0	0	1
	rjb.27.67a-ce-k				0	0	0			0	0				0					
	rjc.27.7afg			0	328	216	197	302	441	391	240	350	241	212	197	339	314	265	431	316
	rjc.27.7e				5	2	8	3	4	4	3	9	14	21	14	13	9	38	31	20
	rje.27.7de						3	5	5	7	7	9	9	12	15	16	15	1	1	
	rje.27.7fg						37	117	124	99	83	106	123	116	121	137	94			
	rjf.27.67														0					

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rjh.27.4a6					0	0										0			
	rjh.27.7afg				166	170	210	313	404	406	351	359	313	338	348	520	721	445	515	372
	rjh.27.7e				7	6	3	5	5	6	3	6	11	9	14	10	23	18	13	9
	rji.27.67							0	0	0	0	0	0	2	2	1	1			
	rjm.27.67bj						0													
	rjm.27.7ae-h				78	63	55	120	70	3	0	1	7	2	16	15	44	125	166	86
	rjn.27.678abd			0	86	81	70	112	93	97	48	51	27	26	28	25	18	0	0	
	rju.27.7de												5	24	15	0	0			36
BEL Total		1568	1328	1405	1083	953	917	1204	1219	1022	737	893	753	763	768	1084	1246	891	1157	840
DE	raj.27.67a-ce-k	39	7	26	60	2	4	3	1						0					
	rjf.27.67															13		2	2	6

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rjh.27.4a6																		0	
DE Total		39	7	26	60	2	4	3	1						0	13		2	2	
DK	rjh.27.4a6											0				0	0	0	0	0
DK Total												0				0	0	0	0	0
ES	raj.27.67a-ce-k	2231	2568	2340	1946	206	52	23	15	9	12	45	61	62	357	135	17	20	26	28
	rjb.27.67a-ce-k	24	6	11	28	5	0.2	1	5	23	80	214	232	256						
	rjc.27.6					16	2	10	6	23	21	12	12	48	43	69	60	57	28	46
	rjc.27.7afg											5	6	9	0.1	0.0	0.1	2	4	1
	rjc.27.7e						0	0												
	rjf.27.67					62	42	29	20	33	20	13	15	22	20	14	14	14	13	13
	rjh.27.4a6					0														

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rji.27.67	86	74	40	7	30	16	22	8	10	5	3	3	11	9	5	2	2	5	2
	rjm.27.67bj				7	7	10	5	0	0	0	1				0			1	1
	rjm.27.7ae-h						0				0	0						0	0	1
	rjn.27.678abd				1	778	480	387	311	373	300	343	372	305	335	295	192	145	221	217
ES Total		2341	2648	2392	1986	1103	603	477	365	471	438	635	701	712	763	520	285	241	298	310
FRA	raj.27.67a-ce-k	2048	1740	1757	1669	548	314	174	160	139	128	123	130	139	126	194	180	196	165	158
	rjb.27.67a-ce-k	351	295	308	414	68	30	15	23	21	32	33	17	18	25	10*	6*	10*	4	4
	rjc.27.6	64	78	73	82	39	24	19	39	28	10	2	1	1	3	13	17	15	20	15
	rjc.27.7afg	379	264	238	181	147	131	133	106	95	107	70	121	147	101	117	80	106	100	50
	rjc.27.7e	95	86	82	64	122	101	114	108	181	224	225	213	176	212	263	264	289	282	321
	rje.27.7de	21	19	19	22	32	28	28	24	26	24	24	8	8	11	15	14	23	31	16

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rje.27.7fg	27	23	18	21	29	21	16	30	30	65	31	5	56	69	92	69	42	84	23
	rjf.27.67	32	25	33	28	144	150	152	147	127	131	151	130	125	129	124	132	138	134	97
	rjh.27.4a6					1					1	1	1	0	1	1	1	0	0	0
	rjh.27.7afg					36	73	131	87	52	170	218	275	257	172	295	277	264	287	117
	rjh.27.7e					56	148	205	169	191	281	304	223	242	396	450	538	539	639	584
	rji.27.67	199	152	185	178	46	35	25	35	26	33	34	37	34	35	25	24	28	40	36
	rjm.27.67bj	13	7	3	4	2	4	7	5	17	53	43	47	40	23	8	1	1	1	1
	rjm.27.7ae-h	1080	902	833	870	785	934	1062	1135	899	912	745	819	717	834	814	576	556	294	261
	rjn.27.678abd	3164	2565	2575	2507	3217	3069	2909	2571	2195	2515	2621	2233	2144	2288	2398	1984	2151	1872	1721
	rju.27.7bj					0				0		0	1	1	0	0	0			0
	rju.27.7de					19	9	20	6	3	10	50	58	79	86	181	159	152	158	812

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
FRA Total		7473	6157	6123	6041	5294	5071	5010	4646	4031	4695	4674	4319	4184	4512	50010	4322	4509	4112	4214
GBR	raj.27.67a-ce-k	2773	2454	2398	1478	508	290	168	153	101	77	46	34	34	30	45	56	46	71	116
	rjb.27.67a-ce-k				96	22	1	19	12	1	63	118	116	113	210	146	5	5	0	1
	rjc.27.6				1	56	61	57	67	120	120	114	147	114	201	233	167	141	115	129
	rjc.27.7afg			0	204	300	371	384	483	416	252	309	274	277	324	322	322	449	305	333
	rjc.27.7e	0	0		3	82	98	98	129	151	151	158	195	173	206	212	189	214	252	264
	rje.27.7de				4	18	40	28	33	32	36	39	19	15	12	20	24	28	33	33
	rje.27.7fg			0	91	157	214	189	208	117	79	78	69	30	55	83	67	68	67	46
	rjf.27.67				13	44	108	97	79	85	55	25	39	21	14	18	17	16	16	14
	rjh.27.4a6				7	5	7	17	4	0	1	3	2	1	3	1	0.3	1	2	2
	rjh.27.7afg		0	0	97	138	226	273	261	262	229	245	245	272	328	404	322	405	293	346

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rjh.27.7e		0		32	159	215	204	175	222	295	396	352	251	323	435	451	434	428	448
	rji.27.67				0	2	0	0	3	25	22	25	35	23	31	4	9	17	3	14
	rjm.27.67bj				5	16	27	32	30	27	29	43	49	43	62	58	1	31	16	53
	rjm.27.7ae-h	0		0	12	38	102	88	85	90	80	70	80	89	93	118	82	95	85	103
	rjn.27.678abd				225	321	421	402	306	269	262	266	254	260	272	289	186	166	154	172
	rju.27.7de				2	2			0			5	22	36	43	63	66	52	74	114
GBR Total		2773	2454	2399	2270	1868	2179	2056	2031	1919	1752	1942	1933	1752	2208	2452	1965	2168	1915	2189
IRL	raj.27.67a-ce-k	2117	1728	1581	1283	1007	547	394	410	243	219	227	230	284	188	148	87	92	69	77
	rjb.27.67a-ce-k			0		2	4	17	1	0	0	9	7	9	9	7	0			0
	rjc.27.6					3	33	56	69	71	85	87	99	130	90	101	70	54	69	71
	rjc.27.7afg					8	80	126	134	146	191	169	220	232	219	182	192	149	166	172

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rjc.27.7e									0		2		2	4	2	1			1
	rje.27.7de													2						
	rje.27.7fg						0	0	0	0	0	0	0			0		0	1	
	rjf.27.67						1	6	7	6	4	2	2	49	63	38	23	15	45	3
	rjh.27.4a6					0	4	1	1	24	9	9	11	5	23	33	20	14	3	2
	rjh.27.7afg	3	6			5	402	382	407	377	420	351	171	154	228	396	383	353	247	199
	rjh.27.7e								0			2		2	3	0	1			0
	rji.27.67						0	4	0									5	9	4
	rjm.27.67bj					1	20	18	25	24	43	28	20	12	19	12	3	4	3	1
	rjm.27.7ae-h					0	19	63	53	40	49	48	41	10	58	64	41	46	57	51
	rjn.27.678abd					12	55	106	108	93	83	79	69	69	115	103	73	55	36	21

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	rju.27.7bj														3					
	rju.27.7de																			1
IRL Total		2120	1734	1581	1283	1038	1165	1173	1218	1025	1104	1012	871	961	1022	1088	895	787	704	602
NLD	raj.27.67a-ce-k	0	1	0	0	0	0	0	0	0										
	rjc.27.7afg												0							0
	rjc.27.7e					0	2	1	0	2		0	0	0	1	1	1	1	0	0
	rjh.27.4a6																		0	
	rjh.27.7afg																			0
	rjh.27.7e								0	0				0	0	0	1	1	0	0
	rjm.27.7ae-h					0		0		0			0			0	0	0	0	
	rjn.27.678abd						0			0	0			0						

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NLD Total		0	1	0	0	1	2	1	1	2	0	0	0	0	0	2	2	2	0	1
NOR	raj.27.67a-ce-k	50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331		2	160
NOR Total		50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331		2	160
Grand Total		16364	14429	14016	12800	10355	10071	9986	9587	8568	8883	9428	8889	8523	9305	10432	9045	8601	8190	8322

Table 18.2. Skates and rays in the Celtic Seas. Regional total landings (ICES estimates, tonnes) of Celtic Seas skate stocks by stock. Some of these stocks extend outside the Celtic Seas ecoregion and data for these divisions are reported in relevant report chapters. *Data updated in 2024. Blank cell = no data reported; 0 = value less than 0.5.

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
raj.27.67a-ce-k	BEL	1568	1328	1405	413	416	333	227	74	8	1	1	3	3	0	8	7	0	0	1
	DE	39	7	26	60	2	4	3	1						1					
	ES	2231	2568	2340	1944	206	52	23	15	9	12	45	61	62	357	135	17	20	26	28
	FRA	2048	1740	1757	1669	548	314	174	160	139	128	123	130	139	126	194	180	196	165	158
	GBR	2773	2454	2398	1478	508	290	168	153	101	77	46	34	34	30	45	56	46	71	116
	IRL	2117	1728	1581	1283	1007	547	394	410	243	219	227	230	284	188	148	87	92	69	77
	NLD	0	1	0	0	0	0	0	0	0										
	NOR	50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331		2	160
raj.27.67a-ce-k Total		10826	9926	9597	6925	2783	1671	1052	919	600	594	714	770	674	731	804	678	355	333	540
rjb.27.67a-ce-k	BEL				0	0	0			0	0				0					

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	ES	24	6	11	28	5	0.21	1	5	23	80	214	232	256	0					
	FRA	351	295	308	414	68	30	15	23	21	32	33	17	19	25	10*	6*	10*	4	4
	GBR				96	22	1	19	12	1	63	118	116	113	210	146	5	5	0	1
	IRL			0		2	4	17	1	0	0	9	7	9	9	7	0			0
rjb.27.67a-ce-k Total		375	301	319	538	97	35	52	42	45	175	375	373	395	245	163	11	15	4	5
rjc.27.6	ES					16	2	10	6	23	21	12	12	48	43	69	60	57	28	46
	FRA	64	78	73	82	39	24	19	39	28	10	2	1	1	3	13	17	15	20	15
	GBR				1	56	61	57	67	120	120	114	147	113	201	233	167	141	115	129
	IRL					3	33	56	69	71	85	87	99	130	90	101	70	53	69	71
rjc.27.6 Total		64	78	73	82	114	120	141	181	241	236	213	260	293	337	416	315	267	232	261
rjc.27.7afg	BEL			0	328	216	197	302	441	391	240	350	241	212	197	339	314	265	431	316

2023	1	50	333	172	872	20		321	164	1	0
2022	4	100	305	166	1005	31		282	252		0
2021	2	106	448	149	971	38		289	214		1
2020	0.1	80	322	192	909	9		264	189	1	1
2019	0.1	117	322	182	960	13		263	212	2	1
2018	0	101	324	219	840	14		212	206	4	1
2017	9	147	277	232	878	21		176	173	2	0
2016	6	121	274	220	861	14		213	195		0
2015	5	70	309	169	903	9		225	158	2	0
2014		107	252	191	790	3		224	151		
2013		95	416	146	1048	4		181	151	0	2
2012		106	483	134	1165	4		108	129		0
2011		133	384	126	944	3	0	114	98		1
2010		131	371	80	780	8	0	101	98		2
2009		147	300	8	671	2		122	82		0
2008		181	204		713	5		64	3		
2007		238	0		238			82			
2006		264			264			86	0		
2005		379			379			95	0		
Country	ES	FRA	GBR	IRL		BEL	ES	FRA	GBR	IRL	NLD
ICES Stock Code					rjc.27.7afg Total	rjc.27.7e					

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.7e To-tal		95	86	82	71	206	208	216	242	339	379	395	423	372	438	490	464	541	566	605
rje.27.7de	BEL						3	5	5	7	7	9	9	12	15	16	15	1	1	
	FRA	21	19	19	22	32	28	28	24	26	24	24	8	8	11	15	14	23	31	16
	GBR				4	18	40	28	33	32	36	39	19	15	12	20	24	28	33	33
	IRL													2						
rje.27.7de Total		21	19	19	26	50	70	61	62	65	67	72	36	36	38	50	53	51	65	49
rje.27.7fg	BEL						37	117	124	99	83	106	123	116	121	137	94			
	FRA	27	23	18	21	29	21	16	30	30	65	31	5	56	69	92	69	42	84	23
	GBR			0	91	157	214	189	208	117	79	78	69	30	55	83	67	68	67	46
	IRL						0	0	0	0	0	0	0			0		0	1	
rje.27.7fg To-tal		27	23	18	112	187	272	323	362	247	227	216	198	201	245	313	230	110	151	69

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjf.27.67	DE															13	0	2	2	6
	BEL														0	0	0			
	ES					62	42	29	20	33	20	13	15	22	20	14	14	14	13	13
	FRA	32	25	33	28	144	150	152	147	127	131	151	130	125	129	124	132	138	134	97
	GBR				13	44	108	97	79	85	55	25	39	21	14	18	17	16	16	14
	IRL						1	6	7	6	4	2	2	49	63	38	23	15	45	3
rjf.27.67 Total		32	25	33	41	250	301	283	253	251	211	192	186	217	225	207	185	186	211	133
rjh.27.4a6	BEL					0	0										0			
	DE																		0	
	DK											0						0	0	0
	ES					0														

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	FRA					1					1	1	1	0	1	1	1	0	0	0
	GBR				7	5	7	17	4	0	1	3	2	1	3	1	0.3	1	2	2
	IRL					0	4	1	1	24	9	9	11	5	23	34	20	13	3	2
	NLD																		0	
rjh.27.4a6 Total					7	6	10	17	5	24	10	14	14	6	27	35	21	15	5	5
rjh.27.7afg	BEL				166	170	210	313	404	406	351	359	313	338	348	520	721	445	515	372
	FRA					36	73	131	87	52	170	218	275	257	172	295	277	264	287	117
	GBR		0	0	97	138	226	273	261	262	229	245	245	272	328	404	322	405	293	346
	IRL	3	6			5	402	382	407	377	420	351	171	154	228	396	383	353	247	199
rjh.27.7afg Total		3	6	0	263	350	910	1099	1160	1097	1170	1172	1004	1020	1077	1616	1703	1467	1342	1034
rjh.27.7e	BEL				7	6	3	5	5	6	3	6	11	9	14	10	23	18	13	9

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	FRA					56	148	205	169	191	281	304	223	242	396	450	538	539	639	584
	GBR		0		32	159	215	204	175	222	295	396	352	251	323	435	451	434	428	448
	IRL								0			2		2	3	0	1			0
	NLD								0	0				0	0	0	1	1	0	0
rjh.27.7e Total			0		39	221	365	414	349	419	579	708	587	504	736	896	1014	992	1080	1041
rji.27.67	BEL							0	0	0	0	0	0	2	2	1	1			
	ES	86	74	40	7	30	16	22	8	10	5	3	3	11	9	5	2	2	5	2
	FRA	199	152	185	178	46	35	25	35	26	33	34	37	34	35	25	24	28	40	36
	GBR				0	2	0	0	3	25	22	25	35	23	31	4	9	17	3	14
	IRL						0	4	0							0	0	5	9	4
rji.27.67 Total		285	226	226	185	78	51	51	46	61	61	63	75	69	77	36	36	52	57	56

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjm.27.67bj	BEL						0													
	ES				7	7	10	5	0	0	0	1	0	0	0	0.3	0		1	1
	FRA	13	7	3	4	2	4	7	5	17	53	43	47	40	23	8	1		1	1
	GBR				5	16	27	32	30	27	29	43	49	44	62	58	1	31	16	53
	IRL					1	20	18	25	24	43	28	20	12	19	12	3	3	3	1
rjm.27.67bj Total		13	7	3	16	27	62	63	61	68	125	114	116	96	104	79	5	37	21	56
rjm.27.7ae-h	BEL				78	63	55	120	70	3	0	1	7	2	16	15	44	124	166	86
	ES						0				0	0						0	0	1
	FRA	1080	902	833	870	785	934	1062	1135	899	912	745	819	717	834	814	576	557	294	261
	GBR	0		0	12	38	102	88	85	90	80	70	80	89	93	118	82	95	85	104
	IRL					0	19	63	53	40	49	48	41	10	58	65	41	46	57	51

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	NLD					0		0		0			0			0.2	0.1	1		
rjm.27.7ae-h Total		1080	902	833	960	887	1110	1332	1344	1032	1042	864	947	818	1001	1012	741	821	602	502
rjn.27.678abd	BEL			0	86	81	70	112	93	97	48	51	27	26	28	25	18	0	0	0
	ES				1	778	480	387	311	373	300	343	372	305	335	295	192	145	221	217
	FRA	3164	2565	2575	2507	3217	3069	2909	2571	2195	2515	2621	2233	2144	2288	2398	1984	2151	1872	1721
	GBR				225	321	421	402	306	269	262	266	254	260	272	289	186	166	154	172
	IRL					12	55	106	108	93	83	79	69	69	115	103	73	55	36	21
	NLD						0			0	0	0	0	0	0	0	0	0		
rjn.27.678abd Total		3164	2565	2575	2819	4408	4096	3916	3388	3028	3209	3360	2955	2804	3037	3111	2453	2517	2282	2131
rju.27.7bj	IRL														3					
	FRA					0				0		0	1	1	0	0	0			0

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.7bj Total						0				0		0	1	1	3	0	0			0
rju.27.7de	BEL												5	24	15	0	0			36
	FRA					19	9	20	6	3	10	50	58	79	86	181	159	152	158	812
	IRL																			1
	GBR				2	2			0			5	22	36	43	63	66	52	74	114
rju.27.7de Total					2	21	9	20	6	3	10	55	84	139	143	244	225	204	233	963
Grand Total		16364	14429	14016	12800	10355	10071	9986	9587	8568	8883	9428	8889	8523	9305	10432	9045	8601	8190	8322

Table 18.3. Skates and rays in the Celtic Seas. ICES Estimates of landings for other skates and rays in subareas 6–7 (excluding Division 7.d) by species, country, and year (in tonnes). Data revised in 2024 (including historical data). Blank cell = no data reported; 0 = value less than 0.5.

Country	Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BEL	*Raja brachyura*	0	0	0	0	0	0	0	1	2						
	Raja clavata	0	0	0	0		0	1	0	0						
	Raja undulata								1	0						
	Rajiformes (indet)	416	333	227	74	8	0	0	1	0	0	8	7	0	0	1
BEL Total		**416**	**333**	**227**	**74**	**8**	**1**	**1**	**3**	**3**	**0**	**8**	**7**	**0**	**0**	**1**
DEU	Rajiformes (indet)	2	4	3	1						1					
DEU Total		**2**	**4**	**3**	**1**						**1**					
ESP	*Raja brachyura*	1			0	1								0	0	
	Raja clavata	65	23	13	6	5	10	44	59	62	18	14	16	20	25	26
	Raja montagui		3													
	Rajiformes (indet)	139	26	11	9	4	2	1	1		338	121	1	0	1	2
ESP Total		**206**	**52**	**23**	**15**	**9**	**12**	**45**	**61**	**62**	**357**	**135**	**17**	**20**	**26**	**28**
FRA	*Amblyraja hyperborea*				3	0	2	18	10	7		1	5	5	13	4
	Amblyraja radiata					4	8	5	9	9	15	22	18	15	21	10
	Raja brachyura	2	5	6	27	31	25	29	45	62	65	94	90	109	88	95
	Raja clavata	82	92	45	53	61	46	42	36	27		28	26	38	21	26
	Raja microocellata	0	2	0	0	1	1	2	0	1	2	17	3	2	1	1
	Raja montagui	0	0	0		0	0	0	0	3		0	0			
	Raja undulata		0		0			0	0			1	4	5	5	9
	Rajiformes (indet)	463	215	123	77	42	46	28	31	30	44	32	34	23	17	14
FRA Total		**548**	**314**	**174**	**160**	**139**	**128**	**123**	**130**	**139**	**126**	**194**	**180**	**196**	**165**	**158**
GBR	*Amblyraja hyperborea*					0	0						1			
	Amblyraja radiata			0	0	1		0			0					
	Raja brachyura	10	5	4	11	1	1	3	2	2	3	2	1	2	2	1
	Raja clavata	30	55	58	58	35	14	20	27	24	12	18	21	23	21	28
	Raja microocellata	6	8	4	2	11	16	18	1	0	1	2	0	0	1	0
	Raja montagui										0	0				

Country	Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Raja undulata								0	0	0	0	0	0	1	0
	Rajiformes (indet)	463	223	102	83	54	45	6	4	8	13	23	32	21	46*	87*
GBR Total		**508**	**290**	**168**	**153**	**101**	**77**	**46**	**34**	**34**	**30**	**45**	**56**	**46**	**71***	**116***
IRL	*Amblyraja radiata*	0			0		0									
	Raja brachyura	5	36	46	47	53	53	40	45	47	40	56	35	39	37	46
	Raja clavata	18	81	88	127	111	117	133	147	151	89	71	39	37	33	31
	Raja microocellata		0				0		0							0
	Raja montagui						1	1	0	42			0	0		
	Rajella fyllae		1		1											
	Rajiformes (indet)	983	429	259	236	79	49	53	38	43	59	21	14	16		
IRL Total		**1007**	**547**	**394**	**410**	**243**	**219**	**227**	**230**	**284**	**188**	**148**	**87**	**92**	**69**	**77**
NLD	*Raja clavata*			0												
	Raja montagui		0													
	Rajiformes (indet)	0		0	0	0										
NLD Total		**0**	**0**	**0**	**0**	**0**										
NOR	Rajiformes (indet)	96	131	62	107	99	157	272	312	153	30	274	331		2	160
NOR Total		**96**	**131**	**62**	**107**	**99**	**157**	**272**	**312**	**153**	**30**	**274**	**331**		**2**	**160**
Grand Total		2783	1671	1052	919	600	594	714	770	674	731	804	678	355	333	540

Table 18.4a. Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks each survey used in the 2022 *Leucoraja naevus* benchmark assessment. Note: 'Stock' is the combined total used as the stock index.

Year	EVHOE	IGFSw	SP_PORC	NIGFS	SCOWCGFSn	Q1SWECOS	comb7gj	comb6a	Stock
2005	3014.88	656.41	298.62	148.56	476.64	244.94	232.86	412.32	5485.23
2006	1966.78	273.60	315.16	98.55	316.17	244.94	185.77	320.02	3720.99
2007	3910.04	641.37	330.05	186.38	597.98	284.18	297.09	611.39	6858.50
2008	4573.19	621.81	206.65	195.03	625.73	673.23	475.92	181.08	7552.64
2009	3266.91	1408.97	159.00	175.83	564.11	935.70	356.95	270.16	7137.62
2010	3472.23	650.27	229.77	171.31	525.14	510.56	213.12	519.23	6291.63
2011	5315.22	762.59	86.20	93.46	564.11	955.89	448.46	251.22	8477.15
2012	3359.69	548.13	120.10	77.13	848.75	1239.52	201.84	496.69	6891.85
2013	5050.91	481.75	80.27	242.06	818.02	1188.01	144.41	344.56	8349.99
2014	8897.90	488.96	180.26	432.05	1330.85	583.45	661.15	463.14	13037.74
2015	8877.80	1548.71	273.35	497.56	976.68	993.67	692.34	184.51	14044.62
2016	4325.24	1030.40	79.29	548.90	1560.28	151.78	704.44	544.97	8945.30
2017	7717.27	848.47	181.69	451.96	1618.16	663.25	550.57	307.09	12338.45
2018	7282.01	656.27	257.19	94.90	728.76	379.01	1048.30	339.96	10786.40
2019	10384.06	177.05	433.62	61.80	974.79	551.38	881.33	141.48	13605.51
2020	8687.95	563.50	136.01	113.57	483.67	881.02	447.10	176.04	11488.86
2021	9737.74	432.98	322.11	228.55	380.47	722.42	809.35	61.59	12695.22

Table 18.4b. Skates and rays in the Celtic Seas. Exploitable biomass estimates (relative, expressed in tonnes based on swept area) for each survey used in the 2022 SPiCT assessment for *Raja undulata* in the English Channel (rju.27.7de).

Year	FR-CGFS	UK-Q1-SWBeam
1990	235.21	
1991	138.20	
1992	209.78	
1993	0.00	
1994	626.01	
1995	150.21	
1996	28.56	
1997	145.94	
1998	356.78	
1999	71.30	
2000	97.14	
2001	143.22	
2002	60.97	
2003	0.00	
2004	93.41	
2005	108.15	
2006	330.66	120.04
2007	383.97	256.48

Year	FR-CGFS	UK-Q1-SWBeam
2008	158.93	859.34
2009	367.01	460.75
2010	251.73	1551.98
2011	147.88	1267.66
2012	518.01	397.66
2013	587.29	497.91
2014	765.19	1442.06
2015	1305.64	803.55
2016	1207.90	985.98
2017	1715.61	2449.01
2018	1663.04	1120.23
2019	3506.81	1821.83
2020	3953.20	305.97*
2021	3270.91	2710.37
2022	2303.85	224.77*
2023	2116.04	413.72

***Not used in the assessment (survey conducted in a different quarter)**

Table 18.5. Skates and rays in the Celtic Seas. Thornback ray (*Raja clavata*, rjc.27.7e) and fishing effort in Division 7.e during 2014–2023 for France (fishing vessels < 24m catching more than 1% of thornback ray) in days (Days being days at sea) and UK (E&W) for all fleets in kW*day (Days being fishing days). Source: UK(E&W) data request to WGEF in 2024, French data provided to ICES MIXFISH. ^ Rounded to two decimal places.

Year	France (days at sea)^	UK(E&W) (kW*days)
2014	47862.55	8788845.5
2015	48548.18	9250932.69
2016	50243.49	10082676.97
2017	45462.94	10142402.6
2018	44139.76	9175233.87
2019	43781.38	8984619.49
2020	41467.08	7578607.83
2021	41233.68	8334463.19
2022	39935.02	8392650.74
2023	37781.94	8252023.62

Table 18.6a. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). Assessment summary. Biomass is relative to B_{MSY} at the end of the year and fishing mortality relative to F_{MSY}. High and low values are 95% confidence intervals. Landings are in tonnes (landings reconstructed from 2005-2008).

Year	Relative biomass			ICES landings (tonnes)	Relative fishing pressure		
	Low	B/B_{msy}	High		Low	F/F_{msy}	High
2005	0.64	0.88	1.22	6149	0.94	1.25	1.66
2006	0.68	0.86	1.09	5455	0.85	1.16	1.59
2007	0.70	0.86	1.06	5283	0.72	1.06	1.57
2008	0.72	0.89	1.10	5010	0.64	1.01	1.58
2009	0.74	0.93	1.16	4408	0.53	0.88	1.45
2010	0.78	0.98	1.25	4096	0.44	0.74	1.24
2011	0.83	1.06	1.35	3916	0.39	0.66	1.10
2012	0.90	1.14	1.45	3388	0.34	0.55	0.92
2013	0.98	1.24	1.56	3028	0.27	0.44	0.71
2014	1.08	1.35	1.69	3209	0.25	0.39	0.62
2015	1.17	1.45	1.80	3360	0.26	0.40	0.62
2016	1.25	1.51	1.82	2955	0.24	0.36	0.56
2017	1.32	1.55	1.82	2804	0.21	0.31	0.48
2018	1.40	1.60	1.84	3037	0.21	0.31	0.47
2019	1.45	1.64	1.86	3111	0.22	0.34	0.51
2020	1.48	1.65	1.84	2453	0.19	0.28	0.44
2021	1.52	1.68	1.85	2517	0.17	0.25	0.39
2022	1.56	1.70	1.87	2282	0.16	0.25	0.38
2023	1.58	1.72	1.88	2131	0.14	0.22	0.33
2024	1.61	1.75	1.90				

Table 18.6b. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). Annual catch scenarios for 2025. All weights are in tonnes.

Basis	Total landings (2025)	Fishing mortality F_{2025}/F_{MSY}	Stock size B_{2026}/B_{MSY} *	% B change**	% advice change***
ICES advice basis					
Maximum sustainable yield (MSY) approach (15th percentile of predicted landings distribution under F = F_{MSY})	7 799	0.82	1.55	−12.1	-3.3
Other scenarios					
F = F_{MSY}	9 351	1.00	1.49	-15.6	16
F = F_{2024}	2 147	0.21	1.77	0.56	-73
F = 0	0	0	1.86	5.3	−100
Landings = 10th percentile of predicted landings distribution under F = F_{MSY}	7 471	0.78	1.56	−11.3	−7.4
Landings = 20th percentile of predicted landings distribution under F = F_{MSY}	8 069	0.85	1.54	−12.7	0.066
Landings = 35th percentile of predicted landings distribution under F = F_{MSY}	8 741	0.93	1.51	-14.2	8.4

* Biomass is at 01 January.
** Percentage change of B_{2026}/B_{MSY} relative to B_{2025}/B_{MSY} (1.76).
*** Advice value for 2025 relative to landings advice value for 2024 (8 064 tonnes).

Table 18.6c. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). Annual catch scenarios for 2026 with F_{2025} = 15th percentile of the predicted landings distribution under F = F_{MSY}. All weights are in tonnes.

Basis	Total landings (2026)	Fishing mortality F2026/FMSY	Stock size B2027/BMSY *	% B change**	% advice change***
ICES advice basis					
Maximum sustainable yield (MSY) approach (15th percentile of predicted landings distribution under F = F_{MSY})	7 529	0.78	1.57	1.14	-3.5
Other scenarios					
F = F_{MSY}	9 394	1.00	1.49	-3.7	20
F = F_{2024}	2 156	0.21	1.78	14.8	-72
F = 0	0	0	1.86	20	−100
Landings = 10th percentile of predicted landings distribution under F = F_{MSY}	7 145	0.74	1.58	2.1	−8.4
Landings = 20th percentile of predicted landings distribution under F = F_{MSY}	7 849	0.82	1.56	0.32	-0.64
Landings = 35th percentile of predicted landings distribution under F = F_{MSY}	8 652	0.91	1.52	-1.74	10.9

* Biomass is at 01 January.
** Percentage change of B2027/BMSY relative to B2026/BMSY (1.55).
*** Advice value for 2026 relative to landings advice value for 2025 (7 799 tonnes).

Figure 18.1a. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas (ICES subareas 6–7 including 7.d), from 1903–2015 (Source: Official nominal catches https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx).

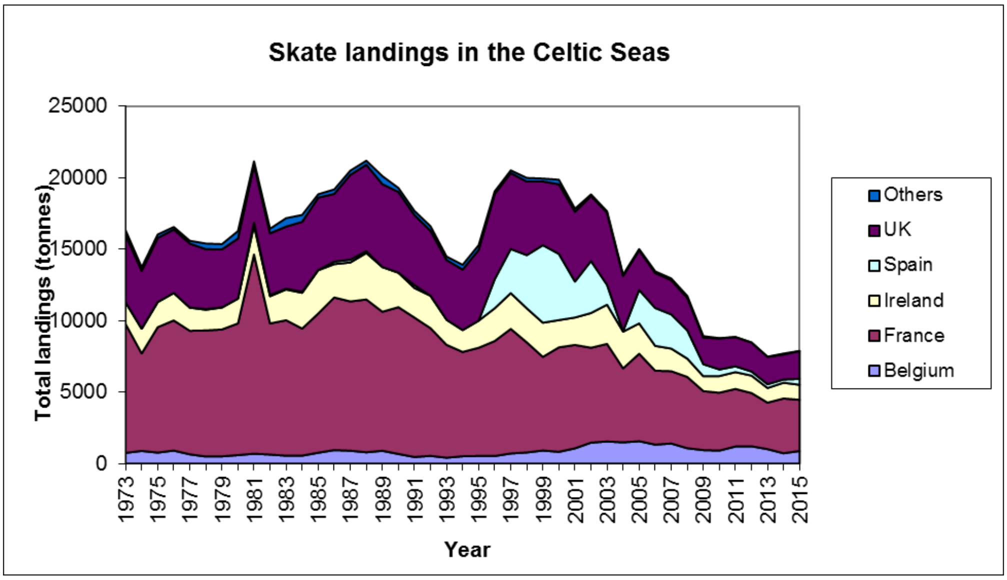


Figure 18.1b. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2015 (Source: Official nominal catches https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx).

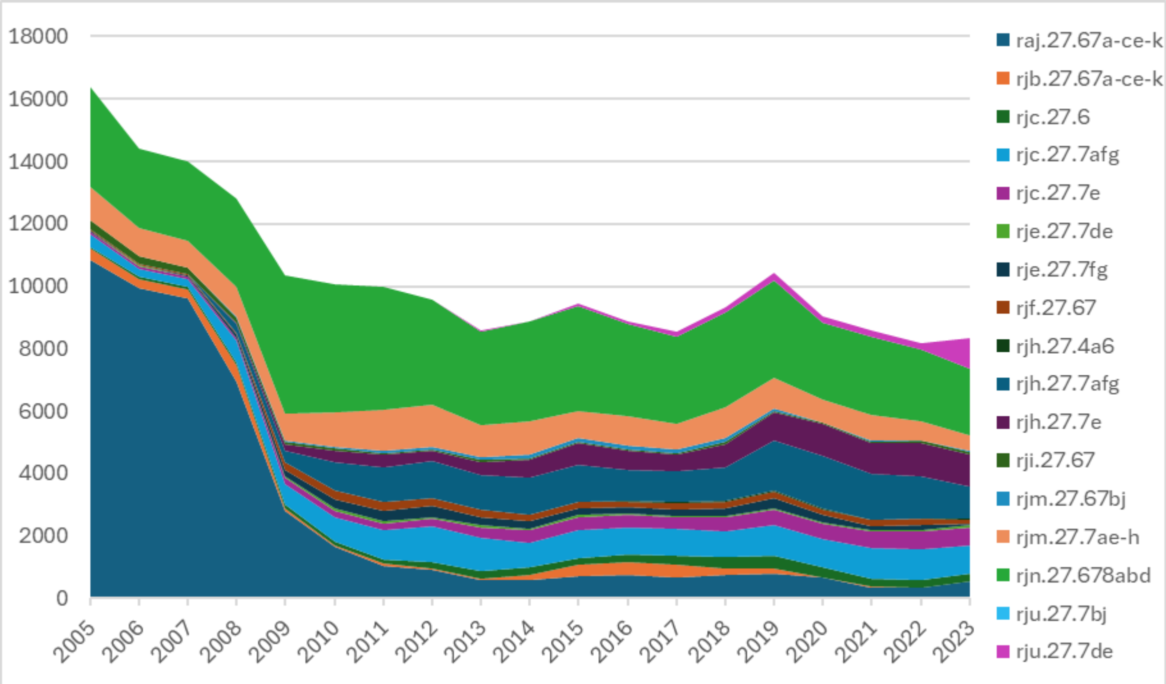


Figure 18.1.c Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by stock in the Celtic Seas from 2005–2023 (Source: ICES).

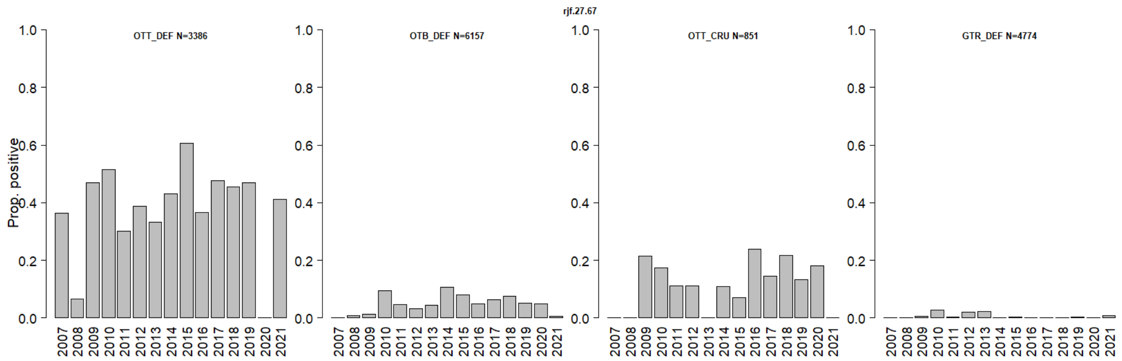


Figure 18.2 Skates and rays in the Celtic Seas. Temporal trends in the proportion of hauls encountering individuals of the stock rjf.27.67, based on French on-board observer trips carried out in application of EU data collection programmes (the zero value in 2020 for OTT-DEF was due to COVID-19 disruption of the sampling.

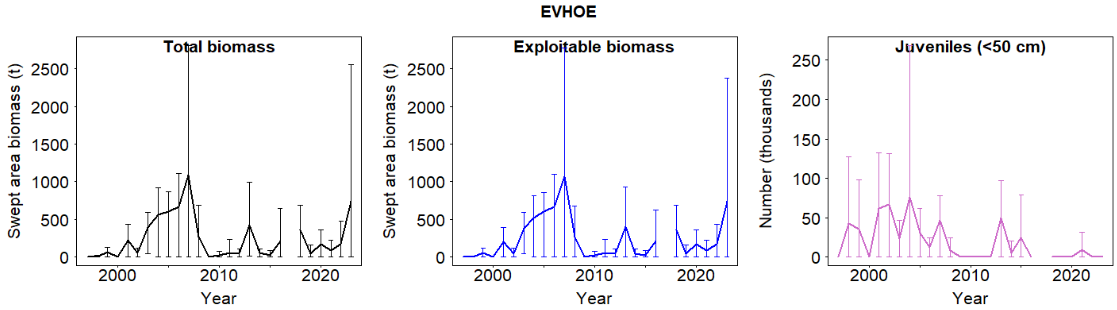


Figure 18.3a. Skates and rays in the Celtic Seas. Total biomass, exploitable biomass (individuals >= 50 cm TL) and number of juveniles (<50 cm TL) of *Leucoraja circularis* (stock rji.27.67) from the EVHOE survey (1997–2023, no survey in 2017).

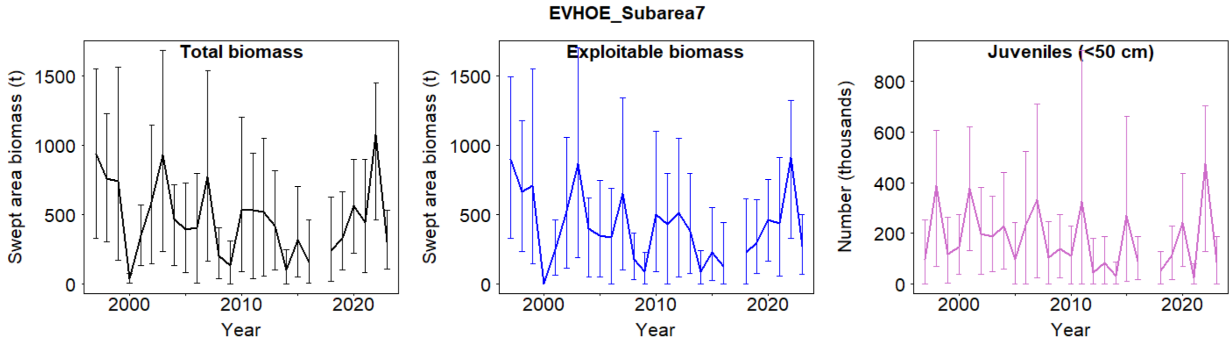


Figure 18.3b. Skates and rays in the Celtic Seas. Total biomass, exploitable biomass (individuals >= 50 cm TL) and number of juveniles (<50 cm TL) of *Leucoraja fullonica* (stock rjf.27.67) in Subarea 7 from the EVHOE survey (1997–2023, no survey in 2017).

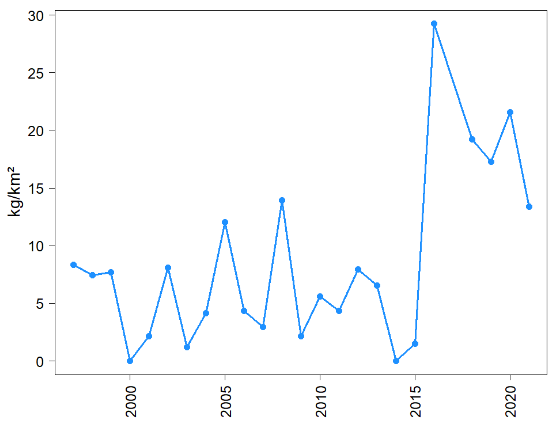


Figure 18.3c. Skates and rays in the Celtic Seas. Exploitable biomass (individuals >= 50 cm TL) per km² of *Raja clavata* in areas of the stock rjc.27.7afg covered by the EVHOE survey (1997–2021, no survey in 2017).

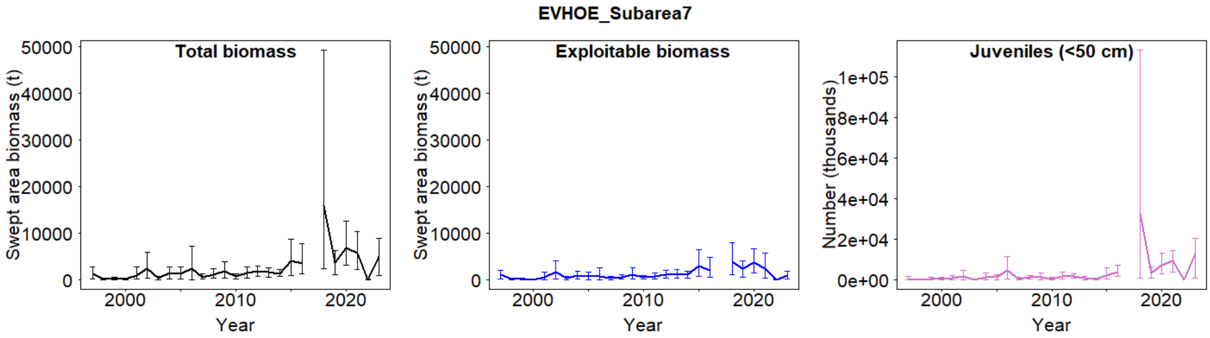


Figure 18.3d. Skates and rays in the Celtic Seas. Total biomass, exploitable biomass (individuals >= 50 cm TL) and number of juveniles (<50 cm TL) of *Raja montagui* in Subareas 7 (stock rjm.27.7ae-h) from the EVHOE survey (1997–2023, no survey in 2017).

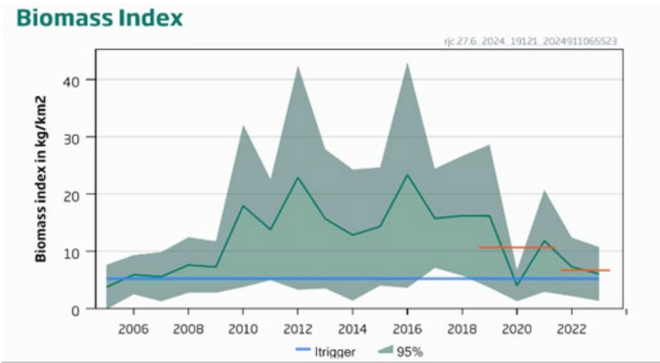


Figure 18.4a. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) biomass index of *Raja clavata* in Division 6 for 2005–2021. Red lines give average for 2019–2021 and for 2022–2023.

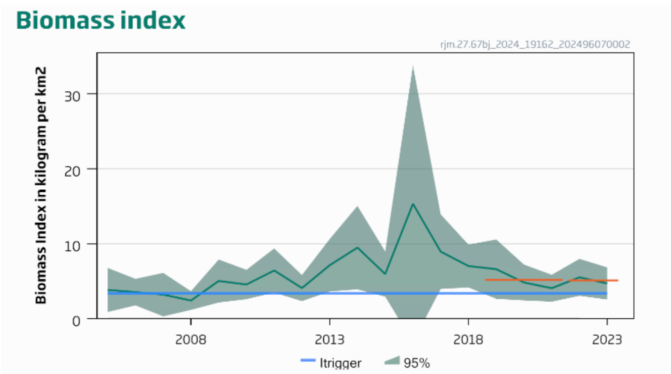


Figure 18.4b. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean CPUE of *Raja montagui* in divisions 6 and 7.b-c for 2005–2021. Red lines give average for 2019–2021 and for 2022–2023.

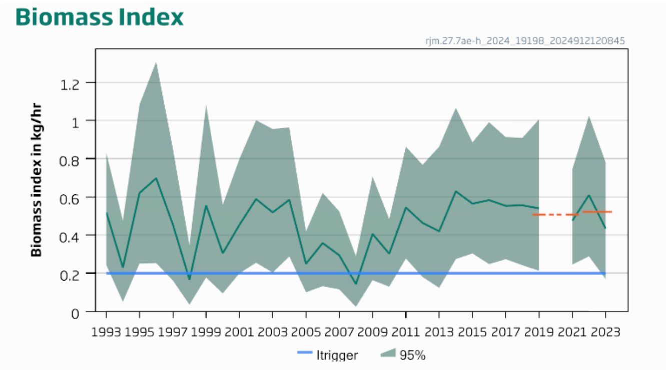


Figure 18.4c. Skates and rays in the Celtic Seas. UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3) mean CPUE (individuals of ≥ 50 cm in total length) of *Raja montagui* in divisions 7.a, e-h for 1993–2021. Red lines give average for 2019–2021 and for 2022-2023. The 2020 survey was not included in the assessment as it did not cover the usual range (Silva, 2022a).

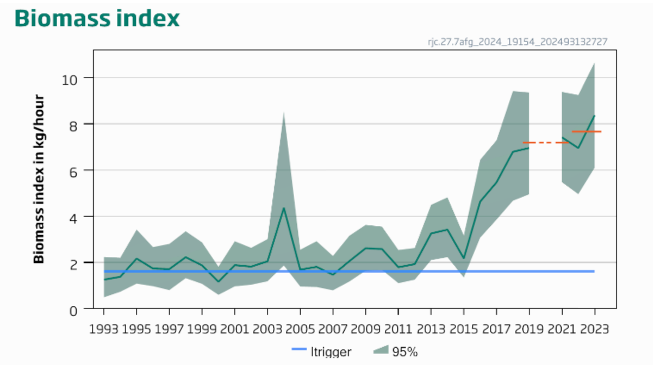


Figure 18.4d. Skates and rays in the Celtic Seas. UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3) mean CPUE (individuals of ≥ 50 cm in total length) of *Raja clavata* in divisions 7.a, f-g for 1993–2023. Red lines give average for 2019–2021 and for 2022-2023. The 2020 survey was not included in the assessment as it did not cover the usual range (Silva, 2022a).

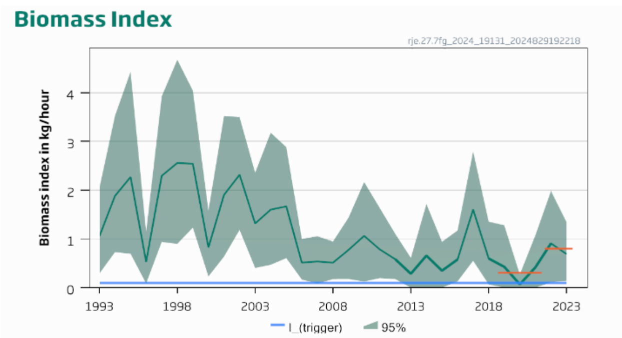


Figure 18.4e. Skates and rays in the Celtic Seas. UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3) mean CPUE (individuals of ≥ 50 cm in total length, kg.hr^{-1}) of *Raja microocellata* in divisions 7.f-g for 1993–2023. The horizontal lines show the mean stock-size indicator for 2019–2021 and 2022–2023.

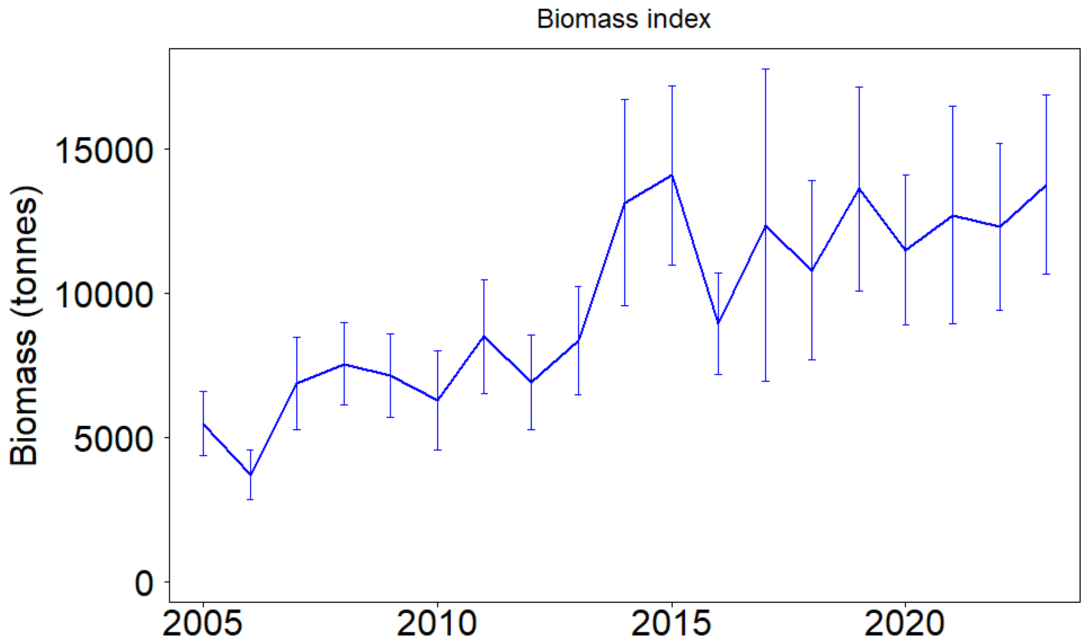


Figure 18.4f. Skates and rays in the Celtic Seas. Combined index of the exploitable biomass (individuals of ≥ 50 cm in total length) of cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd; years 2005–2023).

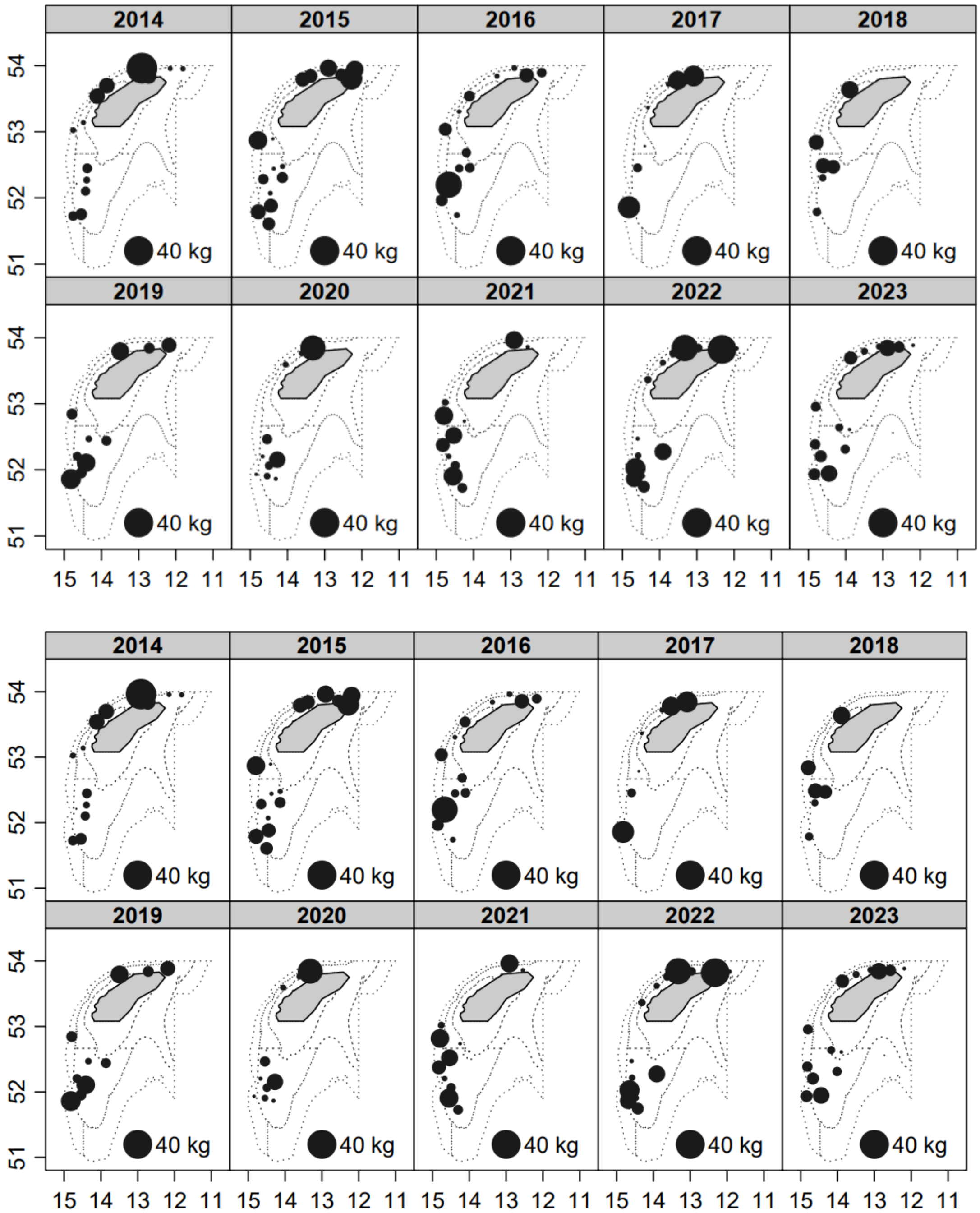


Figure 18.5a. Skates and rays in the Celtic Seas. Geographical distribution of cuckoo ray (*Leucoraja naevus*; top) and sandy ray (*Leucoraja circularis*; bottom) catches (kgx30 min haul^{-1}) in Porcupine survey over the last decade time-series (2014-2023) (Fernández-Zapico *et al.*, 2024WD).

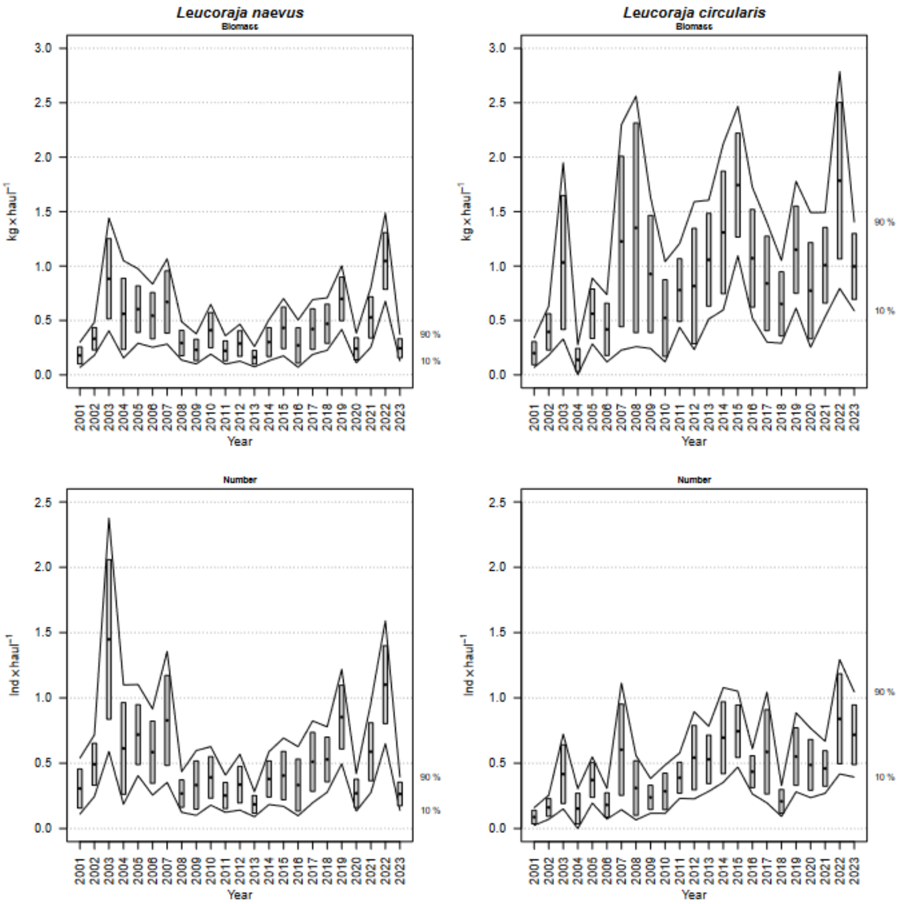


Figure 18.5b. Skates and rays in the Celtic Seas. Evolution of biomass and abundance indices of cuckoo ray (*Leucoraja naevus)* and sandy ray (*Leucoraja circularis*) in Porcupine surveys (2001–2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (Fernández-Zapico *et al.*, 2024WD).

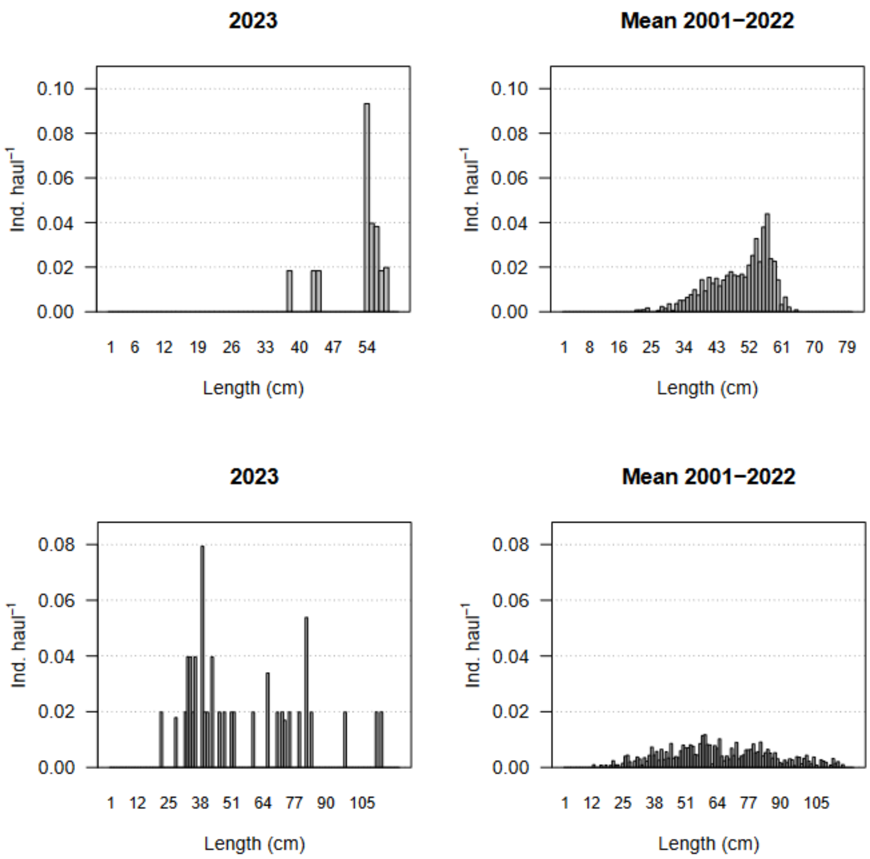


Figure 18.5c. Skates and rays in the Celtic Seas. Stratified length distributions of cuckoo ray (*Leucoraja naevus*) (top) and sandy ray (*Leucoraja circularis*) (bottom) in the last Porcupine survey, and mean values of the time series of the Porcupine survey (Fernández-Zapico *et al.*, 2024WD).

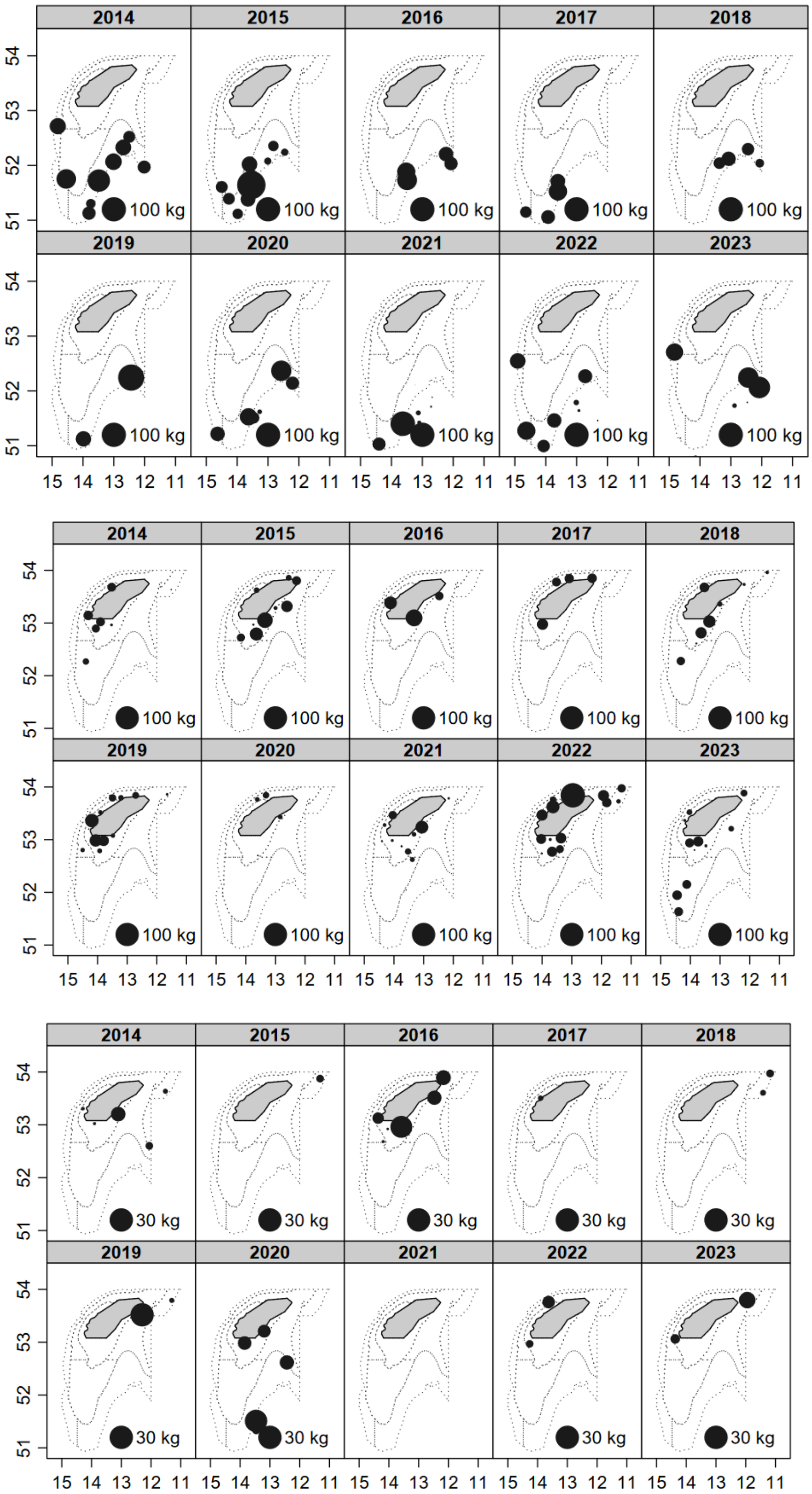


Figure 18.5d. Skates and rays in the Celtic Seas. Geographical distribution of *Dipturus nidarosiensis* (top), *D. batis* (middle) and *D. intermedius* (bottom) catches (kg x 30 min haul^{-1}) in the Porcupine surveys over the last decade (2014–2023) (Fernández-Zapico *et al.*, 2024WD).

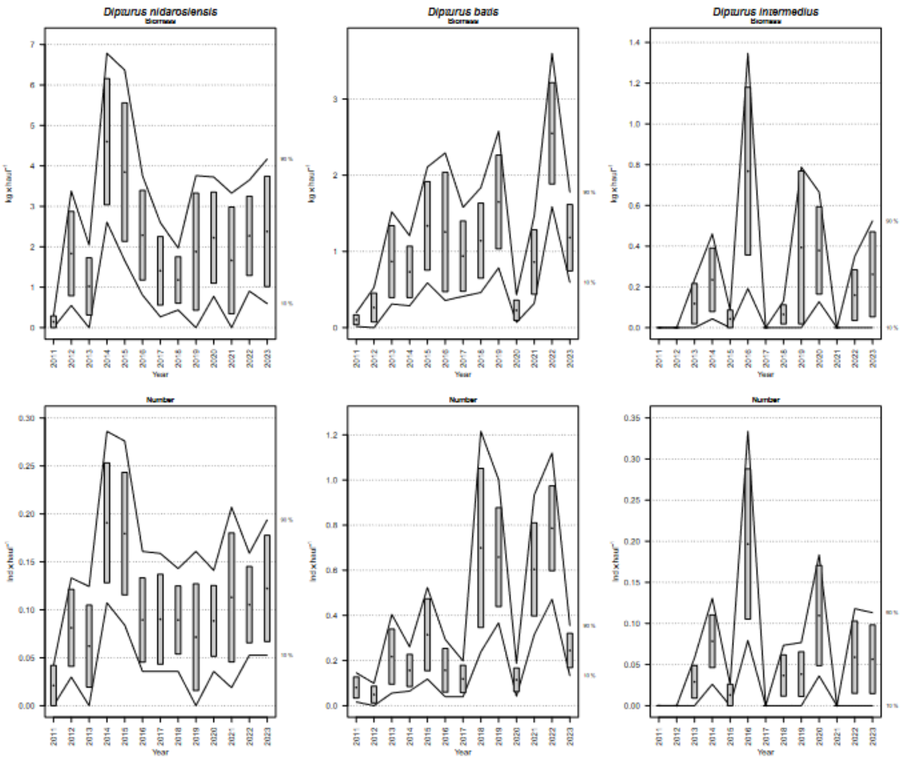


Figure 18.5e. Skates and rays in the Celtic Seas. Evolution of biomass and abundance indices of *Dipturus nidarosiensis*, *Dipturus batis* and *Dipturus intermedius* in the Porcupine surveys (2011–2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (Fernández-Zapico *et al.*, 2024WD).

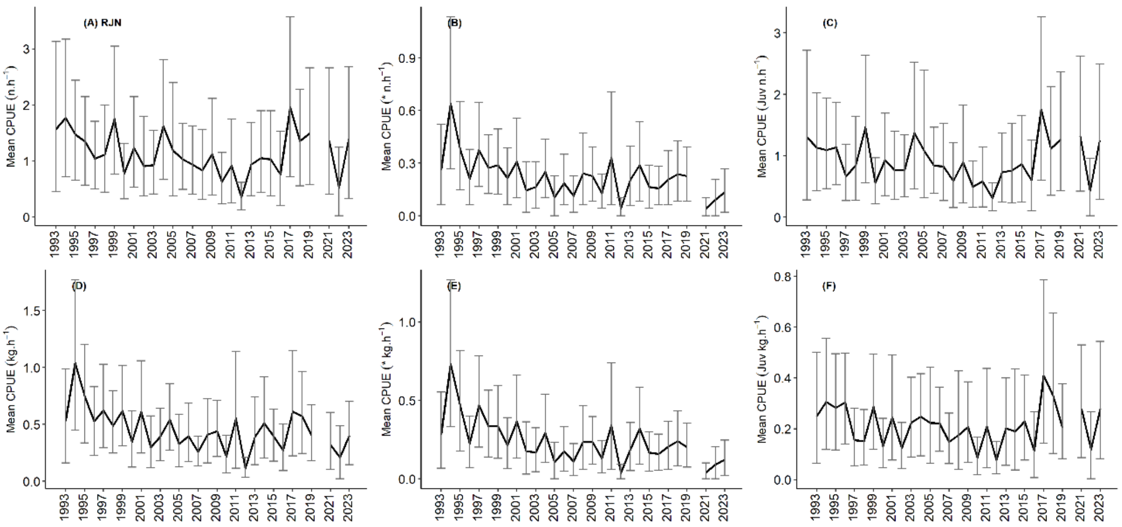


Figure 18.6a. Skates and rays in the Celtic Seas. Temporal trends (1993–2023) in the mean CPUE and associated confidence intervals (95%CI) by (A) individuals (n.h^{-1}), (B) individuals ≥50 cm L_T (*n.h^{-1}), (C) individuals <50 cm L_T (Juv n.h^{-1}), (D) biomass (kg.h^{-1}), € biomass ≥50 cm L_T (*kg.h^{-1}) and (F) biomass <50 cm L_T (Juv kg.h^{-1}) of cuckoo ray *L. naveus* in the 7.af-g beam trawl survey (EngW-BTS-Q3). Note: Index covers divisions 7.a.f-g. Estimates for 2020 not provided as survey area limited to 7.f-g. Different y-axis (Source: DATRAS, retrieval date 10th May 2024).

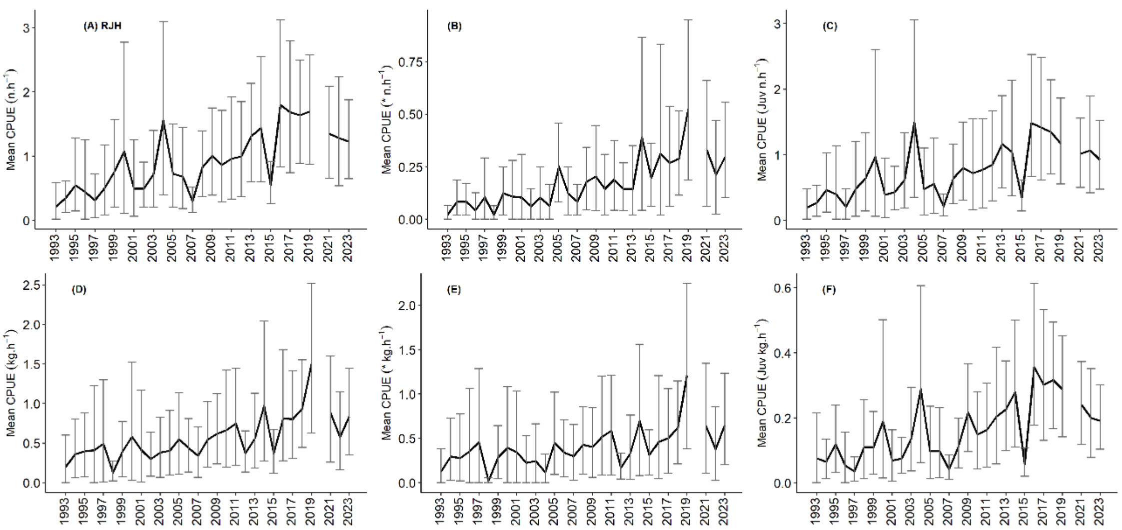


Figure 18.6b. Skates and rays in the Celtic Seas. Temporal trends (1993–2023) in the mean CPUE and associated confidence intervals (95%CI) by (A) individuals (n.h^{-1}), (B) individuals ≥50 cm L_T (*n.h^{-1}), (C) individuals <50 cm L_T (Juv n.h^{-1}), (D) biomass (kg.h^{-1}), (E) biomass ≥50 cm L_T (*kg.h^{-1}) and (F) biomass <50 cm L_T (Juv kg.h^{-1}) of blonde ray *R. brachyura* in the 7.af-g beam trawl survey (EngW-BTS-Q3). Note: Index covers divisions 7.a.f-g. Estimates for 2020 not provided as survey area limited to 7.f-g. Different y-axis (Source: DATRAS, retrieval date 10th May 2024).

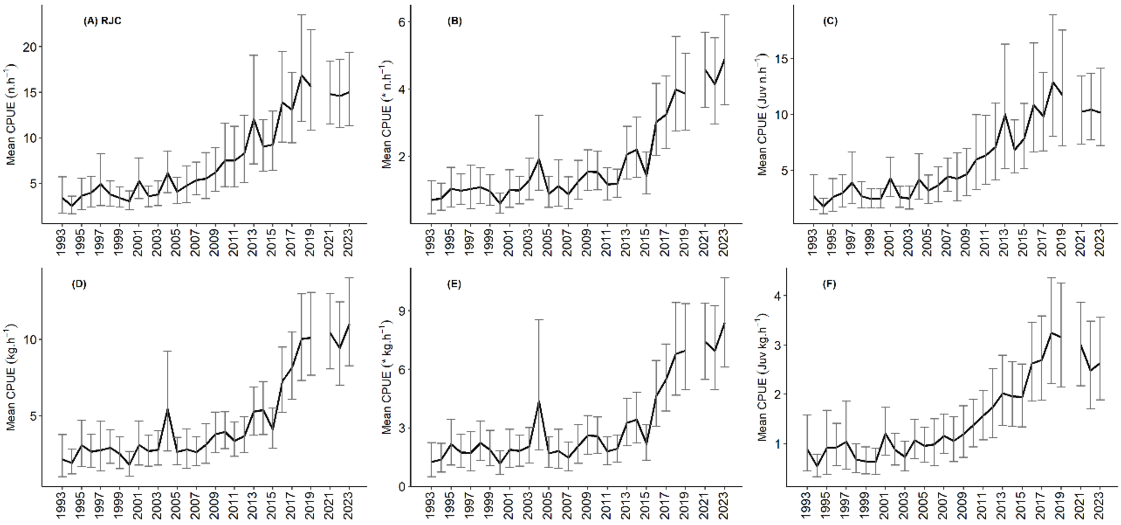


Figure 18.6c. Skates and rays in the Celtic Seas. Temporal trends (1993–2023) in the mean CPUE and associated confidence intervals (95%CI) by (A) individuals (n.h^{-1}), (B) individuals ≥50 cm L_T (*n.h^{-1}), (C) individuals <50 cm L_T (Juv n.h^{-1}), (D) biomass (kg.h^{-1}), (E) biomass ≥50 cm L_T (*kg.h^{-1}) and (F) biomass <50 cm L_T (Juv kg.h^{-1}) of thornback ray *R. clavata* in the 7.af-g beam trawl survey (EngW-BTS-Q3). Note: Index covers divisions 7.a.f-g. Estimates for 2020 not provided as survey area limited to 7.f-g. Different y-axis (Source: DATRAS, retrieval date 10th May 2024).

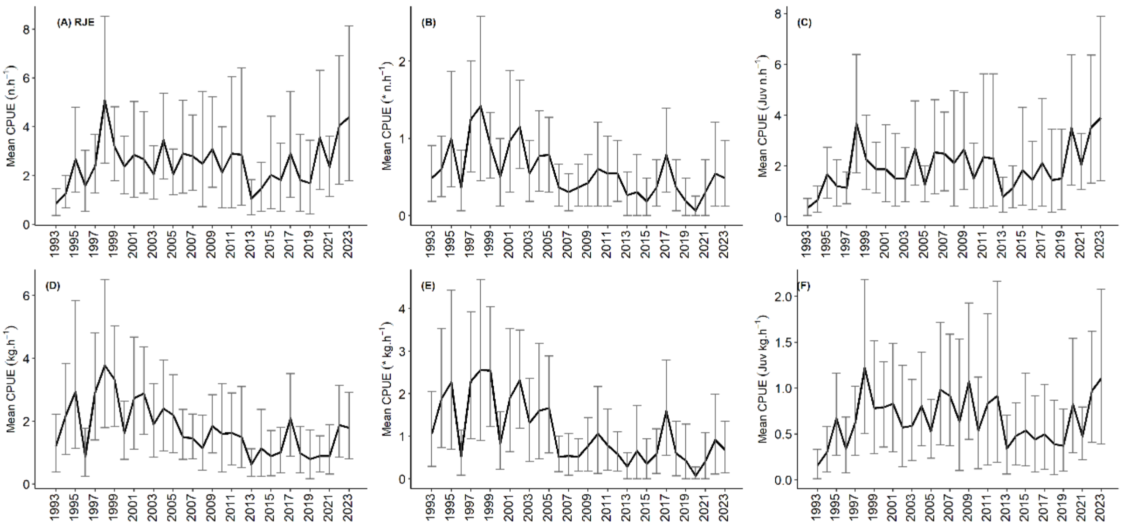


Figure 18.6d. Skates and rays in the Celtic Seas. Temporal trends (1993–2023) in the mean CPUE and associated confidence intervals (95%CI) by (A) individuals (n.h^{-1}), (B) individuals ≥50 cm L_T (*n.h^{-1}), (C) individuals <50 cm L_T (Juv n.h^{-1}), (D) biomass (kg.h^{-1}), (E) biomass ≥50 cm L_T (*kg.h^{-1}) and (F) biomass <50 cm L_T (Juv kg.h^{-1}) of small-eyed ray *R. microocellata* in the 7.af-g beam trawl survey (EngW-BTS-Q3). Note: Index covers only divisions 7.f-g. Different y-axis (Source: DATRAS, retrieval data 10th May 2024).

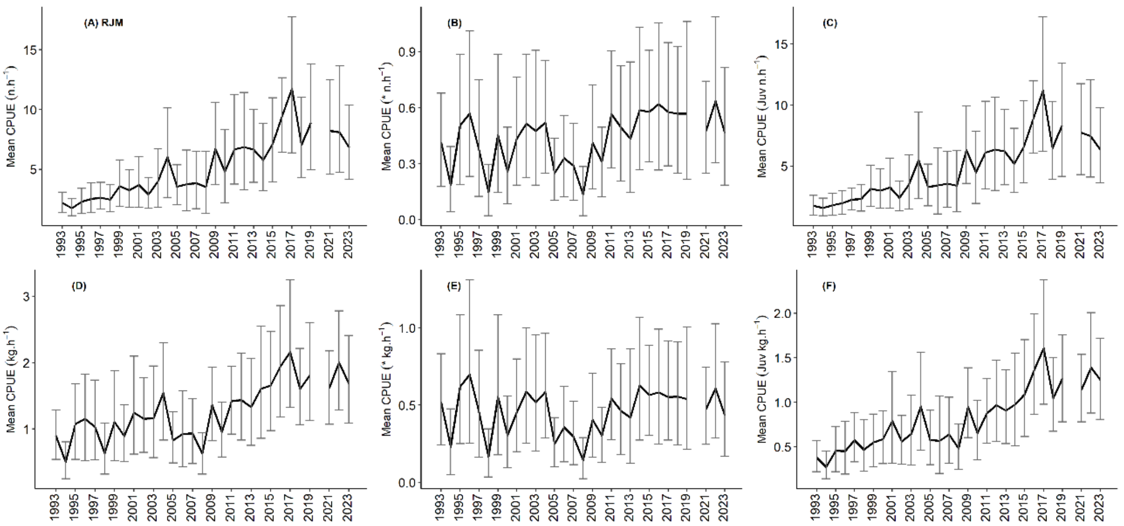
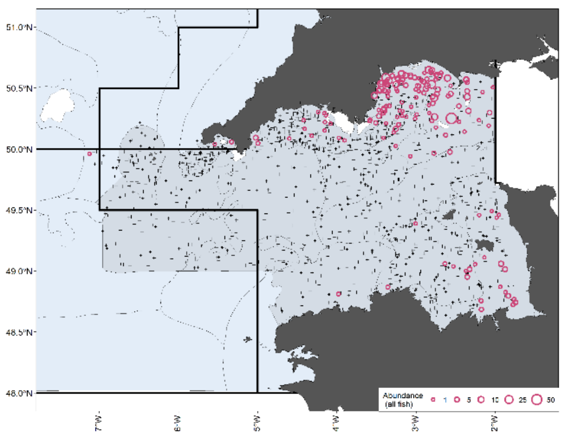
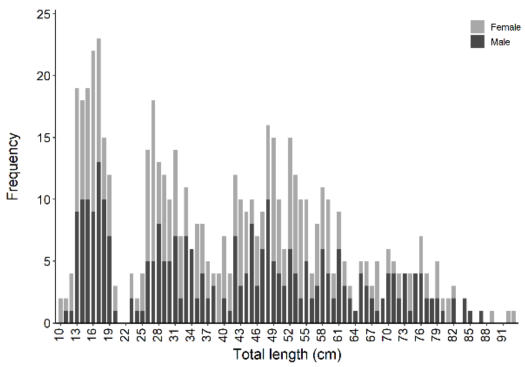


Figure 18.6e. Skates and rays in the Celtic Seas. Temporal trends (1993–2023) in the mean CPUE and associated confidence intervals (95%CI) by (A) individuals (n.h^{-1}), (B) individuals ≥50 cm L_T (*n.h^{-1}), (C) individuals <50 cm L_T (Juv n.h^{-1}), (D) biomass (kg.h^{-1}), (E) biomass ≥50 cm L_T (*kg.h^{-1}) and (F) biomass <50 cm L_T (Juv kg.h^{-1}) of spotted ray *R. montagui* in the 7.af-g beam trawl survey (EngW-BTS-Q3). Note: Index covers divisions 7.a.f-g. Estimates for 2020 not provided as survey area limited to 7.f-g. Different y-axis (Source: DATRAS, retrieval date 10th May 2024).





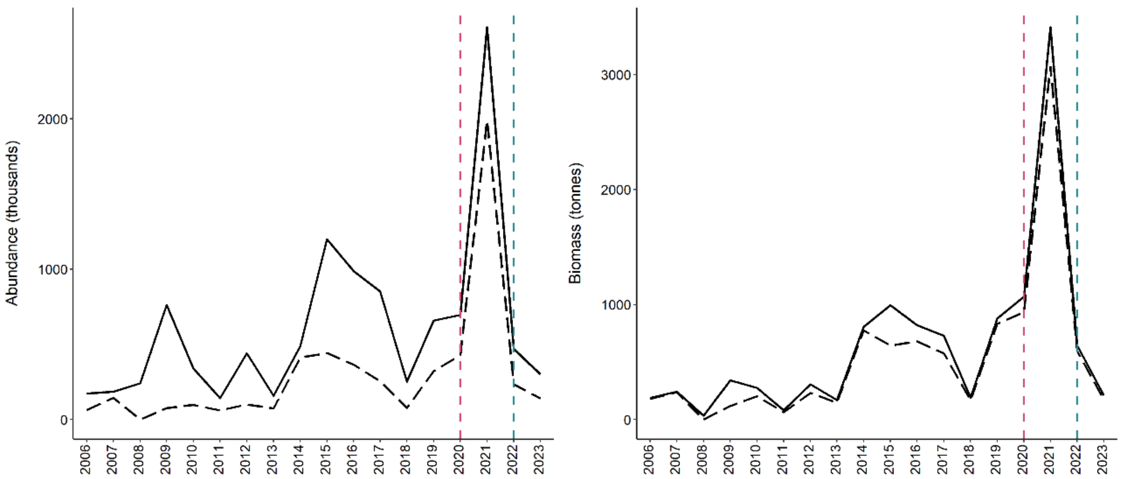


Figure 18.7a. Skates in the Celtic Sea. Distribution and relative abundance (top left) and length-frequency by sex (top right) of thornback ray *Raja clavata* in the Q1SWECOS trawl survey. Preliminary estimates of total abundance (numbers in thousands, bottom left) and total biomass (tonnes, bottom right) for *R. clavata*. Note: Different y-axes. Continuous line relates to all specimens, black dashed line relates to individuals ≥50 cm L_T. Dashed pink vertical line represents year when survey was conducted in June instead of Q1, dashed green vertical line represents year when reduced survey coverage within Division 7.e (Source: WGEF 2024 data call, DATRAS retrieval date 16th May 2024).

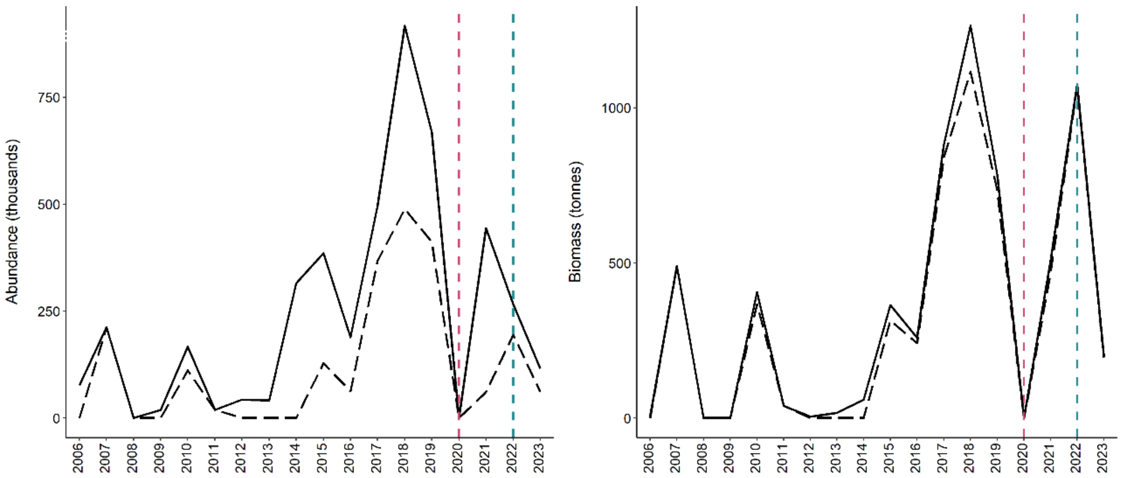


Figure 18.7b. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers in thousands) and total biomass (tonnes) for common skate *Dipturus batis*-complex. Note: Different y-axes. Continuous line relates to all specimens, black dashed line relates to individuals ≥50 cm L_T. Dashed pink vertical line represents year when survey was conducted in June instead of Q1, dashed green vertical line represents year when reduced survey coverage within Division 7.e (Source: WGEF 2024 data call, DATRAS retrieval date 16th May 2024).

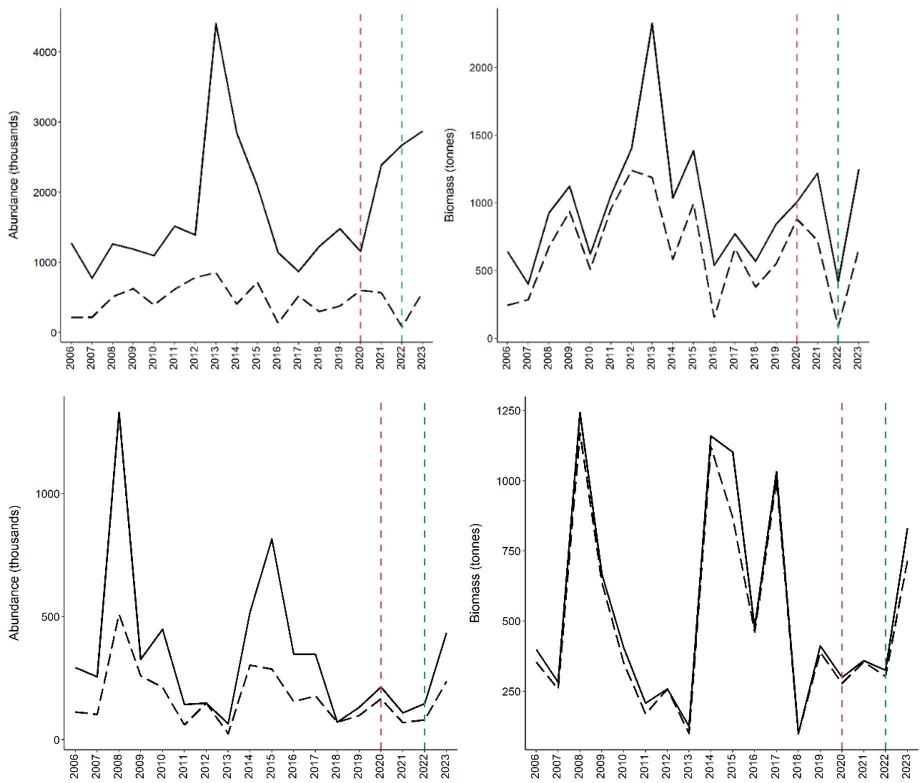


Figure 18.7c. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers in thousands) and total biomass (tonnes) for (top) cuckoo ray *Leucoraja naevus* and (bottom) blonde ray *Raja brachyura*. Note: Different y-axes. Continuous line relates to all specimens, black dashed line relates to individuals ≥50 cm L_T. Dashed pink vertical line represents year when survey was conducted in June instead of Q1, dashed green vertical line represents year when reduced survey coverage within Division 7.e (Source: WGEF 2024 data call, DATRAS retrieval date 16th May 2024).

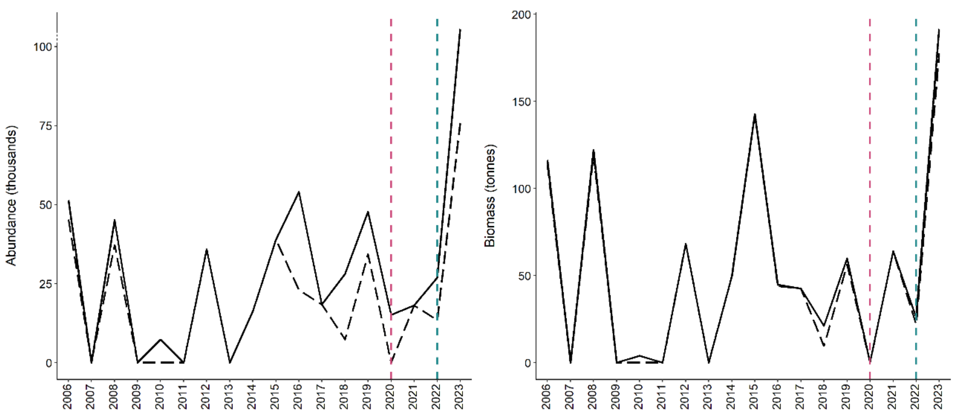


Figure 18.7d. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers in thousands) and total biomass tonnes) for small-eyed ray *Raja microocellata*. Note: Different y-axes. Continuous line relates to all specimens, black dashed line relates to individuals ≥50 cm L_T. Dashed pink vertical line represents year when survey was conducted in June instead of Q1, dashed green vertical line represents year when reduced survey coverage within Division 7.e (Source: WGEF 2024 data call, DATRAS retrieval date 16th May 2024).

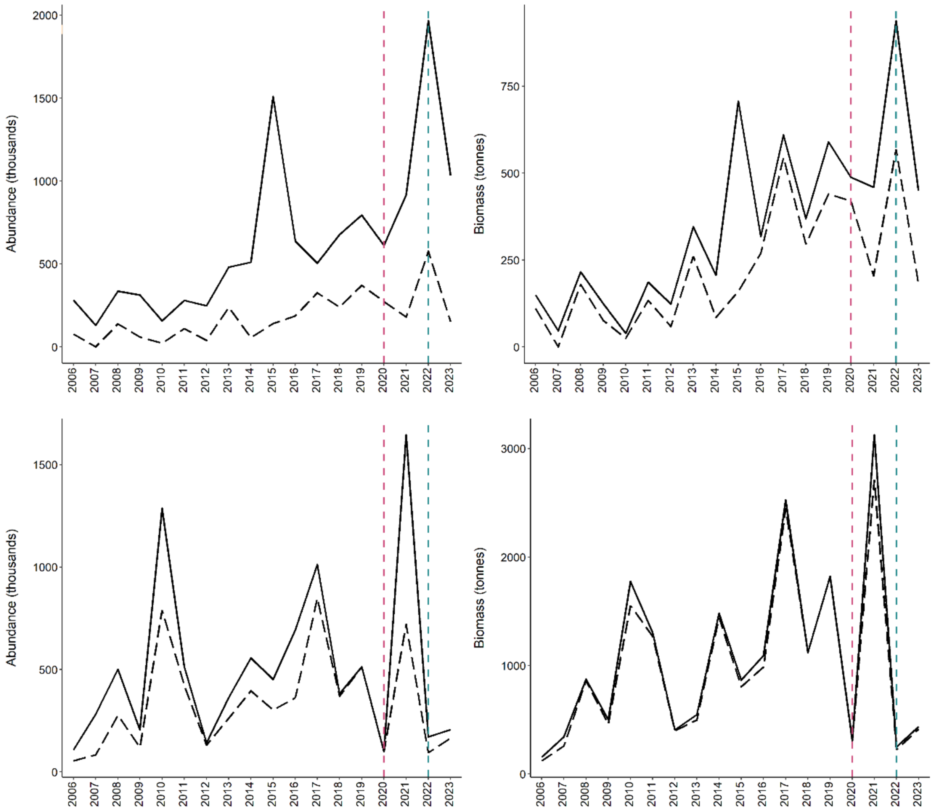


Figure 18.7e. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers in thousands) and total biomass (tonnes) for (top) spotted ray *Raja montagui* and (bottom) undulate ray *Raja undulata*. Note: Data for 2020 for undulate ray showed only for illustrative purposes and should be viewed with caution. Different y-axes. Continuous line relates to all specimens, black dashed line relates to individuals ≥50 cm L_T. Dashed pink vertical line represents year when survey was conducted in June instead of Q1, dashed green vertical line represents year when reduced survey coverage within Division 7.e (Source: WGEF 2024 data call, DATRAS retrieval date 16th May 2024).

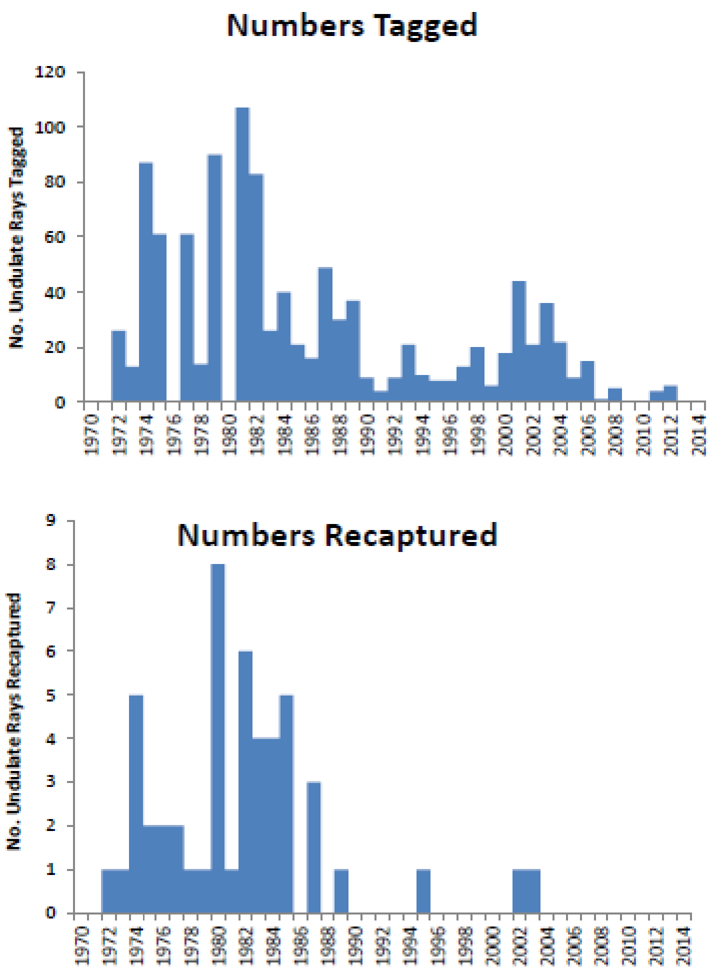


Figure 18.8. Skates in the Celtic Seas. Numbers of *Raja undulata* tagged (top) and recaptured (bottom) in Tralee Bay and surroundings, 1970–2014. Source: Wögerbauer *et al.*, 2014 WD.

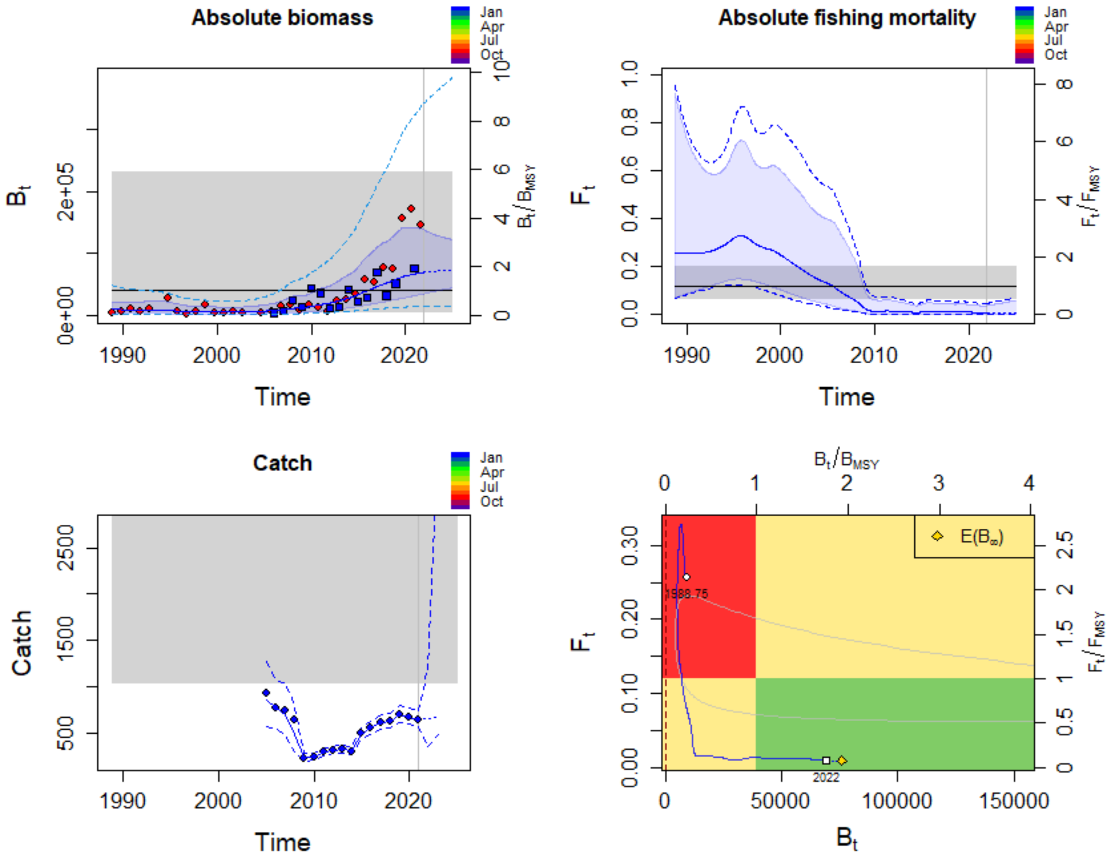


Figure 18.9. Time series of biomass, fishing mortality and catch, as well as Kobe plot estimated from the SPiCT assessment of undulate ray (rju.27.7de). Envelopes represent 95% confidence intervals around estimated values.

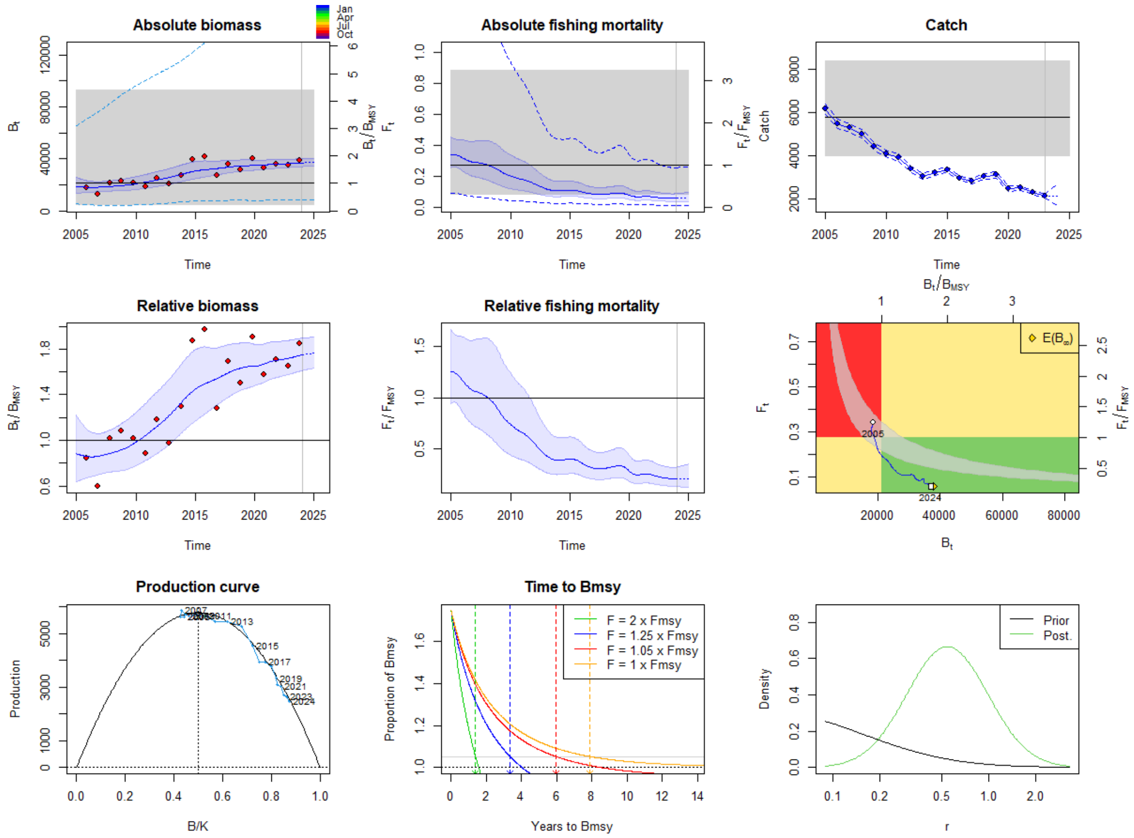


Figure 18.10. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). Time series of biomass, fishing mortality and catch, as well as Kobe plot, production curve estimated from the SPiCT assessment running in 2024 with different short-term forecast scenarios. The vertical grey lines in the absolute/relative biomass, absolute/relative fishing mortality and catch plots indicate the intermediate year (2024) and the horizontal lines show the corresponding reference points (MSY, B/B_{MSY}=0.5 and F/F_{MSY}=1). The envelopes represent 95% confidence intervals.

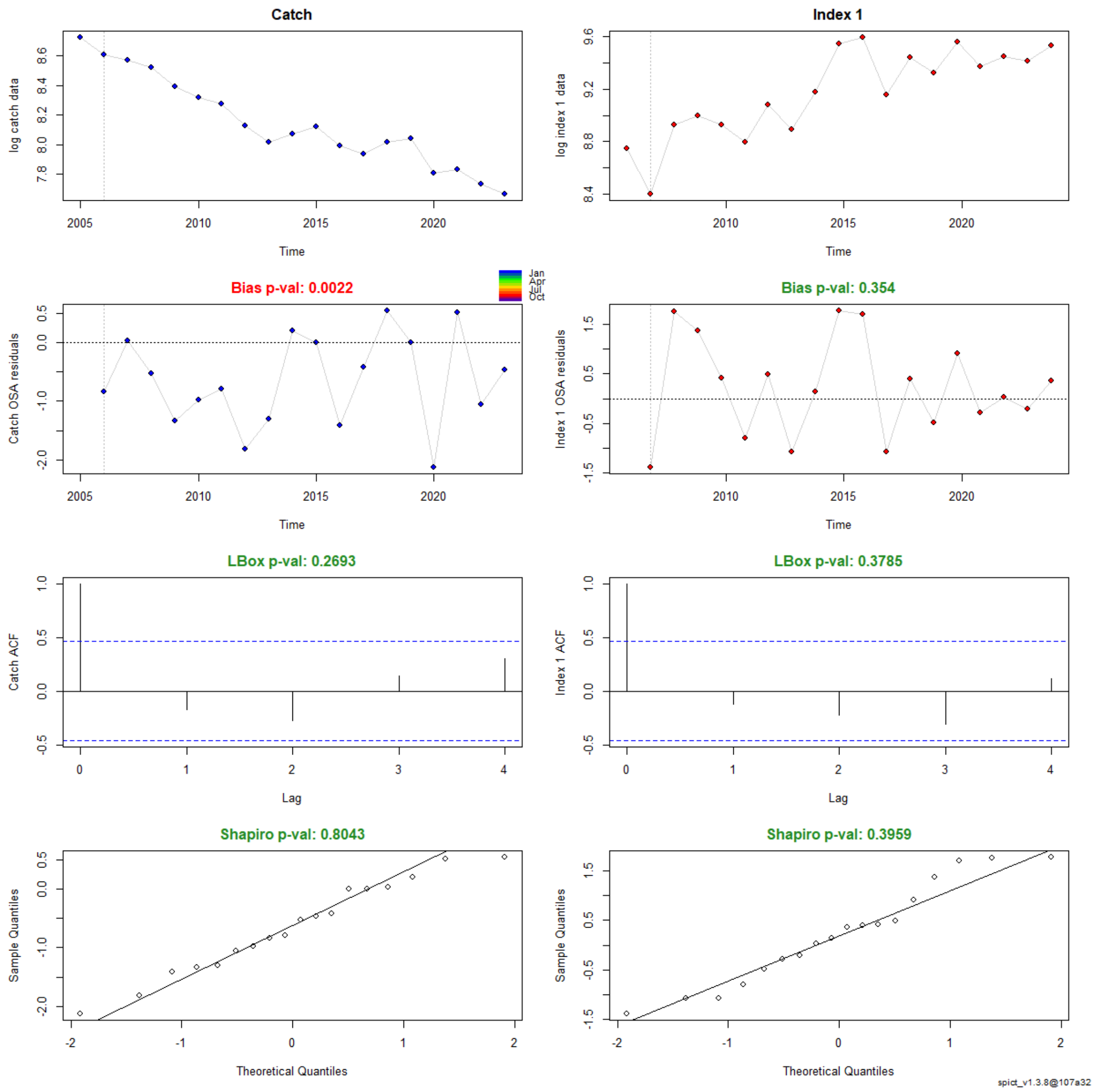


Figure 18.11. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). Evaluation of the SPiCT assessment run in 2024. The residual diagnostics are shown for the two input time series (catch: left, exploitable biomass index: right). From the top to bottom it is shown: the log-transformed input time series, the one-step-ahead residuals with a bias test, the autocorrelation function with a Ljung-Box test, and a QQ-plot with a Shapiro test for normality.

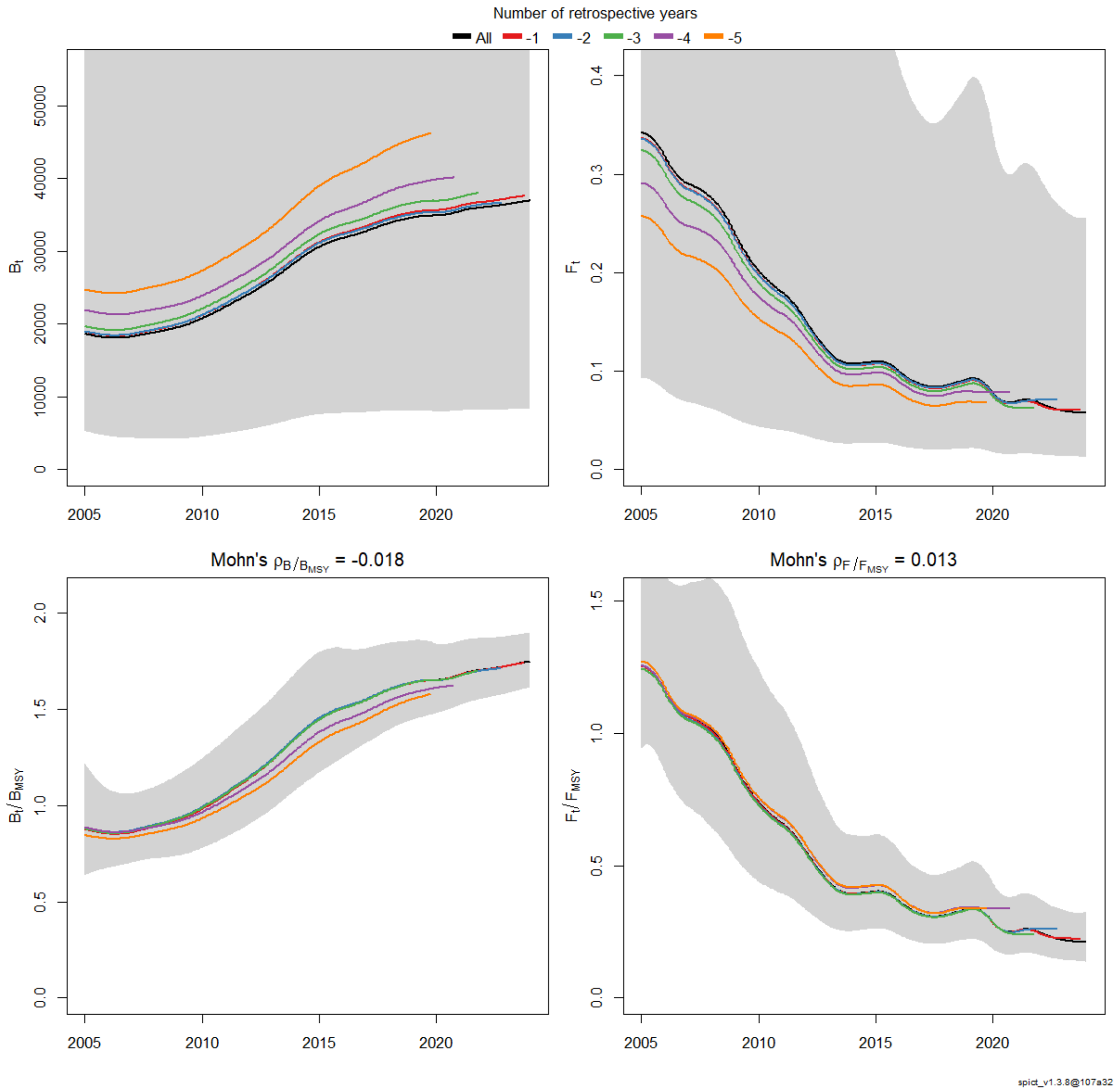


Figure 18.12. Skates and rays in the Celtic Seas. Cuckoo ray (*Leucoraja naevus*) in 27.678abd (rjn.27.678abd). SPiCT model retrospective analysis showing the baseline (black lines) with 95% confidence intervals (shaded area). This analysis is done by removing consecutively the last five years of the available data and fitting the model (coloured lines). The Mohn's rho for the relative quantities is shown on top of their corresponding panels.

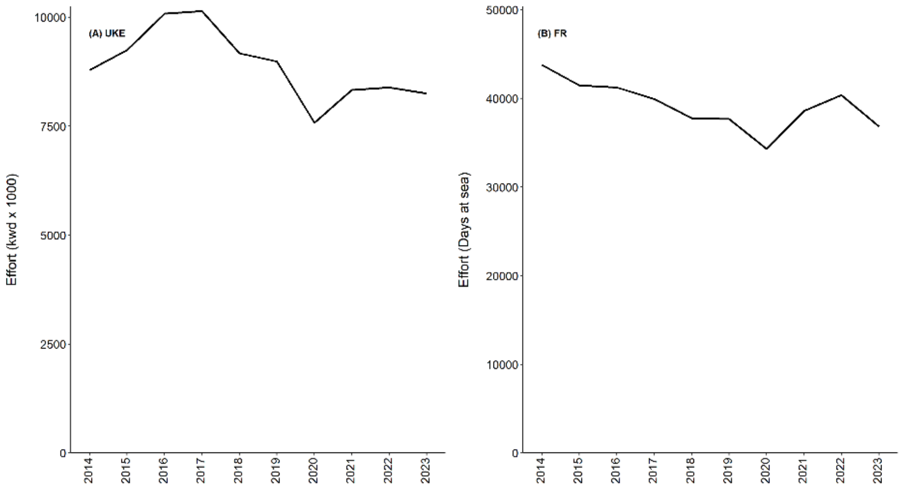


Figure 18.13a. Skates in the Celtic Sea. Thornback ray (*Raja clavata*) and fishing effort in Division 7.e during 2014–2023 for (left) UK (E&W) in kW*day (Days being fishing days, all fleets) and (right) France (fishing vessels < 24m catching more than 1% of thornback ray) in days (Days being days at sea). Source: UK(E&W) data request to WGEF in 2024, French data provided to ICES MIXFISH.

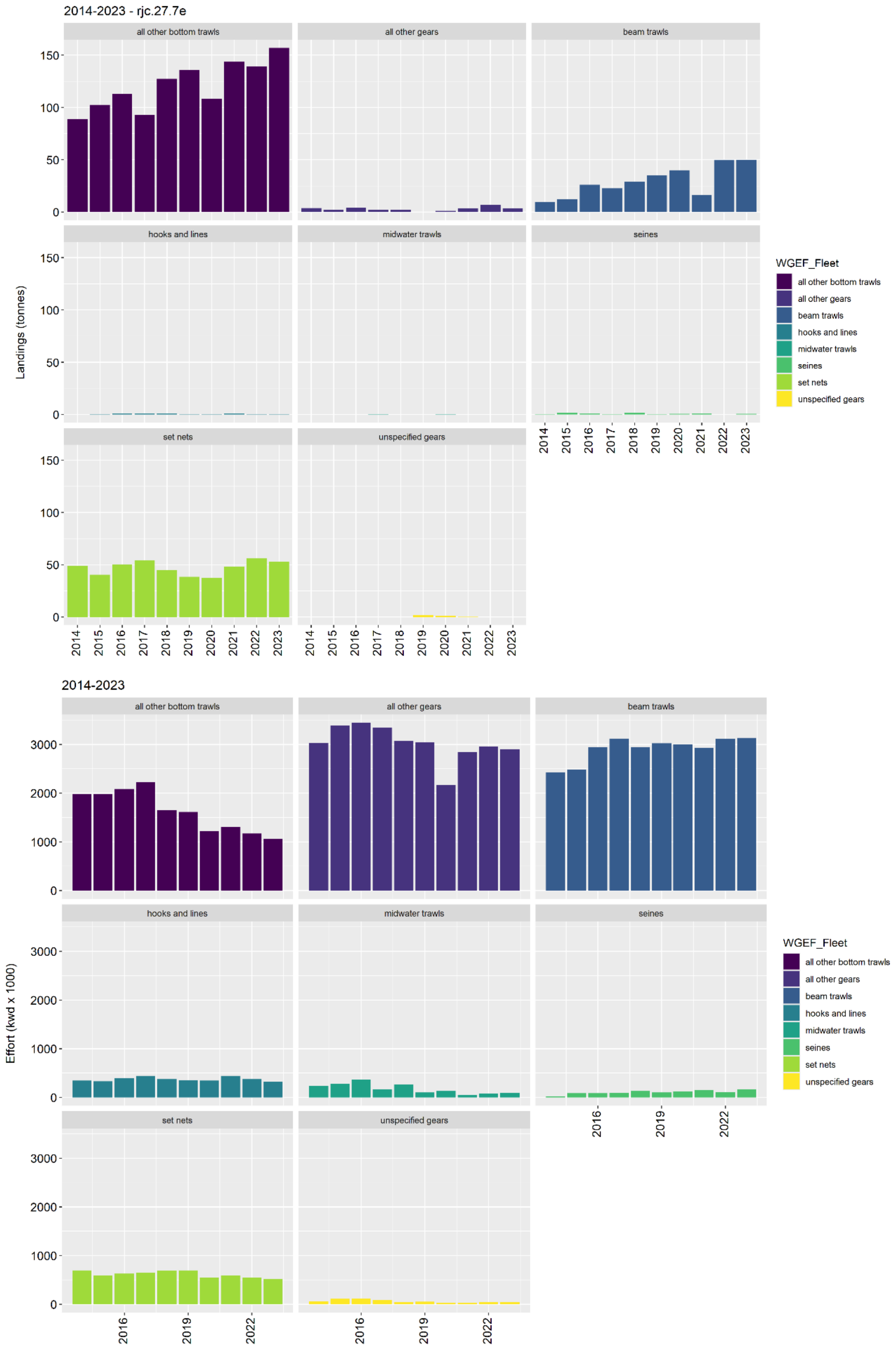


Figure 18.13b. Skates in the Celtic Sea. Thornback ray (*Raja clavata*) (top) landings (in tonnes) in Division 7.e by WGEF fleet during 2014–2023 for UK and (bottom) fishing effort in Division 7.e by WGEF fleet during 2014–2023 for UK (E&W) in kW*day (Days being fishing days, all fleets). Source: UK(E&W) data request to WGEF in 2024. Note: Landings are shown for UK as a whole as historical data are aggregated across nations though, considered representative as UK(E&W) is the main contributor for landings of this species in 7.e.

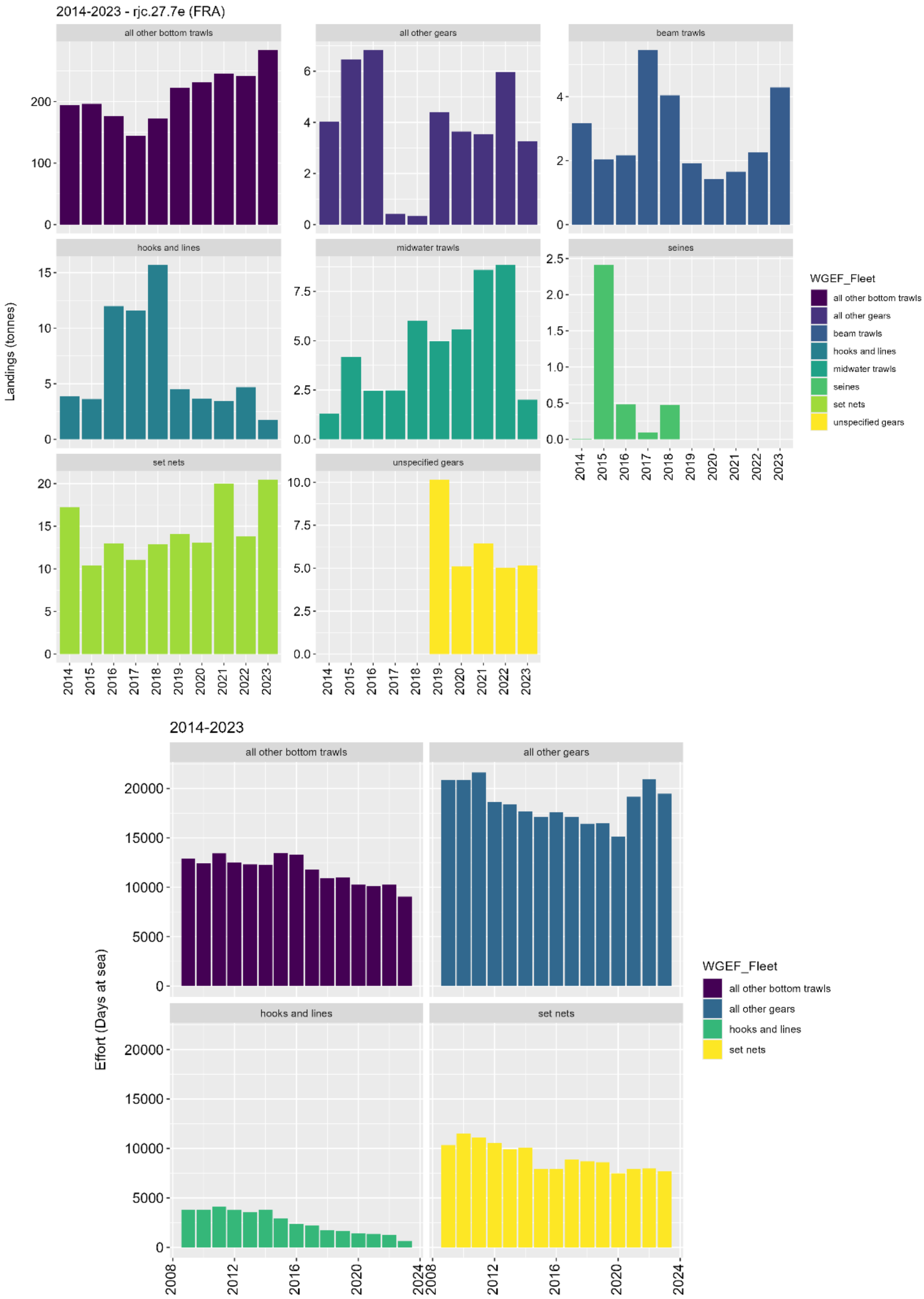


Figure 18.13c. Skates in the Celtic Sea. Thornback ray (*Raja clavata*) (top) landings (in tonnes) in Division 7.e by WGEF fleet during 2014–2023 for France (all fleets) and (bottom) fishing effort in Division 7.e by WGEF fleet during 2014–2023 for France (fishing vessels < 24m catching more than 1% of thornback ray) in days (Days being days at sea). Source: French data provided to ICES MIXFISH. Note: Top panel different y-axis.

18.16 Appendix 1 – rfb method calculations by stock

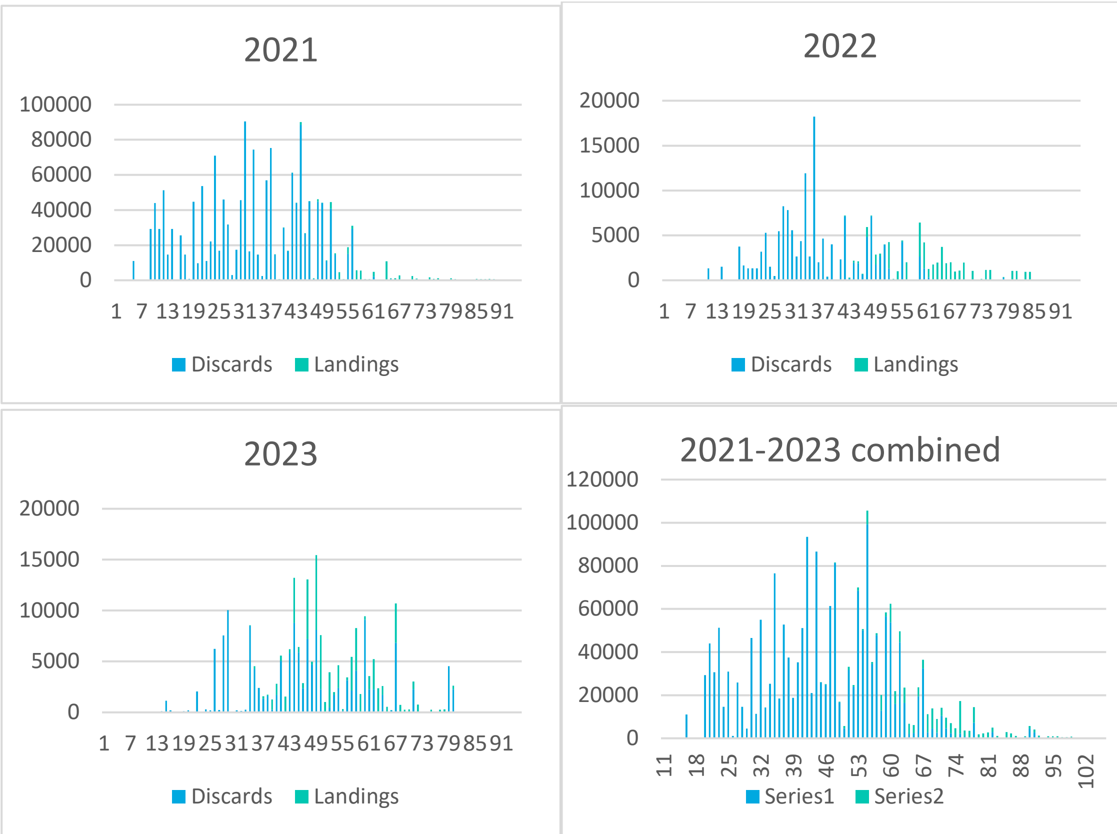
18.16.1 Rjc.27.6

ICES framework for category 3 stocks was applied (rfb rule, method 2.1; ICES, 2024a). A survey biomass index was used as an indicator of stock size. The advice is based on the recent advised landings (2023-2024, issued in 2022), multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and applied to limit the reduction in landings advice to 30%.

Year	Stock-size indicator			Landings
	Low	Biomass index ($kg.km^{-2}$)	High	(tonnes)
2005	0	3.74	7.64	64
2006	2.48	5.92	9.36	78
2007	1.25	5.57	9.88	73
2008	2.75	7.61	12.48	82
2009	2.75	7.27	11.79	114
2010	3.74	17.95	32.17	120
2011	4.95	13.78	22.61	141
2012	3.28	22.9	42.52	181
2013	3.51	15.68	27.85	241
2014	1.37	12.85	24.32	236
2015	4	14.34	24.68	213
2016	3.61	23.37	43.13	260
2017	7.09	15.77	24.45	293
2018	5.76	16.22	26.68	338
2019	3.66	16.16	28.67	416
2020	1.27	4.03	6.78	315
2021	2.9	11.84	20.78	267
2022	2.16	7.29	12.41	232
2023	1.34	6.06	10.78	261

Parameters used in the assessment

Commercial discard and landings length information were examined. Because recent sampling levels were low, it was decided to pool length data from 2021-2023.

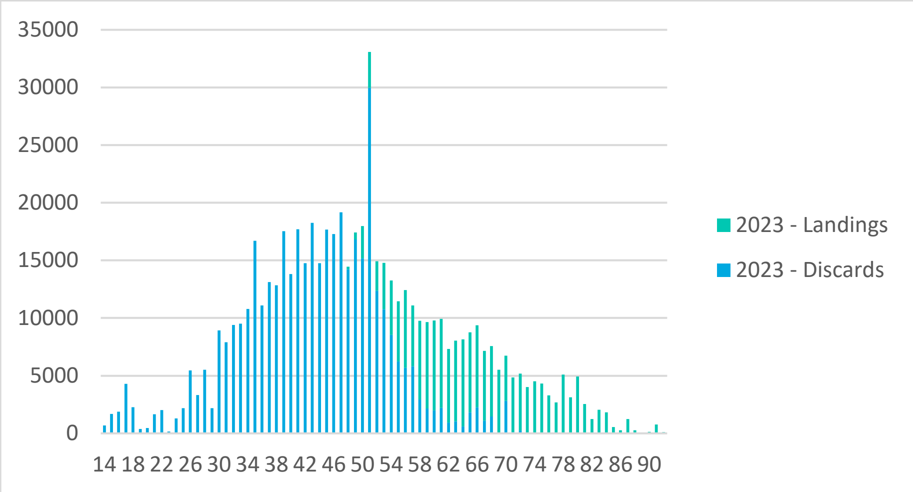


Length data used in the assessment.

Previous landings advice Ay (2023- 2024 Issued in 2022)		96 tonnes
Stock biomass trend		
Index A (2022,2023)		6.67 kg hr^{-1}
Index B (2019, 2020, 2021)		10.68 kg hr^{-1}
r: stock biomass trend (index ratio A/B)		0.62
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022\text{-}2023}$)		58.74 cm
MSY proxy length ($L_{F=M}$)		52.75 cm
Fishing pressure proxy ($L_{F=M}$ /L_{mean})		0.90
f: multiplier for relative mean length in catches (L_{mean} /$L_{F=M}$)		1.11
Biomass safeguard		
Last index value (I_{2023})		6.1 kg hr^{-1}
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		5.2 kg hr$_{-1}$
b: index relative to trigger value, min{$I_{2023}/I_{trigger}$, 1}		1.00
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
RFB calculation**		58 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Applied	0.7
Discard rate		Not available
Landings advice for 2025–2026 ***		67 tonnes
% advice change ^		-30%

18.16.2 Rjc.27.7afg

Length frequencies from 2021-2023 were examined. It was decided that there were sufficient lengths to use 2023 data only. The UK (E&W)-BTS-Q3 survey estimate for 2020 was excluded from the analysis, as due to the COVID-19 this survey did not cover the usual area (Silva, 2022a).



Length frequency (2023)

Year	Stock-size indicator			Landings
	Low	Biomass index (kg h^{-1})	High	(tonnes
1993	0.49	1.26	2.2	
1994	0.73	1.38	2.2	
1995	1.08	2.2	3.4	
1996	0.97	1.74	2.7	
1997	0.80	1.72	2.8	
1998	1.32	2.2	3.4	
1999	1.07	1.87	2.9	
2000	0.60	1.17	1.82	
2001	0.97	1.89	2.9	
2002	1.04	1.82	2.6	
2003	1.18	2	3	
2004	1.87	4.4	8.5	
2005	0.96	1.69	2.6	379
2006	0.94	1.81	2.9	264
2007	0.79	1.47	2.3	238
2008	1.17	2.1	3.2	713
2009	1.64	2.6	3.6	671
2010	1.68	2.6	3.6	780
2011	1.10	1.79	2.5	944
2012	1.25	1.93	2.6	1165
2013	2.1	3.3	4.5	1048
2014	2.2	3.4	4.8	790
2015	1.35	2.2	3.2	903
2016	3.1	4.6	6.5	861
2017	3.9	5.5	7.3	878
2018	4.7	6.8	9.2	840
2019	5.0	7	9.2	960
2020*				909

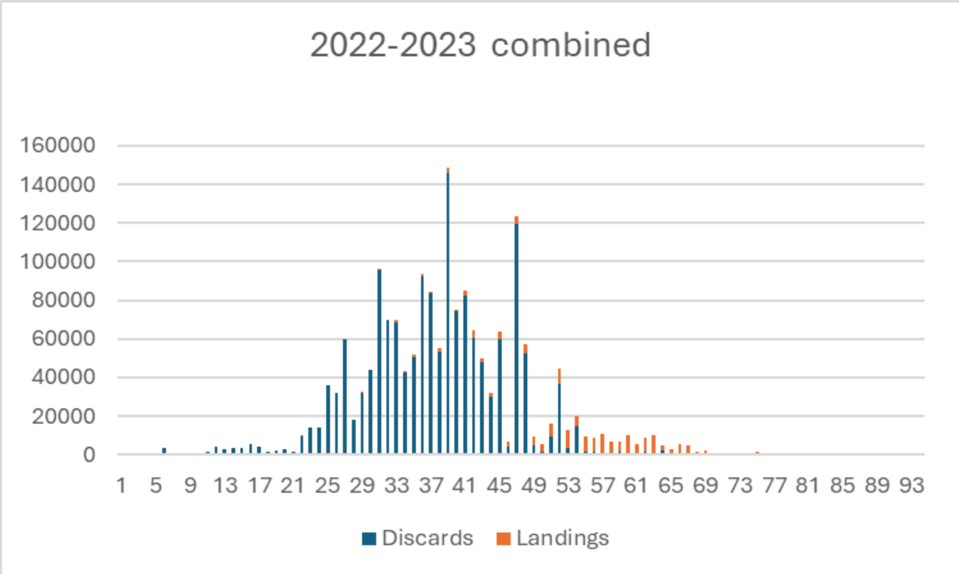
Year	Stock-size indicator			Landings (tonnes
	Low	Biomass index (kg h^{-1})	High	
2021	5.5	7.4	9.6	972
2022	5.0	7.0	9.3	1005
2023	6.1	8.4	10.7	872

Data used in the assessment. 2020 survey not included.

Previous landings advice A_y (2023-2024 issued in 2022)		1833 tonnes
Stock biomass trend		
Index A (2022,2023)		7.67 kg hr^{-1}
Index B (2019, 2021)		7.19 kg hr^{-1}
r: stock biomass trend (index ratio A/B)		1.07
Fishing pressure proxy		
Mean catch length (L_{mean} =L_{2023})		52.38 cm
MSY proxy length ($L_{F=M}$)		54.25 cm
Fishing pressure proxy ($L_{F=M}$ /L_{mean})		1.04
f: multiplier for relative mean length in catches (L_{mean} /$L_{F=M}$)		0.97
Biomass safeguard		
Last index value (I_{2023})		8.37 kg hr^{-1}
Index trigger value ($I_{trigger}$ = I_{loss} × 1.4)		1.63 kg hr^{-1}
b: index relative to trigger value, min{I_{2023}/$I_{trigger}$, 1}		1.00
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
RFB calculations**		1699 tonnes
Stability clause (+20%/−30% compared to Ay, only applied if I_{20231} ≥ $I_{trigger}$)	Not Applied	-
Discard rate		Unquantified
Landings advice for 2025-2026		1699
% advice change ***		-7.3%

18.16.3 Rjm.27.7ae-k

Length frequencies from 2019-2023 were examined. As there were limited lengths sampled in recent years, the length samples from 2022-2023 were combined into one length frequency. Lengths above 90 cm total length were excluded as considered likely to relate to *R. brachyura*.



The UK (E&W)-BTS-Q3 survey estimate for 2020 was excluded from the analysis, as due to the COVID-19 this survey did not cover the usual area (Silva, 2022a). As data for 2020 data were not used in the assessment the stock biomass trend is based on the index A of one year (2021) over Index B of the three preceding years (2017, 2018 and 2019).

The life-history parameter on L∞ used and available in FishBase of 78.4 cm (Gallagher *et al.*, 2005) is lower than the maximum length considered on the length data used in the assessment. However, the quality of data may have been hampered by confounding issues of *R. montagui* with *R. brachyura* within the dataset, and reallocation of these may be difficult to ascertain.

Year	Stock-size indicator			Landings
	Low	Biomass index ($kg.h^{-1}$)	High	(tonnes)
1993	0.26	0.52	0.83	
1994	0.051	0.23	0.49	
1995	0.27	0.62	1.09	
1996	0.26	0.70	1.27	
1997	0.136	0.46	0.88	
1998	0.035	0.166	0.33	
1999	0.164	0.56	1.08	
2000	0.084	0.30	0.56	
2001	0.196	0.45	0.77	
2002	0.25	0.59	0.98	
2003	0.198	0.52	0.94	
2004	0.30	0.58	0.92	
2005	0.111	0.25	0.42	
2006	0.125	0.36	0.64	
2007	0.118	0.29	0.51	
2008	0.023	0.143	0.30	
2009	0.177	0.41	0.69	887
2010	0.138	0.31	0.50	1110
2011	0.28	0.54	0.90	1332
2012	0.193	0.46	0.80	1344
2013	0.129	0.42	0.81	1032
2014	0.29	0.63	1.04	1042
2015	0.28	0.56	0.90	864
2016	0.24	0.58	0.99	947
2017	0.28	0.55	0.88	818
2018	0.25	0.56	0.90	1001
2019	0.189	0.54	1.00	1012
2020*				741
2021	0.25	0.48	0.74	821
2022				602
2023				502

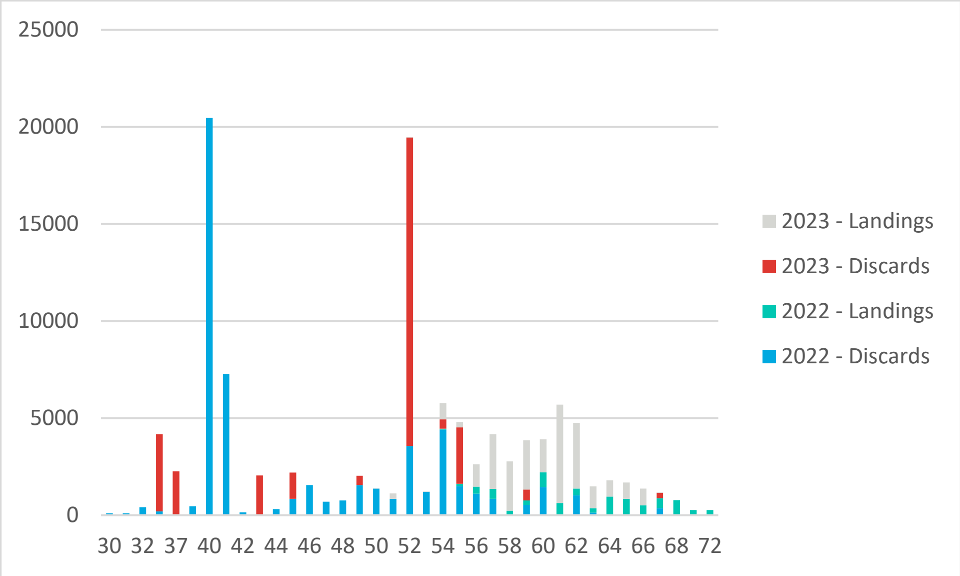
Indices used in the assessment.

Previous landings advice A_y (2023-2024 issued in 2022)	814 tonnes
Stock biomass trend	
Index A (2022,2023)	0.52 kg h^{-1}
Index B (2019, 2021)**	0.51 kg h^{-1}
r: stock biomass trend (index ratio A/B)	1.03
Fishing pressure proxy	
Mean catch length ($L_{mean} = L_{2022\text{-}2023}$)	49.11 cm
MSY proxy length ($L_{F=M}$)	48.85 cm
Fishing pressure proxy ($L_{F=M} / L_{mean}$)	0.99
f: multiplier for relative mean length in catches ($L_{mean} / L_{F=M}$)	1.01
Biomass safeguard	
Last index value (I_{2023})	0.43 kg h^{-1}
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)	0.20 kg h^{-1}
b: index relative to trigger value, min{$I_{2023}/I_{trigger}$, 1}	1

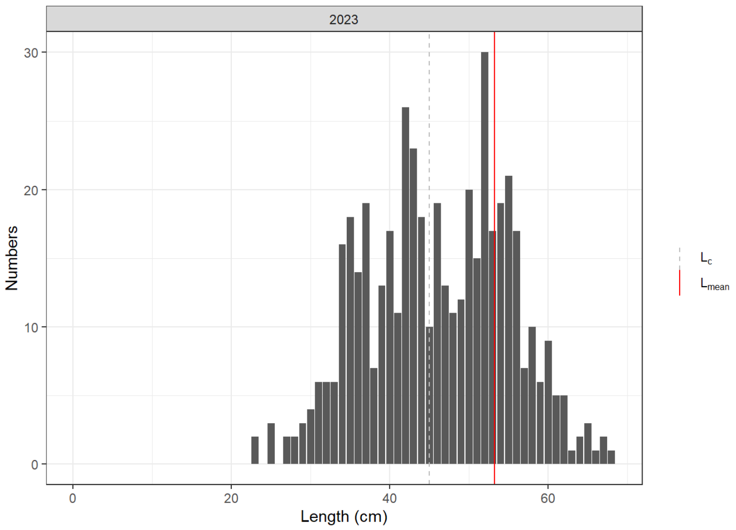
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
RFB calculation***		757 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not Applied	
Discard rate		Unquantified
Landings advice for 2025-2026		757 tonnes
% advice change ^		−7%

18.16.4 Rjm.27.67bj

Commercial discards and landings were examined.



From the figure above, it was decided that there were insufficient lengths to use the commercial data as per the traditional rfb method. Therefore, fishery-independent survey data from 2022 and 2023 were examined and used in the assessment.



Survey length data, IGFS, 2023

Year	Stock-size indicator			Landings
	Low	Biomass index (kg.km^{-2})	High	(tonnes)
2005	0.88	3.8	6.8	
2006	1.76	3.5	5.3	
2007	0.29	3.2	6.1	
2008	1.15	2.4	3.7	
2009	2.2	5.0	7.9	27
2010	2.6	4.6	6.5	62
2011	3.5	6.4	9.4	63
2012	2.3	4.1	5.8	61
2013	3.6	7.1	10.6	68
2014	3.9	9.5	15.0	125
2015	2.9	5.9	9.0	114
2016	0	15.3	34	116
2017	4.0	8.9	13.9	96
2018	4.2	7.0	9.9	104
2019	2.6	6.6	10.6	79
2020	2.3	4.8	7.2	5
2021	2.3	4.1	5.9	36
2022	3.0	5.5	8.0	21
2023	2.5	4.7	6.8	56

Indices used in the assessment.

Other parameters were unchanged from the previous assessment.

Previous landings advice A_y (2023-2024 issued in 2022)		36 tonnes
Stock biomass trend		
Index A (2022-2023)		5.09 kg km^{-2}
Index B (2019, 2020, 2021)		5.15 kg km^{-2}
r: stock biomass trend (index ratio A/B)		0.99
Fishing pressure proxy		
Mean survey length ($L_{mean} = L_{2023}$)		53.26 cm
MSY proxy length ($L_{F=M}$)		53.35 cm
Fishing pressure proxy ($L_{F=M}$ /L_{mean})		1.00
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)		1.00
Biomass safeguard		
Last index value (I_{2023})		4.68 kg km^{-2}
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		3.38 kg km^{-2}
b: index relative to trigger value, min{$I_{2023}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
RFB calculation		32 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not Applied	-
Discard rate		Unquantified
Landings advice for 2025–2026**		32 tonnes
% advice change ***		−11 %

18.16.5 rje.27.7fg

The fishery-independent survey UK(E&W)-BTS-Q3 [B6596] (or EngW-BTS-Q3) is used in the assessment of small-eyed ray *Raja microocellata* in divisions 7.f-g (rje.27.7fg), with input data applicable to the exploitable biomass (individuals ≥50 cm total length, L_T; Table 18. 15a and Figure 18.4.e). This survey covers the main stock area in the Bristol Channel (Division 7.f).

Estimates were updated for the time-series from 1993 to 2023, with methodology described in Silva (2022a; Data from ICES DATRAS retrieved on 01/05/2024).

The biomass estimates are currently at low levels compared to earlier years in the time-series, with 2020 being the lowest observed. However, there has been a slight increase in biomass of individuals ≥50 cm LT in 2022–2023 relatively to 2019–2021 (Table 18.15a and Figure 18.4.e). Although the index used in the assessment is based on biomass (kg.hr^{-1}), it is worth noting that the decline in recent years is also reflected in terms of abundance (numbers of individuals ≥50 cm L_T).

Table 18.15a. Small-eyed ray in divisions 7.f and 7.g. Time-series of survey index used for the advice. Series are the mean biomass per hour (for specimens ≥ 50 cm total length) from the UK (E&W)–BTS–Q3 [B6596]. Note: ICES rounding rules applied.

Year	Biomass index (kg.hr^{-1})	High 95% CI	Low 95% CI
1993	1.05	2.1	0.29
1994	1.88	3.5	0.73
1995	2.3	4.4	0.69
1996	0.53	1.14	0.084
1997	2.3	3.9	0.94
1998	2.6	4.7	0.90
1999	2.5	4.0	1.23
2000	0.82	1.58	0.23
2001	1.90	3.5	0.64
2002	2.3	3.5	1.18
2003	1.32	2.4	0.40
2004	1.60	3.2	0.47
2005	1.67	2.9	0.60
2006	0.51	1.00	0.165
2007	0.54	1.06	0.084
2008	0.51	0.95	0.174
2009	0.77	1.44	0.177
2010	1.06	2.2	0.124
2011	0.79	1.64	0.195
2012	0.58	1.11	0.176
2013	0.28	0.61	0.00
2014	0.66	1.72	0.00
2015	0.35	0.94	0.00
2016	0.58	1.17	0.128
2017	1.60	2.8	0.55

2018	0.60	1.35	0.066
2019	0.43	1.28	0.00
2020	0.068	0.27	0.00
2021	0.42	1.08	0.00
2022	0.91	1.98	0.110
2023	0.69	1.34	0.141

The quality of commercial data may be hampered due to confusion over the local name "sandy ray", with landings and discards from sandy ray *Leucoraja circularis* in divisions 7.a, 7.f, and 7.g considered to refer to small-eyed ray *Raja microocellata* for most countries. The extent of these confounding issues between the two species has not been considered (or quantified) in relation to the length data used to apply WKLIFE methods, due to the lack of information on the fishing area associated with most records.

Length data from 2019 to 2021 were available for UK (E&W), Belgium and France, and thus considered for the initial ICES Category 3 rfb exploratory analysis including years when only landings and/or discards were available for a given country. Although the units of the Belgian length data available on the Accessions database (AC) for 2020 relate only to the raw numbers measured, contrary to the raised numbers provided by the UK (E&W) and France, these were still included as Belgium is one of the main countries contributing to the landings of this species in these divisions. It should be noted that the decrease in Belgian landings since 2021, is due to the introduction from the 1st of January 2021 of a Producer Organisation (PO) measure to exclude landings of this species. Since 2021, there are no Belgian and French length data available for rje.27.7fg. Data from UK (E&W) were available from 2016 to 2021 via Accessions, though only data from 2019 were considered in the 2022 assessment. Data were presented at the meeting, and the EG considered that the high levels of discards in 2021 for specific length classes (ca. 39 and 41 cm total length, L_T) would not be realistic and thus, would skew the perception of the length frequency (Figure 18.15a).

Hence, length data used for the assessment (s) only included 2019–2020 and 2022–2023 as considered the more reliable available data (Table 18.15b-c and Figure 18.15a- b). These data were combined in 2-year period (2019–2020 and 2022–2023) to estimate fishing pressure proxy (ies) as such aggregation provides more representative length compositions of landings and discards (Table 18.15b-d and Figure 18.15a- b). Additionally, commercial length records above the maximum observed total length for small-eyed ray were excluded from the assessment (s) (L_{max} of 91 cm L_T; Ryland and Ajayi, 1984; Figure 18.15a-b).

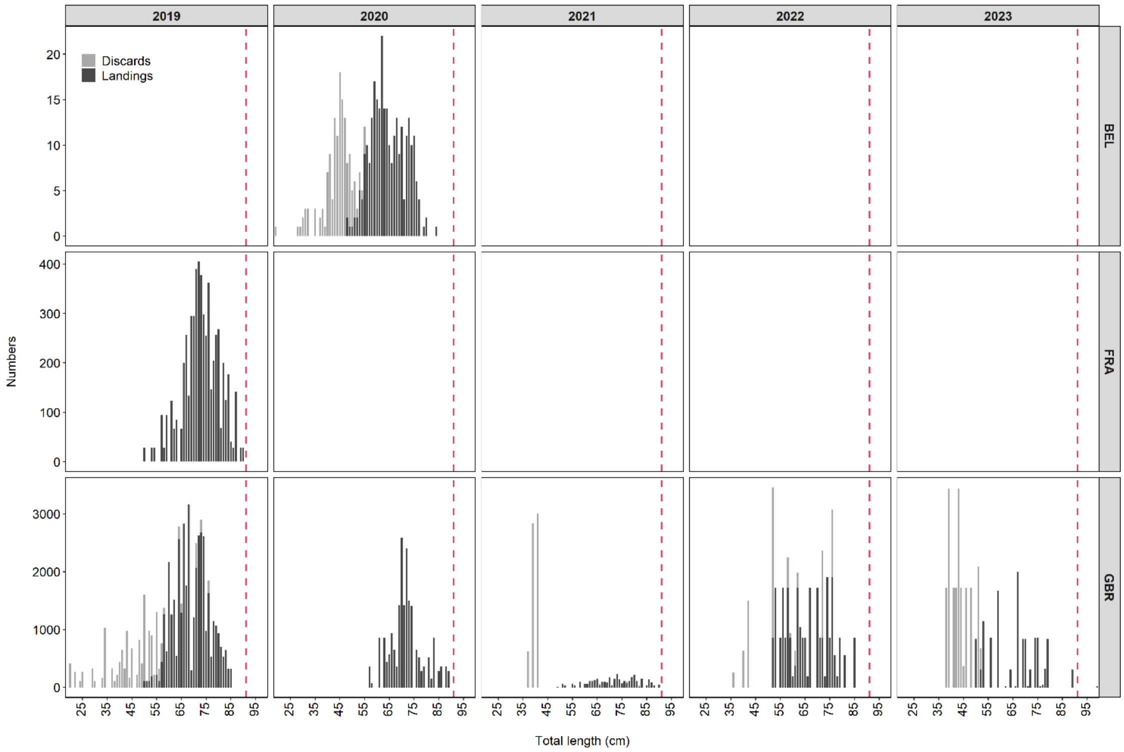
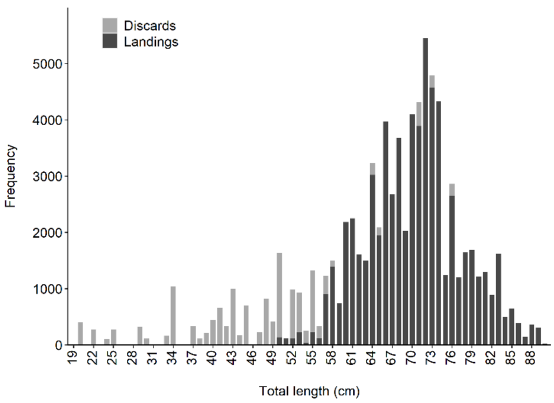


Figure 18.15a. Small-eyed ray in divisions 7.f and 7.g. Length data of commercial landings and discards from 2019–2023 available to WGEF 2024. Note: BEL – Belgium (unraised numbers); FRA – France and GBR – United Kingdom (England and Wales) (raised numbers). Different y-axis. Data for 2021 here shown but excluded from the assessment in 2022 and 2024. Dashed pink line referring to observed L_{max} at 91 cm L_T (Ryland and Ajayi, 1984).

Table 18.15b. – Small-eyed ray in divisions 7.f and 7.g. Length data of commercial landings and discards from 2019–2020 used in the initial application of the rfb rule in 2022. Note: Numbers rounded to two decimal places.

Length (cm)	Number	Length (cm)	Number	Length (cm)	Number
19	1.00	47	230.83	70	4096.45
20	408.44	48	824.88	71	4312.40
22	272.29	49	417.44	72	5451.03
24	108.92	50	1634.43	73	4790.49
25	272.29	51	114.92	74	4329.75
28	1.00	52	983.25	75	1241.38
29	327.75	53	931.57	76	2862.31
30	110.92	54	251.16	77	1202.72
31	3.00	55	1319.00	78	1641.86
32	3.00	56	331.33	79	1687.53
33	163.38	57	1228.04	80	1209.42
34	1034.71	58	1497.13	81	1290.84
35	3.00	59	735.92	82	889.26
37	328.75	60	2183.29	83	1623.47
38	111.92	61	2250.79	84	498.82
39	218.83	62	1608.06	85	646.04
40	442.67	63	1497.85	86	390.98
41	662.50	64	3234.77	87	141.62
42	330.75	65	2090.36	88	362.65
43	993.25	66	3969.64	89	313.09
44	174.38	67	2674.55	90	28.32
45	698.73	68	3675.73		
46	15.00	69	2026.53		



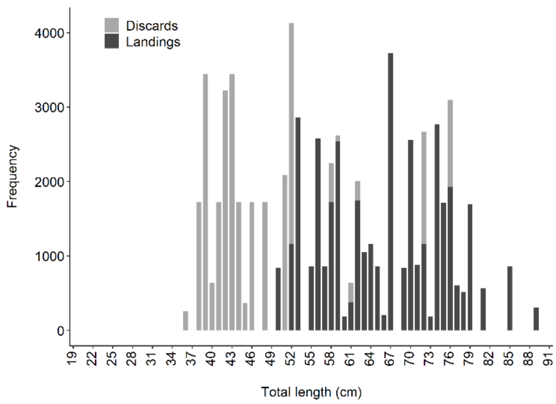


Figure 18.15b. – Small-eyed ray in divisions 7.f and 7.g. Length data of commercial landings and discards from (left) 2019–2020 used in the assessment in 2022 (L_{range} = 19–90 cm L_T) and (right) 2022–2023 used in the assessment in 2024 (L_{range} = 36–89 cm L_T).

Table 18.15c. – Small-eyed ray in divisions 7.f and 7.g. Length data of commercial landings and discards from 2022–2023 used in the assessment in 2024.

Length (cm)	Number	Length (cm)	Number
36	255.27272730	63	1048.03939480
38	1720.71569800	64	1164.73882910
39	3441.43139600	65	860.14834050
40	638.18181820	66	208.90455152
41	1720.71569800	67	3721.14835422
42	3222.89751600	69	837.62384350
43	3441.43139700	70	2557.92052450
44	1720.71569800	71	881.16183772
45	368.46160560	72	2666.92064710
46	1720.71569800	73	187.89105430
48	1720.71569800	74	2766.82507602
50	837.62384350	75	1718.78568122
51	2089.17730360	76	3097.56486852
52	4131.74539020	77	605.70015724
53	2862.51101310	78	513.49504012
55	860.14834050	79	1697.77218400
56	2578.93402172	81	563.67316280
57	860.14834050	85	860.14834050
58	2243.93204600	89	304.59048860
59	2617.98426279		
60	187.89105430		
61	637.59979110		
62	2003.12786072		

Following the rfb rules, on the recent advised landings (2023–2024 issued in 2022), multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The advised landings are higher than previous advice due to the increase in the biomass index of the UK(E-W)-BTS-Q3 survey. The stability clause was considered and applied to limit the increase in landings advice to 20%. Details on the data input used in the assessment are described in Table 18.15d and Table 18.15e.

Table 18.15d. Small-eyed ray in divisions 7.f and 7.g. L_{mean}, $L_{F=M}$, f, and inverse f values for the years 2019–2023. L_c calculated using pooled data from commercial catches from 2019–2020. Note: Information not provided for 2021 as data excluded from assessment.

Year	L_c (cm)	L_{mean} (cm)	$L_{F=M}$ (cm)	f	inverse f
2019	64	72.9888430538149	71.425	1.0218948974983	0.9785742178067
2020	64	72.9888430538149	71.425	1.0218948974983	0.9785742178067

2021	-	-	-	-	-
2022	64	73.1769087194858	71.425	1.0245279484702	0.9760592685570
2023	64	73.1769087194858	71.425	1.0245279484702	0.9760592685570

Table 18.15d. Small-eyed ray in divisions 7.f and 7.g. Components of the rfb rule.

Components	Estimate	Input data	Comment
r: Stock biomass trend	2.6	Index A/Index B Index A = 0.80 $kg.hr^{-1}$ Index B = 0.30 $kg.hr^{-1}$	The stock trend shows an increase comparatively to 2019–2021, though remains at low levels.
b: Biomass safeguard min {$I_{2023}/I_{trigger}$, 1}	1	I_{loss} = 0.068 $kg.hr^{-1}$ $I_{trigger}$ = 0.095 $kg.hr^{-1}$ I_{2023} = 0.69 $kg.hr^{-1}$	I_{loss} - minimum estimate in 2020 $I_{trigger} = I_{loss} \times \omega$, considering ω=1.4 $I_{2023}/I_{trigger}$ = 7.2
m linked to von Bertalanffy k	0.95	k <0.20	Estimates of k = 0.086 (Ryland and Ajayi, 1984). However, the only age and growth study may have confounded 0 and 1 group (Brander and Palmer, 1985).
f: Fishing proxy $L_{mean}/L_{F=M}$	1.02	Length data used from 2022–2023 L_c = 64 cm L_T L_{mean} = 73.18 cm L_T L_{inf} = 93.7 cm L_T $L_{F=M}$ = 71.425 cm L_T	Length data for 2021 excluded from assessment. L_{mean} – considered only length classes > 64 cm L_T (L_c) $L_{F=M}$ = 0.75 L_c + 0.25 L_{inf} Available L_{inf} from the literature of 137 cm L_T is not biologically plausible given the maximum observed length of 91 cm L_T (Ryland and Ajayi, 1984). The only published study on age and growth study may have confounded 0 and 1 group (Brander and Palmer, 1985). FishBase provided also another L_{inf} of 89.7 cm L_T based on L_{max} of 87 cm L_T from Dorel (1986). However, given the observed length observed on commercial length data up to 90 cm L_T to be used in the rfb, this L_{inf} estimate was considered an underestimate. Thus, L_{inf} was recalculated using FishBase – popdyn and L_{max} of 91 cm L_T, resulting on L_{inf} of 93.7 cm L_T.
$A_{y+1} = A_y \times r \times f \times b \times m$	220 tonnes	$A_y \times r \times f \times b \times m$ A_y = 86 tonnes	More than 20% increase relative to previous landings advice of 86 tonnes for 2023 and 2024. Therefore, stability clause was applied to limit increase in advice, see below.
Stability clause	1.2	min{max(0.7A_y,A_{y+1}), 1.2 A_y}	Applied. Stability clause (+20%/−30% compared to Ay, only applied if b ≥ 1).
Landings advice	103 tonnes		Landings advice for 2025 and 2026.
% advice change	+20%	-	Advice value for 2025 and 2026 relative to the advice value for 2023 and 2024,

Contents

19 Skates in the Bay of Biscay and Iberian Waters (ICES Subarea 8 and Division 9.a)

ICES uses the generic term "skate" to refer to all members of the order Rajiformes. The generic term "ray", formerly used by ICES also to refer to Rajiformes, is now only used to refer to other batoid fish, including manta rays and sting rays (Myliobatiformes), and electric rays (Torpediniformes). ICES only provides routine advice for Rajiformes.

19.1 Ecoregion and stock boundaries

The Bay of Biscay and Iberian Waters ecoregion covers the Bay of Biscay (divisions 8.a-b and 8.d), including the Cantabrian Sea (Division 8.c), and the Spanish and Portuguese Atlantic coast (Division 9.a). This ecoregion broadly equates with the area covered by the South Western Waters Advisory Council (SWWAC). Commercially-exploited skates do not occur in the offshore Division 8.e to any significant extent.

The northern part of the Bay of Biscay has a wide continental shelf with flat and soft bottom more suitable for trawlers, whilst the Cantabrian Sea has a narrower continental shelf with some remarkable bathymetric features (canyons, marginal shelves, *etc.*). The Portuguese continental shelf (Division 9.a) is narrow, except for the area located between the Minho River and the Nazaré Canyon, and in the Gulf of Cadíz, where it is about 50 km wide, particularly to the east. The slope is mainly steep with a rough bottom including canyons and cliffs.

Rajidae are widespread throughout this ecoregion but there are regional differences in their distribution as described in earlier reports (ICES, 2010), and this is particularly evident for those species with patchier distributions and limited dispersal (Carrier *et al*., 2004).

Recent studies have provided information on ecologically important habitats for *R. clavata*, *R. brachyura*, *R. montagui*, *R. microocellata*, *R. undulata* and *L. naevus* in Portuguese continental waters (Serra-Pereira *et al*., 2014). Sites with similar geomorphology were associated with the occurrence of juveniles and/or adults of the same group of species. For example, adult *R. clavata* occurred mainly in sites deeper than 100 m with soft sediment. Those were also considered to be habitat for egg-laying of this species. *Raja undulata* and *R. microocellata* occurred preferentially on sand or gravel habitats. Potential nursery areas for *R. brachyura*, *R. montagui* and *R. clavata* were found in coastal areas with rock and sand substrates. Further details are given in the Stock Annexes.

Information from trawl surveys on catches of (viable) skate egg-cases is considered valuable to further identify ecologically important habitats. Further information could be collected in trawl surveys. Skates in this ecoregion include thornback ray *Raja clavata*, cuckoo ray *Leucoraja naevus*, the less frequent blonde ray *Raja brachyura*, small-eyed ray *R. microocellata*, brown ray *R. miraletus*, spotted ray *R. montagui*, undulate ray *R. undulata*, shagreen ray *Leucoraja fullonica*, common skate *Dipturus batis*-complex, (recently split into *D. batis* and *D. intermedius*), long-nosed skate *D. oxyrinchus*, sandy ray *Leucoraja circularis* and white skate *Rostroraja alba*.

Studies undertaken in the Portuguese Atlantic coast (Division 9.a; Serra-Pereira *et al*., 2014), and in the Cantabrian Sea (eastern parts of Division 8.c) indicate spatial overlap between *R. clavata* and *L. naevus* (e.g. Sánchez, 1993). In the Bay of Biscay, *L. naevus* is more abundant on the offshore trawling grounds (Sánchez *et al*., 2002). Along the Portuguese coast *R. clavata* and *L. naevus* co-occur in areas deeper than 100 m, on grounds composed of soft bottom, from mud to fine sand (Serra-Pereira *et al*., 2014). *Raja clavata* can also be found from rocky to coarse sandy bottoms.

Raja brachyura occurs primarily near the coast in shallower depths in areas of rocks surrounded by sand. Juvenile *R. brachyura*, *R. montagui* and *R. clavata* co-occur on grounds shallower than 100 m. In the Bay of Biscay and the Iberian Coast, *R. undulata* and *R. microocellata* occur at depths < 40 m over sandy bottoms. *R. undulata* is locally abundant in the shallow waters between the Loire and Gironde estuaries (eastern Bay of Biscay; divisions 8.a-b) and occurs along most of the French coast.

The geographical distributions of the main skate species in the ecoregion are known, but their stock structure still needs to be more accurately defined. Studies (e.g. tagging and/or genetic studies) to better understand stock structure are required.

A tagging survey of *R. undulata* carried out in the Bay of Biscay (2012–2013) showed that movements of this species were limited to *ca.* 30 km (Delamare *et al*., 2013 WD; Biais *et al*., 2014 WD). This result supports the hypothesis that several local stocks exist in European waters and corroborates the assumption of three distinct assessment units (divisions 8.a–b; 8.c and 9.a) in this ecoregion.

In 2022, the stock of thornback ray in the Bay of Biscay (rjc.27.8) was split between the eastern shelf (divisions 8.abd) and the Cantabrian Sea (Division 8.c) following the benchmark for the stock where the population connectivity was addressed (ICES, 2022b). A third stock unit of thornback ray was already considered separately in Division 9.a. Since 2015, cuckoo ray from ICES subareas 6 and 7 in the Celtic seas ecoregion and the Bay of Biscay is considered to form one single stock, cuckoo ray in subareas 6 and 7 and divisions 8.a-b,d. There are two other stocks of cuckoo ray in this ecoregion: in Division 8.c (Cantabrian Sea) and Division 9.a (Iberian waters). For the spotted ray two stock units are considered: Subarea 8 and Division 9.a. Lastly, for blonde ray the stock unit considered covers only Division 9.a. Landings of skates outside of the boundaries of ICES stock units are considered together with landings not reported species-by-species in a multispecies unit referred to as "Other skates and rays in Subarea 8 and Division 9.a" this unit is not subject to assessment and advice for it was not requested in 2022.

19.2 The fishery

19.2.1 History of the fishery

In the Bay of Biscay and Iberian waters, skates are caught mainly as a bycatch in mixed demersal fisheries, which target various species: primarily hake, nephrops, anglerfish and megrim. The main fishing gears used are otter trawl, bottom-set gillnets and trammel nets. The countries involved in these fisheries are France, Spain and Portugal, as detailed below.

France

Skates are traditional food resources in France, where target fisheries were known to occur during the 1800s. In the 1960s, skates were taken primarily as a bycatch of bottom trawl fisheries operating in the northern parts of the Bay of Biscay, the southern Celtic Sea and English Channel. By this time, *R.clavata* was targeted seasonally by some fisheries, and was the dominant skate species landed. After the 1980s, *L. naevus* became the main species landed. However, landings of both *R.clavata* and *L. naevus* declined after 1986.

Other skates are also landed, including *L. circularis*, *L. fullonica*, *R. microocellata, D. batis* complex (mostly common blue skate), which is included in the prohibited species list by the EU regulation since 2010, and *D. oxyrinchus*. There have been no major annual landings of *Rostroraja alba* by French fleets in the past three decades.

The historical French catches of skates in coastal fisheries are poorly known. Most landings of skates and rays were not reported by species before 2009 when species-specific reporting of landings was required by the EU regulation. For *Raja undulata,* this implies that no species-specific landings were reported before its inclusion on the EU prohibited species list and past levels of catch are unknown.

Spain

Spanish demersal fisheries operating in Galicia and the Cantabrian Sea (Division 9a N and 8.c) and Bay of Biscay (divisions 8.a-b and 8.d) catch various skate species using different fishing gears. Most landings are a bycatch from trawl fisheries targeting demersal teleosts, (e.g. hake, anglerfish and megrim). Among the skate species landed, *R. clavata* and *L. naevus* are the most frequent. Historically, due to their low commercial value, most skate species, especially those derived from artisanal gillnetters, were reported as Rajidae. There are artisanal gillnet fisheries operating in bays, rias and shallow waters along the Cantabrian Sea and Galician coasts (divisions 8.c and 9.a). *Raja undulata* is caught mainly in the coastal waters of Galicia (northern part of Division 9.a and western part of Division 8.c) where it was frequently landed and one of the most abundant species inside the rias. Other skate species caught in Galician waters include *R. brachyura*, *R. microocellata*, *R. montagui*, *R. clavata* and *L. naevus*. The characteristics of Spanish artisanal fleets catching skates are not fully known.

Mainland Portugal

Off mainland Portugal (Division 9.a), skates are caught mainly by the artisanal polyvalent fleet with a smaller contribution of trawlers to landings. This artisanal fleet taking skates operates mostly with trammel nets, but other fishing gears (e.g. longlines and gillnets) are also used. The skate species composition of landings varies along the Portuguese coast. *Raja clavata* is the main species landed, but *R. brachyura*, *L. naevus* and *R. montagui* are also caught. Before being prohibited, *R. undulata* was frequently landed. Other species, such as *R. microocellata*, *D. oxyrinchus*, *R. miraletus*, *R. alba* and *L. circularis,* are also caught, albeit less frequently (particularly the latter three species). Further details on fisheries in Division 9.a are given in the respective Stock Annexes.

19.2.2 The fishery in 2021-2023

COVID-19 is expected to have affected fishing activity in 2020, although so far unquantified, with national or local restrictions on fishing activity as well as disruption of markets and the food chain reducing fishing effort for at least part of the year.

Apart from COVID-19, no other clear changes are noted in recent years.

France

Landings and on-board observation data confirm that skates are primarily a bycatch in numerous fisheries operating in the Bay of Biscay. French landings statistics from more than 100 métiers (defined at DCF level 6) report landings of *R. clavata* and *R. montagui* in the Bay of Biscay. Trammel nets are the main métier for *R. montagui*, while twin-trawl is the main métier for *R. clavata*.

Spain

The results from the DCF pilot study held from 2011–2013 and conducted in the Basque Country waters (Division 8.c) with the objective of describing and characterizing coastal artisanal fisheries (trammel nets targeting mainly hake, anglerfish and mackerel), showed that several skate species (*R. clavata*, *R. montagui*, *L. naevus*, *L. fullonica*, *L. circularis, R. brachyura* and *R. undulata*) are caught as bycatch. The Basque artisanal fleet consists of 55 small vessels that use gillnets and trammel nets during some periods of the year. Vessels had an average length of 12.7 m and an average engine power of 82.4 kW. The proportions of skates in the total sampled trips were 30% (2011), 35% (2012) and 16% (2013). The estimated landings of skates by this fleet were 19.3 t in 2012 and 26.9 t in 2013 (Diez *et al*., 2014 WD). These Basque artisanal fleet has been reduced to 48 vessels in 2023 with an average length of 16.8 m and an average engine power of 191.9 kW.

In the Cantabrian Sea (Division 8.c, 9a) and Bay of Biscay (Division 8abd) most skate landings in 2023 are also from bycatch from otter trawl (66%) and gillnet gears (293%). The remaining landings are derived from longlines (4%) and other fishing gears.

Mainland Portugal

Skates are mainly a bycatch in mixed fisheries, particularly from the artisanal polyvalent fleet (representing around 80% of landings). Set nets (mainly trammel nets), or a combination of set nets and traps, account for most skates' landings (*ca*. 53% in weight and 63% in number of trips in 2021), followed by longline (*ca.* 31% in weight and 26% in number of trips in 2021). Also, within the artisanal polyvalent fleet, small trawlers may account for 7% in weight and 6% in number of trips of the total landings of skates and rays, being only observed in certain landing ports. Methods to estimates landings by skate species were developed during the DCF-funded pilot study focused on skate catches in Portuguese continental fisheries carried out from 2011 to 2013 (Figueiredo *et al*., 2020b).

The experimental quota of *R. undulata* assigned to Portugal since 2016 requires a special fishing license for this species. Vessels with the license are mainly operating close to the coast. This fishery is TAC constrained and has as the main goal to provide fishery data for future scientific advice.

19.2.3 ICES Advice

Before 2012, ICES provided general advice on skates by ecoregions. This is not much adequate as skate species have different life-history traits and this does not fit with stocks straddling the boundaries of ecoregions. For instance, one stock of *L. naevus* straddles subareas 6 and 7 (excl. Division 7.d) and divisions 8.a-b and 8.d.

From 2012–2014, ICES has moved towards providing advice at single stock level, giving quantitative advice where possible.

For all ICES Categories, advice on skates has been given biennially until 2024. However, from 2024 onwards and for skate stocks of Category 5 and Category 6 advice will take place every fourth year. Therefore, advice given in 2024 will apply to years 2025-2026 for Category 2 and 3 stocks and to 2025-2028 for Category 5 and 6 stocks. A summary of these and details for stocks not subject to a landings advice or for which the advice was more complex are provided in the table below.

Scientific name	ICES stock code	Distribution area	Advice for 2025 and 2026	ICES stock data category
Raja undulata	rju.27.8ab	8.a,b	Catches (precautionary approach) should be no more than 202 tonnes in each of the years 2025–2028. If discard rates do not change from the average of the last five years (2019–2023), this implies landings of no more than 13 tonnes	6
Raja undulata	rju.27.8c	8.c	No targeted fisheries, manage bycatch	6
Raja clavata	rjc.27.8abd	8.abd	Catches (MSY approach) should be no more than 306 tonnes in 2025 and 311 tonnes in 2026	2
Raja clavata	rjc.27.8c*	8.c	Landings (MSY approach) should be no more than 363 tonnes in 2025 and 354 tonnes in 2026	2
Leucoraja naevus	rjn.27.8c	8.c	Catches should be no more than 41 tonnes of which no more than 30 tonnes should be landed	3
Raja montagui	rjm.27.8	8	Landings should be no more than 46 tonnes	3
Raja montagui	rjm.27.9a	9.a	Landings should be no more than 78 tonnes	5
Leucoraja naevus	rjn.27.9a*	9.a	Landings (MSY approach) should be no more than 108 tonnes in 2025 and 100 tonnes in 2026	2
Raja clavata	rjc.27.9a*	9.a	Landings (MSY approach) should be no more than 1406 tonnes in 2025 and 1415 tonnes in 2026	2
Raja undulata	rju.27.9a	9.a	Landings should be no more than 31 tonnes	6
Raja brachyura	rjh.27.9a	9.a	Landings should be no more than 249 tonnes	3
Dipturus batis complex *(Dipturus batis)* *(Dipturus intermedius)*	rjb.27.89a	8, 9.a	No advice requested	6
Other skates	raj.27.89a	8, 9.a	ICES cannot provide catch advice	5

***Stocks benchmarked (in 2023 or 2024), changing from category 3 to category 2.**

19.2.4 Management applicable

An EU TAC for skates (Rajiformes) in subareas 8 and 9 was first established in 2009, and set at 6423 t. Since then, the TAC was reduced between 9 and 15% up to 2014, and increased between 8 and 15% since 2017. The history of the EU regulations adopted for skates in this ecoregion and the ICES landings estimates for all Rajiformes (excluding *Raja undulata* from 2014 onwards, where a sub-TAC was set for this species from 2015 in Subarea 8 and from 2016 in Division 9.a) are summarized below:

Year	TAC for EC waters of subareas 8 and 9	TAC change (%)	ICES landing estimates	Regulation
2009	6423 t		4610t	Council Regulation (EC) No 43/2009 of 16 January 2009 (1,2)
2010	5459 t	-15	4147t	Council Regulation (EU) No 23/2010 of 14 January 2010 (1,2)
2011	4640 t	-15	4154 t	Council Regulation (EU) No 57/2011 of 18 January 2011 (1,2)
2012	4222 t	-9	3774t	Council Regulation (EU) No 43/2012 of 17 January 2012 (1,2)
2013	3800 t	-9	3699t	Council Regulation (EU) No 39/2013 of 21 January 2013 (3,2)
2014	3420 t	-10	3692t	Council Regulation (EU) No 43/2014 of 20 January 2014 (3,2)
2015	3420 t	0	3517t	Council Regulation (EU) No 104/2015 of 19 January 2015 amended by the Council Regulation (EU) No 523/2015 of 25 March 2015 (3,4)
2016	3420 t	0	3306 t	Council Regulation (EU) No 72/2016 of 22 January 2016 (3,4)
2017	3762 t	+9	3442t	Council Regulation (EU) No 2017/127 of 20 January 2017 (3,4)
2018	4314 t	-15	3801t	Council Regulation (EU) No 2018/120 of 23 January 2018 (3,4)
2019	4759 t	+10	3816t	Council Regulation (EU) No 2019/124 of 30 January 2019 (3,4)
2020	4759 t	0	3613t	Council Regulation (EU) No 2020/123 of 27 January 2020 (3,4)
2021	5140 t	+8	3765t	Council Regulation (EU) No 2021/703 of 26 April 2021 (3,4)
2022	5140 t	0	3575 t	Council Regulation (EU) No 2022/515 of 31 March 2022(3,4)
2023	5519t	7	4283	Council Regulation (EU) No 2023/194 of 30 January 2023 (3,4)

(1) Catches of cuckoo ray (*Leucoraja naevus*) (RJN/89-C), thornback ray (*Raja clavata*) (RJC/89-C) shall be reported separately.

(2) Does not apply to undulate ray (*Raja undulata*), common skate complex (*Dipturus batis* and *D. intermedius*) and white skate (*Rostroraja alba*). Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(3) Catches of cuckoo ray (*Leucoraja naevus*) (RJN/89-C), blonde ray (*Raja brachyura*) (RJH/89-C), and thornback ray (*Raja clavata*) (RJC/89-C) shall be reported separately.

(4) Shall not apply to undulate ray (*Raja undulata*). This species shall not be targeted in the areas covered by this TAC. By-catch of undulate ray in subarea 8 (since 2015) and 9 (since 2016) may only be landed whole or gutted, and provided that it does not comprise more than 20 kilograms live weight per fishing trip in subarea 8 (in 2015 and 2016) and 40 kilograms of live weight per fishing trip in subarea 9 (in 2016). This provision shall not apply for catches subject to the landing obligation. By-catches of undulate ray shall be reported separately under the codes RJU/8-C and RJU/9-C, respectively for each subarea.

Regarding *R. undulata* no management measures had been adopted by European Commission (EC) until 2009, when EC regulations stated that "*Undulate ray … (in) … EC waters of VI, VII, VIII,* *IX and X … may not be retained on board. Catches of this species shall be promptly released unharmed to the extent practicable"* (CEC, 2009). In 2010, *R. undulata* was listed as a prohibited species on quota regulations (Section 6 of CEC, 2010). In 2017, EC stated that *"it shall be prohibited for third-country vessels to fish for, to retain on board, to tranship or to land undulate ray (Raja undulata) in Union waters of ICES subareas VI, IX and X (*Council Regulation (EU) No 2017/127). A by-catch TAC was established for Subarea 8 since 2015 and for Subarea 9 since 2016, under the limits presented in the table below:

Year	TAC for EU waters of Subarea 8	TAC for EU waters of Subarea 9	ICES landing estimates in Subarea 8	ICES landing estimates in Subarea 9	Regulation
2015	25 t	-	16 t	-	Council Regulation (EU) No 523/2015 of 25 March 2015 (3,4)
2016	25 t	40 t	21 t	31 t	Council Regulation (EU) No 72/2016 of 22 January 2016 (3,4)
2017	30 t	48 t	30 t	46 t	Council Regulation (EU) No 2017/127 of 20 January 2017 (3,4)
2018	30 t	48 t	26 t	52 t	Council Regulation (EU) No 2018/120 of 23 January 2018
2019	33 t	50 t	31 t	38 t	Council Regulation (EU) No 2019/124 of 30 January 2019
2020	33 t	50 t	29 t	45 t	Council Regulation (EU) No 2020/123 of 27 January 2020
2021	33 t	50 t	30 t	35 t	Council Regulation (EU) No 2021/703 of 26 April 2021
2022	33 t	50 t	35 t	53 t	Council Regulation (EU) No 2022/515 of 31 March 2022
2023	33 t	50 t	34t	52t	Council Regulation (EU) No 2023/194 of 30 January 2023

For the period 2024-2026 an additional 28.5 tonnes and 21.5 tonnes by year will be allocated to French and Spanish vessels respectively participating in a sentinel fishery to allow fisheries-based data collection for the stock in Division 8c, and 50 tonnes to Portuguese vessels in subarea 9 (Council Regulation (EU) 2024/257).

Unwanted catches of skates and rays in subareas 8 and 9 for the period 2021–2023 are regulated by the Commission Delegated Regulation (EU) 2020/20153, which establishes the details of the landing obligation in Southern-Western waters. According to this, based on scientific evidences of high survivability, most skates and rays are exempted from the landing obligation. This exemption implies that when discarding skates and rays in the cases referred above, those shall be released immediately, and that during the period 2021–2023, all Member States have to present before 1 May each year additional scientific information supporting the exemption. The Scientific, Technical and Economic Committee for Fisheries shall assess that scientific information by 31 July every year. The exemption applies to:

- All skates and rays (except *L. naevus*) caught by all fishing gears in subareas 8 and 9;
- *L. naevus* caught by trammel nets in subareas 8 and 9 (until 31 December 2022);
- *L. naevus* caught by trawls in Subarea 8 (until 31 December 2022).

19.2.4.1 Regional management measures

Portugal

The Portuguese Administration adopted, on 29 December 2011, national legislation (Portaria no 315/2011) that *prohibits the catch, the maintenance on board and the landing of any skate species belonging to the Rajidae family, during the month of May along the whole continental Portuguese EEZ*. This applies *to all fishing trips, except bycatch of less than 5% in weight*. The legislation was updated on 21 March 2016 (Portaria no 47/2016) by extending the fishing prohibition period to June.

By 22August 2014, the Portuguese Administration adopted a national legislation (Portaria no 170/2014) that *establishes a minimum landing size of 52 cm total length (L_T) for all Raja spp. and Leucoraja spp*. In 2022, the minimum landing size was updated to 60 cm total length for all *Raja spp*. and *Leucoraja spp*. (Portaria nº 255/2022).

On 19May 2016, Portugal adopted a legislative framework (Portaria no. 96/2016) regarding the 2016 quota of *Raja undulata* in Division 9.a assigned to Portugal. This framework includes a set of conditions for licensing specific fishing permits to vessels on the owner's request, provided that each vessel fulfils the set of specific conditions which include fishing vessel type, fishing license and historical skate landings. Vessels having the specific fishing permit shall comply with a set of rules, which include obligation to transmit, to both the General Directorate of Natural Resources, Maritime Security and Services (DGRM) and to IPMA, specific fishing data using a form designed by DGRM and IPMA to register haul and catch data on a haul-by-haul basis; the obligation to accept scientific observers duly accredited by IPMA onboard, except in situations where, demonstrably, due to vessel's technical characteristics, it affects the normal activity of the vessel. In 2019, the DGRM introduced a landing control process according to which, in addition to licensed vessels, vessels not possessing the special fishing license were allowed to land a maximum of one specimen per trip and were also obliged to provide additional information on their fishing activity related to *R. undulata* captures (Portaria no. 4/2019).

On each fishing trip, vessels are prohibited from targeting undulate ray and are obliged to land the species under specific conditions: a maximum of 30 kg of undulate ray live weight (for licensed vessels) or one specimen per trip (for non-licensed vessels) is allowed; only whole or gutted specimens can be landed and a minimum (78 cm L_T) and a maximum (97 cm L_T) landing sizes are adopted. During the months of May, June and July of each year the capture, retention onboard and landing of undulate ray is prohibited, but data on catches should be recorded.

France

Based on feedback from scientific programs carried out since 2011 in close partnership with fishers, it was decided in December 2013 to remove undulate ray from the list of prohibited species, without landings permitted (Total Allowable Catch of zero). In December 2014, a small TAC has been allowed for France in ICES divisions 7.de and 8.ab, with limited bycatch but no targeted fishing. Since then, the French authorities adopted different decrees to regulate bycatch and landings of undulate ray. Starting in 2016, a legislative framework similar to the one adopted by Portugal was implemented, with landing of undulate ray allowed for a limited number of vessels conditioned by the systematic reporting of catches of this species, a minimum landing size of 78 cm and landing limitations per trip and time period. The obligation of possessing a special permit to land *R. undulata*, which was in place since the dedicated TAC for this species in ICES divisions 8.a and 8.b was set over 0, was lifted in 2019. For more details on the different modalities of this bycatch by year, see Gadenne (2017 WD).

All skates are subject to a minimum landings size of 45 cm in France (JORF, 2017).

Spain

The Spanish Ministerio de Agricultura, Pesca y Alimentación published in the Resolution of 1 July 2019 the list of species for 2019 that have high survival and that can be released into the sea once captured that affected the stocks of *Raja microcellata* in 7.fg, Rajiformes in 6, 7, 8, 9 and *Raja undulata* in 8.c and 9.

In March 2020, the list of species with exemption of the landing obligation based on high survival was updated (Boletín Oficial Del Estado nº 66, sec. III), following the Commission Delegated Regulation (EU) 2019/2237. The updated list includes all skates and rays (except *L naevus)* caught by all fishing gears in Divisions 8 and 9, *L. naevus* caught with trawl in Division 9 and *L. naevus*caught with trammel nets in Divisions 8 and 9. The recommendation is to release immediately the unwanted catch of those species below the sea surface.

19.3 Catch data

19.3.1 Landings

Reported landings since the early 1970s have no clear trend, with historical data being incomplete with some national data missing in some years and some year to year variations suggesting changes in reporting practices rather than actual variations in landings (Figure 19.1). Landings data for all Rajiformes combined are considered reliable since 2005 (but species-specific landings are not reliable before 2009 for most stocks). Landings have declined since 2005. Detailed landings by area, species and stock are presented in Tables 19.1a-f and 19.2a-d at the end of this chapter. Table 19.1f gives annual ICES landings by stock and country. Tables 19.2a-c present the annual ICES landing estimates, by division for each skate and ray species and Table 19.2d landings of Dasyatidae, Myliobatidae, Rhinobatidae, Torpedinidae and Gimnuridae species.

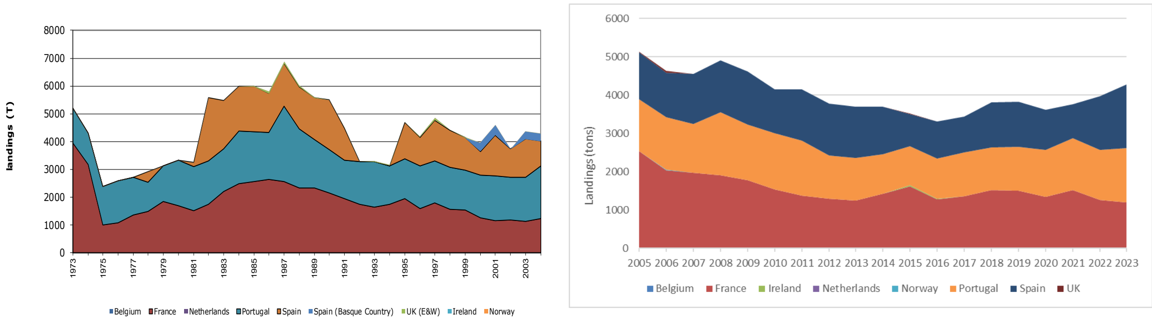


Figure 19.1. Skates in the Bay of Biscay and Iberian Waters. (Left): historical landings of Rajidae in subarea 8 and 9 from 1973 to 2004 from STATLANT data (with WGEF corrections using national data provided by WGEF members for some countries and years), (right): landings in 2005-2023 from data submitted to ICES.

Skates in Bay of Biscay and Cantabrian Sea (Subarea 8)

Since 2005, approximately 66% of landings in Subarea 8 have been caught by France and 34% by Spain. Since 1973, skate landings show no clear trend, although at the earlier years of the time-series (1973–1974) and in the period from 1982–1991 remarkably high values were registered. Data before the 2000s are considered incomplete.

Since 2010, divisions with the highest landings have been 8.a–b (around 70%), and these were mostly from France). In Division 8.c, landings represented 18% of the total landing of Subarea 8 and were mainly from Spain. Landings from Divisions 8.d-e have been low and decreasing since 2005, around 36 tonnes on average in the three last years.

Skates in Division 9.a

Portuguese and Spanish historical landings since 2005 account for *ca.*78% and 22%, respectively of reported skate landings. From 2005 to 2022, total landings of skates remained relatively stable, in the range 1265–1863 tonnes but in 2023 the landings increased to 2037 t.

19.3.2 Discards

Discard quantities available to ICES for Subarea 8 and Division 9.a by country are presented in Table 19.3a at the end of this chapter.

High survival rate of discarded skates has been estimated for several stocks in subareas 8 and 9 and elsewhere so that discards do not correspond to dead catch. Discard survival is considered in more detail where discards are accounted for in stock assessments.

In 2020 and 2021, on-board observation programmes have been disrupted by the COVID-19 pandemic. The sampling was overall lesser than in previous years resulting in a general increase uncertainty and some gaps in discard data.

19.3.3 Discard survival

WKSHARK3 (ICES, 2017a) and WKSHARK 5 (ICES, 2020) reviewed available studies to identify where there are existing data on at-vessel mortality and post-release mortality of elasmobranch species by area, gear type and identified important data gaps.

Discard survival data available on skates caught in trammel net fisheries (mesh size ≥ 100 mm) in ICES Division 27.9.a, collected under the Portuguese DCF pilot study on skates (2011–2013), and presented in previous reports was re-analyzed and the results summarized in Serra-Pereira and Figueiredo (2019 WD). Experiments were conducted on categorical vitality assessment (CVA) after capture of *R. clavata, L. naevus, R. montagui, R. brachyura* and *R. undulata* and indicate that it is generally high for all species, as the percentage of skates in Excellent and Good vitality status was above 75% for all species, mesh size and soak time considered (Table 19.3.3.1).

- ***R. clavata*** - specimens caught in both mesh size groups with soak time < 24h were mainly found in “excellent” condition (100% and 92%, respectively), while those from hauls > 24h, although most specimens were caught in “excellent” condition (72% and 52%), the percentage of “poor/dead” vitality status was comparatively higher (16% and 24%, respectively for each mesh size);
- ***R. brachyura*** - most specimens were caught in “excellent” conditions, representing 67% of the observations frommesh size <180mm and soaking time <24h, 92% for the same mesh and soaking time > 24h, 57% and 70% for mesh size > 180 mm for each soaking time period, respectively. The highest percentage of specimens in “poor/dead” status for that species was observed for mesh size > 180 mm and soaking time < 24h (24%) (for details see stock annex; ICES, 2024a);
- ***R. montagui*** - specimens caught with mesh size < 180 mm and in “excellent” vitality represented 100% and 67% depending on the soaking time; specimens caught with mesh size > 180 mm and in in “excellent” vitality represented 40% and 37%. The percentage of specimens in “poor/dead” conditions was higher for the larger mesh size group (30%) than for the smaller one (0% and 12%);
- ***L. naevus*** - representative data was only obtained for mesh size > 180 mm and soaking time > 24h. Under this situation 58% was the percentage of specimens in “excellent” condition while 21% and 21% corresponded to specimens in “good” and 21% “poor/dead” condition respectively;

- ***R. undulata*** - the percentage of specimens in "excellent" conditions was higher than 79% for all mesh sizes and soak times; highest values observed for mesh size > 180 mm and soaking time > 24h (96%). The percentage of specimens in "poor/dead" conditions was 2% and 5% for mesh size < 180 mm and 3% and 14% for mesh size > 180 mm, respectively for each of the two soaking times considered (for details see Maia *et al.* 2024a).

Results suggest that the vitality after capture of a specimen is not related to its size, as for all the species, and regardless of specimens' size (TL < 52 cm and > 52 cm), the majority was found in "excellent" vitality condition (60–92%). This indicate that fish below the formerly established minimum landing size of 52 cm for all Rajiformes (except *R. undulata*) and 78 cm for *R. undulata* and below the maximum landing size 97 cm for the latter, if released immediately to the water after capture have a potentially high survival capacity.

Table 19.3.3.1. Skates in the Bay of Biscay and Iberian Waters. Percentage of individuals by vitality status after capture (1 = Good; 2 = Moderate; 3 = Poor) in relation to mesh size and soak time in the Portuguese polyvalent fleet operating with trammel nets for *Raja clavata*, *Raja montagui*, *Raja brachyura*, *Leucoraja naevus* and *Raja undulata*. The total length range is also given.

			Vitality status				
Species	**Mesh size (mm)**	**Soak time (h)**	**1**	**2**	**3**	**n**	**TL range (cm)**
Raja clavata	< 180	< 24	100%	0%	0%	17	23-72
		> 24	72%	12%	16%	25	39-80
	> 180	< 24	92%	4%	4%	26	48-88
		> 24	52%	23%	24%	103	40-96
Raja brachyura	< 180	< 24	67%	22%	11%	9	39-66
		> 24	92%	4%	4%	24	27-75
	> 180	< 24	57%	19%	24%	21	49-95
		> 24	70%	20%	10%	143	18-106
Raja montagui	< 180	< 24	100%	0%	0%	18	21-64
		> 24	67%	21%	12%	42	10-60
	> 180	< 24	40%	30%	30%	20	46-62
		> 24	37%	33%	30%	43	37-68
Leucoraja naevus	< 180	< 24	1	-	-	1	53
	> 180	< 24	1	-	-	1	61
		> 24	58%	21%	21%	24	46-62
Raja undulata	< 180	< 24	82%	16%	2%	44	40-89
		> 24	90%	5%	5%	58	43-92
	> 180	< 24	79%	7%	14%	71	32-92
		> 24	96%	1%	3%	174	44-92

Additionally, a mark-recapture study (UNDULATA project, 2014–2015) of *R. undulata* caught by trammel nets obtained a return rate of 11% and the mean observed time-at-liberty was of 54 days and maximum of 313 days. These results are a good indication that the species has a potential high long-term survival.

In 2017, an experiment was carried out in the Bay of Bourgneuf (Division 8.a) during which 163 undulate rays were caught using a bottom otter trawl (Morfin *et al.,* 2019). 144 individuals in a good-enough physical condition were equipped with acoustic transmitters and fixed receivers were deployed in the semi-enclosed bay, in addition to occasional tracking with a mobile antenna. The study concluded that a minimum of 49% of the skates survived at least 2 weeks after tagging (with a maximum estimated survival of 97.5% considering at deck mortality). The 49% estimate is a minimal survival rate because it could not be established whether individuals that were not detected after 2 weeks were dead or had wandered outside the detection range of the receivers during the time of the experimentation.

In 2018, new experiments were conducted onboard PTGFS-WIBTS-Q4 and PT-CTS (UWTV (FU 28–29)) surveys to collect CVA and short-term survival estimates (only in the former) for *R. clavata* caught by otter trawl. Overall, most of the specimens were found in "excellent" or "good" conditions (60–72%), with an at-vessel-mortality of 6–7% (Table 19.3.3.2). All specimens in "excellent" vitality status showed tail grab, spiracles and body flex reflexes. The percentage of body flex and tail grab reflexes decreased with vitality status, 71% to 29% and 48% to 29%, respectively. The preliminary estimated survival, based on captivity observations of *R. clavata* during a maximum of 4 days, was 64%.

Table 19.3.3.2. Skates in the Bay of Biscay and Iberian Waters. Percentage of individuals by vitality status (1 = Excellent; 2 = Good; 3 = Poor; 4 = Dead) of each species assessed onboard IPMA's otter trawl surveys, for different deck times. For n ≤ 5, observed numbers by vitality are shown instead of percentages.

Species	Survey	Deck time	Length class	1	2	3	4	n	TL range (cm)
Raja clavata	PT-CTS	< 108 min	< 52 cm	47%	13%	33%	7%	30	
		< 108 min	> 52 cm	4	-	1	-	5	
		> 108 min	< 52 cm	0%	0%	0%	100%	25	
		> 108 min	> 52 cm	-	1	-	3	4	
	PTGFS-WIBTS-Q4	< 108 min	< 52 cm			1	1	2	
		< 108 min	> 52 cm	26%	46%	23%	6%	35	

In 2018, the Project DESCARSEL, conducted by IEO (Spain), performed survivability experiments to evaluate and estimate the survival of the rays usually discarded in thebottom trawl and trammel fisheries (Valeiras and Alvarez-Blazquez, 2018). A proportion of 93.46% and 100% of discarded rays assessed for vitality in bottom trawling and trammel nets survive to fishing operations and handling onboard. *Raja clavata* scored the lower survivability (58%-100%), *Raja montagui* (100%) and all specimens of *Raja undulata* survived the 36 hours first phase trial without mortality events (100% survivability). In bottom trawler the estimated survival for *R. clavata* at 36h was 58% (47.7-69.9) while in trammel net the estimated survival at 48h was 95.5% (87.1-100). Long-term survivability in *Raja clavata* was 17% (10.1-27.4) at the end of the observed period (one month). Stress and conditions at captivity should be a factor to take into account in this study and to analyse in future works. Most of the thornback rays did not feed till 3 weeks at captivity. Many factors influence survival and some of them are poorly understood and difficult to control across species, such as characteristics of the fishing haul (time, depth, speed, gear…), composition and volume of fish in the cod-end, time of hauling onboard, etc. (Valeiras and Alvarez-Blazquez, 2018).

In 2019, the Project DESCARSEL, performed survivability experiments focused on cuckoo ray (*L. naevus*) in trawl fisheries operating in northern Portugal fishing grounds (Division 9.a) (Valeiras *et al*., 2019). The study was conducted in April–May 2019 onboard a Spanish commercial trawler and included vitality and captivity observations. From a total of 503 individuals captured, 141 were placed in tanks for survival monitoring. The vitality results showed that 7.6% of the skates (n = 38) were assessed as Excellent condition, 24.1% (n = 121) as Good and 35.2% (n = 177) as Poor, and 33.2% (n = 167) were Dead. Estimated survival at 36h was 27% (21–36%). Maximum survivability at tank captivity was 7 days. Estimated 50% survivability was different for each vitality status. Skates assessed as Poor vitality died in 12 hours after hauling, while those with Excellent vitality lasted 41 hours (1.7 days) and those with Good vitality lasted 24 hours. The low survival estimates obtained from this study resulted on the removal of *L. naevus* caught by trawl in Division 9.a. from the exemption of the landing obligation (BOE, 2020, Nº 66, sec. III).

In 2020, the project SURF (Baulier *et al.* 2021) studied the survivability of cuckoo ray (*L. naevus*) discarded by French trawlers targeting demersal fish and operating in the Celtic Sea (Division 7h) and northern Bay of Biscay (Division 8a). The sampling, realised on a French commercial trawler, was stratified by vitality class and sampled individuals were landed and their state was monitored during up to three weeks in aquarium facilities in September 2020. Beside this, the vitality status of other discarded individuals was reported by an onboard observer during fishing trips carried out during winter, spring and summer aboard four different trawlers. The final survival rate ranged from 12% to 22% and was mainly influenced by haul duration and weather conditions (wave height).

In 2021, an Irish study aimed to estimate the survival rate of discarded cuckoo ray caught by a bottom trawler in Division 7a (Oliver *et al*. 2021). Like for the SURF project, individuals were brought ashore and monitored in captivity. Similar outcomes were obtained, with estimated final survival rate comprised between 11% and 16%.

Experiments described here followed the procedures described in previous studies on the survival of this group of species and the recommendations made by the STECF and the ICES Working Group on Methods to Estimate Discard Survival.

In early 2021, ICES conducted a workshop on the inclusion of discard survival in stock assessments (WKSURVIVE; ICES, 2021a). It was recognized that this continues to be an active research, particularly in what regards discard survival of skates and rays, due to its link to the EU conditional survivability exemption and associated evidence roadmap. Due to the complexity and specifications across stocks, it was recommended that the task of including discard survival into stock assessments should be driven by stock assessment groups. To avoid the long benchmark process, this group recommended an inter-benchmark meeting to address the inclusion of discard survival across multiple stocks within the same meeting, to accelerate the process.

19.3.4 Quality of the catch composition data

Species composition of landings in Subarea 8 and Division 9.a, corrected according to the WKSHARK2 reporting guidelines (ICES, 2016) are presented (Tables 19.1a-f and 19.2a-d at the end of the chapter). In the past decade, official landings reported as Rajiformes (indet.) have declined because of the EU mandatory species-specific reporting. For exemple, in the case of the Portuguese official landings statistics, eight commercial designations were reported in 2017: "raia lenga" (*R. clavata*), "raia pontuada" (*R. brachyura*), "raia manchada" (*R. montagui*), "raia-de-dois-olhos" (*L. naevus*), "raia de S. Pedro" (*L. circularis*), "raia-zimbreira" (*R. microocellata*), "raia-de-quatro-olhos" (*R. miraletus*) and "raia bicuda" (*D. oxyrinchus*).

Landings misidentifications and/or coding errors still occur in Subarea 8 and Division 9.a. In Division 9.a, statistical procedures were developed to better estimate species-specific landings during the DCF skate pilot study (2011–2013) (for details see Stock Annexes of Division 9a stocksand Figueiredo *et al.*, 2020b). Since 2017, a dedicated sampling programme on skate and ray species composition, incorporated in the DCF, was implemented in the main landing ports (Matosinhos, Póvoa do Varzim, Peniche, Sesimbra and Setubal). In France, sampling in auction market is carried out in a dedicated project "Elasmobranch on Shore" since 2012 (Mayot and Barreau, 2021) to assess the proportions of mislabelled landings.

More recently, during the ICES benchmark WKBELASMO3 (ICES, 2024a), landings from several skate species in Division 9a were reconstructed for the period 2000-2007 and 2000-2009 for Portugal and Spain, respectively.

19.4 Commercial catch composition and length frequency distribution

Length distribution of landings and discards are collected for all stocks in national programmes carried out in application of EU data collection regulations. However, reliable length distributions are seldom available for the smaller stocks in relation to small number of individuals caught. In 2022, length distributions have been used for assessment and advice of a larger number of stocks following the implementation of the new WKLIFE methods (rfb rule) instead of the previous 2/5 rule.

19.5 Commercial catch–effort data

19.5.1 Portuguese data for Division 9a.

19.5.1.1 Effort data

In the Portuguese continental coast, Rajidae species are mainly landed by the polyvalent segment followed by trawl. In 2022, the landed weight of Rajidae derived from the polyvalent segment represented 80% of the total landings. This fishing segment is characterized by multi-species and mixed fisheries and includes vessels with length overall (LOA) ranging from 5 to 27m, which generally operate between 10 to 150m deep (occasionally down to 600m). The analysis of DCF sampling data indicates that Rajidae are mainly caught by trammel nets, which is considered to be the most appropriated gear to catch these species.

Annual landings by species are calculated using the official daily landings data set and market sampling data collected under DCF according to the procedure described in Figueiredo *et al.* (2020b).

Fishing effort time series (2008–2022) for each fleet segment, polyvalent and trawl, were analysed. Consistently increasing or decreasing trends (monotonic) on the fishing effort data collected over time were investigated and the non-parametric Mann-Kendall trend test was applied (https://cran.r-project.org/web/packages/Kendall/Kendall.pdf). For each fishing segment, the test was applied to the last 10 years of the fishing effort series, considering the number of fishing trips with landings of Rajidae species as sampling unit (Table 19.5.1.1.1). Fishing effort time series (in number of trips) suggests a downward trend and the autocorrelation in data series does not appear significant for both fleets, polyvalent (Mann-Kendall trend test: tau=-0.16, p-value=0.59) and trawl (Mann-Kendall trend test: tau=-0.33, p-value=0.21). Additionally, fishing effort for bottom otter trawls targeting demersal fish in kW*days based on logbook data (DGRM data base) combined with vessel’s technical characteristics (EU Fleet Register) for the period 2010-2021 is also presented in Table 19.5.1.1.1. The overall decrease in fishing effort observed for both fleets may be related to several factors including the inclusion of *R. undulata* in the prohibited species list in 2009, the implementation of seasonal closures since 2012, and changes in the target species in some polyvalent fleets.

Table 19.5.1.1.1. Skates in Division 9.a. Fishing effort (number of trips) from the Portuguese polyvalent and trawl fleets for all species of skates and rays in the period 2008–2022. Fishing effort for demersal fish bottom otter trawl in kW*days for the period 2010–2021 is also presented.

Year	No Fishing trips		kW*days
	Polyvalent	Trawl	Demersal fish otter trawl
2008	36149	6513	
2009	36239	5683	
2010	34767	5461	3783454
2011	36761	5139	3436491
2012	32565	5158	3867366
2013	28007	4658	3860658
2014	25779	4471	3983152
2015	25723	4325	4301238
2016	24476	4593	4533480
2017	25296	4237	3170657
2018	24761	4566	3389243
2019	24561	4492	3396599
2020	27464	4650	3046189
2021	29470	5021	3459537
2022	24675	4692	4264803

19.5.1.2 CPUE and Effort data

In 2024, in Division 9a, standardized LPUEs were updated for *R. brachyura* (see Section 19.9.12 for more details), *R. montagui* (see Section 19.9.8 for more details), *R. clavata* (see Section 19.9.3 for more details) and *R.undulata* (see Section 19.9.11 for more details). For *L. naevus* the series is available for the period 2008-2022 (see Section 19.9.6 for more details).

19.6 Fishery-independent surveys

Groundfish surveys provide data on the spatial and temporal patterns in species composition, size composition, relative abundance and biomass for various skates. The fishery-independent surveys operating in the Bay of Biscay and Iberian Waters are discussed briefly below (see Stock Annexes for further details).

Due to the patchy (mainly coastal) distribution and habitat specificity of some skate species (e.g. *R. undulata, R. brachyura* and *R. microocellata*), existing surveys do not provide reliable information on abundance and biomass. In order to gather information on the distribution and spatio-temporal dynamics, and on abundance and biomass for those species, WGEF recommends dedicated surveys using an appropriate fishing gear be developed in this ecoregion.

19.6.1 French EVHOE survey (Subarea 8)

The EVHOE-WIBTS-Q4 (G9527) survey has been conducted annually in the Bay of Biscay since 1987 (excluding 1993, 1996 and 2017). Data are used to calculate biomass indices of two stocks (rjc.27.8abd and rjn.27.678abd (see the corresponding stock annexes for method).

19.6.2 Spanish survey data (divisions 8.c and 9.a)

The Spanish North Coast Bottom Trawl Survey SpGFS-WIBTS-Q4 (DEMERSALES G2784).

This annual survey in the Cantabrian Sea and Galician waters (divisions 8.c and 9.a) has covered this area since 1983 (except in 1987). In 2023, a new research vessel started to operate. In summary, regarding the main skates caught in the survey in 2023, the biomass of *R. clavata*, *L. naevus* and *R. brachyura* increased, whereas *R. montagui* decreased. Figure 19.6.2.1a shows the evolution of the biomass index of *R. clavata* caught in 8c and 9aN whereas the biomass index of *L. naevus* and *R. montagui*, only found in 8c, are shown in Figures 19.6.2.1b and 19.6.2.1bc, respectively. As usual, only one to few specimens of *Dipturus nidarosiensis*, *Dipturus oxyrinchus* and *Leucoraja circularis* were caught in the 2023 survey. An extensive revision of the historical series of biomass, abundance and length frequencies of the skates and rays found in this survey can be found in the WD of Ruiz-Pico *et al.* (2024), in the Stock Annex of the stocks corresponding to Div. 8c (rjn-27-8c and rjc.27.8c) and in the WKSKATE report (ICES, 2021b).

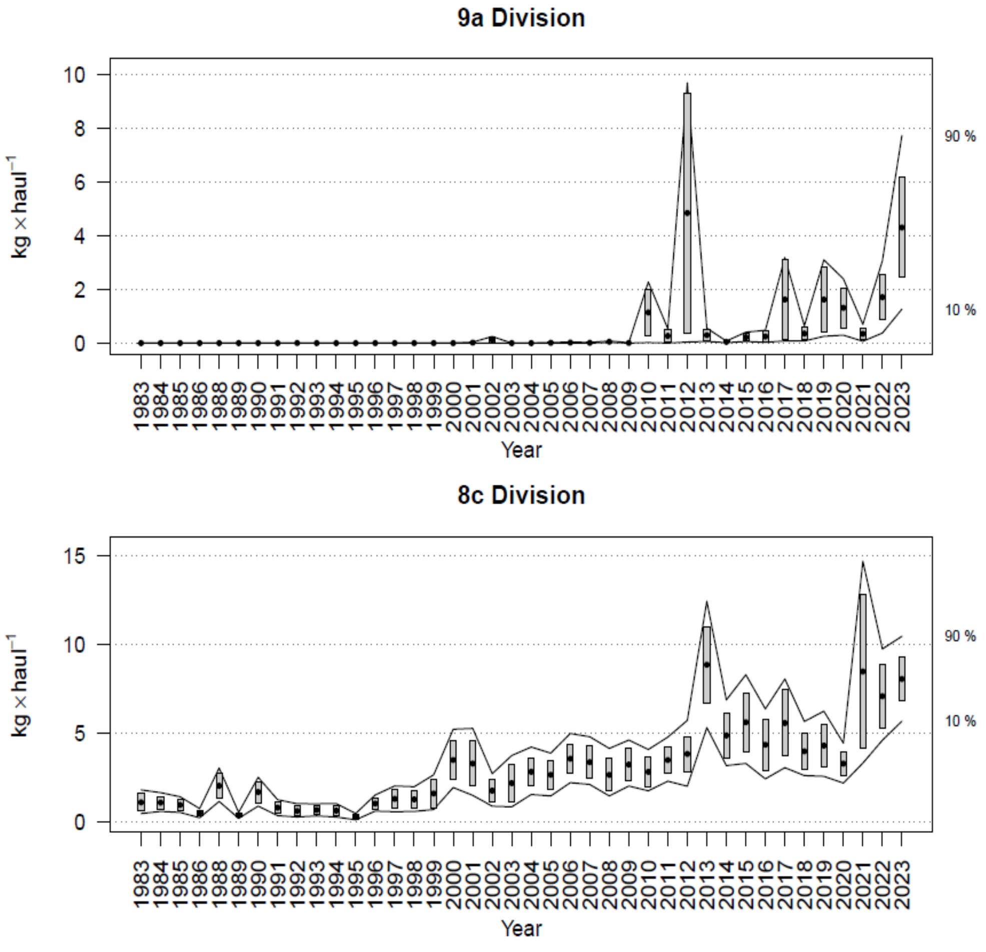


Figure 19.6.2.1a. Evolution of *Raja clavata* biomass index in the North Spanish Shelf groundfish survey time series in the two ICES divisions covered by the survey and with presence of this skate. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

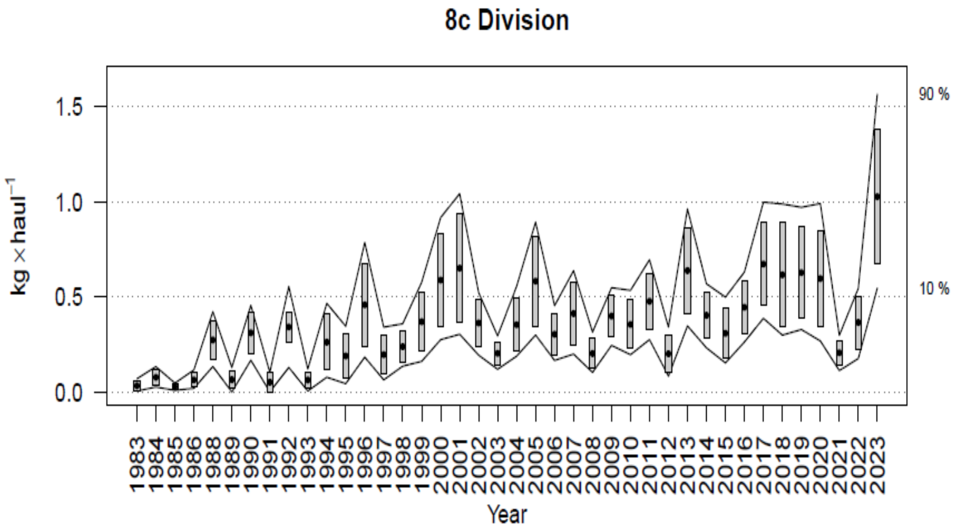


Figure 19.6.2.1b. Evolution of *Leucoraja naevus* biomass index in the Northern Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

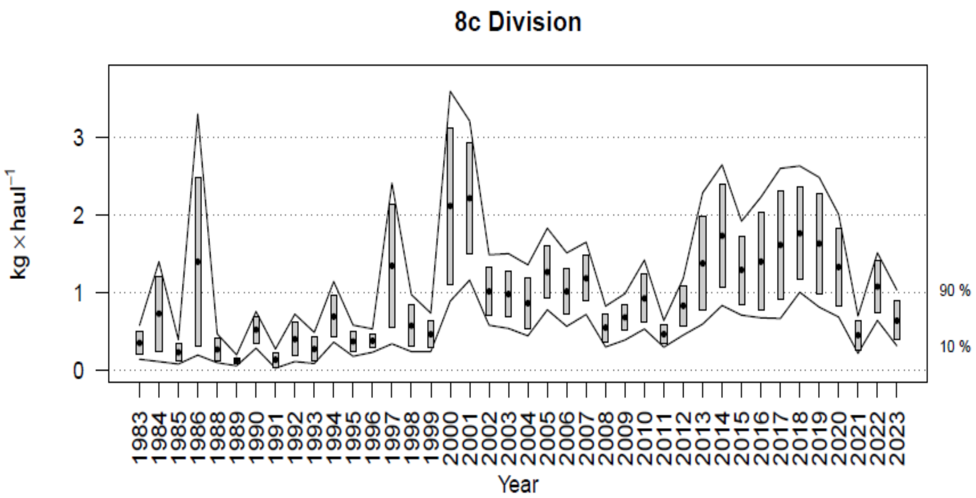


Figure 19.6.2.1c. Evolution *of Raja montagui* biomass index in the Northern Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

The Spanish bottom trawl survey IBTS-GC-Q1-Q4 (ARSA G4309).

This survey takes place in the Gulf of Cadiz (Division 9.a) and has been carried out in spring since 1993 and in autumn since 1997. Despite COVID-19 issues, both surveys were conducted in 2020. However, in 2021, the survey was not conducted dueto the vessel breakdown. The surveyed area corresponds to the continental shelf and upper-middle slope (depths of 15–800 m) and from longitude 6º20’W to 7º20’W, covering an area of 7224 km^2.

In the ARSA time series survey (1993–2023), the most abundant skates are *L. naevus* and *R. clavata.* In 2023, the biomass of *R. clavata* decreased compared to 2022, both in spring and autumn surveys, however remained within the highest values of the time series. In the case of *L. naevus* the biomass index increased in 2023 in both surveys (Figure 19.6.2.2).

Both species showed an increasing trend in biomass since 1997, with the highest values reached in 2013, 2015, 2018 and 2022, although since 2013 the biomass shows large year-to-year variations. The biomass values for *R. clavata* in 2022 increased to the highest peak of the series reaching

7.7 kg.haul^{-1} whereas *L. naevus* shows a decreasing trend since 2018 although the biomass index recovered in 2022 and 2023 (Figure 19.6.2.2).

Despite being variable, abundance indices (nº ind per haul) of *R. clavata* and *L. naevus* show an increasing trend over the time series since 1997. The highest abundance values of *R. clavata* were recorded in 2013 and 2015, and slightly decreased until 2020. In 2022 the abundance recovered to 4.4 individuals/haul. The abundance of *L. naevus* after the peak in 2017 has strongly decreased in 2019–2020 to the lowest values of the time series, although as it is observed in *R. clavata* the values slightly recovered in 2022 and 2023 (Figure 19.6.2.3).

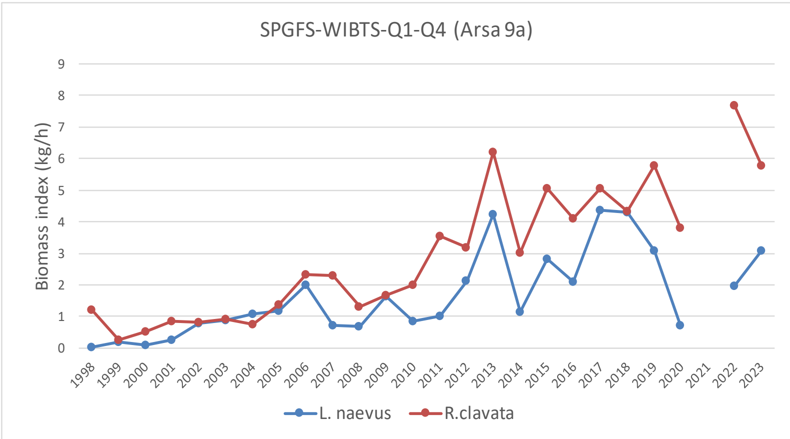


Figure 19.6.2.2. Skates in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as kg per haul from the Spanish bottom trawl survey ARSA carried out in spring and autumn in the Gulf of Cadiz (9.a South) from 1997 to 2023.The average of both surveys Q1 and Q4 has been represented.

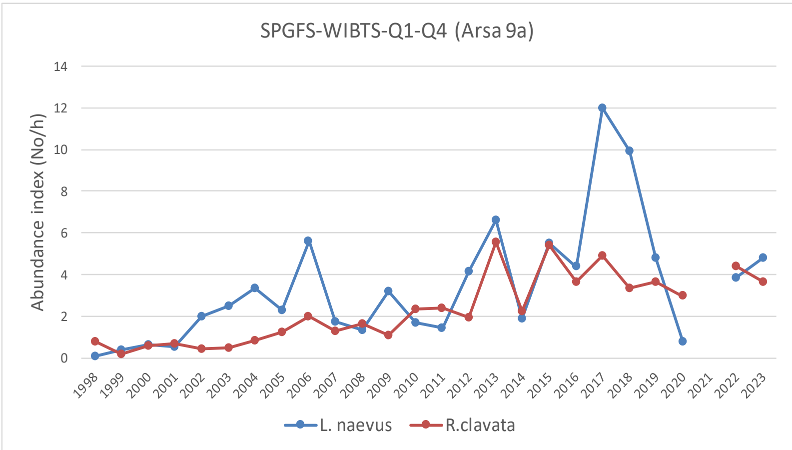


Figure 19.6.2.3. Skates in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as number per haul from the Spanish bottom trawl survey ARSA carried out in spring (Q1) and autumn (Q4) in the Gulf of Cadiz (9.a South) from 1997 to 2023. The average of both surveys Q1 and Q4 has been represented.

19.6.3 Portuguese survey data (Division 9.a)

Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4)

This survey has been conducted by the Portuguese Institute for the Sea and Atmosphere (IPMA, ex-IPIMAR) and has the main objective to monitor the abundance and distribution of hake (*Merluccius merluccius*) and horse mackerel (*Trachurus trachurus*) recruitment (Cardador *et al.*, 1997). PtGFS-WIBTS-Q4 is performed along the Portuguese continental coast, extending from latitude

41°20'N to 36°30'N (ICES Division 9.a) from 20 to 500 m deep. For details on vessels characteristics, survey stratification and technical characteristics of fishing operations see ICES (2017b). The survey was not conducted in 2012, 2019 and 2020. In 2018, the survey had technical problems, and part of the stations were sampled using a commercial trawler and a different fishing net (using FGAV019 instead of NCT). Since 2021 the survey has been conducted with a new vessel, RV "Mario Ruivo" (stern trawler of 75.6 m length and 2290 GRT).

In PtGFS-WIBTS-Q4, thornback ray is the most frequent skate species caught (88% of the total weight of skates), being caught all along the entire Portuguese continental shelf and upper slope, at depths ranging from 18 m to 700 m. The species is more abundant in southwest and south regions at depths shallower than 200 m. This survey is currently used to provide advice for rjc.27.9a and the time-series is available since 1990 (see Section 19.9.3 for more details).

Up to 2018, this survey was used to assess the stock status of *R. montagui*, but due to gaps in the data, the series is no longer considered (see Section 19.9.8 for more details).

Portuguese crustacean surveys / Nephrops Survey Offshore Portugal NepS [G2913]

This survey has been conducted by the Portuguese Institute for the Sea and Atmosphere (IPMA) and the main objective is to monitor the abundance and distribution of the main crustacean species, namely Norway lobster (*Nephrops norvegicus*), rose shrimp (*Parapenaeus longirostris*) and red shrimp (*Aristeus antennatus*).

Although not used to provide advice for rjn.27.9a, due to the irregularity of the series, this survey was used in the past as auxiliary information for the stock (for details see the stock annex).

19.7 Life history information

Available biological parameters of the main species from Portuguese Iberian waters are shown in table 19.7. In 2022, a WD on the reproductive biology of *Raja brachyura* was presented (Maia *et al.*, 2022a).

Data on the life-history traits of *R. undulata* in the Bay of Biscay are also available (Stéphan *et al.*, 2014). The length of first maturity was estimated to be 81.2cm for males (n = 832) and 83.8 cm for females (n=94). Exploratory growth analyses based on increase in size between tagging and recapture of a small number of tagged *R. undulata,* for which size-at-recapture was recorded, were consistent with growth estimates for the species in Portuguese waters. More information, including diet and a trophodynamic model for the northern part of Division 9.a, is available in the Stock Annex.

Table 19.7. Skates in the Bay of Biscay and Iberian Waters. Life-history information. Biological parameter estimates available for skate species inhabiting Portuguese Iberian waters. Growth models: VBR – von Bertalanffy Growth Model; GG – Gompertz Growth Model.

Species	TL range (cm)	L50 (cm) F	L50 (cm) M	l50 (years) F	l50 (years) M	Fecundity	Reproductive period	Growth model	Growth parameters estimates L∞ (cm)	k (y–1)	t0 (years)	Lmax (cm)	lmax (years)	l∞ longevity (years)	Period	Region	Source
R. undulata	19.4–88.2	76.2	73.6	8.98	7.66	-	-	VBG	110.2	0.11	–1.58	88.2	13	-	1999–2001	Algarve	[1,2]
	23.7–90.5	83.8	78.1	9	8	-	Feb–May	VBG	113.7	0.15	–0.01	90.5	12	23.6	2003–2006	Centre	[3]
	32.0–83.2	-	-	-	-	-	-	VBG	119.3	0.12	–0.41	83.2	9	28.9	1999–2001	Algarve	[3]
	23.5–95.9	86.2 ±2.6	76.8 ±2.4	8.7 ±0.3	7.6 ±0.4	69.8 ±3.4	Dec–May	-	-	-	-	-	-	-	2003–2013	North /Centre	[4]
R. clavata	14.3–91.3	-	-	-	-		-	VBG	128.0	0.112	–0.62	91.3	10	-	2003–2007	All	[5]
	12.5–105.0	78.4	67.6	7.5	5.8	136	May–Jan		-	-	-	-	-	-	2003–2008	All	[6]
R. brachyura	37.4–106.1	97.9	88.8	-	-	-	Mar–Jul	VBG	110.51	0.12	0.26	106.1	-	-	2003–2004	All	[7]
	37.6–108.8	96.6	88.6	-	-		Mar–Jul		-	-	-	-	-	-	2003–2012	North /Centre	[10]
	37-111	95.2	90.0				Apr-Sep								2003-2020	All	[11]
R. montagui	25.2–76.1	59.4	50.4	-	-	-	Apr–Jun	VBG	75.9	0.23	0.16	76.1	7	-	2003–2004	All	[8]
	36.8–70.2	56.7	48.0	-	-		Apr-Jul	-	-	-	-	-	-	-	2003–2012	All	[10]
L. naevus	12.7–71.8	55.6	56.5	-	-		-	VBG	79.2	0.24	0.12	71.8	-	-	2003–2004	All	[7]
	13.3–71.8	56.5	56.0	-	-	63	Jan-May		-	-	-	-	-	-	2003–2010	All	[9]

[1] Coelho and Erzini, 2002; [2] Coelho and Erzini, 2006; [3] Moura *et al.*, 2008; [4] Serra-Pereira *et al.*, 2015; [5] Serra-Pereira *et al.*, 2008; [6] Serra-Pereira *et al.*, 2011; [7] Farias, 2005; [8] Serra-Pereira, 2005; [9] Maia *et al.*, 2012; [10] Pina Rodrigues, 2012; [11] Maia *et al.*, 2022a.

19.8 Exploratory assessments

Previous analyses of the skates in this ecoregion were based on commercial LPUE data and on survey data. Updated analyses were conducted (see below).

19.8.1 *Raja undulata* in Divisions 8.a-b

An exploratory assessment based on a mark-recapture approach using data from two project (RAIEBECA and RECOAM) collected from 2011 to mid-2014 in the Bay of Biscay contributed greatly to the knowledge of the spatial distribution, movements and biology of *R. undulata* (see ICES (2020) for a full account). An explanatory assessment using length-based indicators was performed for years 2016–2017 and 2018–2019 based on data collected by the onboard observation programme (DCF programme) on French fishing vessels in divisions 8.a-b (Baulier, 2020 WD). The assessment used the eight indicator ratios recommended by WKLIFE (ICES, 2015) and combined catch data from bottom trawls and trammel nets raised to the corresponding fleets. The reference indicator ratio $L_{mean}/L_{F=M}$ (mean length of individuals larger than the length at first capture over the theoretical average length resulting from exploitation with a fishing mortality equal to natural mortality, which is a proxy for F_{MSY}) suggested that the stock was exploited with a fishing mortality lower than F_{MSY}. However, due to deviations from assumptions necessary to the derivation of reference points (especially steady state and knife-edge selectivity), the actual difference between current fishing mortality and F_{MSY} could not be estimated. Nevertheless, this diagnosis appeared to be robust to the values survival rate of discards applied, the degree of smoothing of the length distribution and the time period considered (2016–2017 or 2018–2019).

19.8.2 *Raja brachyura* in Division 9.a

Trials with the stochastic production model in continuous-time (SPiCT) (Pedersen and Berg, 2017) were run at WGEF in 2022 (Maia *et al.*, 2022d) and also considered in the recent benchmark for skate stocks, WKBELASMO3 (ICES, 2024a). This stock was benchmarked in 2024 and SPiCT assessments using landings since 2000 and one series of biomass indices (LPUE from Portuguese polyvalent fleet) since 2008 were tested but not accepted (ICES, 2024a). The stock remained in category 3 and the advice given according to the rfb rule (see section 19.9.16 for more details).

19.8.3 *Raja montagui* in Division 9.a

In 2022, considering the best knowledge on species biology and distribution, trials with the stochastic production model in continuous-time (SPiCT) (Pedersen and Berg, 2017) were run in line with ICES WKLIFE X guidelines (ICES, 2021b). Preliminary trials were conducted but more tests and sensitivity analyses, particularly concerning the data to be used and the choice of priori distributions, may be considered in the future. It should be noted that, given the increase in the minimum conservation reference size in 2022 (from 52 cm to 60 cm total length) for Portuguese waters, the information available in the most recent years, particularly the commercial standardized LPUE from the Portuguese polyvalent fleet, is no longer considered reliable as a stock size indicator (see section 19.9.12 for more details).

19.8.4 *Raja clavata* in Division 9.a

In 2022, the stock rjc.27.9a was assessed under category 3 (trend-based assessment) with input from standardized LPUE time-series as stock indicator. Following WKBELASMO3, this stock is assessed in the ICES stock data Category 2 using a stochastic production model in continuous-time (SPiCT) (Pedersen and Berg, 2017) (see section 19.9.3 for details).

19.9 Stock assessment carried out in 2024

Given the limited time range of species-specific landing data, and that commercial and biological data are often limited, the status of most skate stocks in this ecoregion is based primarily on survey data and length distribution, following the Category 3 of the ICES approach to data-limited stocks. Further analyses of survey data (see Section 19.6) and catch rates were undertaken. Due to the absence of survey data for some of the species in this ecoregion (e.g. rjh.27.9a, rju.27.9a, rjm.27.9a), other approaches were adopted for the advice (e.g. LPUE or self-sampling data).

In this section, data and analyses are summarized by stock units for which ICES provides advice.

19.9.1 Thornback ray (*Raja clavata*) in divisions 8abd (Bay of Biscay) (rjc.27.8abd)

The stock identity of thornback ray in the Bay of Biscay was considered by the Benchmark WKELASMO (ICES 2022b). Results of a genetic-study where more than 7000 individuals were genotyped to carry out a Close-Kin Mark-Recapture (CKMR) together with data on the geographical distribution of landings, location of catches from on-board observations and surveys and length distribution from surveys allowed to conclude that there was limited flow of individuals between thornback ray from divisions 8.abd and thornback ray from Division 8.c (see ICES, 2022b for details). Genetics clearly showed further meta-population structure within divisions 8.abd. There was no or limited flow between individuals from the Gironde estuary and individuals from the offshore continental shelf and probably other local coastal populations. Nevertheless, quantitative assessment of every small populations is not feasible and the only way forward is to assess larger units comprising meta-populations, some of which being possibly disconnected such as the Gironde and offshore shelf. Assessing two stock units for 8.abd and 8.c (see section 19.9.2) separately is achievable because there is a survey index for each.

Following WKELASMO, this stock is assessed in the ICES stock data Category 2 using a tailored Bayesian Surplus Production Model (BSPM). The model is described in the stock annex for rjc.27.8abd. The assessment used landings only data because dead discards were estimated to be 0.2-3% depending on the year.

The description of the index calculation is included in the stock annex.

19.9.1.1 Biomass index

The biomass index was derived from the EVHOE-WIBTS-Q4 survey [G9527] using DATRAS data for the period 2009 to 2023 (no data in 2017 due to vessel breakdown). Sampling strata were used to delineate the area where the bulk of catch was made in the commercial fisheries and in the survey. Sampling strata where the species was not caught in the survey or with only occasional catches were excluded. Hence only the two largest survey strata (GN4 and GN3) were retained for index calculation (Figure 19.9.1.1).

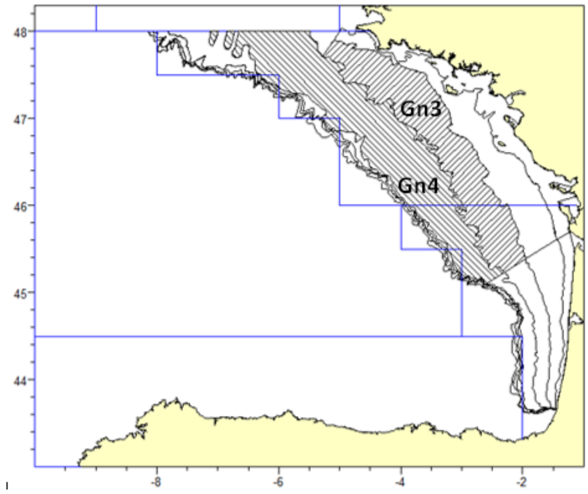


Figure 19.9.1.1. Sampling strata of EVHOE bottom trawl survey [G9527] used for biomass index calculation represented by the striped areas.

The biomass index was calculated using a swept area approach where the biomass caught in the area swept by the sampling trawl was raised to the survey area for the two selected strata. Confidence intervals and the variance of the biomass index were obtained using a non-parametric data bootstrap conditioning on the total number of hauls in a given year and assigning resamples to the appropriate strata. Note that confidence intervals were rather symmetrical, justifying the use of a normal distribution for the observation error in the production model. Indices of total and exploited (individuals >= 50 cm TL) biomass and an index of abundance of juveniles (individuals < 50 cm TL) were calculated (Figure 19.9.1.2). However, only the index of total biomass was used in the assessment (Table 19.9.1.1).

Note that the recent increase in biomass seems to have been preceded by an increase in the abundance of juveniles in 2015-2016. Abundance of juveniles is higher in 2015-2023 than in preceding years.

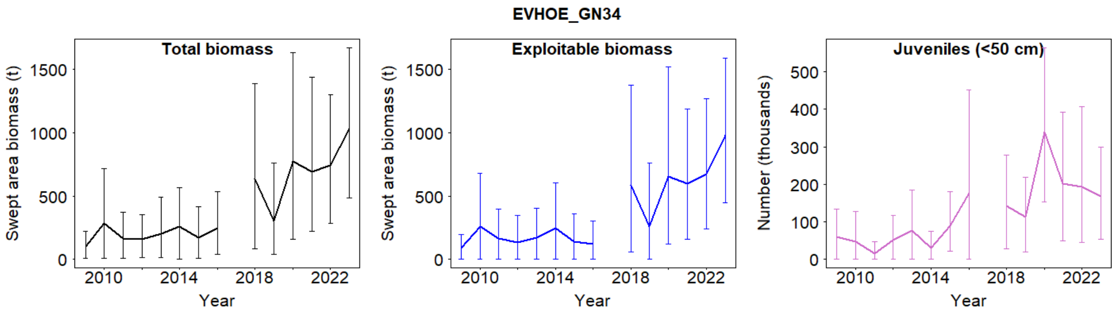


Figure 19.9.1.2. Estimates of total biomass (tonnes), exploited biomass (tonnes) and juveniles (thousands) from EVHOE-WIBTS-Q4 [G9527] for the period 1999-2023, 95% CI from bootstrap.

Table 19.9.1.1. Thornback ray in divisions 8.a-b and 8.d. Time-series of total biomass index used for the 2024 assessment, with 95% confidence intervals. The biomass per km² is also presented.

Year	Biomass	Low 95% CI	High 95% CI	kg.km^{-2}
2009	102	9	224	2.42
2010	283	9	718	6.71
2011	166	5	372	3.94
2012	156	12	352	3.69
2013	205	16	492	4.86
2014	257	0	566	6.10
2015	173	9	414	4.11
2016	247	36	536	5.87
2017*	-	-	-	-
2018	638	80	1387	15.13
2019	304	36	759	7.21
2020	776	155	1632	18.41
2021	692	221	1439	16.41
2022	745	284	1301	17.68
2023	1034	486	1674	24.53

* No survey conducted in 2017.

19.9.1.2 Catches

Landings from 2009 were derived from InterCatch data and treated in the WGEF file for landings. Indeed, landings in years prior to 2009 are not considered as reliable because landings were not reported by species and most landings of thornback ray were reported as "skates and rays". Corrections of reported landings for this stock from 2009 were minor or no-existent.

Dead discards were estimated to represent less than 5% of total catch and were therefore considered negligible for assessment purpose and ignored. Also, all catches are assumed to be landed.

Catches (landings) varied from 200 to 364 tonnes in 2009–2023 (Table 19.9.1.2).

Table 19.9.1.2 Thornback ray in divisions 8.a-b and 8.d. Catches (in tonnes) and assumed to be all landed.

Year	Catches
2009	239
2010	246
2011	217
2012	227
2013	244
2014	241
2015	266
2016	211
2017	232
2018	273
2019	266
2020	266

Year	Catches
2021	305
2022	345
2023	364

19.9.1.3 Close-kin mark-recapture estimate

A Close-Kin Mark-Recapture (CKMR) estimate of abundance was available for this stock (see stock annex, Trenkel and Lorance, 2022 WD, Trenkel *et al.*, 2022). Total biomass was derived from estimated abundance for years 2012–2015 (Table 19.9.1.3).

Table 19.9.1.3. Thornback ray in divisions 8.a-b and 8.d. CKMR derived estimate of total abundance.

Year	Lower CI	Biomass	Higher CI
2012	558.84	1257.93	1957.02
2013	885.59	1271.99	1658.4
2014	921.45	1452.14	1982.84
2015	626.47	1781.2	2935.94

19.9.1.4 Bayesian Surplus Production Model (BSPM)

The model description, priors applied and the forecast method can be found in the stock annex. In 2024, an error (in the benchmark and 2022 assessment) was detected in the model. The model was corrected in 2024 (see section 19.9 Quality of assessment).

In the 2024 assessment, convergence was achieved for all parameters and state variables. All posterior parameter distributions differed markedly from their prior distributions, indicating the important contribution made by the data (Figure 19.9.1.3).

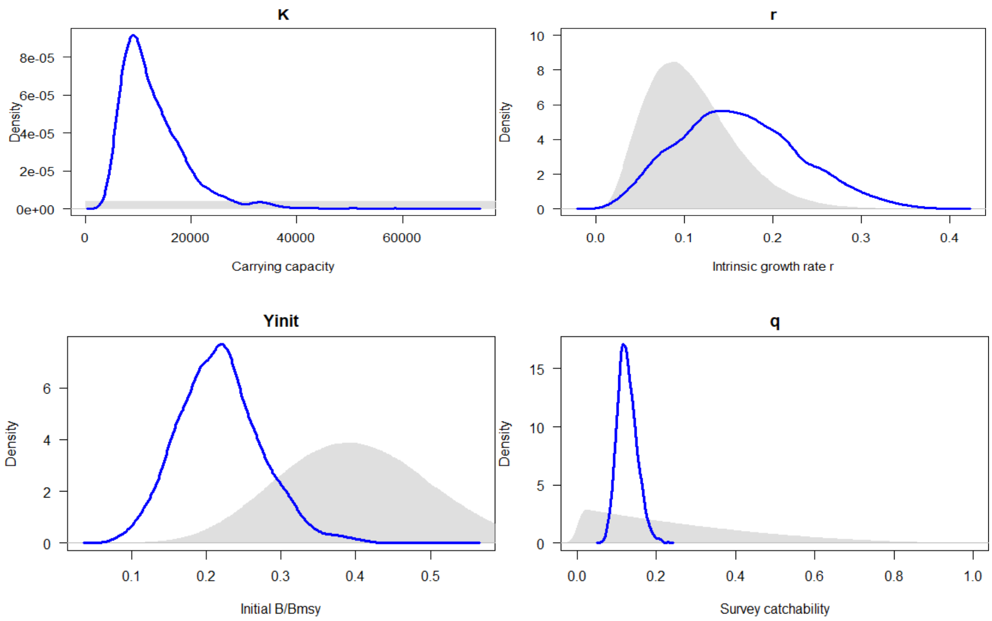


Figure 19.9.1.3. Prior (grey surfaces) and posterior (blue lines) distributions for parameter estimates for production model.

Model parameter estimates are given in table 19.9.1.4. Reference points were directly derived from two estimated model parameters, intrinsic population growth rate r and carrying capacity K, using the median of the posterior distribution (Table 19.9.1.5).

Table 19.9.1.4. Bayesian production model posterior parameter estimates and credible interval points.

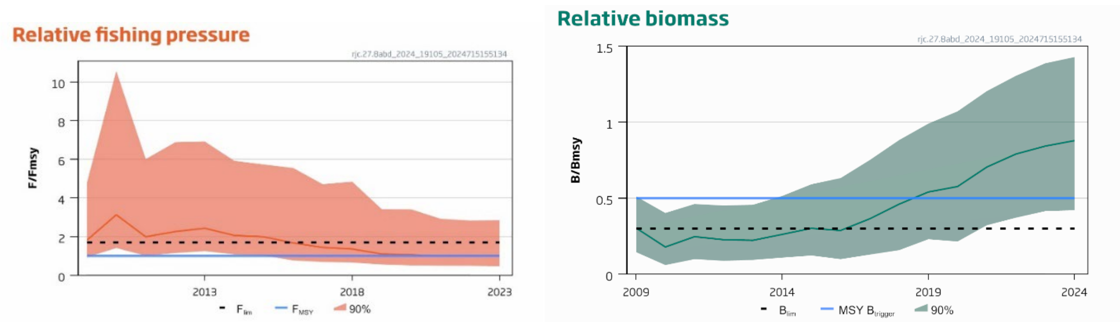
Parameter	Description	Posterior median	Lower 5 percentile	Upper 95 percentile
r	Intrinsic population growth rate	0.16	0.06	0.28
K	Carrying capacity (tonnes)	11 324	5 952	25 299
Q	EVHOE survey catchability	0.12	0.09	0.17
Yinit	Depletion rate in 2009 (B_{2009}/K)	0.22	0.13	0.31

Table 19.9.1.5. Thornback ray in divisions 8.a-b and 8.d. Reference points, values and their technical basis.

Framework	Reference points	Value	Technical basis
MSY approach	MSY $B_{trigger}$	$\frac{B}{B_{MSY}} = 0.5$	Relative value from the Bayesian Surplus Production model. B_{MSY} is estimated directly from the assessment model and changes when the assessment is updated.
	F_{MSY}	$\frac{F}{F_{MSY}} = 1$	Relative value from the Bayesian Surplus Production model. F_{MSY} is estimated directly from the assessment model and changes when the assessment is updated.
Precautionary approach	B_{lim}	0.3 x B_{MSY}	Relative value. (Equilibrium yield at this biomass is 50% of MSY)
	F_{lim}	1.7 x F_{MSY}	Relative value (the F that drives the stock to B_{lim})

Harvest rate estimates as well as total biomass estimates are presented relative to their maximums sustainable yield values, i.e. F/F_{MSY} and B/B_{MSY} respectively. The estimated biomass increased over time, while the harvest rate decreased (Figure 19.9.1.4 top and Table 19.9.1.6). Fishing pressure on the stock is at F_{MSY}, and stock size is above MSY $B_{trigger}$ and B_{lim} (Figure 19.9.1.4 top). Note that the uncertainty of both biomass and harvest rate estimates is rather large but still possibly somewhat underestimated. As the length of the data time series increases, precision of estimates can be expected to improve.

The retrospective analysis which consisted of sequentially removing data corresponding to the three final years showed that estimates were sensitive to this, though median posterior estimates remained within the 80% credible of the full data time series (2009–2022) (Figure 19.9.1.4 bottom). This result is not surprising given the time trend in survey index that appeared at the end of the time series. Mohn's rho was 0.38 for biomass B and 0.016 for harvest rate F. Further, in this retrospective pattern, F doesn't change whereas biomass tends to be overestimated biomass tends to be overestimated when years are removed.



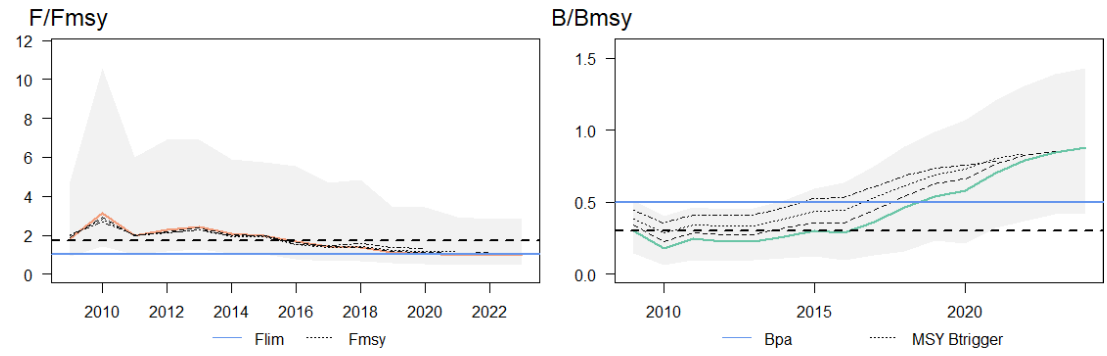


Figure 19.9.1.4. Top row: relative estimates for harvest rate as a proxy for fishing mortality (left) and total biomass (right) as well as precautionary (pa) and MSY reference points. Median estimates (solid lines) and 80% credible intervals. Bottom row: retrospective analysis of harvest rate (left) and total biomass (right) removing final years in model fitting. Grey surface and coloured continuous line correspond to full assessment results in top row.

Table 19.9.1.6. Thornback ray in divisions 8.a–b and 8.d. Assessment summary. Biomass is relative to B_{MSY} at the end of the year and fishing mortality relative to F_{MSY}. High and low values are 90% confidence intervals. Catches are in tonnes and assumed to be all landed.

Year	Relative biomass			Catches (tonnes)	Relative fishing pressure		
	Low	B/B_{MSY}	High		Low	F/F_{MSY}	High
2009	0.145	0.30	0.51	239	0.93	1.81	4.8
2010	0.060	0.179	0.40	246	1.41	3.1	10.6
2011	0.099	0.25	0.46	217	1.01	1.99	6.0
2012	0.088	0.23	0.45	227	1.15	2.3	6.9
2013	0.094	0.22	0.46	244	1.25	2.4	6.9
2014	0.109	0.26	0.51	241	1.08	2.1	5.9
2015	0.123	0.30	0.59	266	1.02	1.99	5.7
2016	0.099	0.29	0.63	211	0.77	1.67	5.6
2017	0.129	0.36	0.75	232	0.69	1.44	4.7
2018	0.158	0.46	0.88	273	0.66	1.36	4.8
2019	0.230	0.54	0.99	266	0.56	1.10	3.4
2020	0.215	0.58	1.07	266	0.51	1.06	3.4
2021	0.322	0.71	1.21	305	0.49	0.99	2.9
2022	0.372	0.79	1.31	345	0.49	1.00	2.8
2023	0.415	0.84	1.39	364	0.47	0.99	2.9
2024	0.421	0.88	1.43				

The results for the interim year projection under status quo harvest rate are given in table 19.9.1.7.

Table 19.9.1.7. Thornback ray in divisions 8.a-b and 8.d. The basis for the catch scenarios.

Variable	Value	Notes
Median F(2024)/F_{MSY}	0.99	Harvest rate in 2024. Status quo F: F_{2023}/F_{MSY}
Median B(2025)/B_{MSY}	0.88	Short-term forecast (STF); B_{2025} is at the beginning of the year 2025
Catch (2024)	379	Projected landings n tonnes (STF); all catches are assumed to be landed.

19.9.1.5 Catch advice

Seven management scenarios were explored and the catches and relative reference points estimated for 2025 and 2026 (Tables 19.9.1.8 and 19.9.1.9).

As in the 2022 assessment, the advice is based on the 35th percentile of predicted catch distribution under F = F_{MSY} (ICES, 2023), given that biomass has been estimated by CKMR. The catch advice for 2025-2026 (306 t in 2025 and 311 t in 2026) is higher than the previous advice (255 t in

2023 and 257 t in 2024). The change in advised catch between 2024 and 2025 (+19%) is due to an increase and upward revision of the absolute biomass and carrying capacity, although the relative biomass is revised downwards.

Table 19.9.1.7. Thornback ray in divisions 8.a-b and 8.d. Annual catch scenarios for 2025. All weights are in tonnes.

Basis	Catch (2025)	Fishing mortality F_{2025}/F_{MSY}	Stock size B_{2026}/B_{MSY}*	% B change **	% advice change***
ICES advice basis					
MSY approach (35th percentile of predicted catch distribution under F = F_{MSY})	306	0.79	0.91	2.5	19
Other scenarios					
F = F_{MSY}	387	1	0.89	0.76	51
F = F_{2024}	382	0.99	0.89	0.89	49
F = 0	0	0	0.96	9.1	-100
Catch = 10th percentile of predicted catch distribution under F = F_{MSY}	163	0.42	0.93	5.6	-36
Catch = 15th percentile of predicted catch distribution under F = F_{MSY}	199	0.52	0.93	4.8	-22
Catch = 20th percentile of predicted catch distribution under F = F_{MSY}	228	0.59	0.92	4.2	-11.3

* Biomass is at 1 January.
** Percentage change of B_{2026}/B_{MSY} relative to B_{2025}/B_{MSY}.
*** Advice value for 2025 relative to catch advice value for 2024 (257 tonnes).

Table 19.9.1.8. Thornback ray in 8.a–b and 8.d. Annual catch scenarios for 2026 with F_{2025}= 35th percentile of the predicted catch distribution under F = F_{MSY}. All weights are in tonnes.

Basis	Catch (2026)	Fishing mortality F_{2026}/F_{MSY}	Stock size B_{2027}/B_{MSY}*	% B change**	% advice change***
ICES advice basis					
MSY approach (35^{th} percentile of predicted catch distribution under F = F_{MSY})	311	0.79	0.92	2.1	1.5
Other scenarios					
F = F_{MSY}	395	1	0.91	0.20	29
F = F_{2024}	389	0.98	0.91	0.33	27
F = 0	0	0	0.98	8.5	-100
Catch = 10th percentile of predicted catch distribution under F = F_{MSY}	159	0.40	0.95	5.3	-48
Catch = 15th percentile of predicted catch distribution under F = F_{MSY}	197	0.50	0.95	4.6	-36
Catch = 20th percentile of predicted catch distribution under F = F_{MSY}	227	0.57	0.94	4.0	-26

* Biomass is at 1 January
** Percentage change of B_{2027}/B_{MSY} relative to B_{2026}/B_{MSY}.
*** Advice value for 2026 relative to catch advice value for 2025 (306 tonnes).

19.9.2 Thornback ray (*Raja clavata*) in Division 8.c (Cantabrian Sea) (rjc.27.8c)

As mentioned previously (section 19.9.1) the stock identity of thornback ray in the Bay of Biscay was reviewed at the Benchmark WKELASMO (ICES 2022b). According to the information presented and discussed at WKELASMO (Lorance, 2022; Rodriguez-Cabello and Sánchez, 2022) the rjc.27.8 stock was split in two stock units were split from. The first assessment on rjc.27.8c stock was conducted in 2022, by applying the rfb rule for the first time. Catch advice for 2023 and 2024 (issued in 2022) was 201 tonnes in each of the years 2023 and 2024 (ICES 2023a). This catch advice implied landings of no more than 173 tonnes if discard rates do not change from the average of the last three years (2019–2021).

As result of the WKELASMO Benchmark and after a data preparatory meeting in 2023 the stock rjc.27.8c was included in the second ICES Benchmark Workshop on the application of SPiCT to produce MSY advice for selected stocks WKBMSYSPiCT2 (ICES, 2023b). The SPiCT assessment of thornback ray in Division 8.c was considered suitable for providing management advice.

19.8.6.1. Input data

Species-specific landings were only available since 2009. WKMSYSPICT recommended to increase the time series of landings, therefore reconstruction of landings from 1996 to 2008 was agreed and carried out during the data compilation workshop (Rodriguez-Cabello et al., 2022 WD). Higher uncertainty was given for landings estimated before 2009. Discard estimates were available for the Spanish fleet since 2015 and were not used in the assessment (Figure 19.8.6.1).

The biomass index available corresponds to the North Spanish bottom trawl survey carried out annually since 1983 (except in 1987). The sampling design is random stratified to the area with five sectors and three depth strata. The depth range covers 70-500 m. For input data it was agreed to start the time series in1990 (see Figure 19.6.2.1a). In 2013 there was a changed in the research vessel replacing the old one. Therefore, during the WKMSYSPICT was decided to give higher uncertainty in 2013 and split the biomass index in two time series 1990-2012 and 2013-2023.

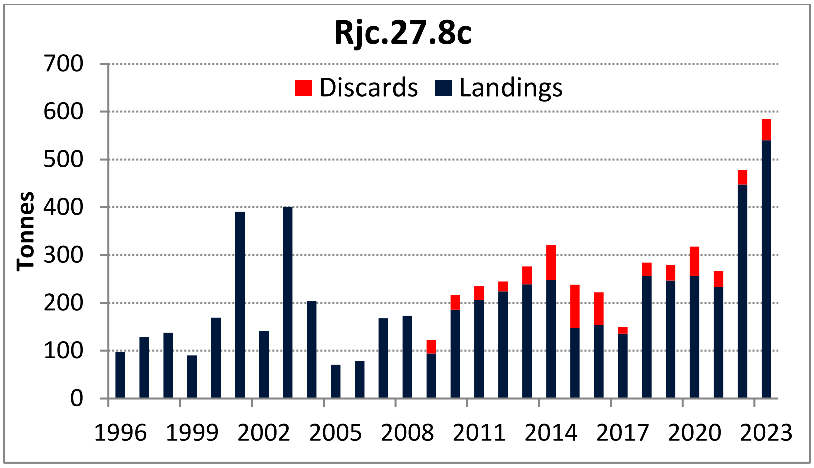


Figure 19.8.6.1. History of commercial landings and discards in tonnes. Landings before 2009 were reconstructed.

19.8.6.2. Model configuration – SPiCT assessment

The SPiCT model was accepted in the benchmark and the following settings were adopted according to the exploratory assessment and agreement.

Input data:

- Landings (1996-2023)
- Biomass Index: North Spanish bottom trawl survey (1990-2023) split in two time series 1990-2012 and 2013-2023.

SPiCT settings:

- Uncertainty in landings: Before 2009: 1.5, after 2009: 0.5 (difference of factor 3)
- Standard deviation scaling for the index observations (stdevfacI) and 3 times original value in 2013 (0.74 x 3 = 2.23)
- Logalfa and logbeta disabled
- Berg´s Gamma Thorson prior. Gamma distribution (3.48, 6.35) based on a meta study by Thorson et al. (2012))
- Prior for the logarithm of the intrinsic growth rate (logr*) r* prior considered (r=0.20) based on FishBase (Froese and Pauly, 2022).
- Prior for the logarithm of the standard deviation of the biomass process noise (logsdb): N (0.15, 0.3) (based on meta study by Casper Berg (unpublished)
- Prior for the logarithm of the standard deviation of the survey index observation noise (logsdi): N (0.37, 0.3) and N (0.33, 0.3) for the 2 indices (based on the mean of the estimated SD).
- Euler discretisation time step (dteuler): 1/16 (default)

The assessment passed all diagnostic checks and it was robust over a wide range of tested alternative scenarios. The assessment included a Gamma prior for the shape of the production curve based on the meta study by Thorson et al. (2012), a prior for the intrinsic rate of population growth around 0.2 based on FishBase, a prior for the biomass process noise around 0.15 based on a meta study (Berg (unpublished)), and a prior for the observation uncertainty of the indices around the average standard deviation of the estimated uncertainty of the stratified mean index calculation. The estimated perception of the stock was not sensitive to the assumed prior distributions.

19.8.6.3. Assessment results

Plots and results from the final assessment are presented in Figures 19.8.6.2. Estimated priors and posterior are shown on Figure 19.8.6.3. The diagnostics of the final assessment are shown on. No significant bias or autocorrelation were found and both QQ-plot and the Shapiro test showed normality in the residuals (Figure 19.8.6.4). Some retrospective pattern is observed when testing 5 years although all peels are within the confidence intervals and Mohn's rho is within the accepted values (Figure 19.8.6.5). Considering the adopted reference points, fishing pressure on the stock is below FMSY, and biomass is above $MSYB_{trigger}$ and B_{lim} (Figure. 19.8.6.6).

19.8.6.4. Short-term projections

Short-term projections consider the fishing mortality in the intermediate year as the estimated F at the time step of the last observation and the estimated seasonal F process. The basis of the catch scenarios is shown in Table 19.8.6.1. The annual catch scenarios for 2025 and 2026 are shown on Tables 19.8.6.2 and 19.8.6.3, respectively. Landings and discard data and relative biomass index and fishing mortality are presented in Table 19.8.6.4.

19.8.6.5. Comments on the assessment

This stock was benchmarked in 2023 (ICES, 2023b). The SPiCT assessment uses landings as input and, therefore, the short-term-forecast is in terms of landings. The advice TAC can be given in terms of landings as presented above, or an assumption needs to be made about the discard rate in order to estimate corresponding catch advice.

Several possible biennial TACs based on a range of catch fractiles were presented in the benchmark report (ICES, 2023b). Due to the following reasons: (i) Elasmobranchs are sensitive species due to lower fertility and less understood stock recruitment relationships, (ii) the model and any advice based on the model is based on landings and does not consider potentially changing discard rates, (iii) the advice is biennial and conservation measures are likely slower, and (iv) the assessment is based on a single abundance index, which suggests a continuously increasing abundance of Thornback ray in Division 8.c., it was considered more precautionary to recommended a TAC on a lower fractile (15th percentile than the general 35th percentile).

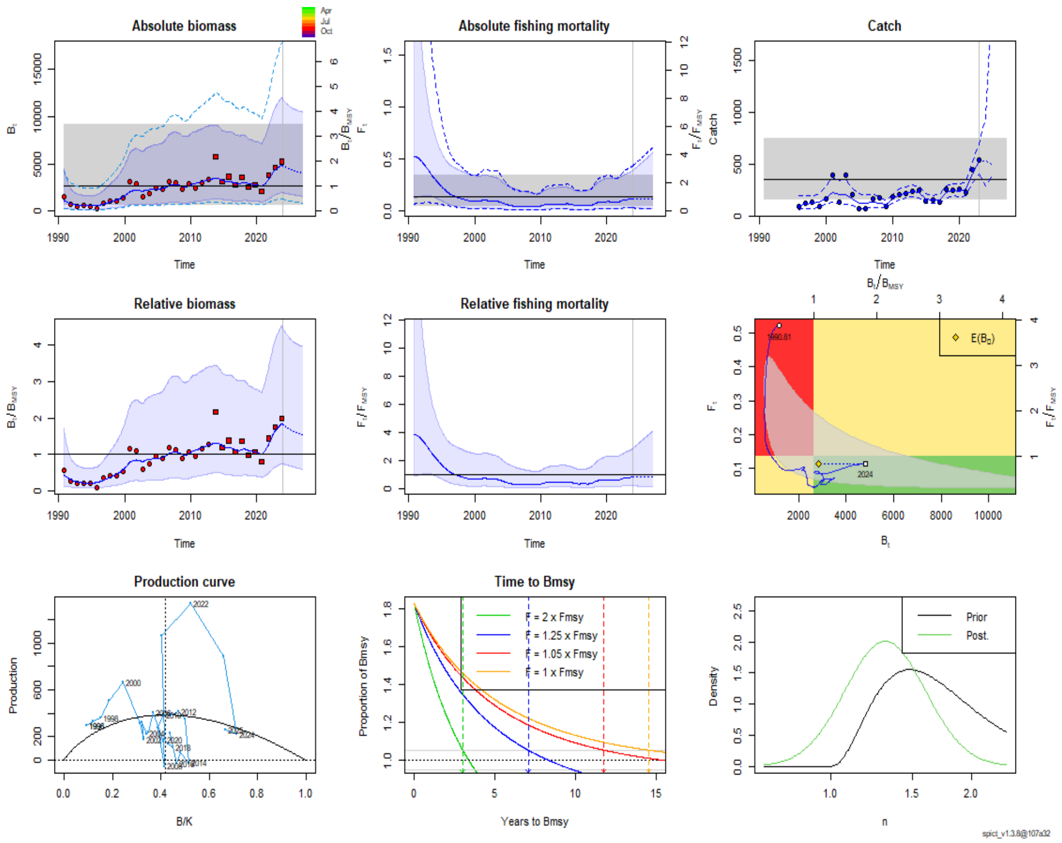


Figure 19.8.6.2. *Raja clavata* in ICES Division 27.8c. Results of final assessment.

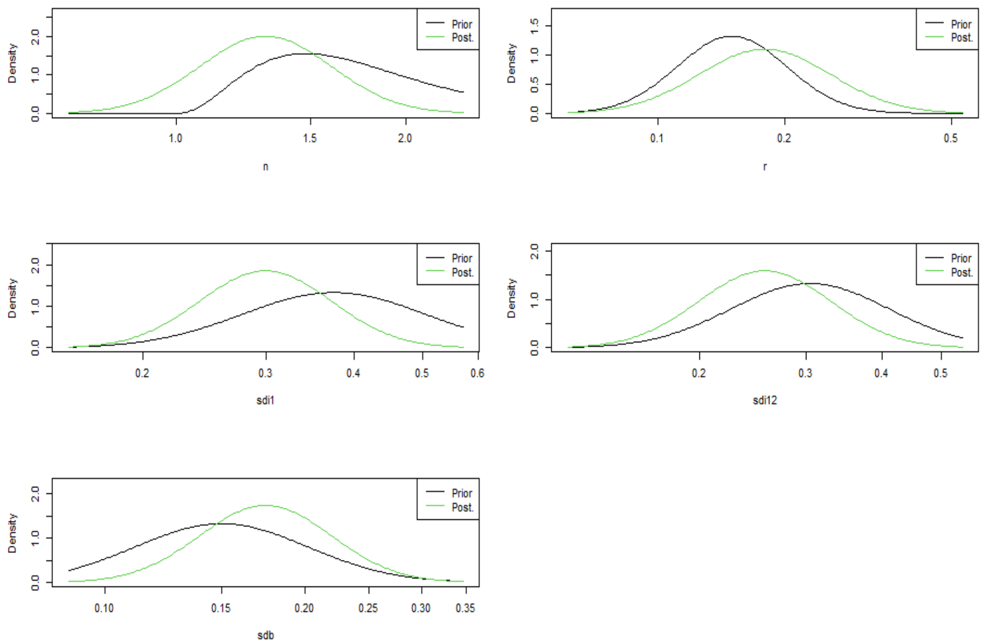


Figure 19.8.6.3. *Raja clavata* in ICES Division 27.8c. Estimated priors and posteriors for the final assessment.

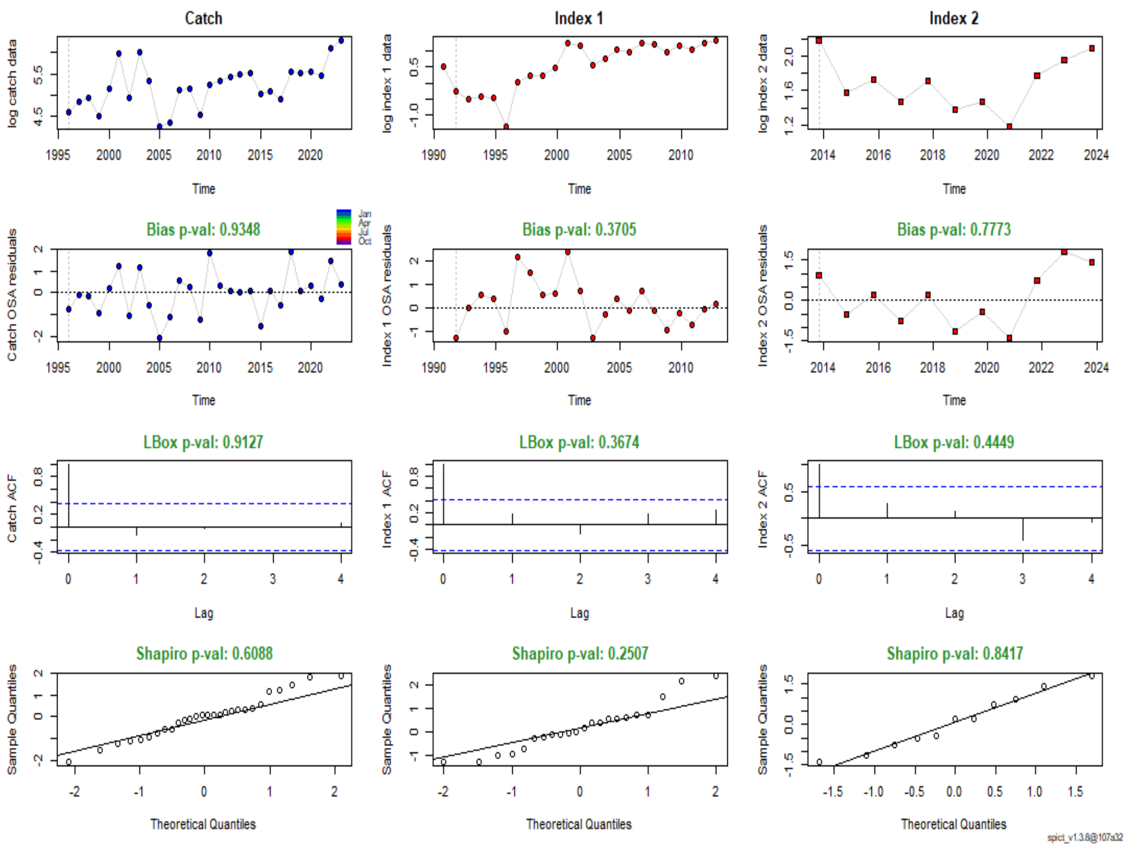


Figure 19.8.6.4. *Raja clavata* in ICES Division 27.8c. Diagnostics of the final assessment.

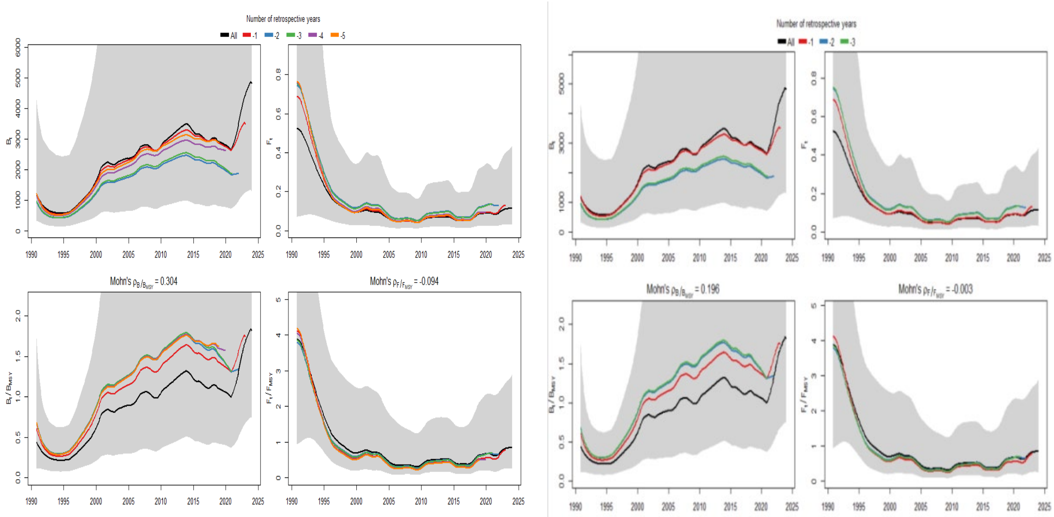


Figure 19.8.6.5. *Raja clavata* in ICES Division 27.8c. Retrospective pattern of the final assessment. Left: using 5 retro-years; Right: using 3 retro-years.

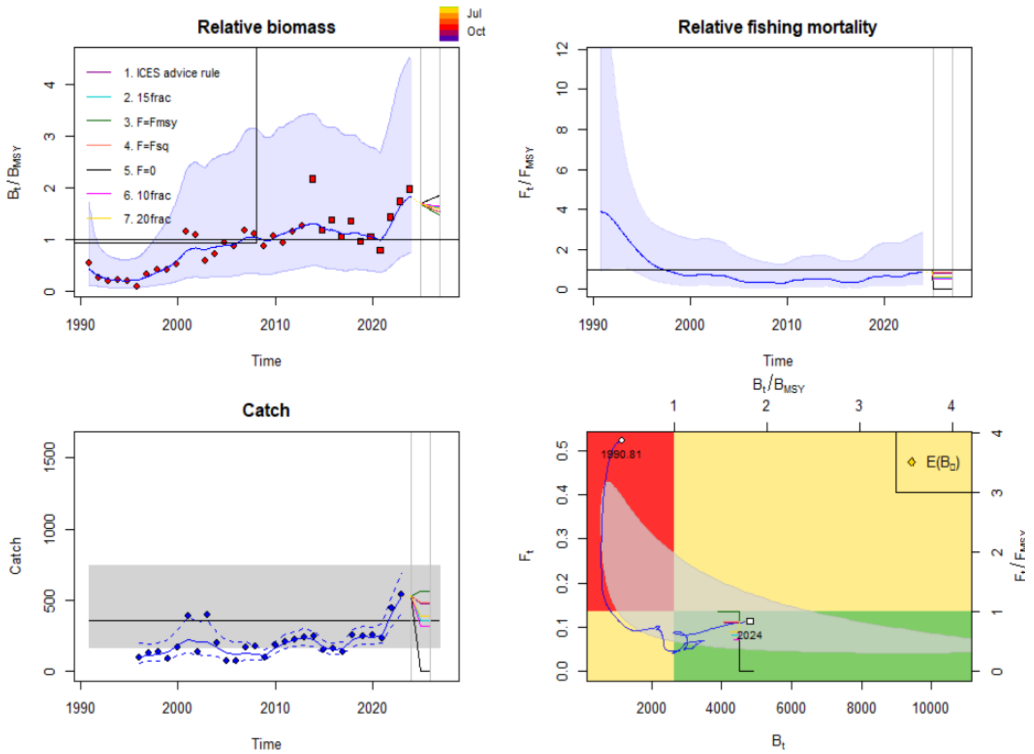


Figure 19.8.6.6. *Raja clavata* in ICES Division 27.8c. Summary of the assessment. Relative fishing pressure on the left, and relative biomass on the right.

Table 19.8.6.1. Thornback ray in division 8.c. The basis for the catch scenarios.

Variable	Value	Notes
F_{2024}/F_{MSY}	0.84	Status quo F: F_{2023}/F_{MSY}
B_{2025}/B_{MSY}	1.70	Short-term forecast (STF)
Catch (2024)	530	Projected catch in tonnes (STF)

Table 19.8.6.2. Thornback ray in Division 8.c. Annual catch scenarios for 2025. Weights are in tonnes.

Basis	Total catch (2025)	Fishing mortality F_{2025}/F_{MSY}	Stock size B_{2026}/B_{MSY}
MSY approach (15th percentile of predicted catch distribution under F = F_{MSY})	363	0.61	1.66
F = F_{MSY}	585	1.00	1.58
F = F_{2023} = F_{sq}	498	0.84	1.61
F = 0	0	0	1.79
F = F_{MSY} fractile 10	324	0.54	1.67
F = F_{MSY} fractile 20	396	0.66	1.64
F = F_{MSY} fractile 35	489	0.83	1.61

Table 19.8.6.3. Thornback ray in Division 8.c. Annual catch scenarios for 2026 with F2025 = 15th percentile of predicted catch distribution under F = FMSY. Weights are in tonnes.

Basis	Total catch (2026)	Fishing mortality F_{2026}/F_{MSY}	Stock size B_{2027}/B_{MSY}
MSY approach (15th percentile of predicted catch distribution under F = F_{MSY})	354	0.61	1.62
F = F_{MSY}	545	1.00	1.48
F = F_{2023} = F_{sq}	473	0.84	1.53
F = 0	0	0	1.86
F = F_{MSY} fractile 10	318	0.54	1.64
F = F_{MSY} fractile 20	384	0.66	1.60
F = F_{MSY} fractile 35	465	0.83	1.54

Table 19.8.6.4. Thornback ray in Division 8.c. Assessment summary. Landings and discards in tonnes. Biomass is relative to BMSY at the beginning of the year and fishing mortality relative to FMSY. High and Low values are 95% confidence intervals

Year	Relative exploitable biomass			Landings		Relative fishing pressure		
	Low	B/B_{MSY}	High	tonnes	Discards	Low	F/F_{MSY}	High
1991	0.113	0.41	1.48			0.95	3.9	15.7
1992	0.100	0.29	0.84			1.08	3.5	11.4
1993	0.082	0.24	0.68			1.10	2.9	7.5
1994	0.075	0.22	0.63			0.95	2.3	5.3
1995	0.074	0.22	0.63			0.72	1.72	4.1
1996	0.081	0.24	0.68	97		0.49	1.29	3.4
1997	0.106	0.30	0.88	128		0.35	1.04	3.1
1998	0.133	0.39	1.13	138		0.27	0.88	2.8

Year	Relative exploitable biomass			Landings		Relative fishing pressure		
	Low	B/BMSY	High	tonnes	Discards	Low	F/FMSY	High
1999	0.161	0.48	1.42	90		0.21	0.74	2.7
2000	0.21	0.62	1.84	169		0.190	0.69	2.5
2001	0.27	0.80	2.4	391		0.22	0.75	2.5
2002	0.28	0.84	2.5	141		0.22	0.74	2.5
2003	0.28	0.82	2.5	401		0.20	0.70	2.4
2004	0.29	0.87	2.6	204		0.175	0.61	2.2
2005	0.30	0.89	2.7	71		0.110	0.45	1.80
2006	0.31	0.93	2.8	78		0.078	0.35	1.60
2007	0.35	1.04	3.1	168		0.083	0.35	1.44
2008	0.35	1.05	3.1	173		0.092	0.35	1.35
2009	0.33	0.99	3.0	94	28	0.077	0.31	1.25
2010	0.36	1.05	3.1	186	31	0.098	0.36	1.33
2011	0.40	1.13	3.2	206	29	0.145	0.48	1.57
2012	0.43	1.20	3.3	224	21	0.151	0.50	1.67
2013	0.47	1.27	3.4	239	37	0.154	0.51	1.69
2014	0.50	1.32	3.4	248	73	0.161	0.52	1.68
2015	0.46	1.22	3.2	150	87	0.122	0.43	1.52
2016	0.44	1.18	3.2	161	61	0.101	0.38	1.41
2017	0.41	1.11	3.0	136	13	0.096	0.37	1.46
2018	0.43	1.14	3.0	256	28	0.130	0.47	1.72
2019	0.42	1.10	2.9	247	31	0.187	0.63	2.1
2020	0.40	1.06	2.8	257	61	0.193	0.67	2.3
2021	0.38	1.03	2.8	233	33	0.171	0.63	2.3
2022	0.51	1.33	3.5	448	30	0.192	0.68	2.4
2023	0.67	1.68	4.2	540	44	0.25	0.82	2.7
2024	0.74	1.82	4.5					

***Biomass index in 2021 not used due to vessel change during the survey.**

19.9.3 Thornback ray (*Raja clavata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjc.27.9a)

This stock was benchmarked in 2024 (WKBELASMO3) and from now on will be assessed under ICES category 2 framework through the application of a stochastic production model in continuous time (SPiCT). All the data available and results are outlined in the benchmark report (ICES, 2024a). The application of the SPiCT model allowed the estimation of relative reference points and advice is now given as total landings estimated relative to it. The assessment of the stock indicates that the fishing pressure is below F_{MSY} and the biomass is above MSY $B_{trigger}$ and B_{lim}. ICES catch advice is based on the 15th percentile of predicted catch distribution and corresponds to 1406 and 1415 tonnes for 2025 and 2026, respectively.

19.8.1.1 SPiCT assessment

19.8.1.1.1 Input data

Landings

During the ICES benchmark WKBELASMO3 (ICES, 2024a), landings data previous to 2008 and 2009 for Portugal and Spain, respectively, were reconstructed down to 2000. A detailed description of the methods used can be found in Maia et al. (2023a). For the period 2000-2023, *R. clavata* landings are mainly derived from Portugal (Table 19.8.7.1), in particular from the polyvalent fleet which represents around 80% of the total annual landed weight of the species (Maia et al., 2022b). Spain landings represent up to 37% for the period 2000-2023.

Discarding is known to take place for thornback ray in ICES Division 9a, but ICES cannot estimate the quantity or the corresponding dead catch. Yet, based on information available, discarding for this stock is assumed to be low and therefore is not considered for the SPiCT assessment. Discards for this stock were mainly reported for the Spanish bottom otter trawl fleet and in low quantities (below 45 tons) compared to the total landings for the stock (average proportion of 0.01±0.018). The low frequency of occurrence registered for the species in the discards of the Portuguese trawl fleet indicates that discards can be considered negligible for that particular fleet (Fernandes, 2021). For the Portuguese polyvalent fleet, discards are known to take place and assumed to be low, but are not fully quantified as the information available is insufficient to estimate total discards (Fernandes, 2021). Further details on the discards for all skate species was presented to WKSHARKS3 (ICES, 2017a; Serra-Pereira et al., 2017).

Discard survival studies suggest that *R. clavata* has relatively high survivorship after capture (for details see Section 19.3.3.).

Table 19.8.7.1. *Raja clavata* in ICES Division 27.9a. ICES estimates of landings by country (in tonnes) for the period 2000-2023.

Year	Spain	Portugal	Total
2000	99	492	591
2001	142	534	676
2002	116	513	629
2003	118	538	655
2004	112	534	646
2005	107	571	678

2006	116	547	663
2007	112	571	683
2008	119	745	864
2009	94	739	833
2010	115	611	725
2011	139	811	950
2012	194	570	764
2013	166	643	809
2014	215	585	800
2015	120	578	697
2016	123	559	682
2017	124	620	744
2018	152	667	819
2019	181	616	797
2020	178	693	871
2021	174	834	1008
2022	339	780	1119
2023	454	783	1273

Exploitable biomass index

A combined stock biomass index, using the exploitable biomass index from the Spanish ARSA survey in Gulf of Cadiz (SpGFS-GC-WIBTS-Q1 and SpGFS-GC-WIBTS-Q4), the standardized commercial Portuguese LPUE and the exploitable biomass index from the Portuguese Autumn Groundfish Surveys (PtGFS-WIBTS-Q4) (Figure 19.8.7.1), is considered as index of stock development. The exploitable biomass indices were constructed considering individuals with total length larger than 35 cm based on the analysis of length frequency data from commercial landings. For details on the surveys and LPUE standardization procedures see WKBELASMO3 report (ICES, 2024a).

Combining the available biomass indices involved a three-step procedure: i) produce a Portuguese index (PT_INDEX) by averaging the normalized PTGFS-WIBTS-Q4 and LPUE series (1990-2023); ii) produce the Spanish/ARSA index (ES_ARSA) by averaging the two ARSA surveys (SpGFS-GC-WIBTS-Q1 and Q4) and normalize (1997-2023) and; iii) calculate the weighted average between the PT-INDEX and ES_ARSA indices, applying the overall proportion of thornback ray landings from each country, i.e. 80% for the PT_INDEX and 20% for the ES_ARSA (1990-2023) (Figure 19.8.7.2). During the WKBELASMO3 (ICES, 2024a), the weighted combined biomass index was considered the most appropriate as it better reflects the contribution of the two areas to the total stock.

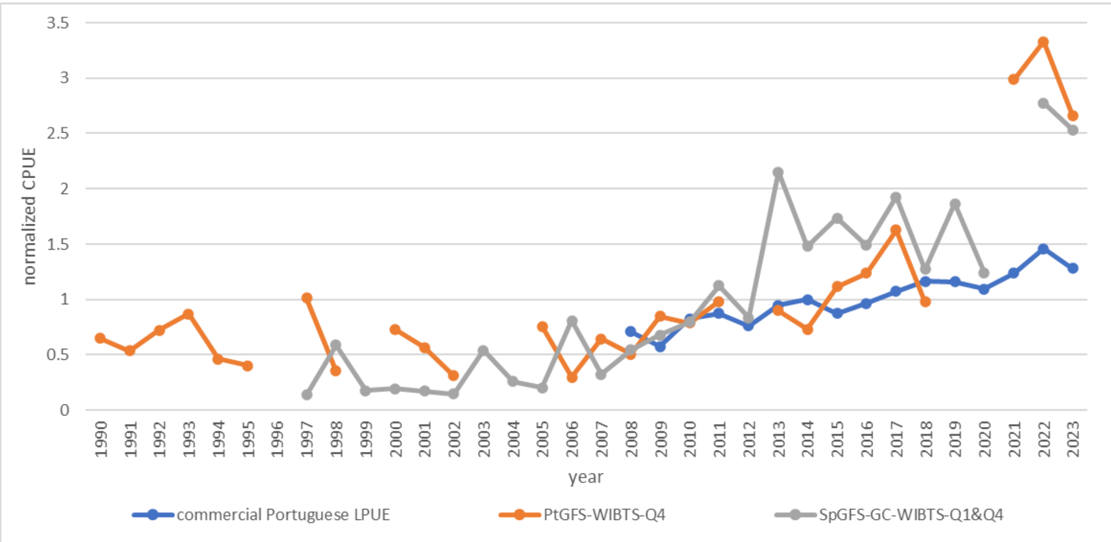


Figure 19.8.7.1. *Raja clavata* in ICES Division 27.9a. Normalized exploitable biomass indices from the Spanish ARSA

surveys in Gulf of Cadiz (average between SpGFS-GC-WIBTS-Q1 and SpGFS-GC-WIBTS-Q4), the commercial Portuguese LPUE and the Portuguese Autumn Groundfish Surveys (PtGFS-WIBTS-Q4) for the period from 1990 to 2023.

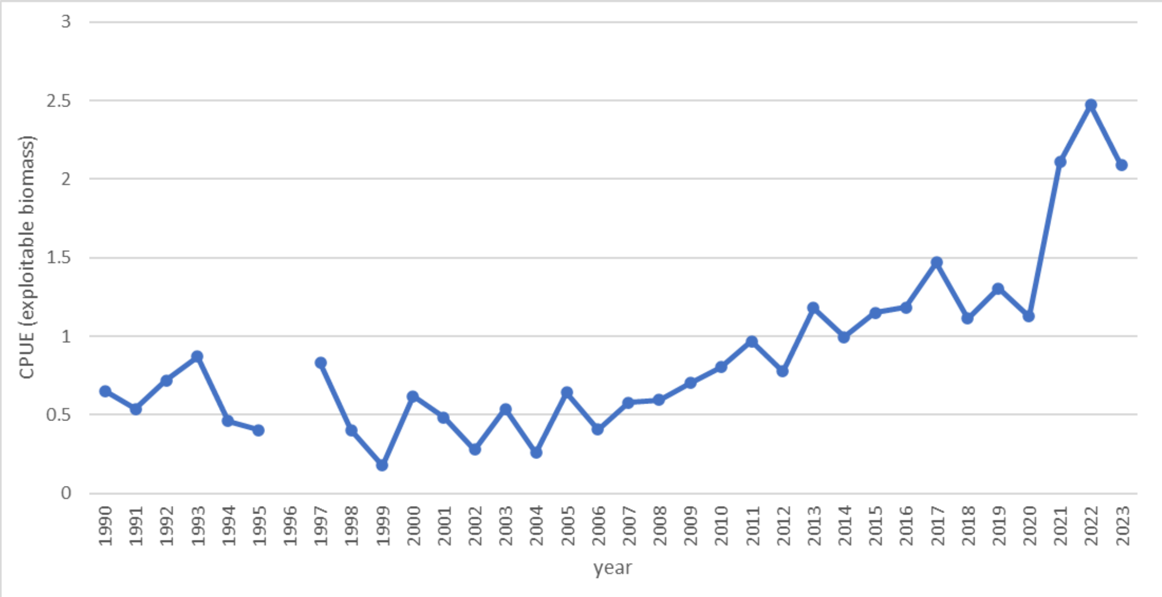


Figure 19.8.7.2. *Raja clavata* in ICES Division 27.9a. Weighted combined exploitable biomass index for the period from 1990 to 2023.

Life-history parameters

Below we fundament the selected biological parameters used as input in the SPiCT assessment:

- Length-weight relationship considered as $W=0.00052*TL^{3.05}$ (Serra-Pereira et al., 2010);
- Length-at-maturity $L_{50\%}$ of 78.4 cm (value estimated for females) was considered (Serra-Pereira et al., 2011). $L_{95\%}$ of 86.24 cm estimated as $L_{95\%}=1.1L_{50\%}$ (Prince et al., 2015);
- Fecundity was assumed to be 136 eggs/female/year (Serra-Pereira et al., 2011).
- Growth parameters: L_{inf} = 128 cm, K = 0.0117 y^{-1} and t_0 = –0.617 $years^{-1}$ (Serra-Pereira et al., 2008);
- Natural mortality (M) of 0.17 estimated as $M=4.118* K^{0.73}*L_{inf}^{-0.33}$ (Then et al., 2015);
- A_{max} of 29.6 years estimated as $A_{max}=5(\ln 2/k)$ (Fabens, 1965).

19.8.1.1.2 Model settings and parameters values

Model settings and parameters configuration are summarized in table 19.8.7.2:

Table 19.8.7.2 *Raja clavata* in ICES Division 27.9a. Settings and parameter values for the SPiCT model.

Input data	
Landings	2000-2023, using reconstructed landings from 2000 to 2007 (Portugal) and 2000-2009 (Spain). 3x higher uncertainty in 2000-2007 and 2x higher uncertainty in 2008-2009
Biomass indices	Weighted combined stock indicator (average between: mean of the normalized PTGFS-WIBTS-Q4 and LPUE + normalized average of ARSA surveys) weighted to the proportion of landings from each country, 80% PT and 20% ES) (1990-2023). Increased uncertainty in years with just one biomass index (2: 1990-1995; 1999; 2003-2004).
Parameter	
intrinsic rate of biomass increase (***r***)	*r* = 0.27 y^{-1}, CV = 0.5 (function jbleslie implemented in R package JABBA (Winker et al., 2023), and using the input parameters available from Portuguese studies)

Shape of the production curve (*logn*)	Schaefer (n=2)
Process error (*sdb*)	*sdb* = 0.15, CV = 0.5
Noise ratios *logalpha*, *logbeta*	Disabled

19.8.1.1.3 Assessment results

Plots and results from the 2024 SPiCT assessment are presented in Figure 19.8.7.3.

The diagnostics of the final assessment are shown on Figure 19.8.7.4. No significant bias or auto-correlation were found and both QQ-plot and the Shapiro test showed normality in the residuals.

The retrospective analysis was done using 5 retro-years and showed consistent patterns (Figure 19.8.7.5). Mohn's rho is with a value of 0.421 for B/B_{MSY} above the value of the general guidelines (0.2), but all peels are within the confidence bounds. An expected range for Mohn's rho was calculated using the R function *mrci* developed by Casper Berg (unpublished) that simulates 400 new datasets conditional on the estimated model, refitting the model and calculating Mohn's rho for each replicate. This gave an expected range (95% of the replicates) of [-0.45, 0.77] for B/B_{MSY}. The observed value of Mohn's rho is thus within the range of the expected values and can be ascribed to the general model uncertainty rather than potential model misspecification.

An hindcast cross-validation was performed for the final assessment showing a Mean Absolute Scaled Error (MASE) smaller than 1 (0.862), which indicates that the model has prediction skill for the index (Figure 19.8.7.6).

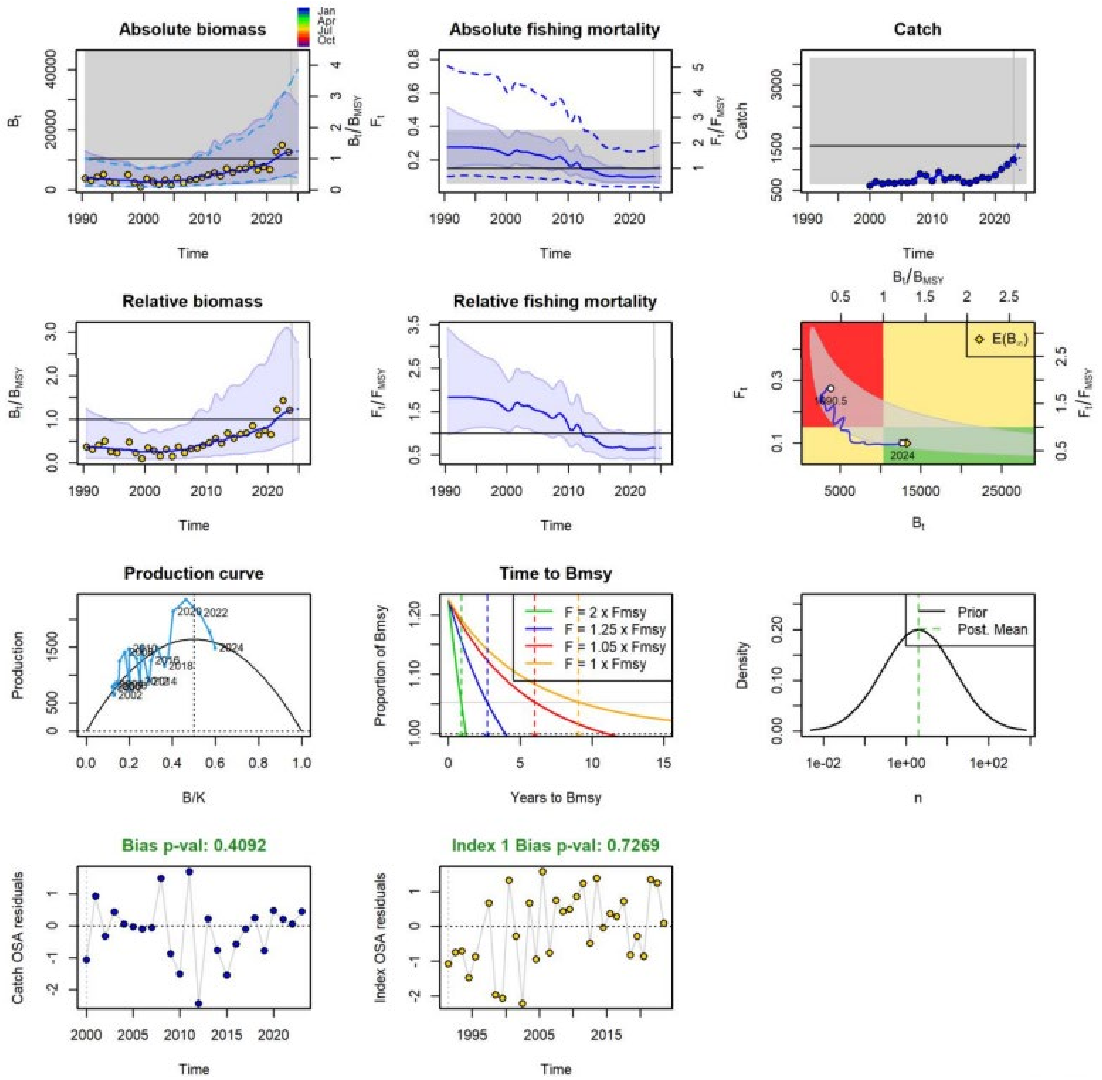


Figure 19.8.7.3. *Raja clavata* in ICES Division 27.9a. Results for the SPiCT assessment.

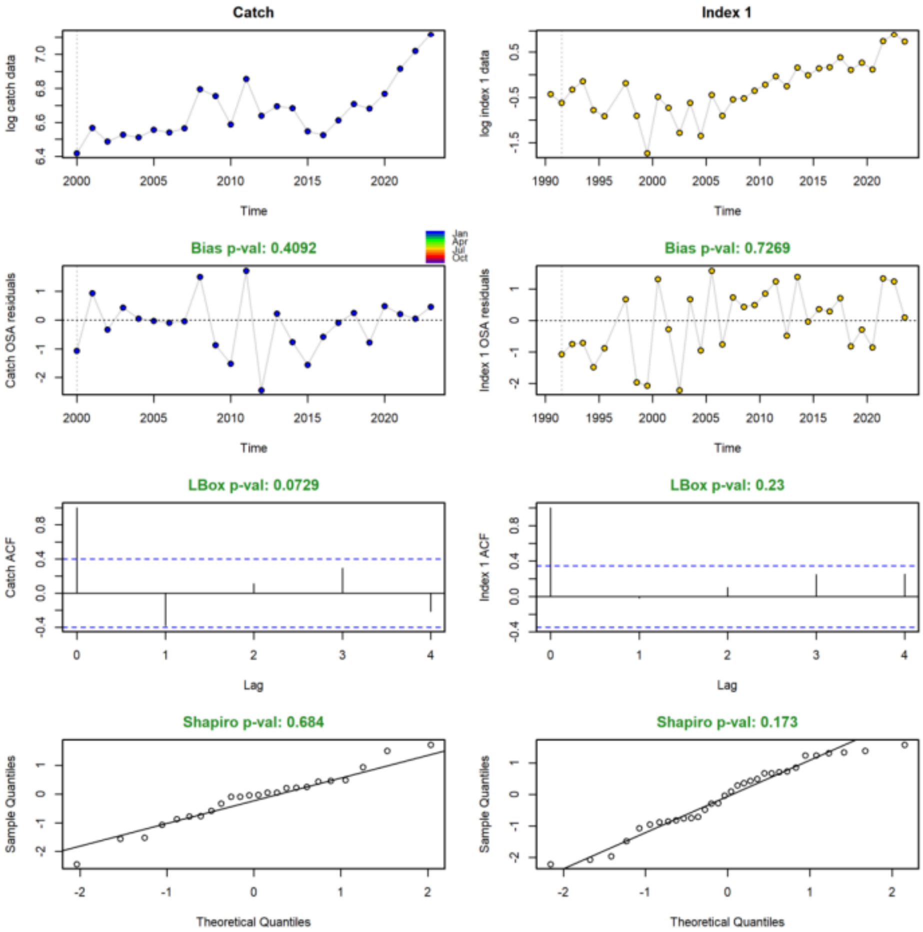
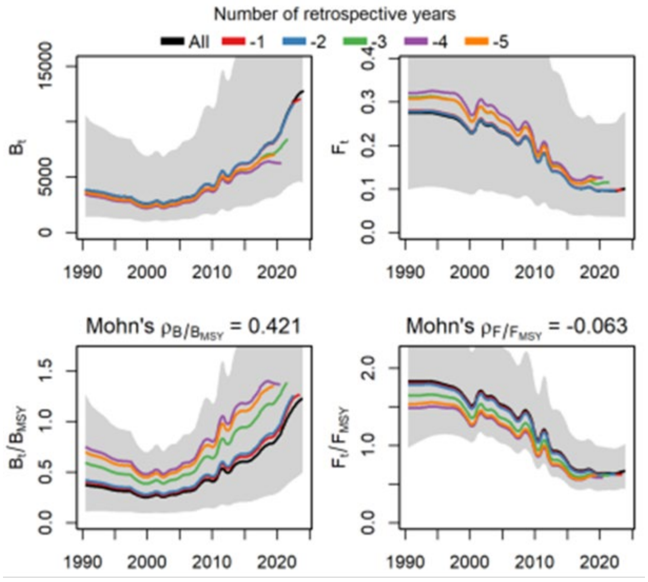


Figure 19.8.7.4. ***Raja clavata*** **in ICES Division 27.9a. Diagnostics of the SPiCT assessment.**



mrci function	BBmsy	FFmsy
2.50%	-0.450	-0.281
50%	-0.005	0.000
97.50%	0.765	0.503

Figure 19.8.7.5. *Raja clavata* in ICES Division 27.9a. Retrospective pattern of the SPiCT assessment and expected range for Mohn's rho calculated using the *mrci* function (Casper Berg, unpublished).

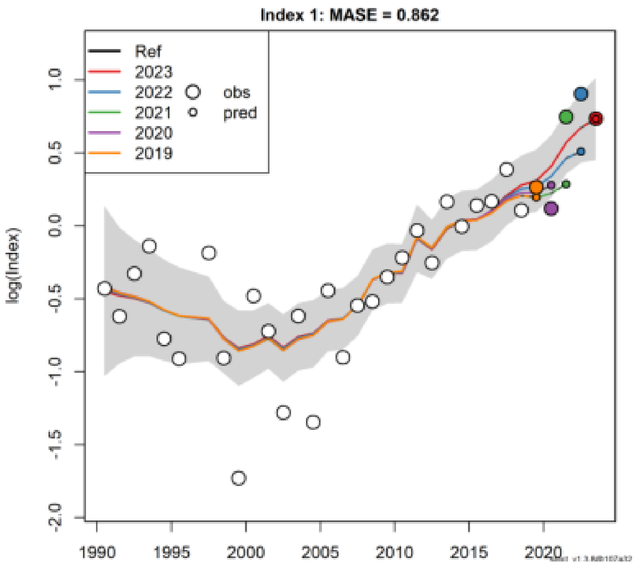


Figure 19.8.7.6. *Raja clavata* in ICES Division 27.9a. Hindcast cross-validation for the SPiCT assessment.

19.8.1.1.4 Short-term projections

ICES catch advice is based on the 15th percentile of predicted catch distribution, which is considered more precautionary than the 35th percentile which is the default method, and corresponds to 1406 and 1415 tonnes for 2025 and 2026, respectively. The choice of the 15th percentile was justified by the need for a more precautionary management for long-lived species such as elasmobranchs, especially where advised catch are much larger than catch in the previous years.

19.8.1.1.5 Biological reference points

Reference points for this stock are defined in terms of relative values (Table 19.8.7.3). The SPiCT estimated values of the ratios F/F_{MSY} and B/B_{MSY} are used to estimate stock and exploitation status relative to the proxy MSY reference points. The assessment of the stock indicates that the fishing pressure is below F_{MSY} and the biomass is above MSY $B_{trigger}$ and B_{lim}.

Table 19.8.7.3 *Raja clavata* in ICES Division 27.9a. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	$\frac{B}{B_{MSY}} = 0.5$	Relative value from the SPiCT model. B_{MSY} is estimated directly from the SPiCT assessment model and changes when the assessment is updated.	ICES (2024a)
	F_{MSY}	$\frac{F}{F_{MSY}} = 1$	Relative value from the SPiCT model. F_{MSY} is estimated directly from the SPiCT assessment model and changes when the assessment is updated.	ICES (2024a)
Precautionary approach	B_{lim}	0.3 x B_{MSY}	Relative value (equilibrium yield at this biomass is 50% of MSY).	ICES (2024a)
	B_{pa}	Not defined		
	F_{lim}	1.7 x F_{MSY}	Relative value (the F that drives the stock to B_{lim}).	ICES (2024a)
	F_{pa}	Not defined		
Management plan	SSB_{mgt}	Not defined		
	F_{mgt}	Not defined		

19.9.4 Cuckoo ray (*Leucoraja naevus*) in subareas 6-7 (Celtic Sea and West of Scotland) and divisions 8.a-b,d (Bay of Biscay) (rjn.27.678abd)

This stock is addressed in Section 18, Skates and rays in the Celtic Seas.

19.9.5 Cuckoo ray (*Leucoraja naevus*) in Division 8.c (Cantabrian sea) (rjn.27.8.c)

A proposal for assessing the status of the stock (rjn.27.8c) using the ICES rfb rule (ICES, 2021a) was presented at WGEF 2022 for the first time. In 2024, the ICES guidance on the parameter determination for the rfb rule (ICES, 2021a; ICES, 2022a) were followed and the input values for applying rfb rule are presented in Table 19.8.9.1. According to the assessment, the advised catches for this stock (rjn.27.8c) in 2025 and 2026 should not be more than 41 tonnes. If discard rates do not change from the average of the last 5 years (2019–2023), this implies landings of no more than 30 tonnes. The stability clause was not applied because the catch advised did not increased or decreased (+20%/−30%) compared to the previous advice (Ay). The discard rate (average 2019-2023) was 28%.

Table 19.8.9.1. *Leucoraja naevus* in ICES Division 8c (rjn. 27.8c). Estimates used in the rfb rule, with comments.

Variable	Estimate	Input data	Comment
r: Stock biomass trend	1.14	Stock-size indicator: Biomass survey index from North Spanish survey (SpNGFS-WIBTS-Q4)	Index A (2022-2023) = 0.70 kg.haul^{-1} Index B (2019-2020*) = 0.61 kg.haul^{-1}
b: Biomass safeguard $= \min(1.\ I_{y-1} / I_{\text{trigger}})$ $I_{\text{trigger}} = I_{\text{loss}}\ \omega$ Considering $\omega = 1.4$	1	Stock indicator; I_{loss}, minimum estimate (1991) = I_{trigger} = 0.07 $(\frac{I_{y-1}}{I_{\text{trigger}}} = 8.60)$	The biomass index has been fluctuating inter-annually since the beginning of the time series with an increasing trend reaching the top of the time series in 2023.
m linked to von Bertalanffy k	0.95	k estimated from the Von Bertalanffy model adopted for the species (K≤ 0.20)	
f: Multiplier for relative mean length in catches	1.00	Length data collected under the sampling program raised to the overall landings. No length data was available in 2020. L_{mean}= 53.6 cm, $L_{F=M}$= 53.6 cm	Length data from 2022-2023 combined. Parameters L_c and $L_{F=M}$ fixed from previous advice in 2022. $L_{F=M}$= 53.6 cm and Lc=46.5 cm
Ay × r × f × b × m	41.2 t		Increase of 8.4 % in relation to the previous advice (A_y of 38 t). The stability clause was not applied.

19.8.9.1. Stock indicator (for the definition of r and b)

The status of this stock in Division 8.c was evaluated based on the annual bottom trawl survey carried out in autumn in the north of Spain (SpNGFS-WIBTS-Q4). The biomass index used to assess this stock corresponds to a standardized biomass index.

Since 1991 that the biomass of *L naevus* has been fluctuating between 0.2 and 0.6 (kg.haul-1) with an increasing trend reaching the top of the time series in 2017 (Figure 19.8.9.1). More information on survey data, species distribution, etc. can be found in (Ruiz-Pico et al., 2024; ICES, 2021b). In 2021 part of the survey was carried out with two different vessels, due to technical problems with the ordinary vessel for that reason the index of 2021 has not been used in the analysis.

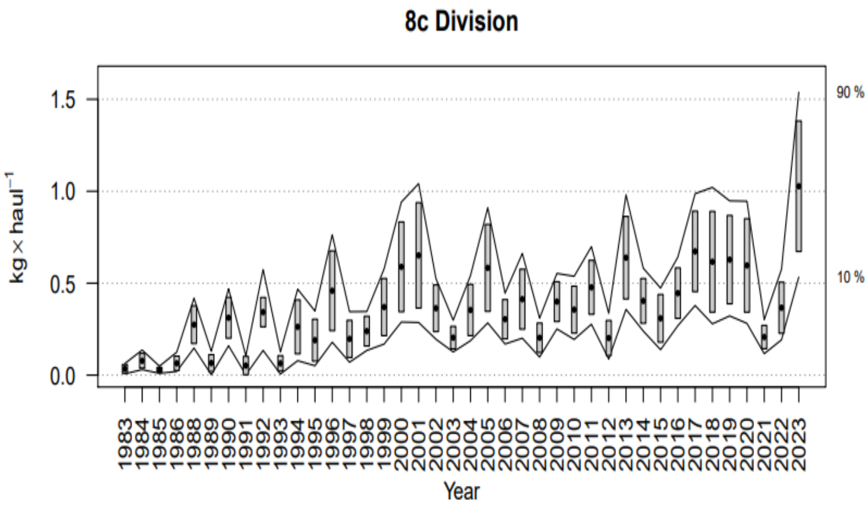


Figure 19.8.9.1. Evolution of *Leucoraja naevus* biomass index (kg.haul^{-1}) during the north Spanish bottom trawl survey (ICES Division 8c). Boxes mark parametric standard error of the stratified biomass index and black lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000).

Since the last assessment, conducted in 2022, the advice for this stock is given as catch advice instead of landings advice (followed in previous assessments). This is due to the ADG recommendation of including discard data when this information is available and reliable. Data on discards were available for this stock since 2015 and although variable, it is considered reliable and thus has been included in the assessments (see section below, Figure 19.8.9.2). Although discard lengths were not used to estimate the f proxy see below).

19.8.9.2. Estimation of length-based indicators (F proxy)

To determine F proxy based on length-based indicators (LBI) estimates of L_{inf}, L_{50} and a and b parameters from the weight-length relationship were used. These parameters are defined for this stock (Table 19.8.9.2). Length frequency distribution of landings from, 2023 included, for the first time, lengths from the gillnet fleet (Figure 19-8-9-3) but those were not used in the LBI. Length distributions combined 2022 and 2023 data. Discard lengths were available since 2021 but were not included in the analysis, due to the irregular data and extremely high values in some sizes, likely as result of sampling and raising process, and to be consistent with previous advice (Figure 19.8.9.4).

Following guidelines Lc and LF=M were fixed from previous advice to 46.5 cm and 53.6 cm, respectively, and length classes of 3 cm were adopted. LBI analysis for 2022-2023 length combined resulted in L_{mean}=53.6 cm thus f_{proxy}=1 (Table 19.8.9.4).

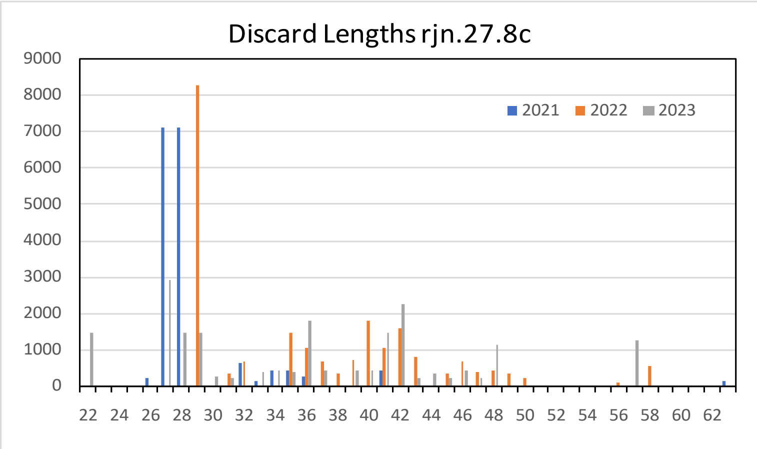


Figure 19.8.9.2. ***Leucoraja naevus*** **in ICES Division 27.8c. Discard Length frequency distribution (2021-2023).**

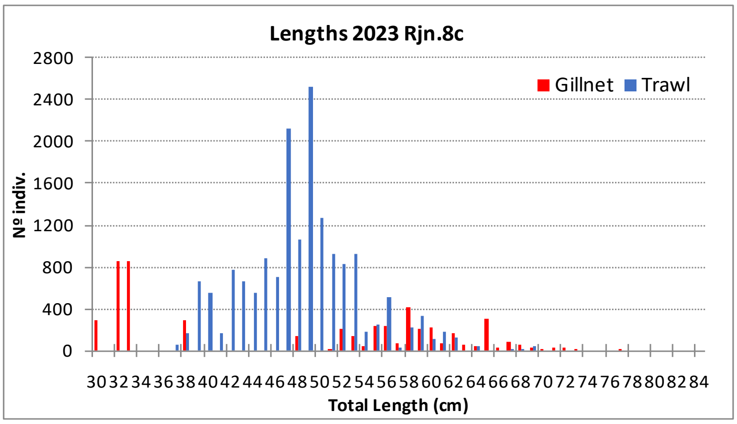


Figure 19.8.9.3. ***Leucoraja naevus*** **in ICES Division 27.8c. Commercial landings length frequency distribution in2023.**

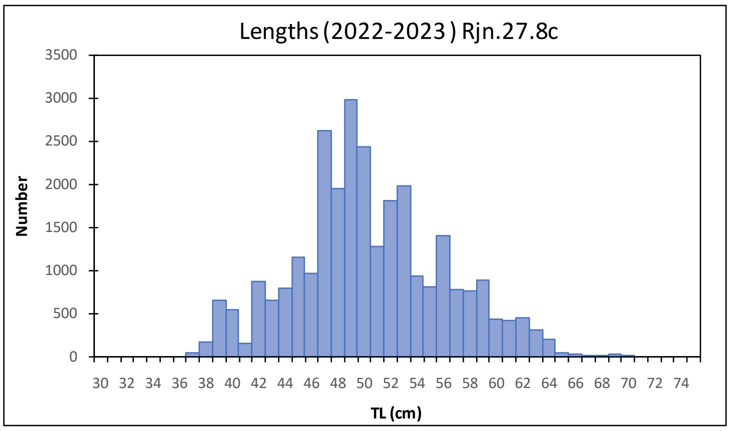


Figure 19.8.9.4. ***Leucoraja naevus*** **in ICES Division 27.8c. Length–frequency distribution for the period 2022-2023 (combined).**

Table 19.8.9.2. Biological parameters used for calculating the LBI parameters (rjn.27.8c).

Parameter	Value	Definition	Source

L∞ (cm)	75	Asymptotic average maximum length	Linf=Lobs / 0.95 (Froese, 2004)
Lmat	56.2	Length at 50% maturity	Maia et al., 2012
a	0.0027	Condition factor parameter of length-weight relationship	IEO Data base (DELASS)
b	3.204	Slope parameter of length-weight relationship	IEO Data base (DELASS)

Table 19.8.9.3. *Leucoraja naevus* stock in ICES Division 8c (rjn.27.8c). Results of length-based indicators obtained from landings length frequency of the Spanish fleet (2022-2023 combined) and previous years. No length data available for 2020.

Year	Lc	L_{mean}	$L_{F=M}$	L_{mean}/L_{FeM}
2016	55.5	60.0	60.4	0.99
2017	40.5	50.1	49.1	1.02
2018	52.5	56.9	58.1	0.98
2019-2021	46.5	53.8	53.6	1.00
2022-2023	46.5	53.6	53.6	1.00

19.8.9.3. Fishery Data

Data used correspond to landings (t) of *Leucoraja naevus* mainly from Spanish fleet which majority operates in this area ICES Div. 8c. Some landings are also reported by the French fleet usually fluctuating from 0 to 0.2 tonnes. Species-specific landings are available only since 2009 (Figure 19.9.5.3). Discard data for the Spanish fleet is available since 2015. Discards are relatively low although highly variable. The average of discards for the whole period is 6 tns which represent the 20% of total catch (Figure 19.8.9.5).

The species is mainly caught as a bycatch in mixed demersal fisheries. The main fishing gears used are otter trawl, bottom-set gillnets and trammel nets. In 2023 the 66% of landings corresponded to trawl gears, 29% to gillnets and the 4% to longlines.

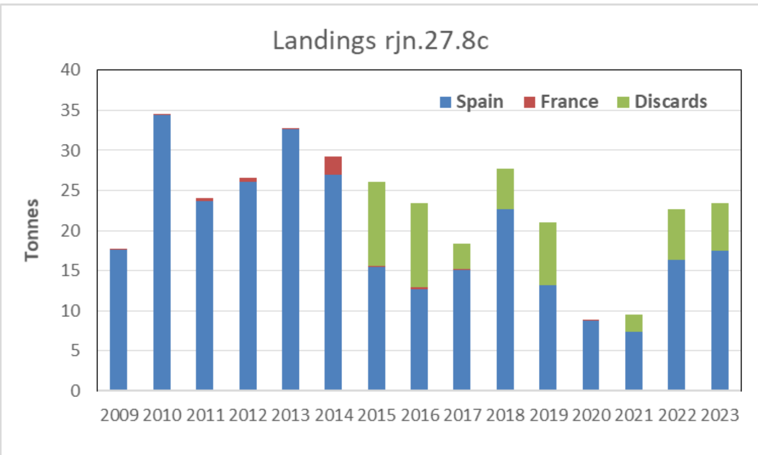


Figure 19.8.9.5. Landings (tones) of cuckoo ray *Leucoraja naevus* in ICES Division 27.8c) and discards of the Spanish fleet.

19.9.6 Cuckoo ray (*Leucoraja naevus*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjn.27.9a)

This stock was benchmarked in 2024, at WKBELASMO 3 (ICES, 2024a). A new model, SPiCT (Pedersen and Berg, 2017) was proposed and accepted to assess this stock. The model used as input data landings and two series of biomass indices (ES-ARSA-Q1 and ES-ARSA-Q4) since 2001. The benchmark workshop also agreed on the settings for the short-term forecast, allowing the stock to be assessed as category 2. This stock is estimated to be harvested well below Fmsy with a biomass above Bmsy. The 15th percentile of the landings at Fmsy is slightly above MSY and corresponds to landings higher (~2 times) than the previous advice.

19.8.10.1. Exploratory assessments

Species-specific landings were only available since 2008 and 2009 for Portugal and Spain respectively (Figure 19.8.10.1). Therefore, reconstruction of landings from 2000-2008 was agreed and carried out during the data compilation workshop (Maia et al., 2024 WD). Discard estimates were only available for the Spanish fleet (2015–2019) and were not used in the assessment. Biomass indices were available from the Portuguese commercial polyvalent fleet (LPUE time series; Serra-Pereira et al., 2020) and from the Spanish trawl survey carried out annually in spring ((SpGC-GFS-WIBTS-Q1) and autumn ((SpGC-GFS-WIBTS-Q4) in the Gulf of Cadiz (9a S). WKBELASMO 3 agreed to use the exploitable survey biomass survey index (TL≥ 35 cm).

WKBELASMO 3 agreed to estimate and test a combined index (ARSA surveys and PT LPUE), weighted by the mean landings of each country. However, LPUE and survey indices have different trends in the last years (ARSA increases and LPUE is in the lowest values). The years that are contradictory are those from 2014 onwards. One possible factor behind this discrepancy could be the start of management regulations in Portuguese waters regarding the minimum legal landing size introduced in 2014 and a decrease in the sampling effort. The increase of the minimum landing size from 52 to 60 cm in 2022 can lead to a decrease in landings of this species in the forthcoming years.

Different model configurations under three scenarios using different biomass indices (Moura et al., 2024 WD) were tested and discussed at WKELASMO 3:

- Scenario 1: combined index LPUE + ARSA Survey (2001-2022)
- Scenario 2: combined index LPUE + ARSA Survey (2008-2022)
- Scenario 3: ARSA surveys only (2001-2022).

WKBELASMO 3 decided to match the beginning of both survey indices and landings. Thus, the data series adopted started in 2001, when the stock was likely at lower levels of biomass due to fishing as shown by the lowest values of the stock size indicator in the earlier part of the time series.

Runs conducted in each scenario considered priors for intrinsic rate of biomass increase (r), shape of the production curve (fixed Schaefer production curve (n=2), a tighter Schaefer or no prior for n), process error (sdb) and initial depletion rate (bkfrac). Given the short time series, the fixed Schaefer production curve was adopted.

The models tested also considered uncertainty in catches in the reconstructed period (2001-2008) and in the period after the implementation of the Portuguese regulations concerning the minimum landing size (stdevfacC=3). Other settings agreed were to disable both logalpha and logbeta noise ratios and consider a prior on sdb to avoid over fitting of the model. A sensitivity analysis around the proposed model was conducted, by testing different values for the r and sdb. No prior was defined for bkfrac to allow the model to estimate the population dynamics and stock status with minimal constraints. All the models tested produced similar results in terms of both trajectories of biomass and fishing mortality, perception of the stock status against the relative reference points and initial depletion rate, which was estimated between 0.221 and 0.238 in all runs (WKBELASMO3 report).

WKBELASMO 3 concluded that the level of uncertainty of the PT LPUE was high from 2014 onwards and could affect the assessment and perception of the stock status. Therefore, it recommended that SPiCT model runs should use the two ARSA surveys as two biomass indices independently and exclude the LPUE data.

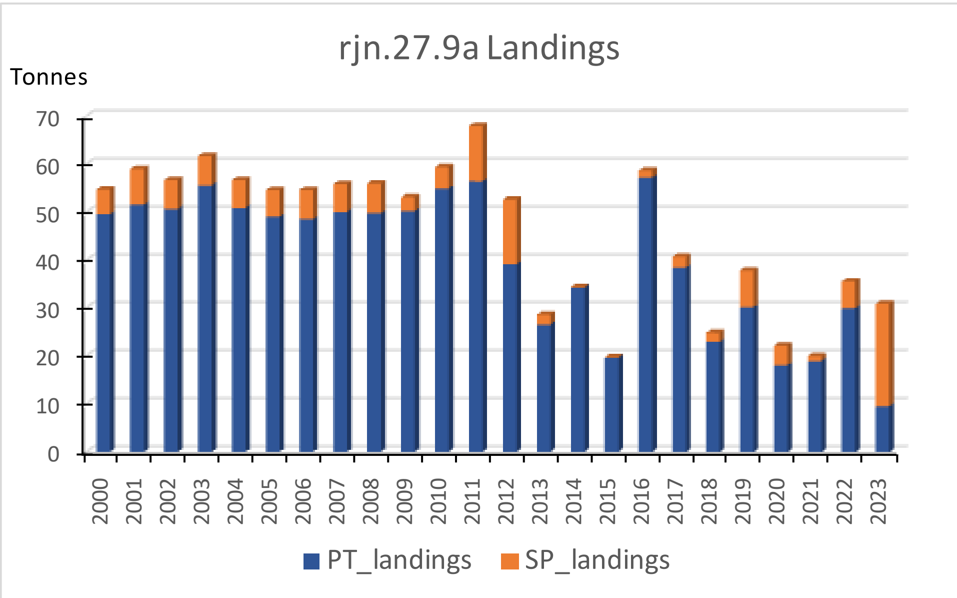


Figure 19.8.10.1. ***Leucoraja naevus*****. History of commercial landings in tonnes. Landings before 2008 were reconstructed.**

19.8.10.2. Model configuration – SPiCT assessment

The SPiCT model accepted in the benchmark was used to assess rjn.27.9a in 2024, by updating the benchmark assessment with one more year (Table 4.1). It should be noted that the biomass series used in this assessment were updated to the exploitable biomass survey series due to an error during benchmark (where all biomass caught was used). The Portuguese landings were also updated (2019-2022). These changes had no major effects in the results from the benchmark, as shown to WGEF 2024.

Input data:

- Landings (2001-2023)
- Biomass I: ARSA Q1 survey – set at March – 2001-2023
- Biomass II: ARSA Q2 survey – set at November – 2001-2023

SPiCT settings:

- Logalfa and logbeta disabled

- Schaeffer production curve
- *r* prior considered (r=0.41)
- Uncertainty in landings (2001-2008; ≥2015; cv=3)
- sdb c(log(0.15), 0.5, 1)

The r value of 0.41 was considered adequate as prior for this species, being among the values adopted for elasmobranch species (Frisk et al., 2001; Cortés, 2016). This value was also supported by the r estimate obtained for rjn.27.678abd stock (r=0.52 y-1), benchmarked in WKELASMO with SPiCT (ICES, 2022b).

It was decided to apply a prior with *sdb* around 0.15 with a CV of 0.5, which was used during WKLIFEII (ICES 2023).

19.8.10.3. Assessment results

Plots and results from the 2024 assessment are presented in Figures 19.8.10.2. Estimated priors and posteriors are shown on Figure 19.8.10.3. The diagnostics of the final assessment are shown on Figure 19.8.10.4. No significant bias or autocorrelation were found and both QQ-plot and the Shapiro test showed normality in the residuals (Figure 19.8.10.4). Some retrospective pattern is observed when testing 5 years although all peels are within the confidence intervals and Mohn's rho is within the accepted values (Figure 19.8.10.5).

19.8.10.4. Short-term projections

Short-term projections consider the fishing mortality in the intermediate year as the estimated F at the time step of the last observation and the estimated seasonal F process. The basis of the catch scenarios is showed in Table 19.8.10.2. The annual catch scenarios for 2025 and 2026 are shown on following Tables 19.8.10.3 and 19.8.10.4 respectively. Landings data and the relative biomass index and fishing mortality are shown (Table 19.8.10.5). Considering the adopted reference points fishing pressure on the stock is below FMSY, and biomass is above $MSYB_{trigger}$ and B_{lim} (Figure. 19.8.10.2).

19.8.10.5. Comments on the assessment

This stock was benchmarked in 2024 (ICES, 2024a). Following this, landings advice is now given as total landings estimated relative to reference points.

The increase in advice in 2025 (83%) compared to the previous advice is due to the stock being benchmarked in 2024, during which the advice basis changed from category 3 to category 2 (ICES, 2024a).

The Benchmark group highlighted the concern over the small area of the distribution of the stock being covered by the Spanish ARSA surveys. However, this stock has been assessed using these surveys since 2015 and this will continue to be the only source of reliable data for the stock. Information from Portuguese waters is limited given the uncertainty of the LPUE values. This biomass index shows an increase in the last period of the time series, as the ARSA surveys, although, in the case of the PT LPUE, it comes after a period of very low LPUE values. The PT-LPUE from the polyvalent fleet should be improved and further work is required to reconcile the ARSA biomass indices qith this LPUE.

Table 19.8.10.1. *Leucoraja naevus* in ICES Division 27.9a. Settings and parameter values agreed for the accepted model.

Input data	
Landings	2001-2023, using reconstructed landings from 2001 to 2008 (Portugal) and 2001-2009 (Spain) 3x higher uncertainty in 2001-2008 and >2014
Biomass indices	Index 1: SpGC-GFS-WIBTS-Q1, 2001-2023 Index 2: SpGC-GFS-WIBTS-Q4, 2001-2023
Parameter	
r	0.41 y^{-1}, cv=0.5
Shape of the production curve	Schaefer (n=2)
Process error (*sdb*)	*sdb* = 0.15, CV = 0.5
Noise ratios *logalpha*, *logbeta*	Disabled

Table 19.8.10.2. Cuckoo ray in Division 9.a. The basis for the catch scenarios.

Variable	Value	Notes
F_{2024}/F_{MSY}	0.17	*Status quo* F: F_{2023}/F_{MSY}
B_{2025}/B_{MSY}	1.84	Short-term forecast (STF)
Catch (2024)	31	STF; all catches are assumed to be landed (in tonnes)

Table 19.8.10.3. Cuckoo ray in Division 9.a. Annual catch scenarios for 2025. Weights are in tonnes.

Basis	Total catch (2025)***	Fishing mortality F_{2025}/F_{MSY}	Stock size B_{2026}/B_{MSY}	% B change *	% Advice change**
ICES advice basis					
MSY approach (15th percentile of predicted catch distribution under F = F_{MSY})	108	0.62	1.68	-8.7	83
Other scenarios					
F_{MSY}		1.00	1.55	-16	183
F = F_{2024}	31	0.170	1.84	0	-47
F = 0	0	0	1.90	3.3	-100
F = F_{MSY} fractile 10	97	0.56	1.70	-7.6	64
F = F_{MSY} fractile 20	117	0.68	1.66	-10	98
F = F_{MSY} fractile 35	142	0.83	1.61	-13	141

* Percentage change of B_{2026}/B_{MSY} relative to B_{2025}/B_{MSY}.
** Advice value for 2025 relative to the landings advice value for 2023 and 2024 (59 tonnes).
*** ICES cannot quantify how any increase in catches may impact discard rates for this stock.

Table 19.8.10.4. Cuckoo ray in Division 9.a. Annual catch scenarios for 2026 with F_{2025} = 15^{th} percentile of predicted catch distribution under F = F_{MSY}. Weights are in tonnes.

Basis	Total catch (2026) ***	Fishing mortality F_{2026}/F_{MSY}	Stock size B_{2027}/B_{MSY}	% B change *	% Advice change**
ICES advice basis					

Basis	Total catch (2026) ***	Fishing mortality F_{2026}/F_{MSY}	Stock size B_{2027}/B_{MSY}	% B change *	% Advice change**
MSY approach (15th percentile of predicted catch distribution under F = F_{MSY})	100	0.62	1.58	-6.0	-7.4
F_{MSY}	145	1.00	1.39	-17	34
F = F_{2024}	31	0.170	1.84	10	-71
F = 0	0	0	1.94	15	-100
F = F_{MSY} fractile 10	91	0.56	1.62	-3.6	-16
F = F_{MSY} fractile 20	107	0.68	1.55	-7.7	-0.93
F = F_{MSY} fractile 35	127	0.83	1.47	-13	18

* Percentage change of B_{2027}/B_{MSY} relative to B_{2026}/B_{MSY}.
** Advice value for 2026 relative to the advice value for 2025 (108 tonnes).
*** ICES cannot quantify how any increase in catches may impact discard rates for this stock.

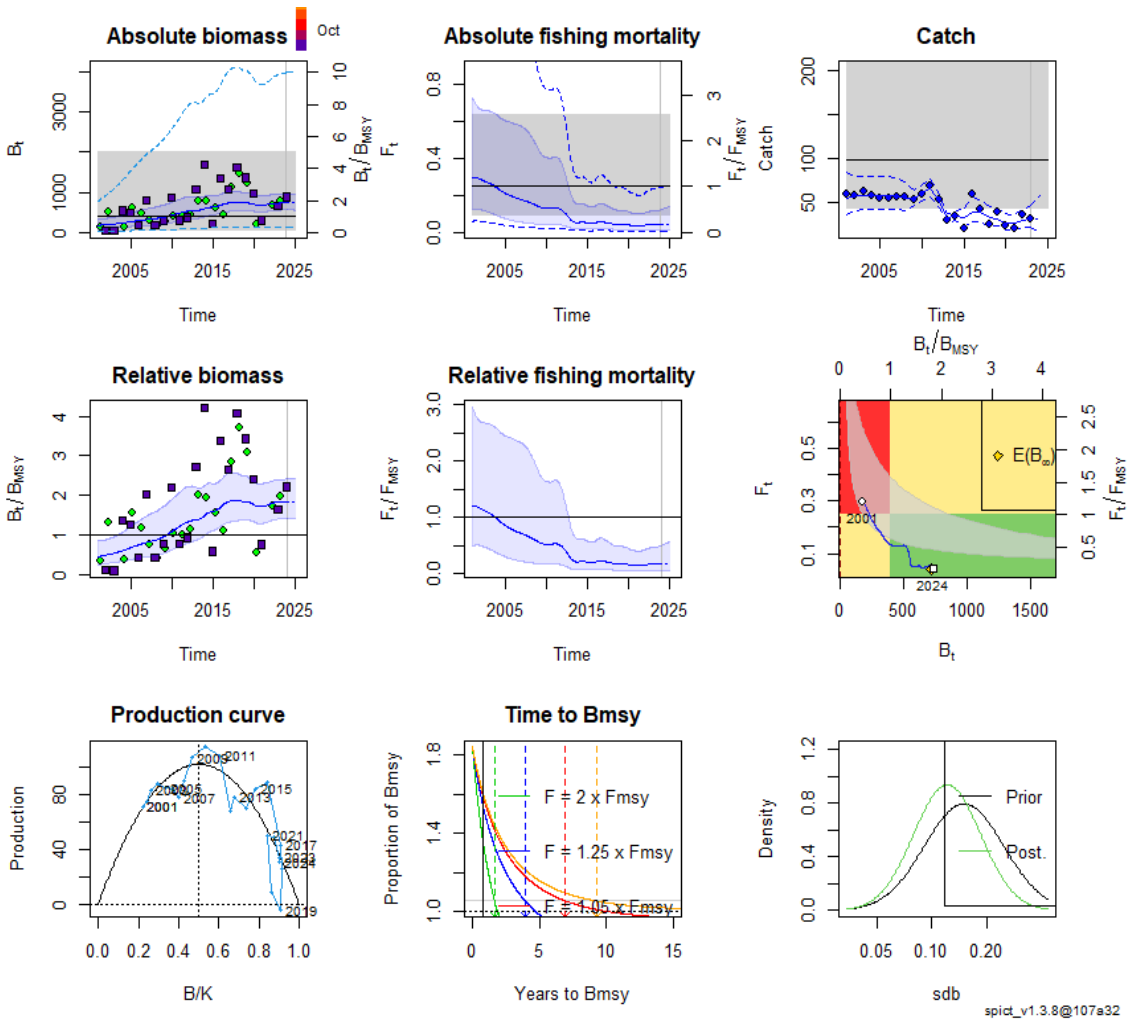


Figure 19.8.10.2. ***Leucoraja naevus*** **in ICES Division 27.9a. Results of the assessment.**

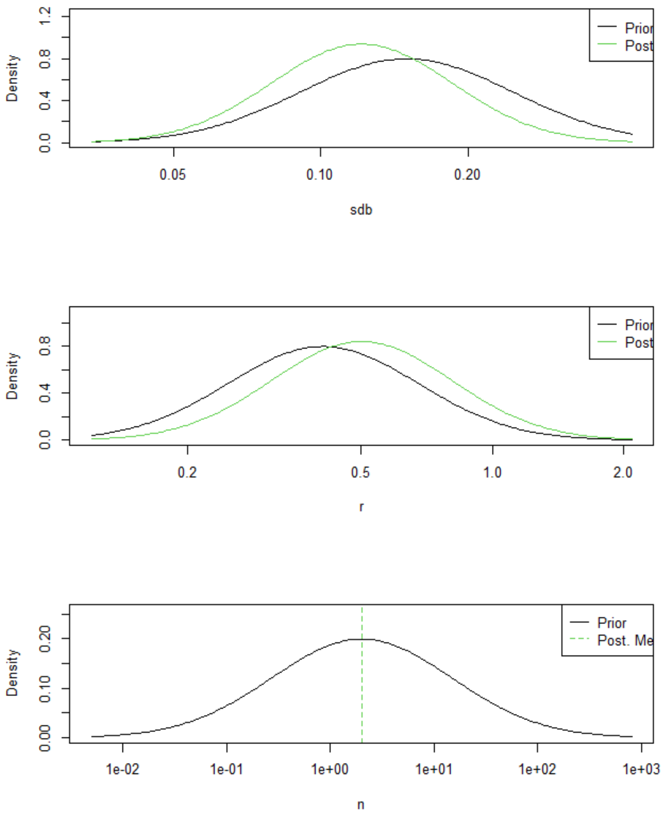


Figure 19.8.10.3. *Leucoraja naevus* in ICES Division 27.9a. Estimated priors and posteriors.

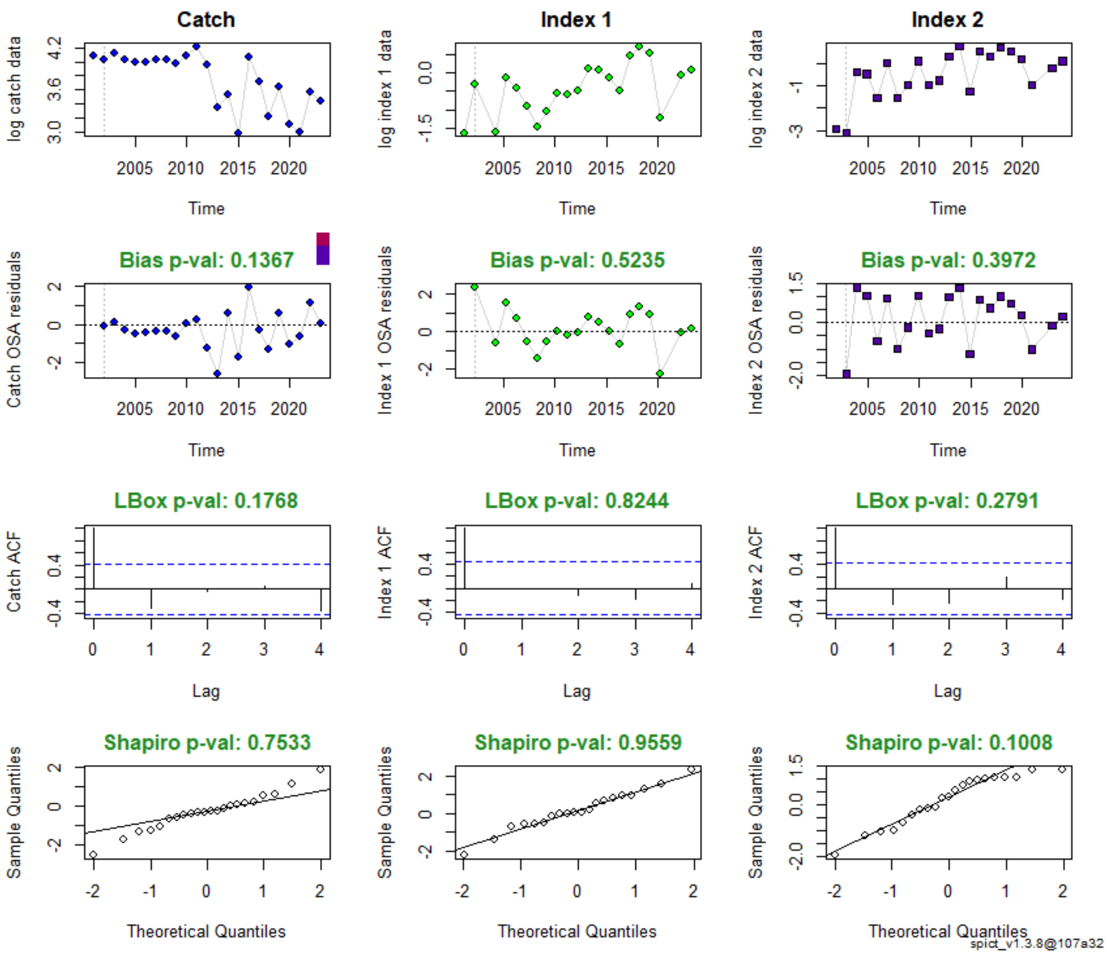


Figure 19.8.10.4. ***Leucoraja naevus*** **in ICES Division 27.9a. Diagnostics of the assessment model.**

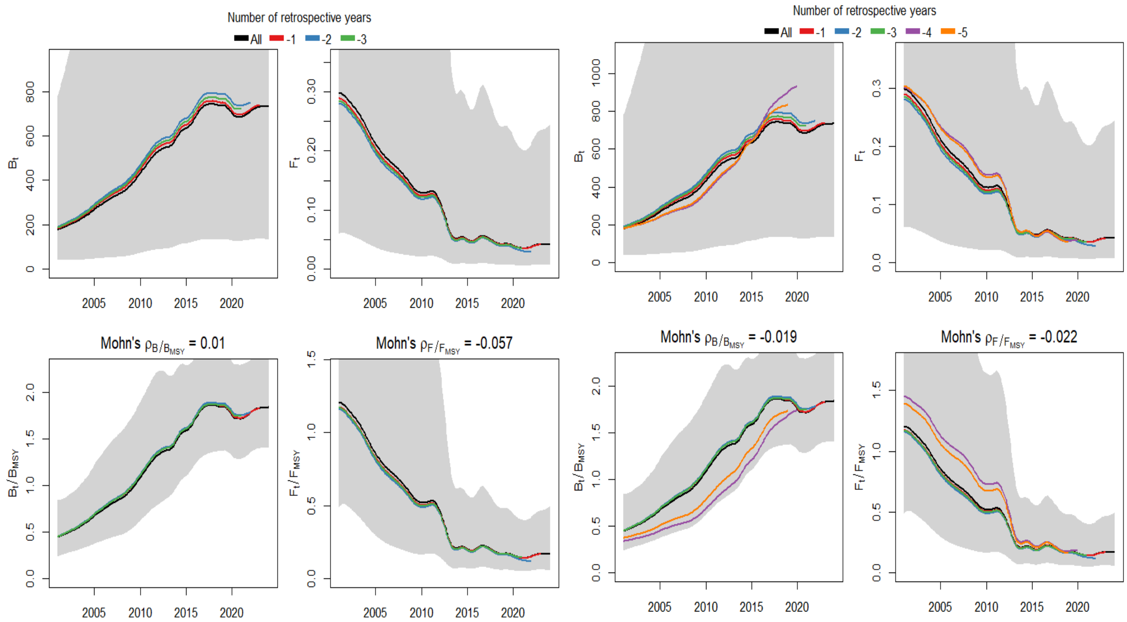


Figure 19.8.10.5. ***Leucoraja naevus*** **in ICES Division 27.9a. Retrospective pattern of the final assessment. Left: using 3 retro-years; Right: using 5 retro-years.**

Table 19.9.10.5. ***Leucoraja naevus*** **in ICES Division 27.9a. Assessment summary. Biomass is relative to B_{MSY} at the beginning of the year and fishing mortality relative to F_{MSY}. High and Low refer to 95% confidence intervals.**

Year	Relative biomass			ICES Land-ings (tonnes)	Relative fishing pressure		
	Low	Relative B	High		Low	Relative F	High
2001	0.24	0.45	0.84	59	0.50	1.16	2.7
2002	0.27	0.49	0.88	57	0.44	1.08	2.7
2003	0.30	0.54	0.95	62	0.37	0.98	2.6
2004	0.34	0.60	1.07	57	0.30	0.86	2.5
2005	0.38	0.68	1.22	55	0.25	0.78	2.4
2006	0.41	0.75	1.36	55	0.22	0.71	2.3
2007	0.45	0.81	1.49	56	0.197	0.65	2.2
2008	0.47	0.87	1.59	56	0.176	0.57	1.85
2009	0.53	0.96	1.72	53	0.166	0.52	1.64
2010	0.62	1.09	1.90	59	0.171	0.53	1.65
2011	0.72	1.23	2.1	68	0.151	0.47	1.48
2012	0.80	1.34	2.2	53	0.092	0.28	0.87
2013	0.87	1.38	2.2	29	0.072	0.21	0.61
2014	0.99	1.50	2.3	34	0.072	0.21	0.58
2015	1.10	1.59	2.3	20	0.072	0.20	0.58
2016	1.23	1.72	2.4	59	0.080	0.22	0.62
2017	1.32	1.85	2.6	41	0.067	0.187	0.53
2018	1.36	1.86	2.5	25	0.061	0.172	0.48
2019	1.37	1.85	2.5	38	0.058	0.162	0.45
2020	1.32	1.76	2.3	22	0.051	0.144	0.40
2021	1.29	1.72	2.3	20	0.056	0.153	0.42
2022	1.35	1.78	2.3	36	0.062	0.170	0.46
2023	1.40	1.83	2.4	31	0.059	0.170	0.49
2024	1.41	1.84	2.4				

19.9.7 Spotted ray (*Raja montagui*) in Subarea 8 (Bay of Biscay and Cantabrian Sea) (rjm.27.8)

In 2024, the assessment was carried out by applying the rfb rule (Table 19.9.7.1). Data used were the Spanish SpGFS-WIBTS-Q4 [G2784] survey and the length distribution from French and Spanish landings. Spotted ray is caught sporadically in divisions 8abd during the EVHOE survey so this survey does not provide a reliable index. Therefore, the biomass index used for assessment comes from Division 8.c only (Figure 19.9.7.1). In Division 8.c, the species has been frequent, especially in the central area Sea during the time-series of the Spanish survey.

In 2021, following a vessel breakdown, the survey was carried out in a different vessel, using the same gear. As the biomass indices of some skate species showed unexpected variations between 2020 and 2021, it was decided to exclude the year 2021 for all species until the possible difference in catchability resulting from the vessel change is clarified. Therefore, in 2024 the change in the biomass index to calculate the *r* of the *rfb* rule was the ratio of the biomass index in 2022-2023 to the average of the biomass index in the three preceding years (2019-2020). Table 19.9.7.1. shows the parameters used in the rfb rule, with details and comments.

Table 19.9.7.1. *Raja montagui* in ICES Subarea 27.8. Estimates used in the rfb rule, with details and comments. 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.

Variable	Estimate	Input data	Comment
Ay	99t	Last landing advice in 2022.	
r: Stock biomass trend	0.58	Stock-size indicator: Biomass survey index from North Spanish survey (SpNGFS-WIBTS-Q4) Two over two: Index A/ Index B	Index A (2022,2023) = 0.85 kg/haul Index B (2019, 2020)= 1.48 kg/haul Index B: survey index in 2021 was not used
f: Multiplier for relative mean length in catches	0.91	Length data collected from commercial landings. Discard lengths were no used.	Lmean = 58.58 cm: average 2022-2023 L(F=M): 64.70 cm: the same as the Advice 2022 (year 2016 was not used)
b: Biomass safeguard	0.99	I_{loss}, minimum estimate (1999) = 0.46 Last index value (2023) = 0.64 $I_{trigger}$ = 0.65	The biomass index has been fluctuating inter-annually since the beginning but is decreasing in last years.
m: multiplier based on life history	0.90	K =0.23 (0.2 ≤ K < 0.32 = 0.90)	K based on Serra-Pereira (2005)
Ay +1: Ay× r × f × b × m	46 t		Decrease of 46 % compared to the last advice (99 t)
Stability clause	---	---	Not applied (biomass safeguard <1)
Discards	unquantified	Discard rate was not used for the advice	Available discards are very variable in last nine years
Projected landings corresponding to advice	46 t	Ay x r x f x b x m	
% advice change	-54%		

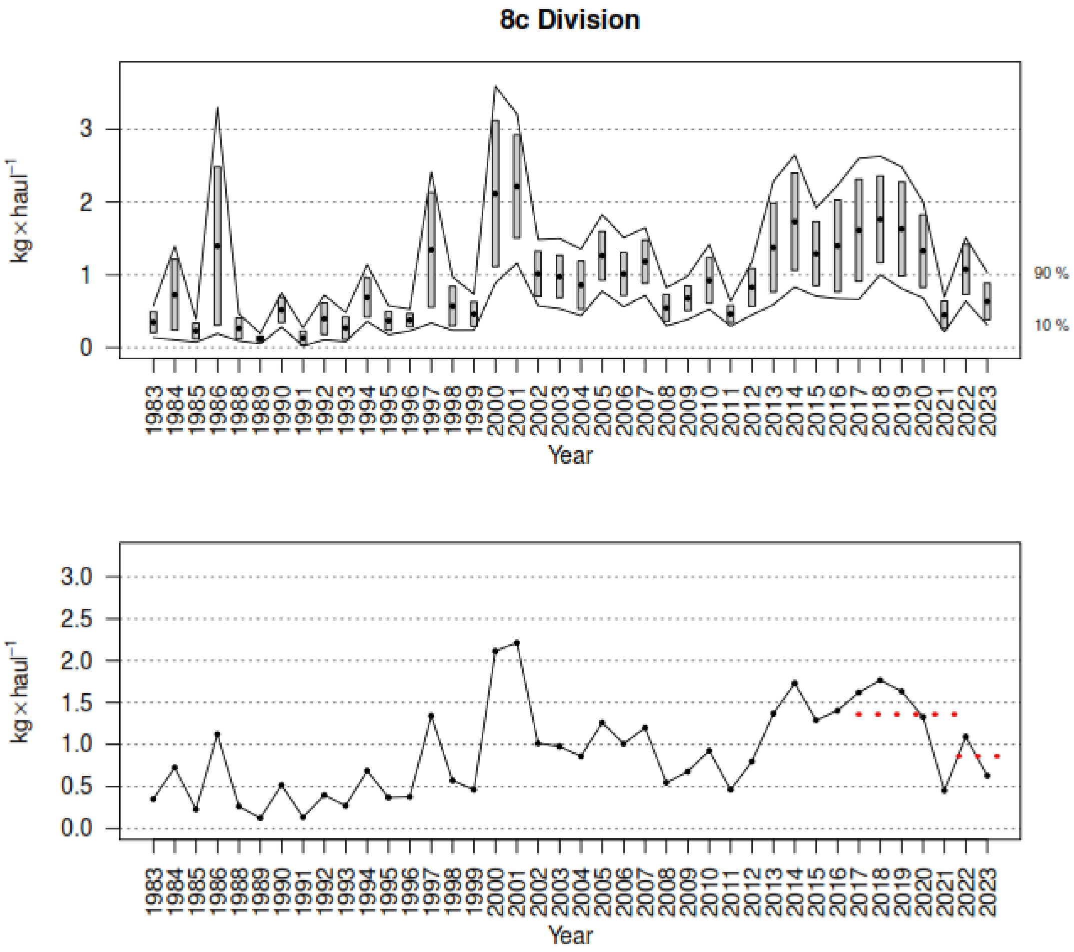


Figure 19.9.7.1. Skates in the Bay of Biscay and Iberian Waters. Time-series of *Raja montagui* biomass index during North Spanish shelf bottom trawl survey (1983–2023) in Division 8.c covered by the survey. Top: boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Bottom: red lines show the average index in the two last years and in the five previous.

19.9.8 Spotted ray (*Raja montagui*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjm.27.9a)

During the ICES benchmark WKBELASMO3 (ICES, 2024a), landings data previous to 2008 and 2009 for Portugal and Spain, respectively, were reconstructed from 2000 to 2009. Detailed description of the methods used can be found in Maia et al. (2023a).

For the period 2000-2023, *Raja montagui* landings have ranged from 36 to 284 tonnes, with Portugal contributing for 59-99% and Spain between 1-41% (Table 19.9.8.1). The increase in the minimum conservation reference size from 52 cm to 60 cm total length for Portugal has reduced the landings of this small-bodied species. Landings from the polyvalent fleet represented 68-91% of the species total landed weight, followed by trawl that have contributing between 9-31%.

Discards information on skates and rays from the Portuguese polyvalent and bottom otter trawl segments operating in the ICES Division 9.a has been collected by the Data Collection Framework (EU DCR). The routine estimator used to estimate total discards in the Portuguese crustacean and demersal fish bottom otter trawl does not apply to species with occurrence lower than

30% of the trips sampled under the DCF Portuguese on-board sampling program, which is the case of all skate and ray species (Serra-Pereira *et al*., 2017). The low frequency of occurrence registered for the species in bottom otter trawl fisheries indicates that discards can be considered negligible (Fernandes, 2021). Regarding the polyvalent fleet, discards are known to take place but are not fully quantified and information available is insufficient to estimate discards of the species. Discard survival studies suggest that *R. montagui* has relatively high survivorship after capture (for details see Section 19.3.3.).

Table 19.9.8.1. *Raja montagui* in ICES Division 27.9a. ICES estimates of landings by country (in tonnes) for the period 2000-2023.

Year	Spain	Portugal	Total Landings
2000	3	149	152
2001	5	162	167
2002	4	171	175
2003	4	179	183
2004	4	189	192
2005	3	200	204
2006	4	195	199
2007	4	207	210
2008	4	144	148
2009	10	184	194
2010	10	275	284
2011	3	121	124
2012	2	108	110
2013	4	111	115
2014	2	101	103
2015	1	67	68
2016	5	68	73
2017	5	94	99
2018	5	59	63
2019	9	80	89
2020	12	56	68
2021	9	103	112
2022	9	62	71
2023	15	21	37

The stock rjm.27.9a was assessed with the rfb rule (ICES category 3, ICES, 2024b) in 2022 (first time the rule was applied). A standardized commercial LPUE time-series was used as an indicator of stock development. The advice was based on the recent advised landings, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in landings relative to the target mean length, a biomass safeguard, and a precautionary multiplier.

However, in 2024 the ADG agreed to move the stock from ICES category 3 to ICES category 5, as the information available is no longer considered reliable to provide an assessment based on the category 3 framework. The increase in the minimum conservation reference size in 2022 (from 52 cm to 60 cm total length) for Portuguese waters, had a significant impact on the availability of data of this small-bodied species, given the lower occurrence in landings. This affects, in particular, the length frequency distribution and the commercial standardized LPUE from the Portuguese polyvalent fleet, that has been used as an indicator of stock size. This year the advice is provided based on a ICES category 5 with landings as the only input data. As the stock has been changed to a category 5 this year, the precautionary buffer was applied. Advised landings in 2025 and 2026 should not exceed 78 t (-20%).

It was also agreed to assess the quality of the data collected in 2024 and 2025 and the possibility to provide advice under a category 3 framework will be re-evaluated in 2026. Nevertheless, the hypothetical advice following ICES guidance on the parameter determination for the rfb rule is presented below. The input values for applying rule on rjm.27.9a are presented in Table 19.9.8.2.

Table 19.9.8.2. *Raja montagui* in ICES Division 27.9a. Estimates used in the rfb rule, with details and comments.

Variable	Estimate	Input data	Comment
r: Stock biomass trend	0.53	Stock-size indicator: standardized commercial LPUE from the Portuguese polyvalent fleet.	Index A (2022, 2023) = 4.56kg.trip^{-1} Index B (2019, 2020, 2021) = 8.57kg.trip^{-1}
b: Biomass safeguard $= \mathbf{min}(\mathbf{1}.\ \boldsymbol{I_{y-1}} / \boldsymbol{I_{\text{trigger}}})$ $I_{\text{trigger}} = I_{\text{loss}}\omega$ Considering $\omega = 1.4$	0.56	Stock indicator; I_{loss}, minimum estimate (2013) = 4.53 $I_{trigger}$ = 6.34 $(\frac{I_{y-1}}{I_{\text{trigger}}} = 0.56)$	The biomass index trigger value ($I_{trigger}$) is based on the lowest observed historical biomass index value (I_{loss}) that was observed in 2009. The biomass index for the stock is model-based and values are updated every year and consequently the biomass index trigger ($I_{trigger}$) value is also updated.
m linked to von Bertalanffy k	0.90	k>0.2 (See comments)	There are no reliable growth studies for this species in ICES division 9a. *K* estimates from studies in other areas of the northeast Atlantic vary from values less than 0.2 year^{-1}(Holden, 1972; Ryland and Ajayi, 1984) to higher than 0.2 year^{-1} (Gallagher et al., 2005). Given the uncertainty on this parameter estimate, the *m* adopted for the calculation of rfb rule was 0.90, following the decisions for other spotted ray stocks. However, stock specific studies are needed.
f: Multiplier for relative mean length in catches	0.99	L_c and $L_{F=M}$ estimated in 2022 (first time applying the rbf rule) were fixed and applied to 2023 length data. Reference values, estimated in 2022, for these two indicators are 50 cm for L_c and 58.55 cm for $L_{F=M}$.	The increase in the minimum conservation reference size from 52 cm to 60 cm total length for Portugal has reduced the landings of small-bodied species as *R. montagui*, and has had a significant impact on the availability of data and the quality of the assessment. Given this, length data available for 2022-2023 was pooled together.
Ay× r × f × b × m	26 t		Decrease of 73% in relation to the previous advice (A_y of 98 t). The stability clause was thus not applied.

Data used included a standardized LPUE time-series as stock indicator and the MSY related indicator ($L_{mean}/L_{F=M}$) as F proxy (see details above).

Up to 2018, this stock was assessed using data from the Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4). However, because of the problems with the PtGFS-WIBTS-Q4 survey data availability for the period 2018–2020 (see details in Section 19.6.3) and uncertain future, an alternative assessment approach using a standardized commercial LPUE series was reviewed and accepted at WKSKATE (ICES, 2021b).

The time-series for *R. montagui* in the ARSA surveys is irregular and with very low catches although a high peak in the biomass and abundance values was observed in 2015 and 2016. There are no records of this species in the Spanish IEO Q4-IBTS survey in Division 9.a over the whole time-series. For these reasons the Spanish surveys are not used in the assessment.

Details on the LPUE estimation methodology can be found in Serra-Pereira *et al.* (2020 WD) and ICES (2021, report). In 2024, the model was updated (explained variance = 0.75, AIC = 142389). The best model selected with the updated dataset included the variables years, quarter, landing port, vessel size and fishing seasonality on skates. More details can be found in Maia *et al*., 2022c WD. The mean annual biomass index (kg/trip) scaled by the overall mean for 2022–2023 (4.56 $kg.trip^{-1}$) was 47% smaller than the observed in the preceding three years (2019-2021:8.57) (Figure 19.9.8.1).

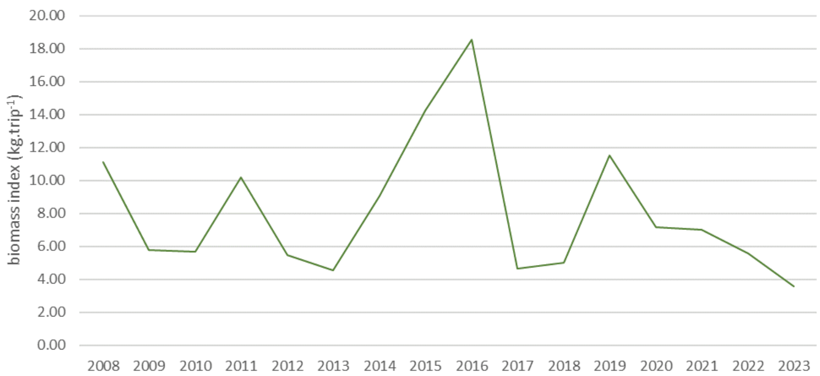


Figure 19.9.8.1. *Raja montagui* in ICES Division 27.9a. Standardized LPUE from the polyvalent segment for the period 2008-2023.

Annual length frequency distributions for the Portuguese combined trawl and polyvalent landings are presented in Figure 19.9.8.2. Spanish landings data were not used since it is only available for trawlers, as well as discards data that are considered deficient. Due to Covid-19 related data collection constraints, data for the period 2019-2021 was combined, according to WGEF decision. The increase in the minimum conservation reference size from 52 cm to 60 cm total length for Portugal has reduced the landings of small-bodied species, and has had a significant impact on the availability of data. Given this, data for 2022 and 2023 was pooled together. To apply the rfb rule in 2024, L_c and $L_{F=M}$ estimated in 2022 (first time applying the rbf rule) were fixed and applied to the 2022 and 2023 length data pooled together. Reference values, estimated in 2022, for these two indicators were 50.0 cm for L_c and 58.55 cm for $L_{F=M}$.

To determine F proxy based on length-based indicators, estimates of L_{inf} (Lmax/0.95; Lmax=80 cm; based on Pauly, 1984), L_{50} (56.7 cm; Pina-Rodrigues, 2012) and parameters from the weight-length relationship *a*=0.000000344 and *b*=3.47 (Serra-Pereira *et al*., 2010) were used.

The ratio of the mean length in the catch to the F_{MSY} proxy ($L_{mean}/L_{F=M}$) suggest that the stock is exploited at sustainable levels ($L_{mean}/L_{F=M}$=0.99 in 2023) (Table 19.9.8.3).

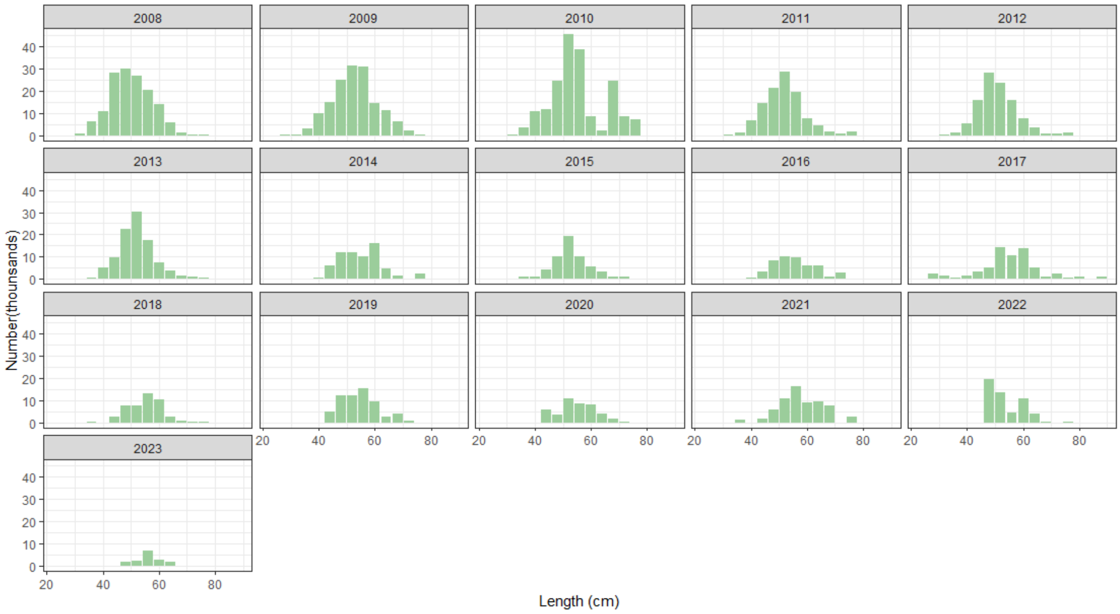


Figure 19.9.8.2. *Raja montagui* in ICES Division 27.9a. Length–frequency distribution (4 cm length classes) for the period for 2008-2023 with polyvalent and trawl fleets combined. The numbers of individuals correspond to raised numbers.

Table 19.9.8.3. *Raja montagui* in ICES Division 27.9a. Indicator table for LBI analysis for the period 2019-2023.

				Fishing pressure indicator	
Year	L_c	$L_{F=M}$	L_{mean}	Length-based fishing pressure proxy (f, $L_{mean}/L_{F=M}$)	Inverse f
2019	50.0	58.55	59.66	1.02	0.98
2020	50.0	58.55	59.66	1.02	0.98
2021	50.0	58.55	59.66	1.02	0.98
2022	50.0	58.55	58.25	0.99	1.01
2023	50.0	58.55	58.25	0.99	1.01

19.9.9 Undulate ray (*Raja undulata*) in divisions 8.a-b (Bay of Biscay) (rju.27.8ab)

The EVHOE survey is uninformative for this stock because the distribution of *R. undulata* is more coastal than the area surveyed. Exploratory assessments were presented by Biais *et al*. (2014 WD) and summarized in Section 19.8.2.

As the discard rate for this stock is very high (0.93) in the period 2019–2023 and the advised catches issued in 2022 were 202 tonnes, the latest assessment advised that no more than 13 tonnes should be landed in each of the years 2025–2028. The advised catches have remained constant since 2018.

The increase of the corresponding landings relative to the previous advice (from 12 tonnes to 13 tonnes) is due to a slight decrease in the average discard rate (from 0.94 to 0.93). Despite the fact that it was last applied in 2018, the PA buffer was not applied in 2022 due to a significant reduction of the fishing effort in métiers likely to catch significant amounts of undulate ray over the period 2014-2023 (Figure 19.9.9.1). The selected gears are: GNS, GTR, LLS, LHM, OTB, OTM, OTT, SSC and TBB. The target species are: DEF and CRU. In order to exclude offshore-operating vessels not fishing in the coastal habitat of undulate ray, only vessels shorter than 24 m where considered.

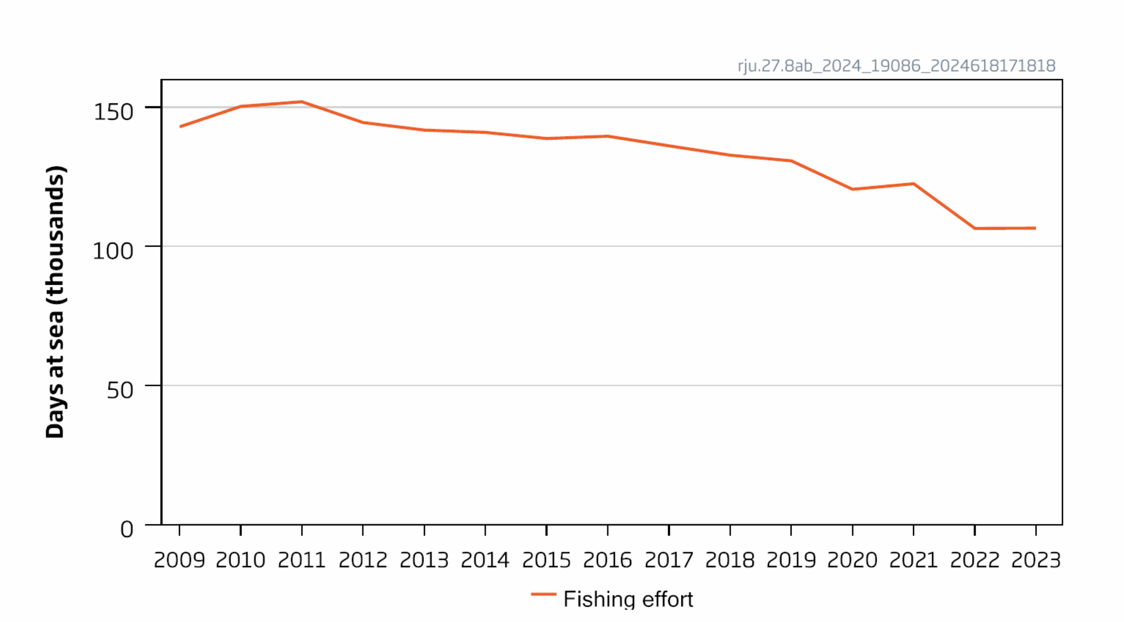


Figure 19.9.9.1. Time series of fishing effort of vessels likely to catch undulate ray in ICES divisions 8a and 8b, expressed in days at sea.

In addition to the agreed TAC, an additional 28.5 tonnes and 21.5 tonnes by year may be allocated to French and Spanish vessels respectively participating in a sentinel fishery to allow fisheries-based data collection for this stock as designed by a national scientific institute for the period 2024-2026 (Council Regulation (EU) 2024/257).

AGEPPOP, a project for estimating the biomass of undulate ray in divisions 8ab was started in March 2023. The project has several objectives including conducting a close-kin mark-recapture (CKMR) estimation of the abundance of the population, estimating age and estimating the stress status of individuals from physiological markers.

Sampling for the CKMR estimation is being carried out at auction markets and onboard fishing vessels. Because of the small TAC, landings at auction markets are not sufficient to collect the large sample of individual biopsies required for this approach (genotyping 4000 individuals is planned). The first few sampling months allowed collecting more than 1500 biopsies, mostly from dedicated surveys and boarding on commercial fishing trips. A dedicated survey was carried out in the Bay of Bourgneuf (Figure 19.9.9.2), where 42 trawl hauls of one hour were carried out. This survey yielded 271 individuals for a total weight of 950 kg. The total swept area (wing spread multiplied by towed distance) was 2.6 km^2.Raising the biomass caught to the total area of Bay of Bourgneuf suggests a biomass of 134 tonnes in this small bay. In divisions 8ab, undulate ray occurs all along the southern coast of Brittany, is more abundant in the central area of the Bay of Biscay (green square, figure 19.9.9.2) and is probably less abundant to the south of the Gironde estuary. Therefore, the Bay of Bourgneuf is a small fraction of the stock area, and represents also a small fraction of the biomass, suggesting that the current 33 t TAC, is well below sustainable limits.

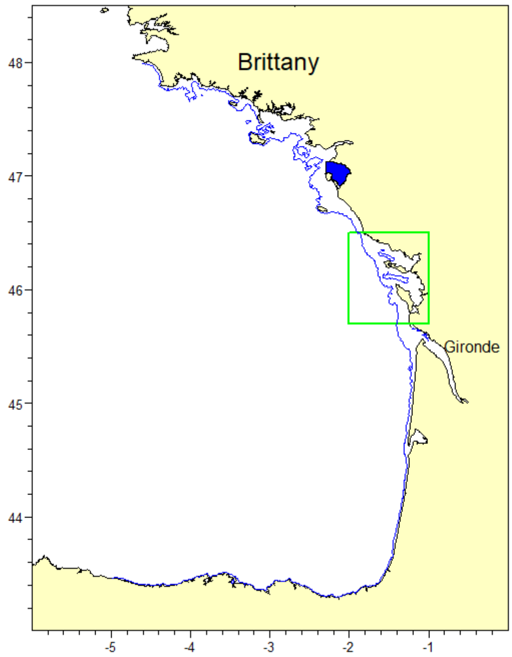


Figure 19.9.9.2. Maps of the Bay of Biscay with the Bay of Bourgneuf (blue area) and the central Bay of Biscay (green square).

Individuals sampled were mostly large adults both in the Bay of Bourgneuf and from other areas (Figure 19.9.9.3). In the Bay of Bourgneuf, small individuals were not abundant. This may come from the more coastal distribution of juveniles, but also reflects the occurrence of numerous large adults in the stock. Individuals from other areas were mostly from sampling on-board commercial trips in the central area of the Bay of Biscay. More juveniles were caught in the area, but again large adults were the most abundant component of the catch. Samples from auction markets (about 100 out of 1200 included in figure 19.9.9.3, right) included only individuals larger than 78 cm, as this size is the MCRS for undulate ray.

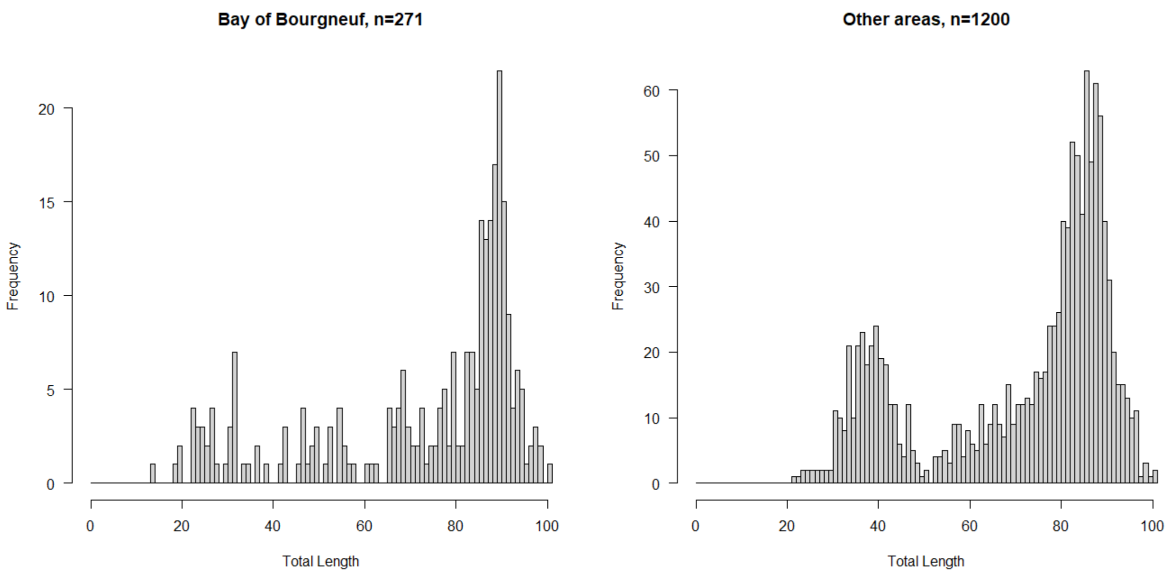


Figure 19.9.9.3. Length distribution of undulate ray sampled during the first months of the project. Left: individuals sampled during a dedicated trawl survey in the Bay of Bourgneuf. Right: individuals sampled in other areas, mostly the central part of the Bay of Biscay.

19.9.10 Undulate ray (*Raja undulata*) in Division 8.c (Cantabrian Sea) (rju.27.8c)

The advice of this stock in 2024 was carried out applying the Precautionary approach. Scientific studies carried out in the eastern parts of Division 8.c have been conducted to characterize the specific composition of the landed skates, the species-specific CPUE and the geographical distribution of the catches (Diez *et al.*, 2014). During the period, 2011–2013, up to 118 trips/hauls of 21 vessels of the trammel net fleet from the nine main ports of the Basque Country were sampled. *Raja undulata* was the fifth species in quantity caught and made up only 5% of the total skates catches. According to fishing interviews, this species is locally frequent and distributed in the coastal waters of Division 8.c, although not very abundant in catches. This situation may not have changed over the years.

Data from existing trawl surveys are limited, owing largely to a poor overlap between surveyed areas and the coastal habitat of this species. *R. undulata*is very scarce in the Spanish IEO Q4-IBTS survey in Division 8.c and usually lower than 0.1 kg haul^{-1} in any year of the series. In 2019, nine individuals of this species, ranging from 38 to 93 cm, were captured between 40 and 84 m deep in the Central and Eastern Cantabrian Sea and no individuals were caught in the period 2020-2023. This due to the fact this species is distributed mainly out of the surveyed ground, in shallower areas not covered because they are not accessible to the vessel and the gear used.

EU fishing regulations allow limited exploitation of this stock. A specified TAC of 33 tonnes applies to all of Subarea 8, thus including two stocks of undulate ray, one in Division 8.c and one in divisions 8.a–b.

For the period 2024-2026 an additional 28.5 tonnes and 21.5 tonnes by year may be allocated to French and Spanish vessels respectively participating in a sentinel fishery to allow fisheries-based data collection for this stock as designed by a national scientific institute. (Council Regulation (EU) 2024/257).

This advice has moved to quadrennial advice until more catch and survey data are made available to ICES.

The historical landings data is uninformative and unrepresentative of population levels. Partial discards are available in two years since 2015 therefore it is considered very incomplete.

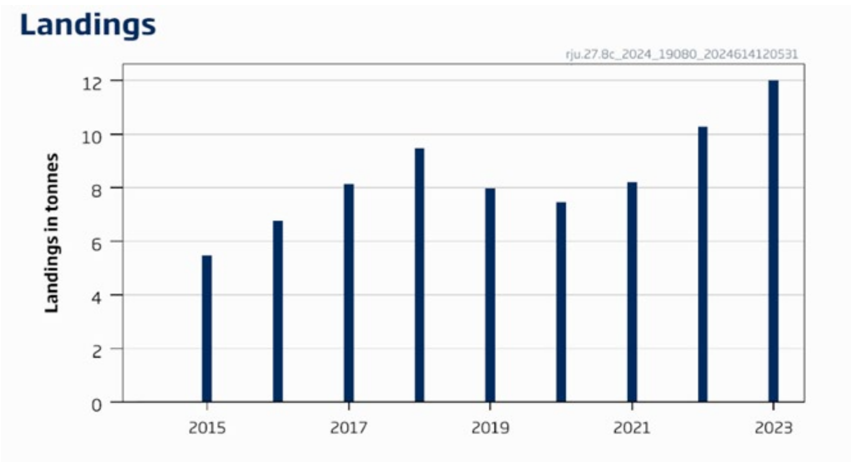


Figure 19.9.10.1. Landings (tonnes) of *Raja undulata* in ICES Div. 8.c.

19.9.11 Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rju.27.9a)

Fishery Overview

Historically and prior the inclusion of *R. undulata* in the European list of prohibited species in 2009, official landings on the species were not informative once landings were not discriminated by species. Portuguese historical landings of *R. undulata* for the period 2003-2008 were presented during the working group in 2015 (Maia *et al*., 2015). *Raja undulata* landings were estimated from aggregated Rajidae multispecies landings following the procedure proposed by Shelton et al. (2012) and using a multinomial–Poisson transformation (Baker 1994). More recently, during the benchmark WKBELASMO3 (ICES, 2024a), Rajidae species historical landings were reconstructed and data for *R. undulata* for the period 2000-2002 is now available (the procedures followed are available in Maia *et al*. 2023a). Landings by country and by fleet for the period 2000-2023 are present in figure 19.9.11.1.

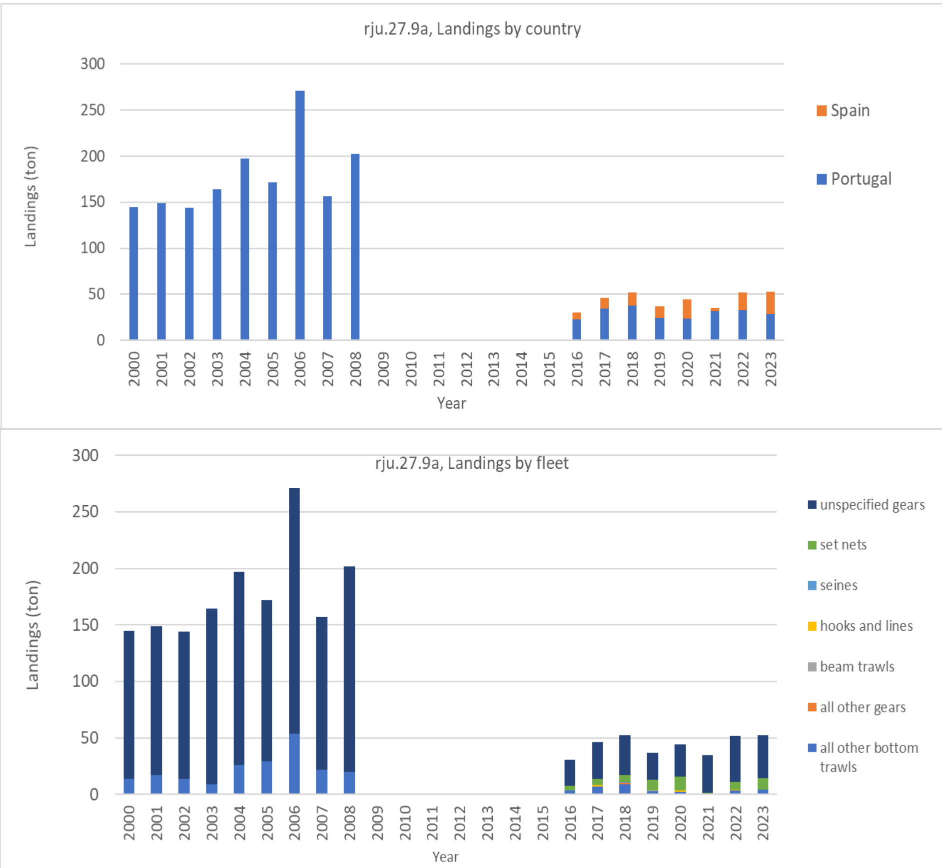


Figure 29.9.11.1. *Raja undulata* in ICES Division 27.9a. Landings by country and by fleet for the period 2000-2023.

Portuguese management measures under the experimental quota

In Portugal, the use of *R. undulata* small experimental quota assigned since 2016 has been guided by scientific protocols and national regulations adopted, which were in turn conditioned by the EU quota assigned.

The legislative framework includes a set of conditions for licensing specific fishing permits to around 60 vessels operating along the Portuguese coast, following a set of criteria which include fishing vessel type, fishing license already assigned to the vessel and historical skate landings. Vessels possessing the specific fishing permit shall comply with a set of rules, which include obligation to transmit, to both the General Directorate of Natural Resources, Maritime Security and Services (DGRM) and to IPMA, fishery data using a form designed by DGRM and IPMA to register haul and catch data on a haul-by-haul basis (including hauls performed with trammel nets with no catch of the species). Furthermore, vessels are prohibited from targeting the species and are constrained to land a maximum of 30 kg per trip and the total length of landed specimens should be in the range 78-97 cm. As additional management measure adopted is prohibition of retaining the species onboard and of landing during the months of May, June and July. Additionally, in 2019, the DGRM introduced a landing control process under which, vessels not possessing the special fishing license are also allowed to land a maximum of one specimen per trip and are also required to provide additional information on their fishing activity related to *R. undulata* catches. Since in this new data collection scenario the forms with information on the species catches are delivered when the fish enters the auction. Because of this new data collection scenario, fishery data on trammel nets hauls with null catches of *R. undulata* were no longer mandatory. For more detail see Maia et al. (2024b).

Portuguese Fishery data after the moratorium period

Data collected under the quota management scenario and comments on its quality/application are summarized in Maia *et al*. (2024b).

Species biology and population parameters

Main biological information available for *R. undulata* in Portuguese waters is summarized in Table 19.7.

Species distribution, abundance and behaviour

Along the Portuguese continental coast, *R. undulata* bathymetric distribution varies from 4 to 128 m deep, being more abundant at depths ranging from 30 to 40 m which hinders the collection of adequate data from both Spanish IEO Q4-IBTS survey or the Portuguese demersal survey (PtGFS-WIBTS-Q4). The inadequacy of surveys is related with its design which has few fishing stations in shallow areas, where the species is known to occurs predominantly.

A mark-recapture study in Portuguese waters - UNDULATA project- showed that *R. undulata* perform short distance movements confirming the species high degree of site fidelity (Maia et al. 2024a). This agrees with preliminary results obtained during the same project from the genetic analysis of mitochondrial markers (in particular from the control region, CR) that suggested the existence of populational differences between geographical areas along the Portuguese coast (Figueiredo et al., 2016). A total of 353 specimens were tagged in the area of Sesimbra/Setúbal. Total length of tagged females ranged between 52-93 cm and between 57-89 cm for males. Figure 2 presents the geographic locations where specimens were tagged and the length frequency distribution of the tagged specimens by sex. A total of 40 recaptures were recorded, which represented 11% of the tagged specimens. The maximum recorded travelled distance was 26 km and 75% of the recaptures were located at distances less than 10km from the tagging location. The longer period between tagging and recapture was 313 days and 50% of the tagged specimens were recaptured more than 54 days after the tagging event. The majority of movements were recorded down to 50 m deep and seem to follow the shoreline between Sesimbra and Sines which reinforced the previous knowledge that the species prefers shallow sandy coastal areas. For details on the results see Maia *et al.* (2024a).

Under the self-sampling program adopted for vessels with specific license for *R. undulata*, a methodology was adopted to estimate the density and abundance of the species. Geo-referenced fishery data collected in 2017 were used. A binomial mixture model (Kéry *et al.*, 2005) was the adequate statistical approach to be used as it accommodates the temporally and spatially replicated count data available. For details on species abundance and main conclusions see Figueiredo *et al.* (2020a).

Survivorship – health status after capture

The assessment of the health status after capture is considered a good indication of the survivorship index of skates. A qualitative assessment of the health status of the captured specimens of *R. undulata* in Portuguese continental waters was performed using the scale from Enever *et al*. (2009). The size of the specimens is the variable with more influence in the survivorship of the species. However irrespective of specimen size, the percentage individuals in "good" health status was always higher than 80%. In conclusion the species in subarea 27.9a is mainly caught by nets and have a high survivorship after capture (see Section 19.3.3). More detail can be found in Maia *et al*. 2024a.

Fishing effort and harvest rate

The harvest rate for 2017 was calculated using *R. undulata* biomass estimate for Portuguese continental coast (Figueiredo *et al*., 2020a) and catches of the year (official data). The resulting harvest rate is 0.003 (see details in Maia *et al*., 2024b), that corresponds to a fishing mortality of 0.00129, which is well below the FMSY estimated for *R. undulata* stock in ICES Division 27.7d-e (0.131) and the empirical estimate determined using the method proposed by Zhou *et al*. (2012) (0.1107) for Chondrichthyes (FMSY=0.41M).

Temporal evolution of abundance index for licensed vessels

Data used for abundance index standardization process comprised the fishery data collected from vessels with a special license for *R. undulata* for the period 2017-2023, which was adjusted to a zero-truncated Poisson regression model (for details on the methodology see Maia *et al*., 2024b). The standardized abundance index show stability along the 7-year period (Figure 19.9.11.2).

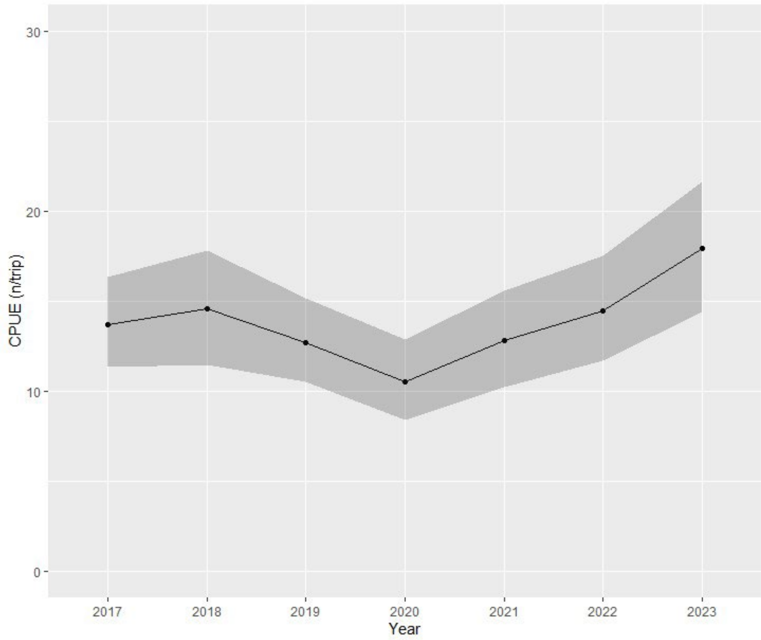


Figure 19.9.11.2. *Raja undulata* in ICES Division 27.9a. Standardized CPUE index (n.trip^{-1}) and respective standard error from 2017 to 2023.

Final considerations for advice

Given the high constrains on fishing opportunities for the species, in particular:

- the small quota assigned to Portugal (12-15 tonnes since 2016);
- the strict management measures as:
  - prohibition of directed fishing;
  - maximum landed weight of 30 kg (~5/6 indiv.);
  - 3 month closed fishing period that protects the species during part of the reproductive season;
  - minimum and maximum landing size that protects juveniles and spawners;
- the expected decrease of fishing effort in relation to the period previous the 2009;
- the standardized abundance index stability and;
- the high survivorship of the species after capture

It is expected that the harvest rate in recent years was at the same level as that estimated for 2017 and that the small quota assigned does not have a negative impact on the stock.

Due to constrains mentioned above, fishery data derived from it do not enable the definition of sustainable exploitation levels particularly in accordance to the F_{MSY} approach.
The main deficiencies on data collected under the quota assigned to ICES Division 27.9.a are:

- the spatial and temporal coverage of fishing is limited as the number of licenses is dependent on the quota available (Figure 9 shows the self-sampling data available by year enlightening the deficient spatial coverage along the coast);
- data from areas where the species is known to concentrate are not available to the fishing as only by-catch is allowed and because fishermen highly avoid those areas;
- length data from landings are limited and considered not representative of the exploitable population mainly because minimum and maximum landing sizes adopted and the total number of specimens allowed to be landed per trip (making it impossible to construct length frequencies for LBI estimation)

In conclusion, the small quota assigned to Portugal since 2016, is considered not to have a negative impact on the stock, but on other hand has had a great impact on the self-sampling program as fishermen´s motivation and collaboration has been continuously decreasing. Fishermen considered that despite their effort to collect data, results are not reflected in the scientific advice provided by ICES; following the guidelines for category 6 stocks, advice on fishing opportunities maintains or reduces in 20% the latest advice.

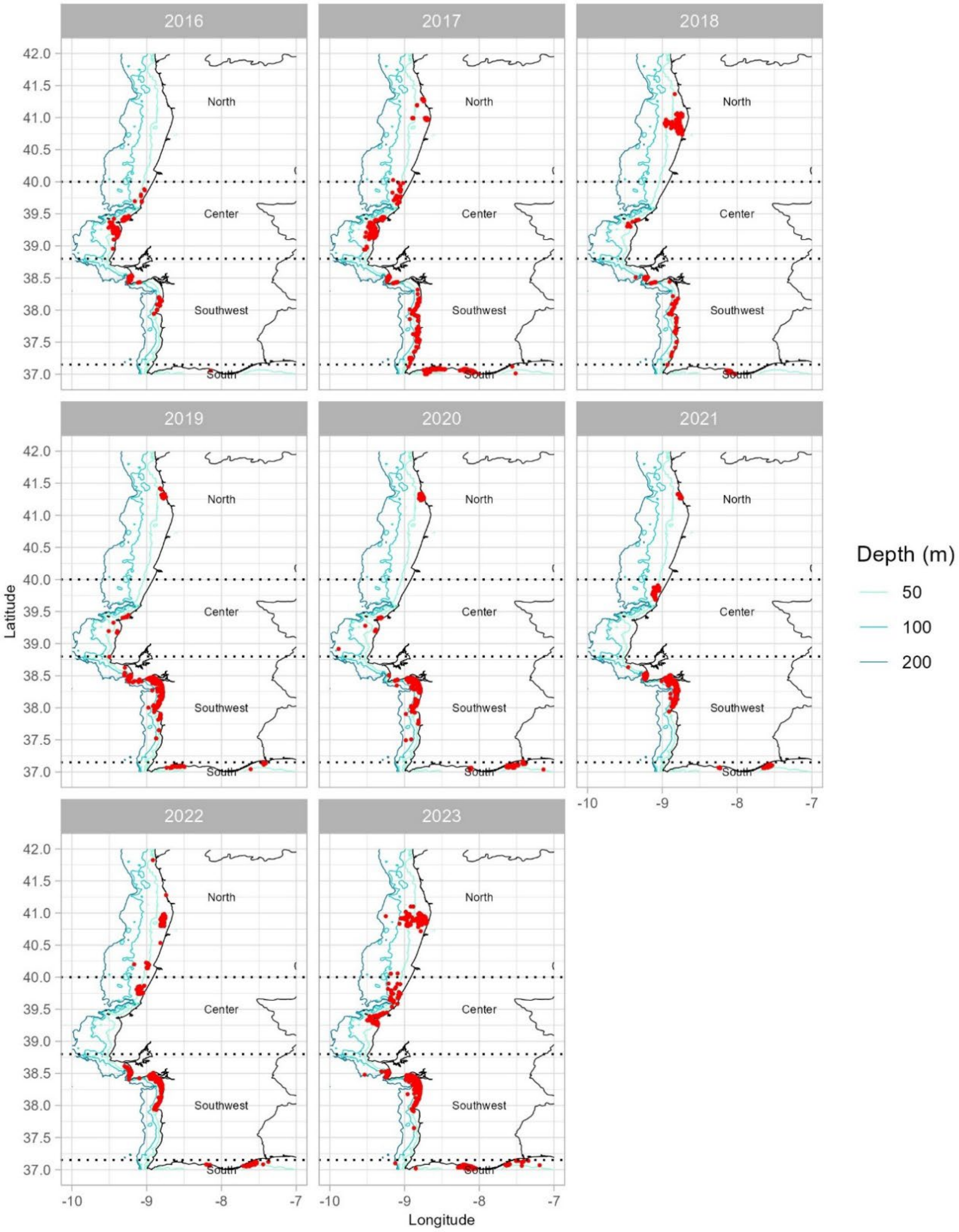


Figure 19.9.11.2. ***Raja undulata*** **in ICES Division 27.9a. Spatial coverage of self-sampling data for the period 2016-2023.**

19.9.12 Blonde ray (*Raja brachyura*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjh.27.9a)

During the ICES benchmark WKBELASMO3 (ICES, 2024a), landings data previous to 2008 and 2009 for Portugal and Spain, respectively, were reconstructed down to 2000. Detailed description of the methods used can be found in Maia et al. (2023a).

Raja brachyura landings in ICES Division 9a have ranged from 162 to 387 tonnes, with Portugal contributing for 95-100% and Spain for up to 4% (Table 19.9.12.1). Landings from the polyvalent fleet represented 71-94% of the species total landed weight, followed by trawl that have contributing between 6-29%.

Discards for *R. brachyura* in ICES Division 9a were mainly reported for the Spanish bottom otter trawl fleet and in low quantities (below 3 tons) compared to the total landings for the stock (average proportion of 0.002±0.004). The low frequency of occurrence registered for the species in discards of the Portuguese trawl fleet indicates that discards can be considered negligible for that particular fleet (Fernandes, 2021). In the Portuguese polyvalent fleet, discards are known to take place and assumed to be low, but are not fully quantified as the information available is insufficient to estimate total discards (Fernandes, 2021). Further details on the discards for all skate species was presented to WKSHARKS3 (ICES, 2017; Serra-Pereira et al., 2017). In summary, discarding is known to take place for *R. brachyura*in ICES Division 9a, but ICES cannot estimate the quantity or the corresponding dead catches. However, based on information available, discarding for this stock is assumed to be low and therefore is not included in the advice.

Discard survival studies suggest that *R. brachyura* has relatively high survivorship after capture (for details see Section 19.3.3.).

Table 19.9.12.1. *Raja brachyura* in ICES Division 27.9a. ICES estimates of landings by country (in tonnes) for the period 2000-2023.

Year	Spain	Portugal	Total
2000	1	262	263
2001	1.44	263	265
2002	1.17	229	230
2003	1.19	248	249
2004	1.13	235	236
2005	1.09	259	261
2006	1.18	205	206
2007	1.13	185	186
2008	1.21	193	194
2009	0.96	164	165
2010	1.79	221	223
2011	1.1	161	162
2012	0.46	165	165
2013	2.8	179	182
2014	0.34	174	174
2015	0.35	236	236
2016	0.98	221	222
2017	0.49	235	236

2018	3.7	183	187
2019	8.3	259	267
2020	12.1	316	328
2021	10.6	217	228
2022	13.4	276	289
2023	14.3	372	387

The stock rjh.27.9a is an ICES category 3 stock and has been assessed based on the rfb rule (rfb rule, ICES, 2024b) since 2022 (first time the rule was applied). A standardized commercial LPUE time-series is used as an indicator of stock development. The advice is based on the recent advised landings (2023-2024 issued in 2022), multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in landings relative to the target mean length, a biomass safeguard, and a precautionary multiplier.

This stock was benchmarked in 2024 and SPiCT assessments using landings since 2000 and one series of biomass indices (LPUE from Portuguese polyvalent fleet) since 2008 were tested but not accepted (ICES, 2024a). The stock remained in category 3 and the advice given according to the rfb rule.

Following the ICES guidance on the parameter determination for the rfb rule, the input values for applying rule on rjh.27.9a are presented in Table 19.9.12.2.

Advised landings in 2025 and 2026 should not exceed 249 t. Since the new advice corresponds to an increase of 8% in relation to the previous advice (231 t), the stability clause was not applied.

Table 19.9.12.2. ***Raja brachyura*** **in ICES Division 27.9a. Estimates used in the rfb rule, with details and comments.**

Variable	Estimate	Input data	Comment
r: Stock biomass trend	1.06	Stock-size indicator: standardized commercial LPUE from Portuguese polyvalent fleet.	Index A (2022, 2023) = 32.71 kg.trip^{-1} Index B (2019, 2020, 2021) = 30.86kg.trip^{-1}
b: Biomass safeguard =$\mathbf{min}(\mathbf{1}.\ \boldsymbol{I}\boldsymbol{y}\mathbf{-1}/\boldsymbol{I}\mathbf{trigger})$ Itrigger=Iloss ω Considering ω=1.4	1	Stock indicator; I_{loss}, minimum estimate (2009) = $I_{trigger}$ = 18.44 $\left(\frac{I_{y-1}}{I_{\text{trigger}}} = \frac{33.31}{18.44}\right) = 1.81($	The biomass index trigger value ($I_{trigger}$) is based on the lowest observed historical biomass index value (I_{loss}) that was observed in 2009. The biomass index for the stock is model-based and values are updated every year and consequently the biomass index trigger ($I_{trigger}$) value is also updated.
m linked to von Bertalanffy k	0.95	k=0.13 year-1; estimated from the Von Bertalanffy growth model (Pina-Rodrigues, 2012)	*k* estimated for females (Pina-Rodrigues, 2012).
f: Multiplier for relative mean length in catches	1.07	L_c and $L_{F=M}$ estimated in 2022 (first time applying the rbf rule) were fixed and applied to 2023 length data. Reference values, estimated in 2022, for these two indicators are 57.50 cm for L_c and 74.63 cm for $L_{F=M}$.	
Ay × r × f × b × m	249 t		Increase of 8% in relation to the previous advice (Ay of 231 t). The stability clause was thus not applied.

Data used included a standardized LPUE time-series as stock indicator and the MSY related indicator ($L_{mean}/L_{F=M}$) as F proxy (see details above).

This is a coastal species with a patchy distribution that is caught infrequently by both Spanish and in Portuguese surveys in Division 9.a (usually lower than 0.1kg.haul^{-1} in any year of the series). Consequently, abundance indices derived from these surveys are not considered indicative of stock status. In this case, the biomass index used for assessment is based on a standardized commercial LPUE time-series

LPUE time-series index was revised and considered to provide information on trends in stock size during the ICES benchmark WKBELASMO3 (ICES, 2024a) and details on the standardization methodology are described inMaia et al. (2023b). The selected best model included the variables years, quarter, vessel size, fishing seasonality on skates and rays and fishing gear (trammel nets or gillnets).In previous analysis a standardized LPUE was given for to a reference situation: quarter = 1, SIZEs = M (medium), SAZ = c (constant) and fishing gear = nets. However, in 2022 WGEF considered the high value estimated for 2019 unreliable and exploratory analyses were performed. As there was no evident reason for 2019 estimate, a new CPUE series was constructed based on the model´s estimated values for the input data set (Figure 19.9.12.1). In 2024, the model was updated (explained variance = 0.75, AIC = 243136). Mean annual biomass index (stock indicator) for 2022-2023 (32.71 kg.trip^{-1}) was 6% higher than observed in the preceding three years (2019–2021; 30.86 kg.trip^{-1}).

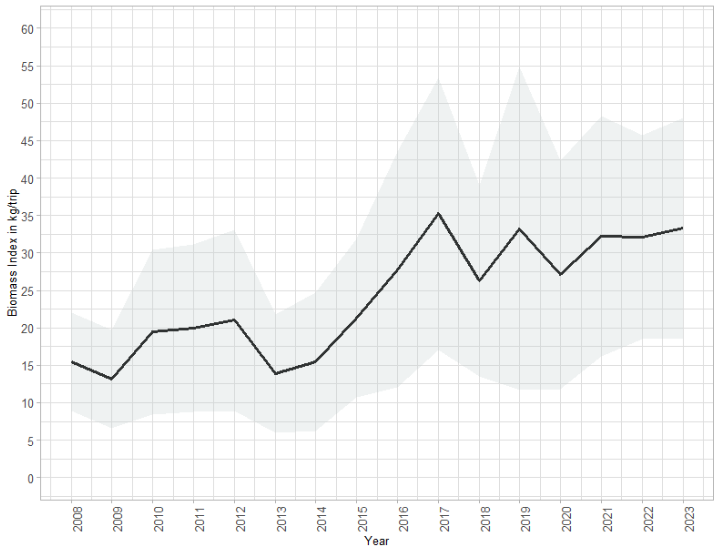


Figure 19.9.12.1. *Raja brachyura*in ICES Division 27.9a. Polyvalent fleet annual standardized CPUE estimates (kg.trip^{-1}) in the Division 9.a for the period 2008–2023.

Annual length frequency distributions for the Portuguese combined trawl and polyvalent catches are presented in Figure 19.9.12.2. Only Portuguese length data were used as, for this stock, Spanish data are not available. It should be remarked that the Portuguese landings represented ~95% to 100% of the total landings of the stock for the period 2008-2023. Due to Covid related data collection constraints, data for the period 2019-2021 was combined, according to WGEF decision. Discard data were only available from the Spanish trawl fleet but length information is deficient.

For advice in 2024, L_c and $L_{F=M}$ estimated in 2022 (first time applying the rbf rule) were fixed and applied to the 2022 and 2023 length data. Reference values, estimated in 2022, for these two indicators were 57.50 cm for L_c and 74.63 cm for $L_{F=M}$.

To determine F proxy based on length-based indicators, estimates of L_{inf} (126.0 cm; Pina-Rodrigues, 2012), L_{50} (95.2 cm; Maia *et al*., 2022a) and parameters from the weight-length relationship *a*=0.00000198; and *b*=3.2 (Serra-Pereira *et al*., 2010) were used.

The ratio of mean length in the catch to the F_{MSY} proxy ($L_{mean}/L_{F=M}$) suggests that the stock is exploited at sustainable levels ($L_{mean}/L_{F=M}$=1.07 in 2023) (Table 19.9.12.3).

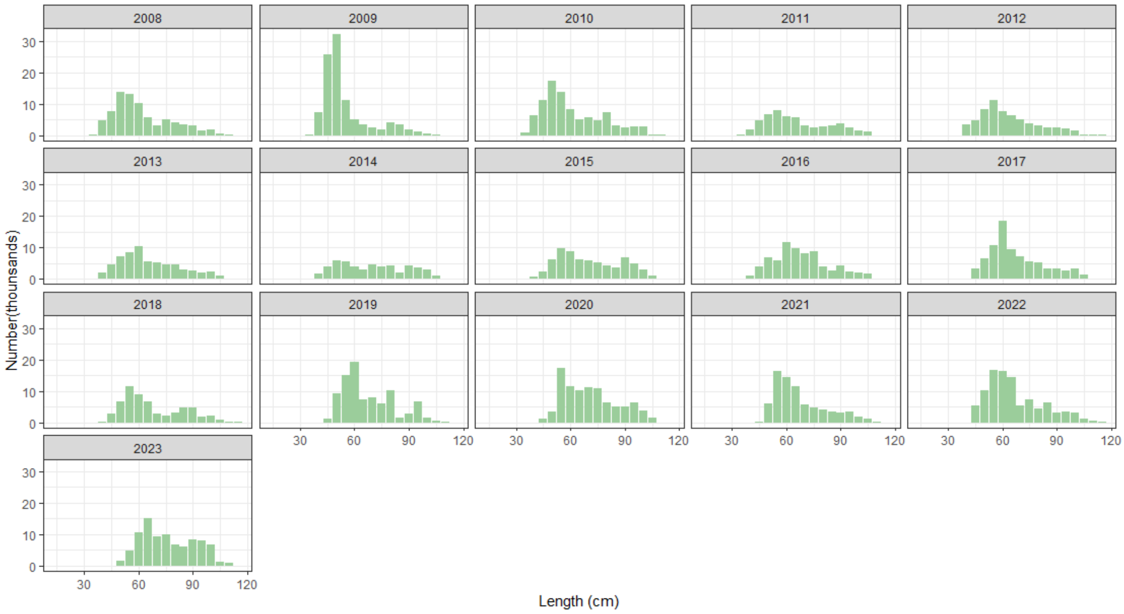


Figure 19.9.12.2. ***Raja brachyura*** **in ICES Division 27.9a. Length–frequency distribution (5 cm length classes) for the period for 2008-2023 with polyvalent and trawl fleets combined. Numbers of individuals correspond to raised numbers.**

Table 19.9.12.3. ***Raja brachyura*** **in ICES Division 27.9a. Indicator table for LBI analysis for the period 2019-2023.**

				Fishing pressure indicator	
Year	L_c	$L_{F=M}$	L_{mean}	Length-based fishing pressure proxy (f, $L_{mean}/L_{F=M}$)	Inverse f
2019	57.5	74.63	74.40	1.00	1.00
2020	57.5	74.63	74.40	1.00	1.00
2021	57.5	74.63	74.40	1.00	1.00
2022	57.5	74.63	73.44	0.98	1.02
2023	57.5	74.63	79.72	1.07	0.94

19.9.13 Common skate *Dipturus batis*-complex (blue skate *Dipturus batis* and flapper skate *Dipturus intermedius*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (rjb.27.89a)

Dipturus batis-complex has been confirmed to comprise two species, the nomenclature has been-stabilized in Last *et al.* (2016) the smaller species (the form described as *D. cf. flossada* by Iglésias *et al.*, 2010) is named common blue skate, *Dipturus batis* and the larger species flapper skate, *D. intermedius*.

These species are only caught occasionally in Subarea 8 and might not occur to any degree in Division 9.a.

There are no stock size indicators for either species. Reported landings are low due to restrictive management measures and do not provide information on stock dynamics. Despite the *Dipturus batis*-complex being prohibited in EU regulations, some individuals were landed occasionally in

French and Spanish fish markets in Subarea 8. In France, sampled specimens in fish markets included an adult female *Dipturusintermedius* (200 cm LT) - a southerly record of the species in recent years; and small individuals of *Dipturus batis* caught in southern French Brittany. As these species are now extirpated from inner shelf areas of their former range, fishermen are not always able to identify them accurately. Available information does not change the perception of the stock status of these species that occur at low levels in this ecoregion.

Differing to other areas, *D. oxyrinchus* was included since 2016 and in the advice for the raj.27.89a and not for rjb.27.89a. It is important to highlight that all landings of the genus *Dipturus* from Portugal in Division 9.a refer to *D. oxyrinchus*, for Spain and France official landings of *D. oxyrinchus* were considered to be correctly identified and all the remaining official landings of the genus *Dipturus* from this ecoregion were allocated to *Dipturus* spp., as species identification problems persist among species of the genus *Dipturus*.

In 2021, information about *Dipturus* species were compiled for this ecoregion and discussed under the Tor *"Evaluate available data at species-specific level within the common skate-complex (Dipturus spp.) stock units in order to further increase our understanding of each individual species and their current status"*. See section 26 of this report for further details.

19.9.14 Other skates in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (raj.27.89a)

Sandy ray *Leucoraja circularis* occurs on the deeper shelf and along the slope of the Bay of Biscay and in minor abundance in Portuguese landings. Minor occurrences of the shagreen ray *Leucoraja fullonica* are also observed to the North of Division 8.a, but this species is largely absent from Division 9.a. Owing to the higher abundance of these two species in the Celtic Seas, the Bay of Biscay may comprise the southern limits of the Celtic Sea stocks.

In divisions 8.a-b, occasional catches of *Raja brachyura* and *Raja microocellata* are found at the coast by artisanal fisheries. These two species are scarce in the historical time-series of the Spanish IEO Q4-IBTS survey in divisions 8.c and 9.a.

All four of these species are caught in too small numbers in the EVHOE survey to calculate reliable population indices.

In Division 9.a, *Raja microocellata*, *R. miraletus* and *Dipturus oxyrinchus* appear occasionally in landings (Table 19.2a at the end of this chapter). *R. microocellata* length–frequency distribution is only presented for the Portuguese commercial polyvalent fleet, due to the low occurrence of this species in landings from the trawl fleet, for the period 2008–2022(Figure 19.9.14). *R. miraletus* and *D. oxyrinchus* are caught in low numbers in Portuguese surveys.

As mentioned in the previous section, landings allocated to *D. oxyrinchus* were included in this stock.

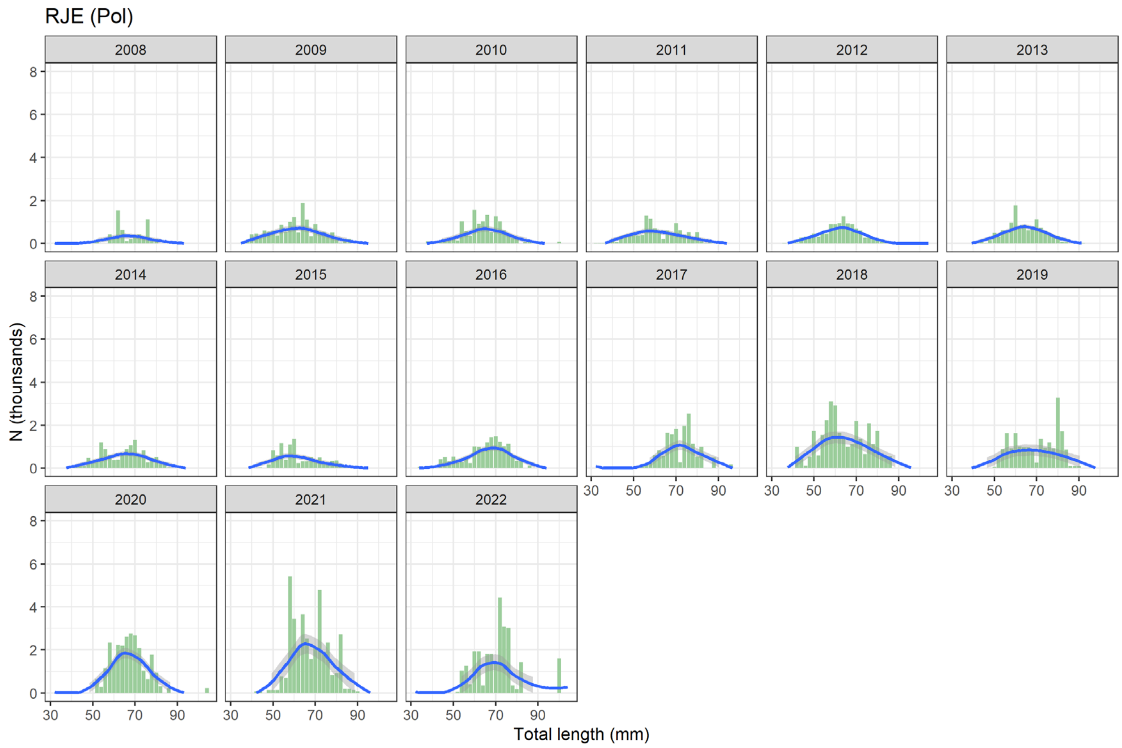


Figure 19.9.14. ***Raja microocellata*** **in ICES Division 27.9a. Length–frequency distribution from the Portuguese commercial polyvalent fleet for the period from 2008–2022. Total number of sampled trips was n = 825. Length–frequency distributions were extrapolated to the total estimated landed weight of each species.**

19.9.15 Summary of the status of skate stocks in the Bay of Biscay and Atlantic Iberian waters

The following table provides a summary of stock status for the main species evaluated in 2024 and using ICES MSY and Data Limited Stock approaches.

Species	ICES stock code	ICES stock data category	Perceived status
Thornback ray *Raja clavata*	rjc.27.8ab,d	2	The stock size indicator is constant between 2009 and 2016 and increases since 2018, with some fluctuations.
	rjc.27.8c*	2	Fishing pressure on the stock is below FMSY, and biomass is above MSY Btrigger and Blim
	rjc.27.9a*	2	Fishing pressure on the stock is below F_{MSY}, and biomass is above MSY $B_{trigger}$ and B_{lim}.
Cuckoo ray *Leucoraja naevus*	rjn.27.9a*	2	Fishing pressure on the stock is below F_{MSY}, and biomass is above MSY $B_{trigger}$ and B_{lim}.
	rjn .27.8c	3	Fishing pressure on the stock is at FMSY proxy, and the stock-size indicator is above I trigger .
Spotted ray *Raja montagui*	rjm.27.8	3	Fishing pressure on the stock is above $F_{MSY\ proxy}$, and the stock-size indicator is just below $I_{trigger}$
	rjm.27.9a	5	The stock has changed from category 3 to category 5, as the information available is no longer considered reliable to provide an assessment based on the category 3 framework. This year, the precautionary buffer was applied.
Undulate ray *Raja undulata*	rju.27.8ab	6	No assessment, ancillary information suggests increase in the stock biomass
	rju.27.8c	6	No assessment, fisheries data may not be informative of trends in stock biomass.
	rju.27.9a	6	No assessment, the current levels of exploitation are not thought to have a negative impact on stock status.
Blonde ray *Raja brachyura*	rjh.27.9a	3	The stock size indicator increased from 2008 to 2017 and levelled off thereafter. Fishing pressure on the stock is below $F_{MSY\ proxy}$, and the stock-size indicator is above $I_{trigger}$.
Common skate *Dipturus batis* complex	rjb.27.89a	6	No assessment, available data do not inform on stock dynamics, species composition, catch, or landings. There are currently no robust stock size indicators.
Other skates	raj.27.89a	6	No assessment. The decline in landings is due primarily to the increase in the proportion of landings of Rajidae that are reported by species.

***Stocks benchmarked in 2023 or 2024, changing from category 3 to category 2.**

19.10 Quality of assessments

LPUE data for *L. naevus and R. clavata* are available for divisions 8.abd since 2001. Since 2008 LPUE were made available for *R. clavata, R. montagui, R. undulata* and *R. brachyura* in Division 9.a. The inclusion of the standardized LPUE series in the assessment of *R. clavata, R. montagui* and *L. naevus* in Division 9.a were reviewed by WKSKATE and peer-reviewed by an external review group (ICES; 2021b).

As in other ecoregions, surveys in Subarea 8 and Division 9.a were not specifically designed for elasmobranchs, producing a high frequency of zero-catch data. The fishing gear used and the survey design are not the most appropriate to sample elasmobranchs, especially for species with patchy distributions. Surveys do not cover coastal and estuarine areas, and therefore do not provide indicators for stocks distributed in shallow waters, e.g. those of undulate ray. Nevertheless, for some stocks, surveys provide reliable biomass indices.

Efforts have been made to overcome data limitations in order to standardize the fishery-independent abundance indexes, using as an example the estimates for *R. clavata* data from the autumn survey (PtGFS-WIBTS-Q4) in Division 9.a (Figueiredo and Serra-Pereira, 2013 WD). To deal with the large amount of zero-catches a generalized linear mixed model (GLMM) was fitted to the data, assuming a Tweedie distribution for the observations. One of the main purposes of applying a GLMM was to incorporate in the model variables that could account for differences between years, namely the difference between stations, depths, survey methodology, etc. Some decisions/assumptions had to be taken in order to proceed with the analysis of the data, including the determination of a subset of the available data, which better represent the geographical distribution of the species.

Tagging studies of *R. undulata* have shown that the distribution of this species is discontinuous, confirming the 2013 tagging results and the need to assess the state of the stocks of this species for areas that fit with the limited movements that this species may make. This behaviour may be a benefit for obtaining mark–recapture stock estimate as the one provided for the central part of the Bay of Biscay. Results allow an exploratory analysis including a lot of assumptions. Consequently, it must be regarded as only indicative of the biomass trend.

Raja clavata – Correction made in 2024 in the model

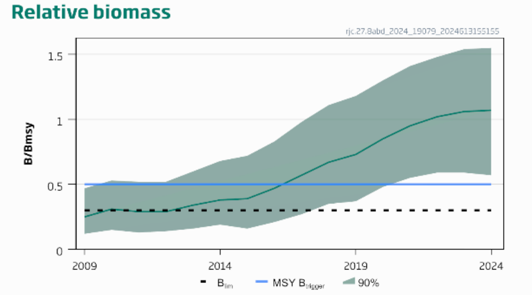
In 2024, an error (in the benchmark and 2022 assessment) was detected in the model used for the assessment of *Raja clavata*. The model was corrected. The error was a missing "+1" in a code line for calculating the absolute biomass (of year+1) by multiplying the relative biomass by the carrying capacity (*K*).

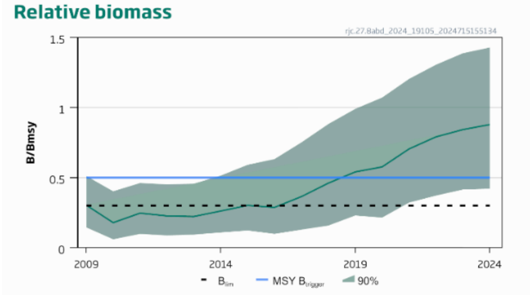
Since the model was revised in 2024, the comparison with the 2022 assessment is not much relevant in terms of model results. However, to better understand the impact of the error and the history plots of the 2024 assessment, an assessment run was performed using the model with the error (same code used as in the 2022 assessment) was conducted (see below).

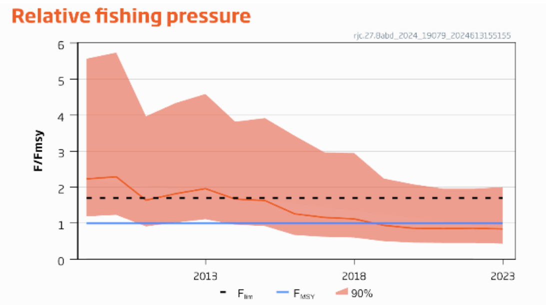
The trend of the stock is similar between the two runs, with relative biomass increasing over time and relative fishing pressure decreasing over time. However, the correction shifts the relative biomass and relative fishing pressure over time (ICES, 2024). There is a decrease in relative biomass, but the biomass is above MSY $B_{trigger}$ and B_{lim} and it increases over time. Relative fishing pressure decreases to 1 in recent years (0.99 in 2021 and 2023; 1.00 in 2022) instead of being less than 1 in the last five years.

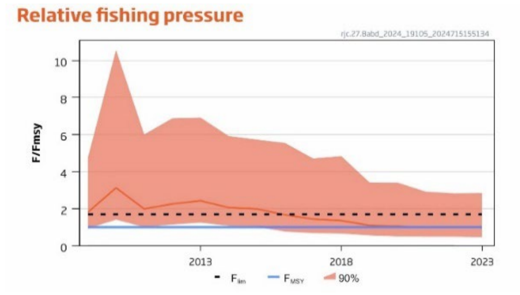
The absolute biomass and carrying capacity are higher in the corrected assessment.

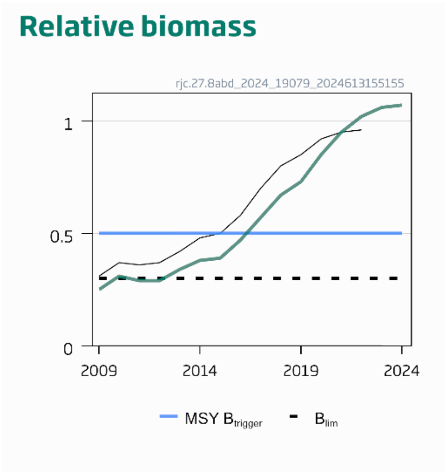
2024 assessment run with the same code than the 2022 assessment (with an error in the model)	**Assessment final 2024 assessment (model corrected)**

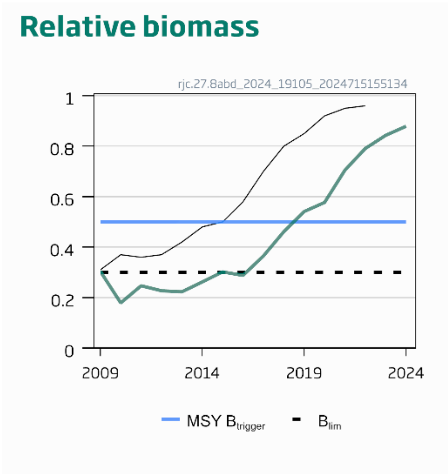


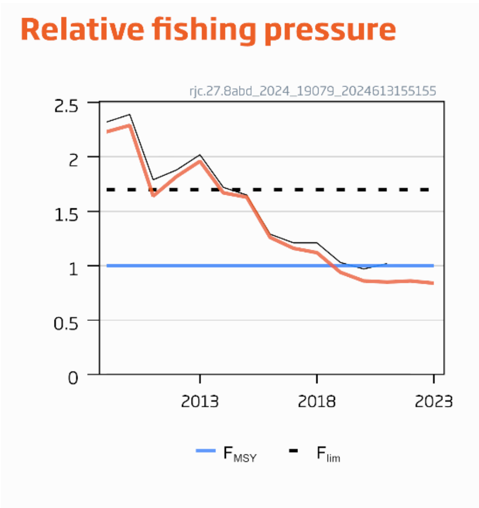


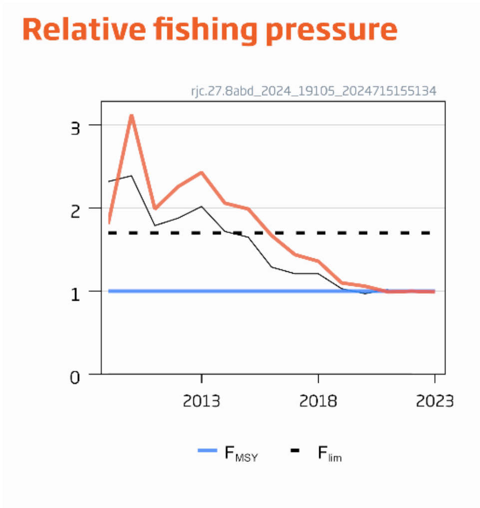












19.11 Management considerations

A TAC for skates in this region was only introduced in 2009, along with requirements to provide species-specific data for the main commercial species (initially *L. naevus* and *R. clavata* and, since 2013, *R. brachyura*). Consequently, there is only a relatively short time-series of species-specific landings. In the case of Portugal, estimates of species-specific landings based on DCF sampling data are available since 2008.

Landings of *Raja undulata* were not allowed from 2009 to 2014, with a bycatch allowance only established for Subarea 8 since 2015, which was then extended to Division 9.a. in 2016. Consequently, landings data for *Raja undulata* are not indicative of stock status. However, landings and discards data could be indicative of stock status for this species along with several monitoring years according to self-sampling programs (French and Portuguese) in these areas.

Currently, fishery-independent trawl survey data provide the longest time-series of species-specific information. These surveys do not sample all skate species effectively, with more coastal species (e.g. *R. brachyura, R. microocellata* and *R. undulata*) not sampled representatively.

The status of more offshore species, such as *L. circularis* and *L. fullonica*, are poorly understood, but these two species may be more common in the adjacent Celtic Seas ecoregion (see Section 18).

Some of the larger-bodied species in this ecoregion are from the genus *Dipturus*, but data are limited for all these species, with some potentially more common further north.

19.12 References

Baker S.G. (1994). The multinomial–Poisson transformation. Statistician 43(4): 495–504 Baker

Baulier, L. 2020. Application of length-based indicator to assess the state of stocks of undulate ray (*Raja unduata*) in ICES divisions 7de and 8ab. Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF 2020) 10 pp.

Baulier L., Morandeau F., Morfin M., Ramonet M., Sourget Q., Winkler J. 2021. The SURF Project: survivability of discarded cuckoo rays (*Leucoraja naevus*) in French bottom trawl fisheries. https://archimer.ifremer.fr/doc/00724/83573/

Biais G., C. Hennache, É. Stéphan, A. Delamare. 2014. Mark–recapture abundance estimate of undulate ray in the Bay of Biscay. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, Lisbon, 17–26 June, 2014.

Blanco, M. Fernández-Zapico, O. Ruiz-Pico, S., Velasco, F. Rodríguez-Cabello, CPreciado, I. Punzón,A. González-Irusta, J.M. VelascoE., 2022. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf.WGEF_2022_WD_07. Working Document presented toICES WGEF. 14th -23th June 2022Lisbon, Portugal.

Cardador, F., Sanchéz, F., Pereiro, F.J., Borges, M.F., Caramelo, A.M., Azevedo, M., Silva, A., Pérez, N., Martins, M.M., Olaso, I., Pestana, G., Trujillo, V. and Fernandez A. 1997. Groundfish surveys in the Atlantic Iberian waters (ICES Divisions VIIIc and IXa): history and perspectives. ICES CM 1997/Y:8.

Carrier, J.C., Musick, J.A. and Heithaus, M.R. (eds). 2004. *Biology of sharks and their relatives*. CRC Press, Florida, USA.

Castelo, J.A.C. 2021. The Estimated Survival of species of skates after being captured by mixed fisheries using trammel nets in Peniche, Portuguese coast, and kept in captive. Master thesis in Marine Biology and Conservation. Instituto Universitário de Ciências Psicológicas, Sociais e da Vida. 54 p.

Coelho, R. and Erzini, K. 2002. Age and growth of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal). *Journal of the Marine Biological Association of the UK*, 82: 987–990.

Coelho, R. and Erzini, K. 2006. Reproductive aspects of the undulate ray, *Raja undulata*, from the south coast of Portugal. *Fisheries Research*, 81:80–85.

Delamare, A., Hennache, C., Stéphan, E. and Biais, G. 2013. Bay of Biscay undulate ray (*Raja undulata*) abundance assessment by mark-recapture method. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Diez, G., Mugerza, E. Iriondo, A., and Santurtun, M. 2014. Characterization of the ray catches of the Basque trammelnet fleet in the Bay of Biscay (VIIIc East). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF) Lisbon, 17 to 26 June 2014, 11 pp.

Enever, R., Catchpole, T. L., Ellis, J. R., and Grant, A. 2009. The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research, 97(1-2): 72–76. Doi: https://doi.org/10.1016/j.fishres.2009.01.001

Farias, I. 2005. Estudo da Biologia de *Leucoraja naevus* (Müller and Heule, 1841) e *Raja brachyura* Lafont, 1873, na Costa Portuguesa. Tese de Licenciatura. Faculdade de Ciências da Universidade de Lisboa, Janeiro 2005.

Fernandes, A.C. 2021. Discards of elasmobranch species by the Portuguese bottom otter trawl fisheries in ICES Division 27.9.a. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 15–24 June 2021.

O. Fernández-Zapico, S. Ruiz-Pico, M. Blanco, C. Rodríguez-Cabello, A. Punzón, J.M. González-Irusta, F. Velasco.2023. Results on main elasmobranch species from 2001 to 2022 Porcupine Bank (NE Atlantic) bottom trawl surveys.Working Document presented to the Working Group on Elasmobranch FishesICES WGEF, 20thto 29th June, 2023, Lisbon, Portugal. 38 pp.

Figueiredo, I. and Serra-Pereira, B. 2013. Modelling *Raja clavata* abundance from Portuguese IBTS data (1990–2011) using GLMM with Tweedie distribution. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Figueiredo, I., Maia, C. and Carvalho, L. 2020a. Spatial distribution and abundance of the by-catch coastal elasmobranch *Raja undulata*: Managing a fishery after moratorium. Fisheries Management and Ecology. 00:1–10. Doi: https://doi.org/10.1111/fme.12426

Figueiredo, I., Maia, C., Lagarto, N. and Serra-Pereira, B. 2020b. Bycatch estimation of Rajiformes in multispecies and multigear fisheries. Fisheries Research: 232. https://doi.org/10.1016/j.fishres.2020.105727https://doi.org/10.1016/j.fishres.2020.105727

Froese, R. 2004. Keep it simple: three indicators to deal with overfishing. Fish and Fisheries, 5: 86-91. https://doi.org/10.1111/j.1467-2979.2004.00144.x

Froese, R. and Binohlan, C. 2000. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. Journal of Fish Biology, 56: 758-773. https://doi.org/10.1111/j.1095-8649.2000.tb00870.x

Gadenne, H. 2017. National self-sampling monitoring of Undulate Ray in France. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon 31 May–07 June 2017, 11 pp.

Gallagher, M. J., Nolan, C. P. and Jeal., F. 2005. An investigation of the Irish ray fishery in ICES divisions VIIa and VIIg. J. Northw. Atl. Fish. Sci., Vol. 35: 47-66 35:1–13.

Holden, M.J. 1972. The Growth Rates of *Raja brachyura, R. clavata* and *R. montagui* as Determined from Tagging Data. ICES Journal of Marine Science, Vol. 34(2): 161–168, https://doi.org/10.1093/icesjms/34.2.161

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 558 pp.

ICES. 2012. Report of the Study Group on Nephrops Surveys (SGNEPS). 6–8 March 2012, Acona, Italy, 36 pp.

ICES. 2015. Report of the Fifth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history Traits, Exploitation Characteristics and other Relevant Parameters for Data-limited Stocks (WKLIFE V), 5–9 October 2015, Lisbon, Portugal. ICES CM 2015/ACOM:56. 157 pp.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016 Lisbon, Portugal. ICES CM 2016/ACOM:40

ICES. 2017a. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20-24 February 2017, Nantes, France. ICES CM 2017/ ACOM:38. 119 pp.

ICES. 2017b. Manual of the IBTS North Eastern Atlantic Surveys. Series of ICES Survey Protocols SISP 15. 92 pp

ICES. 2018. Interim report of the Working Group of Nephrops Surveys (WGNEPS). WGNEPS 2017 Report 28 November – 1 December 2017. Heraklion, Greece. ICES CM 2017/SSGIEOM: 19. 78pp.

ICES. 2020. Workshop on incorporating discards into the assessments and advice of elasmobranch stocks (WKSHARK5, outputs from 2019 meeting). ICES Scientific Reports. 2:87. http://doi.org/10.17895/ices.pub.7494.

ICES. 2021a. Workshop on the Inclusion of Discard Survival in Stock Assessments (WKSURVIVE). ICES Scientific Reports. 3:41. 59 pp. https://doi.org/10.17895/ices.pub.8053

ICES. 2021b. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948

ICES (2021c). 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. 2021c. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 3:59. 822 pp. https://doi.org/10.17895/ices.pub.8199

ICES. 2022a. ICES Guidance for completing single-stock advice. ICES Advisory Committee. 63 pp.

ICES. 2022b. Benchmark Workshop for selected elasmobranch stocks (WKELASMO). ICES Scientific Reports. 4:47. 136 pp. http://doi.org/10.17895/ices.pub.21025021

ICES. 2023a. 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

ICES. 2023b. Benchmark workshop 2 on development of MSY advice using SPiCT (WKBMSY SPiCT2). ICES Scientific Reports. 5:65. 472 pp. https://doi.org/10.17895/ices.pub.23372990

ICES, 2024a. Benchmark Workshop 3 on Selected Elasmobranch Stocks (WKBELASMO3). ICES Scientific Reports. 06:74. 321 pp. https://doi.org/10.17895/ices.pub.26935492

ICES. 2024b. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 2. ICES Guidelines and Policies - Advice Technical Guidelines. 30 pp. https://doi.org/10.17895/ices.pub.26056306

Iglésias, S. P., Toulhoat, L., and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 20(3), 319–333.

JORF, 2017. Arrêté du 21 mars 2017 modifiant l'arrêté du 28 janvier 2013 déterminant la taille ou le poids minimal de capture et de débarquement des poissons et autres organismes marins pour la pêche professionnelle. Journal Officiel De La République Française ,26/03/2017.

Kéry, M., J. A. Royle, and Schmid, H. 2005. Modeling avian abundance from replicated counts using binomial mixture models. Ecological Applications 15:1450-1461.

Last, P., White, W., Carvalho, M.R. de, Séret, B., Stehmann, M. and Naylor, G.J.P. 2016. Rays of the World. Victoria: CSIRO Publishing, 800 pp.Maia, C., Erzini, K., Serra-Pereira, B. and Figueiredo, I. 2012. Reproductive biology of cuckoo ray *Leucoraja naevus*. *Journal of Fish Biology*, 81: 1285–1296.

Lorance, P. 2022. Stock distribution of Thornback ray (*Raja clavata*) in Subarea 8, Bay of Biscay. Working Document to WKELASMO 2022.

Maia, C., Erzini, K., Serra-Pereira, B., and Figueiredo, I. 2012. Reproductive biology of cuckoo ray *Leucoraja naevus*. Journal of Fish Biology, 81(4), 1285-1296.

Maia, C., Figueiredo, I and Serra-Pereira, B. 2015. UNDULATA Project - *Raja undulata* estimation of historical landings in Portugal mainland (ICES Division IXa). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–23th June, 2015.

Maia, C., Serra-Pereira, B., Lagarto, N., Moura, T. and Figueiredo, I. 2022a. Blonde ray *Raja brachyura* reproductive biology in Portuguese waters. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 14–23rd June.

Maia, C., Moura, T., Rodriguez-Cacello, C., Serra-Pereira, B. and Figueiredo, I. 2022b. Summary of the information available for the assessment of *Raja clavata* in Portuguese mainland waters. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 14–23rd June.

Maia, C., Moura, T., Rodriguez-Cabello, C., Serra-Pereira, B. and Figueiredo, I. 2022c. Summary of the information available for the assessment of *Raja brachyura* in Portuguese mainland waters. Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 14–23rd June.

Maia, C., Moura, T., Serra-Pereira, B. and Figueiredo, I (2023a). Reconstruction of Portuguese Historical landings for the period 2000-2007. Working document presented at ICES WKELASMO3, data compilation online meeting, 20th to 24th November.

Maia, C., Moura, T., Serra-Pereira, B. and Figueiredo, I (2023b). LPUE standardization of Blonde ray *Raja brachyura* caught in the polyvalent fleet in Portuguese waters (Division 9a) for the period 2008-2022. Working document presented at ICES WKELASMO3, data compilation online meeting, 20th to 24th November.

Maia, C., Serra-Pereira, B., Lagarto, N. and Figueiredo, I. 2024a. Conventional Tagging of *Raja undulata* in Portuguese continental waters (Division 27.9a) and additional information on survivability to trammel net fisheries. Working document presented at ICES WKTAG 2024, 29-31 january.

Maia, C. and Figueiredo, I. 2024b. Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal and Gulf of Cadiz) (rju.27.9a) – update. Working Document presented at ICES WGEF 2024 Lisbon, 18-27 June.

Mayot, S., Barreau, T. 2021. Monitoring protocol for chondrichtyans landed in French auctions. 18pp. https://drive.google.com/file/d/1XS0Lidh1043RZbwlLj661tka8s8QG-_w/viewMildenberger, T. K., Kokkalis, A., and Berg, C. W. 2020. Guidelines for the stochastic production model in continuous time (SPiCT).

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56: 473–488.

Morfin, M., Simon, J., Morandeau, F., Baulier, L., Méhault, S. and Kopp, D. 2019. Using acoustic telemetry to estimate post-release survival of undulate ray *Raja undulata* (*Rajidae*) in northeast Altantic. *Ocean and Coastal Management*, 178: 104848.

Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Neves, A., Borges, M.F. and Gordo, L.S. 2008. Ontogenetic dietary shift and feeding strategy of *Raja undulata* Lacepède, 1802 (Chondrichthyes: Rajidae) on the Portuguese continental shelf. *Scientia Marina*, 72: 311–318.

Oliver, M., McHugh, M., Murphy, S., Minto, C., Browne, D. and Cosgrove, R. 2021. An assessment of cuckoo ray (*Leucoraja naevus*) survivability in an Irish otter trawl fishery. BIM Fisheries Conservation Report, 16 pp.

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8, 325 pp.

Pedersen, M.W., Berg, C.W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226-243.

Pina-Rodrigues, M. T. 2012. Age, growth and maturity of two skate species (*Raja brachyura* and *Raja montagui*) from the continental Portuguese coast (Doctoral dissertation, Master thesis, Gent University).

Rodríguez-Cabello, C. and Sánchez, F., 2022. Issues related with stock identity of *Raja clavata* (rjc.27.8). Working Document presented to the ICES Benchmark Workshop (WKELASMO 2022). On line meeting, February 2022

Rodríguez-Cabello, C. and Velasco, F., 2022. Exploratory assessment of *Raja clavata*stock in ICES Division 8c(rjc.27.8c) using LBI and the rfb rule. WGEF_2022_WD_14. Working Document presented toICES WGEF. 14th -23th June 2022Lisbon.Portugal.

Rodríguez-Cabello, C., Maia, C., Sobrino, I., Moura, T., Serra-Pereira, B. and Figueiredo, I., 2022. Exploratory assessment of*Leucoraja naevus*stock in ICES Division 9a(rjn.27.9a) using a SPiCT model and application of the rfb rule. WGEF_2022_WD_15. Working Document presented to the ICESWGEF 2022. 14 th – 23 rd June 2022Lisbon. Portugal.

Ruiz-Pico, S., Fernández-Zapico, O. Blanco M., Rodríguez-Cabello, C. Ortiz, P., González-Irusta, JM. Punzón, F. Velasco A. 2024. Results on main elasmobranch species caught in the 2023 Northern Spanish Shelf Ground. Working Document presented to the Working Group on Elasmobranch Fishes Survey. ICES WGEF 18th-27th June 2024, Lisbon, Portugal, 47 pp.

Ryland, J.S. and Ajayi, T.O. 1984. Growth and population dynamics of three Raja species (Batoidei) in Carmarthen Bay, British Isles. J. du Conseil International pour l'Exploration de la Mer 41:111–120

Sánchez, F. 1993. Las comunidades de peces de la plataforma del Cantábrico. *Publ. Espec. Inst. Esp. Oceanogr.* 13: 137 pp.

Sánchez, F., Blanco, M. and Gancedo, R. 2002. Atlas de los peces demersales y de los invertebrados de interés comercial de Galicia y el Cantábrico. Otoño 1997–1999. Instituto Español de Oceanografia, MYC Ed.CYAN. Madrid, 158 pp.

Serra-Pereira B. 2005. Aspectos da Biologia de *Raja clavata* Linnaeus, 1758 e *Raja montagui* Fowler, 1910, na Costa Portuguesa. Tese de Licenciatura. Faculdade de Ciências da Universidade de Lisboa, Janeiro 2005.

Serra-Pereira, B., Figueiredo, I., Farias, I., Moura, T., and Gordo, L. S. 2008. Description of dermal denticles from the caudal region of *Raja clavata* and their use for the estimation of age and growth. – ICES Journal of Marine Science, 65: 1701–1709.Serra-Pereira, B., Farias I., Moura, L. S., Gordo, L. S., Santos, M. and Figueiredo, I. 2010. Morphometric ratios of six commercially landed species of skate from the Portuguese continental shelf, and their utility for identification. *ICES Journal of Marine Science*, 67(8): 1596–1603.

Serra-Pereira, B., Figueiredo, I. and Gordo, L. 2011. Maturation, fecundity, and spawning strategy of the thornback ray, *Raja clavata*: do reproductive characteristics vary regionally? *Marine Biology*, 158: 2187–2197.

Serra-Pereira, B., Erzini, K., Maia, C. and Figueiredo, I. 2014. Identification of potential Essential Fish Habitats for skates based on fisher's knowledge. *Environmental Management*, 53: 985–998.

Serra-Pereira, B., Erzini, K. and Figueiredo, I. 2015. Using biological variables and reproductive strategy of the undulate ray *Raja undulata* to evaluate productivity and susceptibility to exploitation. J Fish Biol 86:1471–1490. https://doi.org/10.1111/jfb.12653

Serra-Pereira, B., Moura T., Maia C., Fernandes A.C and Figueiredo, I. 2017. Portuguese discards sampling programme and compilation of the main outputs on elasmobranch discards. Working Document for ICES Workshop to compile and refine catch and landings of elasmobranchs (WKSHARKS3). Nantes, 20-24 February 2017.

Serra-Pereira, B., Maia, C, Moura, T and Figueiredo, I. 2020. Using LPUE from the Portuguese commercial fleet as an additional source of data for the assessment of Atlantic Iberian stocks (Division 9a). Working Document presented to WKSKATE 2020, 23- 27 November – Remote.

Serra-Pereira, B. and Figueiredo, I. 2019. Scientific evidences on discard survival of skates and rays (Rajidae) in Portuguese mainland waters (ICES division 27.9.a). Working Document to the Working Group on Elasmobranch Fishes (WGEF) meeting, 18-27th June 2019. 23 pp.

Stéphan E., Hennache C., Delamare A., Leblanc N., Legrand V., Morel G., Meheust E., Jung JL. 2014. Length at maturity, conversion factors, movement patterns and population genetic structure of undulate ray (Raja undulata) along the French Atlantic and English Channel coasts: preliminary results. Working Document presented at the Workin Group on Elasmobranch Fishes (WGEF) meeting, 17th-26th June 2014.

Trenkel, V., Lorance, P. 2022. Production model including CKMR abundance estimate for thornback ray in the Bay of Biscay (divisions 8.abd). Working document to WKELASMO, March 2022.

Trenkel, V. M., G. Charrier, P. Lorance, and M. V. Bravington. 2022. Close-kin mark-recapture abundance estimation: practical insights and lessons learned. ICES Journal of Marine Science 79:413-422.

Valeiras, J. and B. Álvarez-Blazquez, 2018. Technical Report of Study on survivability of rays and skates in fisheries at north Spanish fishing ground ICES 8c and 9a. 23 pp.

Valeiras, J., Velasco, E., Barreiro, M., Álvarez-Blázquez, B. 2019. Technical Report of a Study on survivability of cuckoo ray (*Leucoraja naevus*) in trawl fisheries at Iberian waters ICES 9a. Informe Técnico del Instituto Español de Oceanografía (IEO), annex from the Joint Recommendation of the South Western Waters High-Level Group Revision of Discard Plan for Demersal Fisheries in the South Western Waters for 2020-2021), Annex B2. May 2019. 15 pp.

19.13 Tables and Figures

Table 19.1a. Skates in the Bay of Biscay and Iberian Waters. ICES estimates of landings (tonnes) of Rajidae in divisions 8.a-b (the figures in the table are rounded to the nearest tonne. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table).

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	12	15	9	9	12	4	9	4	6	8	5	4	3	1	2	2	1	0	0
France	2405	2405	1960	1884	1799	1693	1461	1294	1202	1179	1349	1541	1220	1322	1463	1458	1271	1481	1226
Ireland											35	28							
Nether-lands					0														
Norway		15	4																
Spain	423	334	408	428	295	190	247	235	242	243	212	262	210	256	213	170	133	296	298
UK	10	40	7	4	0	0	1	2	0		19	0	0	0					
Total	**2850**	**2364**	**2312**	**2239**	**2000**	**1656**	**1551**	**1443**	**1427**	**1601**	**1811**	**1514**	**1534**	**1720**	**1673**	**1443**	**1615**	**1523**	**1452**

Table 19.1b. Skates in the Bay of Biscay and Iberian Waters. ICES estimates of landings (tonnes) of Rajidae in Division 8.d.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	112	63	71	94	72	68	72	76	57	66	61	45	32	46	47	58	35	34	33
Ireland				0				0			0								
Spain	16	12	17	9	0	1	4	2	8	6	6		0	1	0	2	0	3	3
UK	0	3	1	0	0	0	1	0	0	0									
Total	**128**	**77**	**89**	**104**	**72**	**69**	**76**	**78**	**66**	**73**	**67**	**45**	**32**	**48**	**47**	**60**	**36**	**38**	**36**

Table 19.1c. Skates in the Bay of Biscay and Iberian Waters. ICES estimates of landings (tonnes) of Rajidae in Division 8.c.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	1	0	1	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0
Spain	177	194	420	434	533	551	663	654	608	528	364	407	377	541	525	450	408	626	757
Total	**178**	**194**	**421**	**434**	**533**	**552**	**663**	**655**	**609**	**530**	**364**	**408**	**377**	**542**	**525**	**450**	**408**	**626**	**757**

Table 19.1d. Skates in the Bay of Biscay and Iberian Waters. ICES estimates of landings (tonnes) of Rajidae in Division 9.a.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France					1						0								0
Ireland					0														
Portugal	1357	1369	1267	1648	1451	1461	1435	1130	1116	1033	1021	1036	1150	1111	1136	1230	1354	1311	1427
Spain	615	624	467	484	553	409	429	468	481	455	253	304	348	381	436	430	353	473	609
Total	**1972**	**1993**	**1734**	**2131**	**2004**	**1870**	**1864**	**1598**	**1598**	**1488**	**1275**	**1340**	**1498**	**1491**	**1571**	**1659**	**1707**	**1784**	**2037**

Table 19.1e. Skates in the Bay of Biscay and Iberian Waters. Combined Landings (tonnes) of Rajidae in Biscay and Iberian Waters.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	12	15	9	9	12	4	9	4	6	8	5	4	3	1	2	2	1	0	0
France	2517	2023	1955	1893	1766	1529	1367	1279	1236	1418	1602	1264	1354	1510	1505	1329	1516	1261	1187
Ireland				0	0			0			35	28							
Netherlands					0														
Norway		15	4																
Portugal	1357	1369	1267	1648	1451	1461	1435	1130	1116	1033	1021	1036	1150	1111	1136	1230	1354	1311	1427
Spain	1232	1164	1313	1354	1380	1152	1342	1359	1340	1233	835	973	935	1179	1173	1052	894	1399	1668
UK	10	43	8	4	1	0	1	2	0	0	19	0	0	0					
Total	**5129**	**4629**	**4556**	**4908**	**4610**	**4147**	**4154**	**3774**	**3699**	**3692**	**3517**	**3306**	**3442**	**3801**	**3816**	**3613**	**3765**	**3971**	**4283**

Table 19.1f. Skates in the Bay of Biscay and Iberian Waters. Landings (tonnes) by ICES stock unit and country since 2005. Totals by stock are presented in bold (the figures in the table are rounded to the nearest tonne. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table). The stock rjn.27.678abd includes landings in 6 and 7 Divisions.

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
raj.27.89a	Belgium	12	15	9	1	2	1	2	0	1	0	1	0	0	0	0	0			
	France	783	662	610	613	391	244	175	151	179	238	202	181	243	255	280	257	360	411	361
	Ireland				0	0						4	5							
	Netherlands					0														
	Portugal	94	90	80	307	308	293	276	240	144	132	113	99	116	135	123	120	148	130	212
	Spain	1115	1037	1191	1219	880	627	840	762	616	461	299	367	396	422	433	346	286	224	253
	UK	10	43	8	2	0	0		0	0		1								
	Total	**2014**	**1846**	**1899**	**2143**	**1582**	**1166**	**1293**	**1153**	**940**	**831**	**620**	**653**	**755**	**813**	**836**	**723**	**794**	**766**	**826**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rja.27.nea	France	1		2	1	59	11	29	12	15	11	7	4	4	7					
	Ireland										0	0	0		0	0				0
	Portugal	5	6																	
	UK				1	0	0		0	0	0			0			0	0	1	0
	Total	**6**	**6**	**2**	**2**	**59**	**11**	**29**	**12**	**15**	**12**	**7**	**4**	**4**	**7**	**0**	**0**	**0**	**1**	**1**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjb.27.89a	France	11	5	3	5	0	0	0	0	0	0	0	0		0				0	0
	Ireland											13	15							
	Portugal	0		0	1															
	UK										0									
	Total	**11**	**5**	**4**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**15**		**0**				**0**	**0**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.8abd	Belgium				2	2	1	2	2	3	3	1	2	1	1	1	1	1	0	0
	France	276	300	215	187	195	217	177	179	194	202	211	166	191	229	223	226	262	261	269
	Ireland								0			4	7							
	Spain				0	42	28	37	45	47	36	33	37	40	44	42	38	42	84	94
	UK							1	2			17	0	0	0					
	Total	**276**	**300**	**215**	**190**	**239**	**246**	**217**	**227**	**244**	**241**	**266**	**211**	**232**	**273**	**266**	**266**	**305**	**345**	**364**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.8c	France	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Spain		0	0	4	94	186	206	223	238	248	150	161	136	256	247	257	233	448	540
	Total	**0**	**0**	**0**	**4**	**94**	**186**	**207**	**224**	**238**	**248**	**150**	**161**	**136**	**256**	**247**	**257**	**233**	**448**	**541**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.9a	Portugal	571	547	571	745	739	611	811	570	643	585	578	559	620	667	616	693	834	780	783
	Spain	107	116	112	119	123	115	139	194	166	215	120	123	124	152	181	178	174	339	454
	Total	**678**	**663**	**683**	**864**	**862**	**725**	**950**	**764**	**809**	**800**	**697**	**682**	**744**	**819**	**797**	**871**	**1008**	**1119**	**1237**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjh.27.9a	Belgium													0						
	Portugal	259	205	185	193	163	221	161	165	179	174	236	221	235	183	259	316	217	276	372
	Spain	1	1	1	1	2	2	1	0	3	0	0	1	0	4	8	12	11	13	14
	Total	**261**	**206**	**186**	**194**	**165**	**223**	**162**	**165**	**182**	**174**	**236**	**222**	**236**	**187**	**267**	**328**	**228**	**289**	**387**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjm.27.8	Belgium				**0**	**0**	**0**	**0**	**0**					**0**	**0**			**0**	**0**	**0**
	France	155	130	124	106	64	86	91	86	109	121	149	132	153	172	222	188	184	72	73

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjn.27.8c	France	0	0		0	0	0	0	0	0	2	0	0	0	0		0	0		
	Spain					18	34	24	26	33	27	15	13	15	23	13	9	7	16	17
	Total	**0**	**0**		**0**	**18**	**34**	**24**	**27**	**33**	**29**	**16**	**13**	**15**	**23**	**13**	**9**	**7**	**16**	**17**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjn.27.9a	Portugal	49	49	50	50	50	55	56	39	27	34	20	57	39	23	30	18	19	30	10
	Spain	6	6	6	6	8	4	12	13	2	0	0	1	2	2	8	4	1	6	21
	Total	**55**	**55**	**56**	**56**	**58**	**59**	**68**	**53**	**29**	**34**	**20**	**59**	**41**	**25**	**38**	**22**	**20**	**36**	**31**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.8ab	France	1	0		0	3	2	2	3	0	7	11	14	22	17	23	22	22	25	22
	Spain															0	0			
	Total	**1**	**0**	**0**	**0**	**3**	**2**	**2**	**3**	**0**	**7**	**11**	**14**	**22**	**17**	**23**	**22**	**22**	**25**	**22**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.8c	France													0	0			0		
	Spain											5	7	8	9	8	7	8	10	12
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**7**	**8**	**9**	**8**	**7**	**8**	**10**	**12**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.9a	Portugal	100	119	277									23	35	38	24	24	32	33	28
	Spain												8	12	15	13	21	3	19	24
	Total	**100**	**119**	**277**									**31**	**46**	**52**	**37**	**45**	**35**	**52**	**52**

*includes landings in 6 and 7 Divisions

Table 19.2a. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (tonnes) in divisions 8.abde since 2005 (the figures in the table are rounded to the nearest tonne. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table).

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Amblyraja radiata														0					
Dipturus batis																		0	0
Dipturus oxyrinchus	12	10	2	3	1	6	6	0	0	0	0	0	0	0	0	1	0	0	2
Dipturus spp	11	5	3	5	0	0	0	0	0	0	13	15		0					
Leucoraja circularis	84	53	58	69	20	28	16	20	20	25	24	22	0	23	21	28	23	23	20
Leucoraja fullonica	14	8	7	7	45	37	36	30	30	38	47	40	27	31	31	28	31	24	21
Leucoraja naevus	1290	927	1002	987	1310	1102	983	935	959	1057	1214	996	915	1043	923	761	773	658	607
Raja brachyura				0	11	11	18	7	27	67	65	76	144	154	190	164	270	335	270
Raja clavata	276	300	215	190	239	246	217	227	244	241	269	218	232	273	266	266	305	345	364
Raja microocellata	0	0	0	1	3	2	4	13	20	38	21	30	54	33	44	44	41	29	29
Raja montagui	155	130	124	107	65	86	92	86	109	121	162	133	153	172	222	188	184	72	73
Raja undulata	1	0		0	3	2	2	3	0	7	11	14	22	17	23	22	22	25	22
Rajella fyllae									0										
Rajiformes	1135	1008	990	974	373	206	252	199	83	79	65	31	18	22	0	1	2	49	82
Rostroraja alba	1		0	0	3	0	1	1	0	1	3	1	0						
Total	**2979**	**2441**	**2402**	**2343**	**2072**	**1725**	**1627**	**1520**	**1493**	**1673**	**1895**	**1577**	**1566**	**1768**	**1720**	**1504**	**1650**	**1561**	**1489**

Table 19.2b. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings of Rajidae (tonnes) in divisions 8.c since 2005.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dipturus oxyrinchus								0	0	0	3	0							
Dipturus spp	0	0	0	1															
Leucoraja circularis		0		4	1	2	1	1	1	0		0				0	0	0	0
Leucoraja fullonica		0		0	0					0			0			0	0		
Leucoraja naevus	0	0		0	18	34	24	27	33	29	16	13	15	23	13	9	7	16	17
Raja brachyura					0	5	1	0	0	0	1	1	0		2	2	5	9	25
Raja clavata	0	0	0	4	94	186	206	224	238	248	150	161	136	256	247	257	233	448	541
Raja microocellata													0		1	0			
Raja montagui					11	25	22	19	28	40	28	26	27	44	45	42	36	63	79
Raja undulata											5	7	8	9	8	7	8	10	12
Rajiformes	178	194	420	426	409	299	409	385	308	213	162	199	190	210	209	132	119	80	84
Total	**178**	**194**	**421**	**434**	**533**	**552**	**663**	**655**	**609**	**530**	**364**	**408**	**377**	**542**	**525**	**450**	**408**	**626**	**757**

Table 19.2c. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (tonnes) of rajidae in divisions 9.a since 2005.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dipturus oxyrinchus	45	39	38	72	75	20	68	24	64	33	74	26	41	56	38	16	33	14	9
Leucoraja circularis	5	4	4	1	2	11	1	0	0	0	0	2	1	0	5	4	0	1	1
Leucoraja fullonica								0			0				0	0			
Leucoraja naevus	55	55	56	56	58	59	68	53	29	34	20	59	41	25	38	22	20	36	31
Raja brachyura	261	206	186	194	165	223	162	165	182	174	236	222	236	195	267	328	228	289	387
Raja clavata	678	663	683	864	862	725	950	764	809	800	697	682	744	806	797	871	1008	1119	1237
Raja microocellata	40	44	35	19	45	43	29	36	41	45	32	63	68	82	77	90	115	109	191
Raja miraletus	3	3	4	4	2	6	5	5	1	2	0	2	0	0	1			0	0
Raja montagui	204	199	210	148	194	284	124	110	115	103	68	73	99	62	89	68	112	71	37
Raja undulata	172	271	157	202								31	46	52	37	45	35	52	52
Rajiformes	498	497	345	564	594	491	447	432	345	289	139	171	210	207	218	212	156	93	92
Rostroraja alba	7	4	5																
Total	**1967**	**1985**	**1722**	**2124**	**1998**	**1863**	**1853**	**1590**	**1585**	**1481**	**1265**	**1330**	**1487**	**1485**	**1568**	**1656**	**1706**	**1784**	**2036**

Table 19.2d. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (tonnes) of Myliobatiformes, Pristiformes, Rhinopristiformes and Torpediniformes in subareas 8 and 9 since 2005.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dasyatidae					0			0	0							2			
Dasyatis centroura	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0			0
Dasyatis pastinaca	4	3	6	5	3	3	2	2	3	5	6	4							
Dasyatis spp	1	2	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
Gymnura altavela	5	9	12	7	7	7	10	8	12	7	9	10	12	6	4	3	1	0	0
Myliobatidae														43	6	7			
Myliobatis aquila	2	2	1	2	1	1	2	1	1	2	2	2	23	15	11	7	4	4	4
Pteroplatytrygon violacea					0			1											
Rhinobatidae																0			
Rhinobatos spp	0	0	0	0	0		0	0	0	0	0	0		0	0			0	
Torpediniformes	39	49	45	46	39	50	54	39	43	46	43	49	63	50	46	34	34	35	33
Torpedo marmorata	27	24	25	28	25	22	20	20	23	14	18	16				22	22	29	26
Total	**79**	**89**	**89**	**87**	**76**	**84**	**90**	**72**	**83**	**75**	**78**	**81**	**98**	**114**	**67**	**75**	**61**	**69**	**63**

Table 19.3a. Skates in the Bay of Biscay and Iberian. Discards reported to ICES[^1] (tonnes) by ICES stock unit and country. The stock rjn.27.678abd includes discards in 6 and 7 Divisions.

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
raj.27.89a	France												713	882						241
	Portugal					0	0	0	0	0	0	0	0	0	0	0	0			
	Spain															1				13
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**713**	**882**	**0**	**1**	**0**	**0**	**0**	**254**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjb.27.89a	France														19					
	Portugal					0	0	0	0	0	0	0	0	0	0	0	0			
	Spain											3				0				1
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**19**	**0**	**0**	**0**	**0**	**1**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.8abd	Belgium													1			2			
	France												27	24	22	10	50	2	12	7
	Spain											4	30	14	5	5	9	4	3	4
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**58**	**40**	**27**	**15**	**61**	**7**	**14**	**10**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.8c	Spain											73	79	12	28	31	61	33	30	44
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**73**	**79**	**12**	**28**	**31**	**61**	**33**	**30**	**44**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjc.27.9a	Portugal					0	0	0	0	0	0	0	0	0	0	0	0		30	
	Spain											31	43	7	13	21		13	17	23
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**31**	**43**	**7**	**13**	**21**	**0**	**13**	**17**	**23**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjh.27.9a	Portugal					0	0	0	0	0	0	0	0	0	0	0				
	Spain											0	2	0	0	3		1	0	2
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**3**	**0**	**1**	**0**	**2**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjm.27.8	France												71	85	0	63	0	32	7	5
	Spain											1	34	2	5	12		6	0	11
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**104**	**87**	**6**	**75**	**0**	**38**	**7**	**16**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjm.27.9a	Portugal					0	0	0	0	0	0	0	0	0	0	0	0			
	Spain											1	41	12	2	3		2	3	3
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**41**	**12**	**2**	**3**	**0**	**2**	**3**	**3**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjn.27.678abd	Belgium									67	42	22	71	95	34	131	116			
	France	245	282	464	198	868	478	266	348	221	237	752	727	755	667	828	428	25	717	183
	Ireland												896	1363	1364	975	322	849	85	215
	Spain					1661	1799	188	147	289	232	223	233	132	127	241	139	144	133	194
	UK	555	1017	405	186	250	525	193	415	433	499	153	806	414	522	238		655	272	184
	Total	**800**	**1300**	**869**	**384**	**2779**	**2802**	**648**	**911**	**1010**	**1010**	**1150**	**2732**	**2760**	**2713**	**2413**	**1005**	**1673**	**1207**	**777**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjn.27.8c	Spain											11	11	3	5	8		2	6	6
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**11**	**3**	**5**	**8**	**0**	**2**	**6**	**6**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rjn.27.9a	Portugal					0	0	0	0	0	0	0	0	0	0	0				
	Spain											4	41	22	16	7			3	12

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**41**	**22**	**16**	**7**	**0**	**0**	**3**	**12**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.8ab	France												416	230	271	122		368	45	30
	Spain																	1		
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**416**	**230**	**271**	**122**	**0**	**369**	**45**	**30**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.8c	Spain											1		0	0	0				0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Stock	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
rju.27.9a	Portugal					0	0	0	0	0	0	0	0	0	0	0				
	Spain											0	7	14	0	1		4	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**14**	**0**	**1**	**0**	**4**	**0**	**0**

[^1] This table includes estimated discards from fleets (e.g. a DCF levels 6 fleet for one country), for which there was enough (quality controlled) samples for the raising at national level. Unsampled fleets not include

Contents

20 Skates and Rays in the Azores and Mid-Atlantic Ridge

20.1 Ecoregion and stock boundaries

The Mid-Atlantic Ridge (MAR; ICES areas 10.a, b, 12.a.1, c, and 14.b.1) is an extensive and diverse area, which includes several types of ecosystems, including abyssal plains, seamounts, active underwater volcanoes, chemosynthetic ecosystems, and islands coastal areas.

The main species of elasmobranch observed in this ecoregion are deep-water sharks (e.g., *Centrophorus* spp., *Centroscymnus* spp., *Deania* spp., *Etmopterus* spp., *Hexanchus griseus*, *Galeus murinus*, *Somniosus microcephalus*, *Pseudotriakis microdon*, *Scymnodon obscurus*, *Centroscyllium fabricii*; *Dalatias licha,* see sections 3-5 for more information). These species are mostly distributed deeper than 600 m. As a consequence of their low commercial value and EU restrictive management measures, many of these species are discarded (ICES, 2005; 2011). Blue shark *Prionace glauca,* thornback ray *Raja clavata* and tope *Galeorhinus galeus* are the most important commercial elasmobranchs species in the Azores area (see sections 8 and 10 for blue shark and tope respectively).

The present section focuses on the skates taken in Azorean waters. Of these, the most abundant in Subarea 10 is thornback ray *Raja clavata*. Other species observed include the 'common skate complex' (species to be confirmed), *Leucoraja fullonica*, *Rajella bathyphila*, *Raja brachyura, Rostroraja alba* and *Rajella bigelowi* (ICES, 2005; 2014; Santos *et al*., 2020a). All these species are generally discarded if caught in the Azorean commercial fisheries (ICES, 2011). Some of the scarcer skates observed on the MAR include *Bathyraja pallida* and *Bathyraja richardsoni* (ICES, 2005).

Stock boundaries are not known for most of the skate species in this area, neither are the potential movements of species that also occur on the continental shelf of mainland Europe. Genetic studies (Chevolot *et al.,* 2006; Ball *et al*., 2016) and tagging experiments (Santos *et al*., 2021b) support the existence of a self-contained *R. clavata* population in the Azores, i.e., a stock unit, indicating that mixing is limited. Further investigations are necessary to determine potential migrations or interactions of skate populations within this ecoregion and neighbouring areas.

20.2 The fishery

20.2.1 History the fishery

Two broad types of fisheries occur in the Azores and MAR areas. Oceanic fisheries (large midwater and bottom trawlers and longliners) operate in the central region and northern parts of the MAR. Longline and handline fisheries operate inside the Azorean EEZ, where trawling is prohibited. The latter fishery also targets stocks that may extend south of the ICES area, with the southern limit being 36°N.

Fisheries from these areas were described in earlier WGEF reports (ICES, 2005). Landings from the Azorean fleets have been reported to ICES. Landings from the MAR are small and variable, or even absent, and few vessels find the MAR fisheries profitable at present.

Skates are caught in the Azores EEZ by a multispecies demersal fishery, using handlines and bottom longlines, and by the black scabbardfish fishery using drifting bottom longlines (Santos *et al*., 2020a). The most commercially important skate caught and landed from these fisheries is *R. clavata* (Santos *et al*., 2020a).

20.2.2 The fishery in 2023

There are no target fisheries for skates in the Azores, landings are from bycatch. An expansion of the Azorean bottom longline fishery to more offshore seamounts has been observed in the last decade because of intensive fishing of important commercial demersal and deep-water stocks and the introduction of spatial management measures (Santos *et al*., 2019).

Skate landings, mostly composed of *R. clavata,* increased in the Azores since 2009 until 2016. The highest landings were reported in 2014 and 2015, the long-term average is 86 t, and the lowest landing values was recorded in 2019 (42 t). Landings varied between 2020 and 2022 but remained lower than in 2011–2016 (Figure 20.1).

The price of the thornback ray on local market does not seem to vary with quantity landed, suggesting that the domestic consumption can absorb all landings, at levels observed in recent years, with limited export. Although the fishery for this resource has these characteristics, the species is considered one of the twenty-two priority stocks in the Azores (Santos *et al*., 2020b).

Out of Azorean waters, there are no fisheries targeting skates on the MAR (ICES Subareas 10, 12 and 14) with sporadic landings in recent years (Table 20.1–20.3).

20.2.3 ICES advice

ICES advised that when the MSY approach is applied, landings should be no more than 86 tonnes in each of the years 2024 and 2025. ICES cannot quantify the corresponding catches.

20.2.4 Management

There is no EU TAC for skates and rays in the Azores and Mid-Atlantic Ridge. The only EU management measure susceptible to impact fisheries is the list of prohibited species. Amongst prohibited rays and skates only *Dipturus intermedius* may occur in the ecoregion, but is not confirmed, so that the EU management might be considered as having no effect on fisheries.

20.2.4.1 Mid-Atlantic Ridge

NEAFC has adopted management measures for the MAR areas under its regulatory area (https://www.neafc.org/managing_fisheries/measures/current). These include effort limitations, area and gear restrictions.

20.2.4.2 Azores EEZ

In 1998, the Azorean government implemented local management actions to reduce effort on shallow areas around the islands, including a licence threshold based on the requirement of the minimum value of sales and the creation of a box of three miles around the islands, with fishing restrictions by gear (only handlines are permitted) and vessel type.

Under the EU Common Fisheries Policy, a box of 100 miles was created around the Azorean EEZ (ICES Subdivision 10.a.2) where only the Azorean fleets are allowed to line fish for deep-sea species (Regulation EC 1954/2003). During 2009, additional measures were implemented, including area restrictions (temporary closure of the Condor Bank) and gear restrictions by vessel type (licence and gear configuration) (Santos *et al*., 2020a).

In 2014, Portugal introduced a new regulation banning the use of bottom trawling and bottom gillnetting on the high seas in the area covered by Portugal's extended continental shelf under the UN Law of the Sea (Ordinance 114/2014, May 28th). The new regulation expands the EU regulation adopted in 2005 to ban bottom trawling in the Azores and Madeira waters and has the key objective of protecting deep-sea ecosystems (such as cold-water corals and seamounts) from the impact of bottom trawling and gillnetting.

In 2015, a minimum landing size of 52 cm total length for *R. clavata* was implemented in the Azores (Ordinance 74/2015, June 15th) and a regional catch limit has been established since 2020 (Ordinance 92/2019, December 30th). These measures are applied to all individuals or entities, both national and foreign, engaging in fishing activities in the Azorean fishing territory or with the aid of regional vessels.

Regional regulation	Year	ICES Subdivision	TAC	Landings
Ordinance 92/2019, December 30th	2020	10.a.2	100	60
	2021	10.a.2	100	89
Ordinance 135/2021, December 31st	2022	10.a.2	100	77
Ordinance 105/2022, December 28th	2023	10.a.2	100	61
Ordinance 112/2023, December 15th	2024	10.a.2	80	

A timeline with the main management measures adopted in the Azores, including the measures adopted specifically for *R. clavata*, is presented in Figure 20.2.

20.3 Catch data

20.3.1 Landings

Skate landings reported by each country and subarea are given in Tables 20.1–20.3. Landings data from this ecoregion are also collated by NEAFC, and further studies to ensure that these data are consistent with ICES estimates are required.

20.3.2 Discards

Discards of skates collected as part of the European Commission Data Collection Framework (DCF) have no new information available.

Nevertheless, information on discards from observers in the Azorean longline fishery was reported to the WGDEEP from 2004 to 2010 (ICES, 2011). The results showed that *R. clavata* and ‘common skate complex' were among the frequently caught and discarded elasmobranch species. However, it would be important that the discard data collected by DCF in the Azores is available to update this information fourteen years after the last report.

In the past 20 years, management has induced changes in fleet behaviour, expanding the fishing areas to more offshore seamounts and deeper strata, which may have impacted the levels of skates’ bycatch in Azorean fisheries. Fisheries occurring outside the ICES area to the south of the Azores EEZ may exploit the same stocks considered here.

20.3.3 Quality of catch data

Species-specific landings data are not currently available for skates landed in this ecoregion, however, more than 90% of the Azorean landings are estimated to be *R. clavata*.

20.3.4 Discard survival

Information on the discard survival of skates in these fisheries is not currently available.

20.3.5 Species composition

In the Azores, there is no systematic fishery/landing sampling programme for these species because they have low priority on the port sampling programme. Landings of skates and rays from Azorean fisheries are reported under generic categories. Accurate data on the composition of skates landed are not currently available.

20.4 Commercial catch composition

20.4.1 Length composition of landings

Length-frequency data for *R. clavata* from the Azores was available and is shown in Figure 20.3. Length composition showed a stable pattern; however, a small increase of the larger individuals (>60 cm) was observed in the last years. This increase could be a result of the minimum landing size implemented in the region in 2015 (Figure 20.2).

20.4.2 Length composition of discards

No data was made available.

20.4.3 Sex ratio of landings

No data was made available.

20.4.4 Quality of data

Only limited data are available. Improved data collection and quality checks (including for species identification) are required.

20.5 Commercial catch and effort data

Nominal catch-per-unit-effort (CPUE) was estimated for *R. clavata* as kg per day at sea per vessel using the information gathered through DCF inquiries applied in the Azores (Figure 20.4). Details about this dataset can be found in Santos *et al.* (2023).

The period from 2003 to 2022 was selected for this analysis due to limitations in data availability, particularly the smaller sample sizes in the earlier years of the time series. The categories of vessel size (0–10, 10–12, 12–18, 18–24, and 24–40 meters) and geographic location (sampled islands) were selected based on the frequency of DCF inquiries associated with each. Due to the multiplicity of reported métiers, only those representing more than 50% of total catches were included, specifically LLS_DEF (set longlines for demersal fishes) and LHP_FIF (hand lines for pelagic fishes). Standardising these catch rates is, however, necessary to reduce the influence of potential drivers (e.g., targeted species, vessel size, métier), and to obtain relative abundance indices.

20.6 Fishery-independent surveys

Demersal bottom longline surveys (ARQDAÇO–L6563) have been conducted every spring around the Azores EEZ since 1995, although surveys were not carried out in 1998, 2006, 2009, 2014, 2015, 2020 and 2022 (Pinho *et al.*, 2020). This survey utilizes a stratified random sampling method, dividing each sampling zone into depth strata at 50 m intervals up to a depth of 1200 m. Longlines are set perpendicular to the isobaths. Catch rates are adjusted for area size to calculate relative biomass indices, expressed in kilograms per 1000 hooks (Pinho et al., 2020). In 2021, the survey's spatial extent was reduced to 50% of the usual sampling area, specifically including only statistical areas I and II. Although areas III and IV were not included, the abundance trends for areas I and II were consistent with those derived from areas I to IV (Figure 20.5)

Raja clavata is the only skate species commonly caught in this survey (Pinho *et al.*, 2020). Only *Dipturus intermedius* and *Leucoraja fullonica* were caught in more than three longline sets during 1996–2018 and their abundance was 20 to 100 times less than that of *R clavata*.

Length data from the ARQDAÇO (L6563) were updated and are shown in Figure 20.6. The absence of records of the smallest individuals in this survey can be attributed to the gear selectivity. Catches of other skates are insufficient to be informative of stocks trends.

Information on elasmobranchs recorded on the MAR is available from the literature (Hareide and Garnes, 2001) and was summarized in ICES (2005).

20.7 Life-history information

Recently the main life-history parameters of *R. clavata* in the Azores have been estimated by Santos *et al*. (2021b) and showed in Table 20.5. However, the biological knowledge about this species in this ecoregion is still poor and the available information presents some uncertainties.

20.8 Exploratory assessment methods

Length-based indicators reported from WKLIFE-V were explored and for this exercise Azorean commercial fishery length compositions for pooled sexes from 2020–2023 were used (discards are not available). Main life-history parameters used are shown in Table 20.5. Computations were performed using R software and the codes were available in the GitHub library of ICES.

Results from the analysis are shown in Figure 20.7 and Table 20.6. Results show that for immature conservation a substantial harvesting occurs before maturity (L_c and $L_{25\%}<L_{mat}$). This was expected since the current relative exploitation pattern corresponds to a $L_{50\%}\leq L_{mat}$.

For the mature fraction of the population, the results suggest that the large individuals are decreasing ($L_{max5\%}\leq L_{inf}$). The L_{mat} (77.59 cm) is higher than L_{opt} (73 cm) and the results of P_{mega} indicator clearly suggest that the mega spawners in the Azorean commercial fishery are lower than 30% throughout the analysed period. The MSY proxy results show that exploitation is above or close to the MSY level ($L_{mean}<L_{opt}$ and $L_{mean}<L_{F=M}$; Table 20.5 and Figure 20.7).

20.9 Quality of assessments

Analyses of survey trends may be informative for *R. clavata* but do not allow to infer the status of other skates.

20.10 Reference points

No reference points have been proposed for any of these species.

20.11 Conservation consideration

No new information.

20.12 Management considerations

The ecoregion is considered to be a sensitive area. The exploratory analysis demonstrated a sustainable exploitation for these species, but the fishing gear selectivity should be adjusted (increase the size of the hooks).

20.13 References

Ball, R.E., Serra-Pereira, B., Ellis, J., Genner, M.J., Iglésias, S., Johnson, A.F., Jones, C.S., Leslie, R., Lewis, J., Mariani, S., Menezes, G. 2016. Resolving taxonomic uncertainty in vulnerable elasmobranchs: are the

Madeira skate (*Raja maderensis*) and the thornback ray (*Raja clavata*) distinct species? Conservation Genetics, 2016: 1-12.

Chevolot, M., Hoarau, G., Rijnsdorp, A. D., Stam, W. T., Olsen, J. L. 2006. Phylogeography and population structure of thornback rays (*Raja clavata L*., Rajidae). Molecular Ecology, 15: 3693–3705.

Hareide, N. R., Garnes, G. 2001. The distribution and catch rates of deep water fish along the Mid-Atlantic Ridge from 43 to 61 N. Fisheries Research, 519: 297–310.

ICES. 2005. Report of the Study Group on Elasmobranch Fishes. ICES CM 2006/ACFM:03; 224 pp.

ICES. 2006. Report of the Working Group on Elasmobranch Fishes (WGEF). 14–21 June 2006, ICES Headquarters. ICES CM 2006/ACFM:31; 291 pp.

ICES. 2011. Report of the Working Group on Elasmobranch Fishes (WGEF), 20–24 June 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:19. 492 pp

ICES. 2014. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–26 June 2014, Lisbon, Portugal. ICES CM 2014/ACOM:19. 887 pp.

ICES. 2020. Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP). ICES Scientific Reports. 2:38. 928pp. http://doi.org/10.17895/ices.pub.6015

Medeiros-Leal, W.M, Santos, R., Pinho, M. 2022. Updating Survey data from the Azores for deep-water species. Working Document 09 (WD09). ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 28 April to 04 May 2022.

Pinho, M., Medeiros-Leal, W., Sigler, M., Santos, R., Novoa-Pabon, A., Menezes, G., Silva, H. (2020). Azorean demersal longline sur-vey abundance estimates: Procedures and Variability. Regional Studies in Marine Science, 39: 101443. https://doi.org/10.1016/j.rsma.2020.101443

Santos, R. V. S., Silva, W. M., Novoa-Pabon, A. M., Silva, H. M., Pinho, M. R. 2019. Long-term changes in the diversity, abundance and size composition of deep-sea demersal teleosts from the Azores assessed through surveys and commercial landings. *Aquatic Living Resources*, *32*: 25. doi: 10.1051/alr/2019022

Santos, R., Crespo, O., Medeiros-Leal, W., Novoa-Pabon, A., Pinho, M. 2021a. Error Distribution Model to Standardize LPUE, CPUE and Survey-Derived Catch Rates of Target and Non-Target Species. Modelling, 3(1): 1-13. https://doi.org/10.3390/modelling3010001

Santos, R., Medeiros-Leal, W., Novoa-Pabon, A., Crespo, O., Pinho, M. 2021b. Biological Knowledge of Thornback Ray (*Raja clavata*) from the Azores: Improving Scientific Information for the Effectiveness of Species-Specific Management Measures. *Biology*, *10*: 676. https://doi.org/10.3390/biology10070676

Santos, R., Medeiros-Leal, W., Pinho, M. 2020b. Stock assessment prioritization in the Azores: procedures, current challenges and recommendations. Arquipelago. Life and Marine Sciences 37: 45 - 64.

Santos, R., Medeiros–Leal, W., Pinho, M. 2023. Trends in abundance indices derived from commercial fisheries for priority marine stocks in the Azores. *Journal of Fish Biology*, 103(4): 815–827. https://doi.org/10.1111/jfb.15325

Santos, R., Novoa-Pabon, A., Silva, H., Pinho, M. 2020a. Elasmobranch species richness, fisheries, abundance and size composition in the Azores archipelago (NE Atlantic), *Marine Biology Research*, 16:2: 103-116. doi: 10.1080/17451000.2020.1718713

20.14 Tables and Figures

Table 20.1. Landings (t) of skates and rays from ICES Subarea 10 for the period 2005–2023.

Year	France	Portugal (Azores)	Total
2005	0.06	47	47
2006		62	62
2007		71	71
2008	0.063	72	72
2009	0.16	60	60
2010	0.066	68	68
2011	0.156	90	91
2012	0.002	103	103
2013	0.081	115	115
2014	0.03	180	181
2015		171	171
2016		127	127
2017		70	70
2018		61	61
2019		42	42
2020		60	60
2021		89	89
2022	0.0048	77	77
2023		61	61

Table 20.2. Landings (t) of skates and rays from ICES Subarea 12 for the period 2005–2023.

Year	France	Ireland	Spain	France	Total
2005	0.63				0.63
2006	0.029				0.029
2007	0.0135				0.0135
2008	0.0031				0.0031
2009	0.76		1.51		2.3
2010	0.28		5.1		5.4
2011	0.36		1.76		2.1
2012	0.26		0.67		0.93
2013			0.48		0.48
2014	0.189		2.5		2.7
2015	0.055				0.055
2016					
2017					
2018		0.21			0.21
2019					
2020	0.189				0.189
2021	0.078				0.078
2022					
2023					

Table 20.3. Landings (t) of skates and rays from ICES Subarea 14 for the period 2005–2023.

Year	Germany	Total
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
2017	0.011	0.011
2018		
2019		
2020		
2021		
2022		
2023		

Table 20.4. Relative abundance index (in kg per 10^3 hooks) of thornback ray *Raja clavata* from the ARQDAÇO (L6563) survey (1995–2023) for statistical areas I and II in the Azores (ICES Subdivision 10a2).

Year	Abundance index	Lower	Upper
1995	11.74	2.11	20.97
1996	10.25	4.37	16.25
1997	13.42	7.90	19.07
1998*			
1999	11.42	7.12	16.04
2000	5.80	1.64	10.27
2001	6.50	2.42	10.72
2002	13.47	6.35	20.67
2003	6.95	3.55	10.49
2004	12.41	7.10	18.25
2005	30.12	6.88	45.21
2006*			
2007	16.56	5.19	29.18
2008	18.41	9.39	27.37
2009*			
2010	10.42	6.64	14.15
2011	6.67	3.01	11.19
2012	10.27	5.34	15.30
2013	3.93	2.27	5.70
2014*			
2015*			
2016	7.57	4.36	10.89
2017	14.48	5.06	24.93
2018	4.10	2.41	6.13
2019	14.18	7.15	20.16
2020*			
2021	14.30	7.63	19.56
2022*			
2023	25.35	11.55	39.45

*** Survey not conducted.**

Table 20.5. Life-history parameters estimated for thornback ray *Raja clavata* in the Azores (ICES Area 10.a.2).

Parameters	Value	Definition	Obs
L∞ (cm)	110.5	Asymptotic average maximum length	Linf=Lmax/0.95
k (year^{-1})	0.117	Growth coefficient of the von Bertalanffy growth model	Serra-Pereira *et al.* (2008)
Lmat (LT, cm)	77.9	Length at first maturity	Santos *et al*. (2021b)
M	0.16	Natural mortality	Santos *et al.* (2021b)
M/k	1.55	Ratio of natural mortality and the von Bertalanffy growth coefficient	Santos *et al.* (2021b)

Table 20.6. Traffic light indicators for thornback ray *Raja clavata* from the Azorean commercial landings.

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\ 5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2021	0.80	0.8	0.72	0.01	0.93	0.92
2022	0.80	0.8	0.75	0.03	0.93	0.92
2023	0.74	0.8	0.74	0.04	0.93	0.95

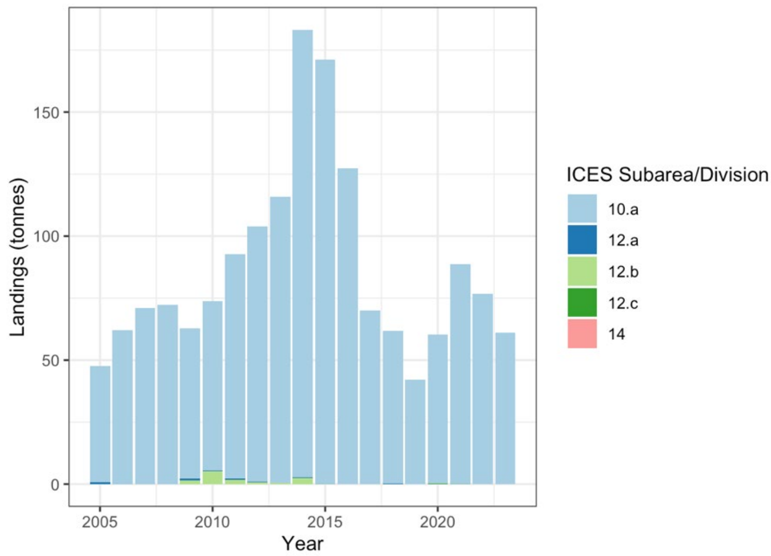


Figure 20.1. Stacked barchart of historical landings (tonnes) of skates and rays by ICES subarea/division.

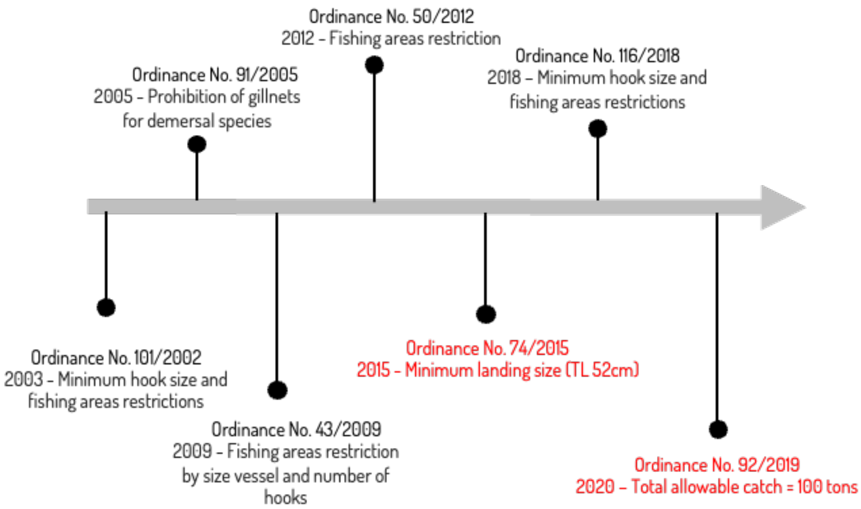


Figure 20.2. Timeline with the main management measures adopted in the Azores to regulate the demersal fishery. In red colour, the measures adopted specifically for thornback ray *Raja clavata*.

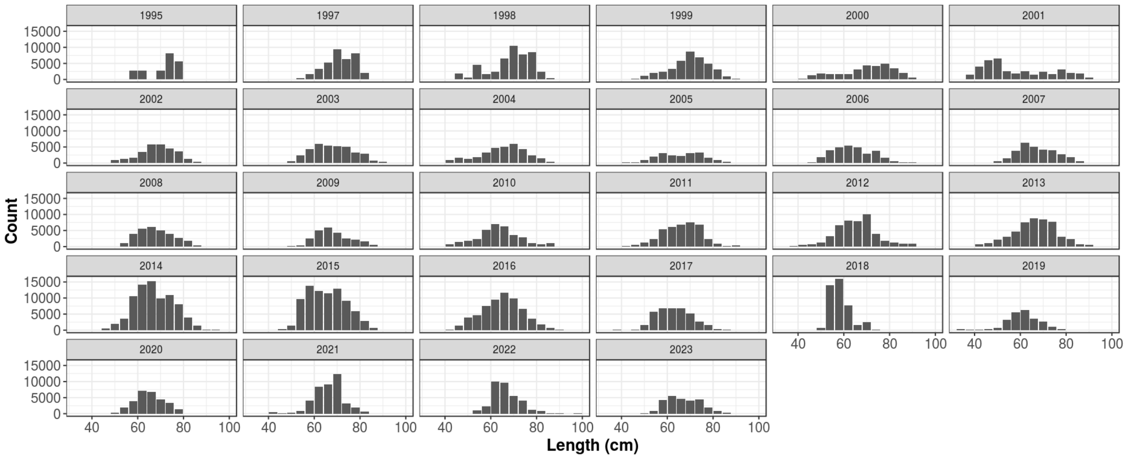


Figure 20.3. Length composition (4-cm class interval) of thornback ray *Raja clavata* from the commercial fishery landings (1995–2023) in the Azores (ICES Subdivision 10a2).

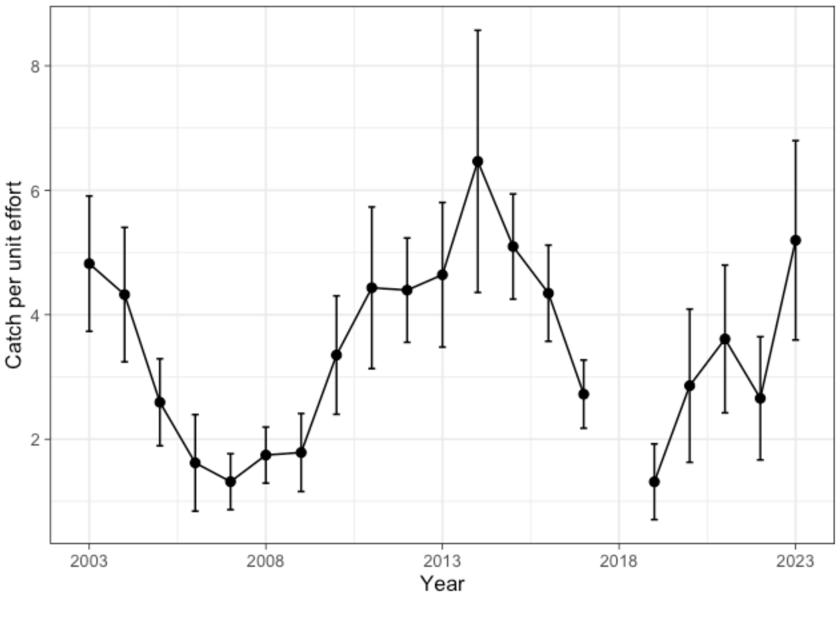


Figure 20.4. Nominal catch per unit effort (in kg per days at sea) of thornback ray *Raja clavata* obtained from DCF inquiries (2003–2023) in the Azores (ICES Subdivision 10a2).

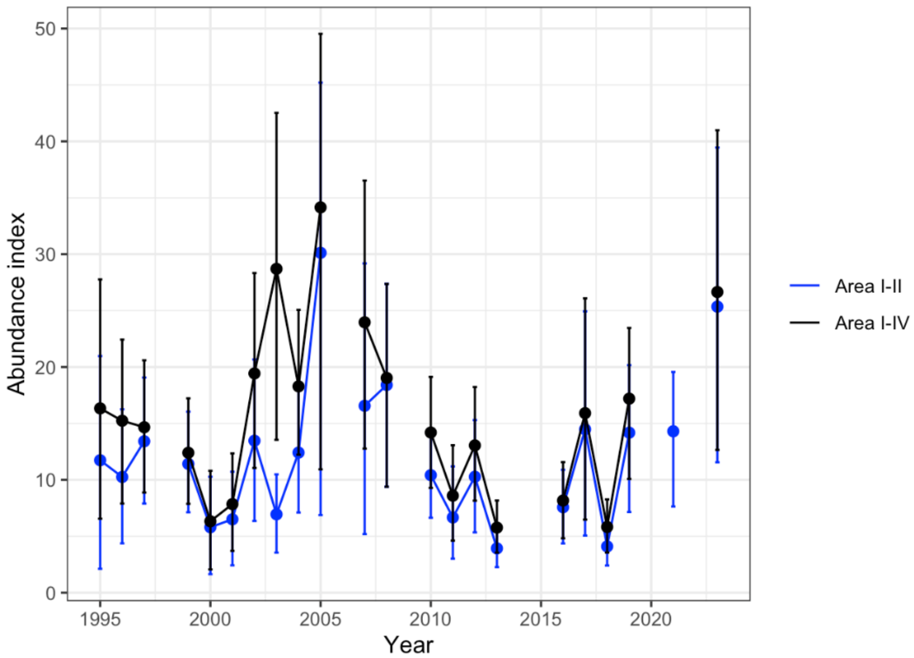


Figure 20.5. Relative abundance index (in kg per 10^3 hooks) of thornback ray *Raja clavata* from the ARQDAÇO (L6563) survey (1995–2023) by statistical areas in the Azores (ICES Subdivision 10a2).

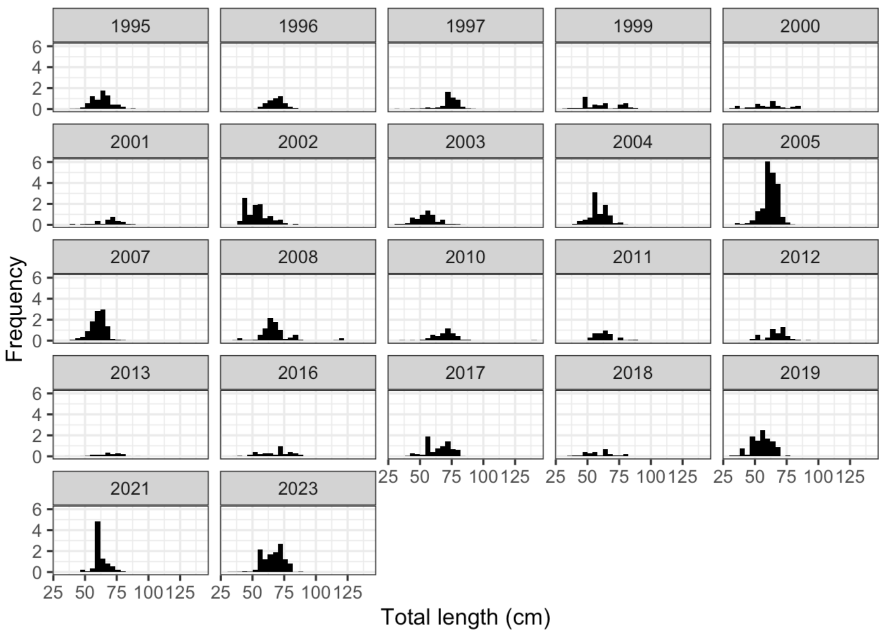


Figure 20.6. Length composition (4-cm class interval) of thornback ray *Raja clavata* from the ARQDAÇO (L6563) survey (1995–2023) for statistical areas I and II in the Azores (ICES Subdivision 10a2).

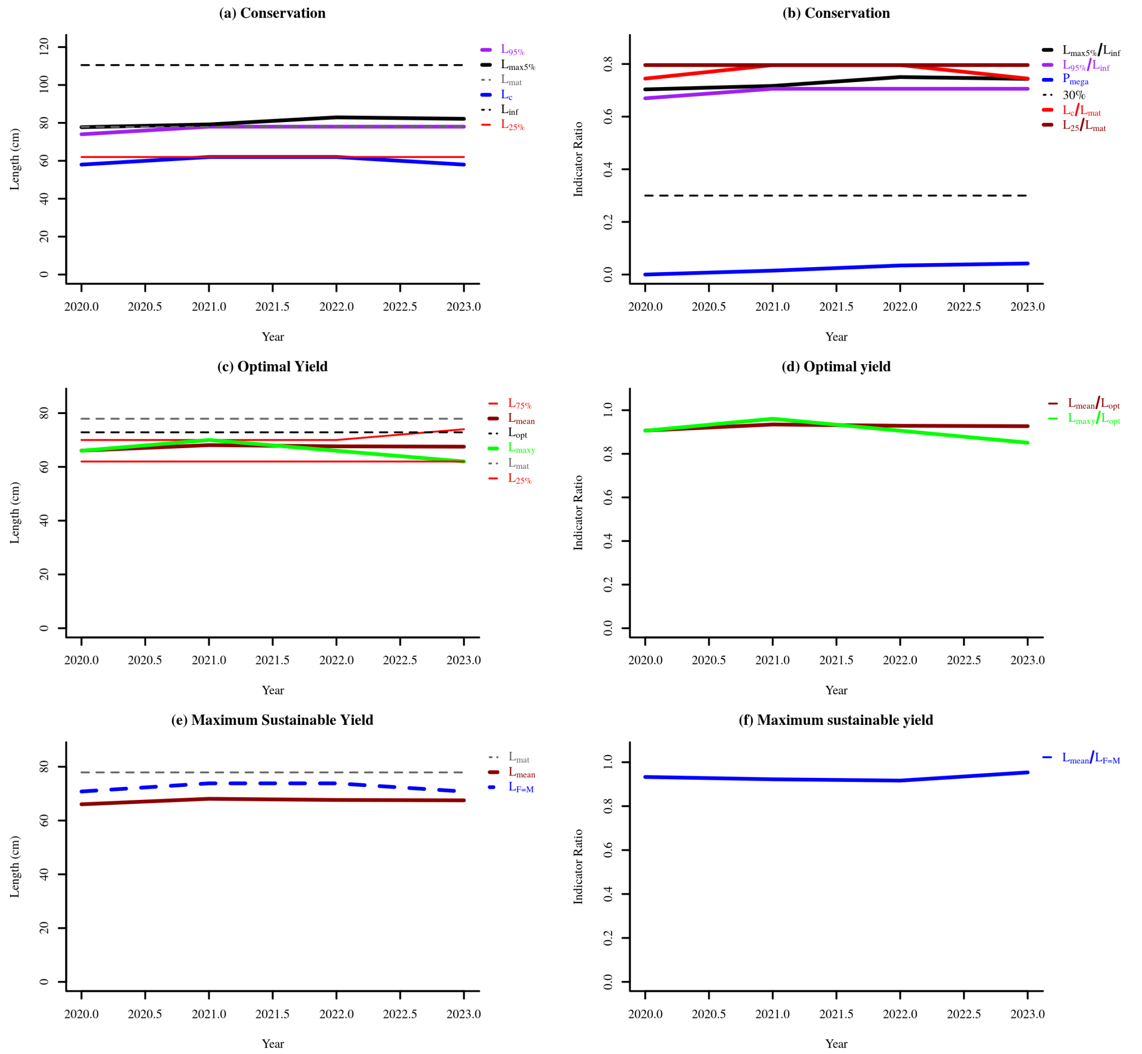


Figure 20.7. Indicator ratios and reference points for thornback ray *Raja clavata* from the Azorean commercial landings (2020-2023).

Contents

21 Smooth-hounds in the Northeast Atlantic

21.1 Stock distribution

Three species of smooth-hound (*Triakidae*) occur in the ICES area.

Starry smooth-hound *Mustelus asterias*

This is the dominant smooth-hound in northern European waters. The development of molecular genetic identification techniques has allowed the reliable identification and discrimination of NE Atlantic *Mustelus* species (Farrell *et al.*, 2009). Subsequent studies involving the collection of 231 *Mustelus* from the Irish Sea, Bristol Channel, Celtic Sea and west of Ireland, identified all to be *M. asterias* (Farrell *et al.*, 2010a, b). Studies of *Mustelus* samples (n = 504) from the North Sea and English Channel (McCully Phillips and Ellis, 2015) also identified all specimens as *M. asterias*.

There are several on-going tag-and-release programmes for *M. asterias* (e.g., Burt *et al.*, 2013 WD). Sportvisserij Nederland, in conjunction with Wageningen Marine Research, have a tagging programme with anglers in the Dutch Delta (Brevé *et al.*, 2016, 2020). As of 2020, 3699 *M. asterias* have been tagged, and 220 recaptures have been reported (Brevé *et al.*, 2020). Recapture positions provide evidence of circannual migration, with fish spending the summer in the southern North Sea and overwintering in the English Channel and Bay of Biscay. The findings also suggest a degree of philopatry with individuals returning to their release locations on an annual basis (Brevé *et al.*, 2016, 2020). These behaviours are supported by electronic tagging studies conducted by Cefas (Griffiths *et al.*, 2020). Sex-based dispersal has also been described in these tagging studies, with females re-distributing over a wider spatial range than their male counterparts (Brevé *et al.*, 2020; Griffiths *et al.*, 2020). Cooperative large-scale analyses of all available tagging data are required to further understand population stock structure of *M. asterias* in the Northeast Atlantic. Tagging studies from the more southern parts of the distribution range could usefully be undertaken.

In the absence of more detailed studies on stock identity, WGEF considers there to be a single biological stock unit of *Mustelus asterias* in the continental shelf waters of ICES subareas 4, 6–8. The southern limits of the stock are uncertain.

Common smooth-hound *Mustelus mustelus*

This species occurs along the west coast of Africa, Mediterranean Sea, and western Europe. It is believed to be the more common species in the southern parts of the ICES area; the northern limits of the stock are uncertain. In recent years, there have been no confirmed specimens in the northern parts of the ICES area and historical records, especially those north of the Bay of Biscay, are considered questionable. Separating *M. mustelus* from *M. asterias* based on the presence or absence of spots is considered unreliable (Compagno *et al.*, 2005; Farrell *et al.*, 2009), and information and data from northern Europe referring to *M. mustelus* likely refers to *M. asterias*.

Black-spotted smooth-hound *Mustelus punctulatus*

This species occurs in the Mediterranean Sea and off Northwest Africa (Quignard, 1972). Its northern limit is believed to be the southernmost part of ICES Division 9.a.

Generic issues

The species composition of smooth-hounds in subareas 8–9 is unclear, and species/stocks in these areas likely extend into the northern part of the CECAF area and Mediterranean Sea. Given species identification issues and that some species and/or stocks may extend beyond the ICES area, the identification of management unit(s) will need appropriate consideration.

Given the problems in separating *M. asterias* and *M. mustelus*, and that data for these two species are likely confounded, data in this chapter are generally combined at the genus level. Whilst assessments conducted by WGEF are based on *Mustelus asterias*, management advice should be applied at the genus level, therefore avoiding potential identification problems and their impacts on management and enforcement.

21.2 The fishery

21.2.1 History of the fishery

Smooth-hounds are a seasonal bycatch in trawl, gillnet, and longline fisheries. Though they are discarded in some fisheries, others land them as bycatch, depending on market demands. Some smooth-hounds may also be landed to supply bait for pot fisheries.

Smooth-hounds are also a relatively important species for recreational sea anglers and charter boat fishing in several areas, with anglers and angling clubs often having catch-and-release protocols, particularly in the Celtic and North Sea ecoregions.

The impact of the COVID-19 pandemic on fishing activity has not been quantified, however, it is assumed based on national and/or local restrictions to have resulted in reduced fishing effort in 2020 and 2021.

21.2.2 The fishery in 2023

No changes to the fishery were observed in 2023.

Anecdotal information from the UK fishing industry suggests that increased landings of smooth-hounds in recent years are partly to supply market demand for 'dogfish', given the current restrictions on spurdog, *Squalus acanthias*. *M. asterias* is also of increasing importance to some inshore fisheries due to restricted quotes for traditional quota stocks. Anecdotal information from these inshore fisheries suggests that the local market value of *M. asterias* has increased beyond that of skates and rays.

21.2.3 ICES Advice applicable

ICES first provided advice for this stock in 2012 for 2013 and 2014 (which was reiterated for 2015), stating that "*Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 4%. Because the data for catches of smooth-hounds are not fully documented and considered highly unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result*".

In 2015, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3272 tonnes in each of the years 2016 and 2017*". This advice was based on a survey-based (Category 3) assessment, with a stock size indicator based on four survey indices.

In 2017, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3855 tonnes in each of the years 2018 and 2019. ICES cannot quantify the corresponding catches*". This advice was based on a survey-based (Category 3) assessment, with a stock size indicator based on three survey indices.

In 2019, ICES advised that "*when the precautionary approach is applied, landings should be no more than 4626 tonnes in each of the years 2020 and 2021. ICES cannot quantify the corresponding catches*". This advice was based on a survey-based (Category 3) assessment, with a stock size indicator based on three survey indices.

In 2021, ICES advised that "*when the precautionary approach is applied, landings should be no more than 4441 tonnes in each of the years 2022 and 2023. ICES cannot quantify the corresponding catches*". This advice was based on a survey based (Category 3) assessment, with a stock size indicator based on five survey indices. Two additional surveys (FR-CGFS-Q4 and IE-IGFS-WIBTS-Q4) were added in 2021 to increase the area covered within the stock unit.

In 2023, ICES advised that "*when the MSY approach is applied, landings should be no more than 5329 tonnes in each of the years 2024 and 2025. ICES cannot quantify the corresponding catches*". This advice was based on the *rfb* rule. The stability clause was applied to limit the increase in landings advice to 20%.

21.2.4 Management applicable

There are no specific management measures for *Mustelus* spp. in the ICES area.

EC Council Regulations 850/98 for the *"conservation of fishery resources through technical measures for the protection of juveniles of marine organisms"* details the minimum mesh sizes that can be used to target fish. Although other dogfish (*Squalus acanthias* and *Scyliorhinus* spp.) can be targeted in fixed nets of 120–219 mm and >220 mm mesh size (in regions 1 and 2), *Mustelus* spp. are classified under *"all other marine organisms"*, and can only be targeted in fixed nets of >220 mm.

21.3 Catch data

21.3.1 Landings

No accurate estimates of catch are available prior to 2014 (Table 21.1; Figure 21.1).

ICES estimates, following WKSHARK2 (ICES, 2016), indicate that landings have exceeded 3000 t since 2005 (Table 21.1). The main nations exploiting smooth-hounds are France and the UK. The English Channel and southern North Sea are important fishing grounds.

Although landings from Spain show a consistent decrease from 2015–2022, this is mostly due to unavailable data from FAO areas 34 and 37, which represented on average ca. 11% and 30% of total landings reported to WGEF for this country during 2005–2014, respectively.

Landings data outside FAO area 27 that are currently reported to WGEF are negligible (ca. 0% to 2% between 2005-2023).

Landings from the Netherlands show an increase in 2019–2023. This increase may be partially linked to an increase in fishing effort by fly shoot (seine) fisheries.

Species-specific landings for the various species of *Mustelus* are not considered accurate, due to confounding identification issues between species thus, data have been collated at genus level. Furthermore, these values are likely underestimates, as some nations still report some landings of 'dogfish and hounds *nei'*.

21.3.2 Discards

Although discards data are available from various nations, data are limited for some nations and fisheries (Table 21.2). Eight countries reported preliminary estimates of discards for 2009–2023, however data show high inter-annual variability by country and thus, further data analysis should be undertaken before the data are used in the assessment. Given the seasonality of catches in some areas, and that *M. asterias* is often taken by inshore vessels where observer data can be more sporadic, further studies to evaluate the most appropriate methods of raising data from observer trips to fleet level are required if catches are to be estimated appropriately.

The collection of discards data in 2020 and 2021 was likely affected by COVID-19 national restrictions. Consequently, a decrease in the number of samples compared to previous years may be assumed, although the impact of has not been quantified. As such discard data for both years should be viewed with caution.

A study has indicated that juvenile *M. asterias* are often discarded (Figure 21.2), although the survival of these discards has not been evaluated (Silva and Ellis, 2019). *M. asterias* taken by UK beam trawl and *Nephrops* trawl were composed primarily of juveniles and sub-adults (<70 cm; total length: L_T), and nearly all were discarded. Gillnet catches were comprised primarily of fish 70–110 cm L_T, with fish <60 cm L_T usually discarded. Otter trawl catches covered a broad length range, and *M. asterias* <60 cm L_T were usually discarded. The absence of full retention at length in these gears is likely linked to various factors (e.g., catch quality and local market value).

Silva and Ellis (2019) also noted that a greater proportion of *M. asterias* have been retained since landing opportunities for spurdog have become restrictive. In the years 2002–2009, the retention of *M. asterias* ≥70 cm L_T was 59% and 44% in gillnet and otter trawl fisheries, respectively. In the period 2010–2016, however, retention increased to 85% (gillnets) and 66% (otter trawl). In addition, length at retention for otter trawl dropped from 41 cm L_T (2002–2009) to 34 cm L_T (2010–2016). High rates of discarding (of smaller fish, <60 cm L_T) have also been observed in otter trawls, where *ca.* 63% and 71% of the total catches were discarded in the North Sea and Celtic Seas, respectively.

WKSHARK3 undertook further exploratory analyses of discards data, noting similar discard-retention patterns to those described above. An analysis of discards data from Scottish fisheries was also presented (ICES, 2017).

21.3.3 Quality of catch data

Landings data have historically been of poor quality, as much of the landings data have been reported under generic landings categories. Most nations have made efforts to improve the recording of species in recent years.

Some northern European nations report more *M. mustelus* than *M. asterias* in official statistics, but WGEF combine these data, as *M. asterias* is the predominant and possibly the only species to occur around the British Isles.

Mustelus spp. are often taken in inshore fisheries, and landings data for vessels <10 m may not be complete.

M. asterias may be landed for bait in pot fisheries around the British Isles targeting whelk, and it is unclear whether such landings are reported consistently.

The availability of landings data from outside the ICES area (e.g., Mediterranean Sea) is limited, and the quality remains uncertain. In 2010, the European Commission collated landings data as an average across 2008–2010 and three species of *Mustelus* were represented in these data; *M. punctulatus* (269 t from Italy), *M. mustelus* (14 t combined from Italy, Spain, Malta, and Slovenia) and *M. asterias* (1 t from Malta) (ICES, 2012). WGEF has not yet considered potential catches/landings for waters off NW Africa.

Better estimates of discarding are required, as are robust estimates of discard survival.

21.3.4 Discard survival

Discard survival is variable across this family (Ellis *et al.*, 2014 WD). Whilst quantitative data are limited in European waters, Fennessy (1994) reported at-vessel mortality of 29% for Arabian smooth-hound *Mustelus mosis* taken in a prawn trawl fishery. Mortality ranged from 57–93% for three triakid sharks taken in an Australian gillnet fishery, despite the soak times being <24 hours (Braccini *et al.*, 2012). High survival of triakids has also been reported in longline fisheries (Frick *et al*., 2010; Coelho *et al*., 2012).

A UK research programme examining movements, behaviour, and discard survival through electronic tagging of *M. asterias* found that in terms of at-vessel mortality, the longline fleet had the greatest proportion of fish in a lively condition (91%; primarily large individuals due to the selectivity of the gear), whilst gillnets had the highest mortality (56%) of the gears studied (McCully Phillips *et al*., 2019). Smaller individuals, which were caught mostly in beam trawls, were found to generally be in a poor condition (McCully Phillips *et al*., 2019).

21.4 Commercial catch composition

Studies to better understand the composition of commercial catches by size and sex (and species where there is spatial overlap) are required. Given the potential for sex-based spatial segregation of *Mustelus*, as evidenced by sex-based dispersal of tagged fish (Brevé *et al.*, 2020; Griffiths *et al.*, 2020) as well as recent work on metazoan parasites (Gérard *et al.*, 2022), an appropriate level of monitoring would be required to fully understand commercial catch compositions over appropriate spatial and temporal scales.

21.4.1 Length composition of landings

In a UK study, 504 *M. asterias* samples (266 females; 238 males, Figure 21.3) were examined (McCully Phillips and Ellis, 2015), of which 286 (with a length range of 52–124 cm L_T) were landed by commercial vessels.

Data on the length composition of landings were available for 2019–2022 for UK and France (Figure 21.4). Data from 2020 onwards for individuals within the range of 24–125 cm L_T were used in the calculation of the fishing proxy *f* (see section 21.9) when applying the rfb rule (ICES, 2022b).

21.4.2 Length composition of discards

Silva and Ellis (2019) analysed the discard and retention patterns of *M. asterias* taken as bycatch in UK fisheries. Beam trawlers caught proportionally more juveniles (most records were of specimens of *ca.* 35–70 cm L_T), and discarding rates were high (95–99%). Gillnets were more selective for larger fish (most fish were 60–100 cm L_T), and typically only larger fish (>70 cm L_T) were retained.

Data on the length composition of discards were available for 2019–2022 from UK, France and the Netherlands (Figure 21.4, see section 21.9). Dutch data from a self-sampling programme were considered limited due to the low coverage of the main fleet catching this species, and the number of samples available insufficient to raise robustly the data. Thus, these were not considered in the assessment. Data from 2020 onwards for individuals within the range of 24–125 cm L_T were used in the calculation of the fishing proxy *f* (see section 21.9).

21.4.3 Sex ratio of landings

Of 286 commercially landed samples of *M. asterias* from the southern North Sea and eastern English Channel in May–November (2012 – 2014), 155 were female and 131 were male (McCully Phillips, unpublished). Due to *M. asterias* aggregating by sex and size, the sex ratio (and length–frequency) is expected to vary over the year and between areas.

21.4.4 Quality of data

The main countries reporting commercial length composition of landings and discards for *Mustelus* were the UK and France. Sporadic information is also available for the Netherlands, however, these data were not considered in the assessment of this stock. During the 2023 assessment, data from 2020–2022 for individuals 24–125 cm L_T were used. This size range was chosen to remove any potential input errors (e.g. records below the known minimum length of free-living neonates) and, to account for any confounding issues with *Galeorhinus* (e.g. records above L_{max} of the most recent literature for starry smooth-hound, McCully Phillips and Ellis, 2015). Although data may have been reported at genus level, it is assumed that these are mainly composed of starry smooth-hound. This is because all length data used in the assessment of the stock are provided by countries where starry smooth-hound is considered to be the main species.

21.5 Commercial-effort data

There are no data available.

21.6 Fishery-independent information

21.6.1 Availability of survey data

Several fishery-independent surveys operate in the stock area. Smooth-hounds are often caught in GOV trawl and other otter trawl surveys. For further details on trawl surveys in the stock area, see Section 15 (North Sea ecoregion), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia).

Larger individuals are not sampled effectively in beam-trawl surveys (because of low gear selectivity). For example, the UK western English Channel beam-trawl survey, which occurs in strata broadly equating to Division 7.e, only occasionally records *M. asterias* >100 cm L_T (Figure 21.5).

Analyses of survey data need to be undertaken with care; smooth-hounds are relatively large-bodied fish (the maximum size of *M. asterias* is at least 124 cm (McCully-Phillips and Ellis, 2015), with other sources suggesting they may attain 133 or 140 cm L_T) and adults may be strong swimmers, and able to avoid capture. As the largest individuals may not be sampled effectively in some survey gears, survey data might not provide a representative sample of the population.

Given their aggregating nature, some surveys may have a large number of zero hauls and a few hauls with relatively large numbers, although this issue does not appear to be as pronounced as seen in spurdog.

Although two species of *Mustelus* are often reported in surveys, the discrimination of these species was usually based on the presence or absence of spots, which is not a reliable identification characteristic. WGEF consider that survey data for these two species should be combined in any analyses, and that *M. asterias* is likely to be the only, or main, species in the Celtic Seas and North Sea ecoregions.

More detailed investigations of data in DATRAS indicate that data for *Mustelus* spp. and *Galeorhinus galeus* (tope shark) may have been confounded. This is most evident for Danish survey data (see Section 21.6.3).

21.6.2 Survey trends

Updated survey data were examined by WGEF in 2023, as summarised below (see Section 21.9 for additional quantitative information).

NS-IBTS-Q1 and NS-IBTS-Q3

The IBTS surveys of the North Sea, undertaken in Q1 and Q3 by seven and six countries respectively, have a common time period of 32 years (1991–2022). These surveys were included in the 2023 assessment of the stock; both surveys catch relatively low numbers of *M. asterias*. The long-term trend in biomass of smooth-hounds has increased in both the Q1 and Q3 time-series (Figure 21.6). However, in the Q3 there seems to have been a peak in biomass in 2017 (and high CIs), followed by a decline in 2019–2021, whereas in Q1 biomass seemed relatively stable for those same years, with a peak occurring in 2022 (Figure 21.6). The survey trends were updated in 2023 for the whole time series and were averaged and treated as one following recommendations from WKSKATE (ICES, 2021a). Data presented for these surveys include all national data for Q1 and Q3 available on DATRAS, with the exception of Danish data for Q3 time-series described in Section 21.6.3. The NS-IBTS-Q3 estimates may differ from previous results used in the 2021 assessment. This change is due to changes in the DATRAS product, with these being mostly related to data previously allocated to Sweden now reallocated to Denmark.

EVHOE-WIBTS-Q4

This survey of ICES divisions 7.g–k and 8.a.b.d has a 25-year time-series of data (1997–2016, 2018–2022) and was included in the assessment of the stock in 2023 (see Section 21.9). The survey covers the south-western part of the stock area. Catch rates, though showing marked inter-annual variability, indicate a broadly increasing trend (Figure 21.7). Survey trends were updated for the whole time series in 2023 and therefore values may differ from previous results used in the 2021 assessment. Estimates used data available on DATRAS following methodology presented at WKSKATE (ICES, 2021a).

FR-CGFS-Q4

This survey of ICES Division 7.d has a 24-year time-series of data (1997–2020) and has been included in the assessment of the stock since 2021 (see Section 21.9). The survey covers part of the stock area in the eastern English Channel. Catch rates indicate a broadly increasing trend despite intra-annual variability (Figure 21.7). The survey trends were updated for the whole time series in 2023 and therefore values may differ from previous results used in the 2021 assessment. Estimates used data available on DATRAS following methodology presented at WKSKATE (ICES, 2021a).

This survey did not cover part of the survey grid in 2020 (ICES rectangles 29F1 and 30E9) and further analysis was conducted to better understand the potential impact on the assessment of this stock (see section 21.9 in ICES, 2022a).

IE-IGFS-WIBTS-Q4

This survey of ICES divisions 6.a and 7.b.g.j has a 18-year time-series of data (2005–2022) and has been included in the assessment of the stock since 2021 (see Section 21.9). The survey covers the north-western part of the stock area. The increasing long-term trend in *M. asterias* is also evident in the Irish Groundfish Survey, although catch rates are generally low and more variable in recent years (2017–2022, Figure 21.8).

UK(E&W)-BTS-Q3 (in 7.afg[1])

This survey of ICES divisions 7.a and 7.f.g has a 29-year time-series of data (1993–2022), and catches reasonable numbers of *M. asterias*, albeit mostly immature specimens. This survey was not used in the 2023 assessment of the stock as the assessment explicitly considers exploitable biomass (i.e., individuals ≥ 50 cm L_T). Since 2023, estimates use a subset of data available on DATRAS from 97 fixed stations, the selection was based on locations that have been consistently and successfully fished during the time-series (further details in Silva, 2022a WD).

The mean catch rate of this survey was derived from the catch rates from fixed stations (97 stations; Silva, 2023 WD). The temporal trend in CPUE (abundance and biomass for all individuals) indicates an increasing trend, although data indicate a decrease in 2021. Both abundance and estimated biomass showed similar trends (Figure 21.9). Data are not provided for 2020 as these are considered not to be representative since these relate only to part of the survey area where this species is most abundant (ICES Division 7.f), and data for other parts of the survey area (where lower catches and more 'nil hauls' would be expected) are lacking (Figure 21.9; Silva and Ellis, 2021 WD; Silva, 2023 WD). The reduction in survey coverage in 2020 to only locations within ICES Division 7.f was due to the COVID-19 pandemic, with a total of 65 fixed stations in ICES divisions 7.a and 7.g being missed. While *M. asterias* is more commonly found in the Bristol Channel (7.f), there has been an increase in occurrence in the Irish Sea (7.a) in recent years (Silva and Ellis, 2021 WD). The 2022 survey had insufficient time to sample 12 locations in 7.a, with only 85 out of the 97 fixed stations successfully fished. Despite this, the area covered is considered spatially broad enough to be representative for most stocks including for starry smoothhound (Silva, 2023 WD).

BTS-Eng-Q3 (in 7.d and 4.c)

This survey of ICES divisions 7.d and 4.c has a 29-year time-series of data (1993–2022) and catches mostly juvenile *M. asterias*. This survey was not used in the 2023 assessment of the stock as the assessment explicitly considers exploitable biomass (i.e., individuals ≥ 50 cm L_T).

The mean catch rate of this survey was derived from the catch rates from fixed stations (78 stations, Silva and Ellis, 2020 WD). The temporal trend in CPUE (abundance and biomass for all individuals) indicates an increasing trend, although CPUE is lower and more variable than recorded in the beam trawl survey of the Irish Sea and Bristol Channel (Figure 21.9). Survey indices for the whole time series were updated following recommendations from WKSKATE, and since 2021, have used a subset of data available on DATRAS (ICES, 2021a). The survey did not occur in 2022 due to logistical and time constraints.

UK-Q1SWBeam[2]

The UK beam-trawl survey in the western Channel (7.e: 2006–2013), and more recently extended to cover the Celtic Sea (2014–2022) also encounters *M. asterias* (Figure 21.10 in Division 7.e). Previous analyses of these data (for the period 2006–2019) noted that 1098 specimens had been caught (713 ≥50 cm L_T for exploitable biomass calculations) accounting for 5% of the elasmobranch catch by numbers; the observed length range was 26–117 cm L_T (Silva *et al.*, 2020 WD based on data held within national database; ICES, 2022a). In the western Channel (Division 7.e), the estimated total abundance and biomass showed similar trends, with peaks in 2009 and 2013–

[1] Only two fixed (prime) station is within ICES Division 7.g (Prime 119 and 501). Also referred as BTS– UK(E&W)–Q3.

[2] This survey may also be referred to as 'Q1SWECOS', 'Q1SWBEAM ', 'BTS-UK-Q1' in other ICES-related documents.

2014, and after a decrease in 2016, data indicate another increase in 2018–2019 (Figure 21.11). Data for both 2020 and 2022 are shown only for illustrative reasons in Figure 21.10 as these may not be representative of the stock status for those years. This is because the survey did not occur in Q1 in 2020 and in 2022, the area covered within the strata in Division 7.e was reduced due to logistical and time constraints. The potential impacts of this are yet to be assessed for this stock. The time-series estimates of this survey should be viewed as 'qualitative assessments', with further evaluations needed to better understand the utility of these trends for providing quantitative assessment and advice (Silva *et al*., 2020 WD).

Other surveys

Other surveys also capture *M. asterias.* Previous analyses of the UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea indicated increasing catch rates, but recent data have not been analysed.

Although smooth-hounds are not usually subject to additional biological sampling in trawl surveys, UK (England and Wales) and IGFS surveys tag and release *M. asterias*, and the individual weights and sex (all fish) and maturity (male fish only) are recorded prior to release (see Section 21.7.5).

21.6.3 Data quality

Exploratory analyses of DATRAS data (numbers at length data, 1992–2022) indicated that there might be some confounded data for *Mustelus* and *Galeorhinus*, which could be due to taxonomic or coding errors.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in NS-IBTS-Q1 were 23 cm L_T and 129 cm L_T, respectively (1992–2022). While the record of 129 cm L_T is questionable, it is also potentially valid, given the range in reported L_{max} for the species. All nations recorded a minimum size of free-living pups that was greater than the length of the smallest neonates recorded by McCully Phillips and Ellis (2015), and are therefore within the accepted range.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in NS-IBTS-Q3 were 22cm L_T and 151 cm L_T, respectively (1992–2022). The minimum lengths observed by each nation (22–54 cm L_T) were within acceptable limits. During 1992–2022, most nations caught *Mustelus* spp. to a maximum length of 107–135 cm L_T, with one nation (Denmark) reporting larger individuals with a maximum length of 151 cm L_T (Figure 21.11). These data indicate that there seems to be inter-annual variation in the species of triakid sharks caught (Figure 21.12), and suggest that DATRAS data for *Mustelus* and *Galeorhinus* are confounded for this nation. The single record of 135 cm L_T from Sweden may be questionable, though also potentially valid, and was therefore retained in further analyses (Figure 21.11). Additional work on these data are required in order to determine whether it is a coding error or misidentification, and also to determine the extent of this issue. Similarly, some large catches linked to a single vessel would benefit from additional investigation.

For stock assessment purposes in 2023, NS-IBTS-Q1 and NS-IBTS-Q3 indices were both based on data held on DATRAS, with NS-IBTS-Q1 including data from all countries, NS-IBTS-Q3 excluded Danish data.

Since 2022, BTS-UK(E&W)-Q3 (in 7.afg) indices were calculated using DATRAS exchange data following recommendations from WKSKATE (ICES, 2021a). Indices provided to the WGEF in 2023 used a selection of fixed (prime) stations within DATRAS exchange data. The stations chosen for the calculations were the same as when using data held within national database (Silva and Ellis, 2021 WD; Silva, 2022a and 2023 WD).

Since 2021, BTS-ENG-Q3 (in 7.d and 4.c) indices were calculated using DATRAS exchange data following recommendations from WKSKATE (ICES, 2021a). Indices provided to the WGEF since 2021 used a selection of fixed (prime) stations within DATRAS exchange data. The stations chosen for the calculations were the same as when using data held within national database (Silva and Ellis, 2020 WD; ICES, 2021a).

Since 2022, UK-Q1SWBeam (in 7.e) estimates were calculated using DATRAS exchange data following recommendations from WKSKATE (ICES, 2021a), with similar methodology as for Rajidae described in Silva (2022b WD).

21.7 Life-history information

Biological data are not collected under EU-MAP, although some *ad hoc* data are collected on fishery-independent surveys and there are several published studies resulting from biological investigations of *Mustelus* spp. in European seas, including from the NE Atlantic (e.g., Farrell *et al.*, 2010a; McCully Phillips and Ellis, 2015) and Mediterranean Sea (e.g., Capapé, 1983; Saidi *et al.*, 2008).

21.7.1 Habitat

The spatial distribution of *Mustelus asterias* around the British Isles has been described by several authors (e.g., Brevé *et al.*, 2016; Griffiths *et al.*, 2020), with more detailed studies being undertaken on habitat utilization in the eastern English Channel (see Martin *et al.*, 2010; 2012).

21.7.2 Spawning, parturition and nursery grounds

Mustelus asterias pups are taken in trawl surveys (including beam trawl surveys), and such data may assist in the preliminary identification of pupping and primary nursery grounds. Most of the records for *M. asterias* pups recorded in UK beam-trawl surveys are from the southern North Sea, English Channel (including near the Solent) and Bristol Channel (Ellis *et al.*, 2005). Studies on other species of smooth-hound have shown high site fidelity of immature individuals to nursery grounds (Espinoza *et al.*, 2011).

Recent biological studies have indicated that full-term pups of *M. asterias* range in size from 205–329 mm L_T and that pup size is positively correlated with maternal length (McCully Phillips and Ellis, 2015; Figure 21.13). The smallest free-swimming neonate reported by this study was 24 cm L_T.

Parturition of *M. asterias* occurred in February in the western English Channel and June–July in the eastern English Channel and southern North Sea (Figure 21.14), indicating either protracted spawning or asynchronous parturition for the stock (McCully Phillips and Ellis, 2015).

21.7.3 Age and growth

Mustelus asterias

Farrell *et al*. (2010a) studied age and growth in the Celtic Seas ecoregion. Growth parameters for males (n = 106) were L_∞ = 103.7 cm L_T, L_0 = 38.1 cm and k = 0.195 year^{-1}. Growth parameters for females (n = 114) were L_∞ = 123.5 cm L_T, L_0 = 34.9 cm and k = 0.146 year^{-1}. Estimates of longevity were 13 years and 18.3 years for males and females, respectively. The lengths-at-age for *M. asterias* based on these growth parameters are given in Table 21.3.

An analysis of samples collected in waters around the British Isles between 2009–2019 provides preliminary estimates of L_∞ = 94.6 cm for males (n = 159, L_T = 24–100 cm ages 0–14) and L_∞ = 130.1 cm for females (n = 163, L_T = 28–124 cm ages 0–17) (Ellis *et al.*, 2019 WD), although it should be noted that this study had more fish at age 0. Further work is required to evaluate the estimated ages, and in terms of stock assessment modelling, the results of Farrell *et al.* (2010a) should still be used.

Further assumptions on L_∞ were considered when applying the rfb rule in 2023 to provide MSY advice (Method 2.1, ICES, 2022b) were an L_∞ of130.5 cm L_T was used (see section 21.9 for further details).

Mustelus mustelus

Age and growth have been reported for South African waters, with males and females estimated to mature at 6–9 and 12–15 years, respectively (Goosen and Smale, 1997). The maximum age reported in this study was 24 years.

21.7.4 Reproductive biology

Mustelus asterias

Studies in the Celtic Seas ecoregion indicated that the total length (and age) at 50% maturity for male and females was 78 cm L_T (4–5 years) and 87 cm L_T (six years), respectively (Farrell *et al.*, 2010b). A subsequent study in the southern North Sea and English Channel, estimated 50% maturity for males at 70.4 cm L_T (smallest mature = 65 cm; largest immature = 74 cm) and females at 81.9 cm L_T (smallest mature = 69 cm; largest immature = 87 cm) (McCully Phillips and Ellis, 2015; Figure 21.15). An analysis of samples collected between 2009–2019 by fishery-independent trawl surveys conducted by Cefas in waters around the British Isles estimated 50% maturity for males at 73.5 cm L_T (smallest mature = 64 cm; largest immature = 99 cm), with 100% maturity attained at ca. 90 cm, and females at 85.4 cm L_T (smallest mature = 75 cm; largest immature = 91 cm), with 100% maturity attained at ca. 92 cm (Ellis *et al.*, 2019 WD).

The smallest mature female that Farrell *et al*. (2010b) reported was 83 cm; considerably larger than the smallest females (69 cm and 75 cm L_T; summarised above) recorded by McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD). This is interesting because the studies use slightly different maturity keys; Farrell *et al*. (2010b) assigning a female to be mature when oocytes were present, yellow, and countable at >3 mm in diameter, whereas the Cefas maturity keys (Table II of McCully Phillips and Ellis, 2015), which are comparable to those keys developed within ICES, assigned a female as mature when the oocytes are slightly larger (>5 mm).

Estimates of fecundity range from 8–27 (ovarian fecundity) and 6–18 (embryonic fecundity), with a gestation period of about twelve months (Farrell *et al*., 2010b). There may also be a resting period of a year between pregnancies, giving a two-year reproductive period. Mature female specimens sampled by McCully Phillips and Ellis (2015) included seventeen late gravid females with term pups (uterine fecundity 4–20), which were found to have numerous yolk-filled follicles (n = 6–22; follicle diameters 6–10 mm). Further studies, including more samples of fish from winter and spring are required to better gauge the reproductive period.

The number of mature follicles ranged from 0–28 in the mature females (McCully Phillips and Ellis, 2015). These will not all necessarily develop into embryos, however, and estimates of ovarian fecundity are known to exceed estimates of uterine fecundity. The size-spectra of the mature follicles (within mature females) ranged from 4.1 mm (mid-term gravid female) to 20.7 mm (mature female).

The uterine fecundity increased with total length and ranged from 4–20 (McCully Phillips and Ellis, 2015), which exceeded the maximum uterine fecundity (18) found by Farrell *et al*. (2010b). That said, Farrell *et al*. (2010b) did state that their values may be underestimated due to females aborting pups on capture. The female identified with a fecundity of 20 was found with full-term pups. Furthermore, there were also positive linear relationships identified between maternal length and average pup length and weight (Figure 21.13; McCully Phillips and Ellis, 2015).

A combined dataset on uterine fecundity, using data from Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and additional samples collected during fishery-independent trawl surveys conducted by Cefas is given in Table 21.4 (Ellis *et al.*, 2019). Of the 74 early- to late-gravid females in this combined study, the uterine fecundity ranged from 2–20 (mean = 8.5) which is similar to the initial studies of subsets of this combined dataset (summarised above). Uterine fecundity (F) had a linear relationship with L_T, as described by the equation $F = 0.28390.L_T - 19.18583$ ($n = 74$; $r^2 = 0.4295$; bottom panel Figure 21.16).

In the Mediterranean Sea, *Mustelus asterias* reach maturity at about 75 cm (males) and 96 cm (females), with estimates of fecundity ranging from 10–45 (ovarian fecundity) and 10–35 (uterine fecundity). Again, fecundity is found to increase with length (Capapé, 1983), although it is possible the higher fecundity in this study may relate to data being confounded with other species of smooth-hound.

Mustelus mustelus

Studies in the Mediterranean Sea have found that females matured at 107.5–123 cm L_T (50% maturity at 117.2 cm) and that males matured at 88–112 cm L_T (50% maturity at 97.1 cm) (Saidi *et al.*, 2008). This study also found that embryonic fecundity ranged from 4–18 embryos, with fecundity increasing with length. Further south off Senegal, the lengths at first (and 100%) maturity for *M. mustelus* were found to be 82 cm (95 cm), for males, and 95 cm (104 cm) for females (Capapé *et al.*, 2006). This study reported litters of 4–21 pups.

21.7.5 Movements and migrations

Mustelus asterias

Although the movements and migrations of *M. asterias* are not fully known, there have been relatively high numbers tagged and released during various elasmobranch research programmes (e.g., Burt *et al.*, 2013 WD, Ellis *et al.*, 2019 WD Figure 21.17). A tagging programme (2011–2014) undertaken by Sportvisserij Nederland, in conjunction with Wageningen Marine Research, involved anglers tagging *M. asterias* in the Dutch Delta. There were 2244 releases and 80 recaptures (Figure 21.18; Brevé *et al.*, 2016). Recapture positions indicated circannual migrations between summertime grounds in the southern North Sea and overwintering grounds in the English Channel and Bay of Biscay, suggesting a degree of philopatry (Brevé *et al*., 2016). This is an on-going tagging programme, and more recently Brevé *et al*. (2020) reported that during 2011–2019 a total of 3699 *M. asterias* were released, of which 220 recaptures were reported (ca. 5.9% return rate). The recent results support previous work from Brevé *et al*. (2016).

Cefas have tagged-and-released specimens of *M. asterias* from fishery-independent trawl surveys since 2003 (Burt *et al.*, 2013). In 2019, a total of 1613 (744 females and 868 males, one unsexed) had been tagged and released, of which 40 (2.48%) have been recaptured and details returned (Ellis *et al.*, 2019 WD). Results suggest that the species is wide ranging in northern European seas and displays seasonal migrations, which are likely related to its reproductive cycle (Figure 21.17; Ellis *et al.*, 2019 WD). An electronic tagging programmes initiated by Cefas in 2017–2019 deployed 125 tags with a return rate of 14.4% to date. On a broad-scale, sex-biased dispersal, and potential metapopulation-like stock structuring either side of the UK continental shelf was seen along with clear diel variation in vertical activity and association with the seabed (Griffiths *et al*., 2020).

21.7.6 Diet and role in ecosystem

Mustelus asterias is primarily carcinophagous (98.8% percentage of index of relative importance, %IRI), with the two main prey species being hermit crab *Pagurus bernhardus* (34% IRI) and flying crab *Liocarcinus holsatus* (15% IRI) in specimens from the Northeast Atlantic (McCully Phillips, *et al*., 2020). Ontogenetic dietary preferences showed that smaller individuals [20–69 cm total length (L_T)] had a significantly lower diversity of prey than larger individuals (70–124 cm L_T) and similarly, specimens from the North Sea ecoregion had a lower diversity of prey types for a given sample size than fish from the Celtic Seas ecoregion (McCully Phillips, *et al*., 2020). This study did not find any fish remains in the examination of 640 stomachs, however Ford (1921) and Ellis *et al*., (1996) found that teleosts were only eaten occasionally by larger individuals. Larger individuals could be important predators of commercial crustaceans, feeding on velvet swimming crab *Necora puber* and small edible crab *Cancer pagurus* (McCully Phillips, *et al*., 2020).

Other studies on the feeding habits of *Mustelus* also indicate a high proportion of crustaceans in the diet (Morte *et al*., 1997; Jardas *et al*., 2007; Santic *et al*., 2007; Saidi *et al*., 2009; Lipej *et al*., 2011; Poiesz *et al.*, 2021; Biton-Porsmoguer, 2022).

The trophic level of specimens from the Northeast Atlantic was calculated as 4.34 when species-level prey categories were used; a value higher than previously indicated by other studies (Cortés, (1999; 3.7), Cotter *et al*. (2008; 3.9), and Pinnegar *et al*. (2002; 4.0)). These differences are due to the high tropic levels of their preferred crustacean prey (McCully Phillips, *et al*., 2020). These findings will have ramifications for food web and ecosystem modelling, with the role of this species (as a top predator) potentially underestimated to date.

21.7.7 Conversion factors

The relationship between total length and weight in smooth-hounds sampled by McCully Phillips and Ellis (2015) are summarised by sex and maturity stage in Table 21.5 (see also figures 21.19 and 21.20).

The relationship for males differed slightly to that of females, largely driven by the larger maximum length of females and the weight of females about to give birth. Of note is the 119 cm outlier, which was a post-partum female with a very low body mass. Samples of the smaller size classes were obtained from scientific trawl surveys, while the larger individuals were commercially landed specimens.

Recent data on overall length-weight relationships for male and female *M. asterias* caught between 2009–2019 by Cefas fishery-independent trawl surveys around the British Isles are illustrated in Figure 21.20.

21.8 Exploratory assessment models

21.8.1 Previous studies

No previous assessments of NE Atlantic smooth-hounds have been made. However, there have been assessment methods developed for the Australian species *Mustelus antarcticus* (e.g. Xiao and Walker, 2000; Pribac *et al*., 2005) which could be applied to the European species when relevant data are available.

21.8.2 Data exploration and preliminary assessments

An analytical age-, sex-, and length-structured assessment model was explored for *M. asterias* following the approach of De Oliveira *et al.* (2013) for spurdog, however, further work is required.

21.9 Stock assessment

The rfb rule (Method 2.1, ICES 2022b) was applied for the first time during the WGEF 2023 to assess the status of smooth-hounds (*Mustelus* spp.) in the Northeast Atlantic (stock sdv.27.nea).

Following the ICES guidance on the parameter determination for the rfb rule (ICES, 2022b), the input values for applying rfb rule on sdv.27.nea are presented in Table 21.6. Calculations used the R package 'cat3advice' which was developed by Fischer (2023).

It should be noted that the assessment is based on trends of fisheries-independent trawl surveys for starry smooth-hound (*Mustelus asterias*), which occurs primarily in subareas 4 and 6–8, and commercial data for the smooth-hound genus from the overall Northeast Atlantic, where two other species may also occur.

21.9.1 Stock size indicator

Since 2015, the stock of *M. asterias* in northern Europe has been evaluated using trends from fishery-independent trawl surveys, as these are the longest time-series of standardised species-specific data available.

The biomass trends of the long-term time-series of five different surveys covering a large proportion of the species distribution range were used in the 2023 assessment (NS-IBTS-Q1, NS-IBTS-Q3, EVHOE-WIBTS-Q4, FR-CGFS-Q4 and IE-IGFS-WIBTS-Q4, Figure 21.22 and Figure 21.23).

NS-IBTS-Q1 and NS-IBTS-Q3

Data from the two North Sea IBTS were used (see Section 15 for further details). These surveys sample the more northerly parts of the stock area. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.6). Data from Denmark were excluded in analyses for the IBTS-Q3, due to the suspicion that data for *Mustelus* and *Galeorhinus* were confounded (see Section 21.6.3). The temporal trends in abundance, total biomass, and exploitable biomass (specimens ≥50 cm L_T) all showed similar patterns (Figure 21.6). Normalized values for the average of NS-IBTS-Q1 Q3 are shown in Figure 21.22 and Table 21.7.

EVHOE-WIBTS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the EVHOE-IBTS-Q4, was included in the 2023 assessment. This survey covers more south-western parts of the stock area (divisions 8.a.b.d; Figure 21.7). Data were available for 1997–2022 (excluding 2017) and indicate an overall increase in total and exploitable biomass, albeit a decline in 2022 is seen compared to 2021. The total biomass was calculated using the weight from on-board catch weight per species, as no individual weights were available for most years. Exploitable biomass (specimens ≥50 cm L_T) was calculated using the length-weight relationship with $W_T = 0.0016.\ L_T^{3.1753}$. Normalized values for this survey are shown in Figure 21.22 and Table 21.7.

FR-CGFS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the FR-CGFS-Q4, was included in the 2023 assessment. This survey covers the eastern English Channel part of the stock area (Division 7.d; Figure 21.7). Data were available for 1997–2022 and indicate an overall increase in total and exploitable biomass, albeit a decrease in 2022 is seen compared to 2021. Despite this, 2022 remains within the highest levels observed in the time-series.

Although, in 2020 the survey did not cover part of the survey grid (ICES rectangles 29F1 and 30E9), data have been included in the assessment (see Section 2.19 in ICES, 2022a). Normalized values for this survey are shown in Figure 21.22 and Table 21.7.

IE-IGFS-WIBTS-Q4

Although the inclusion of this survey reduces the common time frame from 1997–2022 to 2005–2022, it covers the north-western parts of the stock area (divisions 6.a and 7.b.g.j) and was therefore used in 2023 assessment. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.8). Data indicate increasing total and exploitable biomass, though the variation is greater in recent years (Figure 21.8). Normalized values for this survey are shown in Figure 21.22 and Table 21.7.

Summary

The stock size indicator is based on 'exploitable biomass' (individuals ≥50 cm total length). The inclusion of additional surveys such as the IE-IGFS-WIBTS-Q4 truncates the common time period from 1997–2022 to 2005–2022, however, it does extend the spatial range covered within the stock unit. NS-IBTS-Q1 and NS-IBTS-Q3 were averaged prior to standardising to the long-term mean, and are therefore treated as a single survey following recommendations from WKSKATE (ICES, 2021a). The remaining three survey indices were also standardised in relation to their long-term mean. The average of the four surveys was used to derive an annual index of stock size (Figure 21.23; Table 21.7). In 2017, EHVOE-WIBTS-Q4 did not occur and the average for the annual index of stock size was based on the other surveys. All four surveys were given equal weighting.

Following the ICES guidelines for category 3, the stock biomass trend *r* is now based on the ratio of 2 over 3 years, instead of previous assessment where it was based on 2 over 5 years (ICES, 2022b). The mean index for the years 2021–2022 was 2.0, whilst the mean index for the preceding three years (2018–2020) was 1.25 (Figure 21.23; Table 21.6 and Table 21.7). Thus, *r* was set at 1.64 (Table 21.6). The I_{loss} equating to the lowest estimate observed in the time-series was 0.36 (2005; the first year used in the assessment) and $I_{trigger}$ set as 1.4 * I_{loss} was 0.51 (Table 21.6). The biomass safeguard *b* was set at 1 as I_{2022} (2.1) was above $I_{trigger}$ (0.51) with ratio $I_{2022}/I_{trigger}$ of 4.1 (Table 21.6).

Further considerations

The BTS-UK(E&W)-Q3 and BTS-Eng-Q3 surveys primarily sample juvenile *M. asterias*, and so in 2023 were excluded from the assessment. However, data may be informative for pup abundance, and thus it may be possible to develop an index of recruitment from such surveys in the future.

Further studies to better quantify differences between 'total biomass' and 'exploitable biomass' are still to be undertaken. Such work could usefully be appraised during a dedicated workshop for smooth-hounds *Mustelus* spp. and tope *Galeorhinus galeus* as recommended during WKSKATE (ICES, 2021a). Furthermore, the suitability of statistical modelling to provide a single survey index and associated confidence intervals, similar to work developed for spurdog during the benchmark in 2021 (ICES, 2021b), could usefully be examined for *Mustelus*. This would allow for the potential use of multiple surveys while accounting for potential differences (e.g., season, design, gear, depth, sex, length class).

21.9.2 Fishing proxy *f*

Although length composition data from commercial fisheries were available to WGEF since 2016, only data for 2020–2022 for both UK and France were used in the assessment of the stock (Figure 21.4).

The quality of the commercial length data may have also been hampered by the potential confusion between smooth-hound and tope, with records above the maximum observed length in recent literature for starry smooth-hound (L_{max} = 124 cm L_T, McCully Phillips and Ellis, 2015). There were also records below smallest free-swimming neonate reported by the same study (24 cm L_T). Therefore, length data considered for the assessment were truncated to individuals between ≥ 24 and ≤ 125 cm L_T (Figure 21.24 and Figure 21.25).

L_c (length at first capture) was calculated using pooled data from commercial catches from 2020–2022 (Table 21.8 and Figure 21.24), with L_{mean} calculated for each of the years 2020–2022 shown in Table 21.9 and Figure 21.25.

Farrel *et al.* (2010) observed a maximum length of 112 cm L_T in his study, thus the estimated L_{inf} (or L_∞) of 123.5 cm and k of 0.146 year^{-1} for females may be considered an underestimate given the more recent literature in relation to L_{max} observed. Consequently, the WGEF agreed that L_{inf} should be calculated using L_{max}/0.95 (Pauly, 1984), and despite noting historical accounts of a L_{max} of 140 cm L_T (Branstetter *et al.*, 1984), preference was given to use a more recent account from McCully Phillips and Ellis (2015) with L_{max} of 124 cm L_T. Therefore using fishbase.se/popdyn for starry smooth-hound and a new L_{inf} of 130.5 cm L_T, k was set at 0.13 year^{-1}, with m as 0.95.

The fishing proxy *f* values for 2020–2022 are listed in Table 21.9 and Figure 21.26. Results are presented considering both the L_{inf} derived from L_{max} observed in McCully Phillips and Ellis (2015) and using L_{inf} from Farrel *et al.* (2010). The WGEF agreed on the fishing proxy *f* derived L_{inf} of 130.5 cm L_T.

21.9.3 Application of the rfb rule

The rfb catch rule is defined as $A_{y+1} = A_y \times r \times f \times b \times m$ (× stability clause), where A_{y+1} and A_y refer to advised landings in 2024 (and 2025) and 2023, respectively, r to stock biomass trend (set at 1.64), f to fishing pressure proxy (set at 1.06), b to biomass safeguard (set at 1) and m to a precautionary multiplier depending on life-history parameters (set at 0.95). The stability clause was considered in this case and was applied to limit the increase in landings advice to 20% (Table 21.6).

The advised landings for 2024 and 2025 are 20% higher than the previous advice because of the increase in the stock size indicator and the application of the stability clause. Therefore, landings should be no more than 5329 tonnes in each of the years 2024 and 2025 (Table 21.6).

21.10 Quality of the assessment

Commercial landings data are available for recent years but may be compromised by poor data quality. Whilst fishery-independent trawl surveys provide the best time-series information, such surveys may under-represent the largest size classes. It is unclear as to how recent increases in CPUE may relate to increased stock abundance and/or a possible northward shift in distribution.

The positions of survey hauls containing smooth-hounds in the EVHOE-WIBTS-Q4 survey were plotted over the 1997–2019 time-series (Figure 21.27). The number of stations catching smooth-hounds increased over the survey, but the distribution of the catches has remained constant, occurring north of 46°N. There was no evidence from this survey to support the theory of a northward shift in the distribution, which would support the suggestion that increasing catch rates reflect population growth.

21.11 Conservation considerations

The most recent IUCN Red List Assessment for European marine fishes (Nieto *et al*., 2015) upgraded all three *Mustelus* spp. to either Near Threatened (*M. asterias*) or Vulnerable (*M. mustelus* and *M. punctulatus*), identifying them as of increasing conservation interest. These species were listed previously as either Data Deficient or Least Concern (Gibson *et al.*, 2008).

21.12 Management considerations

Smooth-hounds appear to be increasing in relative abundance in trawl surveys, and in commercial landings data. Given the potential expansion in fisheries for smooth-hounds (which may reflect an increased abundance and/or an increase in fishing opportunities due to restrictions on *S. acanthias*), further studies to understand the dynamics, distribution and geographic boundaries of this stock are required.

Smooth-hounds taken by beam trawl are primarily juveniles and subadults (<70 cm L_T), and these are often discarded, as are smooth-hounds <50 cm L_T in otter trawl fisheries. Discard survival has not been quantified for many metiers, and survival is variable in this family (Ellis *et al*., 2014 WD). Further studies on at-vessel mortality and post-release mortality, including of juveniles, are needed.

Survey data are available, and the quality of landings data is thought to be improving. Whilst there have been several recent biological investigations (Farrell *et al*., 2010a, b; McCully Phillips and Ellis, 2015), there is still uncertainty in some key biological parameters, including the duration of the reproductive cycle.

Smooth-hounds are also an important target species in some areas for recreational fisheries; despite this there remains insufficient data to examine the relative economic importance of these fisheries, or the degree of mortality associated with recreational fisheries.

Other species of smooth-hound are targeted elsewhere in the world, including Australia/New Zealand and South America. Although smooth-hounds are generally quite productive stocks (relative to some other elasmobranchs), evidence from these fisheries suggests that various management controls can be considered appropriate.

21.13 References

Biton-Porsmoguer, S. B. 2022. Diet strategies of starry smooth-hound (*Mustelus asterias*) and tope shark (*Galeorhinus galeus*) (Carcharhiniformes: Triakidae) in the Eastern English Channel: implication for conservation. *Cahiers de Biologie Marine*, 62(3): 129-137.

Braccini, M., Van Rijn, J., and Frick, L. 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS One*, 7(2), e32547, 1–9.

Branstetter, S. 1984. Triakidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean, Vol. I. Ed. By P.J.P Whitehead *et al.* UNESCO, Paris, France, pp. 117–121.

Brevé, N.W.P., Winter, H.V., Van Overzee, H.M.J., Farrell, E.D. and Walker, P.A. 2016. Seasonal migration of the starry smooth-hound shark *Mustelus asterias* as revealed from tag-recapture data of an angler-led tagging programme. *Journal of Fish Biology*, 89(2), 1158–1177.

Brevé, N.W.P., Winter, H.V., Wijmans, P.A.D.M., Greenway, E.S.I. and Nagelkerke, L.A.J. 2020. Sex differentiation in seasonal distribution of the starry smoothhound *Mustelus asterias*. *Journal of Fish Biology*, 97: 1870–1875. https://doi.org/10.1111/jfb.14548.

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal, 17–21 June 2013. 12 pp.

Capapé, C. 1983. New data on the biological of the reproduction of *Mustelus asterias* Cloquet, 1821 (Pisces, Pleurotremata, Triakidae) from Tunisian coasts. *Vie et Milieu*, 33: 143–152.

Capapé, C., Diatta, Y., Diop, M., Vergne, Y. and Guelorget, O. 2006. Reproductive biology of the smoothhound, *Mustelus mustelus* (Chondrichthyes: Triakidae) from the coast of Senegal (eastern tropical Atlantic). *Cybium*, 30: 273–282.

Coelho, R., Fernandez-Carvalho, J., Lino, P.G., and Santos, M.N. 2012. An overview of the hooking mortality of elasmobranchs caught in a swordfish pelagic longline fishery in the Atlantic Ocean. *Aquatic Living Resources*, 25: 311–319.

Compagno, L., Dando, M. and Fowler, S. 2005. Sharks of the World. Collins Field Guide. Harper Collins Publishers, London.

Cortés, E. 1999. Standardized diet compositions and trophic levels of sharks. *ICES Journal of Marine Science*, 56: 707–717.

Cotter, J., Rogers, S., Ellis, J., Mackinson, S., Dulvy, N., Pinnegar, J., Jennings, S. and Greenstreet, S. 2008. Marine Ecosystem Integrity: Development of a Marine Trophic Index for UK waters and recommendations for further indicator development. Cefas contract report C3140. Final report for Natural Environment Group, Science Division, Defra, Bristol, UK (CRO 382).

De Oliveira, J. A. A., Ellis, J. R. and Dobby, H. 2013. Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias. ICES Journal of Marine Science*, 70: 1341–1353.

Ellis, J. R., Cruz-Martinez, A., Rackham, B. D. and Rogers, S. I. 2005. The distribution of chondrichthyan fishes around the British Isles and implications for conservation. *Journal of Northwest Atlantic Fishery Science*, 35: 195–213.

Ellis, J. R., Maia, C., Hampton, N., Eastley, G., Silva, J. F. and McCully Phillips, S. R. 2019. Updated biological parameters for starry smooth-hound *Mustelus asterias* in the North-east Atlantic. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, June 18–27 2019; 17 pp.

Ellis, J. R.., McCully, S. R. and Poisson, F. 2014. A global review of elasmobranch discard survival studies and implications in relation to the EU 'discard ban'. Working Document to the ICES Working Group on Elasmobranch Fishes, Lisbon, Portugal. June 2014. 48 pp.

Ellis, J. R., Pawson, M. G. and Shackley, S. E. 1996. The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the North-East Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 76: 89–106.

Espinoza, M., Farrugia, T. J. and Lowe, C. G. 2011. Habitat use, movements and site fidelity of the gray smooth-hound shark (*Mustelus californicus* Gill, 1863) in a newly restored southern California estuary. *Journal of Experimental Marine Biology and Ecology*, 401: 63–74.

Farrell, E. D., Clarke, M. W. and Mariani, S. 2009. A simple genetic identification method for Northeast Atlantic smoothhound sharks (*Mustelus* spp.). *ICES Journal of Marine Science*, 66: 561–565.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010a. Age and growth estimates for the starry smoothhound (*Mustelus asterias*) in the Northeast Atlantic Ocean. *ICES Journal of Marine Science*, 67: 931–939.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010b. Reproductive biology of the starry smoothhound shark *Mustelus asterias*: Geographic variation and implications for sustainable exploitation. *Journal of Fish Biology*, 77: 1505–1525.

Fennessy, S. T. 1994. Incidental capture of elasmobranchs by commercial prawn trawlers in the Tugela Bank, Natal, South Africa. *South African Journal of Marine Science*, 14: 287–296

Fischer, S. 2023. cat3advice: ICES category 3 empirical harvest control rules. R package version 0.0.1.

Ford, E. 1921. A contribution to our knowledge of the life-histories of the dogfishes landed at Plymouth. *Journal of the Marine Biological Association of the United Kingdom*, 12: 468–505.

Frick, L. H., Reina, R. D. and Walker, T. I. 2010. Stress related changes and post-release survival of Port Jackson sharks (*Heterodontus portusjacksoni)* and gummy sharks (*Mustelus anarcticus)* following gill-net and longline capture in captivity. *Journal of Experimental Marine Biology and Ecology*, 385: 29–37.

Gérard, C., Hervé, M. R., Hamel, H., Gay, M., Barbier, M. and Barreau, T. 2022. Metazoan parasite community as a potential biological indicator in juveniles of the starry smooth-hound *Mustelus asterias* Cloquet, 1819 (*Carcharhiniformes Triakidae*). *Aquatic Living Resources*, 35: 3.

Gibson, C., Valenti, S.V., Fordham, S.V. and Fowler, S.L. 2008. The Conservation of Northeast Atlantic Chondrichthyans: Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop. viii + 76 pp.

Griffiths, C. A., Wright, S. R., Silva, J. F., Ellis, J. R., Righton, D. A. and McCully Phillips, S. R. 2020. Horizontal and vertical movements of starry-smooth hound *Mustelus asterias* in the Northeast Atlantic. *PLoS ONE*, 15 (10): e0239480. https://doi.org/10.1371/journal.pone.0239480.

Goosen, A. and Smale, M. J. 1997. A preliminary study of age and growth of the smoothhound shark *Mustelus mustelus* (Triakidae). *South African Journal of Marine Science*, 18: 85–91.

Henderson, A.C., Flannery, K. and Dunne, J. 2003. Biological observations on shark species taken in commercial fisheries to the west of Ireland. *Proceedings of the Royal Irish Academy*, 103B: 1–7.

ICES. 2012. Report of the 6th Meeting of the Mediterranean Planning Group for Methodological Development (PGMED). 30 January to 5 February, 2012, Rome.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40; 69 pp.

ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20–24 February 2017, Nantes, France. ICES CM 2017/ ACOM:38; 119 pp.

ICES. 2021a. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 183 pp. https://doi.org/10.17895/ices.pub.7948.

ICES. 2021b. Benchmark Workshop on North Sea Stocks (WKNSEA). ICES Scientific Reports. 3:25. 756 pp. https://doi.org/10.17895/ices.pub.7922.

ICES. 2022a. Working Group on Elasmobranch Fishes (WGEF). ICES Scientific Reports. 4:74. 848 pp. http://doi.org/10.17895/ices.pub.21089833.

ICES. 2022b. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. *In* Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564.

Jardas, I., Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet of the smooth-hound, *Mustelus mustelus* (chondrichthyes: Triakidae), in the eastern Adriatic Sea. *Cybium*, 31: 459–464.

Lipej, L., Mavric, B., Resek, S., Chérif, M. and Capapé, C. 2011. Food and feeding habits of the blackspotted smooth-hound, *Mustelus punctulatus* (Elasmobranchii: Carcharhiniformes: Triakidae), from the northern Adriatic. *Acta Ichthyologica et Piscatoria*, 41: 171–177.

Martin C. S., Vaz, S., Ellis, J. R., Coppin, F., Le Roy, D. and Carpentier, A. 2010. Spatio-temporal patterns of demersal elasmobranchs in trawl surveys in the eastern English Channel (1988–2008). *Marine Ecology Progress Series*, 417: 211–228.

Martin, C. S., Vaz, S., Ellis, J. R., Lauria, V., Coppin, F. and Carpentier, A. 2012. Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. *Journal of Experimental Marine Biology and Ecology*, 418/419: 91–103.

McCully Phillips, S.R. and Ellis, J.R., 2015. Reproductive characteristics and life-history relationships of starry smooth-hound *Mustelus asterias* in British waters. *Journal of Fish Biology*, 87: 1411–1433.

McCully Phillips, S.R., Grant, A. and Ellis, J.R., 2020. Diet composition of starry smooth-hound *Mustelus asterias* and methodological considerations for assessing the trophic level of predatory fish. *Journal of Fish Biology*, 96: 590–600.

McCully Phillips, S. R., Griffiths, C. A., Silva, J. F., Wright, S. and Ellis, J. R. 2019. Discard survival and movements of starry smooth-hound. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Final report, Contract C7246, x + 79 pp.

Morte, S., Redon, M. J. and Sanz-Brau, A. 1997. Feeding habits of juvenile *Mustelus mustelus* (Carcharhiniformes, Triakidae) in the western Mediterranean. *Cahiers de Biologie Marine*, 38: 103–107.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., Garcia Criado, M., *et al*. 2015. *European Red List of marine fishes*. Luxembourg: Publications Office of the European Union.

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8, 325 pp.

Pinnegar, J. K., Jennings, S., O'Brien, C. M. and Polunin, N. V. C. 2002. Long-term changes in the trophic level of the Celtic Sea fish community and fish market price distribution. *Journal of applied ecology*, 39: 377–390.

Poiesz, S. S. H., van Elderen, T., Witte, J. I. J. and van der Veer. 2021. Historical trophic ecology of some divergent shark and skate species in the Dutch coastal North Sea zone. *Marine Biology*, 168: 165.

Pribac, F., Punt, A. E. Taylor, B. L. and Walker, T. I. 2005. Using length, age and tagging data in a stock assessment of a length selective fishery for gummy shark (*Mustelus antarcticus*). *Journal of Northwest Atlantic Fishery Science*, 35: 267–290.

Quignard, J. P. 1972. Note sur les especes mediterraneenes du genre *Mustelus* (Selachii, Galeoidea, Triakidae). *Rev. Trav. Inst. Peches Marit*., Nantes, 36(1): 15–29.

Saidi, B., Bradai, M. N. and Bouain, A. 2008. Reproductive biology of the smooth-hound shark *Mustelus mustelus* (L.) in the Gulf of Gabes (south-central Mediterranean Sea). *Journal of Fish Biology*, 72: 1343–1354.

Saidi, B., Enajjar, S., Bradai, M. N. and Bouain, A. 2009. Diet composition of smooth-hound shark, *Mustelus mustelus* (Linnaeus, 1758), in the Gulf of Gabes, southern Tunisia. *Journal of Applied Ichthyology*, 25: 113–118.

Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet composition of blackspotted smooth-hound, *Mustelus punctulatus* (Risso, 1826), in the eastern Adriatic Sea. *Journal of Applied ichthyology*, 23: 279–281.

Silva, J. F. 2022a. Rajidae in the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES divisions 7.f-g). Working Document to the ICES Working Group on Elasmobranch Fishes, June 14–23 2022, 23 pp.

Silva, J. F. 2022b. Rajidae in the western Channel (ICES Division 7.e). Working Document to the ICES Working Group on Elasmobranch Fishes, June 14-June 23, 2022; 30 pp.

Silva, J. F. 2023. Demersal elasmobranchs in the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES divisions 7.f-g). Working Document to the ICES Working Group on Elasmobranch Fishes, June 20–29 2023, 13 pp.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Silva, J. F., Ellis, J. R. and Kupschus, S. 2020. Demersal elasmobranchs in the western Channel (ICES Division 7.e) and Celtic Sea (ICES Divisions 7.f-j). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020.

Silva, J. F. and Ellis, J. R. 2020. Skates caught in the Q3 English beam trawl survey of the eastern English Channel (ICES Division 7.d) and southern North Sea (ICES Division 4.c). Working Document to the ICES Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE), 23rd–27th November 2020, 16 pp.

Silva, J. F. and Ellis, J. R. 2021. Catsharks and smooth-hounds in the UK (E&W) beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document to the ICES Working Group on Elasmobranch Fishes, June 15-June 24, 2021; 12 pp.

Xiao, Y. and Walker, T. I. 2000. Demographic analysis of gummy shark (*Mustelus antarcticus*) and school shark (*Galeorhinus galeus*) off southern Australia by applying a generalized Lotka equation and its dual equation. *Canadian Journal of Fisheries and Aquatic Sciences*, 57: 214–222.

21.14 Tables and Figures

Table 21.1. Smooth-hounds in the Northeast Atlantic. ICES estimated landings (t) for the period 1973–2023. Data from 1973-2014 are considered underestimates as some smooth-hounds are landed under generic landings categories. Data from 2005 onwards were revised following the 2016 Data Call (see ICES, 2016); previous estimates are provided in brackets (2005-2014). Species-specific landings data are not available for the Mediterranean Sea and are limited for the northwest African waters. Blank = no data reported; 0 ≤ 0.5 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium														
Germany														
Denmark														
Spain														
France	0	0	0	0	0	0	32	0	0	222	218	66	143	167
UK*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland														
Netherlands														
Portugal														
Total	0	0	0	0	0	0	32	0	0	222	218	66	143	167

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium													
Germany													
Denmark													
Spain													
France	119	64	117	126	93	90	102	138	145	228	187	197	0
UK*	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland													
Netherlands													
Portugal													
Total	119	64	117	126	93	90	102	138	145	228	187	197	0

***Data from 1973–2014 were previously separated into UK –E, W & NI and UK – Scotland but have been merged into UK**.

Table 21.1. Continued. Smooth-hounds in the Northeast Atlantic. ICES estimated landings (t) for the period 1973–2023. Data from 1973-2014 are considered underestimates as some smooth-hounds are landed under generic landings categories. Data from 2005 onwards were revised following the 2016 Data Call (see ICES, 2016); previous estimates are provided in brackets (2005–2014). Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Blank = no data reported; 0 ≤ 0.5 tonnes.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium													(8)	1 (10)	1 (1)
Germany															
Denmark															
Spain**						112	134	138	200	297	129 (34)	106 (48)	120 (9)	80 (83)	70 (14)
France	306	377	585	589	682	2685 (767)	2722 (714)	2958 (908)	3403 (522)	3082 (926)	3204 (969)	3241 (706)	2821 (2695)	2942 (2955)	2836 (2825)
UK*	14	0	0	0	0	171 (0)	130 (0)	155 (0)	171 (115)	199 (133)	275 (161)	315 (919)	339 (337)	325 (323)	331 (647)
Ireland								0	1	0	0	0			0
Netherlands										4	9 (8)	3 (3)	23 (11)	26 (20)	24 (15)
Portugal						44	57	57	41	45	38	43 (35)	42 (42)	41 (41)	17 (187)
Total***	320	377	585	589	682	3013 (767)	3043	3308 (908)	3816 (637)	3628 (1059)	3655 (1172)	3709 (1712)	3345 (3101)	3415 (3433)	3280 (3690)

***Data from 1973–2014 were previously separated into UK –E, W & NI and UK – Scotland but have been merged into UK. **Data not available for Area 34 and 37 in 2015–2021; ***Includes negligible landings reported to Fishing Area 34 and 37 (ca. 0.0-2.4% of the total annual estimated landings).**

Table 21.1. Continued. Smooth-hounds in the Northeast Atlantic. ICES estimated landings (t) for the period 1973–2023. Data from 1973-2014 are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Blank = no data reported; 0 ≤0.5 tonnes.

	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	1	3	2	1	1	3	4	5	2
Germany					1				
Denmark		0	0	1	0	0			0
Spain**	42	40	43	38	30	41	28	29	46
France	2963	2855	2730	3136	2934	2665	3195	3141	3346
UK*	303	469	376	390	474	405	470	483	485
Ireland	0						0	10	2
Netherlands	24	22	22	34	74	91	62	83	98
Portugal	15	18	55	51	53	64	54	47	49
Slovenia								1	2
Total***	3349	3407	3228	3651	3567	3268	3813	3800	4030

****Data not available for Area 34 and 37 in 2015–2021; ***Includes negligible landings reported to Fishing Area 34 and 37 (ca. 0.0-2.4% of the total annual estimated landings).**

Table 21.2. Smooth-hounds in the Northeast Atlantic. Preliminary discards estimates (t) by country for the period 2009–2023. Blank = no data reported; 0 ≤ 0.5 tonnes.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Denmark	0	1	0		0	0	1	25	0	3	9	3	3	0	2
Spain											0				1
France			441	204	308	508	320	510	874	284	464	357	319	244	196
UK	163	109	95	145	111	56	37	118	61	94	68	223	122	223	249
Ireland	26	38	33	56	31	29	15	119	43	27	6	36		51	2
Netherlands			17	64	12	5	32	7	41	40	37	25	42	45	54
Portugal										0	0	0			
Slovenia														0	1
Sweden															0
Total	189	149	586	469	462	598	405	780	1020	449	585	643	486	831	505

Table 21.3. Smooth-hounds in the Northeast Atlantic. Age-length key for *Mustelus asterias*, based on data given in Farrell *et al.* (2010a).

Age	Total length (cm)	
	Male	Female
0	38.1	34.9
1	49.7	46.9
2	59.3	57.3
3	67.2	66.3
4	73.6	74.1
5	79.0	80.8
6	83.3	86.6
7	86.9	91.6
8	89.9	95.9
9	92.4	99.7
10	94.4	102.9
11	96.0	105.7
12	97.4	108.1
13	98.5	110.2
14	99.4	112.0
15	100.2	113.6
16	100.8	114.9
17	101.3	116.1
18	101.7	117.1

Table 21.4. Smooth-hounds in the Northeast Atlantic. Fecundity at length data for *Mustelus asterias*, based on data given in Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD).

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
Henderson *et al.* (2003)	87	10	D
	89	2	D
	109	10	D
Farrell *et al.* (2010)	83	6	
	90	8	
	91	7	
	92	4	
	94	7	
	97	6	
	97	9	
	100	9	
	103	14	
	104	7	
	106	7	
	106	11	
	108	10	
	111	18	
	112	9	
McCully Phillips & Ellis (2015)	80	4	D
	83	7	D
	86	10	E
	88	9	D
	90	7	D
	91	6	F
	92	6	D
	93	4	F
	96	14	F
	97	9	F
	97	5	E
	97	11	D
	98	10	F
	98	10	D
	101	7	F
	101	11	E
	101	10	F
	101	12	D

[3] Maturity stage as per described in McCully Phillips and Ellis, 2015.

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
	102	11	F
	103	12	F
	104	13	F
	105	17	F
	105	8	F
	106	11	F
	110	17	F
	115	12	F
	116	20	F
	116	15	E
	124	13	F
Cefas unpublished[4] in Ellis *et al.* (2019 WD)	101	5	F
Cefas (Ciro 2/02) in Ellis *et al.* (2019 WD)	88	4	D
	92	2	D
	93	2	D
	101	9	F
	111	14	F
Cefas trawl surveys (CEnd 2/13) in Ellis *et al.* (2019 WD)	93	4	F
	97	10	E
Cefas trawl surveys (CEnd 4/18) in Ellis *et al.* (2019 WD)	81	3	F
	85	5	F
	87	4	F
	88	4	F
	89	5	F
	89	5	F
	90	4	F
	90	6	F
	91	7	E
	93	8	F
	97	10	F
	99	9	F
	100	12	F
	101	4	F
Cefas trawl surveys (CEnd 3/19) in Ellis *et al.* (2019)	82	6	F
	99	10	F
	100	12	F
	100	9	E
	108	2	D

[4] April 2019, 101 cm, 3671 g total weight.

Table 21.5. Smooth-hounds in the Northeast Atlantic. Relationship between total length and weight in the smooth-hounds sampled by McCully Phillips and Ellis (2015).

Relationship $Y = ax^b$	Sex/Stage	a	b	r^2	n
Total weight to total length	All females	0.0014	3.2	0.992	248
	All males	0.0020	3.1	0.995	237
	Immature female (stage A/B)	0.0020	3.1245	0.994	170
	Immature male (stage A/B)	0.0014	3.2159	0.991	113
	Mature female (including early gravid) (stage C/D)	0.0021	3.1396	0.913	54
	Mature male (stage C/D)	0.0077	2.8084	0.938	123
	Mid-/late-term gravid females (stage E/F)	0.0002	3.7072	0.935	21
Gutted weight to total length	Sexes combined	0.0014	3.1580	0.995	484
	Female	0.0016	3.1	0.994	249
	Male	0.0014	3.2	0.996	235

Table 21.6. Smooth-hounds in the Northeast Atlantic. Estimates used in the rfb rule, with details and comments. All values have been rounded; calculations were done using unrounded values. Calculations were done using 'cat3advice' R package from Fischer (2023).

Variable	Estimate	Input data	Comments
r: Stock biomass trend	1.64	Stock size indicator is the mean normalized exploitable biomass index (individuals of ≥ 50 cm total length, L_T) of starry smooth-hound from the average of the two NS-IBTS surveys (NS-IBTS-Q1 [G1022] and NS-IBTS-Q3 [G2829]), EVHOE-WIBTS-Q4 [G9527], FR-CGFS-Q4 [G3425], and IE-IGFS-WIBTS-Q4 [G7212].	Index A (2021, 2022) = 2.0 Index B (2018, 2019, 2020) = 1.25 The series shows an increasing trend since 2005.
b: Biomass safeguard	1	$\min\{I_{2022}/I_{trigger}, 1\}$	I_{loss} = 0.36 (2005) $I_{trigger} = I_{loss} \times 1.4 = 0.51$ I_{2022} = 2.1 $I_{2022}/I_{trigger}$ = 4.1 The series shows an increasing trend since 2005.
f: Fishing proxy $L_{mean}/L_{F=M}$	1.06	Length data collected from commercial landings and discards from 2022. L_c is calculated from pooled data from 2020–2022.	L_c = 40 cm $L_{inf} = L_{max}/0.95$ = 130.5 cm L_{max} = 124 cm L_T from McCully Phillips and Ellis (2015) $L_{F=M} = 0.75 * L_c + 0.25 * L_{inf}$ $L_{F=M}$ = 63 cm $L_{mean\ 2022}$ = 66 cm Length data used for individuals ≥ 24 and ≤ 125 cm L_T.
m linked to von Bertalanffy k	0.95	Set at 0.95 when a species-specific k parameter is < 0.2.	k = 0.13 $year^{-1}$ calculated in fishbase.se/popdyn when using $L_{inf} = L_{max}/0.95$ = 130.5 cm (Pauly, 1984)
A_y	4441 tonnes	ICES advice in 2022 (2023)	
A_{y+1}	7360 tonnes	$A_{y+1} = A_y \times r \times f \times b \times m$	Value rounded to the nearest tonne.
Stability clause	1.2	Applied as b ≥ 1	A_{y+1} would be more than 20% compared to A_y thus, stability clause applied
Landings advice for 2024 and 2025 (A_y × stability clause)	5329	$\min(\max(0.7*A_y, A_{y+1}), 1.2*A_y)$	To limit the increase to 20%.

Table 21.7. Smooth-hounds in the Northeast Atlantic. Biomass indices for exploitable biomass (individuals of ≥ 50 cm total length) of starry smooth-hound derived from five surveys (average of NS-IBTS-Q1 and NS-IBTS-Q3, EVHOE-WIBTS-Q4, FR-CGFS-Q4 and IE-IGFS-WIBTS-Q4). The stock size indicator is the annual mean of the normalized surveys indices (2005–2022). Note: rounded numbers as per ICES rounding rules. Values may differ from previous assessment for years prior to 2021 as NS-IBTS Q3, EHVOE-WIBTS-Q4 and FR-CGFS-Q4 time-series were updated in 2023.

Year	NS-IBTS-Q1 Q3	EHVOE-WIBTS-Q4	FR-CGFS-Q4	IE-IGFS-WIBTS-Q4	Stock size indicator
2005	0.28	0.33	0.69	0.150	0.36
2006	0.49	0.166	0.95	0.190	0.45
2007	0.40	0.64	0.78	0.32	0.53
2008	0.41	1.04	0.97	0.27	0.67
2009	0.46	0.00	1.32	0.29	0.52
2010	0.71	0.00	0.78	0.54	0.51
2011	0.86	0.93	0.57	0.24	0.65
2012	0.92	1.17	0.71	0.44	0.81
2013	0.92	0.22	0.72	0.41	0.57
2014	1.54	0.96	0.54	0.74	0.95
2015	0.77	1.82	1.60	1.16	1.34
2016	0.82	1.69	1.04	1.60	1.29
2017	2.3	NA	0.92	1.84	1.69*
2018	1.04	1.55	0.64	1.03	1.06
2019	0.80	1.43	1.68	1.73	1.41
2020	1.55	1.56	1.28**	0.67	1.26
2021	0.99	2.5	1.68	2.8	1.99
2022	2.7	0.97	1.14	3.6	2.1

*** In 2017, the stock size indicator does not include EHVOE-WIBTS-Q4 (Data not available).**

**** Only parts of the survey area covered during FR-CGFS-Q4 though impact considered to be negligible for starry smooth-hound (ICES, 2022a).**

Table 21.8. Smooth-hounds in the Northeast Atlantic. Commercial length data available from UK and France (2020–2022) used in the assessment to calculate L_c. Note: Numbers rounded to two decimal places, with calculations made with un-rounded numbers.

L_T (cm)	Numbers	L_T (cm)	Numbers	L_T (cm)	Numbers
26	2.88	61	69.42	96	25.93
27	3.60	62	75.00	97	17.39
28	1.18	63	72.82	98	25.71
29	1.53	64	96.15	99	11.81
30	4.05	65	93.41	100	14.01
31	25.43	66	65.17	101	17.21
32	2.49	67	78.40	102	11.05
33	13.09	68	108.79	103	11.83
34	20.61	69	108.50	104	15.20
35	14.74	70	90.30	105	8.90
36	20.64	71	125.22	106	5.60
37	22.75	72	101.43	107	6.59
38	42.43	73	177.97	108	4.07
39	51.82	74	120.05	109	3.50
40	102.70	75	94.14	110	7.02
41	126.69	76	85.12	111	2.81
42	110.83	77	100.52	112	3.94
43	116.92	78	87.39	113	2.70
44	89.96	79	154.02	114	2.90
45	115.08	80	91.55	115	1.78
46	121.30	81	107.46	116	0.55
47	125.33	82	64.72	117	3.43
48	68.43	83	97.48	118	1.23
49	79.11	84	68.87	120	0.61
50	89.72	85	84.73	121	0.53
51	56.43	86	84.19	122	0.98
52	75.37	87	61.45	125	0.11
53	52.64	88	69.49		
54	62.90	89	81.94		
55	88.70	90	79.67		
56	57.22	91	60.01		
57	39.66	92	50.17		
58	54.70	93	28.77		
59	63.94	94	38.54		
60	46.72	95	28.38		

Table 21.9. Smooth-hounds in the Northeast Atlantic. L_{mean}, $L_{F=M}$, f, and inverse f values for the years 2020–2022 using different L_{inf}. L_c calculated using pooled length data from commercial catches from UK and France (2020–2022). Note: In bold values used in the final assessment.

Year	L_c	L_{mean}	Using L_{inf} derived from L_{max} observed in McCully Phillips and Ellis (2015)			Using L_{inf} from Farrell *et al.* (2010)		
			$L_{F=M}$	f	inverse f	$L_{F=M}$	f	inverse f
2020	**40**	**70**	**63**	**1.12**	**0.89**	61	1.16	0.87
2021	**40**	**69**	**63**	**1.11**	**0.90**	61	1.14	0.88
2022	**40**	**66**	**63**	**1.06**	**0.94**	61	1.09	0.92

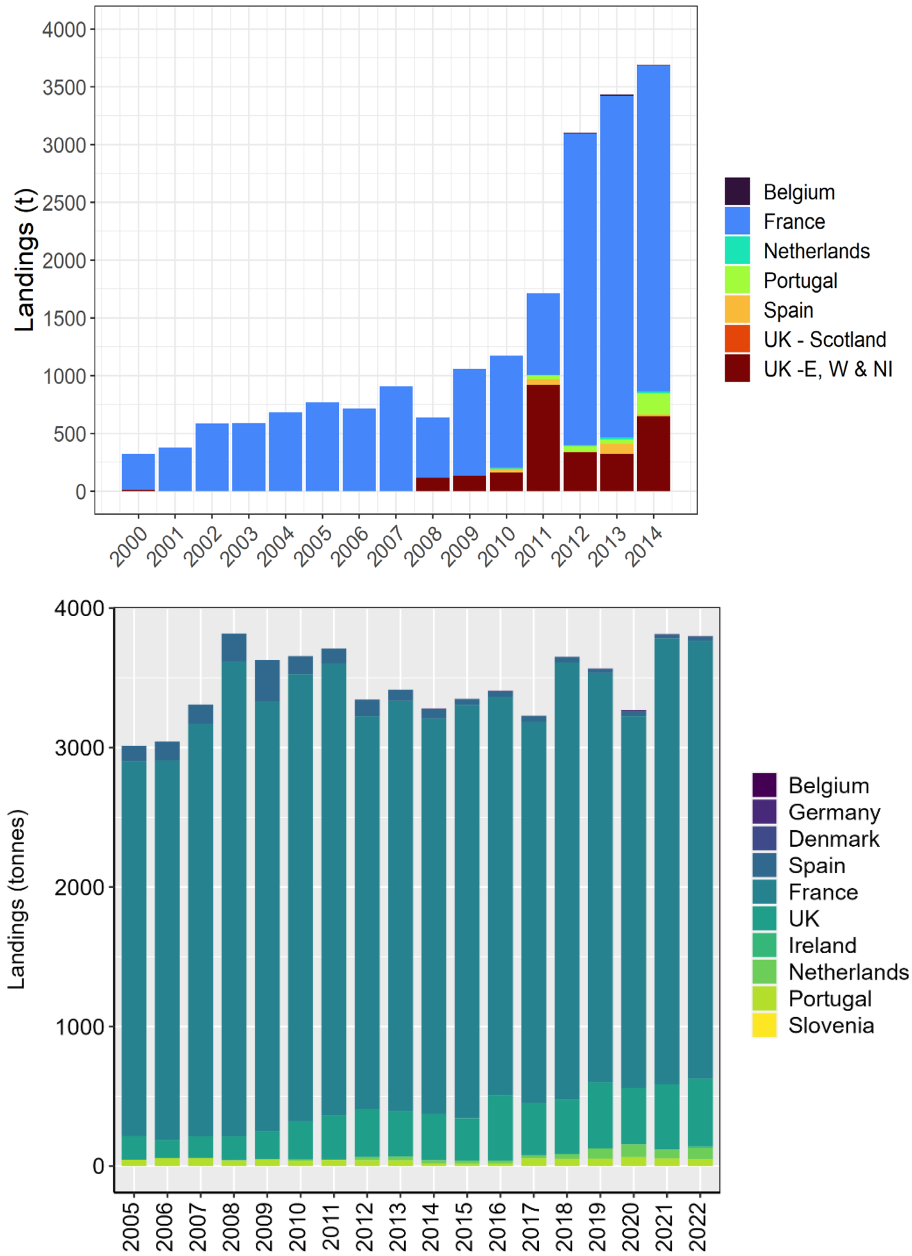


Figure 21.1. Smooth-hounds in the Northeast Atlantic. Earlier ICES estimates of overall *Mustelus* spp. landings by country (2000–2014; top) and revised ICES estimates (2005–2022; bottom). Data are considered underestimates.

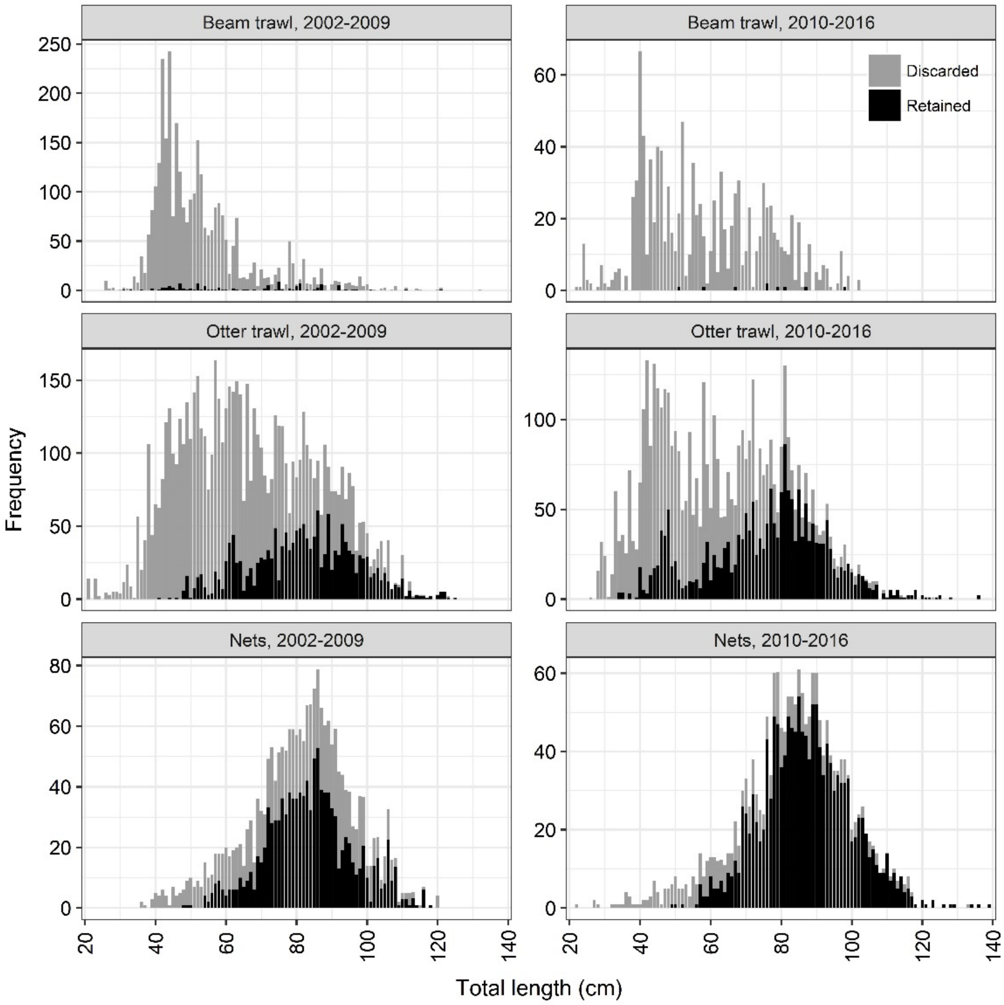


Figure 21.2. Smooth-hounds in the Northeast Atlantic. Length–frequency of discarded (pale grey) and retained (dark grey) starry smooth-hound *Mustelus asterias* caught by beam trawl, otter trawl and gillnets during the periods 2002–2009 and 2010–2016, as recorded in the Cefas observer programme. Data aggregated across North Sea and Celtic Seas ecoregions. (Source: Silva and Ellis, 2019).

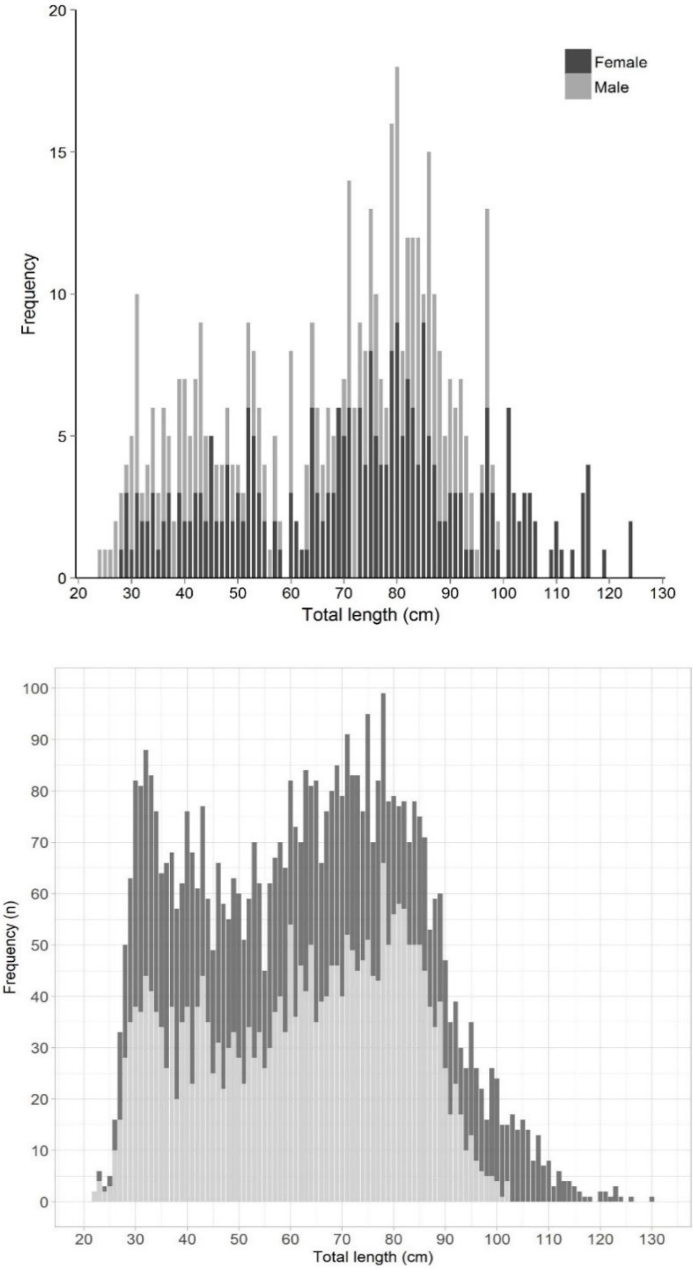


Figure 21.3. Smooth-hounds in the Northeast Atlantic. Number of starry smooth-hounds biologically sampled by length and sex (top; n = 504) from McCully Phillips and Ellis (2015) and (bottom; n = 4951) from Ellis *et al.* (2019 WD).

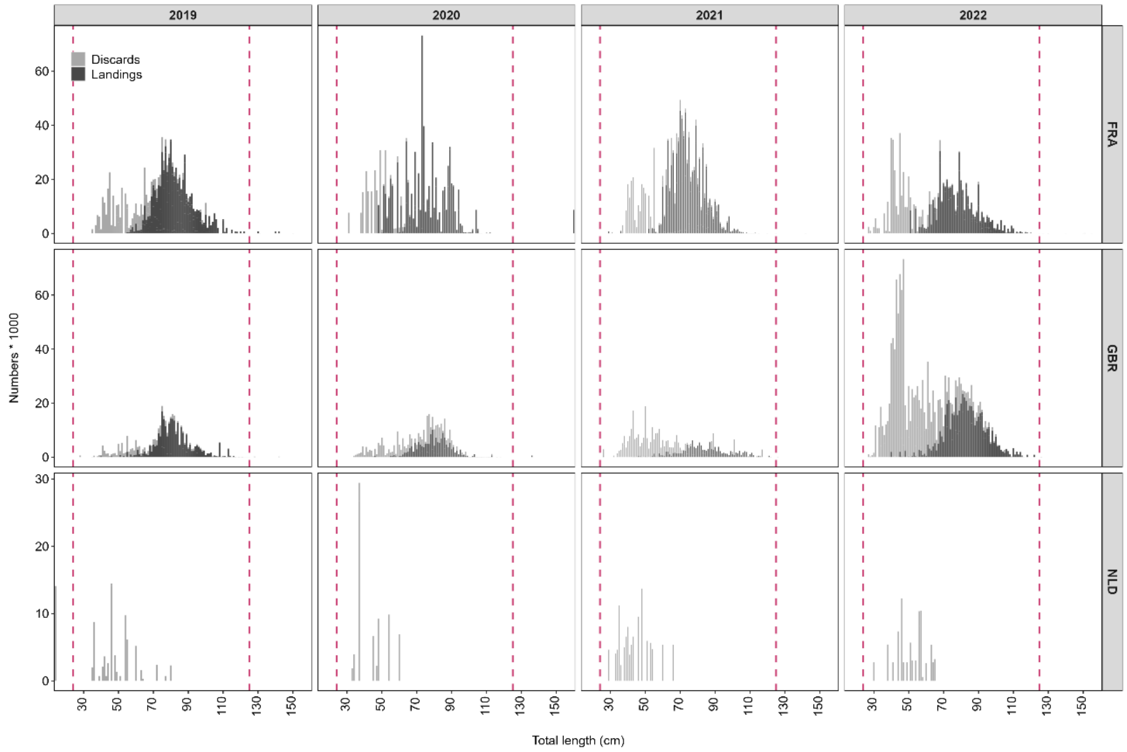


Figure 21.4. Smooth-hounds in the Northeast Atlantic. Combined commercial length data available by country for 2019–2022. Note: data prior to 2019 not shown, only data from 2020 onwards were used in the assessment. Dashed pink line refer to the lengths cut off used at 24 cm L_T and 125 cm L_T.

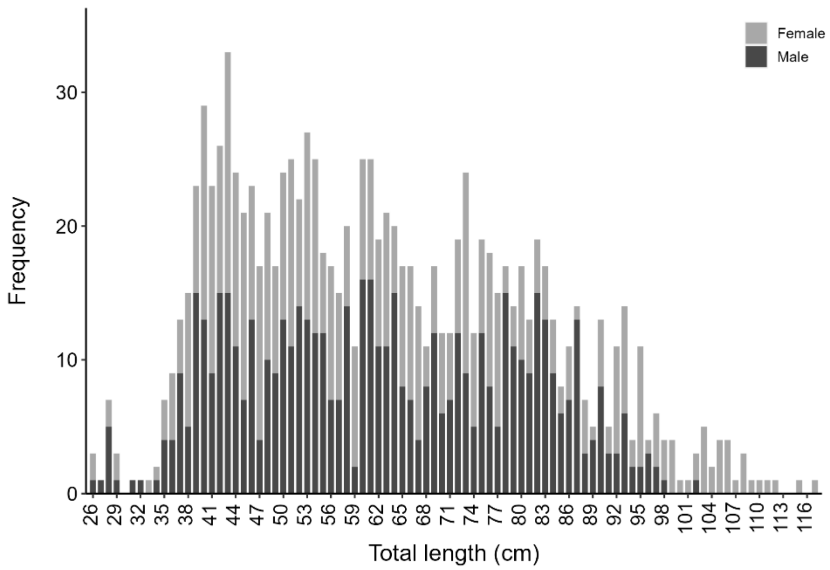


Figure 21.5. Smooth-hounds in the Northeast Atlantic. Length–frequency by sex of smooth-hounds *Mustelus* spp. encountered during the UK western Channel Q1 Beam-trawl survey 2006–2022 in strata broadly equating to Division 7.e. Source: DATRAS.

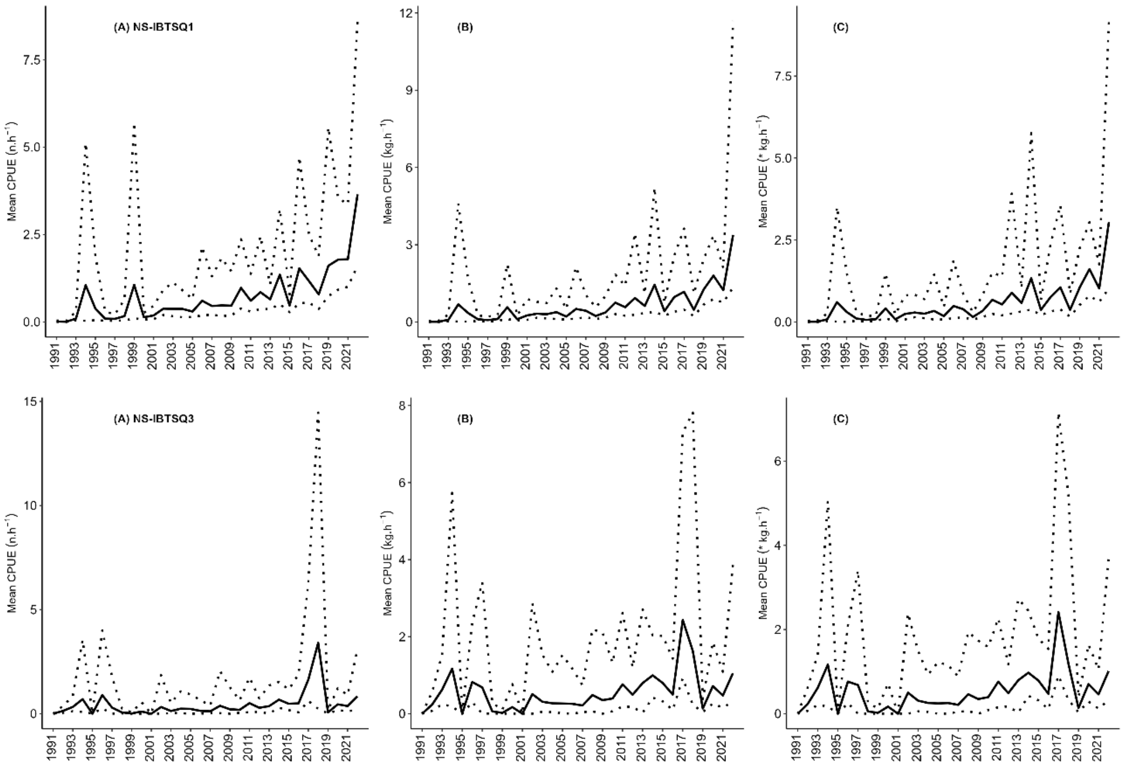


Figure 21.6. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (95% CI) (A – number per hour; B – estimated biomass per hour; and C – estimated exploitable biomass for individuals ≥50 cm total length) in NS-IBTS-Q1 (top) and NS-IBTS-Q3 (bottom) of the North Sea. Note: NS-IBTS-Q3 excludes Danish data. Updated survey estimates in 2023 for whole time-series. Source: DATRAS.

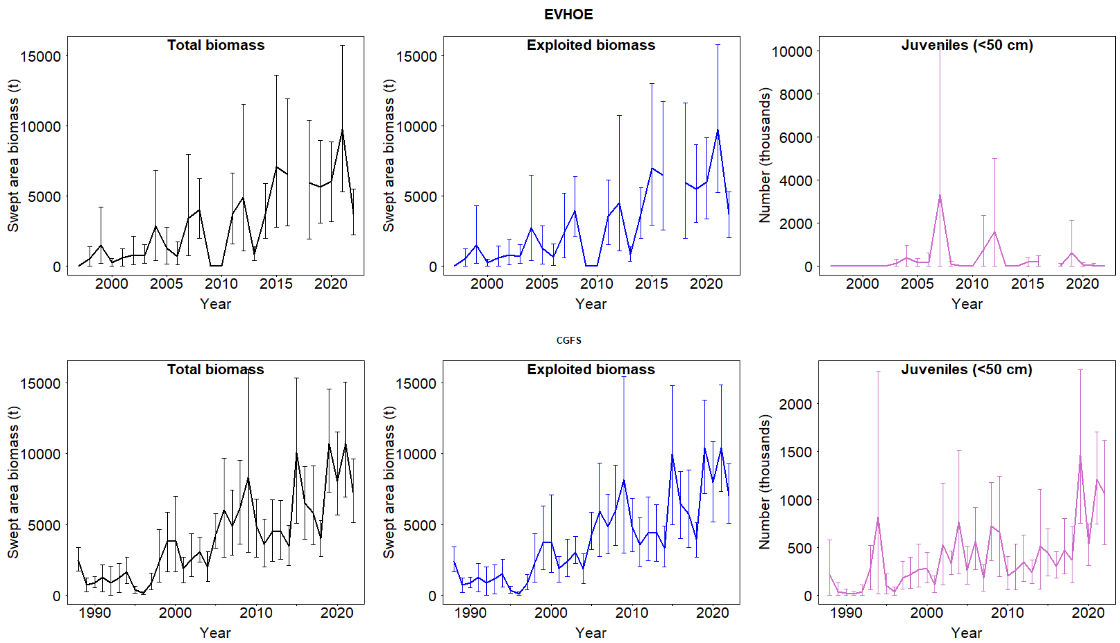


Figure 21.7. Smooth-hounds in the Northeast Atlantic. Swept area exploitable biomass index and associated confidence intervals (95% CIs) from the EVHOE-WIBTS-Q4 survey in divisions 7.g-j, 8.a.b.d (top) and FR-CGFS-Q4 in Division 7.d

(bottom). Note: both surveys indices updated in 2023 for the whole time-series, EVHOE-WIBTS-Q4 survey did not occur in 2017. Source: DATRAS.

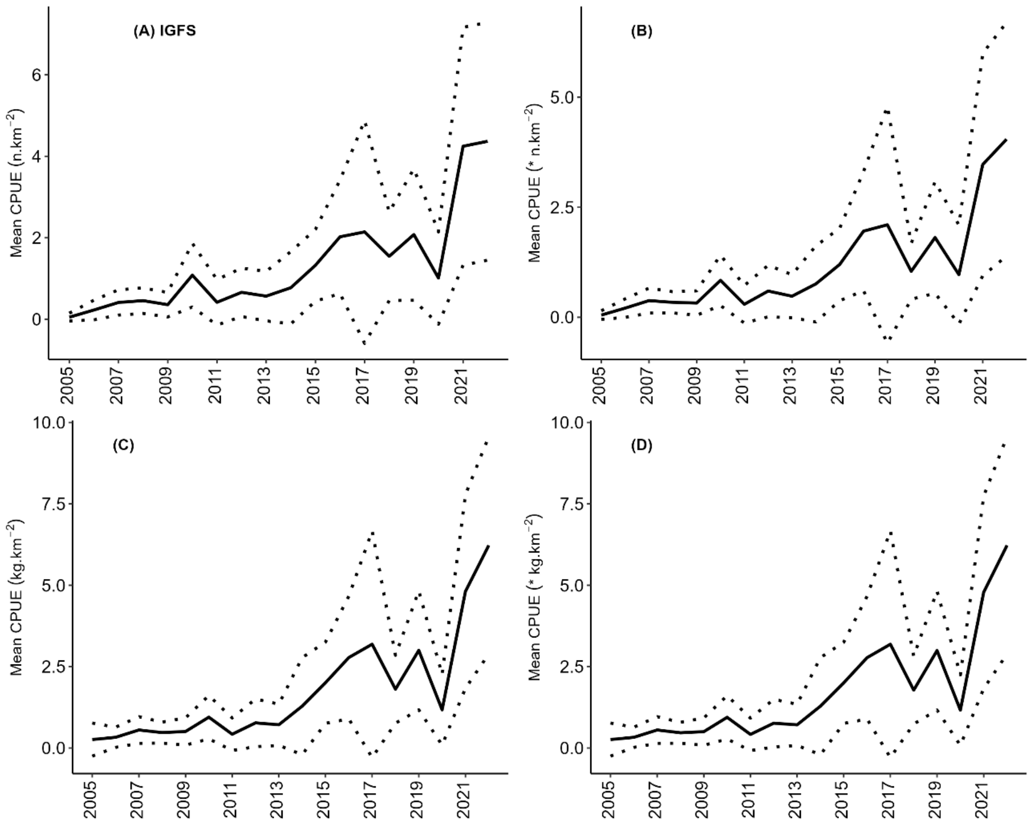


Figure 21.8. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (95%CI) by (A) total abundance (n.km^{-2}), (B) total biomass (kg.km^{-2}), (C) abundance for individuals ≥50 cm total length (*n.km^{-2}) and (D) biomass for individuals ≥50 cm total length (*kg.km^{-2}) from the IE-IGFS-WIBTS-Q4.

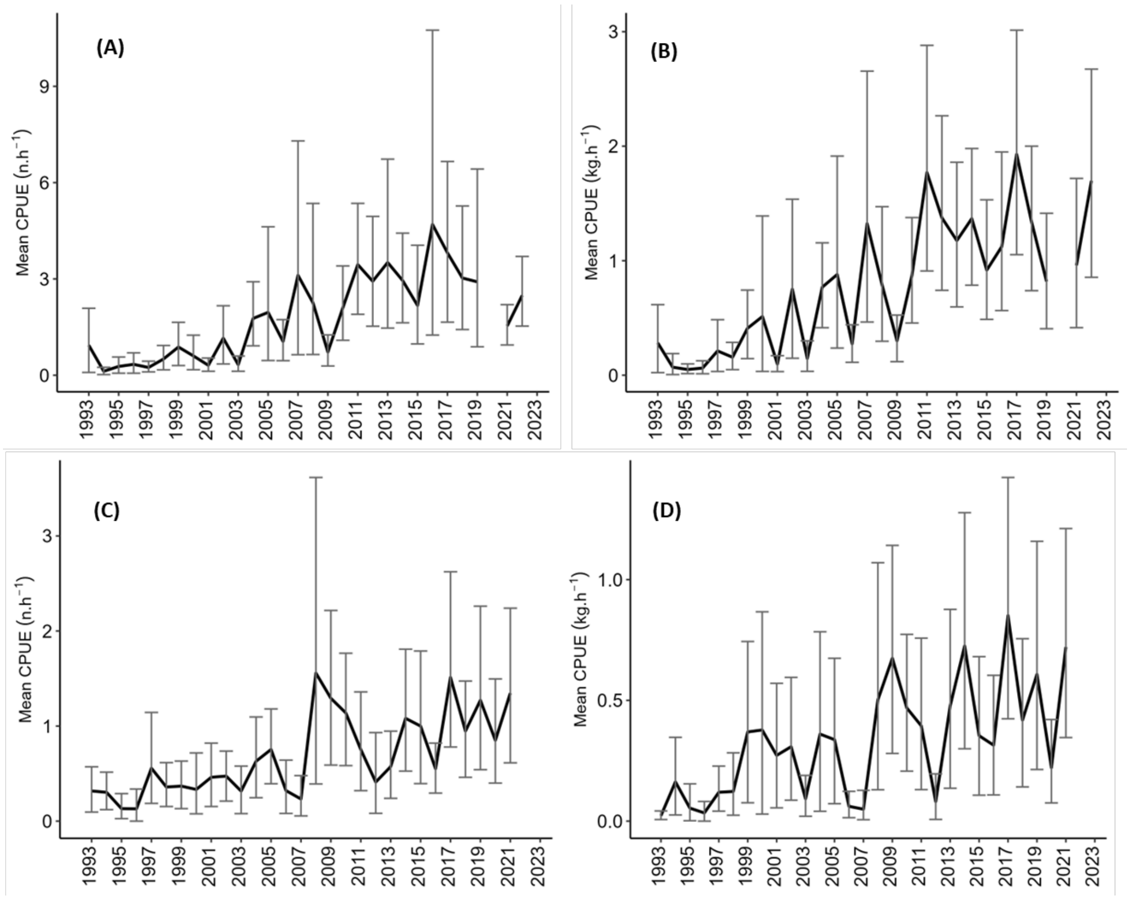


Figure 21.9. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (number per hour for all individuals, estimated total biomass per hour and 95%CI) from UK(E&W)-BTS-Q3 in the Bristol Channel and Irish Sea (top, panel A and B) and BTS-Eng-Q3 in the eastern English Channel and southern North Sea (bottom, panel C and D). Note: 2020 value (top, panel A and B) not shown as survey did not cover Division 7.a (see Section 21.6.2). No data available for 2022 (bottom, panel C and D). Survey indices were updated in 2023.

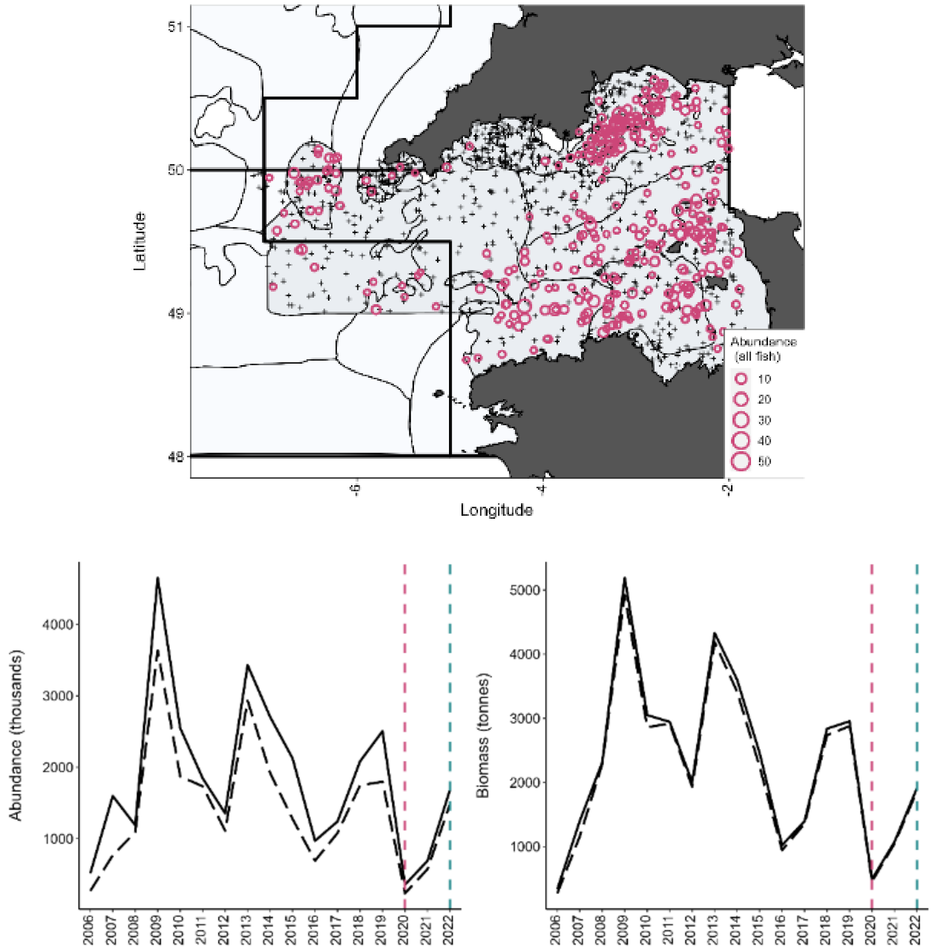


Figure 21.10. Smooth-hounds in the Northeast Atlantic. Spatial distribution and relative abundance of *Mustelus* spp. in the UK-Q1SWBeam (2006–2022) in 7.e (top), and the total abundance (numbers in thousands) and total biomass (tonnes) in 7.e for *Mustelus* spp (bottom). Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. Source: DATRAS. Note: Pink and teal dashed line shown only for illustrative purposes. In 2020 (pink), survey occurred in a different season and, in 2022 (teal) survey coverage was reduced within 7.e strata thus, potentially impacting survey estimates. These data should be viewed with caution.

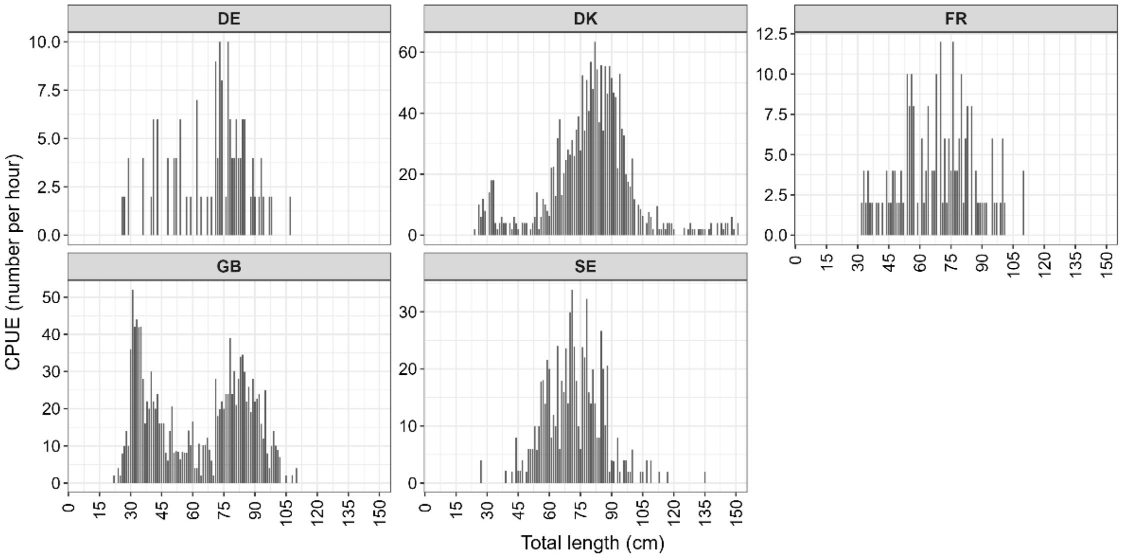


Figure 21.11. Smooth-hounds in the Northeast Atlantic. Length distributions of *Mustelus* spp. in the NS-IBTS-Q3 by nation during 1992–2022. Most nations record *Mustelus* spp. up to 110 cm, while Danish data (to 151 cm) suggests there may be misidentification with *Galeorhinus galeus* or coding errors. Note: DE - Germany, DK - Denmark, FR – France, GB – England, SE – Sweden. Note: Scottish records not shown as data are limited.

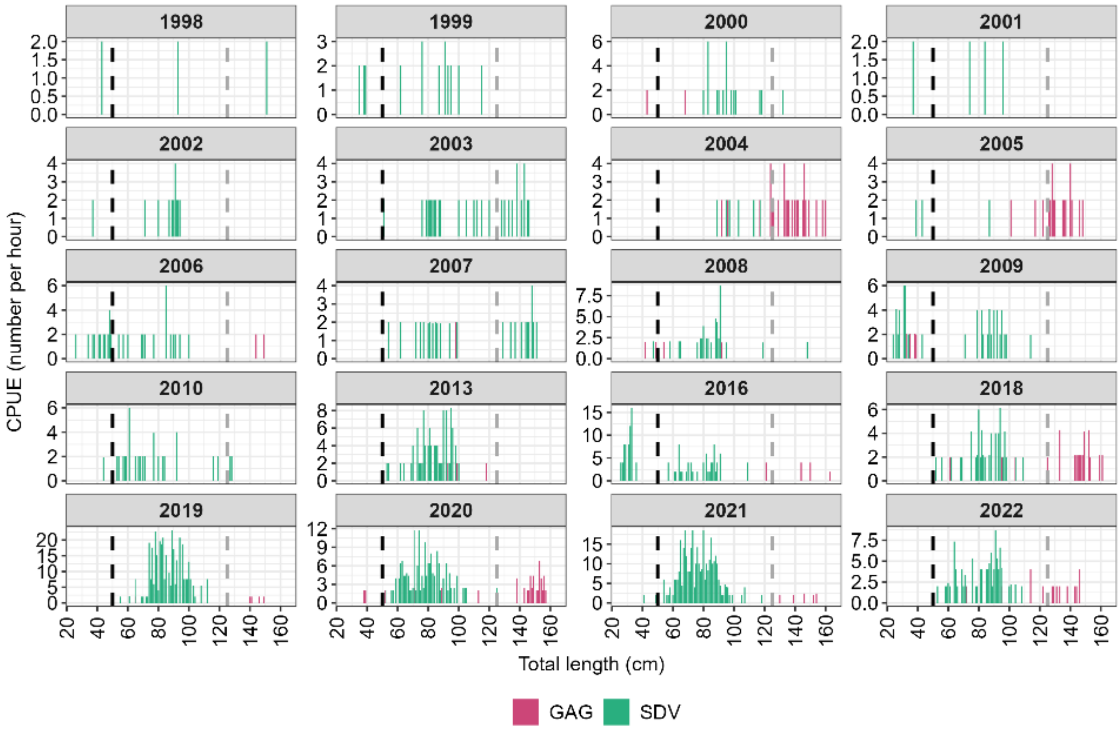


Figure 21.12. Smooth-hounds in the Northeast Atlantic. Length distributions of triakid sharks as reported on DATRAS during NS-IBTS-Q3 for Danish data (1992–2022). Large specimens of triakid sharks (i.e. SDV – *Mustelus* spp. or GAG - *Galeorhinus galeus*) are not usually captured in the same year, which suggests potential identification issues or coding errors. Note: Dashed black line refers to 50 cm L_T, with fish equal or above considered as the exploitable biomass. Grey dashed line refers to the 125 cm L_T used as a cut off length when using commercial length data in the assessment, and here shown for illustrative purposes only.

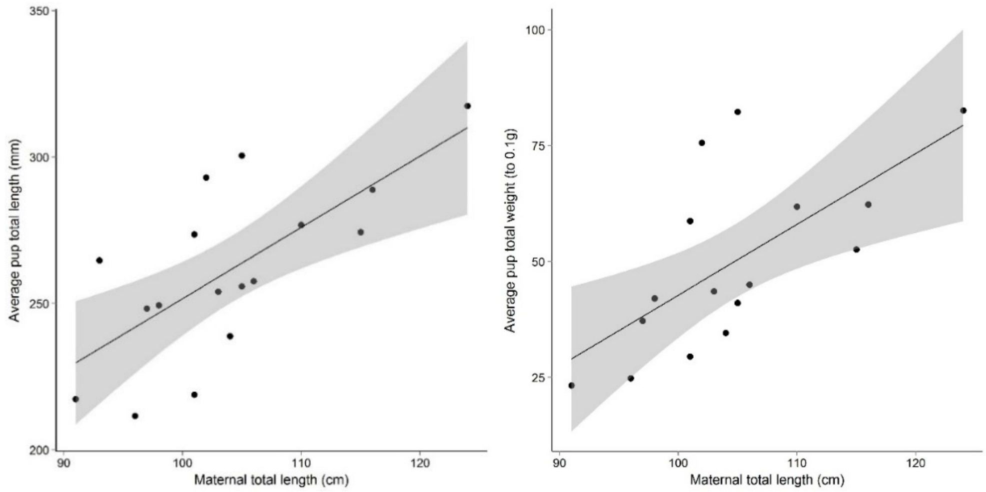


Figure 21.13. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and average length and weight of term pups. Source: McCully Phillips and Ellis (2015).

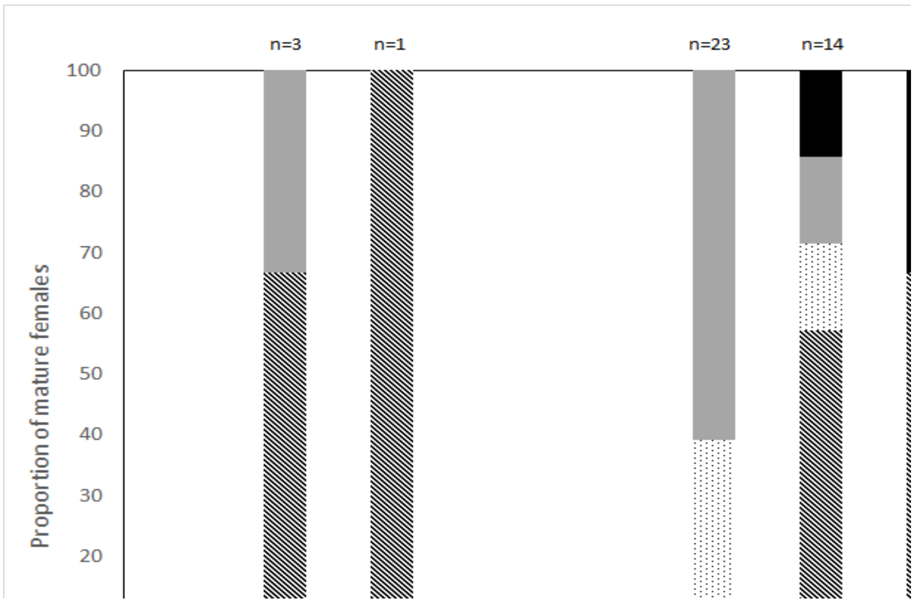


Figure 21.14. Smooth-hounds in the Northeast Atlantic. Percentage of mature females at each developmental stage (D: early gravid; E: mid-gravid; F: late gravid; G: post-partum) by month. Source: McCully Phillips and Ellis (2015).

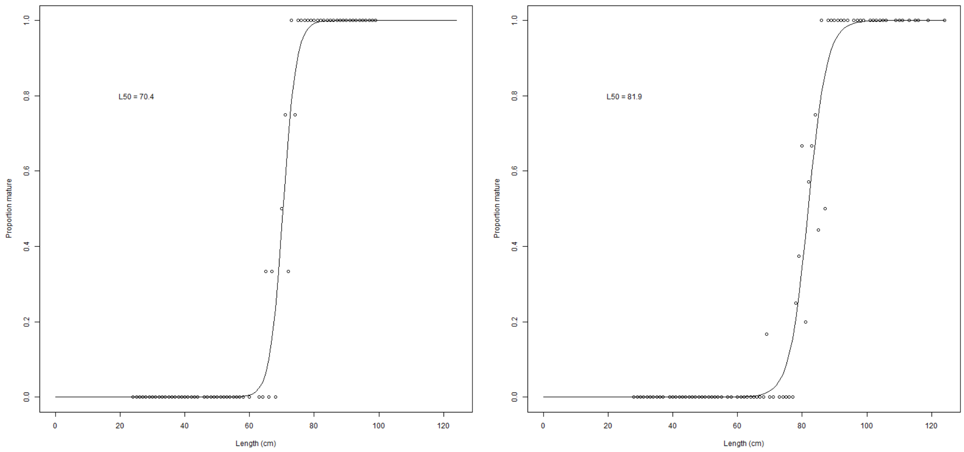


Figure 21.15. Smooth-hounds in the Northeast Atlantic. Maturity ogive for male (n = 237; L_{50} = 70.4 = cm L_T) and female (n = 248; L_{50} = 81.9 cm L_T) *M. asterias*. Source: McCully Phillips and Ellis (2015).

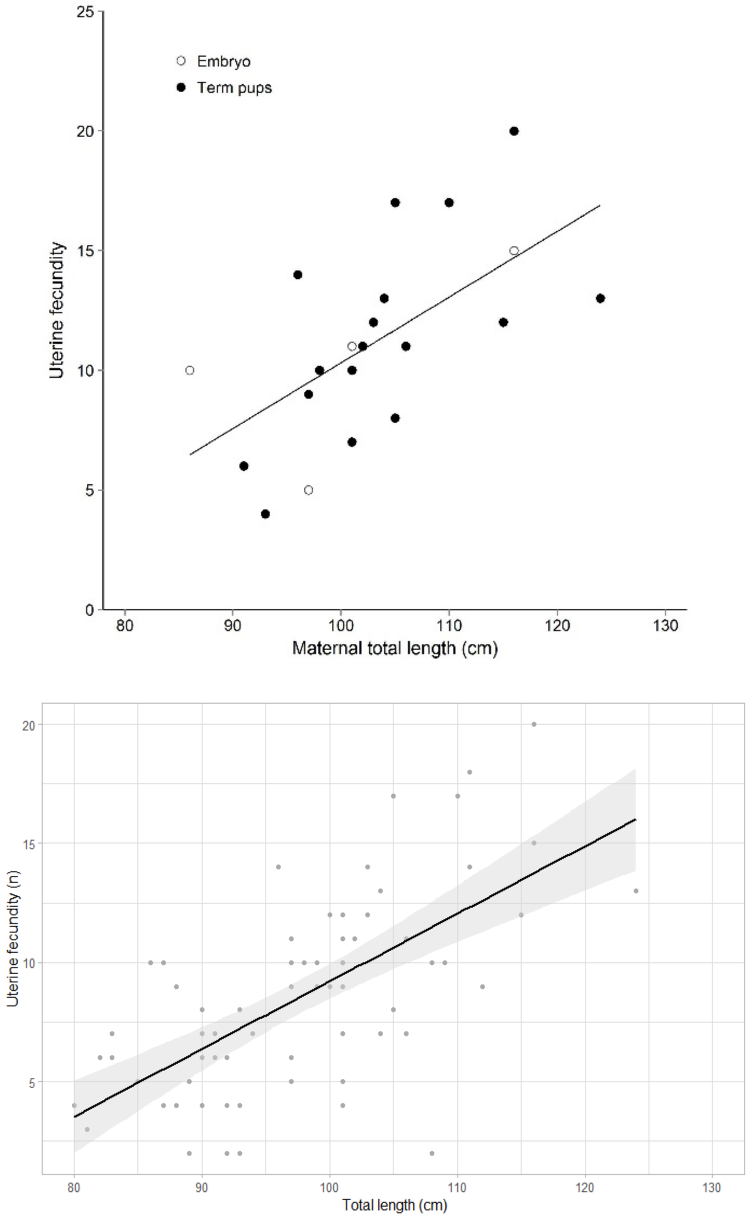


Figure 21.16. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and uterine fecundity (top) from McCully Phillips and Ellis (2015) and (bottom) from Ellis *et al.* (2019 WD).

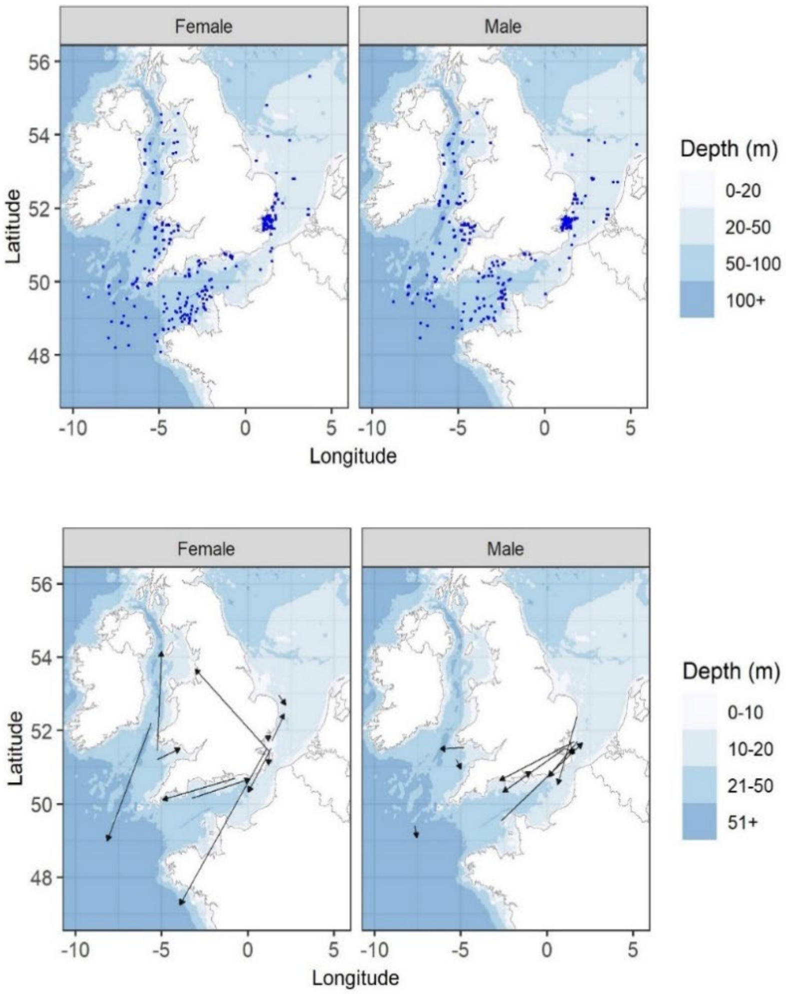


Figure 21.17. Smooth-hounds in the Northeast Atlantic. Tagging locations (top) and displacement vectors (bottom) for male and female *M. asterias*. Source: Ellis *et al.* (2019 WD).

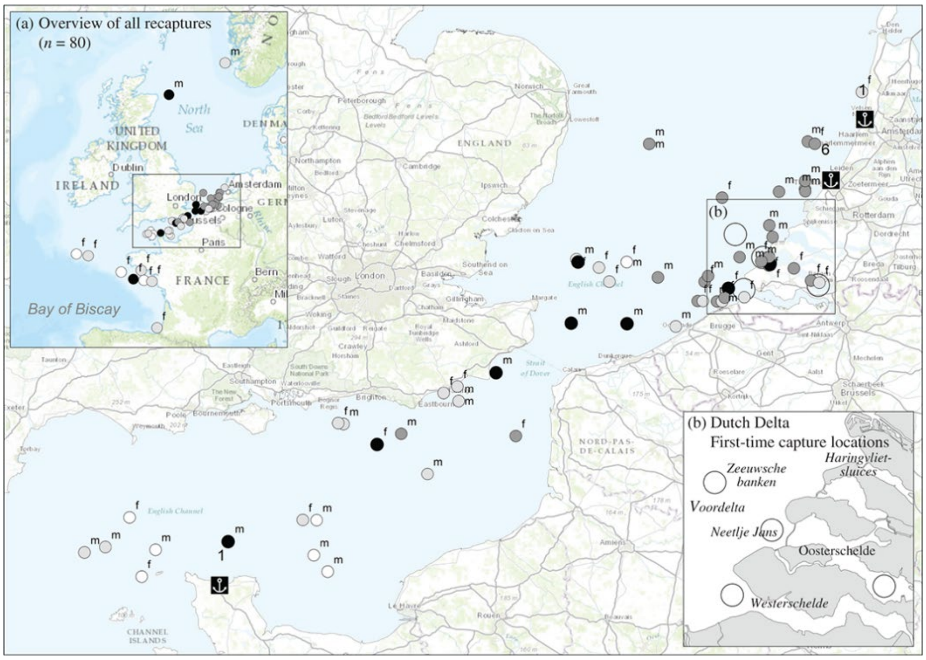


Figure 21.18. Smooth-hounds in the Northeast Atlantic. The main map shows the more detailed distribution of recaptures in the English Channel and southern North Sea. From three fish markets (indicated with anchors), eight tagged *M. asterias* were reported (numbers next to the anchors represent the number of sharks from each fish market) with unknown re-capture location. Inset (a) shows the locations of recaptured *Mustelus asterias* (n = 80) reported by quarter for the years 2011–2014. Their distribution pattern indicates a circannual migration between the Dutch Delta (summer), the English Channel and Bay of Biscay (winter). Inset (b) shows the tag and release location with the main places fished indicated with open circles. Symbols: f = female; m = male; recaptures per quarter are shown for January to March (○), April to June (○), July to September (●) and October to December (●). Source: Brevé *et al*. (2016).

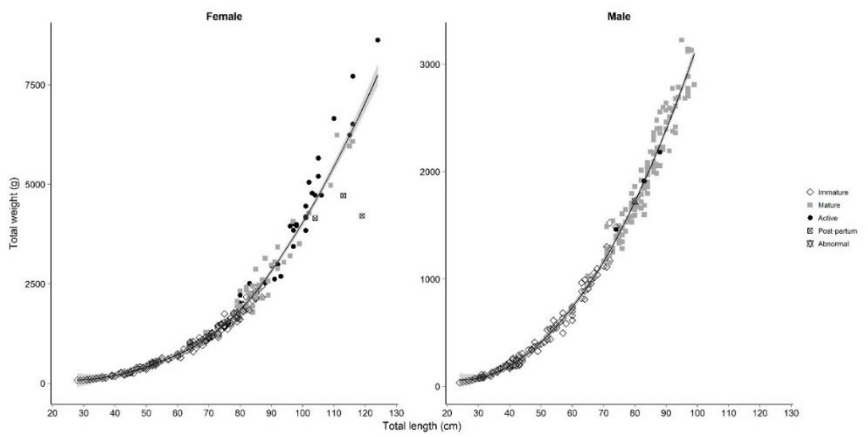


Figure 21.19. Smooth-hounds in the Northeast Atlantic. Length–weight relationship for female (n = 248) and male (n = 237) *M. asterias* by maturity stage (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

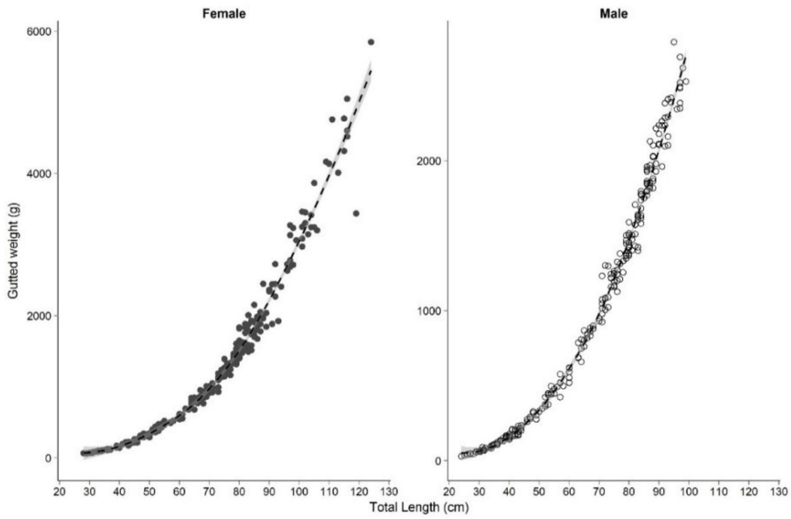


Figure 21.20. Smooth-hounds in the Northeast Atlantic. Total length to gutted weight relationship for female (n = 249) and male (n = 235) *M. asterias* (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

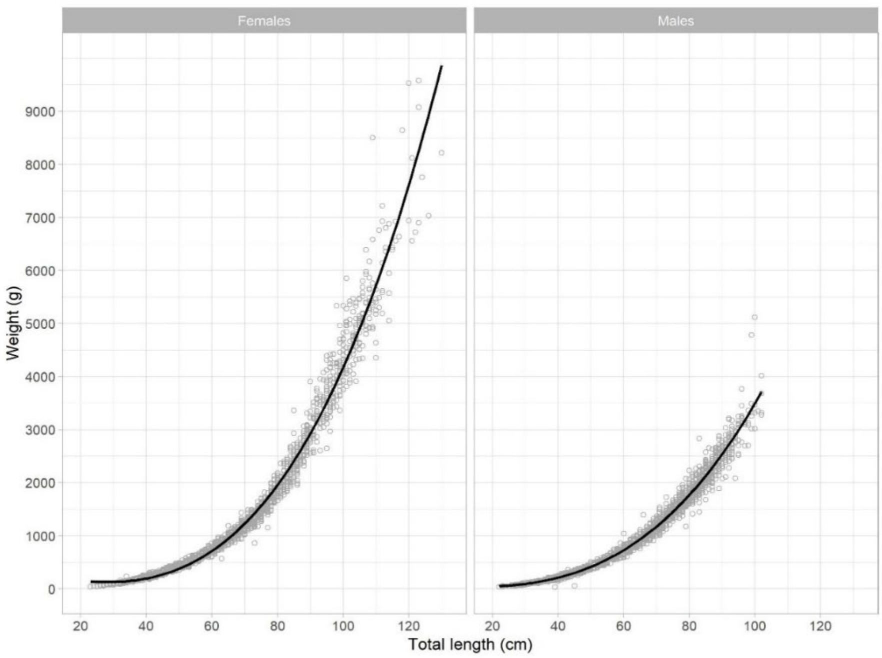


Figure 21.21. Smooth-hounds in the Northeast Atlantic. Length–weight relationships for female and male *M. asterias* caught in fishery-independent trawl surveys conducted by Cefas between 2009–2019. Relationships are described by the equations: females, $M_T = 0.002\ T_L^{3.1}$ ($r^2 = 0.992$, n = 2323); males, $M_T = 0.003\ T_L^{3.0}$ ($r^2 = 0.991$, n = 2471). M_T = Total weight (g), L_T = Total length (cm). Source: Ellis *et al*. (2019 WD).

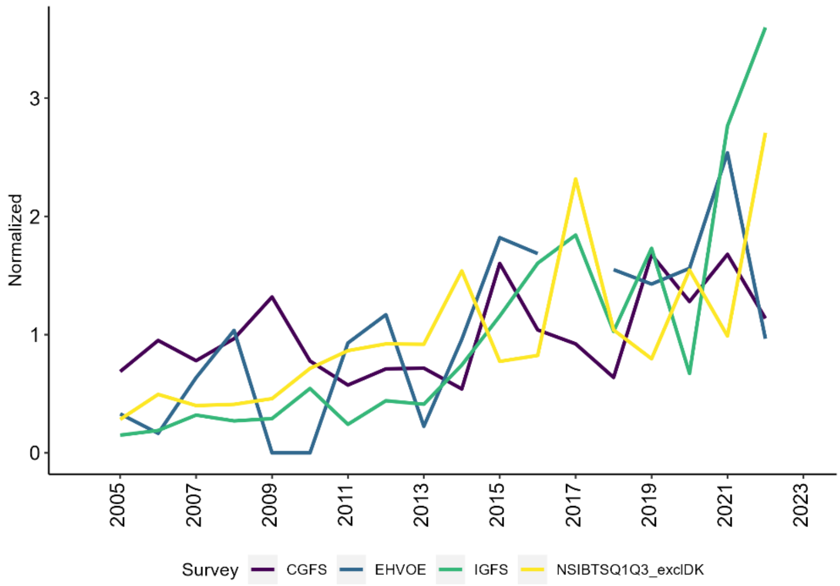


Figure 21.22. Smooth-hounds in the Northeast Atlantic. Normalized exploitable biomass index (individuals of ≥ 50 cm L_T) of starry smooth-hound of the average of the two NS-IBTS surveys (NS-IBTS-Q1 and NS-IBTS-Q3), EVHOE-WIBTS-Q4, FR-CGFS-Q4 and IE-IGFS-WIBTS-Q4. Note: Danish data excluded from NS-IBTS-Q3.

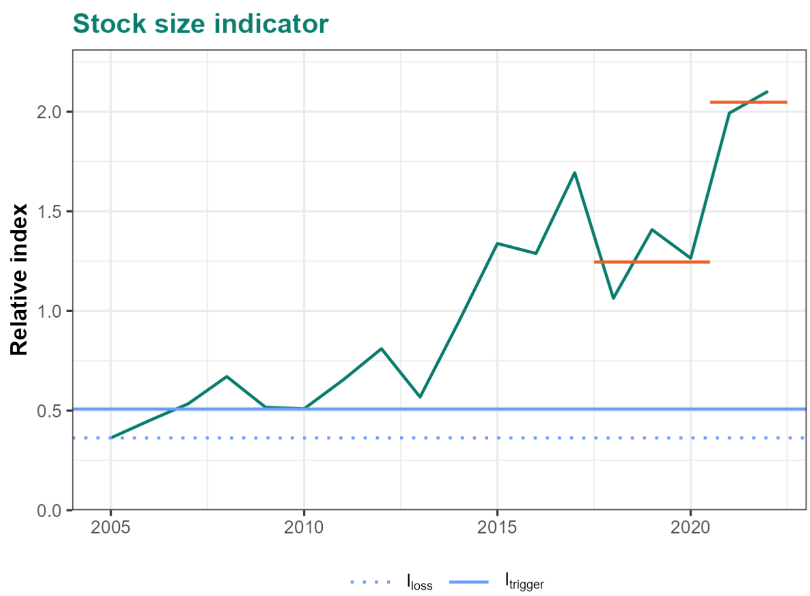


Figure 21.23. Smooth-hounds in the Northeast Atlantic. Stock size indicator is the mean normalized exploitable biomass index (individuals of ≥ 50 cm L_T) of starry smooth-hound from the average of the two NS-IBTS surveys (NS-IBTS-Q1 and NS-IBTS-Q3), EVHOE-WIBTS-Q4, FR-CGFS-Q4 and IE-IGFS-WIBTS-Q4. The horizontal orange lines show the mean stock indicators for 2021–2022 and 2018–2020.

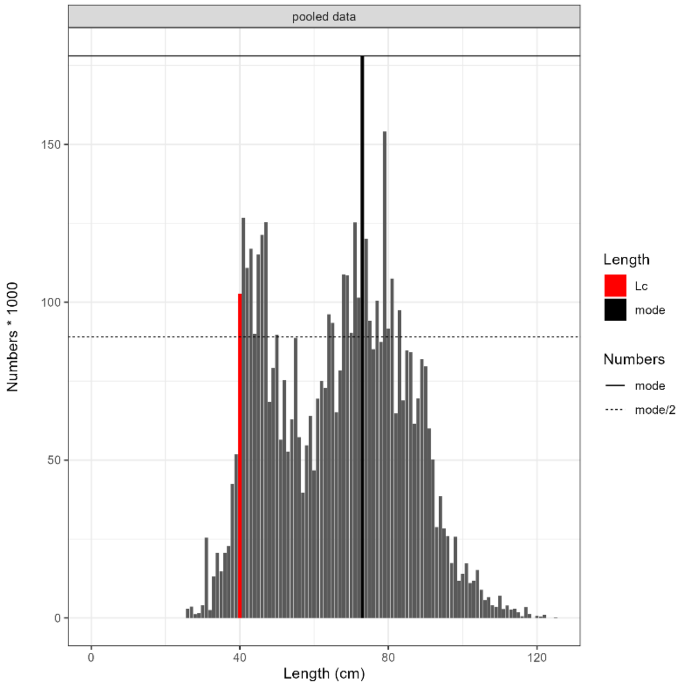


Figure 21.24. Smooth-hounds in the Northeast Atlantic. Combined commercial length data from UK and France (2020–2022) used in the application of the rfb. Note: L_c estimated from pooled data at 40 cm L_T.

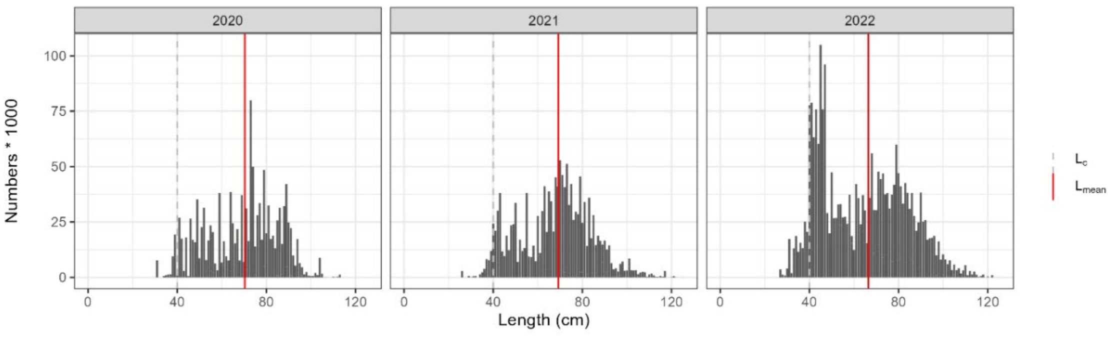


Figure 21.25. Smooth-hounds in the Northeast Atlantic. Combined commercial length data from UK and France (2020–2022) used in the application of the rfb. Note: L_c = 40 cm L_T; L_{mean} 2020 = 70 cm L_T; L_{mean} 2021 = 69 cm L_T; L_{mean} 2022 = 66 cm L_T.

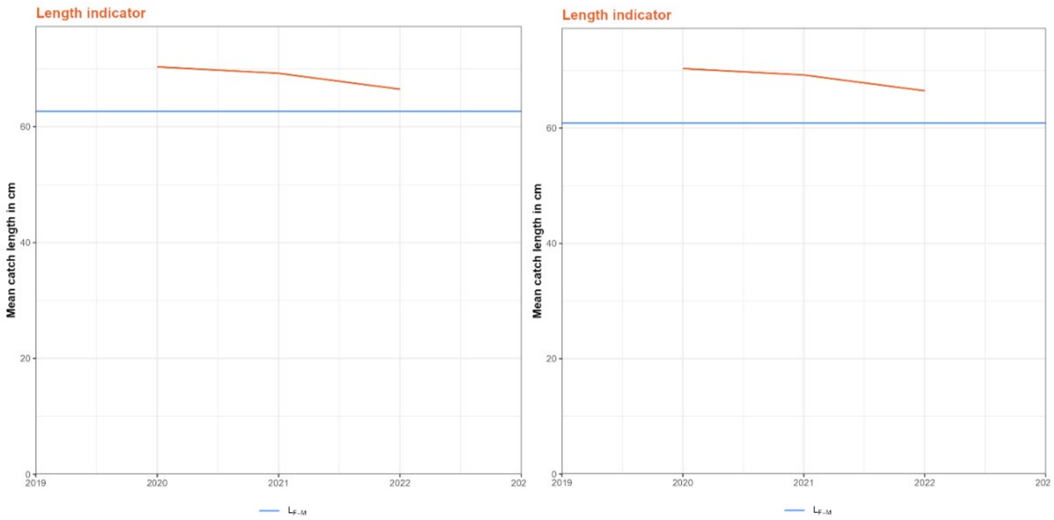


Figure 21.26. Smooth-hounds in the Northeast Atlantic. Fishing pressure proxy (f, $L_{mean}/L_{F=M}$) from the length-based indicator (LBI) method is used for the evaluation of the exploitation status. (Left, used in assessment) using L_{inf} derived from observed L_{max} of 124 cm L_T (McCully Phillips and Ellis, 2015) and (right) using L_{inf} 123.5 cm L_T (Farrell *et al.*, 2010).

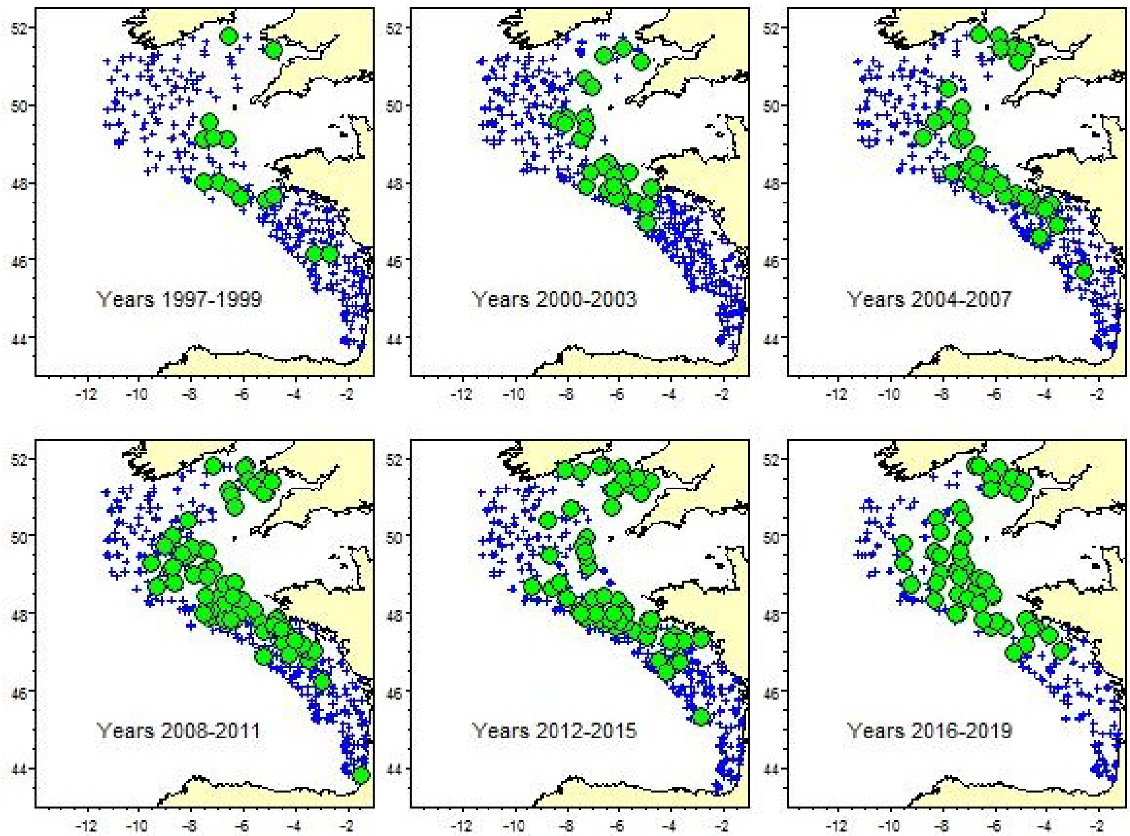


Figure 21. 27. Smooth-hounds in the Northeast Atlantic. Distribution of occurrences of *Mustelus* spp. (green points) in the EVHOE-WIBTS-Q4 survey (1997–2019) by groups of 4 years. Source: National data (Ifremer).

Contents

22 Angel shark *Squatina squatina* in the Northeast Atlantic

22.1 Stock distribution

Angel shark *Squatina squatina* was historically distributed from the British Isles southwards to western Africa, including the Mediterranean Sea (Roux, 1984). As such the species distribution covers parts of ICES subareas 4 and 6–9.

Stock structure is not known, but available data for this and other species of angel shark indicate high site specificity and possibly localized stocks. Mark–recapture data for angel shark have shown that a high proportion of fish are recaptured close to the original release location (Quigley, 2006), although some individuals undertake longer-distance movements. The failure of former populations in the southern North Sea and parts of the English Channel to re-establish is also suggestive of limited mixing. Studies on other species of angel shark elsewhere in the world have also indicated that angel sharks show limited movements and limited mixing (e.g. Gaida, 1997; Garcia *et al.*, 2015). STECF (2003) noted that angel sharks "*should be managed on smallest possible spatial scale*". The long-term decline of this species from various parts of its geographic range have been reported in recent studies (e.g. Hiddink *et al.,* 2019; Shepherd *et al.,* 2019; Bom *et al.,* 2020; Ellis *et al.*, 2021).

Given that this species is considered to be extirpated from parts of its North Atlantic range and is highly threatened both in the ICES area and elsewhere in its geographical range, ICES provide advice at the species level.

22.2 The fishery

22.2.1 History of the fishery

Angel shark is thought to have been the subject of exploitation for much of the 19th century and parts of the 20th century, and was exploited for meat, liver and skin. This species was the original fish termed 'monkfish' until catches declined and anglerfish *Lophius piscatorius* became a marketable species. As catches declined over the course of the 20th century, it was landed occasionally as a 'curio' for fish stalls.

Given the coastal nature of the species, it was also subject to fishing pressure from recreational fishing in parts of its range (e.g. the coasts of Ireland and Wales).

The species has been extirpated from parts of its former range, and most reports of this species in the ICES area are now from occasional bycatch records in trawl and gillnet fisheries (e.g. Tully, 2011; Iglésias *et al.*, 2020).

22.2.2 The fishery in 2023

No new information.

22.2.3 ICES Advice applicable

In 2008, ICES advised that angel shark in the North Sea eco-region was "*extirpated in the North Sea. It may still occur in Division VIId*" (ICES, 2008a). For the Celtic Seas, ICES advised that it "*has a localized and patchy distribution, and is extirpated from parts of its former range. It should receive the highest possible protection. Any incidental bycatch should not be landed, but returned to the sea, as they are likely to have a high survival rate*" (ICES, 2008b).

In both 2010 and 2012, ICES advised that it should remain on the list of Prohibited Species (ICES, 2012).

In 2015, ICES advised that "*when the precautionary approach is applied for angel shark in the Northeast Atlantic, no targeted fisheries should be permitted and bycatch should be minimized. ICES considers that this species should remain on the EU prohibited species list. This advice is valid for 2016 to 2019*".

In 2019, ICES advised that "*when the precautionary approach is applied, there should be zero catches in each of the years 2020–2023*". This advice was reiterated in 2023 for "*each of the years 2024–2027*".

22.2.4 Management applicable

Council Regulation (EC) 43/2009 stated that "*Angel shark in all EC waters may not be retained on board. Catches of these species shall be promptly released unharmed to the extent practicable*".

It was subsequently included on the list of Prohibited Species, under which it is prohibited for EU vessels to fish for, to retain on board, to transship and to land angel shark in EU waters (e.g. Council Regulations (EC) 2018/120). This was subsequently also translated into UK law since 2021.

In 2019, angel shark was listed as a prohibited species (in all Union waters) on Annex I of EU (2019), and thus is no longer specified on the annual documents relating to EU fishing opportunities.

Within the Mediterranean Sea, GFCM "*Recommendation GFCM/42/2018/2 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application, amending Recommendation GFCM/36/2012/3*" states that "*CPCs shall ensure a high protection from fishing activities for elasmobranch species listed in Annex II of the SPA/BD Protocol of the Barcelona Convention* [that includes angel shark], *which must be released unharmed and alive, to the extent possible*" and that "*Specimens of shark species listed in Annex II of the SPA/BD Protocol shall not be retained on board, transhipped, landed, transferred, stored, sold or displayed or offered for sale*".

Within the UK, angel shark is afforded protection through its listing on the Wildlife and Countryside Act (WCA) and it is also listed on Scottish Statutory Instrument (SI) 2012 No. 63 (the Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order).

In 2017, angel shark was added to Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; see Section 22.12). CMS Parties that are Range States to Appendix I listed species should, under Article III(5), "*prohibit the taking of animals belonging to such species*".

In 2019, The Spanish Ministerio para la Transición Ecológica (MITECO) updated the national "*Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas*" (List of Wild Species under Special Protection Regime and the Spanish Catalogue of Threatened Species) to include angel shark (Boletín Oficial del Estado, BOE, 2019).

22.3 Catch data

22.3.1 Landings

Angel shark became increasingly rare in landings data over the available time-period and was reported only rarely prior to it being listed as a Prohibited Species (Table 22.1; Figure 22.1). Total landings have been <2 t for the last 30-years. It is believed that the peak in UK official landings in 1997 from Divisions 7.j-k were either misreported anglerfish (also called monkfish) or hake, given that angel shark is a more coastal species. These figures have been removed from the WGEF estimates of landings. French landings declined from >20 t in 1978 to less than 2 t per year prior to the prohibition on landings.

There are no data available for the numbers of angel shark landed during the recreational fisheries that existed in parts of their range.

22.3.2 Discards

Limited data are available. Analyses of the main discard observer programme for the English and Welsh fleets found that no angel sharks had been observed (Silva *et al.*, 2019), whilst observer trips conducted by the Sea Mammal Research Unit (SMRU) recorded three individuals over the period 2011–2014 (Allen Kingston, pers. comm. 2015). These specimens were caught on 29 April 2011 (50.93°N, 6.65°W, 95 m water depth) and 19 September 2014 (53.40°N, 3.60°W and 53.40°N, 3.63°W, 15–16 m water depth). All were caught in tangle or trammel nets (soak times of 64–78 hours), were of estimated individual weights of 15–25 kg and were all dead.

Examination of data collected under the French discard observer programme (2003–2013) indicated that only two individuals were observed (both in 2012) in the ICES area. According to observations from French fish markets and catches reported by fishermen, four additional individuals (two in 2007 and two in 2010) were also caught (S. Iglésias, pers. comm.). All these six individuals were caught off Pembrokeshire (Wales) at the southern entrance to St George's Channel. Iglésias *et al.* (2020) reported that a female angel shark (126 cm; 26 kg) caught by a bottom trawler (51.3810-51.4823°N; 5.5248–5.5603°W; 100 m depth; March 2018) was not discarded but eaten on board. It is unknown if this was an isolated incidence.

WKSHARK3 also reviewed available information on angel sharks observed during on-board observer programmes, also concluding this species was only observed very occasionally (ICES, 2017).

22.3.3 Quality of catch data

Catch data are incomplete, as data are unavailable for the periods when angel shark was more abundant. There are some concerns over the quality of some of the landings data (see above). The listing as a 'Prohibited Species' will result in commercial landings data nearing zero. Further studies of possible bycatch and fate of discards in known areas of occurrence would be needed to better estimate commercial catch.

Following the WKSHARKS data call in 2016, landings data-from 2005–2015 were re-assessed by WGEF. There were no major differences between previous landings and the new figures.

22.3.4 Discard survival

Limited data exist for the discard survival of angel shark caught in European fisheries. All three specimens observed by SMRU observers after capture by tangle- or trammel net were dead; soak times were 64–78 hours. Recently published observations from Corsica (Mediterranean) indicated that angel sharks caught by trammel nets in shallow water (<5 m depth) with shorter (<12 h) soak times could be released alive (Lapinski & Giovos, 2019).

Other angel shark species have been studied elsewhere in the world (Ellis *et al.*, 2017). Fennessy (1994) reported at-vessel mortality (AVM) of 60% for African angel shark *Squatina africana* caught by South African prawn trawlers. Braccini *et al.* (2012) reported AVM of 25% for Australian angel shark *S. australis* caught by gillnet (where soak times were <24 h).

22.4 Commercial catch composition

No data available.

22.5 Commercial catch and effort data

No data available for commercial fleets.

22.5.1 Recreational catch and effort data

Information from Inland Fisheries Ireland (IFI) was used by WGEF 2015 to inform on the status of angel shark. This indicated that the number of individuals caught by recreational fishers and reported to the specimen fish committee declined over the period 1958–2005 (Table 22.2), with an overall decline in the numbers caught (Figure 22.2).

Other data from the IFI National Marine Sport Fish Tagging Programme confirm the scarcity of angel shark. Tagging of angel sharks has declined markedly in the last 25 years. A total of 1029 individuals have been tagged since 1970, but only a single individual has been tagged since 2006, and no recaptured specimens reported since 2004 (Roche and O'Reilly, 2013 WD; Wögerbauer *et al.*, 2014 WD). Angel shark is now only caught by anglers very occasionally in Tralee Bay, estimated at <3 per year. The Irish angler tagging and specimen catch data have recently been combined with effort data from charter angling vessels to explore the apparent extirpation of this species from two former hotspots: Clew Bay and Tralee bay. This study showed a decline close to zero, despite apparent stable or increasing angler effort (Figure 22.4; Shephard *et al.*, 2019).

22.6 Fishery-independent data

Angel shark is encountered very rarely in trawl surveys, which may reflect the low abundance of the species, poor spatial overlap between surveys and refuge populations and their preferred habitats, and low catchability in some survey gears.

Occasional individuals have been captured in the UK beam trawl survey in Cardigan Bay, but the gear used (4 m beam trawl with chain mat) is not thought to be suitable for catching larger angel sharks.

Existing surveys are not considered appropriate for monitoring the status of this species. Dedicated, non-destructive inshore surveys in areas of known or suspected presence could usefully be initiated. Visual census, combined with citizen-science data, satellite imagery, and snorkel surveys have been conducted around the Canary Islands to evaluate angel shark habitat in the region (Jimenez-Alvarado *et al.*, 2020). Surveys of eDNA in coastal waters could also usefully be undertaken to inform on potential sites of occurrence (Barker *et al.*, 2022; Faure *et al.*, 2023), as has been used for other angel sharks (e.g. Stoeckle *et al.*, 2021).

22.7 Life-history information

Limited life-history data are available (Table 22.3). Most recent biological data have come from studies in the Canary Islands (e.g. Meyers *et al.*, 2017), where this species is found regularly. Life-history parameters were recently collated by Ellis *et al.* (2021).

22.7.1 Habitat

Angel shark is a coastal species that has often been reported from sand bank habitats, sandy areas close to reefs, and similar topographic features. This ambush predator buries into the sand for camouflage. Angel sharks are thought to be nocturnally active (Standora and Nelson, 1977).

In terms of recent information on their habitats, a potential over-wintering area may occur off Pembrokeshire (51°30' to 52°00'N and 5°03' to 6°03'W), small specimens have been reported in Cardigan Bay (summer) and the western coast of Ireland (particularly Tralee Bay) may be important "summer areas" for the species (Wögerbauer *et al*., 2014 WD). Barker *et al*. (2022) reported on the ongoing studies, coordinated by Zoological Society of London (ZSL) and Natural Resources Wales (NRW) to collate historic and recent sightings data (with >2000 records) around the Welsh coastline, especially Cardigan Bay to better understand habitat use and ecology in order to predict habitat suitability.

22.7.2 Spawning, parturition and nursery grounds

No specific information. Angel sharks giving birth have been reported from parts of the North Sea (e.g. Patterson, 1905) and small specimens have been found in the inshore waters or Cardigan Bay. Information from *Squatina squatina* in Wales (Barker *et al*., 2022) and other angel shark species elsewhere in the world suggests that there may be an inshore migration in early summer, with parturition occurring during the summer.

Around the Canary Islands, several sites have been identified as nursery areas. The first discovered and one of the most important is Teresitas beach (Escánez *et al.*, 2016) but others are; Puerto del Carmen and Bay of Sardinia (Jimenez-Alvarado *et al.*, 2020). For more information: https://asociaciontonina.com/portfolio/publicaciones/

22.7.3 Age and growth

No information available for *Squatina squatina.* Studies on other species of angel shark have reported problems using vertebrae for validated age determination (Natanson and Cailliet, 1986; Baremore *et al.*, 2009), with tagging studies providing some data (Cailliet *et al.*, 1992).

22.7.4 Reproductive biology

Angel sharks give birth to live young. Patterson (1905) reported on a female (ca. 124 cm long) that gave birth to 22 young. Capapé *et al.* (1990) reported a fecundity of 8–18 (ovarian) and 7–18 (uterine) for specimens from the Mediterranean Sea. Embryonic development takes one year, but the reproductive cycle may be two (or more) years, as indicated by other members of the genus (Bridge *et al.*, 1998; Colonello *et al.*, 2007; Baremore, 2010). From studies around the Canary

Islands, the reproductive cycle has been estimated at three years, which includes two years of ovarian development, six months of gestation period and six months of ovarian reabsorption (Osaer, 2009). Litter sizes ranged from 7–25 pups with size at birth from 24–30 cm (Osaer, 2009).

22.7.5 Movements and migrations

Tagging data indicate high site fidelity (Capapé *et al*., 1990; Quigley, 2006; ICES, 2013). More than half of tagged angel sharks were recaptured less than 10 km from their original location, but individuals are capable of travelling longer distances within a relatively short window (Figure 22.3; Wögerbauer *et al*., 2014 WD). Occasional longer-distance movements have been reported, with fish tagged off Ireland being recaptured off the south coast of England and in the Bay of Biscay (Quigley, 2006).

Seasonal migrations are suspected, with fish moving to deeper waters in the winter before returning to inshore waters for the summer. Other species of angel shark have also been shown to move into coastal waters in the summer, typically to give birth (Vögler *et al*., 2008).

The uncommon landing of about ten large individuals observed in 2000 from a French trawler fishing off southern Ireland, provide further evidence for localized aggregation of the species (S. Iglésias, *pers. comm*.).

22.7.6 Diet and role in the ecosystem

Angel shark is an ambush predator that predates on a variety of fish (especially flatfish) and various invertebrates (Ellis *et al*., 1996, 2021). In the Canary Islands, Narvaez (2012) found that teleosts were the most important prey item (89.8 %), followed by cephalopods (9.4 %).

22.8 Exploratory assessment models

An exploratory stock assessment of the Tralee Bay (Division 7.j) population, using data from the IFI Marine Sportfish Tagging Programme (Section 22.5.1), was undertaken (Bal *et al*., 2014 WD; ICES, 2014). This was updated after review (Bal *et al*., 2015 WD), with the approach, results and a discussion of the current state of the assessment presented in full in the WGEF 2015 report. In summary, Bal *et al*. (2015) suggested that the current population of angel shark around Ireland is very low compared to the whole historical time-series, although the actual population size remained uncertain. This trend was robust and indicated an important decline starting in the 1980s, concurring with anecdotal reports on angel shark abundance.

22.9 Stock assessment

Whilst no quantitative stock assessment has been benchmarked, due to data limitations, the WGEF perception of the stock is based largely on analyses of historical and contemporary trawl surveys.

Recent studies using recreational catch data have shown that the stock has declined dramatically in Clew and Tralee Bays - two former hotspots on the west of Ireland (Shephard *et al*., 2019). Angler catches of angel shark are now extremely rare at these locations, with only occasional anecdotal reports. Although it is not possible to conduct a quantitative stock assessment, it is evident that the species is in a critically poor state even in important areas of its original geographic range. Ireland's Marine Institute is currently undertaking a multi-disciplinary research project on Angel shark in Tralee Bay, and this study may further clarify current stock abundance, as well as produce information on migration, nursery grounds, feeding etc.

Historically, coastal trawl surveys around the British Isles often reported angel shark, especially in the western English Channel (Garstang, 1903; Rogers and Ellis, 2000) and Bay of Biscay (Quéro and Cendrero, 1996). In contrast, contemporary surveys encounter this species only very infrequently, if at all. Such patterns have been reported elsewhere in the biogeographic range of angel shark (e.g. Jukic-Peladic *et al.*, 2001).

The apparent scarcity of angel sharks in contemporary trawl surveys is in stark contrast to early texts on British fishes, which generally considered that angel shark was encountered regularly in British seas. Indeed, Yarrell (1836) stated that "*It is most numerous on the southern coast of our island; but it is occasionally taken in the Forth, and some other parts of the east coast, particularly around Cromer and Yarmouth. It is common on the coasts of Kent and Sussex …It is also taken in Cornwall*". Similarly, Day (1880–1884) wrote "*In the Firth of Clyde it is by no means uncommon… In fact it is common in the North Sea and Bristol Channel. Occasionally taken off Yorkshire and is common on the Dogger Bank… taken on the coasts of Kent and Sussex, Hampshire and common at all times along the south coast…Common in Cornwall*". Similar examples are also evident in other accounts (see Table 22.4 and Ellis *et al.*, 2021).

WGEF considers that the comparisons of historical data with the near-absence in recent data (landings, surveys, observer programmes, angling data) are sufficient to consider the species to be severely depleted in the Celtic Seas ecoregion and possibly extirpated from the North Sea ecoregion (noting that Zidowitz *et al.* (2017) reported a single specimen from the Central North Sea that was caught in 2002). Whilst its status in the Bay of Biscay and Iberian coastal waters is unknown, it is considered very rare, with only occasional individuals reported.

22.10 Quality of the assessment

No formal stock assessment has been undertaken.

22.11 Reference points

No reference points have been proposed for this stock.

22.12 Conservation considerations

Angel shark is listed as Critically Endangered on the IUCN Red List, both globally and in European waters (Morey *et al*., 2019) and has been listed on the OSPAR List of Threatened and Declining Species since 2008 with the last assessment (OSPAR , 2021) showing the status to be 'poor' across all OSPAR areas of occurrence.

In 2010, angel shark was added to the prohibited species list removing it from fishing opportunities in EU (and since, 2021, EU and UK) waters. Angel shark was listed on Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) at the 12th Meeting of the Conference of the Parties (COP12) in 2017 (CMS, 2018). Contracting Parties to CMS that are Range States (countries in the area of jurisdiction of which species occur) of species listed on Appendix I should prohibit the taking of such species, whilst the Appendix II listing indicates that international cooperation and agreements should be developed to aid the conservation and management of the listed species (https://www.cms.int/en/convention-text). Following the CMS listing, angel shark was subsequently, in 2018, added to Annex 1 of the CMS Memorandum of Understanding (MoU) on the Conservation of Migratory Sharks.

National conservation measures include the listing of angel shark on Schedule 5 of the UK's Wildlife and Countryside Act (WCA, 1981) in 2008 making it an offence to intentionally kill, injure or take this species in English and Welsh waters. The species was included under Schedule 5 (animals which are protected at all times) of the Northern Ireland Wildlife Order (1985) since 2011, and in the Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order (2012) which prohibits landings.

The species of angel shark (*Squatina squatina*) occurring in the ICES area is one of three Critically Endangered species included in the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy (Gordon *et al.*, 2017). This framework aims to improve protection and implementation of legislation, through identifying threats to these species as well as geographic and policy priorities.

22.13 Management considerations

Angel shark is thought to have declined dramatically in the ICES area and Mediterranean Sea, as evidenced from landings data, survey information and the decline in the numbers tagged in Irish waters. The contemporary occurrence of angel shark in the southern parts of the ICES area and off the coasts of northwest Africa remains uncertain, whilst the Canary Islands have been considered as the last hotspot of the species (Meyers *et al.*, 2017).

Since ICES advised that this species should receive the highest protection possible, it has been listed as a prohibited species on European and subsequently also UK fishery regulations.

Dedicated, non-destructive surveys of areas of former local abundance would be needed to inform on current habitat and range, and to assess the possibilities of spatial management.

Given the perceived low productivity of this species and that they have shown high site fidelity, any population recovery would be expected to occur over a decadal time frame.

Improved liaison and training the fishing industry is required to ensure that any specimens captured are released. National observer programmes encountering this species could usefully collect information on the vitality of discarded individuals.

22.14 References

Aflalo, F. G. 1904. British salt-water fishes. Hutchinson & Co., London, 328 pp.

Bal, G., White, J., Johnston, G., Roche, W., O'Reilly, S., Green, P. and Fitzmaurice, P. 2014. Estimates of yearly population size of Angel Sharks from Tralee Bay. Working Document to the ICES Working Group on Elasmobranch Fishes. 8 pp.

Bal, G., Johnston, G., Roche, W., O'Reilly, S., Green, P., Fitzmaurice, P. and Clarke, M. 2015. Estimating the yearly size of the population of angel shark off the coast of Ireland. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; 8 pp.

Baremore, I. E. 2010. Reproductive aspects of the Atlantic angel shark *Squatina dumeril*. *Journal of Fish Biology*, 76: 1682–1695.

Baremore, I. E., Andrews, K. I., and Hale, L. F. 2009. Difficulties associated with modeling growth in the Atlantic angel shark (*Squatina dumeril*). *Fisheries Research*, 99: 203–209.

Barker, J., Davies, J., Goralczyk, M., Patel, S., O'Connor, J., Evans, J., Sharp, R., Gollock, M., Wood, F., Rosindell, J., Bartlett, C., Garner, B., Jones, D., Quigley, D. and Wray, B. (2022). The distribution, ecology and predicted habitat use of the Critically Endangered Angelshark (*Squatina squatina*) in coastal waters of Wales and the central Irish Sea. *Journal of Fish Biology*, 101: 640-658.

Boletín Oficial del Estado, BOE (2019). Orden TEC/596/2019, de 8 de abril, por la que se modifica el anexo del Real Decreto 139/2011, de 4 de febrero, para el desarrollo del Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas. https://www.boe.es/eli/es/o/2019/04/08/tec596 and https://www.boe.es/buscar/pdf/2011/BOE-A-2011-3582-consolidado.pdf

Bom, R. A., van de Water, M., Camphuysen, K. C., van der Veer, H. W., & van Leeuwen, A. 2020. The historical ecology and demise of the iconic Angelshark *Squatina squatina* in the southern North Sea. *Marine Biology*, 167: 91.

Braccini, M., Van Rijn, J., and Frick, L. 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS One*, 7(2), e32547, 1–9.

Bridge, N. F., Mackay, D., and Newton, G. 1998. Biology of the ornate angel shark (*Squatina tergocellata*) from the Great Australian Bight. *Marine and Freshwater Research*, 49: 679–686.

Buckland, F. 1881. The natural history of British fishes. Society for Promoting Christian Knowledge, London.

Cailliet, G. M., Mollet, H. F., Pittenger, G. G., Bedford, D., and Natanson, L. J. 1992. Growth and demography of the Pacific angle shark (*Squatina californica*), based upon tag returns off California. *Marine and Freshwater Research*, 43: 1313–1330.

Capapé, C., Quignard, J. P., and Mellinger, J. 1990. Reproduction and development of two angel sharks, *Squatina squatina* and *S. oculata* (Pisces: Squatinidae), off Tunisian coasts: semi-delayed vitellogenesis, lack of egg capsules, and lecithotrophy. *Journal of Fish Biology*, 37: 347–356.

CMS. 2018. Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), as amended by the Conference of the Parties in 1985, 1988, 1991, 1994, 1997, 1999, 2002, 2005, 2008, 2011, 2014 and 2017. 15 pp. https://www.cms.int/sites/default/files/basic_page_documents/cms_cop12_appendices_e_0.pdf.

Colonello, J. H., Lucifora, L. O., and Massa, A. M. 2007. Reproduction of the angular angel shark (*Squatina guggenheim*): geographic differences, reproductive cycle, and sexual dimorphism. *ICES Journal of Marine Science*, 64: 131–140.

Cooper, A. E. (Ed.) 1934. Sea fishing. Billing & Sons, 352 pp.

Day, F. 1880–1884. The Fishes of Great Britain and Ireland. London: Williams and Norgate.

Ellis, J. R., Barker, J., McCully Phillips, S. R., Meyers, E. and Heupel, M. 2021 Angel sharks (Squatinidae): A review of biological knowledge and exploitation. *Journal of Fish Biology*, 98: 592–621.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, 90: 653–722.

Ellis, J. R., Pawson, M. G., and Shackley, S. E. 1996. The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the north-east Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 76: 89–106.

Escánez, A., Crespo, A., Rodríguez Ramallo, S., Oñate, M. and Marrero, J. 2016. Estudio del primer área de cría del Angelote (Squatina squatina) descubierta en Canarias. *Chronica Naturae*, 6: 50–62.

EU. 2019. Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) 2016/1139, (EU) 2018/973, (EU) 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 850/98, (EC) No 2549/2000, (EC) No 254/2002, (EC) No 812/2004 and (EC) No 2187/2005. Official Journal of the European Union, L198: 105–201.

Faure, N., Manel, S., Macé, B., Arnal, V., Guellati, N., Holon, F., Barroil, A., Pichot, F., Riutort, J.J., Insacco, G. and Zava, B. 2023. An environmental DNA assay for the detection of Critically Endangered angel sharks (Squatina spp.). Aquatic Conservation: Marine and Freshwater Ecosystems.

Fennessy, S. T. 1994. Incidental capture of elasmobranchs by commercial prawn trawlers on the Tugela Bank, Natal, South Africa. *South African Journal of Marine Science*, 14: 287–296.

Forrest, H. E. 1907. The vertebrate fauna of North Wales. Witherby & Co., London, 537 pp.

Gaida, I. H. 1997. Population structure of the Pacific angel shark, *Squatina californica* (Squatiniformes: Squatinidae), around the California Channel Islands. *Copeia*: 738–744.

Garcia, G., Pereyra, S., Gutierrez, V., Oviedo, S., Miller, P., and Domingo, A. 2015. Population structure of *Squatina guggenheim* (Squatiniformes, Squatinidae) from the south-western Atlantic Ocean. *Journal of Fish Biology*, 86: 186–202.

Garstang, W. 1903. Report on trawling and other investigations carried out in the bays on the south-east coast of Devon during 1901 and 1902. *Journal of the Marine Biological Association of the United Kingdom*, 6: 435–527.

Gordon, C. A., Hood, A. R., Barker, J., Bartolí, À., Dulvy, N. K., Jiménez Alvarado, D., Lawson, J. M. and Meyers, E. K. M. 2017. Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy. The Shark Trust, UK. https://www.sharktrust.org/Handlers/Download.ashx?IDMF=f019a882-4184-4004-a91c-8777a104476e

Herdman, W. A. and Dawson, R. A. 1902. Fishes and fisheries of the Irish Sea. *Lancashire Sea-Fisheries Memoir*, no. 11, 98 pp.

Hiddink, J. G., Shepperson, J., Bater, R., Goonesekera, D., & Dulvy, N. K. 2019. Near disappearance of the Angelshark *Squatina squatina* over half a century of observations. *Conservation Science and Practice*, 1: e97.

ICES. 2008a. Demersal elasmobranchs in the Celtic Seas (ICES Areas VI, VIIa c, e k). ICES Advice 2008, Book 5, Section 5.4.39, 13 pp.

ICES. 2008b. Demersal elasmobranchs in the North Sea (Subarea IV), Skagerrak (Division IIIa), and eastern English Channel (Division VIId). ICES Advice 2008, Book 6, Section 6.4.30, 201–205.

ICES. 2012. Angel shark (*Squatina squatina*) in the Northeast Atlantic. ICES Advice 2012, Book 9, Section 9.4.25, 5 pp.

ICES. 2013. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–21 June 2013, Lisbon, Portugal. ICES CM 2013/ACOM:19; 649 pp.

ICES. 2014. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–26 June 2014, Lisbon, Portugal. ICES CM 2014/ACOM:19; 671 pp.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40; 69 pp.

ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20-24 February 2017, Nantes, France . ICES CM 2017/ACOM:38; 119 pp.

Iglésias, S.P., Bergot, P., Breton, P., Brunelle, S., Camusat, M. *et al.* 2020. French ichthyological records for 2018. *Cybium,* 44: 285–307.

Jiménez-Alvarado, D., Meyers K. M., Caro, M.B., Sealey, M.J. and Barker, J. 2020. Investigation of juvenile angelshark (*Squatina squatina*) habitat in the Canary Islands with recommended measures for protection and management. *Aquatic Conservation. Marine and Freshwater Ecosystems,* 30: 2019–2025.

Jukic-Peladic, S., Vrgoc, N., Krstulovic-Sifner, S., Piccinetti, C., Piccinetti-Manfrin, G., Marano, G., and Ungaro, N. 2001. Long-term changes in demersal resources of the Adriatic Sea: comparison between trawl surveys carried out in 1948 and 1998. *Fisheries Research*, 53: 95–104.

Lapinski, M., & Giovos, I. 2019. New records of the critically endangered *Squatina squatina* (Linnaeus, 1758) from Corsica, France. *Acta Adriatica*, 60: 205–209.

Laver, H. 1898. The mammals, reptiles and fishes of Essex. *Essex Field Club Special Memoirs,* 3: 138 pp.

Le Danois, E. 1913. Contribution a l'étude systématique et biologique des poissons de la manche occidentale. PhD Thesis, Faculté des Sciences de Paris, Paris.

Lozano Rey, L. 1928. Fauna Ibérica: Peces. Madrid: Museo Nacional de Ciencias Naturales.

Marine Biological Association (MBA), 1957. Plymouth Marine Fauna. 3rd Edition, 457 pp.

Meyers, E.K., Tuya, F., Barker, J., Jiménez Alvarado, D., Castro-Hernández, J.J., Haroun, R. and Rödder, D., 2017. Population structure, distribution and habitat use of the Critically Endangered Angelshark, *Squatina squatina*, in the Canary Islands. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 27: 1133–1144.

Morey, G, Barker, J., Hood, A., Gordon, C., Bartolí, A., Meyers, E.K.M., Ellis, J., Sharp, R., Jimenez-Alvarado, D. & Pollom, R. 2019. *Squatina squatina*. The IUCN Red List of Threatened Species 2019: e.T39332A117498371. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T39332A117498371.en. Downloaded on 15 June 2021.

Moreau, E. 1881. Histoire naturelle des Poissons de la France. Paris, Volume I.

Murie, J. 1903. Report on the Sea Fisheries and Fishing Industries of the Thames Estuary. Part I. Kent and Essex Sea Fisheries Committee, London 250 pp.

Narvaez, K. 2012. Aspectos biologicos y ecologicos del tiburón angel *Squatina squatina* (linnaeus, 1978) en las Isla de Gran Canaria. Tesis doctoral, Universidad de las Palmas de Gran Canaria, Spain; 271 pp.

Natanson, L. J., and Cailliet, G. M. 1986. Reproduction and development of the Pacific angel shark, *Squatina californica*, off Santa Barbara, California. *Copeia*, 1986(3): 987–994.

Nobre, A. 1935. Vertebrados (mammiferos, reptis e peixes). Fauna marinha de Portugal, 1: 574 pp.

Meyers, E. K. M., F. Tuya, J. Barker, D. J. Alvarado, J. J. Castro-Hernandez, R. Haroun, and D. Rodder. 2017. Population structure, distribution and habitat use of the Critically Endangered Angelshark, *Squatina squatina*, in the Canary Islands. Aquatic Conservation-Marine and Freshwater Ecosystems 27:1133-1144.OSPAR Commission. 2010. Background document for angel shark *Squatina squatina*. OSPAR Biodiversity Series, Publication Number 471/2010, 20 pp.

Osaer, F. 2009. Morfometría y reproducción del angelote *Squatina squatina* (Linnaeus, 1758) en la isla de Gran Canaria. 2009. Tesis doctoral, Universidad de las Palmas de Gran Canaria, Spain; 173 pp.

OSPAR. 2021. BDC2021/Angel shark. https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-assesments/angel-shark/

Patterson, A. H. 1905. Nature in eastern Norfolk. Methuen & Co., London.

Patterson, A. H. 1910. Rough notes on the fish and fisheries of East Suffolk. John Buckle, Great Yarmouth.

Poll, M. 1947. Poissons marins. Faune de Belgique, 452 pp.

Quéro, J. C., and Cendrero, O. 1996. Incidence de la pêche sur la biodiversité ichtyologique marine: le bassin d'Arcachon et le plateau continental sud Gascogne. *Cybium*, 20: 323–356.

Quéro J., Dardignac J. and Vayne J. 1989. Les poisons du golfe de Gascogne. Ifremer/Secrétariat de la Faune et de la Flore, 229 pp.

Quigley, D. T. 2006. Angelshark (*Squatina squatina*) in Irish Waters. *Sherkin Comment*, 41: 5.

Roche, W. and O'Reilly, S. 2013. Note on recent Angel shark (*Squatina squatina*) angling and tagging activity in Ireland-1970–2011. Working Document presented to the Working Group on Elasmobranch Fishes, 2 pp.

Rogers, S. I., and Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. *ICES Journal of Marine Science*, 57: 866–881.

Roux, C. 1984. Squatinidae. In: Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, pp. 148–150. Ed. by P. J. P. Whitehead et al. UNESCO, Paris. 510 pp.

Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order (2012). https://www.legislation.gov.uk/ssi/2012/63/made?view=plain

Shephard, S., Wögerbauer, C., Green, P., Ellis, J.R. and Roche, W.K. 2019. Angling records track the near extirpation of angel shark *Squatina squatina* from two Irish hotspots. *Endangered Species Research*, 38: 153–158.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Standora, E. A., and Nelson, D. R. 1977. A telemetric study of the behavior of free-swimming Pacific angel sharks, *Squatina californica*. *Bulletin of the Southern California Academy of Sciences*, 76: 193–201.

STECF. 2003. Report of the Subgroup on Resource Status (SGRST) of the Scientific, Technical and Economic Committee for Fisheries (STECF): Elasmobranch Fisheries. Brussels, 22–25 July 2003. Commission Staff Working Paper SEC (2003) 1427; 207 pp.

Stoeckle, M.Y., Adolf, J., Charlop-Powers, Z., Dunton, K. J., Hinks, G. and Van Morter, S. M. 2021. Trawl and eDNA assessment of marine fish diversity, seasonality, and relative abundance in coastal New Jersey, USA. *ICES Journal of Marine Science*, 78: 293-304.

Tortonese, E. 1956. Leptocardia, Cyclostoma, Selachii. Fauna d‟Italia 2. Calderini, Bologna, 334 pp.

Tully, O. 2011. A review of the management of crayfish (Spiny Lobster, *Palinurus elephas*) in Ireland. FSS, Marine Institute, Oranmore, Galway, 38 pp.

Vögler, R., Milessi, A. C., and Quiñones, R. A. 2008. Influence of environmental variables on the distribution of *Squatina guggenheim* (Chondrichthyes, Squatinidae) in the Argentine–Uruguayan Common Fishing Zone. *Fisheries Research*, 91: 212–221.

Went, A. E. J. and Kennedy, M. 1976. List of Irish fishes. Third Edition. Dublin Stationary Office.

Wildlife and Countryside Act 1981 https://www.legislation.gov.uk/ukpga/1981/69

Wildlife (Northern Ireland) Order 1985. https://www.legislation.gov.uk/nisi/1985/171

Williams, G. 1954. Fauna of Strangford Lough and neighbouring coasts. *Proceedings of the Royal Irish Academy*, 56 B: 29–133.

Wögerbauer C., O'Reilly S., Green P. and Roche W. 2014. IFI Marine Sportfish Tagging Programme: Preliminary results for selected species, Inland Fisheries Ireland. Report No: IFI/2014/1-4231; 38 pp.

Yarrell, W. 1836. A history of British fishes. London: John Van Voorst.

Zidowitz, H., Kaschner, C., Magath, V., Thiel, R., Weigmann, S. and Thiel, R., 2017. Gefährdung und Schutz der Haie und Rochen in den deutschen Meeresgebieten der Nord- und Ostsee. Germany: Bundesamt für Naturschutz Skripten, 450, 224 pp.

22.15 Tables and Figures

Table 22.1a. Angel shark in the Northeast Atlantic. Reported landings (t) for the period 1978–2004. French landings from ICES and Bulletin de Statistiques des Peches Maritimes. UK data from ICES and DEFRA. UK landings for 1997 considered to be misreported fish. Data for 2000 onwards updated during WGEF (2021). Blank cell = no data reported; + = an unspecified value ≤ 0.5 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
France	8	3	32	26	29	24	19	18.7	19.5	18	13
UK											
Total	8	3	32	26	29	24	19	18.7	19.5	18	13

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
France	9	13	14	12	11	2	2	1	1	1	1
UK						2	1	1			
Total	9	13	14	12	11	4	3	2	1	1	1

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
France	2	1	2	+	1					0.03
UK			(47)			0.04	0.01	0.02		
Total	2	1	2	0	1	0.04	0.01	0.02	0	0.03

Table 22.1b. Angel shark in the Northeast Atlantic. Reported landings (t) for the period 2005–2023, following WHSHARK2 (ICES, 2016) and subsequent data calls. Blank cell = no data reported

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
France	1.03	0.40	0.74	0.27	1.60	1.40	0.97	1.22	0.02	0.01	0.53	0.03
UK	0.06	0.04	0.01									
Total	1.09	0.44	0.75	0.27	1.60	1.40	0.97	1.22	0.02	0.01	0.53	0.03

	2017	2018	2019	2020	2021	2022	2023
France	0.02				0.07	0.01	
UK	0.13	0.02	0.08				
Total	0.15	0.02	0.08	0	0.07	0.01	

Table 22.2. Angel shark in the Northeast Atlantic. Numbers of specimen angel shark (total weight >22.68 kg) reported to the Irish Specimen Fish Committee from 1958–2005.

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
No. specimen fish reported	3	1	0	0	4	1	15	13	5	13	0	2

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
No. specimen fish reported	1	3	3	1	4	2	1	5	4	10	5	10

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
No. specimen fish reported	7	3	2	2	0	1	1	2	2	2	1	3

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. specimen fish reported	2	1	0	1	1	0	0	0	2	0	0	0

Table 22.3. Angel shark in the Northeast Atlantic. Summary of life-history parameters for *Squatina squatina*.

Common name	Angel shark
Scientific name	*Squatina squatina*
Stock unit	Unknown

The stock structure is unknown, but available data for this and other species of angel sharks indicates high site fidelity, possibly with localized stocks. STECF (2003) noted that angel sharks "*should be managed on smallest possible spatial scale*". However, given that angel shark is perceived as highly threatened throughout the ICES area (and elsewhere in European waters), ICES provide advice at the species level.

Length–weight relationship	$W = 0.021.L^{2.8269}$ (n = 24)			Ellis *et al.* (2021)
Reproductive mode	Aplacental viviparity			Capapé *et al.* (1990)
Reproductive cycle	Possibly biennial, based on data for congeneric species			Baremore (2010)
Spawning season	Parturition: Summer (possibly June to July)			Quigley (2006)
Fecundity (ovarian)	8–18 (mode = 13)			Capapé *et al.* (1990)
Fecundity (uterine)	8–18 (mode = 13) in the Mediterranean Up to at least 22 in the Atlantic			Capapé *et al.* (1990) Patterson (1905)
Development (months)	Annual			Capapé *et al.* (1990)
Length at birth/hatching	25–28 cm			Capapé *et al.* (1990)
Maximum length	244 cm			Quigley (2006)
	Female	**Male**	**Combined**	
Length of smallest mature fish	128 cm	80 cm (?)	–	Capapé *et al.* (1990)
Length at 50% maturity	–	–	–	–
Length of largest immature fish	–	–	–	–
Age at 1st maturity	–	–	–	–
Age at 50% maturity	–	–	–	–
Age at 100% maturity	–	–	–	–
L_{inf}	–	–	–	–
K	–	–	–	–
t_0	–	–	–	–
Maximum age (years)		–		–
Trophic role	Ambush predator that feeds on fish, including flatfish, and larger crustaceans (Ellis *et al.*, 1996)			

Table 22.4. Angel shark in the Northeast Atlantic. Regional chronology of perceived status of angel shark.

Area	Description
Southern North Sea	Laver (1898) "*This frequents the entire Essex coast. It is usually caught in nets. Though occasionally eaten by fishermen, it is according to my taste, far too rank in flavour for a more delicate palate*"
	Murie (1903) "*The 'fiddlers' are got all round the Kent coast in moderate quantity, but Webb regards it as somewhat of a rarity just at Dover. It is not a common fish in the Thames estuary, in one sense, though there are seasons when it is very frequently got in the trawlers' nets. In 1893 they were unusually plentiful during the summer months in the neighbourhood of the Oaze, Girdler, Gilman, and so called S. Channel generally. From June till August there were few boats but had examples among their catch, and some of the specimens were of large size*"
	Patterson (1910) "*has been brought into* (Lowestoft) *on several occasions*"
	Poll (1947) wrote "*Espècie commun, surtout en été*" [A common species, especially in summer]
English Channel	Buckland (1881) "*found in the North Sea, the British Channel, the Mediterranean … It is taken on the 'long lines' which are set for ray, &c … It is common on the bays of Archachon and, I believe, on the sandy banks all along the Bay of Biscay. They are frequently seen in the markets of Dieppe, and are not uncommon at Brighton and Hastings*"
	Aflalo (1904) "*familiar on most parts of the coast, and is a frequent object of unintentional capture on the long-lines, as well as in both trawl and drift-nets … Small examples of from 12 to 18"are common in many south coast estuaries, notably at Teignmouth, where a few are brought ashore almost every week during May in the sand-eel seines worked just outside the bar*"
	Le Danois (1913) "*à Roscoff, assez commun vers la fin de l'été*" [At Roscoff, it is quite common in late summer]
	Cooper (1934) "*Several specimens of this species are caught every year by anglers, usually when Tope fishing, but it appears to have been more common on the south coast of England some twenty or thirty years ago than it is today*"
	MBA (1957) "*A haul of the trawl in Cawsand Bay will generally yield several specimens. Occasionally trawled on other grounds*"
Irish Sea Ireland	Herdman and Dawson (1902) "*common off our coasts in spring and summer. It occurs not infrequently in the trawl net in the Lancashire district. We have taken it as near Liverpool as the Rock and Horse Channels, and the Deposit Buoy. We have also taken it near Piel in the Barrow Channel, and off Maughold Head. Mr Walker records it from Rhos weir and Colwyn Bay, and Professor White from the Menai Straits. It has been frequently taken off the Isle of Man, one is recorded from Port Erin, and we have taken it also in the Ribble, and have seen it taken on the offshore grounds by the trawlers*"
	Forrest (1907) "*… frequently met with it off Aberffraw … from Barmouth … not uncommon in the Menai Straits, Colwyn Bay and along the north coast …* (taken in) *St Tudwal's Roads, Red Wharf Bay, and other places*"
	Williams (1954) "*Taken rather infrequently off Strangford Bar. Said to be common off the north shore of Ireland"*
	Went & Kennedy (1976) listed it as common noting that it was "*more often caught on rod and line than by any other method*"

Table 22.4. (continued). Angel shark in the Northeast Atlantic. Regional chronology of perceived status of angel shark.

Area	Description
France (Bay of Biscay and Mediterranean)	Moreau (1881) "*L'Ange se trouve sur toutes nos côtes, mais il paraît plus commun dans l'ocean que dans la Méditerranée, il est même assez rare à Cette*" [Angel shark is on all our coasts, but it seems more common in the (Atlantic) ocean than in the Mediterranean, it is quite rare at Séte] Quéro *et al*. (1989) recorded individual fish from trawl surveys, including one from coastal waters near Pornic (just south of the Loire Estuary) in 1973 and one further offshore south-west of the mouth of the Gironde in 1975
Spain	Lozano Rey (1928) reported that angel shark "*vive en todo el litoral ibérico, aunque parece más frecuente en las costas del Atlántico que en las del Mediterráneo, pero en este tampoco es rara … Los individuos jóvenes se pescan en la misma orilla. Nosotros hemos capturadao ejemplares de este especie, de menos de treinta centímetros de longitude, en la bahía de Santander, a un par de metros de profundidad*" [lives all along the Iberian coast, although it seems more common in the Atlantic coasts than in the Mediterranean, but this is not unusual ... Young individuals are caught in the same bank. We have captured specimens of this species, less than 30 cm long, in the Bahía de Santander, in waters a few meters deep] In relation to the Bahía de Santander, García-Castrillo Riesgo (2000) noted "*Hoy en día, esta especie de angelote no está presente en el entorno de la Bahía. La última referencia que tenemos data de 1985, cuando se recogió un ejemplar adulto y moribundo en el Puntal. Por el contrario a principios de siglo, según los datos de la Estación Biólogica de Santander, los jovenes eran frecuentes en los arenales del Puntal, el sable de Afuear, Enmedio y el fondeadero de la Osa, siendo aún más abundantes en al Abra del sardinero y las Quebrantas*". [Today, this kind of angelfish is not present in the environment of the Bahía. The last reference we have dates from 1985, when a dying adult specimen was collected in the Puntal. Rather early in the century, according to data from the Biological Station of Santander, the young were frequent off the beach at Puntal, saber Afuear, Enmedio and the anchorage of the Osa, still more abundant in the Abra del Sardinero and Quebrantas]
Portugal	Nobre (1935) wrote "*Esta espécie aparece freqüentemente no norte do País, sendo apanhada nas rêdes de fundo*" [This species appears frequently in the north of the country, where it is caught in bottom nets]
Italy	Tortonese (1956) stated it was "*Più o meno commune in tutti i nostri mari*" [more or less common in all our seas]

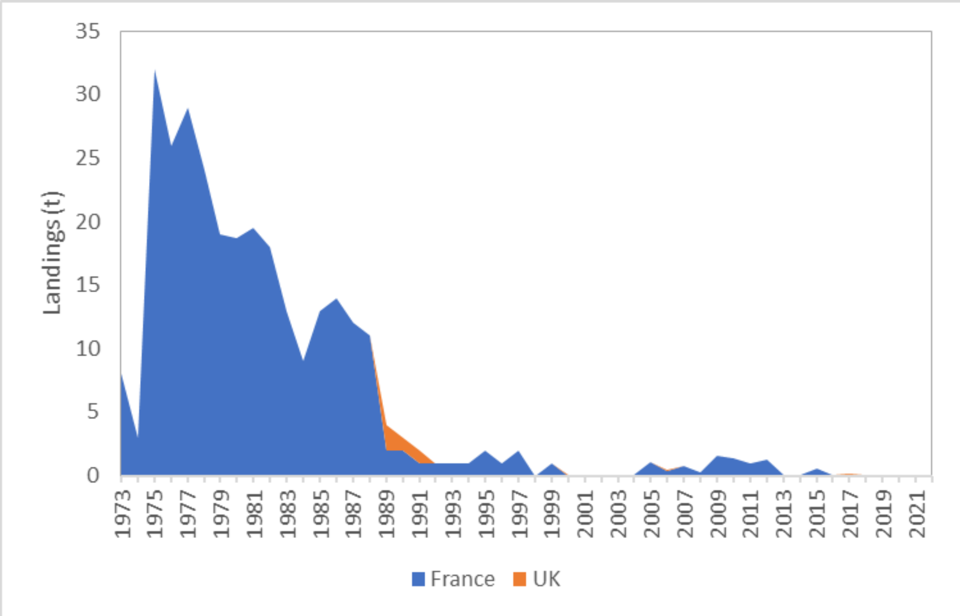


Figure 22.1. Angel shark in the Northeast Atlantic. Total reported landings of *Squatina squatina* (1973–2023). Angel shark has been listed as a non-retained/prohibited species on European fisheries regulations since 2009 and so this species is now reported very rarely in landing statistics in recent years.

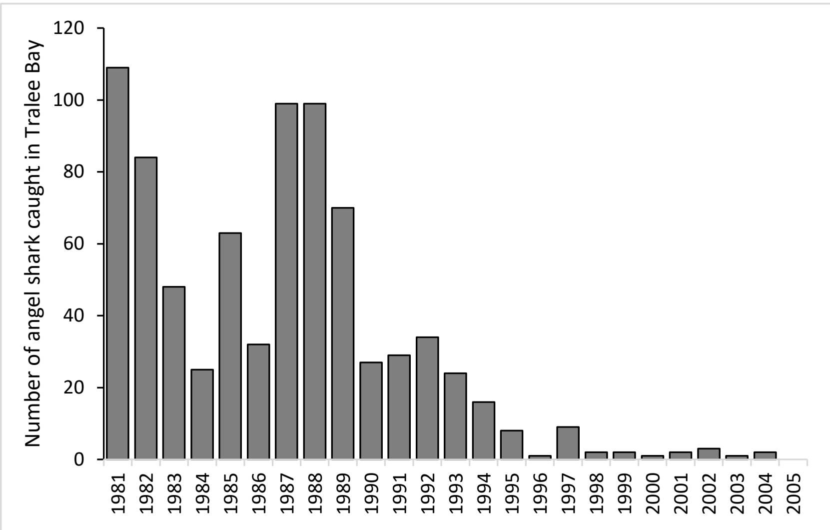


Figure 22.2. Angel shark in the Northeast Atlantic. Numbers of angel shark caught by two charter boats in Tralee Bay 1981–2005. Adapted from Irish Central Fisheries Board data presented in ICES (2008).

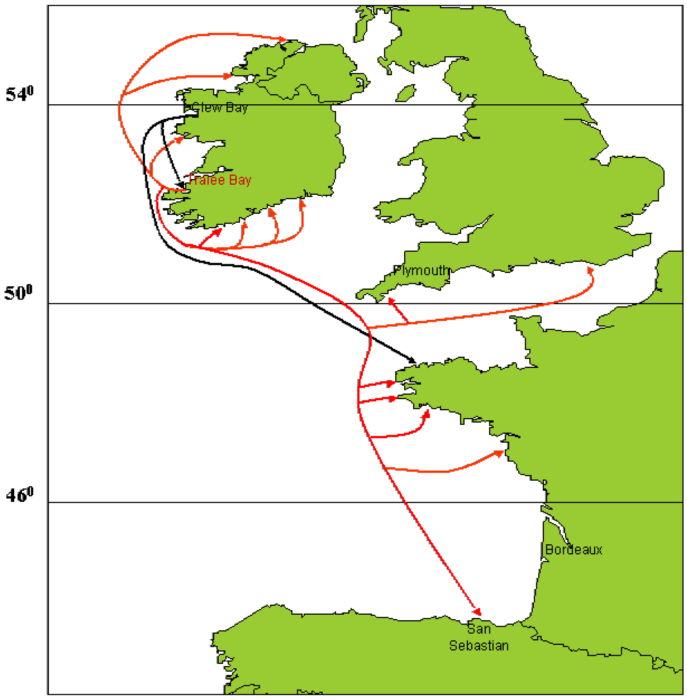


Figure 22.3. Angel shark in the Northeast Atlantic. Longer-distance movements of angel shark tagged off the west coast of Ireland, 1970–2006. Source: Irish Central Fisheries Board.

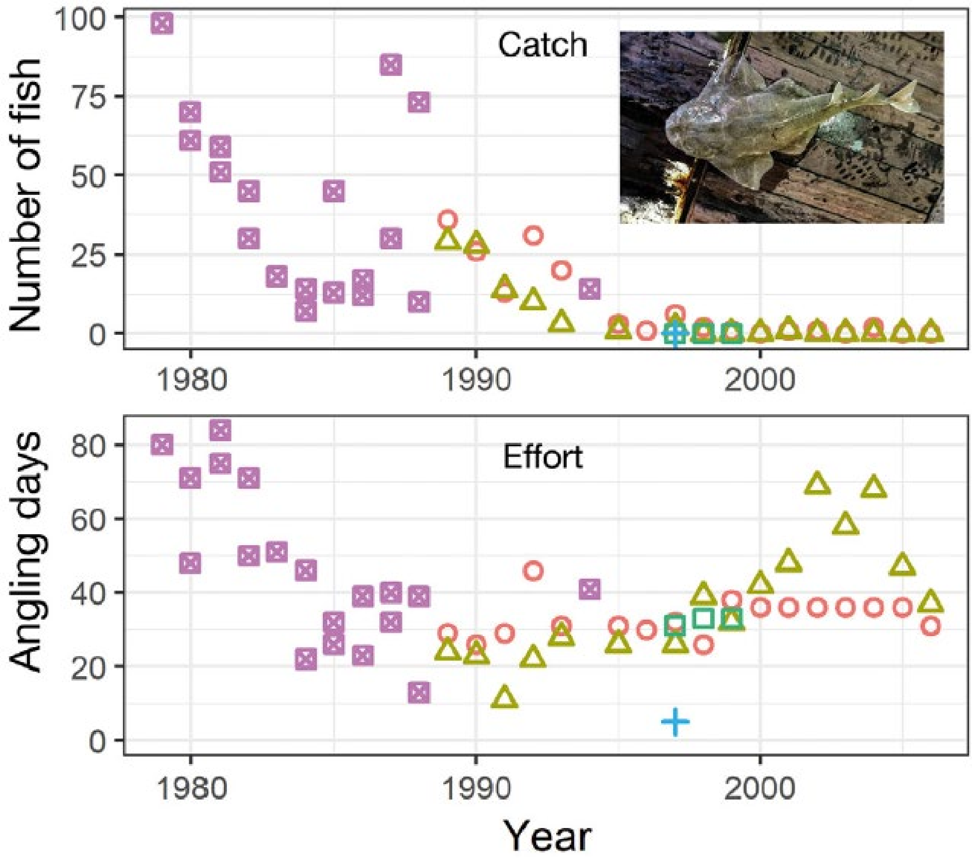


Figure 22.4. ***Squatina squatina*** **annual angling catch and effort for charter vessels in Tralee Bay, Ireland. Inset photograph of** ***S. squatina*** **(100 cm total length) caught and released alive from FV 'Eblana' in 2016. Colours of the data points refer to different vessels. Figure from Shephard** ***et al*****. (2019).**

Contents

23 White skate *Rostroraja alba* in the Northeast Atlantic

23.1 Stock distribution

White skate *Rostroraja alba* is distributed in the eastern Atlantic from the British Isles to southern Africa, including the Mediterranean Sea (Stehmann and Bürkel, 1984). As such, the species distribution covers parts of ICES subareas 7–9, and may possibly have extended into the southern parts of subareas 4 and 6.

The stock structure within the overall distribution area is unknown, therefore ICES provide advice for the whole ICES area.

23.2 The fishery

23.2.1 History of the fishery

R. alba is thought to have been subject of targeted exploitation for much of the 19th and early 20th centuries, with targeted fisheries in the English Channel, Brittany and possibly the Isle of Man (Irish Sea). It was viewed as a highly marketable skate due to its large size and thickness of the wings (Ellis *et al.*, 2010).

In 1964, 59 tonnes of *R. alba* were landed in the port of Douarnenez (Brittany) from a target longline fishery (Du Buit, *pers. comm*.). After this, the fishery and local stock collapsed. The use of the landing name 'Raie blanche' (white skate) is now discontinued in French fish markets and only known by the oldest fishermen and fish-market workers. Up to 2009, only occasional individuals were landed in France, often under the name '*Dipturus batis*'. It was estimated that 13 ±10 individuals (117 ±89 kg) were landed in 2005 in France under the name '*D. batis*'. During a sampling programme of large skates in French ports (2006–2007), only one *R. alba* specimen was positively identified from the 4110 skates examined (Iglésias *et al.*, 2010). Prior to the inclusion of *R. alba* on the EU prohibited list, individuals were recorded occasionally in Portuguese landing ports (Serra-Pereira *et al.*, 2011).

In recent decades, *R. alba* may be a very occasional bycatch in some trawl and gillnet fisheries, although as a prohibited species, individuals caught should be released promptly. In 2013, there was an authenticated record of an individual caught (and released) in the English Channel (J. Ellis, pers.comm.). Nowadays, as the species is largely unknown by fishermen and does not have highly conspicuous morphological characters for its identification, individuals might occasionally be mixed with other skates, in particular those with long snout including *Dipturus* spp. and *Leucoraja fullonica*.

23.2.2 The fishery in 2023

In January 2023, a female of 183 cm long was caught by Spanish fishermen in the north coast of Spain. Identification has been confirmed by pictures (Rodriguez – Cabello, pers. comm.).

No other information was made available to WGEF.

23.2.3 ICES Advice applicable

In 2014, ICES advised "*on the basis of the precautionary approach … there be no catches of this species. Measures should be taken to minimize bycatch to the lowest level*". ICES (2014) also stated that "*Rostroraja alba is designated on the EU prohibited species list in the entire ICES area. This is a high-level, long-term conservation strategy aimed at very depleted and vulnerable species. ICES supports this listing, having reviewed it in 2010*".

In 2016, ICES advised that "*when the precautionary approach is applied, there should be zero catches of this species in each of the years 2017, 2018, and 2019.*"

In 2019, ICES advised the precautionary approach with zero catches of this species in each of the years 2020, 2021, 2022, and 2023.

In 2023, ICES advised the precautionary approach with zero catches of this species in each of the years 2024, 2025, 2026, and 2027.

23.2.4 Management applicable

Council Regulation (EC) 2019/124 continues to prohibit European Union vessels to fish for, to retain on board, to tranship or to land *R. alba* in Union waters of ICES subareas 6–10. Council Regulation (EC) 2018/120 also states that "*when accidentally caught, species…shall not be harmed*" and "*specimens shall be promptly released*". This prohibited status has been in force since 2009.

Regulation (EU) 2015/812 requires that all white skate caught and discarded should be reported.

R. alba is legally protected in UK waters, being listed on the Wildlife and Countryside Act.

23.3 Catch data

23.3.1 Landings

R. alba became increasingly rare in landings prior to the requirements for species-specific recording (Ellis *et al.*, 2010), and so there is great uncertainty on historical levels of exploitation.

Some of the nominal landings reported for *R. alba* are thought to refer to either other large-bodied skates (*Dipturus* spp.) or shagreen ray *Leucoraja fullonica*, as this species also has a sharply pointed snout. In addition to possible misidentifications, there are likely input errors, especially as the FAO code for Rajidae (RAJ) could easily be input as RJA (*R. alba*).

Landings from around Scotland are assumed to refer to *L. fullonica,* and landings from other areas outside the former distribution have been assigned to Rajiformes for the period 2009-2014 (see ICES, 2016). Other nominal landings of *R. alba* (Table 23.1 and Table 23.2) may still be unreliable.

Since 2019, landings from France under the FAO code RJA (*Rostroraja alba*) are corrected into RAJ as those landings data refer to a mixture of species such as *Amblyraja radiata*, *Rajella lintea*, *Bathyraja spinicauda*, *Rajella fyllae* and *Amblyraja hyperborea*.

23.3.2 Discards

Limited data are available. The discard observer programme for the English and Welsh fleets did not record any *R. alba* (Silva *et al.*, 2012). The Portuguese Pilot Study for Skates recorded single specimens of *R. alba* (47 and 62 cm L_T) in two trips using trammel nets, from a total of 20 fishing trips and a total sample of 667 skates. There is uncertainty in the reliability of some nominal records of *R. alba* recorded in other national observer programmes.

One specimen was by-caught in a monitored crayfish fishery in the south-west of Ireland in 2020.

23.3.3 Quality of catch data

Both landings and discard data for *R. alba* are very limited and may be confounded with other species. The nominal landings presented are considered unreliable.

23.3.4 Discard survival

There are no species-specific data on the discard survival of *R. alba*. Discard survival of skates has been examined for a range of other skate species, with at-vessel mortality low in some inshore fisheries, but more limited data available for post-release mortality (Ellis *et al*., 2017). The two specimens recorded in the EU/PNAB observer trips were considered in "good" health condition (following Enever *et al*., 2009).

23.4 Commercial catch composition

No data available.

23.5 Commercial catch and effort data

No data available.

23.6 Fishery-independent information

R. alba is encountered very rarely in trawl surveys, which may reflect the low abundance of the species and/or poor spatial overlap between surveys and refuge populations and/or their favoured habitats. Existing surveys are not considered appropriate for monitoring the status of this species.

Although not taken in English trawl surveys (Ellis *et al*., 2005), occasional individuals have been captured in the Irish Groundfish survey along the west coast of Ireland, in the Spanish survey at Porcupine and in the Portuguese Groundfish survey in recent years. One egg-laying female (185 cm L_T) was caught in the Portuguese Groundfish Survey in 2007.

23.7 Life-history information

Although taken periodically along the west coast of Ireland (Quigley, 1984), the biology of this species in northern European seas is largely unknown. It has been better studied in the Mediterranean Sea (Capapé, 1976; 1977). Kadri *et al.* (2014) examined specimens from the Mediterranean: the smallest mature fish were 110 cm (male) and 120 cm (female). The youngest mature female in this study was estimated to be 17 years old, and the oldest fish 35 years old.

R. alba egg cases are occasionally found in Galway Bay and Tralee Bay in the West of Ireland (G. Johnston, pers. comm.).

French fishers consider this species to live preferentially on harder substrates, and so it may have been caught more frequently in static set nets and longline fisheries (Iglésias, pers. comm.).

Recent acoustic monitoring collected information on movement patterns of three *R. alba* within a protected area in the West coast of Portugal (Sousa *et al.*, 2019). A mature female (138 cm) stayed in the area for 20 months while the two others, which were immature, moved from the area after three to four months. The three skates displayed daily patterns of activity being more mobile at sunset and sunrise with a relatively low activity during day light. They also seem to spend more time in deeper water but the mature female was also detected at shallower depth during spring and summer.

Another acoustic monitoring study was undertaken in the Luís Saldanha Marine Park Marine Protected Area (MPA) in Portugal from 2019-2022 to determinate the use of this MPA by *Rostroraja alba* (Kraft *et al.*, 2024). Thirty individuals have been captured and tagged. Most of them were immatures, only two have been qualified as mature but only based on size at maturity. No differences in movement pattern were detected between sexes. Individual seems more active and in shallower waters during night and twilight showing some quick vertical movement into the water column. Acoustic telemetry showed that level of residency is moderate in the MPA and rather constant throughout the year.

23.8 Exploratory assessment models

No exploratory assessments have been undertaken.

23.9 Stock assessment

No formal stock assessment has been undertaken. The perceived stock status is based on the comparison between recent and historical trawl survey catch data.

Historically, trawl surveys around the British Isles reported *R. alba* (Rogers and Ellis, 2000), whereas it has now disappeared from parts of their former range. Similar longer-term declines were also reported for the Bay of Biscay (Quéro and Cendrero, 1996).

WGEF considers that the comparison of historical data with the near-absence in recent data sources (historical landings, surveys, observer programmes) is sufficient to consider the species to be severely depleted and near-extirpated from various parts of the Celtic Seas and Biscay-Iberian ecoregions.

23.10 Quality of the assessment

No formal stock assessment has been undertaken.

23.11 Reference points

No reference points have been proposed for this stock.

23.12 Conservation considerations

R. alba is listed as Critically Endangered on the IUCN Red List (Gibson *et al.*, 2008; Nieto *et al.*, 2015). It is listed on the OSPAR List of Threatened and Declining Species (OSPAR Commission 2010). It is protected on the UK's Wildlife and Countryside Act.

R. alba is listed as a prohibited species for which there is a prohibition to fish for, retain on board, tranship, land, store, sell, display or offer for sale Union waters of ICES subareas 6-10 in Regulation (EU) 2019/1241, this regulation has been consolidated the 01/01/2021.

In 2020, WKSTATUS reviewed and updated the OSPAR status assessments of *R. alba*. Experts specified that there is no information suggesting an improvement in the status of this stock since 2010, the year of the last assessment. Therefore, the species continues to justify its inclusion on the OSPAR List (ICES, 2020, OSPAR, 2021).

23.13 Management considerations

Since ICES advised that this species should receive the highest protection possible, it has been listed as a prohibited species on EC fishery regulations.

Given the low abundance of this species and its high conservation interest, WGEF recommend that (i) any data on *R. alba* collected from national observer programmes be verified whenever possible (e.g. photographed) and (ii) that ongoing national observer programmes collect information on the health state (e.g. lively, sluggish, dead) of any discards of this species.

Dedicated, non-destructive surveys of areas of former abundance would be needed to inform on current habitat and range.

Given the perceived low productivity of this species, any population recovery would take a decadal time frame.

As this species could be overlooked in catches of mixed skates, improved identification material could usefully be developed.

Although regulation requires any catch to be reported, it is highly probable that fishers cannot identify this species as they rarely encountered it.

23.14 References

Capapé, C. 1976. Contribution à la biologie des Rajidæ des côtes tunisiennes. *Raja alba* Lacépède, 1801: Répartition géographique et bathymétrique, sexualité, reproduction, fécondité. *Annales de l'Institut Michel Pacha*, 9: 23–47.

Capapé, C. 1977. Contribution à la biologie des Rajidae des côtes tunisiennes. 8. *Raja alba* Lacepede, 1803: Régime alimentaire. *Archives de l'Institut Pasteur de Tunis*, 54 : 85–95.

Ellis, J. R., Cruz-Martinez, A., Rackham, B. D. & Rogers, S. I. 2005. The distribution of chondrichthyan fishes around the British Isles and implications for conservation. *Journal of Northwest Atlantic Fishery Science*, 35: 195–213.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. Journal of Fish Biology, 90: 653–722.

Ellis, J. R., Silva, J. F., McCully, S. R., Evans, M. & Catchpole, T. 2010. UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10, 38 pp.

Enever, R., Catchpole, T. L., Ellis, J. R. & Grant, A. 2009. The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. *Fisheries Research*, 97: 72–76.

Gibson, C., Valenti, S. V., Fordham, S. & Fowler, S. L. 2008. The Conservation of Northeast Atlantic Chondrichthyans. Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop. viii + 76 pp.

ICES. 2014. White skate (*Rostroraja alba*) in the Northeast Atlantic. ICES Advice 2014, Book 9, Section 9.3.30; 3 pp.

ICES. 2016. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19–22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40, 69 pp.

ICES. 2020. Workshop to review and update OSPAR status assessments for stocks of listed shark, skates and rays in support of OSPAR (WKSTATUS). *ICES Scientific Reports*, 2:71. 152 pp. http://doi.org/10.17895/ices.pub.7468

Iglésias, S. P., Toulhoat, L. & Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: Important consequences for their conservation status. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 20: 319–333.

Kadri, H., Marouani, S., Bradai, M. N., Bouaïn, A. & Morize, E. 2014. Age, growth, mortality, longevity and reproductive biology of the white skate, *Rostroraja alba* (Chondrichthyes: Rajidae) of the Gulf of Gabès (Southern Tunisia, Central Mediterranean). *Turkish Journal of Fisheries and Aquatic Sciences*, 14: 193–204.

Kraft, S., Winkler, A.C. & Abecasis, D. (2024). Horizontal and vertical movements of the critically endangered *Rostroraja alba* in a coastal marine protected area. Aquatic Conservation: Marine and Freshwater Ecosystems, 34(6), e4204. https://doi.org/10.1002/aqc.4204

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J. *et al.* 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

OSPAR. 2010. Background document for white skate *Rostroraja alba*. OSPAR Biodiversity Series, Publication Number 476/2010, 17 pp.

OSPAR. 2021. Status Assessment 2021 – White skate. BDC2021/White skate. https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-assesments/white-skate/

Quéro, J.-C. & Cendrero, O. 1996. Incidence de la pêche sur la biodiversité ichtyologique marine: le bassin d'Arcachon et le plateau continental sud Gascogne. *Cybium*, 20: 323–356.

Quigley, D. T. G. 1984. White Skate, *Raja alba* Lacépède, 1803 (*R. marginata*, Lacép.) in Irish waters: A further record and review of Irish records. *Irish Naturalists' Journal*, 21: 217–220.

Rogers, S. I. & Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. *ICES Journal of Marine Science*, 57: 866–881.

Serra-Pereira, B., Moura, T., Griffiths, A. M., Serrano Gordo, L. & Figueiredo, I. 2011. Molecular barcoding of skates (Chondrichthyes: Rajidae) from the southern Northeast Atlantic. *Zoologica Scripta*, 40: 76–84.

Silva, J. F., Ellis, J. R. & Catchpole, T. L. 2012. Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. *Journal of Fish Biology*, 80: 1678–1703.

Sousa, I., Baeyaert, J., Gonçalves J. M. S. & Erzini K. 2019. Preliminary insights into the spatial ecology and movement patterns of a regionally critically endangered skate (*Rostroraja alba*) associated with a marine protected area. *Marine and Freshwater Behaviour and Physiology*, 52(6): 283-299.

Stehmann, M. & Bürkel, D. L. 1984. Rajidae. In Fishes of the North-eastern Atlantic and the Mediterranean,Vol. I (Whitehead, P. J. P., Bouchot, M.-L., Hureau, J.-C., Nielsen, J. and Tortonese, E. (Eds)), pp. 163–196. Paris: UNESCO.

Table 23.1. White skate in the Northeast Atlantic. Nominal landings of *R. alba* in the ICES area between 2005 – 2008 not changed by WKSHARK2. The accuracy of data is unclear, due to possible input errors for the codes RAJ (Rajidae) and RJA (*Rostroraja alba*).

Year	France	Ireland	Portugal	UK	Total*
2005	1	-	7.1**	-	8.1
2006	-	-	4.1**	-	4.1
2007	1.5	-	4.6**	-	6.2
2008	0.7	-	-	0.9	1.7

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

** Portuguese data revised in 2024

Table 23.2. White skate in the Northeast Atlantic. Nominal landings of *R. alba* in the ICES area between 2009-2022*. Some national data reported from 2009-2014 as white skate have been reassigned to Rajiformes (indet.) or *L. fullonica* (see ICES, 2016). The accuracy of remaining data (below) is unclear, due to possible input errors for the codes RAJ (Raj-idae) and RJA (*Rostroraja alba*).

Year	France	Ireland	Portugal	UK	Total
2009	4.1**	-	-	0.1	4.2**
2010	1.8**	-	-	0.1	1.8**
2011	2.0**	-	-	-	2.0**
2012	1.5**	-	-	-**	1.5**
2013	1.4**	-	-	-**	1.4**
2014	1.9**	0.3	-	-**	2.1**
2015	7.5	0.0	-	-	7.5
2016	4.2	0.1	-	-	4.3
2017	4.3	-	-	0.1	4.4
2018	7.0	0.4	-	-	7.4
2019	-	0.1	-	-	0.1
2020	-	-	-	0.1	0.1
2021	-	-	-	0.1	0.1
2022	-	-	-	0.6	0.6
2023	-	0.3	-	0.3	0.5

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

** Data revised in 2024

Contents

24 Greenland shark *Somniosus microcephalus* in the Northeast Atlantic

24.1 Stock distribution

The known North Atlantic distribution of Greenland shark *Somniosus microcephalus*, which has been defined primarily by observations of specimens caught in cold-water commercial fisheries, extends from temperate waters to the Arctic Ocean (MacNeil *et al*., 2012). It ranges from Georgia (USA) to Greenland, Iceland, Spitzbergen and the Arctic coasts of Russia and Norway to the North Sea and Ireland, with only very occasional individuals recorded further south (Ebert and Stehmann, 2013). Due to their known tolerance for extreme cold water and their ability to inhabit abyssal depths, Greenland sharks may be more widespread. The known distribution is also compromised by taxonomic problems in this genus (MacNeil *et al*., 2012). The metapopulation structure is unknown.

24.2 The fishery

24.2.1 History of the fishery

Fishing for Greenland shark has been a part of the Scandinavian, Icelandic and Inuit cultures for centuries, extending back to the 13th and 14th century in Norway and Iceland, respectively. Although the meat of Greenland shark may be toxic when fresh (e.g. Anthoni *et al*., 1991; McAllister, 1968), it is eaten in some countries after curing.

In the early to mid-20th century, Greenland sharks were caught in large quantities as a source of liver oil. At that time, peak annual catches e.g. in Norway are thought to have been in the order of 58 000 individuals (Ebert and Stehmann, 2013; MacNeil *et al*., 2012). After the invention of synthetic oil in the late 1940s, demand for shark oil diminished, and no intensive fisheries for Greenland sharks have been reported since (Nielsen *et al*., 2014).

Greenland shark is still targeted in small-scale artisanal fisheries in Iceland and Greenland. Artisanal fisheries target Greenland shark with hook and line, longline or gaffs, but it is also taken in seal nets and cod traps (Ebert and Stehmann, 2013). There is also substantial bycatch in longline, trawl and gillnet fisheries in the cooler waters of the North Atlantic.

24.2.2 The fishery in 2023

No specific changes in the fishery were apparent in 2023. Apart from Iceland, no countries have reported landings since 2016. Iceland reported landings of 16 tonnes in both 2020 and 2021, 13 tonnes in 2022, and 20 tonnes in 2023.

24.2.3 ICES Advice applicable

ICES has not been asked to provide advice on Greenland shark.

24.2.4 Management applicable

In 2016, Regulation (EU) 2016/2336 specified conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and included the Greenland shark to the list of deep-sea sharks on EC quota regulations for deep-sea fishes. Therefore from 2016 to 2018, Greenland shark was subject to the zero TAC for deep-sea sharks for EU vessels fishing in Union and international waters of ICES subareas 5–10 (EC, 2015). In 2019 and 2020, it was subject to the prohibition applied to deep-sea sharks (Council regulation (EU) 2018/2025. From 2021, the EU regulation for prohibited species no longer mentioned a list of deep-sea sharks but individual species, which did not include Greenland shark (Council regulation (EU) 2021/92). From 2023, the EU regulation once again explicitly lists Greenland shark as one of the deep-sea sharks prohibited in United Kingdom, Union and international waters of ICES subareas 5-10 and 12. In 2018, NAFO agreed to prohibit direct fishing of Greenland sharks and minimizing bycatch. These conservation measures were expanded in 2022 to include banning of fishing, retention and landing of (part or whole) Greenland sharks in the regulatory area (NAFO, 2022).

24.3 Catch data

24.3.1 Landings

Limited landings data are available. More comprehensive landings data are only available from Iceland (www.hagstofa.is and Marine Freshwater Research Institute databases). Reported annual landings by Iceland (Table 24.1) from ICES Division 5.a and Subarea 14 have varied from about 2 tonnes (2007) to 87 tonnes (1998). Monthly Icelandic landings of Greenland shark (2009–2023) indicate a peak during the late spring and summer months (Figure 24.1).

24.3.2 Discards

Limited data are available. Greenland shark is a bycatch in trawl fisheries for Greenland halibut *Reinhardtius hippoglossus* and northern shrimp *Pandalus borealis*, as well as in gillnet and longline fisheries (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014).

In the Barents Sea, bycatch of Greenland shark in bottom trawls were related to sea temperature, with more bycatch at lower water temperatures (Rusyaev and Orlov, 2013). Despite limited data on Greenland shark bycatch in the commercial trawl fishery, Rusyaev and Orlov (2013) estimated an annual catch of 140–150 tonnes in the Barents Sea.

In local fishing communities in Greenland, Greenland shark accounts for 50% of the total waste produced by the fishing industry. Estimated annual amounts of waste products of Greenland shark from fishing and hunting in specific counties may be *ca.* 1000 tonnes (Gunnarsdóttir and Jørgensen, 2008).

24.3.3 Quality of catch data

As observers are not mandatory in the fisheries that may have a bycatch of Greenland shark, bycatch levels are uncertain. In some areas there may be confusion with other members of the genus or even basking sharks (MacNeil *et al.*, 2012).

24.3.4 Discard survival

No estimates on discard survival are available for this species. According to on-board observers, some Greenland sharks caught in offshore trawl and longline fisheries are released alive (MacNeil *et al.*, 2012).

Studies with electronic tags have indicated that another deep-water shark, the leafscale gulper shark *Centrophorus squamosus*, one of the species occurring in European seas, can survive after being caught by longline (2–3 h soak time) from waters of 900–1100 m (Rodríguez-Cabello and Sánchez, 2014). Quantified data on the at-vessel mortality and post-release mortality of deep-water sharks that may be a by-catch in existing deep-water commercial fisheries are currently lacking (Ellis *et al*., 2017).

24.4 Commercial catch composition

No information available.

24.5 Commercial catch and effort data

24.5.1 Recreational CPUE data

There are recreational catch and release fisheries for Greenland sharks in Norway (year-round) and Greenland (in March; MacNeil *et al.*, 2012), but CPUE data are not available.

24.6 Fishery-independent information

Greenland sharks are caught regularly during gillnet and bottom-trawl surveys around Greenland, such as the Greenland Institute of National Resources Annual bottom trawl survey (Nielsen *et al.*, 2014). Irregular catches are also reported from the annual German Greenland groundfish survey (71 individuals between 1981 and 2019, Figure 24.2). Trawl surveys conducted in the Barents Sea also encounter Greenland shark. Occasional catches are also reported in various Icelandic surveys, but with a total of just 68 observations over the period 1936–2012.

Existing scientific surveys are not appropriate for monitoring the abundance of Greenland sharks in their distribution area because catches are rare.

24.7 Life-history information

24.7.1 Habitat and abundance

Greenland sharks show a marked preference for cold water with most observations from waters of -1.8 to 10°C and the majority of records from waters <5°C (Skomal and Benz, 2004; Stokesbury *et al.*, 2005; Fisk *et al.*, 2012; MacNeil *et al.*, 2012). They occur on continental and insular shelves and upper slopes (Ebert and Stehmann, 2013). Confirmed observations cover a broad depth range from abyssal depths of at least 1560 m (Fisk *et al.*, 2012) to shallow water (Yano *et al.*, 2007; MacNeil *et al.*, 2012). Devine *et al*. (2018) found that off the northern Canadian coast, shark densities peaking at intermediate temperatures sampled, and at depths between 450–800 m. Though primarily considered a demersal species, it may be caught both at the surface and in the pelagic zone (e.g. Stokesbury *et al.*, 2005; MacNeil *et al.*, 2012). They often associate with fjord habitats (MacNeil *et al.*, 2012).

Using baited remote underwater video cameras, Devine *et al*. (2018) calculated Greenland shark abundance and biomass in Arctic Canada. Density estimates varied from 0.4 to 15.5 individuals per km^2 (biomass: 93.3–1210.6 kg per km^2) among regions; being highest in warmer (>0 °C), deeper areas and lowest in shallow, sub-zero temperature regions.

24.7.2 Spawning, parturition and nursery grounds

The only captures of Greenland shark with near-term embryos were near fjords in the Faroe Islands. Based on observations on two presumed neonatal specimens captured by mid-water trawl off Jan Mayen Island, Kondyurin and Myagkov (1983) suggested that parturition may occur in the Norwegian Sea in July–August. Specimens of presumed neonatal size have also been reported from Canadian, Norwegian and Greenland fjords (Bjerkan and Koefoed, 1957).

24.7.3 Age and growth

Greenland shark is the second largest shark in the ICES area and the largest fish inhabiting Arctic seas (Ebert and Stehmann, 2013). Bigelow and Schroeder (1948) reported a maximum size of 640 cm L_T and weight of 1023 kg. Females may attain a larger size than males. The growth rate of Greenland sharks is unknown, but observations from tagging experiments indicate growth rates of 0.5–1 cm y^{-1} (Hansen, 1963). Conventional vertebral ageing methods are not applicable for Greenland shark (MacNeil *et al.*, 2012). However, a recent study using radiocarbon analysis from eye lenses suggests that Greenland sharks live to be several hundred years-old (Nielsen *et al*., 2016).

24.7.4 Reproductive biology

The Greenland shark is an aplacental viviparous species (Carrier *et al*., 2004; Ebert and Stehmann, 2013). The exact size at birth as well as the gestation period remain unknown, but size at birth is thought to be *ca.* 40–100 cm L_T (MacNeil *et al.*, 2012). Size-at-maturity is difficult to determine. The onset of maturity in male Greenland sharks probably occurs at *ca.* 260 cm L_T but is variable, and males may reach maturity at *ca.* 300 cm L_T (Yano *et al.*, 2007). Females from Icelandic waters mature at 355–480 cm L_T (MacNeil *et al.*, 2012). Based on changes in ovary weight, Yano *et al.* (2007) suggested that females matured at >400 cm L_T. Nielsen *et al*. (2016) suggested the age at sexual maturity to be at least 156 ± 22 years. Fecundity is uncertain, but has been suggested to be approximately ten (Bjerkan and Koefoed, 1957; Ebert and Stehmann, 2013; Carter and Soma 2020); however, Nielsen *et al*. (2020) suggested a much larger fecundity, estimating up to 200–324 pups per pregnancy (depending on maternal size) with a body length-at-birth of 35–45 cm.

24.7.5 Movements and migrations

Studies using conventional and electronic (satellite and acoustic) tags have informed on the movements and migrations of Greenland sharks. Recent studies deploying archival pop-off tags (PATs) have shown that sharks display a broad vertical distribution, but no obvious diel movements were noted (Campana *et al*., 2015; Fisk *et al*., 2012). Tagged sharks move into deeper water when they mature, and it is possible that they migrate offshore to mate and/or give birth (Campana *et al*., 2015). A recent study revealed a previously unknown directed migration from Canadian Arctic to NW-Greenland (Hussey *et al*. 2018). Previous studies have also examined the behaviour of Greenland sharks in the Northwest Atlantic (Skomal and Benz, 2004; Stokesbury *et al*., 2005). All such studies have found examples of localized movements and site fidelity, as well as some larger scale movements.

24.7.6 Diet and role in ecosystem

Greenland sharks feed on a wide variety of invertebrates, fish and marine mammals, indicating they are generalist predators on both benthic and pelagic organisms (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014), and they are important predators in Arctic food webs (Leclerc *et al.*, 2012). They are also important scavengers, including of whales (Leclerc *et al.*, 2011). Recent studies showed an ontogenetic dietary shift with small sharks (<200 cm) mainly feeding on lower trophic level prey such a squid, while larger sharks feed on seals as well as epibenthic and benthic fishes. Additionally, it was indicated that Greenland sharks are capable of active predation on fast swimming mammals and large fishes (Nielsen *et al*., 2019).

24.8 Exploratory assessment models

No exploratory stock assessments have been undertaken.

24.9 Stock assessment

No stock assessment has been undertaken.

24.10 Quality of the assessment

No stock assessment has been undertaken.

24.11 Reference points

No reference points have been proposed for this stock.

24.12 Conservation considerations

On the basis of possible population declines and limiting life-history characteristics, the Greenland shark is listed as globally Vulnerable in the IUCN Red List (Kulka *et al.*, 2020). It is listed as Near Threatened on both the Norwegian Red List (Hesthagen *et al.*, 2021) and European Red List (Burgess, *et al*., 2015).

24.13 Management considerations

Stock status and many other aspects of the biology of Greenland sharks are unknown. Given the large body size of this species and perceived low population productivity, further studies to better understand population dynamics and sources of mortality are required.

Ruud (1968) reported a longer-term decline in Greenland shark in the Oslofjord, but it is unclear as to how such local depletions towards the south of the distribution range relate to wider population trends.

24.14 References

Anthoni, U., Christophersen, C., Gram, L., Nielsen, N.H. and Nielsen, P. 1991. Poisonings from flesh of the Greenland shark *Somniosus microcephalus* may be due to trimethylamine. *Toxicon*, 29: 1205–1212.

Bigelow, H.B. and Schroeder, W.C. 1948. Sharks. In Tee-Van, J., Breder, C.M., Hildebrand, S.F., Parr, A.E. and Schroeder, W.C. (Eds.) Fishes of the Western North Atlantic, Part 1. Yale, CT: Yale University, Sears Foundation for Marine Research: 59–546.

Bjerkan, P. and Koefoed, E. 1957. Notes on the Greenland Shark *Acanthorhinus carcharias* (Gunn). Report on Norwegian Fishery and Marine Investigations, 11: 1–12.

Burgess, G.H., Sherrill-Mix, S.A. and Kyne, P.M. 2015. *Somniosus microcephalus* (Europe assessment). The IUCN Red List of Threatened Species 2015: e.T60213A48917268. Accessed on 26 September 2024.

Campana, S.E.,Fisk, A.T. and Klimley, A. 2015. Movements of Arctic and northwest Atlantic Greenland sharks (*Somniosus microcephalus*) monitored with archival satellite pop-up tags suggest long-range migrations. *Deep Sea Research Part II.* 115:109-115.

Carrier, J.C., Pratt, H.L. Jr. and Castro, J.I. 2004. Reproductive biology of elasmobranchs. In Carrier J.C., Musick, J.A. and Heithaus, M.R. (Eds.) Biology of Sharks and their Relatives, Boca Raton, FL, CRC Press: 269–286.

Carter, A.M. and Soma, H., 2020. Viviparity in the longest-living vertebrate, the Greenland shark (*Somniosus microcephalus*). Placenta, 97, pp.26-28.

Devine, B. M., Wheeland, L. J. and Fisher, J. A. 2018. First estimates of Greenland shark (Somniosus microcephalus) local abundances in Arctic waters. Scientific reports, 8(1), p.974.

EC. 2015. Council Regulation (EU) No 1367/2014 of 15 December 2014 fixing for 2015 and 2016 the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks. Official Journal of the European Union L 366; 1–14.

Ebert, D.A. and Stehmann, M.F. 2013. Sharks, batoids, and chimaeras of the North Atlantic, Food and Agriculture Organization of the United Nations: 537 pp.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. 2017. A review of capture and post-release mortality of elasmobranchs. Journal of fish biology, 90(3), pp.653-722.

Fisk, A.T., Lydersen, C. and Kovacs, K.M. 2012. Archival pop-off tag tracking of Greenland sharks *Somniosus microcephalus* in the High Arctic waters of Svalbard, Norway. *Marine Ecology Progress Series*, 468: 255–265.

Gunnarsdóttir, R. and Jørgensen, M.W. 2008. Utilization possibilities of waste products from fishing and hunting to biogas and bio-oil production in Uummannaq County. In Sustainable Energy Supply in the Arctic - sun, wind, water, etc.: ARTEK Event. Arctic Technology Centre, Department of Civil Engineering, Copenhagen: 52–58.

Hansen, P.M. 1963. Tagging Experiments with the Greenland shark (*Somniosus microcephalus* (Block and Schneider)) in Subarea 1. International Commission for the Northwest Atlantic Fisheries. Special Publication, 4: 172–175.

Hesthagen, T., Wienerroither, R., Bjelland, O., Byrkjedal, I., Fiske, P., Lynghammar, A., Nedreaas, K. and Straube, N. 2021. Rødlista for arter 2021. Artsdatabanken. http://www.artsdatabanken.no/lister/rodlisteforarter

Hussey, N. E., Orr, J., Fisk, A. T., Hedges, K. J., Ferguson, S. H. and Barkley, A. N. 2018. Mark report satellite tags (mrPATs) to detail large-scale horizontal movements of deep water species: First results for the Greenland shark (Somniosus microcephalus). Deep Sea Research Part I: Oceanographic Research Papers, 134, pp.32-40.

Kondyurin, V.V. and Myagkov, N.A. 1983. Catches of newborn Greenland shark, *Somniosus microcephalus* (Bloch and Schneider) (Dalatiidae). *Journal of Ichthyology* 23: 140–141.

Kulka, D.W., Cotton, C.F., Anderson, B., Derrick, D., Herman, K. & Dulvy, N.K. 2020. *Somniosus microcephalus*. The IUCN Red List of Threatened Species 2020: e.T60213A124452872. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T60213A124452872.en. Downloaded on 06 July 2021.

Leclerc, L.-M., Lydersen, C., Haug, T., Bachmann, L., Fisk, A. and Kovacs, K. 2012. A missing piece in the Arctic food web puzzle? Stomach contents of Greenland sharks sampled in Svalbard, Norway. *Polar Biology*, 35: 1197–1208.

Leclerc, L.-M., Lydersen, C., Haug, T., Glover, K. A., Fisk, A. T. and Kovacs, K. M. 2011. Greenland sharks (*Somniosus microcephalus*) scavenge offal from minke (*Balaenoptera acutorostrata*) whaling operations in Svalbard (Norway). *Polar Research*, 30: 4 pp.

MacNeil, M.A., McMeans, B.C., Hussey, N. E., Vecsei, P., Svavarsson, J., Kovacs, K.M., Lydersen, C., *et al*. 2012. Biology of the Greenland shark *Somniosus microcephalus. Journal of Fish Biology*, 80: 991–1018.

McAllister, D.E. 1968. Poisonous and venomous fishes of Canada. National Museum of Canada Natural History Papers, 42: 2–3.

NAFO. 2022. 44th annual meeting of NAFO – September 2022. Measure to conserve Greenland sharks. NAFO/COM Doc. 22-15.

Nielsen, J., Hedeholm, R.B., Lynghammar, A., McClusky, L.M., Berland, B., Steffensen, J.F. and Christiansen, J.S., 2020. Assessing the reproductive biology of the Greenland shark (*Somniosus microcephalus*). PloS one, 15(10), p.e0238986.

Nielsen, J., Christiansen, J.S., Grønkjær, P., Bushnell, P., Steffensen, J.F., Kiilerich, H.O., Præbel, K. and Hedeholm, R. 2019. Greenland shark (*Somniosus microcephalus*) Stomach Contents and Stable Isotope Values Reveal an Ontgenetic Dietary Shift. *Frontiers in Marine Science*, 6: 125. doi: 10.3389/fmars.2019.00125

Nielsen, J, Hedeholm, R.B., Bushnell, P.G., Christiansen, J.S., Olsen, J.,Bronk, C.B., Brill, R.W. *et al*. 2016. Eye lens radiocarbon reveals centuries of longevity in the Greenland shark (*Somniosus microcephalus*). *Science*, 253:702-704

Nielsen, J., Hedeholm, R.B., Simon, and M.J., Steffensen, 2014. Distribution and feeding ecology of the Greenland shark (*Somniosus microcephalus*) in Greenland waters. *Polar Biology*, 37: 37–46.

Rodríguez-Cabello, C. and Sánchez, F. 2014. Is *Centrophorus squamosus* a highly migratory deep-water shark? Deep Sea Research, Part I 92, 1–10

Rusyaev, S. and Orlov, A. 2013. Bycatches of the Greenland shark *Somniosus microcephalus* (Squaliformes, Chondrichthyes) in the Barents Sea and adjacent waters under bottom trawling data. *Journal of Ichthyology*, 53: 111–115.

Ruud, J. T. 1968. Changes since the turn of the century in the fish fauna and the fisheries of the Oslofjord. *Helgoländer Wissenschaftliche Meeresuntersuchungen*, 17: 510–517.

Skomal, G.B. and Benz, G.W. 2004. Ultrasonic tracking of Greenland sharks, *Somniosus microcephalus*, under Arctic ice. *Marine Biology*, 145: 489–498.

Stokesbury, M.J.W., Harvey-Clark, C., Gallant, J., Block, B.A. and Myers, R.A. 2005. Movement and environmental preferences of Greenland sharks (*Somniosus microcephalus*) electronically tagged in the St. Lawrence Estuary, Canada. *Marine Biology*, 148: 159–165.

Yano, K., Stevens, J.D. and Compagno, L.J.V. 2007. Distribution, reproduction and feeding of the Greenland shark *Somniosus* (*Somniosus*) *microcephalus*, with notes on two other sleeper sharks, *Somniosus* (*Somniosus*) *pacificus* and *Somniosus* (*Somniosus*) *antarcticus*. Journal of Fish Biology, 70: 374–390.

Electronic references

http://www.hagstofa.is Accessed 25th September 2024.

24.15 Tables and Figures

Table 24.1. Greenland shark *Somniosus microcephalus* in the Northeast Atlantic. Preliminary estimates of landings (t) for the period 1992–2023). Data were updated with landings from ICES historic nominal landings database (ICES, 2016) and national landings data provided to the WG (June 2024). ^Data revised in 2024.

Year	Iceland	Greenland	Portugal	Sweden	Total
1992	68				68
1993	41				41
1994	42				42
1995	43				43
1996	61				61
1997	73				73
1998	87				87
1999	51				51
2000	45				45
2001	57				57
2002	56				56
2003	55				55
2004	58				58
2005	50		0.3		50
2006	28		0.5		29
2007	2	17	0.7		20
2008	42		0.6		43
2009	26			0.4	26
2010	43				43
2011	18				18
2012	19				19
2013	6				6
2014	26^	8			34
2015	30^	17			47
2016	26				26
2017	17				17
2018	9				9
2019	6				6
2020	16				16
2021	16				16
2022	13				13
2023	20				20

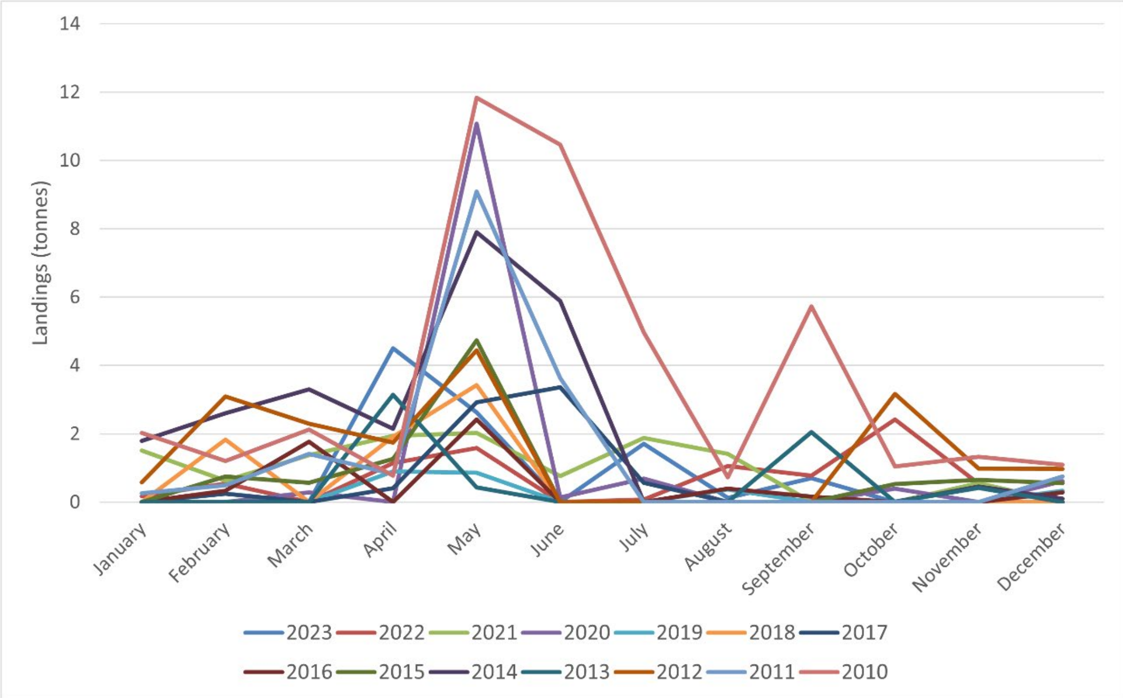


Figure 24.1. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Monthly Icelandic landings of Greenland shark 2010–2023. Data from www.hagstofa.is

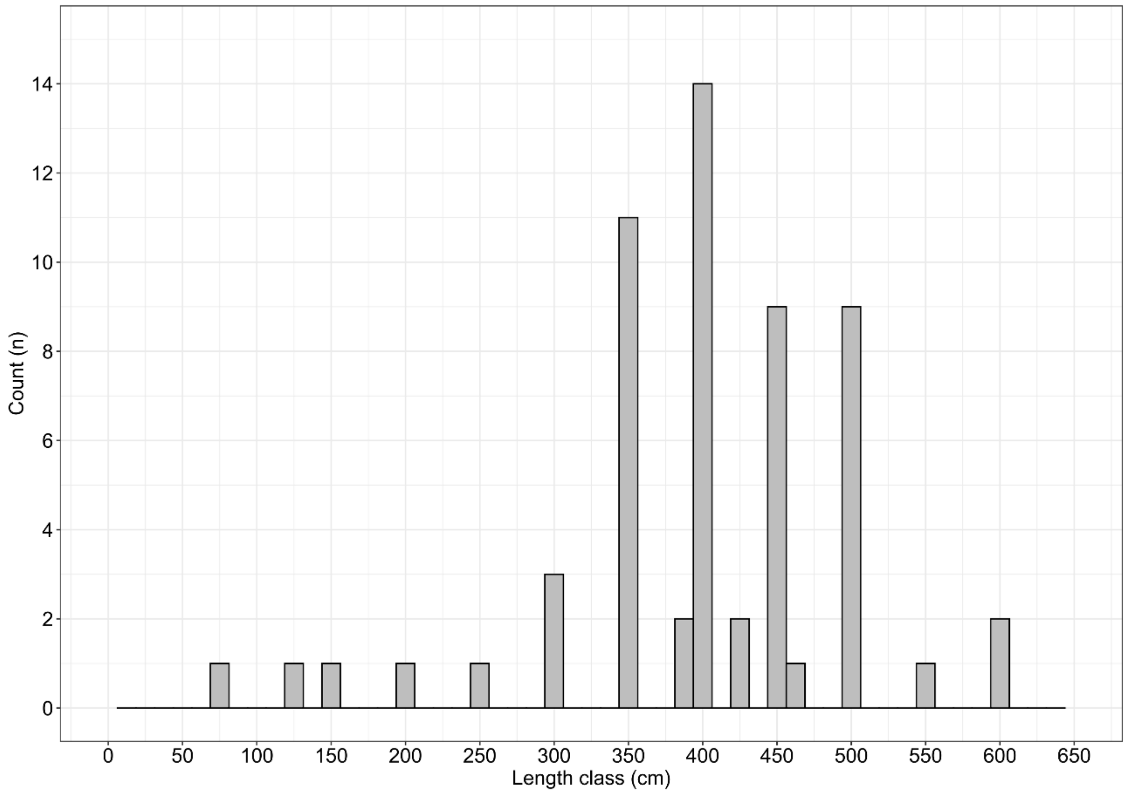


Figure 24.2. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Length distribution of Greenland shark captured during the annual German Greenland Groundfish Survey (1981–2020; n = 72; length measurements available for n = 60 specimens).

Contents

25 Catsharks (*Scyliorhinidae*) in the Northeast Atlantic

25.1 Stock distribution

This section addresses four species of catsharks that occur on the continental shelf and upper slope of the ICES area: lesser-spotted dogfish (or small-spotted catshark) *Scyliorhinus canicula*, greater-spotted dogfish *Scyliorhinus stellaris*, black-mouth dogfish (or black-mouth catshark) *Galeus melastomus* and Atlantic catshark *Galeus atlanticus.* Other catsharks that occur in deeper waters (*Apristurus* spp. and *Galeus murinus*) are not included here (see Section 5). All catsharks are demersal and oviparous (egg-laying) species.

These species have been referred to as catsharks, dogfishes and other names including hounds. Names recognised by FAO may not be suitable to minimise confusions with *Scyliorhinus canicula* being referred to as small-spotted catshark and *S. stellaris* as nursehound. Therefore, ICES refer to these species as follows:

English name	Scientific name
Lesser-spotted dogfish	*Scyliorhinus canicula*
Greater-spotted dogfish	*Scyliorhinus stellaris*
Black-mouth dogfish	*Galeus melastomus*
Atlantic catshark	*Galeus atlanticus*

Lesser-spotted dogfish: *S. canicula* is an abundant species occurring on a range of substrates (from mud to rock) on the European continental shelves, from coastal waters to the upper continental slope, but is most abundant on the shelf. Its distribution ranges from Norway and the British Isles to the Mediterranean Sea and Northwest Africa (Ebert and Stehmann, 2013). ICES currently consider 4 stock units for this species: (i) North Sea ecoregion (Subarea 4 and divisions 3.a and 7.d), (ii) Celtic Seas and west of Scotland (Subarea 6 and divisions 7.a–c and 7.e–j), (iii) northern Bay of Biscay (divisions 8.a–b and 8.d), and (iv) Atlantic Iberian waters (divisions 8.c and 9.a).

See stock annexes for information about *S. canicula* in northern Bay of Biscay (divisions 8.a–b and 8.d) and in the Cantabrian Sea and Atlantic Iberian waters (divisions 8.c and 9.a).

Greater-spotted dogfish: *S. stellaris* is a locally frequent inshore shark of the Northeast Atlantic continental shelf and is generally found from shallow water to depths of about 125 m on rough or rocky bottoms, including areas with algal cover (e.g. kelp forests) (Ebert and Stehmann, 2013). It is Europe’s largest catshark, growing to at least 130 cm.

This species is currently only assessed for the subareas 6 and 7, as it is locally common in parts of this area, and data are limited for other parts of the species’ biogeographic range, where it occurs at lesser density.

See stock annex for information about *S. stellaris* in subareas 6 and 7.

Black-mouth dogfish*: G. melastomus* is a small-sized shark (<90 cm), found on the upper slope in the Mediterranean Sea and the Atlantic from northern Norway and the Faroe Islands to Senegal (Ebert and Stehmann, 2013).

This species is currently assessed over two management units (i) Celtic Seas and west of Scotland (Subarea 6 and divisions 7.a–c and 7.e–j), and (ii) Bay of Biscay and Atlantic Iberian waters (Subarea 8 and Division 9.a).

See stock annex for information about *Galeus melastomus* in Atlantic Iberian waters (Subarea 8 and Division 9.a).

Atlantic catshark: *Galeus atlanticus* is a small catshark found on the continental slopes living in depths of 330–790 m. Its distribution in the Eastern Atlantic ranges from North of Spain to Portugal into the Mediterranean and further south to Morocco and possibly to Mauritania. Northern range limits are unknown (Ebert and Stehmann, 2013), as there is confusion between this species and *G. melastomus* (see Rey *et al.*, 2006 for distinguishing characters). The stock status of *G. atlanticus* is not assessed.

25.2 The fishery

25.2.1 History of the fishery

Catsharks are a bycatch of demersal trawl, gillnet and longline fisheries over much of the ICES area. They are usually of low commercial value and, with the exception of some seasonal, small-scale fisheries in some coastal areas, are not subject to target fisheries.

The retention patterns of catsharks in the North Sea and Celtic Seas ecoregions are highly variable, with varying proportions retained/discarded (Silva and Ellis, 2019). Larger individuals are landed for human consumption (more so in the southern parts of the ICES area). They are also landed in some areas as bait for pot fisheries, especially in fisheries for whelk *Buccinum undatum* or brown crab *Cancer pagurus* around the British Isles.

25.2.2 The fishery in 2023

No new information.

25.2.3 ICES Advice applicable

Before 2012, ICES advice on catsharks was included in the regional demersal elasmobranch advice. Species-specific advices for catsharks have been given since 2012. Advice is provided every two years.

The last assessments of catsharks were carried out in 2023 valid for 2024 and 2025. The Table 25.2 presents a summary of the last assessments.

Table 25.2. Summary of the catsharks stocks assessed in ICES areas and the advice provide for years 2024-2025.

STOCK	STOCK CODE	ASSESSMENT CATEGORY	ADVICE BASIS	ADVISED LANDINGS (2024–2025)
Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 4 and divisions 3.a and 7.d	syc.27.3a47d	3	MSY approach	2680 tonnes
Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 6 and divisions 7.a-c and 7.e–j	syc.27.67a-ce-j	3	MSY approach	3984 tonnes
Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.a-b and 8.d	syc.27.8abd	3	MSY approach	ICES has not been requested to provide advice on fishing opportunities for this stock.
Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.c and 9.a	syc.27.8c9a	3	MSY approach	ICES has not been requested to provide advice on fishing opportunities for this stock.
Greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7	syt.27.67	3	MSY approach	ICES advises that when the MSY approach is applied, landings should be no more than 682 tonnes
Black-mouth dogfish (*Galeus melastomus*) in subareas 6 and 7 (West of Scotland, southern Celtic Seas, and English Channel)	sho.27.67	3	MSY approach	Catches in each of the years 2024 and 2025 should be decreased by no less than 30% compared to the average catches in 2020-2022
Black-mouth dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a	sho.27.89a	3	MSY approach	ICES has not been requested to provide advice on fishing opportunities for this stock.

25.2.4 Management applicable

These species are not subject to species-specific fisheries management measures in EU and UK waters.

Galeus melastomus was originally included in the list of deep-water sharks, but Council Regulation (EC) 1182/2013 removed this species from this list following ICES advice. This review was based on the fact that its main distribution extended to upper slope and outer shelf habitats, which are not considered deep-water habitats, and that it had different life-history traits from other species on the list (with the assumption of lower vulnerability towards fishing pressure). There is no TAC for catsharks in the ICES area.

25.3 Catch data

25.3.1 Landings

Landings of catsharks were traditionally reported in generic category groups (e.g. dogfishes and hounds) in some countries, though in recent years more species-specific landings have become available. The lack of historical landings data and the uncertainty associated with recent species-specific information suggest data herein should be viewed with caution.

Nevertheless, in areas where S*cyliorhinus canicula* is much more abundant than *S. stellaris*, reported landings may be regarded as representative of the former species. The species is of minor interest to small-scale fisheries and local markets and most landings are being sold through fish auction markets.

ICES estimates of landings are presented in tables (25.1a–g). Some reported data were corrected, allocation to stocks were consolidated based on expert knowledge:

i. Some landings of catsharks have previously been reported in generic ´dogfish´ categories, this fraction of the landings is reducing in recent years to a few percent since 2016;
ii. some landings reported as either *S. canicula* or *S. stellaris* may comprise a fraction of the other species. For example, Portuguese landings from 9a assigned to *S. stellaris* are likely to correspond to *S. canicula* only;
iii. it is unclear as to whether catsharks used for pot bait are reported in landings data.

The confusion between *S. canicula* and *S. stellaris* is likely to have a greater impact on data for the lesser abundant *S. stellaris*.

Nominal landings data for *S. canicula* (including possible mixing with *S. stellaris*) from Subarea 4 and divisions 3.a and 7.d (Table 25.1a), subareas 6 and 7 (Table 25.1b), divisions 8.a–b and 8.d (Table 25.1.c) are reported mainly from France and Spain, while those from divisions 8.c and 9.a are reported by Spain and Portugal (Table 25.1d).

Nominal landings data for *G. melastomus* from subareas 6 and 7 (Celtic Seas) have only been reported by France and Spain (Table 25.1e) and were minor in recent years. There are no reported landings prior to 2002. It is likely that this species was caught in deep-water fisheries prior to these years, but was discarded or reported under generic landing categories.

Landings data for *G. melastomus* from Subarea 8 are reported mainly by Spain, whereas most landings from Division 9.a are from both the Portuguese and the Spanish fleets (Table 25.1f). In 2010, reported landings declined due to the introduction of the zero-TAC for deep-water sharks (where this species was previously included). Following the removal of this species from the list of deep-water sharks in 2013, international landings increased to reach their highest value in 2020 (183 tonnes).

Given the widespread discarding of catsharks, reported landings are not considered representative of catch.

25.3.2 Discards

Scyliorhinus canicula and other catsharks are often discarded by continental shelf fisheries (e.g. Silva and Ellis, 2019). The potentially high discard survival of species in the Scyliorhinidae family, at least for continental shelf fisheries, means that landing data are likely to be more representative of dead removals.

Discard information of *S. canicula* is available from several countries and areas (Table 25.2a-d). Discard data for *Scyliorhinus stellaris* (syt.27.67) is reported on Table 25.2.e and discard data for *Galeus melastomus* is also available from several countries in subareas 6, 7, 8 and 9 (Table 25.2f-g).

The “Spanish Discards Sampling Programme” for otter and pair bottom trawl fleets, covering ICES subareas 6, 7, 8c and North 9, provides data on elasmobranchs discards annually since 2003. The sampling strategy and the estimation methodology follow the “Workshop on Discard Sampling Methodology and Raising Procedures” guidelines (ICES, 2003). The on-board observers programme is based on a stratified random sampling design. Métier is the lower stratum and trips (the sampling units) are randomly or quasi-randomly selected for sampling within métiers. Discard estimates for several elasmobranchs species show high variation between years, exceeding 50% CV (Santos *et al.*, 2010).

In the Portuguese crustacean bottom otter trawl fishery operating in Division 9.a, the most frequently discarded demersal elasmobranchs are *G. melastomus* and *S. canicula*. Discard information (sampling effort and discard estimates) has been compiled and reported annually. Revised discard estimation methods were used for the two species between 2020 and 2022. These estimates were derived by multiplying the total fishing hours of the fleet in 2020-2022 by the average DPUE (Discards per Unit of Effort) values from the period 2017-2019, as detailed in Fernandes (2021 WD11). *Scyliorhinus canicula* and *G. melastomus* are also among the most discarded species by commercial fishing vessels with a fishing permit to set gillnets or trammel nets (LOA >= 12 m) (Figueiredo *et al*., 2017 WD). Frequency of occurrence (%) of both species in the discards from hauls with gillnets and/or trammel nets from those vessels range between 31% and 57% for *S. canicula* and between 0% and 6% for *G. melastomus* (Figueiredo *et al*., 2017 WD). For further details regarding estimated total discarded weight, length distribution and sex ratio for both species please refer to ICES (2014), Prista and Fernandes (2013 WD), Figueiredo *et al.* (2017 WD) and Fernandes (2021 WD11).

Discards in French fisheries have been estimated for stocks syc.27.347d, syc.27.8abd, syc.27.7a-ce-j, syt.27.67, sho.27.67, sho.27.89a. The raising factor of observed discards to the total fleet is fishing effort by DCF level 6 métier.

25.3.3 Discard survival

Scyliorhinus canicula have been shown to have a high discard survival in beam and otter trawl fisheries (Revill *et al*., 2005; Rodríguez-Cabello *et al*., 2005b; Barragán-Mendez *et al*., 2020), and anecdotal observations suggest that it would also have high survival in coastal longline fisheries. A review of survival studies on this species and other sharks can be found in Ellis *et al*. (2016). There are no data for discard survival of these species in gillnet fisheries. There are also no data for the survival of *G. melastomus* caught in fisheries operating along the outer continental shelf and upper slope. A study of survival of deep-water sharks caught by longline indicated some survivorship for this species using this fishing gear (Rodríguez-Cabello and Sanchez, 2017).

25.3.4 Quality of catch data

Accurate species-specific landings data are not currently available for all stocks. The ongoing (since 2012) French programme "Elasmobranches On Shore" aims to better evaluate the relative proportion of species mixed under a single landing name, as it is for *S. canicula* and *S. stellaris* (Mayot *et al*., 2021). This programme will enable to correct a large part of the French Landings Data. To date, the results have been only partially communicated. In the past, only *S. canicula* was used for catsharks landing but labelling has been improving in recent years in France with the progressive appearance of the landing name *S. stellaris* in fish markets.

25.4 Commercial catch composition

Data from national observer programmes have provided information on the size distribution of the retained proportions of the catch. In general, only larger individuals of catsharks are retained. However, retention of *S. canicula* and *S. stellaris* may depend locally more on market demand rather than size as these species can be often landed as bait for pot fisheries (Silva and Ellis, 2021).

The length distributions for *S. canicula* from France (divisions 7.a-c.e.k, for stocks syc.27.3a47d and syc.27.8abd; 2011–2015) and Spain (OTB Basque fleet for stock syc.27.8abd; 2011–2015) were shown in ICES (2017). Length-distributions of *S. canicula* from the Basque country trawl fleet are shown on Figure 25.1a. Catch length ranges from 10 cm to 73 cm. However, the proportion retained is from 40 cm to 73 cm, while fish of lengths from 10 cm to 50 cm are mostly discarded. Length data for discarded catches is available for the Spanish fleet operating in ICES divisions 8.c and 9.a. Catch length range from 10 cm to 70 cm but the proportion retained is mostly from 40 cm to 65 cm (Figure 25.1b).

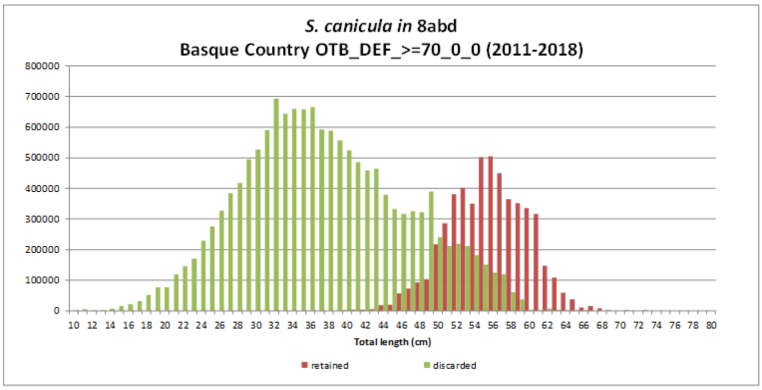


Figure 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequencies of *S. canicula* retained (in red) and discarded (green) recorded from the trawl fleet of the Basque country from 2011 to 2018 in ICES divisions 8.a-b, d.

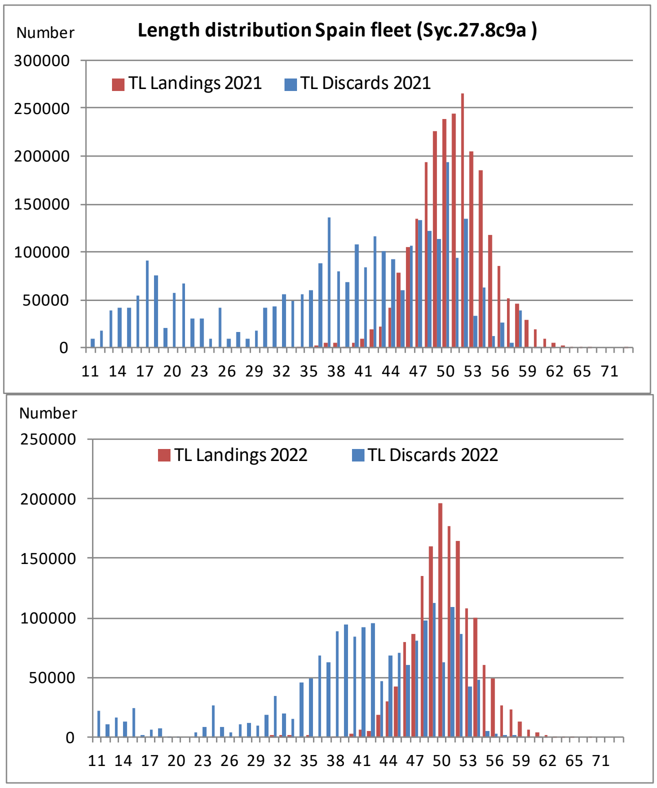


Figure 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequency distribution of *S. canicula* landed and discarded by the Spanish fleet in ICES areas 8.c and 9.a in 2021 and 2022.

Length–frequency distribution of *S. canicula* and *Galeus melastomus* obtained from specimens sampled at Portuguese landing ports and onboard observers programme, respectively, are shown in Figures 25.1c and 25.1d.

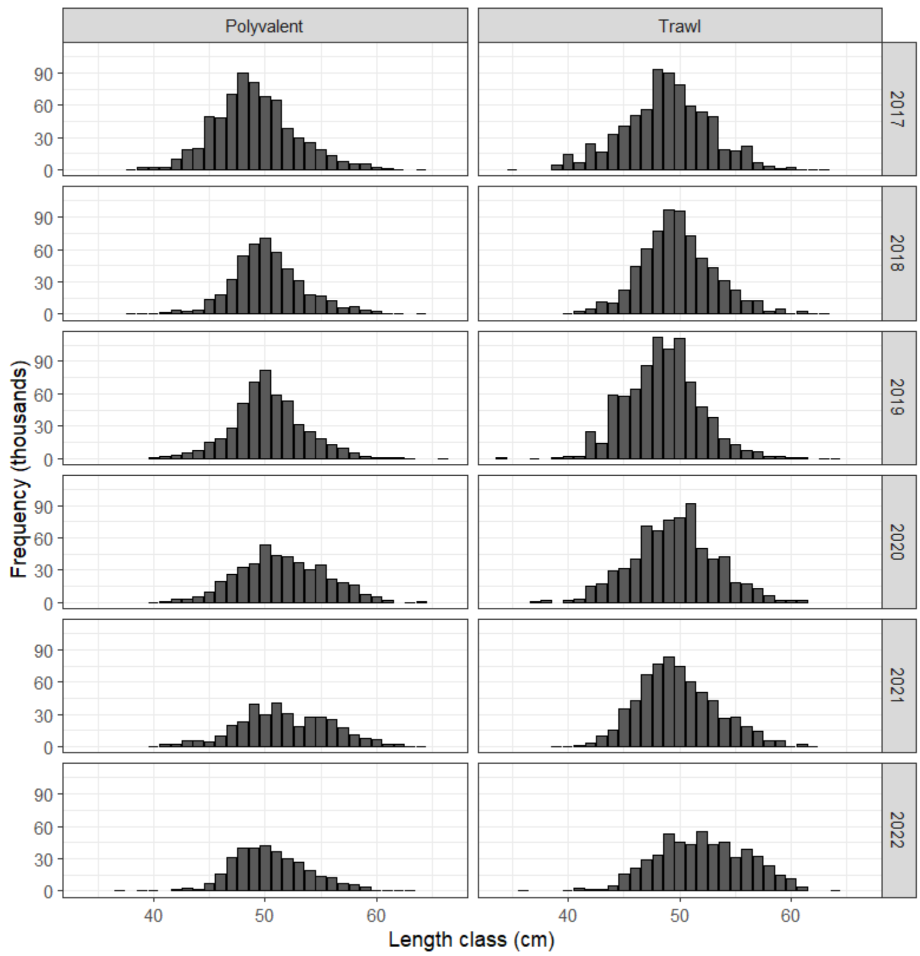


Figure 25.1c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length–frequency distribution of *S. canicula* from specimens sampled at Portuguese landing ports from polyvalent and trawl fleets raised to total landings (2019–2022).

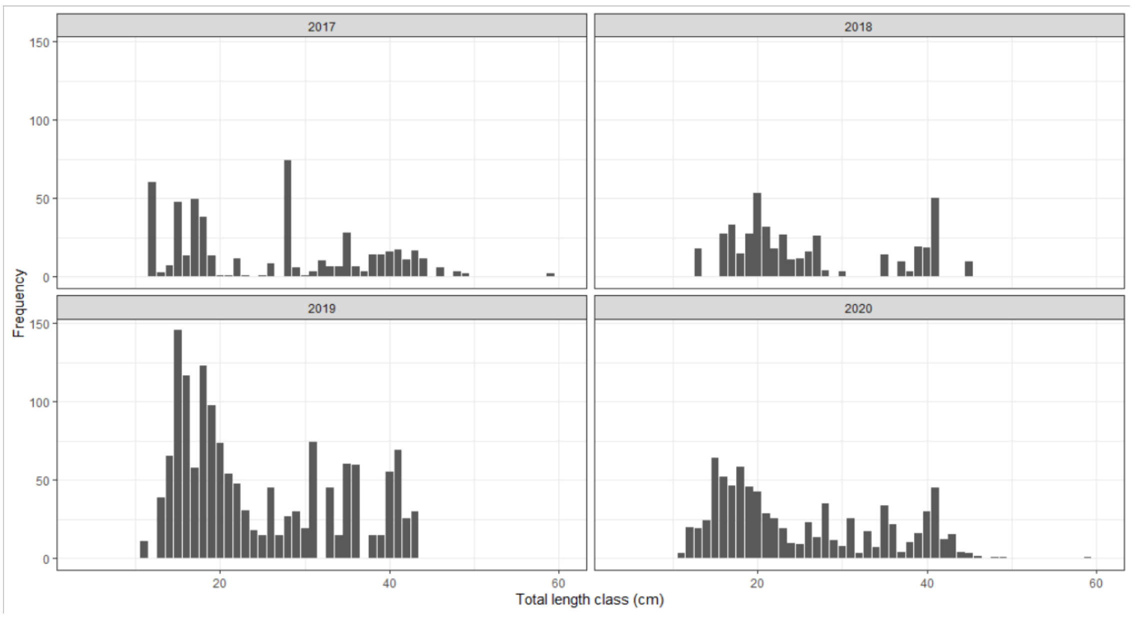


Figure 25.1d. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequency distribution of *G. melastomus* of discards in the Portuguese trawl fleet (OTB_CRU_55; 2017–2020).

For the assessments of each stock, length distributions of the landings and discards submitted to InterCatch were analysed, and were used depending on their reliability (see section 25.9 for stock-by-stock details).

25.5 Commercial catch–effort data

Commercial effort data are not used for assessment of Scyliorhinidae stocks in the ICES area.

25.6 Fishery-independent information

Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance of catsharks. These surveys were not designed primarily to inform on these populations, and so the gears used, timing of the surveys and distribution of sampling stations may not be optimal. However, these surveys provide the longest time-series of species-specific information.

Depending on the area and species, one to several surveys provide reliable time-series of data (Table 25.3). Data until 2022 is here presented.

Table. 25.3. Summary of the surveys available for each of the stocks assessed in ICES areas.

ICES stock code	Survey used for assessment
syc.27.3a47d	IBTS-Q1 and Q3, BTS-Eng-Q3, CGFS-Q4, and BTS-BE-Q3 (included since 2021).
syc.27.67a-ce-j	EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4, Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3, and UK (E&W)-BTS-Q3 (2005-2020).
syc.27.8abd	EVHOE-WIBTS-Q4
syc.27.8c9a	Spanish surveys in the South (Gulf of Cadiz) SpGFS-GC-WIBTS-Q1-Q4 (ARSA) and in the North of Spain (SpNGFS-WIBTS-Q4) and Portuguese survey (PtGFS-WIBTS-Q4)
syt.27.67	UK (E&W)-BTS-Q3 and CGFS-Q4 (included since 2021)
sho.27.67	Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3
sho.27.89a	EVHOE-WIBTS-Q4 survey in Subarea 8, Spanish IBTS-CG-Q1-Q4 (ARSA) and the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS UWTV (FU 28-29)).

Survey data used for assessment were taken from DATRAS, national database or from working documents (e.g. Fernández-Zapico *et al.,* 2022).

For the stock syc.27.3a47d biomass index of the following surveys are available and have been used in the stock assessment (Figure 25.2). These are: NS-IBTS-Q1 and NS-IBTS-Q3 (kg per hour), d FR-CGFS-Q4 (kg per swept area), BTS-BEL-Q3 and BTS-Eng-Q3 surveys (kg per hour).

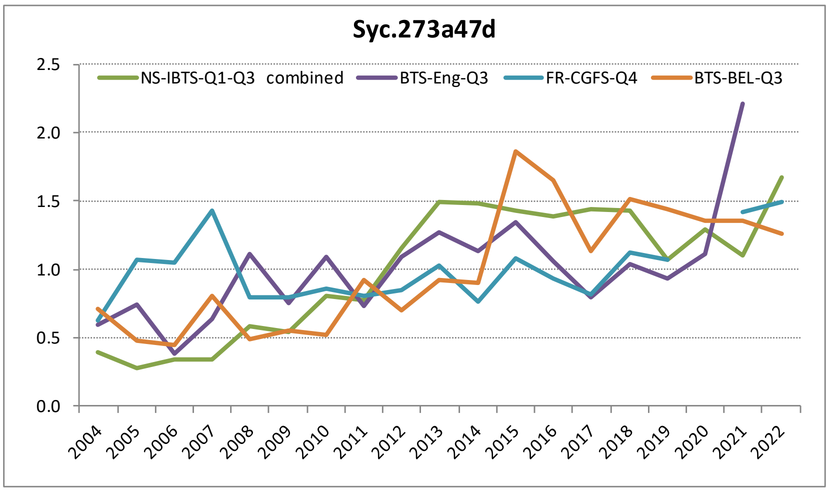


Figure 25.2. ***Scyliorhinus canicula*** **in Subarea 4 and Divisions 3.a and 7.d. Yearly normalized values for the biomass survey indices from the NS-IBTS-Q1, NS-IBTS-Q3, FR-CGFS-Q4, BTS-BEL-Q3 and BTS-Eng-Q3 surveys.**

For the stock syc.27.67a-ce-j four surveys index are available. These are: EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4, Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3, and UK (E&W)-BTS-Q3 (2005-2020). Each of these surveys are considered reliable indicator and provides spatial coverage of the stock (Figure 25.3).

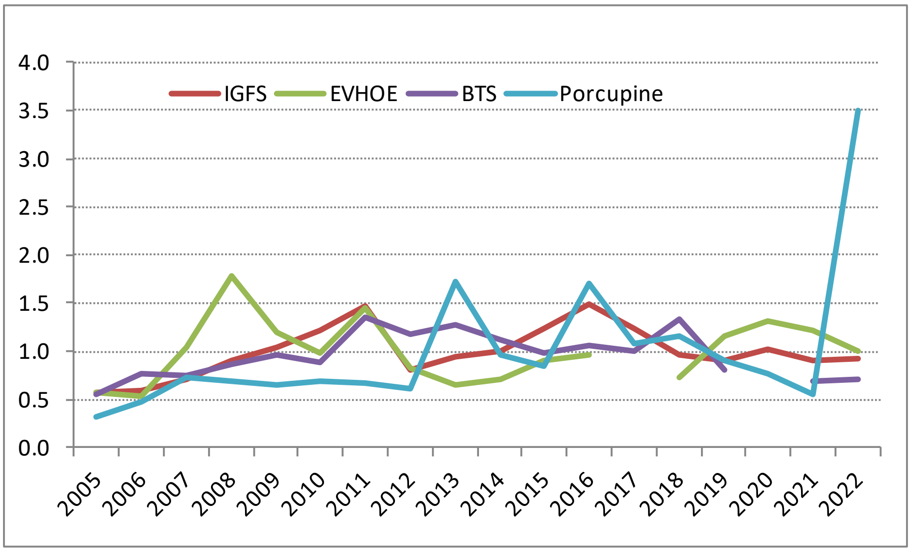


Figure 25.3. ***Scyliorhinus canicula*** **in in Subarea 6 and divisions 7.a–c and 7.e–j (West of Scotland, Irish Sea, southern Celtic Seas). Yearly normalized values for the biomass survey indices from the four surveys.**

In the case of *Scyliorhinus canicula* in Divisions 8abd (syc.27.8abd), the French survey EVHOE WIBTS Q4 is the one that covers this stock and provides the biomass index (kg/km²) for the stock assessment (Figure 25.17 in section 25.9.4).

For syc.27.8c9a, three surveys provide reliable time series of abundance or biomass index which are used in the assessment of this stock. These are the Spanish bottom trawl survey carried out in the north of Spain waters, Galician and Cantabrian Sea shelf (Figure 25.4) (Blanco et al., 2022 WD07; Fernández-Zapico *et al.*, 2023) and in the south of Spain, Gulf of Cádiz (Figure 25.5) which is carried out in two seasons in Spring (Q1) and Autumn (Q4). The Portuguese survey (PtGFS-WIBTS-Q4) also included covers all the central area of Division 9.a (Figure 25.6).

In 2022, the biomass of *S. canicula* increased in both, 9a and 8c Divisions compared to the previous year returning to the upper-middle values of the time series. The mean biomass of the last two years was markedly higher to the previous five years in 9c and slightly higher in 8c (Figure 25.4).

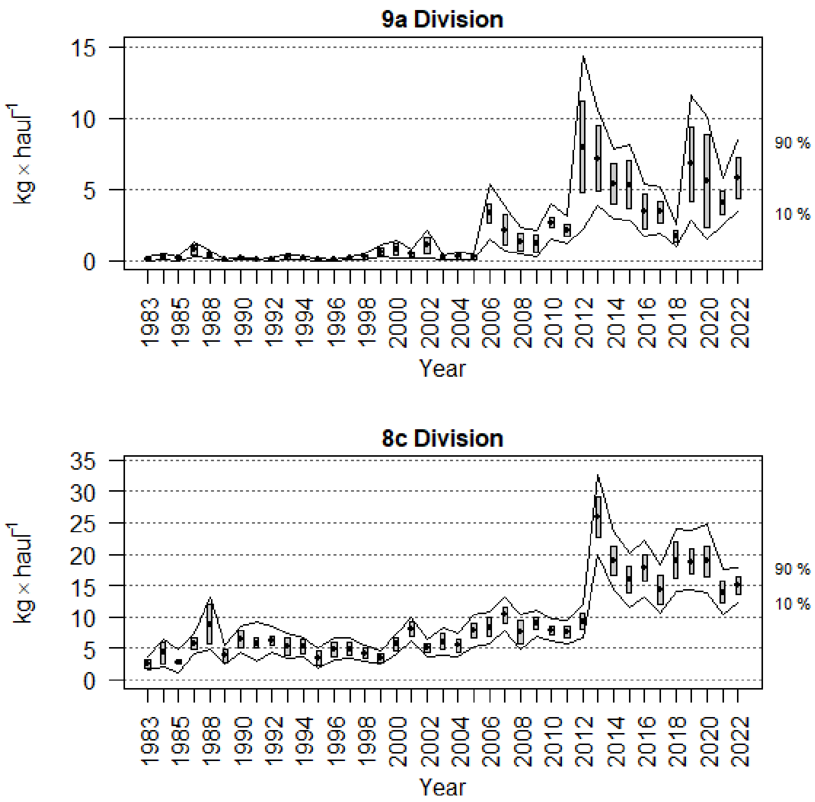


Figure 25.4. Evolution of *Scyliorhinus canicula* biomass index during the North Spanish shelf bottom trawl survey time series in the two ICES Divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000).

The surveys in Gulf of Cadiz were not conducted in 2021 due to a vessel breakdown. In the autumn survey the biomass index slightly decreased however remaining in the high values of the time series. In the spring survey, there was a notable increase in biomass following a significant decline in 2020 (Figure 25.5).

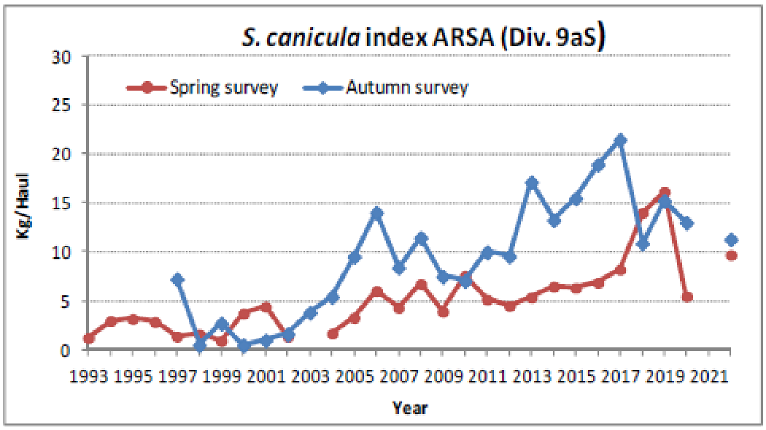


Figure 25.5. Evolution of *Scyliorhinus canicula* biomass index during the South Spanish bottom trawl surveys (ARSA) conducted in Gulf of Cádiz (ICES Div. 9a).

Due to technical problems followed by the COVID-19 pandemic, the PtGFS-WIBTS-Q4 survey was not conducted in 2019 and 2020. In 2021 and 2022 the survey (PtGFS-WIBTS-Q4) was carried out on a new vessel and more information is required to conclude about the continuity of the series. Therefore, these last two years were not included in the assessment (Figure 25.6).

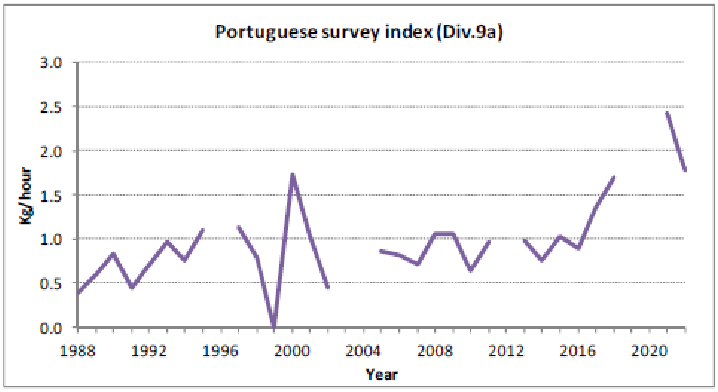


Figure 25.6. Evolution of *Scyliorhinus canicula* biomass index obtained from Portuguese bottom trawl survey (ICES Div. 9a).

In the case of greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7 two surveys provide biomass index. The French survey FR-CGFS-Q4 [G3425] in Division 7.d (kg.km^{-2}) and UK (E&W)-BTS-Q3 [B6596] in divisions 7.a and 7.f (kg.hr^{-1}). The evolution of the time series is shown in Figure 25.7.

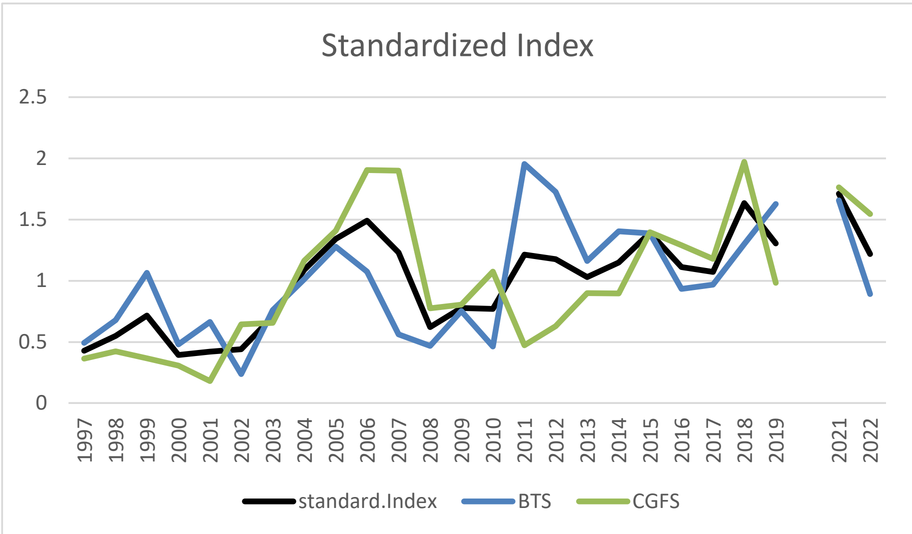


Figure 25.7. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus stellaris* in subareas 6 and 7 (Celtic Seas and West of Scotland). Standardized indices of exploitable biomass (individuals >50 cm TL) from FR-CGFS-Q4 [G3425], UK (E&W)-BTS-Q3 [B6596] and combined standardized index (1997–2022).

For sho.27.67, the Spanish Porcupine Bank survey (SP-PORC-WIBTS-Q3) provides a reliable biomass index that is used within the assessments. In 2022, there was a decline in the biomass and abundance of *G. melastomus*. However, these values remained relatively high when compared to the two-year average, in contrast to the trends observed over the previous five years (Figure 25.8 and see Figure 25.23 in section 25.9.7).

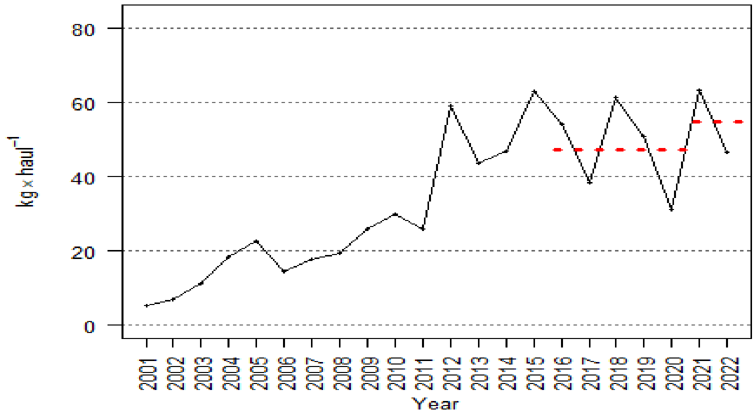


Figure 25.8. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in the biomass index in kg per haul of *Galeus melastomus* during the Porcupine Bank survey SP-PORC-WIBTS-Q3 (2001–2022). Dotted lines compare mean stratified biomass in the last two years and in the preceding five years.

For the stock sho.27.89a three surveys are available. These are: the French survey EVHOE-WIBTS-Q4 which is conducted in survey in Subarea 8, the Spanish surveys in the south (9a) IBTS-CG-Q1-Q4 (ARSA) and the Portuguese Crustacean Surveys/Nephrops TV Surveys (PT-CTS UWTV (FU 28-29)) in Division 9 (Figure 25.9).

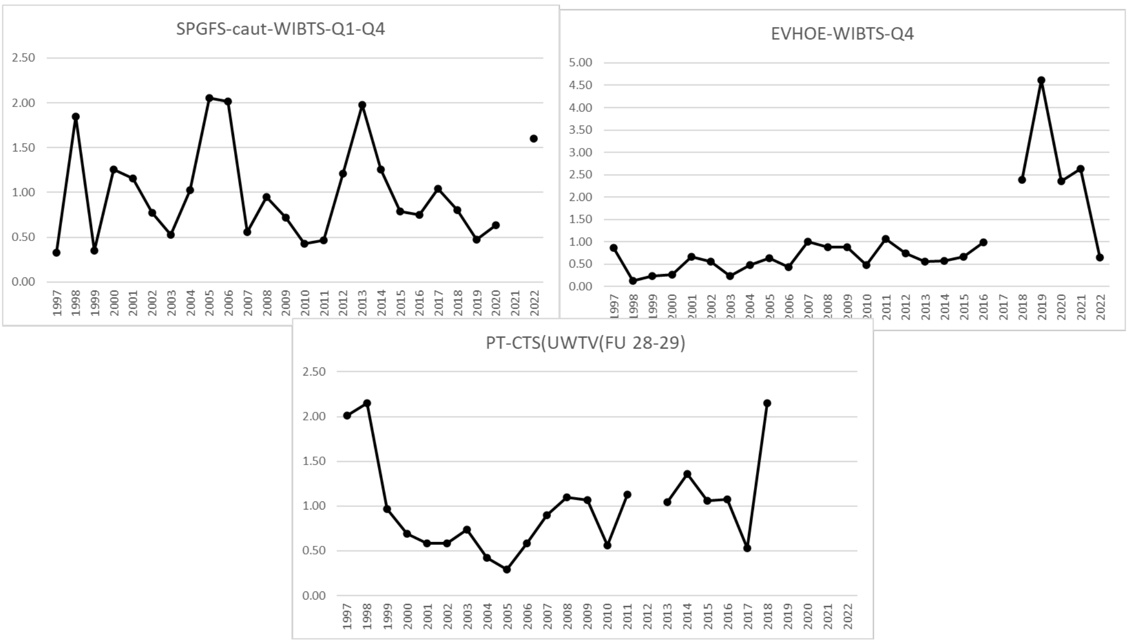


Figure 25.9. Time series of biomass index of *Galeus melastomus* obtained from Spanish surveys in the Gulf of Cadiz, Div.9a (top left), French survey EVOHE (Top right) in division 8abd and Portuguese trawl survey in Div. 9 (bottom).

The Spanish SpN-GFS-WIBTS-Q4 survey catches *G. melastomus.* However, data are only shown as general trends and not used for assessment since most of the biomass (nearly the 75%) is caught in the additional deeper hauls (depths over 500 m) that are not standardized (Blanco *et al.*, 2022; Fernández-Zapico *et al.*, 2023). In the standard hauls, the biomass of *G. melastomus* remained consistent with the previous year in Division 8c and experienced a slight decrease in Division 9a. In both cases, the indices were among the highest values observed in the time series (see Figure 25.10).

In contrast, during additional deeper hauls, the biomass of *G. melastomus* in Division 9a strongly decreased in 2022 compared to the previous year. However, in Division 8c, there was a notable increase (Fernández-Zapico *et al.*, 2023).

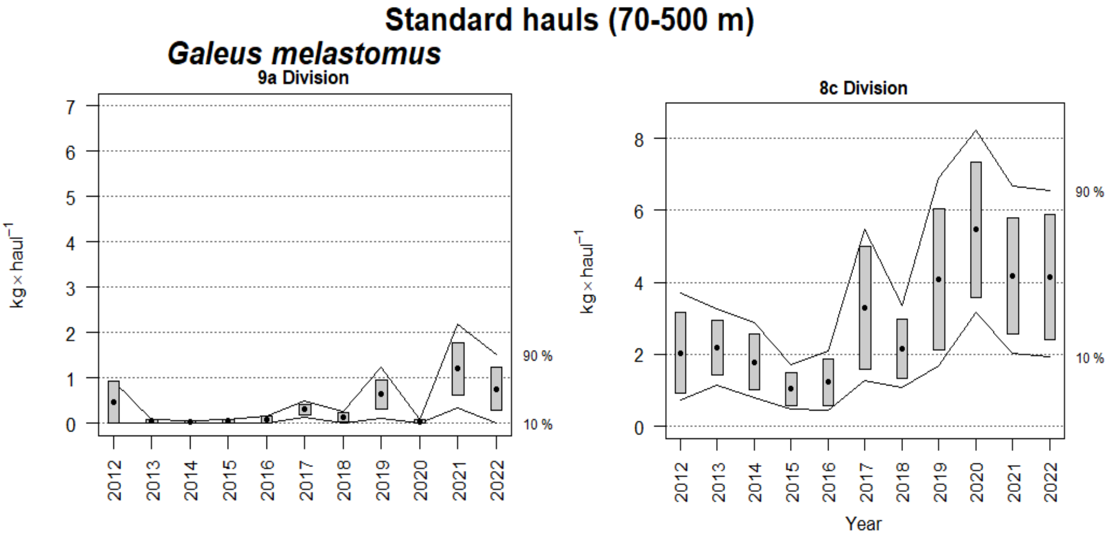


Figure 25.10. Evolution of *Galeus melastomus* stratified biomass index in standard hauls (70- 500 m) during the North Spanish shelf bottom trawl survey between 2012 and 2022 in the two ICES Divisions. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80 bootstrap iterations = 1000).

Due to technical problems followed by the COVID-19 pandemic, the PT CTS (UWTV [FU 28–29]) survey was not conducted in 2019 and 2020. In 2021 and 2022 the survey was carried out on a new vessel and more information is required to conclude about the continuity of the series. Therefore these last two years were not included in the assessment.

Catsharks occur out of the range of assessment stock units. *S. stellaris* is a coastal species that is caught only occasionally in surveys in the Biscay and Iberian ecoregions. *G. melastomus* is caught in the northern North Sea (Division 4.a) and Norwegian Deep, but most IBTS-Q1 and Q3 survey stations are <200 m deep, and so catch rates may not be informative of stock size.

25.7 Life-history information

While data on life-history parameters in the study area have not been updated, recent studies have been conducted focusing on social behavior, sexual dimorphism, and population genomics (Barragán-Méndez, *et al.*, 2020; Manuzzi *et al.*, 2019). Summaries of knowledge on life history of the various species are provided in the corresponding stock annexes and in WD Ellis *et al.*, 2023).

Catsharks can have protracted spawning periods, with *S. canicula* bearing egg cases observed for much of the year. This protracted egg-laying season may result in no apparent cohorts in length distributions. Age and growth parameters are uncertain for all the species considered here.

The reproductive biology of *S. canicula* has been studied in different regions by different authors. According to Ellis and Shackley (1997), males in the Bristol Channel mature at lengths of 49–54 cm ($L_{50\%}$ at 52 cm) and females at 52–64 cm ($L_{50\%}$ at 55 cm). The egg-laying season lasts at least ten months with a peak in June and July, and fecundity increases with fish length. Egg cases are often laid on erect, sessile invertebrates (e.g. bryozoans, poriferans and hydroids). In the Portuguese Coast southern to Nazaré Canyon, *S. canicula* individuals attained maturity at smaller sizes: 42.6 cm (6 years) for males and 44.5 cm (7 years) for females (Moreira *et al*., 2022). Although, data for *S. stellaris* in the Atlantic may be lacking, studies in the Mediterranean suggested that for both sexes length-at-maturity ranges from 76–79 cm (Capapé, 1977).

The reproductive biology of *G. melastomus* was studied from specimens collected off the Portuguese southern slope by Costa *et al.*, (2005). Sex ratio from specimens caught by commercial crustacean trawlers was 1:1. This species is sexually dimorphic with males approaching maturity at smaller sizes than females ($L_{50\%}$ males = 49.4 cm; $L_{50\%}$ females = 69.7 cm). Mating and egg deposition were found to take place all year round, with peaks of reproductive activity in winter and in summer.

A large nursery ground for *G. melastomus* was found in an Irish offshore Special Area of Conservation in 2018 (Marine Institute, 2019).

25.8 Exploratory assessment models

No exploratory assessment was presented in 2023 or 2024, stocks were last assessed following the ICES category 3 framework.

25.9 Stock assessment

25.9.1 Approach

Scyliorhinidae stocks were assessed in 2023 using ICES stock data category 3 rules. Indices of the total biomass were used for all stocks except greater-spotted dogfish in subareas 6 and 7 where exploitable biomass indices were used. Survey data used are described above (see Section 25.6).

25.9.2 Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 4, and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern English Channel)

The assessment of the status of the stock syc.27.3a47d, *Scyliorinus canicula* in Subarea 4 and Divisions 3.a and 7.d, was presented to WGEF in 2023 following the ICES rfb rule (ICES, 2021a) for Category 3 stocks.

The rfb rule is defined as:

$$A_{y+1} = A_y \times r \times f \times b \times m \qquad \text{(Eq 1)}$$

Where A_{y+1} and A_y refer to the advised catch in 2024 (and 2025) and 2022, respectively; r is the stocks stock size indicator, f a fishing mortality proxy, b a biomass safeguard and m a multiplier derived based on species-specific life-history parameters.

A stability clause is also included in Equation 1 to restrict the change in advised catch to +20%/-30% conditional on b exceeding 1.

The input values for the application of the rfb rule for syc.27.3a47d are listed in Table 25.4. Following the rfb rule, the advised catches in 2024 and 2025 should not exceed 2680 tonnes. The advice change (12.2%) is within the range of +20% compared to A_y, and therefore the stability clause was not applied.

Table 25.4. *Scyliorhinus canicula* in Subarea 4 and Divisions 3.a and 7.d. Estimates used in the rfb rule, with details and comments. All values have been rounded to two decimal places when appropriate; calculations were done using un-rounded values.

Variable	Estimate	Input data	Comments
r	1.23	Stoc size indicator of biomass index. From the combined index. NS-IBTS-Q1 and NS-IBTS- Q3, FR-CGFS-Q4, BTS-BEL-Q3 and BTS-Eng-Q3	Index A(2021,2022)= 1.50 Index B (2018-2020) =1.22
b	1.00	Set to 1.00 at $I_{2022}/I_{trigger}$	Iloss = 0.56 Itrigger = 0.78 I2022 = 1.47
m	0.95	Set at 0.95 when a species-specific k parameter is < 0.20	k = 0.118 year-1
f	0.96	Length data collected from commercial discards and landings 2019 - 2022. Lc and $L_{F=M\ c}$alculated based on pooled data from 2019 - 2022	Lc = 51 cm Lmean = 58 cm Lmode= 56 cm LF=M = 60 cm
A_Y	2389 tonnes	ICES advice in 2022	ICES (2021a)
A_{Y+1}	2680 tonnes	Ay+1= Ay x r x f x b x m	

The stock size indicator used for this stock corresponds to the mean biomass index taken from the combined average of NS-IBTS-Q1 and NS-IBTS-Q3 (kg per hour) and FR-CGFS-Q4 (kg per swept area), BTS-BEL-Q3 and BTS-Eng-Q3 surveys (kg per hour). Survey indices are then normalized to their respective long term mean and a single biomass index is calculated taking the mean of the four normalized indices. The survey index (figure 25.11 and table 25.5) spans the time period of 2004-2022 and covers most of the stock area.

Following the technical guidelines of the rfb rule (ICES, 2022), r is calculated as the average of the two most recent years of data (2021 and 2022) divided by the average of the three years prior to the most recent two (2018-2020). Consequently, r is 1.23.

The parameter b is set as 1.00 because the survey index in 2022 (1.47) is above $I_{trigger}$ (0.78) and the ratio $I_{2022}/I_{trigger}$ is 1.88. Here, $I_{trigger}$ has been set as 1.4 x I_{loss} with I_{loss} being the lowest point in the survey index (0.56 in 2006) between 2004-2022.

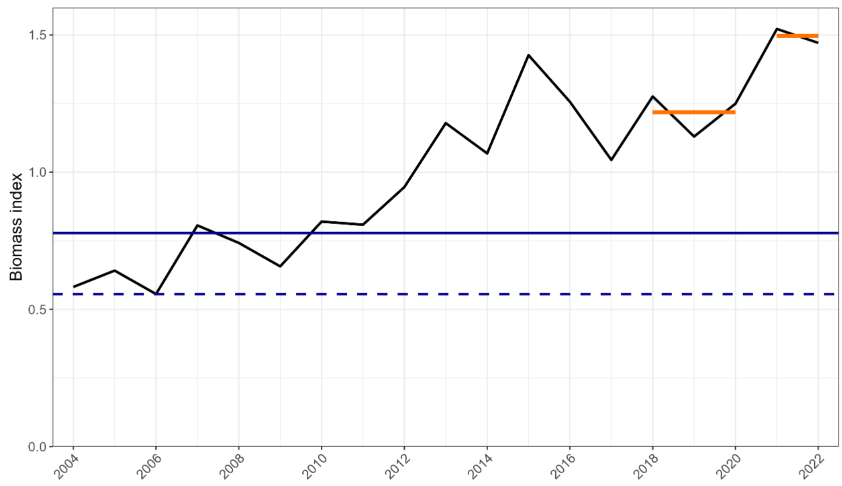


Figure 25.11. *Scyliorhinus canicula* in Subarea 4 and divisions 3.a and 7.d. Biomass index from 2004-2022, calculated as the combined CPUE indices from the NS-IBTS-Q1, NS-IBTS-Q3, FR-CGFS-Q4, BTS-BEL-Q3 and BTS-Eng-Q3. Orange lines

show the two parts of the "2-over-3" rule used to calculate r. The solid and dashed blue lines show the calculated $I_{trigger}$ and I_{loss} values, respectively.

Table 25.5. *Scyliorhinus canicula* in Subarea 4 and divisions 3.a and 7.d. Yearly normalized values for the biomass survey index. Values have been round to two decimal places; calculations were done using unrounded values.

Year	NS-IBTS-Q1, NS-IBTS-Q3 combined	BTS-Eng-Q3	FR-CGFS-Q4	BTS-BEL-Q3	Combined index
2004	0.39	0.59	0.63	0.71	0.58
2005	0.28	0.74	1.07	0.48	0.64
2006	0.34	0.38	1.05	0.45	0.56
2007	0.34	0.64	1.43	0.81	0.81
2008	0.58	1.11	0.79	0.49	0.74
2009	0.54	0.75	0.79	0.55	0.66
2010	0.81	1.09	0.86	0.52	0.82
2011	0.77	0.73	0.81	0.92	0.81
2012	1.15	1.09	0.85	0.70	0.95
2013	1.49	1.27	1.03	0.92	1.18
2014	1.48	1.13	0.76	0.90	1.07
2015	1.43	1.34	1.08	1.86	1.43
2016	1.39	1.06	0.93	1.65	1.26
2017	1.44	0.79	0.82	1.13	1.04
2018	1.43	1.04	1.12	1.51	1.28
2019	1.07	0.93	1.07	1.44	1.13
2020	1.29	1.11		1.35	1.25
2021	1.10	2.21	1.42	1.35	1.52
2022	1.67		1.49	1.26	1.47

Estimation of length-based indicators (used to derive f-proxy)

Length information for lesser-spotted dogfish is available for both landings and discards. Length data is available from the period 2016-2022 (Figure 25.12), however, earlier years (2016-2018) did not cover the entire length distribution available and therefore were excluded. In 2022, data is provided by 6 countries. Data from France, the Netherlands, England and Scotland for 2019-2022 were considered for the calculation of the length-based reference points.

To determine the f-proxy (f), L_{mode} was calculated as 56 cm (Figure 25.13); as per the technical guidelines of the rfb rule (ICES, 2022). L_c was calculated as 51cm, which is the first length class above a 50% threshold of the numbers at L_{mode}. L_{mean} in 2022 is then calculated as 58 cm.

Figure 25.12. ***Scyliorhinus canicula*** **in Subarea 4 and divisions 3.a and 7.d. Length frequency distribution by year and catch category (discards and landings).**

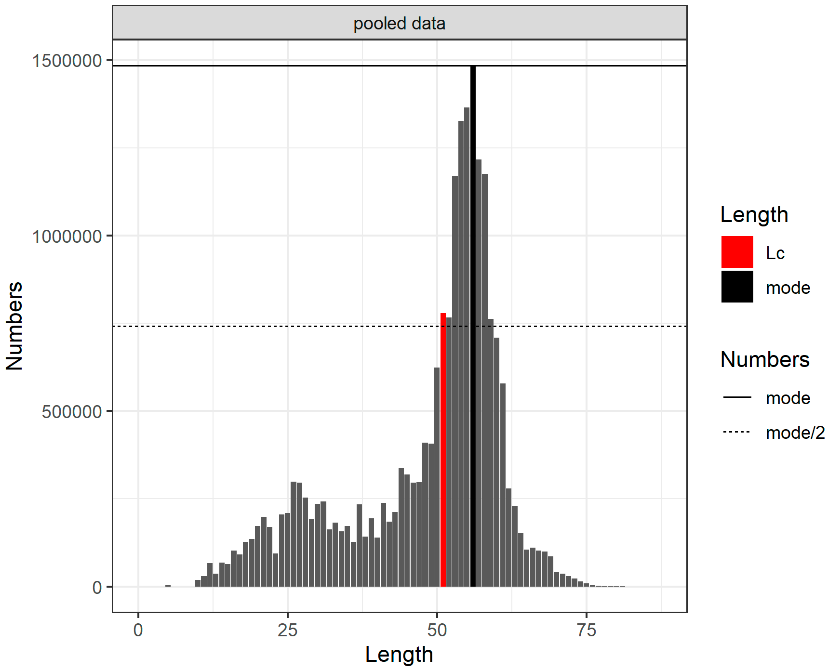


Figure 25.13. ***Scyliorhinus canicula*** **in Subarea 4 and Divisions 3.a and 7.d. Pooled length frequency distribution (2019-2022) used to calculate the length based reference points. Shown in red is the L_c (length at first capture), black the L_{mode}, horizontal black line and dashed line the number of fish at L_{mode} and $L_{mode}/2$, respectively.**

Information on (female) life history parameters were taken from Ivory *et al.*, (2005) and detailed in Ellis *et al.*, (2023). The study used vertebrae for analysis of life history parameters and samples were collected from the Irish Sea (divisions 7.a,g). These values are listed in Table 25.6.

Table 25.6 *Scyliorhinus canicula* in Subarea 4 and divisions 3.a and 7.d. Life history parameters taken from Ivory *et al.*, (2005) and Ellis *et al.*, (2023 – Table 2).

Study area	Sex	N	Linf	k
Irish Sea (Div. 7.a,g)	F	405	87.4	0.118
Irish Sea (Div. 7.a,g)	M	301	75.1	0.150

$L\infty$ was set at 87.4cm. The target reference length ($L_{F=M}$) is then calculated as:

$$L_{F=M} = 0.75\ Lc + 0.25\ L\infty \quad \text{(Eq 2)}$$

$0.75 \times 51 + 0.25 \times 87.4 = 60.1\ cm$

Such that *f* in 2022 is calculated as:

$$f = L_{mean2022} / L_{F=M} \quad \text{(Eq 3)}$$

And *f* in 2019, 2020 and 2021 is calculated as:

$$f = L_{meanyear} / L_{F=M}$$

Where the $L_{meanyear}$ equals each of the years 2019, 2020 and 2021. The L_{mean} and f values per year are found in table 25.7.

Table 25.7. *Scyliorhinus canicula* in Subarea 4 and divisions 3.a and 7.d. L_{mean} values and calculated *f* values for years 2019-2022.

Year	Lc	L_{mean}	$L_{F=M}$	*f*
2019	51	56.9	60.1	0.95
2020	51	56.6	60.1	0.94
2021	51	57.1	60.1	0.95
2022	51	57.8	60.1	0.96

25.9.3 Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 6 and divisions 7.a–c and 7.e–j (Celtic Seas and West of Scotland)

Scyliorhinus canicula in the Celtic Seas (syc.27.a-ce-j) is normally assessed on a biennial cycle as a Category 3 stock, for which survey data are available. Advice was last provided in 2023 for 2024 and 2025. It was the first year for which the rfb rule is used by ICES to assess the stock and provide a catch forecast.

Input data and application of the rule

For this stock assessment the following inputs are available:

- Landings information. Reported discards are considered unreliable.
- Four survey indices, combined to produce a relative biomass index.
- Length-frequency from commercial catches, including landings and discards.

Catch Data

Species specific landings are available from 2005 onwards (Table 25.1b). The annual declared quantity of discards is highly variable. Discard information is considered incomplete and is therefore not used in the analysis.

Survey indices

Four survey indices are used in the assessment: EVHOE-WIBTS-Q4 [G9527], IE-IGFS-WIBTS- Q4 [G7212], SP-PORC-WIBTS-Q3 [G5768], and UK (E&W)-BTS-Q3 [B6596]. Each of these is considered reliable indicator and provides spatial coverage of the stock. All surveys are part of the International Bottom Trawl Survey series and use standardized gear and sampling methods. Each survey was normalized by comparing each annual value to the long-term mean value of the survey (Table 25.8). In turn, the mean value for each year is calculated for the normalized values (Figure 25.14). The total survey time series is truncated to the shortest of the available time series. Missing values, where a particular survey did not take place in a particular year, are not included in the calculations.

Table 25.8. Survey table. Blank cells are those where the survey either did not take place or was incomplete for a given year.

Year	IGFS	EVHOE	BTS	Porcupine	Mean
2005	0.580338	0.562735	0.553182299	0.312698216	0.502238
2006	0.595856	0.523538	0.772145391	0.465586901	0.589282
2007	0.715388	1.038879	0.740839568	0.722993533	0.804525
2008	0.904412	1.774894	0.869817888	0.693304148	1.060607
2009	1.043453	1.187699	0.960058642	0.644049169	0.958815
2010	1.221342	0.988494	0.876907218	0.69552456	0.945567
2011	1.469445	1.44855	1.348407484	0.660713205	1.231779
2012	0.809587	0.825392	1.181256671	0.61385784	0.857523
2013	0.949369	0.658538	1.281835915	1.726371974	1.154029
2014	1.006604	0.713901	1.115675052	0.962943552	0.949781
2015	1.243513	0.903362	0.979738561	0.847146543	0.99344
2016	1.488877	0.953113	1.064355256	1.709529534	1.303969
2017	1.240122		0.992921196	1.075017957	1.102687
2018	0.965951	0.732328	1.337822872	1.149056725	1.04629
2019	0.908676	1.159249	0.811032765	0.912202777	0.94779
2020	1.016664	1.321806		0.772596983	1.037022
2021	0.909472	1.212301	0.680016583	0.54546486	0.836814
2022	0.930929	0.99522	0.711146688	3.490941521	1.532059

Figure 25.14. Combined survey index from each normalized survey index (see Figure 25.3).

Length data

Landings and length data are taken from submissions to the ICES WGEF data call. Lengths from both landings and discards are included (Figure 25.15). Lengths are illustrated for each year from 2020-2022. It was agreed by the group (WGEF 2023) that no individual year's data showed a representative reflection of the lengths in the catch. Therefore, these data were pooled to create a combined length frequency (Figure 25.15).

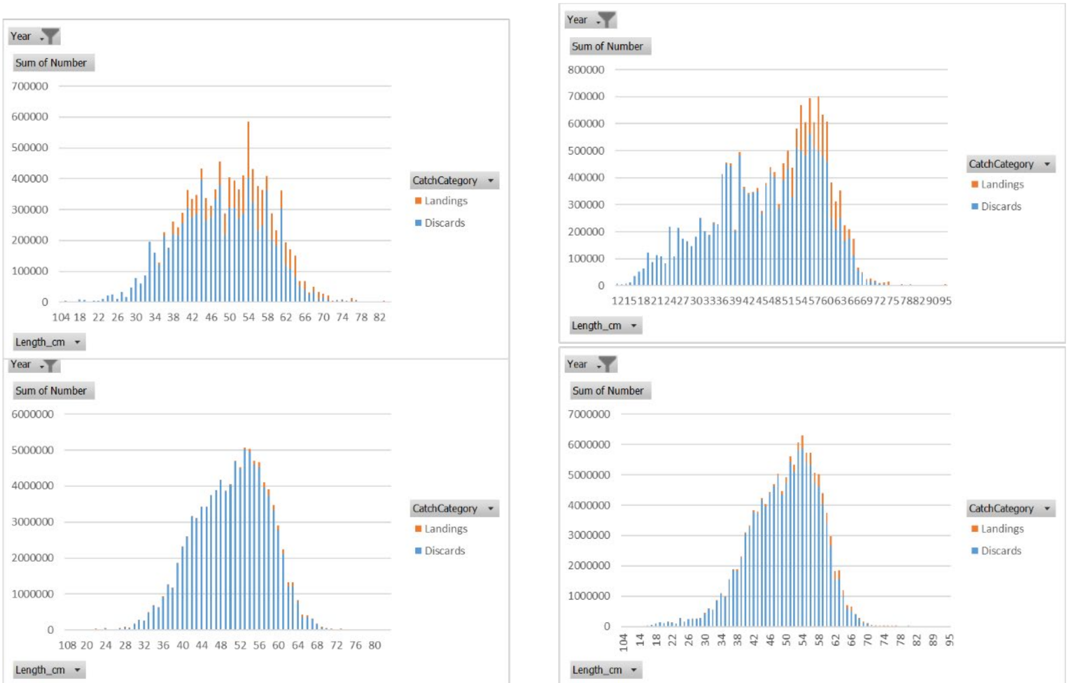


Figure 25.15. Length frequencies by year. Top left 2020. Top Right 2021. Bottom left 2022. Bottom right combined 2020-2022.

Application of the rfb rule.

The rfb rule is defined as:

$$Ay+1 = Ay \times r \times f \times b \times m$$

where $Ay+1$ and Ay refer to the advised catch in 2024 (and 2025) and 2022, respectively; r is the stock size indicator, f a fishing mortality proxy, b a biomass safeguard and m a multiplier derived based on species-specific life-history parameters.

If data are incomplete, other methods may be more appropriate. In this case data are available for each of these variables so the rfb rule was applied.

To calculate the values for the assessment, the R package "cat3advice" provided by Simon Fisher was used. The complete run is provided in Appendix 1 of syc.27.a-ce-j rfb document in WGEF SharePoint. Table 25 9 show the results of the advice.

a) Biomass trend: r

Stock biomass trend (r) is calculated by taking the mean value of the last two years and dividing by the mean value of the previous three years. In this case

r= mean $_{(2021\text{-}2022)}$/mean$_{(2018\text{-}2020)}$

r= 1.18/1.01 therefore r=1.17

b) Length at first capture, L_c

Following ICES guidelines of the rfb rule (ICES, 2022), Lc was calculated as 40 cm, which is the first length class above a 50% threshold of the numbers at L_{mode}. L_{mean} in 2022 is then calculated as 52 cm (Figure 25.16). L_{inf} was set at 87.4 cm, taken from fishbase.se.

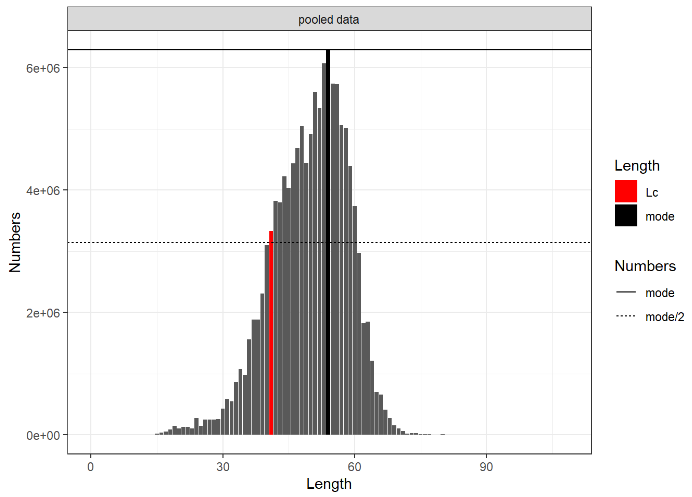


Figure 25.16. *Scyliorhinus canicula* in Subarea 6 and divisions 7.a–c and 7.e–j 4. Combined length frequency distribution (20209-2022) used to calculate the length based reference points. Shown in red is the Lc (length at first capture), in black the $L_{mode,}$ Horizontal black line and dashed line the number of fish at L_{mode} and $L_{mode/2}$, respectively.

c) Fishing pressure proxy: f

Mean catch length (L_{mean} = L_{2022}): 52 cm

MSY proxy length ($L_{F=M}$): 53 cm

f: Fishing pressure proxy relative to MSY proxy ($L_{2022}/L_{F=M}$) : 0.99

d) Biomass safeguard: b

Last index value (I_{2022}): 1.53

Index trigger value ($I_{trigger} = I_{loss}$ x 1.4): 0.70

b: index relative to trigger value: 1.00

e) Multiplier: m

m <-m(hr = "rfb", k = 0.1)

m= 0.95

Table 25.9. Main parameters used in the rfb-rule assessment of syc.27.67 and results of the advice.

Previous landings advice A (2022, 2023)	3596 tonnes	
Stock biomass trend		
Index A (2021, 2022)	1.18	
Index B (2018, 2019, 2020)	1.01	
r: Index ratio (A/B)	1.17	
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022}$)	52 cm	
MSY proxy length ($L_{F=M}$)	53 cm	
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)	0.99	
Biomass safeguard		
Last index value (I_{2022})	1.53	
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)	0.7	
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}	1.00	
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)	0.95	
RFB calculation: $A_{y+1} = A_y \times r \times f \times b \times m$	3984 tonnes	
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate	Unquantified	
Landings advice for 2024 and 2025 (A_y × stability clause)	3984 tonnes	
% advice change	10.8 %	

25.9.4 Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.a–b and 8.d (Bay of Biscay)

An assessment of the status of the stock syc.27.8abd (lesser spotted dogfish, *Scyliorhinus canicula*) in Divisions 8abd using the ICES rfb rule (ICES, 2021a) was presented at WGEF 2023. The ICES framework for category 3 stocks was applied (rfb rule to provide MSY advice, Method 2.1 (ICES, 2022). ICES has not requested to provide advice for this stock this year.

Stock indicator
A total biomass index derived from the EVHOE WIBTS Q4 survey (kg/km2) was used as index of stock development (Figure 25.17).

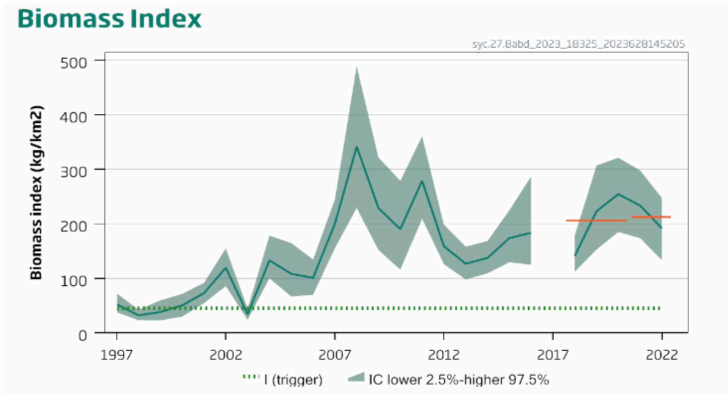


Figure 25.17. Syc.27.8abd. Total biomass index derived from the EVHOE WIBTS Q4 survey (kg/km2) G9527. The survey was incomplete in 2017. The horizontal orange lines show the mean stock indicators for 2021- 2022 (212 kg/km2) and 2018–2020 (206 kg/km2). Index ratio = 1.03.

Catch scenarios

The advice is based on the ratio (r: Index ratio (A/B)of the mean of the last two index values (index A) and the mean of the three preceding values (index B), multiplied by the landing average of the last three years (A_y); a ratio of observed mean length in the catch relative to the target mean length (f) (Figure 25.18, Table 25.10); a biomass safeguard (b); and a generic multiplier based on life history (m) (Tables 25.11 and 25.12).

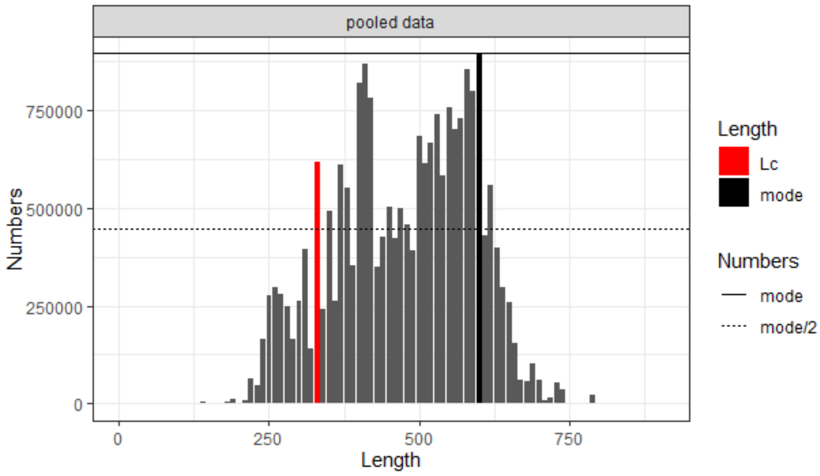


Figure 25.18. Syc.27.8abd. Commercial annual length–frequency distribution of catches (1 cm classes) and for the period for 2019-2022. Lc in red and Lmode in black.

Table 25.10. Syc.27.8abd. Fishing pressure proxy parameters used in the rfb assessment.

	2019	2020	2021	2022	2019-2022
L_{mean} (cm)	52.8	47.9	48.7	48.1	
MSY proxy length ($L_{F=M}$) (cm)	41.6	41.6	41.6	41.6	
L_{mean}/ $L_{F=M}$ =f	1.27	1.15	1.17	1.16	
1/f	0.79	0.87	0.85	0.87	
L_{mode} (cm)					60.0
Lc (cm)	40.0	33.0	32.0	26.0	33.0

Table 25.11. Syc.27.8abd. Life history parameters used in the rfb-rule assessment

Area	ICES Div.	Linf (cm)	K	Reference

Galicia and Cantabrian Sea	Div. 8.c	67.5	0.21	Rodríguez-Cabello *et al.*, (2005a)

Table 25.12. Syc.27.8abd. Main parameters used in the rfb-rule assessment.

A_y Landing average in last three years, (2020-2022) = 754 ton
r: Index ratio (A/B) = 1.03.
b multiplayer = 1
f: multiplier = 1.2
m multiplier = 0.9 (K = 0.21)
(I_{loss}) (1998) = 32 kg/km2
$I_{trigger}$ = I_{loss} × 1.4 = 45 kg/km2

Following rfb-rule (Figure 25.19), the landings in 2024 and 2025 should not exceed 807 t. Since the advice corresponds to an increase of 7% in relation to the landings average of the last three years (754 t), the stability clause was not applied (Table 25.13).

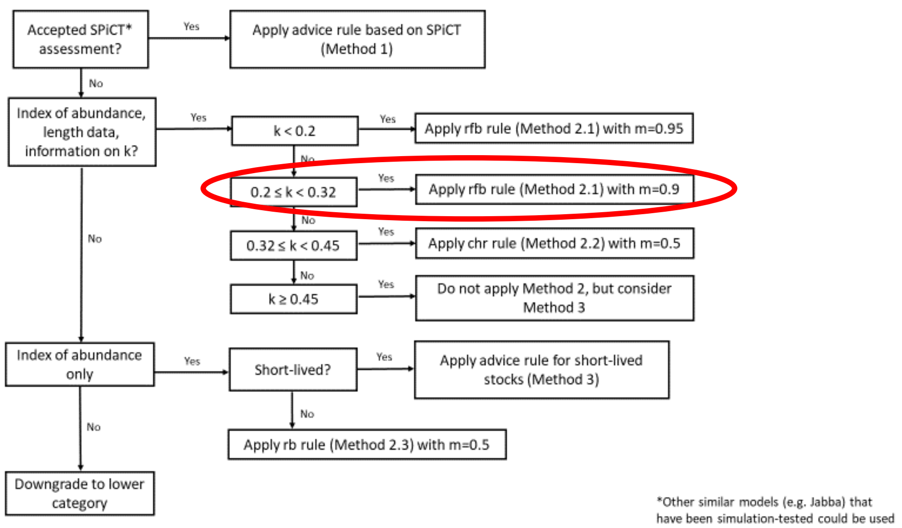


Figure 25. 19. The decision tree for applying ICES advice rules to stocks in category 3; stocks with life history information, catch data, and a biomass or abundance index. The left-hand boxes refer to the reliable data and information to be used in the provision of advice; k refers to the von Bertalanffy growth parameter k (unit: yr-1).

Table 25.13. Syc.27.8abd. in ICES Division 27.8abd. Basis for the catch scenarios.

Landing average in last three years, Ay (2020-2022)	754 tonnes
Stock biomass trend	
Index A (2021, 2022)	212 (kg/km^2)
Index B (2018, 2019, 2020)	206 (kg/km^2)
r: Index ratio (A/B)	1.03
Fishing pressure proxy	
Mean catch length (L_{mean} = L_{2022})	48.7 cm
MSY proxy length ($L_{F=M}$)	41.6 cm
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)	1.2
Biomass safeguard	
Last index value (I_{2022})	192

Landing average in last three years, Ay (2020-2022)		754 tonnes
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		45
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.9
RFB calculation: $A_{y+1} = A_y \times r \times f \times b \times m$		807 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate		69
Landing advice for 2024 and 2025 (A_y × stability clause)		807 tonnes
% advice change^		7 %

25.9.5. Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.c and 9.a (Atlantic Iberian waters)

Lesser-spotted dogfish has been assessed since 2014 under category 3 of ICES DLS (ICES, 2018) using biomass indicator trends estimated from survey data. Assessment of this stock has been provided by ICES WGEF every two years but the last scientific advice was conducted in 2018; since then, ICES has not been requested to give advice on this stock. Previous assessment was based on landings data and biomass index applying the 2 over 5 rule. In 2023, the rfb-rule was applied for the first time to this stock. Biomass index, fishery data and results from length-based indicators (LBI) are presented as well as the application of the rfb rule.

Survey Data

The stock size indicator used in this analysis corresponds to the standardized biomass index obtained from several surveys conducted in the area:

1) The Spanish annual bottom trawl survey carried out in the North of Spain Demersales (SpNGFS-WIBTS-Q4) corresponding to ICES Divisions 8c and 9a (north). The survey index time series started in 1983 and is standardized from 1990. Evolution of the biomass index time series is shown on Figure 25.4.

2) The Spanish surveys conducted in the south of Spain (Gulf of Cádiz, Div. 9a south) in two seasons, one in spring (mainly in March) and other in autumn (November) (Sp GC-GFS- WIBTS-Q1 and Q4). Spring survey has been performed since 1993 (except in 2003) and the autumn survey since 1997 (Figure 25.5).

3) The Portuguese Groundfish Survey (PtGFS-WIBTS-Q4) carried out along the Portuguese coast (ICES Div. 9a) at the beginning of the 4th quarter, in October since 1981 (Figure 25.6). It covers depths from 20 to 500 m, following the standard IBTS methodology for the western and southern areas (ICES, 2017).

The stock indicator (Figure 25.20 and Table 25.14) is obtained from the average of the survey biomass index of all surveys previous normalized to the time series. The stock size indicator was truncated in time to the shortest time series available. Missing values, when a particular survey did not take place in a particular year, are not included in the calculations (Table 25.8). In 2021 the surveys in Gulf of Cádiz were not conducted. In 2021 and 2022 the Portuguese survey PT-GFS-WIBTS-Q4 was carried out with a new research vessel without calibration therefore these two years were not included in the analysis of the stock indicator.

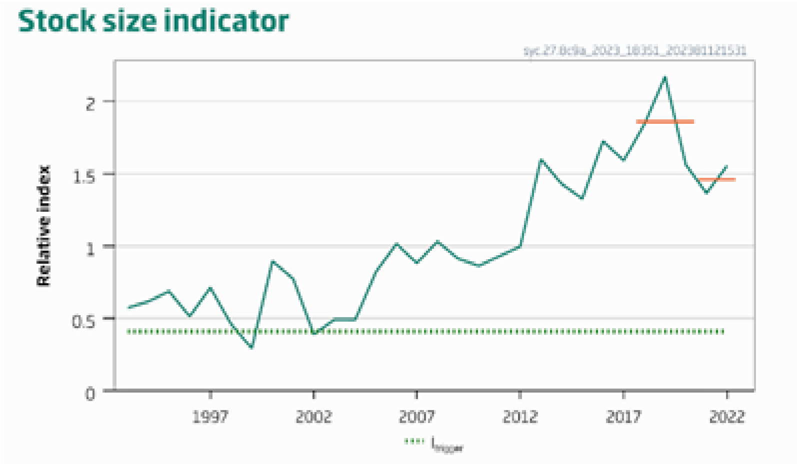


Figure 25.20. Stock size indicator of *S. canicula* (syc.27.8c9a) is the mean normalized biomass index from the average of the two Spanish trawl surveys in the Gulf of Cadiz: SP GCGFS-WIBTS-Q1 (G7511) and SP-GCGFS-WIBTS-Q4 (G4309), the Portuguese survey PT-GFS-WIBTS-Q4 (G8899) and the Northern Spanish survey SP-NGFS–WIBTS–Q4 (G2784). The horizontal orange lines show the mean stock indicators for 2021 and 2022 and 2018–2020.

Table 25.14. *Scyliorhinus canicula* in Atlantic Iberian waters, divisions 8.c and 9.a. Yearly normalized values of the biomass survey indices. Values have been round to two decimal places, calculations were done using unrounded values.

Year	Pt-WIBTS-Q4	Sp-N-WIBTS-Q4	Sp-GC-WIBTS-Q1-Q4 (Combined)	Stock indicator
1993	0.98	0.49	0.25	0.57
1994	0.77	0.48	0.60	0.62
1995	1.11	0.31	0.64	0.69
1996		0.45	0.58	0.51
1997	1.14	0.46	0.54	0.71
1998	0.79	0.40	0.19	0.46
1999		0.34	0.24	0.29
2000	1.74	0.54	0.40	0.89
2001	1.06	0.76	0.50	0.77
2002	0.46	0.49	0.23	0.39
2003		0.56	0.42	0.49
2004		0.51	0.47	0.49
2005	0.88	0.73	0.86	0.82
2006	0.82	0.84	1.38	1.02
2007	0.73	1.02	0.90	0.88
2008	1.06	0.72	1.31	1.03
2009	1.06	0.86	0.81	0.91
2010	0.65	0.79	1.15	0.86
2011	0.98	0.74	1.07	0.93
2012	1.00	1.01	0.98	1.00
2013	0.76	2.54	1.49	1.60
2014	1.04	1.86	1.38	1.43
2015	0.91	1.58	1.49	1.33
2016		1.71	1.74	1.72
2017	1.36	1.39	2.01	1.59
2018	1.71	1.80	2.01	1.84
2019		1.87	2.47	2.17
2020		1.85	1.27	1.56
2021		1.36		1.36
2022		1.51	1.60	1.55

Fishery data

Landings

The landings of this stock correspond mainly to Spanish and Portuguese fleets. French landings in the last period are minor and close to 0.05 tonnes (Table 25.1d).

Discards

Scyliorhinus canicula is often discarded from continental shelf fisheries. The potentially high discard survival of species in the Scyliorhinidae family, at least for continental shelf fisheries, means that landing data are likely to be more representative of dead removals. The low market value is the main factor that forces the fleet to discard these species. Discard data is available for the Spanish trawl fleet but not for all the stock/area (Table 25.2d), therefore was not considered in the assessment.

Length-distribution of landings

Annual landings length frequency distributions for the Spanish and Portuguese fleet are shown on Figure 25.21. Maximum observed length in Portuguese landings is 66 cm and length range usually from 34-64 cm, whereas in 8c the maximum length recorded from commercial fisheries is 75 cm however length distributions usually ranged from 30 to 62 cm. Biological parameters are available for this stock both in Div. 9a and 8c and in other ICES areas Ellis *et al.*, 2023) with some differences among them. According to these values and the maximum length observed both in surveys and landings in both areas an asymptotic length of 70 cm has been applied based on Froese (2004) equation (Table 25.19).

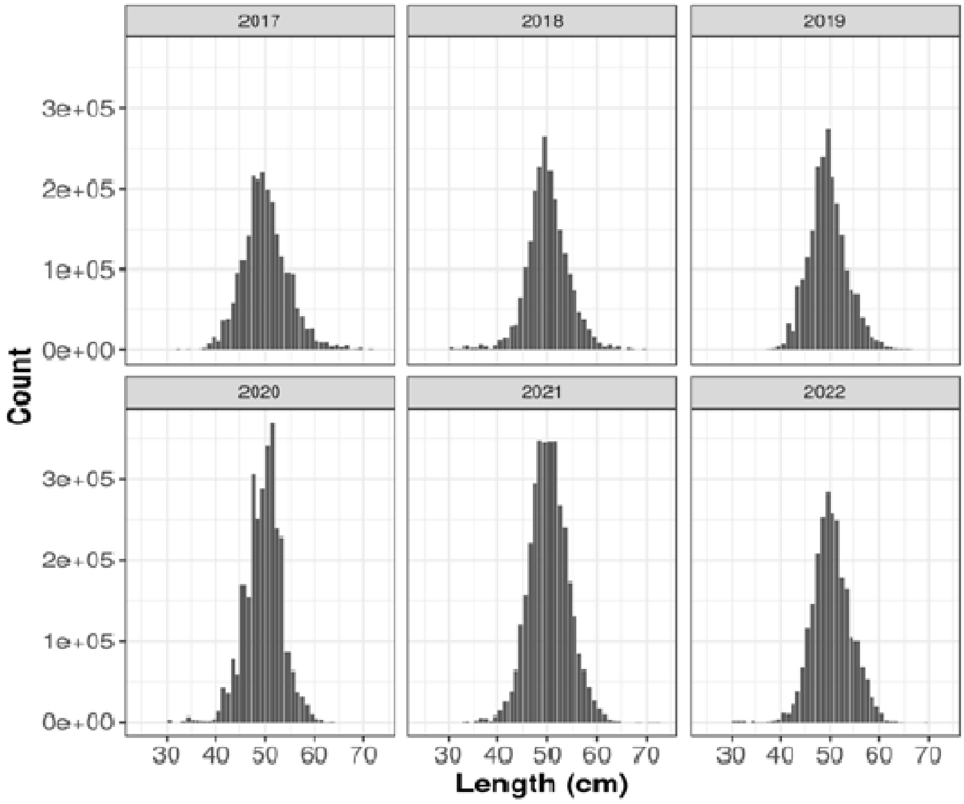


Figure 25.21. *Scyliorhinus canicula* (syc.27.8c9a). Landings length–frequency distribution for both areas and fleets combined.

Table 25.19. ***Scyliorhinus canicula*** **(syc.27.8c9a). Biological parameters used for calculating the LBI parameters.**

Parameter	Value	Definition	Source
L∞ (cm)	70	Asymptotic average maximum length	Maximun observed length from PT landings based on Linf=Lobs / 0.95 (Froese, 2004)
Lmat	54.2	Length at 50% maturity	Rodriguez-Cabello et al., 1998
a	0.0023	Condition factor parameter of length-weight relationship	Gandara et al., 1994 (IEO Data)
b	3.09	Slope parameter of length-weight relationship	Gandara et al., 1994 (IEO Data)
M/K	1.5	ratio of natural mortality to von Bertalanffy growth rate	Jensen, 1996

The length distribution of discards was not used because discards data are incomplete and dead discards are unknown. Nevertheless, trials with the available length distribution data of discards were done and results did not change the estimated LBI.

The output of the LBI indicators is presented in Table 25.20 (considering 1 cm length classes). The F_{MSY} proxy ($L_{mean}/L_{F=M}$) value is below the threshold value but very close to 1 (threshold value) and the stock size indicator is above the $I_{trigger}$ which suggests that the syc.27.8c9a stock is exploited at sustainable levels.

Table 25.20. ***Scyliorhinus canicula*** **in Iberian waters ICES Div.8c9a. Indicator table for LBI analysis. Results from the length landings distribution Portuguese and Spanish fleet combined for the period (2019-2022).**

Year	Conservation				Optime Yield	MSY	L_c	L_{mean}	$L_{F=M}$
	L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max\,5}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$			
2017	0.84	0.88	0.87	0.38	1.09	0.35	45.5	51.0	51.6
2018	0.86	0.88	0.85	0.37	1.09	0.34	46.5	51.1	52.4
2019	0.86	0.88	0.84	0.32	1.09	0.30	46.5	50.7	52.4
2020	0.88	0.88	0.82	0.38	1.09	0.35	47.5	51.0	53.1
2021	0.86	0.88	0.84	0.41	1.10	0.38	46.5	51.2	52.4
2022	0.86	0.88	0.84	0.41	1.10	0.37	46.5	51.1	52.4

The results of the advice based on applying the rfb rule is presented in the table below (Table 25.21).

Table 25.21. Lesser-spotted dogfish in divisions 8.c and 9.a (syc.27.8c9a). Input parameters and results of the advice following the rfb rule.

Landings average in last 3 years A_y (2020-2022)	1328 tonnes
Stock biomass trend	
Index A (2021, 2022)	1.46 $kg.h^{-1}$
Index B (2018, 2019, 2020)	1.86 $kg.h^{-1}$
r: Index ratio (A/B)	0.79
Fishing pressure proxy	
Mean catch length ($L_{mean} = L_{2022}$)	51.1 cm
MSY proxy length ($L_{F=M}$)	52.4 cm
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)	0.98
Biomass safeguard	
Last index value (I_{2022})	1.55
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)	0.41
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}	1

Landings average in last 3 years A_y (2020-2022)	1328 tonnes	
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)	0.95	
RFB calculation: $A_{y+1} = A_y \times r \times f \times b \times m$	977 tonnes	
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate	Unquantified	
Landings advice for 2024 and 2025 (A_y × stability clause)	977 tonnes	
% advice change	26%	

25.9.6. Greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7 (Celtic Seas and West of Scotland)

The greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7 (syt.27.67), was assessed as an ICES Category 3 stock. The rfb rule was first applied in 2023. This was the first time ICES assessed this stock using the rfb rule and the previous advice did not recommend a catch level. Therefore, A_y, the advice value for the current year, was replaced by the average landings in recent years. Survey indices were used to derive the *r* and *b* factors of the RFB rule and the *f* factor was derived from length distribution of landings. Discards data were insufficient to be included in the assessment. Further, survival is expected to be high for *S. stellaris*, as for the related *S. canicula* but has not been quantified for *S. stellaris*. Lastly, the *m* multiplier of 0.95 was applied as the coefficient *k* of the Von Bertalanffy growth model is considered smaller than 0.2.

Survey indices were calculated following methods from WKSKATE (ICES, 2021b), two indices of exploitable biomass (individuals ≥50 cm TL). The standardized survey index was calculated from the UK (E&W)–BTS–Q3 [B6596] index in $kg.h^{-1}$ and the FR-CGFS-Q4 [G3425] index in $kg.km^{-2}$. The standardized index is the average of the two indices standardized to their long-term mean for years 1997–2022 (Figure 25.22). Data from 2020 were not included because UK(E&W)-BTS-Q3 covered only Division 7.f, so that the main part of the stock area, Cardigan Bay and Anglesey in 7.a, was not sampled due to COVID-19 (Silva and Ellis, 2021 WD10) and FR-CGFS-Q4 only covered the French part of 7.d. As a consequence, the assessment is based on the comparison of the combined index in 2018 and 2019 to the average of the index in 2021–2022. Reported landings have increasing since 2009 and seem to stabilize in recent years. This is mainly explained by the labelling improvement for *Scyliorhinus stellaris* in logbooks and sales records.

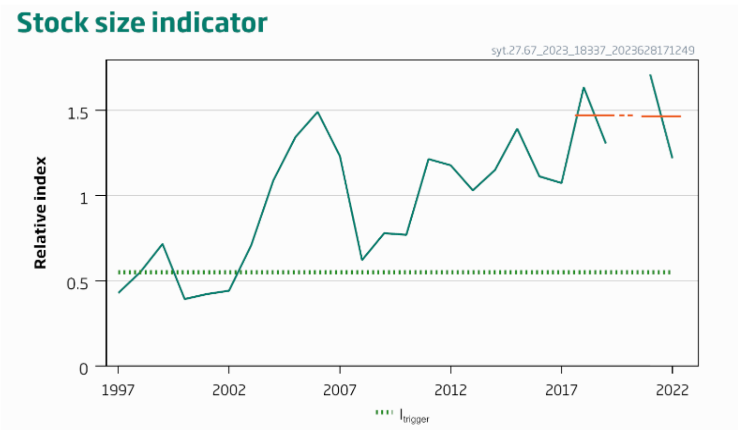


Figure 25. 22. Greater spotted dogfish in subareas 6 and 7. The stock size indicator is the mean normalized exploitable biomass index (individuals of ≥ 50 cm total length) from the average of the UK(E&W)-BTS-Q3 [B6596] survey **in divisions**

7.a and 7.f in kg.hr−1 and FR-CGFS-Q4 [G3425] survey in Division 7.d in kg.km−2. The horizontal orange lines show the mean stock size indicator for years 2018–2019 (2020 missing) and 2021–2022.

Landings length distribution were taken from data submitted to InterCatch (Figure 25.23). The cat3advice R package was used to analyse length data as follows:

- length at first capture (*Lc*) was calculated from pooled data for years 2019-2022, using 2 cm length classes. Five cm length classes resulted in the same *Lc* estimate, but 1 cm length classes resulted in a smaller *Lc*, because of uneven length distribution (Figure 25.23).
- *Lc*=60 cm was retained as resulting from a smoother length distribution because high and low, including empty length classes are observed in the length distribution by 1 cm classes.

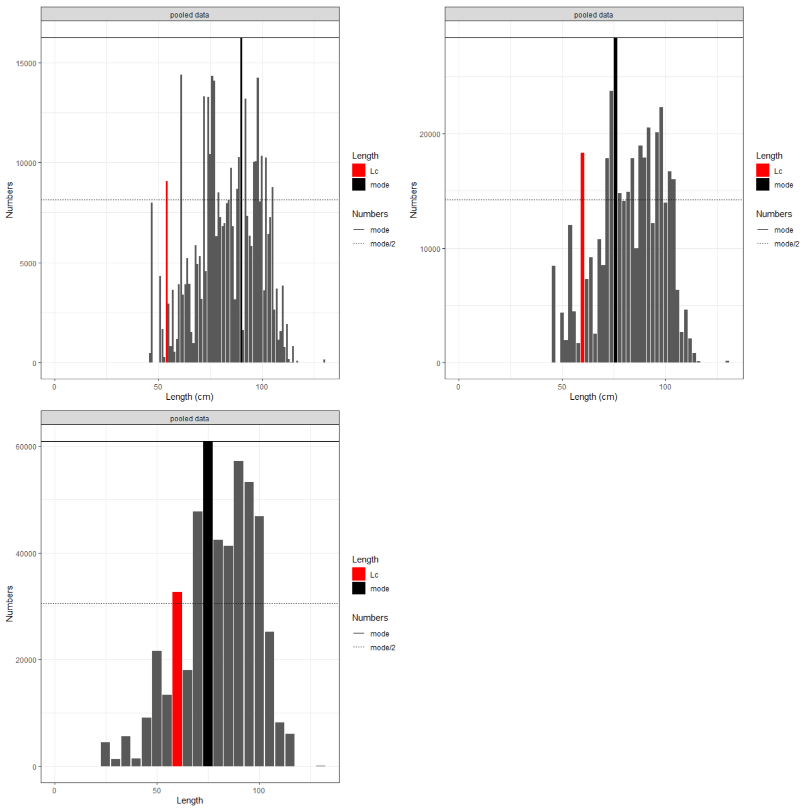


Figure 25.23. *Scyliorhinus stellaris* in subareas 6 and 7. Length frequency distribution of the landings, pooled data from 2019 to 2022, with *Lc* (red bar) and mode of the distribution (black bar) using length bins of 1, 2 and 5 cm.

The length distribution of discards was not used because discards data are incomplete and survival, which is expected to be high, has not been estimated. Although, trials where the available length distribution data of discards were included did not changed the estimated LBIs, length distribution of discards was considered too uncertain to be included. The rfb rule was applied as detailed in the Table 25.22.

Table 25.22. Greater-spotted dogfish in subareas 6 and 7. Input parameters and results of the advice following the rfb rule.

Variable	Estimate	Input data	Comment
		r: biomass indicator	

Index A (2021-2022)	1.46456411	Stock-size indicator: mean normalized exploitable biomass index (individuals of ≥ 50 cm TL) from the average of the UK(E&W)-BTS-Q3 (B6596) in divisions 7.a and 7.f and FR-CGFS-Q4 (G3425) in Division 7.d	UK(E&W)-BTS-Q3 in kg.hr^{-1}
Index B (2018-2019)	1.47027873		FR-CGFS-Q4 in kg.km^{-2} 2020 data not used for UK-BT, survey coverage reduced (COVID-19 disruption)
r: Stock biomass trend	0.99611324		
f: length distribution of landings from 2019 to 2020			
L_∞	127.3684	cm	No realistic estimate of L_∞ from growth study. Lmax=121 cm taken from Heesen *et al*. (2015). L estimated as Lmax/0.95=127.3684 (rfb calculation carried out with unrounded inputs)
L_{mean}	86.79916 (20122)	Mean length (cm) in the catch 2022, using 2 cm bins	
Lc	60	Length at first capture (cm) in landings, using 2 cm bins and pooling length data from 2019 to 2022	Length data are not numerous so four year were pooled and length classes aggregated. Larger length classes of 5 cm result in the same *Lc*.
$L_{F=M}$	76.84211	cm	0.75*Lc+0.25*L_∞
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$)	1.12957816506019		
b: Biomass safeguard			
I_{loss}	0.3924567	Lowest index in the time series (2000)	The biomass index shows an increasing trend since the beginning of the time series
$I_{trigger} = I_{loss}$ 1.4	0.5494394		
I_{2022}	1.2185871		
b	1	$\min(1.\ I_{y-1}/I_{trigger})$	
m: Based on the parameter k of the Von Bertalanffy growth			
m linked to von Bertalanffy k	0.95	*k* estimated from the Von Bertalanffy model adopted for the species	*No suitable growth estimates. Species considered moderately productive so k<0.2*
Stability clause		Not applied	
Ay × r × f × b × m	638 x 0.99611324 x 1.12957816506019 X 1 x 0.95	Ay*r*f*b*m	RFB rule applied for the first time and previous advice did not quantify catch. *Ay* taken as average of landings in the three last years

	538, 677 and 699 tonnes in 2020, 2021, 2022.

Landings data are presented in table 25.1e and time series of biomass indices used for assessment are given in the following table 25.23.

Table 25.23. Greater-spotted dogfish in subareas 6 and 7 (syt.27.67). Yearly normalized values of the biomass survey index.

	Standardized biomass indices			
Year	FR-CGFS	UK-BTS	Average	Values for calculating the *r* ratio
1997	0.36268204	0.49173998	0.42721101	
1998	0.42430385	0.67740496	0.5508544	
1999	0.36674425	1.06501176	0.71587801	
2000	0.30572944	0.47918398	0.39245671	
2001	0.18025511	0.66300954	0.42163232	
2002	0.64449483	0.2380663	0.44128056	
2003	0.65591037	0.76010688	0.70800862	
2004	1.16348182	1.01400183	1.08874182	
2005	1.40933907	1.27769223	1.34351565	
2006	1.90615687	1.07539532	1.4907761	
2007	1.90082376	0.56272498	1.23177437	
2008	0.77402183	0.46809633	0.62105908	
2009	0.80499998	0.75235288	0.77867643	
2010	1.07565818	0.46315287	0.76940552	
2011	0.4724864	1.95501536	1.21375088	
2012	0.6285922	1.72607698	1.17733459	
2013	0.89801222	1.16233545	1.03017384	
2014	0.89566642	1.40418745	1.14992694	
2015	1.39682669	1.38766957	1.39224813	
2016	1.29006137	0.9345857	1.11232353	
2017	1.17932249	0.96724914	1.07328581	
2018	1.97138967	1.29995407	1.63567187	
2019	0.98336385	1.62640732	1.30488558	Index B: 1.47027873
2020				
2021	1.76288132	1.6582009	1.71054111	
2022	1.54679599	0.89037824	1.21858711	Index A: 1.46456411

25.9.7. Black-mouth dogfish (*Galeus melastomus*) in subareas 6 and 7 (Celtic Sea and West of Scotland)

An assessment of the status of blackmouth catshark, (*Galeus melastomus*) in the Celtic Sea, subareas 6 and 7 (sho.27.67) was presented at WGEF 2023. This species is normally assessed on a biennial cycle as a Category 3 stock, for which survey data are available. Advice was last provided in 2023 for 2024 and 2025. A biomass index, catch statistics and results from length-based indicators (LBI) were considered for assessment, but the rb rule rather than the rfb rule was applied in the final assessment.

Stock indicator

The stock size indicator is based on the biomass index (kg.hr^{-1}) obtained from the Spanish bottom trawl survey carried out annually in Porcupine (SP-POR-WIBTS-Q3 survey). This is the only survey that provides data for this stock which started in 2001 (Figure 25.24).

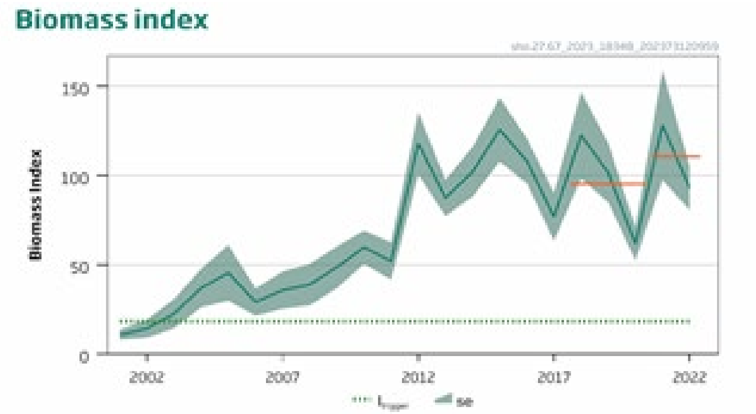


Figure 25.24. *Galeus melastomus* (sho.27.67). Biomass index derived from Spanish Porcupine survey (SP-POR WIBTS-Q3). The horizontal orange lines show the mean stock indicators for 2021- 2022 and 2018–2020. Index ratio = 1.16.

Length data

Landings and length data are taken from submissions to the ICES WGEF data call. Lengths from both landings and discards were considered at WGEF. (Figure 25.25). Length data were available for 2019, 2021 and 2022. No data were submitted for 2020. It was agreed that even when three years of data (four-year time-span) were combined, the supplied length frequency could not be considered to be representative of the stock, and therefore length could not be used in the assessment. Therefore, instead of the rfb rule the rb rule was applied.

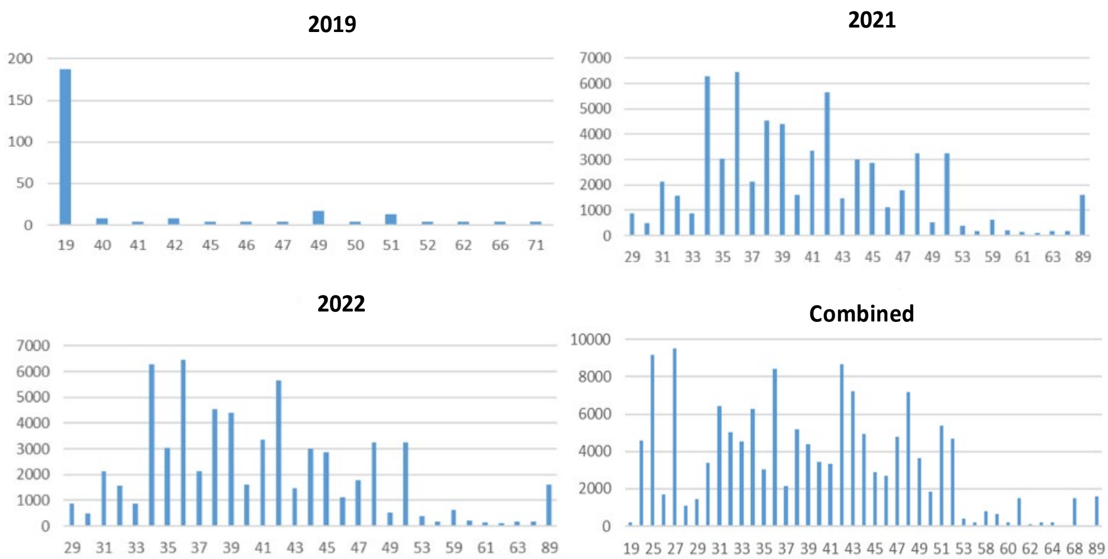


Figure 25.25. Length distribution of landings available for *Galeus melatomus* (sho.27.67).

Catch Data

Landings

Species specific landings are available from 2005 onwards (Table 25.24). The annual declared quantity of discards is highly variable. Discard information is considered incomplete and is therefore not used in the analysis.

Table 25.24. Landings data used in the assessment. Source: WGEF landings database.

Year	France	Spain	Total
2005		0.10	0.10
2006		2.89	2.89
2007		0.35	0.35
2008	0.06		0.06
2010	0.44		0.44
2011	0.05		0.05
2012	0.02		0.02
2015	0.26		0.26
2016	0.13		0.13
2017	0.07		0.07
2019	0.23		0.23
2020	0.05		0.05
2021	0.20		0.20

Discards

Annual international landings reported as blackmouth dogfish are of a similar magnitude as that which may be observed in a single survey haul, indicating that reported species-specific landings are not reflective of stock abundance and most of the commercial catch would be discarded. However reported discards are also very low and not in line with expected catches. Available discards are not considered to be of sufficient quality to be used in the assessment (Table 25.25).

Table 25.25. Reported Discards of blackmouth dogfish, *Galeus melastomus* in subareas 6 and 7. Source: WGEF Discards database.

Year	Spain	Ireland	Total
2009		15.04	15.04
2010		14.17	14.17
2011		6.75	6.75
2014		0.44	0.44
2015		2.15	2.15
2016		67.24	67.24
2017		0.38	0.38

Year	Spain	Ireland	Total
2018	67.80	12.68	80.47
2019	5.46	13.95	19.41
2020	0.08	14.23	14.32
2021	13.38	155.48	168.86
2022	14.86		14.86

Application of the rb rule.

The rb rule is defined as: $Ay+1 = Ay \times r \times b \times m$

Where r is the stock size indicator, b is a biomass safeguard and m is a multiplier, fixed in this case at 0.5 to ensure a precautionary reduction in advice of up to 50% per annum. The input parameters and results are shown on Table 25.26.

a) Biomass trend: r

Stock biomass trend (r) is calculated by taking the mean value of the last two years and dividing by the mean value of the previous three years. In this case:

r= mean(2021-2022)/mean(2018-2020)

r= 110.7/95.4 thus, r=1.16

b) Biomass safeguard: b

Itrigger=Iloss*1.4

Itrigger=Iloss(2001)*1.4 thus Itrigger=10.8*1.4=15.1

b: index relative to trigger value, min{I2023/Itrigger, 1} 1

c) Multiplier: m m= 0.5

Following the rb rule the results are shown on Table 25.26.

Table 25.26. *Galeus melastomus* in ICES subareas 6 and 7 (sho.27.67) basis for the catch scenarios.

Previous catch advice A_y (2022, 2023)		NA
Biomass index		
I: most recent biomass index (I_{2022})	93.03	
MSY proxy harvest rate	NA	
Stock biomass trend		
Index A (2021, 2022)		110.7
Index B (2018, 2019, 2020)		95.4
r: Index ratio (A/B)		1.16
Biomass safeguard		
Index trigger value (Itrigger)		15.2
b: index relative to trigger value, min{I2023/Itrigger, 1}		1
Precautionary multiplier to maintain biomass above Blim with 95% probability		0.5
RB calculation $A_{y+1}=A_y \times r \times b \times m$		0.58
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Applied	0.7

Previous catch advice A_y (2022, 2023)	NA
Discard rate	Unquantified
Catch advice for 2024 and 2025 (A_y × stability clause)	Unquantified
Projected landings corresponding to advice**	Unquantified
% advice change^	-30%

"ICES advises that when the precautionary approach is applied, catches in each of the years 2022 and 2023 should be decreased by no less than 36% compared to the average catches in 2018–2020. ICES cannot quantify the corresponding catches or landings."

This means that this advice can also not be provided in quantifiable amounts. As the stability clause is applied, this means that a further reduction in catches of 30% is advised. ICES cannot quantify the corresponding catches or landings.

25.9.8. Black-mouth dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)

An assessment of the status of the stock sho.27.89a, black-mouth catshark, (*Galeus melastomus*) in divisions 8 and 9a was presented at WGEF 2023. An rfb-rule was tried for assessment, but the length data were not considered reliable for this stock and therefore, the fishing mortality proxy (f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M}$ 2022) could not be used in the assessment. Therefore, an ICES framework rb-rule for category 3 stocks was applied (Figure 25.26).

The method is defined as: Ay × r × b × m where *Ay* corresponds to the landing average of the last three years, *r* to the stock biomass trend, *b* to the biomass safeguard, *m* to a multiplier related to life history. The stability clause (+20%/-30%) is only applied if the change in the advice b≥1).

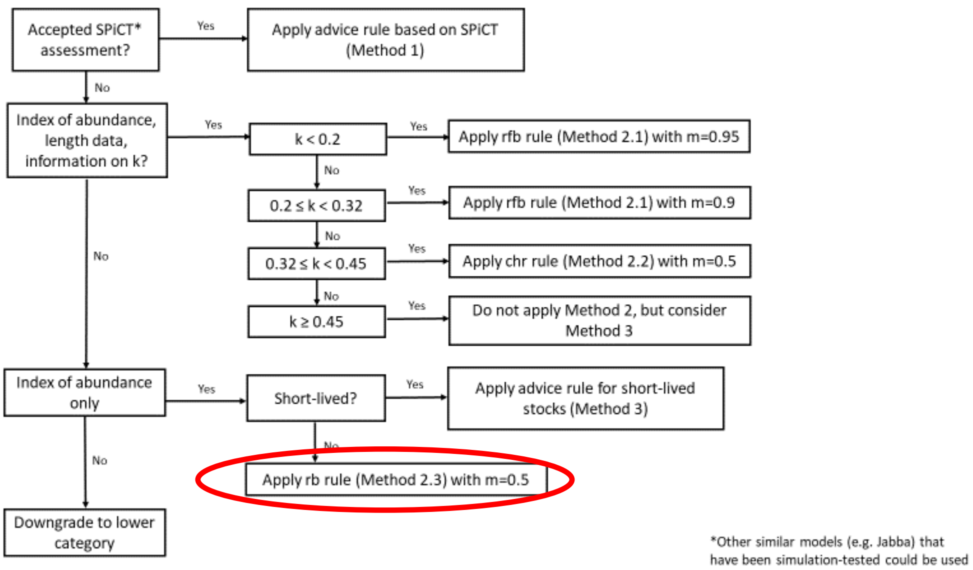


Figure 25.26. The decision tree for applying ICES advice rules to stocks in category 3; stocks with life history information, catch data, and a biomass or abundance index. The left-hand boxes refer to the reliable data and information to be used in the provision of advice; k refers to the von Bertalanffy growth parameter k (unit: yr-1).

Stock indicator

A combined stock biomass index, using the standardized biomass index from the average of the two Spanish surveys SP-GCGFS-WIBTS-Q1 [G7511], SP-GCGFS-WIBTS-Q4 [G4309], as well as EVHOE WIBTS Q4 [G9527] and PT CTS (UWTV [FU 28–29]; [G2913] was considered as index of stock development (Figure 25.27).

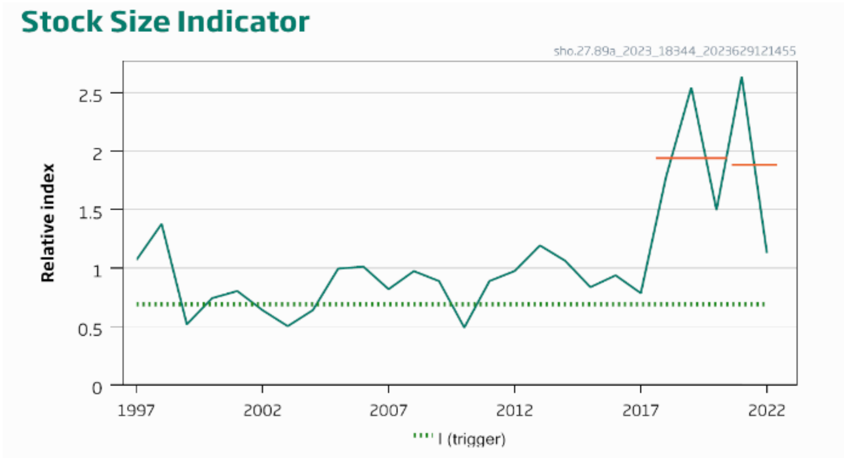


Figure 25.27. *Galeus melastomus* (sho.27.89a). Combined biomass index derived from the three surveys. The horizontal orange lines show the mean stock indicators for 2021- 2022 and 2018–2020. Index ratio = 0.971.

Catch scenarios

The advice is based on the ratio (r: Index ratio (A/B) of the mean of the last two index values (index A) and the mean of the three preceding values (index B), multiplied by the landing average of the last three years (Ay); a biomass safeguard (b); and a generic multiplier based on life history (m) (Tables 25.27 and 25.28).

Table 25.27. *Galeus melastomus* (sho.27.89a). Life history parameters used in the rbm-rule assessment.

Linf (cm)*	K**
90.0	0.13

*https://fishbase.mnhn.fr/popdyn/PopCharSummary.php?ID=807&GenusName=Galeus&SpeciesName=melastomus&fc=703&vStockcode=823&autoctr=17616

**Baptista *et al*. (2010).

Table 25.28. *Galeus melastomus* (sho.27.89a). Main parameters used in the rb-rule assessment.

Ay Landing average in last three years, (2020-2022) = 113 ton
r: Index ratio (A/B) = 0.971.
b multiplayer = 1
m multiplier = 0.5
(I_{loss}) (2010) = 0.49
$I_{trigger} = I_{loss} \times 1.4 = 0.69$

Due to the advice Ay+1/Ay = 55/113 = -51%, the stability clause was considered and applied to limit the decrease in catch advice to 30%. Following rb rule, the landings in 2024 and 2025 should not exceed 79 t (Table 25.29).

Table 25.29. *Galeus melastomus* (sho.27.89a). Basis for the catch scenarios.

Landing average in last three years, Ay (2020-2022)		113 tonnes
Stock biomass trend		
Index A (2021, 2022)		1.88
Index B (2018, 2019, 2020)		1.94
r: Index ratio (A/B)		0.971
Biomass safeguard		
Last index value (I_{2022})		1.13
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		0.69
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.5
RB calculation: $A_{y+1} = A_y \times r \times b \times m$		55 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Applied	0.7
Discard rate		Unquantified
Landing advice for 2024 and 2025 (A_y × stability clause)		79 tonnes
% advice change		-30%

25.10 Quality of the assessments

Although the trawl surveys used in this report were not designed to sample catsharks, *S. canicula* and *G. melastomus* are sampled in large numbers in various surveys. Survey indices are considered to properly track stock abundance trends for these species.

In relation to *G. melastomus*, fisheries-independent data in the Portuguese surveys suggest that this species may have been historically aggregated with *G. atlanticus*, and there may be some problems with misidentification of these two species, especially historically (Moura *et al.*, 2015 WD; Moura *et al.*, 2017 WD). Data from the Portuguese crustacean surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29))) conducted in 2014 showed that *G. melastomus* is more abundant and distributed mainly >500 m deep, and so data from depths ≥500 m were considered for assessment purposes.

Survey effort on rocky, inshore grounds is limited, and so catch rates for the larger-bodied *S. stellaris* are low in some surveys, as this species favours rocky, inshore habitats.

Commercial data are more problematic due to the widespread use of generic categories (e.g. "dogfish"), especially in earlier years. Although a greater proportion of the data is reported to species or genus level, the quality of these data has not been evaluated. Other issues may constrain the use of these data, for example possible misidentification in areas such as the Celtic Seas where both *S. canicula* and *S. stellaris* occur. Furthermore, historical data may be underestimated as these species may have not been marketed for human consumption, and might therefore not have all been included in official landings, e.g. in those areas where *S. canicula* may be landed for use as bait in pot fisheries. Therefore, landings data are not considered to be accurate and should be viewed as preliminary results.

Catsharks are mainly caught as bycatch and have a moderate market value (including no human consumption market for the smaller fraction) resulting in a high level of discarding. Previous studies have shown that *S. canicula* may have a high survival rate (see Section 25.3.3), and while there are no current studies for *S. stellaris*, it can be assumed that the survival of this shallow-water species may be high. Therefore, discards of Scyliorhinidae should not be considered exclusively as dead removals. However, for *G. melastomus* anecdotal information suggests survival will be lower. Further studies should be considered if more accurate information on the level of discarding is to be inferred for the two latter species.

Portuguese surveys ((PTGFS-WIBTS-Q4 and PT-CTS UWTV (FU 28–29)) were not conducted in 2019 and in 2020 but the effect in the stock size indicators of syc.27.8c9a and sho.27.89a is thought to be minimal (see Section 25.6; WD05 – Moura *et al.*, 2021).

Although discussions during WKSKATE highlighted the importance of using DATRAS datasets instead of national databases, there are remaining discrepancies in species mapping on historical data within UK(E&W)-BTS-Q3 (in 7.afg) survey series on DATRAS (e.g. *Scyliorhinus stellaris*). Therefore, to make calculations similar across sharks and skate species (with the latter shown in Silva and Ellis, 2020 WD), survey indices presented in 2021 relate to national data (Silva and Ellis, 2021 WD10).

In 2021, EVHOE-WIBTS-Q4 survey indices were updated following WKSKATE methodology using data available on DATRAS (ICES, 2021b), contrary to previous advice where calculations were based on national data.

25.11 Reference points

No reference points have been proposed for these stocks.

25.12 Conservation considerations

Both *S. canicula* and *G. melastomus* are listed as Least Concern, *S. stellaris* previous listed as near threaten is now included in the category of vulnerable (Finucci *et al.*, 2021a) and *G. atlanticus* is listed as Near Threatened (Finucci *et al*., 2021b) on the IUCN Red List (IUCN, 2021) and in the Red List of European marine fish (Nieto *et al.*, 2015).

S. canicula, S. stellaris and *G. melastomus* are listed as Least Concern on the Irish Red List of Cartilagenous Fish (Clarke *et al.,* 2016).

25.13 Management considerations

Catsharks are generally viewed as relatively productive in comparison to other elasmobranchs (e.g. McCully Phillips *et al.*, 2015). Given this, and that they have a low commercial value and are bycatch species, catsharks are typically of lower management interest in comparison to other elasmobranchs.

Landings data are highly uncertain, and further efforts are required to construct a meaningful time-series. Discarding is known to occur for most of these Scyliorhinidae species and is known to be very high and variable between fleets. Therefore, further efforts are needed to best estimate discard rates.

Over the past two decades, biomass indicators of *S. canicula* and *S. stellaris* have been increasing in almost all surveys. As one of the more productive demersal elasmobranchs that is often discarded (with a high discard survival) and is known to scavenge on discards, it is unclear as to whether or not the increasing biomass of *S. canicula* is a sign of healthy ecosystems.

Discard survival of *Scyliorhinus* spp. is considered high, but estimates for discard survival for *Galeus* spp. are currently unavailable.

25.14 References

Baptista, Miguel., Coelho, Rui., Figueiredo, Ivone., Erzini, Karim. 2010. Determination of age and growth of *Galeus melastomus*, rafinesque, 1810, A deepwater shark, using a modification to the cobalt nitrate technique. ICES CM 2010/E:40

Barragán-Méndez, C., Ruiz-Jarabo, I., Fuentes, Mancera, J.M., Sobrino, I. 2020. Survival rates and physiological recovery responses in the lesser-spotted catshark (Scyliorhinus canicula) after bottom-trawling, *Comparative Biochemistry and Physiology, Part A*, https://doi.org/10.1016/j.cbpa.2019.03.016

Blanco, M., Fernández-Zapico, O., Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A., González-Irusta, JM., Velasco, E. 2022. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD 07 presented to IICES WGEF, 14th- 23th June 2022 Lisbon. Portugal.

Capapé, C. 1977. Contribution à la connaissance de la biologie des Scyliorhinidae des côtes Tunisiennes III. *Scyliorhinus stellaris* (Linné, 1758). *Acta Adriatica*, 17: 1–21.

Clarke, M., Farrell, E.D., Roche, W., Murray, T.E., Foster, S. and Marnell, F. 2016. Ireland Red List No. 11: Cartilaginous fish [sharks, skates, rays and chimaeras]. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. Dublin, Ireland.

Costa, M.E., Erzini, K., Borges, T.C. 2005. Reproductive biology of the blackmouth catshark, *Galeus melastomus* (Chondrichthyes: Scyliorhinidae) off the south coast of Portugal. *Journal of the Biological Association of the United Kingdom* 85, 1173–1183.

Ebert, D.A. and Stehmann, M.F.V. 2013. Sharks, batoids,and chimaeras of the North Atlantic. FAO Species catalogue for fishery purposes. No 7. Rome, FAO, 523 pp.

Ellis, J. R., McCully Phillips, S. R., Poisson, F. 2016. A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology* 90 (3): 653-722.

Ellis, J.R., and Shackley, S.E. 1997. The reproductive biology of *Scyliorhinus canicula* in the Bristol Channel, UK. *Journal of Fish Biology* 51: 361–372.

Ellis, J. R., Silva, J. F., and McCully Phillips, S. R. 2023. An overview of the growth parameters of demersal elasmobranchs in the ICES area and adjacent waters. Working Document presented to the ICES Working Group on Elasmobranch Fishes, June 20–29 2023.

Fernandes, A.C. 2021. Discards of elasmobranch species by the Portuguese bottom otter trawl fisheries in ICES Division 27.9.a. Working Document (WD11) for the ICES Working Group on Elasmobranch Fishes (WGEF), 15-24 June, 2021, 7 pp.

Fernández-Zapico, O., Blanco, M., Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Baldó, F. 2022. Results on main elasmobranch species from 2001 to 2021 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document (WD 06) presented to ICES WGEF 14-23 June 2022.

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Rodríguez-Cabello, C., Punzón, A., González-Irusta, J.M., Velasco, F. 2023. Results on main elasmobranch species captured in the 2022 Northern Spanish Shelf Groundfish Survey. Working Document presented to the Working Group on Elasmobranch Fishes. ICES WGEF 2023, 20-29 June, Lisbon, Portugal.

Figueiredo, I., Moura, T., Serra-Pereira, B. 2017. Description of elasmobranch discards and estimate of preliminary total discards for *Raja clavata* from vessels with LOA> 12m using set nets in Portuguese Continental waters. Working Document presented to the Working Group on Elasmobranch Fishes, June 2017. 12 pp.

Finucci, B., Derrick, D., Pacoureau, N. 2021a. *Scyliorhinus stellaris*. The IUCN Red List of Threatened Species 2021: e.T161484A124493465. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T161484A12449 3465.en

Finucci, B., Derrick, D., Pacoureau, N., VanderWright, W.J. 202b1. *Galeus atlanticus*. The IUCN Red List of Threatened Species 2021: e.T63149A124463343. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T63149A124463343.en

https://fishbase.mnhn.fr/popdyn/PopCharSummary.php?ID=807&GenusName=Galeus&SpeciesName=melastomus&fc=703&vStockcode=823&autoctr=17616

ICES. 2014. Report of the Working Group on Elasmobranch Fishes (WGEF), 17–26 June 2014, Lisbon, Portugal. ICES CM 2014/ACOM:19. 887 pp.

ICES. 2017. Report of the Working Group on Elasmobranchs (2017), 31 May-7 June 2017, Lisbon, Portugal. ICES CM 2017/ACOM:16. 1018 pp.

ICES. 2018. Technical Guidelines- ICES reference points for stocks in categories 3 and 4. ICES Technical Guidelines. https://doi.org/10.17895/ices.pub.4128

ICES. 2021a. 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. 2021b. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948.

ICES. 2022. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. In Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564.

ICES, 2003. Report of ICES Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2-4 September 2003.

Ivory, P., Jeal, F. and Nolan, C.P. 2005. Age determination, growth and reproduction in the lesser-spotted dogfish, Scyliorhinus canicula (L.). Journal of Northwest Atlantic Fishery Science, 35: 89–106.

Manuzzi, A., Zane, L., Muñoz-Merida, A., Griffiths, A.M. and Veríssimo, A. 2019. Population genomics and phylogeography of a benthic coastal shark (*Scyliorhinus canicula*) using 2b-RAD single nucleotide polymorphisms. *Biological Journal of the Linnean Society*, 2019, 126, 289–303

Marine Institute. 2019. Government-supported scientists discover rare shark nursery. Online reference https://www.marine.ie/Home/site-area/news-events/press-releases/government-supported-scientists-discover-rare-%E2%80%98shark-nursery%E2%80%99-0 downloaded on 31/07/2019.

Mayot, S., Barreau, T. 2021. Monitoring protocol for chondrichtyans landed in French auctions. 18pp. https://drive.google.com/file/d/1XS0Lidh1043RZbwlLj661tka8s8QG-_w/view

McCully Phillips, S. R., Scott, F. and Ellis, J. R. 2015. Having confidence in Productivity Susceptibility Analyses: A method for underpinning scientific advice on skate stocks? *Fisheries Research*, 171: 87–100.

Moreira, I., Figueiredo, I., Farias, I., Lagarto, N., Maia, C., Robalo, J., Moura, T. 2022. Growth and maturity of the lesser-spotted dogfish *Scyliorhinus canicula* (Linnaeus, 1758) in the southern Portuguese continental coast. Journal of Fish Biology, 100(1), 315-319.

Moura, T., Mateus, C., Serra-Pereira, B., Figueiredo, I. 2015. Blackmouth catshark *Galeus melastomus* in the Portuguese continental slope. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2015; 12 pp.

Moura, T., Fernandes, Chaves, C., Figueiredo, I. 2017. New information for the blackmouth catshark *Galeus melastomus* in the Portuguese continental slope. Working Document to ICES Working Group on Elasmobranch Fishes (WGEF), Lisbon, 2017; 8 pp.

Moura, T., Rodríguez- Cabello, C., Díez, G., Serra-Pereira, B., Maia, C., Figueiredo, I. 2021. Effect of the Portuguese surveys in the assessment of catsharks syc.27.8c9a and sho.27.89a. Working Document (WD 05) presented to ICES WGEF 15-24 June 2021; 8 pp.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., *et al.* 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union, iv + 81 pp.

Prista, N. and Fernandes, C. 2013. Discards of elasmobranchs by the Portuguese bottom otter trawl and deep-water set longline fisheries operating in ICES Division XIa (2004–2012). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June.

Revill, A.S, Dulvy, N.K., and Holst, R. 2005. The survival of discarded lesser-spotted dogfish (*Scyliorhinus canicula*) in the Western English Channel beam trawl fishery. *Fisheries Research* 71: 121–124.

Rey, J., Séret, B., Lloris, D., Coelho, R., and Gil de Sola, L. 2006. A new redescription of *Galeus atlanticus* (Vaillant, 1888) (Chondrichthyes: Scyliorhinidae) based on field marks. *Cybium*, 30: 7–14.

Rodríguez-Cabello, C., Sánchez, F., and Velasco, F. 2005a. Growth of Lesser Spotted Dogfish (*Scyliorhinus canicula* L., 1758) in the Cantabrian Sea, Based on Tag-recapture Data. J. Northw. Atl. Fish. Sci., Vol. 35: 131–140.

Rodríguez-Cabello, C., Fernández, A., Olaso, I. and Sánchez, F. 2005b. Survival of small-spotted catshark (*Scyliorhinus canicula*, L.) discarded by trawlers in the Cantabrian Sea. *Journal of the Marine Biological Association of the United Kingdom*, 85: 1145–1150.

Rodríguez-Cabello, C. and, Sánchez, F. 2017. Catch and post-release mortality of deepwater sharks caught by bottom longlines in the Cantabrian Sea (NE Atlantic). Journal of Sea Research.

Santos, J., Araújo, H., Salinas, I., and Pérez, N. 2010. Elasmobranches Results from Spanish Discard Sampling Programme. Working Document presented to the ICES Working Group on Elasmobranch Fishes, WGEF 2010. Lisbon June 22–29.

Silva, J. F. and Ellis, J. R. 2019. Bycatch and discarding patterns of dogfish and sharks taken in English and Welsh commercial fisheries. *Journal of Fish Biology*, 94: 966–980. https://doi.org/10.1111/jfb.13899.

Silva, J.F. and Ellis, J. R. 2020. Skates in the UK beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document to the ICES Working Group on Elasmobranch Fishes (WGEF), June 16–25 2020, 6 pp.

Silva, J. F. and Ellis, J. R. 2021. Catsharks and smooth-hounds in the UK (E&W) beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g). Working Document (WD 10) presented to ICES WGEF 15-24 June 2021; 12 pp.

25.15 Tables and Figures

Table 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern English Channel) (syc.27.3a47d). These data should be viewed with caution as some countries may have aggregated both *S. canicula* and *S. stellaris* as Scyliorhinidae and the proportion of species in these landings may be unknown as both species occur in this area.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	238	267	264	337	309	290	311	249	231	325	416	343	338	305	328	256	279	291	283
Denmark											0	0	0	0	0	0	0	0	0
France	2265	1857	1843	1822	1758	2055	2150	2061	2021	2189	2090	2173	1641	1580	1640	1613	1425	1322	1344
Germany																	0	0	1
Netherlands	56	48	32	29	37	37	47	35	36	45	85	122	141	177	218	186	168	252	227
UK	92	121	104	94	118	146	185	181	184	146	185	330	287	275	302	292	270	246	271
Total	2652	2293	2243	2282	2222	2528	2693	2526	2472	2705	2776	2968	2407	2337	2488	2448	2142	2112	2125

Table 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in subareas 6 and divisions 7a-c and 7.e-j (Celtic Seas) (syc.27.67a-ce-j). These data should be viewed with caution as some countries may have aggregated both *S. canicula* and *S. stellaris* as Scyliorhinidae and the proportion of species in these landings may be unknown as both species occur in this area.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	240	225	199	165	168	165	227	236	216	141	252	194	209	181	194	175	175	192	187
France	2936	2873	3101	2728	2479	2368	2359	2060	2284	2292	2024	1969	3355	1518	1376	1210	1305	1277	996
Ireland	92	42	128	248	190	232	317	221	310	336	367	425	524	411	235	224	222	144	70
Netherlands		0			0	6	1	1	4	0	3	1	0	3	4	2	1	0	4
Spain	34	33	37	12	17	28	48	109	26	18	20	9	12	21	7	6	3	6	8
UK	123	22	115	191	226	111	111	241	380	389	1282	1333	1075	1628	1510	1364	1250	1058	767
Total	3426	3195	3579	3344	3080	2909	3064	2868	3219	3176	3948	3932	5175	3762	3325	2981	2956	2678	2032

Table 25.1c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in divisions 8.a–b and 8.d (Bay of Biscay) (syc.27.8abd).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium	10	13	13	18	24	28	28	32	23	26	27	32	26	25	24	20	8	12	10
France	1229	1247	1352	1382	1117	1085	1000	912	883	720	735	731	671	698	600	459	498	426	418
Ireland				2															
Spain	355	338	327	460	445	302	303	472	54	92	130	239	498	370	332	223	275	340	324
UK	3						0	2											
Total	1597	1598	1691	1863	1586	1415	1330	1418	960	838	892	1002	1195	1093	957	702	781	778	751

Table 25.1d. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in divisions 8.c and 9.a (Atlantic Iberian waters) (syc.27.8c9a).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	1	1	1	1	0		0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	568	591	595	546	535	522	551	544	520	521	554	589	619	530	588	555	493	451	422
Spain	297	333	327	272	229	336	354	555	577	464	417	398	448	484	449	853	1001	632	616
Total	866	925	923	819	765	858	905	1099	1097	985	971	987	1067	1014	1037	1408	1495	1082	1039

Table 25.1e. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of greater spotted dogfish (*Scyliorhinus stellaris*), by country and year, in subareas 6 and 7 (Celtic Seas) (syt.27.67).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium									18	27	37	39	49	41	61	51	34	45	39
France	212	174	203	213	235	218	363	217	214	245	282	402	561	460	517	477	634	652	671
Ireland								8	16	13	27	3		1	20	10	9	0	0
Spain																		2	1
UK															7	0			
Total	212	174	203	213	235	218	363	225	248	285	345	444	609	502	605	538	677	699	712

Table 25.1f. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of black-mouth dogfish (*Galeus melastomus*), by country and year, in subareas 6 and 7 (Celtic Seas) (sho.27.67).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France							0.1	0	0.4	0.05	0.02	0		0.26	0.13	0.1	0.0	0.2	0.0	0.2		
Spain	9	1		0.1	2.9	0.4							0					0.0				
Total	9	1	0	0.1	2.9	0.4	0.1	0	0.4	0.05	0.02	0	0	0.26	0.13	0.1	0.0	0.2	0.0	0.2	0	0

Table 25.1g. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of landings (t) of black-mouth dogfish (*Galeus melastomus*), by country and year, in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (sho.27.89a).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	1	1	2	2	3	0	0	1	0	1				0	0			0	0
Portugal	37	28	24	12	16	7	2	2	1	21	25	26	34	31	35	42	40	23	26
Spain	53	68	103	103	75	24		8	15	54	123	141	124	119	65	140	31	60	19
UK							1												
Total	91	97	130	116	93	32	3	11	16	75	148	167	158	151	100	183	71	84	45

Table 25.2a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discard (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern English Channel) (syc.27.3a47d). Estimates may not be available for some countries, fleets and years.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium									517	614	412	587	510	471	748
Denmark	2	3	9	59	15	8	13	8	6	41	21	10	9	12	7
France			3709	7378	3452	3777	4415	251	400	782	320	194	315	136	527
Germany														0	0
Netherlands			115	417	121	265	368	344	352	509	462	377	723	634	417
Sweden										1	2			1	0
UK	151	1127	146	472	351	681	39	615		36	7	656	445	824	989
Total	153	1131	3979	8325	3940	4732	4835	1219	1275	1982	1224	1826	2003	2078	2687

Table 25.2b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discard estimates (t) of lesser-spotted dogfish (*Scyliorhinus canicula*),by country and year, in subareas 6 and divisions 7a-c and 7.e-j (Celtic Seas) (syc.27.67a-ce-j). Estimates may not be available for some countries, fleets and years.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium									737	430	1250	388	1003	488	999
France			29	4	88	80	67	3774	2312	1847	1490	466	1134	2278	804
Ireland	1226	2482	970	2045	1906	3201	2614	5013	1144	1953	2039	772	842	966	837
Spain										336	451		382	736	878
UK	1102	820	639	687	853	3482	3352	2942	1521	10 754	5799	4091	4661	42560	9830
Total	2328	3302	1638	2737	2847	6763	6033	11 730	5715	15 319	11 028	5717	8022	47 027	13 348

Table 25.2c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discard estimates (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in divisions 8.a-b and 8.d (Bay of Biscay) (syc.27.8abd). Estimates may not be available for some countries, fleets and years.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium							91	52	71	71		37	143
France	3342	4835	2497	4432	8616	3397	6102	5445	4024	2450	1327	690	3996

Spain								744	1048	1197	851	544	517
Total	3342	4835	2497	4432	8616	3397	6193	6240	5143	3717	2179	1272	4656

Table 25.2d. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discard (t) of lesser-spotted dogfish (*Scyliorhinus canicula*), by country and year, in divisions 8.c and 9.a (Atlantic Iberian waters) (syc.27.8c9a). Estimates may not be available for some countries, fleets and years.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Portugal									0	0	67	72		76	51
Spain	954	665	1213	849	1506	2127	1864	1131	699	686	562	109	654	465	400
Total	954	665	1213	849	1506	2127	1864	1131	699	686	629	181	654	541	451

Table 25.2e. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discard (t) of greater spotted dogfish (*Scyliorhinus stellaris*), by country and year, in subareas 6 and 7 (Celtic Seas) (syt.27.67). Estimates may not be available for some countries, fleets and years.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium									67	94	88	16	12	406	111
France			23	49	17	154	26	26	32	30	20	89	13	23	17
Ireland	8	35	64	206	121	77	111	169	10	16	34	81		85	73
Spain										0	0				
UK	47	22	35	37	30	13	35	11	5	55	16		1	99	21
Total	55	57	123	292	168	244	171	205	113	196	159	185	26	613	221

Table 25.2f. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discards (t) of black-mouth dogfish (*Galeus melastomus*), by country and year, in subareas 6 and 7 (Celtic seas) (sho.27.67).

	2009	2010	2011	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ireland	15	14	7	0	2	67	0	13	14	14	155		4
Spain								68	5	0	13	15	8
Total	15	14	7	0	2	67	0	80	19	14	169	15	12

Table 25.2g. Catsharks (Scyliorhinidae) in the Northeast Atlantic. ICES estimates of discards (t) of black-mouth dogfish (*Galeus melastomus*, by country and year, in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (sho.27.89a). Estimates may not be available for some countries, fleets and years.

	2017	2018	2019	2020	2021	2022	2023
France		5					

Portugal	40	31	91	54	73	57	67
Spain		242	466	35	193	272	266
Total	40	278	557	89	266	330	333

Table 25.3 Black-mouthed dogfish in subareas 6 and 7. Assessment summary, biomass index from the Spanish Porcupine (SP-PORC-WIBTS-Q3) trawl survey (in kg tow^{-1}).

Year	kg tow^{-1}
2001	5.40
2002	7.16
2003	11.33
2004	18.52
2005	22.74
2006	14.59
2007	17.91
2008	19.46
2009	24.31
2010	29.91
2011	26.04
2012	59.03
2013	43.76
2014	51.09
2015	62.88
2016	54.14
2017	38.49
2018	61.35
2019	50.83
2020	30.90
2021	64.17

Contents

26 Common skate

26.1 Available data relating to skates of the genus *Dipturus*

This section updates the work undertaken previously to address the ToR from 2021 "*Evaluate available data at species-specific level within the common skate-complex (Dipturus spp.) stock units in order to further increase our understanding of each individual species and their current status*".

Given that identification issues relating to the common skate complex may also extend to long-nosed skate *Dipturus oxyrinchus* and Norwegian skate *D. nidarosiensis*, data relating to these species have also been considered where available.

26.1.1 Background

26.1.1.1 History of the common skate complex

Flapper skate *Dipturus intermedius* (Parnell, 1837) was, as *Raia intermedia*, described originally by Parnell (1837), from specimens caught in the Firth of Forth, on the Scottish east coast. A more detailed description was given in a subsequent account of the fishes of the Firth of Forth (Parnell, 1838). Parnell (1838) considered flapper skate to be "*the connecting link*" between *Raia batis* [=*Dipturus batis*] and *'Raia oxyrhynchus'*, though it should be noted that, based on his description of *R. oxyrhynchus,* Parnell (1838) was discussing white skate *Rostroraja alba* rather than long-nosed skate *Dipturus oxyrinchus.*

Parnell (1838) highlighted the following distinguishing features:

Dipturus intermedius: "*… the upper surface of the body being perfectly smooth, without granulation, and of a dark olive colour spotted with white; in the anterior part of each orbit being furnished with a strong spine pointing towards the tail; in the dorsal fins being more remote from each other, and in the anterior margins of the pectorals rather more concave, giving the snout a sharper appearance*".

Dipturus batis: "*… the upper surface of the body is rough to the touch, of a uniform dusky grey without spots; the orbits without spines; the dorsals nearly approximate, and the anterior margins of the pectorals nearly straight*".

In a revision of the European skates, Clark (1926) synonymised flapper skate with the common skate, and this perception continued in the scientific literature and regional field guides (e.g. Stehmann and Bürkel, 1984) for much of the 20th century and early 21st century, over which time data for the two species would have been confounded, including survey data, biological investigations (e.g. Heintz, 1962; Du Buit, 1976) and landings data (e.g. Silva *et al.*, 2012).

Iglésias *et al.* (2010), after undertaking genetic and morphological studies of the large skates being landed in France, confirmed that what was known as 'common skate' was indeed a complex, with this paper suggesting the two species be known as blue skate *Dipturus* cf. *flossada* (Risso, 1826) and flapper skate *Dipturus* cf. *intermedia* (Parnell, 1837).

Iglésias *et al.* (2010) also provided morphometric data and described other morphological features that could help separate the two species, although it should be noted that some of these features are not apparent in juvenile stages. In terms of morphometrics, Iglésias *et al.* (2010) observed that, proportionally, *Dipturus intermedius* had a longer preorbital length; eyes larger; distance from the anterior margin of the orbit to the posterior end of the spiracle is longer; narrower inter-orbital distance; longer inter-spiracular distance; longer inter-dorsal space; and longer snout. The distinguishing morphological features and contrasting life-history parameters, as reported by Iglésias *et al.* (2010), are summarised in Table 26.1.

A subsequent study by Griffiths *et al.* (2010) confirmed the genetic differences within the common skate complex, and provided initial geographical information, with what would equate with flapper skate occurring in the shelf seas west of Ireland, west of Scotland and off Shetland, and what would equate with common blue skate occurring on the Rockall Bank, west of Ireland and in the Celtic Sea. The two species, therefore, have a degree of spatial overlap.

Subsequent taxonomic accounts (e.g. Ebert and Stehmann, 2013[1]; Weigmann, 2016) recognised that the common skate complex comprised two species. However, given that '*batis*' was a Linnean name, this part of the nomenclature was retained, with the scientific name for flapper skate based on the original description by Parnell (1837).

The nomenclature of the common skate complex was stabilised by Last *et al.* (2016), using the names common blue skate *Dipturus batis* (L., 1758) and flapper skate *Dipturus intermedius* (Parnell, 1837). Following this taxonomic revision, an FAO code was introduced for flapper skate (DRJ) which allowed for separation from common blue skate (RJB), although earlier data reported under the latter code would clearly relate to both species.

26.1.1.2 Stock boundaries and review on the species distribution

ICES had previously been requested by the EU to provide further information on the distributions of the two species, which was through a Special Request (ICES, 2012). Whilst some of the current locations of the individual species are becoming better documented, there is still uncertainty in their broader distributions, especially in northern areas (Subarea 2), Icelandic waters (Division 5.a), the Mid-Atlantic Ridge (Division 12), Azores (Division 10) and southern geographical limits in the Biscay-Iberian area (Divisions 8–9).

At the present time, ICES provide three advice sheets (Category 6.3) for the common skate complex at the ecoregion level: rjb.27.3a4, rjb.27.67a-ce-k and rjb.27.89a. Only landings data are presented and no assessments are undertaken. Where deemed appropriate, the landings data may include information for all four species from the genus *Dipturus* known to occur in European waters: *D. batis*, *D. intermedius*, *D. nidarosiensis* and *D. oxyrinchus*.

Whilst tagging data are limited, available data do not indicate large-scale movements (e.g. Sutcliffe, 1994; Fitzmaurice *et al.*, 2003; Bird *et al.*, 2020), with Fitzmaurice *et al.* (2003) reporting the longest minimum distance travelled being 120 miles. Recent genetic analyses could help define population structure (Delaval *et al.*, 2022).

Common skate complex

The information and distributional data in the available IUCN Red List assessment for common skate (Dulvy *et al.*, 2006) related to the species complex and thus were updated for common blue skate *Dipturus batis* and flapper skate *Dipturus intermedius*, in 2021 (Ellis *et al.* 2021a, 2021b). However, the limits of the distributions of both species remain unclear. Speciation and validation of the distributional data for all species from the genus *Dipturus* are required, given that many data sources have confounded the two species from the complex, as well as potential confusion with long-nosed skate *Dipturus oxyrinchus* and Norwegian skate *Dipturus nidarosiensis*. Misidentification with other species may occur in other areas, such as spinytail ray *Bathyraja spinicauda*

[1] Ebert and Stehmann (2013) also recognised an as yet undescribed *Dipturus* sp. from the deeper waters of the NE Atlantic, that is characterised by having notably long and pointed anterior pelvic fin lobes.

in the Barents Sea, given that this species also attains a large size (170–180 cm) and has a ventral surface with a grey margin (Ebert and Stehmann, 2013).

Whilst *"Dipturus batis"* has nominally been reported from more northerly waters of the ICES area, including the Norwegian Sea and Barents Sea (Andriyashev, 1954; Dolgov *et al.*, 2005a, 2005b; Williams *et al.*, 2008), published species-specific data following the recent taxonomic revision are more limited. Moreover, common skate complex was not included in the recent atlas of Barents Sea fishes (Wienerroither *et al.*, 2013). The probable incorrect identifications of the common skate complex in northern Norwegian waters were also highlighted by Lynghammar *et al.* (2014).

Earlier accounts generally indicates that "*Dipturus batis*" occurred in the Mediterranean Sea, however recent studies have provided limited information regarding whether the complex occurs there (Capapé *et al.*, 2006; Cariani *et al.*, 2017; Serena *et al.*, 2020). There seem to no published data that confirms whether either *Dipturus batis* or *Dipturus intermedius* occur in the area. Whilst some recent papers from Mediterranean samples have considered *D. batis* (e.g. Turan, 2008; Benmeslem *et al.*, 2019; Karadurmuș and Sarı, 2024), the accuracy of the species identification is uncertain and the former study likely relates to *D. oxyrinchus*. In terms of potential historical occurrence, the re-examination of any relevant museum specimens could usefully be undertaken. With increased uncertainty regarding the contemporary occurrence of the 'common skate complex' in the Mediterranean, an improved appraisal of historical information is required, especially since the earlier proposed nomenclature for blue skate (*Dipturus* cf. *flossada*) was based on a description from the Mediterranean coast of France (Risso, 1926; Table 26.2).

Two specimens of *D. batis* have been observed with a ROV in the Canary Islands but identification is uncertain as those records could correspond to other members of the genus and involve potential misidentification (Tuya, *et al.*, 2021).

Flapper skate *Dipturus intermedius*

Dipturus intermedius is most frequent around the western and eastern coasts of Scotland, as has been supported by the increasing number of scientific studies from these areas (Wearmouth and Sims, 2009; Neat *et al.*, 2015; Benjamins *et al.*, 2018a, 2018b, 2021; Bache-Jeffreys *et al.*, 2021, Lavender *et al.*, 2021; Phillips *et al.*, 2021; Régnier *et al.*, 2021; Thorburn *et al.*, 2021; Dodd *et al.*, 2022; Garbett *et al.*, 2023; Thorburn *et al.*, 2023; Régnier *et al.*, 2024).

The occurrence of *D. intermedius* in Norwegian waters has also been confirmed (Lynghammar *et al.* 2014; Vienthe 2023 WD).

Flapper skate is also present along the west coast of Ireland and in the Celtic Sea (Barreau *et al.*, 2016, Garbett *et al.*, 2023) where the distribution overlaps with the more abundant common blue skate (Bache-Jeffreys *et al.*, 2021). Recent observations were recorded in the Bay of Biscay near the Rochebonne Bank (Barreau *et al.*, 2016).

There have also been nominal records of "*Raja batis*" or "*Dipturus batis"* from the Mid-Atlantic Ridge (e.g. Hareide and Garnes, 2001) and Azores. In terms of the Azores, Santos *et al.* (1997) had stated previously that "*The occurrence of this species in the region needs further documentation*", with subsequent studies also referring to the complex (e.g. Menezes *et al.*, 2006; Rosa *et al.*, 2006; Santos *et al.*, 2020). The presence of *D. intermedius* from the Azores was later confirmed by genetic analyses (Bache-Jeffreys *et al.*, 2021; Garbett *et al.*, 2023).

Species Distribution Models have indicated that the distribution of *Dipturus intermedius* (in the waters around Scotland) are, among other factors, influenced by distance from shore and depth (Pinto *et al.*, 2016). This study reported that *D. intermedius* appeared to favour waters of 100–400 m that were also relatively close to land, including sea lochs and around islands. In relation to water temperature, Frost *et al.* (2020) found that flapper skate occur over a broader temperature range than common blue skate. However, it should be recognised that this study was based primarily on data from the Rockall Bank, Hebridean Shelf and Celtic Sea, and inclusion of other parts of the species' ranges, such as deeper habitat, could usefully be considered in future studies.

Common blue skate *Dipturus batis*

Whilst *Dipturus batis* is the more abundant species in the Celtic Sea (Bendall *et al.*, 2012; Barreau *et al.*, 2016; Brown-Vuillemin *et al.*, 2020), there have also been studies on this species from Scottish waters, Rockall and the Faroe Islands (e.g. Beard, 1890; Frost *et al.*, 2020; Bache-Jeffrey *et al.*, 2021; Delaval *et al.*, 2022) and as far north as Iceland (Pálsson & Jakobsdóttir, 2018).

Specimens were also identified from photographs from the Irish Sea (Moore, 2023), western and eastern English Channel (Barreau pers. com.) and analyses of a DST tag on a female indicated movements up to the eastern Channel (Bendall *et al.*, 2017). This species, which is assumed to inhabit offshore water, was also identified in 2023 in the Iroise Sea (Division 7.h) closer to the coast (APECS pers. com. confirmed by pictures).

The southern limit seems to be the Bay of Biscay, with confirmed presence in the northern part of Subarea 8 (Barreau *et al.*, 2016).

Delaval *et al.* (2022) demonstrated significant genomic discontinuities between inshore (continental shelf) and offshore (Rockall and Faroe) sites inhabited by the species. Tagging (Bendall *et al.,* 2017) and genomic close-kin mark-recapture (Delaval *et al.,* 2023) analyses indicate that most individuals in the Celtic Sea have high residency. These results support the need for new studies in order to refine the stock boundaries in the future.

Long-nosed skate *Dipturus oxyrinchus*

Long-nosed skate occurs from Norwegian waters to the Mediterranean Sea, with the latter supporting most of the published biological studies on the species (Yigin & Ismen, 2010; Kadri *et al.*, 2015; Mulas *et al.*, 2015; Bellodi *et al.*, 2017; Melis *et al.*, 2018, Garbett *et al.*, 2023, Albonetti *et al.*, 2023). It is also noteworthy that genetic studies suggest that *Dipturus oxyrinchus* from the Mediterranean Sea and Atlantic are genetically distinct (Griffiths *et al.*, 2011).

This species can occur from 90 to 900 m depth, but the main distribution is in waters of 200 to 500 m and it is found rarely on the shelf (Mulas *et al.*, 2015).

Norwegian skate *Dipturus nidarosiensis*

Norwegian skate occurs from the Norwegian Sea to the Mediterranean Sea (Cannas *et al.*, 2010; Follesa *et al.*, 2012; Ramírez-Amaro *et al.*, 2017; Carbonara *et al.*, 2019 and 2021; Geraci *et al.*, 2019). In the Atlantic, the species is present at depths over 500 m all along the slope from Norway to the north of Spain. In the Mediterranean Sea, it has been observed around Sardinia and in the Adriatic Sea and a morphological trait distinction was made between those two areas. The species is considered a deepwater skate, as no records have been authenticated from the shelf. Whilst there was a record of this species in the Celtic Sea given by Warnes and Jones (1995), the location and size of the specimen would be consistent with that of juvenile flapper skate (see below), which was not recognised as a valid species at the time.

26.2 Synopsis of Icelandic data

This Section was based on the results presented at a recent ICES Annual Science Conference by Pálsson & Jakobsdóttir (2018) in a poster entitled "*The Flapper or the Blue? D. batis complex in Icelandic waters*". The data presented in this study included the length-distribution from surveys (Figure 26.1), with the majority of samples <160 cm L_T, which was in accordance with the likely length-frequency distribution of *Dipturus batis*. The estimated lengths-at-maturity (Figure 26.2) were 115 cm (males; n = 294) and 119 cm (females; n = 340), and these values were also consistent with the earlier estimates for *D. batis* given by Iglésias *et al.* (2010). Laboratory examination of some retained specimens also indicated that they matched the descriptions provided by Iglésias *et al.* (2010) for common blue skate. Bache-Jeffreys *et al.* (2021) further confirmed the occurrence of *D. batis* in Icelandic waters based on morphological and genetic evidence.

Consequently, available information indicates that the common skate complex in Icelandic waters (Division 5.a) includes *D. batis* only, and that the species is distributed mainly along the southern coasts of Iceland (Figure 26.3).

26.3 Synopsis of Norwegian data

Lynghammar *et al.* (2014) reported on the confirmed presence of one individual of *Dipturus intermedius* from the area (65 kg female caught at 58.633°N, 3.917°E in February 2009; Lynghammar, pers. comm.). There have also been some subsequent records of *D. intermedius* from Norwegian waters, including west off Bud, off Florø, near Vatlandsvåg, in the Flekkefjord and off the coasts of southern Norway; Lynghammar, pers. comm.). These records confirm the presence of *Dipturus intermedius* in Norwegian waters of southern parts of Division 2.a, Subarea 4 and Division 3.a. Two other species of the genus *Dipturus* were observed along the coast of Norway: *D. nidarosiensis* and *D. oxyrinchus* (Lynghammar *et al.*, 2014).

26.4 Synopsis of data from Danish landings

In Denmark, rays and skates are more often landed as "wings". This presentation makes species identification difficult. Between 2021–2022, genetic samples were collected at the auction to identify the skate community landed in the Danish harbours (Vienthe, WD 2023). Analyses revealed that no *Dipturus batis* were landed as wings within this period, this suggests that the landings usually declared as *D. batis* in Denmark could be misidentifications. Within the study two of the wings sampled were genetically identified as *D. intermedius* (Rindorf *et al.*, 2023).

26.5 Synopsis of data from CEFAS surveys

26.5.1 Data available and methods

Ellis and Silva (2021, WD10) summarised those data relating to *Dipturus* that are held on the CEFAS' Fishing Survey System (FSS) database, from both historic and recent surveys, as well as additional data from recent fishery-dependent surveys (2014–2017). Available data relating to the spatial distribution, length and sex composition, and biological parameters from this WD are provided below.

Data relating to the genus *Dipturus* were extracted from the FSS database (08/06/2021), including data for *Dipturus batis, Dipturus intermedius, Dipturus oxyrinchus* and *Dipturus nidarosiensis* (Table 26.3). These data relate to all records available from east of the Mid-Atlantic Ridge and related to data collected over the period 1901–2021, including lengths and biological information (sex, maturity, wing width) for some of the records. This study analysis was conducted using R software (R Core Team, 2020). These data were largely taken as they were recorded with this study as a preliminary overview of the data currently hold and, therefore, further QA/QC procedures should be undertaken if more detailed analyses are required.

Records were summarised according to how catch was processed (e.g. weighed and measured) to account for differences in historical data compared to recent data. Data for the common skate complex (SKT) only relates to the records where specimens were not identified and/or allocated to a specific species. Although, only recently has FSS been able to accommodate these two species separately (SKG and SKF) when recording the catch, there was a brief recent period where although catch records were recorded to the common skate-complex, when collecting additional information on individual weight and maturity, the identification to species-specific was described on a comments field within the database, and therefore a retrospective re-allocation of these individuals to the particular species was possible (these amendments still need to be made to the original data held on FSS and also on DATRAS) .

Spatial distributions are not shown as such, due to changes in spatial coverage changing over the study period, therefore, only maps of presence (positive hauls) for each species were produced. The hauling positions were used instead of shoot positions as the latter may require further investigation on some outliers (in historical data). Length-frequency distributions were produced for each species, by sex when available, and these were separated by either time period or survey type, depending on the species and quantity of data available.

Length-weight distributions were calculated for total length (L_T, measured to the cm below) and total weight (W_T, g), using the exponential relationship ($W_T = a \times L_T^b$), with conversion factors obtained using a linear regression through natural logarithmic transformation. No outliers were removed from these relationships for this study.

Additionally, the linear relationship between L_T and wing width (D_W, measured to the cm or 0.5 cm below) was also calculated by species where data were available. One record was deemed unsuitable, with potential for correction pending further investigations.

26.5.2 Results and discussion

There were 1599 records of *Dipturus* held on FSS (Table 26.4), noting that this refers to station records with accompanying data for the various species. These data, which included fish that had been measured, weighed, counted or observed (noting that data collection on historical surveys was more variable), can be used to examine geographical distribution, in terms of presence only.

The survey coverage has varied over time, with some historical surveys extending into northern areas, whilst recent CEFAS surveys have generally been confined to the North Sea and Celtic Seas ecoregions (Subareas 4 and 7). Consequently, these data cannot be used in isolation to examine temporal changes in species distributions.

Spatial distributions

The distributions of all species shown will not be representative of the wider range and it should be noted that survey hauls with no records of any of the species are not shown here. Furthermore, given the longer-term taxonomic confusion in these species, outlier records should be interpreted with extreme caution.

The available distributional data, by time period, for both members of the common skate complex indicate that they are distributed widely around the British Isles (Figure 26.4). More recent data, which have been separated between the two species (Figure 26.5) show that *D. batis* is recorded relatively frequently in the Celtic Sea and western English Channel, with occasional specimens in the Irish Sea, North Sea and Irish Sea. *Dipturus intermedius* was recorded in the northern North Sea and in the Celtic Sea. It should be noted that the surveys used in this study do not include those waters west of either Scotland or Ireland.

Data for both *Dipturus oxyrinchus* and *D. nidarosiensis* were more limited (Figure 26.6). It should also be noted that it is possible that *Dipturus intermedius* may have been misidentified as one of either of these species, if specimens were simply being viewed as being different from *Dipturus batis*. For example, juvenile *D. intermedius* have a much darker ventral surface than *D. batis*, and so the reported presence of *D. nidarosiensis* in the Celtic Sea could relate to juvenile *D. intermedius* (noting that the lengths of these two specimens were 29 and 37 cm). Indeed, it has not been possible to authenticate any of the nominal records relating to *D. nidarosiensis*. In terms of *D. oxyrinchus*, recent, authenticated captures have been made along the western slope of the Norwegian Deep, with some of the other records, especially those from shallower areas, potentially questionable.

Length-frequency

Length data were available for 3950 individual *Dipturus* (Table 26.5), with the majority of these (61.9%) coming from dedicated surveys on a commercial gillnetter, with various otter trawl surveys in the south-west (DCRDC, Q1SWOTTER, Q4SWIBTS and WCGFS) and beam trawl surveys in the southwest (Q1SWBEAM) accounting for 9.0% and 5.3% of measured individuals, respectively. North Sea surveys (NSGFS, IBTS3E and IBTS4E) accounted for only 1.2%, with various historic surveys (HISTORIC and HISTORWEST, including research vessels and chartered fishing vessels) accounting for 22.5%.

The overall length-range reported at the complex level (SKT; Figure 26.7) was 10–217 cm. However, the smaller individuals recorded are probably misidentified (or from confusion of the use of the generic term ‘skate’ in earlier logbooks), as these sizes would be below the length-at-hatching. More recent data collected just on-board RV CEFAS Endeavour (2003–present; SKT, SKF and SKG) indicated that the smallest individuals were 18 cm.

The length-frequency distribution of specimens identified as *Dipturus batis* ranged from 18–136 cm (scientific trawl surveys) and 29–149 cm (chartered surveys on a commercial gillnetter). Scientific trawl surveys generally caught proportionally smaller *D. batis*, generally <120 cm, whilst the commercial netters were more selective for larger individuals, with one peak at ca. 70–110 cm and a main peak at 110–140 cm (Figure 26.8). Data were more limited for *D. intermedius,* which were recorded over a length range of 34–195 cm (Figure 26.9).

Biological parameters

Data relating to the length-weight relationship, including a summary of earlier published data, are summarised (Table 26.6) with data analysed presented in Figure 26.10. Available data on the relationships between total length and disc width, or wing width (Figure 26.11) indicate no obvious difference between *D. batis* and *D. intermedius*, though more data are certainly required to better examine this. Similarly, maturity data are also limited (Figure 26.12), though it should be noted that on-going tag-and-release protocols on CEFAS trawl surveys means that the collection of maturity data for females is particularly limited.

Biological studies on the life-history parameters for both species are limited, with earlier studies potentially confounding the two species (e.g. Du Buit, 1976; Fahy, 1991), and so further biological data collection is required, particularly in relation to sampling of dead bycatch.

26.6 Synopsis of French data

26.6.1 IFREMER

D. batis and *D. intermedius* are now frequently caught in the Celtic Sea during the EVHOE survey. The distinction between the two species in IFREMER data began in 2018, although species identification has been made on board by scientists from MNHN for previous years. From those data, a biomass index in ICES Subarea 7 was calculated for *D. batis* from 2011 (Figure 26.13) (2024 WD Baulier).

Sample sizes from the onboard observation programme (DCF) are generally too low to derive estimates of discarded *Dipturus* at the scale of the stock. However, the proportion of skippers reporting discards of *D. batis* and *D. intermedius* has been increasing.

26.6.2 Muséum national d'Histoire naturelle (MNHN)

This section is based on some of the results presented by Barreau and Iglésias (2021 WD12). Between 2006 and 2016, the French National Museum of Natural History (MNHH) has collected data on the common skate complex, including data from fish auctions, opportunistically from fishers and during surveys onboard commercial fishing vessels, mainly in the Celtic Sea. Most data were collected between 2013 and 2016 within a dedicated program "POCHETEAUX". Dead individuals have been dissected when possible. These studies have also provided data for other *Dipturus* spp., but these data are not shown here.

Species distributions (Figure 26.14)

Only one trip took place off Northwest Scotland, with this trip onboard a vessel specialized in deep-water fishing. Data from this trip showed a higher proportion of *D. intermedius* compared to *D. batis*. In contrast, the other trips were undertaken on the continental shelf of the Celtic Sea, with a higher proportion of *D. batis.* The southernmost individual of *D. intermedius* observed was caught by a fishing boat near the Rochebonne Bank in the Bay of Biscay in May 2014. This specimen was an adult female of 193.4 cm length. Several specimens of *D. batis* were collected in the northern part of the Bay of Biscay. They were reported by professional fishermen or found in auctions in 2014 and 2015 and related to immature individuals (54.6–110.5 cm).

Depth distribution (Figure 26.15)

Common blue skate were recorded during fishing trips at sea over a depth range of 108–630 m (Barreau *et al.*, 2016), but was observed to be more abundant in shelf seas as depths of around 120 m. In contrast, *Dipturus intermedius* had a larger depth range, being observed at depths of 114–1000 m (Barreau *et al.*, 2016). Both species occur on soft (sandy-muddy) bottoms.

Length-frequency distribution (Figure 26.16)

Data on length are represented in 10 cm sizes classes. *Dipturus batis* showed a typical size distribution for a skate population with the presence of two peaks. The first one represents the young individuals, while the second one is due to the accumulation of mature individuals in a larger size class as growth slows down once maturity is attained. The observed length-frequency distribution of *D. intermedius* was more erratic, due to the more restricted sample size. For both species, the larger individuals were mainly female, though the overall sex ratio is close to 1:1.

Length-weight relationships

Data on the relationships between total length and gutted weight were collected by sex and species during the POCHETEAU project (Figure 26.17, Table 26.6). Meaningful data relating to total weight were only available for *Dipturus batis* caught in the Celtic Sea (Figure 26.18, Table 26.6) as the number of *D. intermedius* was too low.

Length-disc width relationship

Tails of skates are often cut of damaged, and so the relationship between total length (L_T) and disc width (D_W) allows the total length of damaged specimens to be estimated. There are also some historical studies or sampling datasets where the disc width rather than the total length was measured. Total length-disc width relationships (mm) were calculated for both species (Figure 26.19) and were defined by the following relationships:

Dipturus batis $D_W = 0.7075\ L_T + 9.3838$ (n = 1374, $r^2 = 0.997$)

Dipturus intermedius $D_W = 0.7836\ L_T – 38.255$ (n = 115, $r^2 = 0.998$)

Length-at-maturity

Data from Iglésias *et al.* (2010) estimated the length at 50% maturity (L_{50}) at 115.0 cm (male) and 122.9 cm (female) for *D. batis* and 185.5 cm (male) and 197.5 cm (female) for *D. intermedius*. The age at 50% maturity was tentatively suggested as 11 years and 19–20 years for *D. batis* and *D. intermedius*, respectively. More recent studies for *D. batis* were used to estimate the length at 50% maturity, using the package "sizeMat" and the function "gonad_mature" on R software (https://cran.r-project.org/web/packages/sizeMat/index.html). The length at 50% maturity (L_{50}) was estimated at ca. 115 cm for males (Figure 26.20). Two estimates of L_{50} were calculated for female, one based on dissected specimens, and another based on the assumption that all females <90 cm were immature and that female caught alive but not dissected were mature if a flaccid cloaca was observed. L_{50} results of these two approaches were 117.5 cm and 119 cm respectively.

26.6.3 POPOC Project

The POPOC project is a French project focusing on *D. batis* in the northern Bay of Biscay and Celtic Sea conducted between November 2019 and June 2021 (2022 WD05). Data on catches (numbers caught, length distribution and sex, at the scale of the fishing operation) were obtained using self-sampling on board French otter trawl vessels which are part of the Producers Organisation "Les Pêcheurs de Bretagne" (The Fishermen from Brittany). Vessels originated from two ports located in south-west Brittany: Le Guilvinec and Saint-Guénolé. In addition, an exemption has been obtained to land samples of large female *D. batis*. These are then examined in order to estimate ovarian fecundity.

Data from the POPOC and POCHETEAUX project in combination with samples collected during the EVHOE and other scientific trawl surveys as well as the French onboard observation programme (Obsmer) were used to provide insight in the spatial distribution using presence/absence maps of the species.

Spatial distribution

During international scientific trawl surveys, distinction of the two species is variable between surveys and did not start in the same year, therefore data for common skate complex have been merged. For the surveys considered here, the species complex has been observed from the northern part of the Bay of Biscay to north of Shetland. These species have not been observed in the southern North Sea since 2013 (Figure 26.21). This increase is particularly noticeable in the Celtic Sea (IE-IGFS and EVHOE). In this area, as well as on the Rockall Bank, *D. batis* dominates the catch of the common skate complex in 2019, a year for which the two species were separated in the data (Figure 26.22)

The temporal coverage associated with Obsmer data allows the observation of a gradual spatial extension of the distribution area of *D. batis* in the Celtic Sea. Densities derived for the southern part of the Celtic Sea and northwestern Bay of Biscay tended to increase since 2009 (Figure 26.23). The comparison with densities derived from data collected during the POCHETEAU project is rendered difficult by the smaller sample size in this latter project, but both data sets indicate a temporally stable area of greater density in the central part of the Celtic Sea, west of the Isles of Scilly. The location of this area is confirmed by the self-sampling data collected during the PO-POC project (Figure 26.24).

Biomass series from EVHOE

The approximated series of common blue skate biomass from the EVHOE survey indicates a recent increase of the index starting in 2018, after a period of lower stable and relatively uncertain biomass (Figure 26.25).

From the interviews conducted with five skippers, a perceived recent increase in biomass of common blue skate was reported, especially in the southern part of the Celtic Sea. All fishers identified 2017 as a turning point in the time series which seems consistent with the increase observed between 2016 and 2018 in the EVHOE index.

26.7 Synopsis of Spanish survey data

26.7.1 From the Porcupine Bank survey

Three species of the genus *Dipturus* were reported by Fernández-Zapico *et al.* (2024 WD): *D. batis, D, intermedius* and *D, nidarosiensis*. Some of these data (pre-2011) are presented here at the genus-level. Figures and results have been updated based on the new working document.

The overall abundance of *Dipturus* spp. decreased compared to 2021 and 2022. The overall biomass remains between the higher values of the temporal series(Figure 26.26), with the mean biomass index from the last two years above that of the previous five years (Figure 26.27).

Species-specific data were available for more recent years, with the biomass and abundance of *D. batis* decreasing strongly in 2023 after the peak of previous year . The abundance and biomass of *D. nidarosiensis* and *D. intermedius* show a slight increase. (Figure 26.28).

During the 2023 Porcupine Bank survey, *Dipturus nidarosiensis* was reported from the deeper parts of the survey area to the south and east of Porcupine Bank (Figure 26.29). *Dipturus batis* and *D. intermedius* were reported at shallower depths close to the Bank (Figure 26.30 and Figure 26.31). *D. batis* was also found in the south out of the bank.

In 2023, 19 specimens of *D. nidarosiensis* were recorded falling within the 28–179 cm length range (Figure 26.32), whilst only 15 specimens of *D. batis* (30–127 cm) were recorded (Figure 26.33). Since 2011, the maximum size recorded for *D. intermedius* has been about 140 cm, which corresponds to immature individuals. This year the three individual caught measured 65, 73 and 123 cm (Figure 26.34).

Available data confirm that both members of the common skate complex occur on and around the Porcupine Bank, with Norwegian skate also occurring in deeper waters. While *Dipturus batis* was the main species of the complex occurring in this area in 2022, *D. nidarosiensis* was the most observed species in 2023.

26.7.2 From the Northern Spanish Shelf Groundfish Survey

From Ruiz-Pico *et al.* (WD, 2024), *D. nidarosiensis* and *D. oxyrinchus* were caught in deeper additional hauls outside the standard stratification of the survey. Three specimen of *D. nidarosiensis* (43, 54 and 97 cm) were caught in three different hauls at depth ranging from 556 to 687 m in the Galician waters. Two specimen of *D. oxyrinchus* (91 and 110 cm) were caught in one haul at average depth of 597 m in west of Peñas Cape.

26.8 Synopsis of Portuguese data

This section was based on the results presented by Serra-Pereira *et al.* (2021 WD08). This WD summarized the available information for *Dipturus* spp. from mainland Portugal (Division 9.a), including data from the DCF commercial sampling and from surveys, to inform on landings, spatial distribution, and length ranges for *Dipturus oxyrinchus*. The data presented reinforces the current perception that *D. oxyrinchus* is the main *Dipturus* species occurring in Division 9.a, with some anecdotal observations relating to *D. nidarosiensis.*

Since 2016, Portuguese data for *Dipturus oxyrinchus* (Division 9.a) have been included in the 'Other skates and rays in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)' stock. No misidentifications with other *Dipturus* spp. have been recorded by the DCF sampling programme of Portuguese landings, so these data are not presented with the common skate *Dipturus batis*-complex (rjb.27.89a).

Misidentifications and/or coding errors in landings data, as observed in other areas, occur in Division 9.a, with Rajidae being commonly landed under incorrect commercial denominations. To address this, IPMA developed a statistical procedure to estimate species-specific landings during the DCF skate pilot study (2011–2013; Figueiredo *et al*., 2020). The output from this procedure is the basis for the annual reported ICES landing estimates from Portugal, since 2008, including those for *D. oxyrinchus.* No other *Dipturus* species have been identified by DCF in landing ports over this time.

The estimated landings of *D. oxyrinchus* from Division 9.a (2008–2020) are presented in Figure 26.35 by fleet segment. Landings from the polyvalent fleet accounted for about 80% (56–99%) of the total landings. For the polyvalent fleet, landings were mostly recorded from the 'Centro' and 'Lisboa e vale do Tejo' regions, more specifically in the landing ports of Peniche and Sesimbra, respectively (Figure 26.36). The same was observed for the trawl landings, although those in the 'Centro' were less representative.

Length data have been collected during the DCF sampling programme. Due to the low number of individuals measured in some years, the length frequency distribution was combined for the whole time-period (2008–2020) (Figure 26.37). The lengths recorded ranged from 48 to 158 cm, and the overall length-frequency distribution was similar between the two fleets.

Dipturus oxyrinchus is often caught during the Portuguese crustacean trawl survey/*Nephrops* Survey Offshore Portugal (NepS (FU 28–29)), which covers the Portuguese southwestern and southern coasts, along eight sectors (Figure 26.38). This survey has operated since 1997, but was not conducted in 2004, 2010, 2012, 2019 or 2020. More details on the survey characteristics were described in WKSKATE (see Rodríguez-Cabello *et al*., 2020 WD).

Dipturus oxyrinchus was found at depths of 43–776 m, but was caught more commonly in the southwest (south off Cabo Espichel) at depths of 350–600 m deep, and in the southern region at 400–700 m depth (Figure 26.38– Figure 26.40). The occurrence and spatial distribution of the species varied over the years (Figure 26.39). Lower catches were observed in 2000, 2005, 2008 and the absence in 1999 may be influenced by the use of a net with different characteristics from the standard protocol (i.e., CAM net with 20 mm mesh size).

The length distribution of *D. oxyrinchus* has been variable over the time-series, mainly due it being a rarely recorded species with a wide size range, from 18–160 cm L_T (Figure 26.41). The mean length of the overall time-series was 57 cm, with some years catching more juveniles (e.g. 2016–2018), while in other catching larger individuals (e.g. 2002, 2011, 2012, 2015; Figure 26.42).

During the NepS (FU 28–29) surveys time series, *Dipturus nidarosiensis* was also caught but in very few numbers, with only three individuals identified between 1997 and 2018 (2014: 68.5 cm male, 755 m depth; 2014: 165 cm female, 657 m depth; and 2016: 47.7 cm female, 104 m depth).

26.9 Analyses of DATRAS data

This section was initially based on some of the results presented by Barreau and Iglésias (2021 WD12) but overall results have been recalculated with new data downloaded from DATRAS which could explain the differences in numbers from the WD.

Exchange format data were downloaded from DATRAS for the years 2010–2023. Until 2023, the number of individuals recorded under *D. batis* (related to the species complex) has decreased in part of the survey to be better ascribed to either flapper or common blue skate. In recent years, while some surveys were still using *D. flossada* for common blue skate, some already started to use *D. batis* (Last *et al.* 2016). However, a radical change occurred in 2022 with no more individuals recorded as *D. flossada*. Now, records of common blue skate are only ascribed to *D. batis* following the new nomenclature based on Last *et al.* (2016) (Table 26.7, Figure 26.43). Recent records of *D. batis* may now be considered as common blue skate. It is to be noted that the scientific name used in DATRAS for flapper skate was *D. intermedia,* but has now become *D. intermedius* from 2022, following the official nomenclature.

The spatial distributions of the two species are now better known from around the British Isles, with flapper skate mainly around the coasts of Scotland, whilst the common blue skate is observed mostly in the Celtic Sea and on the Rockall Bank as also confirmed by the available data used here (Figure 26.44).

Available DATRAS data on the depth distribution of the *D. batis* complex were examined for 2010–2023. *D. batis* was present from 31 to 928 m depth, however those results include mainly data on the complex (Figure 26.45). Common blue skate, *D. batis* (*D.* cf. *flossada*), was recorded at depths of 37–701 m but was more abundant in shelf seas at depths <200 m. *Dipturus intermedius* had a broader depth range (17–882 m) and a slightly shallower median depth.

In order to see if some of the surveys could be relevant to describe temporal trends in the stock, the catch rate in number per hour was calculated for each survey within the last 10 years (Figure 26.46). These preliminary results should not be used to draw conclusions on actual stock trends, as potential changes in gear and survey design have not been taken into account. They are only informative results on the evolution of the catch per species per survey and to identify which surveys could usefully be subject to closer examination.

D. batis has been observed mainly in Beam Trawl Surveys since 2013, with records decreasing in the SWC-IBTS/ SCOWCGFS (where improved speciation has occurred since 2012). All records increase in 2022 and 2023 for the main survey due to the use of *D. batis* for common blue skate.In EVHOE, records are more or less stable since 2020 when data on *D.* cf. *flossada* started to be recorded as *D. batis* except for 2022 when a lower number of individuals were observed.

Common blue skate *D. batis* (=*D.* cf. *floassada*) was recorded mainly on Rockall (SCOROC survey) with the highest catch rates, which increased during the period, as well as IE-IAMS, IE-IGFS and SWC-IBTS/ SCOWCGFS surveys to end up to zero with the use of the scientific name *D. batis*. EVHOE trends arestrongly decreasing since 2020 as the common blue skate is now recorded as *D. batis* and so appears in the top graph.

Flapper skate *Dipturus intermedius* was observed with a slight decrease during the IE-IGFS. The number of specimens strongly increased during the IE-IAMS and to a lesser extent during SWC-IBTS/ SCOWCGFS.

Whilst no specimens are reported on DATRAS during EVHOE for 2022, an observer from MNHN present on board recorded four *D. intermedius*. The reasons for records not appearing in DATRAS are unknown (Barreau, pers. com.).

It is to be noticed that data on DATRAS for SP-PORC do not reflect the results presented in Ruiz-Pico *et al.* (2024 WD) for unknown reasons.

Length and sex data were recorded for most of the individuals caught during research vessel surveys (to the cm below). The observed *D. intermedius* size distribution seems coherent with the expected shape described in Iglésias *et al.* (2010), with a high number of relatively small individual and the appearance of a small mode at larger size corresponding to the accumulation of the mature individuals into the larger length classes (Figure 26.47). However, the length-frequency distribution of *D. batis (=D.* cf. *flossada*) seems incorrect, with several individuals >150 cm. This suggests that misidentifications (or coding/reporting errors) are present in some datasets.

As the name *D.* cf. *flossada* is no longer used in survey it has to be assumed that, since 2022, *D. batis* records should relate to common blue skate. However, looking into length measurements for 2022 and 2023, misidentification still occurs with *D. intermedius* with several length measurements (158, 167, 184, 217 and 225 cm) well above the accepted maximum size of common blue skate (i.e: 150 cm). This implies highly probable misidentifications in the smaller sizes as well.

26.10 Summary and future work

There is increased interest in the status of both species, and especially *D. intermedius* (demonstrated by the recent studies published), in European seas (e.g. Garbett *et al*., 2021). The previous IUCN assessment for the species complex (Dulvy *et al*., 2006) considered a decline in geographic extent among the criteria used. Given the recent separation of the two species and the continually improving understanding of their current distributions, a more rigorous appraisal of historical information and examination of museum samples are now required to provide better information on their historical distributions.

In terms of historical studies, ichthyological accounts for the period approximately from 1837/1838 (when *D. intermedius* was described) until 1926 (when it was synonymised with *Dipturus batis*), may provide some relevant information. For example, Murie (1903) reported skate (as *Raia batis*) from the Outer Thames area but noted that flapper skate (as *R. macrorhynchus*) had not been reported from that area. Similarly, Herdman and Dawson (1902) confirmed that common blue skate (as *Raia batis*) was in the Irish Sea and, in relation to flapper skate (as *R. macrorhynchus*), noted that it had been reported by fishers from the area but that the authors had not seen any specimens of skate that they considered distinct from common blue skate. Day (1880–1884) noted that flapper skate (as *R. macrorhynchus*) had also been observed at Plymouth and from Dublin Bay, but that data were limited. Such information would suggest that *D. batis* was the main species of the complex occurring in the Irish Sea (Division 7.a) and potentially the only species of the complex occurring in the southern North Sea (Division 4.c). Collation of other relevant accounts could potentially provide more information on the distributions of the two species.

Additionally, given that some parasites of elasmobranchs, particularly cestodes, can show a high degree of host-specificity, a critical review of published parasitological studies (e.g. Rees & Llewellyn, 1941; Williams, 1959; Manger, 1972; Kennedy and Williams, 1989; Benmeslem *et al.*, 2019) could also usefully be considered.

Survey data are becoming increasingly available for each species within the common skate complex. However, they must be handled with care, as the accepted scientific name of common blue skate *Dipturus batis* (and also the accepted FAO code) can be confused with historical data, and field identification guides produced prior to 2010 do not separate the two species. Even if identification on trawl surveys is improving, consistent identification is still required. Concerning the potential for confusion regarding the name of common blue skate, it would be useful if the scientists in charge on surveys could ensure that more detailed comments confirming the occurrence of each of the species, and that reporting of *D. batis* indeed relates to common blue skate *D. batis*, rather than relating to the species-complex. If the exact species is not known, data should be reported at the genus level (i.e. *Dipturus* spp., Aphia ID = 105762). Based on the 2022 change and the disappearance of the name *D. flossada* in DATRAS, data recorded as *D. batis* from now on could be considered as common blue skate records. Detailed work should now be undertaken to be able to identify the year surveys started to switch from *D. batis* as a complex to *D. flossada* as the common blue skate, assuming that identification was accurate, in order to reconstruct real time series of the catch. This future work could define the year from which DATRAS data users will be aware that distinction was properly done between the two species. Even so, misidentification is still observed during latter scientific survey meaning that training on species recognition should carry on.

Present knowledge on the distribution of *D. intermedius* and *D. batis* in their main area of occurrence, as well as the improvements in the data collected on surveys, could be used in the short-term to medium-term to better define the likely biological stock units for both species (*D. batis* and *D. intermedius*) separately, and potentially providing data on stock status. Baulier (WD, 2024) started to explore the possibility to use the EVHOE survey as a starting point to develop a biomass index. These preliminary results should be discussed during the proposed WKSKATE2 workshop and a benchmark in years to come. Reconstructing catch data, however, may be more problematic.

26.11 References

Albonetti, L., Maiello, G., Cariani, A., Carpentieri, P., Ferrari, A., Sbrana, A., Shum, P., Talarico, L., Russo, T. and Mariani, S. 2023. DNA metabarcoding of trawling bycatch reveals diversity and distribution patterns of sharks and rays in the central Tyrrhenian Sea. *ICES Journal of Marine Science*, 80 : 664-674.

Andriyashev, A.P. 1954. Fishes of Northern Seas of the USSR. Key to Fauna of the USSR. Moscow: Academy of Science of the Union of Soviet Socialist Republics, Moscow, Russia.

Bache-Jeffreys, M., Lins Caldas de Moraes, B, Ball, R.E., Menezes, G., Pálsson, J., Pampoulie, C., Stevens, J.R. and Griffiths, A.M. 2021. Resolving the spatial distributions of Dipturus intermedius and Dipturus batis—the two taxa formerly known as the 'common skate'. *Environmental Biology of Fishes*, 104(8): 923-936.

Barreau, T. and Iglésias, S.P. 2021. Knowledge available on common skate from the French National Museum of Natural History and from European research surveys to answer the ToR l) of the WGEF 2021. Working Document to the ICES Working Group on Elasmobranch Fishes, June 15–24 2021, 20 pp.

Barreau T., Caraguel J.-M., Vuillemin S. and Iglésias S. P. 2016. Programme POCHETEAUX, Rapport final. Muséum national d'Histoire naturelle, 100 p.

Baulier, L. and Rimaud, T. 2022. Recent population dynamics of *Dipturus batis* in Celtic Sea. Working Document to the ICES Working Group on Elasmobranch Fishes, June 14–23 2022, 11 pp.

Baulier, L. 2024. Derivation of a biomass index for common blue skate *Dipturus batis*, in ICES Subarea 7. Working Document to the ICES Working Group on Elasmobranch Fishes, June 18–27 2024, 5 pp.

Beard, J. (1890). On the development of the common skate (*Raja batis*). *Eighth Annual Report of the Fishery Board for Scotland*, Part III; 300–311.

Bellodi, A., Porcu, C., Cannas, R., Cau, A., Marongiu, M.F., Mulas, A., Vittori, S. and Follesa, M. C. 2017. Life-history traits of the long-nosed skate *Dipturus oxyrinchus*. *Journal of Fish Biology*, 90: 867–888.

Bendall, V. A., Hetherington, S. J., Ellis, J. R., Smith, S. F., Ives, M. J., Gregson, J. and Riley, A. A. 2012. Spurdog, porbeagle and common skate bycatch and discard reduction. Cefas, Fisheries Science Partnership 2011–2012, Final Report. 88 pp.

Bendall, V.A., Jones, P., Nicholson, R., Hetherington, S. and Burt, G. 2017. Common skate survey Annual Report (ELECTRA MF6001: Work Package Task 1.4) Cefas. 39 pp.

Benjamins, S., Cole, G., Naylor, A., Thorburn, J. A. and Dodd, J., 2021. First confirmed complete incubation of a flapper skate (*Dipturus intermedius*) egg in captivity. *Journal of Fish Biology*, in press.

Benjamins, S., Dodd, J., Thorburn, J., Milway, V. A., Campbell, R. and Bailey, D. M. 2018a. Evaluating the potential of photo-identification as a monitoring tool for flapper skate (*Dipturus intermedius*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 28: 1360–1373.

Benjamins, S., Fox, C. J., Last, K. and McCarty, C. E. 2018b. Individual identification of flapper skate *Dipturus intermedius* using a baited camera lander. *Endangered Species Research*, 37: 37–44.

Benmeslem, K., Randhawa, H.S. and Tazerouti, F. 2019. Description of a new species of rhinebothriidean tapeworm from the skate *Dipturus batis* in the Mediterranean Sea. *Journal of Helminthology*, 93: 589–600.

Bird, C., Burt, G. J., Hampton, N., McCully Phillips, S. R. and Ellis, J. R. 2020. Fifty years of tagging skates (Rajidae): Using mark-recapture data to evaluate stock units. *Journal of the Marine Biological Association of the United Kingdom*, 100: 121–131.

Brown-Vuillemin, S., Barreau, T., Caraguel, J. M. and Iglésias, S. P. 2020. Trophic ecology and ontogenetic diet shift of the blue skate (*Dipturus* cf. *flossada*). *Journal of Fish Biology*, 97: 515–526.

Cannas, R., Follesa, M.C., Cabiddu, S., Porcu, C., Salvadori, S., Iglésias, S. P., Deiana, A.M. and Cau, A. 2010. Molecular and morphological evidence of the occurrence of the Norwegian skate *Dipturus nidarosiensis* (Storm, 1881) in the Mediterranean Sea. *Marine Biology Research*, 6: 341–350.

Capapé, C., Guélorget, O., Vergne, Y., Marquès, A. and Quignard, J.P. 2006. Skates and rays (Chondrichthyes) from waters off the Languedocian coast (southern France, northern Mediterranean): a historical survey and present status. *Annales: Series Historia Naturalis*, 16, 1–14.

Carbonara, P., Cannas, R., Donnaloia, M., Melis, R., Porcu, C., Spedicato, M. T., Zupa, W. and Follesa, M. C. 2019. On the presence of *Dipturus nidarosiensis* (Storm, 1881) in the Central Mediterranean area. *PeerJ*, *7*, p.e7009.

Carbonara, P., Bellodi, A., Zupa, W., Donnaloia, M., Gaudio, P., Neglia, C., and Follesa, M. C. 2021. Morphological Traits and Capture Depth of the Norwegian Skate (*Dipturus nidarosiensis* (Storm, 1881)) from Two Mediterranean Populations. *Journal of Marine Science and Engineering*, 9: 1462.

Cariani, A., Messinetti, S., Ferrari, A., Arculeo, M., Bonello, J.J., Bonnici, L., Cannas, R., Carbonara, P., Cau, A., Charilaou, C. and El Ouamari, N. 2017. Improving the conservation of Mediterranean chondrichthyans: the ELASMOMED DNA barcode reference library. *PloS one*, 12(1), p.e0170244.

Clark, R. S. 1926. Rays and skates. A revision of the European species. *Fisheries Board of Scotland, Scientific Investigations*, 1: 1–66.

Coull, K. A., Jermyn, A. S., Newton, A. W., Henderson, G. I. and Hall, W.B. 1989. Length/weight relationships for 88 species of fish encountered in the North East Atlantic. *Scottish Fisheries Research Report*, 43: 81 pp.

Day, F. 1880–1884. The fishes of Great Britain and Ireland. London: Williams and Norgate.

Delaval, A., Frost, M., Bendall, V., Hetherington, S.J., Stirling, D., Hoarau, G., Jones, C.S., and Noble, L.R. 2022. Population and seascape genomics of a critically endangered benthic elasmobranch, the blue skate *Dipturus batis*. *Evolutionary Applications*, 15:78–94.

Delaval, A., Bendall, V., Hetherington, S.J., Skaug, H.J., Frost, M., Jones, C.S., and Noble, L.R. 2023. Evaluating the suitability of close-kin mark-recapture as a demographic modelling tool for a critically endangered elasmobranch population. *Evolutionary Applications*, 16:461-473.

Dodd, J., Baxter, J.M., Donnan, D.W., James, B.D., Lavender, E., McSorley, C.A., Mogg, A.O.M. and Thorburn, J.A. 2022. First report of an egg nursery for the Critically Endangered flapper skate *Dipturus intermedius* (Rajiformes: Rajidae). *Aquatic Conserv: Mar Freshw Ecosyst*, 32: 1647–1659.

Dolgov, A. V., Drevetnyak, K. V. and Gusev, E. V. 2005a. The status of skate stocks in the Barents Sea. *Journal of Northwest Atlantic Fishery Science*, 35: 249–260.

Dolgov, A. V., Grekov, A. A, Shestopal, I. P. and Sokolov, K. M. 2005b. By-catch of skates in trawl and long-line fisheries in the Barents Sea. *Journal of Northwest Atlantic Fishery Science*, 35: 357–366.

Du Buit, M. H. 1976. Age et croissance de *Raja batis* et de *Raja naevus* en Mer Celtique. *Journal du Conseil International pour l'Exploration de la Mer*, 37: 261–265.

Dulvy, N. K., Notarbartolo di Sciara, G., Serena, F., Tinti, F., Ungaro, N., Mancusi, C. and Ellis, J. 2006. *Dipturus batis*. The IUCN Red List of Threatened Species 2006: e.T39397A10198950. https://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T39397A10198950.en. Downloaded on 11 June 2021.

Ebert, D. A. and Stehmann, M. F. W. 2013. Sharks, batoids, and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes No. 7. Food and Agricultural Organization of the United Nations (FAO). FAO, Rome.

Ellis, J. R. and Silva, J. F. 2021. Overview of data relating to *Dipturus* species. Working Document to the ICES Working Group on Elasmobranch Fishes, June 15–24 2021, 24 pp.

Ellis, J.R., McCully-Philipps, S.R., Sims, D., Walls, R.H.L., Cheok, J., Derrick, D. & Dulvy, N.K. 2021a. *Dipturus intermedius*. *The IUCN Red List of Threatened Species* 2021: e.T18903491A68783461. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T18903491A68783461.en.

Ellis, J., McCully-Philipps, S.R., Sims, D., Derrick, D., Cheok, J. & Dulvy, N.K. 2021b. *Dipturus batis*. *The IUCN Red List of Threatened Species* 2021: e.T203364219A203375487. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T203364219A203375487.en.

Fahy, E. 1991. The south eastern ray *Raja* spp. fishery, with observations on the growth of rays in Irish waters and their commercial grading. *Irish Fisheries Investigation. Series B: Marine*.

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Velasco, F., Rodríguez-Cabello, C. and Baldó, F. 2024. Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic). Working Document presented to the Working Group on Elasmobranch Fishes (WGEF), 18–27 June, 2024, 40 pp.

Figueiredo, I., Maia, C., Lagarto, N. and Serra-Pereira, B. 2020. Bycatch estimation of Rajiformes in multi-species and multigear fisheries. *Fisheries Research*, 232, 105727

Fitzmaurice, P., Keirse, G., Green, P. and Clarke, M. 2003. Common skate tagging in Irish Waters (1970–2002). Central Fisheries Board, Ireland.

Follesa, M. C., Cannas, R., Cabiddu, S., Cau, A., Mulas, A., Porcu, C. and Cau, A. 2012. Preliminary observations of the reproductive biology and diet for the Norwegian skate *Dipturus nidarosiensis* (Rajidae) from the Central Western Mediterranean Sea. *Cybium*, 36: 473–477.

Frost, M., Neat, F. C., Stirling, D., Bendall, V., Noble, L. R. and Jones, C. S. 2020. Distribution and thermal niche of the common skate species complex in the north-east Atlantic. *Marine Ecology Progress Series*, 656: 65–74.

Garbett, A., Phillips, N.D., Houghton, J.D., Prodöhl, P., Thorburn, J., Loca, S.L., Eagling, L.E., Hannon, G., Wise, D., Pothanikat, L. and Gordon, C. 2021. The critically endangered flapper skate (*Dipturus intermedius*): Recommendations from the first flapper skate working group meeting. *Marine Policy*, 124, p.104367.

Garbett, A., Loca, S. L., Barreau, T., Biscoito, M., Bradley, C., Breen, J., Clarke, M., Ellis, J.R., *et al.* 2023. A holistic and comprehensive data approach validates the distribution of the critically endangered flapper skate (*Dipturus intermedius*). *Journal of Fish Biology*: jfb.15466.

Geraci, M.L., Di Lorenzo, M., Falsone, F., Scannella, D., Di Maio, F., Colloca, F., Vitale, S. and Serena, F. 2019. The occurrence of Norwegian skate, *Dipturus nidarosiensis* (Elasmobranchii: Rajiformes: Rajidae), in the Strait of Sicily, central Mediterranean. *Acta Ichthyologica et Piscatoria*, 49: 203–208.

Griffiths, A. M., Sims, D. W., Cotterell, S. P., El Nagar, A., Ellis, J. R., Lynghammar, A., McHugh, M., Neat, F. C., Pade, N. G., Queiroz, N., Serra-Pereira, B., Rapp, T., Wearmouth, V. J. and Genner, M. J. 2010. Molecular markers reveal spatially segregated cryptic species in a critically endangered fish, the common skate (*Dipturus batis*). *Proceedings of the Royal Society, B - Biological Sciences*, 277: 1497–1503.

Griffiths, A.M., Sims, D. W., Johnson, A., Lynghammar, A., McHugh, M., Bakken, T. and Genner, M. J. 2011. Levels of connectivity between longnose skate (*Dipturus oxyrinchus*) in the Mediterranean Sea and the north-eastern Atlantic Ocean. *Conservation Genetics*, 12: 577–582.

Hareide, N. R. and Garnes, G. 2001. The distribution and catch rates of deep water fish along the Mid-Atlantic Ridge from 43 to 61°N. *Fisheries Research*, 51: 297–310.

Heintz, N. 1962. On *Raia batis* L., *R. nidrosiensis* [sic] Collett and *R. oxyrhynchus* (L.) from Norwegian waters and their mutual relationship. *Sarsia*, 5: 1–67.

Herdman, W. A., & Dawson, R. A. 1902. Fishes and fisheries of the Irish Sea (Lancashire Sea-Fisheries Memoir 11). London: George Philip & Son Ltd.

ICES. 2012. Special request on spatial distribution, stock status, and advice on *Dipturus* species. ICES Advice Book 9, Section 9.3.2.4. International Council for the Exploration of the Seas, Copenhagen, Denmark.

Iglésias, S. P., Toulhout, L. and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. *Aquatic Conservation Marine and Freshwater Ecosystems*, 20: 319–333.

Kadri, H., Marouani, S., Bradai, M. N., Bouain, A. and Morize, E. 2015. Age, growth, longevity, mortality and reproductive biology of *Dipturus oxyrinchus*,(Chondrichthyes: Rajidae) off the Gulf of Gabès (Southern Tunisia, central Mediterranean). *Journal of the Marine Biological Association of the United Kingdom*, 95: 569–577.

Karadurmuș¸, U. & Sarı, M. (2024). Distribution and diversity of elasmobranchs in the Sea of Marmara: A 2023 status report. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 34(3), e4121. https://doi.org/10. 1002/aqc.4121Kennedy, C. R. and Williams, H. H., 1989. Helminth parasite community diversity in a marine fish *Raja batis* L. *Journal of Fish Biology*, 34: 971–972.

Last, P., White, W., Carvalho, M.R. de, Séret, B., Stehmann, M. and Naylor, G.J.P. 2016. Rays of the World. Victoria: CSIRO Publishing.

Lavender, E., Aleynik, D., Dodd, J., Illian, J., James, M., Wright, P. J., Smout, S. and Thorburn, J. 2022. Movement patterns of a Critically Endangered elasmobranch (*Dipturus intermedius*) in a Marine Protected Area. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 32: 348–365.

Lynghammar, A., Christiansen, J. S., Griffiths, A. M., Fevolden, S. E., Hop, H. and Bakken, T., 2014. DNA barcoding of the northern Northeast Atlantic skates (Chondrichthyes, Rajiformes), with remarks on the widely distributed starry ray. *Zoologica Scripta*, 43: 485-495.

Manger, B. 1972. Some cestode parasites of the elasmobranchs *Raja batis* and *Squalus acanthias* from Iceland. *Bulletin British Museum of Natural History (Zoology)*, 24: 161–181.

McCully, S. R., Scott F. and Ellis J. R. 2012. Length at maturity and conversion factors for skates (Rajidae) around the British Isles, with a critique of earlier studies. *ICES Journal of Marine Science*, 69: 1812–1822.

Melis, R., Vacca, L., Bellodi, A., Cau, A., Porcu, C., Follesa, M. C. and Cannas, R. 2020. Insights into population genetics, connectivity and demographic history of the longnosed skate *Dipturus oxyrinchus* (Linnaeus, 1758) in the western Mediterranean Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 30: 86–103.

Menezes, G.M., Sigler, M.F., Silva, H.M. and Pinho, M.R., 2006. Structure and zonation of demersal fish assemblages off the Azores Archipelago (mid-Atlantic). *Marine Ecology Progress Series*, 324: 241–260.

Moore, A.B. 2023. A ray of hope? The re-appearance of Irish Sea skate decades after local extinction. *Journal of Fish Biology*, 102: 1503–1505.

Mulas, A., Bellodi, A., Cannas, R., Cau, A., Cuccu, D., Marongiu, M. F., Porcu, C. and Follesa, M. C. 2015. Diet and feeding behaviour of longnosed skate *Dipturus oxyrinchus*. *Journal of Fish Biology*, 86: 121–138.

Murie, J. 1903. Report on the sea fisheries and fishing industries of the Thames Estuary. Part I. Kent and Essex Sea Fisheries Committee.

Neat, F., Pinto, C., Burrett, I., Cowie, L., Travis, J., Thorburn, J., Gibb, F. and Wright, P. J. 2015. Site fidelity, survival and conservation options for the threatened flapper skate (*Dipturus* cf. *intermedia*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25: 6–20.

Pálsson, J. and Jakobsdóttir, K.. 2018. in a poster entitled "*The Flapper or the Blue? D. batis complex in Icelandic waters*". Poster presented at ICES ASC.

Parnell, R. 1837. An account of a new species of British bream, and a species of skate new to science; with a list of, and observations on, the fishes of the Firth of Forth and neighborhood. *Proceedings of the Royal Society of Edinburgh, 1(11):* 166–167 + Plate.

Parnell, R. 1838. Prize essay on the natural and economical history of the fishes, marine, fluviatile, and lacustrine, of the river district of the Firth of Forth. Edinburgh: Wernerian Natural History Society.

Phillips, N. D., Garbett, A., Wise, D., Loca, S. L., Daly, O., Eagling, L. E., Houghton, J. D., Verhoog, P., Thorburn, J. and Collins, P. C. 2021. Evidence of egg laying grounds for Critically Endangered flapper skate (*Dipturus intermedius*) off Orkney, UK. *Journal of Fish Biology*, in press.

Pinto, C., Thorburn, J. A., Neat, F., Wright, P. J., Wright, S., Scott, B. E., Cornulier, T. and Travis, J. M. 2016. Using individual tracking data to validate the predictions of species distribution models. *Diversity and Distributions*, 22: 682–693.

Ramírez-Amaro, S., Ordines, F., Puerto, M.Á., García, C., Ramon, C., Terrasa, B. and Massutí, E. 2017. New morphological and molecular evidence confirm the presence of the Norwegian skate *Dipturus nidarosiensis* (Storm, 1881) in the Mediterranean Sea and extend its distribution to the western basin. *Mediterranean Marine Science*, 18: 251–259.

R Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rees, G. and Llewellyn, J. 1941. A record of the trematode and cestode parasites of fishes from the Porcupine Bank, Irish Atlantic Slope and Irish Sea. *Parasitology*, 33: 390–396.

Régnier, T., Dodd, J., Benjamins, S., Gibb, F.M. and Wright, P.J. 2021. Age and growth of the Critically Endangered flapper skate, *Dipturus intermedius*. *Aquatic Conservation: Marine and Freshwater Ecosystems*,1–8.

Régnier, T., Dodd, J., Benjamins, S., Gibb, F.M. & Wright, P.J. 2024. Spatial management measures benefit the critically endangered flapper skate, Dipturus intermedius. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 34(4), e4150. https://doi.org/10.1002/ aqc.4150

Rindorf, A., Eg Nielsen, E., Jacobsen, L. M. W., Storr-Paulsen, M., Vinther, M., Håkansson, K. B., and Mildenberger, T. 2023. DNA based monitoring of sharks, skates and rays, and risk-based evaluation of bycatch in Danish fisheries. DTU Aqua. DTU Aqua-rapport No. 429-2023

Risso, A. 1826. Histoire naturelle des principales productions de l'Europe méridionale et particulièrement de celles des environs de Nice et des Alpes maritimes. Paris and Strasbourg.

Rodríguez-Cabello, C., Serra-Pereira, B., Velasco, F., Sobrino, I., Gil, J., Diez, G., Moura, T., Maia, C. and Figueiredo, I. 2020. Review of survey data for the assessment of skates in ICES 9a. Working document presented to the ICES Workshop on the use of surveys for stock assessment for Rays and Skates (WKSKATE). 23–27 November 2020. 24 pp.

Rosa, A., Menezes, G., Melo, O. and Pinho, M. R. 2006. Weight–length relationships of 33 demersal fish species from Azores archipelago. *Fisheries Research*, 80: 329–332.

Ruiz-Pico, S., Fernández-Zapico, O., Blanco, M., Rodríguez-Cabello, C., Ortiz, P., González, J.M., Punzón, A. and Velasco, F., 2023. Results on main elasmobranch species caught in the 2023 Northern Spanish Shelf Groundfish Survey. Working Document presented to the Working Group on Elasmobranch Fishes (WGEF), 18–27 June, 2024, 47 pp.

Santos, R., Novoa-Pabon, A., Silva, H. and Pinho, M. 2020. Elasmobranch species richness, fisheries, abundance and size composition in the Azores archipelago (NE Atlantic). *Marine Biology Research*, 16: 103–116.

Santos, R. S., Porteiro, F. M. & Barreiros, J. P. 1997. Marine fishes of the Azores: An annotated checklist and bibliography. *Arquipélago. Life and Marine Sciences*, Supplement 1: xxiii + 242 pp.

Serena, F., Abella, A.J., Bargnesi, F., Barone, M., Colloca, F., Ferretti, F., Fiorentino, F., Jenrette, J. and Moro, S. 2020. Species diversity, taxonomy and distribution of Chondrichthyes in the Mediterranean and Black Sea. *The European Zoological Journal*, 87: 497–536.

Serra-Pereira, B., Moura, T., Maia, C. and Figueiredo, I. 2021. Summary of the information available for *Dipturus* spp. from Portuguese mainland waters. Working Document presented to the Working Group on Elasmobranch Fishes (WGEF), 15–24 June, 2021, 6 pp.

Silva, J. F., Ellis, J. R. and Ayers, R. 2013. Length-weight relationships of marine fish collected from around the British Isles. *Science Series Technical Report*, CEFAS (Lowestoft), 150: 109 pp.

Silva, J. F., Ellis, J. R. and Catchpole, T. L. 2012. Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. *Journal of Fish Biology*, 80: 1678–1703.

Stehmann, M. and Burkel, D.L. 1984. Rajidae. In: P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds) Fishes of the North-eastern Atlantic and Mediterranean. Vol. 1. pp: 163–196. Paris: UNESCO.

Sutcliffe, R. 1994. Twenty years of tagging common skate and tope off the west coast of Scotland. In Earll, R. C. & Fowler, S. L. (Eds) *Tag and release schemes and shark and ray management plans. Proceedings of the second European Shark and Ray Workshop* (Natural History Museum, London, 15–16 February 1994), 14–16.

Thorburn, J., Wright, P.J., Lavender, E., Dodd, J., Neat, F., Martin, J.G.A., Lynam, C. and James, C. 2021. Seasonal and Ontogenetic Variation in Depth Use by a Critically Endangered Benthic Elasmobranch and Its Implications for Spatial Management. *Front. Mar. Sci.*, 8:656368.

Thorburn, J., Cole, G., Naylor, A., Garbett, A., Wilson, K., James, M., Dodd, J., Houghton, J. D. R. and Collins, P. C. 2023. Preliminary insight into the reproductive traits of the flapper skate Dipturus intermedius using in-field ultrasonography and circulating hormone concentrations. *Endangered Species Research*, 52: 97-111.

Turan, C. 2008. Molecular systematic analyses of Mediterranean skates (Rajiformes). *Turkish Journal of Zoology*, 32: 437–442.

Warnes, S. and Jones, B.W. 1995. Species distributions from English Celtic Sea groundfish surveys, 1984 to 1991. *Fisheries Research Technical Report*, MAFF Directorate of Fisheries Research (Lowestoft), 98: 42 pp.

Wearmouth, V. J. and Sims, D. W. 2009. Movement and behaviour patterns of the critically endangered common skate *Dipturus batis* revealed by electronic tagging. *Journal of Experimental Marine Biology and Ecology*, 380: 77–87.

Weigmann, S. 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity. *Journal of Fish Biology,* 88: 837–1037.

Wienerroither, R. *et al.* 2013. Atlas of the Barents Sea Fishes based on the winter survey. IMR-PINRO Report 2-2013. Institute of Marine Research, Bergen, 220 pp.

Wilhelms, I. 2013. Atlas of length-weight relationships of 93 fish and crustacean species from the North Sea and the North-East Atlantic, Thünen Working Paper, No. 12, Johann Heinrich von Thünen-Institut, Braunschweig.

Williams, H. H. 1959. A list of parasitic worms, including 22 new records, from marine fishes caught off the British Isles. *Journal of Natural History*, 2: 705–715.

Williams, T., Helle, K. and Aschan, M. 2008. The distribution of chondrichthyans along the northern coast of Norway. *ICES Journal of Marine Science*, 65: 1161–1174.

Yıgın, C. and Ismen, A. 2010. Age, growth, reproduction and feed of longnosed skate, *Dipturus oxyrinchus* (Linnaeus, 1758) in Saros Bay, the north Aegean Sea. *Journal of Applied Ichthyology*, 26: 913–919.

26.12 Tables and Figures

Table 26.1. Distinguishing features of common blue skate *Dipturus batis* and flapper skate *Dipturus intermedius*. Adapted from Iglésias *et al.* (2010), with more recent data added where relevant (*).

Feature	Common blue skate	Flapper skate
Eye (iris colour)	Pale yellow	Dark olive-green
Eye-spots on pectoral fin	*"Blotch on wing with ocellus with dark centre surrounded by pale ring"*	*"Blotch of grouped pale spots"*
Lateral thorns on tail	Lateral thorns perpendicular	Lateral thorns project anteriorly (towards head)
Dentition	Teeth relatively narrower	Teeth relatively broader
Maximum length	143.2 (to at least 149 cm*)	228.8 cm
Length-at-maturity (female)	122.9 cm	197.5 cm
Length-at-maturity (male)	115 cm	185.5 cm

Table 26.2. Original description of *Raia flossada* Risso, 1826

Cette espèce, la plus remarquable de nos bords par sa grandeur, présente un corps épais, bombé au milieu, d'un gris cendré, parsemé de taches irrégulières blanches et noirâtres, couvert de petite aspérités qui le rendant âpre au toucher; tout le dessous est blanc, tacheté de points noirs; le museau est prolongé en pointe arrondie; les yeux sont proéminents, ovales oblongs, et ont l'iris blanchâtre, avec la prunelle bleue; les narines sont grandes, arquées; la bouche a beaucoup d'ampleur, et ses mâchoires sont munies dans leur milieu de onze rangées de dents coniques, aiguës et crochues, et seulement de chaque côté de sept rangées de dents un peu obtuses; les ouvertures branchiales sont linéaires; les nageoires ventrales sinueuses, à dix-huit rayons chacune; la queue est courte, épaisse, courbée, terminée au sommet, qui est tronqué, par deux nageoires oblongues; elle est bombée en dessus, aplatie en dessous, et munie de chaque côté de quarante-deux aiguillons crochus; la chair de cette raie est blanche et d'un goût fade. La femelle est aussi grosse que le mâle. Long. 1,200, enverg. 0,900. Séj. Grandes profondeurs. App. Avril, mai.
[*This species, the most remarkable of our borders by its size, has a thick body, rounded in the middle, of an ash grey, dotted with white and blackish irregular spots, covered with small denticles which make it harsh to the touch; all below is white, speckled with black dots; the snout is extended in a rounded point; the eyes are prominent, oblong oval, and have a whitish iris, with blue centre; the nostrils are large, arched; the mouth is very full, and its jaws are provided in their middle with eleven rows of conical, sharp, hooked teeth, and only on each side with seven rows of somewhat obtuse teeth; the gill openings are linear; sinuous ventral fins, eighteen rays each; the tail is short, thick, curved, terminating at the top, which is truncated, by two oblong fins; it is rounded above, flattened below, and provided on each side with forty-two hooked spines; the flesh of this ray is white and tasteless. The female is as big as the male. Length: 120 cm, width: 90 cm. Habitat: Great depths. Appearance: April May.*]

Table 26.3. Taxonomic units of the genus *Dipturus* occurring in the North-east Atlantic, including taxa considered in the present analyses. In the subsequent two tables, the FSS species codes have been used, as these better separate the two species from the complex. Information on the undescribed *Dipturus* sp. is provided in Ebert and Stehmann (2013).

Common name	Scientific name	Code (FSS)	Code (FAO)	AphiaID
Common skate complex	*Dipturus batis*-complex	SKT	RJB	-
Common blue skate	*Dipturus batis*	SKG	RJB	105869
Flapper skate	*Dipturus intermedius*	SKF	DRJ	711846
Long-nosed skate	*Dipturus oxyrinchus*	LNS	RJO	105872
Norwegian skate	*Dipturus nidarosiensis*	RNS	JAD	105871
Undescribed *Dipturus* sp.	*Dipturus* sp.	-	-	-
Unidentified *Dipturus* spp.	*Dipturus* spp.	-	-	105762

Table 26.4. Summary of catch records for *Dipturus* spp. held on CEFAS' database in relation to process code (CO = counted only; MO = measured only; OB = observed; WC = weighed and counted; WM = weighed and measured; WO = weighed only) and survey series for the years 1901–2021. These data refer to station records and not the numbers of individual animals caught (see below). Surveys with no records of either of the case study species not included. Current trawl survey monitoring programmes indicated*. See Table 26.3 for list of species codes, including those used on FSS (shown here) and the corresponding FAO codes.

Survey series	Process code	LNS	RNS	SKF	SKG	SKT	Total
ARCTIC	CO					40	40
	OB					15	15
	WO					2	2
DCRDC	WM					24	24
ELASMOS[1]	MO			16	158		174
HISTORIC	CO	4	2			354	360
	MO					277	277
	OB	15				61	76
	WC					32	32
	WM					16	16
	WO					11	11
HISTORWEST	CO	2			1	72	75
	MO					99	99
	OB					3	3
	WC					1	1
	WO					2	2
IBTS3E*[2]	MO					1	1
	WM	2		6	1	13	22
IBTS4E	WM					2	2
MEMFISH	WM					1	1
NSGFS	OB	1				2	3
	WM	6				10	16
Q1SWBEAM*[3]	OB					1	1
	WM			1	65	111	177
Q1SWOTTER	WM			5	63	2	70

Survey series	Process code	LNS	RNS	SKF	SKG	SKT	Total
Q4SWIBTS	WM					21	21
WCGFS	WM	6	2			68	76
YFS	MO					2	2
Total		36	4	28	288	1243	1599

[1] Data collected on chartered commercial fishing vessel

[2] This survey relates to NS-IBTS-Q3

[3] This survey may also be referred to as 'Q1SWECOS', 'BTS-UK-Q1' or 'UK-Q1SWBeam' in other ICES-related documents.

Table 26.5. Summary of number of measured *Dipturus* spp. held on CEFAS' database by survey series (1901–2021). Current trawl survey monitoring programmes indicated*. See Table 26.3 for list of species codes, including those used on FSS (shown here) and the corresponding FAO codes.

Survey series	LNS	RNS	SKF	SKG	SKT	Total
ELASMOS	–	–	30	2416	–	2446
HISTORIC	–	–	–	–	692	692
*Q1SWBEAM	–	–	1	85	125	211
Q1SWOTTER	–	–	7	195	3	205
HISTORWEST	–	–	–	–	195	195
WCGFS	7	2	–	–	83	92
DCRDC	–	–	–	–	31	31
*IBTS3E	2	–	10	1	16	29
Q4SWIBTS	–	–	–	–	27	27
NSGFS	7	–	–	–	10	17
IBTS4E	–	–	–	–	2	2
YFS	–	–	–	–	2	2
MEMFISH	–	–	–	–	1	1
ARCTIC	–	–	–	–	–	0
Total	16	2	48	2697	1187	3950

Table 26.6. Length-weight parameters for members of the common skate complex, including earlier published studies by sex (M: Male; F: Female; C: Sexes combined).

Species	Sex	N	L_T (cm)	Weight (g)	a	B	r2	Source
Total weight (W_T)								
Dipturus batis-complex	C	8	18–49 D_W	88–1886	0.0108	3.0787	–	Coull *et al.* (1988)[5]
	C	32	52–130	700–15960	0.0010	3.391	0.986	Rosa *et al.* (2006)[3]
	F	32	19–135	–	0.0026	3.222	0.99	McCully *et al.* (2012)
	M	30	20–118	–	0.0041	3.123	0.95	
	C	46	19–131	36–13940	0.0038	3.1201	0.996	Silva *et al.* (2013)
	C	37	9.5–210.5[2]	–	0.00740	2.953	0.984	Wilhelms (2013)
	C [1]	140	18–200	26–80000[4]	0.0032	3.1679	0.980	This study
Dipturus batis	C	334	18–136	24–15770	0.003	3.1723	0.996	This study
	F		167	-	0.0024	3.2034	0.996	Barreau *et al.* (2016)
	M		196	-	0.0025	3.192	0.997	
Dipturus intermedius	C	19	34–170	170–33280	0.0017	3.2781	0.998	This study
Gutted weight (W_T)								
Dipturus batis	F	175	–	–	0.0026	3.1555	0.996	Barreau *et al.* (2016)
	M	197	–	–	0.0025	3.1718	0.997	
Dipturus intermedius	F	45	–	–	0.0011	3.3236	0.995	
	M	56	–	–	0.0006	3.4453	0.986	

[1] Includes only data where specimens were not identified to species-specific level.
[2] Minimum size given (9.5 cm) is less than the length-at-hatching.
[3] Data from the Azores, and so there is potential uncertainty in species.
[4] Maximum weight may be underestimated, as the Electronic Data Capture (EDC) system originally had a maximum weight of 80 kg.
[5] Values based on disc width (D_W) and not total length.

Table 26.7. Number of individual *Dipturus* spp. collected during Research Vessels surveys between 2010 and 2023, as reported on DATRAS. Data for the various species names used derived from the ScientificName_WoRMS. - = No survey or truncated survey.

Species	Survey	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Dipturus spp.	NS-IBTS	2	2	1	0	1	2	1	2	0	0	0	0	0	0	11
	SP-PORC	0	0	6	0	0	0	0	1	0	0	0	0	0	0	7
Dipturus batis complex	BTS	3	1	4	3	10	24	18	56	35*	31	1	20	30	7	243
	BTS-VIII	-	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	EVHOE	1	4	6	16	11	20	25	-	5	0	104	129	74	122	517
	IE-IAMS	-	-	-	-	-	-	0	0	0	7	1	0	97	171	276
	IE-IGFS	20	14	0	0	0	0	0	0	0	0	0	0	22	49	105
	NIGFS	0	0	0	0	1	0	0	0	0	0	1	0	1	2	5
	NS-IBTS	14	24	14	7	0	0	0	0	0	1	1	0	1	8	70
	PT-IBTS	0	0	-	0	0	0	0	0	0	-	-	2*	0	0	2*
	ROCKALL/SCOROC	-	0	40	0	0	0	0	0	0	0	0	0	74	84	198
	SP-NORTH	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	SP-PORC	6	5	5	15	0	30	8	6	39	0	0	32	0	0	146
	SWC-IBTS/SCOWCGFS	82	60	0	0	0	0	0	0	0	0	0	0	12	19	173
Dipturus batis (= *D.* cf. *flossada*)	EVHOE	0	0	0	0	0	0	0	-	84	84	0	0	0	0	168
	IE-IAMS	-	-	-	-	-	-	87	35	52	93	66	77	0	0	410
	IE-IGFS	5	2	5	13	32	34	47	11	25	53	34	47	0	0	308
	NS-IBTS	0	0	0	6	3	4	2	2	8	6	11	9	0	0	51
	ROCKALL/SCOROC	-	12	0	29	63	34	67	61	85	98	61	134	0	0	644
	SWC-IBTS/SCOWCGFS	0	2	6	0	21	17	26	14	17	10	24	20	0	0	157
Dipturus intermedius	BTS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	EVHOE	0	0	0	0	0	0	0	-	3	4	0	0	0	8	15
	IE-IAMS	-	-	-	-	-	-	185	193	205	277	46	134	119	369	1478
	IE-IGFS	8	20	33	24	38	20	22	50	63	37	19	46	78	65	523
	NS-IBTS	0	0	22	27	10	7	16	19	17	26	19	33	30	28	254
	ROCKALL/SCOROC	-	20	0	0	0	0	0	0	0	0	0	0	0	0	20
	SWC-IBTS/SCOWCGFS	0	81	234	124	158	97	131	151	94	151	116	83	62	128	1610
Dipturus oxyrinchus	IE-IAMS	-	-	-	-	-	-	0	0	0	0	0	3	1	0	4
	IE-IGFS	0	0	0	0	0	0	0	0	0	0	2	8	0	0	10
	NS-IBTS	0	0	0	0	0	0	0	0	0	2	0	1	0	0	3
	PT-IBTS	0	0	-	0	2	0	0	0	0	-	-	1*	26	2	31
	ROCKALL/SCOROC	-	8	4	3	5	8	0	6	3	2	2	10	13	13	77
	SP-ARSA	0	0	0	0	0	0	0	0	51	0	0	-	0	0	51
	SP-NORTH	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
Dipturus nidarosiensis	IE-IAMS	-	-	-	-	-	-	8	4	0	3	0	0	12	16	43
	ROCKALL/SCOROC	-	0	0	0	0	0	4	0	0	0	0	0	0	0	4
	SP-NORTH	0	0	0	0	1	0	0	2	0	0	0	0	0	0	3
	SP-PORC	2	1	6	4	0	16	5	6	5	0	0	18	0	0	63

*** Data corrected in 2024**

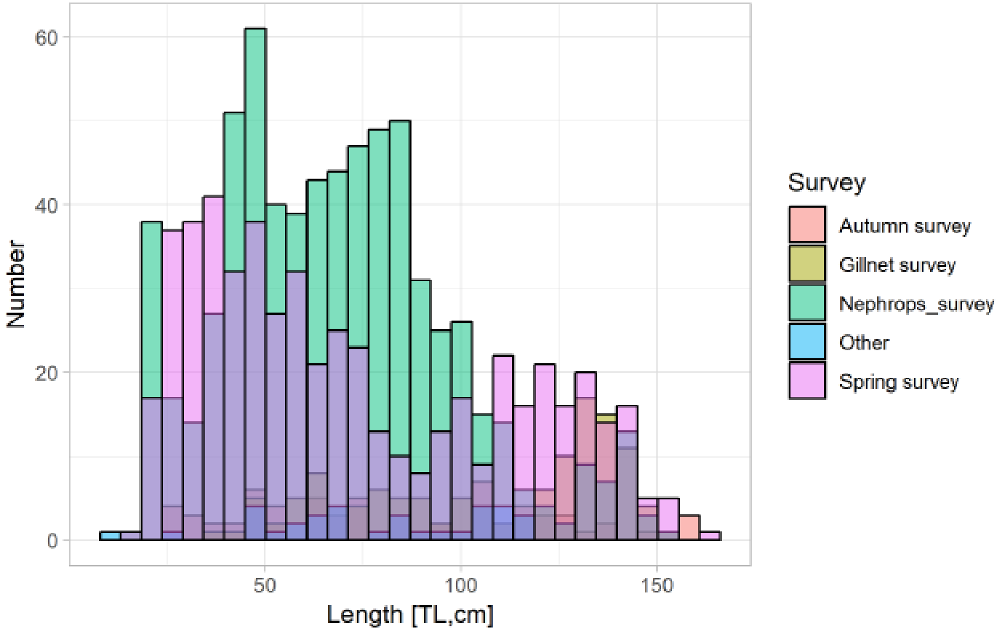


Figure 26.1. Length-frequency of 'common skate' recorded in various Icelandic surveys. The near absence of large individuals would be indicative of *Dipturus batis* being the main species present.

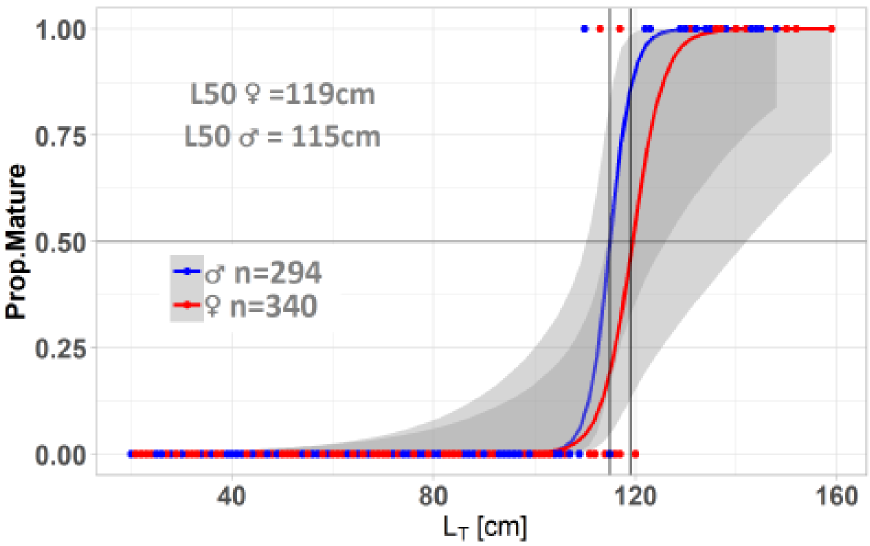


Figure 26.2. Length-at-maturity of 'common skate' recorded in Icelandic surveys. The estimated lengths-at-maturity are consistent with those values provided by Iglésias *et al.* (2010) for *Dipturus* cf. *flossada*, thus being indicative of *Dipturus batis.*

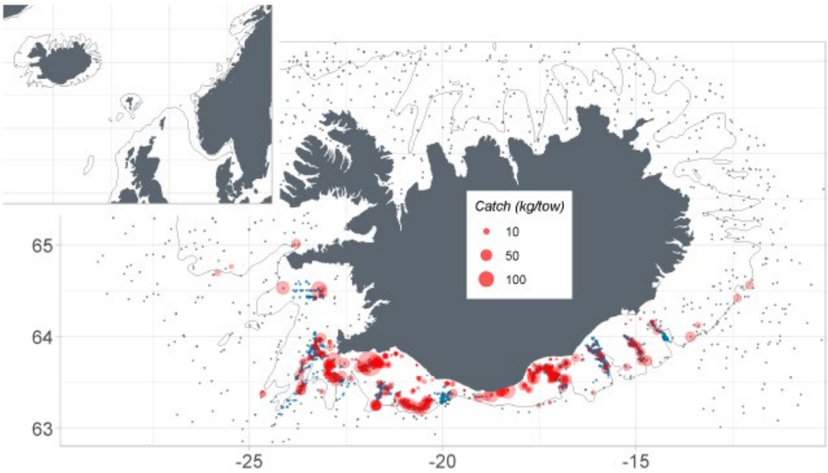


Figure 26.3. Distribution of common skate complex (presumed to be *D. batis*) in Icelandic waters. Grey points: Stations sampled in spring and autumn bottom trawl surveys each year. Red circles indicate the occurrence and catch rates of *D. batis*, with blue circles using data from a *Nephrops* survey (2002–2018).

Figure 26.4. Recorded presence of common skate-complex by time period in scientific trawl surveys. Note: Latitude and longitude used from hauling positions. Only shown records where specimens were not identified and/or allocated to particular species. Hauls with no records are not shown, and so broadscale changes in distribution over time are not indicated.

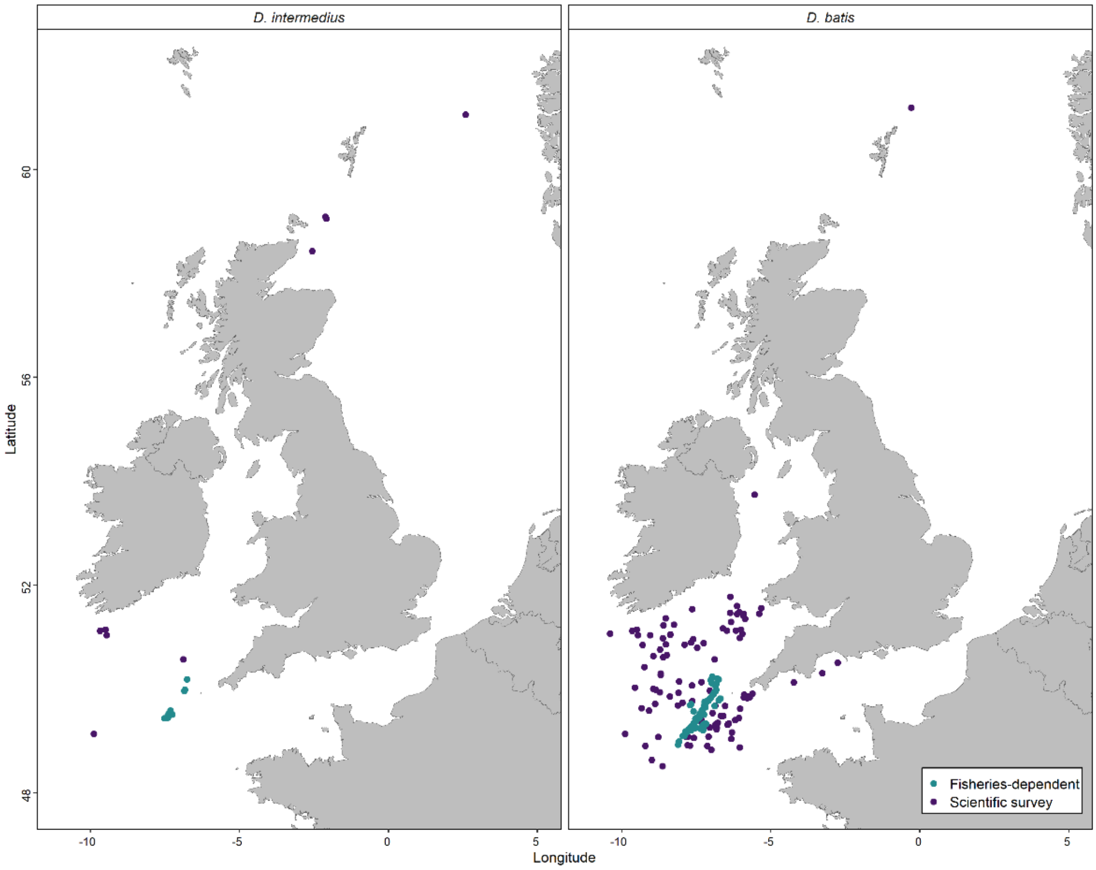


Figure 26.5. Recorded presence of common blue skate *D. batis* and flapper skate *D. intermedius* by survey. Note: Latitude and longitude used from hauling positions.

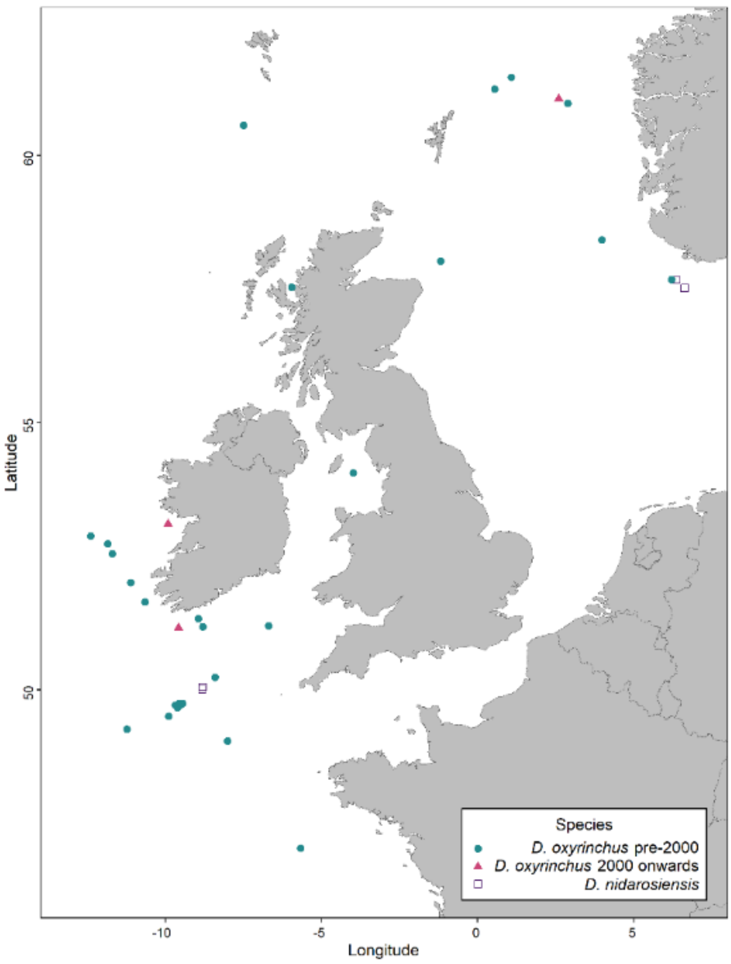


Figure 26.6. Recorded presence of long-nosed skate *D. oxyrinchus* (pre-2000 and 2000 onwards) and Norwegian skate *D. nidarosiensis*. Note: Latitude and longitude used from hauling positions. These two species have only occurred on scientific surveys (fisheries-independent). Note: Given that most of these records were recorded prior to the revised separation of the common skate complex, these data may include misidentified flapper skate. Hence, these data should be interpreted with caution.

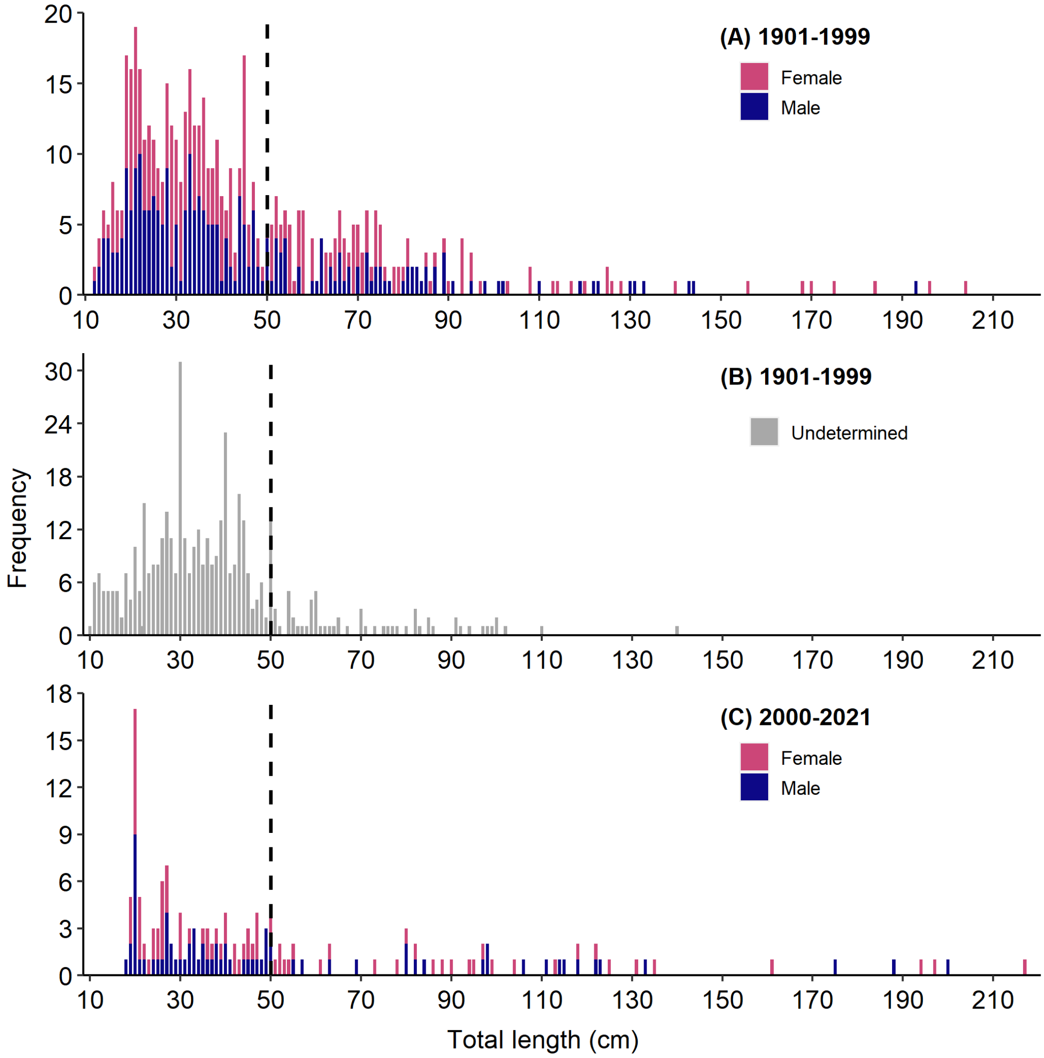


Figure 26.7. Length frequency distribution for common skate-complex *Dipturus batis*-complex by sex for (A) 1901–1999 (Females, n = 291, 12–204 cm L_T; Males n = 258, 12–193 cm L_T), (B) 1901–1999 (Undetermined, n = 425, 10–140 cm L_T) and (C) 2000–2021 (Females, n = 83, 19–217 cm L_T; Males, n = 74, 18–200 cm L_T). Note: Dashed line represents length assumed for 'exploitable biomass' at 50 cm L_T. Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific, these were only reported during scientific surveys. Different y-axis to avoid data to be skewed.

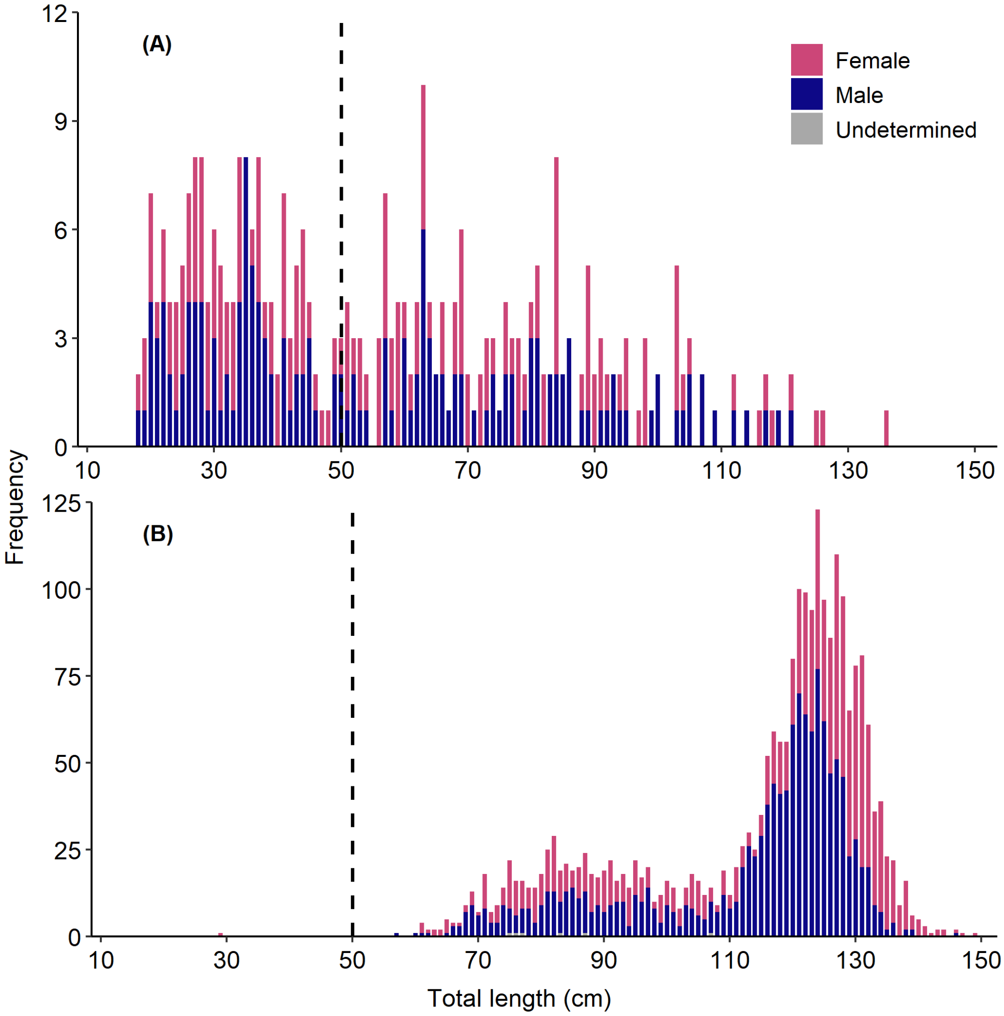


Figure 26.8. Length frequency distribution for common blue skate *D. batis* by sex and survey (A) scientific survey (Females, n = 174, 18–136 cm L_T; Males, n = 161, 18–121 cm L_T) and (B) fisheries-dependent survey (Females, n = 1,113, 29–149 cm L_T; Males, n = 1,297, 57–146 cm L_T; Undetermined, n = 6, 75–107 cm L_T). Note: Dashed line represents length assumed for 'exploitable biomass' at 50 cm L_T. Different y-axis to avoid data to be skewed.

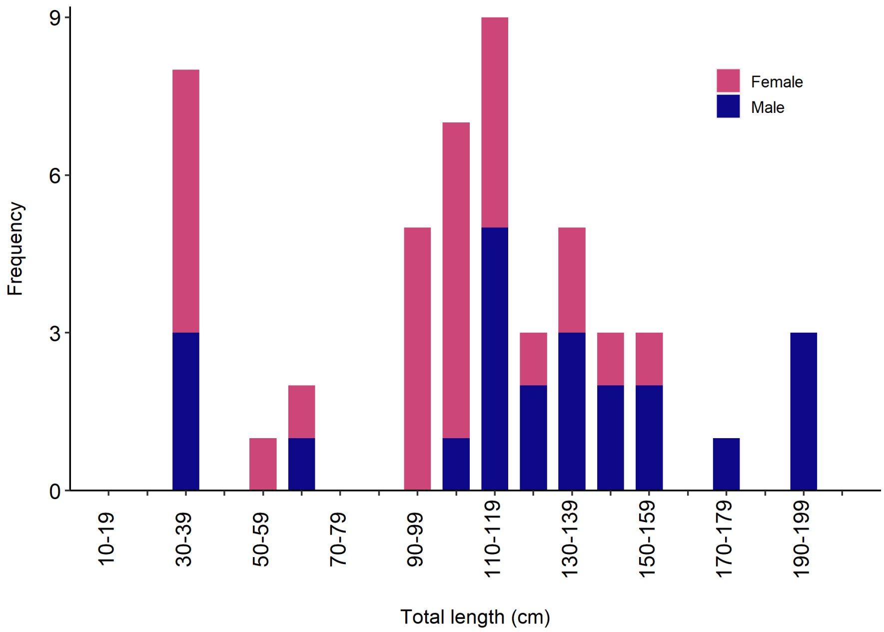


Figure 26.9. Length frequency distribution for flapper skate *D. intermedius* by sex (Females: n = 27, 34–154 cm L_T; Males: n = 23, 34–195 cm L_T). Note: Data aggregated across surveys due to limited available records and in 10 cm bins.

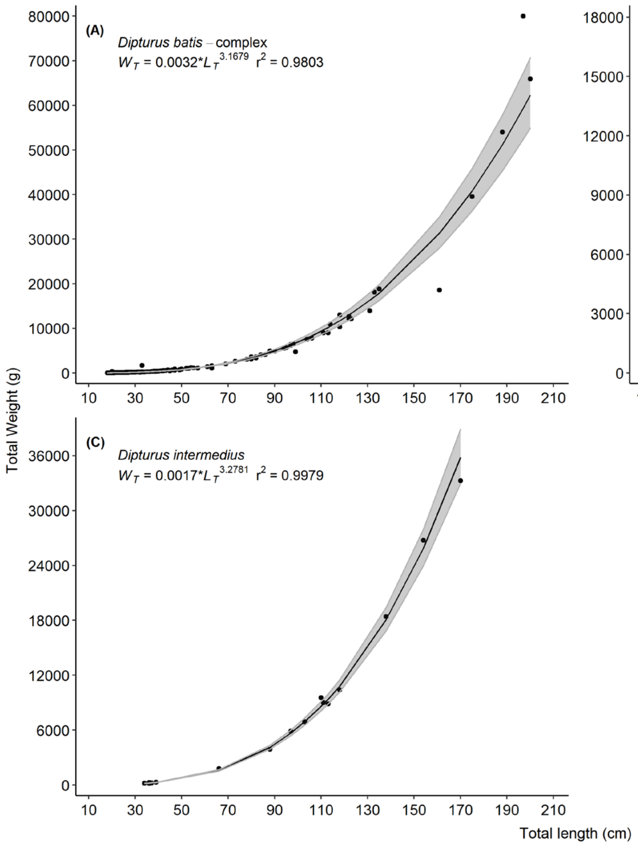


Figure 26.10. Relationships between total weight (W_T, g) and total length (L_T, cm) across years and surveys for (A) common skate-complex (n = 140), (B) common blue skate *D. batis* (n = 334) and (C) flapper skate *D. intermedius* (n = 19). Note: Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific (A). Different axes used to avoid data being skewed. See also Table 26.6.

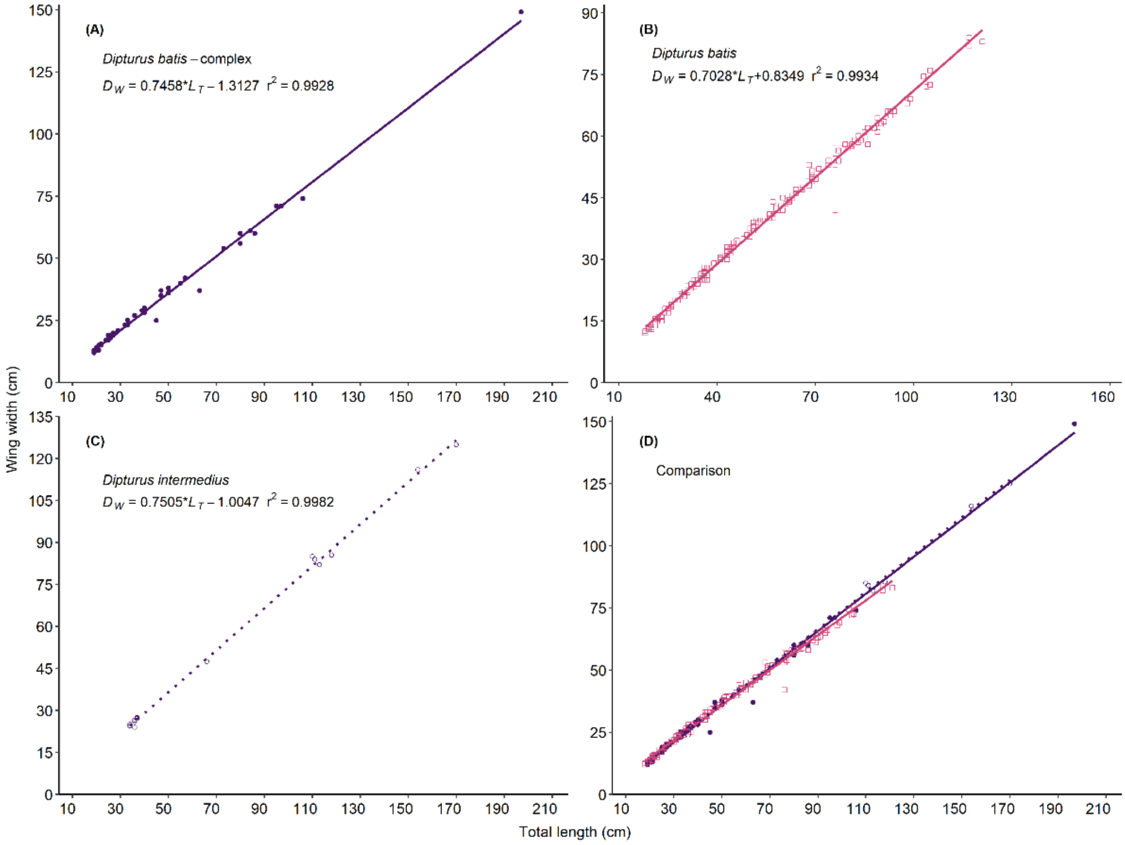


Figure 26.11. Total length (L_T, cm) to wing width (D_W, cm) across years and surveys for (A) common skate-complex (n = 53), (B) common blue skate *D. batis* (n = 204), (C) flapper skate *D. intermedius* (n = 14) and (D) comparison of relationships. Note: Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific (A). Different axis to avoid data to be skewed.

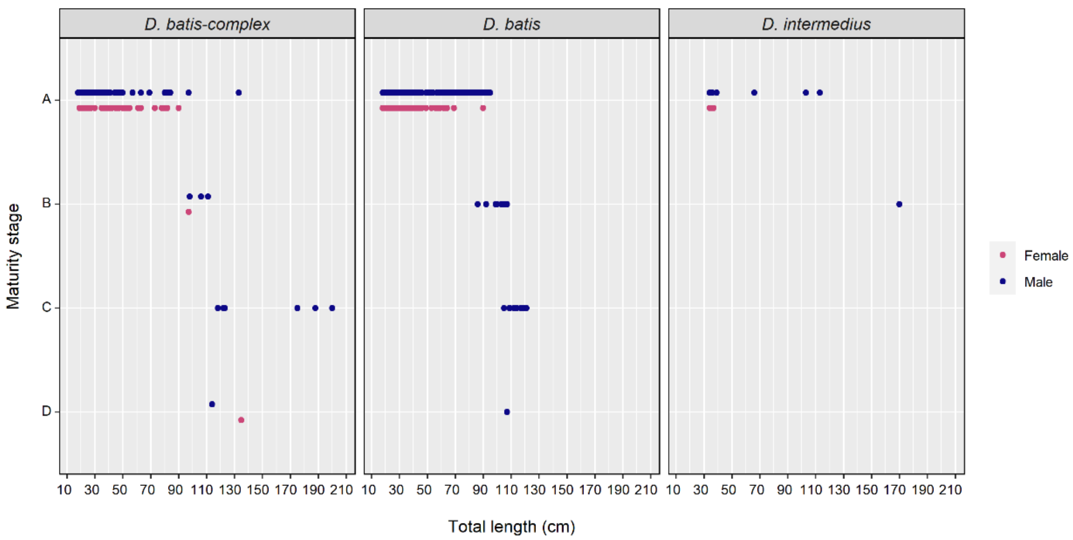


Figure 26.12. Maturity stage by sex and total length (L_T) (A) common skate-complex *D.* batis-complex (n = 53), (B) common blue skate *D. batis* (n = 204) and (C) flapper skate *D.* intermedius (n = 14). Note: Data for common-skate complex only

considered records where specimens were not identified and/or allocated to a specific species. Maturity stages: A (Immature), B (Maturing), C (Mature) and D (Active). Other species not shown as limited data but describe in text.

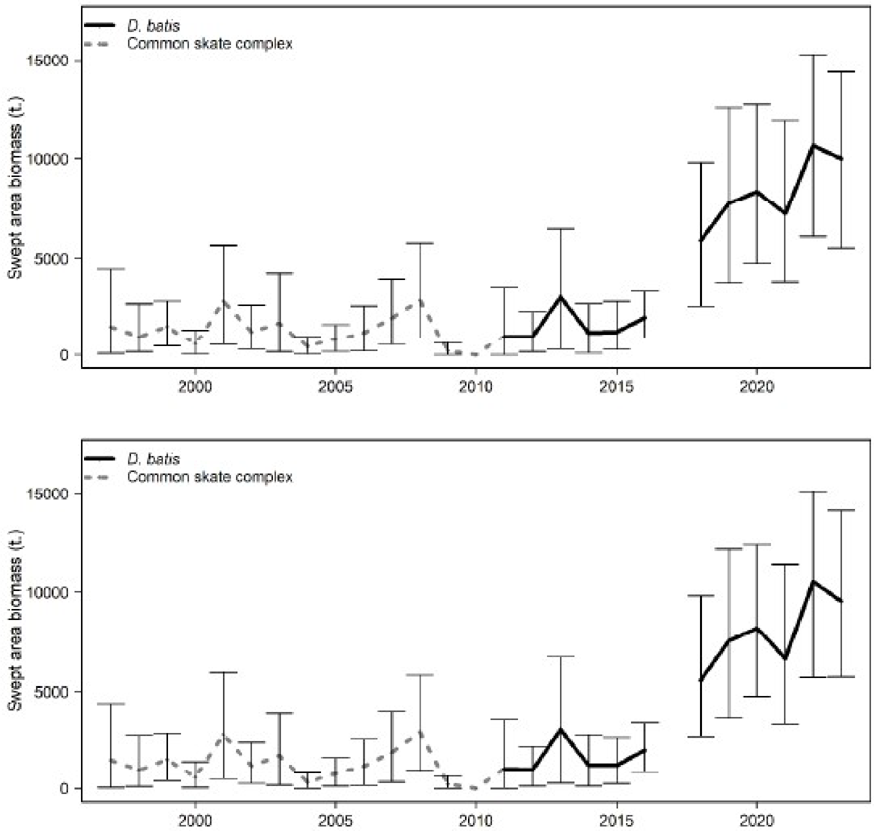


Figure 26.13. Biomass indices of biomass of *Dipturus batis* in Subarea 7 in the FR-EVHOE-Q4 survey, with 95% confidence intervals. Upper panel: total biomass; Lower panel: biomass of individuals ⩾ 50 cm TL (2024, WD Baulier).

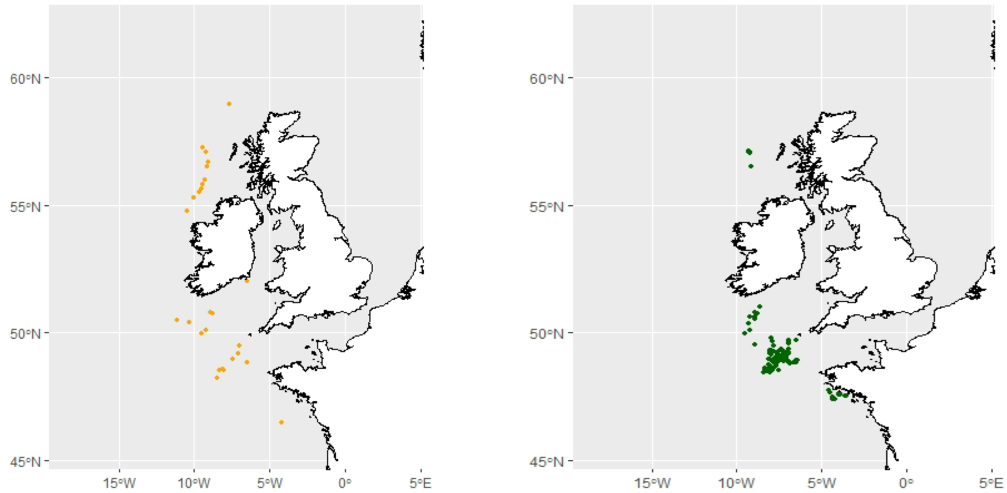


Figure 26.14. Observed occurrence (2006–2016) of flapper skate *Dipturus intermedius* (left, orange circles; n = 95) and common blue skate *Dipturus batis* (right, green circles; n = 1378) recorded during onboard fishing vessels observation program ''POCHETEAU''. Source: Barreau *et al.* (2016).

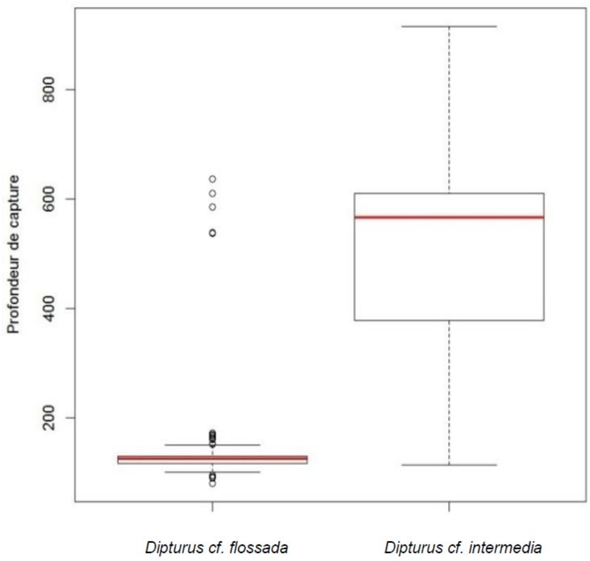


Figure 26.15. Boxplot on depth of capture for *Dipturus batis* (here labelled as "*D. cf. flossada*"; n = 1332) and *D. intermedius* (here labelled as ''*D. cf. intermedia*''; n = 64) recorded during onboard fishing vessels observation program ''POCHETEAU'' including one trip on the edge of the North-west Scotland shelf (2007) and six trips (2013–2015) on the continental shelf of the Celtic Sea. Red line is the median depth of catch. Source: Barreau *et al.* (2016).

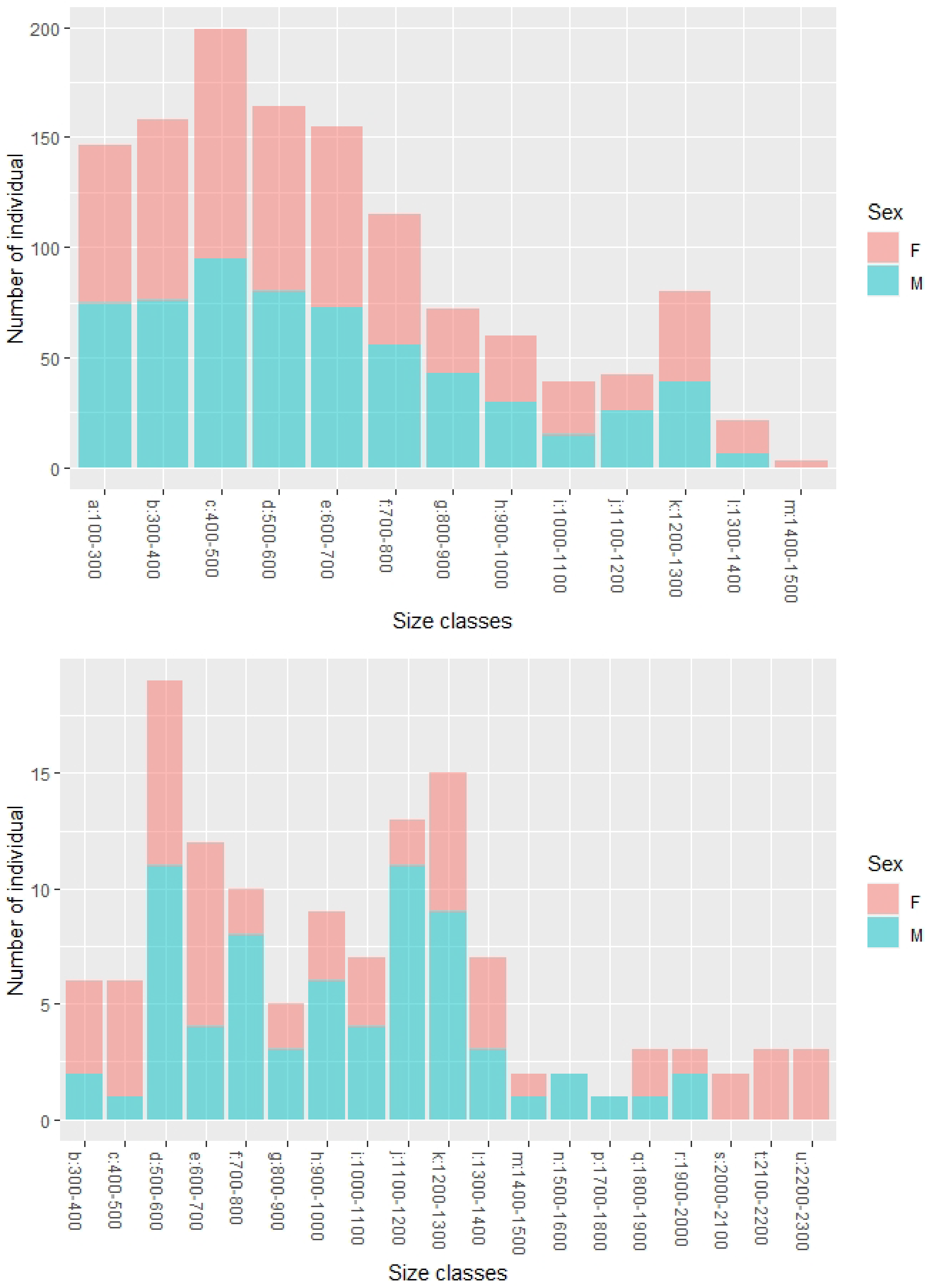


Figure 26.16. Length-frequency distributions (in 10 cm size classes) by sex (red: female; blue: male) of common blue skate *Dipturus batis* (top; n = 1254) and flapper skate *D. intermedius* (bottom; n = 128) observed during the Pocheteau project (2013–2015). Source: Barreau *et al.* (2016).

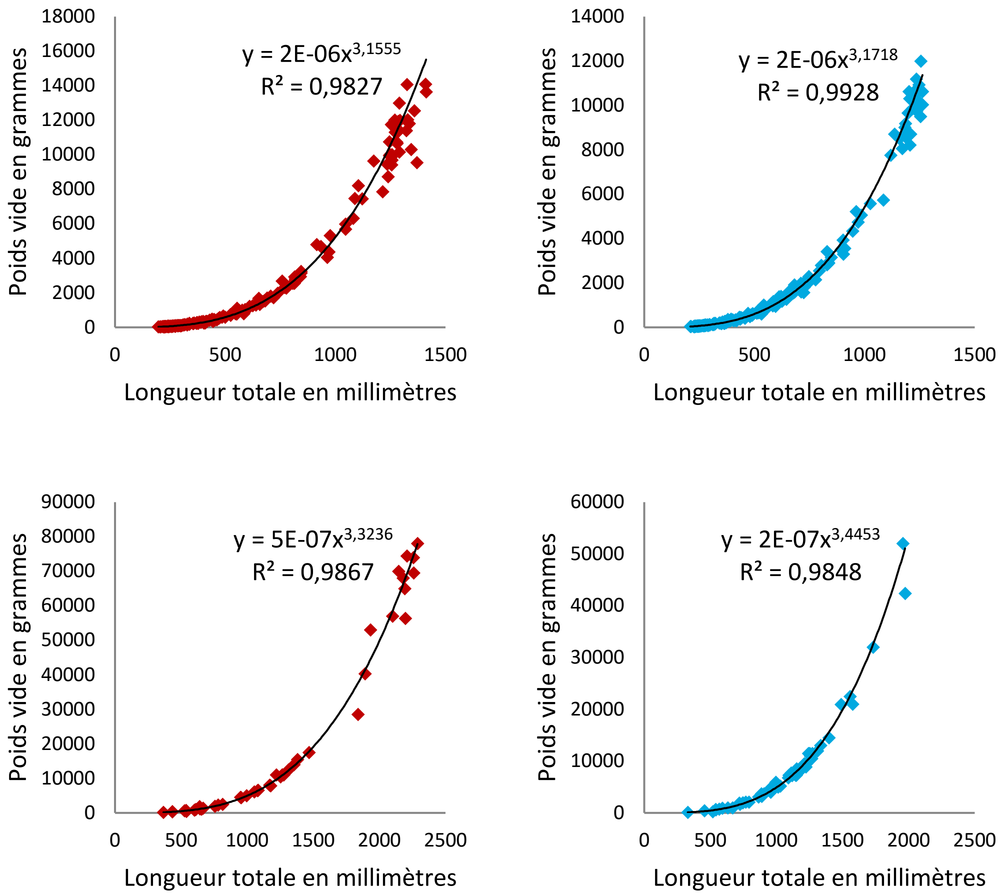


Figure 26.17. Length-gutted weight relationships per sex based for common blue skate *Dipturus batis* (top left: female, n = 175; top right: male, n = 197) and flapper skate *Dipturus intermedius* (bottom left: female, n = 45; bottom right: male, n = 56). Source: Barreau *et al.* (2016). See also Table 26.6.

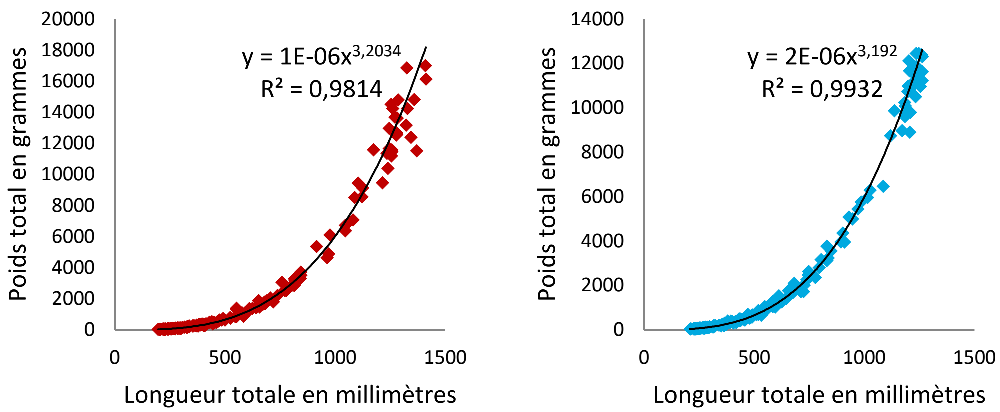


Figure 26.18. Length-total weight relationship per sex for common blue skate *Dipturus batis* (left: female, n = 167; right: male, n = 196). Source: Barreau *et al.* (2016). See also Table 26.6.

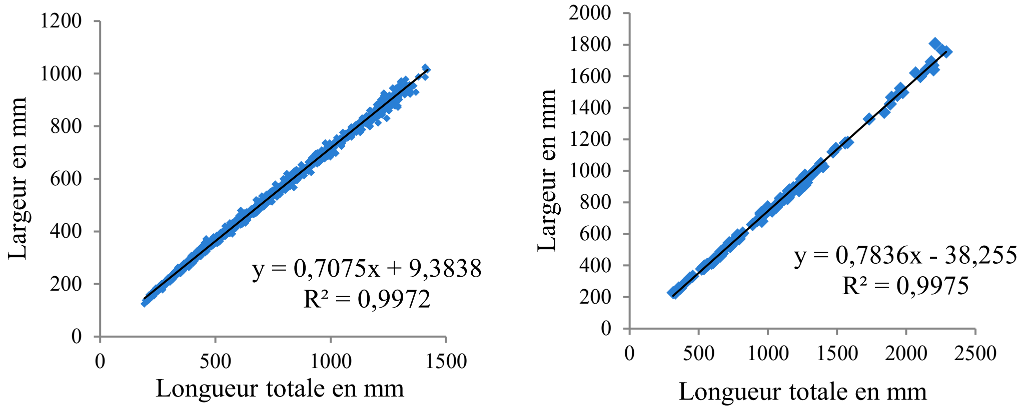


Figure 26.19. Relationship between disc width (largeur, mm) and total length (longueur total, mm), as defined by $y = ax + b$ for common blue skate *D. batis* (left, n = 1374) and flapper skate *D. intermedius* (right, n = 115). Source: Barreau *et al.* (2016).

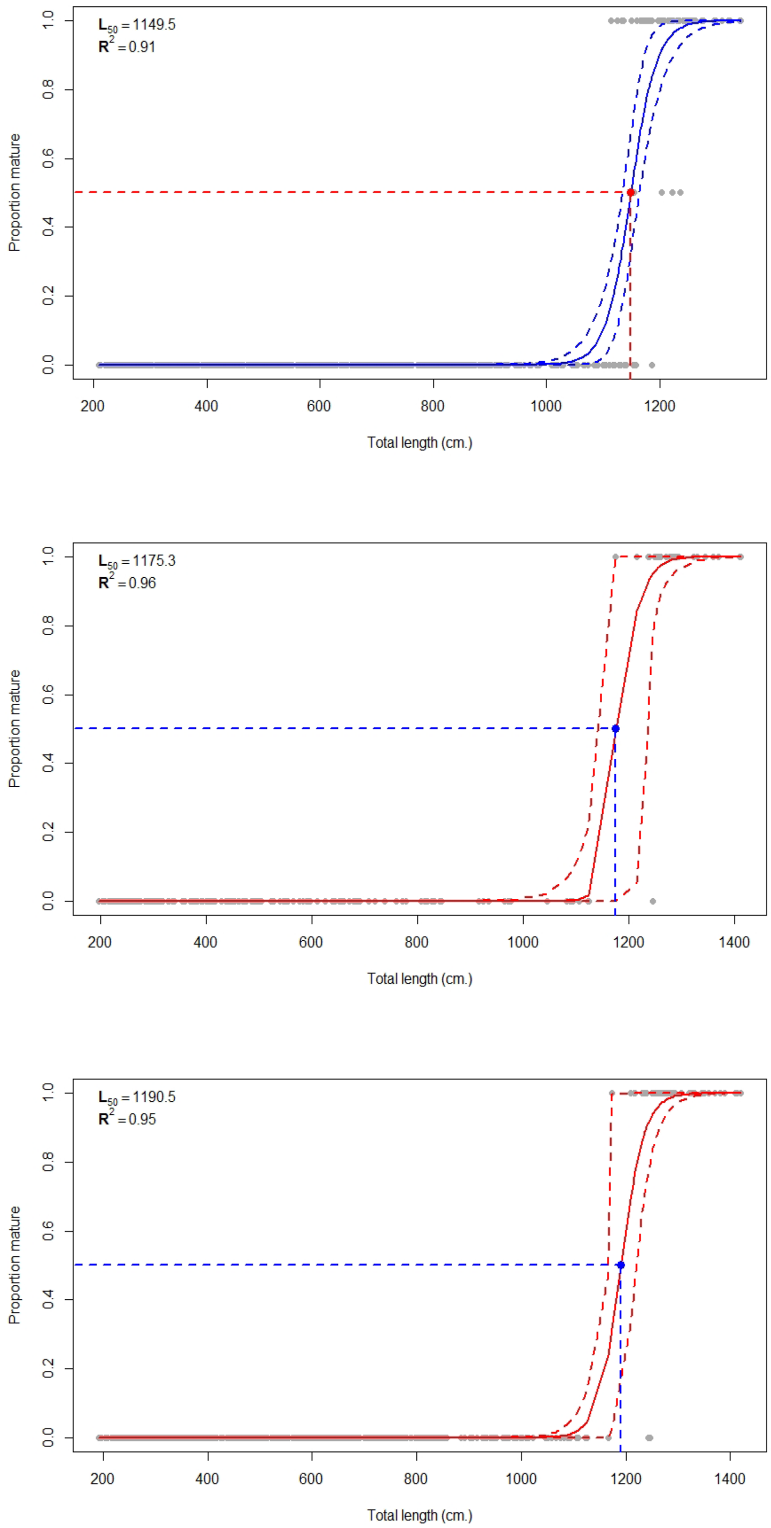


Figure 26.20. Maturity ogives for common blue skate *Dipturus batis* for males (top; n = 756; L_{50} = 114.95 cm), females (centre; n = 184; L50 = 117.53 cm, based on dissected specimens) and females (bottom; n = 694; L_{50} = 119.05 cm, based on the assumption that all females <90 cm are immature and that female caught alive but not dissected were mature if a flaccid cloaca was observed).

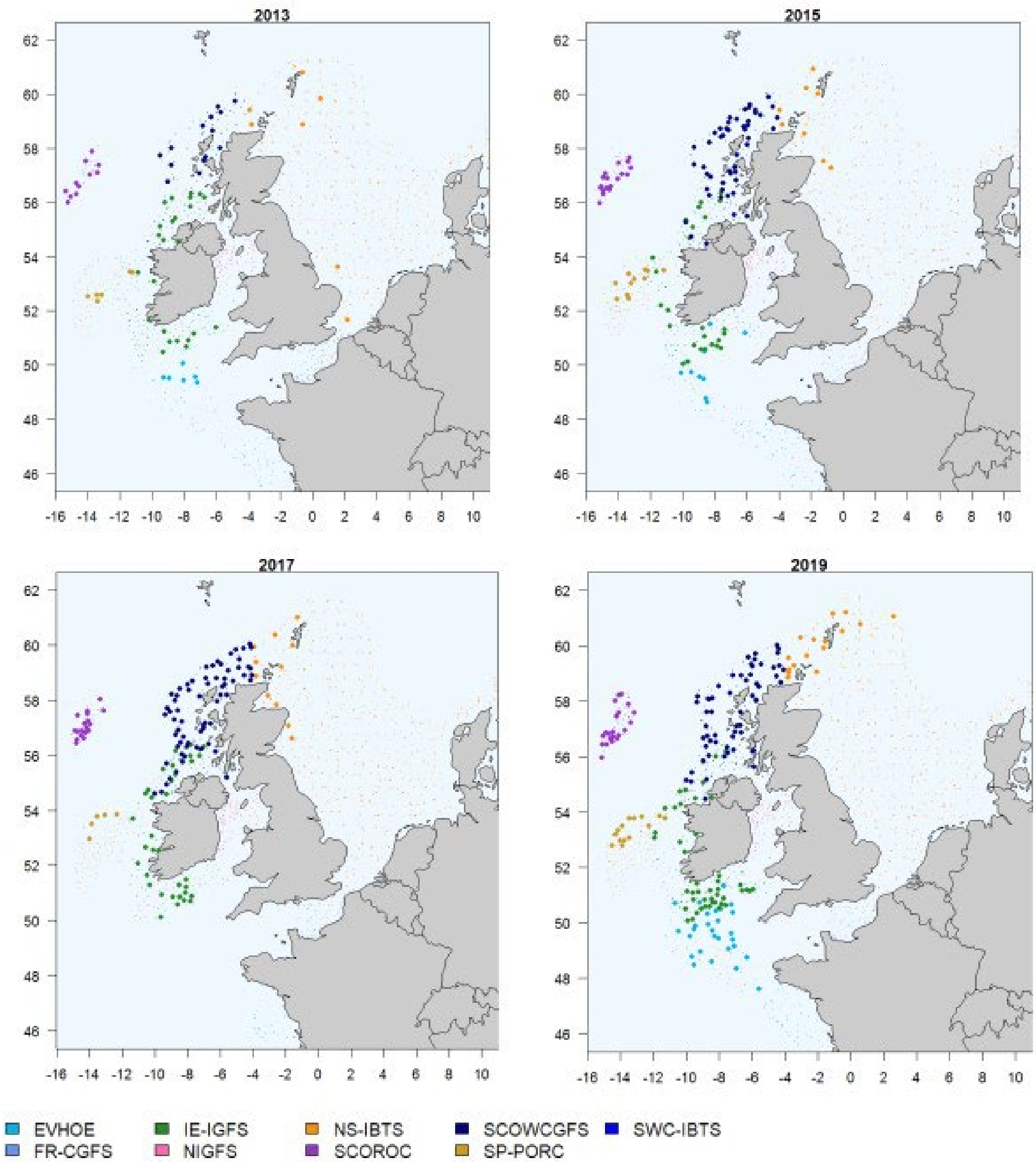


Figure 26.21 Presence-absence of the common blue skate complex (*D. batis* and *D. intermedius*) in IBTS surveys (Source: DATRAS) for odd-numbered years between 2013 and 2019. Circles indicates stations where at least one of the species is present while dots signals stations where they were not observed. Each colour corresponds to a particular survey. In 2017, EVHOE-WIBTS-Q4 (light blue) did not cover the Celtic Sea.

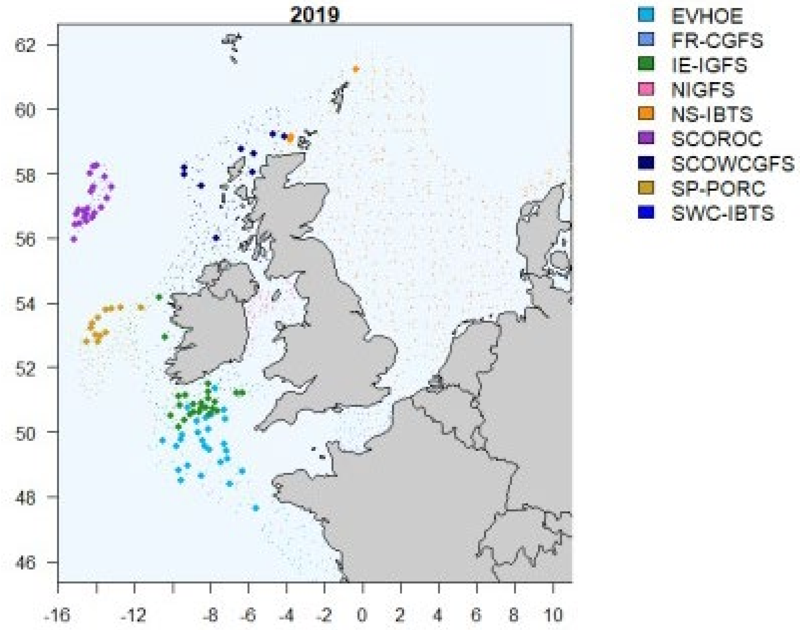


Figure 26.22 Presence-absence of common blue skate complex (*D. batis*) in IBTS surveys (source: DATRAS) in 2019 Circles indicates stations where the species is present while dots signals stations where they it not observed. Each colour corresponds to a particular survey.

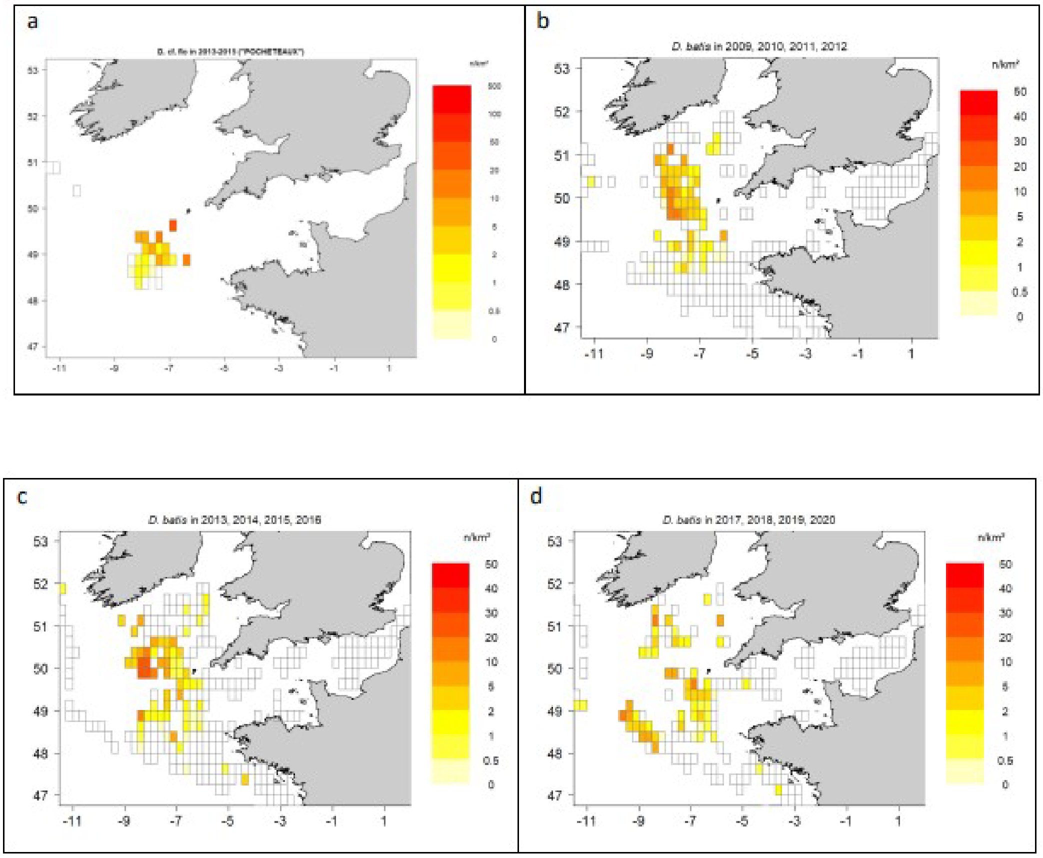


Figure 26.23 Distribution of densities of *D. batis* in the Celtic Sea in numbers by km², from Obsmer data (b to d) for periods of 4 years in 0.25° lat x 0.25° lon cells, and compared to densities derived from data collected during the POCHETEAUX project (a). Average densities are calculated from otter trawl data. Only cells with a minimum of 3 observed fishing operations are represented.

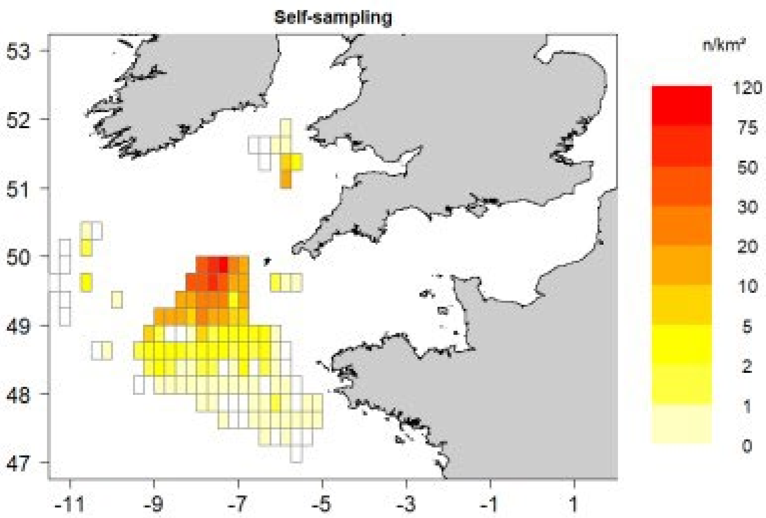


Figure 26.24 Distribution of densities of *D. batis* in the Celtic Sea in numbers by km², from self-sampling data collected between October 2019 and April 2022 in 0.25° lat x 0.25° lon cells.

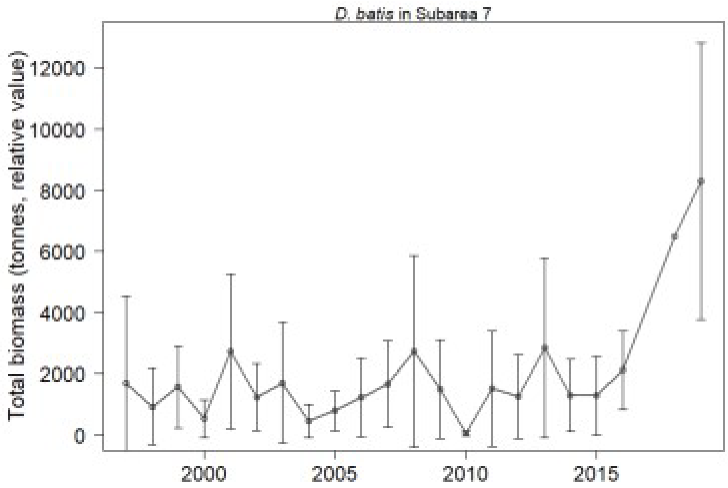


Figure 26.25 Approximated time series of biomass of *D. batis* in Subarea 7 from the EVHOE survey, with 95% confidence intervals. No confidence interval was calculated for year 2018, for which data include a mixture of individuals identified at the level of the species and other individuals described as belonging to the common skate complex.

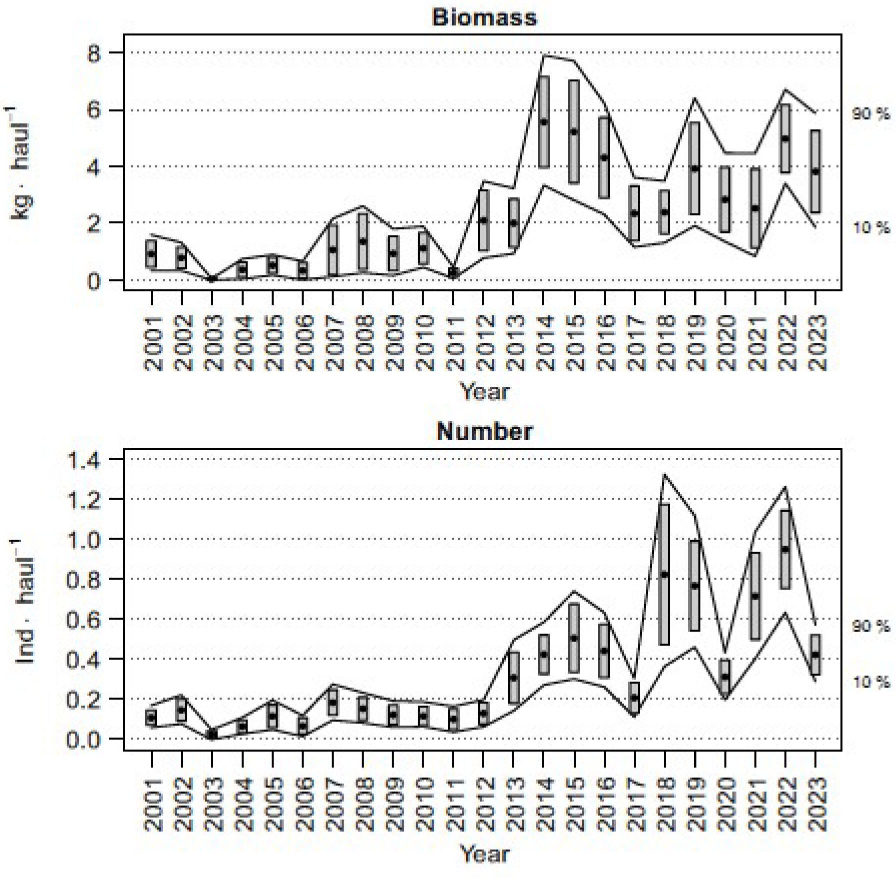


Figure 26.26 Evolution of biomass and abundance indices of *Dipturus spp.* during the Porcupine Bank survey (2001-2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

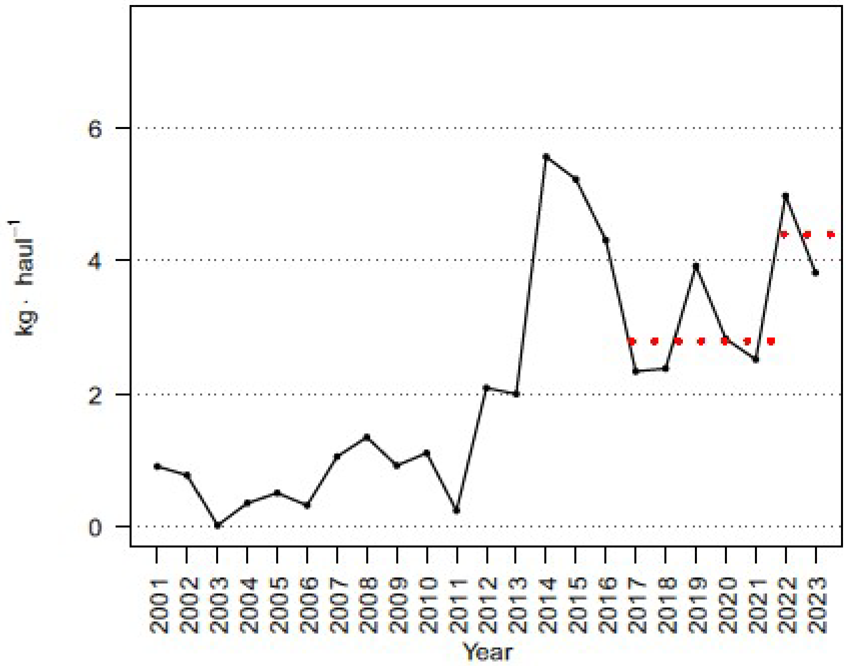


Figure 26.27 Evolution of biomass index for *Dipturus spp.*, as recorded during the Porcupine Bank survey (2001–2023). Dotted lines compare the mean stratified biomass in the last two years with five previous years.

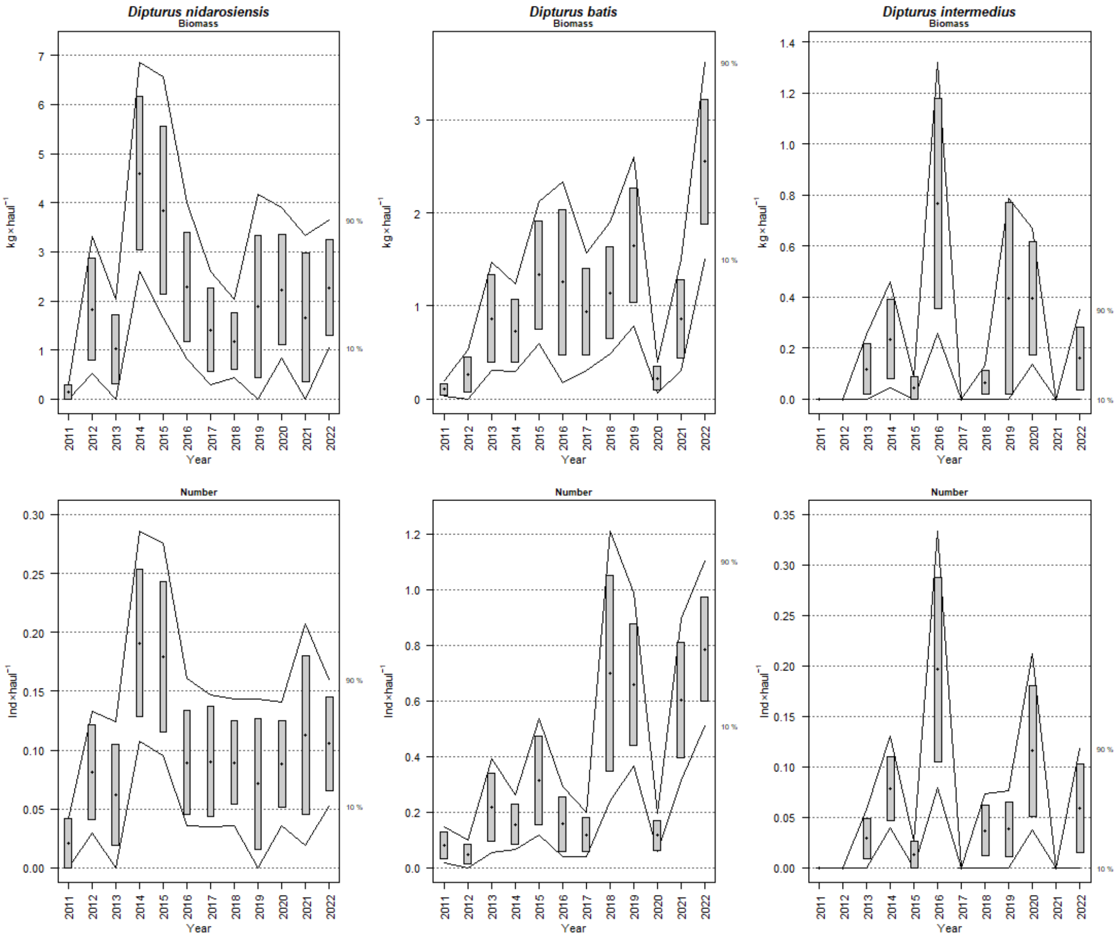


Figure 26.28 Evolution of biomass and abundance indices from 2011 to 2023 of *Dipturus nidarosiensis* , *D. batis* and *D. intermedius* as recorded in the Porcupine Bank survey (species-specific data available). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

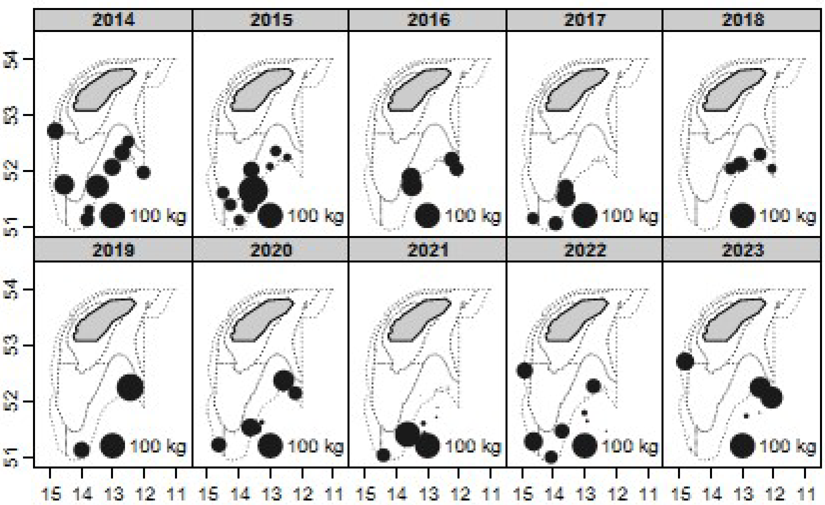


Figure 26.29 Geographic distribution and catch rates (kg.haul^{-1}) of *D. nidarosiensis* during Spanish surveys on the Porcupine Bank (2014–2023).

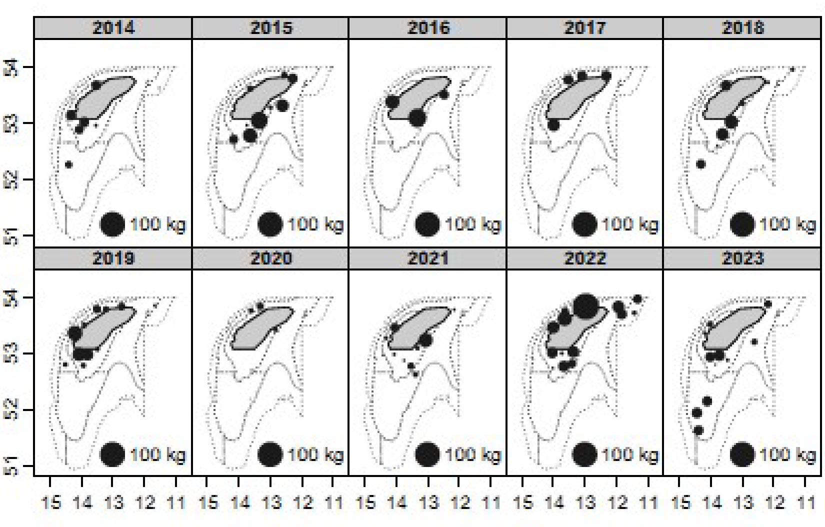


Figure 26.30 Geographic distribution and catch rates (kg.haul^{-1}) *Dipturus batis* during Spanish surveys on the Porcupine Bank (2014–2023).

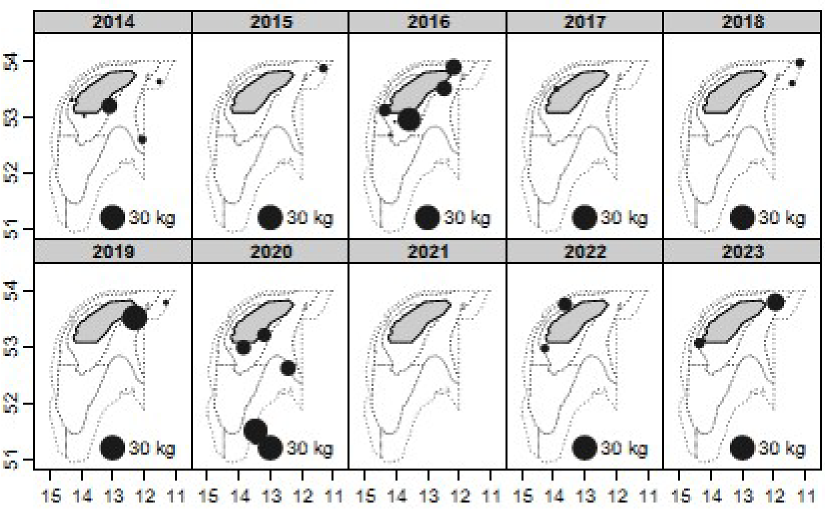


Figure 26.31 Geographic distribution and catch rates (kg.haul^{-1}) of *Dipturus intermedius* during Spanish surveys on the Porcupine Bank (2014–2023).

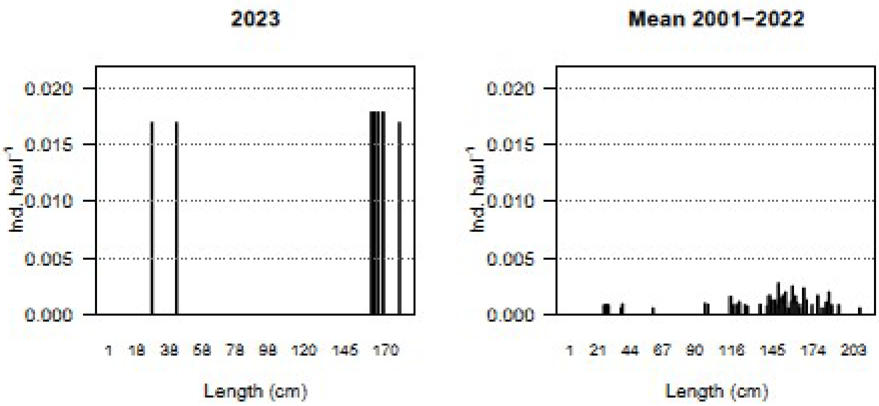


Figure 26.32 Stratified length distributions of *D. nidarosiensis* during Spanish surveys on the Porcupine Bank (2001–2023).

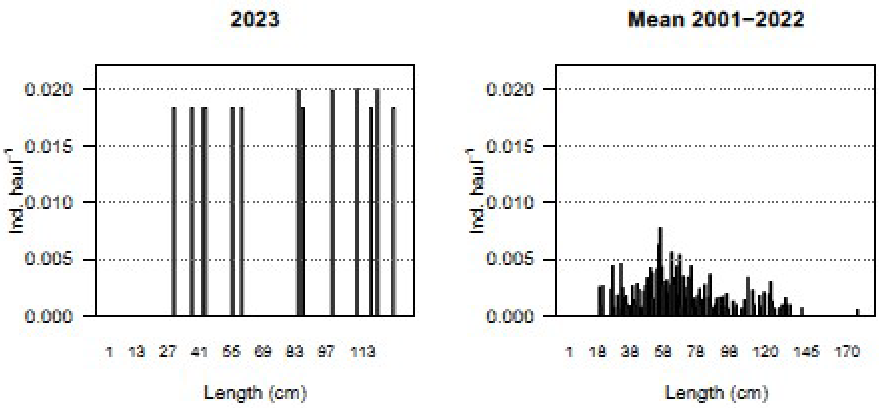


Figure 26.3333 Stratified length distributions of *Dipturus batis* during Spanish surveys on the Porcupine Bank (2001–2023).

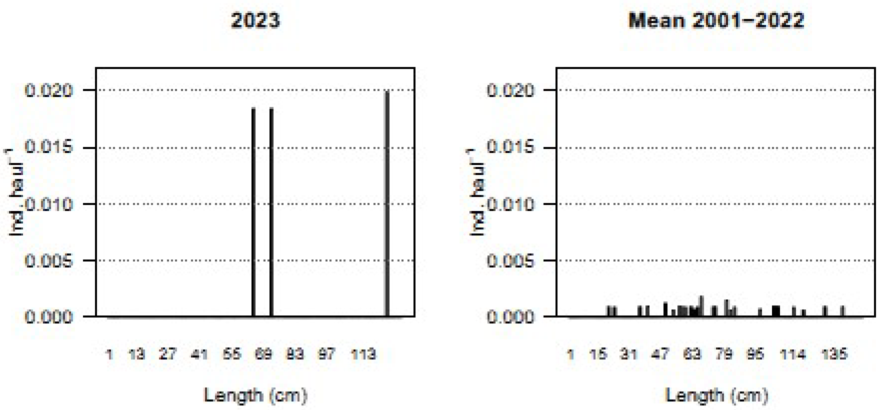


Figure 26.3434. Stratified length distributions of *D. intermedius* during Spanish surveys on the Porcupine Bank (2001–2023).

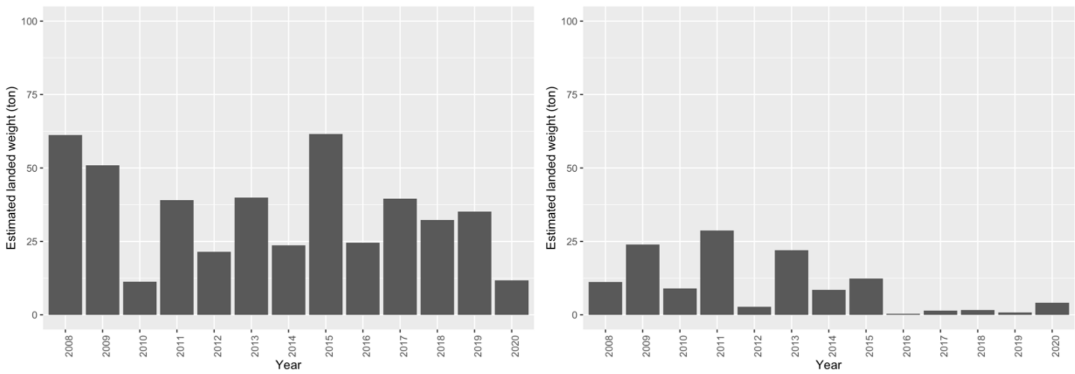


Figure 26.35. Estimated Portuguese landings of *Dipturus oxyrinchus* from Division 9.a by fleet segment: polyvalent (left) and trawl (right).

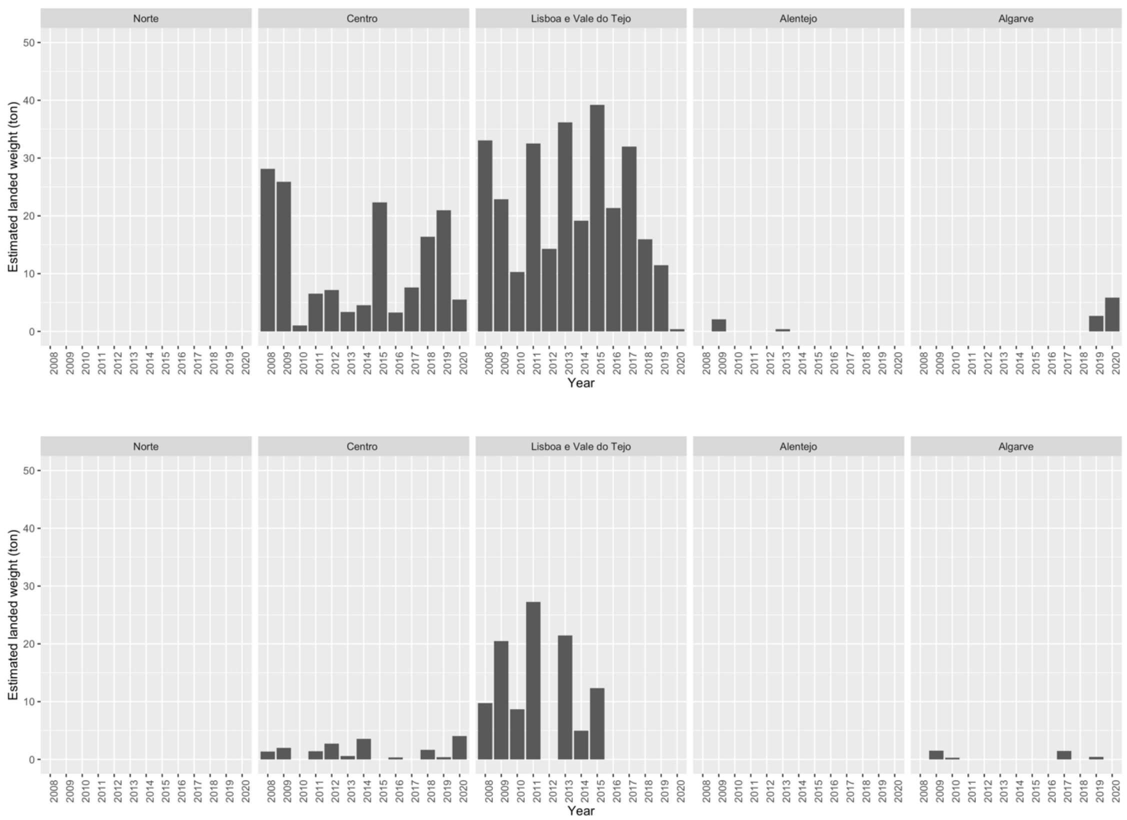


Figure 26.36. Estimated Portuguese landings of *Dipturus oxyrinchus* from Division 9.a by fleet segment (polyvalent: top; trawl: bottom) and region (from north to south).

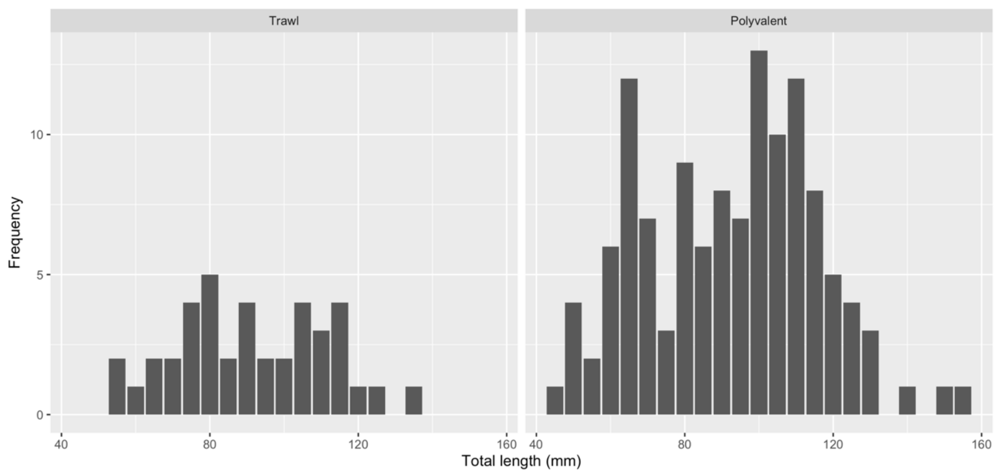


Figure 26.37. Length-frequency distribution of *Dipturus oxyrinchus* sampled in Portuguese landings from Division 9.a (2008–2020) by fleet segment (left: trawl, n = 112; right: polyvalent, n = 401). Data was not raised to the total estimated catch of the fleet.

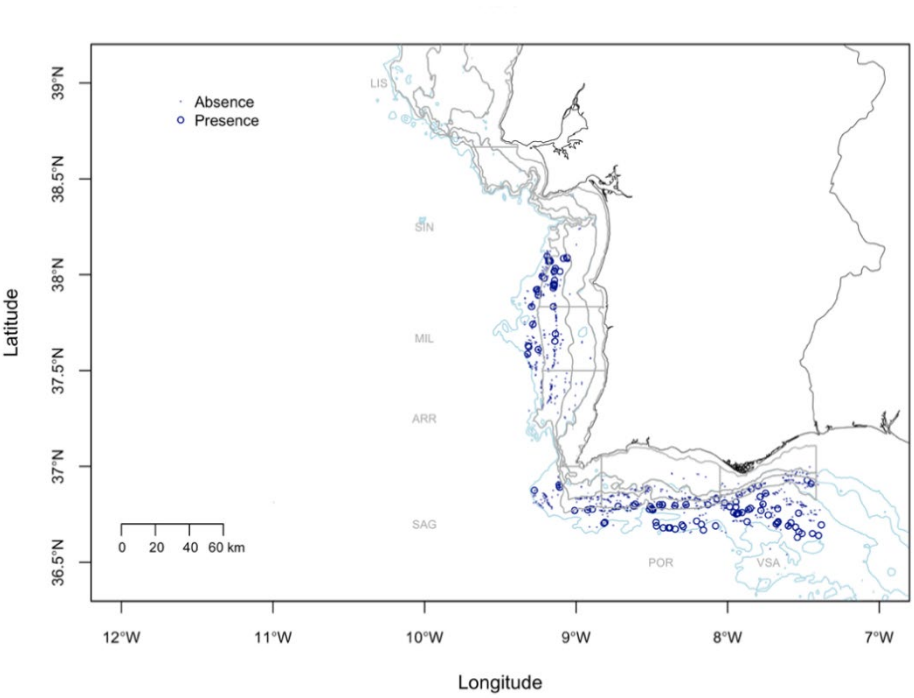


Figure 26.38. Presence/absence distribution of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) from 1997 to 2018.

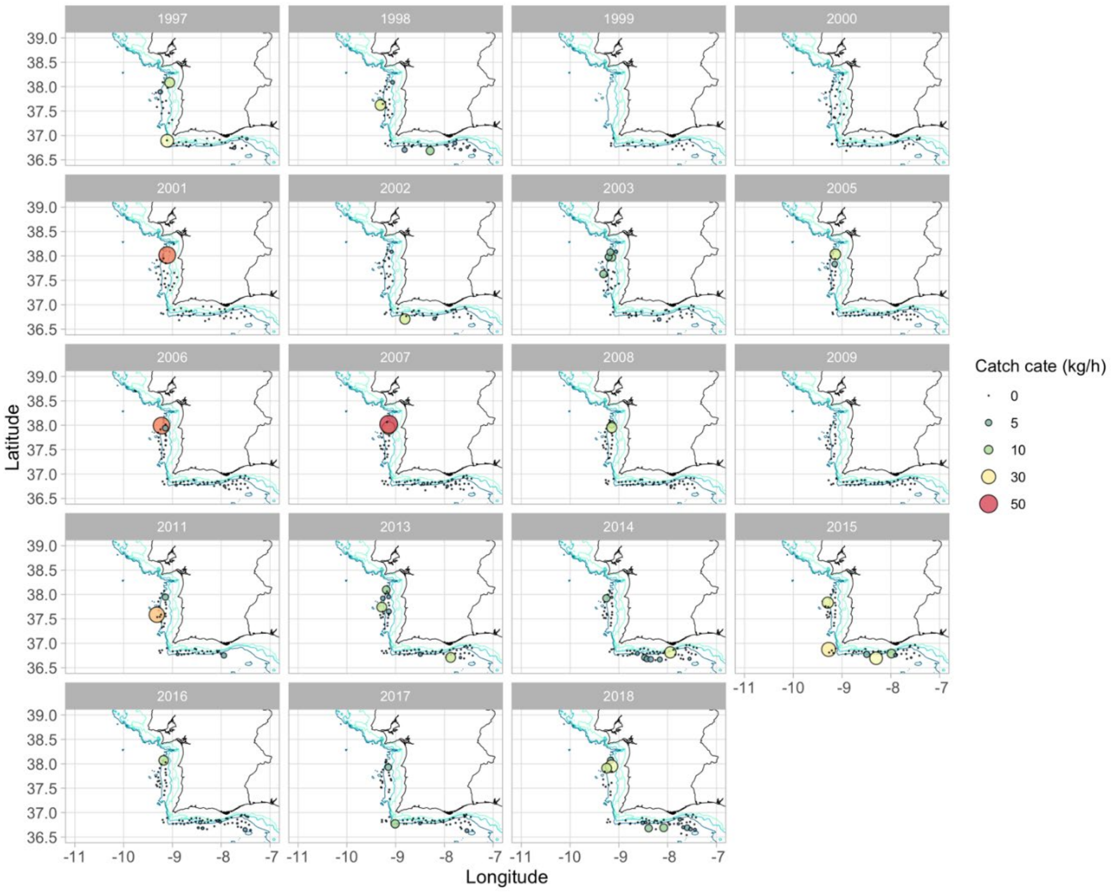


Figure 26.39. Catch distribution (n.h^{-1}) of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) by year, from 1997 to 2018.

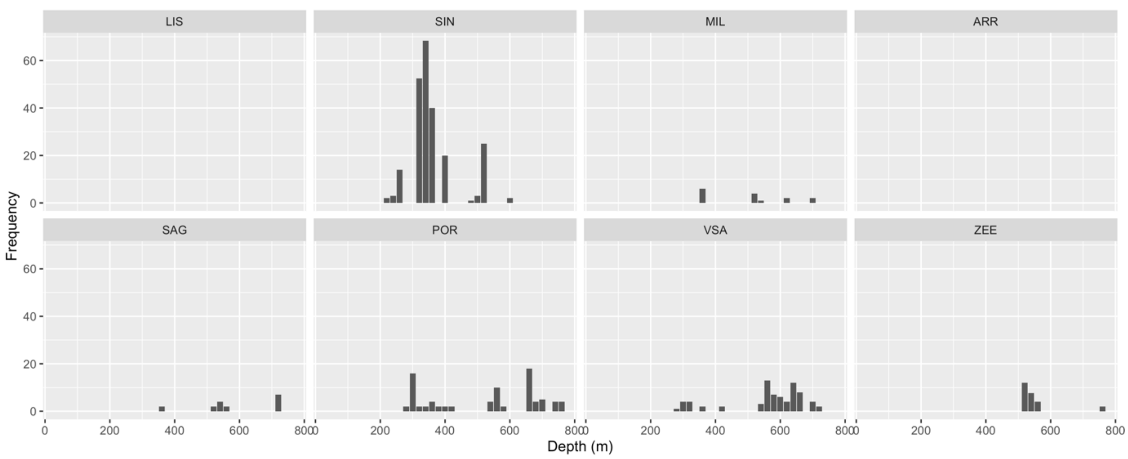


Figure 26.40. Bathymetric range of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) from 1997 to 2018, by sector.

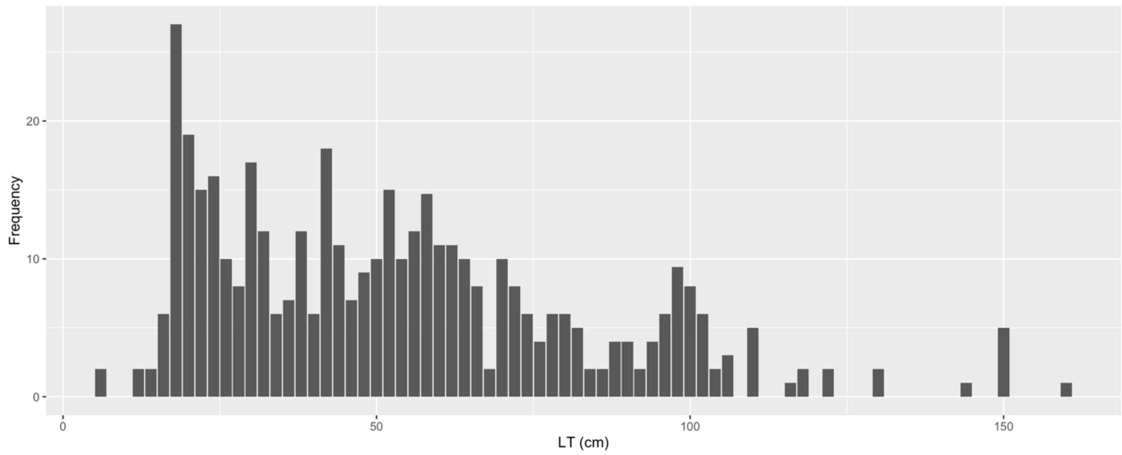


Figure 26.41. Length-frequency distribution of *Dipturus oxyrinchus* during NepS (FU 28–29) for the period 1997–2018.

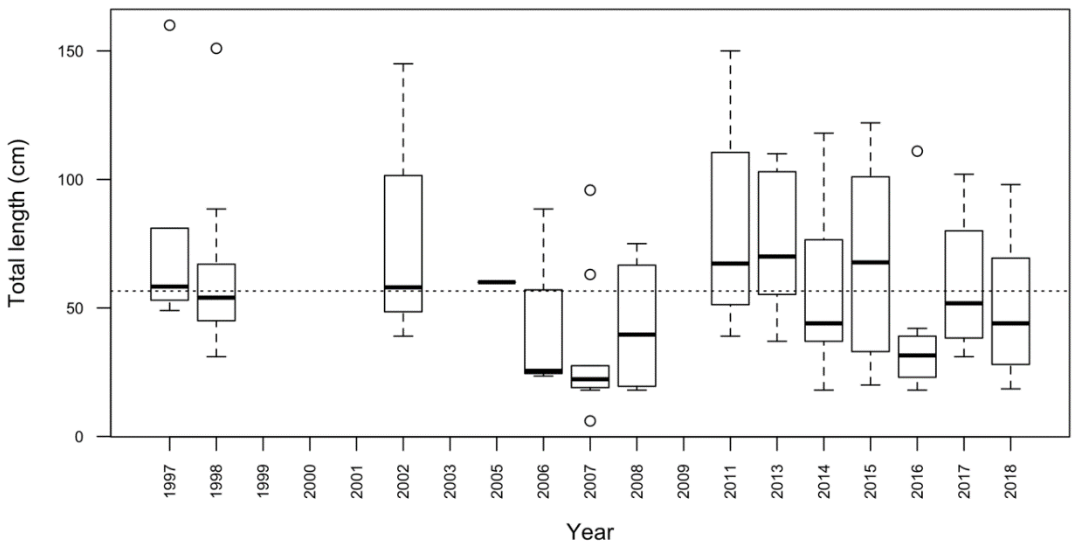


Figure 26.42. Total length variation of *Dipturus oxyrinchus*, by year on NepS (FU 28–29) (dashed line represents the mean annual length for 1997–2018).

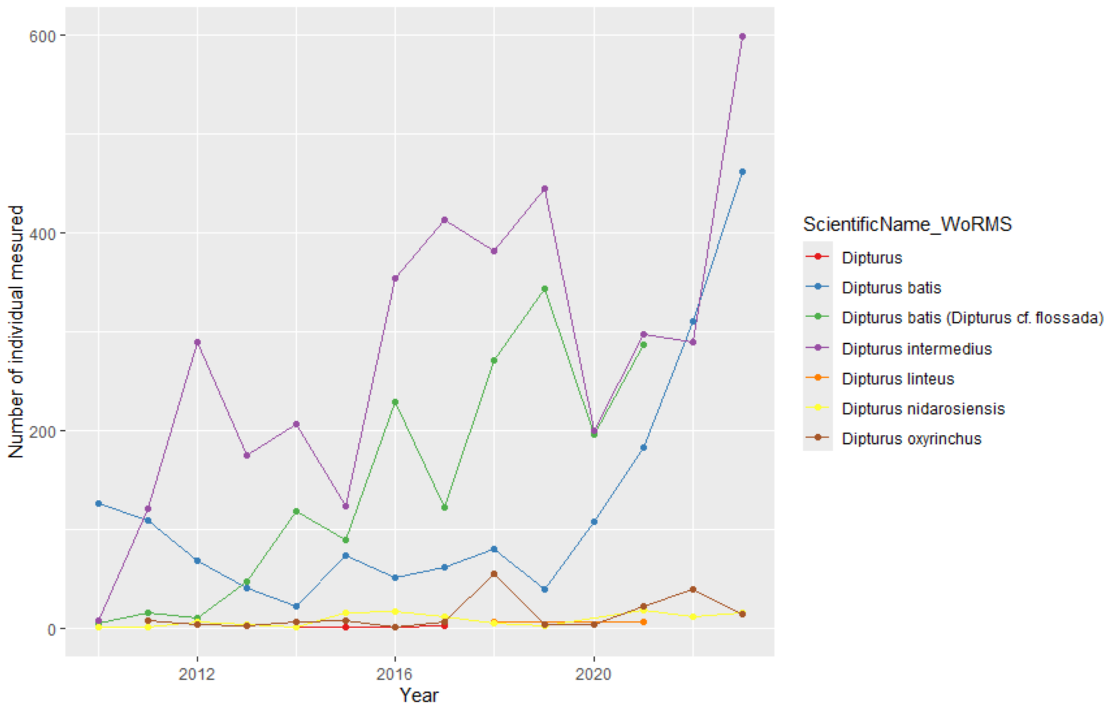
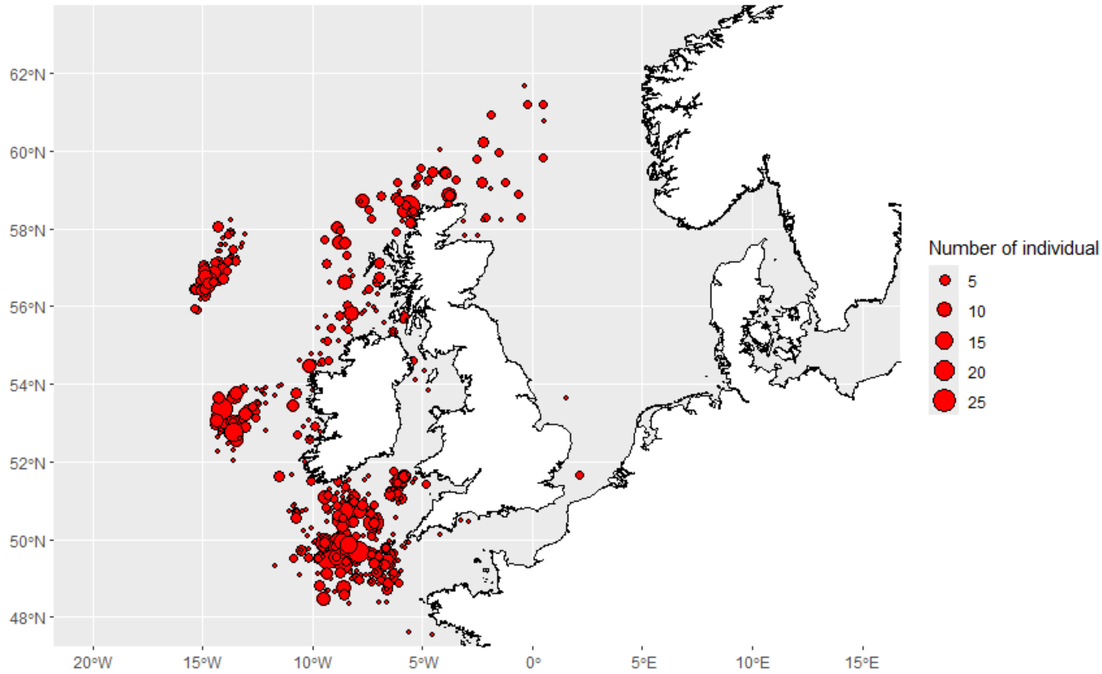
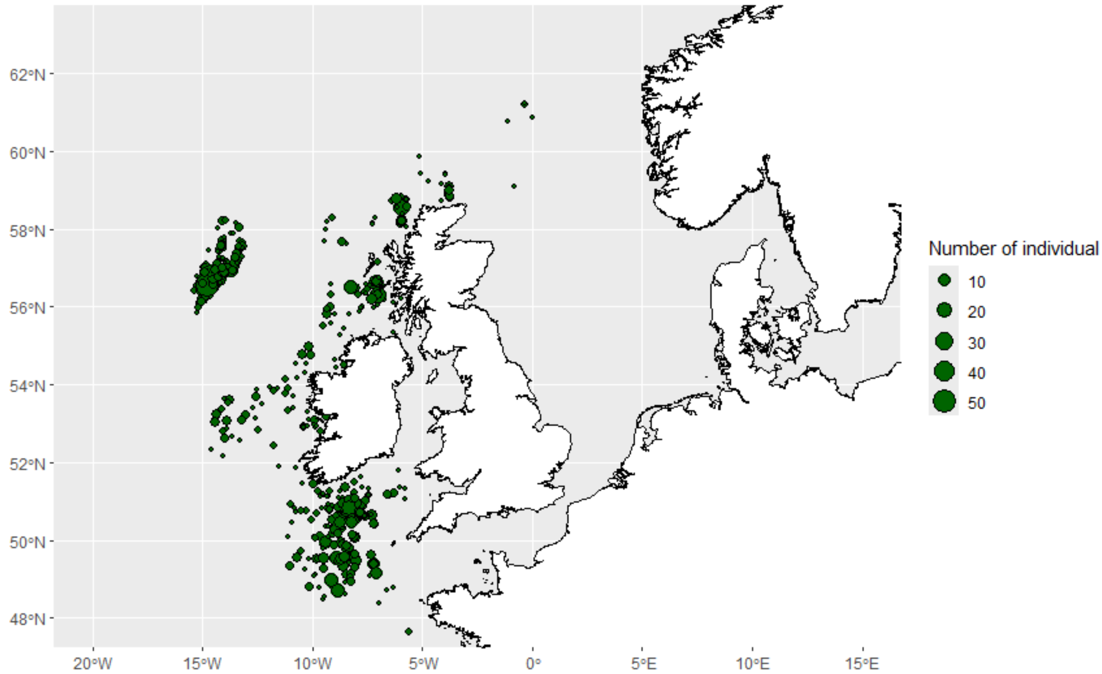


Figure 26.43. Number of individual *Dipturus* records per species (2010–2023) from those research surveys available on DATRAS.

Number of D. batis caught during research survey between 2010 and 2023



Number of D. flossada caught during research survey between 2010 and 2023



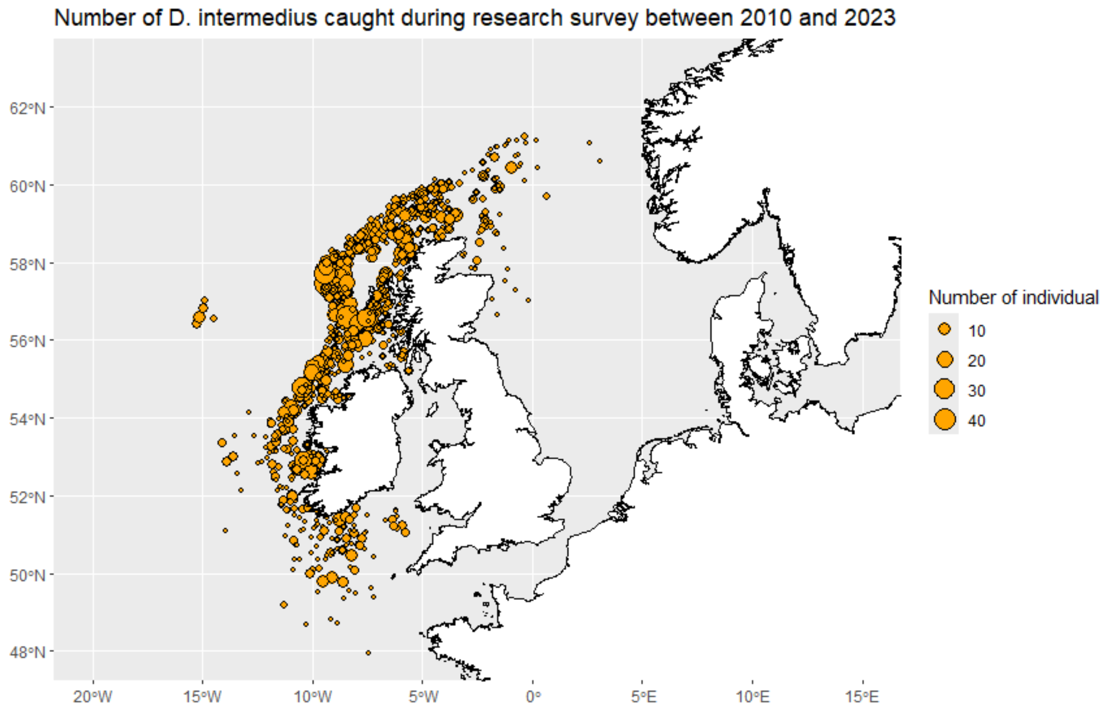


Figure 26.44. Spatial distribution and catch rates of *Dipturus batis*-complex (top, n = 1726), *Dipturus batis (Dipturus* cf. *flossada* (center, n = 1738) and *Dipturus intermedius* (bottom, n = 3901), as recorded during research vessel surveys between 2010 and 2023.

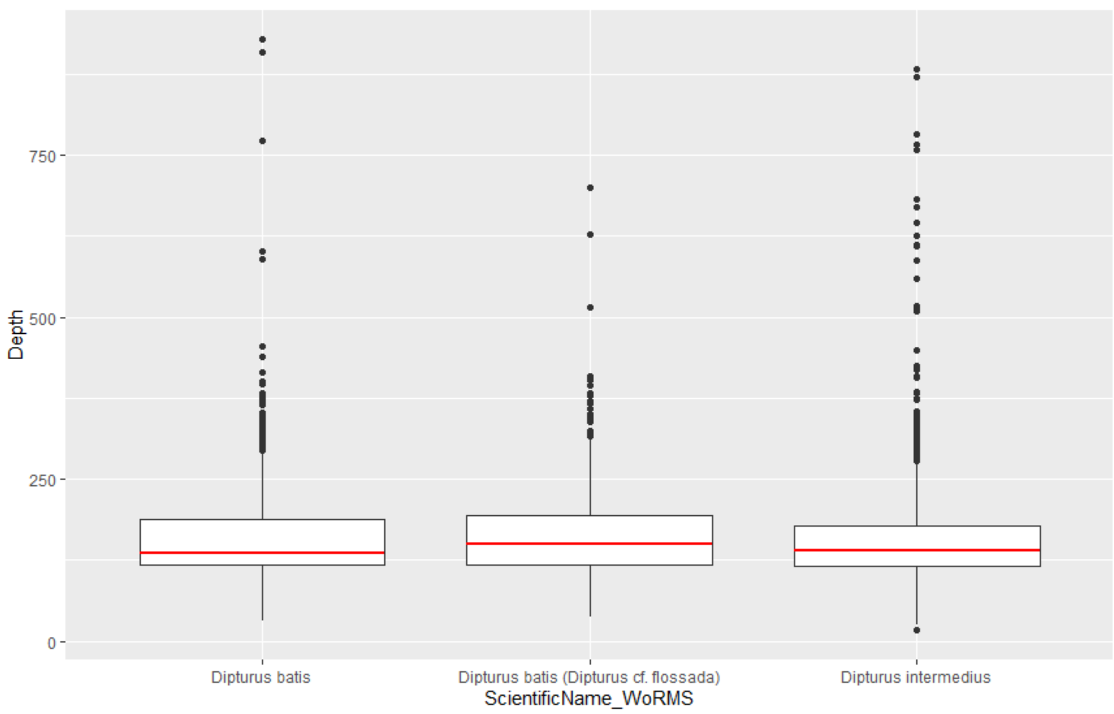
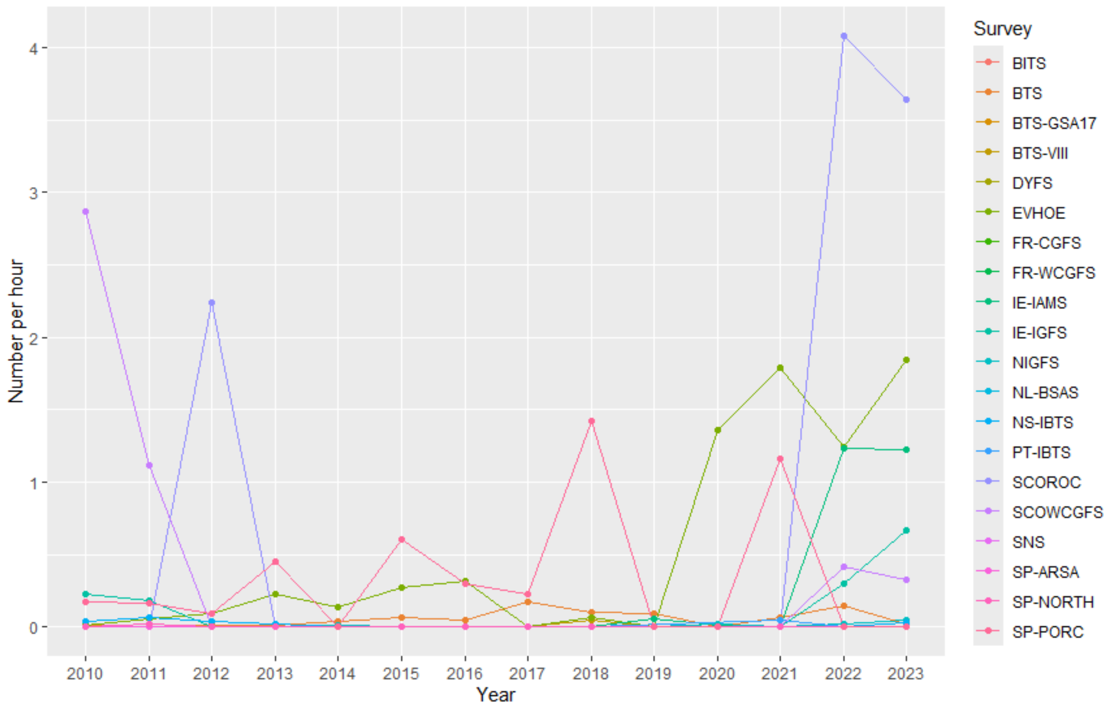
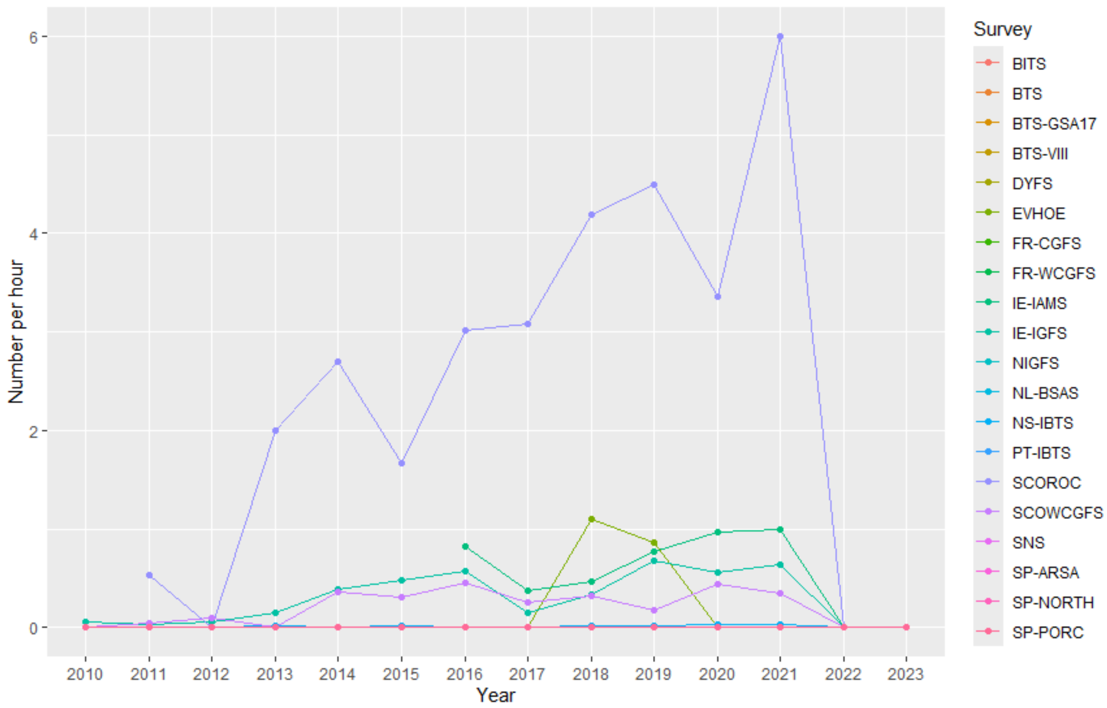


Figure 26.45. Boxplot on depth range (m) for *D. batis* (n = 1725), *Dipturus batis (Dipturus cf. flossada)* (n = 1738) and *D. intermedius* (n = 3900) recorded during research vessel trawl surveys between 2010 and 2023. Red line is the median depth of catch.


Number per hour
Year
Survey
BITS
BTS
BTS-GSA17
BTS-VIII
DYFS
EVHOE
FR-CGFS
FR-WCGFS
IE-IAMS
IE-IGFS
NIGFS
NL-BSAS
NS-IBTS
PT-IBTS
SCOROC
SCOWCGFS
SNS
SP-ARSA
SP-NORTH
SP-PORC


Number per hour
Year
Survey
BITS
BTS
BTS-GSA17
BTS-VIII
DYFS
EVHOE
FR-CGFS
FR-WCGFS
IE-IAMS
IE-IGFS
NIGFS
NL-BSAS
NS-IBTS
PT-IBTS
SCOROC
SCOWCGFS
SNS
SP-ARSA
SP-NORTH
SP-PORC

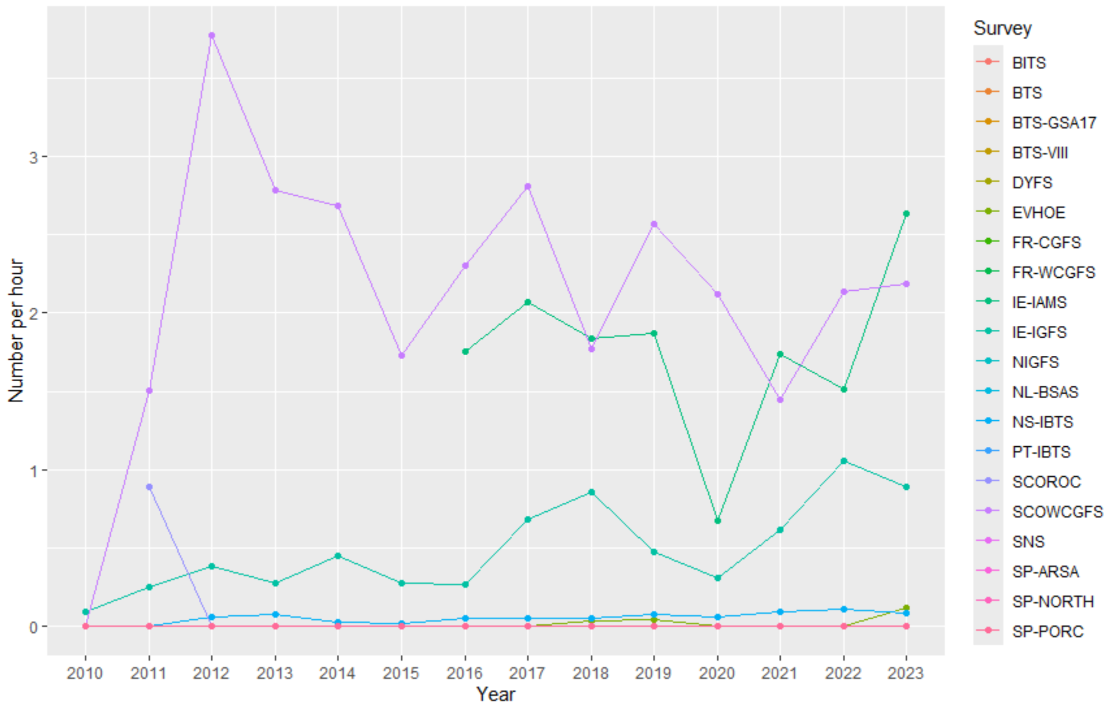
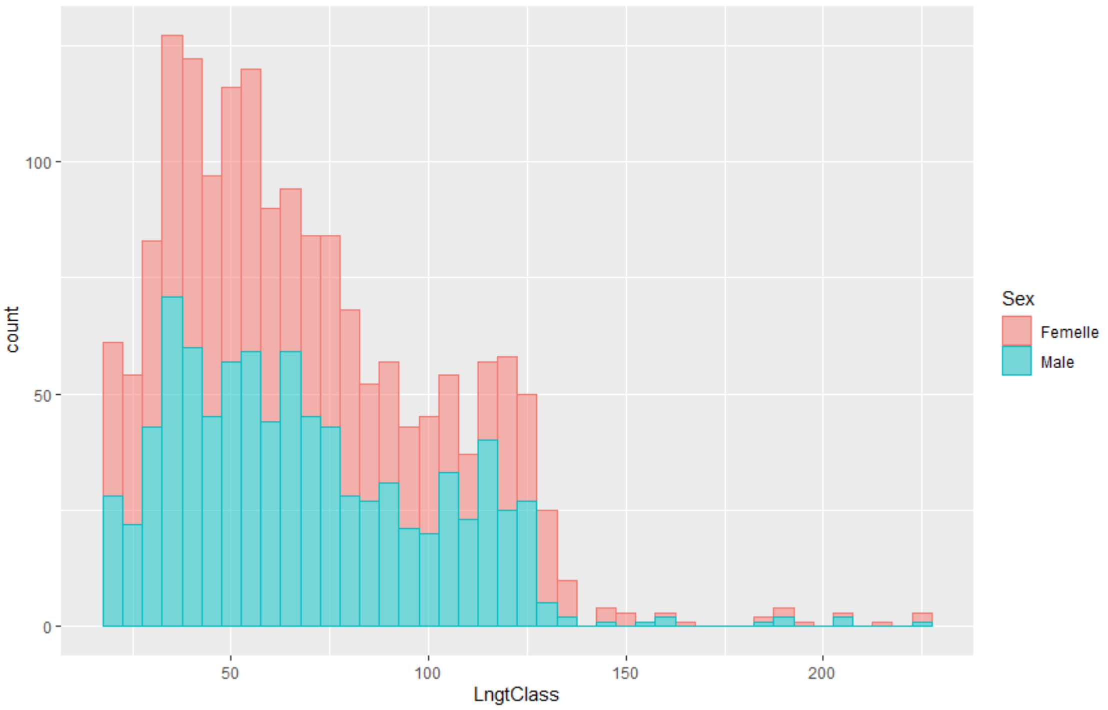
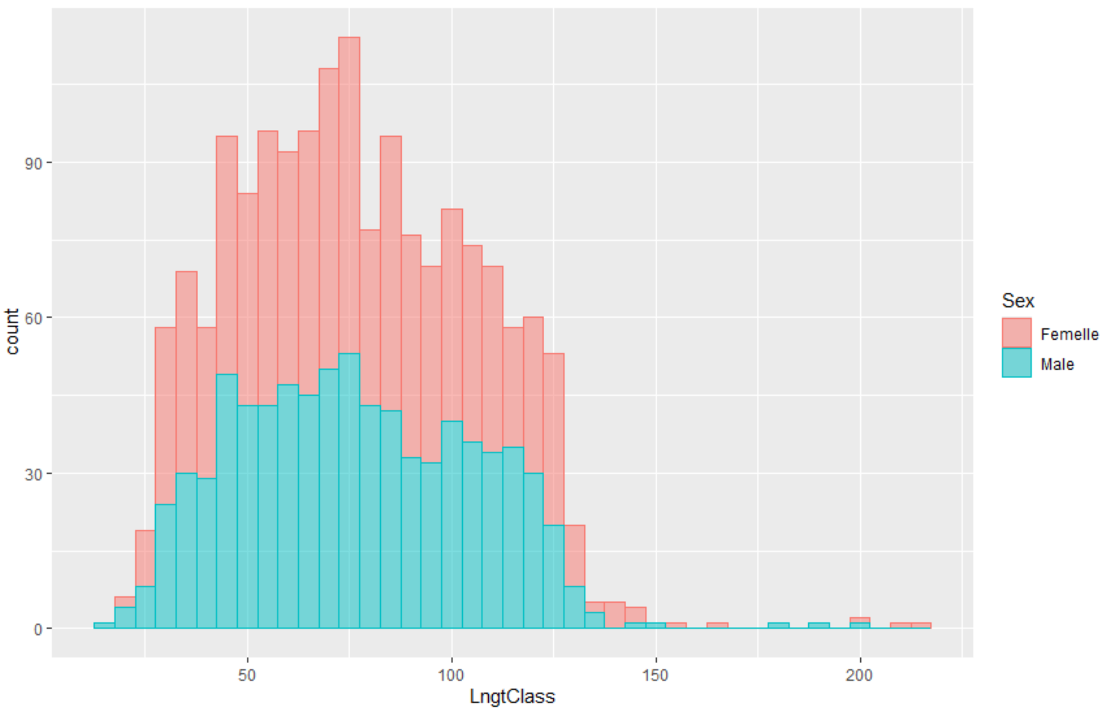


Figure 26.46. Nominal catch rates (number per hour) for *D. batis* complex (top), common blue skate *Dipturus batis (D.* cf. *flossada)* (centre) and flapper skate *Dipturus intermedius* (bottom) as reported during trawl surveys available in DATRAS (2010–2023).


count
100
50
0
50
100
150
200
LngtClass
Sex
Femelle
Male


count
90
60
30
0
50
100
150
200
LngtClass
Sex
Femelle
Male

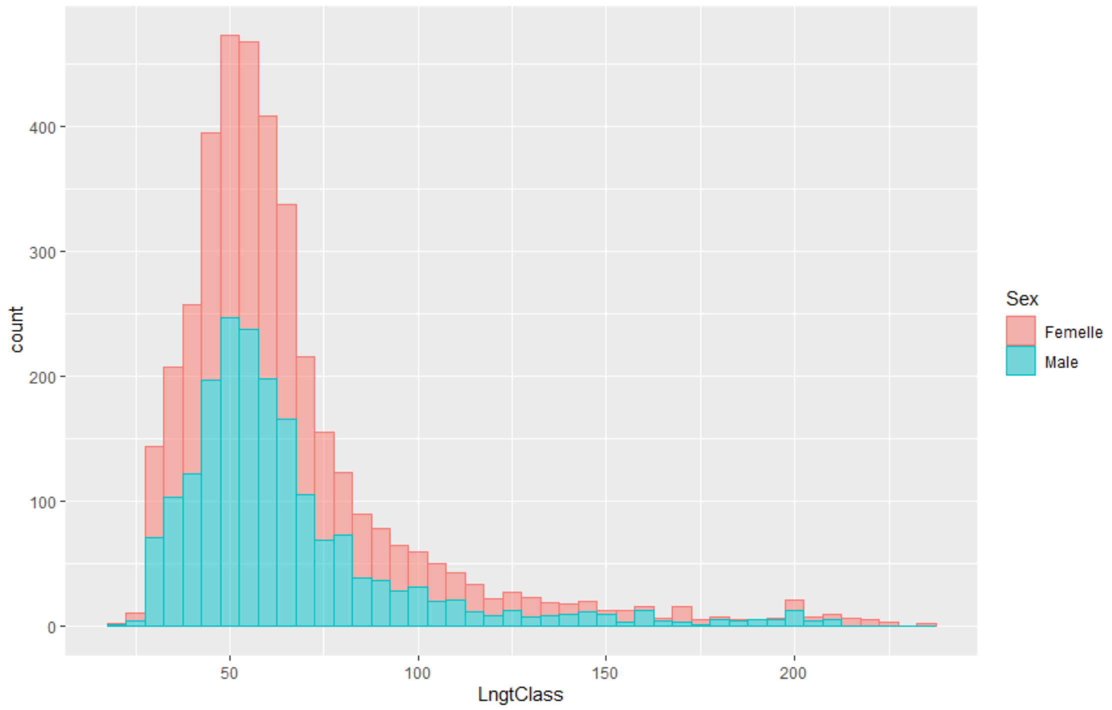


Figure 26.47. Length-frequency distributions of *D. batis* complex (top, n = 1714), common blue skate *Dipturus batis* (*D.* cf. *flossada*)(centre, n = 1653) and flapper skate (bottom, n = 3895), as observed in scientific trawl surveys from DATRAS data between 2010 and 2023.

Contents

27 Other issues

27.1 Code of conduct and conflict of interest

As knowledge provider ICES gives a high priority to credibility, legitimacy, transparency and accountability of their work. In this context, it is essential that experts contributing to ICES science and advice maintain scientific independence, integrity and impartiality. In addition, behaviours and actions of members should minimise any risk of actual, potential or perceived conflicts of interest. A conflict of interest arises when there is an actual, potential or perceived possibility that a member of the group makes a contribution to ICES work that is not based on a systematic scientific review of the available information and evidence or when decisions or outcomes may be influenced, or are perceived to be influenced, by self-interest or external pressures and other factors.

The Code of Conduct drawn up by ICES is to ensure transparency and responsibility in ICES work and to preserve the role of ICES as knowledge provider. The code of conduct applies to scientists participating in ICES Expert Groups, Review and Advice Drafting Groups as well as ACOM and SCICOM meetings.

ICES has requested the chairs of the working group to address the Code of Conduct and Conflict of Interest at the start of the meeting. All participants at the meeting, including the chairs, are required to declare any Conflicts of Interest and their commitment to agree with the Code of Conduct before their work commences. In 2024, all participants, including the chairs, declared no Conflict of Interest and agreed to abide with the Code of Conduct.

27.2 Cyberattack

During the main WGEF 2024 meeting ICES experienced a ransomware cyber attack on 21 June (four days into our 10-day meeting). This took our all ICES Infrastructure offline and thus experts were unable to access any data, documents, online assessment tools for several days. Whilst temporary sharepoints were setup to facilitate document sharing, there were losses to existing work and issues associated with porting documents from one site to another. Online assessment tools to complete draft advice remained offline for a prolonged period following a second attack on 12th July. Subsequently, the work of the group was severely impacted and progress delayed. However, the members and ICES Secretariat worked immensely hard in very challenging circumstances to deliver the assessments, draft advice and report on time which is a credit to their professionalism and diligence.

27.3 Benchmarked stocks

In contrast to many other assessment Expert Groups, previously, WGEF had fewer stocks that had gone through the benchmark process. The first was spurdog (*Squalus acanthias*), which was carried out through correspondence in 2021 (ICES, 2021b). In recent years, more effort has been made into exploring new assessment models and acquiring relevant data for assessments. As a result, in 2020, WGEF proposed potential benchmarks for several stocks which were successfully completed for four stocks (por.27.nea, rjc.27.8abd, rjn.27.678 and rju.27.7de) in 2022 (ICES, 2022), four stocks (rjc.27.3a47d, rjm.27.3a47d, rjh.27.4bc7d and rjc.27.8c) in 2023 (ICES, 2023a, b), and a further two (rjc.27.9a, rjh.27.9a) in 2024 (ICES, 2024).

There were three stocks from Iberian waters proposed for benchmark in 2024: rjc.27.9a, rjh.27.9a and rjn.27.9a. A SPiCT assessment using landings since 2000 and one series of biomass indices (PT-LPUE from polyvalent fleet) since 2008 was tested for blonde ray (rjh.27.9a) but not accepted. The SPiCT assessments for the other two stocks were accepted with harvesting estimated to be well below F_{MSY} with biomass' above B_{MSY}.

WGEF have not proposed any stocks for future benchmarks in 2025 or 2026.

27.4 WKSKATE

In 2019, it was agreed that a dedicated workshop was needed to examine the use of surveys in the assessment of elasmobranchs. New surveys and time series and a lack of standardization amongst stocks meant that current assessment inputs and combination methods may no longer be the best sources of information on stock status. A Workshop on the use of surveys for stock assessment and Reference Points for Rays and Skates (WKSKATE) was proposed and accepted by ACOM.

WKSKATE was successfully held online in November 2020 (ICES, 2021a). Primarily due to constraints caused by COVID-19, it was decided prior to the meeting to concentrate on stocks that were due to be assessed by WGEF in 2021, namely skates and ray stocks in the North Sea. It was also decided to examine skate and ray stocks in Biscay and Iberia that were affected by the cessation of Portuguese surveys.

A second workshop examining the survey use and methods to provide indices is being considered. The workshop would have a particular focus on elasmobranch stocks in the Celtic Sea and Iberian waters. While initially planned for 2022, it was decided to defer the WKSKATE2 workshop until after WGEF 2024. This is primarily due to the large time demands being made on ICES elasmobranch experts in recent years, i.e. several consecutive benchmarks since 2021. In addition to the work on skates and rays, a third workshop would be beneficial to examine the surveys used to assess the remaining stocks, primarily sharks, including catsharks.

27.5 Data preparatory meeting

Prior to the WGEF 2023 and 2024 meetings, a data preparatory meeting was organized with a small group of WGEF members (including the chairs) to prepare all data submitted to InterCatch or Accessions. These were online meetings held two-weeks before the main WGEF meeting. The aim of this meeting is to finalize landings, discards and length data for all species and stocks submitted to the WGEF data call. Preparing these in advance will enable stock assessors to start with their assessments in advance of the meeting and thus will relieve some of the time pressure. During the 2-day meeting, the group split in three subgroups and worked on the three different tables separately. Work was discussed in plenary sessions.

For the landings table, extensive work has already been done and an issue list and stock allocation file already exist which can be applied to latest submitted landings. The first day of the data prep meeting was mainly used to harmonize historic landings which included the following steps not necessarily in this order:

- WGEFfleet; e.g. in earlier years we used 'bottom trawls', in more recent years 'all other bottom trawls'. All fleet types were checked and harmonized to the same spelling.
- Fishing area; e.g. fishing areas 27.3.a.20 and 27.3.a.21 were harmonized to 23.3.a. All areas were also checked on spelling and additional spaces.
- WGEFSpeciesName; this is assigned automatically in the script based on the stock allocation list. However, in historic landings this has been done manually resulting in for

example three different spellings for the same species. All names were checked and updated accordingly.

- ICESStockCode; this is assigned automatically in the script based on the stock allocation list. Checks showed that some stocks contained up to 4 different spellings (e.g. "syc.27.67a-ce-j","syc.27.67a-ce-k","syc.27.67acej","syc.27.67acek"). All stock codes were checked and updated accordingly.

WGEF has also put effort in creating a discards and length data table in 2021 and 2022, respectively. In the data prep meetings, this was further updated. Standardized scripts were already available for the discards table but were further harmonized following the same stock allocation list as for the landings table. The script for the length data table was further developed. Historical data were harmonized where necessary.

The second day of the meeting was used to harmonize submitted data from the data call and these were collated with the tables. During this meeting an issue list specifically for discards has also been discussed. In future meetings, effort will have to be put in creating such lists as conceivably these data will be used in the assessments (e.g. SPiCT) of more stocks.

27.6 Implementing WKLIFE method

The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X; ICES 2021c) developed methods for stock assessment and catch advice for stocks in ICES Categories 3 and 4, focusing on the provision of sound advice rules that are within the ICES MSY framework.

Previous category 3 assessments for skates and rays applied a two over five rule on the stock size indicator as these species have long generation times. However, WKLIFE X emphasized the need to have assessment methods which accounted for the uncertainty and being more effective and precautionary compared to this two over five rule. Additional work on advice rules for stocks in Category 3 based on life-history traits (k), tested through simulation and management strategy evaluation (MSE), showed that the addition of specific multipliers based on the stock's life-history characteristics decreases the risk of the control rule´s performance.

Starting in 2022, the advice rules for category 3 stocks were introduced within WGEF. During 2022 and 2023, 13 and 11 category 3 stocks, respectively, transitioned from the conventional 2 over 5 rule to adopting the rfb or rb-rule, with the biennial reassessments of the 2022 stocks undertaken in 2024. Consequently, all category 3 assessments within WGEF have been revised, and advice is now given in alignment with the MSY framework.

27.7 Science

In 2024 (as in 2023) a short dedicated science session was organised in which members of the group were given the opportunity to present their science projects related to elasmobranchs. In total the following presentations were given:

- Atlas of Chondrichthyans: Improving knowledge of chondrichthyan distribution within northeastern Atlantic and French Mediterranean waters, presented by Thomas Barreau.
- Northeast Atlantic elasmobranch community on the move: Functional reorganization in response to climate change, presented by Noémie Coulon.
- Elasmobranch Discard Survival Mega-analysis, presented by Damian Villagra Villanueva.

- Update on common blue skate *Dipturus batis* in ICES Subarea 7: Derivation of a biomass index from the EVHOE survey, presented by Loïc Baulier.

27.8 References

ICES. 2021a. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948.

ICES. 2021b. Benchmark Workshop on North Sea Stocks (WKNSEA). ICES Scientific Reports. 3:25. 756 pp. https://doi.org/10.17895/ices.pub.7922

ICES. 2021c. 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. 2022. Benchmark Workshop for selected elasmobranch stocks (WKELASMO). ICES Scientific Reports. 4:47. 136 pp. http://doi.org/10.17895/ices.pub.21025021

ICES. 2023a. Benchmark Workshop for selected elasmobranch stocks (WKBELASMO). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.22760042.v1

ICES. 2023b. Benchmark workshop 2 on development of MSY advice using SPiCT (WKBMSYSPiCT2). ICES Scientific Reports. 5:65. 472 pp. https://doi.org/10.17895/ices.pub.23372990

ICES. 2024. Report of the Benchmark Workshop on Selected Elasmobranch Stocks (WKBELASMO3). ICES Scientific Reports 06:74. http://doi.org/10.17895/ices.pub.26935492

ICES SCIENTIFIC REPORTS

RAPPORTS SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

CIEM COUNSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

Contents

Annex 1: List of Participants

WGEF - Working Group on Elasmobranch Fishes

Name	Institute	Country	Email
Aurelien Delaval	Institute of Marine Research, Tromsø, Norway	Norway	aurelien.delaval@hi.no
Barbara Serra Pereira	IPMA Portuguese Institute for the Sea and the Atmosphere	Portugal	bpereira@ipma.pt
Catarina Maia	IPMA Portuguese Institute for the Sea and the Atmosphere	Portugal	cmaia@ipma.pt
Christopher Griffiths	SLU Swedish University of Agricultural Sciences	Sweden	christopher.griffiths@slu.se
Cristina Rodríguez-Cabello	IEO Instituto Español de Oceanografía Centro Oceanográfico de Santander	Spain	cristina.cabello@ieo.csic.es
Damian Villagra Villanueva	Flanders Research Institute for Agriculture, Fisheries and Food	Belgium	Damian.Villagra@ilvo.vlaanderen.be
Graham Johnston	Marine Institute	Ireland	graham.johnston@marine.ie
Guzman Diez	AZTI-BRTA Marine and Food Science and Technology.	Spain	gdiez@azti.es
Inigo Martinez	ICES Secretariat	Denmark	inigo@ices.dk
Jaylene Mbararia	ICES Secretariat	Denmark	jaylene.mbararia@ices.dk
Jim Ellis	Cefas Centre for Environment, Fisheries and Aquaculture Science	UK	jim.ellis@cefas.gov.uk
Joana Silva	Cefas Centre for Environment, Fisheries and Aquaculture Science	UK	joana.silva@cefas.gov.uk
José De Oliveira	Cefas Centre for Environment, Fisheries and Aquaculture Science	UK	jose.deoliveira@cefas.gov.uk

Name	Institute	Country	Email
Jurgen Batsleer (observer)	DG Maritime Affairs and Fisheries, European Commission	Belgium	Jurgen.Batsleer@ec.europa.eu
Katinka Bleeker	WMR Wageningen Marine Research	Netherlands	katinka.bleeker@wur.nl
Klara Jakobsdottir	Hafro Marine and Freshwater Research Institute	Iceland	klara@hafro.is
Loïc Baulier	Ifremer Lorient Station	France	loic.baulier@ifremer.fr
Matthias Schaber	Thünen Thünen Institute of Sea Fisheries	Germany	matthias.schaber@thuenen.de
Nana Afranewaa	WMR Wageningen Marine Research	Netherlands	nana.afranewaa@wur.nl
Noémie Deleys	Ifremer Nantes Centre	France	noemie.deleys@ifremer.fr
Pascal Lorance	Ifremer Nantes Centre	France	pascal.lorance@ifremer.fr
Rebecca Holt	Cefas Centre for Environment, Fisheries and Aquaculture Science	UK	Rebecca.holt@cefas.gov.uk
Régis Souza Santos	University of the Azores	Portugal	regis.vs.santos@uac.pt
Ross O'Neill	Marine Institute	Ireland	Ross.ONeill@Marine.ie
Sophy McCully Phillips (chair)	Cefas Centre for Environment, Fisheries and Aquaculture Science	UK	sophy.phillips@cefas.gov.uk
Tanja Miethe	Marine Science Scotland Marine Laboratory	UK	t.miethe@marlab.ac.uk
Teresa Moura (chair)	IPMA Portuguese Institute for the Sea and the Atmosphere	Portugal	tmoura@ipma.pt
Thomas Barreau	Muséum National d'Histoire Naturelle, station Dinard	France	thomas.barreau@mnhn.fr
Tobias Mildenberger	DTU-Aqua	Denmark	tobm@aqua.dtu.dk

Annex 2: List of Working Documents 2024

WD number	Title	Authors
1	Derivation of a biomass index for common blue skate *Dipturus batis*, in ICES Subarea 7.	Loïc Baulier
2	Results on main elasmobranch species caught in the 2023 Northern Spanish Shelf Groundfish Survey	S. Ruiz-Pico, O. Fern´andez-Zapico, M. Blanco, C. Rodr´ıguez-Cabello, P. Ortiz, JM. Gonz´alez-Irusta, A. Punz´on, F. Velasco
3	Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal and Gulf of Cadiz) (rju.27.9a) - update	Catarina Maia ,Bárbara Serra-Pereira, Teresa Moura and Ivone Figueiredo
4	Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic)	O. Fern´andez-Zapico, S. Ruiz-Pico, M. Blanco, P. Ortiz, F. Velasco, C. Rodr´ıguez-Cabello, F. Bald´o

Derivation of a biomass index for common blue skate *Dipturus batis*, in ICES Subarea 7

Working document for the WGEF annual meeting, 2024

Loïc Baulier

Introduction

The once separated flapper skate and common blue skate were aggregated under the denomination "Common skate", since 1926 (Iglésias *et al.*, 2010). This species complex was designated under the scientific name *Dipturus batis*. The distinction between the smaller species (common blue skate, *D. batis*) and the larger one (flapper skate, *D. intermedius*) re-emerged in 2010 (Iglésias *et al.*, 2010), but separate identification in scientific surveys re-occurred at various time after that year.

This situation has hindered the derivation of long series of separate biomass indices for these species. As for the FR-EVHOE-Q4 bottom trawl survey [G9527], the effective distinction between the two species (i.e. with the use of different species identification codes) started in 2018. A scientific observer affiliated to the French National Museum of National History(MNHN) has been boarding the RV Thalassa at least for the second leg of the FR-EVHOE-Q4 survey since 2009. This leg covers the northern part of the FR-EVHOE-Q4 survey area, where *D. batis* and *D. intermedius* are usually encountered. The data collected by the MNHN observer included the distinction between *D. batis* and *D. intermedius* individuals. By combining the Ifremer and MNHN data bases for FR-EVHOE-Q4, it was possible to distinguish between the two species in the Ifremer data base, and then to produce specific biomass indices.

Data

Data from the FR-EVHOE-Q4 survey were analysed here. The FR-EVHOE-Q4 was not conducted in 2017 due to engine failures. Because no scientific observed from MNHN participated in the 2010 survey, the time series considered here starts in 2011.
The number of *D. batis* caught annually ranged from 7 (in 2011) to 129 (in 2021). A marked increase in the number of individuals observed occurred between 2016 and 2018.

Table 1: Dipturus batis data from FR-EVHOE-Q4 in ICES Subarea 7. Number of observed individuals and average individual weight.

Year	n	Avg. W (kg)
2011	7	3.90
2012	9	3.16

2013	16	6.58
2014	12	4.12
2015	19	2.21
2016	21	3.86
2017	NA	NA
2018	84	2.40
2019	82	3.50
2020	100	3.14
2021	129	2.00
2022	74	4.28
2023	119	3.00

Methods

Data selection

The first year of FR-EVHOE-Q4 data considered here was 1997, which coincides with a change of vessel used for the survey. Prior to 2011, the two species of common skate were not distinguished in the data. Due to the low number of *Dipturus intermedius* observed during the FR-EVHOE-Q4 survey (28 individuals caught between 2011 and 2023), only the smaller species *D. batis* was considered for the derivation of a biomass index here. In addition, the low number of *D. batis* caught in ICES Subarea 8 (5 individuals in total) was insufficient to derive a biomass index for this subarea. In the FR-EVHOE-Q4 survey, all elasmobranchs are sexed and measured individually. Based on the date of observation, station number, sex and total length, all *D. batis* individuals recorded in the MNHN data base could be matched with individual observations in the Ifremer data base. As the resulting updated data base has not been uploaded to Intercatch yet, a local data base was used to derive the series of biomass index for common blue skate in ICES Division 7.

Derivation of the index

A so-called "design-based approach" was applied, considering homogenous strata (Figure 1) within which stations are sampled. Each station correspond to a 30 minute trawl haul. The swept area was derived as the product of the distance covered by the GOV trawl on the bottom and wing spread. In instances where wing spread was unknown, a linear regression between door spread and wing spread was applied to reconstruct missing values, setting of a minimum wing spread at 15 m. Average densities expressed in kg per unit of swept area were calculated, then raised to the surface area of each stratum. The index value for a given year is the sum of the estimated biomass raised to the area of each stratum. A 95% confidence interval around this central value was generated using bootstrap. The bootstrap procedure applied here randomly drew the stations in each stratum. The procedure was applied 1000 times. Separate indices were calculated for total biomass and biomass of individuals ⩾ 50 cm in total length. The threshold value of 50 cm TL is used to define the exploitable part of the biomass for the majority of skate stocks.

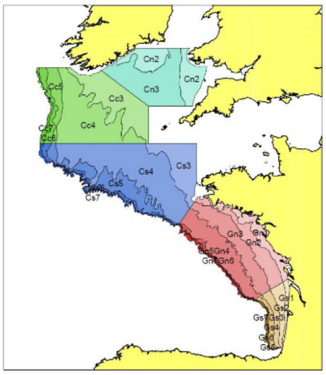
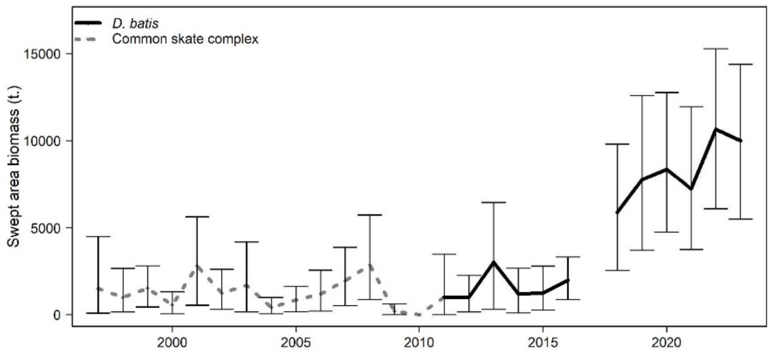


Figure 1: Sampling strata of the FR-EVHOE-Q4 survey. Source: Mahe and Poulard (2005)

Results

Because the majority of *D. batis* observed during the survey are individuals larger than 50 cm TL, the series of biomass indices for all individuals and individuals larger than 50 cm TL appear quite similar (Figure 2). Before 2011, the two species constituting the common skate complex could not be separated in the data base. However, *D. batis* representing the vast majority of individuals since 2011 (95.9% in numbers, 90.5% in biomass), the combined indices for the complex of species are expected to be close to the indices that would have been derived for *D. batis* before 2011. Both indices show a steep increase between 2016 and 2018. The 2018-2023 index averages are 5.3 and 5.2 times higher than the 2011-2016 averages for total biomass and biomass of individuals larger than 50 cm TL, respectively. Despite the large confidence intervals, the sustained high values of the biomass indices after 2016 strongly support an increase of the biomass of common blue skate in Subarea 7.



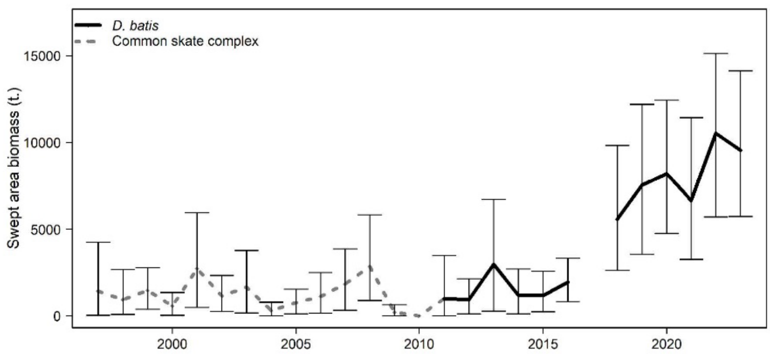


Figure 2: Biomass indices of biomass of Dipturus batis in Subarea 7 in the FR-EVHOE-Q4 survey, with 95% confidence intervals. Upper panel: total biomass; Lower panel: biomass of individuals ⩾ 50 cm TL.

The individuals of *Dipturus batis* observed during the survey have a total length comprised between 18 cm and 148 cm. The time series of individual weights (Figure 3) shows rather stable values between 2011 and 2023 (mean=3.5 kg). A linear regression of individual weights of *D. batis* against time leads to a non-significant trend (slope= -0.07, Student t-test, p.value=0.139). This suggests that the composition of the fraction of the population living in Subarea 7 has only marginally changed over the recent years.

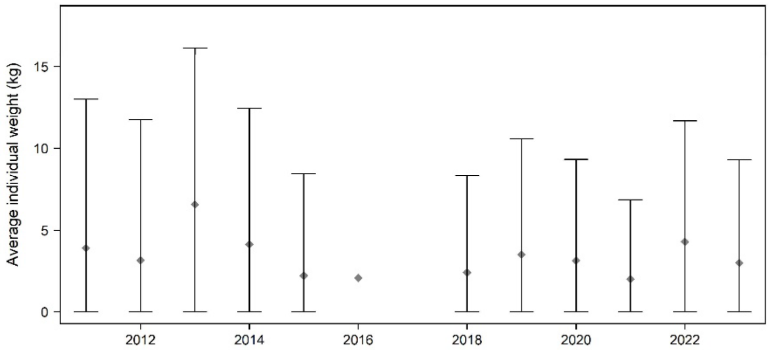


Figure 3: Individual weight of D. batis in Subarea 7 over time, as observed in FR-EVHOE-Q4 data.

Discussion

Data from the FR-EVHOE-Q4 survey since 2011 suggest a strong increase of the biomass of common blue skate present in ICES Subarea 7 starting between 2016 and 2018. This recent increase in biomass follows a period of stable low stock size extending back to at least 1997. The Celtic Sea constitutes the southern limit of the current distribution of *D. batis* for stock rjb.27.67a-c,e-k. At this stage, data from other areas are necessary to establish whether the increase in biomass observed in the Celtic Sea reflects an overall improvement in stock status, or whether this biomass increase is locally limited. To answer this question, data from other parts of the stock distribution have to be examined. The observations from the Scottish West Coast Groundfish Survey (SCOWCGFS - G4748) for instance may usefully serve this purpose. This survey is conducted in Division 6a, and catches of *D. batis* have been reported every year since 2014. Though this survey has a limited time extension (SCOWCGFS was initiated in 2011), the observation period covers the period of recent increase in biomass.

References

Iglésias, S. P., Toulhoat, L., and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: Important consequences for their conservation status. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 319–333. Wiley Online Library.

Mahe, J.-C., and Poulard, J.-C. 2005. Manuel des protocoles de campagne halieutique. Campagnes EVHOE (EValuation des ressources halieutiques de l'ouest europe). https://archimer.ifremer.fr/doc/00036/14707/12013.pdf.

Working Document presented to the Working Group on Elasmobranch Fishes
ICES WGEF 18th-27th June 2024, Lisbon, Portugal

Results on main elasmobranch species caught in the 2023 Northern Spanish Shelf Groundfish Survey*

S. Ruiz-Pico†, O. Fernández-Zapico, M. Blanco, C. Rodríguez-Cabello, P. Ortiz, JM. González-Irusta, A. Punzón, F. Velasco

Abstract

This working document presents the results on the most abundant elasmobranch species caught in the 2023 Northern Spanish Shelf groundfish survey. Biomass, abundance, length distributions and geographic ranges were analysed for *Scyliorhinus canicula* (lesser spotted dogfish), *Galeus melastomus* (blackmouth catshark), *Etmopterus spinax* (velvet belly), *Hexanchus griseus* (bluntnose sixgill shark), *Raja clavata* (thornback ray), *Raja montagui* (spotted ray), *Leucoraja naevus* (cuckoo ray), *Raja brachyura* (blonde ray) and other scarce elasmobranches. Biomass of *S. canicula*, *G. melastomus*, *E. spinax*, *R. clavata*, *L. naevus* and *R. brachyura* increased, whereas *H. griseus* and *R. montagui* decreased. *S. ringens* and *Deania* spp. were scarce as usual and only one or a few specimens of *Dalatias licha*, *Dipturus nidarosiensis*, *Dipturus oxyrinchus* and *Leucoraja circularis* were found. Signs of recruitment were found for *E. spinax* in additional deep hauls.

Introduction

The bottom trawl survey on the Northern Spanish Shelf has been carried out every autumn since 1983, except in 1987, to provide data and information for the assessment of the commercial fish species and the ecosystems on the Galician and Cantabrian shelves (ICES Divisions 8c and 9a North).
The aim of this working document is to update the results (abundance indices, length frequencies and geographic distribution) of the most common elasmobranch fish species caught on the bottom trawl surveys on the Northern Spanish Shelf after the results presented previously (Blanco et al. 2022, Fernández-Zapico et al. 2023, 2021, 2020, 2018, 2016, Ruiz-Pico et al. 2019, 2017, 2015). The species analysed were *Scyliorhinus canicula* (lesser spotted dogfish), *Galeus melastomus* (blackmouth catshark), *Etmopterus spinax* (velvet belly), *Hexanchus griseus* (bluntnose sixgill shark), *Raja clavata* (thornback ray), *Raja montagui* (spotted ray), *Leucoraja naevus* (cuckoo ray), *Raja brachyura* (blonde ray) and other scarce elasmobranchs.

Material and methods

The area covered in the Northern Spanish Shelf groundfish survey on the Cantabrian Sea an off Galicia (Divisions 8c and Northern part of 9a; SPNGFS) extends from longitude 1° W to 10° W

*Citation: Ruiz-Pico S, Fernández-Zapico O, Blanco M, Rodríguez-Cabello C, Ortiz P, González-Irusta JM,Punzón A, Velasco F (2024) Results on main elasmobranch species captured in the 2023 Northern Spanish Shelf Groundfish Survey. ICES Working Group on Elasmobranch Fishes, 18-27 June 2024, Lisbon, Portugal. https://doi.org/10.20350/digitalCSIC/16331

†Instituto Español de Oceanografía (IEO), CSIC, Centro Oceanográfico de Santander, susana.ruiz@ieo.csic.es

and from latitude 42° N to 44.5° N, following the standard IBTS methodology for the western and southern areas (ICES, 2017). The sampling design is random stratified with five geographic sectors (MF: Miño-Finisterre, FE: Finisterre-Estaca de Bares, EP: Estaca de Bares - Peñas, PA: Peñas - Ajo, AB: Ajo - Bidasoa) and three depth strata (70-120 m, 121-200 m and 201-500) (Figure 1, ICES, 2017). The shallower depth stratum was changed in 1997 from 30-100 m to 70-120 m, due to the small area and scarcity of trawlable shallower grounds. Nevertheless, some extra hauls are carried out every year, if possible, to cover shallower (<70 m) and deeper (>500 m) grounds. These additional hauls are plotted in the distribution maps, although they are not included in the calculation of the stratified abundance indices since the coverage of these grounds (shallower and deeper) are not considered representative of the area. However, the information from these depths is considered relevant due to the changes in the depth distribution of fishing activities in the area (Punzón et al. 2011) and these hauls are also used to define the depth range of the species.

Results

In this last survey 125 valid hauls were carried out, 112 of these were standard hauls and 13 additional hauls (1 of them shallower than 70 m and 12 of them between 500 m and 1000 m) (Figure 1).
The total stratified fish catch in biomass per haul decreased this last survey, although remained among the high values of the time series (Figure 2). Elasmobranchs represented the 17% of this total stratified fish catch. In the study area, *S. canicula*, *R. clavata*, *R. brachyura*, *L. naevus* and *R. montagui* were found mainly in standard hauls, whereas *G. melastomus*, *E. spinax*, *H. griseus*, *Deania profundorum* or *Scymnodon ringens* showed nearly 50% or more of their catches in the additional deep hauls (>500 m). To show a more complete picture of the distribution of these species, catches in standard and additional hauls were plotted on the maps in this report, but additional hauls are not considered on the stratified abundance indices since they are not part of the stratified design.
Other scarce elasmobranchs found this last year were *Dalatias licha*, *Dipturus nidarosiensis*, *Dipturus oxyrinchus* and *Leucoraja circularis*.
In 2023, the biomass of *S. canicula*, *G. melastomus*, *E. spinax*, *Deania* spp., *R. clavata*, *L. naevus* and *R. brachyura* increased, whereas it decreased for the species *H. griseus*, *S. ringens* and *R. montagui*. Only a few specimens of *D. licha*, *D. nidarosiensis*, *D. oxyrinchus* and *L. circularis* were found as usual and no specimens of the occasional species *Mustelus mustelus*, *Centrophorus squamosus*, *Oxynotus paradoxus*, *Torpedo marmorata*, *Tetronarce nobiliana*, *Neoraja iberica*, *Leucoraja fullonica* and *Raja microocellata* were found in this last survey. Signs of recruitment were found for *E. spinax* in additional deep hauls.

Scyliorhinus canicula(lesser spotted dogfish) and *Scyliorhinus stellaris*(nursehound)

In 2023, the biomass of *S. canicula* increased considerably in 8c Division, reaching the second highest value in the time series, whereas decreased in 9a but remaining in the upper-middle values of the time series (Figure 3). The mean biomass of the last two years was higher than among the previous five years in both Divisions (Figure 4). *S. stellaris*, scarcer than *S. canicula* in the area, decreased its biomass but remained between the average values of the time series this last survey (Figure 5). *S. canicula* was found throughout the study area as usual, but with big spots of biomass in the easternmost and central area of Cantabrian Sea. The biomass from Finisterre to Coruña (sector FE) was lower than the previous year (Figure 6). *S. stellaris* was found only in 8 hauls in the central Cantabrian Sea (Figure 7). Sizes of *S. canicula* ranged from 10 to 69 cm, similar to previous years but with high abundance of specimens from 31 to 54 cm (Figure 8). By Division, two modes were showed in 9a, around 30 cm and 50 cm, whereas one mode and more abundance of specimens was found in 8c (Figure 9). The size range of *S. stellaris* was narrower than that of *S. canicula*, from 19 to 54 cm, and with lower abundance of specimens than the previous year (Figure 10).

Galeus melastomus (blackmouth catshark) and _Galeus atlanticus_ (atlantic sawtail catshark)

This last year, the biomass of *Galeus* spp. (mainly *Galeus melastomus*) increased sharply in standard hauls reaching the highest value of the time series, whereas in additional hauls remained similar to the previous year (Figure 11). As in previous years, 32% of the hauls with presence of *G. melastomus* were found in additional deep hauls strata (>500 m) and they made up 44% of the biomass. Examining by species *G. atlanticus* has been found scarcely but appears in every survey since it was first identified in 2009 after its redescription and validation in 2007 (Castilho et al., 2007). In the standard hauls (Figure 12), *G. melastomus* increased sharply this last survey in both divisions whereas *G. atlanticus* increased slightly only in 9a. In additional deep hauls (Figure 13), biomass of *G. melastomus* increased in both Divisions and four specimens of *G. atlanticus* were found only in 8c. *G. melastomus* kept on being widespread in the study area although big spots of biomass were found in the Galician area in the last survey (Figure 14).The few spots of biomass of *G. atlanticus* found this last year were mainly in the Galician area too (Figure 15). Length distribution of *G. melastomus* showed the smallest specimens (<30 cm) in the standard hauls, adults from 30 to 50 cm in standard and additional deep hauls and the largest adults (> 50 cm) mainly in additional deep hauls (Figure 16). By Division, small specimens increased in 9a Division while they decreased in 8c (Figure 17). Only 18 specimens of *G. atlanticus* were found from 30 to 65 cm, the largest ones from 57 to 65 cm in additional deep hauls.

Etmopterus spinax (velvet belly)

E. spinax has been mostly found in additional hauls (>500 m) in the last decade. Nevertheless, the biomass in those deep hauls decreased slightly in this last survey whereas increased markedly in standard hauls, reaching the second highest value of the time series (Figure 18). No specimens were found in 9a Division in standard hauls but three big spots of biomass were found in front of Coruña from 417 to 452 m. In additional hauls, a big spot of biomass was found in this area at 687 m but also in the south of Galician waters at 607 m. The species was also found throughout the study area in 8 hauls deeper than 500 m but with smaller spots of biomass (Figure 19). Specimens ranged from 12 to 36 cm in standard hauls, with great abundance of specimens from 14 to 24 cm. A wider length range was found in additional hauls as usual (10-46 cm), where signs of recruitment were found (Figure 20). In general, larger sizes correspond to females.

Hexanchus griseus (bluntnose sixgill shark)

H. griseus has been mainly found in standard hauls of the 8c Division over the time series. In this last survey, the biomass decreased sharply after the peak of the previous year. However, the value of biomass for the last two years remained higher than the previous five (Figure 21). A total of five hauls, between 125 and 417 m deep, showed presence of the species, and only 8 specimens from 70 to 111 cm were caught, mostly in the north of Galicia and also west of Peñas Cape, similar to the previous years (Figure 22 and Figure 23).

***Deania profundorum* (arrowhead dogfish) and *Deania calceus* (birdbeak dogfish)**

Both species have been mainly found in additional deep hauls over the time series as in this last survey. The catches of *D. profundorum* remained similar to the previous years whereas *D. calceus* increased (Figure 24). The species *D. profundorum* was caught in five hauls, in Galician area as usual, among 533 and 687 m. *Deania calceus* was found just in one haul (17 specimens) in the south of Galician waters at 941 m deep (Figure 25 and Figure 26). Regarding sizes, *D. profundorum* ranged from 24 to 98 cm with more abundance of specimens from 26 to 45 cm and *D. calceus* ranged from 55 to 106 cm (Figure 27). In general, larger sizes correspond to females.

***Scymnodon ringens* (knifetooth dogfish)**

S. ringens has been mainly found in additional deep hauls over the time series as in this last survey. Twelve specimens were caught in five hauls (four in the Galician area and one in the central Cantabrian Sea) from 573 and 941 m deep, with a size range from 33 to 76 cm (Figure 28, Figure 29 and Figure 30).

***Raja clavata* (thornback ray)**

The biomass of the most abundant ray in the area, *R. clavata*, increased this last year in both divisions especially in 9a despite its historically scarcity in this area (Figure 31). The mean biomass of the last two years was higher than the previous five years in both divisions too (Figure 32). The species has been mainly found in standard hauls throughout the study area as usual with greater abundance in northern Galicia and in the central Cantabrian Sea in depths from 80 to 313 m this last year, and also in one additional shallower haul at 52 m west of Peñas Cape (Figure 33). Sizes ranged from 12 to 95 cm with two high modes around 27 and 37 cm and a small one around 52 cm in 2023 (Figure 34). By Division, more abundance of larger specimens was found in 8c as usual but more abundance of specimens around 29 cm was found in 9a in this last survey (Figure 35).

***Raja montagui* (spotted ray)**

The biomass of *R. montagui*, scarcer than *R. clavata*, decreased in this last survey and the mean biomass of the last two years was substantially below the mean value of the previous five (Figure 36). Like *R. clavata*, the species has been mainly found in standard hauls as usual but only in 8c Division, from 81 to 148 m, and also in one additional shallower haul at 52 m west of Peñas Cape. In this last survey, few specimens were found in the central and eastern area of the Cantabrian Sea (Figure 37). The length distribution in 2023 was similar to the previous year with specimens from 23 to 64 cm, although with no clear mode and fewer specimens around 54 cm than the previous year (Figure 38).

***Leucoraja naevus* (cuckoo ray)**

L. naevus has been mainly found in standard hauls over the time series and only in 8c Division like *R. montagui*. In this last survey, the biomass increased sharply reaching the highest value of the time series (Figure 39). The large spots of biomass usually found in the Cantabrian Sea between 6° and 7°W longitude, as well as between 3° and 5°W longitude, were present again this last year, although bigger than the previous year (Figure 40). The sizes ranged from 20 to 65 cm with more abundance of large specimens than the previous year (Figure 41).

***Raja brachyura* (blonde ray)**

This species was scarcely found in the survey, but this last year, the biomass increased markedly, reaching the highest value of the time series (Figure 42). Specimens were found in 15 standard hauls only in 8c Division, from 81 to 155 m and also in one additional shallower haul at 52 m west of Peñas Cape (Figure 43). Length distribution ranged from 27 to 114 cm, showing a high proportion of individuals from 47 to 54 cm, with a mode in 51 cm (Figure 44).

Other scarce elasmobranchs

Other species scarcely caught in the last survey were *D. licha*, *D. nidarosiensis*, *D. oxyrinchus* and *L. circularis*. They have been caught outside the standard stratification in deeper additional hauls (> 500 m).
D. licha was caught in one haul at 941 m in the south of Galician area, one female specimen of 61 cm.
D. nidarosiensis was caught in three hauls from 556 to 687 m in the Galician waters. Three specimens of 43, 54 and 62 cm.
Two specimens of *D. oxyrinchus* were found in one haul at 597 m west of Peñas Cape. Two males of 91 and 110 cm.
L. circularis was caught in three hauls from 452 to 687 m in the north of Galician area. Three specimens of 20, 71 and 97 cm.
No specimens of the occasional species *Mustelus mustelus*, *Centrophorus squamosus*, *Oxynotus paradoxus*, *Torpedo marmorata*, *Tetronarce nobiliana*, *Neoraja iberica*, *Leucoraja fullonica* and *Raja microocellata* were found in this last survey.

Acknowledgements

We would like to thank the R/V Miguel Oliver crew and the IEO scientific team that made the SPNSGFS Survey possible. Included in the ERDEM5 project, the survey has been co-funded by the EU through the European Maritime, Fisheries and Aquaculture Fund (EMFAF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

References

Blanco, M., Fernández-Zapico, O., Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A, González-Irusta, J.M., Velasco, E. 2022. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2022. https://doi.org/10.20350/digitalCSIC/15287

Castilho, R., Freitas, M., Silva, G., Fernandez-Carvalho, F. and R. Coelho, 2007. Morphological and mitochondrial DNA divergence validates blackmouth, *Galeus melastomus*, and Atlantic sawtail catsharks, *Galeus atlanticus*, as separate species. Journal of Fish Biology (2007) 70 (Supplement C), 346-358. http://doi:10.1111/j.1095-8649.2007.01455

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A, 2020. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2020.

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A, 2021. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2021. https://doi.org/10.20350/digitalCSIC/15285

Fernández-Zapico, O., Ruiz-Pico, S., Blanco, M., Rodríguez-Cabello, C., Punzón, A, González-Irusta J.M., Velasco, F. 2023. Results on main elasmobranch species captured in the 2022 Northern Spanish Shelf Groundfish Survey. WD presented to the ICES WGEF, June 2023. https://doi.org/10.20350/digitalCSIC/15299

Fernández-Zapico, O., Velasco, F., Rodríguez-Cabello, C., Punzón, A., Preciado, I., Ruiz-Pico, S., Blanco, M., 2016. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2016.

Fernández-Zapico, O., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A., Ruiz-Pico, S., Blanco, M., 2018. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2018.

ICES.2017. Manual of the IBTS North Eastern Atlantic Surveys. Series of ICES Survey Protocols SISP 15. 92 pp. http://doi.org/10.17895/ices.pub.3519

Punzón, A., Serrano, A., Castro, J., Abad, E., Gil, J. and Pereda, P., 2011. Deep-water fishing tactics of the Spanish fleet in the Northeast Atlantic. Seasonal and spatial distribution. Sci. Mar., 2011, 75(3), 465-476

Ruiz-Pico, S., Blanco, M., Fernández-Zapico, O., Velasco, F., Rodriguez-Cabello, C., Punzón, A., Preciado, I, 2019. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2019.

Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Punzón, A., Preciado, I., Fernández-Zapico, O., Blanco, M., 2015. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2015.

Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Preciado, I., Punzón, A., Fernández-Zapico, O., Blanco, M., 2017. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. WD presented to the ICES WGEF, June 2017.

Figures

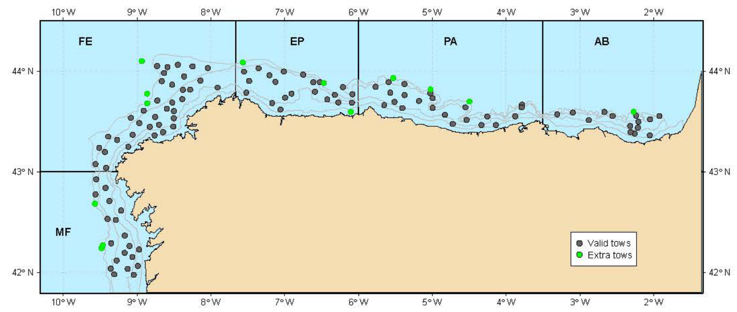


Figure 1: Stratification design and hauls on the Northern Spanish Shelf groundfish survey in the last year; Depth strata are: A) 70-120 m, B) 121 - 200 m and C) 201 - 500 m. Geographic sectors are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-cabo Peñas, PA: Peñas-cabo Ajo, and AB: Ajo-Bidasoa.

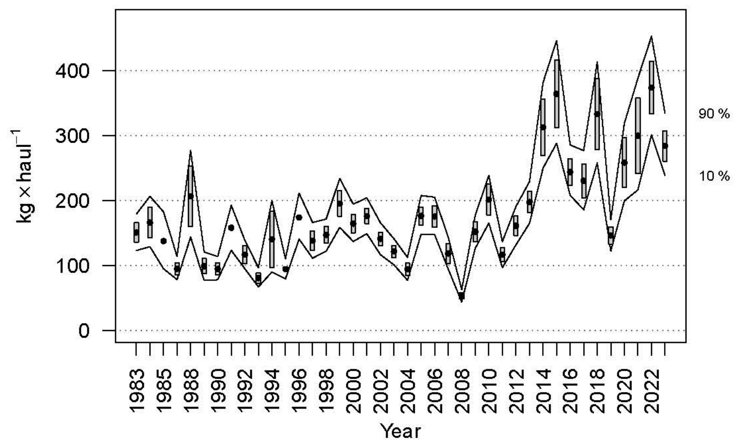


Figure 2: Evolution of the total fish caught in biomass on the Northern Spanish Shelf groundfish survey.

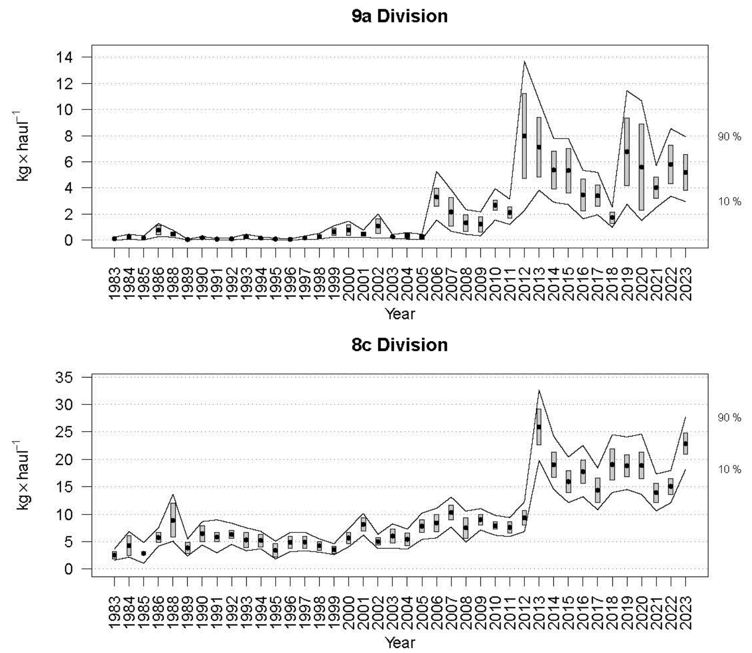


Figure 3: Evolution of *Scyliorhinus canicula* biomass index in the the Northern Spanish Shelf groundfish survey time series in the two ICES divisions. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

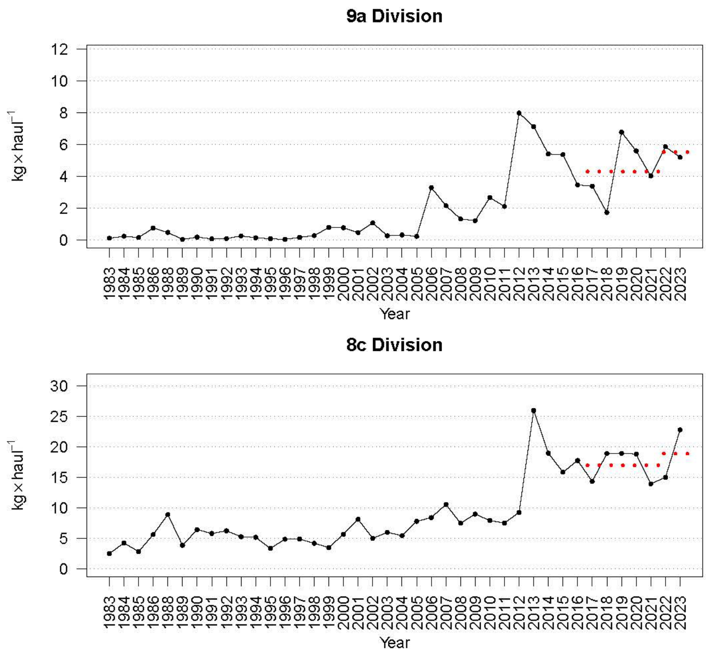


Figure 4: Evolution of *Scyliorhinus canicula* biomass index in the Northern Spanish Shelf groundfish survey time series in the two ICES divisions. Red lines mark a comparative between last two years and the five previous.

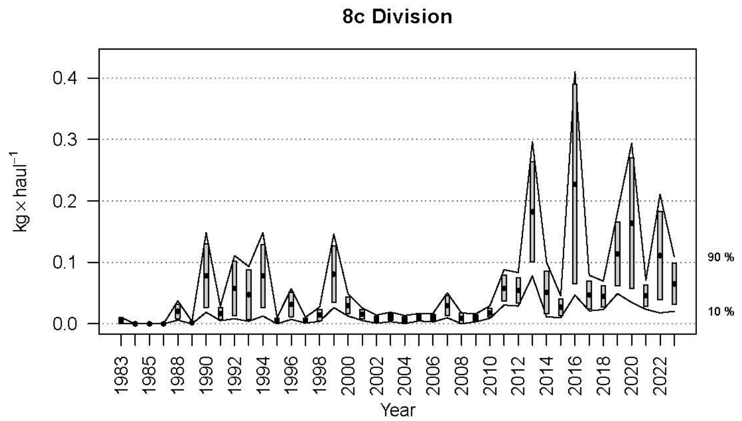


Figure 5: Evolution of *Scyliorhinus stellaris* biomass index in the North Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

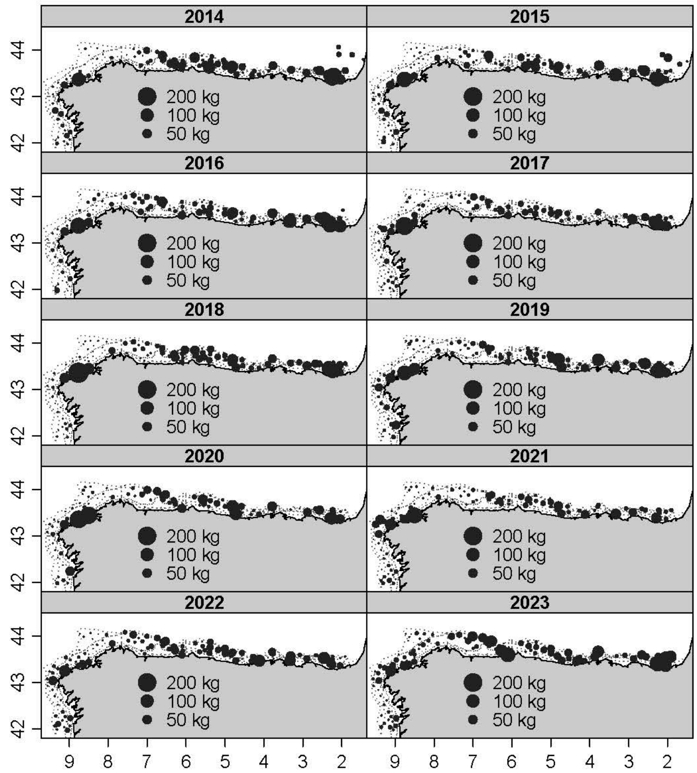


Figure 6: Geographic distribution of *Scyliorhinus canicula* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

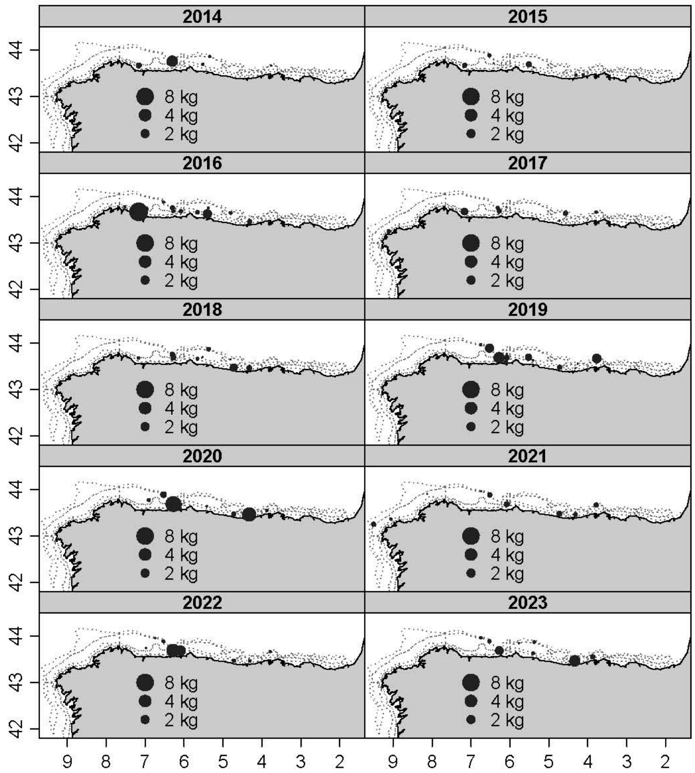


Figure 7: Geographic distribution of *Scyliorhinus stellaris* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

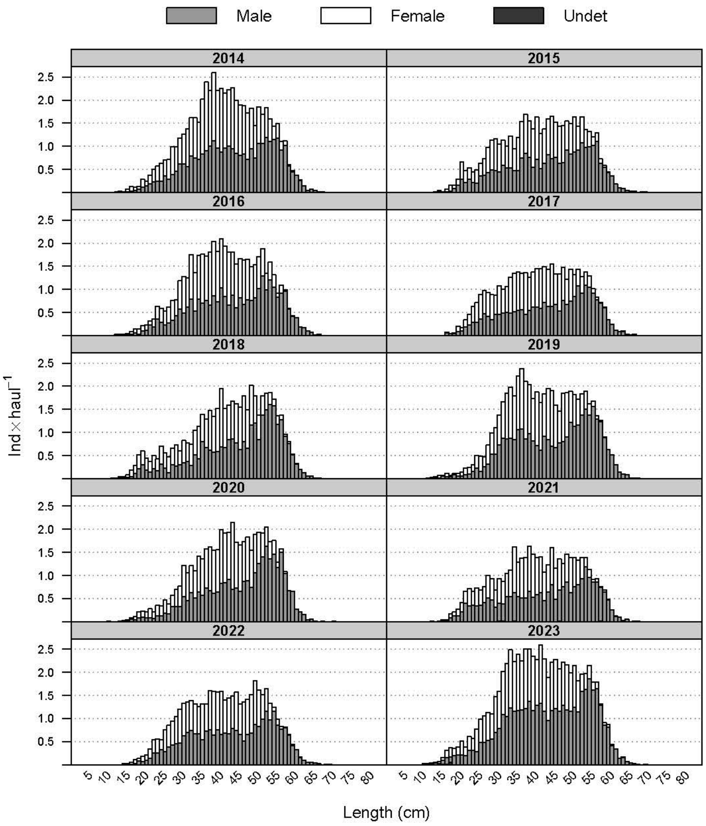


Figure 8: Mean stratified length distributions of *Scyliorhinus canicula* in the Northern Spanish Shelf groundfish survey in the last decade.

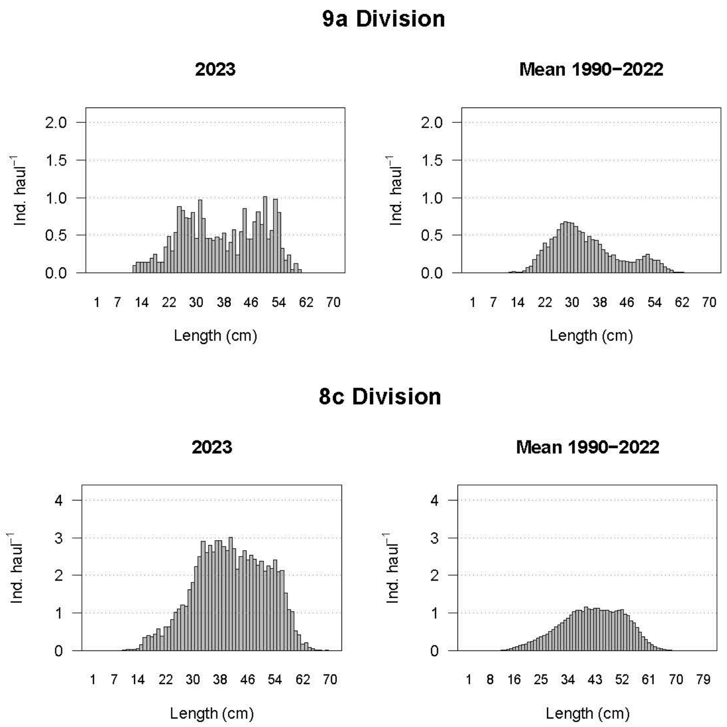


Figure 9: Stratified length distributions of *Scyliorhinus canicula* in the Northern Spanish Shelf groundfish survey in the two ICES divisions for the last year and the mean values for the time series.

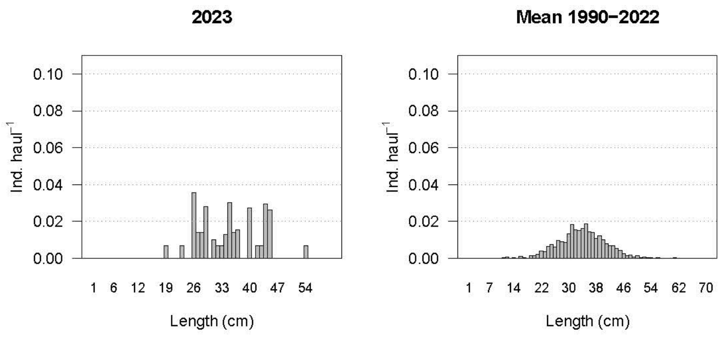


Figure 10: Stratified length distributions of *Scyliorhinus stellaris* in the Northern Spanish Shelf groundfish survey in the 8c Division for the last year and the mean values for the time series.

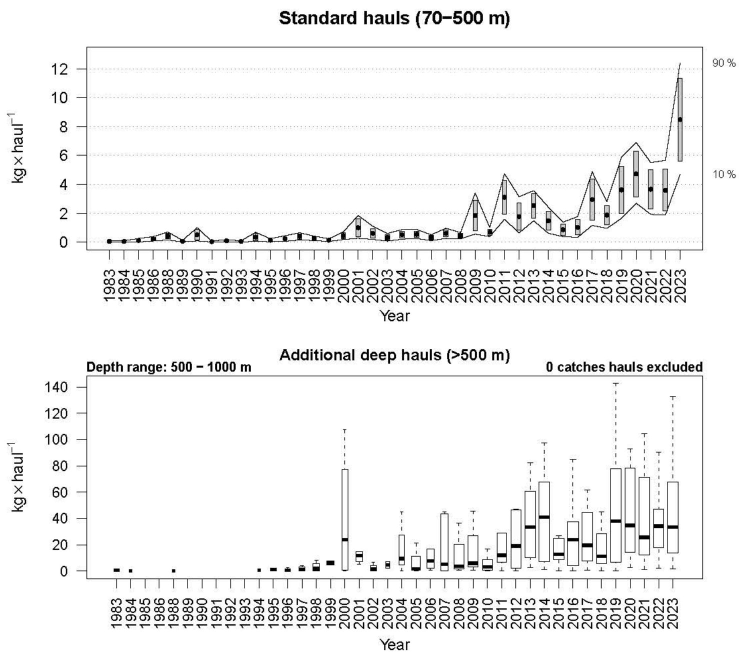


Figure 11: Evolution of *Galeus* spp. stratified biomass index in standard hauls and additional deep hauls during the Northern Spanish Shelf groundfish survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a=0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

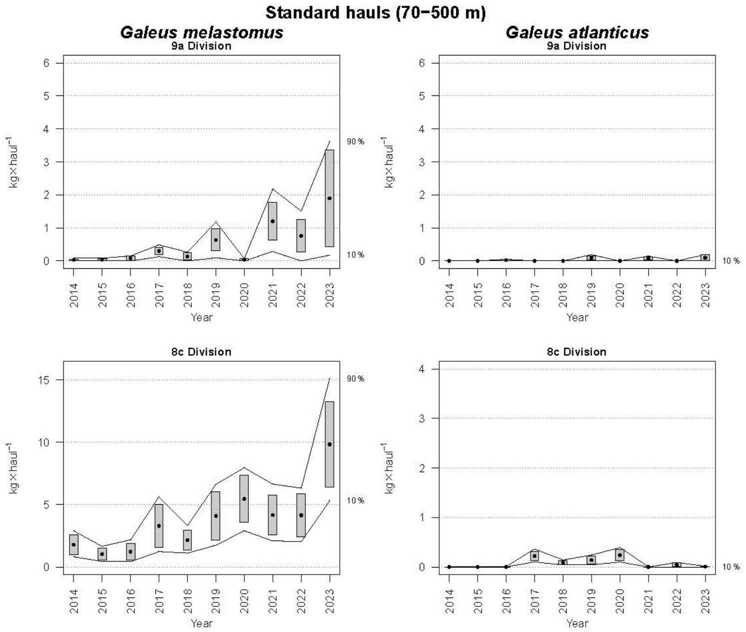


Figure 12: Evolution of *Galeus melastomus* and *Galeus atlanticus* stratified biomass index in standard hauls of the two ICES divisions in the last decade during the Northern Spanish Shelf groundfish survey. The standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a=0.80, bootstrap iterations = 1000).

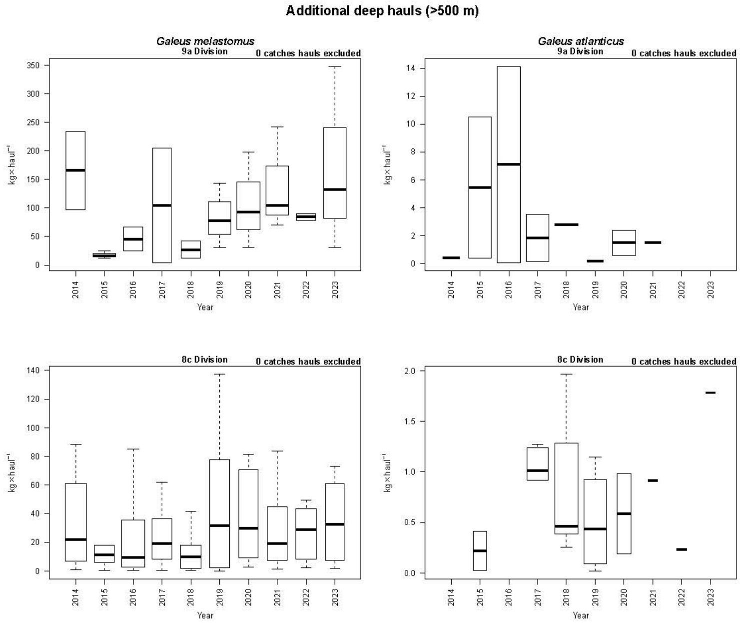


Figure 13: Evolution of *Galeus melastomus* and *Galeus atlanticus* catches in additional deep hauls of the two ICES divisions in the last decade during the Northern Spanish Shelf groundfish survey. Boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Confidence intervals are estimated only when there are two or more hauls with catch of the species.

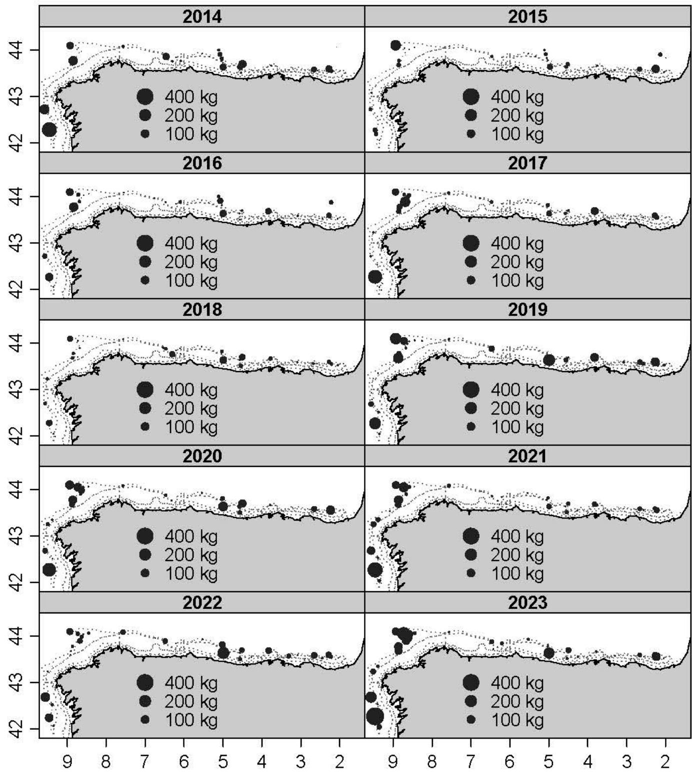


Figure 14: Geographic distribution of *Galeus melastomus* catches (kg/30 min haul) including both standard and additional deep hauls in the Northern Spanish Shelf Groundfish Survey in the last decade.

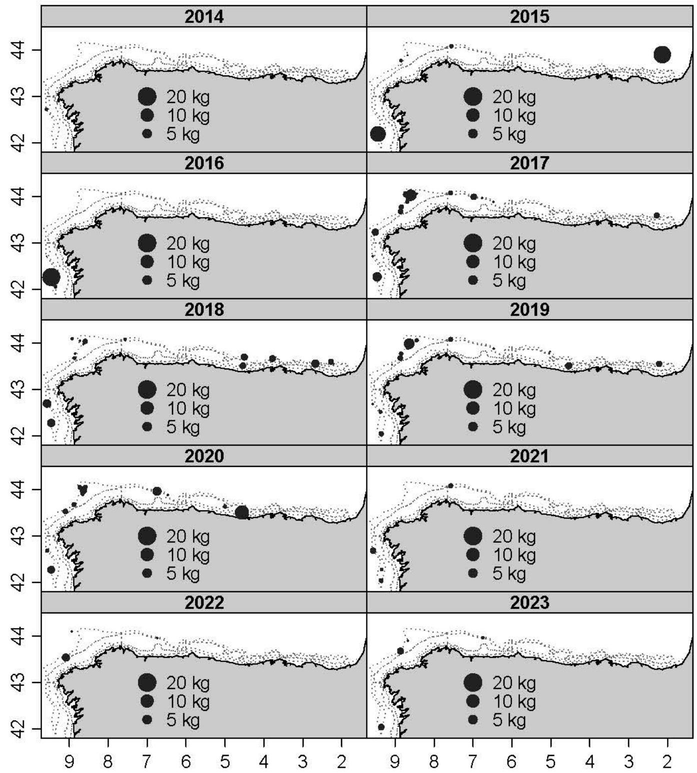


Figure 15: Geographic distribution of *Galeus atlanticus* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

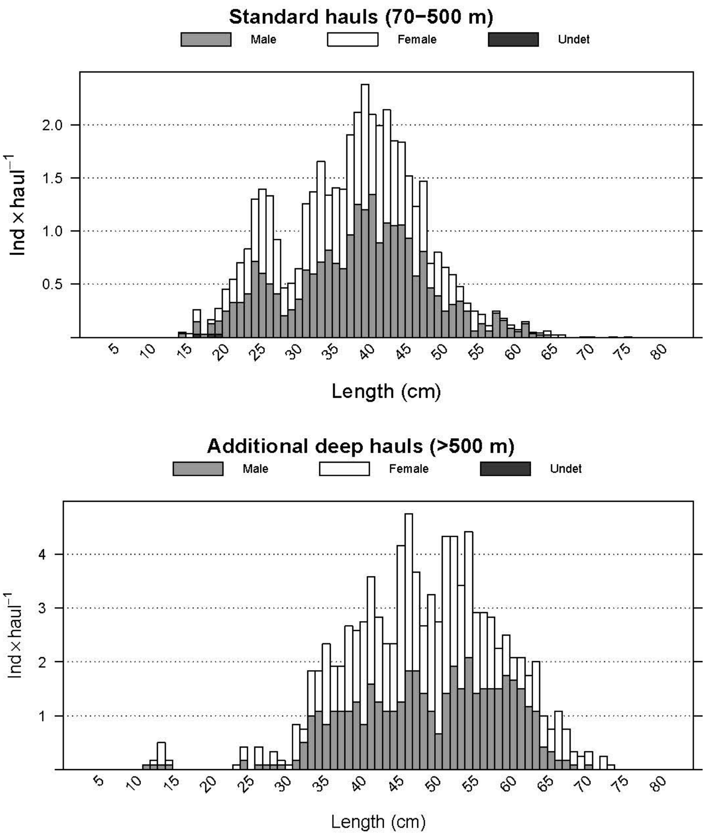


Figure 16: Mean length distributions of *Galeus melastomus* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the last Northern Spanish Shelf groundfish survey.

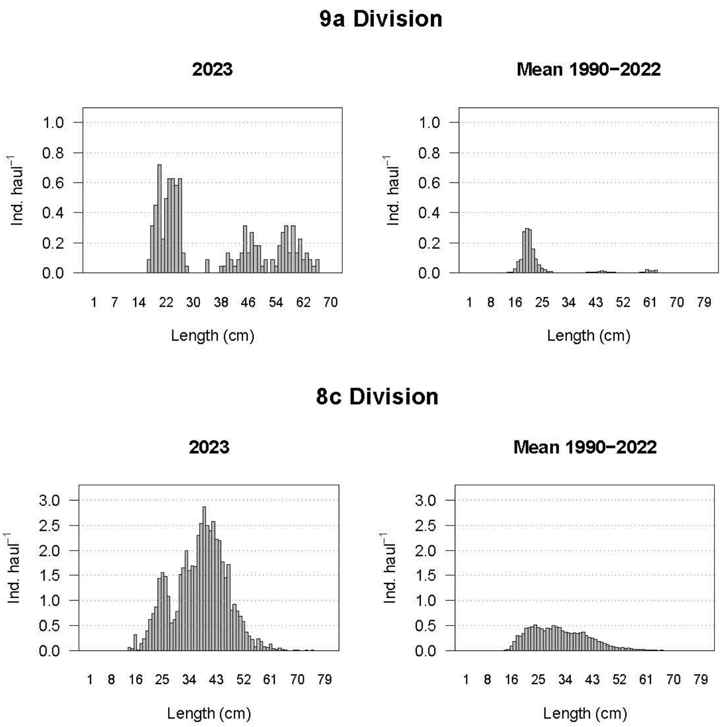


Figure 17: Stratified length distributions of *Galeus melastomus* in the two ICES divisions covered by the North Spanish Shelf groundfish survey for the last year and the mean values for the time series.

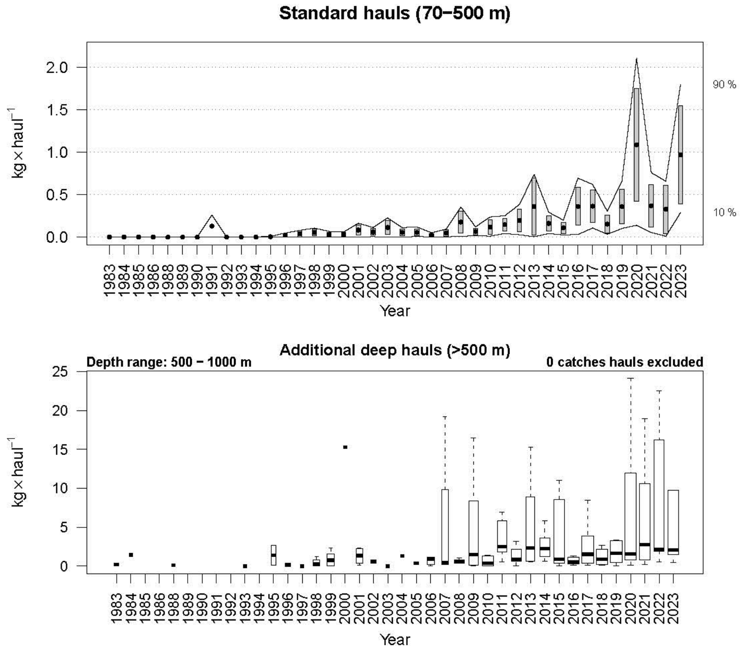


Figure 18: Evolution of *Etmopterus spinax* stratified biomass index in standard hauls and additional deep hauls during the Northern Spanish Shelf groundfish survey time series. For the standard hauls boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a=0.80, bootstrap iterations = 1000). For the additional deep water hauls boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed.

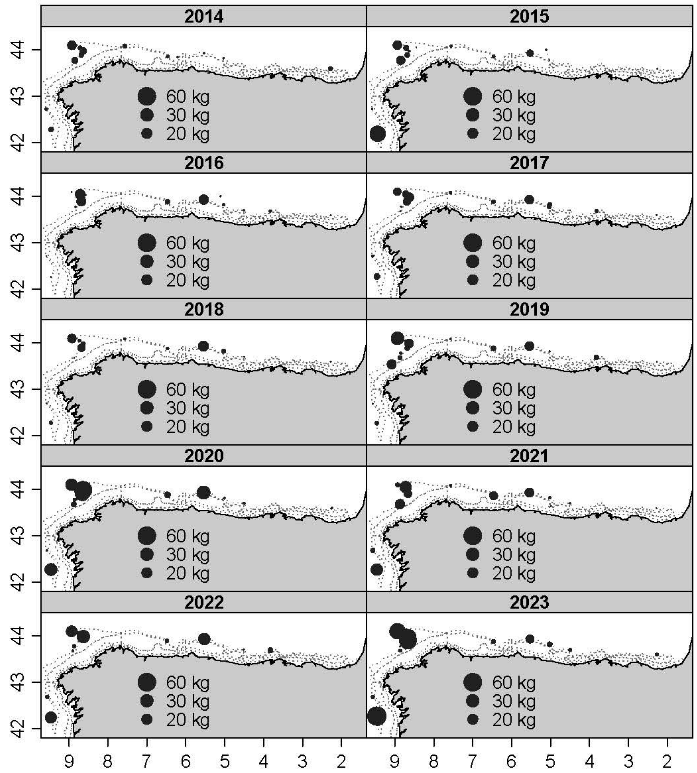


Figure 19: Geographic distribution of *Etmopterus spinax* catches (kg/30 min haul) including both standard and additional deep hauls in the Northern Spanish Shelf groundfish survey in the last decade.

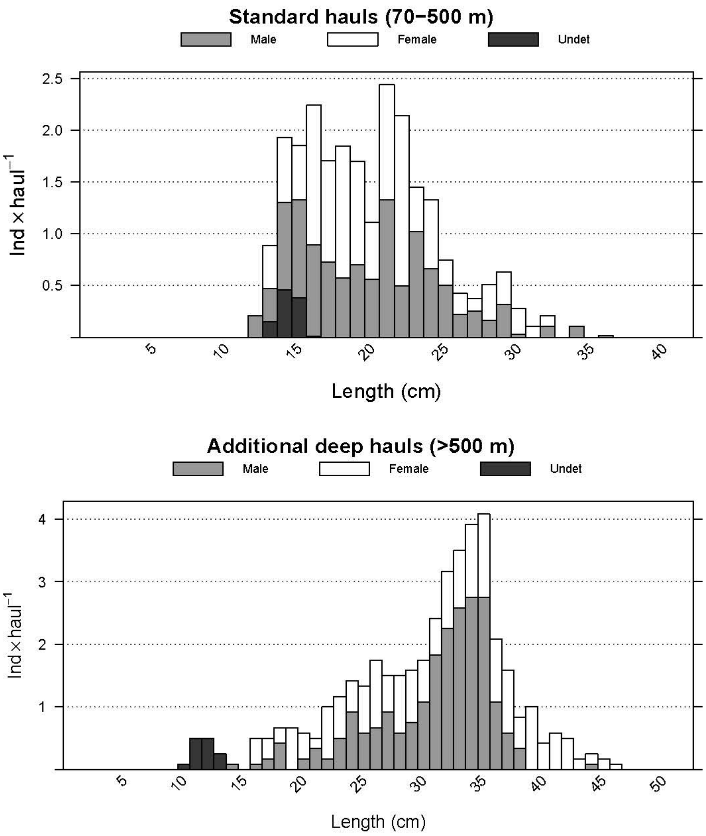


Figure 20: Mean length distributions of *Etmopterus spinax* in additional hauls (>500 m) and in the standard hauls (70-500 m) in the last Northern Spanish shelf groundfish survey.

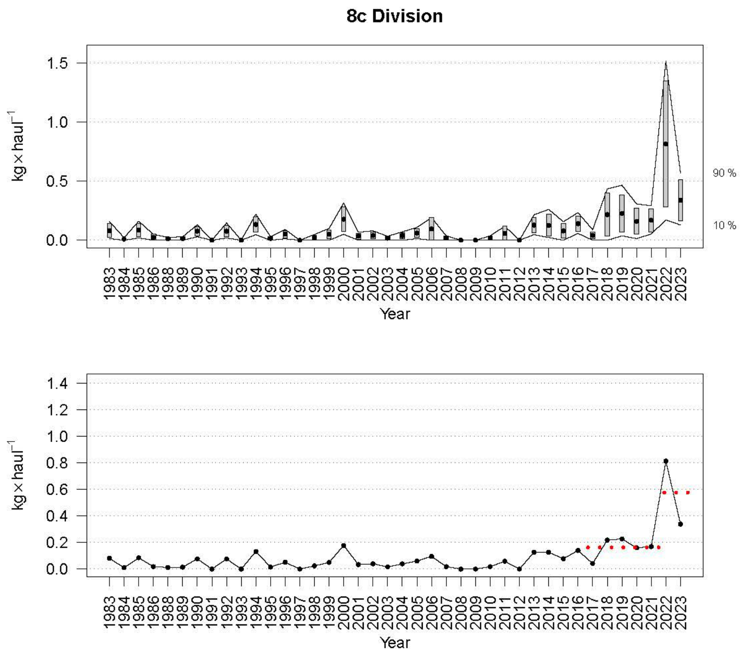


Figure 21: Evolution of *Hexanchus griseus* biomass index during the Northern Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000). Red lines mark a comparative between last two years and the five previous.

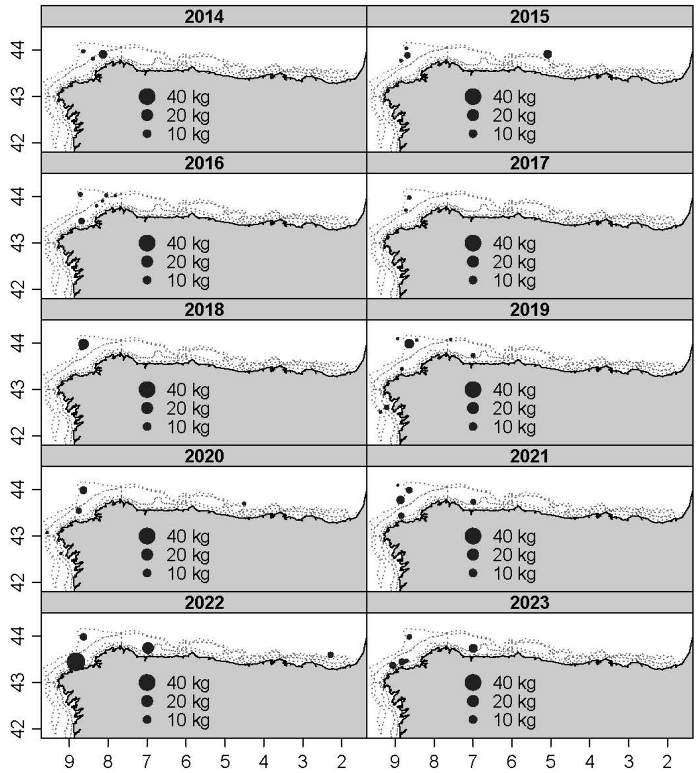


Figure 22: Geographic distribution of *Hexanchus griseus* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

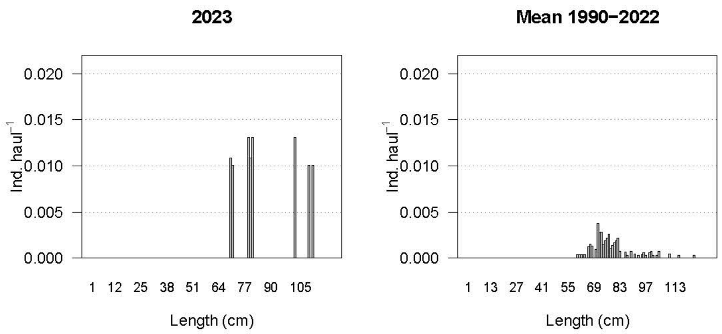


Figure 23: Stratified length distributions of *Hexanchus griseus* in the 8c Division covered by the Northern Spanish Shelf groundfish survey for the last year and the mean values for the time series.

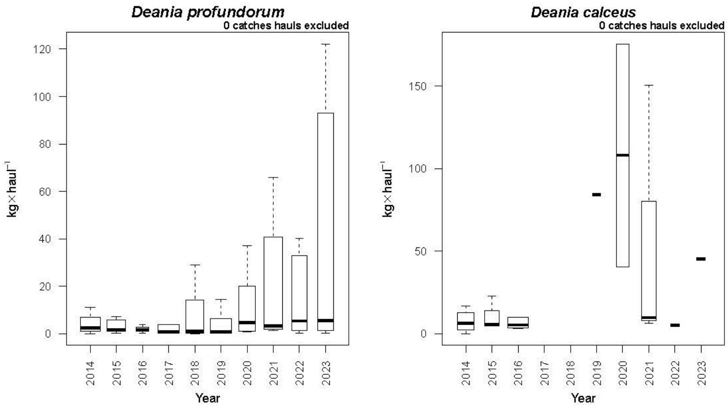


Figure 24: Evolution of *Deania profundorum* and *Deania calceus* catches in additional deep hauls the Northern Spanish Shelf groundfish survey in the last decade. Boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Confidence intervals are estimated only when there are two or more hauls with catch of the species.

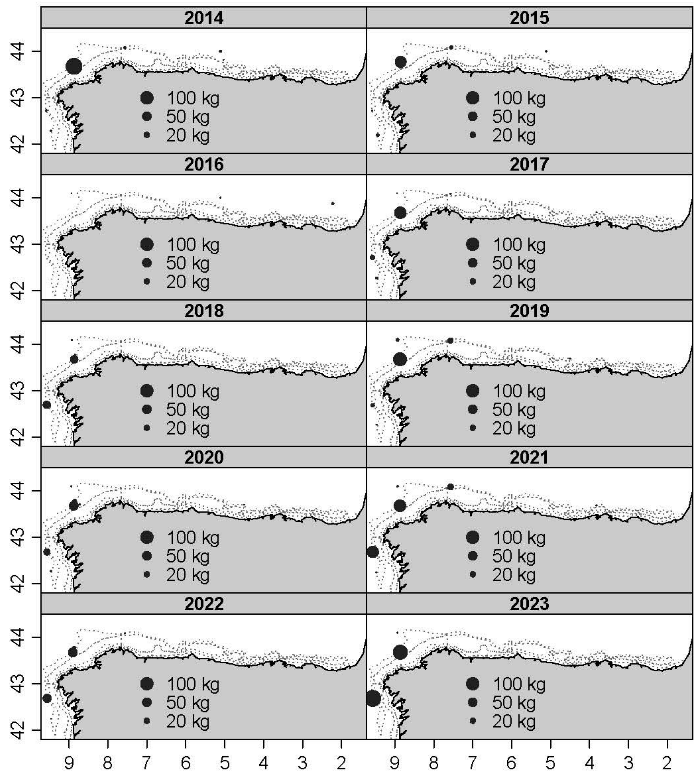


Figure 25: Geographic distribution of *Deania profundorum* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

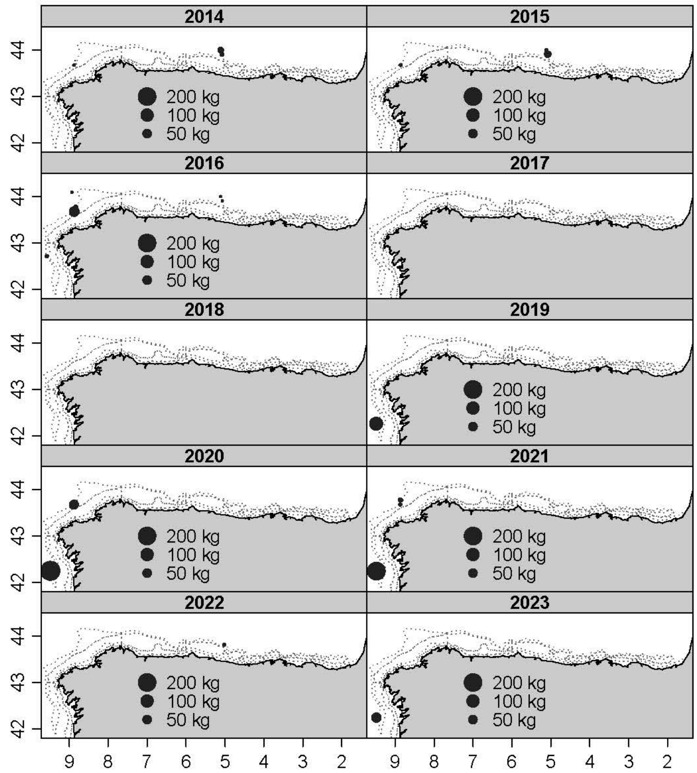


Figure 26: Geographic distribution of *Deania calceus* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

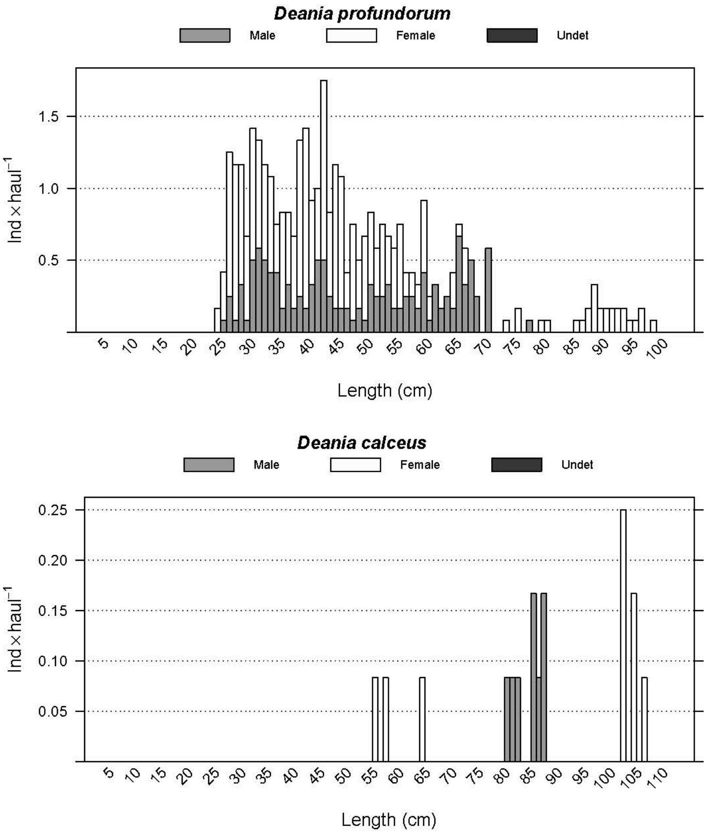


Figure 27: Mean length distributions of *Deania profundorum* and *Deania calceus* in additional hauls (>500 m) in the last Northern Spanish Shelf groundfish survey.

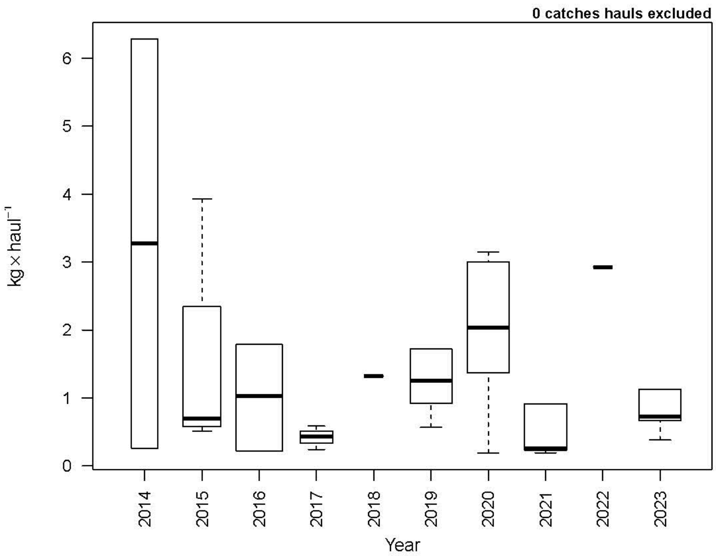


Figure 28: Evolution of *Scymnodon ringens* catches in additional deep hauls in the Northern Spanish Shelf groundfish survey in the last decade. Boxplots represent the median and interquartiles of the biomass catches in the deep hauls performed. Confidence intervals are estimated only when there are two or more hauls with catch of the species.

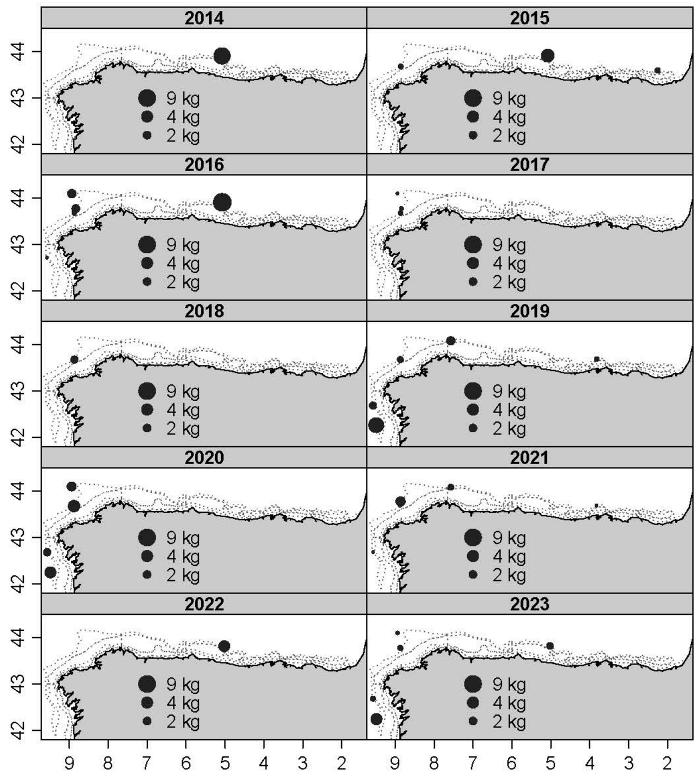


Figure 29: Geographic distribution of *Scymnodon ringens* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

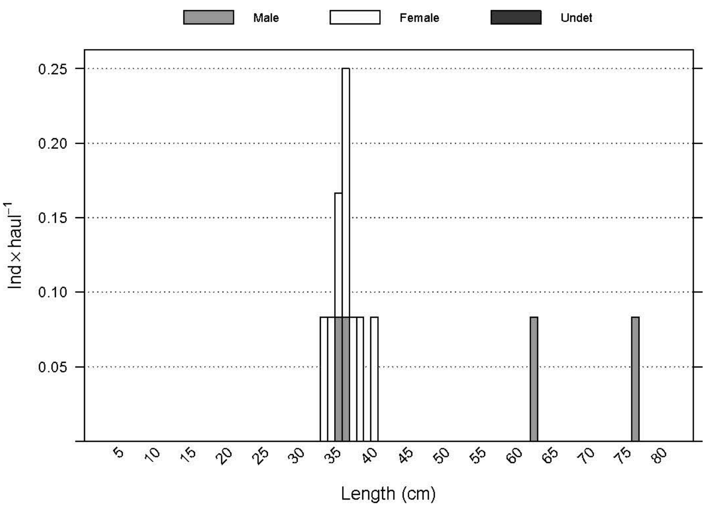


Figure 30: Mean length distributions of *Scymnodon ringens* in additional hauls (>500 m) in the last Northern Spanish Shelf groundfish survey.

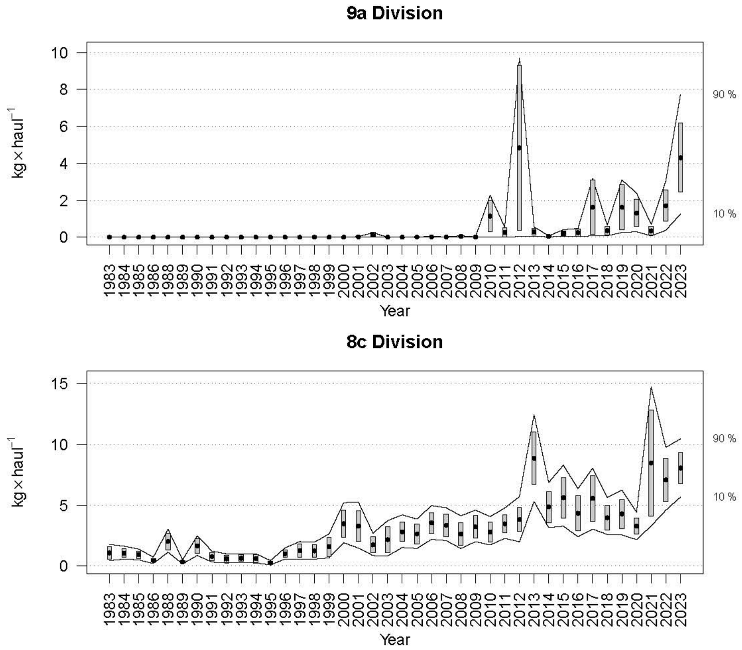


Figure 31: Evolution of *Raja clavata* biomass index in the Northern Spanish Shelf groundfish survey time series in the two ICES divisions. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

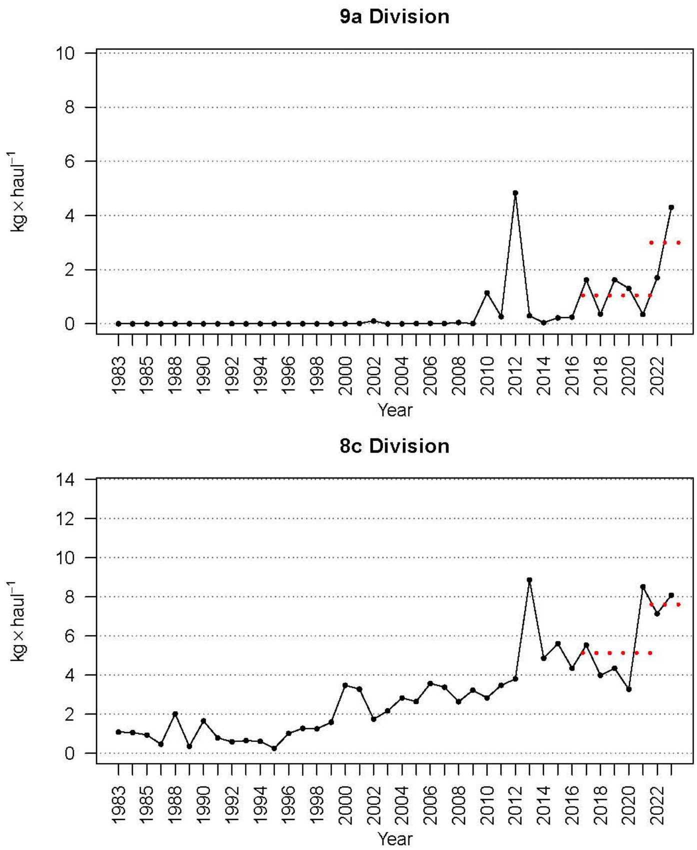


Figure 32: Evolution of *Raja clavata* biomass index in the North Spanish Shelf groundfish survey time series in the two ICES divisions covered by the survey. Red lines mark a comparative between last two years and the five previous.

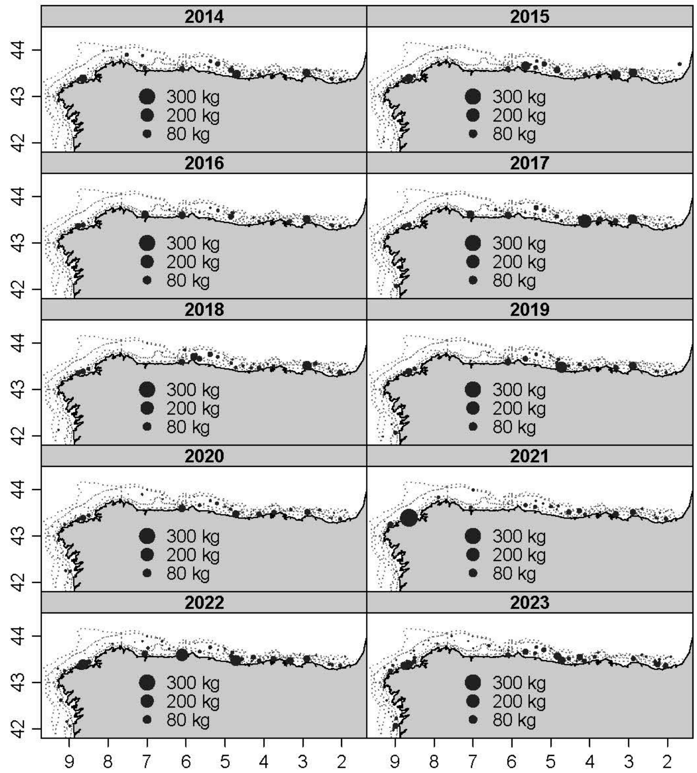


Figure 33: Geographic distribution of *Raja clavata* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

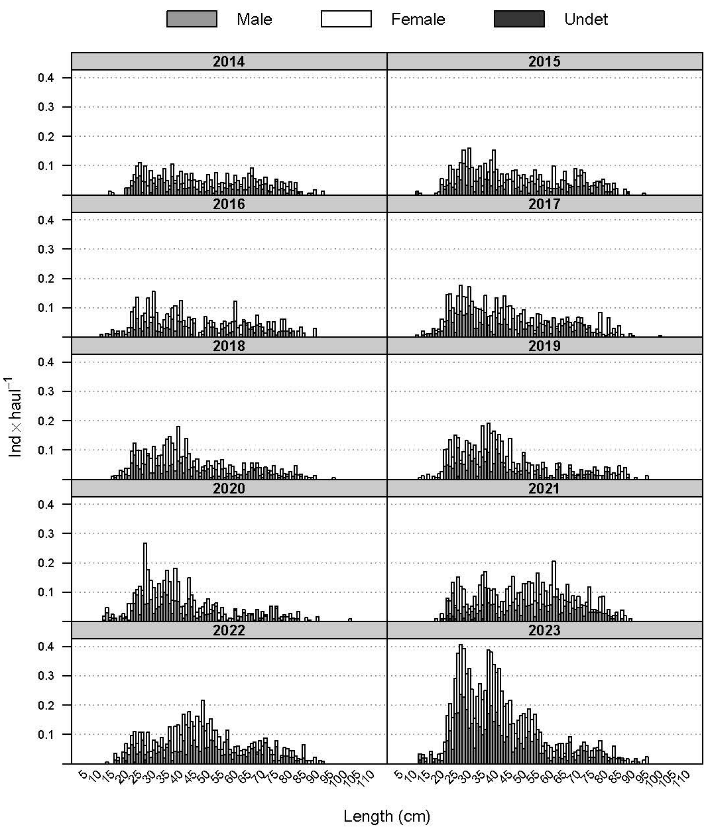


Figure 34: Mean stratified length distributions of *Raja clavata* in the Northern Spanish Shelf groundfish survey in the last decade.

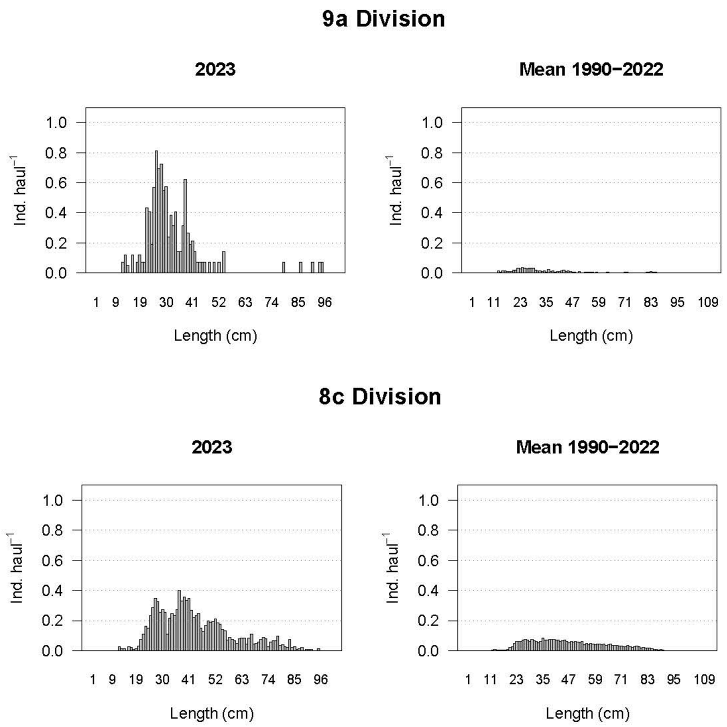


Figure 35: Stratified length distributions of *Raja clavata* in the Northern Spanish Shelf groundfish survey in the two ICES divisions for the last year and the mean values for the time series.

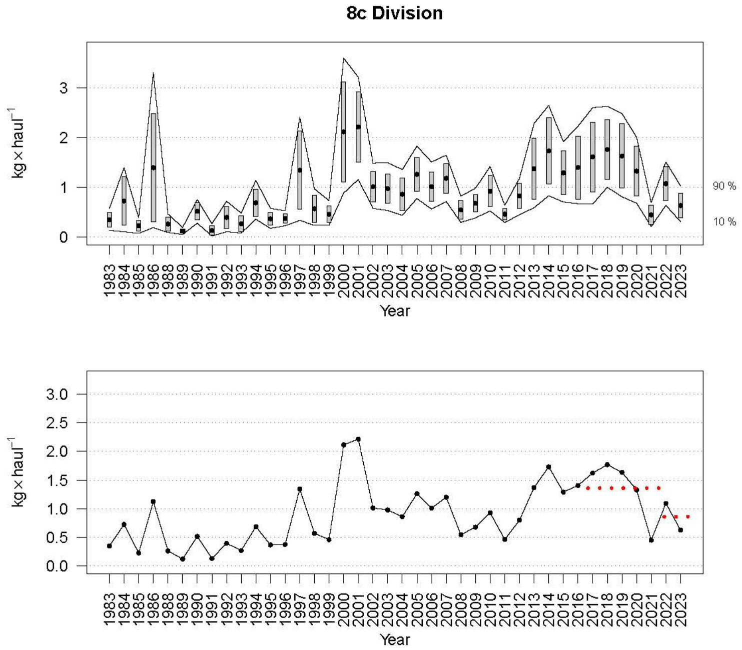


Figure 36: Evolution of *Raja montagui* biomass index in the Northern Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000). Red lines mark a comparative between last two years and the five previous.

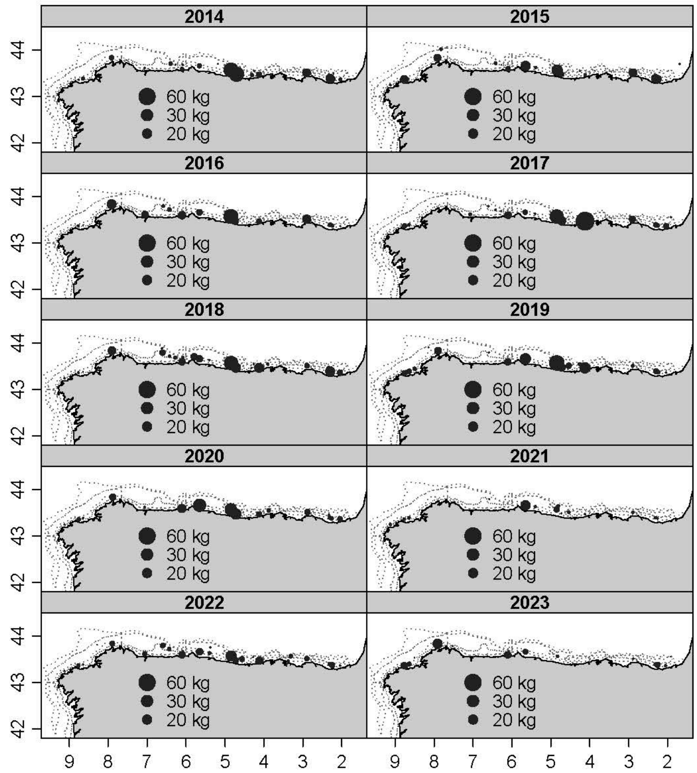


Figure 37: Geographic distribution of *Raja montagui* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

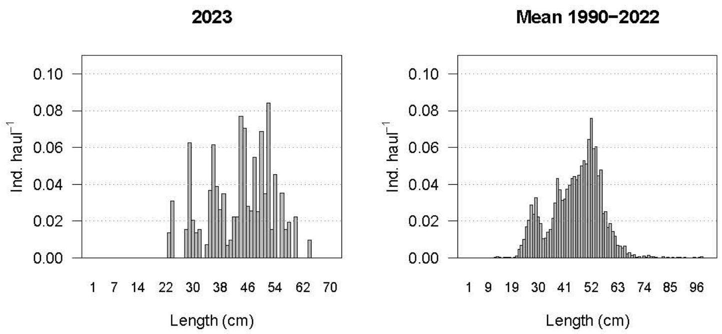


Figure 38: Stratified length distributions of *Raja montagui* in the Northern Spanish Shelf groundfish survey in the 8c Division for the last year and the mean values for the time series.

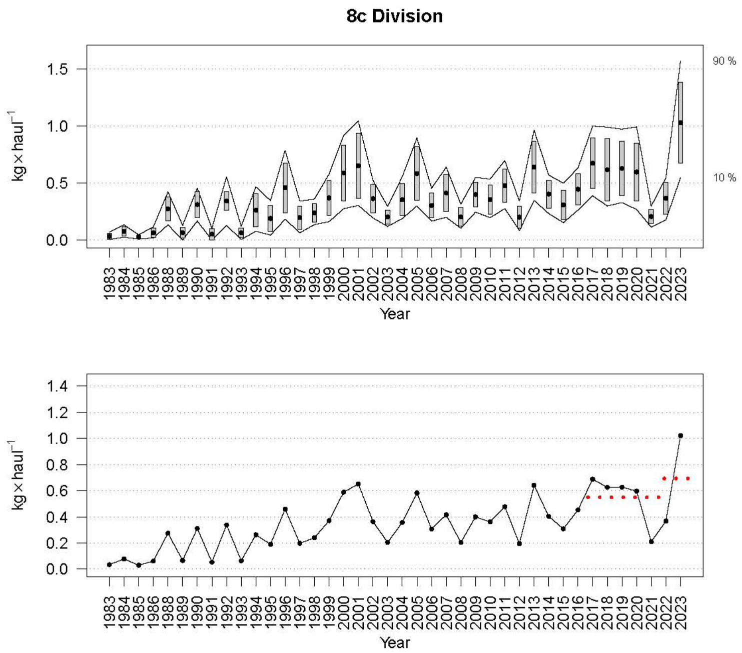


Figure 39: Evolution of *Leucoraja naevus* biomass index in the Northern Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000). Red lines mark a comparative between last two years and the five previous.

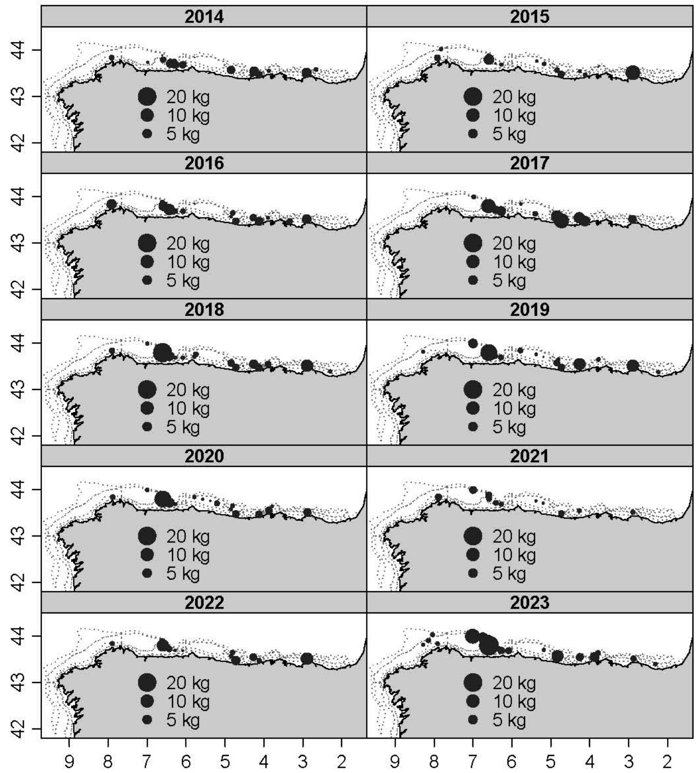


Figure 40: Geographic distribution of *Leucoraja naevus* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

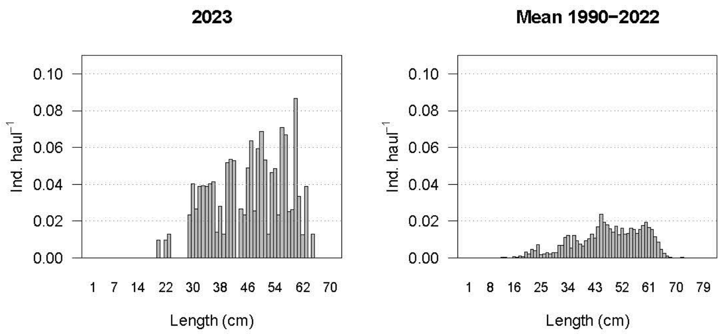


Figure 41: Stratified length distributions of *Leucoraja naevus* in the Northern Spanish Shelf groundfish survey in the 8c Division for the last year and the mean values for the time series.

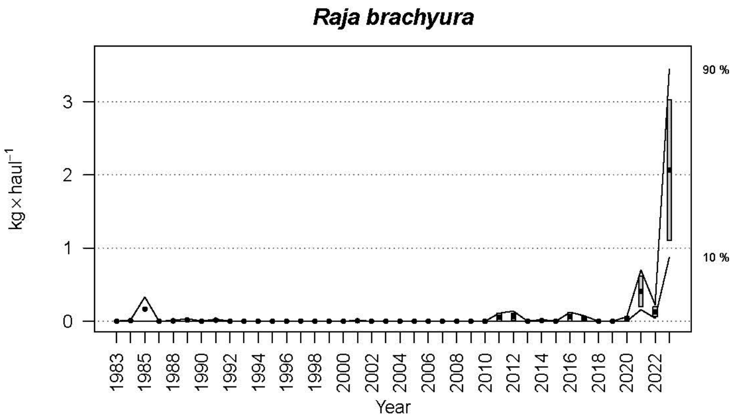


Figure 42: Evolution of *Raja brachyura* biomass index in the North Spanish Shelf groundfish survey time series in the 8c Division. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).

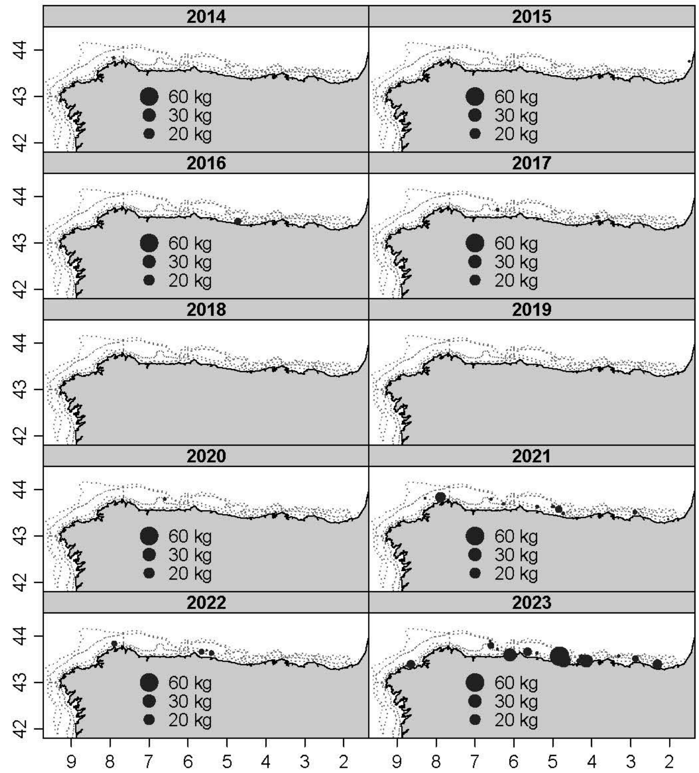


Figure 43: Geographic distribution of *Raja brachyura* catches (kg/30 min haul) in the Northern Spanish Shelf groundfish survey in the last decade.

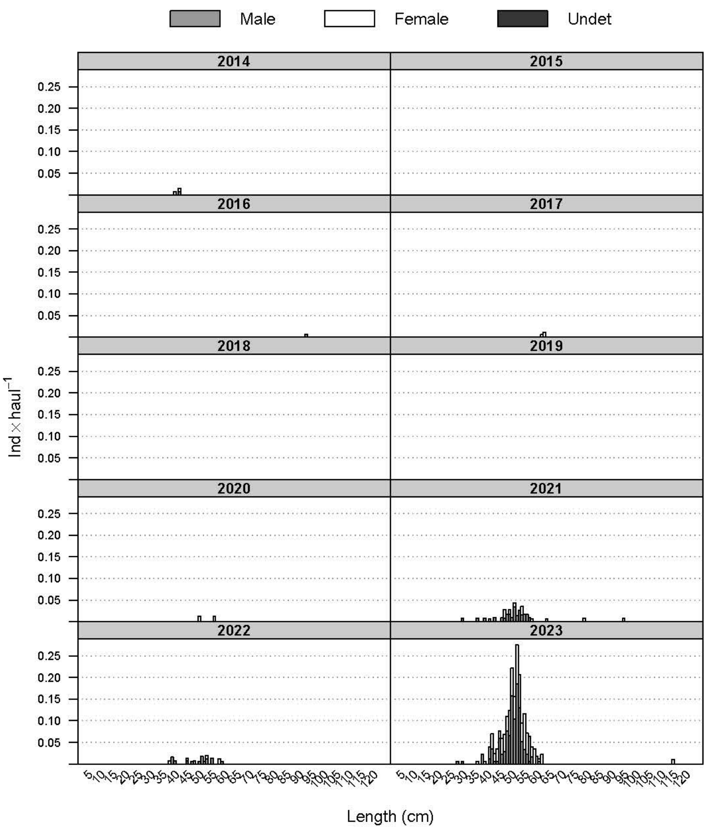


Figure 44: Mean stratified length distributions of *Raja brachyura* in the Northern Spanish Shelf groundfish survey in the last decade.

Working Document presented at WGEF Lisbon, 18th to 27th June 2024

Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal and Gulf of Cadiz) (rju.27.9a) - update

Catarina Maia[1],Bárbara Serra-Pereira[1], Teresa Moura[1] and Ivone Figueiredo[1]

[1]Divisão de Modelação e Gestão de Recursos da Pesca, Instituto Português do Mar e da Atmosfera (IPMA)

Rua Alfredo Magalhães Ramalho 6, 1495-006 Lisboa, PORTUGAL

Fishery Overview

Historically and prior the inclusion of *R. undulata* in the European list of prohibited species in 2009, official landings on the species were not informative once landings were not discriminated by species. Portuguese historical landings of *R. undulata* for the period 2003-2008 were presented during the working group in 2015 (Maia et al., 2015). *Raja undulata* landings were estimated from aggregated Rajidae multispecies landings following the procedure proposed by Shelton et al. (2012) and using a multinomial–Poisson transformation (Baker 1994). More recently, during the benchmark WKBELASMO3, Rajidae species historical landings were reconstructed and data for *R. undulata* for the period 2000-2002 is now available (the procedures followed are available in Maia et al. 2023). Landings by country and by fleet for the period 2000-2023 are present in figure 1.

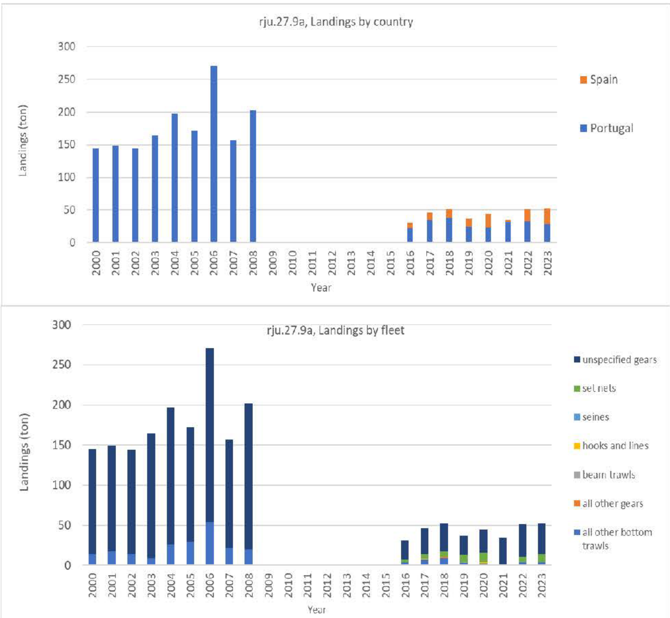


Figure 1: *Raja undulata* in ICES Division 27.9a. Landings by country and by fleet for the period 2000-2023.

Portuguese management measures under the experimental quota

The inclusion of *R. undulata* in the European list of prohibited species lead to claims from European fishermen, namely from France and Portugal, that argued the species was locally abundant. As result, fishery-science partnerships were established both in France and Portugal to collate information on the species. In France, Raimouest, RaieBeca and RECOAM were setup to study the abundance of the species in these areas and the final results were delivered in 2014 (Diez et al., 2014). Similar Portuguese fisheries initiatives took place in ICES Division 27.9a. and the results were communicated to ICES in the context of the WGEF. In recognition of the efforts undertaken by fishermen and scientific institutes, EU decided to remove the species from the European list of prohibited species in 2014 for ICES Divisions 27.7 and 27.8 and in 2015 for ICES Division 27.9. In 2015 for ICES Division 27.9, a zero TAC was still in force, which meant that the species could not be landed. However, in 2016, an EU by-catch allowance for ICES Division 27.9.a. was set. This by-catch was considered as a small experimental quota which would enable the collection of fishery data on *R. undulata* "*to ensure the continuity of scientific studies and to assess the state of the resource and ensure, in the future, its sustainable exploitation*" (COUNCIL REGULATION (EU) 2016/72 of 22 January 2016).

In Portugal, the use of *R. undulata* small experimental quota was guided by scientific protocols and national regulations adopted, which were in turn conditioned by the EU quota assigned.

Regarding the management of the experimental quota, Portugal adopted in 2016 a legislative framework that is still in place. The legislative framework includes a set of conditions for licensing specific fishing permits to around 60 vessels operating along the Portuguese coast, following a set of criteria which include fishing vessel type, fishing license already assigned to the vessel and historical skate landings. Vessels possessing the specific fishing permit shall comply with a set of rules, which include obligation to transmit, to both the General Directorate of Natural Resources, Maritime Security and Services (DGRM) and to IPMA, fishery data using a form designed by DGRM and IPMA to register haul and catch data on a haul-by-haul basis (including hauls performed with trammel nets with no catch of the species). Furthermore, vessels are prohibited from targeting the species and are constrained to land a maximum of 30 kg per trip and the total length of landed specimens should be in the range 78-97 cm. As additional management measure adopted is prohibition of retaining the species onboard and of landing during the months of May, June and July. Additionally, in 2019, the DGRM introduced a landing control process under which, vessels not possessing the special fishing license are also allowed to land a maximum of one specimen per trip and are also required to provide additional information on their fishing activity related to *R. undulata* catches. Since in this new data collection scenario the forms with information on the species catches are delivered when the fish enters the auction. Because of this new data collection scenario, fishery data on trammel nets hauls with null catches of *R. undulata* were no longer mandatory.

EU by-catch allowance to Portugal since 2016 and the number of licenses attributed is present in table 1.

Table 1: *Raja undulata* in ICES Division 27.9a. EU experimental quota assign to Portugal and number of licenses attributed for the period 2016-2023.

Year	Quota (ton)	Nº licenses
2016	12	53
2017	14	52
2018	15	60
2019	15	60
2020	15	51
2021	15	60
2022	15	55
2023	15	61

Portuguese Fishery data after the moratorium period

Data collected under the quota management scenario and comments on its quality/application are summarized in Table 2. To stress, the late licenses assignment in 2018 that resulted in insufficient data, the lack of information on zero catches from 2019 and the data requirements misinterpretation.

Table 2. *Raja undulata* in ICES Division 27.9a. Number of hauls reported the under quota management scenario per region: N – North; C – Center; SW – Southwest and; S – South. Comments on the data quality are presented.

Year	N	C	SW	S	Comment	Application
2016	1	337	192	14	Data derived exclusively from licensed vessels; fishing hauls using different fishing gears; data reporting zero catches from trammel nets; incomplete data. 2016 is considered experimental year as fishermen were not completely clarified what they should provide.	
2017	162	378	583	324	Data derived exclusively from licensed vessels; data from fishing hauls using different fishing gears; data reporting zero catches from trammel nets; still some incomplete data, but improvements on data quality were achieved.	Relative abundance/biomass estimates (Figueiredo *et al*. 2020). For details see *Species distribution, abundance and behaviour* below
2018	0	13	591	28	Late assignment of licenses (in April just before the fishing closed period for the species – May to July) and consequently few data available; data derived exclusively from specific licensed vessels; data from fishing hauls using different fishing gears; data reporting zero catches from trammel nets; incomplete data.	Impossible to apply the method accepted by ICES
2019	164	126	864	170	Data derived from DGRM landing control process; new template associated with authorization of no-licensed vessels to land 1 specimen per trip; does not include data reporting zero catches; data from fishing hauls using different fishing gears; misreporting errors were detected (41% records with catches equal to 1 specimen, possible fisherman problems of template interpretation)	Impossible to apply the method accepted by ICES
2020	471	320	868	408	Same as 2019; does not include data reporting zero catches; data from fishing hauls using different fishing gears; misreporting errors were detected (41%) and 43% records with	Impossible to apply the method accepted by ICES

					catches equal to 1 specimen (problems of template interpretation)	
2021	546	143	1183	306	Same as 2019; does not include data reporting zero catches; data from fishing hauls using different fishing gears; misreporting errors were detected (49%) and 44% records with catches equal to 1 specimen (problems of template interpretation)	Impossible to apply the method accepted by ICES
2022	323	263	799	136	Same as 2019; does not include data reporting zero catches; data from fishing hauls using different fishing gears; misreporting errors were detected (36%) and 50% records with catches equal to 1 specimen (problems of template interpretation)	Impossible to apply the method accepted by ICES
2023	282	226	1033	146	Same as 2019; does not include data reporting zero catches; data from fishing hauls using different fishing gears; misreporting errors were detected (49%) and 44% records with catches equal to 1 specimen (problems of template interpretation)	Impossible to apply the method accepted by ICES

Species biology and population parameters

Main biological information available for *R. undulata* in Portuguese waters is summarized in Table 3.

Table 3. *Raja undulata* in ICES Division 27.9a. Summary of published life history data giving L_{50} (A_{50}): Length (age) at 50% maturity; M_{50}: size-at-maternity; growth parameters L_{∞}: asymptotic length, k: growth rate and t0: size at age-0; L_{max}: maximum observed length (age): L_{max} (A_{max}); A_{∞}: maximum theoretical age; TW ~ aLTb: length-weight relationship; r': potential rate of population increases; and M: natural mortality.

Period		1999–2001	1999–2001	2003–2006	2001–2008	2003–2013
Region		Algarve	Algarve	Centre	North/Centre	North/Centre
Depth range (m)		–	–	–	–	4 to 128 (mostly 30–40)
Egg-laying depth range (m)		–	–	–	–	10 to 55 (mostly < 30)
Length range (cm)		19.4–88.2	32.0–83.2	23.7–90.5	48.0–95.9	23.5–95.9
L_{50} (cm)	F	76.2	–	83.8	–	86.2±2.6
	M	73.6	–	78.1	–	76.8±2.4
A_{50} (years)	F	8.98	–	9	–	8.7±0.3
	M	7.66	–	8	–	7.6±0.4
M_{50} (cm)		–	–	–	–	95.7±15.3
Reproductive period		Dec–Feb	–	Feb–May	–	Dec–Jun
Fecundity (eggs per female)		–	–	–	–	69.8±3.4
Size-at-birth (cm)		–	–	–	–	13.5
L_{max} (cm)		88.2	83.2	90.5	–	95.9
L_{∞} (cm)		110.2	119.3	113.7	–	–
k ($year^{-1}$)		0.11	0.12	0.15	–	–
t_0 (years)		–1.58	–0.41	–0.01	–	–
A_{max} (years)		13	9	12	–	12.6
A_{∞} (years)		–	28.9	23.6	–	–
$W = aL_T^b$	a	–	–	–	$1.92*10^{-5}$	–
	b	–	–	–	2.86	–
r' (using Jennings *et al.* (1999)		–	–	–	–	0.49
M: Jensen 1996 method (Pauly 1980 method)		–	–	–	–	0.24 (0.27)
References		[1], [2]	[3]	[3]	[4]	[5]

Sources: [1] Coelho & Erzini, 2002; [2] Coelho & Erzini, 2006; [3] Moura et al. 2007; [4] Serra-Pereira et al. 2010; [5] Serra-Pereira et al., 2015.

Species distribution, abundance and behaviour

Along the Portuguese continental coast, *R. undulata* bathymetric distribution varies from 4 to 128 m deep, being more abundant at depths ranging from 30 to 40 m. Egg-laying sites are known to be located between 10 and 55 m deep, but occur preferentially on grounds shallower than 30 m. Estuaries and coastal lagoons are likely to be important habitats for the species, particularly to newborn/juveniles and egg-laying females where both groups tend to concentrate during some periods of the year (Coelho *et al.* 2005, Serra-Pereira *et al.*, 2014). Juveniles were recorded in the outer estuary of the Tagus (centre of Portugal) and within the Ria Formosa coastal lagoon (south of Portugal).

In ICES Division 27.9a, the coastal distribution of *R. undulata* and its habitat preferences, hinders the collection of adequate data from both Spanish IEO Q4-IBTS survey or the Portuguese demersal survey (PtGFS-WIBTS-Q4). The inadequacy of surveys is related with its design which has few fishing stations in shallow areas, where the species is known to occurs predominantly.

A mark-recapture study in Portuguese waters - UNDULATA project- showed that *R. undulata* perform short distance movements confirming the species high degree of site fidelity (Maia et al. 2024). This agrees with preliminary results obtained during the same project from the genetic analysis of mitochondrial markers (in particular from the control region, CR) that suggested the existence of populational differences between geographical areas along the Portuguese coast (Figueiredo et al., 2016). A total of 353 specimens were tagged in the area of Sesimbra/Setúbal. Total length of tagged females ranged between 52-93 cm and between 57-89 cm for males. Figure 2 presents the geographic locations where specimens were tagged and the length frequency distribution of the tagged specimens by sex. A total of 40 recaptures were recorded, which represented 11% of the tagged specimens. The maximum recorded travelled distance was 26 km and 75% of the recaptures were located at distances less than 10km from the tagging location (Figure 3). The longer period between tagging and recapture was 313 days and 50% of the tagged specimens were recaptured more than 54 days after the tagging event. The majority of movements were recorded down to 50 m deep and seem to follow the shoreline between Sesimbra and Sines which reinforced the previous knowledge that the species prefers shallow sandy coastal areas (Figure 3).

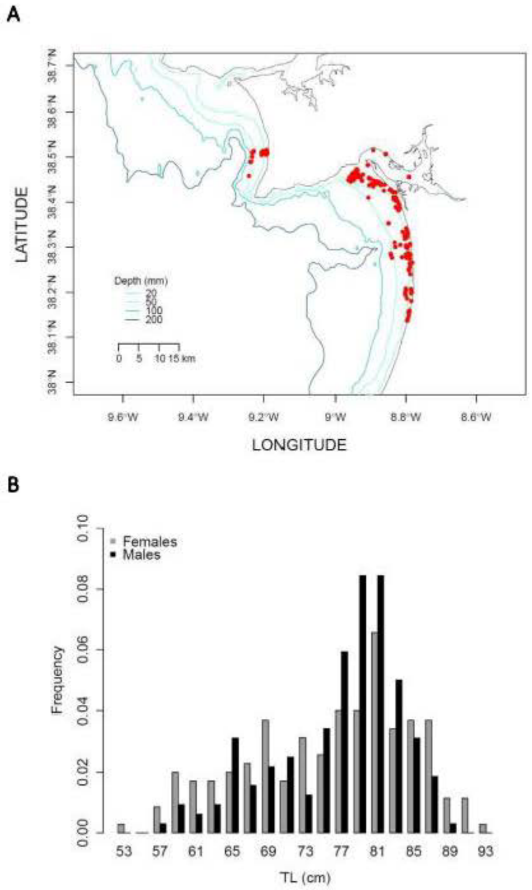


Figure 2: ***Raja undulata*** **in ICES Division 27.9a. (A) tagging locations within the study area and (B) length frequency distribution by sex of the tagged specimens.**

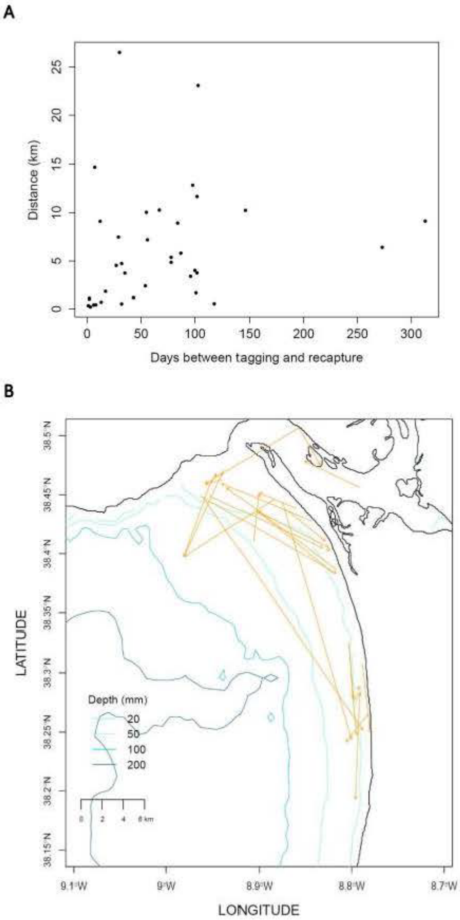


Figure 3: ***Raja undulata*** **in ICES Division 27.9a. (A) Distance from tagging to recapture plotted against time between the two events; (B) mark-recapture positions in the area of Setúbal/Sesimbra, SW mainland Portugal (n=40).**

Under the self-sampling program adopted for vessels with specific license for *R. undulata,* a methodology was adopted to estimate the density and relative abundance of the species. Geo-referenced fishery data collected in 2017 were used. A binomial mixture model (Kéry, Royle, & Schimid, 2005) was the adequate statistical approach to be used as it accommodates the temporally and spatially replicated count data available. The statistical approach applied to 2017 fishery data collected under the self-sampling program allowed to: a) obtain relative abundance of *R. undulata* in several regions of the Portuguese continental coast; b) compare the relative abundance among regions and identify major data deficiencies associated with estimated variances and; c) revise the adopted self-sampling programme and evaluate the optimal sampling size under different precision levels (i.e. mean catch rate error). Main results

are presented in Figures 4-5 and Table 4. Results confirmed the expected distribution of the species and highlighted its correlation with particular environmental variables, showing a preferential distribution in certain areas. Details on methodology, results and conclusions can be found in Figueiredo *et al.*, 2020.

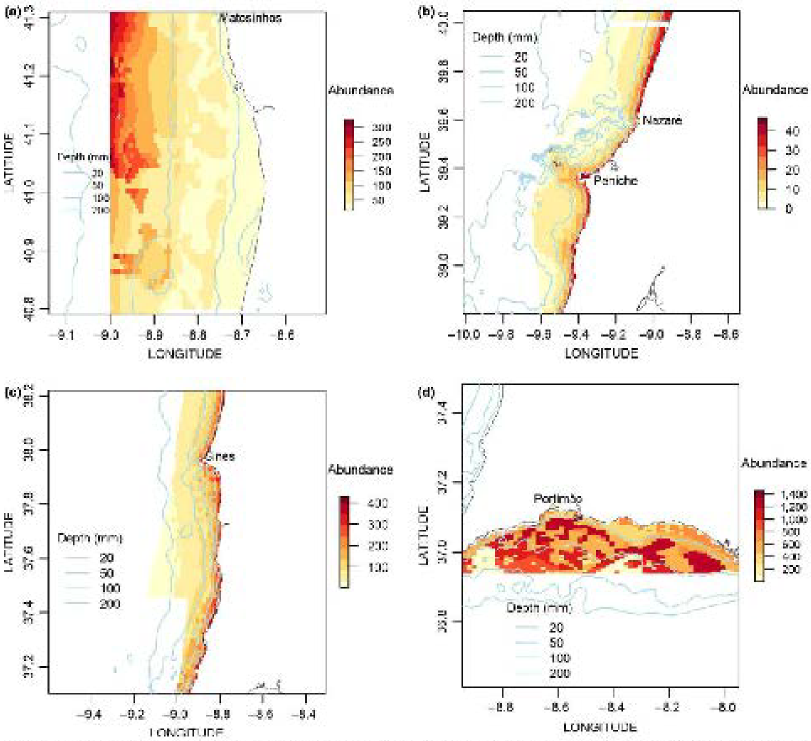


Figure 4. *Raja undulata* in ICES Division 27.9a. Relative abundance estimates in the study regions: (a) North; (b) Centre; (c) Southwest; and (d) South. Source: Figueiredo et al., 2020.

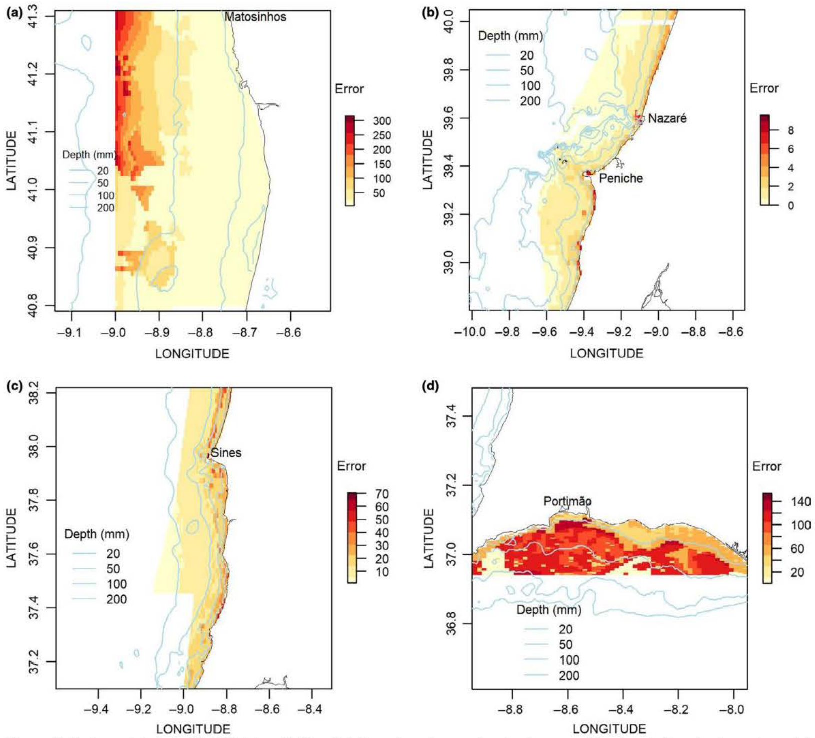


Figure 5. *Raja undulata* in ICES Division 27.9a. Relative abundance standard error estimates in the study regions: (a) North; (b) Centre; (c) Southwest; and (d) South. Source: Figueiredo *et al*., 2020.

Table 4. *Raja undulata* in ICES Division 27.9a. Density estimates per region and total abundance for the prediction area in each region with indication of the total of prediction area and the average of the standard errors of the abundance estimate. Source: Figueiredo *et al*., 2020.

Region	Total estimated number	Area (km^2)	Average density	Interquartile of standard errors of the density estimate [$q_{25\%}$, $q_{75\%}$]	Biomass estimate (t)
North	236,034	1,525.3	154.7	[6.15, 49.65]	1,426.5
Centre	10,773	3,503.6	3.1	[0.18, 0.93]	65.1
Southwest	201,457	2,133.0	94.4	[3.62, 13.03]	1,217.5
South	1,641,420	1,330.4	1,233.8	[56.31, 116.24]	9,920.0

Survivorship – health status after capture

The assessment of the health status after capture is considered a good indication of the survivorship index of skates. Categorical vitality assessment (CVA) of *R. undulata* caught by the trammel net fleet of the polyvalent segment were conducted under the UNDULATA project (2014-2015) and the DCF Pilot Study on Skates (2011-2013). The sampling was conducted onboard commercial polyvalent vessels operating with trammel nets. Two major groups of mesh size were considered: i) 180 mm (200-280 mm). A qualitative assessment of the health status of the captured specimens of *R. undulata* in Portuguese continental waters was performed using the scale from Enever et al. (2009). The percentage of specimens in "excellent" conditions was higher than 78% for all mesh sizes and soak times tested; highest values observed for mesh size >180 mm and soaking time > 24h (96%). The percentage of specimens in Poor/Dead conditions was 2% and 5% for mesh size < 180 mm and 3% and 14% for mesh size >180 mm, respectively for each two soaking times considered (table 5). The size of the specimens is the variable with more influence in the survivorship of the species. However irrespective of specimen size, the percentage individuals in "good" health status was always higher than 77% (Table 6). More detail can be found in Maia et al. 2024.

In conclusion the species in subarea 27.9a is mainly caught by nets and have a high survivorship after capture. Additionally, the mark-recapture study (UNDULATA project, 2014–2015) of *R. undulata* caught by trammel nets obtained a return rate of 11% and the mean observed time-at-liberty was of 54 days and maximum of 313 days. These results are also a good indication that the species has a potential high long-term survival.

Table 5. *Raja undulata* in ICES Division 27.9a. Percentage of individuals by vitality status (1 = Excellent; 2 = Good; 3 = Poor/Dead) by skate and ray species in relation to mesh size and soak time in the Portuguese polyvalent fleet operating with trammel nets. The total length range is also given.

			Vitality status				
Species	Mesh size (mm)	Soak time (h)	1	2	3	n	TL range (cm)
Raja undulata	< 180	< 24	82%	16%	2%	44	40-89
		> 24	90%	5%	5%	58	43-92
	> 180	< 24	79%	7%	14%	71	32-92
		> 24	96%	1%	3%	174	44-92

Table 6. *Raja undulata* in ICES Division 27.9a. Percentage of individuals from each skate and ray species by vitality status (1 = Excellent; 2 = Good; 3 = Poor/Dead) in relation to length class. The values are presented for retained and for discarded specimens separately. For n ≤5, observed numbers by vitality are shown instead of percentages.

		Retained				Discarded			
		Vitality status				Vitality status			
Species	Length class	1	2	3	n	1	2	3	n
Raja undulata	<52 cm	-	-	-	-	78%	16%	5%	37
	>52 cm	-	-	-	-	91%	3%	6%	318

Fishing effort and harvest rate

The harvest rate for 2017 was calculated using *R. undulata* biomass estimate for Portuguese continental coast (Figueiredo et al., 2020) and catches of the year (2023, official data). The resulting harvest rate is 0.0022 (Table 7), that corresponds to a fishing mortality of 0.00129, which is well below the F_{MSY} estimated for *R. undulata* stock in ICES Division 27.7d-e (0.131) and the empirical estimate determined using the method proposed by Zhou et al. (2012) (0.1107) for Chondrichthyes (F_{MSY}=0.41M).

Table 7. *Raja undulata* in ICES Division 27.9a. Estimate of harvest rate for 2017. Abundance estimates for 2017 were obtained from Figueiredo *et al.*, 2020.

Abundance estimate (tonnes)	
North	1426.5
Center	65.1
Southwest	1217.5
South	9920.0
Total	12629.1
2017 Portuguese landings (tonnes)	28.2439
Harvest rate	0.22%

Temporal evolution of abundance index for licensed vessels

Data used for abundance index standardization process comprised the fishery data collected from vessels with a special license for *R. undulata* for the period 2017-2023. Important to emphasize that the activity of licensed vessel, authorized to land up to 30kg of *R. undulata* per trip, is highly constrained by the Portuguese legislation in place, so numbers reported result from by-catch. Given the restrictions imposed by legislation and the small quota assigned to ICES Division 27.9.a, fishermen are avoiding places where they know the species concentrates.
For the standardization process, the following settings were considered: data was restricted to trammel nets; months from May to July were excluded (seasonal fishing closure for *R. undulata* in Portugal mainland) and; trips with catches higher than the quartile 99% (<150 individuals per trips) were removed. Catch rates (number/trip) distribution is presented in Figure 6.

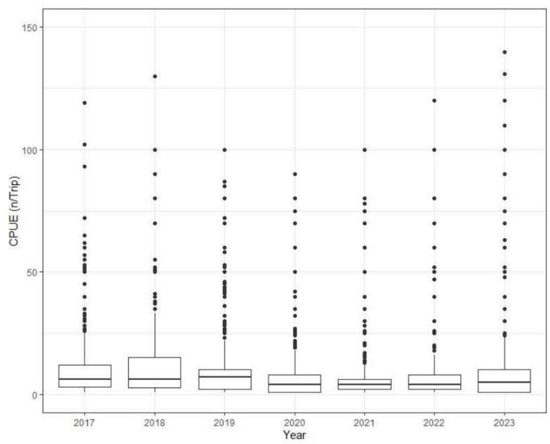


Figure 6. *Raja undulata* in ICES Division 27.9a. Distribution of the nominal CPUE by year.

To standardize the abundance index, the fishery data from the self-sampling were adjusted to a zero-truncated Poisson regression model; this was done to overcome the problem associated with no zero data, once these models are commonly used to model positive count data and considering a Poisson distribution. The response variable is the number of specimens caught per fishing trip and the explanatory variables considered were: year (2017 to 2023), region (North, Center, Southwest and South), substrate type (Sand, Rock, Muddy sand and mixed), mesh size (<150mm or >150mm), vessel size (<9m or >9m), depth interval (in meters; [0-40], [40-80] or >=80), distance to coast interval (in km, [0-2], [2-5] or >5), expressed as:

vglm(CPUE ~ Year+ Region + Substrate + mesh size + vessel size + depth interval + distance interval ,family = pospoisson())

The annual standardized abundance index was estimated under the following reference situation: Southwest region, mesh size <150mm, substrate type sand, depth interval [0-40] and distance to coast [2-5] (Figure 7, table 8). The index show stability along the 5 years period, varying between 10.49 (in 2020) and 17.93 (2023) with an average of 13.81 individuals per trip. The plot of the residuals versus fitted values shows that the mean is around zero across all the fitted levels, indicating there were no strong violations of the underlying assumptions (Figure 8).

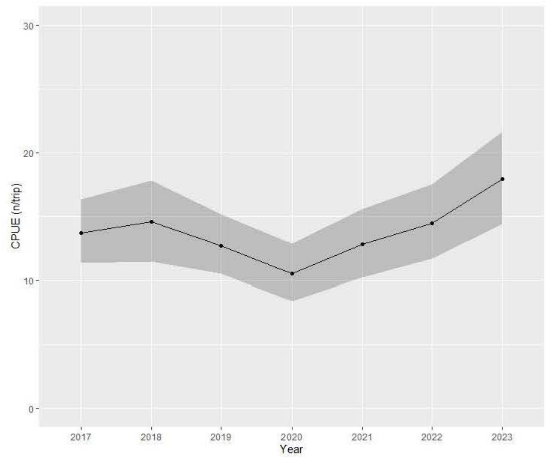


Figure 7. *Raja undulata* in ICES Division 27.9a. Standardized CPUE index (n/trip) and respective standard error from 2017 to 2023.

Table 8. *Raja undulata* in ICES Division 27.9a. Standardized Abundance index (n/trip) and respective standard error from 2017 to 2023.

Year	Abundance index (n/trip)	pLL	pUL
2017	13.70	11.33	16.36
2018	14.60	11.45	17.80
2019	12.70	10.53	15.18
2020	10.49	8.38	12.84

2021	12.79	10.21	15.60
2022	14.49	11.67	17.55
2023	17.93	14.41	21.68

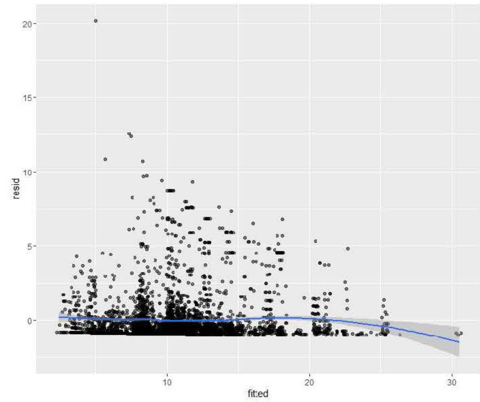


Figure 8. *Raja undulata* in ICES Division 27.9a. Zero-truncated Poisson regression model plot of the residuals versus fitted values.

Final considerations for advice

Given the high constrains on fishing opportunities for the species, in particular:

- the small quota assigned to Portugal (12-15 tonnes since 2016);
- the strict management measures as:
  - prohibition of directed fishing;
  - maximum landed weight of 30 kg (~5/6 indiv.);
  - 3 month closed fishing period that protects the species during part of the reproductive season;
  - minimum and maximum landing size that protects juveniles and mega-spawners;
- the expected decrease of fishing effort in relation to the period previous the 2009;
- the standardized abundance index stability and;
- the high survivorship of the species after capture

It is expected that the harvest rate in recent years was at the same level as that estimated for 2017 and that the small quota assigned does not have a negative impact on the stock.

Due to constrains mentioned above, fishery data derived from it do not enable the definition of sustainable exploitation levels particularly in accordance to the F_{MSY} approach.
The main deficiencies on data collected under the quota assigned to ICES Division 27.9.a are:

- the spatial and temporal coverage of fishing is limited as the number of licenses is dependent on the quota available (Figure 9 shows the self-sampling data available by year enlightening the deficient spatial coverage along the coast);
- data from areas where the species is known to concentrate are not available to the fishing as only by-catch is allowed and because fishermen highly avoid those areas;

- length data from landings are limited and considered not representative of the exploitable population mainly because minimum and maximum landing sizes adopted and the total number of specimens allowed to be landed per trip (making it impossible to construct length frequencies for LBI estimation)

In conclusion, the small quota assigned to Portugal since 2016, is considered not to have a negative impact on the stock, but on other hand has had a great impact on the self-sampling program as fishermen´s motivation and collaboration has been continuously decreasing. Fishermen considered that despite their effort to collect data, results are not reflected in the scientific advice provided by ICES; following the guidelines for category 6 stocks, advice on fishing opportunities maintains or reduces in 20% the latest advice.

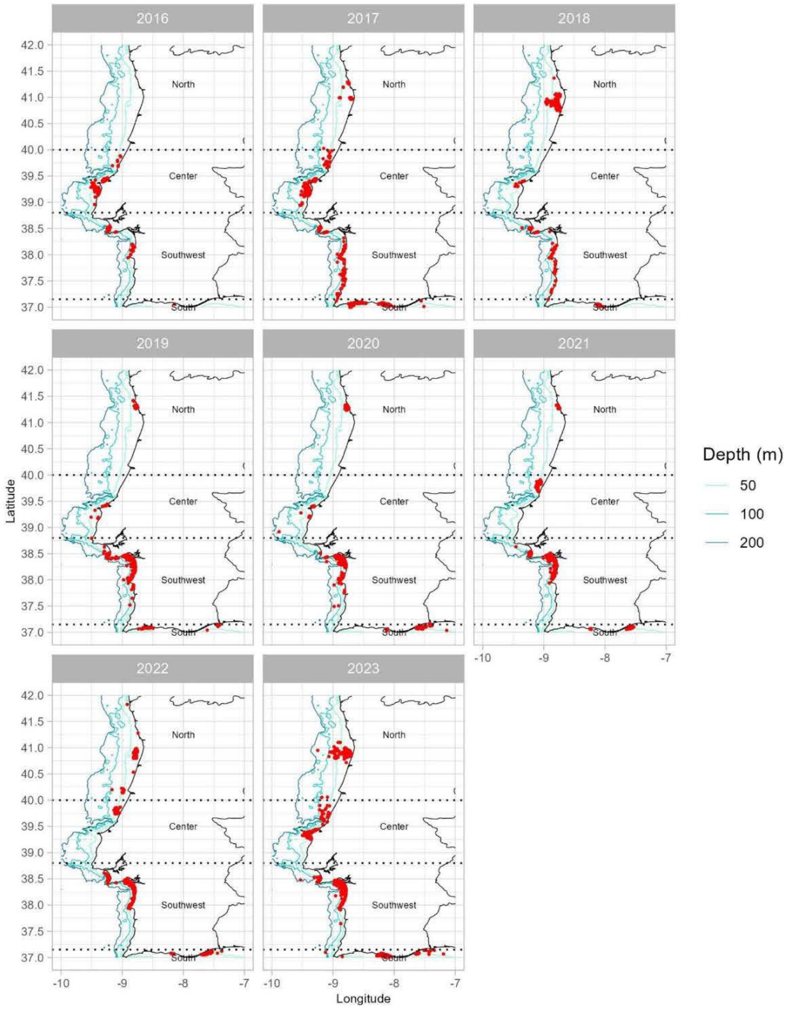


Figure 9. *Raja undulata* in ICES Division 27.9a. Spatial coverage of self-sampling data for the period 2016-2023.

References

Coelho, R. & Erzini, K. (2002). Age and growth of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal). Journal of the Marine Biological Association of the UnitedKingdom82,987 – 990. doi: 10.1017/S0025315402006495

Coelho, R., Erzini, K., Bentes, L., Correia, C., Lino, P. G., Monteiro, P., Ribeiro, J. and Gonçalves, J.M.S. 2005. Semi-pelagic longline and trammel net elasmobranch catches in Southern Portugal: catch composition, catch rates and discards. Journal of Northwest Atlantic Fishery Science, 35:531-537.

Coelho, R. & Erzini, K. (2006). Reproductive aspects of the undulate ray, *Raja undulata*, from the south coast of Portugal. Fisheries Research81,80 – 85. doi: 10.1016/j.fishres.2006.05.017

Figueiredo, I., Maia, C. and Neves, J. 2016. Estudo para o conhecimento da dinâmica populacional da espécie raia curva *R. undulata*, na costa continental Portuguesa. Relatório final do Projecto Undulata (Ref: UNDULATA -Nº31-03-01 FEP186) no âmbito do Programa PROMAR. Eixo 3, Acções Colectivas. 71 pp.

Figueiredo, I., Maia, C. and Carvalho, L. 2020. Spatial distribution and abundance of the by-catch coastal elasmobranch *Raja undulata*: Managing a fishery after moratorium. Fisheries Management and Ecology. 00:1–10.

Maia, C., Figueiredo, I. and Serra-Pereira, B. 2015. Project UNDULATA - *Raja undulata* estimation of historical landings in Portugal mainland (ICES Division IX). Working Document presented at ICES WGEF 2015 Lisbon, 17-23 June 2015.

Maia, C., Moura, T., Serra-Pereira, B. and Figueiredo, I (2023). Reconstruction of Portuguese Historical landings for the period 2000-2007 Working document presented at ICES WKELASMO3, data compilation online meeting, 20th to 24th November.

Maia, C., Serra-Pereira, B., Lagarto, N. and Figueiredo, I. 2024. Conventional Tagging of *Raja undulata* in Portuguese continental waters (Division 27.9a) and additional information on survivability to trammel net fisheries. Working document presented at ICES WKTAG 2024, 29-31 january.

Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Coelho, R., Erzini, K., Neves, A. & Gordo, L. S. (2007). The use of caudal thorns for ageing *Raja undulata* from the Portuguese continental shelf, with comments on its reproductive cycle. Marine and Freshwater Research58,983 – 992. doi: 10.1071/MF07042

Serra-Pereira, B., Farias, I., Moura, T., Gordo, L. S., Santos, M. N. & Figueiredo, I. 2010. Morphometric ratios of six commercially landed skate species from the Portuguese continental shelf and their utility for identification. ICES Journal of Marine Science67,1596 – 1603. doi: 10.1093/icesjms/fsq056

Serra-Pereira, B., Erzini, K., Maia, C., and Figueiredo, I. 2014. Identification of potential essential fish habitats for skates based on fishers' knowledge. Environmental Management, 53(5):985-98.

Serra-Pereira, B., Erzini, K. and Figueiredo, I. 2015. Using biological variables and reproductive strategy of the undulate ray *Raja undulata* to evaluate productivity and susceptibility to exploitation. J Fish Biol 86:1471–1490.https://doi.org/10.1111/jfb.12653

Zhou, S., Yin, S., Thorson, J., Smith, A.D.M. and Fuller, M. 2012. Linking fishing mortality reference points to life history traits: An empirical study. Canadian Journal of Fisheries and Aquatic Sciences. 69. 1292-1301. 10.1139/f2012-060.

Working Document to be presented to the Working Group on Elasmobranch Fishes
ICES WGEF $18^{th} - 27^{th}$ June 2024, Lisbon, Portugal

Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic)*

O. Fernández-Zapico[†], S. Ruiz-Pico, M. Blanco, P. Ortiz, F. Velasco, C. Rodríguez-Cabello, F. Baldó[‡]

Abstract

This working document presents the results of the most significant elasmobranch species caught on the Porcupine Spanish Groundfish Survey (SP-PORC-Q3) in 2023. Biomass and abundance indices, spatial distribution and length frequency were analysed for *Galeus melastomus* (blackmouth catshark), *Deania calceus* (birdbeak dogfish), *Deania profundorum* (arrowhead dogfish), *Scymnodon ringens* (knifetooth dogfish), *Scyliorhinus canicula* (lesser spotted dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Dalatias licha* (kitefin shark), *Hexanchus griseus* (bluntnose sixgill shark), *Squalus acanthias* (picked dogfish), *Dipturus nidarosiensis* (Norwegian skate), *Dipturus batis* (common skate), *Dipturus intermedius* (common skate), *Leucoraja circularis* (sandy ray) and *Leucoraja naevus* (cuckoo ray), *Raja clavata* (thornback ray) and *Raja montagui* (spotted ray). In 2023 the biomass of *G. melastomus*, *H. griseus*, *S. ringens*, *E. spinax* and *D. licha* increased, but the remaining elasmobranchs decreased or were similar to the previous year. Signs of recruitment were only found for *G. melastomus* and *E. spinax*. Some species continue being scarce like *S. acanthias*, *D. profundorum* and *D. intermedius*. In the additional hauls deeper than 1000 m on the Porcupine Seabight, the elasmobranchs *Apristurus melanoasper*, *Centrophorus squamosus*, *Centroscymnus coelolepis* and *Centroscymnus crepidater* were found. Some scarce but previously common species in the survey, not found in 2023, were *Raja clavata* and *Raja montagui*. Some other species occasionally found in previous surveys but not in the latter were *Apristurus laurussonii*, *Apristurus manis*, *Galeus murinus*, *Galeorhinus galeus*, *Centroscyllium fabricii*, *Oxynotus paradoxus*, *Neoraja caerulea* and *Rajella fyllae*.

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 species in the area (Baldó 2023). The aim of this working document is to update the results of the most common elasmobranch species on Porcupine bottom trawl surveys, after the results presented previously (Fernández-Zapico et al. 2011, 2013, 2015, 2017, 2021, 2022, Ruiz-Pico et al. 2012, 2014, 2016, 2018, 2019, 2020, 2023, Velasco et al. 2010). The species analysed were: *Galeus melastomus* (blackmouth catshark), *Deania calceus*

*Citation: Fernández-Zapico O, Ruiz-Pico S, Blanco M, Ortiz P, Velasco F, Rodríguez-Cabello C, Baldó F (2024) Results on main elasmobranch species from the 2023 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic). ICES Working Group on Elasmobranch Fishes, 18 - 27 June 2024, Lisbon, Portugal. https://doi.org/10.20350/digitalCSIC/16326

†Instituto Español de Oceanografía (IEO), CSIC, Centro Oceanográfico de Santander, olaya.fernandez@ieo.csic.es
‡Instituto Español de Oceanografía (IEO), CSIC, Centro Oceanográfico de Cádiz, francisco.baldo@ieo.csic.es

(birdbeak dogfish), *Deania profundorum* (arrowhead dogfish), *Scymnodon ringens* (knifetooth dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Scyliorhinus canicula* (lesser spotted dogfish), *Dalatias licha* (kitefin shark), *Hexanchus griseus* (bluntnose sixgill shark), *Squalus acanthias* (picked dogfish), *Leucoraja circularis* (sandy ray), *Leucoraja naevus* (cuckoo ray), *Dipturus nidarosiensis* (norwegian skate), *Dipturus batis* and *Dipturus intermedius* (common skate), *Raja clavata* (thornback ray) and *Raja montagui* (spotted ray).

Material and methods

The Spanish Ground Fish Survey on the Porcupine Bank (SP-PORC-Q3) has been annually carried out since 2001 onboard 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 IBTS methodology for the western and southern areas (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. Four extra hauls were performed within the standard stratification to improve coverage in gaps left by random sampling and four more hauls outside the standard stratification to explore the continuity of the community on Porcupine Seabight.

More details on the survey design and methodology are presented in the Manual of the IBTS North Eastern Atlantic Surveys (ICES, 2017).

The tow duration is 20 min since 2016, but the results presented were extrapolated to 30 min of trawling time to keep up with the time series.

Results

In 2023, 80 valid standard hauls and 8 extra hauls were carried out, 4 of them to cover gaps left by the random sampling and the remaining 4 between 918 m and 1219 m, on the Porcupine Seabight (Figure 1). The total stratified catch per haul increased slightly in 2023 and reaching again the highest value of the time series (Figure 2). Fish represented 95% of the total catch and the elasmobranchs were the 6% of that total fish catch, with the following percentages per species: *Galeus melastomus* (53%), *Hexanchus griseus* (18%), *Scyliorhinus canicula* (7%), *Deania calceus* (7%), *Scymnodon ringens* (6%), *Etmopterus spinax* (2%), *Dalatias licha* (0.5%), *Squalus acanthias* (0.2%) and *D. profundorum* (0.1%). The skate and rays species were: *Dipturus nidarosiensis* (3%), *Dipturus batis* (1%), *Leucoraja circularis* (1%), *Dipturus intermedius* (0.3%) and *Leucoraja naevus* (0.3%). In 2023, the most remarkable increase in biomass was in *H. griseus*, but it was mainly due to the catch of one individual specially big. The biomass increased also for *G. melastomus*, *S. ringens*, *E. spinax* and *D. licha*. In contrast, the abundance of remaining elasmobranchs decreased or were similar to the previous year. Recruitment of most species remained similar to the previous years, low in general, except for *G. melastomus* and *E. spinax*. Some species continue to be scarce like *S. acanthias*, *D. profundorum* and *D. intermedius*. In the additional hauls deeper than 1000 m on the Porcupine Seabight, the elasmobranchs *Apristurus melanoasper*, *Centrophorus squamosus*, *Centroscymnus coelolepis* and *Centroscymnus crepidater* were found. Some scarce but previously common species in the survey, not found in 2023, were *Raja clavata* and *Raja montagui*. Some other species occasionally found in previous surveys but not in the latter were *Apristurus laurussonii*, *Apristurus manis*, *Galeus murinus*, *Galeorhinus galeus*, *Centroscyllium fabricii*, *Oxynotus paradoxus*, *Neoraja caerulea* and *Rajella fyllae*.

Galeus melastomus (blackmouth catshark)

In 2023, both the biomass and abundance of *G. melastomus* increased slightly and the values remained among the high on the time series, however the average of the last two years in terms of biomass decreased mildly, in contrast to the previous five years (Figures 3 and 4). The species, as usual was distributed mainly in the southern deepest area (Figure 5). The length distribution ranged from 13 to 77 cm and in 2023 only two of the three usual modes can be observed, in 21 cm and 53 cm. Signs of recruitment can be observed (Figure 6).

Deania calceus (birdbeak dogfish) and *Deania profundorum* (arrowhead dogfish)

Although *D. profundorum* is rather scarcer than *D. calceus* in the area, it has been found every survey since *D. profundorum* was first identified in 2012. In this latest survey, the biomass of *Deania* spp. (mainly *D. calceus*) increased scantly but its abundance decreased slightly, remaining among the medium values of the time series and the average of the last two years in terms of biomass was barely below the average of the previous five years (Figures 7 and 8). Biomass and abundance of *D. profundorum* remained similar to the previous year (Figure 9). *Deania* spp. (mainly *D. calceus*) was found mainly in western and southern deepest strata, as usual (Figure 10). Specimens of *D. calceus* ranged mainly from 80 to 113 cm with the two usual modes around 86 and 101 cm, but there was a lack of individuals below 65 cm (Figure 11). One specimen 27 cm length of *D. profundorum* was found and another five between 55 and 71 cm.

Scymnodom ringens (knifetooth dogfish)

Biomass of *S. ringens* increased considerably in 2023 compared to the previous year and abundance remained similar, after the sharp drop in 2022 in both values. The biomass index of the last two years remained below the mean of the previous five years (Figures 12 and 13). As usual, *S. ringens* was found in the deepest strata, in the southern area (Figure 14). The length distribution ranged from 29 to 113 cm, following a distribution with three modes, as usual, but there was a specially high mode in 76 cm compared to previous years. The other two common modes in the temporal series were drawn in 44 and 109 cm in this last survey (Figure 15).

Scyliorhinus canicula (lesser spotted dogfish)

Both the biomass and abundance of *S. canicula* decreased considerably in this last survey, after the peak of the time series marked the previous year, and being the average of the last two years about three times above the average of the previous five years (Figures 16 and 17). The same large biomass patch of last year remained in the northeast corner of the study area, as well as many other smaller ones throughout the Irish shelf and around the bank, but only in the north of the study area, not appearing in the deeper southern area, and away from the Irish shelf as usual (Figure 18). The length distribution ranged mainly from 34 to 79 cm in this last survey, with a mode around 55 cm. Despite the decrease from last year in biomass of *S. canicula*, more small individuals among 18 and 29 cm were found compared to the previous year (Figure 19).

Etmopterus spinax **(velvet belly)**

This species slowly continues the upward trend of recent years, in terms of abundance after the decline of 2017, whereas in terms of biomass the time series is stable. The mean stratified biomass in the last two years was slightly above the previous five years (Figures 20 and 21). *E. spinax* was distributed mostly southeast of the bank as usual (Figure 22). The length distribution of *E. spinax* ranged from 11 to 52 cm and showed an unusual high abundance of specimens around 23 cm, as well as the common mode around 38 cm, and also other mode around 16 cm, with a lower abundance (Figure 23).

Hexanchus griseus **(bluntnose sixgill shark)**

The biomass of *H. griseus* in 2023 exceeded 8 times the highest in the time series until then, in 2014, and the abundance increased considerably, although much less. This high increase is partially due to the capture of a large individual of 450 cm TL and 800 kg weight. The mean biomass of the last two years increased strongly compared to the mean value of the previous five years (Figures 24 and 25). The geographical distribution, as usual, did not show a clear pattern, but in this last survey most specimens were caught mainly south to the bank, in the deepest strata, but also in the shallow area near the bank. The large biomass patch found in the northeast corner of the bank corresponds to one individual, female, 800 kg weight (Figure 26). The length distribution ranged mainly from 53 to 131 cm in this last survey, but also one 450 cm individual was found (Figure 27).

Dalatias licha **(kitefin shark)**

Biomass of *D. licha* increased in 2023 and also abundance, although in a much more subtle mode, keeping very similar values to the previous year (Figure 28). However the mean biomass of the last two years was below to the previous five years, due to the peak in 2021 (Figure 29). A total of 10 hauls in the southeast and west of the bank showed presence of this species, between 426 and 954 m deep, with a total of 15 specimens from 37 to 113 cm (Figures 30 and 31).

Squalus acanthias **(picked dogfish)**

In 2023, the biomass and abundance of this scarce elasmobranch increased slightly (Figure 32). Seven specimens between 33 and 89 cm were found in only one haul at 222 m in the north of the Irish shelf (Figure 33), which upholds the aggregate behavior acknowledge (or known to occur) on this species.

Leucoraja naevus **(cuckoo ray) and *Leucoraja circularis*** **(sandy ray)**

In 2023, both biomass and abundance of *L. naevus* fell sharply, reaching the lowest values in the time series. The species *L. circularis* also decreased strongly, but more markedly in biomass terms, keeping the medium-high values of the time series (Figure 34). As usual, specimens of *L. naevus* were distributed in the shallower stratum around the bank, whereas *L. circularis* was caught in deeper waters in the south and also near the bank but only in the northern part (Figures 35 and 36). Specimens of *L. naevus* ranged from 38 to 58 cm, with a mode around 54 cm. Comparing with the average of the temporal series, the size range has narrowed at the expense, mainly, of the smallest individuals (Figure 37). However *L. circularis* showed a wider range of sizes that agrees with the mean of the time series. Specimens ranged from 22 to 113 cm with a mode in 39 cm, much smaller than the average of the time series, around 60 cm (Figure 38).

***Dipturus* spp. (common skate)**

Dipturus nidarosiensis, *Dipturus cf. flossada* and *Dipturus intermedius* were comparatively analysed since 2011 when *D. batis* was split into *D. cf. flossada* and *D. cf. intermedia* (Iglésias et al. 2010). After that, *D. cf. flossada* was accepted as *D. batis*, whereas *D. cf. intermedia* kept its original name as *D. intermedius* (Last et al. 2016). Then, the three skates together as *Dipturus* spp. were analysed, but also *D. nidarosiensis*, *D. batis* and *D. intermedius*. Biomass and abundance of *Dipturus* spp. decreased in 2023, specially in abundance, whereas in biomass terms it remained between the high values of the temporal series (Figure 39) and the mean biomass index of the last two years was above the average of the previous five years (Figure 40). In particular, the species *D. batis* fell strongly both in biomass and abundance terms, after the peak of the previous year, whereas *D. nidarosiensis* and *D. intermedius* increased slightly (Figure 41). *D. nidarosiensis* was distributed in the deep south stratum and also in the east in this last survey, whereas *D. batis* and *D. intermedius* were found in the shallow stratum near the bank, the former with much more biomass and also found out of the bank, further south (Figures 42, 43 and 44). 19 specimens of *D. nidarosiensis* were found in this last survey, ranging from 28 to 179 cm (Figure 45). A total of 15 specimens of *D. batis* were caught with lengths ranging from 30 to 127 cm (Figure 46). Only three specimens of *D. intermedius* of 65, 73 and 124 cm were found (Figure 47).

***Raja clavata* (thornback ray) and *Raja montagui* (spotted ray)**

No specimens of these two scarce but quite usual species have been found in this last survey (Figure 48).

Other scarce elasmobranchs

The scarce elasmobranchs found in 2023 were *Apristurus melanoasper*, *Centrophorus squamosus*, *Centroscymnus coelolepis* and *Centroscymnus crepidater*. They were not found in the standard stratification, but outside the stratification, in the deep hauls on the Porcupine Seabight from 918 and 1219 m. Thirteen individuals of the species *A. melanoasper*, ranging between 63 and 70 cm were found in just one haul at 918 m depth. Two individuals of *C. squamosus*, 108 and 113 cm length were found in two hauls at 918 and 953 m depth. Only one individual, 92 cm length, of *C. coelolepis* was found at 1219 m and three specimens of *C. crepidater*, 57, 74 and 78 cm length were found at 1149 and 1219 m depth. The species *Apristurus laurussonii*, *Apristurus manis*, *Galeus murinus*, *Galeorhinus galeus*, *Centroscyllium fabricii*, *Oxynotus paradoxus*, *Neoraja caerulea* and *Rajella fyllae*, found scarcely in previous surveys, were not found in this last survey.

Acknowledgements

We would like to thank the R/V Vizconde de Eza crew and the IEO scientific teams, as well as the Irish staff, that made the Porcupine Spanish Groundfish Survey possible. Included in the PORCUDEM project, the survey has been co-funded by the EU through the European Maritime, Fisheries and Aquaculture Fund (EMFAF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

References

Fernández-Zapico O, Blanco M, Ruiz-Pico S, Velasco F, Rodríguez-Cabello C, Baldó F (2022) Results on main elasmobranch species from 2001 to 2021 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 14-23 June 2022, Lisbon, Portugal. https://doi.org/10.20350/digitalCSIC/15245

Fernández-Zapico O, Ruiz-Pico S, Blanco M, Velasco F, Rodríguez-Cabello C, Baldó F (2021) Results on main elasmobranches species from 2001 to 2020 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 15-24 June 2021, Online meeting.

Fernández-Zapico O, Ruiz-Pico S, Baldó F, Velasco F, Rodríguez-Cabello C (2017) Results on main elasmobranches species from 2001 to 2016 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 31 May - 7 June 2017, Lisbon, Portugal.

Fernández-Zapico O, Velasco F, Baldó F, Rodríguez-Cabello C, Ruiz-Pico S (2015) Results on main elasmobranch species captured during the 2001-2014 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 17-23 June 2015, Lisbon, Portugal.

Fernández-Zapico O, Velasco F, Baldó F, Rodríguez-Cabello C, Ruiz-Pico S (2013) Results on main elasmobranch species captured during the 2001-2012 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 17-21 June 2013, Lisbon, Portugal.

Fernández-Zapico O, Velasco F, Baldó F, Ruiz-Pico S, Blanco M (2011) Results on main elasmobranch species captured during the 2001-2010 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 20-24 June 2011, Copenhagen, Denmark.

ICES (2017) Manual of the IBTS North Eastern Atlantic Surveys. Series of ICES Survey Protocols, No. SISP 15. 92 pp. https://doi.org/10.17895/ices.pub.3519

Iglésias SP, Toulhoat L, Sellos DY (2010) Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquat Conserv 20: 319-333. https://doi.org/10.1002/aqc.1083

Kingsley MCS, Kanneworff P, Carlsson DM (2004) Buffered random sampling: a sequential inhibited spatial point process applied to sampling in a trawl survey for northern shrimp Pandalus borealis in West Greenland waters. ICES J Mar Sci 61: 12-24. https://doi.org/10.1016/j.icesjms.2003.11.001

Last PR, Séret B, Stehmann MFW, Weigmann S (2016) Skates. Family Rajidae. In: Last PR, White WT, de Carvalho MR, Séret B, Stehmann MFW, Naylor GJP (eds) Rays of the world. CSIRO Publishing, Clayton South. p 204-363.

Ruiz-Pico S, Fernández-Zapico O, Blanco M, Velasco F, Rodríguez-Cabello C, Baldó F (2023) Results on main elasmobranch species from the 2022 Spanish Groundfish Survey on the Porcupine Bank (NE Atlantic). ICES Working Group on Elasmobranch Fishes (WGEF), 20-29 June 2023, Lisbon (Portugal).

Ruiz-Pico S, Fernández-Zapico O, Blanco M, Velasco F, Rodríguez-Cabello C, Baldó F (2020) Results on main elasmobranches species from 2001 to 2019 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 16-25 June 2020, Online meeting.

Ruiz-Pico S, Blanco M, Fernández-Zapico O, Baldó F, Velasco F, Rodríguez-Cabello C (2019) Results on main elasmobranches species from 2001 to 2018 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 18-27 June 2019, Lisbon, Portugal.

Ruiz-Pico S, Fernández-Zapico O, Baldó F, Velasco F, Rodríguez-Cabello C (2018) Results on main elasmobranches species from 2001 to 2017 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 16-28 June 2018, Lisbon, Portugal.

Ruiz-Pico S, Baldó F, Velasco F, Rodríguez-Cabello C, Fernández-Zapico O (2016) Results on main elasmobranches species from 2001 to 2015 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 15-24 June 2016, Lisbon, Portugal.

Ruiz-Pico S, Velasco F, Baldó F, Rodríguez-Cabello C, Fernández-Zapico O (2014) Results on main elasmobranch species captured during the 2001-2013 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 17-26 June 2014, Lisbon, Portugal.

Ruiz-Pico S, Baldó F, Velasco F, Fernández-Zapico O, Rodríguez-Cabello C (2012) Results on main elasmobranch species captured during the 2001-2011 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 18-26 June 2012, Lisbon, Portugal.

Velasco F, Blanco M, Baldó F (2010) Results on main elasmobranch species captured during the 2001-2009 Porcupine Bank (NE Atlantic) bottom trawl surveys. ICES Working Group on Elasmobranch Fishes (WGEF), 22-29 June 2010, Horta, Portugal.

Velasco F, Serrano A (2003) Distribution patterns of bottom trawl faunal assemblages in Porcupine bank: implications for Porcupine surveys stratification design. International Bottom Trawl Survey Working Group (IBTSWG), 25-28 March 2003, Lorient, France.

Figures

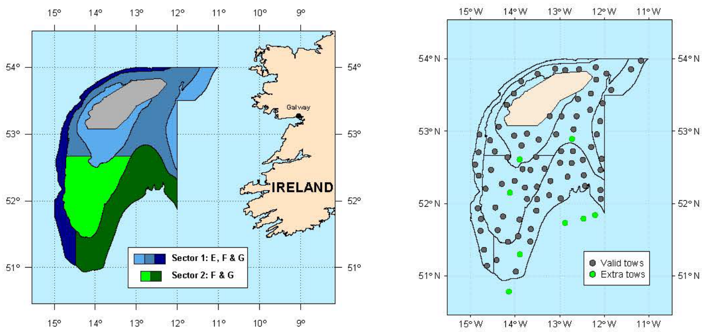


Figure 1: Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 - 450 m and G) 451 - 800 m. The grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: Distribution of hauls performed in the last survey.

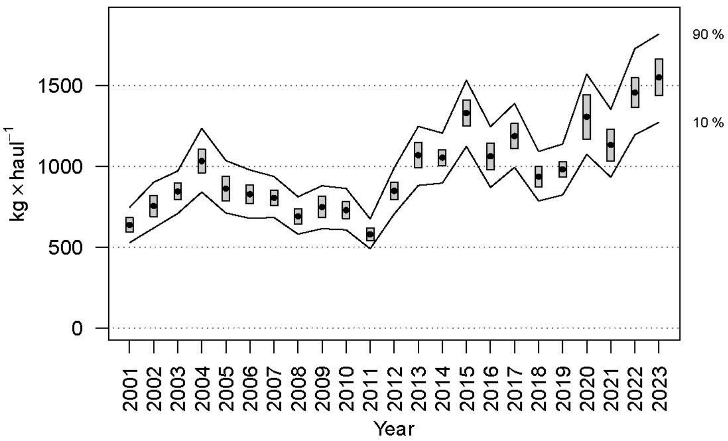


Figure 2: Evolution of the total catch in biomass in the Porcupine surveys.

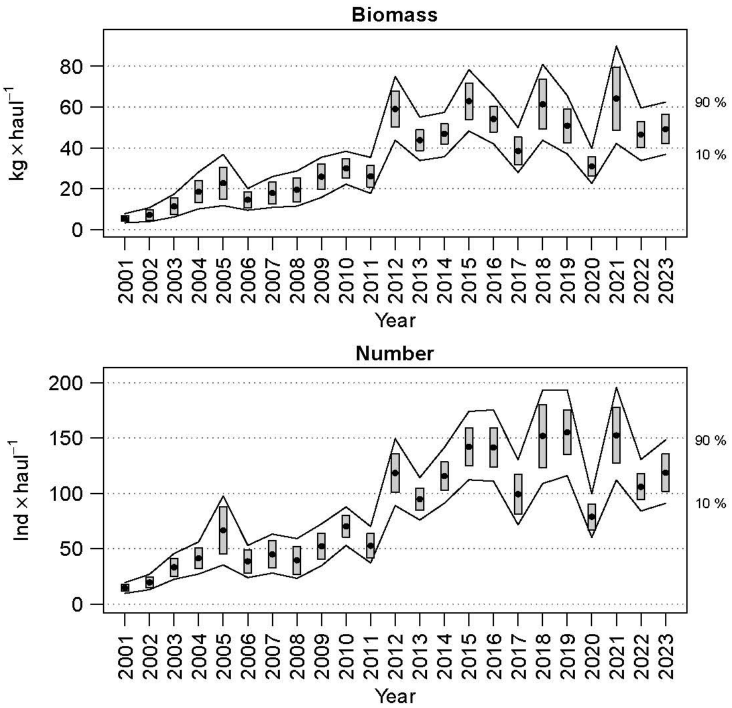


Figure 3: Evolution of biomass and abundance indices *Galeus melastomus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a=0.80, bootstrap iterations=1000).

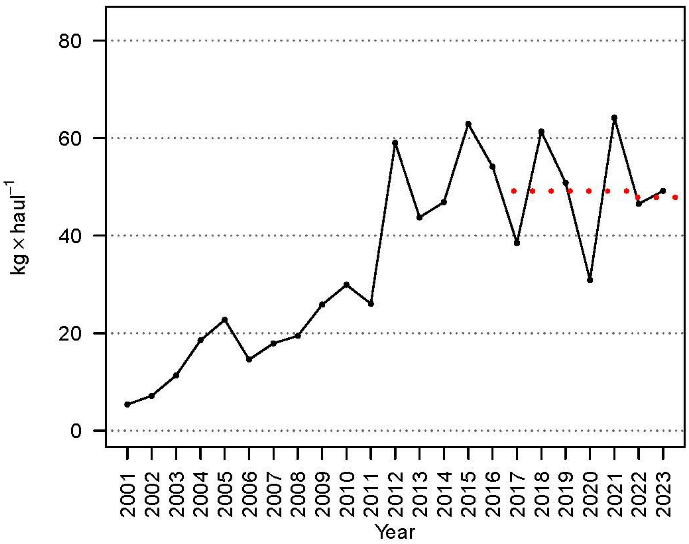


Figure 4: Evolution of biomass index *Galeus melastomus* in the Porcupine survey. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

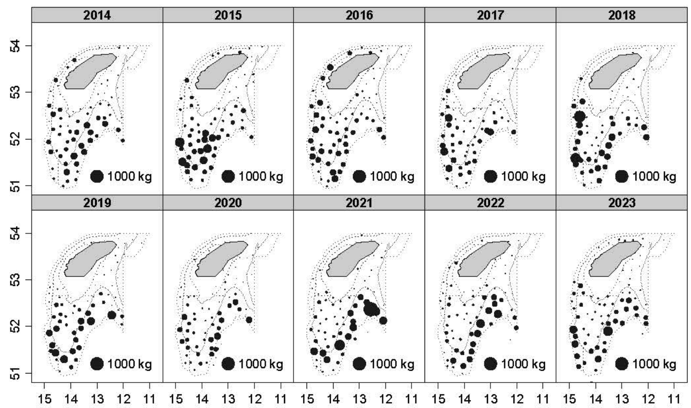


Figure 5: Geographic distribution of *Galeus melastomus* catches (kg×30 min haul^{-1}) in the Porcupine surveys over the last decade.

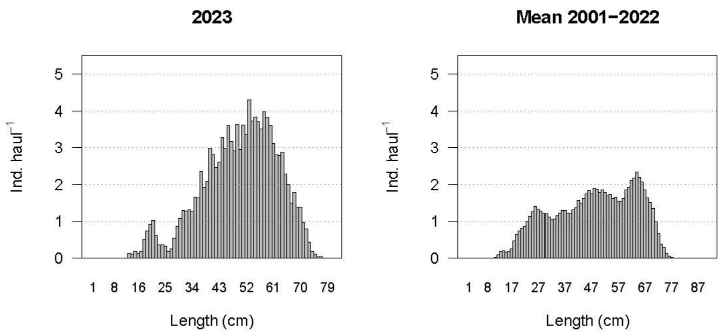


Figure 6: Stratified length distributions of *Galeus melastomus* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

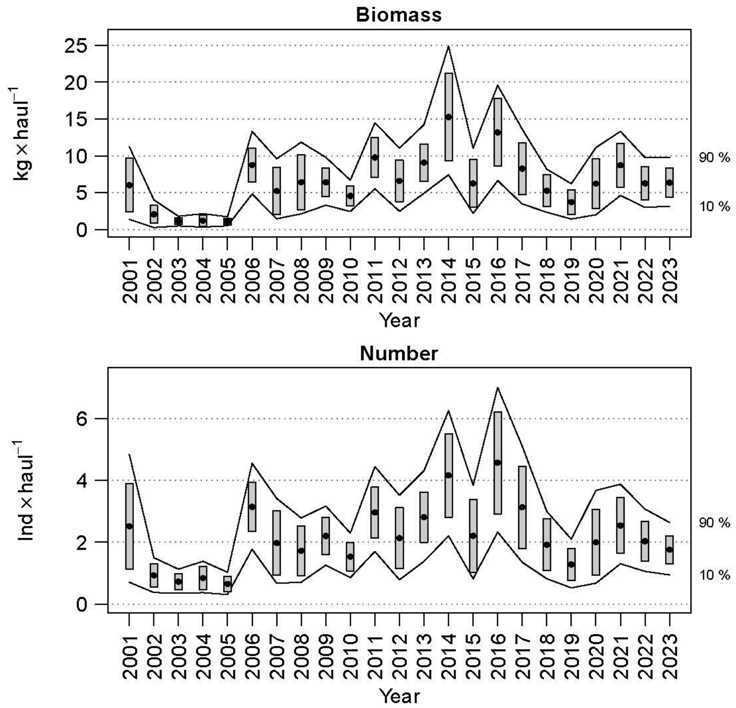


Figure 7: Evolution of biomass and abundance indices *Deania* spp. (mainly *D. calceus*) in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

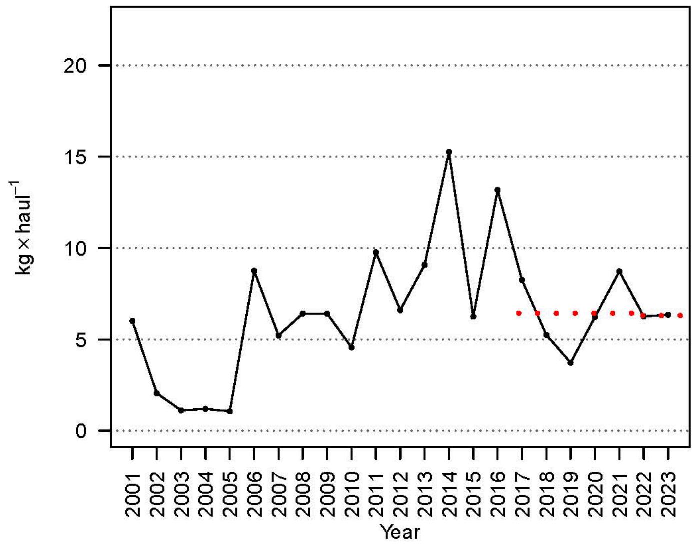


Figure 8: Evolution of biomass index *Deania* spp. (mainly *D. calceus*) in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

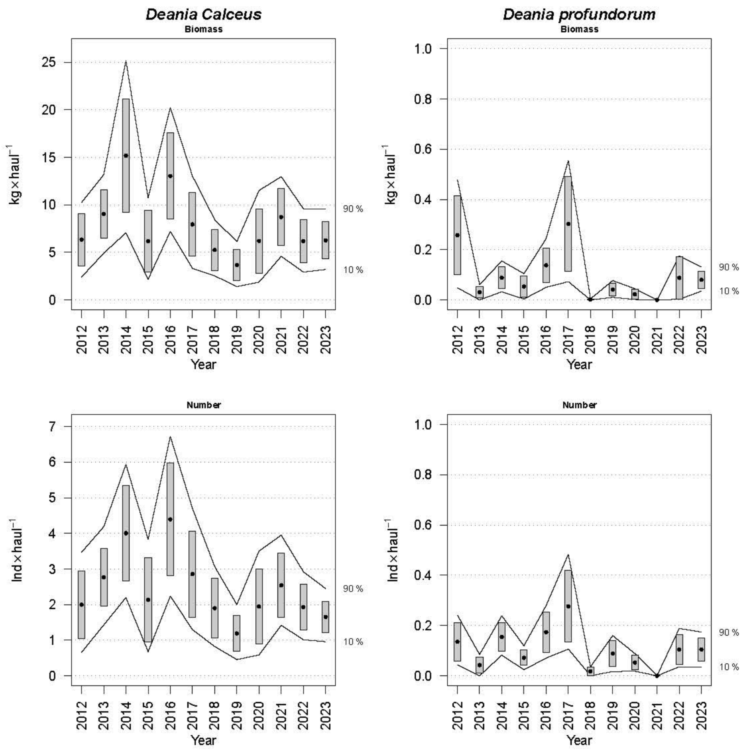


Figure 9: Evolution of biomass and abundance indices of *Deania calceus* and *Deania profundorum* from 2012 and 2023 in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

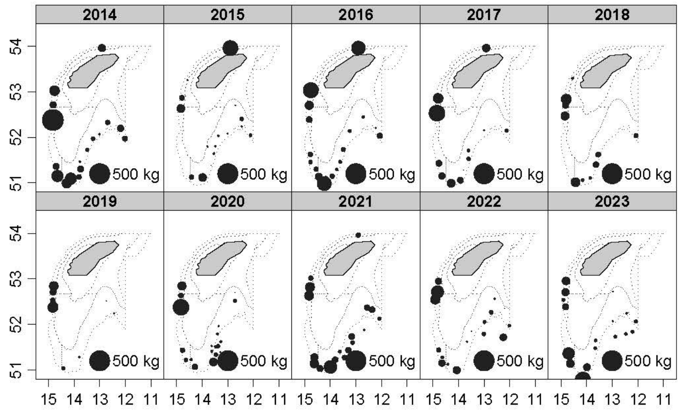


Figure 10: Geographic distribution of *Deania* spp. (mainly *D. calceus*) catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

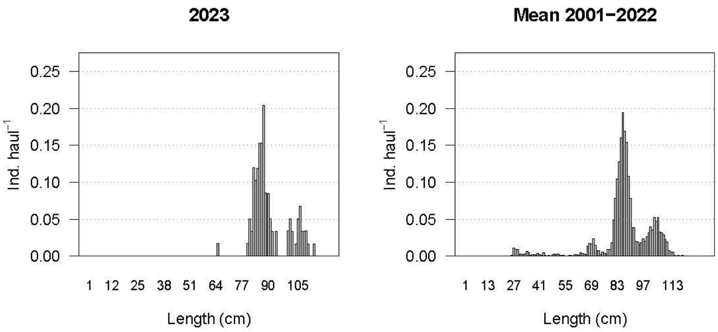


Figure 11: Stratified length distribution of *Deania calceus* in the last Porcupine survey, and mean values in Porcupine surveys in the last decade.

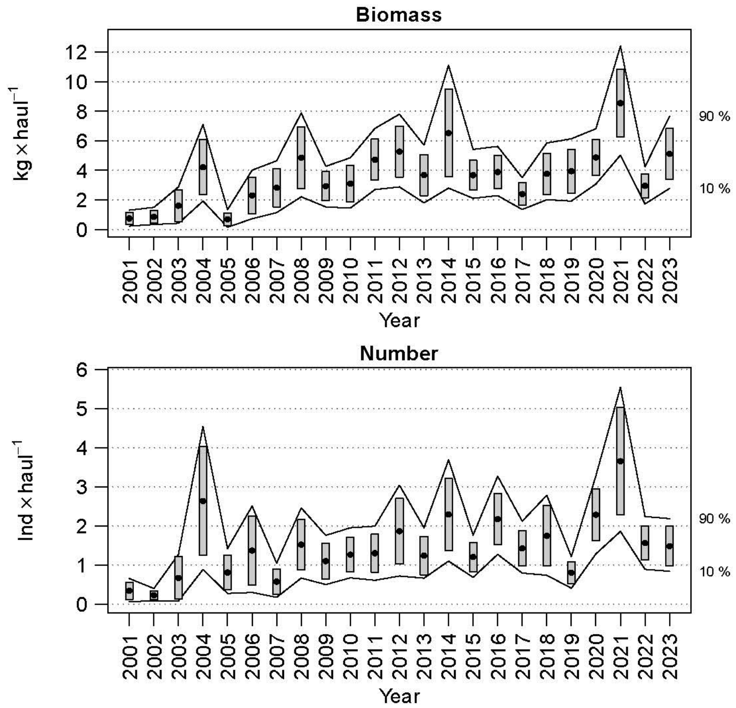


Figure 12: Evolution of biomass and abundance indices *Scymnodom ringens* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

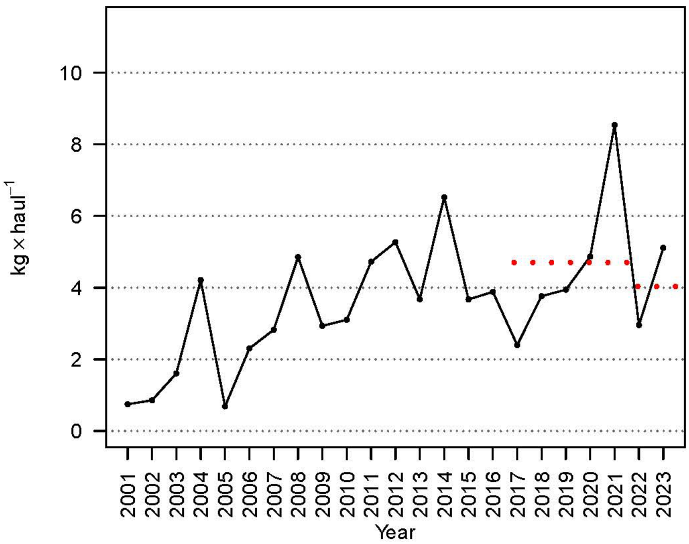


Figure 13: Evolution of biomass index *Scymnodom ringens* in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

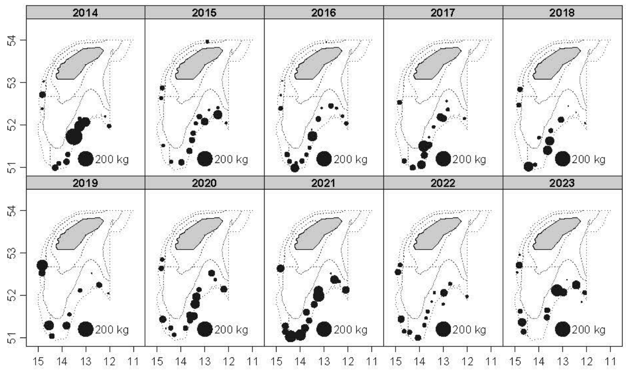


Figure 14: Geographic distribution of *Scymnodom ringens* catches (kg×30 min haul^{-1}) in the Porcupine surveys over the last decade.

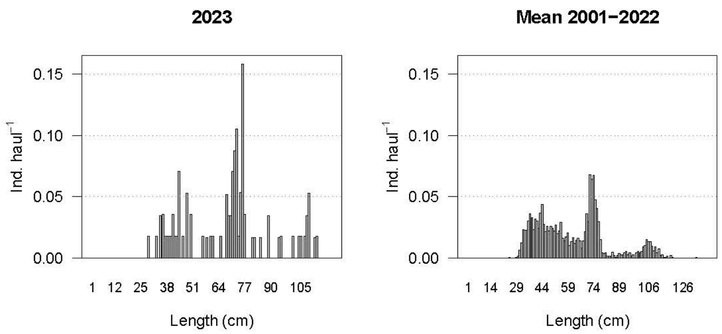


Figure 15: Stratified length distributions of *Scymnodom ringens* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

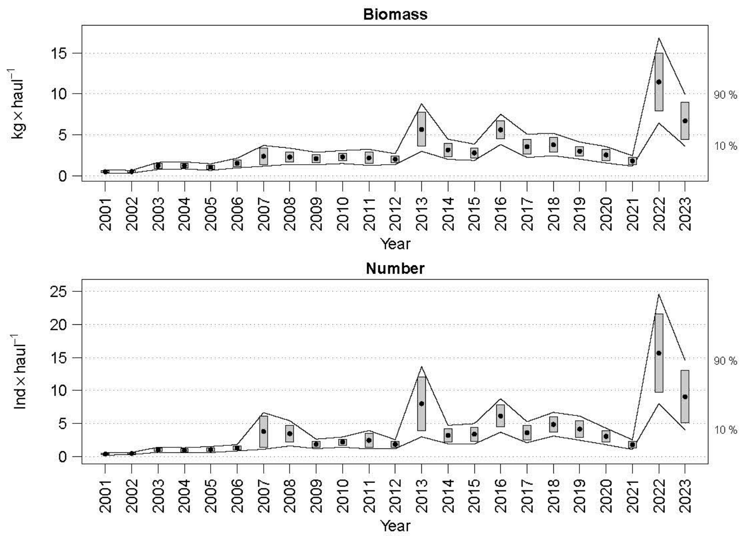


Figure 16: Evolution of biomass and abundance indices of *Scyliorhinus canicula* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

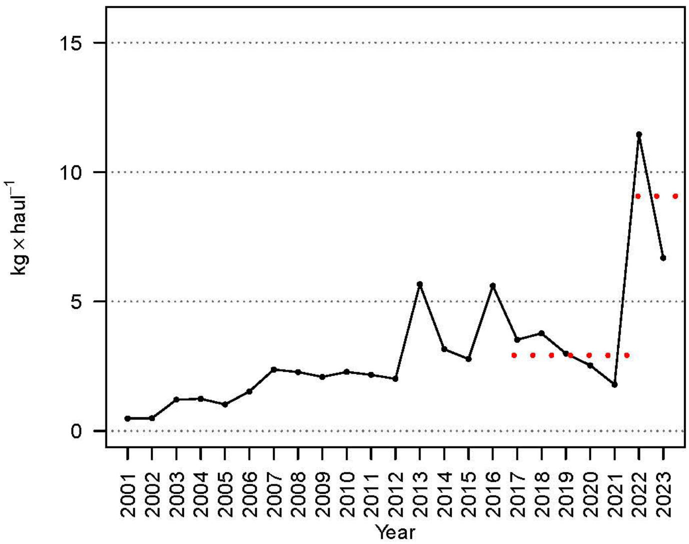


Figure 17: Evolution of biomass index of *Scyliorhinus canicula* in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

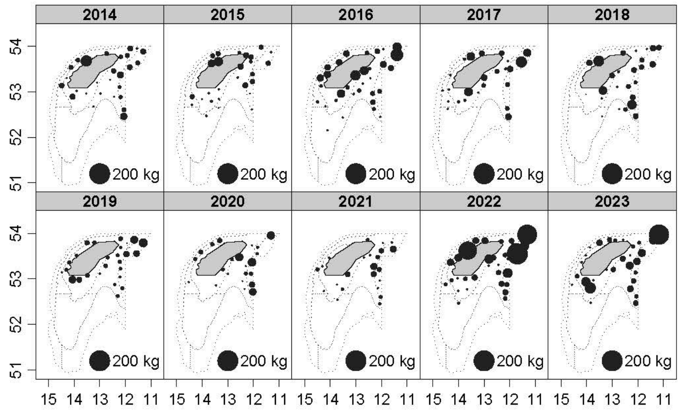


Figure 18: Geographic distribution of *Scyliorhinus canicula* catches (kg×30 min haul^{-}1) in the Porcupine surveys over the last decade.

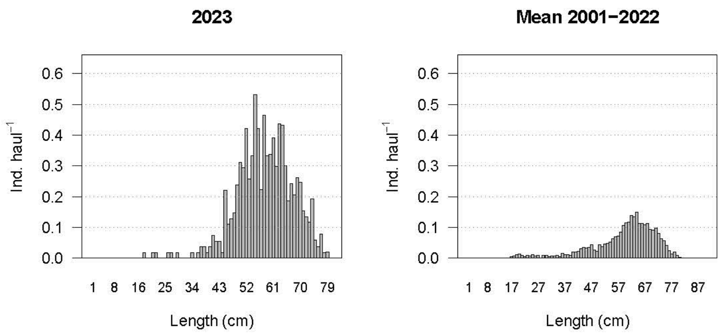


Figure 19: Stratified length distribution of *Scyliorhinus canicula* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

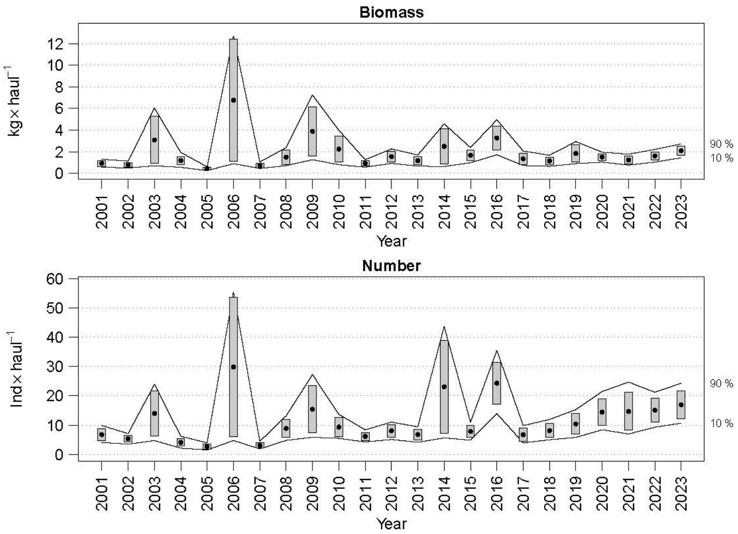


Figure 20: Evolution of biomass and abundance indices of *Etmopterus spinax* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

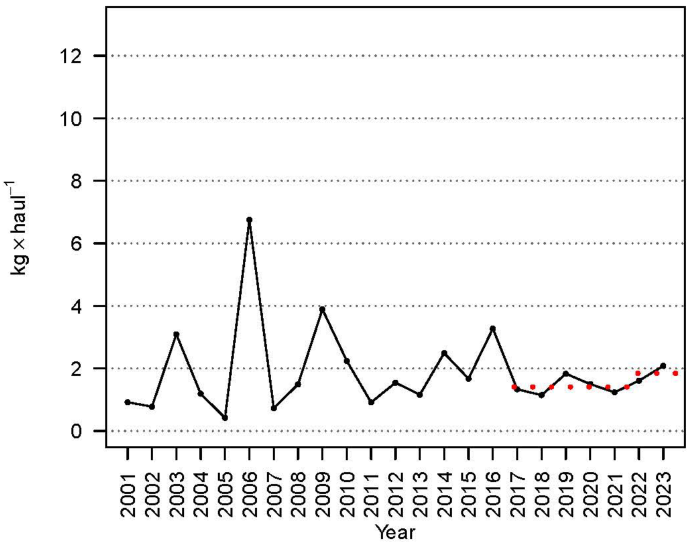


Figure 21: Evolution of biomass index of *Etmopterus spinax* in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

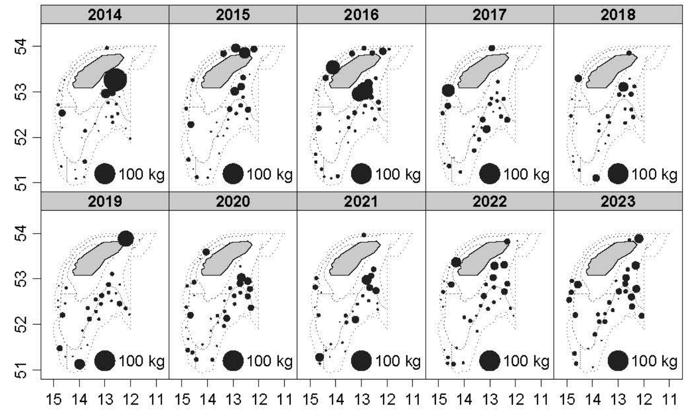


Figure 22: Geographic distribution of *Etmopterus spinax* catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

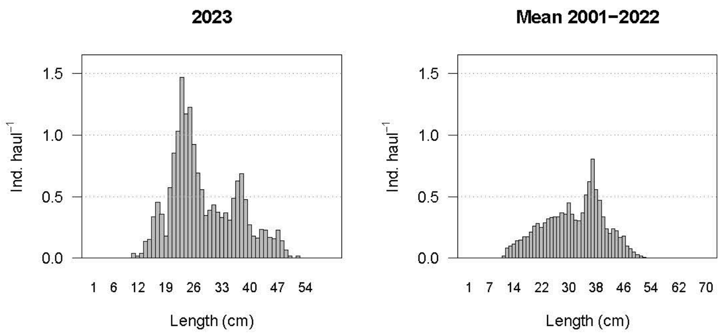


Figure 23: Stratified length distribution of *Etmopterus spinax* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

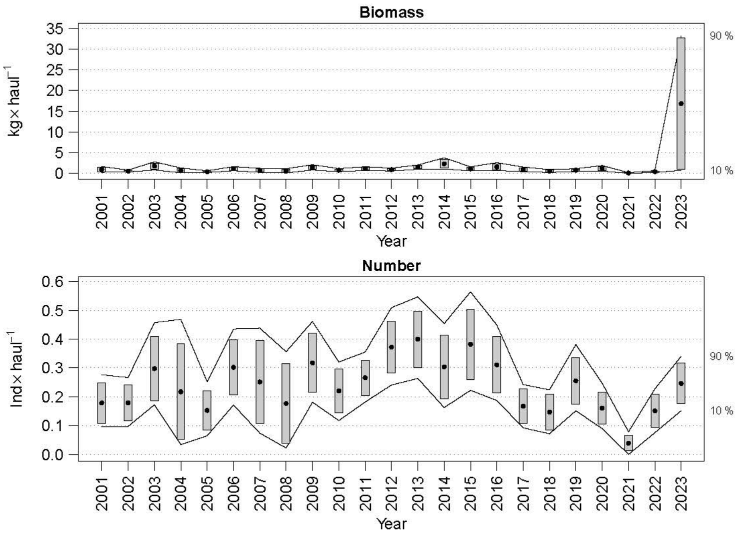


Figure 24: Evolution of biomass and abundance indices of *Hexanchus griseus* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

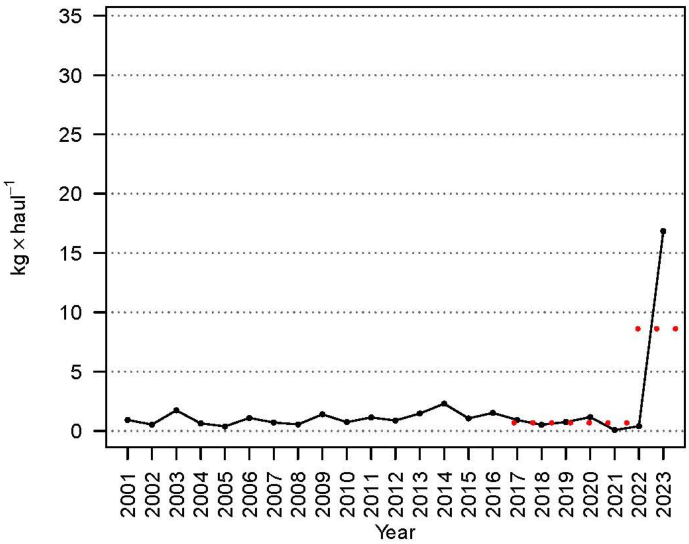


Figure 25: Evolution of biomass index of *Hexanchus griseus* in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

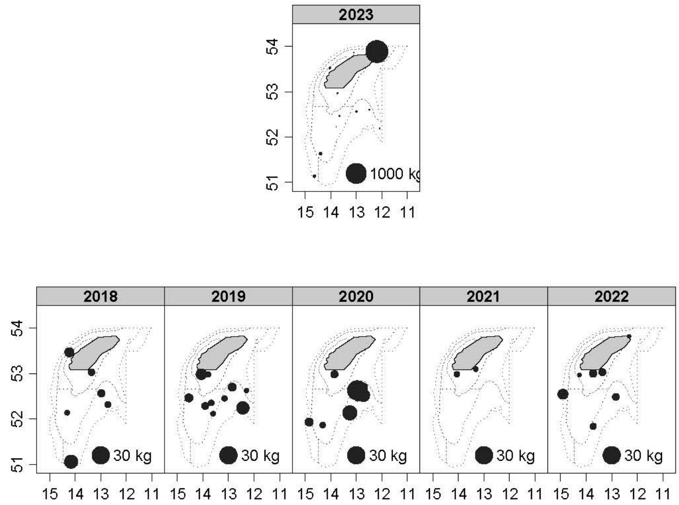


Figure 26: Geographic distribution of *Hexanchus griseus* catches (kg×30 min haul⁻1) in the last Porcupine survey and also in the Porcupine surveys over the previous five years.

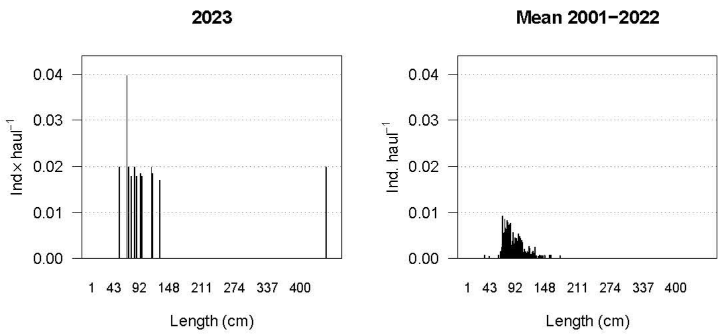


Figure 27: Stratified length distribution of *Hexanchus griseus* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

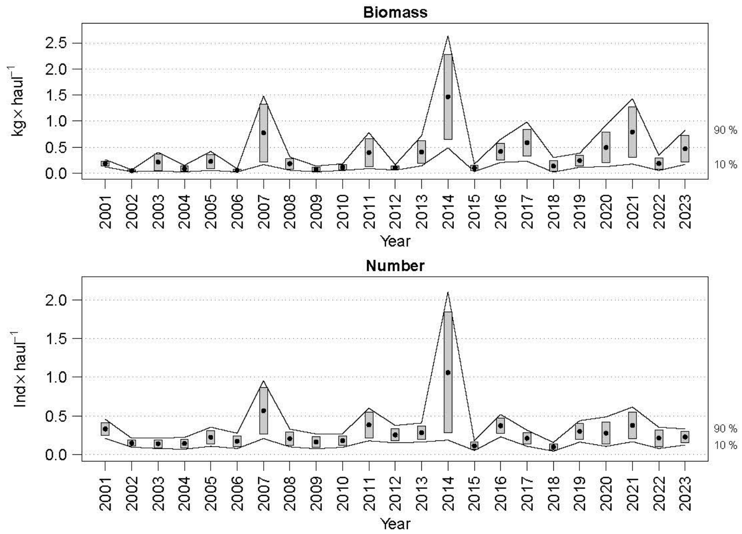


Figure 28: Evolution of biomass and abundance indices of *Dalatias licha* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

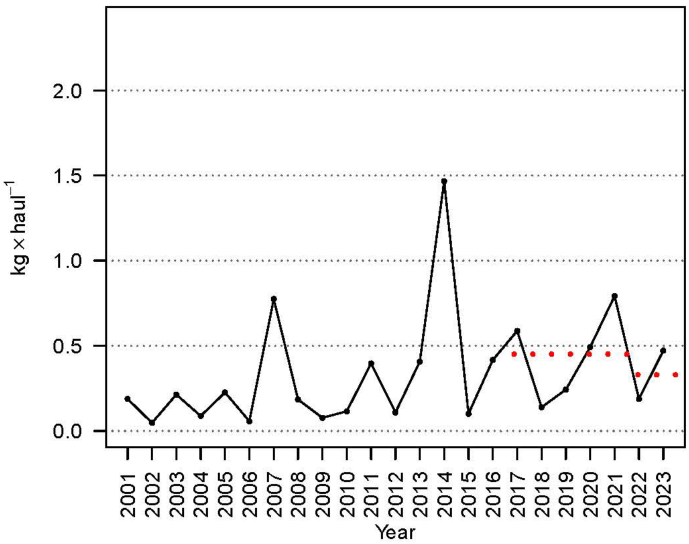


Figure 29: Evolution of biomass index of *Dalatias licha* in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

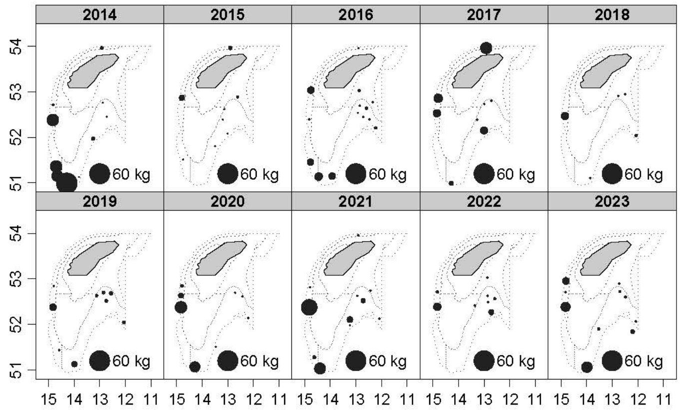


Figure 30: Geographic distribution of *Dalatias licha* catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

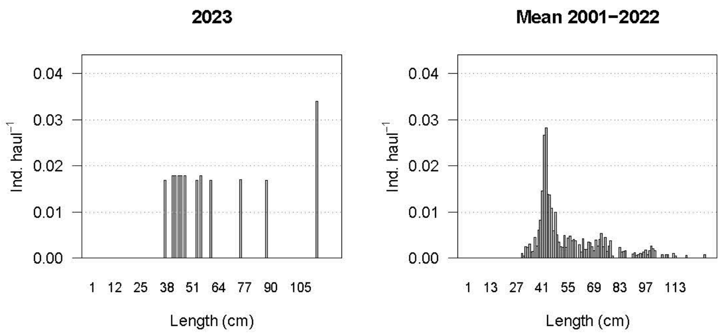


Figure 31: Stratified length distribution of *Dalatias licha* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

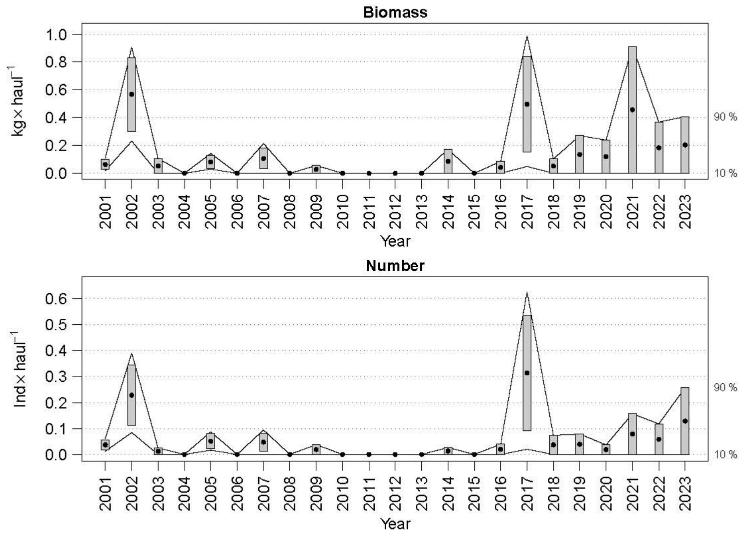


Figure 32: Evolution of biomass and abundance indices of *Squalus acanthias* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

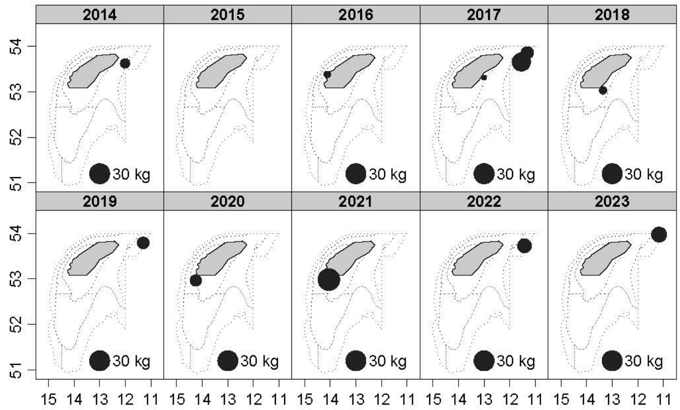


Figure 33: Geographic distribution of *Squalus acanthias* catches (kg×30 min haul^{-1}) in the Porcupine surveys over the last decade.

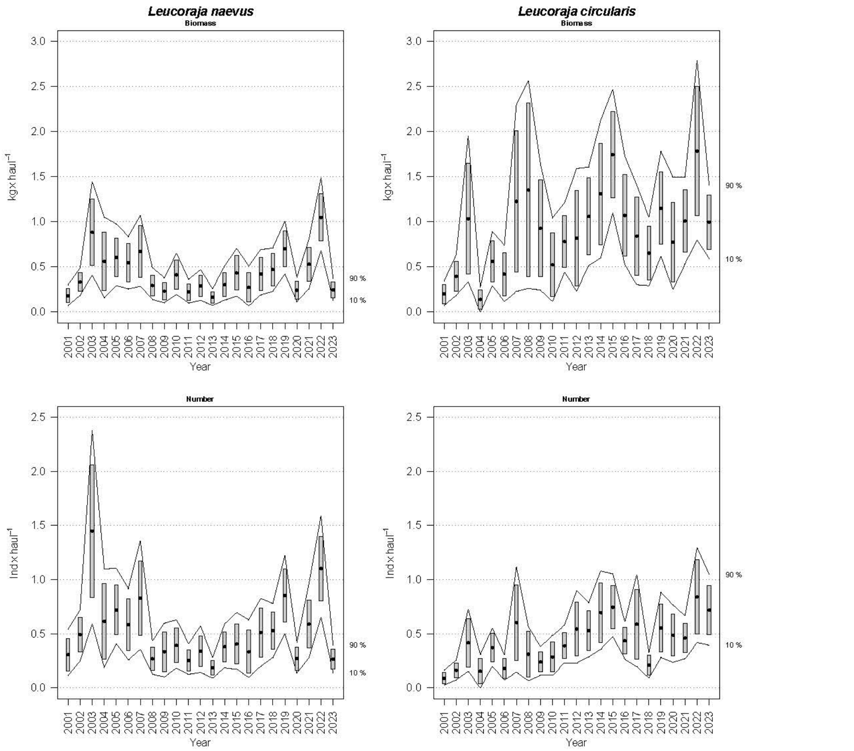


Figure 34: Evolution of biomass and abundance indices of *Leucoraja naevus* and *Leucoraja circularis* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

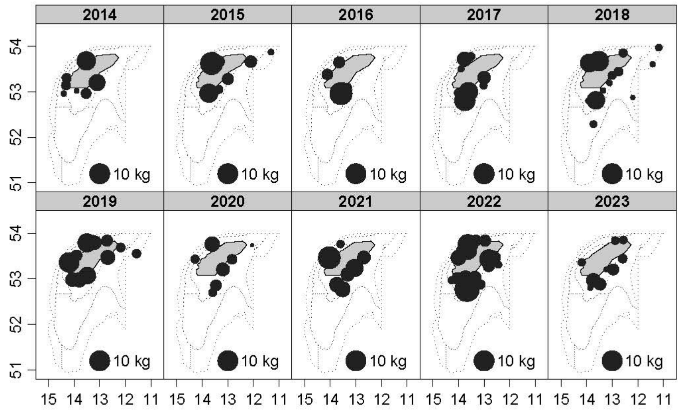


Figure 35: Geographic distribution of *Leucoraja naevus* catches (kg×30 min haul^{-}1) in the Porcupine surveys over the last decade.

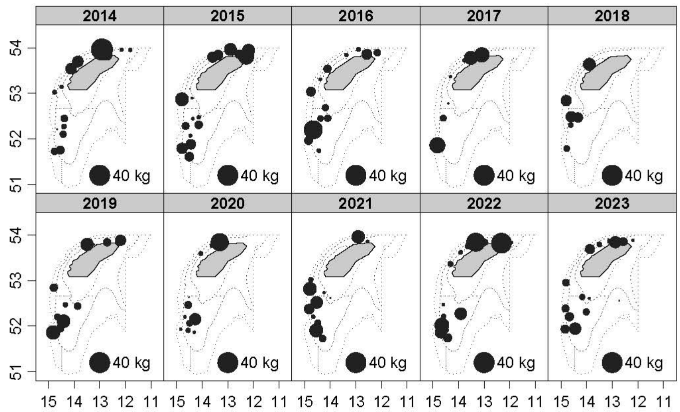


Figure 36: Geographic distribution of *Leucoraja circularis* catches (kg×30 min haul^{-}1) in the Porcupine surveys over the last decade.

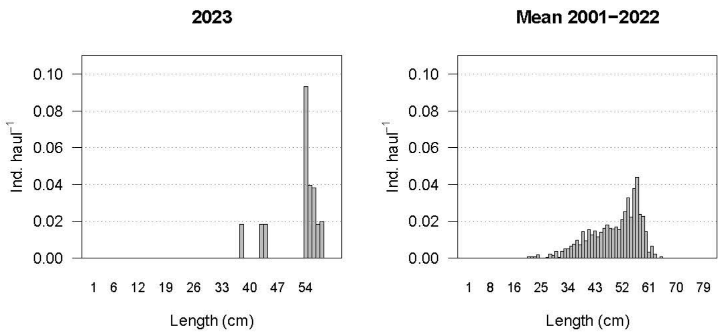


Figure 37: Stratified length distribution of *Leucoraja naevus* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

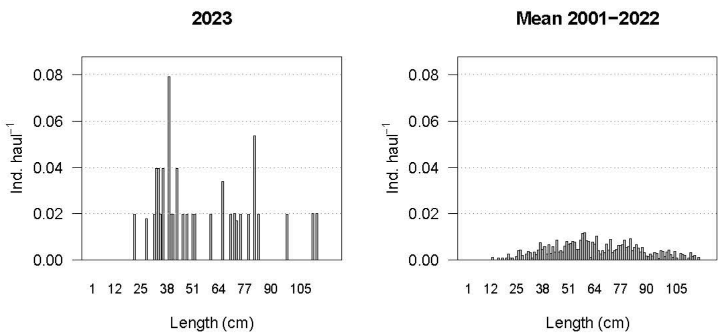


Figure 38: Stratified length distribution of *Leucoraja circularis* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

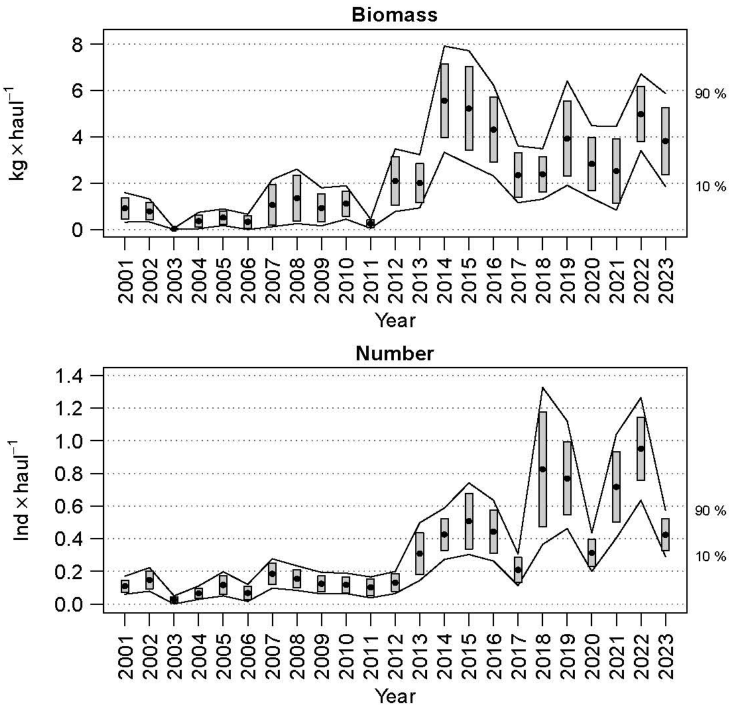


Figure 39: Evolution of biomass and abundance indices of *Dipturus* spp. in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

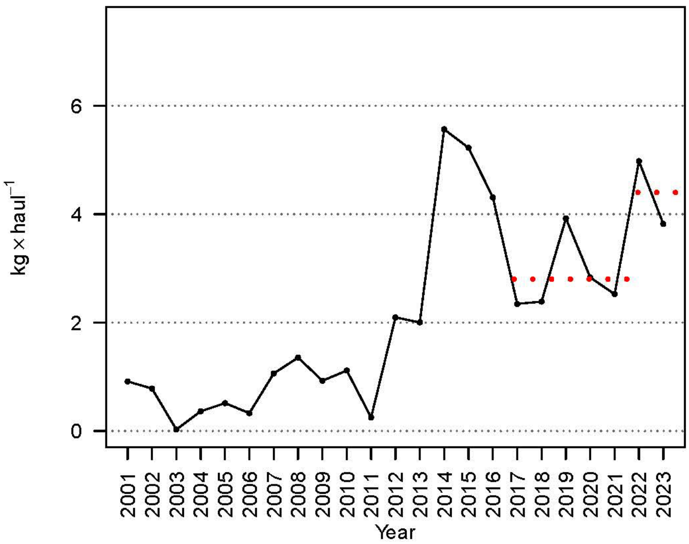


Figure 40: Evolution of biomass index of *Dipturus* spp. in the Porcupine surveys. Dotted lines compare mean stratified biomass in the last two years with the five previous years.

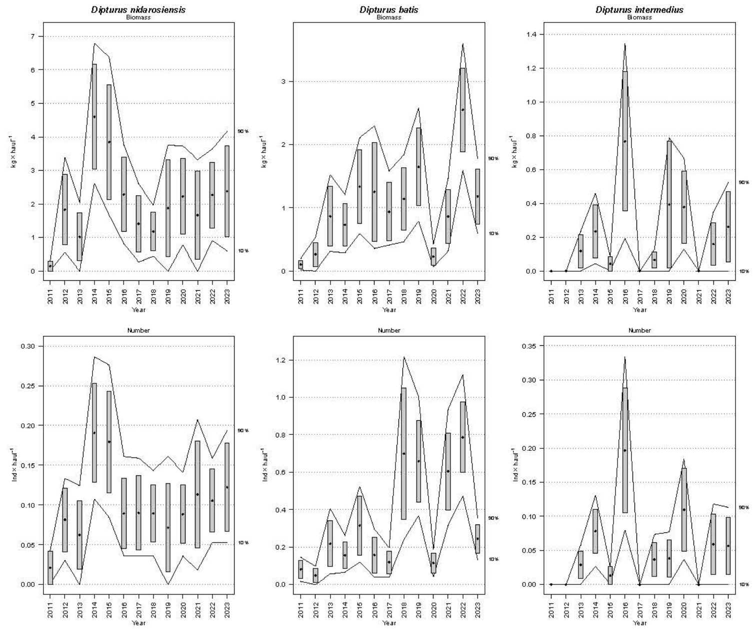


Figure 41: Evolution of biomass and abundance indices of *Dipturus nidarosiensis*, *Dipturus batis* and *Dipturus intermedius* in the Porcupine surveys (2011-2023). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

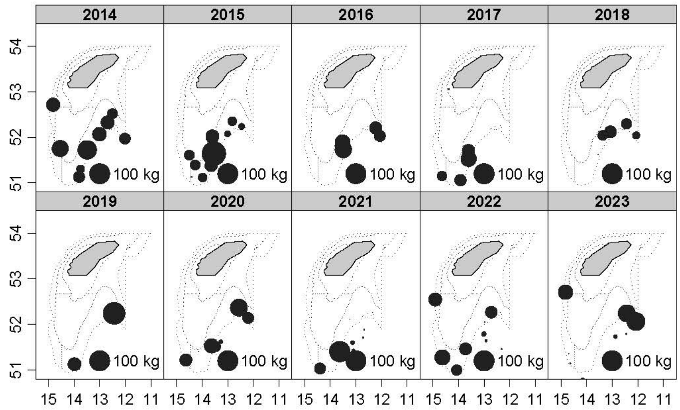


Figure 42: Geographic distribution of *Dipturus nidarosiensis* catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

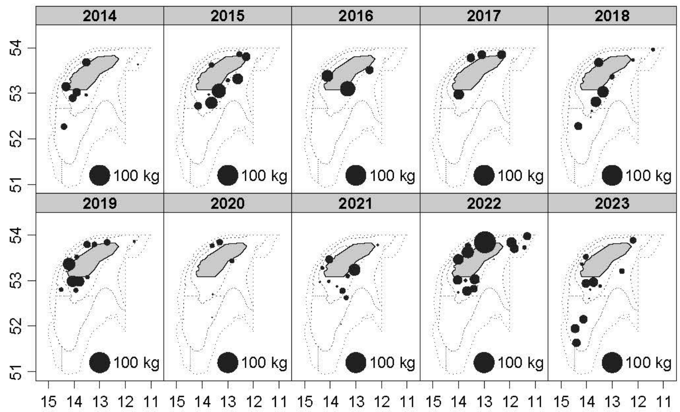


Figure 43: Geographic distribution of *Dipturus batis* catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

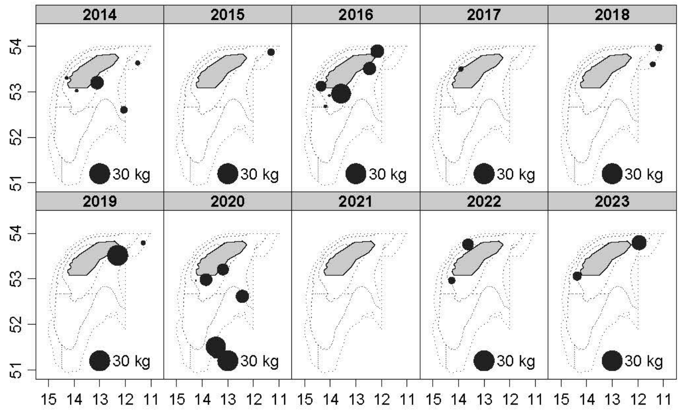


Figure 44: Geographic distribution of *Dipturus intermedius* catches (kg×30 min haul⁻1) in the Porcupine surveys over the last decade.

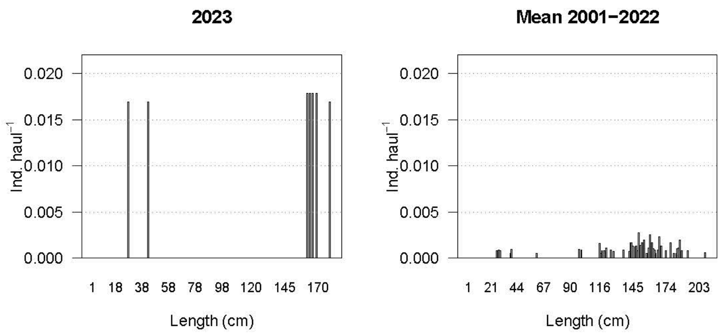


Figure 45: Stratified length distribution of *Dipturus nidarosiensis* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

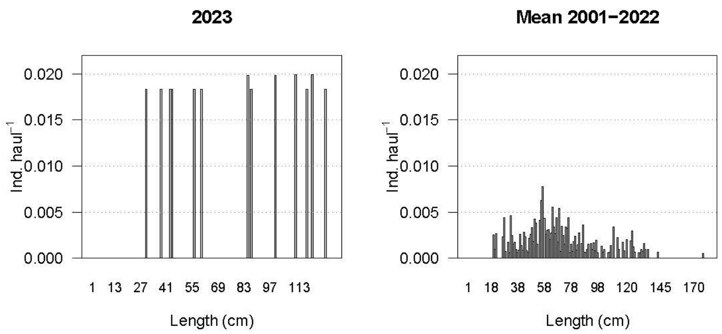


Figure 46: Stratified length distribution of *Dipturus batis* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

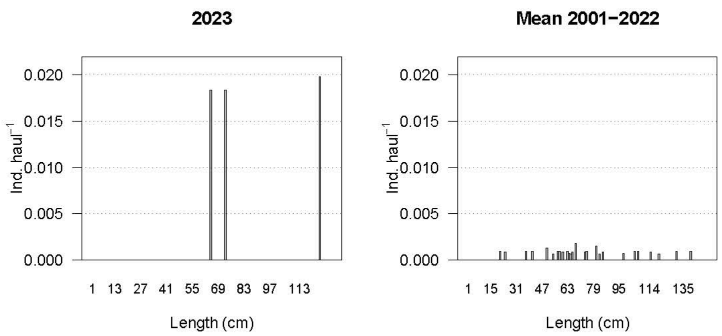


Figure 47: Stratified length distribution of *Dipturus intermedius* in the last Porcupine survey, and mean values in the time series of the Porcupine surveys.

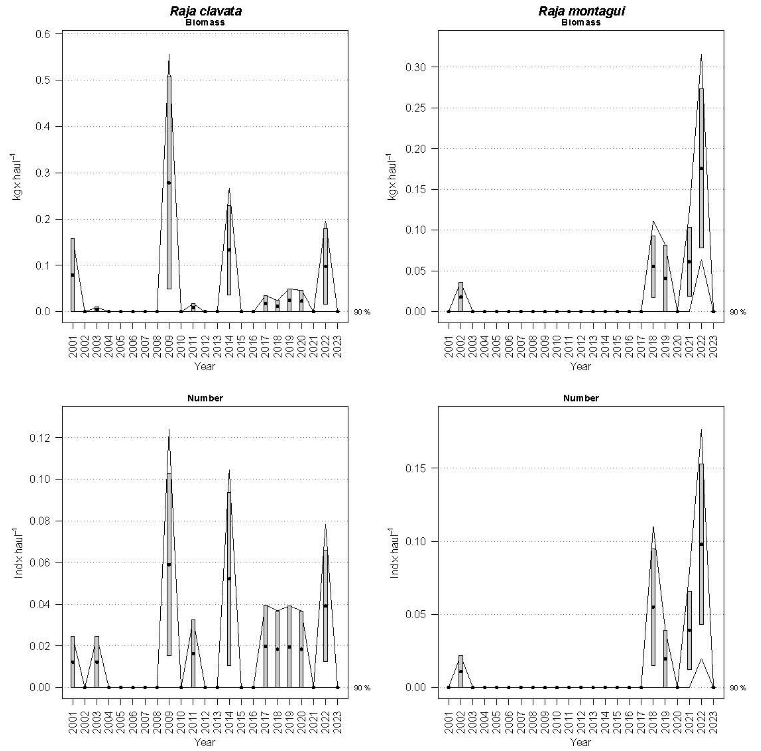


Figure 48: Evolution of biomass and abundance indices of *Raja clavata* and *Raja montagui* in the Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).