ICES WGEF REPORT 2015

ICES ADVISORY COMMITTEE

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Report of the Working Group on Elasmobranch Fishes (WGEF)

17–23 June 2015

Lisbon, Portugal

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Executive Summary

The ICES Working Group on Elasmobranch Fishes, 2015 (Chairs, Ivone Figueiredo, Portugal and Jim Ellis, United Kingdom) was held at IPMA, Lisbon, Portugal from the 17–23 June 2015. Twenty Expert Group members attended, with ten other members contributing via correspondence. One representative of the ICES Secretariat also attended the meeting. Eight ICES Member States were represented.

ICES WGEF meets annually, with advice for a subset of stocks drafted in alternating years. No special requests were received this year. Work in 2015 focused on those stocks for which it was an advisory year: Skates in the North Sea ecoregion, skates in the Azorean and Mid Atlantic Ridge ecoregion, Portuguese dogfish, leafscale gulper shark, kitefin shark, catsharks (*Scyliorhinus canicula* and *Galeus melastomus*), smooth-hounds (*Mustelus* spp.), tope, porbeagle, basking shark and angel shark.

Twenty-five Working Documents were presented to the Group, mainly relating to survey results, biological sampling and exploratory assessment methods. Several working documents presented results from national projects to better understand the spatial and temporal dynamics and biology of assessed species, including some species currently listed as 'prohibited species'. See Annex 3 for a list of working documents presented to WGEF in 2015.

Some of the data used this year were submitted following the ICES Data Call. WGEF concluded that the format of the Data Call, whereby some nations submitted individual files for each of the named stocks, was problematic. In particular, no generic landings categories were submitted by some nations and that increased the workload of the group.

Discard observer data were also submitted following the ICES Data Call. Whilst WGEF wants to make progress from 'landings' to 'catch'-based advice, data from discard observer programmes were used in exploratory analyses only. The nature of elasmobranch spatial dynamics (whereby some species may have highly seasonal or local abundance, or occur infrequently), the frequent problems associated with identification, together with the fact that they are mainly a bycatch in fisheries means that such data need careful appraisal so that appropriate, standardised raising treatments can be developed. A dedicated forum for exploring and analysing these data is required if the data are to be used to provide scientifically justifiable estimates of discards. Furthermore, there will be a degree of discard survival, which will need to be addressed if 'catch' is to be used in relation to removals from the stock.

The following stocks chapters were addressed at the 2014 WGEF meeting:

Section	Species/Assemblage	Area	Assessment type
2	Spurdog	Northeast Atlantic	Updated information
3	Leafscale gulper shark and Portuguese dogfish	Northeast Atlantic (IV–XIV)	Updated information and advice
4	Kitefin shark	Northeast Atlantic (entire ICES area)	Updated information and advice
5	Other Deepwater sharks	Northeast Atlantic (ICES Subareas IV–XIV)	Updated information
6	Porbeagle	Northeast Atlantic (ICES Subareas I–XIV)	Updated information and advice
7	Basking shark	Northeast Atlantic (ICES Subareas I–XIV)	Updated information and advice
8	Blue shark	North Atlantic (North of 5ºN)	Updated information
9	Shortfin mako	North Atlantic (North of 5ºN)	Updated information
10	Tope	Northeast Atlantic and Mediterranean	Updated information and advice
11	Thresher sharks	Northeast Atlantic and Mediterranean	Updated information
12	Other Pelagic sharks	Northeast Atlantic	Updated information
13	Skates and rays	Barents Sea	Updated information
14	Skates and rays	Norwegian Sea	Updated information
15	Skates and rays	North Sea, Skagerrak, Kattegat and eastern Channel	Updated information and advice
16	Skates and rays	Iceland and East Greenland	Updated information
17	Skates and rays	Faroes Islands	Updated information
18	Skates and rays	Celtic Seas (ICES Subareas VI and VII except Division VIId)	Updated information and assessment
19	Skates and rays	Bay of Biscay and Iberian waters (ICES Subarea VIII and Division IXa)	Updated information and assessment
20	Skates and rays	Azores and Mid-Atlantic Ridge	Updated information and advice
21	Smooth-hounds	Northeast Atlantic	Updated information and advice
22	Angel shark	Northeast Atlantic	Updated information and advice
23	White skate	Northeast Atlantic	Updated information
24	Greenland shark	Northeast Atlantic	Updated information
25	Catsharks	Northeast Atlantic	Updated information and advice

1 Introduction

1.1 Terms of Reference

2014/2/ACOM20 The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Ivone Figueirdo, Portugal, and Jim Ellis, UK, will meet in Lisbon, Portugal, from 17–23 June 2015 to:

a) Address generic ToRs for Regional and Species Working Groups (see table below);

b) 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 area. 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).

c) Continue to work towards the F_{MSY} Framework for the stocks listed in the table below;

d) Evaluate the stock status for the provision of quadrennial advice due in 2015 for the following widely-distributed shark stocks: (i) Portuguese dogfish; (ii) Leafscale gulper shark; (iii) Kitefin shark; (iv) Porbeagle, and the following species that are on the prohibited species list: (v) angel shark, (vi) basking shark;

e) Evaluate the stock status for the provision of biennial advice due in 2015 for (i) skate stocks in the North Sea ecoregion; (ii) skate stocks in the Azores and MAR; (iii) catsharks (Scyliorhinidae) in the Grater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast ecoregions; (iv) smooth-hounds in the Northeast Atlantic and (v) tope in the Northeast Atlantic;

f) Conduct exploratory analyses and collate relevant data in preparation for the evaluation of other stocks (spurdog, and skates in the Celtic Seas and Bay of Biscay and Iberian Coast ecoregions) in preparation for more detailed biennial assessment in 2016;

g) Consider the stock ID of *R. naevus* stock (rjn-678abd) using the survey information as well as published studies to decide whether VI, VII and VIIIabd is the correct stock area or if some part(s) (VI and/or VIIafg) should be considered as a separate stock unit;

h) Review, update and standardise Stock Annexes for elasmobranchs where necessary.

Material and data relevant for the meeting must be available to the Group no later than 14 days prior to the starting date.

WGEF will report by 03 August 2015 for the attention of ACOM.

1.2 Participants

The following WGEF members attended the meeting:

Ole Thomas Albert	Norway
Gérard Biais	France
Tom Blasdale	UK (Scotland)
Guzmán Diez	Spain (Basque Country)
Jim Ellis (chair)	UK (England and Wales)
Ivone Figueiredo (chair)	Portugal
Hélène Gadenne	France
Graham Johnston	Ireland
Armelle Jung	France
Pascal Lorance	France
Catarina Maia	Portugal
Inigo Martinez	ICES Secretariat
Sophy McCully Phillips	UK (England and Wales)
Teresa Moura	Portugal
Mário Rui Pinho	Portugal (Azores)
Jan-Jaap Poos	the Netherlands
Cristina Rodríguez-Cabello	Spain
Barbara Serra-Pereira	Portugal
Sam Shepherd	Ireland
Joana Silva	UK (England and Wales)
Tone Vollen	Norway

The following WGEF members assisted by correspondence:

Guillaume Bal	Ireland
Klara Jakobsdottir	Iceland
José De Oliveira	UK (England and Wales)
Kelle Moreau	Belgium
Francis Neat	UK (Scotland)
Harriet van Overzee	Netherlands
Matthias Schaber	Germany
Francisco Velasco	Spain
Morten Vinther	Denmark
Paddy Walker	The Netherlands

1.3 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 proven very difficult because of the lack of data. The 1999 meeting was held concurrently with an EC-funded Concerted Action Project meeting (FAIR CT98-4156) allowing for a greater participation from various European institutes. 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 as a consequence of the DELASS project, a three-year collaborative effort involving fifteen fisheries research institutes and two subcontractors (Heessen, 2003). Though much progress was made on methodology, 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. The medium-term remit of this WG being to adopt and extend the methodologies 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.

In 2003, WGEF met in Vigo, Spain and worked to further the stock assessment work carried out under DELASS. In 2003, landings data were collated for the first time. This exercise was based on data from ICES landings data, the FAO FISHSTAT database, and data from national scientists (ICES, 2003). In 2004, WGEF worked by correspondence to collate and refine catch statistics for all elasmobranchs in the ICES area. This task was complicated by the use (by many countries) of generic reporting categories for sharks, rays and dogfish. WGEF evaluated sampling plans and their usefulness for providing assessment data. (ICES, 2004)

In 2005, WGEF came under ACFM and was given the task of supporting the advisory process. This was because ICES has been asked by the European Commission to provide advice on certain species. This task was partly achieved by WGEF in that preliminary assessments were provided for spurdog, kitefin shark, thornback ray (North Sea) and deep-water sharks (combined). ACFM produced advice on these species, as well as for basking shark and porbeagle, based on the WGEF Report. A standard reporting and presentation format was adopted for catch data and best estimates of catch by species were provided for the first time (ICES, 2005).

In 2006, work continued on refining catch estimates and compiling available biological data (ICES, 2006), with good progress made in some ecoregions. Work was begun on developing standard reporting formats for length–frequency, maturity and cpue data.

In 2007, WGEF met in Galway, with the demersal elasmobranchs of three ecoregions (North Sea, Celtic Seas and Bay of Biscay/Iberian waters) subject to more detailed study and assessment (ICES, 2007), with special emphasis on skates (Rajidae), given that these are some of the more commercially valuable demersal elasmobranchs in these shelf seas. It should be noted, however, that though there have been some historical tagging studies (and indeed there are also ongoing tagging and genetic studies), current knowledge of the stock structure and identity for many of these species is poor, and in most instances the assumed stock area equates with management areas.

WGEF met twice in 2008. The first meeting was in March (in parallel with WGDEEP) in order to update assessments and advice for deep-water sharks and demersal elasmobranchs. A second WGEF subgroup met with the ICCAT shark subgroup in Madrid in September 2008 to address the North Atlantic stocks of shortfin mako and blue shark, and to further refine data available for the NE Atlantic stock of porbeagle (ICES, 2008a).

In June 2009 WGEF held a joint meeting with the ICCAT SCRS Shark subgroup at ICES headquarters in Copenhagen. This was a highly successful meeting and for the first time pooled all available data on North Atlantic porbeagle stocks (ICES, 2009). In addition, updated assessments were carried out for North Sea, Celtic Seas, and Biscay and Iberian demersal elasmobranchs and for the deep-water sharks *Centrophorus squamosus* and *Centroscymnus coelolepis*. A three year assessment schedule was also agreed.

In June 2010 WGEF met in Horta, Portugal. This meeting was a full assessment meeting and stock updates were carried out for 19 species or species groups (ICES, 2010b), with draft advice provided for eight species. In addition three special requests from the EC, relating to new advice on five elasmobranch species, were answered.

In June 2011 WGEF met at ICES Headquarters Copenhagen. Although this was not an advice year, advice was provided for *Squalus acanthias*. This was the result of a benchmark assessment of this species carried out via correspondence during spring 2011. The updated model was used to provide F_{MSY}-based advice for the first time. A special request from NEAFC, on sharks and their categorisation by habitat was also addressed (ICES, 2011).

In June 2012 WGEF met at IPMA in Lisbon (ICES, 2012b). This meeting was a full assessment meeting during which both stock updates and draft advice were provided. Two special requests, one from NEAFC and the other from the NWWRAC (via the EC), were also answered. WGEF also met in Lisbon the following year (ICES, 2013a) with preparatory work and exploratory analyses conducted, in addition to addressing some special advice requests from the EU.

From 2014, it was decided with ICES that advice would be staggered, with the main stocks divided across alternating years and with advice for prohibited and most of the zero TAC stocks done once every four years. In 2014, WGEF advised on skates (Rajidae) in the Celtic Seas and Biscay-Iberian ecoregions (ICES, 2014).

Overall the working group has been very successful in maintaining participation from a wide range of countries. Attendance has increased and reached a stable level in recent years, with participation from quantitative assessment scientists, fishery managers, survey scientists and elasmobranch biologists.

Interest in the work of WGEF from other RFMOs has increased, with regular contact and cooperation between WGEF and ICCAT and the GFCM. Since WGEF 2011, ICES WGEF members have been invited to stock assessments carried out by the International Commission for the Conservation of Atlantic Tunas (ICCAT), and by the General Fisheries Commission for the Mediterranean (GFCM). As many elasmobranch species and stocks range outside the ICES area, WGEF encourages co-operation between ICES and such RFMOs, both in providing information, and in sharing resources for stock assessment.

Stock assessments for many elasmobranchs are particularly difficult owing to incomplete (or lack of) species-specific catch data, the straddling and/or highly migratory nature of some of these stocks (especially with regards deep-water and pelagic sharks), and that internationally-coordinated fishery-independent surveys only sample a small number of demersal elasmobranchs with any degree of effectiveness.

1.4 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 time frame for advice (Table 1.1).

In 2014, the following species and stocks were assessed and advice drafted:

- Spurdog in the Northeast Atlantic;

- Skates and rays (Rajidae) in the Celtic Seas (ICES Subareas VI and VII except Division VIId);[1]
- Skates and rays (Rajidae) in the Bay of Biscay and Iberian Coast (ICES Subarea VIII and Division IXa);
- White skate.

In 2015, the following species and stocks were addressed for advice:

- Skates and rays (Rajidae) in the Greater North Sea, (including Skagerrak, Kattegat and eastern Channel) (seven stocks and 'other skates');
- Skates and rays (Rajidae) in the Azores and Mid-Atlantic Ridge (mainly *R. clavata*);
- Smooth-hounds in the Northeast Atlantic;
- Tope in the Northeast Atlantic;
- Catshark stocks in the Northeast Atlantic (seven nominal stock units);
- Leafscale gulper shark in the Northeast Atlantic (IV–XIV);
- Kitefin shark in the Northeast Atlantic (ICES Subareas I–XIV);
- Portuguese dogfish in the Northeast Atlantic (ICES Subareas I–XIV);
- Angel shark in the Northeast Atlantic;
- Porbeagle in the Northeast Atlantic (ICES Subareas I–XIV);
- Basking shark in the Northeast Atlantic (ICES Subareas I–XIV).

[1] Note: Skate species that have a stock unit of VIId–e are included within the Celtic Sea chapter and advice. Skate species that have a stock unit of IVc–VIId are included within the North Sea chapter and advice.

Table 1.1. Stocks with advice given in 2014.

ICES Stock code	Stock name	EcoRegion	Advice updated	Advice
dgs-nea	Spurdog (*Squalus acanthias*) in the Northeast Atlantic	Widely distributed	2014	Biennial
rjb-89a	Common skate (*Dipturus batis*-complex) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian coast	2014	Biennial
rjn-bisc	Cuckoo ray (*Leucoraja naevus*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)	Bay of Biscay and Iberian coast	2014	Biennial
rjn-pore	Cuckoo ray (*Leucoraja naevus*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2014	Biennial
rjh-pore	Blonde ray (*Raja brachyura*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2014	Biennial
rjc-bisc	Thornback ray (*Raja clavata*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)	Bay of Biscay and Iberian coast	2014	Biennial
rjc-pore	Thornback ray (*Raja clavata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2014	Biennial
rjm-bisc	Spotted ray (*Raja montagui*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)	Bay of Biscay and Iberian coast	2014	Biennial
rjm-pore	Spotted ray (*Raja montagui*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2014	Biennial
rju-8ab	Undulate ray (*Raja undulata*) in Divisions VIIIa,b (Bay of Biscay)	Bay of Biscay and Iberian coast	2014	Biennial
rju-8c	Undulate ray (*Raja undulata*) in Divisions VIIIc (Cantabrian Sea)	Bay of Biscay and Iberian coast	2014	Biennial
rju-9a	Undulate ray (*Raja undulata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2014	Biennial
raj-89a	Other skates and rays in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian coast	2014	Biennial
rjb-celt	Common skate (*Dipturus batis*) complex (flapper skate (*Dipturus* cf. *flossada*) and blue skate (*Dipturus* cf. *intermedia*)) in Subareas VI and VII (excluding VIId)	Celtic Seas	2014	Biennial
rji-celt	Sandy ray (*Leucoraja circularis*) in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Seas	2014	Biennial
rjf-celt	Shagreen ray (*Leucoraja fullonica*) in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Seas	2014	Biennial

ICES Stock code	Stock name	EcoRegion	Advice updated	Advice
rjn-celt	Cuckoo ray (*Leucoraja naevus*) in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Seas	2014	Biennial
rjh-7afg	Blonde ray (*Raja brachyura*) in Divisions VIIa, f, g (Irish and Celtic Sea)	Celtic Seas	2014	Biennial
rjh-7e	Blonde ray (*Raja brachyura*) in Division VIIe (western English Channel)	Celtic Seas	2014	Biennial
rjc-7afg	Thornback ray (*Raja clavata*) in Divisions VIIa, f, g (Irish and Celtic Sea)	Celtic Seas	2014	Biennial
rjc-echw	Thornback ray (*Raja clavata*) in Division VIIe (Western English Channel)	Celtic Seas	2014	Biennial
rjc-VI	Thornback ray (*Raja clavata*) west of Scotland (Subarea VI)	Celtic Seas	2014	Biennial
rje-7ech	Small-eyed ray (*Raja microocellata*) in the English Channel (Divisions VIId,e)	Celtic Seas	2014	Biennial
rje-7fg	Small-eyed ray (*Raja microocellata*) in Divisions VIIf, g (Bristol Channel)	Celtic Seas	2014	Biennial
rjm-67bj	Spotted ray (*Raja montagui*) in Subarea VI and Divisions VIIb,j (west of Scotland and Ireland)	Celtic Seas	2014	Biennial
rjm-7aeh	Spotted ray (*Raja montagui*) in Divisions VIIa and VII e–h (southern Celtic seas)	Celtic Seas	2014	Biennial
rju-7bj	Undulate ray (*Raja undulata*) in Divisions VIIb,j (Southwest of Ireland)	Celtic Seas	2014	Biennial
rju-ech	Undulate ray (*Raja undulata*) in Divisions VIId, e (English Channel)	Celtic Seas	2014	Biennial
rja-nea	White skate (*Rostroraja alba*) in the Northeast Atlantic	Widely distributed	2015	Quadrennial
raj-celt	Other skates and rays in Subareas VI and VII (excluding VIId)	Celtic Seas	2014	Biennial

Table 1.2. Elasmobranch stocks with assessments in 2015.

ICES Stock code	Stock name	EcoRegion	Advice updated	Advice
sho-89a	Black-mouth dogfish (*Galeus melastomus*) in in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2015	Biennial
syc-8c9a	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIc and IXa (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2015	Biennial
syc-bisc	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIa,b,d (Bay of Biscay)	Bay of Biscay and Iberian seas	2015	Biennial
sho-celt	Black-mouth dogfish (*Galeus melastomus*) in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Seas	2015	Biennial
syc-celt	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea VI and Divisions VIIa–c, e–j (Celtic Seas and west of Scotland)	Celtic Seas	2015	Biennial
syt-celt	Greater-spotted dogfish (*Scyliorhinus stellaris*) in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Seas	2015	Biennial
rjb-34	Common skate (*Dipturus batis*-complex) in Subarea IV and Division IIIa (North Sea and Skagerrak)	North Sea	2015	Biennial
rjn-34	Cuckoo ray (*Leucoraja naevus*) in Subarea IV and Division IIIa (North Sea and Skagerrak and Kattegat)	North Sea	2015	Biennial
rjh-4aVI	Blonde ray (*Raja brachyura*) in Division IVa and Subarea VI (Northern North Sea and west of Scotland)	North Sea	2015	Biennial
rjh-4c7d	Blonde ray (*Raja brachyura*) in Divisions IVc and VIId (Southern North Sea and eastern English Channel)	North Sea	2015	Biennial
rjc-347d	Thornback ray (*Raja clavata*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat and eastern English Channel)	North Sea	2015	Biennial
rjm-347d	Spotted ray (*Raja montagui*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2015	Biennial
rjr-234	Starry ray (*Amblyraja radiata*) in Subareas II, IIIa and IV (Norwegian Sea, Skagerrak, Kattegat and North Sea)	North Sea	2015	Biennial
raj-347d	Other skates and rays in the North Sea ecoregion (Subarea IV, and Divisions IIIa and VIId)	North Sea	2015	Biennial

ICES Stock code	Stock name	EcoRegion	Advice updated	Advice
syc-347d	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2015	Biennial
agn-nea	Angel shark (*Squatina squatina*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Quadrennial
bsk-nea	Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Quadrennial
cyo-nea	Portuguese dogfish (*Centroscymnus coelolepis*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Quadrennial
gag-nea	Tope (*Galeorhinus galeus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Biennial
guq-nea	Leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Biennial/Quadrennial
por-nea	Porbeagle (*Lamna nasus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Quadrennial
raj-mar	Rays and skates (mainly thornback ray) in the Azores and Mid-Atlantic Ridge	Widely distributed and migratory stocks	2015	Biennial
sck-nea	Kitefin shark (*Dalatias licha*) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Quadrennial
trk-nea	Starry smooth-hound (*Mustelus* spp.) in the Northeast Atlantic	Widely distributed and migratory stocks	2015	Biennial

1.5 ICES approach to F_{MSY}

Most elasmobranch species are slow growing, with low production. 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, it is not believed that F_{MSY} is an appropriate or achievable target in all cases, particularly in the short term. However the ICES F_{MSY} methodology has evolved in recent years. For example, new methods that are more appropriate for data-deficient stocks have been developed, and there is a greater interest in considering generation time into such methods and for the provision of advice. The generation time of elasmobranchs is often much longer than most teleosts. For each assessed stock the ICES precautionary approach is considered, and the group's approach and considerations are outlined in the stock summary sheets.

1.6 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 detail on this plan and its relevance to this WG can be found in the 2009 WG Report.

1.7 Conservation advice

Several terms are used to define stock status, particularly at low levels. Some of these terms mean different things to different people. Therefore WGEF takes this opportunity to define how terms are used within this report, and also how we believe these terms should be used when providing advice.

In addition, several elasmobranch species are currently on the Prohibited Species List in European Council Regulations fixing Fishing Opportunities each year. Although this may be appropriate, WGEF believes that this status should only be used for long-term conservation, whilst a (near) zero TAC may be more appropriate for short-term management.

These ideas are discussed in detail below.

Extinction vs. extirpation

Extinction is defined as "*The total elimination or dying out of any plant or animal species, or a whole group of species, worldwide*" (Chambers Dictionary of Science and Technology), yet increasingly the term 'extinct' is used in conservation and scientific literature to highlight the disappearance of a species from a particular location or region, even if the area is at the periphery of the main geographical range.

Additionally, some of the studies that have reported a species to be (locally or regionally) 'extinct' can be based on limited data, with supporting data often neither spatially nor temporally comprehensive enough to confirm the loss, especially with regards to species that are wide-ranging, small-bodied and/or cryptic, or distributed in habitats that are difficult to survey.

In terms of a standardized approach to the terminology of lost species, WGEF consider the following:

Extinct: When an animal or plant species has died out over its entire geographical range.

Extirpated: When an animal or plant species has died out over a defined part of its range, from where it was formerly a commonly occurring species. This loss should be due, whether directly or indirectly, to anthropogenic activities.

If anthropogenic activities are not considered to have affected the loss of the species, then the species should be considered to have 'disappeared' or been lost from the area in question. The term 'extirpated' should also be used to identify the loss of the species from part of the main geographical range or habitat, and therefore be distinguished from a contraction in the range of a species, where it has been lost from the fringes of its distribution or suboptimal habitat.

Additionally, the terms 'extinct' and 'extirpated' should be used when there have been sufficient appropriate surveys (i.e. operating at the relevant temporal and spatial scale and with an appropriate survey or census method) to declare the species extinct/extirpated. Prior to this time, these terms could be prefixed near- or presumed.

Presumed extinct/extirpated should be used when the species has not been recorded in available survey data (which should operate at an appropriate temporal and spatial scale), but when dedicated species-specific surveys have not been undertaken.

Near extinct/extirpated should be used when there are isolated reports of the species existing in the geographical area of interest.

In terms of ICES advice, the term 'extinct' was used in both 2005 and 2006 to describe the status of angel shark in the North Sea; although since 2008 the term 'extirpated' has been used.

The utility of the 'Prohibited species' on the TACs and quotas regulations

The list of prohibited species on the TACs and quotas regulations 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 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.

In 2009 and 2010 undulate ray, *Raja undulata* was moved on to the prohibited species list. This had not been recommended 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. There have been subsequent changes in the listing of this species. It was removed from the Prohibited Species List for Subarea VII in 2014 (albeit as a species that cannot be retained or landed). From 2015 undulate ray was only maintained in the prohibited species list in Subareas VI and X and a small TAC was established for stocks in the English Channel and Bay of Biscay.

1.8 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, 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.

1.9 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.

1.10 Current ICES expert groups of relevance to the WGEF

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 IVc, and is taken 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.

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 VIa and the deeper waters of the Celtic Sea (VIIh–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.

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 2010a). Two WGEF members attended in order to carry out an assessment of the deep-water shark species *Centrophorus squamosus* and *Centroscymnus coelolepis*. Considerable progress during the meeting in terms of the 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, and its further development and possible future application is to be strongly encouraged.

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 such work 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. This sort of analysis is 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.

Workshop on Sexual Maturity Staging of Elasmobranchs (WKMSEL)

The first workshop met in October 2010, following a recommendation from PGCCDBS. Its objectives were to agree on a common maturity scale for elasmobranchs, both oviparous and viviparous species, across laboratories and compare existing scales and standardize maturity determination criteria (ICES, 2010c). Although WGEF agrees that standardization across laboratories is important, there are concerns over some of the new scales proposed. In particular, the increase in the number of stages compared with other scales used will lead to some problems if introduced. These include:

- Comparison of new records with older samples;
- Training requirements for all staff who stage elasmobranchs;
- Adoption of new systems and/or software adjustments for survey/other databases, such as IBTS, DATRAS, etc.

A second workshop was held in December 2012, following a recommendation by ICES, to revise and update the maturity scales proposed by WKMSEL. The new macroscopic scales for males and females of oviparous and viviparous species have simple descriptions that facilitate the assignment of maturity stages, as it was recommended by WGEF in 2012. The adoption of substages (e.g. 3a and 3b) allow for an optional simplified version of the scale, useful for quick uses or when the capacity and experience are a constraint.

Following WGEF recommendations, previous scales were reanalysed to make a correspondence between them and the new. The correspondence was adequate for most of the stages proposed except for the later ones, e.g. post-laying for oviparous females and regenerating for both oviparous and viviparous. These new stages were considered essential to fully understand the reproductive strategies of the species and get better estimates for life-history parameters, needed in demographic and other assessment models (ICES, 2013b).

1.11 Other meetings of relevance to WGEF

1.11.1 ICCAT

WGEF has conducted joint assessments with ICCAT in 2008 and 2009. These 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. ICCAT shark specialist subgroup also recommends maintaining links and sharing data with WGEF. In 2012 a representative of WGEF attended the ICCAT Ecological Risk Assessment and shortfin mako stock assessment in Faro, Portugal. Data from this meeting were used in the WGEF account of shortfin mako (Chapter 9). In 2015, representatives of WGEF will participate at the ICCAT blue shark stock assessment that will be held in Lisbon, Portugal.

Meanwhile further collaborative meetings with the ICCAT shark sub-group will continue to be investigated intersessionally and the ICES Secretariat should make efforts to establish such collaboration.

1.11.2 General Fisheries Commission for the Mediterranean (GFCM)

From 2010 to 2013, the GFCM carried out a programme to improve the knowledge and assess the status of elasmobranchs in the Mediterranean and the Black Sea. The main outcomes of this four year programme were three meetings and two publications:

1) Expert Meeting on the status of elasmobranchs in the Mediterranean and Black Sea (Sfax, Tunisia, 20–22 September 2010);
2) Workshop on stock assessment of selected species of elasmobranchs (Brussels, Belgium, 12–16 December 2011);
3) Workshop on age determination (Antalya, Turkey, 8–12 October 2012);
4) Bibliographic review to sum up the information gathered during the above mentioned meetings, published in 2012 within the GFCM Series Studies and Reviews; and
5) Publication of a technical manual on age determination of elasmobranchs.

In 2013, the GFCM decided to develop a three-year extension of this programme including the:

1) Preparation of a draft proposal on practical options for mitigating bycatch for the most impacting gears in the Mediterranean and Black Sea;
2) Production and dissemination of guidelines on good practices to reduce the mortality of sharks and rays caught incidentally by artisanal fisheries;
3) Development of studies on growth, reproduction, population genetic structure and post-released mortality and identification of critical areas (nurseries) at national or regional level;
4) Preparation of factsheets and executive summaries for some commercial species presenting identification problems;
5) Assessment of the impact of anthropogenic activities other than fisheries on the observed decline of certain sharks and rays populations;
6) Implementation of a pilot tagging programme for pelagic sharks.

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.

1.12 Relevant biodiversity conservation issues

ICES work on elasmobranch fish is becoming increasingly important as a source of information to various multilateral environmental agreements concerned about the conservation status of some species. Table 1.3 lists species occurring in the ICES area that are being considered within these fora. An increasing number of elasmobranchs are now ‘prohibited’ species in European fisheries regulations, and these are also summarised in Table 1.4.

1.12.1 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 Community. 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 1.3), either across the entire OSPAR region or in areas where they were perceived as declining. Background Documents summarize the status of these species are available (OSPAR, 2010).

1.12.2 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 1.3 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.

1.12.3 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).

1.12.4 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 II*".

Table 1.3. 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		
Centrophoridae	Gulper shark *Centrophorus granulosus*	✓			
	Leafscale gulper shark *Centrophorus squamosus*	✓			
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	✓			
Squatinidae	Angel shark *Squatina squatina*	✓			App III (Med)
Rhincodontidae	Whale shark *Rhincodon typus*		App II	App II	
Alopiidae	Pelagic thresher *Alopias pelagicus*		App II		
	Bigeye Thresher *Alopias superciliosus*		App II		
	Common Thresher *Alopias vulpinus*		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 *Carcharhinuns falciformis*		App II		
	Oceanic white-tip *Carcharhinus longimanus*			App II	
	Blue shark *Prionace glauca*				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	

Table 1.3. (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	
Rajidae	Common skate (*Dipturus batis*) complex (*Dipturus cf. flossada and Dipturus cf. intermedia*)	✓			
	Thornback ray *Raja clavata*	✓ North Sea			
	Spotted ray *Raja montagui*	✓			
	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		
	Manta rays *Manta* spp.			App II	
	Longhorned mobula *Mobula eregoodootenkee*		App I and II		
	Lesser devil ray *Mobula hypostoma*		App I and II		
	Spinetail mobula *Mobula japanica*		App I and II		
	Shortfin devil ray *Mobula kuhlii*		App I and II		
	Giant devil ray *Mobula mobular*		App I and II		App II (Med)
	Munk's (or pygmy) devil ray *Mobula munkiana*		App I and II		
	Lesser Guinean devil ray *Mobula rochebrunei*		App I and II		
	Chilean (or sicklefin) devil ray *Mobula tarapacana*		App I and II		
	Smoothtail mobula *Mobula thurstoni*		App I and II		

Table 1.4. 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. Adapted from CEC (2015).

Family	Species	Area
Centrophoridae	Leafscale gulper shark *Centrophorus squamosus*	EU waters of IIa and IV; EU and international waters of I and XIV
	Birdbeak dogfish *Deania calcea*	EU waters of IIa and IV; EU and international waters of I and XIV
Etmopteridae	Smooth lantern shark *Etmopterus pusillus*	EU waters of IIa and IV; EU and international waters of I, V-VIII, XII and XIV
	Great lantern shark *Etmopterus princeps*	EU waters of IIa and IV; EU and international waters of I and XIV
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	EU waters of IIa and IV; EU and international waters of I and XIV
Dalatiidae	Kitefin shark *Dalatias licha*	EU waters of IIa and IV; EU and international waters of I and XIV
Squatinidae	Angel shark *Squatina squatina*	Union waters
Cetorhinidae	Basking shark *Cetorhinus maximus*	All waters
Lamnidae	White shark *Carcharodon carcharias*	All waters
	Porbeagle shark *Lamna nasus*	All waters
Triakidae	Tope *Galeorhinus galeus*	When taken by longline in EU waters of IIa and IV, and EU and international waters of I, V-VIII, XII and XIV.
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 I-XII

Table 1.4. (continued). Elasmobranch taxa listed as Prohibited Species on EU fisheries regulations.

Family	Species	Area
Rajidae	Starry ray *Amblyraja radiata*	EU waters of IIa, IIIa, IV and VIId
	Common skate (*Dipturus batis*) complex (*Dipturus cf. flossada and Dipturus cf. intermedia*)	EU waters of IIa, III-IV, VI-X.
	Norwegian skate *Dipturus nidarosiensis*	EU waters of VI, VIIa-c, e-k
	Thornback ray *Raja clavata*	EU waters of IIIa
	Undulate ray *Raja undulata*	EU waters of VI and X
	White skate *Rostroraja alba*	EU waters of VI-X;
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

1.13 ICES fisheries advice

ICES advice is now 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.

1.14 Data availability

Provision of data prior to working group

WGEF members agree that future meetings of WGEF should continue to meet in June, as opposed to earlier meetings, as (a) more 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.

Some of the data used in 2015 were submitted following the ICES Data Call. WGEF concluded that the format of the Data Call, whereby some nations submitted individual files for each of the named stocks, was problematic, as it resulted in generic landings categories not being submitted by all nations and increased the workload of the group.

Discard observer data were also submitted following the ICES Data Call. Whilst WGEF want to make progress from 'landings' to 'catch'-based advice, data from discard observer programmes was used in exploratory analyses only. The nature of elasmobranch fish (whereby some species may have highly seasonal or local abundance, occur infrequently or have potential identification issues) means that such data need careful appraisal so that appropriate, standardised raising treatments can be developed. This is required if these data are to be used to provide scientifically justifiable estimates of discards. Furthermore, there will be a degree of discard survival, which may need to be addressed if 'catch' is to be used in relation to perceived removals from the stock.

The group agreed that cpue from surveys should be provided as disaggregated raw data, and not as compiled 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.

WGEF recommends that MS 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).

Landings data

Since 2005, WGEF has collated landings data for all elasmobranchs in the ICES area, although this task has been hampered by the use by so many countries of "nei" (not elsewhere identified) categories. Landings data (as extracted from ICES FishStat Database) have been collated in species-specific landings tables and stored in a WG archive. These data have been corrected as follows:

- Replacement with more accurate data provided by national scientists;
- Expert judgements of WG members to reallocate data to less generic categories (usually from a "nei" category to a specific one).

The data in these archives are considered to be the most complete data and are presented in tabular and graphical form in the relevant chapters of this Report and on the WG ICES SharePoint.

WGEF aims to allocate progressively more of the "nei" landings data over time, and some statistical approaches have been presented to WGEF (see Johnston *et al*., 2005; ICES, 2006). However 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 overreporting;

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.

The data may also be imprecise as a result of revisions by reporting parties. WGEF aims to arrive at an agreed set of data for each species and will document any changes to these datasets in the relevant working group report. A Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2) will be held early 2016.

Discards

Discards data are available to WGEF but more detailed studies of such datasets are required. Other issues that need to be considered for more detailed studies of discard data are species identification problems, and the problems of raising such data for those species that are only occasionally recorded, or can be found in large numbers occasionally.

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 chapters 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 of the cases, the identification of stock is based on the distribution and relative abundance of the species, current knowledge of movements and migrations, reproductive mode, and consistency with management units.

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

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

Length measurements

Further information on the issues of different types of length measurement can be found in earlier reports (see Section 1.15 of the ICES 2010b). WGEF recommends that length–frequency information both commercial and survey be made available to the group for those species for which length-based assessments could be considered.

Other issues–*Dipturus* complex

Two papers (Iglésias *et al.*, 2010; Griffiths *et al.*, 2010), demonstrated that *Dipturus batis*, frequently referred to as common skate, is in fact a complex of two species, that were erroneously synonymised in the 1920s. Hence, much of the data for *Dipturus batis* is a confusion of blue skate *D. batis* (c.f. *flossada)* and flapper skate *D. intermedia*.

In 2012 a special request was received from the European Commission to determine whether these species could be reliable identified and whether they have different distributions, with regard to the possible setting of separate TACs for the two species. This special request is dealt with in Annex IV of 2012 WGEF report. Where possible, this report refers to the species separately, with the confounded data referred to as the *Dipturus batis* complex.

Currently labs can only upload data to DATRAS for *D. batis*, as TSN codes are not available for provisionally-titled species. The Secretariat and IBTSWG are attempting to enable species-specific data to be input. In 2012, the case was submitted to the International Commission on Zoological Nomenclature (ICZN) with *Dipturus batis* proposed for the smaller species (ex. *Dipturus batis cf. flossada*) and *Dipturus intermedia* for the larger one. Pending on the decision of this commission, ICES is unable to progress this issue further.

This issue is further discussed in Section 21.1 of the 2010 WGEF report.

1.15 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 teleosts stocks, and the analyses of survey, biological and landings data are used more to evaluate the status of the species/stocks.

Analytical assessment models are only used in the stock assessments of two species; porbeagle and spurdog. In 2011 WGEF updated and refined the model last used for the spurdog assessment in 2008 and 2010. A benchmark assessment of spurdog was carried out prior to, and during WGEF 2011. Further information can be found in Section 2 of 2011 WGEF report.

For other species WGEF followed the latest ICES guidelines on the assessment of data-limited stocks (ICES, 2012a). For most species survey data was available. For certain low-abundance species, only landings information is available. For demersal elasmobranchs in the Celtic and North Sea, a 'survey status' is provided for each species. For Bay of Biscay and Iberia Coast besides survey data for more frequently caught species there is also fishery-dependent information. Survey data quickly illustrate the relative abundance of each species in each survey, as well as a visual indication of trends in abundance and mean length. Further details are outlined in each chapter.

1.16 InterCatch

WGEF has not used InterCatch for its landings figures. Landings figures are supplied by individual members. These are considered to be superior to 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 addition, the problems of the use of generic categories and species misidentification can be better evaluated in advance by WGEF members.

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2 Spurdog in the Northeast Atlantic

2.1 Stock distribution

Spurdog, *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 I) to the Bay of Biscay (Subarea VIII), and that this is the most appropriate unit for assessment and management within ICES. Spurdog in Subarea IX 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.

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 WG estimates of total landings are shown in Figure 2.1a and Table 2.1. Spurdog has historically been exploited by France, Ireland, Norway and the UK (Figure 2.1b and Table 2.2). The main fishing grounds for the NE Atlantic stock of spurdog are the North Sea (IV), West of Scotland (VIa) and the Celtic Seas (VII) and, during the decade spanning the late 1980s to 1990s, the Norwegian Sea (II) (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 quota, a maximum landing length and bycatch regulations. Further details of the historical development of the fishery are provided in the Stock Annex.

2.2.2 The fishery in 2014

The zero TAC for spurdog for EU vessels has resulted in a major change in the magnitude and spatial distribution of reported landings. Landings have declined across all ICES subareas in recent years, although there are some landings in the northern parts of the ICES area.

The Norwegian directed fishery with small costal vessels was prohibited from 2011, but Norwegian landings decreased by 50% from 2010 to 2011. For first half of 2012 bycach up to 20% were allowed and was calculated as percentage of all landings during a week. This was modified for second half of the year allowing 20% bycatch calculated for the whole half-year period. In 2013 the bycatch allowance was reduced to 15% calculated for each half-year period. In 2012, 64% of the total reported landings were by Norwegian vessels. These landings were bycatches in gillnet fisheries operating in Divisions IIa, IIIa and IVa. In Subarea IIIa, a significant component of the landings was taken as bycatch by shrimp trawlers. The remainder of the landings were taken as bycatch in line fisheries and, to a lesser extent, other trawl fisheries. Preliminary reported landings of spurdog from Norwegian fisheries were 313 t in 2014.

No other countries reported significant landings of spurdog in 2014. Landings reported by Denmark, France, Iceland, and Ireland accounted for 11–19 t each, while no other nations reported more than 1 t. Notably, with the zero TAC from 2011, the reported landings from UK (England and Wales), traditionally one of the major exploiters of the spurdog stock, are now reduced to about one tonne.

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

Further general information on the mixed fisheries exploiting this stock and changes in effort can be found in ICES (2009 a, b) and STECF (2009).

2.2.3 ICES advice applicable

In 2014, ICES advised that "on the basis of the MSY and the precautionary considerations that there should be no target fishery and that bycatch should be minimized. Survival of discards is highly variable. Bycatch should be managed as part of a rebuilding plan, including close monitoring of the stock and fishery."

2.2.4 Management applicable

The following table summarizes ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2014:

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC (IIa(EC) and IV) (tonnes)	TAC IIIa , I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	TAC IIIa(EC) (tonnes)	TAC I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
2000	No advice	-	9470				15 890
2001	No advice	-	8870	-	-	-	16 693 (1)
2002	No advice	-	7100	-	-	-	11 020
2003	No advice	-	5640	-	-	-	12 246
2004	No advice	-	4472	-	-	-	9365
2005	No advice	-	1136	-	-	-	8356
2006	F=0	Stock depleted and in danger of collapse	1051	-	-	-	4054
2007	F=0	Stock depleted and in danger of collapse	841 (2)	2 828	-	-	2853
2008	No new advice	No new advice	631 (2,3)	-	-	2004 (2)	1759
2009	F=0	Stock depleted and in danger of collapse	316 (3,4)	-	104 (4)	1002 (4)	2557
2010	F=0	Stock depleted and in danger of collapse	0 (5)		0 (5)	0 (5)	1248
2011	F=0	Stock depleted and in danger of collapse	0 (6)		0	0 (6)	580
2012	F=0	Stock below possible reference points	0 (6)		0	0 (6)	261
2013	F=0	Stock below possible reference points	0		0	0	330
2014	F=0	Stock below possible reference points	0				379

(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 (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calcea*), leafscale gulper shark (*Centrophorus squamosus*), greater lantern shark (*Etmopterus princeps*), smooth lantern shark (*Etmopterus spinax*) and Portuguese dogfish (*Centroscymnus coelolepis*). This quota may only be taken in zones IV, VI and VII.

([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 (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calceus*), leafscale gulper shark (*Centrophorus squamosus*), greater lantern shark (*Etmopterus princeps*), smooth lantern shark (*Etmopterus pusillus*) and Portuguese dogfish (*Centroscymnus coelolepis*) and spurdog (*Squalus acanthias*) are included (Does not apply to IIIa); 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 vesselCatches 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 (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calcea*), leafscale gulper shark (*Centrophorus squamosus*), greater lanternshark (*Etmopterus princeps*), smooth lanternshark (*Etmopterus pusillus*), Portuguese dogfish (*Centroscymnus coelolepis*) and spurdog (*Squalus acanthias*) are included. Catches of these species shall be promptly released unharmed to the extent practicable.

In all EU regulated areas, a zero TAC for spurdog was retained for 2014. No landings were permitted, in contrast to 2010 when some landings were allowed under a bycatch TAC (equal to 10% of the 2009 quotas), provided certain conditions were met, including a maximum landing length and bycatch ratio limits.

In 2007 Norway introduced a general ban on target fisheries for spurdog in the Norwegian economic zone and in international waters of ICES Subareas I–XIV, with the exception of a limited fishery for small coastal vessels. Bycatch could be landed and sold as before. From 2011, all directed fisheries have been banned, although there is still a bycatch allowance. Since October 2011, the bycatch must 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 1st 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 the fisher during a 24-hour period.

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

2.3 Catch data

2.3.1 Landings

Total annual landings (over a 60 year time period), as estimated by the WG for the NE Atlantic stock of spurdog are given in Table 2.1 and illustrated in Figure 2.1a. Preliminary estimates of landings for 2014 were 379 t.

2.3.2 Discards

Estimates of total amount of spurdog discarded are not routinely provided although some discard sampling does take place.

Data from Scottish observer trips in 2010 were made available to the WG. Over 1200 spurdog (raised to trip level and then summed across trips) were caught over 29 trips (across Division IVa and VIa), but on no occasion were any retained.

At the 2010 WG, a working document was presented on the composition of Norwegian elasmobranch catches, which suggested significant numbers of spurdog were discarded.

Preliminary observations on the discard-retention patterns of spurdog as observed on UK (English) vessels were presented by Silva *et al*. (2013 WD; Figure 2.2).

No attempts to raise observed discard rates to fleet level have been undertaken, and given the aggregating nature of spurdog, such analyses would need to be undertaken with care.

Further information on discards can be found in the Stock Annex.

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).

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 where stocks with highly restrictive quotas have been recorded as spurdog. However, 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 may mean that these misreporting problems have declined since 2006.

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

Given the zero TAC in place, recent catch data are highly uncertain. Whilst data from discard observer programmes may allow catches to be estimated, the 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*.

2.4 Commercial catch composition

2.4.1 Length composition of landings

Sex disaggregated length–frequency samples are available from UK(E&W) for the years 1983–2001 and UK(Scotland) for 1991–2004 for all gears combined. The Scottish length–frequency distributions appear to be quite different from the length–frequency distributions obtained from the UK(E&W) landings, with a much larger proportion of small females being landed by the Scottish fleets. Figure 2.3 shows landings length–frequency distributions averaged over five year intervals. The Scottish data have been raised to total Scottish reported landings of spurdog while the

UK(E&W) data have only been raised to the landings from the sampled boats, a procedure which is likely to mean that the latter length frequencies are not representative of total removals by the UK(E&W) fleet. For this reason, the UK(E&W) length frequencies are assumed to be representative only of the landings by the target fleet from this country.

Raw market sampling data were also provided by Scotland for the years 2005–2010. However, sampled numbers have been low in recent years (due to low landings) and use of these data was not pursued.

2.4.2 Length composition of discards

There are no international estimates of discard length frequencies.

Discard length–frequency data were provided by UK(Scotland) for 2010. Length frequencies raised to trip level and pooled over all trips and areas by gear type are shown in Figure 2.4. These have not been raised to fleet level.

Discard length–frequency data were provided by UK(England) for four broad gear types (Figure 2.2). In general beam trawlers caught relatively few spurdog, and these were comprised mostly of juveniles, gillnets catches were dominated by fish 60–90 cm TL and otter trawlers captured a broad length range. Data for larger fish sampled across the whole time-series were most extensive for gillnetters operating in the Celtic Seas (Silva *et al*, 2013 WD). The discarding rates of commercial sized fish (80–100 cm LT) from these vessels increased from 7.5% (2002–2008) to 18.7% (2009–2010), whereas the proportion of fish >100 cm LT discarded increased from 6.2% (2002–2008) to 34.1% (2009–2010), indicating an increased proportion of larger fish were discarded in line with the maximum landing length regulations that were in force during 2009–2010. The zero TAC with no bycatch allowance resulted in the discarding of all observed spurdog in 2011.

2.4.3 Sex ratio

No recent data.

2.4.4 Quality of data

Length–frequency samples are only available for UK landings and these are aggregated into broader length categories for the purpose of assessment. No data were available from Norway, France or Ireland, which are the other main nations exploiting this stock. For the 20 years prior to restrictive measures, UK landings accounted for approximately 45% of the total. However, there has been a systematic decline in this proportion since 2005 and the UK landings in 2008 represented 15% of the total. In 2010 UK landings were just above 5% of the total, and <1% in 2011. It is not known to what extent the available commercial length–frequency samples are representative of the catches by these other nations. In addition, there are only limited length–frequency data from recent years.

2.5 Commercial catch-effort data

No commercial cpue data were available to the WG.

The outline of a Norwegian sentinel fishery on spurdog was presented to the 2012 WG (Albert and Vollen, 2012 WD). This potential provider of an abundance index series has not been initiated yet.

A UK Fishery Science Partnership (FSP) study carried out by CEFAS examined spurdog in the Irish Sea (Ellis *et al*., 2010), primarily to (a) evaluate the role of spurdog in longline fisheries and examine the catch rates and sizes of fish taken in a longline fishery; (b) provide biological samples so that more recent data on the length-at-maturity and fecundity can be calculated; and (c) tag and release a number of individuals to inform on the potential discard survivorship from longline fisheries. Survey stations were chosen by the fishermen participating in the survey.

This survey undertook studies on a commercial, inshore vessel that had traditionally longlined for spurdog during parts of the year. Four trips (nominally one in each quarter), each of four days, were undertaken over the course of the year. The spurdog caught were generally in good condition, although the bait stripper can damage the jaws, and those fish tagged and released were considered to be in a good state of health.

Large numbers of spurdog were caught during the first sampling trip, of which 217 were tagged with Petersen discs and released. The second sampling trip yielded few spurdog, although catches at that time of year are considered by fishermen to be sporadic. Spurdog were not observed on the first three days of the third trip, but reasonable numbers were captured on the last day, just off the Mull of Galloway. The fourth trip (spread over late October to early December, due to poor weather) yielded some reasonably large catches of spurdog from the grounds just off Anglesey.

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 surveys coordinated by IBTS have higher catchability and the gears are considered suitable for this species. Spatial coverage of the North and Celtic Seas represents a large part of the stock range (Figure 2.5). For further details of these surveys and gears used see ICES (2010, 2012). The following survey data have been used in earlier analyses by WGEF:

- UK(England & Wales) Q1 Celtic Sea groundfish survey: years 1982–2002.
- UK(England & Wales) Q4 Celtic Sea groundfish survey: years 1983–1988.
- UK(England & Wales) Q3 North Sea groundfish survey 1977–present.
- UK(England & Wales) Q4 SWIBTS survey 2004–2009 in the Irish and Celtic Seas.
- UK(NI) Q1 Irish Sea groundfish survey 1992–2008.
- UK(NI) Q4 Irish Sea groundfish survey 1992–2008.
- Scottish Q1 west coast groundfish survey: years 1990–2010.
- Scottish Q4 west coast groundfish survey: years 1990–2009.
- Scottish Q1 North Sea groundfish survey: years 1990–2010.
- Scottish Q3 North Sea groundfish survey: years 1990–2009.
- Scottish Rockall haddock survey: years 1990–2009.
- Irish Q3 Celtic Seas groundfish survey: years 2003–2009.
- North Sea IBTS (NS-IBTS) survey: years 1977–2010.

A full description of the current groundfish surveys can be found in the Stock Annex.

Norwegian data on spurdog from the Shrimp survey (NO-shrimp-Q1) and the Coastal survey (NOcoast-Aco-Q4) were presented to the WGEF in 2014 (Vollen, 2014 WD). The survey coverage is shown in Figure 2.6, and general information on the surveys can be found in Table 2.4.

The annual shrimp survey (1998–2013) covers the Skagerrak and the northern parts of the North Sea north to 60°N. The timing of the survey changed from quarter 4 (1984–2003), via quarter 3 (2002–2004), to quarter 1 from 2005. Mesh size was not specified for the first years, 35 mm from 1989–1997, and 20 mm from 1998. Trawl time was one hour from 1984–1989, then 30 minutes for later years.

The coastal survey (1996–2012) yearly covers the areas from 62°N to the Russian border in the north in October–November. Only data south of 66°N were used, as very few spurdog were caught north of this latitude. Length data were available from 1999 onwards. A Campelen Shrimp trawl with mesh size 40 mm was used from 1995–1998, whereas mesh size was 20 mm for later years. Trawl time was 20–30 minutes.

Spurdog catches in these surveys are not numerous. Number of stations with spurdog catches ranged from one to 35 per year in the shrimp survey; and from 0 to 8 per year in the coastal survey. The total number of spurdog caught ranged from one to 341 individuals per year in the shrimp survey, and from 0 to 106 individuals per year in the coastal survey (Table 2.4).

2.6.2 Length-frequency distributions

Length–frequency distributions (aggregated overall years) from the UK(E&W), Scottish and Irish groundfish surveys are shown in Figures 2.7–2.8.

The UK(E&W) groundfish survey length–frequency distribution (Figure 2.7a) consists of a high proportion of large females, although this is influenced by a single large catch of these individuals. Mature males are also taken regularly and juveniles often caught on the grounds in the northwestern Irish Sea.

The Irish Q3 GFS also catches some large females (Figure 2.7b), but the majority of individuals (both males and females) are of intermediate size, in the range 50–80 cm.

The Scottish West coast groundfish surveys demonstrate an almost complete absence of large females in their catches (Figure 2.8). These surveys show a high proportion of large males and also a much higher proportion of small individuals, particularly in the Q1 survey. However, it should be noted that length frequency distributions exhibit high variability from year to year (not shown) with a small number of extremely large hauls dominating the length–frequency data.

In the UK FSP survey the length range of spurdog caught was 49–116 cm (Figure 2.9), with catches in Q1 and Q3 being mainly large (>90 cm) females. Catches in Q4 yielded a greater proportion of smaller fish. The sex ratio of fish caught was heavily skewed towards females, with more than 99% of the spurdog caught in Q1 female. Although more males were found in Q3 and Q4, females were still dominant, accounting for 87% and 79% of the spurdog catch, respectively. Numerically, between 16.5 and 41.9% of spurdog captured were >100 cm, the Maximum Landing Length in force at the time.

In the Norwegian Shrimp and Coastal surveys the length–frequency distribution was rather uniform overall years, with the length groups 60–85 cm being the most abundant (Figure 2.10). Increased occurrence of smaller individuals (<40 cm) could be seen in later years, primarily in the shrimp survey (Figure 2.11).

Previously presented length frequencies are displayed in the Stock Annex.

2.6.3 Cpue

Spurdog survey data are typically characterised by highly variable catch rates due to occasional large hauls and a significant proportion of zero catches. Average catch rates (in numbers per hour) from the NS-IBTS are shown in Figure 2.12. Although the time-series is noisy, it appears that spurdog are now being seen in a greater proportion of hauls in the Q3 survey, with average catch rates also increasing in Q3.

Time-series plots of frequency of occurrence (proportion of non-zero hauls) and catch rates (confidence intervals not shown) for the Irish surveys are shown in Figure 2.13. This short time-series shows a stability on the frequency of occurrence and on the catch rates.

Frequency of occurrence (five year running mean) and average catch rate (in number per hour zero hauls not included, with five year running mean,) from the Norwegian Survey trends from the Norwegian Shrimp and Coastal surveys are shown in Figures 2.14–2.15. The frequency of occurrence declined for the Shrimp survey from late 1980s and reached a low in late 1990s. Since then, the Shrimp survey shows an increasing trend, whereas the Coastal survey shows a decreasing trend. With regards to average catch range, numbers are variable but a decrease can be seen from the 1980s to the late 1990s for the Shrimp survey. For the Coastal survey, a peak could be seen around 2004, but it should be noted that results are generally based on very few stations.

Previously presented data (either discontinued or not updated this year) have indicated a trend of decreasing occurrence and decreasing frequency of large catches with catch rates also decreasing (although highly variable) (Figures 2.16–2.17).

Future studies of survey data could usefully examine surveys from other parts of the stock area, as well as sex-specific and juvenile abundance trends. In the absence of accurate catch data, fishery-independent trawl surveys will be increasingly important to monitor stock recovery.

2.6.4 Statistical modelling

At the 2006 WG meeting, an analysis of Scottish survey data was presented, which investigated methods for standardizing the survey catch rate with the aim obtaining an appropriate index of abundance. Following on from this, and the subsequent comments of the Review Group, further analysis was conducted in 2009 to provide an index of biomass catch rates rather than abundance in $N.hr^{-1}$.

Data from four Scottish surveys listed above (1990–2013) were considered in the analysis (Rockall was not included due to the very low numbers of individuals caught in this survey). The dataset consists of length–frequency distributions at each trawl station (over 6000 in total), together with the associated information on gear type, haul time, depth, duration and location. For each haul station, catch-rate was calculated: total weight caught divided by the haul duration to obtain a measure of catch-per-unit of effort in terms of g/30 minutes.

The objective of the analysis was to obtain standardized annual indices of cpue (on which an index of relative abundance can be based) by identifying explanatory variables which help to explain the variation in catch rate and which is not a consequence of changes in population size. Due to the highly skewed distribution of catch rates and the presence of the large number of zeros, a ‘delta’ distribution approach was taken to the statistical modelling. Lo *et al.,* 1992 and Stefansson, 1996 describe this method which combines two generalized linear models (GLM): one which models the probability of a positive observation (binomial model) and the second which models the catch rate conditioned on it being positive assuming a lognormal distribution. The overall year effect (annual index) can then be calculated by multiplying the year effects estimated by the two models.

The aim of the analysis was to obtain an index of temporal changes in the cpue and therefore year was always included as a covariate (factor) in the model. Other explanatory variables included were area (Scottish demersal sampling area, see Dobby *et al*., 2005 for further details) and month or quarter. Variables which explained greater than 5% of the deviance in previous analysis were retained in the model. All variables were included as categorical variables.

The model results, in terms of retained terms and deviance values are presented in Table 2.5. Estimated effects are shown in Figure 2.18. The diagnostic plot for the final lognormal model fit is shown in Figure 2.19, indicating that the distributional assumptions are adequate: the residuals show a relatively symmetrical distribution, with no obvious departures from normality, and the residual variance shows no significant changes through the range of fitted values.

The estimated year effects for the binomial component of the model demonstrate a significant decline over the time period while the year effects for the catch rate given that it is positive do not indicate any systematic trend. It was considered that this is a potentially useful approach for obtaining an appropriate index of abundance for NE Atlantic spurdog. However, there are a number of issues associated with the analysis which should be highlighted:

- the survey data analysed only covers a proportion of the stock distribution;
- the two Scottish west coast surveys underwent a redesign in 2011, including the use of new ground-gear. No consideration has been given to potential changes in catchability due to the new ground-gear in this analysis.
- further attempts should be made to obtain sex-specific abundance indices.

2.7 Life-history information

Maturity and fecundity data were collected on the UK FSP surveys. The largest immature female spurdog was 84 cm, with the smallest mature female 78 cm. The smallest mature and active female observed was 82 cm. All females ≥90 cm were mature and active. The observed uterine fecundity was 2–16 pups, and larger females produced more pups. In Q1, the embryos were either in the length range 11–12 cm or 14–18 cm, and no females exhibited signs of recently having given birth. In Q3, near-term pups were observed at lengths of 16–21 cm. During Q4, near-term and term pups of 19–24 cm were observed, and several females showed signs of recently having pupped. This further suggests that the Irish Sea may be an important region in which spurdog give birth during late autumn and early winter, although it is unclear if there are particular sites in the area that are important for pupping.

The biological parameters 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 has declined, 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 (ICES, 2006).

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

The assessment for spurdog, presented as exploratory in 2006 (ICES, 2006), was extended in 2010 to account for further years of landings data, updated statistical analyses of survey data, a split of the largest length category into two to avoid too many animals being recorded in this category, and fecundity datasets from two periods (1960 and 2005). This model was not used to provide advice as it had not been through the benchmark process. A benchmark assessment of the model was carried out in 2011 by two external reviewers (via correspondence). A summary of review comments and response to it were provided in Appendix 2a of the 2011 WGEF report (ICES, 2011).

In 2011 WGEF updated the model based on the benchmark assessment. The results of this are presented here for data up to 2013.

The statistical analysis of survey data provides a delta-lognormal GLM-standardised index of abundance (with associated CVs), based on Scottish groundfish surveys. The assessment assumes two "fleets", with landings data split to reflect a fleet with Scottish selectivity ("non-target fleet"), and one with England & Wales selectivity ("target fleet"). The non-target and target selectivities were estimated by fitting to proportions-by-length-category data derived from Scottish and England & Wales commercial landings databases.

The assessment is based on an approach developed by Punt and Walker (1998) for school shark (*Galeorhinus galeus*) off southern Australia (De Oliveira *et al.*, 2013). The approach is essentially an age- and sex-structured, but is based on processes that are length-based, such as maturity, pup-production, growth (in terms of weight) and gear selectivity, with a length–age relationship to define the conversion from length to age. Pup-production (recruitment) is closely linked to the numbers of mature females, but the model allows deviations from this relationship to be estimated (subject to a constraint on the amount of deviation).

The implementation for spurdog was coded in AD Model Builder (Otter Research). The approach is presented in De Oliveira *et al*. (2013) and is similar to Punt and Walker (1998), but uses fecundity data from two periods (1960 and 2005) in an attempt to estimate the extent of density-dependence in pup-production and fits to the Scottish groundfish surveys index of abundance, and proportion-by-length-category data from both the survey and commercial catches (aggregated across gears). Five categories were considered for the survey proportion-by-length-category data, namely length groups 16–31 cm (pups); 32–54 cm (juveniles); 55–69 cm (sub-adults); and 70–84 cm (maturing fish) and 85+ cm (mature fish). The first two categories were combined for the commercial catch data to avoid zero values.

A closer inspection of the survey proportion-by-length-category data showed a greater proportion of males than females in the largest two length categories. This could indicate a lower degree of overlap between the distribution of females and the survey area compared to males, and requires both a separate selectivity parameter to be fitted for the largest two length categories, and the survey proportion-by-length-category data to be fitted separately for females and males. However, the low numbers of animals in the largest length category (85+) resulted in the occurrence of zeros in this length category, so the approach has been to combine the two largest length categories (resulting in a total of four length categories: 16–31 cm, 32–54 cm, 55–69 cm, and ≥70 cm) when fitting to survey proportions-by-length-category data for females and males separately.

The parameters to be estimated are the total number of pregnant females in the virgin population ($N_0^{f,preg}$), Scottish survey selectivity-by-length-category (four parameters), commercial selectivity-by-length-category for the two fleets (six parameters, three reflecting non-target selectivity, and three target selectivity), extent of density-dependence in pup production (Q_{fec}), and constrained recruitment deviations (1960–2013). Although two fecundity parameters could in principle be estimated from the fit to the fecundity data, these were found to be confounded with Q_{fec}, making estimation difficult, so instead of estimating them, values were selected on the basis of a scan over the likelihood surface. The model also assumes two commercial catch exploitation patterns that have remained constant since 1905, which is an oversimplification given the number of gears taking spurdog, and the change in the relative contribution of these gears in directed and mixed fisheries over time, but sensitivity tests are included to show the sensitivity to this assumption. Growth is considered time invariant, as in the Punt and Walker (1998) approach, but growth variation could be included given appropriate data (Punt *et al*., 2001). The population dynamics model is described in more detail in the Stock Annex.

Changes in the assessment in 2011 compared to 2010 are an attempt to address some of the concerns of the reviewers following the benchmark review of spurdog in early 2011 (see Appendix to Chapter 02, ICES, 2011). These changes are summarised as follows:

- To address the concern about appropriate raising procedures for the England and Wales length–frequency data, and the concern that these data are likely heavily biased towards targeted fisheries, the estimated Scottish selectivity is treated as "non-target", and England and Wales selectivity as "target", and alternative scenarios for allocating landings data to non-target and target fisheries are explored. Further details are provided in the Appendix to Chapter 02, ICES (2011) (response R1.2).

- To address the concern that Scottish survey proportion-by-length-category data are dominated by the occasional large tow of spurdog when these occur, these data were recalculated by using the same spatial stratification that forms the basis of the delta-lognormal GLM standardisation of the survey abundance indices. Further details are provided in the Appendix to Chapter 02, ICES (2011) (response R1.5).
- To account for the lack of large females in the Scottish surveys, likely resulting from lack of availability to the survey, the two largest length categories have been combined to form a 70+ category, and separate selectivity parameters defined for males and females in this length category. Furthermore, the survey proportion-by-length-category data are fitted separately for females and males.
- To account for the presumed lack of targeting as a result of management restrictions throughout the distribution area from 2008 onwards, landings data are assumed to come entirely from non-target fisheries from 2008 onwards.

The assessment presented here is an update of the 2011 assessment (presented in ICES, 2011) that includes data up to 2013.

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 2.6, and described visually in Figure 2.20.

Landings data used in the assessment are given in Table 2.7. The assessment requires the definition of fleets with corresponding exploitation patterns, and the only information currently available to provide this comes from Scottish and England & Wales databases. Two fleets, a "non-target" fleet (Scottish data) and a "target" fleet (England & Wales data), were therefore defined and allocated to landings data. Several targeting scenarios were explored in order to show the sensitivity of model results to these allocations (ICES, 2011), and these results are included here. In order to take the model back to a virgin state, the average proportion of these fleets for 1980–1984 were used to split landings data prior to 1980, but two of the targeting scenarios assume historic landings were only from "non-target" or "target" fleets.

The Scottish survey abundance index (biomass catch rate) was derived on the basis of applying a delta-lognormal GLM model to four Scottish surveys over the period 1990–2013, and is given in Table 2.8 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, is given in Table 2.9 separately for females and males.

Table 2.10 lists the proportion-by-length-category data for the two commercial fleets considered in the assessment, along with the raised sample sizes. Because these raised sample sizes 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 $n_{pcom,j,y} = \overline{n}_{pcom,j}$ 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 for sampling details) are given as pairs of values reflecting length of pregnant female and corresponding number of pups, and are listed in Tables 2.11a and b for the two periods (1960 and 2005).

2.9.2 Summary of model runs

Category	Description	Figures	Tables
• Base case run		2.21–27, 2.31–33	2.12–15
• Retrospective	A 6-year retrospective analysis, using the base case run and omitting one year of data each time	2.28	
• Sensitivity			
Q_{fec}	A comparison with an alternative Q_{fec} values that fall within the 95% probability interval of Figure 2.21, with a demonstration of the deterioration in model fit to the survey abundance index for higher Q_{fec} values	2.22, 2.29	
Targeting scenarios	A comparison of alternative assumptions about targeting (taken from ICES, 2011): Tar 1: the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980–1984) Tar 2: as for WGEF in 2010 (Scottish landings are "non-target", E&W "target", and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984) Tar 3: as for Tar 2 but with E&W split 50% "non-target" and 50% "target" Tar 4: as for Tar 1, but with pre-1980 selection entirely non-target Tar 5: as for Tar 1, but with pre-1980 selection entirely target	2.30	2.12

2.9.3 Results for base case run

Model fits

Fecundity data available for two periods presents 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} for the two time periods 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 2.21. The two 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 2.21d 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} chosen for the base case run (1.98) corresponded to the lower bound of the 95% probability interval shown in Figure 2.21. Lower Q_{fec} values correspond to lower productivity, so this lower bound is more conservative than other values in the probability interval. Furthermore, sensitivity tests presented below show that higher

Q_{fec} values are associated with a deterioration in the model fit to the Scottish survey abundance index.

Figure 2.22 shows the model fit to the Scottish surveys abundance index for the base case value of Q_{fec} and for alternative values that still fall within the 95% confidence interval of Figure 2.21c; it is clear from Figure 2.22 that the model fit to the Scottish surveys abundance index deteriorates as Q_{fec} increases. Figure 2.23a shows the model fit to the Scottish and England & Wales commercial proportion-by-length-category data, and Figure 2.23b to the Scottish survey proportion-by-length-category data, the latter fitted separately for females and males. Model fits to the survey index and commercial proportion data appear to be reasonably good with no obvious residual patterns, and a close fit to the average proportion-by-length-category for the commercial fleets. Figure 2.23b indicates a poorer fit to the survey proportions compared to the commercial proportions, and given the residual patterns (a dominance of positive residuals for females, and, more weakly, the opposite for males) that it may be possible to estimated sex ratio (not attempted).

Figure 2.24a compares the deterministic and stochastic versions of recruitment, and plots the estimated recruitment residuals normalised by σ_r. The fits to the two periods of fecundity data are shown in Figure 2.25, highlighting the difference in the fecundity relationship with female length for the two periods, this difference being due to Q_{fec}.

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 (q_{sur}), and current (2014) total biomass levels relative to 1905 and 1955 (B_{depl05} and B_{depl55}), are shown in Table 2.12a ("Base case") together with estimates of precision. Estimates of the natural mortality parameter M_{pup}, the fecundity parameters a_{fec} and b_{fec}, and MSY parameters ($F_{prop,MSY}$, MSY, B_{MSY} and MSYR) are given in Table 2.12b. Table 2.13 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 the commercial selectivity parameters associated with length categories 55–69 cm and 70–84 cm, and Q_{fec} vs. q_{sur}.

Estimated commercial- and selectivity-at-age patterns are shown in Figure 2.26, and reflect the relatively lower proportion of large animals in the survey data when compared to the commercial catch data, and the higher proportion of smaller animals in the Scottish commercial catch data compared to England & Wales (see also Figure 2.23). 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 2.6) 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 2.24b 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 points lies on the replacement line, which implies that the population is 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 2.27.

Time-series trends

Model estimates of total biomass (B_y) and mean fishing proportion ($F_{prop5\text{-}30,y}$) are shown in Figure 2.32 together with observed annual catch ($C_y = \sum_j C_{j,y}$). They indicate a strong decline in spurdog total biomass, particularly since the 1940s (to around 15% of pre-exploitation levels, Table 2.12a), which appears to be driven by relatively high exploitation levels, given the biological characteristics of spurdog. $F_{prop5\text{-}30,y}$ appears to have declined in recent years with B_y levelling off. Figure 2.32 also shows total biomass (B_y), recruitment (R_y) and mean fishing proportion ($F_{prop5\text{-}30,y}$) together with approximate 95% probability intervals. The fluctuations in recruitment towards the end of the time-series are driven by information in the proportion-by-length-category data. Table 2.14 provides a stock summary (recruitment, total biomass, landings and $F_{prop5\text{-}30,y}$).

2.9.4 Retrospective analysis

A six year retrospective analysis (the base case model was re-run, each time omitting a further year in the data) was performed, and is shown in Figure 2.28 for the total biomass (B_y), mean fishing proportion ($F_{prop5\text{-}30,y}$) and recruitment (R_y). There are almost no signs of retrospective bias given the current model configuration.

2.9.5 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 lower bound of the 95% probability interval (Q_{fec}=1.98; Figure 2.21a-c) was selected for the base case run. This sensitivity test compares it to the runs for which the a_{fec} and b_{fec} input values provide the optimum (Q_{fec}=2.32) and upper bound (Q_{fec}=2.92). Model result are fairly sensitive to these options (Figure 2.29, Table 2.12a and b), but higher Q_{fec} values, although still within the 95% probability interval, lead to a deterioration in the fit the Scottish survey abundance index, as demonstrated in Figure 2.22b. This is part justification for selecting the lower bound as the base case value.

b) Alternative targeting scenarios

Alternatives targeting scenarios for both the post-1980s landings data (for which data are available by nation) and the pre-1980s landings data (not available by nation) were explored in this set of sensitivity analyses presented in ICES (2011) and shown again here. The alternative scenarios are listed in Section 2.9.3, and results shown in Figure 2.30. These results indicate a general lack of sensitivity to alternative assumptions about targeting.

2.9.6 MSY $B_{trigger}$

The current estimates of B_{MSY} for spurdog is 963 741 t ("Base case" in Table 2.12b). Given the long catch history for spurdog, and the fact that this is accounted for in the assessment (in contrast to other ICES assessments), it is recommended that this estimate (rounded off to 963 700 t) be used as the value for MSY $B_{trigger}$ to be used in the ICES MSY rule for spurdog.

2.9.7 Projections

The base case assessment is used as a basis for future projections under a variety of catch options. These are based on:

- the ICES MSY rule, which assumes that $F_{prop,MSY}$=0.029 and MSY $B_{trigger}$=B_{MSY}=963 700 t (Table 2.12b; this rule fishes at $F_{prop,MSY}$=0.029 for total biomass values at or above MSY $B_{trigger}$, but reduces fishing linearly when total biomass is below MSY $B_{trigger}$ by the extent to which total biomass is below MSY $B_{trigger}$), and could accommodate bycatch in mixed fisheries (since it produces catches similar to average landings for 2007–2009);
- zero catch (for comparison purposes);
- TAC_{2009}=1422 t, the last non-zero TAC set for spurdog in 2009;
- average landings for 2007–2009=2384 t, an amount that could accommodate bycatch in mixed fisheries;
- fishing at $F_{prop,MSY}$=0.029.

Results are given in Table 2.15, expressed as total biomass in future relative to the total biomass in 2014, and are illustrated in Figure 2.31.

2.9.8 Conclusion

Since this is an updated assessment, results for the base case model is presented as the final assessment. The base case model shows almost no retrospective bias and provides reasonable fits to most of the available data. 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. However, results show a marked deterioration of the model fit to the Scottish survey abundance index as Q_{fec} increases, thereby justifying the selection of the more conservative lower bound as the base case value (Q_{fec}=1.98). The model is relatively insensitivity to alternative targeting scenarios, including assumptions about selection patterns prior to 1980. A summary plot of the final assessment (the base case run), showing landings and estimates of recruitment, mean fishing proportion (with $F_{prop,MSY}$=0.029) and total biomass, together with estimates of precision, is given in Figure 2.32 and Table 2.14.

Results from the current model confirm that spurdog abundance has declined, 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.

A comparison with the 2011 assessment is provided in Figure 2.33 and shows very little difference.

2.10 Quality of assessments

WGEF has attempted various analytic assessments of NE Atlantic spurdog using a number of different approaches (see Stock Annex (2011) and ICES, 2006). Although these models have not proved entirely satisfactory (as a consequence of the quality of the assessment input data), these exploratory assessments and survey data all indicate a decline in spurdog.

2.10.1 Catch data

The WG has provided estimates of total landings of NE Atlantic spurdog and has used these, together with UK 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;
- lack of commercial length–frequency information for countries other than the UK (UK landings are a decreasing proportion of the total and therefore the length frequencies may not be representative of those from the fishery as a whole);
- low levels of sampling of UK landings and lack of length–frequency data in recent years when the selection pattern may have changed due to the implementation of a maximum landing length (100 cm);
- lack of discard information.

2.10.2 Survey data

Survey data are particularly important indicators of abundance trends in stocks such as this where an analytical assessment is not available. However, it should be highlighted that:

- the survey data examined by WGEF cover only part of the stock distribution and analyses should be extended to other parts of the stock distribution;
- spurdog survey data are difficult to interpret because of the typically highly skewed distribution of catch-per-unit of effort;
- annual survey length–frequency distribution data (aggregated over all hauls) may be dominated by data from single large haul.

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.

2.10.4 Assessment

As with any stock assessment model, the 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 two 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 the 1960 fecundity dataset to be fitted. Nevertheless, the model has difficulty estimating both Q_{fec} and the fecundity parameters simultaneously, and additional information, such as on appropriate values of MSYR for a species such as spurdog, and possibly also additional fecundity data (which are now available but have not been included), would help with this problem. Further refinements of the model are possible, such as including variation in growth. 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 is considered appropriate for providing an assessment of spurdog, though it could be further developed in future if the following data were available:

- Selectivity parameters disaggregated by gear for the main fisheries (i.e. for various trawl, longline and gillnets);
- Appropriate indices of relative abundance from fishery-independent surveys, with corresponding estimates of variance;
- Improved estimates for biological data (e.g. growth parameters, reproductive biology and natural mortality);
- Inclusion of additional fecundity data;
- Information on likely values of MSYR for a species such as spurdog.

2.11 Reference points

MSY considerations: In 2013 the exploitation status of the stock was considered to be below $F_{prop,\mathrm{MSY}}$, as estimated from the results of the assessment. However, biomass has declined to record low levels in recent years and therefore to allow the stock to rebuild, catches should be reduced to the lowest possible level in 2015 and 2016. Projections assuming application of the ICES MSY rule (which would accommodate bycatch in mixed fisheries) suggest that the stock will rebuild by 5–9% of its 2014 level by 2017 (Table 2.15).

$F_{prop,\mathrm{MSY}}$=0.029, as estimated by the current assessment, assuming a non-target selection pattern.

2.12 Conservation considerations

In 2006, the IUCN categorised Northeast Atlantic spurdog as 'Critically Endangered'. This categorisation was based on an exploratory assessment which gave a more pessimist view of the stock status than the assessment method that has been benchmarked by ICES. The results from the assessment presented in De Oliveira *et al.* (2013) would support an IUCN listing of 'Endangered' A Red List Workshop for European chondricthyans was held in May 2014, but the outcome of this has not been formally agreed as yet.

2.13 Management considerations

Perception of state of stock

All analyses presented in 2014 and previous reports of WGEF have indicated that the NE Atlantic stock of spurdog has been declining rapidly and is around its lowest ever level. Preliminary assessments making use of the long time-series of commercial landings data suggest that this decline has been going on over a long period of time and that the current stock size may only be a fraction of its virgin biomass (<20%).

Although spurdog are less frequently caught in groundfish surveys than they were 20 years ago, there is some suggestion that spurdog are now being more frequently seen in survey hauls and survey catch rates starting to increase (Figure 2.12).

Stock distribution

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

There should be a single TAC area. Although all areas of the stock distribution are covered by zero TACs, the establishment of bycatch TACs (10% of 2009 values) could result in area misreporting should the TAC for one area be more restrictive than the other.

Biological considerations

Spurdogs are long-lived, slow growing, have a high age-at-maturity, and are particularly vulnerable to high levels of fishing mortality. 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.

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 dogfish 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.

North Sea fisheries were regulated by a bycatch quota (2007–2008), whereby spurdog should not have comprised more than 5% by live weight of the catch retained on board. This was extended to western areas in 2008. The bycatch quota was removed in 2009, when the maximum landing length was brought in.

Spurdog were historically subject to large targeted fisheries, but are increasingly now taken as a bycatch in mixed trawl fisheries. In these fisheries, measures to reduce overall demersal fishing effort should also benefit spurdog. However, a restrictive TAC in this case would likely result in increased discards of spurdog and so may not have the desired effect on fishing mortality if discard survivorship is low.

There is limited information on the distribution of 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.

The survivorship of discarded juvenile spurdog is not known.

2.14 New information since last assessment (2014)

Trends in composition and abundance in Norwegian waters

Input data to the assessment model have so far been restricted to the British sector, and data from other areas have been requested. In Norwegian waters, from where more than 80% of the current landings originate, there is no dedicated survey for spurdog, but data are recorded on all regular surveys, as well as by the Norwegian Reference fleet, and during official controls of commercial catches and landings. Two WDs were presented at 2015 WGEF meeting to indicate the potential for establishing one or several new tuning fleets in Norwegian waters to inform future assessments of this stock.

Albert and Vollen (2015 WD) gives an overview of recent time-series on total spurdog recordings in Norwegian waters from the above mentioned multitude of sources. Data were extracted from the IMR database for the period 2003–2014, which covers a total of 175 157 unique catches. There were in total 4073 catches that included spurdog, and 16 398 individual length measurements from 1846 of these catches. All catches were allocated to one of the following five fishery groups:

1) Surveys: Bottom trawl catches from research vessels or hired commercial vessels used in research;
2) Trawls: Bottom trawl catches from commercial fishery;
3) Gillnets: Gillnet catches from commercial fishery;
4) Longlines: Longline catches from commercial fishery;
5) Other: All other catches.

Fishery groups 1–4 covered 130 099 of the catches in the database, and spurdog was recorded in 3983 of these catches, including 15 835 length measurements. The 90 spurdog catches in fishery group 5 (other) were excluded from analyses.

The occurrence of spurdog in sampled catches increased through the time-series, including from the surveys, longlines, and in particular from the gillnet fishery groups. There were no obvious large-scale trends in distribution or catch size for any of the four fishery groups.

Large spurdog (>80 cm L_T) are usually not caught in the surveys and small spurdog (<40 cm L_T) are usually not caught in commercial fisheries, thus the former may be used to inform about recruitment, and the latter to indicate trends in spawning stock. With 12 167 length measurements, the gillnet group represented 77% of all length samples of spurdog. There was a clear trend of increasing length range throughout the gillnet fleet time-series, with more of the largest individuals without reductions of the smaller adults. From 2007 onwards, there was a consistent and substantial increase of fish >80 cm, and a similar but slower increase of fish >100 cm. Although the data were limited for the smaller spurdog (<40 cm) in the surveys, it was noted that the four largest values of small fish were from the seven last years of the time-series, suggesting improved recruitment.

The four fishery groups represent preliminary defined potential tuning fleets covering substantial parts of the distribution area and the fished area of the stock. Before any of them can be applied in the assessments it is necessary to further evaluate any trends in the representativeness of the catch and composition data. This may include any changes in composition of the Reference Fleet, change in fisher behaviour, changes in gears, technological creep, etc. The validity of the temporal coverage of the time-series should also be evaluated.

In addition to the potential tuning fleets described above, Vollen and Albert (2015) analysed trends from two Norwegian standardized survey series with consistent but limited coverage of spurdog. One covering the southern coast (57.30–60°N) and one along the west coast of mid Norway (62–66°N). The southern survey series goes back to 1984 and includes annually around 100 bottom trawl stations, whereas the northern survey started in 1995 and includes approximately 30 stations.

From 2003 onwards the frequency of occurrence of spurdog in the southern survey was about double of the previous decade. Since 2012 catch rates has been higher than in any other year after 1990. Abundance data from the northern survey were highly variable without any clear trends.

Since 2002 there has been a significant gradual increase in occurrence and catch rates of small spurdog (<40 cm) in the southern survey. The limited data from the northern survey are in accordance with this. Larger spurdog (>80 cm) are only caught sporadically in these surveys, but it was noted that the occurrence was lower in the mid-1990s than both before and after this period. In several of the last years the frequency of occurrence of large spurdog was at the same level as before 1980.

Further work is foreseen in the coming year to develop robust abundance indices and composition data for spurdog from both of these fishery-independent and fishery-dependent sources in Norwegian waters.

Recent life-history information

Recent collection of contemporary biological data for *S. acanthias* was possible as part of a Defra-funded project aiming to better understand the implications of elasmobranch bycatch in the southwest fisheries around the British Isles (Silva and Ellis, 2015 WD). A total of 1112 specimens were examined, including 805 males (53–92 cm L_T) and 307 females (47–122 cm L_T), as well as associated pups (n = 935, 98–296 mm L_T). Conversion factors were calculated for the overall relationships between total length and total weight by sex and maturity stage and gutted weight by sex only. Futher analyes will be conducted to provide information by maturity stages for both females and males, in time for the 2016 assessment.

Preliminary results suggested there may be no changes of length-at-maturity of females in comparison to earlier estimates of Holden and Meadows (1962), indicating that this life-history parameter may not have changed in relation to recent overexploitation. However, the maximum fecundity observed (n = 19 pups) reported in this recent study is higher than reported in earlier studies (e.g. Ford, 1921; Holden and Meadows, 1964; Gauld, 1979), and provides further support to the hypothesis that there has been a density-dependent increase in fecundity (see Ellis and Keable, 2008 and references therein).

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Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2014).

Year	Landings (tonnes)	Year	Landings (tonnes)	Year	Landings (tonnes)
1947	16 893	1972	50 416	1997	15 347
1948	19 491	1973	49 412	1998	13 919
1949	23 010	1974	45 684	1999	12 384
1950	24 750	1975	44 119	2000	15 890
1951	35 301	1976	44 064	2001	16 693
1952	40 550	1977	42 252	2002	11 020
1953	38 206	1978	47 235	2003	12 246
1954	40 570	1979	38 201	2004	9 365
1955	43 127	1980	40 968	2005	8 356
1956	46 951	1981	39 961	2006	4 054
1957	45 570	1982	32 402	2007	2 853
1958	50 394	1983	37 046	2008	1 759
1959	47 394	1984	35 193	2009	2 557
1960	53 997	1985	38 674	2010	1 248
1961	57 721	1986	30 910	2011	580
1962	57 256	1987	42 355	2012	261
1963	62 288	1988	35 569	2013	330
1964	60 146	1989	30 278	2014	379
1965	49 336	1990	29 906		
1966	42 713	1991	29 562		
1967	44 116	1992	29 046		
1968	56 043	1993	25 636		
1969	52 074	1994	20 851		
1970	47 557	1995	21 318		
1971	45 653	1996	17 294		

Table 2.2. Spurdog in the NE Atlantic. WG estimates of total landings by nation (1980–2014).

	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	6	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
Portugal	2	0	0	0	0	0	1	5	3	2	128	188	250	323	190	256
Russia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	8	653	0	0	0	0	0	0	0	0	0	0	0	0
Sweden	399	308	398	300	256	360	471	702	733	613	390	333	230	188	95	104
UK (E&W)	9229	9342	8024	6794	8046	7841	7047	7684	6952	5371	5414	3770	4207	3494	3462	2354
UK (Sc)	4994	3970	3654	4371	4957	6749	6267	8043	8075	8024	7768	8531	9677	6614	4676	8517
Total	40 968	39 961	32 402	37 046	35 193	38 674	30 910	42 355	35 569	30 278	29 906	29562	29046	25636	20851	21318

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	430	443	382	354	400	410	23	11	13	20	17	0	0	7	1	0	0	0	0
Denmark	142	196	126	131	146	156	107	232	219	82	68	0	0	0	11	26	31	20	11
Faroe Islands	51	218	362	486	368	613	340	224	295	225	271	241	144	462	179	104	0	0	0
France	1607	1555	1286	998	4342	4304	2569	1705	1062	2426	715	453	366	577	348	131	42	13	19
Germany	38	21	31	54	194	304	121	98	138	144	6	0	0	1	1	1	1	0	1
Iceland	156	106	80	57	107	199	276	200	142	71	75	36	52	95	58	51	44	6	19
Ireland	2305	2214	1164	904	905	1227	1214	1416	1076	940	614	558	163	214	26	11	2	27	13
Netherlands	0	0	0	0	28	39	27	10	25	41	34	28	26	5	7	2	28	1	0
Norway	2748	1567	1293	1461	1643	1424	1091	1119	1054	1010	790	616	711	543	541	246	108	251	313
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	120	100	46	21	2	3	4	4	9	6	10	9	4	2	2	3	2	2	1
Russia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	28	95	372	363	306	135	17	71	106	16	15	32	6	4	0	4	0
Sweden	154	196	140	114	123	238	0	275	244	170	148	95	9	80	5	0	0	0	0
UK (E&W)	2670	3066	4480	4461	3654	4516	2823	3109	1729	1887	434	386	91	194	8	0	2	1	1
UK (Sc)	6873	5665	4501	3248	3606	2897	2120	3708	3342	1263	766	415	178	345	56	1	1	6	0
Total	17 294	15 347	13 919	12 384	15 890	16 693	11 020	12 246	9365	8356	4054	2853	1759	2557	1248	580	261	330	379

Table 2.3. Spurdog in the NE Atlantic. WG estimates of landings by ICES subarea (1980–2014).

Area	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
I and II	138	20	28	760	40	120	137	417	1559	2808	4296	6614	5063	5102	3124	2725	1853	582
III and IV	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
V	45	27	18	27	5	22	9	41	6	73	182	133	336	335	364	484	217	320
VI	4590	4011	5052	7007	8491	12422	8107	9038	7517	6406	5407	6741	6268	5927	5622	5164	4168	3412
VIIA	2722	4013	4566	4001	6336	6774	6458	7305	5569	3389	2801	2527	2669	2700	2313	1185	1650	1534
VIIB,C	704	925	424	1777	2178	1699	1197	2401	1579	893	369	293	316	2009	1175	1004	603	450
VIID,E, F	6693	8210	5989	4664	2450	1280	1644	2892	2120	1634	1339	1122	852	785	800	760	852	646
VIIG–K	4793	5479	3881	6924	4902	4965	3864	8106	6175	4477	3736	2495	2622	1745	2680	2034	2229	2984
VIII	739	1095	479	312	234	257	507	497	242	174	273	367	406	435	406	602	408	418
IX	0	0	0	0	0	0	1	4	1	2	4	4	2	5	7	5	2	2
X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	12
XIV	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	39 961	32 402	37 046	35 193	38 674	30 910	42 355	35 569	30 278	29 906	29 562	29 046	25 636	20 851	21 318	17 294	15 347

Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Baltic	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
I and II	607	779	894	462	357	440	423	685	498	312	337	230	190	92	50	74	122
III and IV	3895	2705	2475	2516	1904	2395	2163	1019	742	550	490	554	407	185	92	198	204
V	442	545	879	1406	808	583	677	473	457	352	211	565	240	155	44	6	28
VI	2831	2715	5977	5624	3169	3398	2630	2841	851	502	165	265	75	0	1	0	0
VIIA	1771	2153	1599	1878	1529	2021	938	605	411	280	74	114	3	1	0	3	2
VIIB,C	854	1037	1028	816	527	588	432	358	270	262	56	95	7	0	1	0	0
VIID,E, F	443	411	438	555	295	268	278	290	174	197	162	314	166	109	43	18	9
VIIG–K	2656	1822	2161	2846	2130	2339	1739	1973	531	338	196	340	112	14	1	24	12
VIII	308	171	405	469	269	134	56	97	85	50	64	80	38	17	26	4	1
IX	2	3	19	8	11	5	14	7	35	9	4	5	4	7	2	4	1
X	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XII	104	22	14	41	22	74	12	9	0	0	0	0	0	0	0	0	0
XIV	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0
Other or unspecified	6	4	1	2	0	0	0	0	1	0	0	2	5	0	0	0	0
Total	13 919	12 384	15 890	16 693	11 020	12 246	9365	8356	4054	2853	1759	2557	1248	580	261	330	379

Table 2.4. Spurdog in the NE Atlantic. Norwegian Shrimp and Coastal survey, 1984–2014. Month of survey, mean duration of tows, total number of stations, number of stations with spurdog, total number of spurdog caught, and mesh size used. Source: Vollen (2014 WD).

Year	Survey	Month of survey	Mean duration (h)	# of stations	# of stations with spurdog	# spurdogs caught	Mesh size	Survey	Month of survey	Mean duration (h)	# of stations	# of stations with spurdog	# spurdogs caught	Mesh shze
1984	S	10–11	0.96	59	10	67								
1985	S	10–11	1.00	86	29	303								
1986	S	10–11	0.96	57	26	341								
1987	S	10–11	0.99	93	29	90								
1988	S	10–11	0.97	102	29	87								
1989	S	10–11	0.50	89	11	18	35							
1990	S	10–11	0.49	77	19	130	35							
1991	S	10–11	0.52	101	11	38	35							
1992	S	10–11	0.50	99	12	22	35							
1993	S	10–11	0.50	106	10	14	35							
1994	S	10–11	0.47	101	10	18	35							
1995	S	10–11	0.48	102	8	15	35	C	9–10	0.43	29	6	22	40
1996	S	10–11	0.50	103	4	15	35	C	9–10	0.45	22	5	9	40
1997	S	10–11	0.49	93	10	18	35	C	8–9	0.42	44	1	2	20
1998	S	10–11	0.49	95	9	14	20	C	10–11	0.47	33	8	106	20
1999	S	10–11	0.50	97	4	7	20	C	10–11	0.44	34	2	4	20
2000	S	10–11	0.50	98	5	18	20	C	10–11	0.47	28	6	12	20
2001	S	10–11	0.50	70	2	3	20	C	10–11	0.42	17	5	64	20
2002	S	10–11	0.50	77	1	1	20	C	10–11	0.46	37	4	43	20
2003	S	10–11	0.53	68	12	34	20	C	10–11	0.44	23	4	21	20
2004	S	5–6	0.50	60	7	48	20	C	10–11	0.37	33	5	104	20
2005	S	5–6	0.51	86	7	12	20	C	10–11	0.46	18	2	17	20
2006	S	1–2	0.49	43	9	33	20	C	10–11	0.30	34	8	52	20
2007	S	1–2	0.50	64	14	27	20	C	10–11	0.35	36	7	35	20
2008	S	1–2	0.51	73	13	52	20	C	10–11	0.56	7	0	0	20
2009	S	1–2	0.47	92	16	39	20	C	10–11	0.39	19	0	0	20
2010	S	1–2	0.47	95	20	34	20	C	10–11	0.36	26	3	25	20
2011	S	1–2	0.49	97	18	43	20	C	10–11	0.33	20	5	6	20
2012	S	1–2	0.47	63	14	71	20	C	10–11	0.36	31	5	9	20
2013	S	1–2	0.38	100	35	177	20	C	10	0.42	19	1	1	20
2014	S	1	0.47	68	18	99	20							

Table 2.5. Spurdog in the NE Atlantic. Analysis of Scottish survey data. Summary of significance of terms in final delta-lognormal cpue model.

Binomial model	Df	Deviance	Resid df	Resid dev	%	P(>|Chi|)
			6212	6897.7		
as.factor(year)	23	82.49	6189	6815.3	5%	1.25e-08
as.factor(month)	11	1061.37	6178	5753.9	68%	< 2.20E-16
as.factor(roundarea)	19	421.41	6159	5332.5	27%	< 2.20E-16
Lognormal model	Df	Deviance	Resid df	Resid dev	%	Pr(>F)
			1512	4146.5		
as.factor(year)	23	222.81	1489	3923.6	30%	1.45E-10
as.factor(Q)	3	338.04	1486	3585.6	45%	<2.20E-16
as.factor(roundarea)	17	192.25	1469	3393.4	26%	2.19E-10

Table 2.6. 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 2.7	
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
l_{mat00}^f	Female length at first maturity 70 cm	average from literature
P''_a	Proportion females of age a that become pregnant each year $P''_a = \frac{P''_{\max}}{1 + \exp\left[-\ln(19) \frac{l_a^f - l_{mat50}^f}{l_{mat95}^f - l_{mat50}^f} \right]}$ where $P''_{\max}$ is the proportion very large females pregnant each year, and l_{matx}^f the length at which *x*% of the maximum proportion of females are pregnant each year	
$P''_{\max}$	0.5	average from literature
l_{mat50}^f, l_{mat95}^f	80 cm, 87 cm	average from literature

Table 2.7. Northeast Atlantic spurdog. Landings used in the assessment, with the allocation to "Non-target" and "Target" as assumed for the base case run. 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 from 2010 onwards are assumed to be the average for 2007–2009.

	Non-target	Target	Total		Non-target	Target	Total		Non-target	Target	Total
1905	3503	3745	7248	1942	5135	5490	10625	1979	18462	19739	38201
1906	1063	1137	2200	1943	3954	4227	8181	1980	20770	20198	40968
1907	690	738	1428	1944	3939	4212	8151	1981	20953	19009	39962
1908	681	728	1409	1945	3275	3501	6776	1982	16075	16327	32402
1909	977	1045	2022	1946	5265	5630	10895	1983	17095	19951	37046
1910	755	808	1563	1947	8164	8729	16893	1984	15047	20147	35194
1911	946	1011	1957	1948	9420	10071	19491	1985	17048	21626	38674
1912	1546	1653	3199	1949	11120	11890	23010	1986	15138	15772	30910
1913	1957	2093	4050	1950	11961	12789	24750	1987	19557	22797	42354
1914	1276	1365	2641	1951	17060	18241	35301	1988	17292	18277	35569
1915	1258	1344	2602	1952	19597	20953	40550	1989	15354	14923	30277
1916	258	276	534	1953	18464	19742	38206	1990	14390	15516	29906
1917	164	175	339	1954	19607	20963	40570	1991	14034	15529	29563
1918	218	233	451	1955	20843	22284	43127	1992	15711	13335	29046
1919	1285	1374	2659	1956	22691	24260	46951	1993	12268	13369	25637
1920	2125	2271	4396	1957	22023	23547	45570	1994	9238	11613	20851
1921	2572	2749	5321	1958	24355	26039	50394	1995	12104	9214	21318
1922	2610	2791	5401	1959	22905	24489	47394	1996	10026	7269	17295
1923	2733	2922	5655	1960	26096	27901	53997	1997	9157	6190	15347
1924	3071	3284	6355	1961	27896	29825	57721	1998	8509	5410	13919
1925	3247	3472	6719	1962	27671	29585	57256	1999	7233	5152	12385
1926	3517	3760	7277	1963	30103	32185	62288	2000	9282	6607	15889
1927	4057	4338	8395	1964	29068	31078	60146	2001	9513	7180	16693
1928	4602	4920	9522	1965	23843	25493	49336	2002	6019	5001	11020
1929	4504	4816	9320	1966	20642	22071	42713	2003	7167	5080	12247
1930	5758	6156	11914	1967	21320	22796	44116	2004	5717	3647	9364
1931	5721	6117	11838	1968	27085	28958	56043	2005	4165	4192	8357
1932	8083	8643	16726	1969	25166	26908	52074	2006	2616	1439	4055
1933	9784	10460	20244	1970	22983	24574	47557	2007	1770	1083	2853
1934	9848	10530	20378	1971	22063	23590	45653	2008	1737	0	1737
1935	10761	11505	22266	1972	24365	26051	50416	2009	2561	0	2561
1936	10113	10812	20925	1973	23880	25532	49412	2010	2384	0	2384
1937	11565	12365	23930	1974	22078	23606	45684	2011	2384	0	2384
1938	8794	9402	18196	1975	21322	22797	44119	2012	2384	0	2384
1939	9723	10396	20119	1976	21295	22769	44064	2013	2384	0	2384
1940	4556	4872	9428	1977	20420	21832	42252				
1941	4224	4516	8740	1978	22828	24407	47235				

Table 2.8. Northeast Atlantic spurdog. Delta-lognormal GLM-standardised index of abundance (with associated CVs), based on Scottish groundfish surveys.

Year	Index	CV
1990	153.3	0.32
1991	90.8	0.32
1992	76.9	0.31
1993	143.2	0.31
1994	125.6	0.35
1995	48.3	0.45
1996	80.2	0.35
1997	52.2	0.35
1998	78.7	0.34
1999	166.6	0.33
2000	69.0	0.36
2001	89.7	0.33
2002	89.5	0.33
2003	83.9	0.34
2004	59.8	0.36
2005	75.4	0.35
2006	60.7	0.34
2007	83.0	0.31
2008	72.3	0.35
2009	58.9	0.36
2010	88.6	0.46
2011	83.8	0.38
2012	72.5	0.38
2013	70.8	0.38

Table 2.9. Northeast Atlantic spurdog. Scottish survey proportions-by-length category for females (top) and males (bottom), with the actual sample sizes given in the second column.

	$n_{psur,y}$	16-31	32-54	55-69	70+
Females					
1990	539	0.0112	0.2685	0.1265	0.1272
1991	962	0.0636	0.1218	0.1092	0.1123
1992	145	0.1430	0.1514	0.2055	0.0424
1993	398	0.1259	0.1635	0.0788	0.1296
1994	1656	0.0744	0.2426	0.0519	0.0352
1995	2278	0.0572	0.3087	0.0779	0.1520
1996	230	0.0722	0.2381	0.0831	0.0684
1997	167	0.0438	0.2011	0.0955	0.0815
1998	446	0.0361	0.2404	0.1201	0.1731
1999	186	0.0316	0.0787	0.0331	0.1079
2000	1994	0.0962	0.2136	0.0456	0.1149
2001	118	0.0132	0.2060	0.0735	0.1363
2002	148	0.0428	0.0789	0.1773	0.1879
2003	224	0.0123	0.1578	0.0788	0.1898
2004	63	0.0412	0.0834	0.1240	0.0597
2005	121	0.0243	0.1434	0.1568	0.0756
2006	92	0.0360	0.1130	0.1727	0.0413
2007	152	0.0287	0.1773	0.1075	0.1657
2008	232	0.0708	0.1590	0.0127	0.1047
2009	233	0.0427	0.1175	0.2547	0.1167
2010	3495	0.1787	0.2687	0.1127	0.0002
2011	130	0.0183	0.1565	0.0684	0.1812
2012	808	0.0364	0.2320	0.0855	0.1316
2013	65	0.1713	0.2228	0.0146	0.1513
Males					
1990	1044	0.0204	0.1300	0.0575	0.2587
1991	1452	0.0711	0.1273	0.0824	0.3123
1992	154	0.2324	0.0534	0.0504	0.1215
1993	644	0.0503	0.1202	0.1555	0.1762
1994	2467	0.0832	0.1809	0.1472	0.1847
1995	1905	0.0566	0.1259	0.0478	0.1738
1996	453	0.0597	0.1480	0.1237	0.2068
1997	270	0.0228	0.1033	0.0803	0.3716
1998	436	0.0207	0.0974	0.0969	0.2155
1999	503	0.0269	0.2437	0.1136	0.3646
2000	2045	0.0100	0.1144	0.0799	0.3255
2001	221	0.0141	0.1045	0.0753	0.3771
2002	264	0.0252	0.0654	0.1209	0.3016
2003	392	0.0209	0.0818	0.1257	0.3328
2004	190	0.0045	0.1397	0.1250	0.4225
2005	225	0.0297	0.0572	0.1506	0.3622
2006	180	0.0846	0.0992	0.1027	0.3505
2007	264	0.0044	0.1786	0.1423	0.1954
2008	395	0.0699	0.1482	0.0669	0.3678
2009	417	0.0252	0.1247	0.0719	0.2466
2010	2478	0.0028	0.1863	0.0644	0.1861
2011	567	0.0170	0.0896	0.0836	0.3853
2012	1278	0.0434	0.1249	0.0495	0.2968
2013	59	0.0242	0.1673	0.0639	0.1847

Table 2.10. Northeast Atlantic spurdog. Commercial proportions-by-length category (males and females combined), for each of the two fleets (Scottish, England & Wales), with raised sample sizes given in the second column.

	$n_{pcom,j,y}$	16-54	55-69	70-84	85+
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
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

Table 2.11a. Northeast Atlantic spurdog. Fecundity data for 1960, 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		
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 2.11b. Northeast Atlantic spurdog. Fecundity data for 2005, 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'	l^f	P'
84	6	92	9	94	11	97	5	98	12	100	7	101	14	102	13	103	11	105	16	107	11	109	18
87	8	92	5	95	7	97	12	98	7	100	12	101	9	102	12	103	11	105	15	107	12	109	13
89	6	92	8	95	9	97	7	98	13	100	11	101	14	102	13	103	11	105	15	107	15	109	16
89	6	92	9	95	10	97	12	98	13	100	12	101	10	102	5	103	16	105	5	107	16	110	15
89	5	92	3	95	11	97	14	98	10	100	8	101	10	102	13	104	14	105	16	107	17	110	10
89	3	93	5	96	11	97	14	98	7	100	9	101	10	102	12	104	11	105	19	107	12	110	13
89	8	93	3	96	10	97	7	98	12	100	10	101	12	102	17	104	12	105	11	108	16	111	19
89	5	93	9	96	7	97	7	98	12	100	9	102	17	102	13	104	14	105	8	108	13	112	17
90	9	93	4	96	7	98	12	98	10	100	9	102	3	103	14	104	14	105	17	108	16	112	12
90	7	93	11	96	11	98	12	99	10	100	12	102	15	103	11	104	15	105	13	108	14	112	16
90	9	94	8	96	10	98	7	99	11	100	14	102	16	103	14	104	13	106	16	108	14	113	15
90	4	94	6	97	12	98	16	99	8	101	17	102	13	103	14	104	14	106	16	108	12	113	21
91	6	94	9	97	6	98	8	99	11	101	13	102	10	103	13	104	17	106	14	109	15	114	14
91	6	94	5	97	8	98	11	99	12	101	13	102	12	103	16	105	15	106	7	109	13	116	16
92	8	94	9	97	8	98	5	99	11	101	6	102	13	103	15	105	12	107	12	109	10		

Table 2.12a. Northeast Atlantic spurdog. Estimates of key model parameters, with associated Hessian-based estimates of precision (CV expressed as a percentage and given in square parentheses) for the base-case run, and two sensitivity tests for assuming alternative selectivity-at-age prior to 1980.

	Base case (Q_{fec}=1.98)		Q_{fec}=2.32		Q_{fec}=2.92	
$N_0^{f,preg}$	96 851	[2.1%]	86 577	[2.0%]	73 502	[2.1%]
Q_{fec}	1.978	[1.8%]	2.321	[2.1%]	2.919	[3.2%]
q_{sur}	0.00061694	[22%]	0.00061065	[22%]	0.0005358	[23%]
$B_{dep/05}$	0.150	[27%]	0.180	[29%]	0.280	[32%]
$B_{dep/55}$	0.185	[27%]	0.218	[28%]	0.324	[32%]

Table 2.12b. Northeast Atlantic spurdog. Estimates of other estimates of interest for the base case run, and two sensitivity tests for assuming alternative selectivity-at-age prior to 1980.

	Base case (Q_{fec}=1.98)	Q_{fec}=2.32	Q_{fec}=2.92
M_{pup}	0.758	0.683	0.581
a_{fec}	-12.598	-10.445	-8.358
b_{fec}	0.184	0.155	0.126
$F_{prop,MSY}$	0.0289	0.0352	0.0447
MSY	20 321	23 975	28 742
B_{MSY}	963 741	898 658	818 748
M_{SYR}	0.0293	0.0382	0.0525

Table 2.13. Northeast Atlantic spurdog. Correlation matrix for some key estimable parameters for the base-case.

	$N_0^{f,preg}$	$S_{c2,non\text{-}tgt}$	$S_{c2,tgt}$	$S_{c3,non\text{-}tgt}$	$S_{c3,tgt}$	$S_{c4,non\text{-}tgt}$	$S_{c4,tgt}$	S_{s1}	S_{s2}	S_{s3}	S_{s4}	Q_{fec}	$\varepsilon_{r,09}$	$\varepsilon_{r,010}$	$\varepsilon_{r,11}$	$\varepsilon_{r,12}$	$\varepsilon_{r,13}$	q_{sur}
$N_0^{f,preg}$	1																	
$S_{c2,non\text{-}tgt}$	-0.12	1																
$S_{c2,tgt}$	-0.01	0.00	1															
$S_{c3,non\text{-}tgt}$	-0.24	0.41	0.01	1														
$S_{c3,tgt}$	-0.05	0.01	0.08	0.07	1													
$S_{c4,non\text{-}tgt}$	-0.32	0.42	0.01	0.88	0.09	1												
$S_{c4,tgt}$	-0.21	0.07	0.10	0.20	0.55	0.24	1											
S_{s1}	0.04	-0.05	-0.01	-0.13	-0.09	-0.14	-0.15	1										
S_{s2}	0.07	-0.06	-0.01	-0.16	-0.11	-0.17	-0.17	0.47	1									
S_{s3}	0.09	-0.05	-0.01	-0.11	-0.06	-0.13	-0.11	0.37	0.50	1								
S_{s4}	0.03	-0.04	-0.01	-0.09	-0.07	-0.10	-0.10	0.30	0.40	0.33	1							
Q_{fec}	-0.06	0.05	0.01	0.18	0.17	0.18	0.22	-0.12	-0.11	-0.01	-0.05	1						
$\varepsilon_{r,09}$	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.11	0.00	0.00	-0.02	1					
$\varepsilon_{r,10}$	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-0.18	-0.04	-0.01	0.00	0.00	0.03	1				
$\varepsilon_{r,11}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.03	0.00	0.00	0.00	0.00	-0.01	1			
$\varepsilon_{r,12}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.06	0.00	0.00	0.00	0.00	0.00	0.02	0.01	1		
$\varepsilon_{r,13}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	
q_{sur}	-0.29	0.03	0.00	-0.03	-0.14	-0.02	-0.13	-0.11	-0.23	-0.35	-0.34	-0.58	0.02	0.00	0.01	0.00	0.00	1

Table 2.14. Northeast Atlantic spurdog. Summary table of estimates from the base case assessment: recruitment (number of pups), total biomass (t) and fishing proportion (averaged over ages 5–30); and WG estimates of landings (t) used in the assessment.

	R (pups)	B_{tot} (t)	Catch (t)	F_{prop} (5-30)
1980	194517	586414	40968	0.099
1981	178369	563219	39962	0.101
1982	167952	540433	32402	0.085
1983	165597	524746	37046	0.100
1984	154639	503214	35194	0.099
1985	144153	482359	38674	0.113
1986	141588	457365	30910	0.094
1987	137549	439403	42354	0.134
1988	130157	409212	35569	0.121
1989	130698	385706	30277	0.110
1990	121928	366801	29906	0.114
1991	127916	348548	29563	0.120
1992	117597	330032	29046	0.124
1993	103180	311231	25637	0.117
1994	99145	295683	20851	0.101
1995	87977	284231	21318	0.106
1996	87367	272148	17295	0.089
1997	86327	263736	15347	0.081
1998	84650	256762	13919	0.075
1999	82211	250646	12385	0.068
2000	82122	245646	15889	0.089
2001	80504	236746	16693	0.097
2002	80137	226875	11020	0.067
2003	82465	222723	12247	0.076
2004	82188	217241	9364	0.060
2005	82345	214615	8357	0.054
2006	81662	212924	4055	0.026
2007	83513	215591	2853	0.018
2008	86982	219551	1737	0.011
2009	91749	224770	2561	0.016
2010	101399	229615	2384	0.014
2011	91208	233931	2384	0.014
2012	93457	238353	2384	0.014
2013	99445	243135	2384	0.014

Table 2.15. Northeast Atlantic spurdog. Assessment projections under different future catch options. Estimates of begin-year total biomass relative to the total biomass in 2014 are shown, assuming that the catch in 2014 is 2384 tons (average landings for 2007–2009). 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. All landings from 2008 onwards are assumed to be taken by non-target fisheries only. The "+x yrs" in the first column is relative to 2014 (so "+3 yrs" indicates 2017).

	Medium-term projections				
	MSY rule	zero	TAC 2009	Ave land 2007-9	$F_{prop,MSY}$
ave Catch	2746	0	1422	2384	6125
Point estimates					
+ 3 yrs	1.07	1.08	1.07	1.06	1.04
+ 5 yrs	1.12	1.15	1.12	1.11	1.06
+ 10 yrs	1.25	1.32	1.27	1.23	1.11
+ 30 yrs	1.85	2.21	2.02	1.88	1.35
Point estimates - 2 standard deviations					
+ 3 yrs	1.05	1.06	1.05	1.04	1.01
+ 5 yrs	1.08	1.11	1.08	1.07	1.02
+ 10 yrs	1.18	1.25	1.19	1.15	1.04
+ 30 yrs	1.57	1.97	1.81	1.65	1.18
Point estimates + 2 standard deviations					
+ 3 yrs	1.09	1.11	1.10	1.09	1.06
+ 5 yrs	1.16	1.18	1.16	1.15	1.10
+ 10 yrs	1.33	1.39	1.34	1.31	1.18
+ 30 yrs	2.13	2.44	2.22	2.12	1.53

"ave Catch" is the average for the period 2015-2043

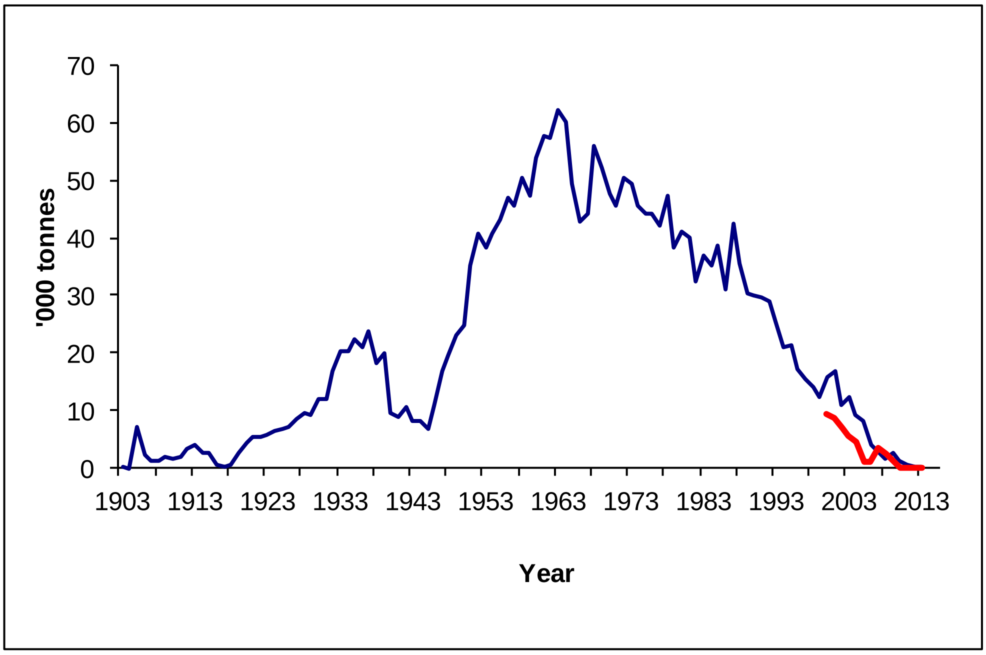


Figure 2.1a. Spurdog in the NE Atlantic. WG estimates of total international landings of NE Atlantic spurdog (1903–2013, blue line) and TAC (red line). Restrictive management (e.g. through quotas and other measures) is only thought to have occurred since 2007.

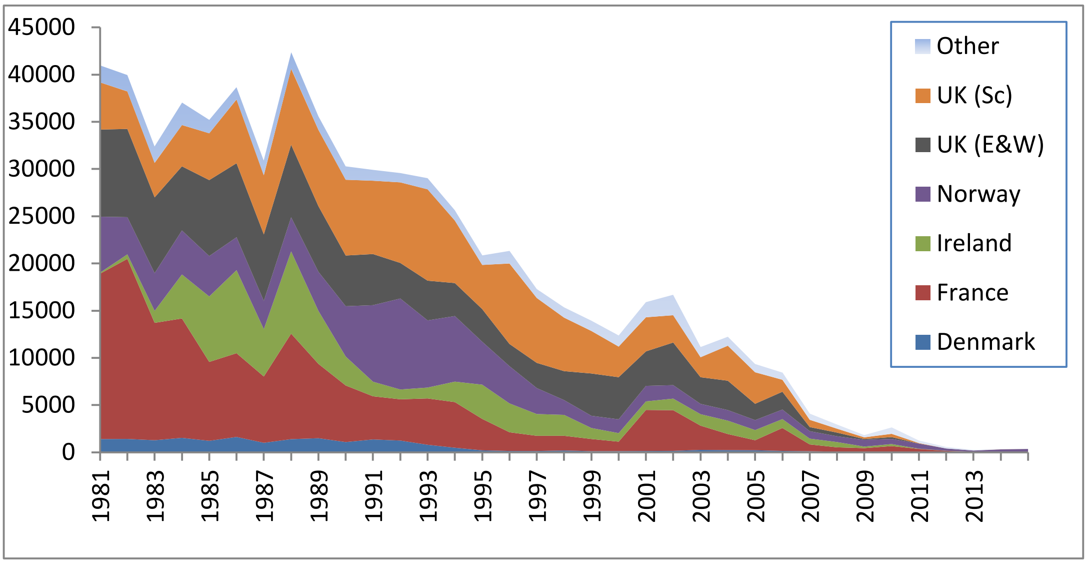


Figure 2.1b. Spurdog in the NE Atlantic. WG estimates of landings by nation (1980–2014).

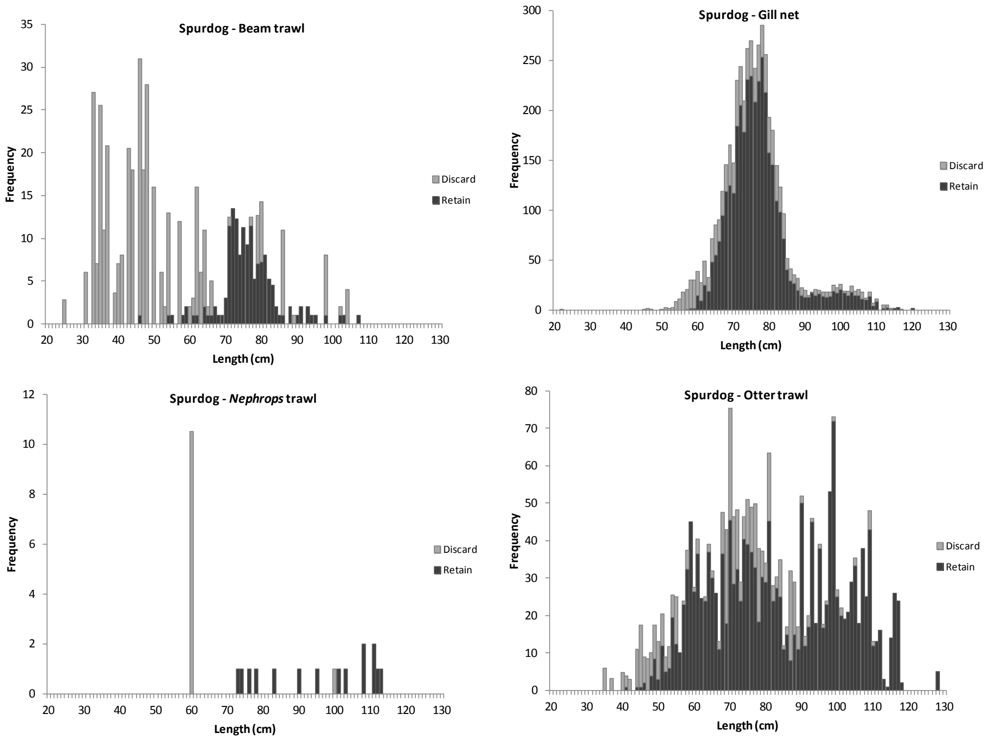


Figure 2.2. Spurdog in the NE Atlantic. Discard-retention patterns of spurdog taken in UK (English) vessels using beam trawl, gillnet, *Nephrops* trawl and otter trawl.

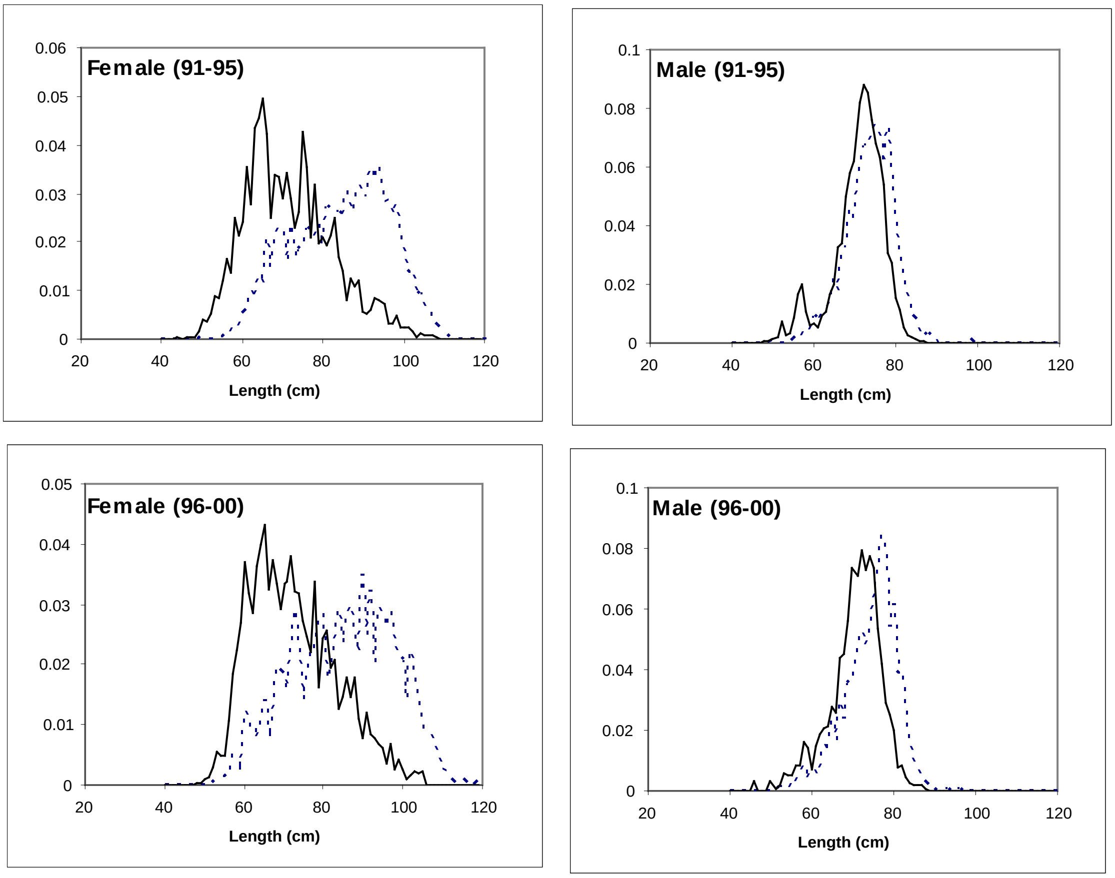


Figure 2.3. Spurdog in the NE Atlantic. Comparison of length–frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK(E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.

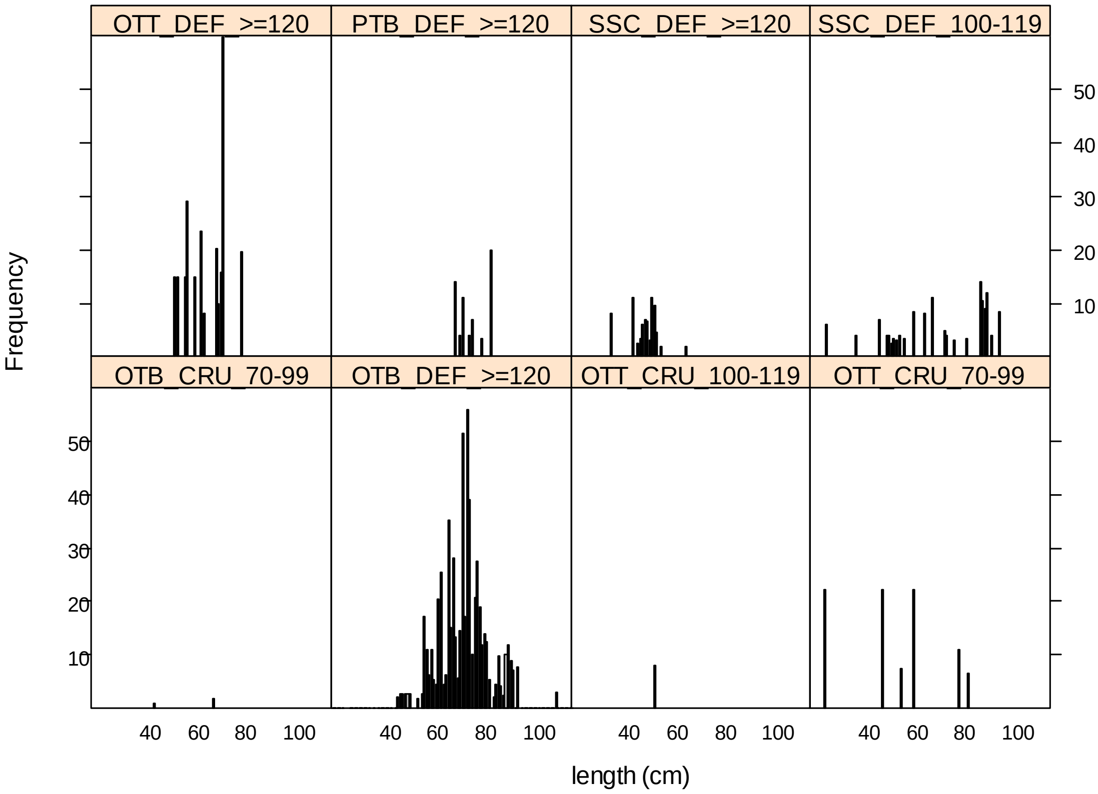


Figure 2.4. Spurdog in the NE Atlantic. Length distributions of spurdog caught on Scottish observer trips in 2010. Data are aggregated across trips for each gear category. Gear codes relate to gear type, target species and mesh size. OTT – Otter trawl twin; PTB – Pair trawl bottom; SSC – Scottish Seine; OTB – Otter trawl bottom; DEF – demersal fish; CRU – crustacean.

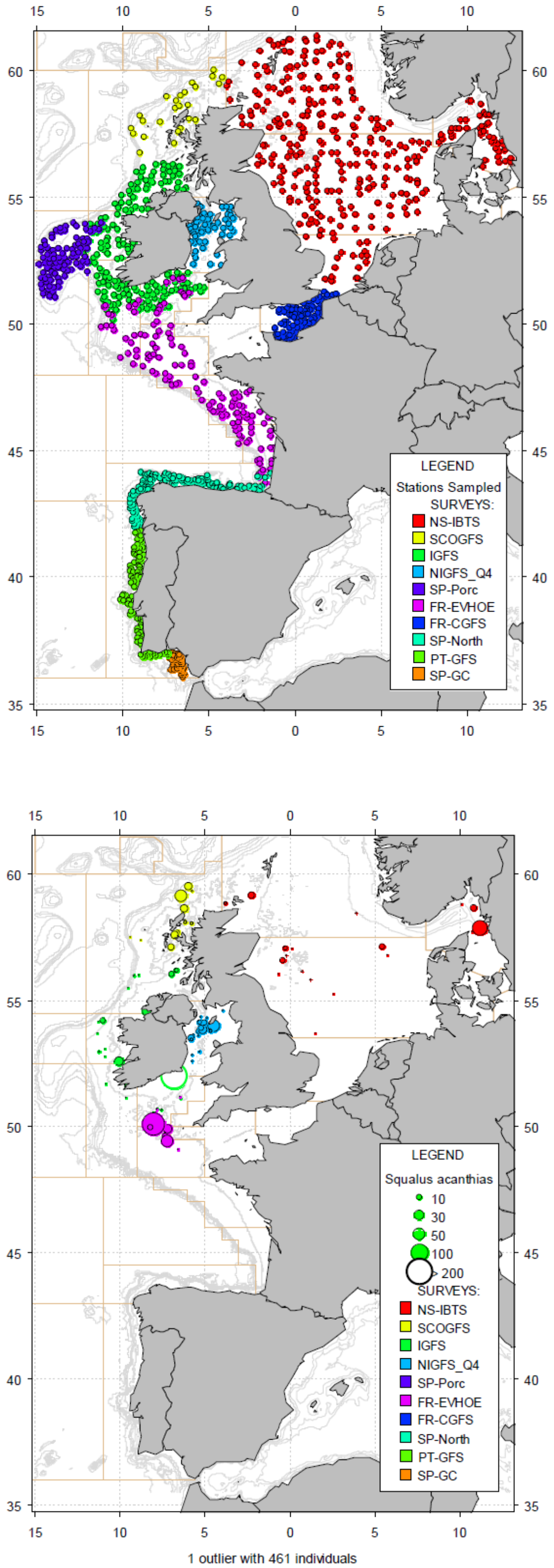


Figure 2.5. Spurdog in the NE Atlantic. Overall spatial coverage of the IBTS (top, all surveys combined) and captures of spurdog (number per hour, bottom) as reported in the 2013 summer/autumn IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey (From ICES, 2014).

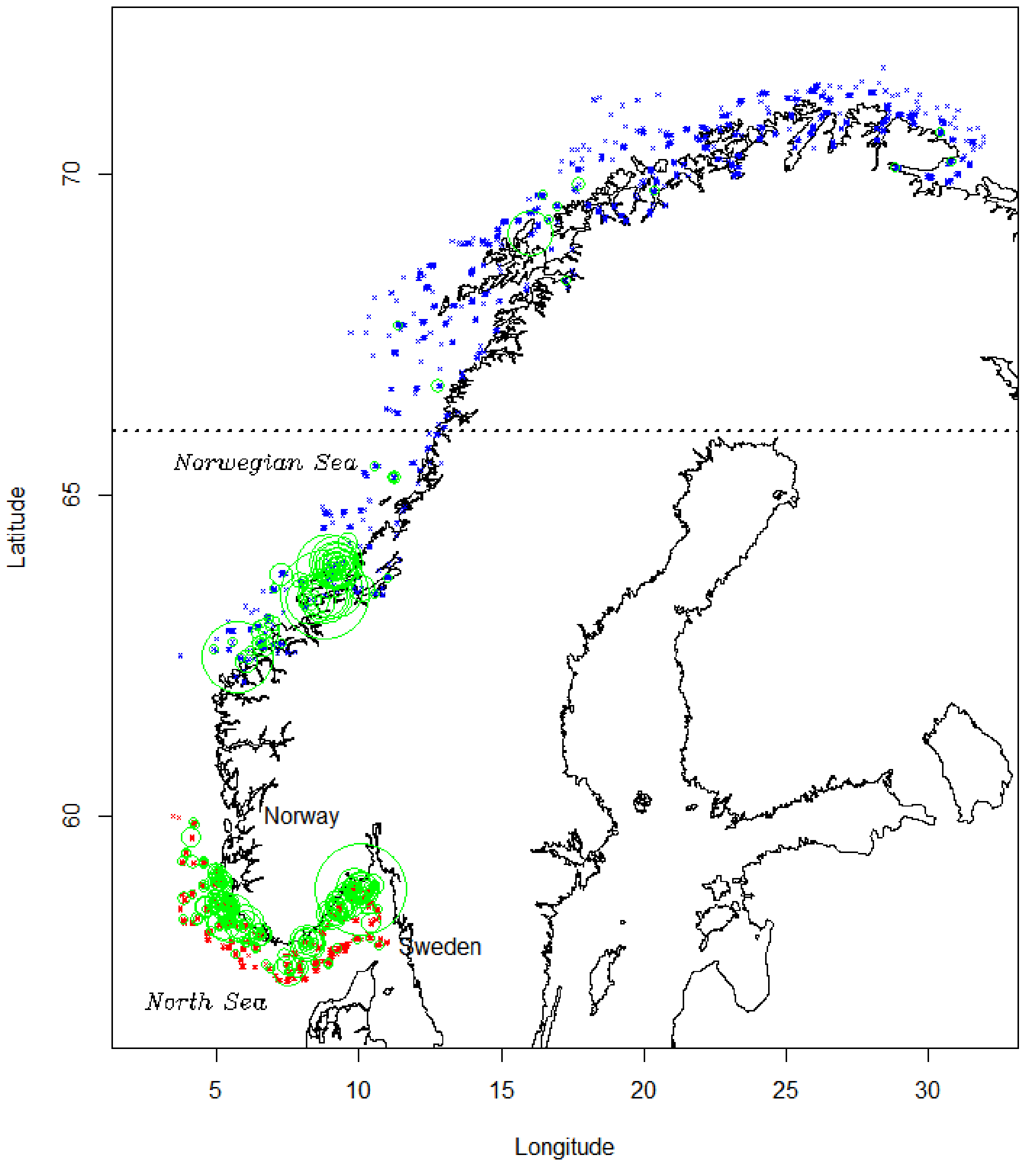


Figure 2.6. Spurdog in the NE Atlantic. Map of survey areas with all stations 1996–2013 for Coastal survey (blue) and Shrimp survey (red). Green circles indicate catches of spurdog, circle area is proportional to catch in number of individuals. Dotted line indicate northern limit of data selection. Source: Vollen (2014 WD).

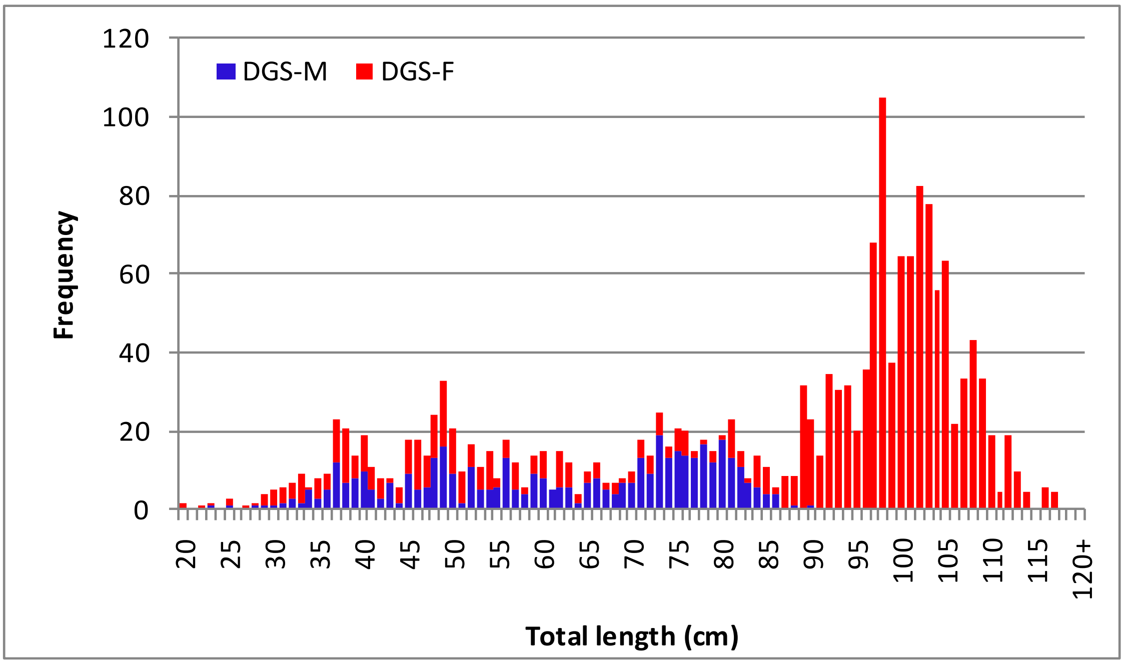


Figure 2.7a. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid and additional tows). Length distribution highly influenced by a single haul of large females.

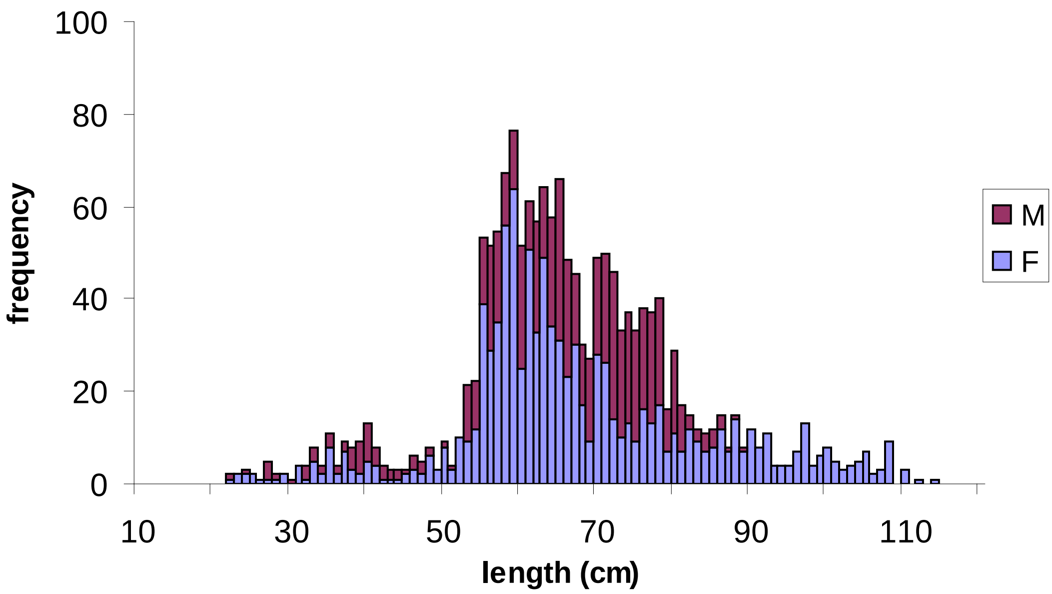


Figure 2.7b. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Irish Q3 Celtic Seas groundfish survey (2003–2009).

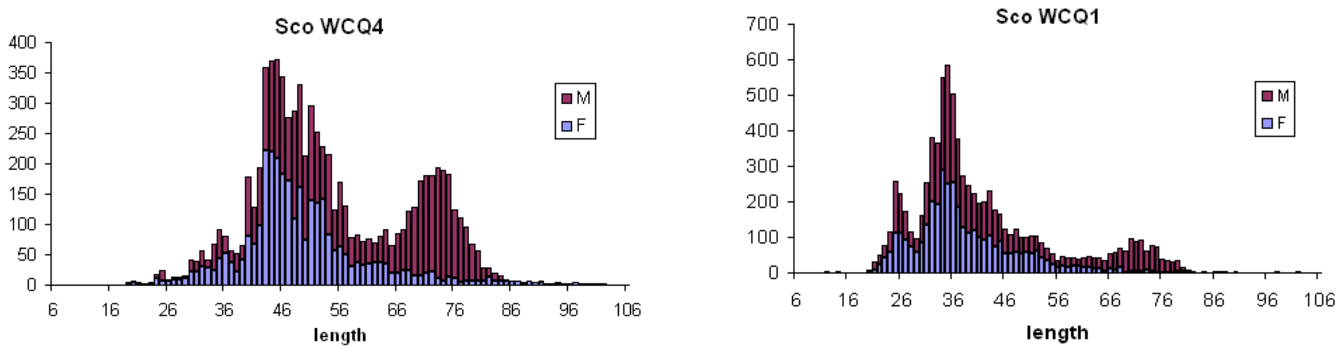


Figure 2.8. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Scottish Q1 and Q4 groundfish surveys (1990–2010). Length–frequency distributions highly influenced by a small number of hauls containing many small individuals.

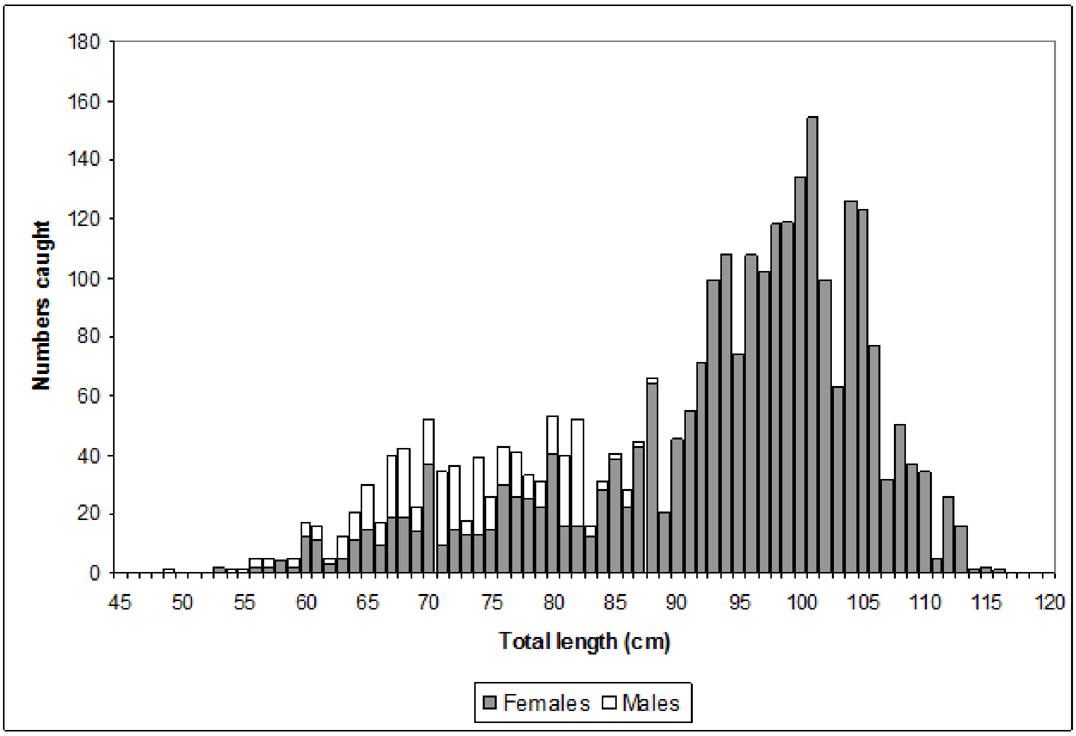


Figure 2.9. Spurdog in the NE Atlantic. Total length–frequency of male and female spurdog taken during the UK(E&W) FSP survey, raised for those catches that were sub-sampled (n = 2517 females and 356 males).

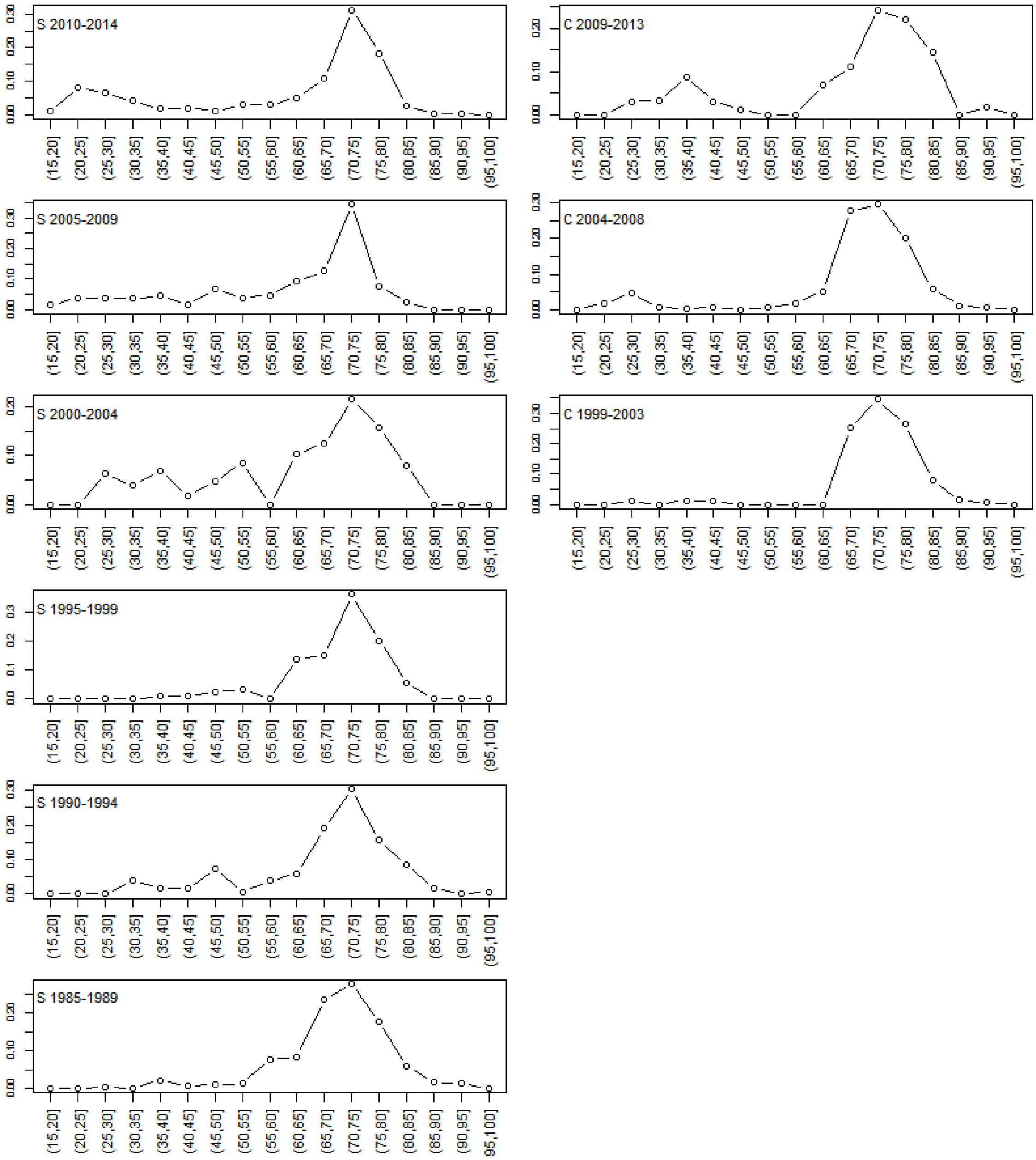


Figure 2.10. Spurdog in the NE Atlantic. Relative length–frequency distributions (5 cm length groups and five year periods) for the Shrimp survey (left) and Coastal survey (right).

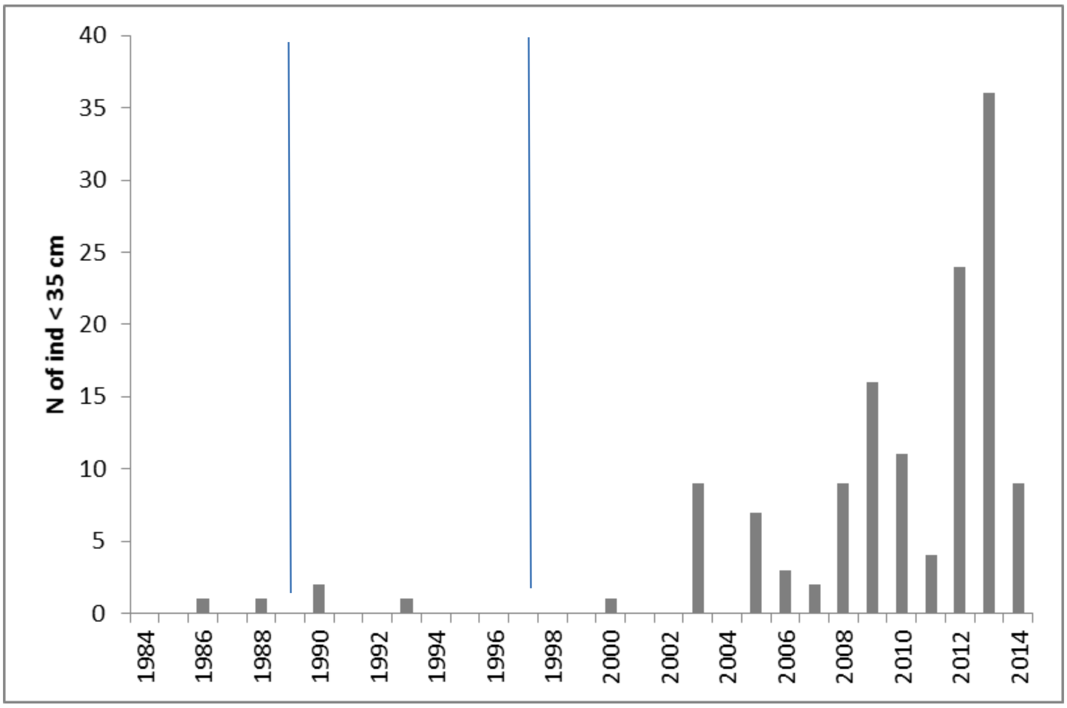


Figure 2.11. Spurdog in the NE Atlantic. Frequency of individuals <35 cm length, both Norwegian surveys combined. Mesh size in 1984–1988 was unknown; in 1989–1997: 35 mm; in 1998–2014: 20 mm.

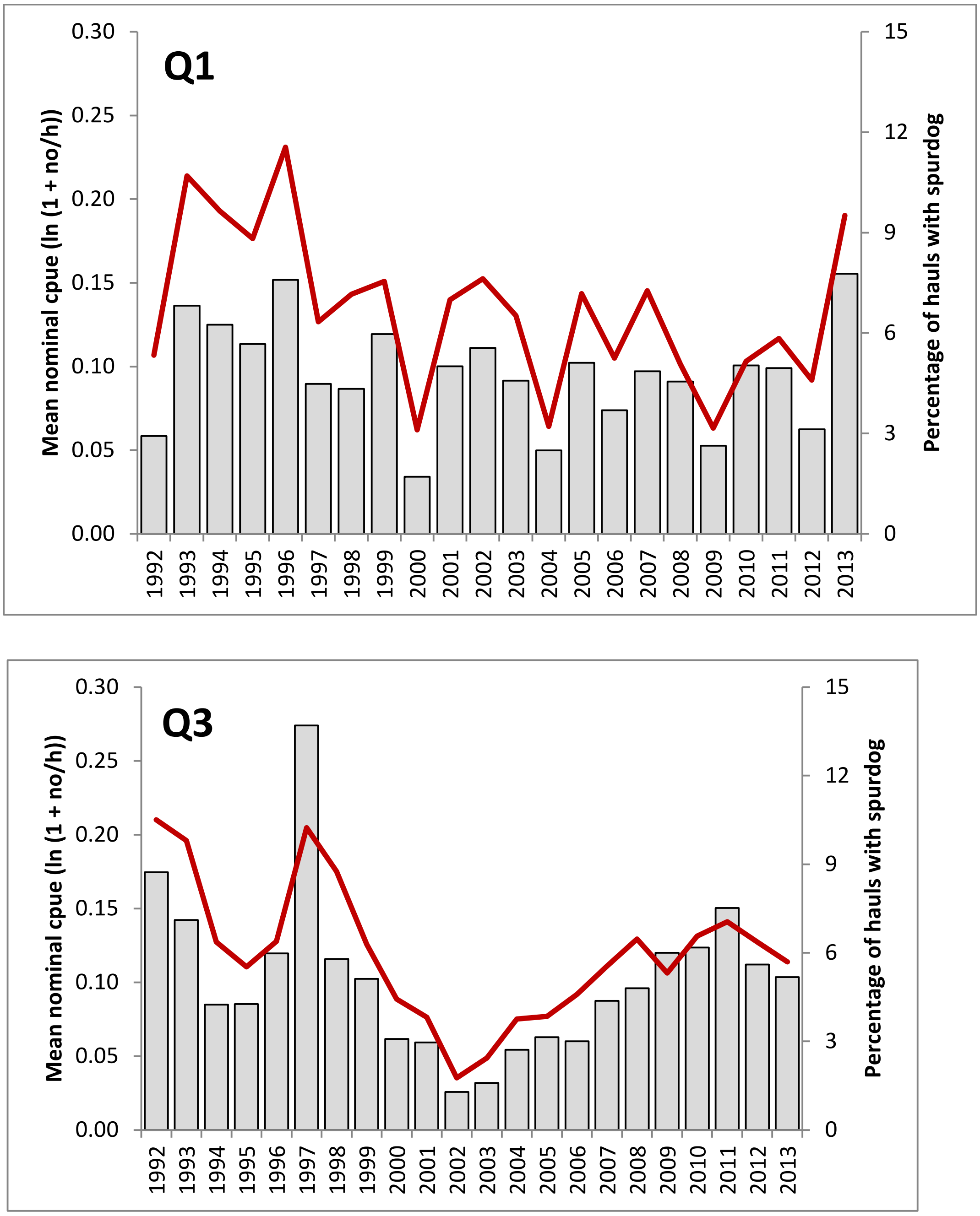


Figure 2.12. Spurdog in the NE Atlantic. Nominal catch per unit of effort (grey bars) and frequency of occurrence (red line) of spurdog in the Q1 and Q3 North Sea IBTS (1992–2013). Catch per unit of effort is mean ln(1+n/h) for all stations in roundfish areas 1–9. Data accessed from DATRAS (19 June 2014).

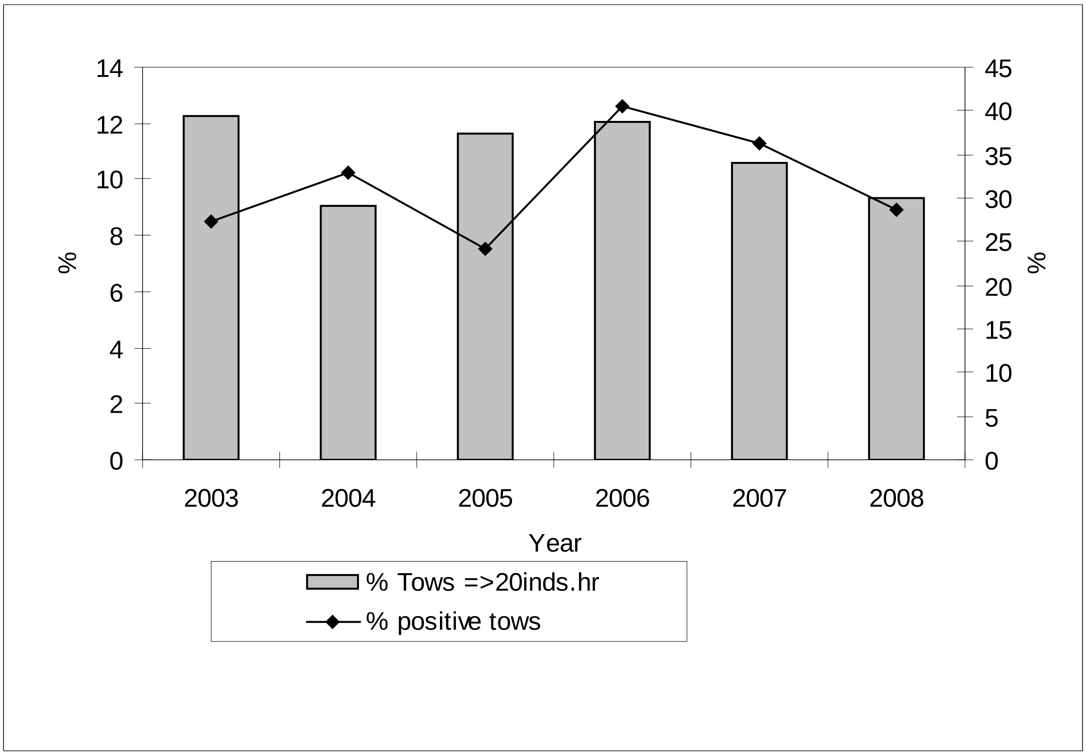


Figure 2.13. Northeast Atlantic spurdog. Proportion of survey hauls in Irish Q3 groundfish survey 2003–2008, ICES Area VII, in which nominal cpue was ≥20 per one hour tow, and percentage of tows in which spurdog occurred.

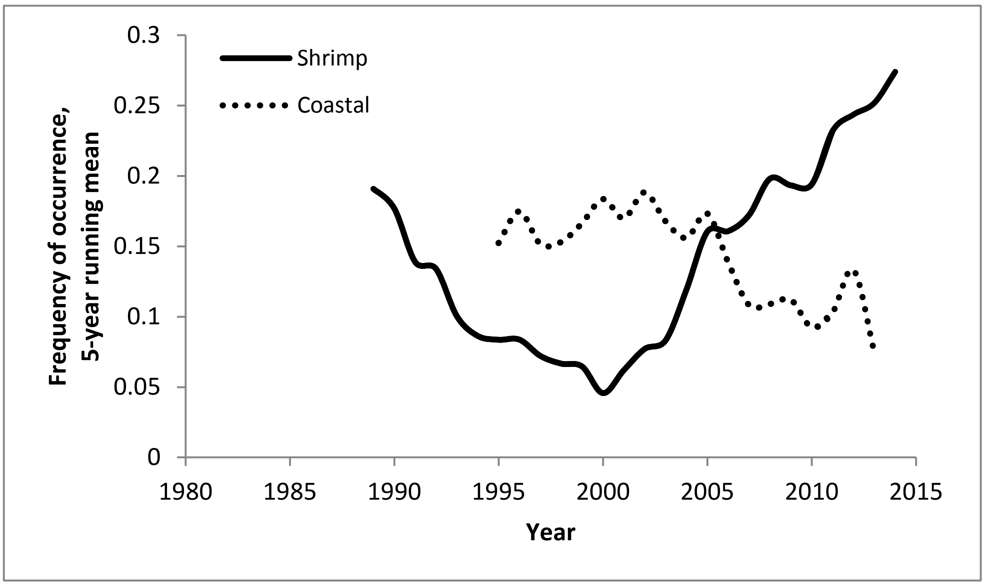


Figure 2.14. Spurdog in the NE Atlantic. Frequency of occurrence of spurdog in the Norwegian Coastal survey and Shrimp survey. A five year running mean is used. Source: Vollen (2014 WD).

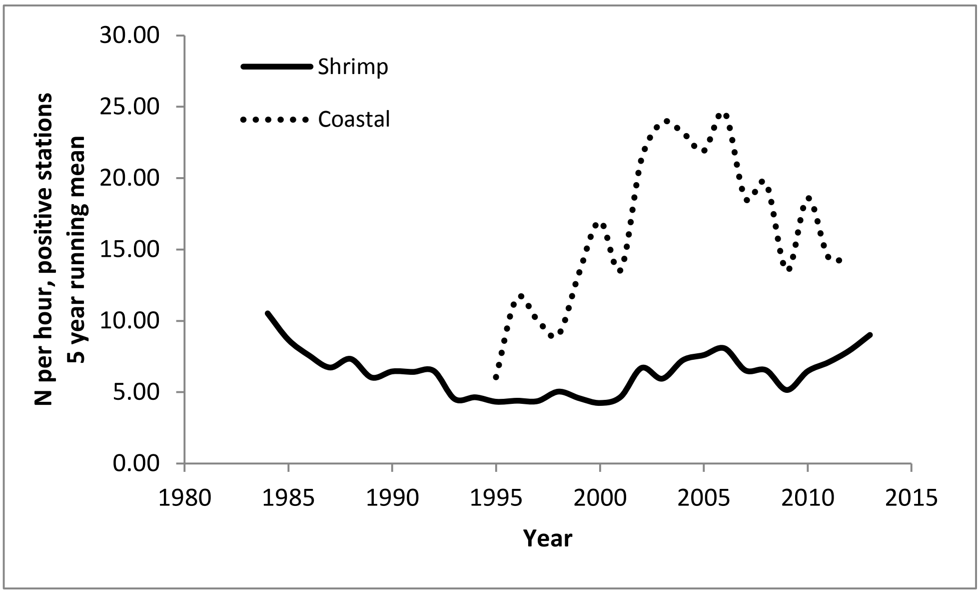
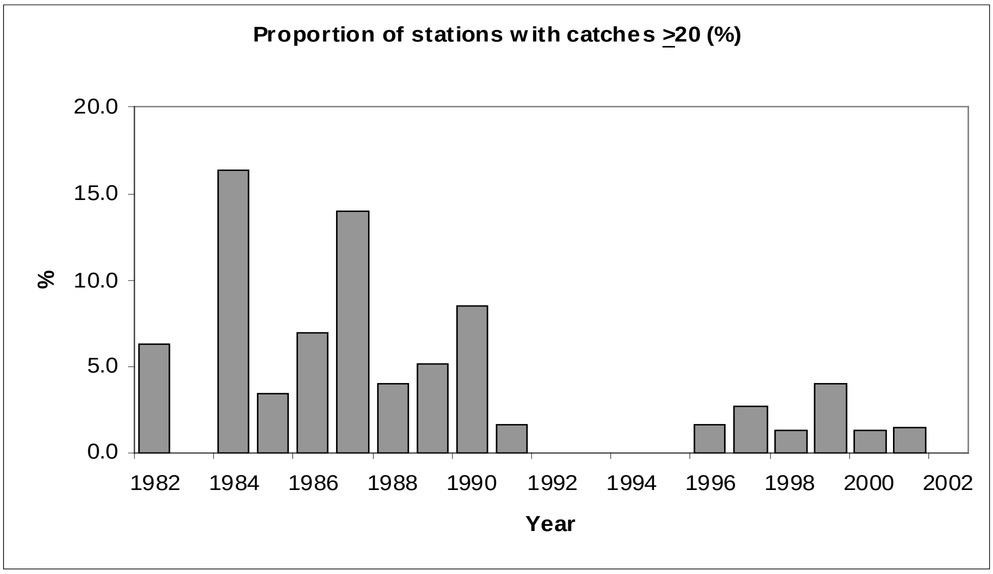


Figure 2.15. Spurdog in the NE Atlantic. Mean number of spurdog caught per hour in the Norwegian Coastal survey and Shrimp survey. A five year running mean is used. Source: Vollen (2014 WD).



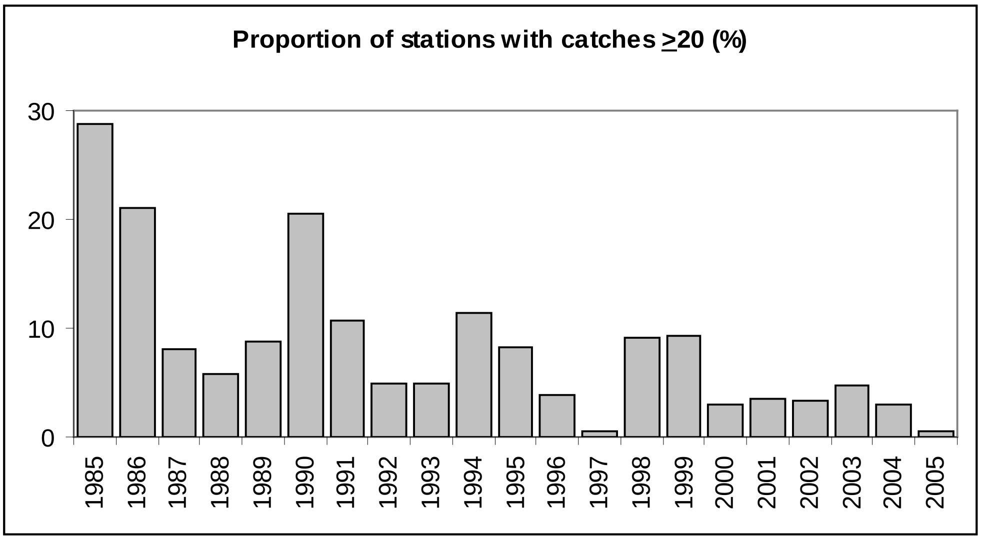
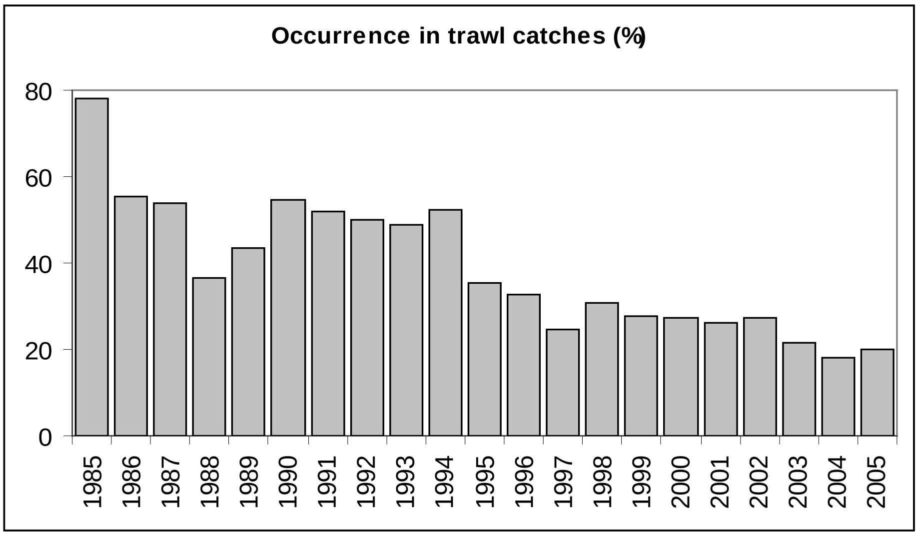


Figure 2.16. Spurdog in the NE Atlantic. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h–1. (Source: ICES, 2006).

a)



b)

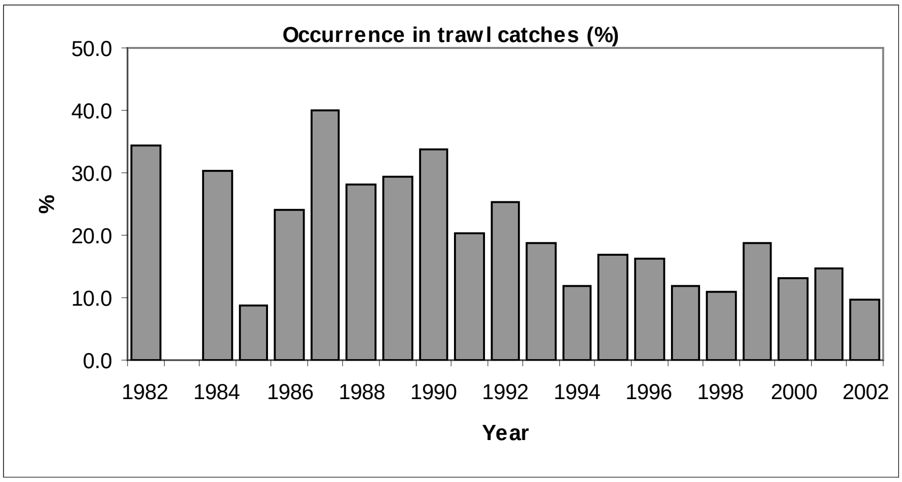


Figure 2.17. Spurdog in the NE Atlantic. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).

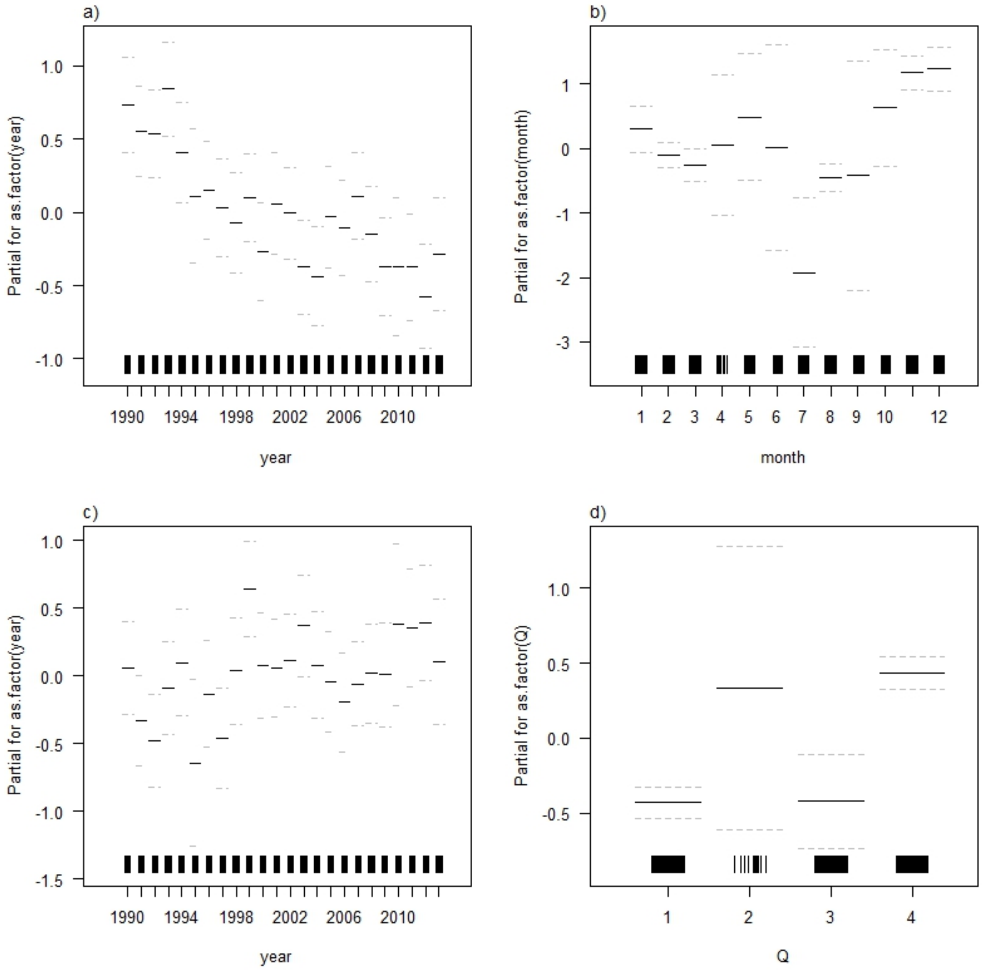


Figure 2.18. Northeast Atlantic spurdog. Estimated year and quarter effects (± 1 s.e.) from the delta-lognormal GLM: binomial model shown in a) and b), and lognormal results in c) and d) (log scale).

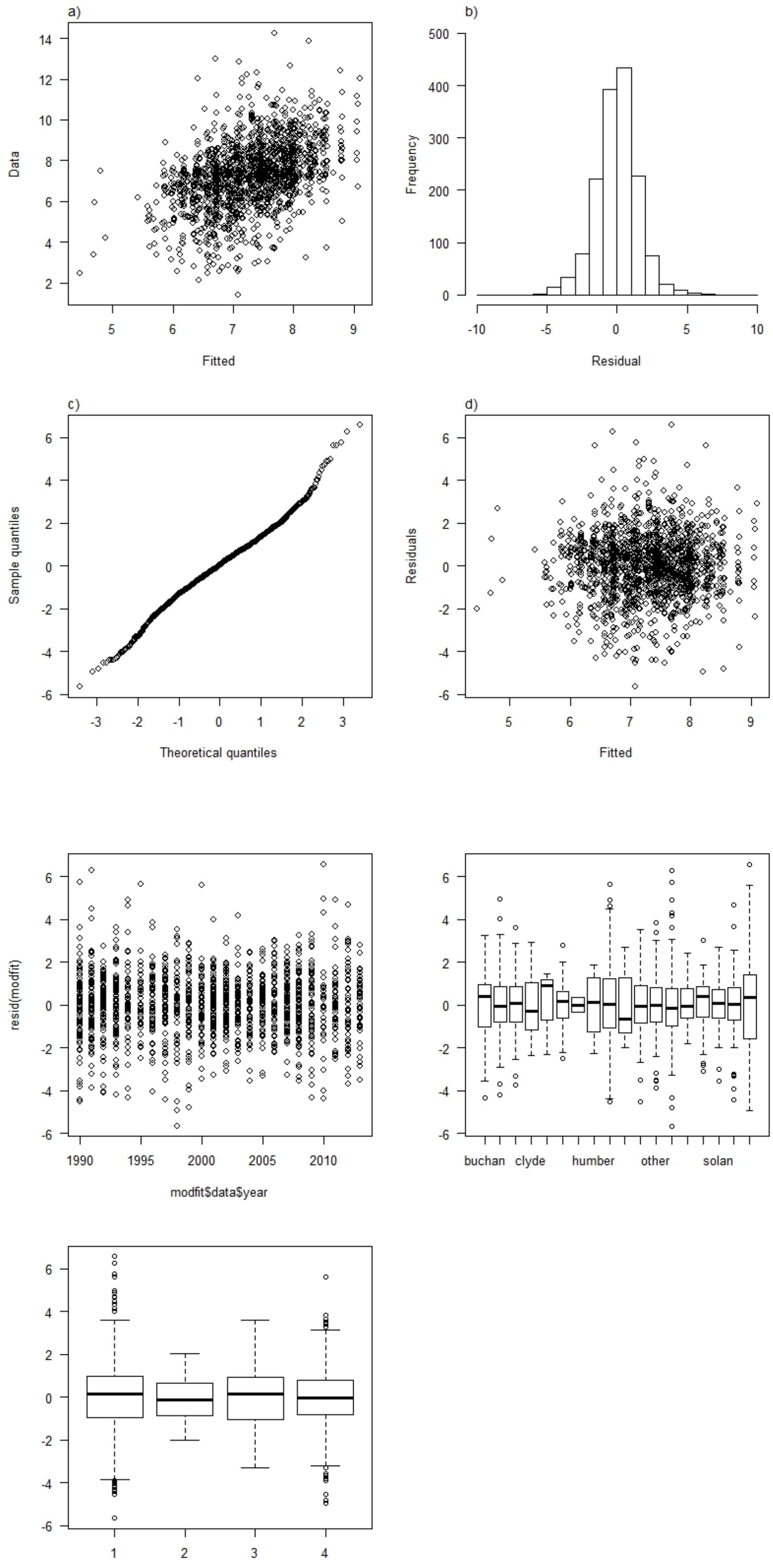


Figure 2.19. Northeast Atlantic spurdog. Analysis of Scottish survey data. Residual plot of final lognormal model fit: a) observed vs. fitted values, b) histogram of residuals, c) normal Q-Q plot, d) residuals vs. fitted values and e), f) and g) residuals vs. year, area and quarter.

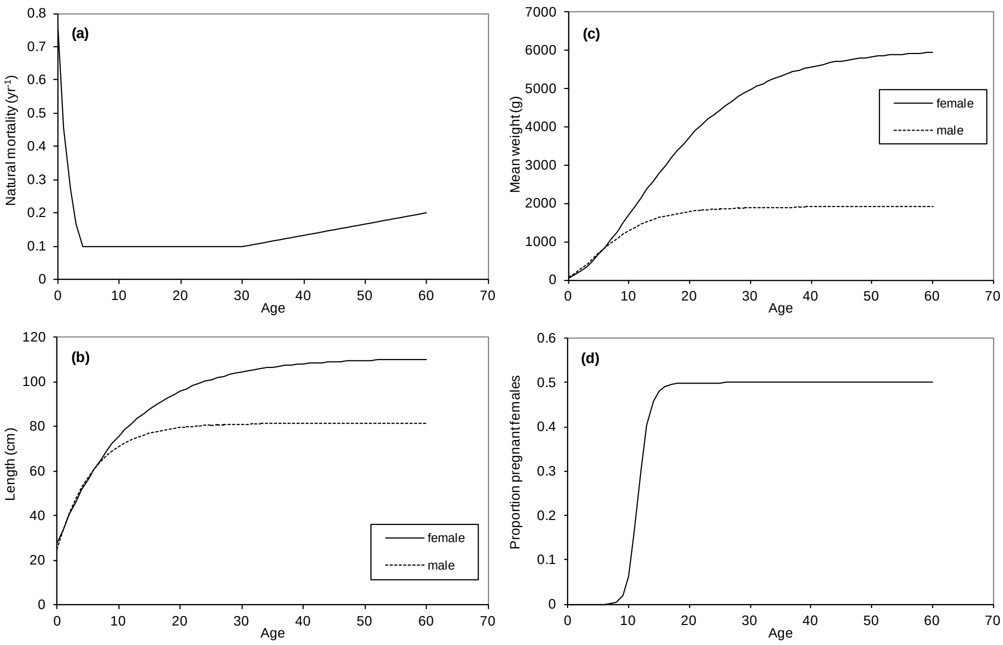


Figure 2.20. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.5. [Note, the value of natural mortality-at-age 0 is a parameter derived from the assessment.]

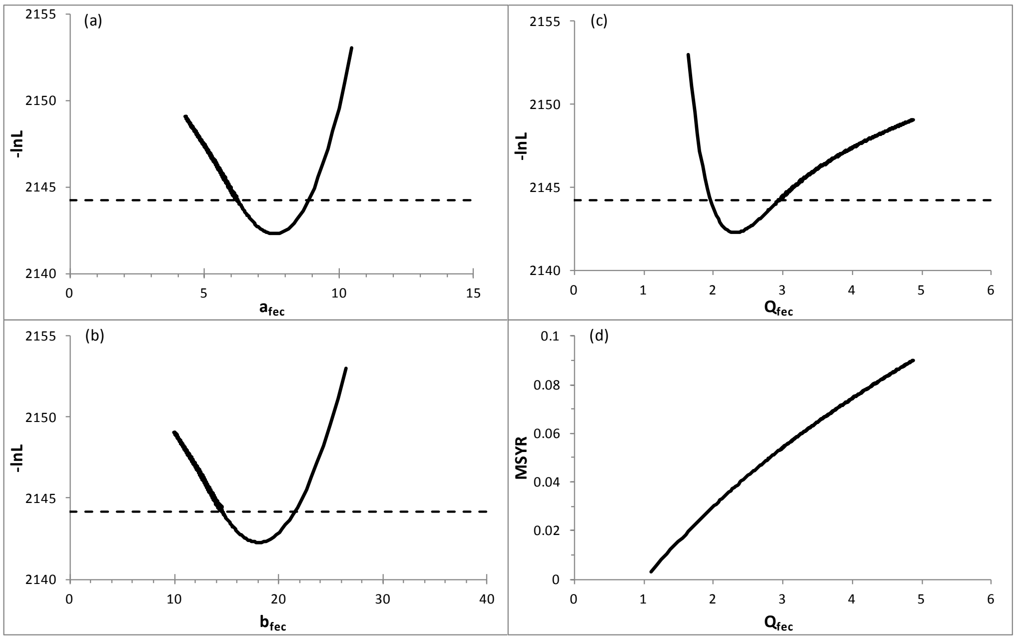


Figure 2.21. Northeast Atlantic spurdog. Negative log-likelihood (-ln*L*) for a range of (a) a_{fec} and (b) b_{fec} values, with (c) corresponding Q_{fec}. Plot (d) shows MSYR (MSY/B_{MSY}) vs. Q_{fec}. Using the likelihood ratio criterion, the hashed line in plots (a)–(c) indicate the minimum –ln*L* value + 1.92, corresponding to 95% probability intervals for the corresponding parameters for values below the line.

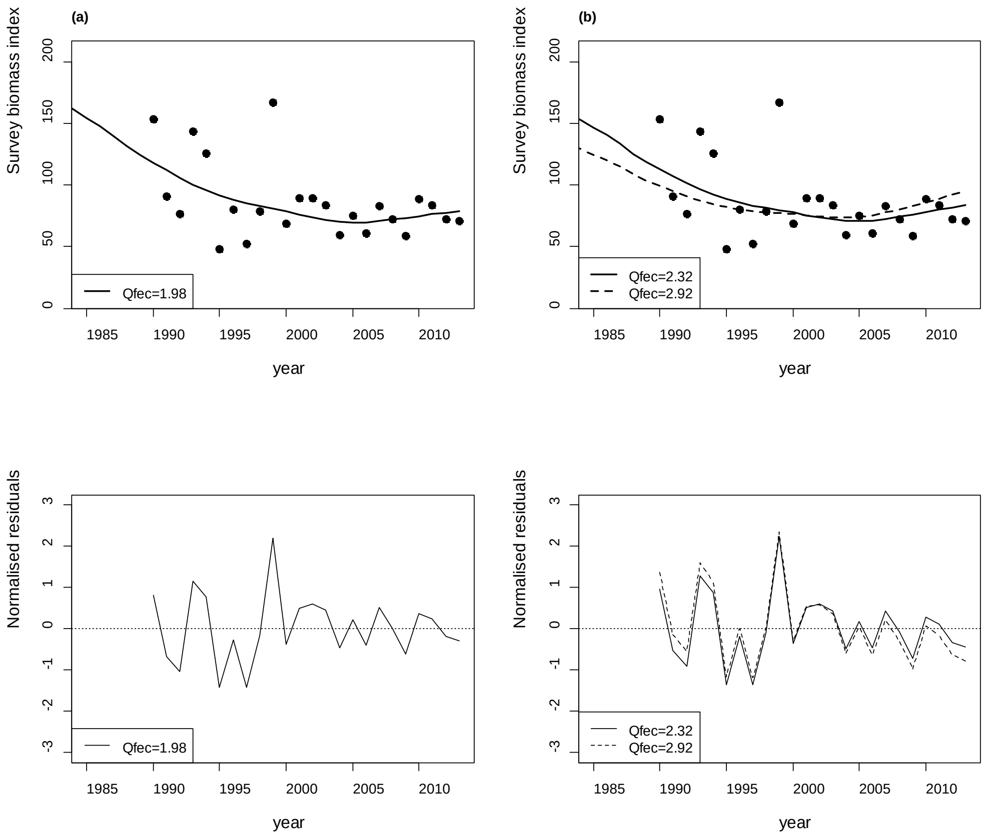


Figure 2.22. Northeast Atlantic spurdog. Model fits to the Scottish surveys abundance index (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in Stock Annex equation 9b) (bottom) for (a) the base-case Qfec=1.98 (the more conservative lower bound in Figure 2.21c) and (b) for two alternatives (the optimum and upper bounds in Figure 2.21c) that fall within the 95% confidence bounds.

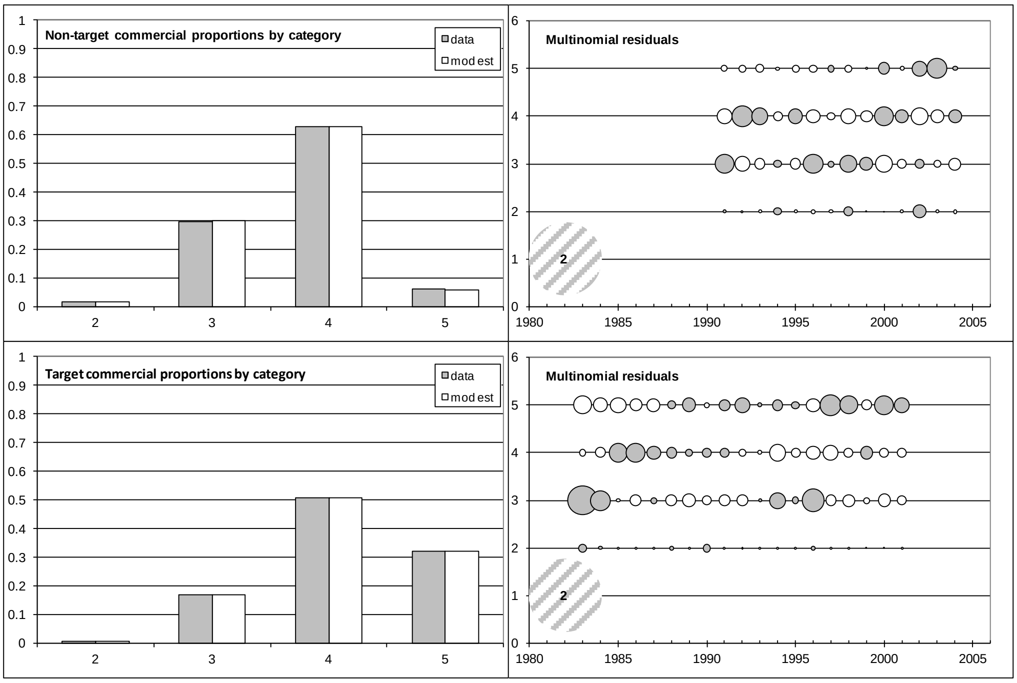


Figure 2.23a. Northeast Atlantic spurdog. Model fits to the non-taraget (Scottish; top row) and target (England & Wales; bottom row) commercial proportions-by-length category data for the base case run. The left-hand side plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The right-hand side 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 (the light-grey hashed bubble indicates a residual size of 2, and is shown for reference), and length category indicated on the vertical axis. The length categories considered are 2: 16–54 cm; 3: 55–69 cm; 4: 70–84 cm; 5: 85+ cm.

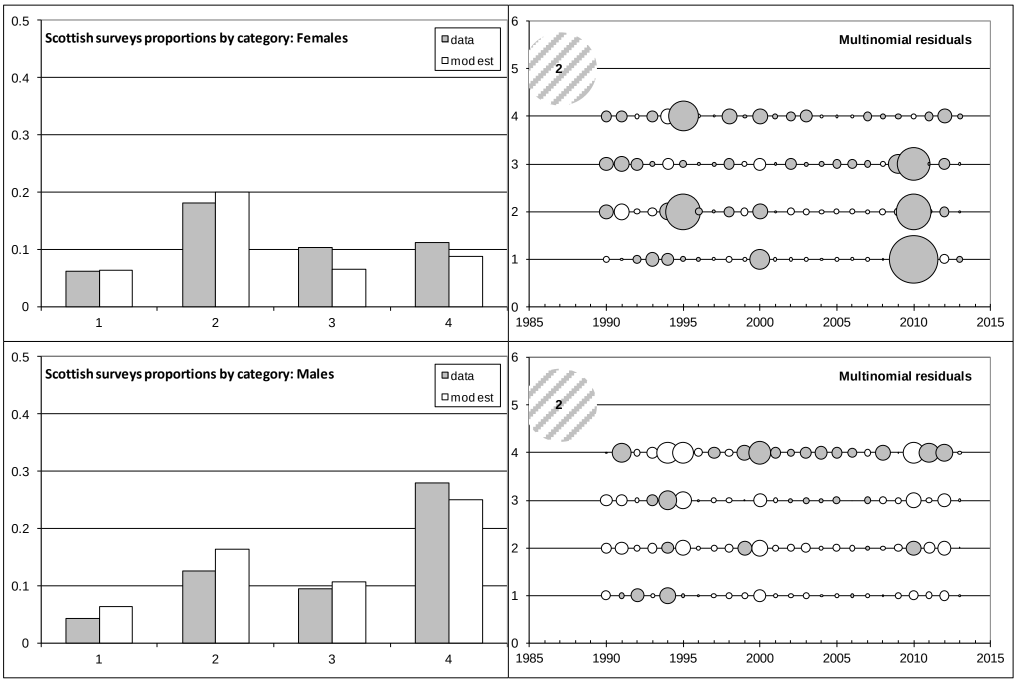


Figure 2.23b. Northeast Atlantic spurdog. Model fits to the Scottish survey proportions-by-length category data for the base-case run for females (top row) and males (bottom row). A further description of these plots can be found in the caption to Figure 2.23a. Length categories considered are 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70+ cm.

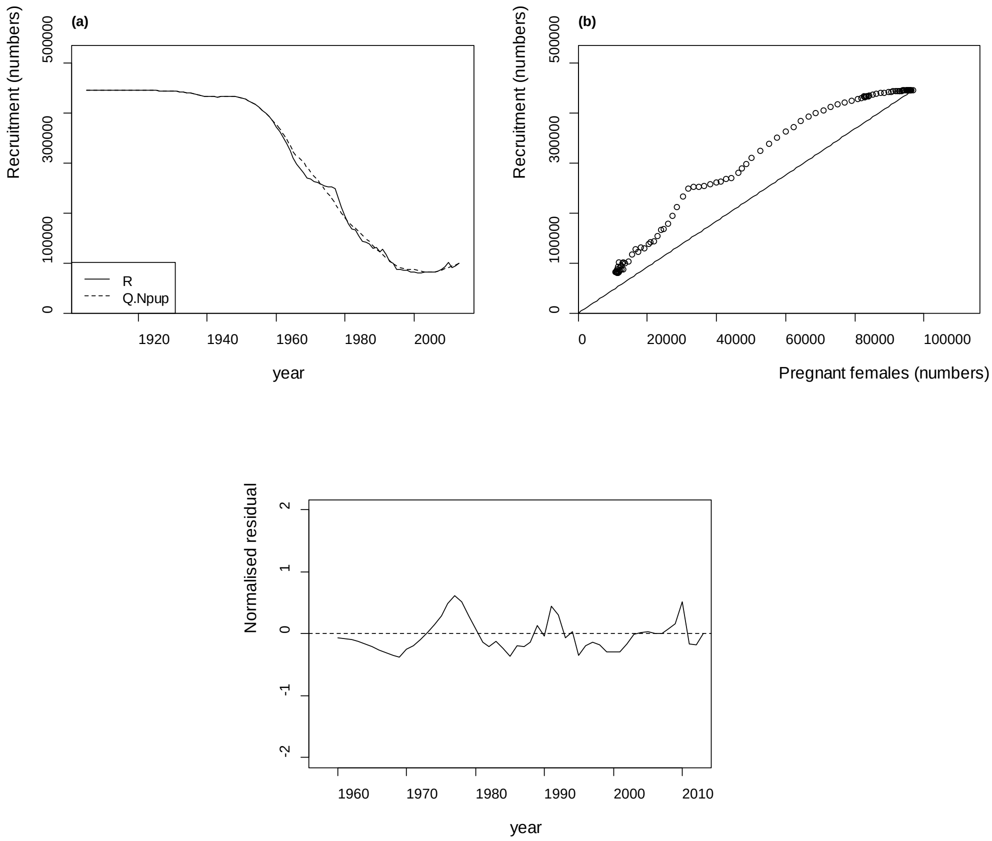


Figure 2.24. Northeast Atlantic spurdog. (a) A comparison of the deterministic (*N_{pup}*) and stochastic (*R*) versions of recruitment (Stock Annex equations 2a–c) (top-left panel) with normalised residuals ($\varepsilon_{r,y}/\sigma_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model) (bottom); and (b) a plot of recruitment (R) vs. number of pregnant females (open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).

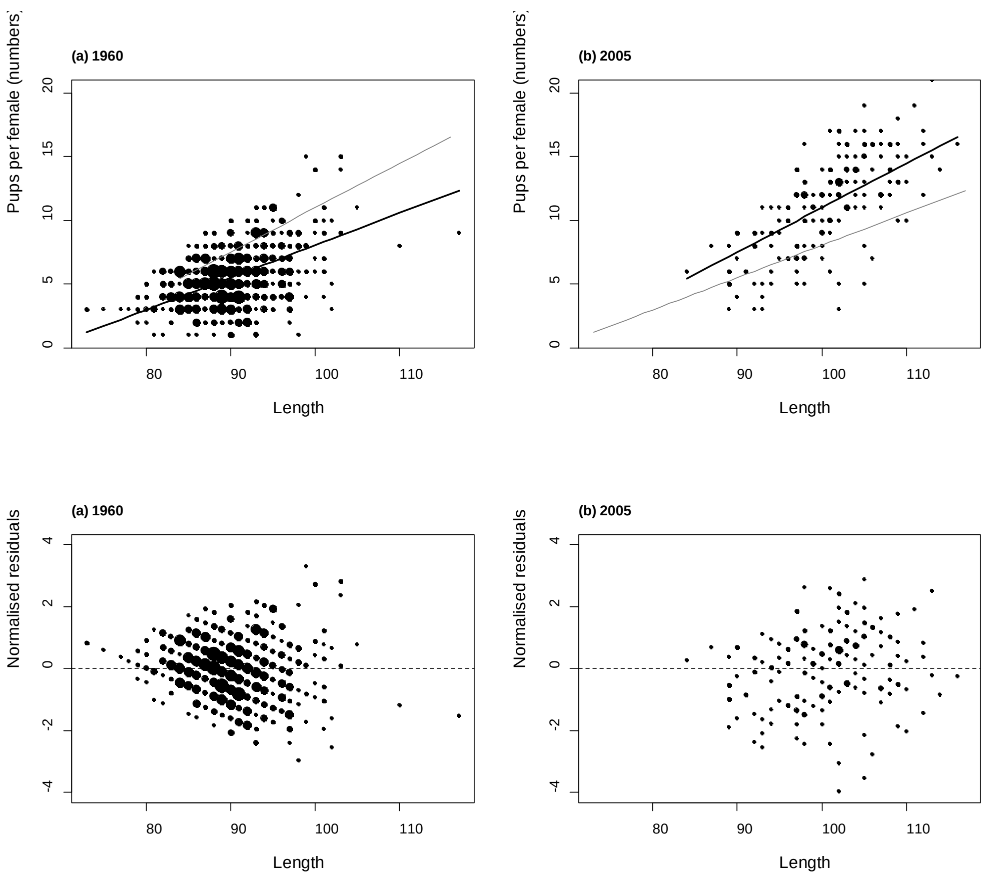


Figure 2.25. Northeast Atlantic spurdog. Fit to fecundity data from two periods (top row) for (a) 1960 and (b) 2005, with associated normalised residuals ($\varepsilon_{fec,k,y}$ in Stock Annex equation 11b) (bottom row). For the top plots, the heavy black lines reflect the model estimates for the given points, while the light grey ones, reflecting the model estimates for the points in the adjacent plot, are given for comparison. 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.

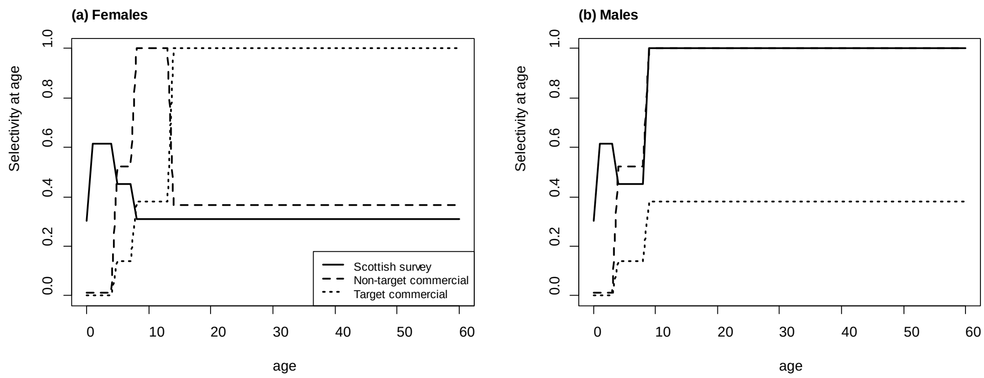


Figure 2.26. Northeast Atlantic spurdog. Estimated selectivity-at-age curves for the base case run for (a) females and (b) males. The two commercial fleets considered have non-target (Scottish) and target (England & Wales) selectivity, which differ by sex because of the life-history parameters for males and females (Table 2.6). The survey selectivity relies on Scottish survey data.

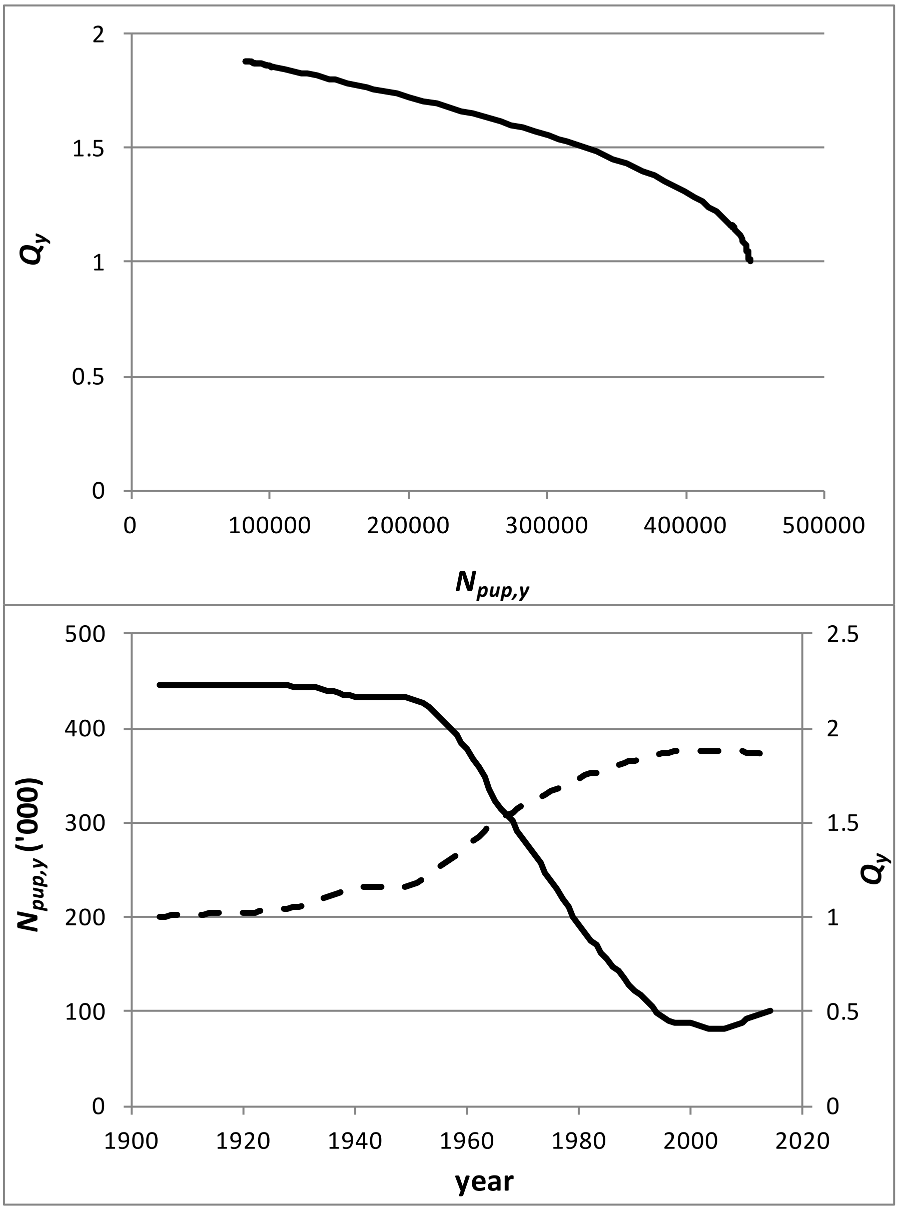


Figure 2.27. Northeast Atlantic spurdog. A plot of the density-dependent factor Q_y (Stock Annex equation 2b) against the number of pups $N_{pup,y}$ (top), and both plotted against time (bottom; solid line for $N_{pup,y}$, and hashed line for Q_y).

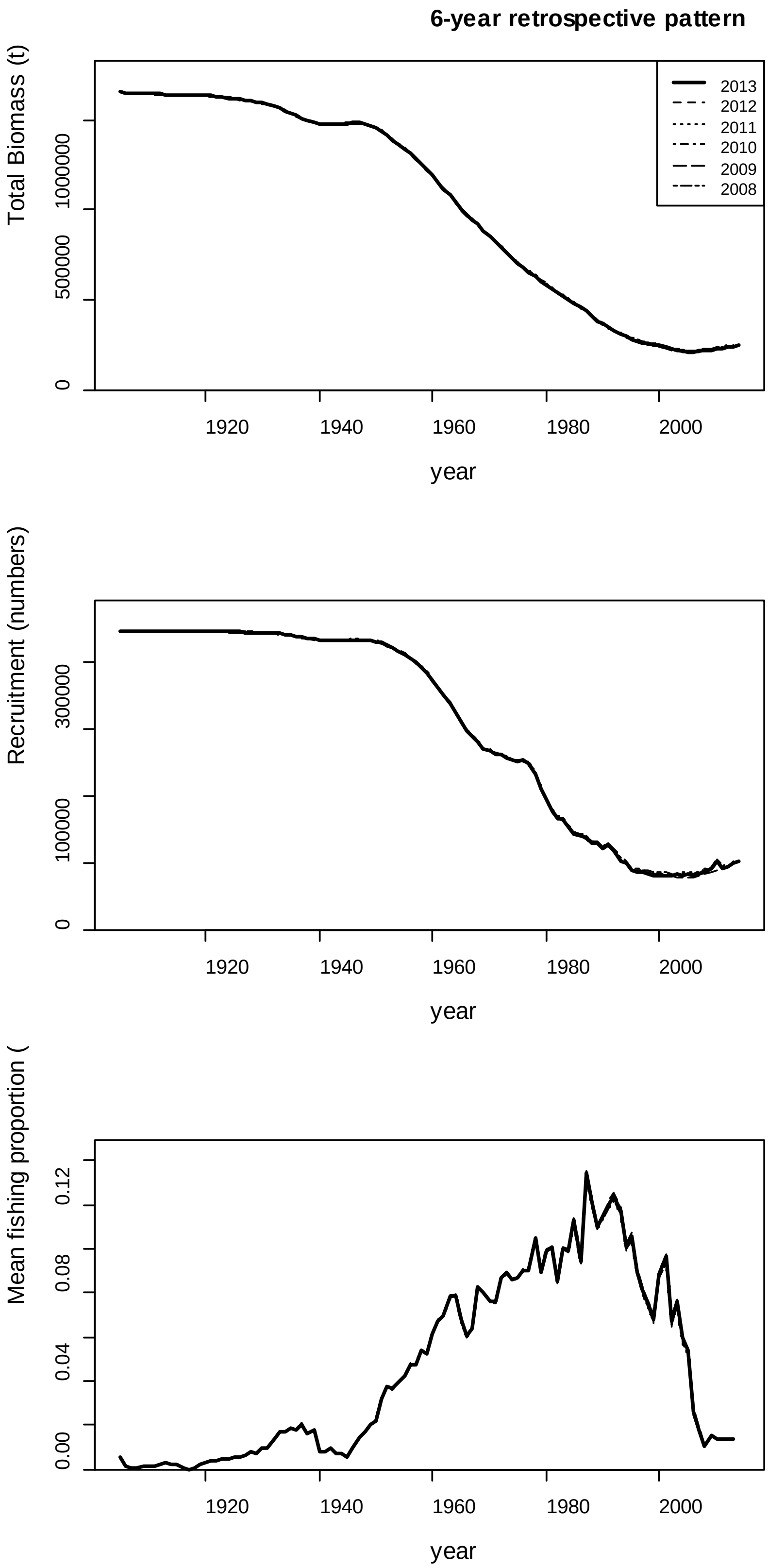


Figure 2.28. Northeast Atlantic spurdog. Six-year retrospective plots (omitting probability intervals for clarity; the model was re-run, each time omitting a further year in the data).

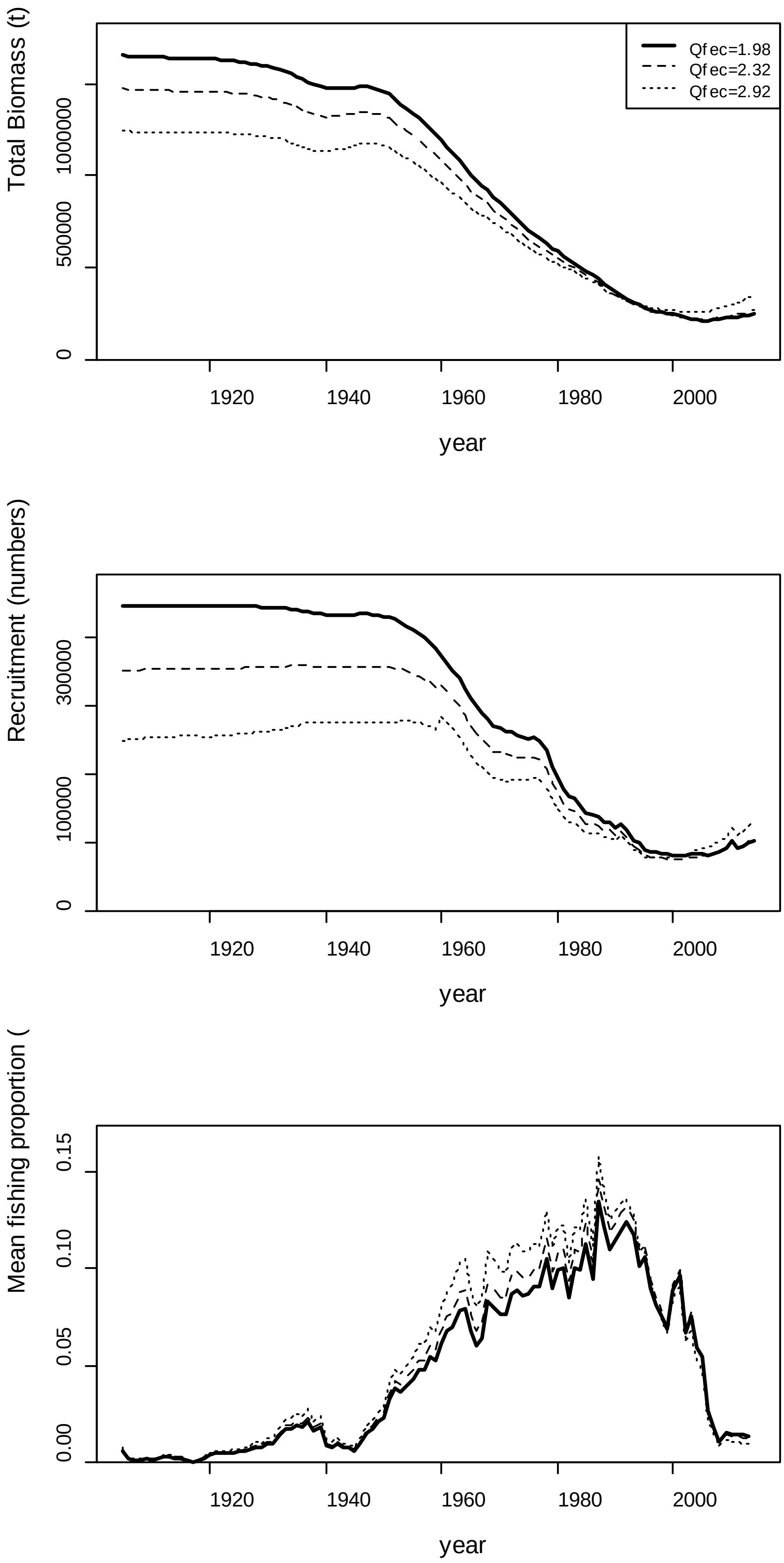


Figure 2.29. Northeast Atlantic spurdog. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production (Q_{fec}). Three alternative values are considered, related to the smallest, optimum (in terms of lowest –ln*L*) and largest value of Q_{fec} below the hashed line in Figure 2.21c (respectively 1.98 [base case], 2.32 and 2.92).

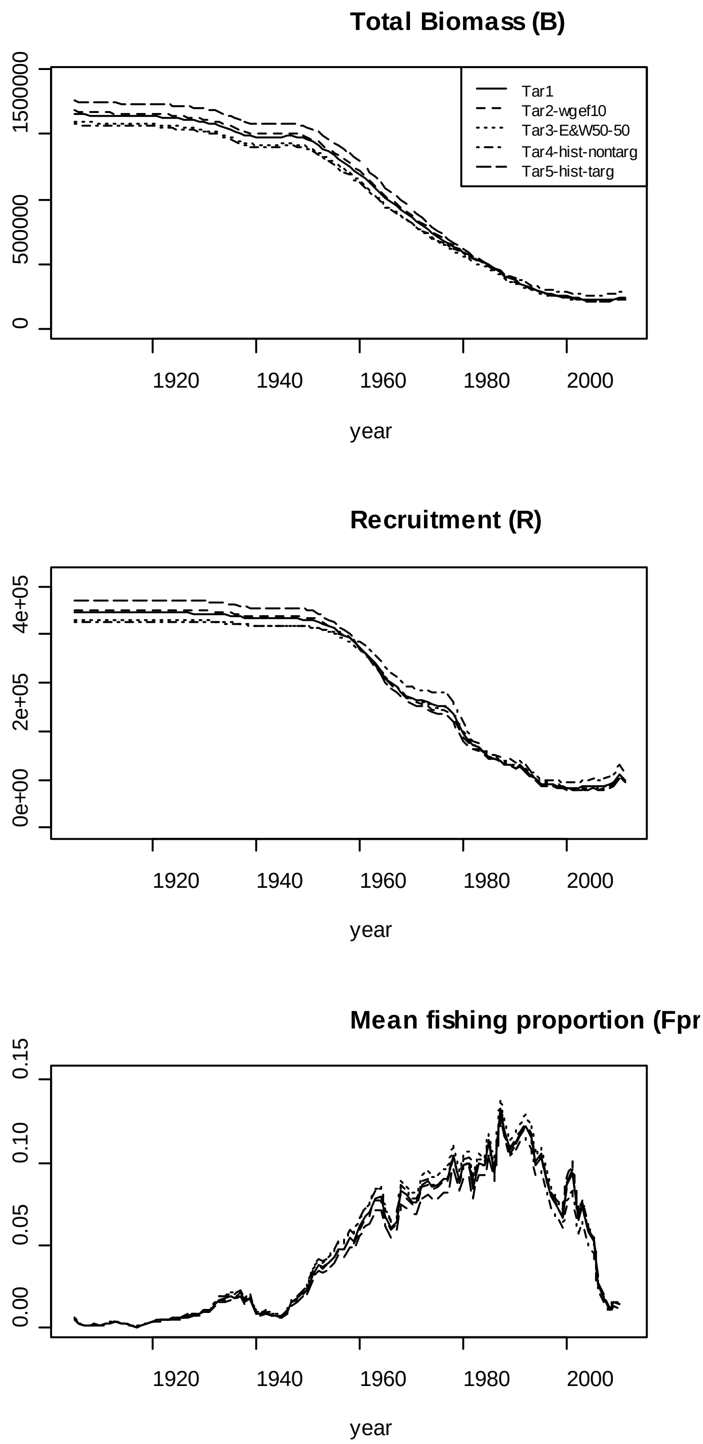


Figure 2.30. Northeast Atlantic spurdog. A comparison of the alternative targeting scenarios, where fishing is defined as either "non-target" (Scottish selectivity) or "target" (England & Wales selectivity). Tar 1 is the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980–1984), Tar 2 is as for WGEF in 2010 (Scottish landings are "non-target", E&W "target", and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984), Tar 3 as for Tar 2 but with E&W split 50% "non-target" and 50% "target", and Tar 4 and 5 as for Tar 1, but with pre-1980 selectivity entirely non-target (former) or target (latter). This figure is taken from WGEF (2011; i.e. not updated with 2013 data) to illustrate sensitivity to assumptions about historic selection.

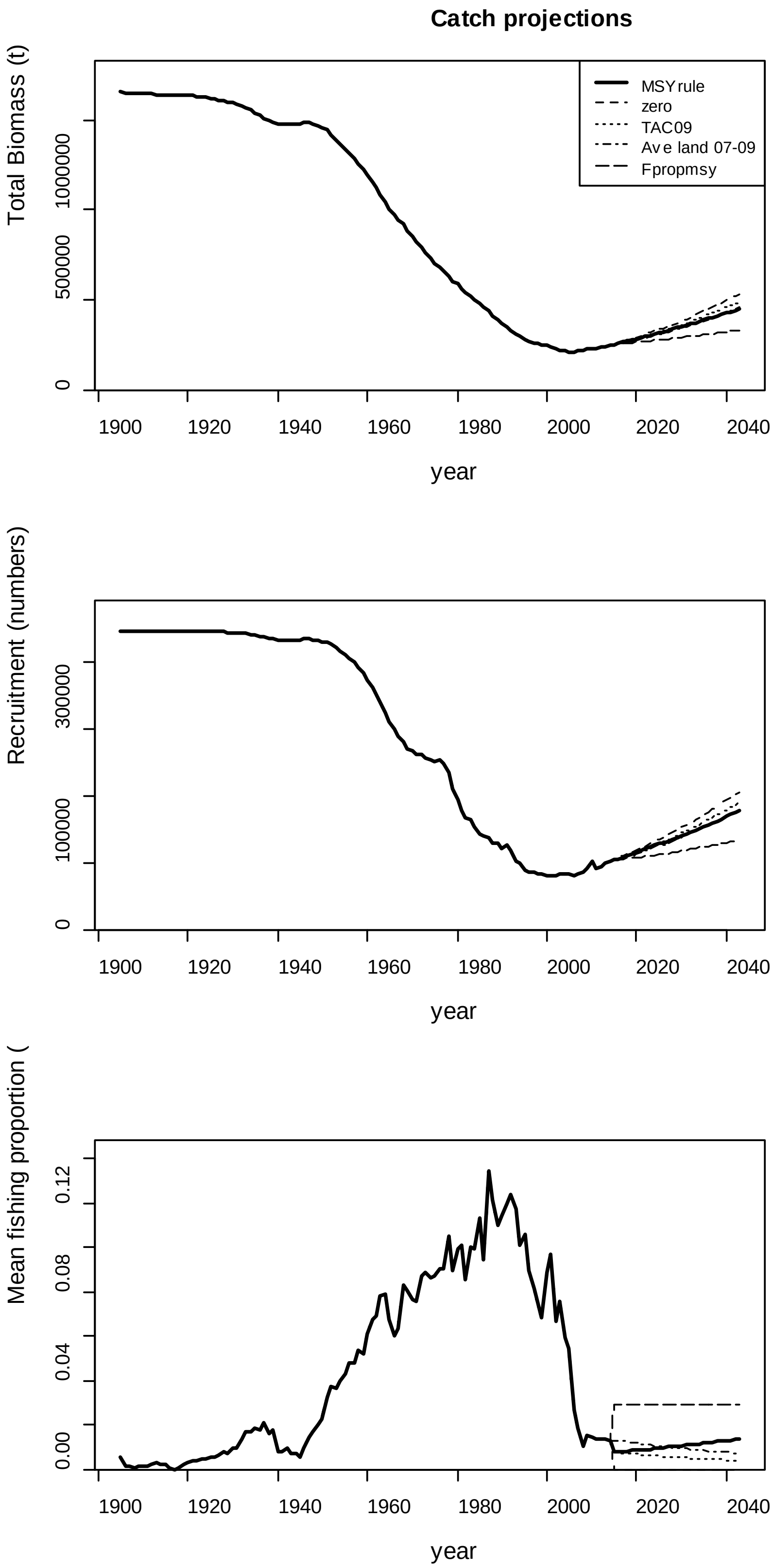


Figure 2.31. Northeast Atlantic spurdog. Northeast Atlantic spurdog. 30-year projections for different levels of future catch, including zero catch for reference.

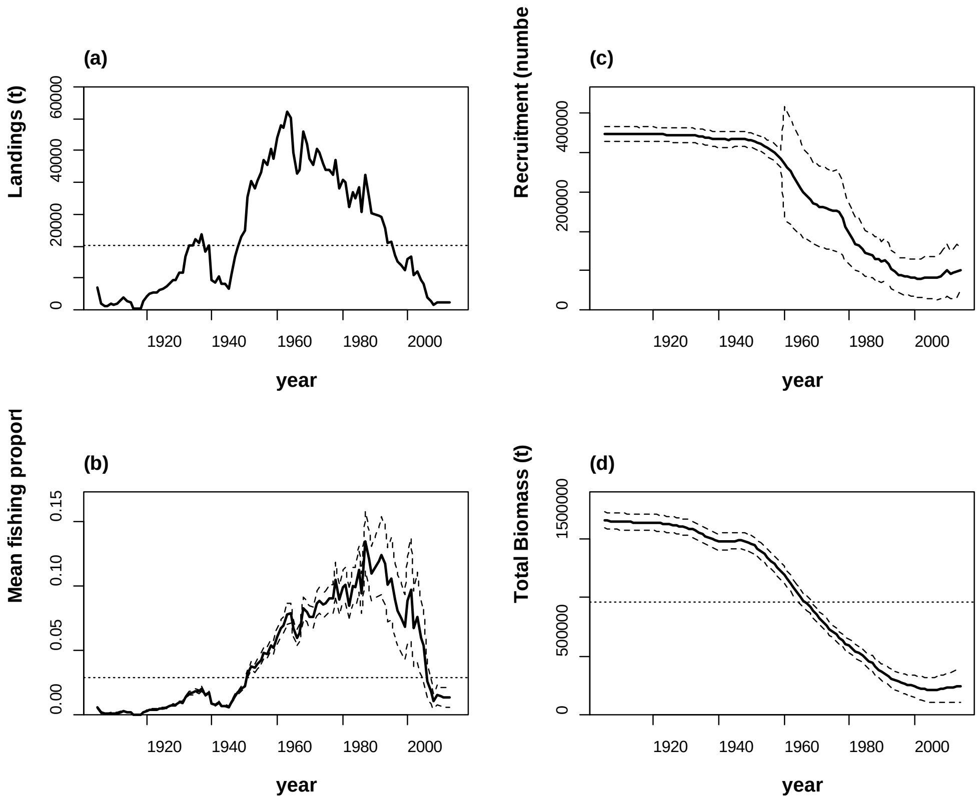


Figure 2.32. Northeast Atlantic spurdog. Summary four-plot for the base-case, showing long-term trends in landings (tons; dotted horizontal line=MSY=20 321 t), recruitment (number of pups), mean fishing proportion (average ages 5–30; dotted horizontal line=$F_{prop,MSY}$=0.029) and total biomass (tons; dotted horizontal line=associated *MSY* level=963 741 t). Hashed lines reflect estimates of precision (±2 standard deviations).

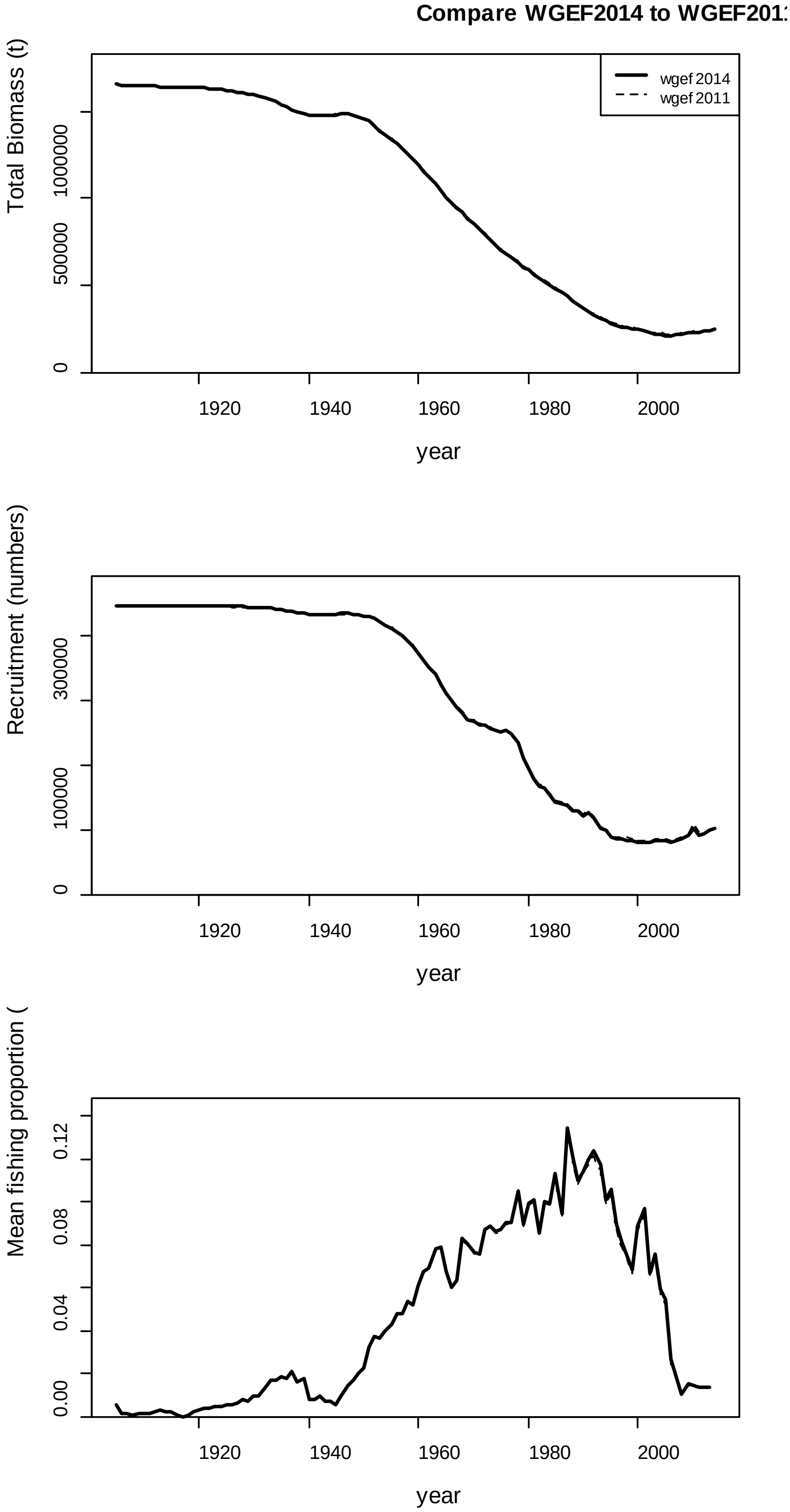


Figure 2.33. Northeast Atlantic spurdog. Comparison with the assessment from WGEF (2011). [Note, there is almost no change.]

3 Deep-water sharks; Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV)

3.1 Stock distribution

A number of species of deep-water sharks are, or 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 some of European fisheries, landings data for the two species were combined for most of the period from the beginning of the fishery. In the past these two species have been assigned to a generic term "siki".

3.1.1 Leafscale gulper shark

Leafscale gulper shark has a wide distribution in the 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 bottoms 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). In the NE Atlantic the distribution pattern formerly assumed for this species considered the existence of a large-scale migration, where females would give birth off the Madeira Archipelago, from which there were reports of pregnant females (Severino *et al.*, 2009). New 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 rarely caught. 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 were distributed at warmer waters compared to the remaining maturity stages, particularly immature females, which were usually found at greater depths and lower temperatures (Moura *et al.*, 2014). Although based on a small sample size, recent tagging studies have observed movements from the Cantabrian Sea to the Porcupine Bank (Rodríguez-Cabello and Sánchez, 2014).

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

3.1.2 Portuguese dogfish

Portuguese dogfish is distributed widely in the NE Atlantic. Stock structure and spatial dynamics are poorly understood. Specimens below 70 cm have been recorded very rarely. The absence of these small fish 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 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). The 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, suggests that this species is able to complete its life cycle within these areas (Moura *et al.*, 2014).

Population structure studies developed so far were inconclusive (Moura *et al.*, 2008 WD; Verissimo *et al.*, 2011). In the absence of more clear 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 these species are described in stock annexes for leafscale gulper shark and Portuguese dogfish.

3.2.2 The fishery in 2013 and 2014

Since 2010, EU TACs for deep-water sharks have been set at zero. Consequently, reported landings of most of the species covered in this chapter in 2014 were very low or zero. As most of these species are taken as bycatch in mixed fisheries, it is likely that discarding has increased. French vessels operating in Faroese waters reported landings of 38 t.

In accordance with EC Regulation 43/2009, "rasco (gillnet)" fishing gear was banned at depths lower than the 600 m isobath. 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. From 2013–2015 a study to characterise the "rasco" métier used by the Basque fleet was carried out. It aimed to assess the impact of this fishery on the bycatch of deep-water species, especially sharks, to manage these fishing activities sustainably. The fishing grounds of this study were located in ICES Division VIIIc at more than 12 nm from the coast according to the regulations that prevent fishing within this limit.

3.2.3 ICES advice applicable

In 2012 ICES advised: *on the basis of the precautionary approach that there should be no catches of Portuguese dogfish and leafscale gulper shark.* This advice is valid for 2013, 2014 and 2015.

3.2.4 Management applicable

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

fishing opportunities	V, VI, VII, VIII, IX	X	XII (includes also *Deania histricosa* 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

(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.

Since 2015, the two species, leafscale gulper shark and Portuguese dogfish, have been included on the EU prohibited species list for Union waters of ICES Division IIa and ICES Subarea IV and in all waters of ICES Subareas I and XIV (Council Regulation (EC) No 2014/0311, Art. 13:1(e)).

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 ICES Divisions VIa, b, VII b, c, j, k and Subarea XII. A maximum bycatch of deep-water shark of 5% is allowed in hake and monkfish gillnet catches.

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 the 1st February 2006.

NEAFC Recommendation 7: 2013 requires Contracting parties to 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 calcea, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

3.3 Catch data

During 2011–2012, the project "*Reduction of deep-sea sharks bycatches in the Portuguese longline black scabbard fishery*" (Ref. MARE C3/IG/re ARES (2011) 1021013) was carried out to study the bycatch of deep-water sharks, mainly leafscale gulper shark and Portuguese dogfish, in the Portuguese longline fisheries targeting black scabbardfish (mainland Portugal, Azores and Madeira) with the following objectives: i) evaluate the species distributions; ii) evaluate the overlap between deep-sea sharks and black scabbardfish; and iii) evaluate the testing modification of the fishing gear. WGEF considers that this study does not provide representative information on the deep-water shark species distribution and on their stocks, as it was restricted to the exploited areas of the deep-water longline fisheries targeting black scabbardfish. Sampling levels were low and did not provide sufficient spatial coverage to allow evaluation of the spatial overlap between deep-sea sharks and black scabbardfish. The trends in estimated biomass indices presented combined quite distinct data sources, logbooks and on-board observations conducted during the project, both sources have great caveats. No relevant technical modifications on the fishing gear were evaluated that could contribute to minimize the deep-sea sharks bycatch levels.

Recent geostatistical studies (Veiga *et al*., 2013; Veiga *et al*., 2015 WD) used fishery-dependent data (vessel monitoring systems, logbooks and official daily landings) to evaluate the spatial distribution and overlap between black scabbardfish and leaf-scale gulper shark and between black scabbardfish and Portuguese dogfish taken by the longline fishery operating off mainland Portugal (ICES Division IXa). Results indicated that in fishing grounds where black scabbardfish is more abundant, the relative occurrence of both deep-water shark species are reduced. These findings have implications for alternative management measures to be adopted in this particular fishery, particularly where it concerns the minimization of deep-water shark bycatch.

3.3.1 Landings

Landings of leafscale gulper shark and Portuguese dogfish have historically been included by many countries in mixed landings categories such as sharks NEI, dogfish NEI, etc. Where possible, WGEF has used the experience of WG participants to assign mixed landings by species. The assumptions that have been made are described in the Stock Annex. For a significant proportion of landings, it was not possible to determine identity to species level and hence the landings presented here are of "siki" sharks are a mixed category comprising mainly *C. squamosus* and *C. coelolepis* but also including unknown quantities of other species.

Figure 3.1 shows landings trends by country and Figure 3.2 shows trends by area. The Working Group estimates of total landings of mixed deep-water sharks, believed to be mainly Portuguese dogfish and leafscale gulper shark but possibly also containing a small component of other species, are presented in Tables 3.1–3.2. From 2010 onwards landings are presented by species.

Landings have declined from around 10 000 t in 2001–2004 to one ton 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.

3.3.2 Discards

Since 2010 the EU TACs in for deep-water sharks has been set at zero, and consequently it is believed that the discarding in mixed deep-water fisheries has increased. New discard data were provided by Portugal (IXa), Spain (VI–VII and VIIIc–IXa), France (VI and VII) and Ireland (VIIc,d,j,k).

Portugal. The on-board sampling programme of Portuguese commercial vessels that operate deep-water longlines to target black scabbardfish (métier LLD_DWS_0_0_0), carried out by IPMA/INRB, started in mid-2005. Sampling effort was fixed at three trips per quarter and sampled trips and vessels were selected in a quasi-random way (Fernandes *et al*., 2001 WD). In 2014 only two trips were sampled. Reasons for lower coverage are mostly related to vessels not having space on board to accommodate observers and/or being unable to guarantee their safety under bad weather conditions, logistic constraints in accessing ports of departure and, after 2009, an increasing need to allocate observers to other fisheries, namely set gillnet/trammelnets that also target demersal stocks.

Table 3.3 presents haul information of sampled trips and sets and the frequency of occurrence (%) of Portuguese dogfish and leafscale gulper sharks in the discards of the sets sampled. It was not possible to raise discards sampled in the longline fishery to fleet level due to suspected bias in sampled trips with respect to vessel size and fishing ground. Specifically, larger vessels and vessels that operate in the northern reaches of the Portuguese coast appear to have been sampled more in recent years than in the early stages of the sampling programme. Summary data of length–frequency and sex-ratio of elasmobranchs discarded by the Portuguese longline fishery targeting black scabbardfish are given (Table 3.4).

Under the same sampling programme a small number of Portuguese dogfish specimens (n = 7) were discarded from bottom otter trawl fishery that targets deep-water rose shrimp and Norway lobster (OTB__>=55_0_0) in 2013 (Prista *et al.*, 2014 WD).

To evaluate the level of shark bycatch and discards, and to increase the knowledge on the fishery, a pilot study on the Portuguese trammelnets fishery targeting anglerfish in ICES Division IXa (200–600 m deep) took place, under the PNAB/DCF from 2012 to 2014. Results collected show that the fishery targeting anglerfish between 200 and 600 m has a low frequency of occurrence of Portuguese dogfish. No leafscale gulper shark specimens were sampled. Higher frequencies are likely to be observed at fishing hauls held deeper than 600 m.

Spain. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES Subareas VI, VII, VIIIc and North IX, was started in 1988; however, it did not have yearly continuity 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 detail of this applied to this area is explained in Santos *et al*. (2010 WD).

Discards of *Centrophorus* spp. are presented in Table 3.5. It is not known whether these are leafscale gulper shark or another species of this genus. It is also unknown whether observers have the necessary identification skills and experience to reliably identify the various deep-water sharks. It should also be noted that observer coverage in this fishery is very low and thus a very large raising factor has been applied. The mix of other species discarded suggest that the majority of the fishery occurs at depths shallower than the usual depth range for *Centrophorus* spp. and hence it is likely that they are only encountered in the small percentage of trips carried out in at the shallower end of the depth distribution. It does not appear that the sampling has been stratified to account for this and this probably explains the high inter-annual variation. The results presented in Table 3.5 can therefore not be considered reliable estimates of the quantities discarded. They are included in this report as indicative that some discarding of this genus does occur and may be of relatively large magnitude.

France. In 2012, 2013 and 2014, ten, twelve and eleven vessels, respectively landed more than 10 t of roundnose grenadier *Coryphanoides rupestris*, black scabbardfish *Aphanopus carbo* and blue ling *Molva dypterygia*. The catch of these 10–12 vessels represented 99% of the total French landings per year of these three species. In the three years (2012–2014), on-board observers boarded seven, ten and eight of these vessels, respectively. The deep-water fishery for these three species is carried out to the west of Scotland, Ireland and in Faroese waters. The majority of the landings are from ICES Divisions VIa, Vb and VIIc, with an additional 2–3% coming from VIIj. In 2014, all on-board observations of this fishery came from ICES Division VIa and VIIb,c. Landings of other deep-water species by French vessels are mostly bycatch in demersal fisheries.

The depth distribution of French on-board observation was assessed by selecting all hauls where a catch of roundnose grenadier, black scabbardfish or blue ling was recorded. Over this eleven year period, the proportion of deep hauls sampled has reduced (Figure 3.3). In 2014, no hauls deeper than 1200 m were sampled, although the on-board observations covered more than 350 hauls. WGDEEP made the same observation based upon logbooks reported by deep-water fishing vessels, which cover a larger number of hauls (logbooks are not used here since they only include data on landed species and not on deep-water elasmobranchs).

French bycatch of Portuguese dogfish and leafscale gulper shark occurs mainly, if not only, in the deep-water fishery to the West of Scotland. The frequency of occurrence of both deep-water shark species in French on-board observations does not show clear trends. Variations, including lower occurrence of Portuguese dogfish in recent years or the higher occurrence in 2009–2014 of leafscale gulper shark may result from the shallower distribution of the fishing grounds (Table 3.6).

French discards were raised using the standard procedure developed in the COST project (Anon., 2009; Jansen *et al.*, 2009). The raising of discards to the total fleet activity is problematic. In addition to difficulties identified from several species, Portuguese dogfish and leafscale gulper shark are not landed so that discards cannot be raised to the discards-to-landings ratio and raising should be done using an effort measure. Raising can be done to the fishing time, number of trips, number of fishing operations and number of fishing days. Raising to these effort variables returned different estimates of discards, ranging from 13–200 t of Portuguese dogfish and from 40–700 t of leafscale gulper shark. Further analyses are required to evaluate how sampled discards should be raised to the total fishing activity.

WGEF 2013 applied an exploratory technique for estimating total catch of Portuguese dogfish and leafscale gulper shark (equivalent to discards since the introduction of the 0 TAC in 2010) using cpue from observed sampling raised to fleet level with VMS data. The analysis covered only the period 2003–2007 due to limitations on VMS data availability. It was not possible to further extend this analysis, however it is expected that improved data availability in the future will allow this method to be used to produce estimates of discards from the French fleet in future years.

At present this approach is applied to leafscale gulper shark and Portuguese dogfish combined. Results by species are not yet fully available, although species were reliably identified at least from 2009. Cpue was estimated from observer data and these were aggregated spatially through the use of a "nested grid" following the approach used for VMS point data presented by Gerritsen *et al.* (2013). Effort data derived from VMS were then used to raise the gridded cpue data to estimate total catch. The resulting estimates are given in Table 3.7 together with reported landings in those years. A full description of the method used can be found in an earlier report (ICES, 2013).

3.3.3 Quality of the catch data

Historically, very few countries have provided landing 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.

Furthermore it is believed that immediately prior to the introduction of quotas for deep-water species in 2001, some vessels may have logged 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 logged monkfish as sharks.

In the past misreporting was considered a minor problem but this is likely to have changed as a reaction to the EU restrictive measures adopted for deep-water sharks. Data provided as a result of the DCF landing sampling programme at Sesimbra landing port in 2009 and 2010 revealed the existence of misidentification problems (Lagarto *et al.*, 2012 WD). Data collected in 2014 indicates that the misidentification problems persist. Sampling data derived from 13 trips on deep-water longliners (a small proportion of the total number of trips) indicate that nearly 50% of the sampled specimens landed as *Galeorhinus galeus* corresponded to leafscale gulper shark and Portuguese dogfish. Despite the limited data available interquartile ranges of estimated proportion (in weight) of leafscale gulper shark and Portuguese dogfish were 0.01–0.51 and 0.15–0.46, respectively. The wide range obtained is probable associated to differences on catch values between fishing grounds which are, in turn, associated to differences on the spatial distribution pattern of both deep-water sharks (Veiga *et al.*, 2013, 2015 WD).

IUU fishing is thought to take place, especially in international waters.

3.3.4 Discard survival

No information available for commercial fishing operations. Scientific studies have recently tagged leafscale gulper sharks caught by longline at depths of 900–1100 m, indicating that they are capable of surviving capture by that gear (Rodríguez-Cabello and Sánchez, 2014). However, in this study soaking times were restricted to 2–3 hours and the lines were hauled back at a slower speed (0.4–0.5 $m.s^{-1}$) than under normal fishing practices.

3.4 Commercial catch composition

3.4.1 Species composition

Between 2006 and 2011, WGEF made a number of attempts to split mixed landings data by species using catch ratios from various historical sources. The benchmarked procedure agreed by WKDEEP 2010 is described in the Stock Annex. This methodology was further explored by a dedicated workshop on splitting of deep-water shark historical catch data in 2011 (ICES, 2011). Initial analysis of new data presented at this meeting indicated that the proportion of leafscale gulper shark to Portuguese dogfish varied considerably on both a temporal and spatial level and that further work would be required to split the data reliably.

In the absence of reliable spatial data at a higher resolution than is currently available to national institutes, no further work has been carried out and no species level landings estimates are presented in 2015.

3.4.2 Length composition

Limited new information is available.

3.4.3 Quality of catch and biological data

Despite the past efforts to improve the quality of data, particularly on species composition, considerable uncertainties persist on historical data.

Since the reduction of EU TACs to zero, it is expected that significant quantities of both these species are discarded by deep-water fisheries. Although some sampling of discarding has been done, the data are not adequate to estimate the quantities caught.

3.5 Commercial catch-effort data

No new data.

3.6 Fishery-independent surveys

Marine Scotland Science has conducted deep-water surveys in Subarea VI at depths ranging from 300–2040 m since 1996. The survey can be considered to be standardised in terms of depth coverage since 1998.

Ireland carried out a deep-water survey each year in Subareas VI and VII, concentrating on NW Ireland–west of Scotland, and the Porcupine area to the west of Ireland. Fishing took place at 500 m, 1000 m, 1500 m and 1800 m. The survey took place in September from 2006–2008 and in December 2009. No further surveys have since taken place.

These and other surveys are part of a planned coordinated survey in the ICES area, through the Planning Group on Northeast Atlantic Continental Slope Surveys (WGNEACS). WGNEACS 2012 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

No new information.

3.8 Exploratory assessments

3.8.1 Analyses of Scottish deep-water survey data

A Generalized Additive Model (GAM) with a negative binomial distribution was used to standardise abundance indices for leafscale gulper shark and Portuguese dogfish caught in the Scottish deep-water survey (2000–2013). The survey covered depths of 300–2040 m and gave representative coverage of the continental slope between approximately 55°N and 59°N (Figures 3.4–3.5). Data collected in 2013 included approximately 20 hauls from Rockall and Rosemary Bank, which has only been surveyed in recent years and therefore, could potentially bias the trend. These stations have been excluded from the present analysis and data are now exclusively derived from hauls on the continental slope. The majority of hauls were made at the following strata: 500, 1000, 1500 and 1800 m. In any one year there were usually around 5–6 hauls for each of these depth strata. Data used in the model were restricted to the "core" depth range for each species, established through visual inspection of the data. Core depth ranges for Portuguese dogfish and leafscale gulper shark were considered to be 700–1900 m and 500–1800 m, respectively. The percentages of hauls within the expected depth range in which both deep-water sharks were caught are presented in Figures 3.6–3.7. Summary information is given in Table 3.8.

The model took the form:

No ~ duration+ depth+ latitude + year

Depth and latitude were considered as smoothed variables, duration as a continuous variable and year as a factor. Summaries of the model fits for both species are presented in Table 3.9 and Figures 3.8–3.9.

The abundance index was standardised to a fixed duration of 60 minutes for both species, and to a depth of 1000 m and latitude 57°N for leafscale gulper shark (1600 m and 56°N for Portuguese dogfish). These reference depths and latitudes were selected to reflect highest catch rates and low standard deviation in the fitted GAMs. Standardised abundance indices are plotted in Figures 3.10–3.11.

3.8.2 Analyses of Portuguese data

To evaluate the spatial overlap between Portuguese dogfish and leafscale gulper shark with the targeted black scabbardfish, IPMA conducted a pilot survey on board of commercial fishing vessels from the Portuguese mainland black scabbard fishery (Veiga, 2015 WD). Ten fishing hauls were sampled, half of them located at the fishing grounds exploited by the black scabbardfish fleet (BSF fishing grounds) and the other half located at deeper areas adjacent to these fishing grounds; each pair carried out by one vessel (five vessels in the total). For each fishing haul, the proportion of each shark species was estimated as the 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. Table 3.10 shows the proportion values obtained for Portuguese dogfish and leafscale gulper shark by fishing trip. Within vessels, the proportions differed between the BSF fishing grounds from those located deeper, with values being higher at the latter. The Wilcoxon rank sum was used to test the equality between paired samples. For the two species, the p-values were significant (p-value = 0.01 and 0.08 for Portuguese dogfish and leafscale gulper shark, respectively) at 0.1 significance level, indicant that the significant differences on the proportion between BSF fishing grounds and deeper fishing grounds.

3.9 Stock assessment

The ICES framework for category 3 stocks was applied (ICES, 2012). The indicator used for each species was GAM standardized cpue derived from the Scottish deep-water survey 2000 to 2013 (see Section 3.8.1 above), and trends were assessed using the ratio between the mean value for the most recent two years (2012 and 2013) and that of the previous five year period (2007 to 2011 excluding 2010 when no survey occurred). For both stocks, current landings are zero and thus application of the category 3 approaches gives advice of zero.

3.10 Quality of the assessments

Abundance indices used in the assessments are derived from the Scottish deep-water survey that takes place in only a small proportion of the stock range. These data are only available for after the development of the fishery. There are no fishery-independent data for areas further south which prevent understanding abundance in these areas.

The absence of landings data as a result of the reduction of EU TACs to zero creates difficulties for assessment the stock status of leafscale gulper shark or Portuguese dogfish. 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 will remain uncertain. Discards are known to occur, but have not been fully quantified, and survival is expected to be very low.

3.11 Reference points

WGEF was not able to propose appropriate reference points for advice under the MSY framework. Methods for establishing MSY reference points and/or proxies for similar data-poor stocks are continuing and WGEF will use this work as a basis to develop reference points for deep-water sharks.

3.12 Conservation considerations

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

3.13 Management considerations

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

On the basis of the precautionary approach, ICES has routinely advised against targeted fisheries on leafscale gulper shark and Portuguese dogfish.

Whilst the zero TAC for deep-water sharks has prevented targeted fisheries for deep-water sharks, these species can still be a bycatch in other deep-water fisheries. The levels of bycatch in these fisheries is uncertain.

There are limited data to evaluate the stocks of these species. The Scottish deep-water survey provides a meaningful time-series of species-specific data, but this survey commenced after the fishery was developed that takes place in only a small proportion of the stock ranges of both leafscale gulper shark and Portuguese dogfish. Fishery-independent data from other areas of the stock range are limited or lacking.

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Table 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) by ICES area. Landings are combined until 2009; from 2010 onwards landings are presented by species (leafscale gulper shark - Portuguese dogfish).

	IV a	Va	Vb	VI	VII	VIII	IX	X	XII	XIV	Unknown Area	
1988	0	0	0	0	0	0	560	0	0	0	0	560
1989	12	0	0	8	0	0	507	0	0	0	0	527
1990	8	0	140	6	0	6	475	0	0	0	0	635
1991	10	0	75	1013	265	70	1075	0	1	0	0	2509
1992	140	1	123	2013	1171	62	1114	0	2	0	0	4626
1993	63	1	97	2781	1232	25	946	0	7	0	0	5152
1994	98	0	198	2872	2087	36	1155	0	9	0	0	6455
1995	78	0	272	2824	1800	45	1354	0	139	0	0	6512
1996	298	0	391	3639	1168	336	1189	0	147	0	0	7168
1997	227	0	328	4135	1637	503	1311	0	32	9	0	8182
1998	81	5	552	4133	1038	605	1220	0	56	15	0	7705
1999	55	0	469	3471	895	531	972	0	91	0	0	6484
2000	1	1	410	3455	892	361	1049	0	890	0	0	7059
2001	3	0	475	4459	2685	634	1130	0	719	0	0	10105
2002	10	0	215	3086	1487	669	1198	0	1416	12	0	8093
2003	16	0	300	3855	3926	746	1180	0	849	4	0	10876
2004	5	0	229	2754	3477	674	1125	0	767	0	0	9031
2005	4	0	239	1102	842	376	1033	1	134	0	1323	5054
2006	4	0	195	638	323	208	1325	0	0	0	34	2727
2007	3	0	590	737	94	23	517	0	1	61	0	2025
2008	1	0	171	621	111	27	463	0	0	0	0	1393
2009	1	0	24	54	4	105	33	0	0	0	0	220
2010	1 - 0	0 – 0	38 - 8	21 - 22	4 - 0	4 - 1	4 - 1	0 - 0	0 - 0	0 - 0	0 - 0	71 - 33
2011	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	1 - 0	1 - 1	0 - 0	0 - 0	0 - 0	0 - 0	2 - 1
2012	0 - 0	0 - 0	51 - 0	0 - 0	0 - 0	0 - 0	1 - 0	0 - 0	0 - 0	0 - 0	0 - 0	52 - 1
2013	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
2014	0 - 0	0 - 0	32 - 5	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	33 - 5

Table 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) in the Northeast Atlantic by country. Landings are combined until 2009; from 2010 onwards landings are presented by species (leafscale gulper shark - Portuguese dogfish).

	France	UK (Scot)	UK (E&W)	Ireland	Iceland	Spain (Basque)	Portugal	Germany	Estonia	Latvia	Lithuania	Poland	Russia	Spain (Galicia)	Faeroe Island	Norway	Total
1988	0	0	0	0	0	0	560	0	0	0	0	0	0	0	0	0	560
1989	0	20	0	0	0	0	507	0	0	0	0	0	0	0	0	0	527
1990	140	14	0	0	0	0	481	0	0	0	0	0	0	0	0	0	635
1991	1288	24	104	0	0	0	1093	0	0	0	0	0	0	0	0	0	2509
1992	3104	165	80	0	1	0	1128	148	0	0	0	0	0	0	0	0	4626
1993	3468	469	174	0	1	0	946	91	0	0	0	0	0	0	3	0	5152
1994	3812	743	387	0	0	0	1155	358	0	0	0	0	0	0	0	0	6455
1995	3186	801	986	33	0	0	1354	92	0	0	0	0	0	0	60	0	6512
1996	3630	576	1036	5	0	286	1189	164	0	0	0	0	0	0	282	0	7168
1997	3095	766	2202	0	0	473	1314	106	0	0	0	0	0	0	226	0	8182
1998	3177	1007	1494	3	5	561	1260	40	0	0	0	0	0	0	158	0	7705
1999	3079	625	1019	2	0	450	1036	214	0	0	0	0	0	0	54	5	6484
2000	3519	623	413	138	0	280	1108	265	0	0	0	0	0	572	23	118	7059
2001	3684	2429	320	454	0	608	1151	431	0	0	14	0	0	615	0	399	10105
2002	2103	1184	335	577	0	621	1198	518	53	0	40	8	0	1381	0	75	8093
2003	1454	1594	4027	493	0	719	1180	640	4	0	28	0	0	737	0	0	10876
2004	1189	1135	3610	764	0	563	1125	0	0	0	0	0	0	626	0	19	9031
2005	866	802	1533	381	0	359	1033	79	0	0	0	0	0	0	0	0	5053
2006	744	184	537	113	0	78	1072	0	0	0	0	0	0	0	0	0	2727
2007	855	86	23	36	0	0	522	0	0	0	1	0	500	0	0	0	2023
2008	802	49	7	8	0	0	463	0	0	0	62	0	0	0	3	0	1393

	France	UK (Scot)	UK (E&W)	Ireland	Iceland	Spain (Basque)	Portugal	Germany	Estonia	Latvia	Lithuania	Poland	Russia	Spain (Galicia)	Faeroe Island	Norway	Total
2009	52	30	0	0	0	84	54	0	0	0	0	0	0	0	0	0	220
2010	63 - 10	1 - 20	0 - 0	0 - 0	0 - 0	0 - 0	7 - 2	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	71 - 33
2011	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	1 - 1	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	2 - 1
2012	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	1 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	51 - 0	0 - 0	52 - 1
2013	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
2014	33 - 5	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	33 - 5

Table 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Frequency of occurrence (%) of Portuguese dogfish and leafscale gulper sharks in the discards of the sets sampled in the Portuguese longline fishery for black scabbardfish (2005–2013).

YEAR	Number of trips sampled	Number of sets	Hours fished	*Centroscymnus coelolepis* (%)	*Centrophorus squamosus* (%)
2005	3	3	115	33	0
2006	6	5	197	20	0
2007	3	3	110	33	0
2008	4	4	157	0	0
2009	6	6	247	17	0
2010	9	9	373	11	11
2011	6	6	169	0	0
2012	9	9	380	0	0
2013	2	2	NA	0	0

Table 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Length (in cm) and sex-ratio of discards of Portuguese dogfish and leafscale gulper shark sampled on board the Portuguese deep-water set longline fishery that targets black scabbardfish (2005–2012).

Taxa	n	Mean	SD	Range	% sexed	sex ratio F:M
C. coelolepis	5	61.4	8.2	52–71	100	4:1
C. squamosus	1	65		65–65	0	-

Table 3.5. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Spanish discard data for *Centrophorus* spp. Numbers of sampled trips and total trips are not yet available for the years 2010 onward.

Year	Celtic Sea (Subareas (VI-VII))			Iberian Waters (Divisions (VIIIc–IXa))		
	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 3.6. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). 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
2014	France	31	365	34	0.09	9	0.04

Table 3.7. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Catch of "siki" sharks per year estimated from on-board observation cpue (average 2004–2012) multiplied by VMS effort in 2003–2007 compared to logbook landings (all French landings) in the same years.

Year	Nested grid estimate	Logbook landings
2003	1492.8	1454
2004	1543.2	1189
2005	1321.4	866
2006	926.0	744
2007	866.8	855

Table 3.8. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Data included in the GAM analysis of Scottish deep-water survey data: numbers of hauls within the specified depth range, numbers of individuals caught and numbers caught per hour.

		C. coelolepis			*C. squamosus*	
Year	N hauls	N fish	Mean NpH	N hauls	N fish	Mean Nph
2000	22	103	2.35	28	70	1.28
2002	20	63	1.71	26	65	1.39
2004	15	27	0.91	22	18	0.44
2005	14	39	1.39	19	46	1.21
2006	20	35	0.95	28	34	0.64
2007	13	35	1.35	19	16	0.43
2008	20	40	1.22	28	11	0.24
2009	28	31	1.32	35	19	0.63
2011	20	30	1.39	25	0	0.00
2012	21	31	1.63	26	4	0.17
2013	21	47	2.25	21	18	0.89

Table 3.9. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Summary of model fit GAM analysis of Portuguese dogfish in Scottish deep-water surveys (2000–2013).

	Leafscale gulper shark				Portuguese dogfish			
	Estimate	Std.Error	T value	Pr(>|t|)	Estimate	Std.Error	T value	Pr(>|t|)
(Intercept)	-0.18513	0.74411	-0.249	0.803724	-0.41495	0.864963	-0.48	0.631974
duration	0.00297	0.005925	0.501	0.616683	0.01194	0.006925	1.724	0.086296
factor(year)2002	-0.09828	0.314159	-0.313	0.754663	-0.32501	0.366705	-0.886	0.376581
factor(year)2004	-1.1757	0.389805	-3.016	0.00282	-1.30199	0.434982	-2.993	0.003128
factor(year)2005	-0.42267	0.36239	-1.166	0.244571	-1.01513	0.445597	-2.278	0.023832
factor(year)2006	-0.51623	0.329347	-1.567	0.118256	-1.35051	0.396976	-3.402	0.000816
factor(year)2007	-0.80809	0.407522	-1.983	0.04845	-0.93407	0.422153	-2.213	0.028114
factor(year)2008	-1.64471	0.448447	-3.668	0.000298	-1.11555	0.415218	-2.687	0.007857
factor(year)2009	-1.33222	0.555516	-2.398	0.017199	-0.74614	0.581794	-1.282	0.201236
factor(year)2011	-17.5612	648.8721	-0.027	0.97843	-0.96198	0.546003	-1.762	0.079704
factor(year)2012	-2.44396	0.722332	-3.383	0.000829	-0.61962	0.594581	-1.042	0.298685
factor(year)2013	-0.89794	0.525898	-1.707	0.088962	-1.06745	0.584921	-1.825	0.06958
Approximate significance of smooth terms:								
	edf	Ref.df	F	p-value	edf	Ref.df	F	p-value
s(depth)	6.122	7.098	15.483	<2e-16	4.692	5.617	29.984	<0.00001
s(latitude)	4.736	5.727	2.936	0.01	7.448	8.388	3.527	0.000653
R-sq.(adj)	0.481				0.707			
Deviance explained	60.0%				65%			
UBRE = 1.0697	1.0899				1.1271			
Scale est. = 1	1				1			
n	277				214			

Table 3.10. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Fishing hauls depth and proportion values of both species from the pilot study conducted onboard of commercial fishing vessels from the Portuguese mainland black scabbard fishery. PCYO, proportion of Portuguese dogfish; PGUQ proportion of leafscale gulper shark.

	BSF fishing grounds (depth, m)	Deeper fishing grounds (depth, m)	BSF fishing ground		Deeper fishing ground	
			P_{CYO}	P_{GUQ}	P_{CYO}	P_{GUQ}
Vessel 1	1170	1463	---	0.026	0.884	0.881
Vessel 2	1357	1461	---	0.148	0.893	0.334
Vessel 3	1180	1376	0.224	0.074	0.720	0.267
Vessel 4	1198	1382	0.122	0.112	0.820	0.734
Vessel 5	1189	1445	0.058	0.110	0.279	0.044

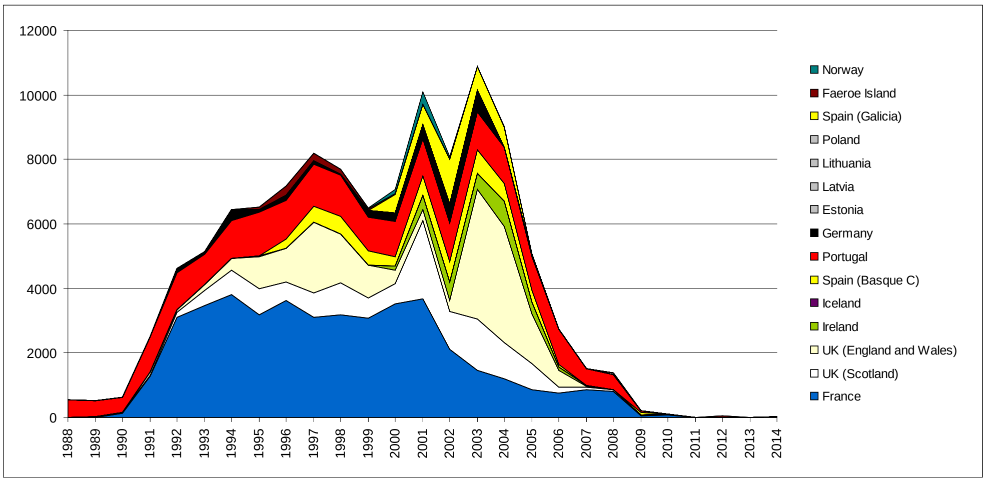

Figure 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by country.

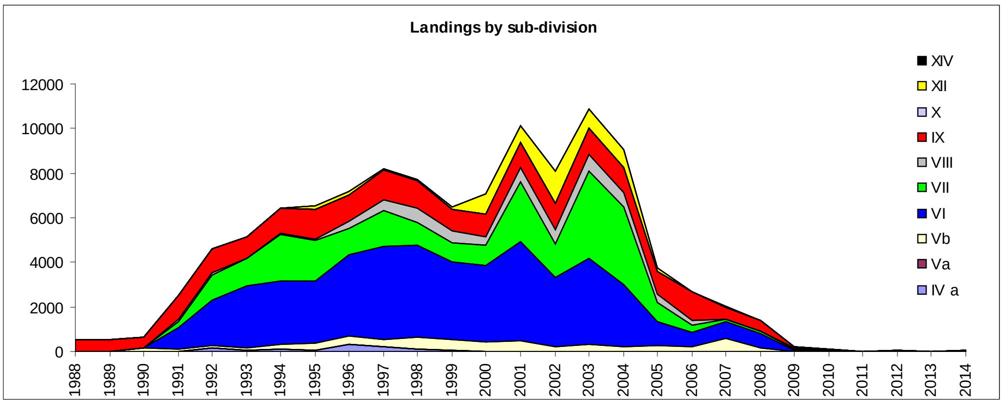

Figure 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by ICES Subarea.

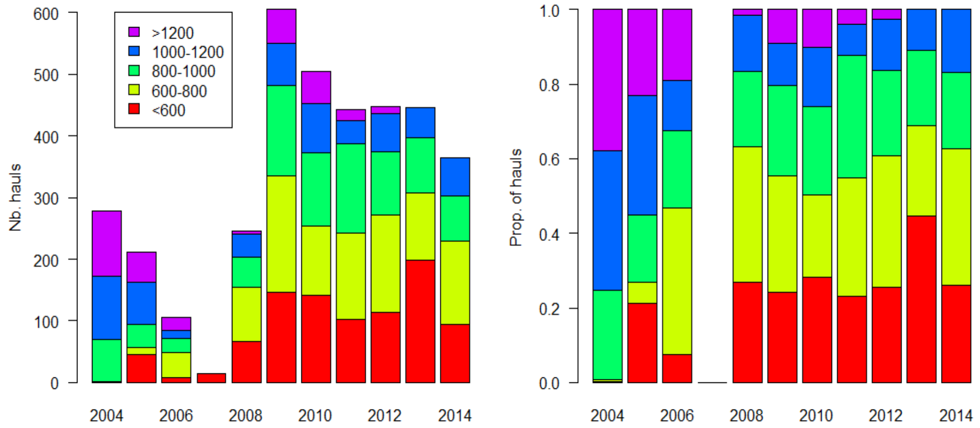

Figure 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Depth distribution of on-board observation of French deep-water fisheries 2004–2014, number of hauls per 200 m depth range (left) and proportions (right), proportions in 2007 where there was no sampling dedicated to deep-water fisheries are not given.

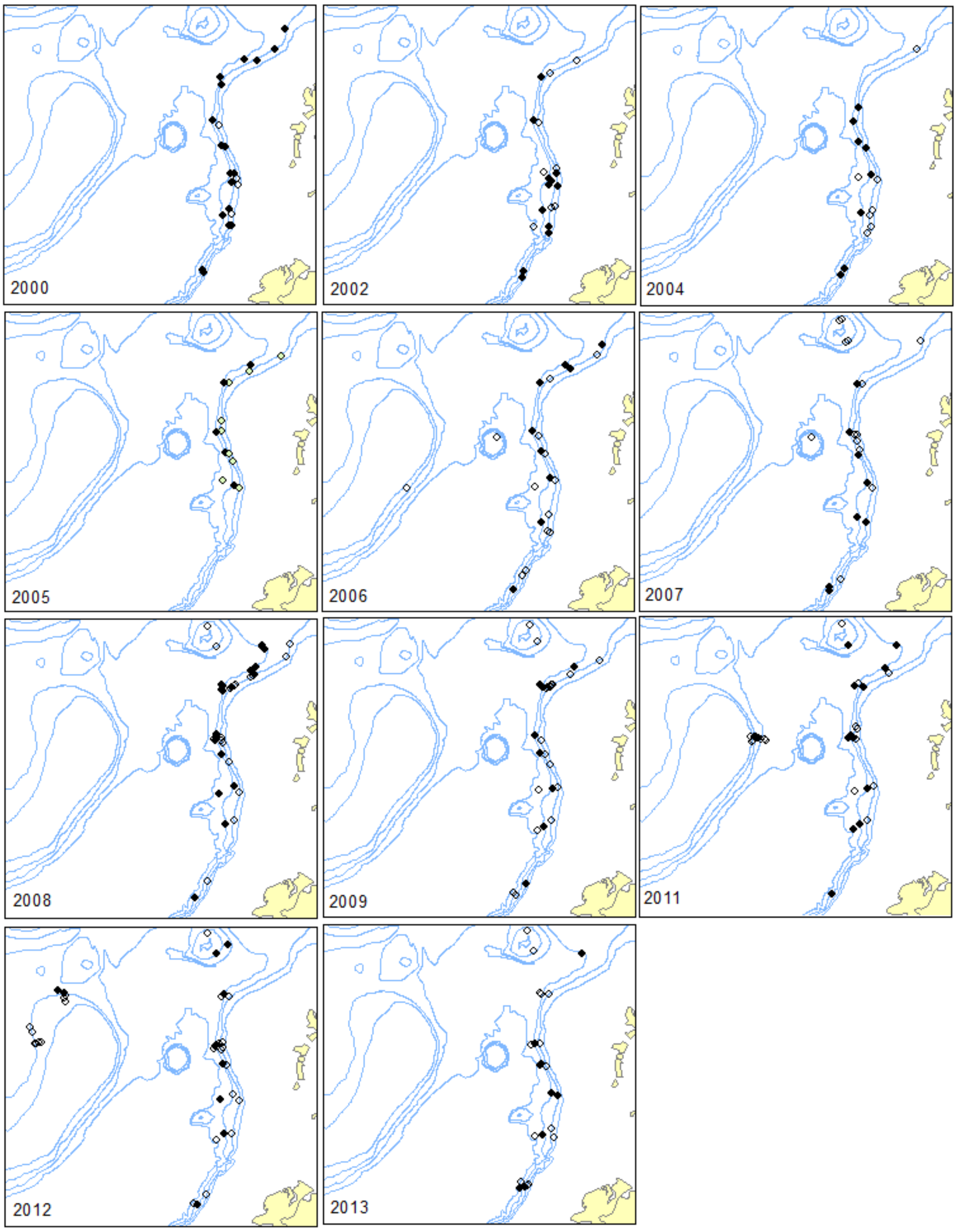

Figure 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Distribution of catches of Portuguese dogfish within the expected depth range (700 to 1900 m) in Scottish deep-water surveys 2000 to 2013. Solid circles indicate catches of one or more individuals, open circles hauls with no catch of this species.

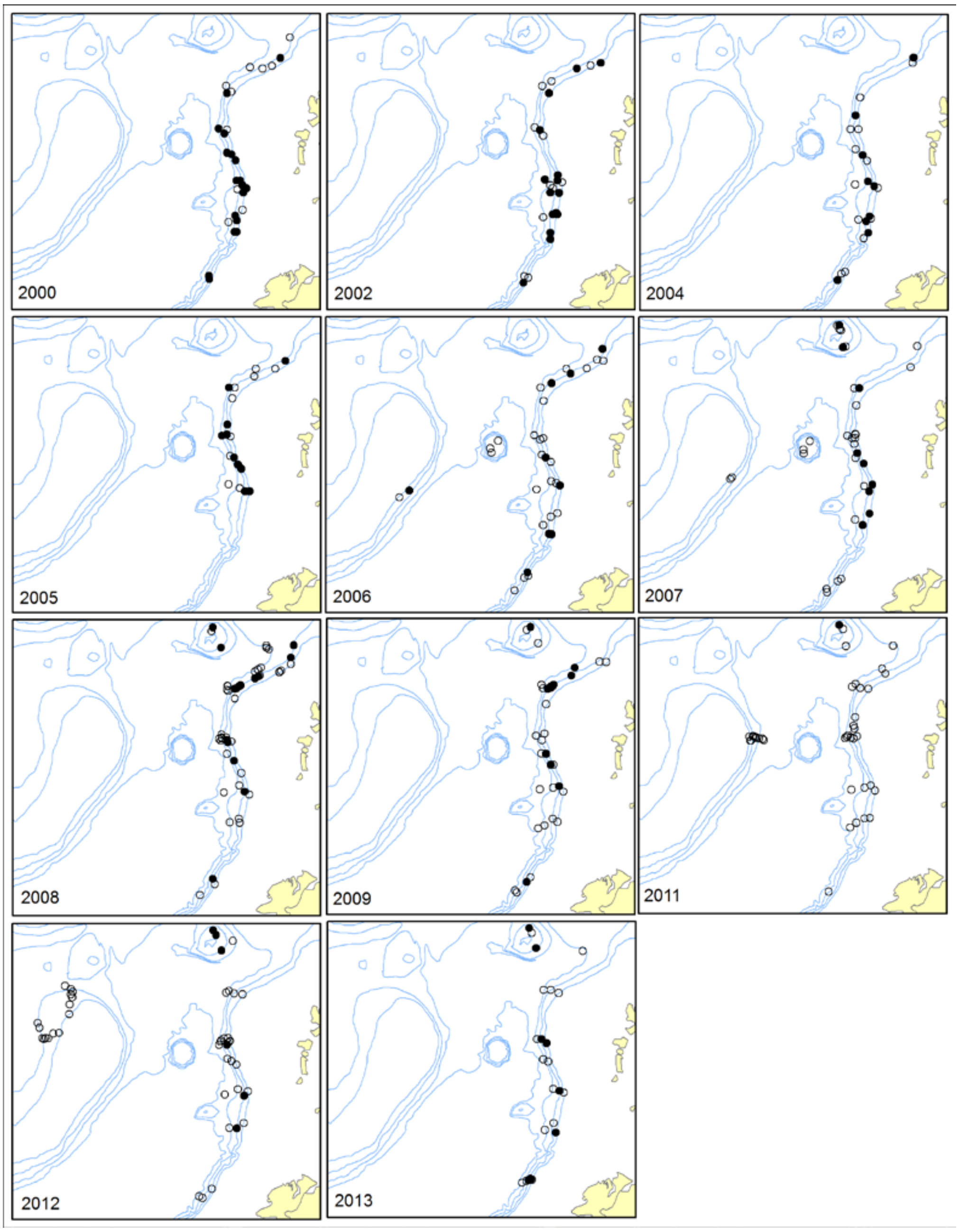

Figure 3.5. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Distribution of catches of leafscale gulper shark within the expected depth range (500 to 1800 m) in Scottish deep-water surveys 2000 to 2013. Solid circles indicate catches of one or more individuals, open circles hauls with no catch of this species.

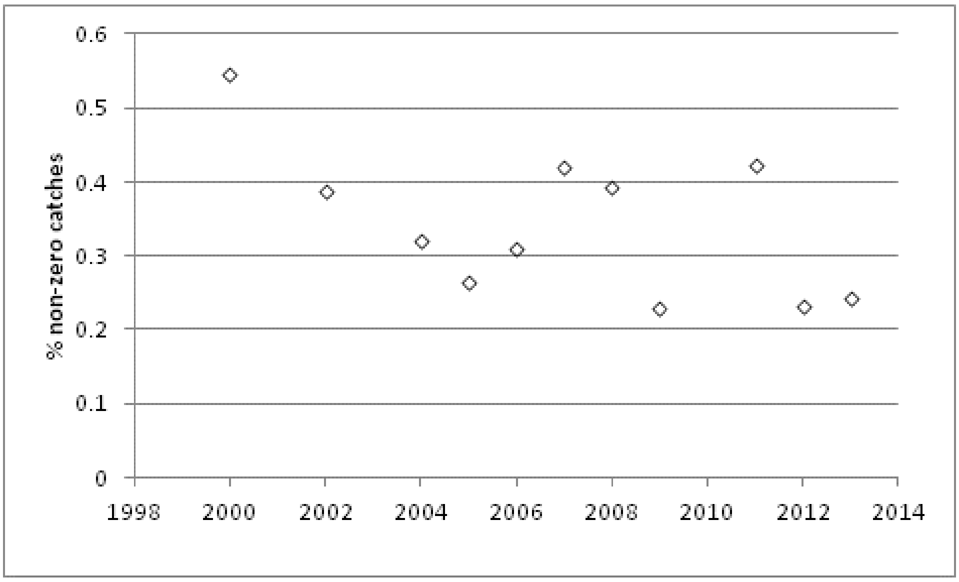

Figure 3.6. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Percentage of hauls within the expected depth range (700 to 1900 m) in which Portuguese dogfish were caught. Scottish deep-water surveys 2000 to 2013 slope stations only.

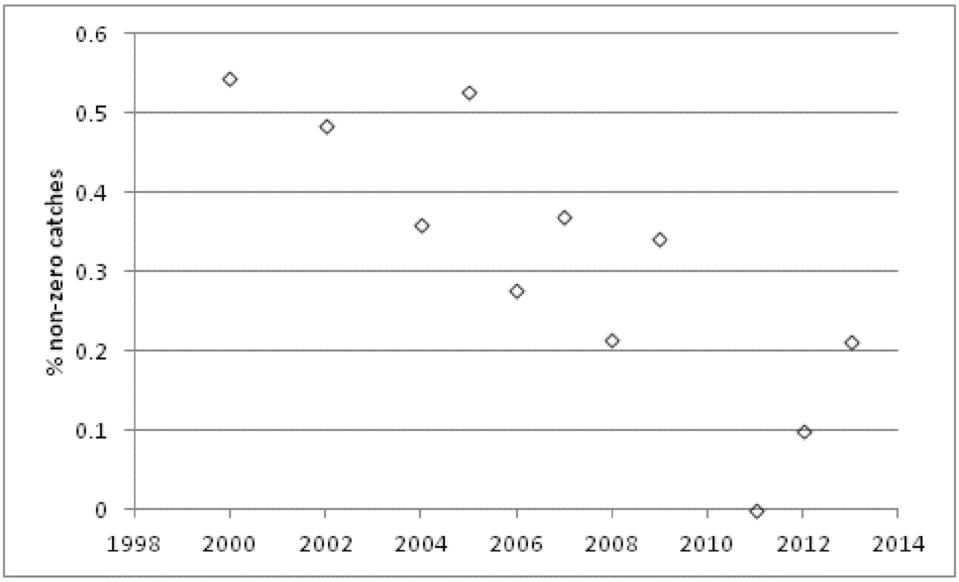

Figure 3.7. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Percentage of hauls within the expected depth range (500–1800 m) in which Leafscale gulper shark were caught. Scottish deep-water surveys 2000 to 2013 slope stations only.

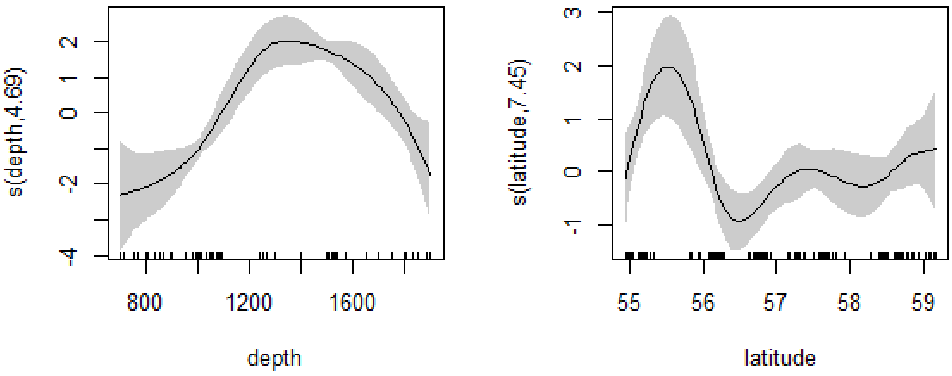

Figure 3.8. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Model fits for smoothed terms in GAM analysis of Portuguese dogfish in Scottish deep-water surveys 2000 to 2013.

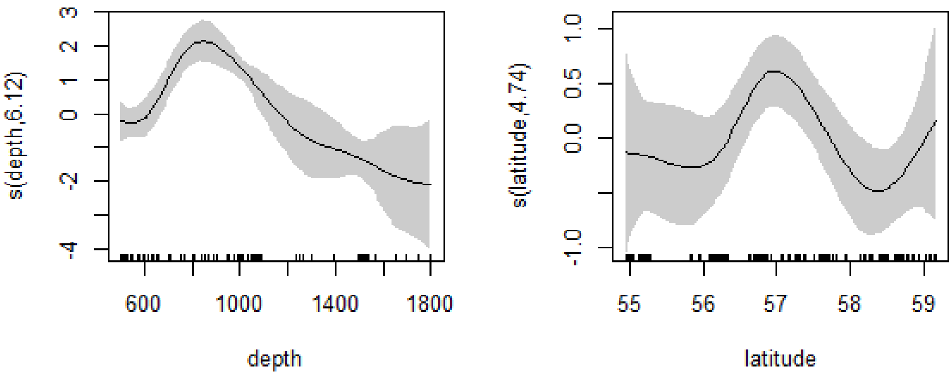

Figure 3.9. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Model fits for smoothed terms in GAM analysis of leafscale gulper shark in Scottish deep-water surveys 2000 to 2013.

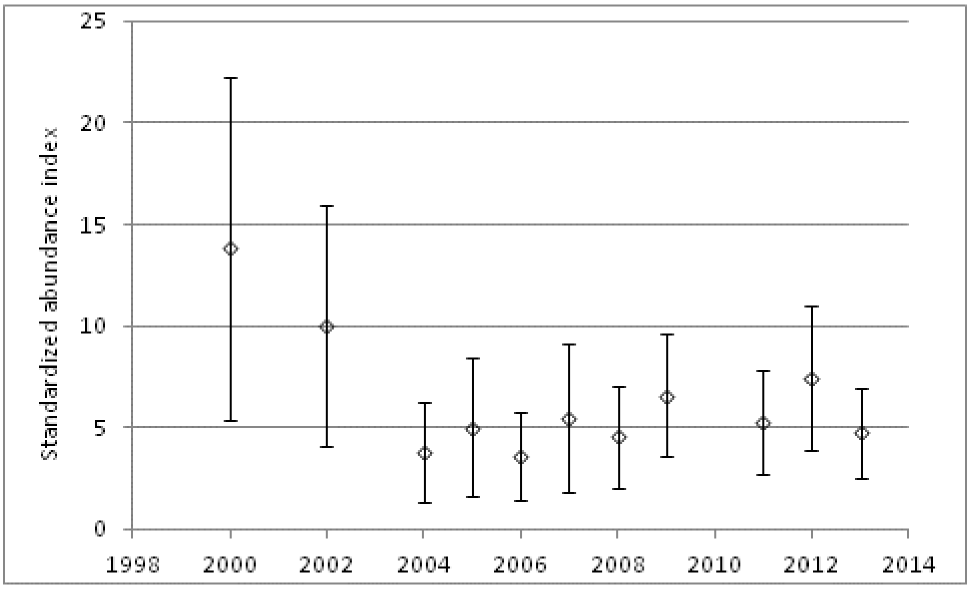

Figure 3.10. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Standardized abundance index for Portuguese dogfish in Scottish deep-water surveys 2000 to 2013.

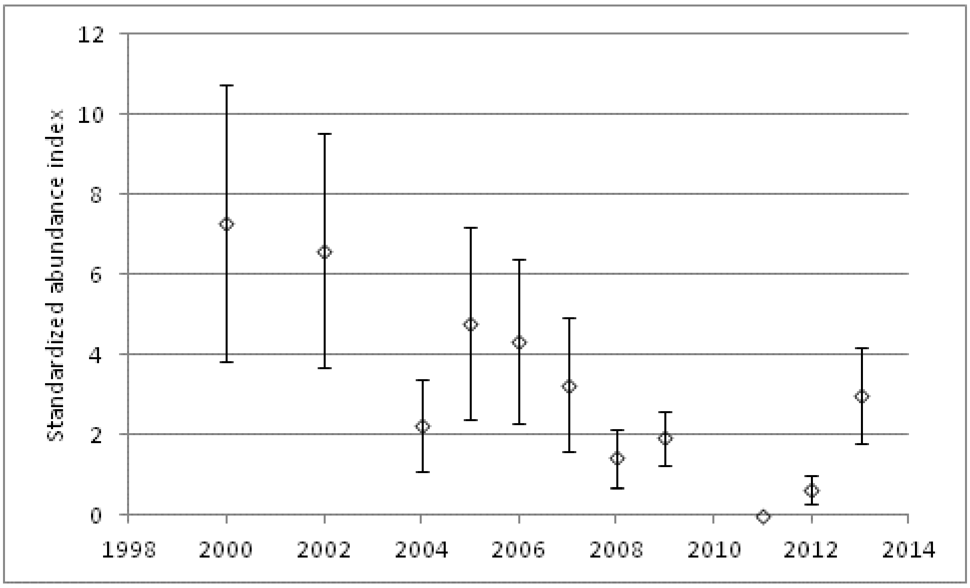

Figure 3.11. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Standardized abundance index for leafscale gulper shark in Scottish deep-water surveys 2000 to 2013.

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

4.1 Stock distribution

Kitefin shark *Dalatias licha* is widely distributed in the deeper waters of the North Atlantic, from Norway to northwestern 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 (ICES Subarea X). Elsewhere in the NE Atlantic, kitefin shark is recorded infrequently. Kitefin shark is caught as bycatch in mixed deep-water fisheries in Subareas V–VII, 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 (ICES Subarea X) is considered as a management unit.

4.2 The fishery

4.2.1 History of the fishery

The Azorean target fishery stopped at the end of the 1990s because it was not profitable. In the North Atlantic it is commonly caught an accessory species in other fisheries. A detailed description of the fisheries can be found in Heessen (2003) and ICES (2003).

Historically, landings from the Azores began in the early 1970s and increased rapidly to over 947 t in 1981 (Figure 4.1). From 1981–1991 landings fluctuated considerably, following market fluctuations, peaking at 937 t in 1984 and 896 t in 1991. Since 1991 the reported landings have declined, possibly as a result of economic problems related to markets. Since 1988, a bycatch has been reported from mainland Portugal with 282 t in 2000 and 119 t in 2003.

4.2.2 The fishery in 2013 and 2014

Kitefin shark from the Azores is now a bycatch from different demersal/deep-water mixed hook and line fisheries, with landings in the period 2004–2009 usually 10 t or less, less than 2 t during 2010 and 2011 and zero during the last three years (Pinho, 2014a, 2015 WD). Landings of kitefin shark in other areas are at low levels (Table 4.1).

4.2.3 ICES advice applicable

For 2013 and 2014, ICES advised on the basis of the precautionary approach that no targeted fisheries should be permitted unless there are reliable estimates of current exploitation rates and sufficient data to assess productivity. There should be no fisheries unless there is evidence that this will be sustainable.

This is similar to the 2006 advice where ICES advised: "*This stock is managed as part of the deep-sea shark fisheries. No targeted fisheries should be permitted unless there are reliable estimates of current exploitation rates and sufficient data to assess* *productivity. It is recommended that exploitation of this species should only be allowed when indicators and reference points for future harvest have been identified and a management strategy, including appropriate monitoring requirements has been decided upon and is implemented*".

4.2.4 Management applicable

In Community waters, deep-water sharks are subject to management and in certain non-Community waters for stocks of deep-sea species (EC no 2270/2004 article 1). Fishing opportunities (TAC) for stocks of deep-sea shark species for Community vessels were presented in an Annex (EC no 2270/2004 and EC no 2015/2006 annex part 2). A list of species was given to be considered in the Group of 'deep-sea sharks'.

The 2007–2008 TAC for V, VI, VII, VIII and IX for these species was 2472 t. In Subarea X the TAC was 20 t and in Subarea XII 99 t. The 2009 TAC for V, VI, VII, VIII and IX was 824 t, for XII 25 t and 10 t for Area X. A zero TAC was set for all areas since 2010 (EC Reg. no 1359/2008, EC Reg no 1262/2012).

In 2009 the Azorean Regional Government introduced new technical measures for the demersal/deep-water fisheries (Portaria n.º 43/2009 de 27 de Maio de 2009) including area restrictions by vessel size and gear, and gear restrictions (hook size and maximum number of hooks on the longline gear). During 2010 the Condor seamount) was closed to demersal/deep-water fisheries.

In Azorean waters there is a network of closed areas (summarized in Section 20).

4.3 Catch data

4.3.1 Landings

The landings reported from each country, for the period 1988–2014 are given in Table 4.1 and the total historical landings 1972–2014 in Figure 4.1.

4.3.2 Discards

No new data were presented this year. Discard rates between 15% and 85% of the kitefin shark caught by set were reported from the sampled Azorean longliners during 2004–2010 (ICES, 2012). During 2011–2014 the discards may have increased due to management restrictions, or landed as unspecified elasmobranchs.

Sporadic and low levels of kitefin shark discards were reported from the Spanish trawl fleets operating in Iberian waters (Divisions VIIIc, IXa) in 2010–2012.

4.3.3 Quality of catch data

Historic landings of deep-water sharks taken in the Azores were usually gutted, finned, beheaded and also skinned. Only the trunks and, in some cases, the livers were landed, and so species misidentification problems were likely to occur with deep-water sharks landings.

The Azorean landing data reported to ICES come exclusively from the commercial first sale of fresh fish on the auctions. Therefore, data in Table 4.1 may be an underestimate of total landings.

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 will not provide relevant information for the assessment.

Relative abundances of kitefin shark (number per hour trawling) from the Scottish deep-water trawl survey (depth range 500–1000 m) was submitted to the group and is presented in Table 4.2. These data confirm that only low numbers (less than ten individuals per year) are normally caught. The total sample (n = 34) comprised eight males (60–110 cm) and 26 females (40–140 cm).

Relative abundance data of kitefin shark (kg per haul) from the Spanish ground fish survey on the Porcupine bank were presented to the group (Ruiz-Pico *et al.*, 2014 WD; Figures 4.2–4.4). A total of 177 individuals were caught over the twelve year survey period.

The Azorean longline survey (ARQDACO(P)-Q1) has on average 495 fishing stations stations per survey covering a depth range 50–1200 m. During the period 1996–2013, a total of 59 kitefin specimens were caught, which represents four individuals per year on average (Pinho, 2014b WD). Over the entire time period, specimens were caught at depths of 300–800 m and their total length ranged from 43–50 cm.

4.7 Life-history information

There is no new information available.

In Azorean waters individuals smaller than 98 cm are scarce, suggesting that spawning and juveniles probably occur in deep-water or in non-exploited areas. Male kitefin shark are more available to the fishery at 100 cm (age 5) and females at 120 cm (age 6).

4.8 Exploratory assessment models

4.8.1 Previous assessments of stock status

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

During the DELASS project (Heessen, 2003) a Bayesian stock assessment approach using three cases of the Pella-Tomlinson biomass dynamic model with two fisheries (handline and bottom gillnets) was performed (ICES, 2003; 2005). The stock was considered depleted based on the probability of the Biomass 2001 being less than B_{MSY}.

4.9 Stock assessment

No new assessment of the species status was undertaken, because no new data were available.

4.10 Quality of assessments

No new assessments were undertaken.

4.11 Reference points

No reference points have been proposed for this stock.

4.12 Conservation considerations

Kitefin shark is listed as 'Near threatened' on the IUCN Red List (Blasdale *et al.*, 2009)

4.13 Management considerations

Preliminary assessment results suggest that the stock may have been depleted to about 50% of virgin biomass. However, further analysis is required to better understand the 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. The working group considers that the development of a fishery should not be permitted unless data on the level of sustainable catches are to be available. If an artisanal, sentinel fishery is established, it should be accompanied by a data collection programme.

The Condor seamount has been closed to fisheries up to 2014, accompanied by a multidisciplinary research (ecological, oceanography and geological) project for the characterization of the dynamics of the stock in the area (Portaria n.º 48/2010 de 14 de Maio de 2010).

4.14 References

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Pinho, M. R. 2014a. Elasmobranchs from the Azorean fisheries (ICES Area X). ICES Working Document WGEF 2014.

Pinho, M. R. 2014b. Resuming elasmobranchs survey data from the Azores (ICES Area X). ICES Working Document WGEF 2014.

Pinho, M. R. 2015. Updating the elasmobranchs data from the Azorean fisheries (ICES AREA X). ICES Working Document WGEF 2015.

Ruiz-Pico, S., Velasco, F., Baldó, F., Rodríguez-Cabello, C., and Fernández-Zapico, O. 2014. Results on main elasmobranch species captured during the 2001–2013 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–26 June 2014, 26 pp.

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.

Table 4.1. Kitefin shark in the Northeast Atlantic. Working Group estimates of landings (t) of kitefin shark *Dalatias licha*.

Country	Subarea	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
France	VII, VIII	.	.	.	.	.	.	.	.	.	.	.
UK Scotland	Vb, VI	.	.	.	.	.	.	.	.	.	.	.
UK (E&W)	VI, VII,VIII	.	.	.	.	.	.	.	.	.	.	.
Germany	VII	.	.	.	.	.	.	.	.	.	.	.
Portugal	VI, IXa	149	57	7	12	11	11	11	7	4	4	6
Portugal (Azores)	X	549	560	602	896	761	591	309	321	216	152	40
Total		698	617	609	908	772	602	320	328	220	156	46

Country	Subarea	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
France	VII, VIII	.	.	.	.		+	+	3	1	.
UK Scotland	Vb, VI	.	.	.	.	+	+	8	0	+	.
UK (E&W)	VI, VII,VIII	.	.	.	.	+	+	+	2	5	.
Ireland	X	.	.	.	.	.	.	0	.	.	.
Germany	VII	.	.	.	.	.	.	21	.	.	.
Portugal	VI, IXa	14	282	176	5	119	2	3	6	3	1
Portugal (Azores)	X	31	31	13	35	25	6	14	10	7	10
Total		45	313	189	40	144	9	47	21	14	11

Country	Subarea	2009	2010	2011	2012	2013	2014
France	VII, VIII	.	0	9	0	0	0
UK Scotland	Vb, VI	.	0	0	.	.	.
UK (E&W)	VI, VII,VIII	.	0	0	.	.	.
Ireland	X	.	0	0	.	.	.
Germany	VII	.	0	0	.	.	.
Portugal	VI, IXa	1	0	0	0	0	.
Portugal (Azores)	X	6	2	1	0	0	.
Total		7	2	11	1	1	0

Table 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin shark (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), ICES Area VI.

Year	N° hauls	N° positive hauls	N° 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

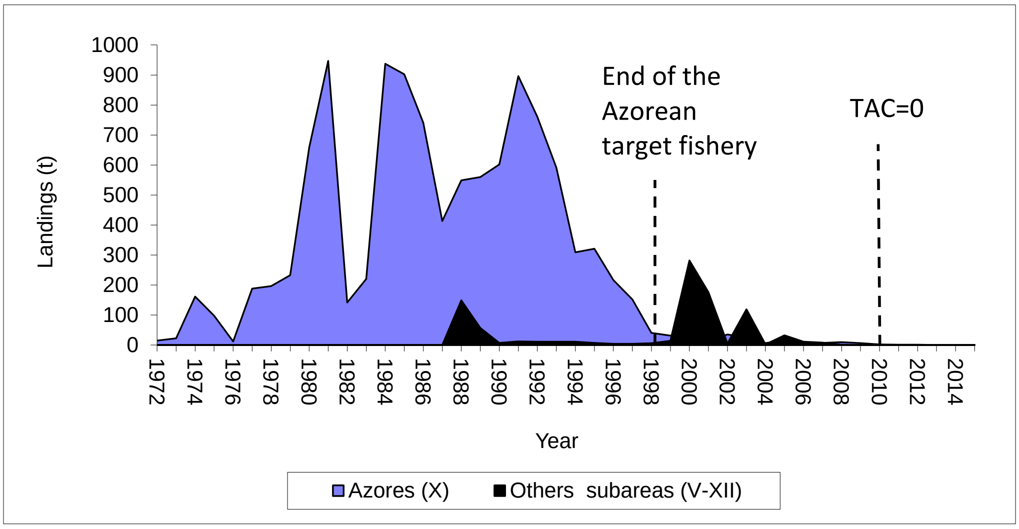

Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin shark by ICES division. Management information is given on the graph.

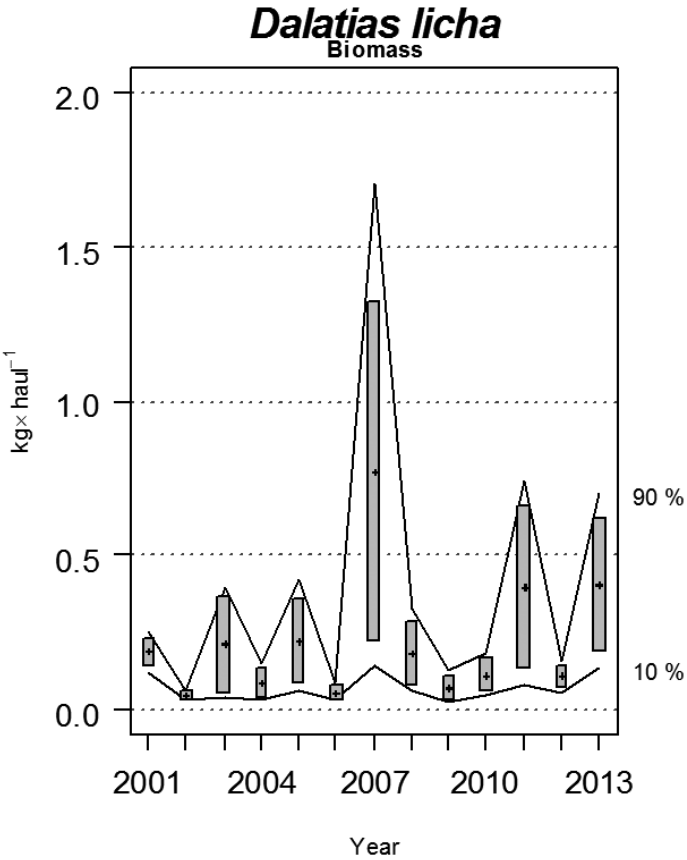

Figure 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin shark, in weight (kg/haul), from the Spanish groundfish survey on the Porcupine bank. Source: Ruiz-Pico *et al.* (2014 WD).

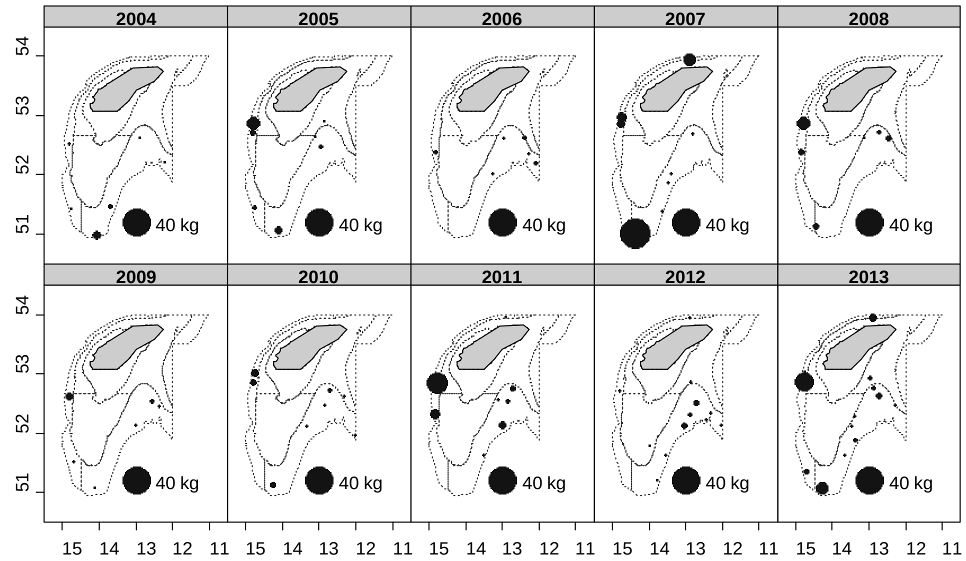

Figure 4.3. Kitefin shark in the Northeast Atlantic. Annual (2004–2013) spatial distribution of kitefin shark (kg/haul) on the Porcupine bank survey. Source: Ruiz-Pico *et al.* (2014 WD).

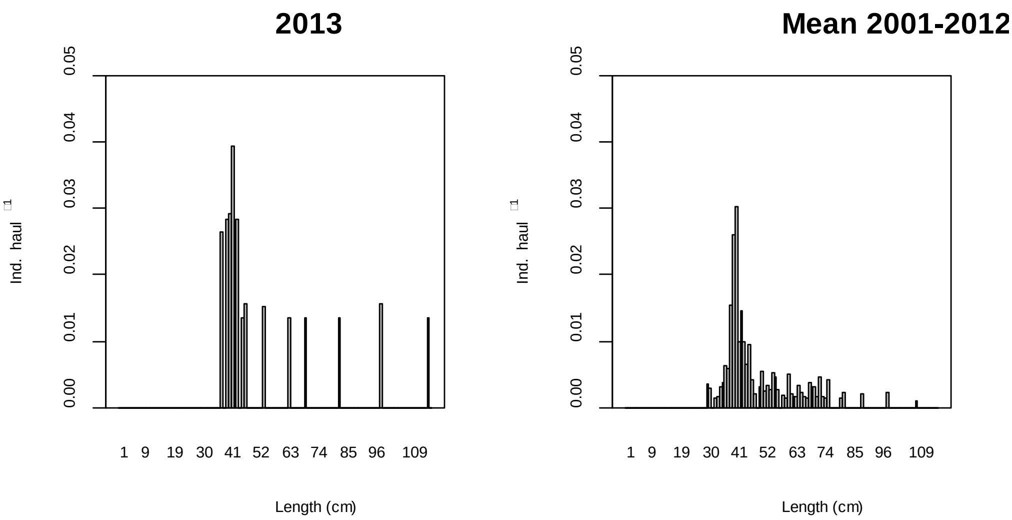

Figure 4.4. Kitefin shark in the Northeast Atlantic. Annual length composition of kitefin shark from the Spanish groundfish survey on the Porcupine Bank. Source: Ruiz-Pico *et al.* (2014 WD).

5 Other deep-water sharks and skates from the Northeast Atlantic (ICES Subareas IV–XIV)

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 landing data are presented are: gulper shark *Centrophorus granulosus*, birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*, velvet belly *Etmopterus spinax*, lantern sharks *nei Etmopterus* spp., and 'aiguillat noir' (which may include *C. fabricii, C. crepidater* and *Etmopterus* spp.).

Fourteen species of skate (Rajidae) are known from deep water in 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 *Dipturus batis*-complex and *Leucoraja fullonica* may also be found in deep water, but their main areas of distribution are in shallower waters and they are not considered in this section. One species of electric ray (*Torpedo nobiliana*) may also occur in the deep water of this area.

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 (114 t in 2012, 177 t in 2013) to produce "ratfish oil". Catches of Chimaeridae are included in the report of the ICES Working Group on Deep-water Fisheries Resources (WGDEEP).

5.2 The fishery

5.2.1 History of the fishery

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

5.2.2 The fishery in 2014

Since 2010, EU TACs for deep-water sharks have been set at zero (see Section 5.2.4 below). Consequently, reported landings of most of the species covered in this chapter in 2014 were very low or zero. As most of these species are taken as bycatch in mixed fisheries, it is likely that discarding has increased.

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

Prior to 2010 in EC waters, a combined TAC was set for a group of deep-water sharks. These include Portuguese dogfish (*Centroscymnus coelolepis*), leafscale gulper shark (*Centrophorus squamosus*), birdbeak dogfish (*Deania calcea*), kitefin shark(*Dalatias licha*), greater lanternshark (*Etmopterus princeps*), velvet belly (*Etmopterus spinax*), black dogfish (*Centroscyllium fabricii*), gulper shark (*Centrophorus granulosus*), blackmouth catshark (*Galeus melastomus*), mouse catshark (*Galeus murinus*), longnose velvet dogfish (*Centroscymnus crepidater*), frilled shark (*Chlamydoselachus anguineus*), bluntnose sixgill shark (*Hexanchus griseus*), sailfin roughshark (*Oxynotus paradoxus*), Greenland shark (*Somniosus microcephalus*), knifetooth dogfish (*Scymnodon ringens*) and Iceland catshark (*Apristurus* spp.). In Subarea XII, rough longnose dogfish (*Deania histricosa*) and arrowhead dogfish (*Deania profundorum*) are also included on the list.

In 2010, TACs in all areas were reduced to zero with an allowance for bycatch of 10% of 2009 TACs. For 2011, the bycatch allowance was reduced to 3% of 2009 TACs and in 2012 no allowance for bycatch was permitted. This remains the *status quo* in 2013 and 2014. In 2014 the list of sharks was updated to include all *Centrophorus* species and remove the blackmouth catshark which was considered a demersal species.

Deep-water skates are included in EU TACs for “Skates and Rays Rajidae”. In EU waters of VIa, VIb, VIIa–c and VIIe–k, Norwegian skate *Dipturus nidarosiensis* is one of a group of species which may not be retained on board and must be promptly released unharmed to the extent practicable.

5.3 Catch data

5.3.1 Landings

The data call for landing data on elasmobranch species issued by ICES in 2015 did not include any of the species considered in this chapter. Consequently, most countries did not provide any data on landings in 2014 and the landings data (Tables 5.1–5.9) for that year for all species must be considered to be incomplete. Landings in 2013 were very low due to the zero TAC in force for deep-water sharks.

Gulper shark *Centrophorus granulosus*

Reported landings of gulper shark are presented in Tables 5.1 and 5.9. Almost all landings have been from the Portuguese longline fishery in Subarea IX. Until 2008, annual landings from this fishery were around 100 t however, in 2009, Portuguese landings reduced to 2 t. Other countries reported very small landings from Subareas VI and VII since 2002. Reported landings of this species by UK vessels in Subareas VI and VII are considered to be misidentified. These data have been included in Working Group estimates of “siki sharks”.

Birdbeak dogfish *Deania calcea*

Reported landings of birdbeak dogfish are presented in Tables 5.2 and 5.9. It is likely that landings reported as this species include other species in the same genus, particularly in Portuguese landings from Subareas X (Pinho, 2010 WD). Misidentification problems were detected in mainland Portuguese landing ports with two different species of *Deania* being observed in catches: *D. calcea* and *D. profundorum*.

Five European countries have reported landings from Subareas VII and IX of bird-beak dogfish: Ireland, UK (England and Wales), UK (Scotland), Spain and Portugal. In 2005, the total reported landings for all subareas reached 194 t; however this declined to 66 t in 2008 and zero by 2009.

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

Longnose velvet dogfish *Centroscymnus crepidater*

Reported landings of longnose velvet dogfish are presented in Tables 5.3 and 5.9. It is likely that some landings of this species are also included in data for "siki sharks" (see Section 3) and in other mixed categories.

European countries that have reported landings from Subareas VI, VII, VIII and IX are: UK (England and Wales), UK (Scotland), France, Spain and Portugal. Highest landings (400 t) were recorded in 2005 and were principally derived from the UK registered deep-water gillnet fleet. Reported landings have since declined to zero, probably as a result of the ban on deep-water gillnet fishing and reduced EU TACs for deep-water sharks.

Black dogfish *Centroscyllium fabricii*

Reported landings of black dogfish are presented in Tables 5.4 and 5.9. Landings of this species may also be included in the grouped category "*Aiguillat noir*" and other mixed categories, including siki sharks.

Four European countries have reported landings, from Subareas IVa, Vb, VII and XII: UK, Iceland, France and Spain.

France reported the majority of the landings of black dogfish in the ICES area, starting to report landings in 1999. French annual landings peaked at about 400 t in 2001 and have since declined. These landings are mainly from Division Vb and Subarea VI. Iceland reported few landings, all from Division Va. The largest annual landings reported by Spain came from Subarea XII in 2000 (85 t) and 2001 (91 t), but recent data are lacking.

Since 2009, only Iceland reported catches of black dogfish, mainly from Subarea V, but always in small amounts (1 t in 2013).

Velvet belly *Etmopterus spinax*

Reported landings of velvet belly are presented in Tables 5.5 and 5.9. Five countries have reported landings of velvet belly, from Subareas II, III, IV, VI, VII, VIII and X: Denmark, Norway, UK (England and Wales), UK (Scotland) and Spain. Greatest landings are from Denmark. Landings began in 1993, peaked in 1998 at 359 t and have since declined. In recent years catches have mostly been reported by Norway, with a maximum of 19 t in 2013.

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

Lantern sharks nei *Etmopterus* spp.

Reported landings of lantern sharks nei are presented in Tables 5.6 and 5.9. Four European countries have reported landings from Subareas IV, Vb, VI, VII and IX: France, UK (Scotland), Spain and Portugal.

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

Reported French landings began in 1994, peaked at nearly 3000 t in 1996 then declined by 1999. There is doubt as to whether these landings are actually of this genus and further investigations are required. French landings of *Etmopterus princeps* have been included in siki sharks.

Spanish landings began in 2000, peaked at over 300 t in 2001. Spanish landings data have not been available since 2003.

Few landings data have been reported since 2003.

"Aiguillat noir"

This is a generic category only used by France to record landings on small, deep-water squaliform sharks mainly of black dogfish *Centroscyllium fabricii* with lesser quantities of longnose velvet dogfish and lantern sharks nei. Reported landings started in 2000 (249 t) then declined from 266 t in 2001 to 1 t in 2007, since when there have been no reported landings. Landings data are presented in Tables 5.7 and 5.9.

Lowfin gulper shark *Centrophorus lusitanicus*

Reported landings of this species in Portuguese area (ICES Subarea IX) in 2009–2014 (Tables 5.8. and 5.9) are believed to refer to misidentified *C. squamosus*, *C. coelolepis, S. ringens*, *D. calcea* and *D. profundorum* (Serra-Pereira *et al*., WD 2011; Lagarto *et al*., 2013 WD).

Norwegian skate *Dipturus nidarosiensis*

The species is occasionally landed in three French ports mostly under the landing name "*D. oxyrinchus*" with the code RJO. The length–frequency distribution of *Dipturus nidarosiensis* observed in the 2012–2014 French landing are presented in Figure 5.1, individuals landed mostly come from the ICES Subarea VIa.

Other skates

Surveys of French fish markets show that *Rajella lintea*, *Rajella kukujevi*, *Rajella fyllae*, *Bathyraja spinicauda* and *Dipturus nidarosiensis* are occasionally landed from ICES Division VIa, but without specific landing names.

5.3.2 Discards

Azores, Portugal. Discards information from the Azorean observer programme was provided in Pinho and Canha (2011 WD) (Table 5.10). This information was not updated in 2014.

Portugal (mainland). Discards data from the Portuguese longline fishery were presented. *Etmopterus* spp. and *C. crepidater* are the species with higher percentages of discards along the time-series (although *C. crepidater* was not sampled in 2013). Other elasmobranchs were rarely discarded (Prista *et al*., 2014 WD). Estimates of percentage discarded by species from deep-water longlines and demersal bottom trawls are given in Table 5.11.

To evaluate the level of bycatch and discards of deep-water sharks in the Portuguese trammelnet fishery a pilot study was undertaken in ICES Division IXa (Moura *et al*., 2015 WD). Results show that the fishery targeting anglerfish and operating at depths ranging from 200–600 m has a low frequency of occurrence of deep-water sharks (Table 5.12). Results further suggest that relatively higher frequencies of occurrence are likely to be observed deeper than 600 m, according to the depth ranges reported for most of these species (Table 5.12).

Spain. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES Subareas VI, VII, VIIIc and IX (North), started in 1988; however, it did not have yearly continuity 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 detail of this applied to this area was explained in Santos *et al*. (2010). An estimate of Spanish deep-water elasmobranch discards from 2003 to 2014 is presented in Table 5.13.

5.3.3 Quality of the catch data

Unknown quantities of deep-water species are landed in grouped categories such as "sharks nei", "Dogfish nei" and "*Raja* rays nei", so catches presented here are probably underestimated. Landings reported by UK vessels for 2003/2004 were considered to be unreliably identified and were therefore amalgamated into a mixed deep-water shark (siki) category together with Portuguese dogfish and leafscale gulper shark. Since 2005/2006, UK landings for most species were considered to be more reliably identified; however, reported landings of gulper shark are still considered to be unreliable and have been added to landings of siki sharks.

As result of restrictive quotas for deep-water shark, landings these species from the Portuguese longline fishery in Division IXa may have been misidentified.

In addition, it is likely that the available landing data for some species may be unreliable due to problems with species identification. For example gulper shark *Centrophorus granulosus* may be sometimes confused with morphologically similar species such as *C. lusitanicus* and *C. harrissoni* (Compagno *et al.,* 2005). Also White *et al.* (2013) demonstrated that *C. niaukang* is an ontogenic stage of *C. granulosus*.

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 VI

The Scottish deep-water trawl survey has operated from 1996 to 2014 at depths of 300–2000 m along the continental slope between approximately 55˚N and 59˚N (see Neat *et al.*, 2010 for details). Neat *et al.* (2015) analysed catches of deep-water elasmobranch species from Scottish deep-water trawl survey.

5.6.2 ICES Subarea VII

The Spanish survey on the Porcupine Bank (SpPGFS-WIBTS-Q4) in ICES Subarea VII (VIIc and VIIk) 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). The sampling design is a random stratified (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 Ruiz-Pico *et al*. (2014 WD) and Fernández-Zapico *et al.* (2015 WD).

The most abundant deep-water shark species in biomass in these surveys were *Deania calcea* (birdbeak dogfish), *Deania profundorum* (arrowhead dogfish), *Scymnodon ringens* (Knifetooth dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Dalatias licha* (Kitefin shark), and *Hexanchus griseus* (bluntnose sixgill shark).

5.6.3 ICES Divisions VIIIc and IXa

The Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters covers this area annually since 1983 (except in 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranchs. More details on the survey design, methodology and results can be found in Ruiz-Pico *et al*. (2015 WD). In 2014, elasmobranchs made up ca. 7% of the total fish catch. The majority of the species showed a decrease in biomass with regard to 2013, when highest values of the time-series were reached and a new vessel (R/V Miguel Oliver) was used. The results of this last survey, also on board of R/V Miguel Oliver, seem to return to the values previous to 2013 (Ruiz-Pico *et al.,* 2015 WD).

In the Portuguese survey (PtGFS-WIBTS-Q4) taking place in the southern occidental and southern coast the deep-water shark with higher catches is *D. profundorum*. This survey is designed for crustacean species and operates to depths of 700 m.

5.6.4 ICES Subarea X

Data from the Azorean bottom longline survey (ARQDACO(P)-Q1) in ICES Division Xa2 was presented (Pinho, 2014 WD). *Deania* spp. were the most representative (abundant) species in the survey. *C. crepidater* was common but much less abundant. Other species occurred in very low numbers (on average between one and four individuals per year). Depth range and length composition are available. However, it should be remarked that the gear configuration used is not adequate for sampling all the species (Pinho, 2014 WD).

5.7 Life-history information

Several recent studies have provided relevant biological information:

Moore *et al.* (2013) provide length of first maturity of *Centroscymnus crepidater* (57.2 cm total length (TL) for males and 75.4 cm TL for females) and of *Apristurus aphyodes* (49.0 cm TL for males and 56.9 cm TL for females) from the Rockall Trough.

Rodriguez-Cabello *et al*. (2013) showed that the distribution of *Galeus murinus* extended southward, to Cantabrian Sea, and *Neoraja caerulea* and northwards the distribution of *Neoraja iberica.*

Coelho *et al.* (2014) conducted demographic analysis of *E. spinax* using an age-based model. They found that the population should be stable if there is a two year reproductive cycle, but would be declining if there is a three year cycle, highlighting why an accurate knowledge of reproductive periodicity is important.

Moura *et al.* (2014) found that *Deania calcea* was spatially segregated by size, sex and maturity. Pregnant females inhabit shallower and warmer waters; large immature specimens were deeper, and mature males were more broadly distributed than mature females, supporting the possibility of sex-biased dispersal.

5.8 Exploratory assessments analyses of relative abundance indices

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

5.8.1 Spanish Porcupine Bank (SpPGFS-WIBTS-Q4) and Spanish IEO Q4-IBTS survey

Abundance indices for some deep-water elasmobranchs caught in the Spanish survey on the Porcupine Bank (SpPGFS-WIBTS-Q4) and the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters are presented below.

Information for *E. spinax*, *H. griseus*, *S. ringens*, *D. calcea* and *D. profundorum* is presented however the majority of these species are usually found at deeper waters than those covered by the Spanish IEO Q4-IBTS survey (additional hauls) and thus the abundance indices must be treated with caution.

5.8.2 Scottish deep-water trawl survey in Division VIa

Neat *et al*. (2015) analysed catches of deep-water elasmobranch species from the Scottish deep-water trawl survey in Division VIa. Selected results are presented below.

Scientific dual-warp bottom-trawls with rock-hopper ground gear (for details see Neat *et al*., 2010) were carried out at 527 sites along the deep-water slopes, banks and seamounts of the Rockall Trough, to the west of Scotland. Surveys were carried out from 1996 to 2013 at depths of between 300 and 2030 m. In 1996 FRV Scotia IV was in service, but was replaced by FRV Scotia V in 1998. Most of the records in the database derive from Scotia V and in particular from surveys carried out in September that used the Jackson BT-184 deep-water bottom trawl. For species distribution mapping all data were used, but for statistical analyses over time only data from 1998 onwards (Scotia V only) and only data collected with the same trawl net (Jackson BT184) from the continental slope during the month of September were used. For some species of the genus *Apristurus* there has been an ongoing taxonomic debate, for example *A. melanoasper* was only formally described in 2004. Therefore time-series analyses were restricted to two of the more common *Apristurus* species (*A. aphyodes* and *A. microps*) that did not pose identification problems or nomenclature changes during the survey period.

For each species, the relationship between number caught per hour of trawling and depth were visually inspected and a core depth range established that included >99% of individuals. All hauls within this range (including those with zero catch of that species) were used to generate estimates of catch per unit of effort. As a consequence of variable depth ranges of each species, the sample sizes (number of hauls) vary from species to species.

Distribution maps for each species were produced using ARC GIS. To assess areas of relatively high abundance in close proximity to each other, the 'Hot Spot Analysis' tool in ARC GIS was used. This calculates the 'Getis-Ord Gi' statistic for each feature in a dataset. The resultant values indicate where features with either high or low values cluster spatially based on the proximity of neighbouring features. The analysis highlights samples with a high value that are surrounded by other features with high values as well. It is a useful tool for visualising the spatial distribution of high abundance data.

General additive models (Zuur *et al*., 2009) were used to analyse trends over time. This was necessary as the relative abundance of most species showed non-linear relationships with depth and over time. The GAM uses a smoothing function to account for the non-linear relationships. Latitude was also included in the model as a continuous variable as there was often a weak but significant relationship. Negative binomial or Tweedie variance structures were used to account for the variable occurrence of hauls with zero catch. GAMs were applied to eleven species that were regularly encountered from year-to-year. Several species were too infrequently sampled to analyse.

5.8.3 Summary of trends by species

Birdbeak dogfish (*Deania calcea*) and Arrowhead dogfish (*Deania profundorum*)

In the SpPGFS-WIBTS-Q4 survey series, these two species were traditionally registered together, but have been better separated since 2012, as reported in previous documents (Ruiz-Pico *et al*., 2014). The most recent survey indicates that both species showed an increase in both its abundance and biomass, although *D. calcea* remains representing the most percentage of the *Deania* genus in the area (Figure 5.2). Analysing both species together, 2014 shows a peak of catch, with the highest value for the historical series, both in biomass as in number.

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, *D. calcea* and *D. profundorum* were recorded together until 2009. *D. profundorum* was first separately recorded in 2009 (Sanjuan *et al*., 2012), To avoid confounding effects between the two species results previous to 2009 combine the two species and were referred as *Deania* spp. (Figure 5.3). Comparative analysis between *D. calcea* and *D. profundorum* in the last six years showed a decrease in the catches of *D. calcea* in 2014 in VIIIc and an absence in IXaN, whereas *D. profundorum* increased in both divisons.

The abundance of *Deania calcea* in hauls within the core depth range of 400–1500 m on the Scottish slope has fluctuated generally between 0.7 and 2.2 ind.h^{-1} with no evident trend (since 1998; Table 5.14). The catch rate in 2013 was anomalously high at 5 ind.h^{-1}, the highest in the series. Preliminary analyses by Neat *et al.* (2015) showed a significant positive trend ($p = 0.001$) over time (Figure 5.4). The results of this analysis should be considered as preliminary and indicative only of general trends.

Knifetooth dogfish (*Scymnodon ringens*)

In the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) a slight decrease in biomass and abundance of *S. ringens* was found, but the levels of both variables were similar to those from the 2009–2012 period (Figure 5.5). After a slight decrease on biomass and on abundance in 2013 , there was an increase in 2014, recovering the increasing trend observed since 2010 (Fernandez-Zapico *et al*., 2015 WD).

Catches in the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters have fluctuated since 2004 with no evident trend (Figure 5.6). In 2014 the value decreased in relation to the maximum value of the series registered in 2013 (Ruiz-Pico *et al.*, 2015 WD).

Velvet belly lantern shark (*Etmopterus spinax*)

The biomass of *E. spinax* in the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) increased in 2014 reaching values similar to 2010. The increase in abundance was even larger (Figure 5.7) (Fernandez-Zapico *et al.*, 2015 WD).

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, the biomass index shows an increasing trend since 1996 with the strong increase in recent years (2006–2013); the highest value was registered in 2013 (Figure 5.8). In 2014, about 65% of the biomass of this scarce elasmobranch was found in hauls deeper than 500 m (Ruiz-Pico *et al.*, 2015 WD). In Division IXaN, *E. spinax* was less frequent than in 2013, appearing only in two additional hauls around 600 m. In VIIIc Division, the catches of this species in standard hauls have decreased to 0.2 $kg{\cdot}haul^{-1}$ after the highest value of the time-series found in 2013 (0.44 $kg{\cdot}haul^{-1}$).

The relative abundance of *Etmopterus spinax* derived from Scottish deep-water survey at depths from 300 to 1100 m has varied with no overall trend (between 3–10 $ind.h^{-1}$) since 1998 (Table 5.15 and Figure 5.9). Preliminary analyses using GAM with Tweedie distribution suggest no significant trend over time (Neat *et al*., 2015).

Greater lantern shark (*Etmopterus princeps*)

The relative abundance of this species between depths of 800–1800 m from Scottish deep-water survey has been variable (averaging 3 $ind.h^{-1}$), for the past 14 years (Table 5.16; Figure 5.10). Preliminary analyses using GAM with Tweedie distribution suggest no trend over time (Neat *et al*., 2015).

Bluntnose sixgill shark (*Hexanchus griseus*)

Stratified biomass and abundance indices of *H. griseus* in the Spanish Porcupine survey maintained the increasing trend described in recent years registering the highest value in 2014 (Fernandez-Zapico *et al*., 2015 WD). Abundance has been stable along the time-series, with slight decrease in 2014 (Figure 5.11).

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, the catch rate of *H. griseus* decreased in relation to 2013 (highest values of the historical series, Figure 5.12) (Ruiz-Pico *et al*., 2015 WD).

The relative abundance of *H. griseus* between depths of 300–800 m from Scottish deep-water survey averaged <1 $ind.h^{-1}$ over the past 14 years (Table 5.17). There was an anomalously high catch of 15 individuals in 2008.

Black dogfish (*Centroscylium fabricii*)

The relative abundance of *C. fabricii* between depths of 800–1800 m from Scottish deep-water survey has fluctuated with no evident trend (ca. 5 ind.h^{-1}) since 1998 (Table 5.18; Figure 5.13). Variability of the catch rates is high, wityh occasional large catches recorded. Preliminary analyses using GAM with Tweedie distribution suggest no significant trend over time (Neat *et al*., 2015).

Longnose velvet dogfish (*Centroscymnus crepidater*)

The relative abundance of this species between depths of 500–1800 m from Scottish deep-water survey has been variable (averaging 5 ind.h^{-1}, but with occasional very high catches) for the past 14 years (Table 5.19; Figure 5.14). Preliminary analyses using GAM with Tweedie distribution suggest a significant negative trend ($p < 0.001$) over time (Neat *et al*., 2015).

Mouse catshark (*Galeus murinus*)

The relative abundance of this species at depths of 500–1500 m from Scottish deep-water survey was, on average, 1 ind.h^{-1} over the past 14 years (Table 5.20; Figure 5.15).

Pale catshark (*Apristurus aphyodes*)

The relative abundance of this species between depths of 800–2030 m from Scottish deep-water survey was on average 4 ind.h^{-1} for the past 14 years (Table 5.21; Figure 5.16). Preliminary analyses using GAM with Tweedie distribution suggest an increasing trend over time ($p < 0.001$) (Neat *et al*., 2015).

Deep-water skates and rays

Most species of skates and rays in the Scottish deep-water survey occur at a very low frequencies. Total number of specimens caught of each species, blue pygmy skate (*Neoraja caerulea*), Mid-Atlantic skate (*Rajella kukujevi*), round skate (*Rajella fyllae*), deep-water skate (*Rajella bathyphila*), Bigelow's skate (*Rajella bigelowi*), Richardson's skate (*Bathyraja richardsoni*), Jensen's skate (*Amblyraja jenseni*), Krefft's skate (*Malacoraja kreffti*), per year across all depths is presented (Table 5.22).

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 these species.

5.12 Conservation considerations

The recent European Red List of mairne fishes considers *Centrophorus granulosus* to be Critically Endangered, *Centrophorus lusitanicus, Echinorhinus brucus, Deania calcea* and *Dalatias licha* as Endangered; and *Centrophorus uyato* and *Oxynotus centrina* as Vulnerable (Nieto *et al*., 2015).

5.13 Management considerations

No management advice is given in 2013.

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Table 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of gulper shark.

	PORTUGAL	SPAIN	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	203		203
2004	89.4	n.a.	89.4
2005	62.2	n.a.	62.2
2006	104		104
2007	132		132
2008	93		93
2009	13		13
2010	6.4		6.4
2011	3	+	3
2012			0
2013			0
2014*	0.03		0.03

***landings in 2014 are preliminary.**

Table 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of birdbeak dogfish.

	Ireland	Spain	UK (England and Wales)	UK(Scotland)	France	Portugal	Total
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							
2000						13	13
2001				1		37	38
2002		5		+		67	72
2003		n.a.	+	3		72	75
2004		n.a.	+	38		157	195
2005		n.a	47	2		145	194
2006			19			74	94
2007						43	43
2008					5	66	71
2009						22	22
2010						5	5
2011					+	1	1
2012	0.815				+	1	1
2013	0.815				+	0.3	0.3
2014*							

*landings in 2014 are preliminary.

Table 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of longnose velvet dogfish.

	France	UK (Scotland)	UK (England and Wales)	Portugal	Spain	Total
7.5						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999	+	+				+
2000	+	+		1	85	86
2001	+	+		3	68	71
2002	13	+		4	n.a.	17
2003	10	21	+	2	n.a.	33
2004	8	7	+	1	n.a.	16
2005	6	97	113	.	n.a.	216
2006	0	128	281	0	0	409
2007	0	19	0	1		20
2008	5	0	0	0		5
2009				27		27
2010				+		0
2011				0		0
2012				0		0
2013				0		0
2014				0		0

***landings in 2014 are preliminary.**

Table 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of black dogfish.

	France	Iceland	UK (England and Wales)	Spain	Total
1990					
1991					
1992		1			
1993					
1994					
1995		1			
1996		4			
1997					
1998					
1999	+				
2000	382			85	467
2001	395			91	486
2002	47	+		n.a.	47
2003	90	+	+	n.a.	90
2004	49	n.a.	+	n.a.	49
2005			5		5
2006	35				35
2007					
2008	137				137
2009		1			
2010		10			
2011	+	1			
2012	+	3			
2013		1			
2014*					

***landings in 2014 are preliminary.**

Table 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of velvet belly.

	Norway	Denmark	UK (Scotland)	UK (England and Wales)	Spain	Total
1990						
1991						
1992						
1993		27				27
1994		+				+
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						
2005				8		8
2006						
2007			8			8
2008						
2009						
2010						
2011	4			2	1	7
2012	11					11
2013	19			0		19
2014*	46					46

*landings in 2014 are preliminary.

Table 5.6. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of lantern sharks NEI.

	France	Spain	Portugal	UK Scotland	total
1990					
1991					
1992					
1993					
1994	846		+		846
1995	2388		+		2388
1996	2888		+		2888
1997	2150		+		2150
1998	2043				2043
1999	+				+
2000	+	38	+		38
2001	+	338			338
2002	+	99			99
2003	+				+
2004	+		+		+
2005			+		+
2006			+		+
2007					
2008				20	20
2009			0.008		+
2010					
2011	+				
2012	+		+		+
2013	+				+
2014*					

*landings in 2014 are preliminary.

Table 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of "*aiguillat noir*".

	France	total
2000	123	123
2001	165	165
2002	11	11
2003	37	37
2004	21	21
2005	5	5

Table 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of *Centrophorus lusitanicus*.

	Portugal	total
2007	n.a.	
2008	n.a.	
2009	423	423
2010	271	271
2011	584	584
2012	688	688
2013	613	613
2014*	+	+

*landings in 2014 are preliminary.

Table 5.9. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings by species.

SPECIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gulper shark	1056	801	958	886	344	423	242	291	187	95	54	96
Birdbeak dogfish											13	38
Black dogfish											467	486
Longnose velvet dogfish											86	71
Velvet belly				27	+	10	8	32	359	128	25	52
Lantern shark NEI					846	2388	2888	2150	2043	+	38	338
Aiguillat noir											123	165
Angular roughshark												
Lowfin gulper shark												
Knifetooth dogfish												
Arrowhead dogfish												
TOTAL	1127	876	1042	974	1269	2893	3238	2588	2708	303	894	1340

Table 5.9. Continued.

Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gulper shark	167	203	89	62	104	132	93	20	7	3	1	1	+
Birdbeak dogfish	72	75	195	194	94	43	72	22	5	1	2	1	0
Black dogfish	47	90	49	5	35	1	137	1	10	1	3	1	0
Longnose velvet dogfish	17	33	16	216	409	23	2	27	0	0	1	1	+
Velvet belly	85			8		8	0	0	0	23	11	19	46
Lantern shark nei	99					0	20	0	0	0	0	0	0
Aiguillat noir	11	37	21	5		0	0	0	0	0	0	0	0
Angular Roughshark			75	99	52	0	0	54	46	17	0	0	0
Lowfin gulper shark						0	0	311	271	584	689	613	+
Knifetooth dogfish						196	0	83	115	4	5	1	0
Arrowhead dogfish						n.a.	n.a.	n.a.	n.a.	5	1	0	0
TOTAL	641	523	562	684	750	432	404	561	505	675	757	657	46

Table 5.10. Other deep-water sharks and skates from the Northeast Atlantic. Discards of deep-water shark species (numbers) recorded by Azores observers 2005–2010.

Species	Damaged	Non commercial	Undersized	Not identified	Total
Centrophorus granulosus		2			2
Dalatias licha		41	3		44
Deania calceus	6	254	1		261
Etmopterus spinax	8	6302	8	1	6319
Hexanchus griseus		2	1	2	5

Table 5.11. Other deep-water sharks and skates from the Northeast Atlantic. Frequency of occurrence (%) of deep-water sharks in the discards of the hauls sampled on board the Portuguese fisheries by gear type: crustacean bottom otter trawl - OTB_CRU; demersal fish bottom otter trawl - OTB_DEF; deep-water set longline fishery that targets black scabbardfish LLS_DWS (2004–2012). "---" indicates no occurrence; NA, information not available by species.

Fishery	Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OTB_CRU	*Deania calcea*	5	5	3	4	9	2	2	2	4	NA
	Centrophorus granulosus	---	---	---	---	---	---	1	---	1	NA
	Deania profundorum	---	---	---	---	---	---	---	2	---	NA
	Etmopterus spp.	36	24	50	22	17	8	11	23	29	7
OTB_DEF	*Deania calcea*	1	---	---	---	---	---	---	---	---	NA
	Etmopterus spp.	4	3	1	---	---	2	---	---	---	---
LLS_DWS	*Centroscymnus crepidater*	---	---	80	67	25	17	22	17	11	---
	Centroscymnus cryptacanthus	---	---	---	---	25	---	---	---	---	NA
	Deania calcea	---	---	---	---	25	17	11	---	22	NA
	Squalus spp.	---	---	---	---	---	---	---	---	11	NA
	Deep-water sharks nei	---	---	---	---	---	---	22	---	---	NA
	Deania profundorum	---	---	---	---	---	---	---	---	11	NA
	Etmopterus spp.	---	100	100	100	100	100	100	100	100	100
	Scymnodon ringens	---	67	---	67	---	17	---	---	---	NA

Table 5.12. Other deep-water sharks and skates from the Northeast Atlantic. Number and catch weight of anglerfish (*Lophius* spp.) and number of sharks by 100 m depth strata sampled from the pilot study on the trammelnet fishery targeting anglerfish in Portuguese waters (IXa) (2012–2014). *Lophius* spp. combines *Lophius piscatorius* and *Lophius budegassa*. N = number of sampled specimens; W_{est}, estimated weight (based on length–weight relationships). From Moura *et al.* (2015 WD).

		Depth stratum (m)					
	Total	100–200	200–300	300–400	400–500	500–600	>600
Species	**n**	n	n	n	n	n	n
*Centroscymnus crepidater**	**2**		1				1
*Scymnodon ringens**	**3**					1	2
*Chlamydoselachus anguineus**	**8**			2		1	5
*Dalatias licha**	**6**		1			1	4
*Centrophorus granulosus**	**1**			1			
*Deania calcea**	**13**			3		2	9
*Etmopterus spinax**	**4**			4			
Etmopterus pusillus	**3**		1	2			
Squaliformes NI	**1**					1	
Mitsukurina owstoni	**2**				2		
Galeus atlanticus	**1**			1			
Galeus spp.	**50**	3	6	12	12	5	12
Scyliorhinus canicula	**177**	29	107	40	1	0	0
Mustelus spp.	**1**		1				
Isurus oxyrhinchus	**1**	1					
Prionace glauca	**5**	4		1			
Galeorhinus galeus	**3**		3				
Lophius spp. (n)	**3229**	344	2040	716	13	25	91
Lophius spp. (weight, kg)	**11 711.1**	1254.4	6564.7	2416.5	149.9	187.9	1137.8
No hauls	**90**	**16**	**50**	**14**	**2**	**2**	**6**

*** sharks included in the EU deep-water shark list.**

Table 5.13. Other deep-water sharks and skates from the Northeast Atlantic. Spanish discard data of deep-water shark species. In bold weight discarded (tons.) of demersal elasmobranches and below in italics. CV of estimations by fishing ground. For detailed information see (Santos *et al.*, 2010).

Fishing Ground Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Celtic Sea (Subareas VI–VII)												
Dalatias licha	0	90.9	13.9	1.3	0	0	2.9	0.5	47.7	0.4		
	-	99.7	99.7	98.8	-	-	99.3	99.5	99.7	99.6		
Deania calcea	0	9.8	87.3	17.3	22.2	6.1	2.6	3.6	0	6.2		
	-	99.7	76	49.5	99.7	62.1	99.3	99.5	-	72		
Etmopterus spinax	16.2	296.1	117.7	2.8	6.6	653.6	60.1	206.1	167.2	16.9		
	63.5	94.4	59.5	84.7	99.7	92.9	39.1	76.3	80.5	96.8		
Galeus melastomus	90.1	504.4	169.5	12.8	220.7	456.6	984.6	1045.7	737.1	395.1		6.3
	95.1	64.3	57.1	36.6	47.8	73.5	81.3	77	44.6	89.7		
Iberian Waters (Divisions VIIIc–IXa)												
Dalatias licha	0	0	1.3	2.6	0	0	0	3.8	0	0.1	2.0	
	-	-	102.6	100.2	-	-	-	99.7	-	99.7	84.3	
Deania calcea	10.8	51.4	5.5	22.8	1.8	17.9	27.6	157.4	32.4	39.5	164	
	54.9	81.3	61.4	84.5	69.9	96.6	53.9	62.1	43.4	49.9	47.7	
Etmopterus spinax	0.5	332.1	5.6	1.8	1.7	19.5	37.9	28.8	23.3	78.5	14.7	
	90.5	90.8	49.5	68.5	59.4	58.9	75.6	58.6	79.5	72.7	58.1	
Galeus melastomus	588.8	243.5	527.3	553.2	1063.4	225.8	903.7	1271.9	730.7	1433	749	1123
	31.4	54.8	36	60.7	36.7	28.5	62.8	51.1	34.8	40.5	31.8	

Table 5.14. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for Birdbeak dogfish *D. calcea* from Scottish deep-water survey. (N hauls- number of hauls; N fish- number of fishes; Mean NpH – mean number per hour).

Year	N hauls	N fish	Mean NpH	Proportion of positive hauls
1998	19	28	0.7	0.63
2000	31	134	2.2	0.9
2002	27	79	1.6	0.84
2004	24	73	1.7	0.63
2005	18	35	1.0	0.47
2006	28	109	2.1	0.68
2007	18	59	1.7	0.47
2008	25	41	1.0	0.26
2009	31	19	0.7	0.42
2011	21	14	0.6	0.37
2012	21	34	1.8	0.58
2013	23	109	5.0	0.63

Table 5.15. Other deep-water sharks and skates from the Northeast Atlantic Summary data for *E. spinax* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
1998	18	319	8.5	0.39
2000	22	360	8.4	0.36
2002	20	137	3.8	0.55
2004	19	137	4.1	0.32
2005	13	98	3.8	0.31
2006	21	201	5	0.33
2007	12	221	9.4	0.42
2008	17	257	8.7	0.53
2009	24	91	4.6	0.13
2011	13	66	5	0.38
2012	27	176	7.6	0.52
2013	37	367	10.5	0.46

Table 5.16. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for *Etmpterus princeps* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
2000	20	148	3.70	0.63
2002	16	247	8.33	0.81
2004	14	123	4.48	0.54
2005	14	77	2.75	0.58
2006	19	102	3.97	0.56
2007	15	163	5.62	0.69
2008	22	57	1.74	0.55
2009	29	149	5.62	0.48
2011	21	68	2.96	0.61
2012	22	74	3.46	0.36
2013	23	118	5.2	0.52

Table 5.17. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for bluntnose sixgill shark (*Hexanchus griseus*) from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
1998	18	1	0.03	0.06
2000	16	0	0	0
2002	13	3	0.13	0.15
2004	14	0	0	0
2005	7	2	0.14	0.14
2006	11	1	0.05	0.09
2007	6	8	0.68	0.33
2008	8	15	1.09	0.25
2009	8	1	0.14	0.13
2011	8	0	0	0
2012	8	1	0.14	0.13
2013	11	3	0.31	0.18

Table 5.18. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for *Centroscymnus fabricii* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
2000	20	372	9.3	0.75
2002	15	107	3.8	0.53
2004	13	104	4.0	0.46
2005	12	158	6.6	0.58
2006	17	180	5.6	0.53
2007	12	109	4.6	0.5
2008	19	175	5.7	0.58
2009	25	138	6.4	0.56
2011	14	214	14.1	0.64
2012	14	119	9.9	0.64
2013	13	71	5.4	0.62

Table 5.19. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for long nosed velvet dogfish, *Centroscymnus crepidater* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
1998	18	1054	27.2	0.78
2000	28	524	9.6	0.75
2002	23	276	6.6	0.74
2004	20	341	9.3	0.7
2005	17	248	7.3	0.71
2006	25	271	5.8	0.72
2007	15	213	7.1	0.67
2008	18	499	16.2	0.72
2009	25	192	9.1	0.64
2011	17	183	10.1	0.47
2012	16	103	7.3	0.56
2013	21	223	11.0	0.48

Table 5.20. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for mouse catshark (*Galeus murinus*) from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
1998	7	16	0.984615	0.57
2000	15	38	1.271612	0.6
2002	10	56	3.146067	0.6
2004	8	18	1.142857	0.5
2005	8	2	0.125	0.12
2006	10	30	1.578947	0.6
2007	6	33	2.8125	0.83
2008	9	12	0.75	0.56
2009	16	38	3.064516	0.75
2011	7	4	0.541761	0.43
2012	8	12	1.773399	0.75
2013	9	10	1.149425	0.22

Table 5.21. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for pale catshark, *Apristurs aphyodes* from Scottish deep-water survey. .(N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour)

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
2000	20	43	1.08	0.2
2002	16	49	1.55	0.44
2004	14	81	2.89	0.57
2005	14	96	3.43	0.54
2006	19	174	5.03	0.61
2007	15	89	2.94	0.46
2008	22	100	3.16	0.6
2009	29	64	2.22	0.3
2011	21	178	7.80	0.56
2012	26	105	4.32	0.58
2013	18	88	5.0	0.39

Table 5.22. Other deep-water sharks and skates from the Northeast Atlantic. Total number of deep-water skates and rays from Scottish deep-water survey across all depths and all years of time-series: blue pygmy skate (*Neoraja caerulea*), Mid-Atlantic skate (*Rajella kukujevi*), round skate (*Rajella fyllae*), deep-water skate (*Rajella bathyphila*), Bigelow's skate (*Rajella bigelowi*), Richardson's skate (*Bathyraja richardsoni*), Jensen's skate (*Amblyraja jenseni*), Krefft's skate (*Malacoraja kreffti*).

YEAR	N. CAERULEA	R. KUKUKUJEVI	R.FYLLAE	R.BATHYPHILA	R.BIGELOWI	B. RICHARDSONI	A. JENSENI	M. KREFTI
1998	1	0	11	0	0	0	0	0
2000	1	0	6	2	2	0	0	0
2002	4	1	9	4	0	0	1	1
2004	0	1	7	1	0	0	0	0
2005	0	0	2	0	1	0	0	0
2006	0	0	7	2	1	0	0	0
2007	1	0	4	1	1	0	6	2
2008	0	0	6	0	0	0	3	0
2009	0	0	8	0	2	2	1	1
2011	0	4	4	0	1	0	1	0
2012	5	0	6	0	1	2	6	0
2013	0	0	1	0	3	10	6	2
Total	12	6	71	10	12	14	24	6

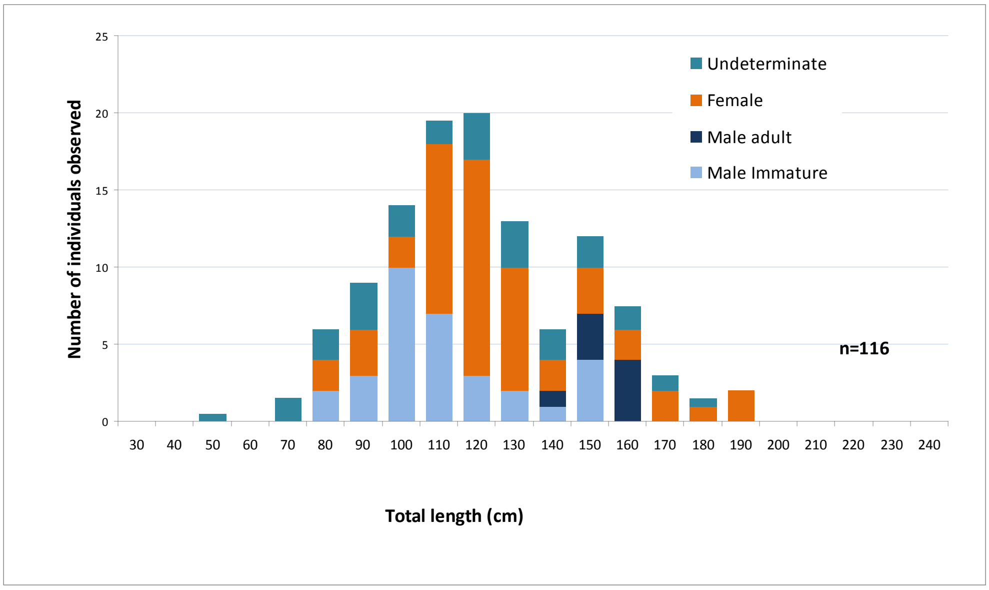

Figure 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Length–frequency distribution of *Dipturus nidarosiensis* observed in the 2012–2014 French landing and coming from ICES Areas VI and VII.

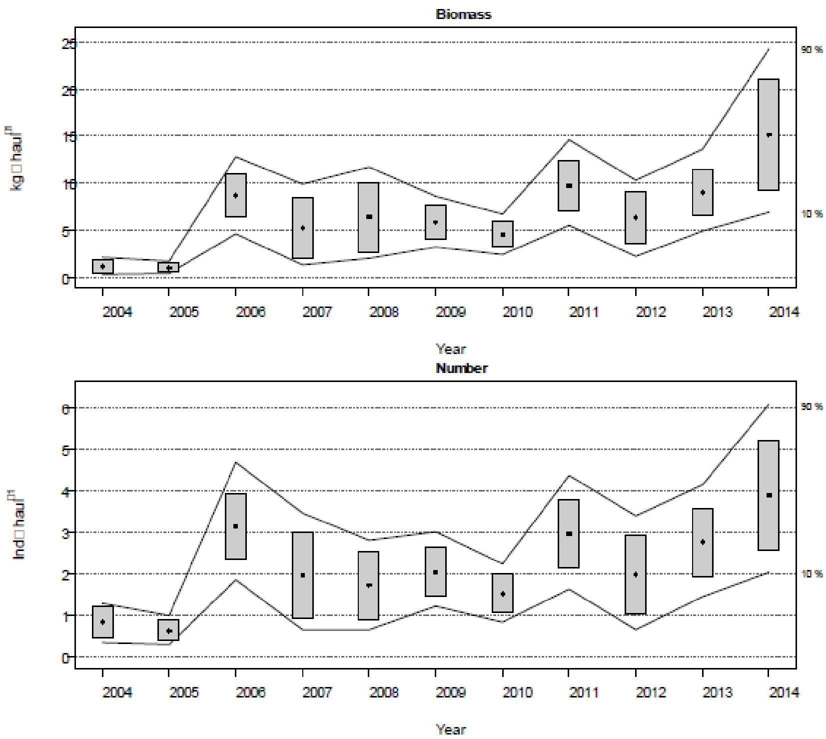

Figure 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Birdbeak dogfish (*Deania calcea*) biomass index (Kg haul⁻¹) from the Spannish Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2014). Boxes show parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2015 WD).

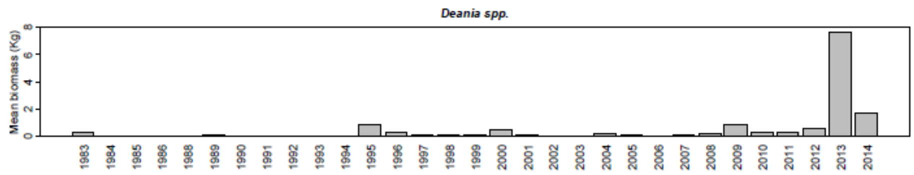

Figure 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Catches by weight of *Deania* spp. In north Spanish shelf bottom trawl surveys (Spanish IEO Q4-IBTS survey) 2004–2014, including all additional hauls out of the standard stratification (>500 m) during the last decade. From Ruiz-Pico *et al.* (2015 WD)

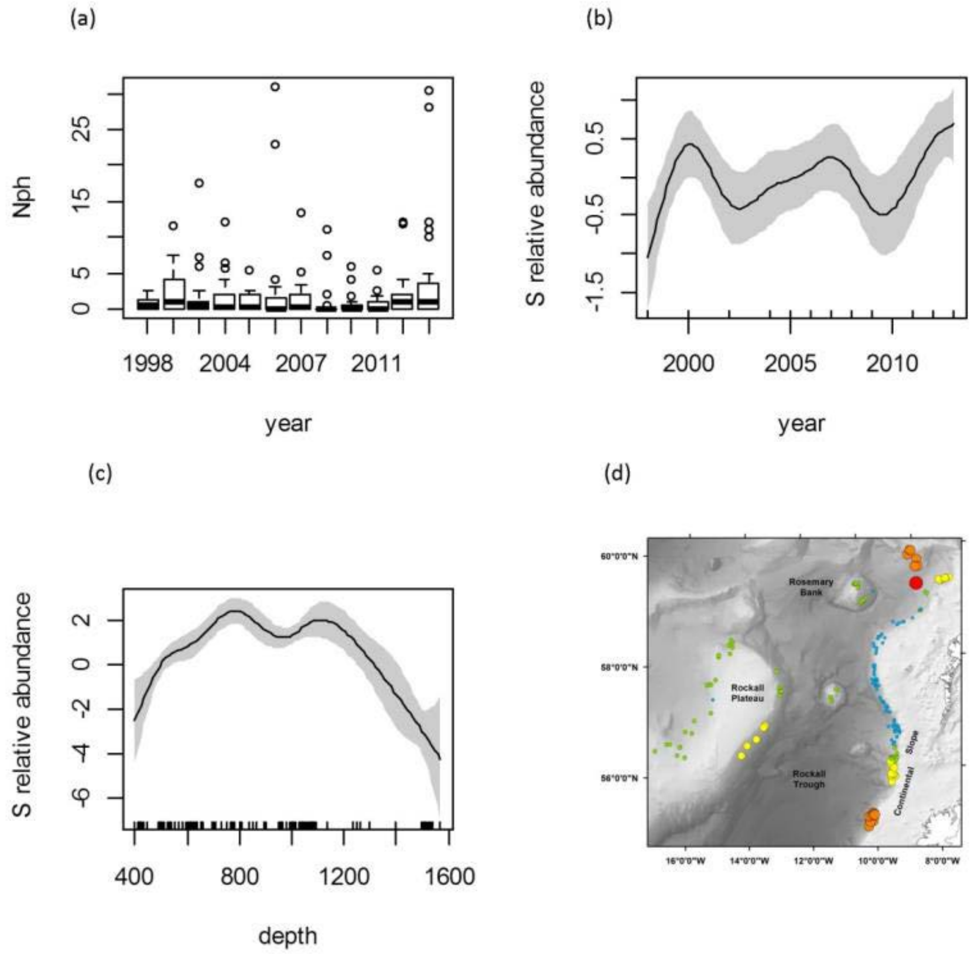

Figure 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of Birdbeak dogfish *Deania calcea* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

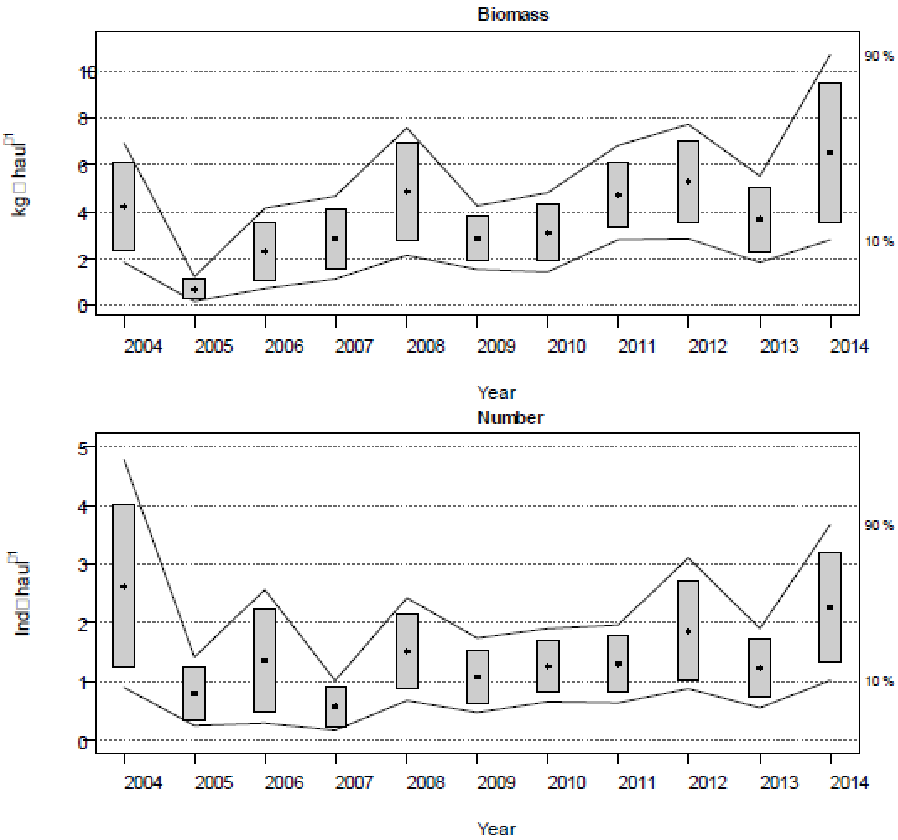

Figure 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Knifetooth dogfish (*Scymnodon ringens*) biomass index (top, kg·haul^{-1}) and abundance index (bottom, numbers. Haul in the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2014). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (2015 WD).

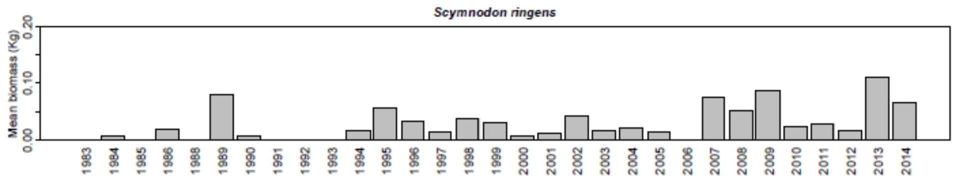

Figure 5.6. Other deep-water sharks and skates from the Northeast Atlantic. Catches by weight of Knifetooth dogfish (*Scymnodon ringens*) in north Spanish shelf bottom trawl surveys (Spanish IEO Q4-IBTS survey) 2004–2014 including all additional hauls out of the standard stratification (>500 m) during the last decade. From Ruiz-Pico *et al.* (2015 WD).

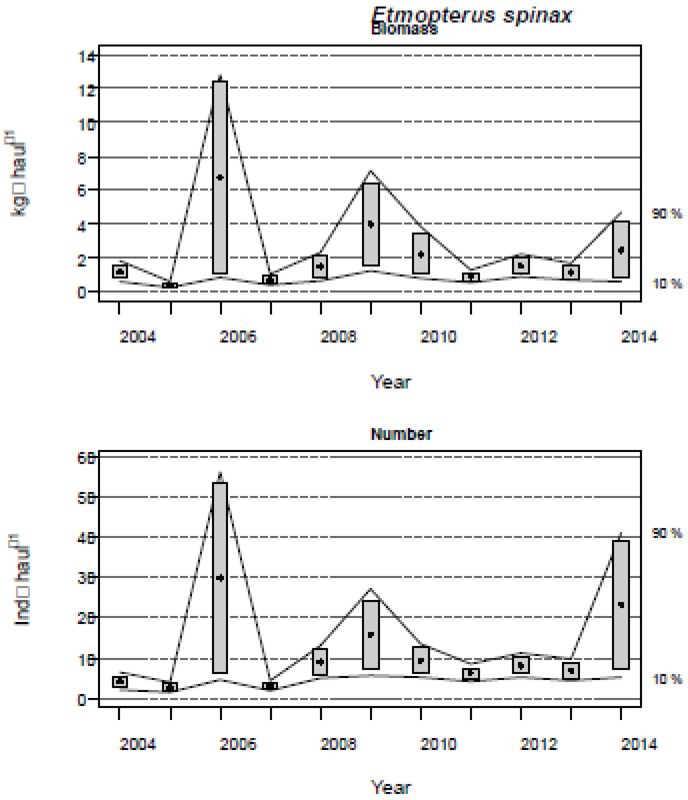

Figure 5.7. Other deep-water sharks and skates from the Northeast Atlantic. ***Etmopterus spinax*** **biomass index (top, kg·haul–1) and abundance index (bottom, numbers. haul–1) during Porcupine survey time-series (2001–2014). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico** ***et al.*** **(2015 WD).**

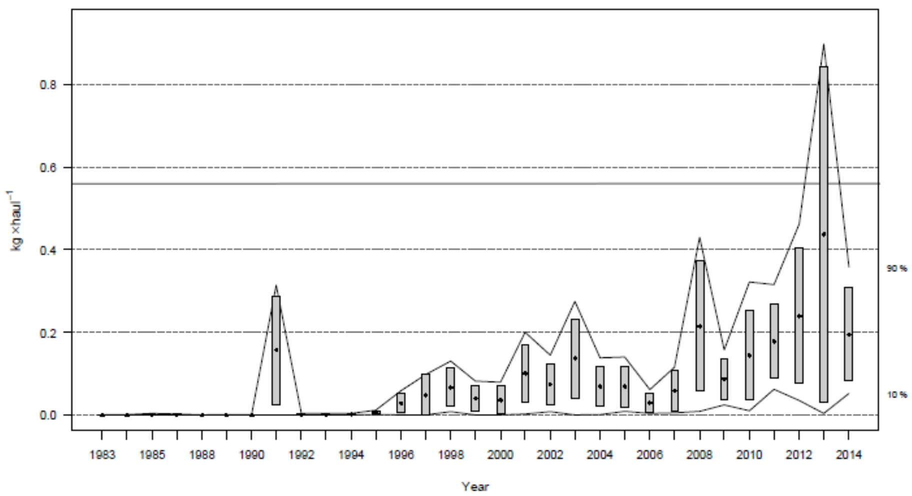

Figure 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Catches by weight of velvet belly shark (*Etmopterus spinax*) in north Spanish shelf bottom trawl surveys (1983–2014) in Division VIIIc covered by the survey. From Ruiz-Pico ***et al.*** **(2015 WD).**

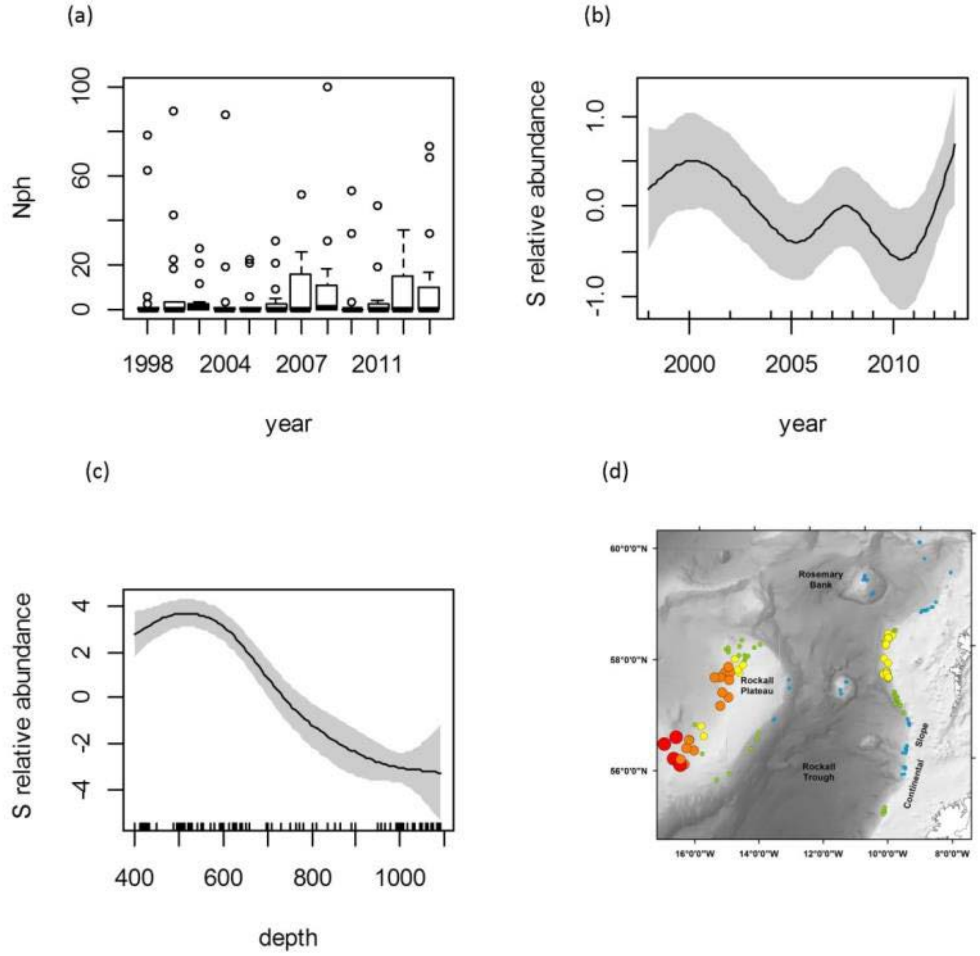

Figure 5.9. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of Velvet belly shark (*Etmopterus spinax*) in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

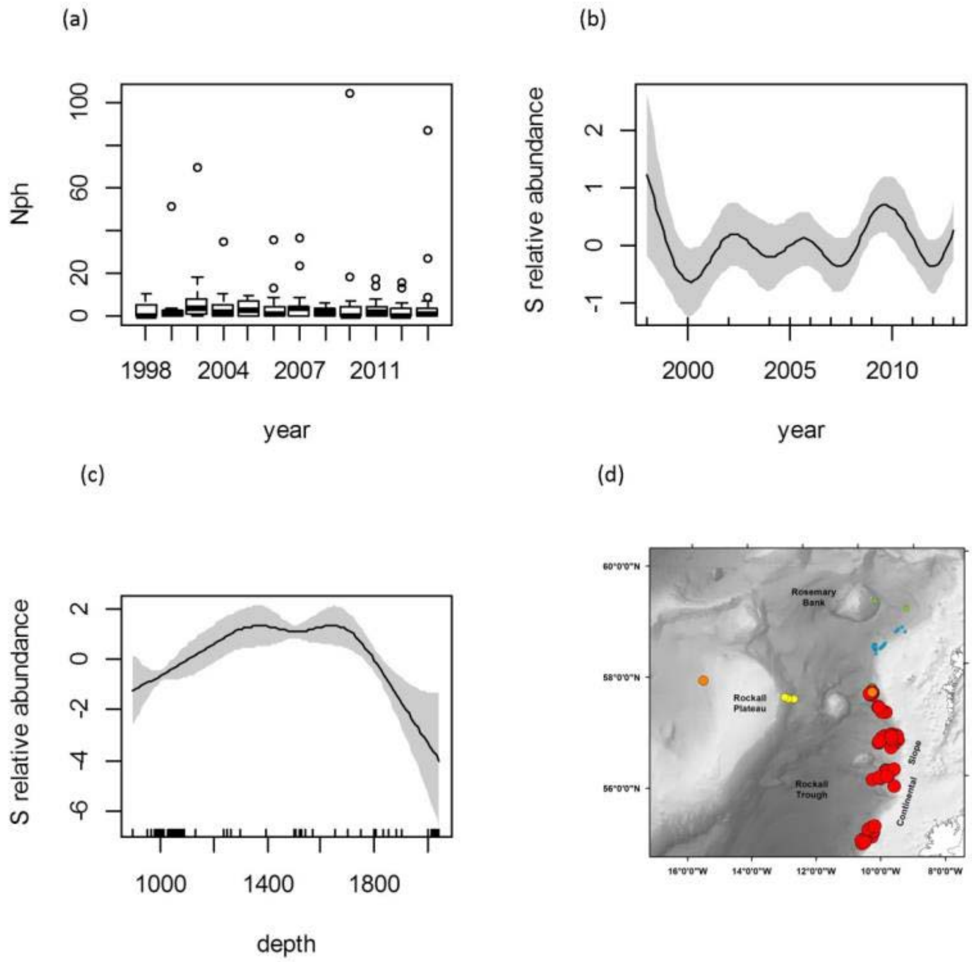

Figure 5.10. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Etmopterus princeps* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

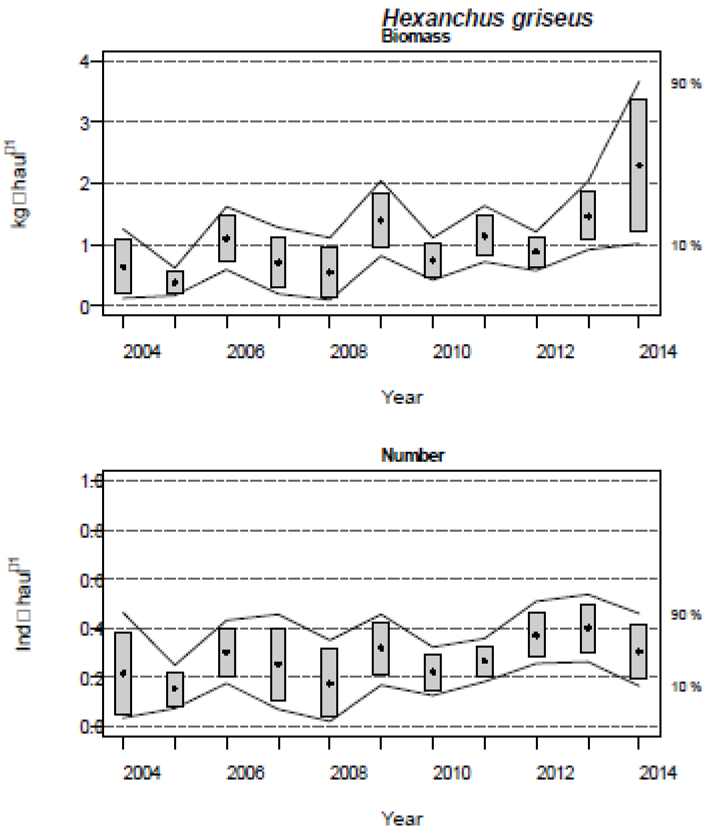

Figure 5.11. Other deep-water sharks and skates from the Northeast Atlantic. Changes in bluntnose sixgill shark (*Hexanchus griseus*) biomass index (Kg haul^{-1}) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2014). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al*. (2015 WD).

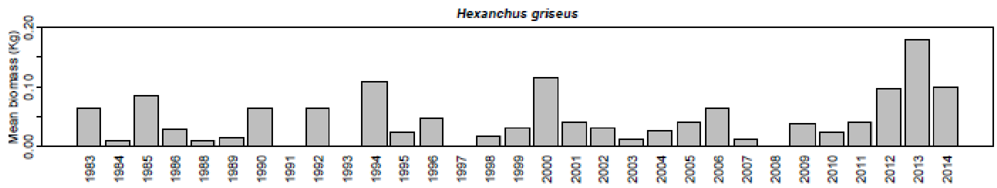

Figure 5.12. Other deep-water sharks and skates from the Northeast Atlantic. Catches by weight of bluntnose six-gilled shark (*Hexanchus griseus*) in north Spanish shelf bottom trawl surveys (Spanish IEO Q4-IBTS survey) 2004–2014 including all additional hauls out of the standard stratification (>500 m) during the last decade. From Ruiz-Pico *et al.* (2015 WD).

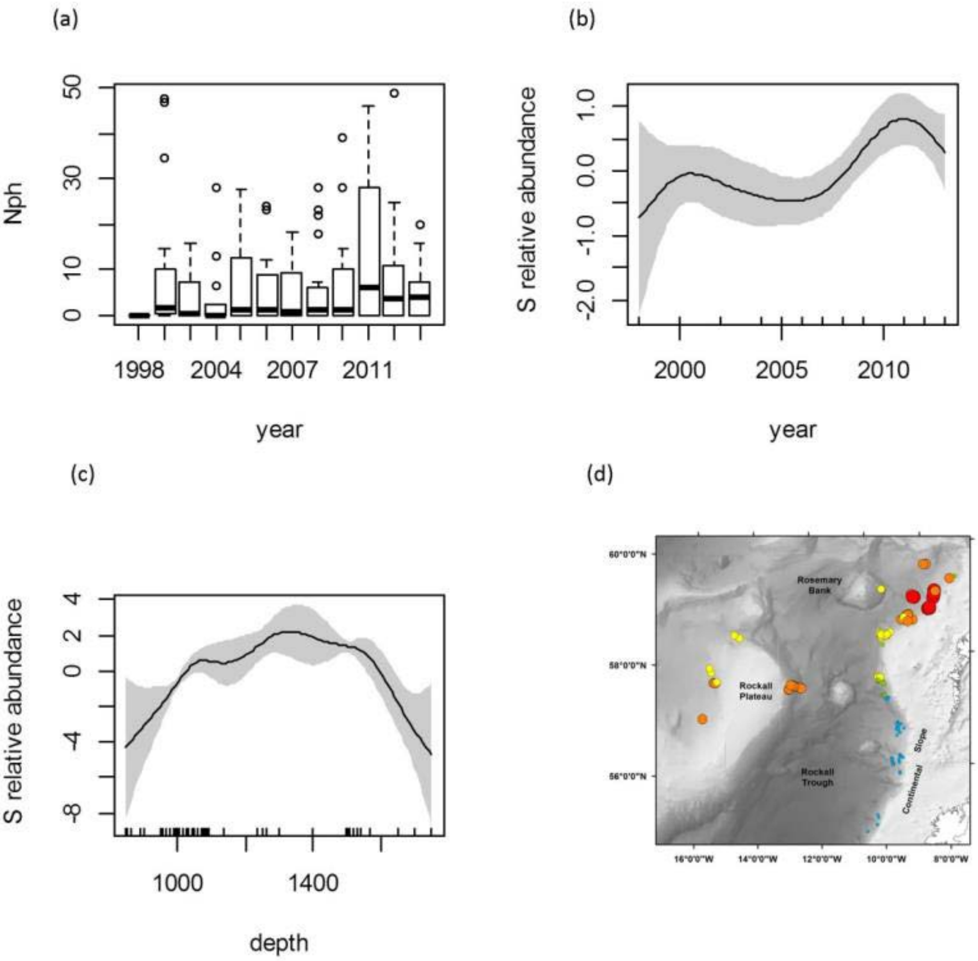

Figure 5.13. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Centroscymnus fabricii* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

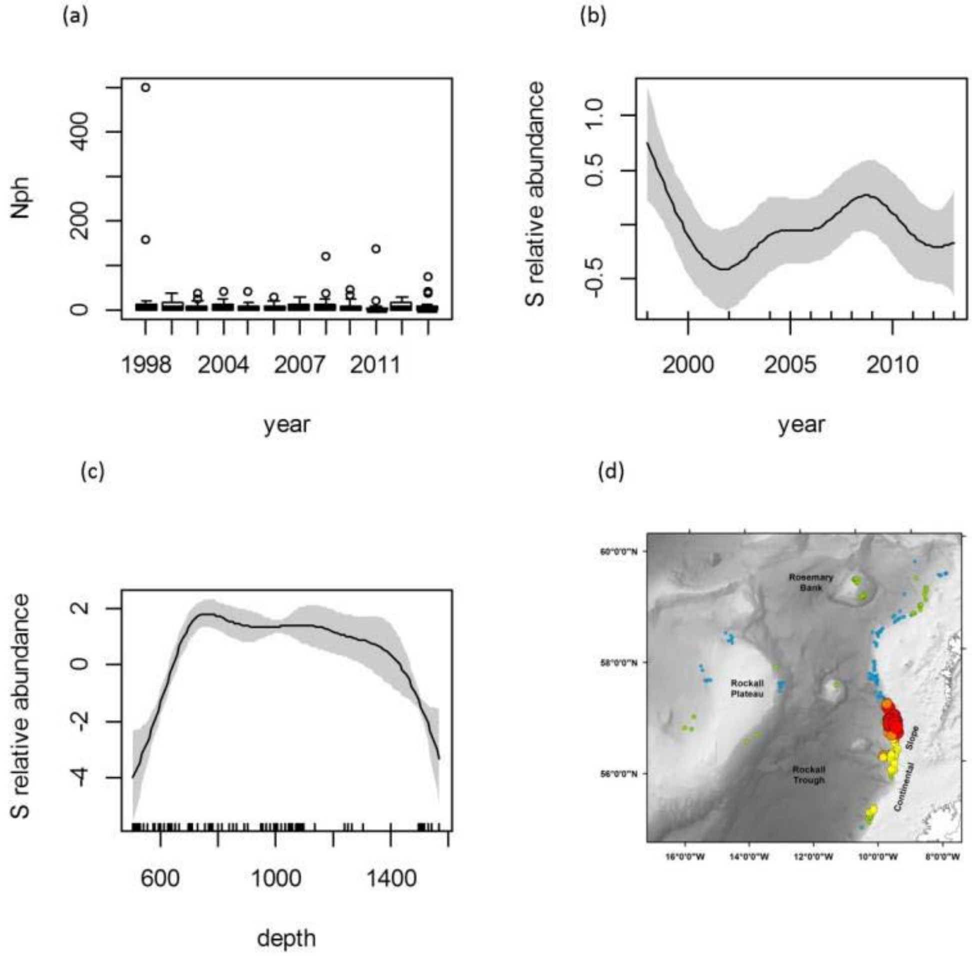

Figure 5.14. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Centroscymnus crepidater* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

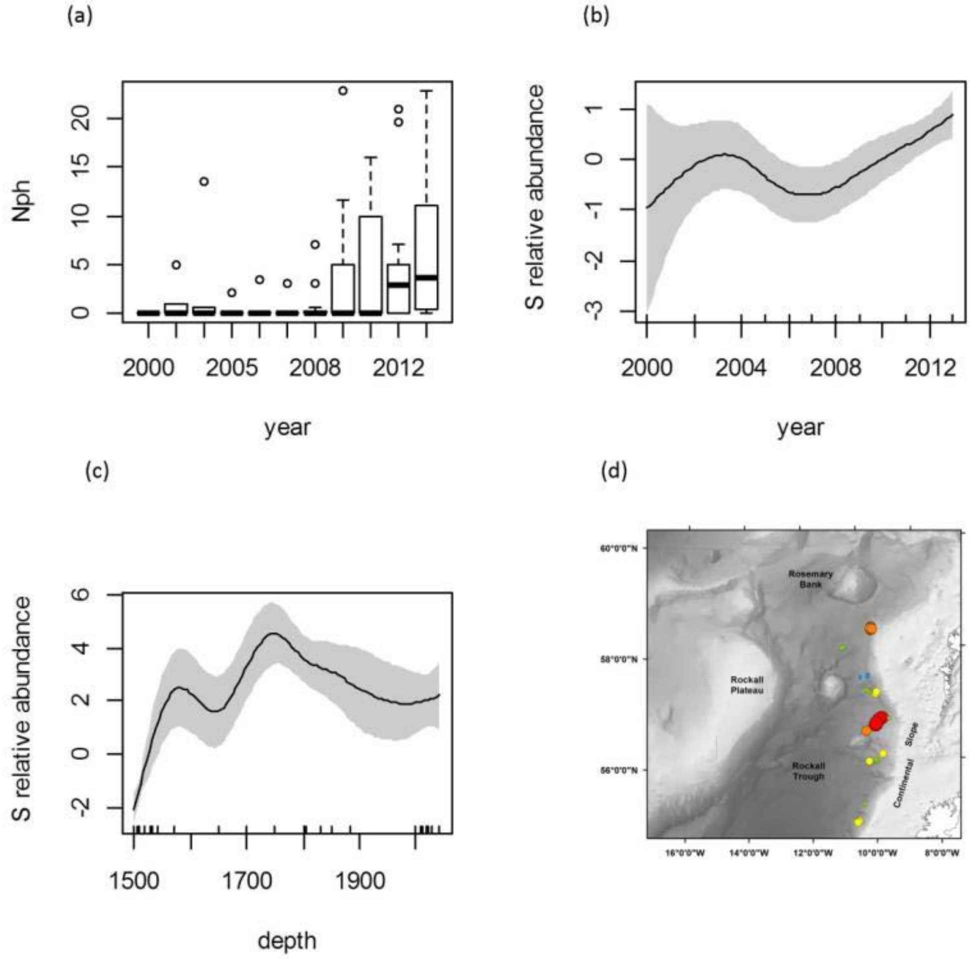

Figure 5.15. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Apristurus microps* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

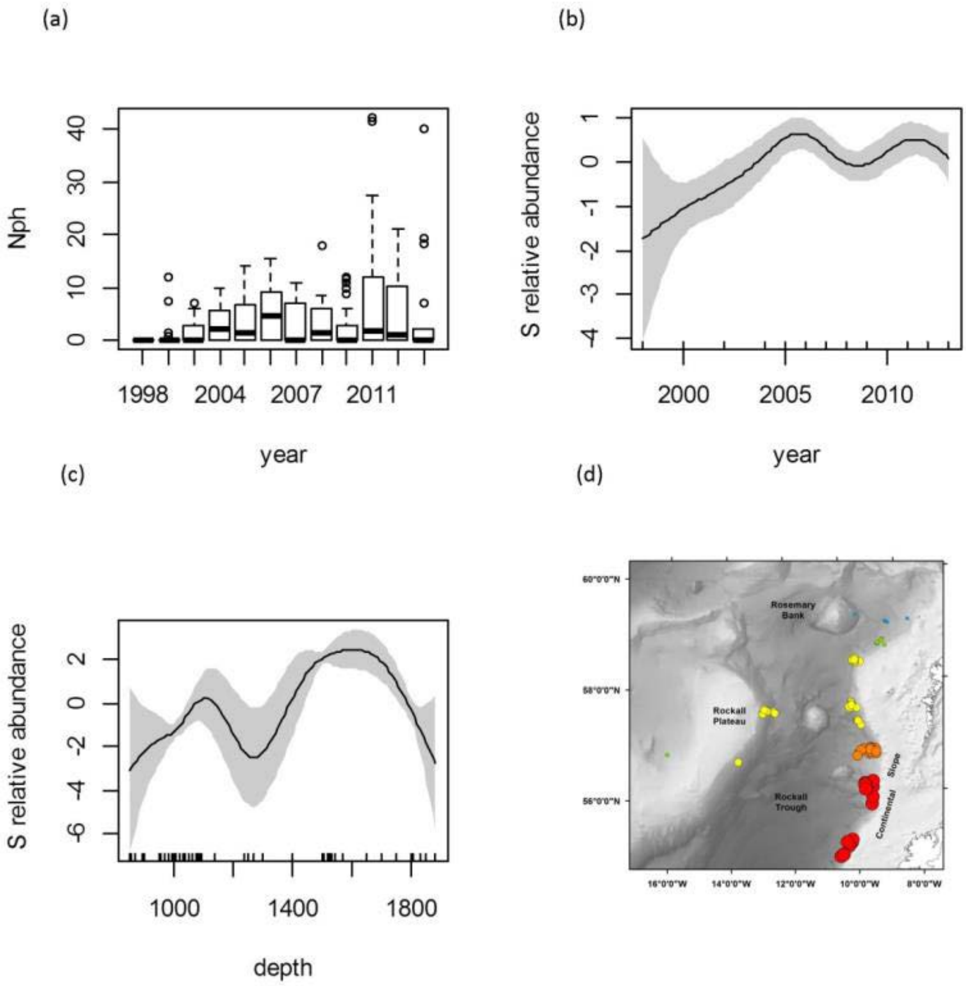

Figure 5.16. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Apristurus aphyodes* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

6 Porbeagle in the Northeast Atlantic (Subareas I–XIV)

6.1 Stock distribution

WGEF has traditionally considered that there is a single stock of porbeagle *Lamna nasus* in the NE Atlantic that occupies the entire ICES area (Subareas I–XIV). This stock extends from Norway, Iceland and the Barents Sea to Northwest Africa. For management purposes the southern boundary of the stock is 36°N and the western boundary at 42°W. The information to identify the stock unit is in the Stock Annex (ICES, 2011).

New evidence available from studies using archival or Smart Position or Temperature Transmitting Tags (SPOT tags) around the British Isles and in the Bay of Biscay shelf edge, however, indicates that porbeagle can cross the North Atlantic to at least the Mid-Atlantic Ridge, and if the archival tags transmits data after the winter, they can show a springtime return to the Northeast Atlantic. Figure 6.1 shows the movements of one porbeagle tagged in Ireland that spent a considerable time just west of the Mid-Atlantic Ridge. Additionally, there is one record from the Inland Fisheries Ireland Agency of one porbeagle that was tagged off Ireland and recaptured in American waters (IFI, unpublished data). Genetic studies have suggested that gene flow has occurred across the North Atlantic (Pade, 2009). However, of about 2000 conventional tags that have been deployed in the NW Atlantic and the 209 recaptures made (up to 2012), none showed any transatlantic migration (Campana *et al.*, 2013).

As the results of recent tagging studies become available, WGEF considers that such information will provide useful information on stock structure, potential mixing and areas of ecological importance.

6.2 The fishery

6.2.1 History of the fishery

The main country catching porbeagle in the last decade was France and, to a lesser extent, Spain, UK and Norway. The only regular target fishery that has existed recently was the French fishery (although there have been occasional targeted fisheries in the UK). However, historically there were important Norwegian and Danish target fisheries. Porbeagle is also taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain. A detailed history of the fishery is in the Stock Annex (ICES, 2011).

New information was presented to WGEF that indicated that the Norwegian catch decline in the 1950s and 1960s may not simply reflect a decline in abundance, but may also have been influenced by a decrease in effort (Biais *et al.*, 2015a WD). The discovery of good fishing grounds off Ireland in 1960 and the failure to find the same abundance on these grounds in the two following years had an important role in the 1960–1963 catch decline (Figure 6.2). Available data on the mean weights of fish indicate that this fishery off Ireland was located on nursery areas (Biais *et al.*, 2015b WD). Analyses of long-term landings data need to be interpreted in relation to catch per unit of effort experienced by this fleet in both the NE and NW Atlantic fishing grounds, as well as other factors (e.g. other fishing opportunities).

6.2.2 The fishery in 2014

No EU fishery has been allowed since the implementation of a zero TAC in 2010. However, some limited landings are reported in 2014 as in the previous three years (Table 6.1). The 2014 WGEF estimate is 7 t in 2014 and since the zero TAC was implemented, the mean WGEF estimate is 22 t per year. However, data since 2010 must be considered as unrepresentative of removals, as dead discards are not quantified.

6.2.3 ICES advice applicable

The 2012 advice (although released initially as biennial advice) was valid for 2013–2015, and stated: "I*CES advises on the basis of the precautionary approach that no fishing for porbeagle should be permitted. Landings of porbeagle should not be allowed. A rebuilding plan should be developed for this stock*."

6.2.4 Management applicable

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).

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.

EC Regulation 40/2008 first established a TAC (581 t) for porbeagle taken in EC and international waters from ICES Subareas I–XII and XIV for 2008. The TAC was reduced by 25% in 2009 and a maximum landing length of 210 cm (fork length) was implemented.

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 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 was not mandatory.

It has been forbidden to catch and land porbeagle in Sweden since 2004, but this is the edge of the distributional range.

6.3 Catch data

6.3.1 Landings

Tables 6.1a, b and Figures 6.3–6.4 show the historical landings of porbeagle in the Northeast Atlantic. From 1971 onwards, France remained the major contributor. The Danish time-series for 1946–1949 was completed using the information collected for analysing the trends in the Northern European porbeagle fishery (Biais *et al*., 2015a WD).

More detailed information on landings is presented in the Stock Annex.

6.3.2 Discards

Because of the high value of this species, it is likely that specimens caught incidentally were landed prior to quota becoming restrictive. Historical discards are consequently thought to be low. The EU adoption in 2009 of a maximum landing size for this species likely lead to an increase of discarding of large fishes by vessels from the directed fishery but there is no account of the numbers discarded.

Current levels of discarding are uncertain, and may seasonally occur in some métiers. For example, observations on porbeagle bycatch have been made for some gillnetters operating in the Celtic Sea (Bendall *et al.*, 2012a,b; Ellis and Bendall, 2015 WD), but there are no estimates of total dead discards.

Anecdotal information indicates that porbeagle is a regular bycatch in the Norwegian pelagic trawl fishery for blue whiting in the Norwegian Sea. Due to the fishing method, whereby the catch is pumped on board, all specimens are reportedly dead when caught. It was also suggested that there is an increased occurrence of porbeagle in this fishery since 2014/2015. The lack of observer coverage on these vessels means that such observations have not been independently verified.

6.3.3 Quality of catch data

Some EU nations have incomplete recording of porbeagle (e.g. they have been reported as generic sharks; have been captured by <10 m LOA vessels). Although catch data for this stock are considered to be underestimated, these are mostly for nations catching small quantities, and more comprehensive data are available for the main fishing nations. Since the zero TAC / prohibited listing was introduced, reported landings are not representative of catch. There are no estimates of recent catches, as only limited data from discard observer trips are available for porbeagle (and it is unclear as to whether these data would be sufficiently representative to provide robust estimates dead removals).

6.3.4 Discard survival

Data on discard survival are limited. Bendall *et al.* (2012a) examined the vitality of porbeagle caught in gillnet fisheries, and only four (20%) of the 20 fish captured were alive. It is important to recognise that this study was based on a small sample size and the soak time was shorter than that adopted by normal fishing operations. Survival on longlines is likely to be much higher, but would depend on soak time. Fishers have reported mortality of porbeagle caught in pelagic trawl fisheries, but this has not been quantified.

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 target fishery (Hennache and Jung, 2010; Figure 6.5). These distributions are considered representative of the international catches because during that period France was the major contributor for catch figures.

The composition by weight class (<50 kg and ≥50 kg) of the French fishery catches reveals that the proportion of large porbeagle in the landings was higher before 1998 than after 2003 but with large inter-annual changes (Table 6.2).

Catch data derived from the target French fishery highlighted the dominance of porbeagle (89%) on the total catch. Other species included blue shark (10%), common thresher (0.6%) and tope (0.3%).

6.4.1 Conversion factors

Length–weight relationships are available for different geographic areas and for time periods (Table 6.3). Relationships between alternative length measurements with total length in porbeagle were recently presented (Table 6.4; Ellis and Bendall, 2015 WD).

6.5 Commercial catch and effort data

A new cpue series from Norwegian porbeagle longliners (1950–1972 was presented (Biais *et al*., 2015b WD). Personal logbooks of three fishermen (covering periods of three, ten and 15 years) were used to get this new series. Data were reported for each fishing day of the trip, including days with zero catch. Most of the fishing days were in northern European waters (IIa, Iva–b, VIa North of 59°N, Va), the historical Norwegian fishing zone, but some data were also available for fishing days west of the British Isles, including the Celtic Sea.

The time series trend in this area was explored by carrying out a GLM on log transformed values fitted with a gamma link function. The annual index series provided by this analysis showed no significant temporal trend (Figure 6.6).

A cpue series based on data collected from 17 boats belonging to the French targeted fishery were presented by Biais and Vollette (2009). These boats landed more than 500 kg of porbeagle per year during more than six years after 1972 and more than four years from 1999 onwards (to include a boat that had entered the fishery towards the end of the time-series, given the limited number of boats in recent years).

At the 2009 ICCAT-ICES meeting, standardized catch rates were also presented for North Atlantic porbeagle during the period 1986–2007, caught as low prevalent bycatch in the Spanish surface longline fishery targeting swordfish in the Atlantic Ocean (Mejuto *et al*., 2009). The analysis was performed using a GLM approach that considered several factors such as longline type, quarter, bait and also spatial effects by including seven zones.

The nominal and the standardized catch rate series of the French fleet show that higher values occurred by the late 1970s (Figure 6.7). Since then, cpue varied between 400–900 kg per day without showing a trend.

The caution with which trend on short periods must be considered was shown by an analysis of the effect of porbeagle aggregating behaviour, as well as an effect of cooperation between skippers. The analysis was carried out for years 2001–2008 for which detailed data were available (Biais and Vollette, 2010). The analysis showed that inter-annual variation in local abundance may be higher than indicated by catch by trip or catch by day.

Spanish data showed a higher variability than the French (Figure 6.8), possibly as they were based on bycatch data and derived from fishing fleet that operate in areas with lower abundance of porbeagle.

6.6 Fishery-independent surveys

No fishery-independent survey data are available for the NE Atlantic, although records from recreational fisheries may be available. Tagging studies from dedicated surveys are currently available (see Section 6.7.1).

6.7 Life-history information

The life-history information (including habitat description) is presented in Stock Annex.

Nicolaus *et al.* (2015 WD) reported high levels of mercury (Hg) in both the red and white muscle of porbeagle (n = 33) caught in the Celtic Sea. Hg concentrations in either the red or white muscle that exceeded the maximum levels established in European regulations for seafood were observed in a third of specimens. Hg concentration, however, increased with length, and all fish >195 cm total length had concentrations >1.0 mg kg^{-1}, with a maximum observed value of 2.0 mg kg^{-1}.

6.7.1 Movements and migrations

Migrations of three porbeagle tagged off Ireland with archival pop-up tags (PAT) 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 water column ranging from 0 to 700 m with temperatures varying from 9° to 17°C, but during the night they preferentially stayed at upper layers. The Irish tagging programme is continuing.

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 marine waters. Altogether, 21 satellite tags were deployed between July 2010 and September 2011, and 15 tags popped off after two to six months. However, four tags failed to communicate. The tags attached to sharks in the Celtic Sea generally popped off to the south of the release positions while those to sharks off the northwest coast of Ireland popped off in diverse positions. One of them popped off in the western part of the North Atlantic, one close to the Gibraltar Straits and another in the North Sea. Several tags popped off close to the point of release (Bendall *et al.*, 2012b).

In June–July 2011, France (Ifremer and IRD) joined the international tagging effort in cooperation with Cefas by undertaking a survey on the shelf edge in the West of Brittany. A second survey was carried out in 2013 by Ifremer. Three PATs were deployed by Ifremer-IRD and three by Cefas (results in Bendall *et al.*, 2012a) during the 2011 survey, and nine during the 2013 survey. Pop-off dates were set at twelve months for the PSATs deployed by France which were all used to tag large females (L_T >2 m). Eight PSATs popped up after four months and four at twelve months. Track reconstructions, based on Grid Filtering, were carried out for these eight tags (Biais, pers. comm. 2015). They revealed large migrations of the sharks; going from the Bay of Biscay northward to the Arctic Circle, southward to Madeira and three fish moved westwards to the Mid-Atlantic Ridge. A general circular migration pattern was observed with a return to the Bay of Biscay or the SW Celtic Sea shelf edge when PSATS popped up at 12 months. In these cases, the small observed distances between tagging and pop-up positions (mean 190 km) are remarkable given that movements could be of several thousand km.

6.7.2 Reproductive biology

A research programme carried out by the NGO APECS (Hennache and Jung, 2010) provided information based on a large sampling (n = 1770) on 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.

6.7.3 Genetic information

A preliminary study of the genetic diversity (mitochondrial DNA haplotype and nucleotide diversities) was carried 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. However while the mtDNA haplotype diversity was very high, sequence diversity was low, which suggests that most females breed in particular places, which also indicates the stock is likely to be genetically robust (Pade, 2009). Further studies are still required.

6.8 Exploratory assessment models

6.8.1 Previous studies

The first assessment of the NE Atlantic stock was carried out in 2009 by the joint ICCAT/ICES meeting using a Bayesian Surplus Production (BSP) model (Babcock and Cortes, 2009) and an age-structured production (ASP) model (Porch *et al.*, 2006). The 2009 assessments have not been updated since.

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. However, it is important to recognise both the uncertainty in the input parameters for this assessment and the low productivity of the stock. More detailed results from these are detailed in the Stock Annex.

6.8.2 Population dynamics model

A recent analysis by Campana *et al.* (2013), utilising a forward-projecting age- and sex-structured population dynamics model found that the Canadian porbeagle population could recover from depletion, even at modest fishing mortalities. The population is projected forward from an equilibrium starting abundance (assumed an unfished equilibrium at the beginning of 1961 prior to directed commercial fisheries) and age distribution by adding recruitment and removing catches. All model projections predicted recovery to 20% of spawning stock numbers before 2014 if the fishing mortality rate was kept at or below 4% of the vulnerable biomass. Under the low productivity model, recovery to spawning stock numbers at maximum sustainable yield was predicted to take over 100 years at exploitation rates of 4% of the vulnerable biomass. The results of this study may need to be re-appraised, depending on improved knowledge of the stock unit(s).

6.9 Stock assessment

Since the closure of the fishery and the designation of porbeagle as a prohibited species, there are insufficient commercial data (and no fishery-independent data) with which to ascertain the current status of the stock. It is planned to update the assessment of porbeagle in 2018 in conjunction with ICCAT.

6.10 Quality of assessments

The assessments (and subsequent projections) conducted at the joint ICCAT/ICES meeting that are summarized in the Stock Annex were considered exploratory assessments, considering the assumptions (carrying capacity for the SSB model, F in the historic period in the ASP model) and available data, (particularly a lack of cpue data for the peak of the fishery; uncertainty in some of the landings data).

The cpue index used in the ICCAT/ICES assessment included catch per day from the French fleet for the years 2001–2008. This showed that catch rates could vary a lot between consecutive years, and so may not be reflective of stock abundance.

Consequently, the model outputs were considered highly uncertain (ICCAT, 2009) and in 2009 and subsequent years, WGEF considered that there was insufficient new information to inform on current stock status.

Available cpue from a few Norwegian fishing boats showed no consistent trend from 1950 to 1972. This new information provided at the 2015 WGEF also suggests that the northern fisheries ceased partly because of the attraction of other fisheries. It underlines also that economic and social factors are important considerations in explaining why a fishery may not operate or resume even if the abundance does not decline. An update of the ICES/ICCAT assessment should consider these new data during the next ICCAT porbeagle assessment scheduled for 2017.

6.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status of pelagic shark stocks. 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.

6.12 Conservation considerations

At present, the porbeagle shark subpopulations of the NE Atlantic and Mediterranean are listed as Critically Endangered in the IUCN red list (Stevens *et al*., 2006).

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.

6.13 Management considerations

WGEF/ICCAT considered all available data in 2009. This included updated landings data and cpue from the French and Spanish fisheries. Collation of historical information, as provided in 2015, supports the need to update the ICCAT/ICES assessment.

The new cpue series provided for the Norwegian fishery from 1950 to 1972 further highlights the difficulties in interpreting stock trends with contrasting trends in cpue and landings.

In the absence of target fisheries and reliable information on bycatch and discards, one or several dedicated longline surveys covering the main parts of the stock area would be needed if stock status is to be monitored appropriately. Such a survey could not only provide data on porbeagle but also the wider large pelagic fish assemblage, and there should be due consideration of such initiatives.

This species has a low population productivity, and is so highly susceptible to over-exploitation. Consequently, WGEF considers that target fishing should not proceed without a programme to monitor stock abundance. WGEF also highlight that the present fishing ban hampers any quantitative assessment of current stock status.

A maximum landing length (MLL) was adopted by the EC in 2009. It constituted a potentially useful management measure in targeted fisheries, as it should deter targeting areas with mature females. However, there are also potential benefits from limiting fishing mortality on juveniles. Given the difficulties in measuring (live) sharks, other body dimensions (e.g. height of the first dorsal fin or pre-oral length) that could be pragmatic surrogate measurements could usefully be identified. The correlation of some measurements with fork length is high (Bendall *et al*., 2012a) but further studies, so as to better account for natural variation (e.g. potential ontogenetic variation and sexual dimorphism) in such measurements, are needed to identify the most appropriate options for managing size restrictions.

Further ecological studies on porbeagle, as highlighted in the scientific recommendations of ICCAT (2009), would help to further develop management measures for this species. Such work could usefully build on recent and ongoing tagging projects, and various Member States have undertaken increasing studies on porbeagle.

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 the Member States having fisheries for this stock as well as other countries longlining in the ICES area.

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Table 6.1a. Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1926–1970). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.

Year	Estimated Spanish data	Denmark	Norway (NE Atl)	Scotland
1926			279	
1927			457	
1928			611	
1929			832	
1930			1505	
1931			1106	
1932			1603	
1933			3884	
1934			3626	
1935			1993	
1936			2459	
1937			2805	
1938			2733	
1939			2213	
1940			104	
1941			283	
1942			288	
1943			351	
1944			321	
1945			927	
1946			1088	
1947			2824	
1948			1914	
1949			1251	
1950	4	1900	1358	
1951	3	1600	778	
1952	3	1600	606	
1953	4	1100	712	
1954	1	651	594	
1955	2	578	897	
1956	1	446	871	
1957	3.	561	1097	
1958	3	653	1080	7
1959	3	562	1183	9
1960	2	362	1929	10
1961	5	425	1053	9
1962	7	304	444	20
1963	3	173	121	17
1964	6	216	89	5
1965	4	165	204	8
1966	9	131	218	6
1967	8	144	305	7
1968	11	111	677	7
1969	11	100	909	3
1970	10	124	269	5

Table 6.1b. Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2013). Data derived from ICCAT, ICES and national data. Data are considered an underestimate for some (minor) fishing countries.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Denmark	**311**	**523**	158	170	265	233	289	112	72	176	158	84	45	38
Faroe Is	**1**		5			1	5	9	25	8	6	17	12	14
France	**550**	**910**	545	380	455	655	450	550	650	640	500	480	490	300
Germany			6	3	4	.	.	.	.	.	.	.	.	.
Iceland			2	2	4	3	3	.	1	1	1	1	1	1
Ireland			.	.	.	.	.	.	.	.	.	.	.	.
Netherlands			.	.	.	.	.	.	.	.	.	.	.	.
Norway	**111**	**293**	230	165	304	259	77	76	106	84	93	33	33	97
Portugal			.	.	.	.	.	.	.	.	.	.	.	.
Spain	**11**	**10**	12	9	12	9	10	11	8	12	12	14	28	20
Spain (Basque Country)														
Sweden		**4**			3			5	1	8	5	6	5	9
UK (E,W, Nl)	**7**	**15**	14	15	16	25			1	3	2	1	2	5
UK (Scot)			13											
Japan	**991**	**1755**												
TOTAL	**1971**	**1972**	985	744	1063	1185	834	763	864	932	777	636	616	484

	1985	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Denmark	72	56	33	33	46	85	80	91	93	86	72	69	85	107	73
Faroe Is	12	33	14	14	14	7	20	76	48	44	8	9	7	10	13
France	196	233	341	327	546	306	466	642	824	644	450	495	435	273	361
Germany	.	.	.	.	.	.	.	1	.	.	.	.	2	0	17
Iceland	1	1	1	1	.	.	1	3	4	5	3	2	3	3	2
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	8	2
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Norway	80	25	12	27	45	35	43	24	26	28	31	19	28	34	23
Portugal	.	3	3	2	2	1	0	1	1	1	1	1	1	0	15
Spain	23	30	61	40	26	46	15	21	49	17	39	23	22	15	11
Spain (Basque Country)											20	12	27	41	1
Sweden	10	5	3	3	2	2	4	3	2	2	1	1	1	1	38
UK (Eng,Wal & Nl)	12	3	3	15	9					0			1	6	7
UK (Scot)															.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	2	NA	NA	NA
TOTAL	406	389	471	462	690	482	629	862	1047	827	628	633	612	498	**563**

Table 6.1b. (continued). Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2013). Data derived from ICCAT, FAO, ICES and national data. Data are considered an underestimate for some (minor) fishing countries.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Denmark	76	42	21	20	4	3	2	2	4	0	2	3	0	0
Faroe Is	8	10	14	5	19	21	13	11	4	.	0	0	.	-
France	339	439	394	374	246	185	347	221	299	7	2	27	13	2
Germany	1	3	5	6	5	0	.	0	0	.	0	0	0	0
Iceland	4	2	0	1	0	1	0	1	1	1	1	2	1	<1
Ireland	6	3	11	18	3	4	8	7	0	0	0	0	0	0
Netherlands	.	.	0	.	0	.	0	0	0	0	0	0	.	-
Norway	17	14	19	24	11	27	10	12	10	12	10	17	8	5
Portugal	4	11	4	57	10	6	2	0	0	.	0	0	.	-
Spain	23	49	22	9	10	26	6	32	0	.	0	0	.	-
Spain (Basque Country)	45	16	22	10	11	5	16	13	3	0	2	0	.	-
Sweden	1	.	.	5	0	.	1	0	0	.	0	0	.	-
UK (Eng,Wal & Nl)	10	7	25	24	24	11	26	12	10	0	0	0	.	-
UK (Scot)	1	.	.	.	.	.	.	1	0	0	0	0	.	0
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	.	-
TOTAL	535	596	537	553	343	289	431	313	333	20	17	48	22	7

Table 6.2. Porbeagle in the NE Atlantic. Proportion of small (<50 kg) and large (≥50 kg) porbeagle taken in the French longline fishery 1992–2009. Source: Hennache and Jung (2010).

	% WEIGHT OF IN THE CATCHES OF PORBEAGLE:	
Year	< 50 kg	>50 kg
1992	26.0	74.0
1993	29.7	70.3
1994	33.1	66.9
1995	49.9	53.1
1996	31.9	68.1
1997	39.2	60.8
1998	Data not available by weight category	
1999		
2000		
2001		
2002		
2003	53.7	46.3
2004	44.0	56.0
2005	40.0	60.0
2006	44.3	55.7
2007	44.9	55.1
2008	45.9	54.1
2009	51.8	48.2

Table 6.3. Porbeagle in the NE 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
NE Atlantic (Biscay / SW England/W Ireland)	$W = (4 \times 10^{-5})\ L_F\ 2.7316$	M	564	88–230 cm	Hennache and Jung, 2010
	$W = (3 \times 10^{-5})\ L_F\ 2.8226$	F	456	93–249 cm	
	$W = (4 \times 10^{-5})\ L_F\ 2.7767$	C	1020	88–249 cm	

Table 6.4. Porbeagle in the Northeast Atlantic. Relationships between alternative length measurements with total length in porbeagle (n = 53), where total length refers to the total length with the upper lobe of the caudal fin flexed down (L_{T_under}) and measured under the body. Relationships given as an equation and in proportional terms (percentage of L_{T_under}). Source: Ellis and Bendall (2015 WD).

Measurement	Equation	R^2
Total length (depressed), measured over body (L_{T_over})	L_{T_over} = 1.0279.L_{T_under} – 0.3109	0.99
Total length (natural), measured under body (L_{N_under})	L_{N_under} = 0.9906.L_{T_under} – 3.9749	0.99
Total length (natural), measured over body (L_{N_over})	L_{N_over} = 0.9979.L_{T_under} – 1.0713	0.99
Fork length, measured under body (L_{F_under})	L_{F_under} = 0.877.L_{T_under} – 3.6981	0.99
Fork length, measured over body (L_{F_over})	L_{F_over} = 0.8919.L_{T_under} – 1.4538	0.99
Standard length, measured under body (L_{S_under})	L_{S_under} = 0.7688.L_{T_under} – 2.1165	0.99
Standard length, measured over body (L_{S_over})	L_{S_over} = 0.7849.L_{T_under} – 0.2599	0.99
Measurement	% of L_{T_under} (mean ± SD and range)	
Total length (depressed), measured over body (L_{T_over})	102.6 ± 1.31 (100.0–106.7)	
Total length (natural), measured under body (L_{N_under})	96.7 ± 1.72 (91.9–101.9)	
Total length (natural), measured over body (L_{N_over})	99.1 ± 1.82 (95.3–102.6)	
Fork length, measured under body (L_{F_under})	85.5 ± 0.99 (83.3–88.9)	
Fork length, measured over body (L_{F_over})	88.3 ± 1.34 (85.2–92.5)	
Standard length, measured under body (L_{S_under})	75.6 ± 1.07 (74.1–79.1)	
Standard length, measured over body (L_{S_over})	78.3 ± 1.34 (75.6–82.2)	

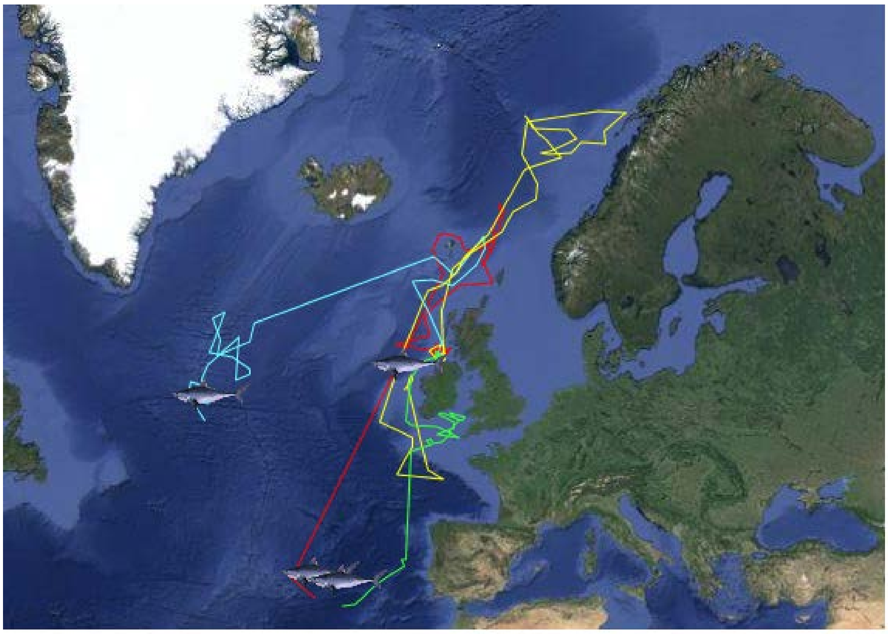


Figure 6.1. Porbeagle in the NE Atlantic. Movement of porbeagle tagged in Irish porbeagle archival tagging programme.

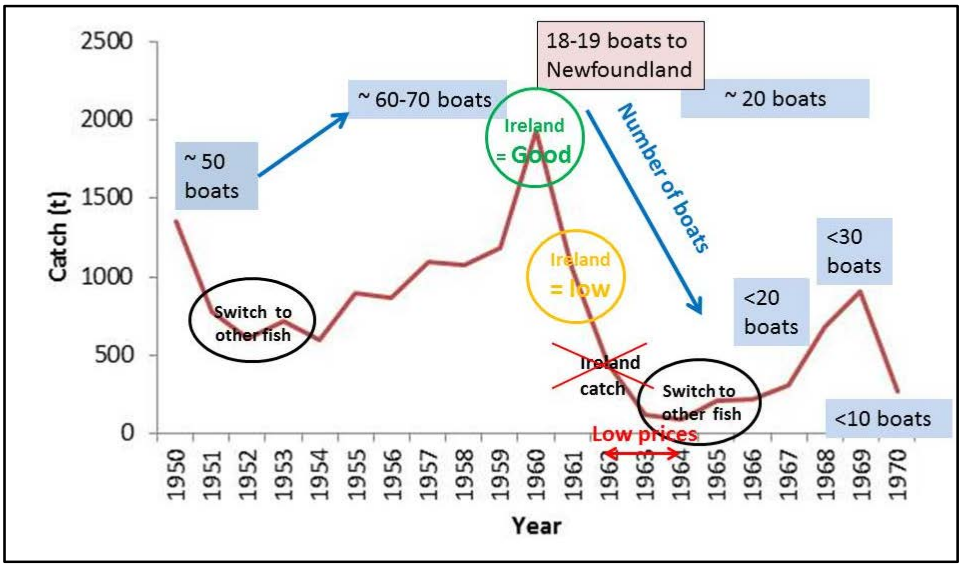
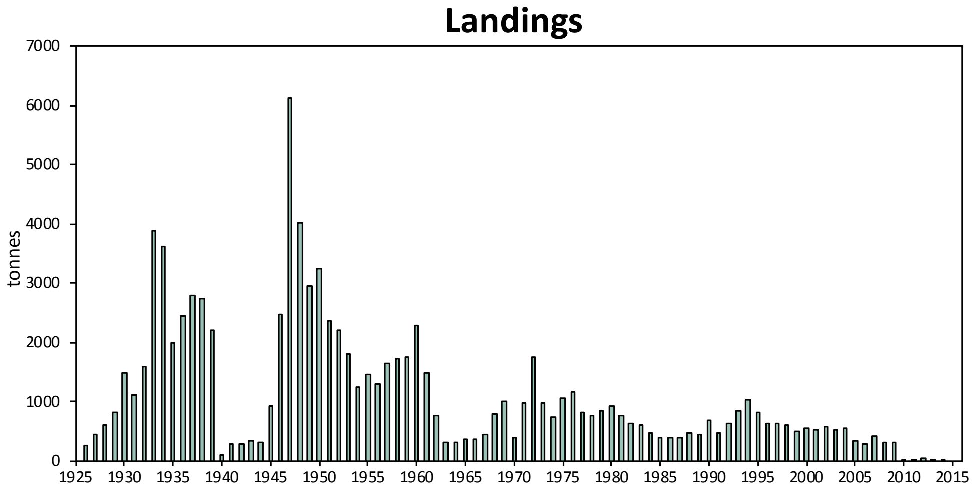


Figure 6.2 Porbeagle in the NE Atlantic. Trend in Norwegian catch and information on the fishery. Source: Biais *et al.* (2015a WD).



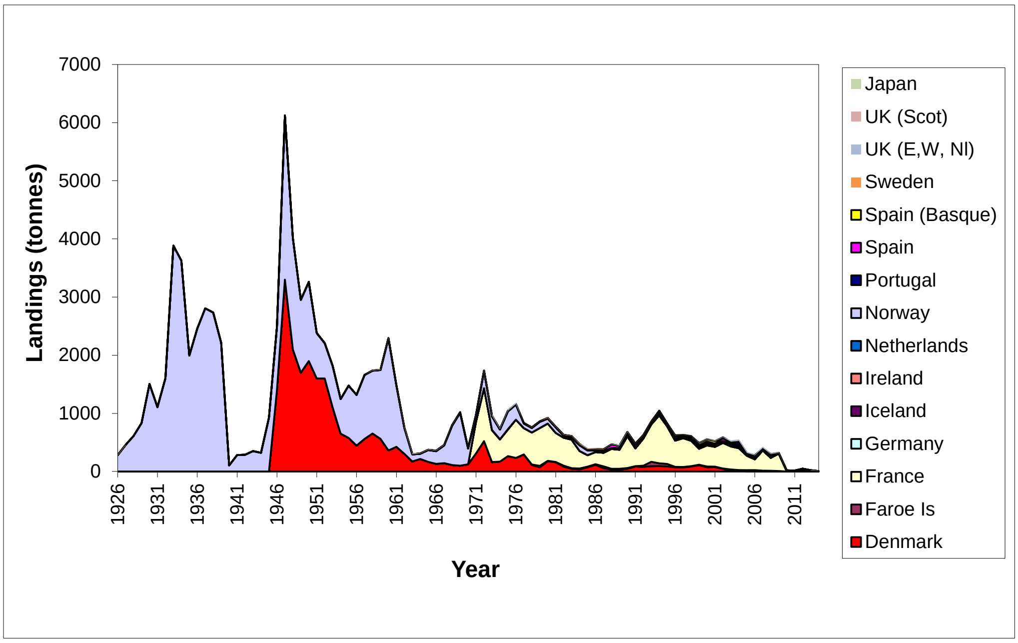


Figure 6.3. Porbeagle in the NE Atlantic. Working Group estimates of longer term trend in landings of porbeagle in the NE Atlantic

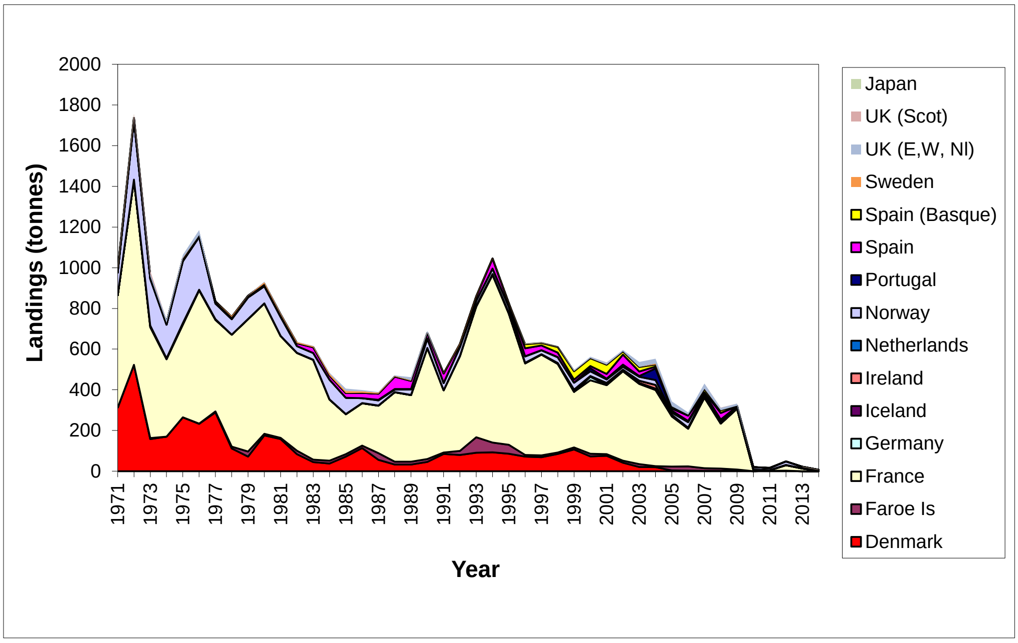


Figure 6.4. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2014 by country.

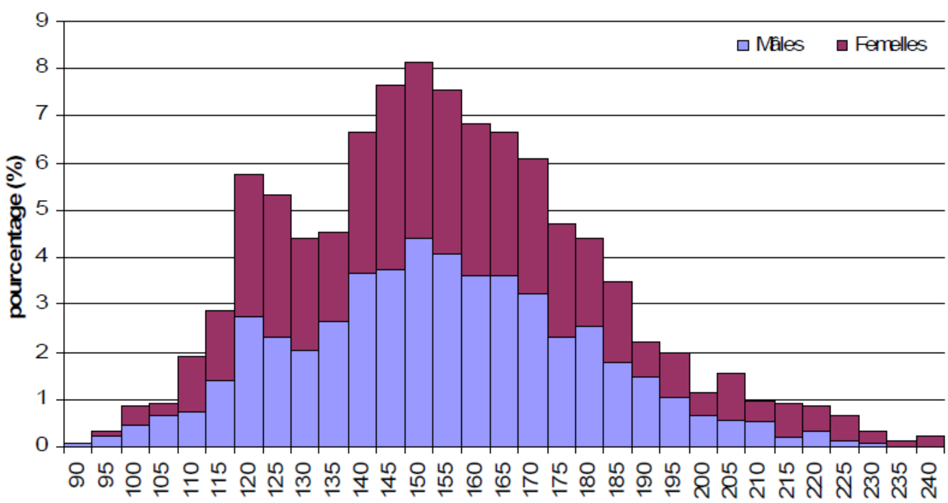


Figure 6.5. Porbeagle in the NE Atlantic. Length–frequency distribution of the landings of the Yeu porbeagle targeted fishery in 2008–2009 (n =1769). Source: Hennache and Jung (2010).

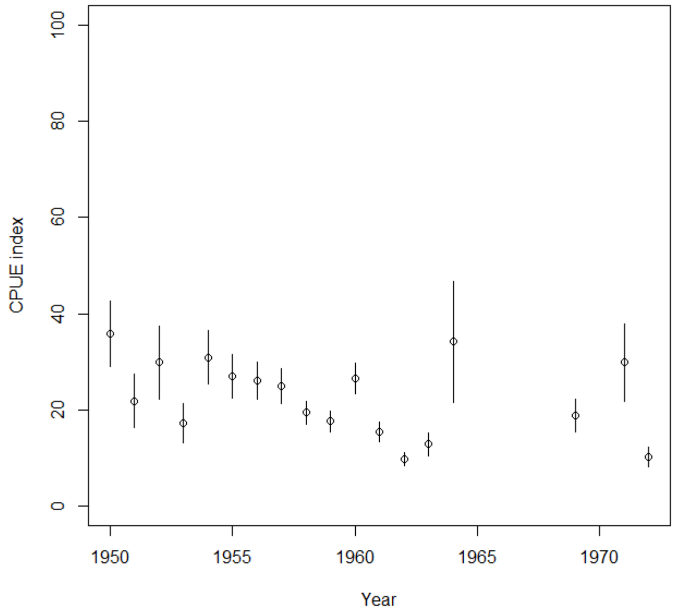


Figure 6.6. Porbeagle in the NE Atlantic. Temporal trends in cpue index for the Norwegian target longline fishery for porbeagle (1950–1972) in the northern European waters (IIa, Iva–b, VIa North of 59°N, Va). Source: Biais *et al.* (2015b WD).

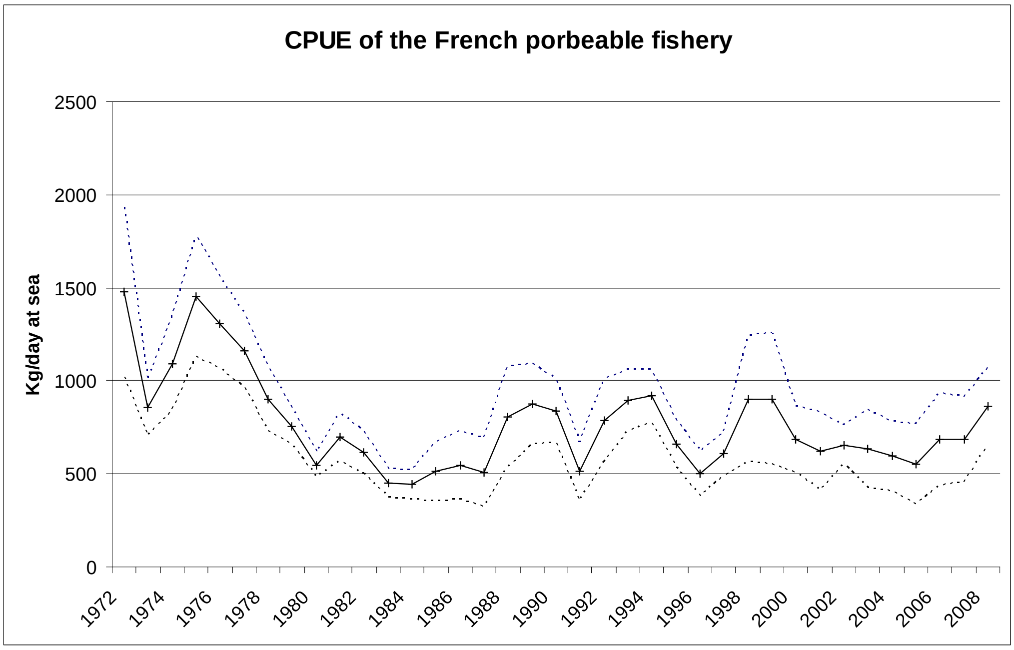


Figure 6.7. Porbeagle in the NE Atlantic. Nominal cpue (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (± 2 SE of ratio estimate). From Biais and Vollette (2009 WD).

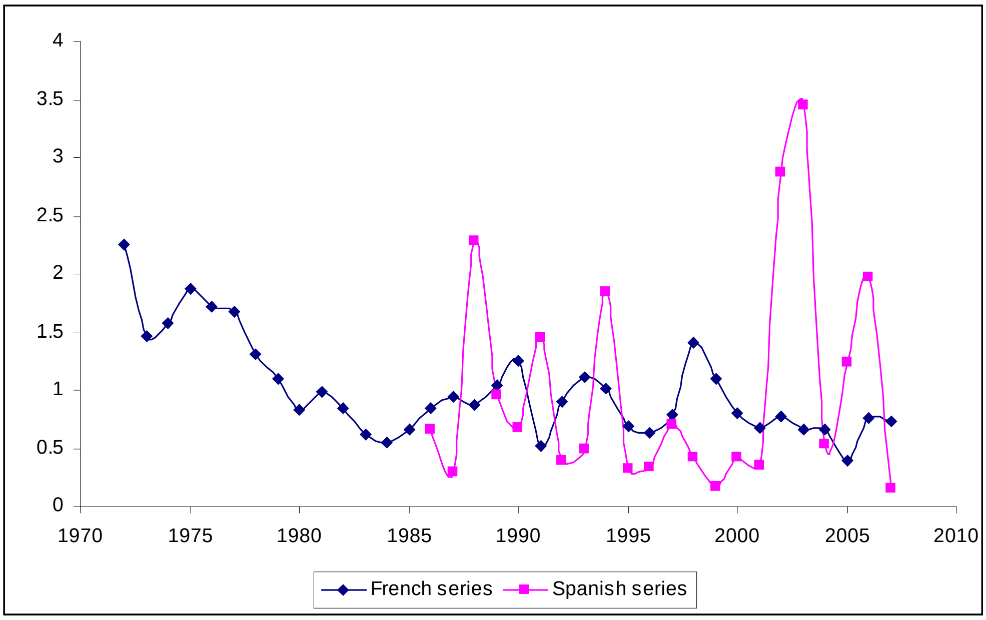


Figure 6.8. Porbeagle in the NE Atlantic. Temporal trends in standardized cpue for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the NE Atlantic (1986–2007).

7 Basking Shark in the Northeast Atlantic (ICES Areas I–XIV)

7.1 Stock distribution

In the Northeast Atlantic, basking shark *Cetorhinus maximus* is present from Iceland, Norway and as far north as the Russian White Sea (southern Barents Sea) and extends south to the Mediterranean Sea (Compagno, 1984; Konstantinov and Nizovtsev, 1980).

WGEF considers that basking shark in the ICES area exists as a single stock and management unit. However, the WGEF is aware of recent tagging studies showing both transatlantic and transequatorial migrations, as well as migrations into tropical areas and mesopelagic depths (Gore *et al*., 2008; Skomal *et al*., 2009).

Marked seasonality of basking shark sightings and significant correlation between the duration of the sightings season in each year and the North Atlantic Oscillation, has been reported (Witt *et al*., 2012). A genetic study by Hoelzel *et al*. (2006) indicates panmixia, whereas Noble *et al*. (2006) suggested little gene flow between populations in the northern and southern hemispheres. A rough estimate of the population size was given by Hoelzel *et al*. (2006). Migration and mixing levels have yet to be determined.

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). 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 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/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.

Further information on the history of the fishery is included in the Stock Annex.

7.2.2 The fishery in 2014

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 and EU vessels should release/discard any individuals caught. Norwegian vessels may land dead specimens but should release live specimens. Since 2013 reported landings have been <500 kg.

7.2.3 ICES advice applicable

ICES advice has been for a zero TAC since 2006. In 2012 ICES advised on the basis of the precautionary approach that there should be no landings of basking shark and that it should remain on the Prohibited Species List.

7.2.4 Management applicable

Since 2007, the EU has prohibited fishing for, retaining on board, transhipping or landing basking sharks by any vessel in EU waters or EU vessels fishing anywhere (Council regulation (EC) No 41/2006).

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 I–XIV. 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. 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).

The 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).

Since 2004, Sweden has forbidden fishing for or landing basking shark.

7.3 Catch data

7.3.1 Landings

Landings data within ICES Subareas I–XIV from 1977–2014 are presented in Table 7.1, and Figure 7.1–7.2. Landings of basking shark peaked in 1979 at a total of 5266 t, and declined rapidly towards 1988. Another peak in landings was registered in 1992, with 1697 t basking shark landed. Since the ban in direct fishery in 2006/2007, yearly landings have been <30 t and are currently <1 t.

Reported landings data come from UK (Guernsey) in 1984 and 2009, Portugal (1991–2008), France (1990–2008 and 2013) and Norway (1977–2011). Most landings are from Subareas I, II and IV and are taken by Norway. For Portugal and France the reported landings were between 0.1 and 2 t. Landings for Portugal in 2004 and 2007 from FishStat were higher, but needs to be confirmed.

Landings in numbers from Scotland and Norway (1977–2014) are presented in Figure 7.3. The trends are very similar to those of landings in biomass, with a first maximum of 1748 individuals in 1979, a second maximum of 573 individuals in 1992, and less than ten individuals after 2006.

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 Directorate of Fisheries in Norway from 1990–2011. During most of the 1990s harpoon was the major 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 of directed fishery was introduced 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 is included in the Stock Annex.

7.3.2 Discards

Limited quantitative information exists on basking shark discarded bycatch. However, anecdotal information is available indicating that this species is caught in gillnet and trawl fisheries in most parts of the ICES area. Most of this bycatch takes place in summer as the species moves inshore. The total extent of these catches is unknown.

Berrow and Heardman (1994) estimated 77–120 sharks were caught annually in the gillnet fishery in the Celtic Sea. These authors received 28 reports on specimens being entangled in fishing gear around the Irish coast in 1993. In the Isle of Man, bycatch in herring and pot fishery (entanglement in ropes) is estimated at 14–20 sharks annually. Bonfil (1994) estimated that 50 specimens were taken annually by the oceanic gillnet fleet in the Pacific Ocean. Fairfax (1998) reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter, and Valeiras *et al.* (2001) reported that of twelve basking sharks were 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) are given in Table 7.4. This table also includes data on eleven bycatches from the Norwegian coast, published in the Norwegian media (prior to 2013).

Accidental bycatch of three basking shark were reported from The Smalls, Ireland (VIIg) in 2005. Sharks were released alive (Johnston, pers. comm. 2015). There are no other records of basking sharks in the Irish discard observer programme.

In 2009, observers from French national observer programmes reported three accidentally caught, but released, basking sharks (around four meters long). Two basking specimens were recorded in Area VIa and one in Area IVa. One individual of 8 m long was recorded in Area VIa in 2010.

In April 2014, two basking sharks were found dead, 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 $^1/_3$ of her dorsal body lacerated with a propeller.

Five specimens of basking shark 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 in ICES Subarea II.

The requirement for EU fleets to discard all basking sharks accidentally caught results on a lack of information on these catches. 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 Atock Annex.

7.3.4 Discard survival

Limited information available, and national observer programmes could usefully collect data on fate (released alive/released dead) of basking shark specimens caught.

7.4 Commercial catch composition

There is some information on minimum, maximum and median weight 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.

7.5 Commercial catch-effort data

There are no effort or catch per unit of effort (cpue) data available for recent years. Historical cpue data from the Norwegian fishery (1965–1985) are given in the Stock Annex.

7.6 Fishery-independent surveys

Several countries, e.g. Norway, Denmark, Ireland, conduct scientific whale-counting surveys. During these surveys observations of basking sharks are normally recorded.

The Norwegian whale-counting survey observed a total of 87 basking shark 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 done within nine short time periods (hours or 1–2 day). 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.

All French scientific surveys (e.g. MEDIT, EVHOE, PELGAS), as well as military planes and vessels, record basking shark sightings and report them annually to the NGO APECS. A national sightings program also exists along the French coastline (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 (APECS, unpubl. data). Early sightings are reported off the island of Corsica in February–March; in 2011 one basking shark was reported in Saint Pierre et Miquelon.

There is a sightings programme in the UK (Marine Conservation Society, 2003; Southall *et al*., 2005) and in Ireland through the Irish Basking Shark Study Group and the Irish Whale and Dolphin Group.

7.7 Life-history information

No new 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.

Habitat

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 off-the-shelf edge and in the Porcupine Bight (Figure 7.4). The greatest depths recorded were 144 m and 136 m, respectively, demonstrating that although 'Shark B' was located over deep water off-the-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.

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 7.5). One of the tags set in the Iroise 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 especially distributed at depths of 50–100 m during cold season (Figure 7.5.a, tracks 95 766 and 85 385). The track of a 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 7.5.b, track 79 781).

Since 2011, APECS tagged two additionnal sharks off south Brittany (France), 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 north Bay of Biscay, and the second one in the Celtic Sea, about 40 nm south of Ireland. The Manx Basking Shark Watch also deployed tags in 2008, 2011, 2012 and 2013 and the Irish Basking Shark Study Group in 2012 and 2013.

SPOT Tagging technology has been successfully experimented in the Inner Hebrides (West Scotland) on basking shark since 2012: nine SPOTs were deployed in July 2012 by the basking shark tagging project (Witt *et al.*, 2013). One 5–6 m female tagged; moved 3000 km south, down to the Western African coasts within 135 days of (pop off near the Canary Island in November), whilst the other sharks demonstrated a degree of site fidelity in the Inner Hebrides (at various spatial scale) that will be interesting to consider in a context of spatial planning conservation.

7.8 Exploratory assessment models

No assessments have been undertaken.

7.9 Quality of assessments

No assessments have been undertaken.

Further information on migration on and stock mixing is required.

7.10 Reference points

No reference points have been proposed for this stock.

7.11 Conservation considerations

Basking shark is listed as "Endangered" on the Norwegian Red List (Sjøtun *et al.*, 2010).

The Northeast Atlantic subpopulation of basking shark is listed as "Endangered" in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species. Globally, the species is listed as "Vulnerable" (Fowler, 2009).

Basking shark was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002.

Basking shark was listed on Appendices I and II of the Convention on the Conservation of Migratory Species (CMS) in 2005.

Basking shark is listed on Annex I, Highly Migratory Species, of the UN Convention on the Law of the Sea (UNCLOS).

Basking shark was listed on the OSPAR (Convention on the protection of the marine environment of the Northeast Atlantic) list of threatened and/or declining species in 2004.

7.12 Management considerations

The current status of the stock is unknown. At present there is no directed fishery for this species. WGEF considers that no directed fishery should be permitted unless a reliable estimate of a sustainable exploitation rate is available.

The species may be found in all ICES areas, and thus the TAC area should correspond to the entire ICES area.

Proper quantification of bycatch and discarding both in weight and numbers of this species in the entire ICES area is required.

Where national legislation prohibits landing of bycaught basking sharks, measures should be put in place to ensure that incidental catches are recorded in weight and numbers, and carcasses or biological material made available for research.

7.13 References

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Table 7.1. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2014. "."=zero catch, "+" = <0.5 t.

	I & II	III & IV	Va	Vb	VI	VII	VIII	IX	X	XII	XIV	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	87	.	.	.	.	1	+	2	.	.	.	90
2006	6	.	.	.	.	+	+	.	.	.	.	7
2007	26	.	.	.	.	.	+	8	3	.	.	38
2008	4	.	.	.	.	+	2	.	.	.	.	7
2009	.	.	.	.	.	+	.	.	.	.	.	+
2010	.	.	.	.	.	.	.	.	.	.	.	0
2011	4	.	.	.	.	.	.	.	.	.	.	4
2012	22	.	.	.	.	.	.	.	.	.	.	22
2013	.	.	.	.	.	.	.	.	.	.	+	+
2014	.	.	.	.	.	.	.	.	.	.	.	0

Table 7.2. 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)	Recommended by ICESWGEF 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
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 sharks 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	Area IIa							Area IVa	
	Harpoon	Gillnets	Driftnets*	Undefined nets	Bottom Trawl	Danish seine	Hooks and line	Harpoon	Gillnets
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 sharks in the Northeast Atlantic. Summary details of bycatch reported from France (Unpublished data - APECS) and Norwegian bycatch reported in media.

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
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, museum collection	Unpublished data - APECS
France		May	2009	Mediterranean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterranean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterranean	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	Mediterranean	45.841	1.531	Bottom trawl	20 m			Discarded	Unpublished data - APECS
France	20	May	2009	Mediterranean	43.051	-3.391	Pelagic trawl	45 m	5 m		Discarded	Unpublished data - APECS
France	30	May	2011	Mediterranean	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, immature	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		Obsmer data, genetic sample	
France	17	May	2013	Atlantic	47.780	4.210	Gillnet		3.3 m		Discarded, samples, immature male	Unpublished data - APECS
Norway		Dec	2006	Atlantic	59.03	9.80	Gillnet	50 m	3.5 m	350	Approx. position	Media
Norway		Sep	2006	Atlantic	58.81	9.90	Gillnet		~4 m	500	Discarded, approx. position	Media
Norway		Aug	2007	Atlantic	61.97	5.02	Gillnet		4.5 m	250	Discarded, approx. position	Media
Norway			2007	Atlantic	64.13	8.20	Gillnet		4 m	500	Approx. position	Media
Norway		Sep	2007	Atlantic	58.45	8.86	Gillnet		4–5 m		Approx. position	Media

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
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

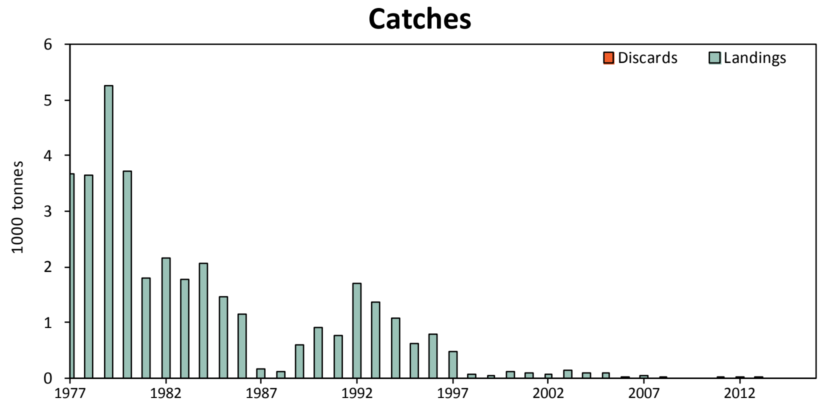

Figure 7.1. Basking sharks in the Northeast Atlantic. Total landings (1000 tonnes) of basking sharks in ICES Areas I–XIV from 1977–2014.

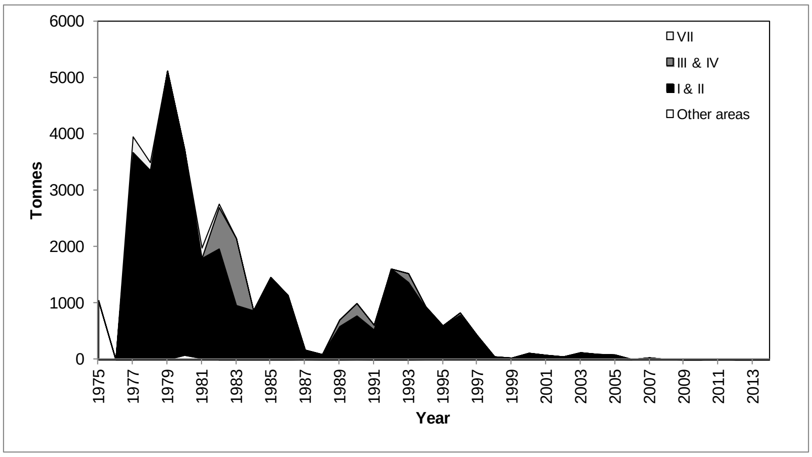

Figure 7.2. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1975–2014.

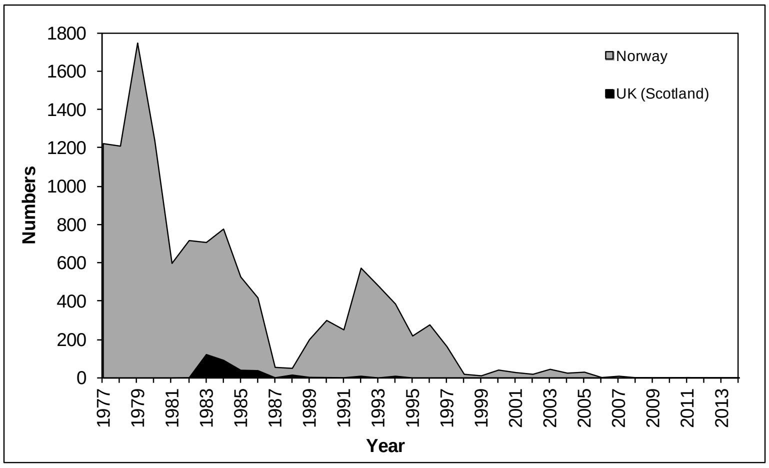

Figure 7.3. Basking sharks in the Northeast Atlantic. Numbers of basking sharks landed by Norway and Scotland in ICES Areas I–XIV from 1977–2014.

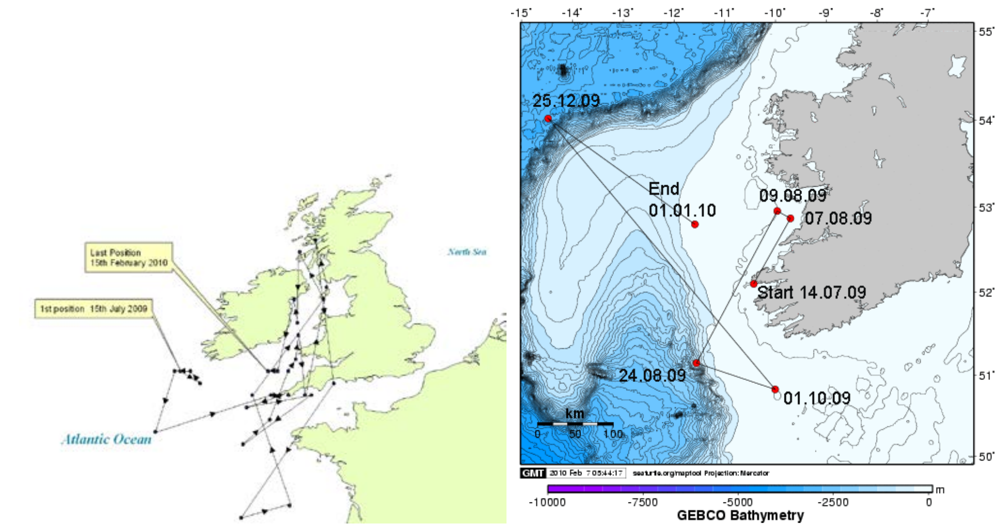

Figure 7.4. Basking sharks in the Northeast Atlantic. Geolocations from basking shark A (left, sex=male) and B (right, sex=unknown). Source: Berrow and Jackson, 2010.

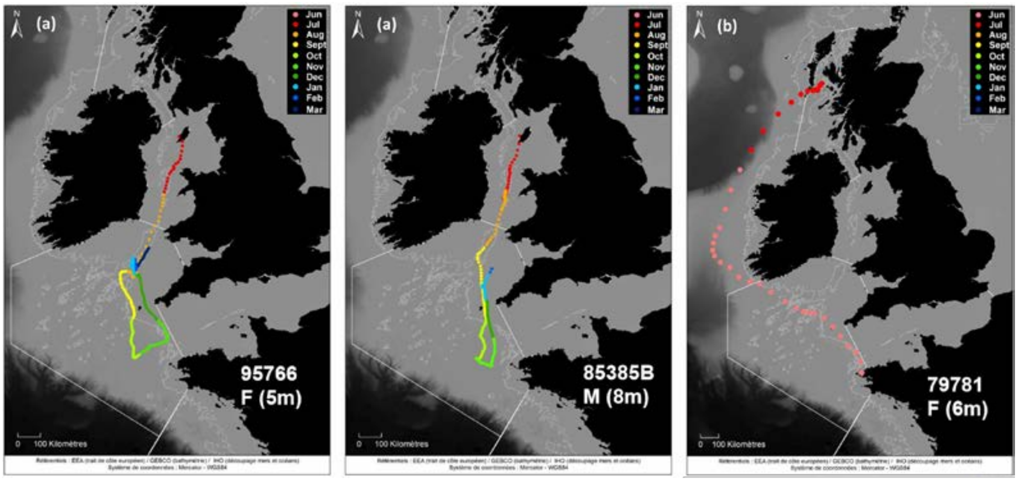

Figure 7.5. (a) Most probable track for sharks 95766 (Female - 5 meters) and 85385 (Male - 8 meters) tracked for more than 200 days and which stayed in the Irish Sea and Celtic Sea waters. (b) Most probable track for shark 79 781 (Female - 6 meters) tracked for 38 days.

8 Blue shark in the North Atlantic (North of 5°N)

8.1 Stock distribution

The DELASS project and the ICCAT Shark Assessment Working Group consider there to be one stock of blue shark *Prionace glauca* in the North Atlantic (Heessen, 2003; Fitzmaurice *et al.*, 2005; ICCAT, 2008). The ICES area is only part of the stock area. The 5°N parallel is considered the southern limit of the stock boundary (ICCAT, 2008) and the division between North and South Atlantic blue shark stocks. This is based on oceanographic features and to facilitate comparison with fisheries statistics from tuna-like species, as other North Atlantic stocks also have this southern stock boundary.

Preliminary results from a recent genetic study based on the control region of mitochondrial DNA sequences and using samples from the temperate NE Atlantic (Portugal), tropical NE Atlantic (Cape Verde), South Atlantic (Brazil) and SW Indian Ocean suggests that the blue shark is among the elasmobranch species with the highest nucleotide and haplotype diversity. There are also indications of high gene flow between regions without clear delimitation of different genetic stocks (Anon., 2015).

In March 2014 there was an inter-sessional meeting of the ICCAT Shark species group, and WGEF welcomes their conclusion that they "*recommend the continuation of the joint collaboration with the ICES Working Group on Elasmobranch Fishes; a formal invitation should be sent to the chair of this Working Group for their active participation in the 2015 BSH data preparatory and stock assessment sessions*" (ICCAT, 2014).

In July 2015, members of WGEF participated in the ICCAT blue shark stock assessment meeting that took place in Lisbon, Portugal (ICCAT, 2015). WGEF presents a section on blue shark here, to help summarize available data and present relevant results on the North Atlantic stock assessment.

8.2 The fishery

8.2.1 History of the fishery

In recent years, more information has become available about fisheries taking blue shark in the North Atlantic. Although available data are incomplete, it offers information on the situation in fisheries and trends. Although there are no large-scale directed fisheries for blue shark, it is a major bycatch in tuna and billfish fisheries, where it can comprise up to 70% of the total catches and even exceed the actual catch of targeted species (ICCAT, 2005). In the North Atlantic, the EU fleet (Portugal and Spain) is responsible for approximately 82% of the total landings (Anon, 2015).

Observer data indicated that substantially more sharks are caught as bycatch than reported in catch statistics. Blue sharks are also caught in considerable numbers in recreational fisheries, including in the ICES area (Campana *et al.*, 2005).

Since 1998 there has been a Basque artisanal longline fishery targeting blue shark and other pelagic sharks in the Bay of Biscay (Díez *et al.*, 2007). This fishery takes place from June to November and historically has involved between three and five vessels. As a consequence of changes in local fishing regulations the number of vessels has been reduced to two since 2008.

8.2.2 The fishery in 2014

In 2015, ICCAT nominal catch statistics of blue sharks by stock, flag and gear were reviewed. No major updates were made to the historical catch series. Only the most recent years of official catches were added/updated. Before 1997, there is a lack of official catches statistics for some of the major Countries operating in the stock area.

8.2.3 Advice applicable

ACOM has never provided advice for blue shark in the ICES area. Assessment of this stock is considered to be the responsibility of ICCAT. In 2015, ICCAT considered that the status of the North Atlantic stock is unlikely to be either overfished or subject to overfishing. However, due to the level of uncertainty in the assessment results no specific management recommendation was provided (ICCAT, 2015).

8.2.4 Management applicable

There are no measures regulating the catches of blue shark in the North Atlantic.

EC Regulation No. 1185/2003 prohibits the removal of shark fins of this species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

8.3 Catch data

8.3.1 Landings

It is difficult to accurately quantify landings of blue shark in the North Atlantic, as data are incomplete, and generic reporting of shark catches has resulted in underestimation. Landing data from different sources (ICCAT, FAO and national statistics) vary a lot. Table 8.1 gives the catch data (total landings and discards by stock, flag and major gears) collated by ICCAT, and which appears to provide the most complete landings for this species. ICCAT considers that the reported landings of blue shark were underestimated more so in the early part of the time-series (prior to 1997), with official landings and estimates of a comparable magnitude since 1997, with annual landings in the region of 20 000–40 000 t.

In 2015, alternative ways to estimate catch series were discussed, including different types of data and methods: 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. Generally, the overall data for blue shark (and sharks in general) has been improved slightly (more complete series by species, fewer quantities of unclassified sharks, less weight of unclassified gears in the shark series, etc.). However many unclassified sharks species, mostly grouped by family (Squatinidae, Squalidae, Lamnidae, Carcharhinidae, Sphyrnidae, Scyliorhinidae) and genera (*Apristurus*, *Squalus*, *Galeus*, *Ginglymostoma*, *Rhizoprionodon*, *Scyliorhinus*, *Mustelus*, *Etmopterus*, *Sphyrna* and *Alopias* spp.) were reported to ICCAT in the past. The largest portion of unclassified sharks (1982–2013) is concentrated in longline and gillnet fisheries (Anon., 2015).

In the North Atlantic, thirteen fisheries (in descending order of importance: 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). In the Mediterranean blue shark catches are residual (Anon., 2015).

Traditionally catches of this species reported to ICES have been minimal (0 to ~2500 t over the last 35 years), therefore in this report the more comprehensive data from ICCAT are presented in the catch table (Table 8.1). In the ICES area, blue shark is reported predominantly by Spain, Portugal, Japan and USA (Figure 8.1). The national data reported to ICES for 2012 totalled 1135 t, with the majority of this being reported by Spain (682 t) and Azores. This Spanish reported catch is derived from an artisanal directed pelagic shark longline fishery held by the Basque country. There were also comparatively low levels (<300 t) also reported by France, Portugal (Azores) and the United Kingdom.

Landings data of blue shark from FAO (FishStat) by major fishing area are shown in Figure 8.2. Figure 8.3 presents the different landings reported to ICCAT and FAO respectively.

The landing input data available for the assessment models used in 2015 ICCAT are comprehensively described and presented in the 2015 blue shark data preparatory meeting report (Anon., 2015). Figure 8.4 shows the various catch series (1971–2013) for North Atlantic blue shark available for the 2015 stock assessment (SA2015) estimates, 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). Both stock assessment series follow a similar trend (but with large differences in some years) with catches oscillating several times between 15 000 t and 55 000 t. The three shark-fin series show a completely different tendency (continuous upward trend) with catches starting around 10 000 t in the 1980s and growing to nearly 60 000 t in 2011 (Anon., 2015).

8.3.2 Discards

The low value of blue shark means that it is not always retained for the market. The most valuable body parts are the fins. In some fisheries the fins are retained and the carcasses discarded. In 2013 EU regulation (Regulation EU No 605/2013 of the European Parliament and of the Council of 12 June 2013) closed the loophole in the 2003 ban that had allowed fishermen with permits to remove shark fins on board vessels and land them separately from the bodies by amending Council Regulation (EC) No 1185/2003 on the removal of fins of sharks on board vessels. Accurate estimates of discarding are required in order to quantify total removals from the stock. Currently no such estimates are available. Differences between estimated and reported catch in various fisheries (ICCAT, 2008 and references cited therein) suggest that discarding is widespread in fisheries taking blue shark.

Discard estimates are available only for fisheries from Chinese Taipei Korea Rep USA, and UK (Bermuda). Excluding USA discards of the remaining fisheries are negligible. USA reported discards in quantities of 63–1136 t.year^{-1}, averaging about 268 t.year^{-1} over time (Anon., 2015).

The full extent of bycatch of blue shark cannot be interpreted from present data, but available evidence suggests that longline operations can catch more blue shark than target fish. There is considerable bycatch of blue sharks in Japanese and Taiwanese tuna longliners operating in the Atlantic. However it is not possible, from the information available, to estimate discard rates from these fleets. Discards can be presumed to be far higher than reported (Campana *et al.*, 2005), especially in high seas fisheries. It is thought that most discards of whole sharks would be alive on return to the sea. It is noted that discard survival rate is about 60% in longline fisheries and 80% in rod and reel fisheries (Campana *et al.*, 2005).

A study conducted on the Canadian pelagic longliners targeting swordfish in the Northwest Atlantic (Campana *et al*., 2009) demonstrated that "*the overall blue shark bycatch mortality in the pelagic longline fishery was estimated at 35%, while the estimated discard mortality for sharks that were released alive was 19%. The annual blue shark catch in the North Atlantic was estimated at about 84 000 t, of which 57 000 t is discarded. A preliminary estimate of 20 000 t of annual dead discards for North Atlantic blue sharks is similar to that of the reported nominal catch, and could substantially change the perception of population health if incorporated into a population-level stock assessment*".

In ICES IXa, information on discards of elasmobranchs in demersal otter trawl, deep-water set longlines, set gillnet and trammelnet fisheries for the period 2004–2013 showed that blue shark was only caught and discarded in the longline fishery in small numbers, and it was not observed in the other fisheries (Prista *et al*., 2014).

8.3.3 Discard survival

Blue shark appears to be one of the most frequent shark species captured in longline fisheries. Several studies have reported the at-vessel mortality of longline-caught blue shark to broadly range from about 5–35% (summarised in Ellis *et al.,* 2014 WD). Discard survival in such fisheries can be influenced by several factors, including hook type, soak time and size of shark.

The survival rate at hauling for blue shark was estimated to be 49% for the French pelagic longliners targeting swordfish in the southwestern Indian Ocean; experiments conducted with gear equipped with hook timers indicated also that 29% were alive after eight hours after their capture (Poisson *et al*., 2010). The survival rate of blue shark at haul back after a soak during the night was lower than that during day longline sets: 100% (Boggs, 1992), 80–90% (Campana *et al*., 2005), 69% (Diez and Serafy, 2005) and 87% (Francis *et al*., 2001).

8.3.4 Quality of catch data

Catch data are incomplete, and the extent of finning in high seas fisheries is unclear. The historical use of generic shark categories is problematic, although many European countries have begun to report more species-specific data.

Discrepancies have been identified between data reported to ICCAT and that reported to other agencies (ICCAT, 2008). However, work is now underway to consolidate the ICCAT, FAO and EUROSTAT databases (Palma *et al*., 2012). However, landings data are not sufficient to quantify total catch, because discarding is so widespread.

Methods developed to identify shark species from fins (Sebastian *et al*., 2008; Holmes *et al*., 2009) could help to gather data on species targeted by illegal fishers, this information will greatly assist in management and conservation.

The absence of blue shark mortality estimates related to the proportion of live discards can hamper the estimations of the total removals, although there are improving approaches to reporting of live discards to the ICCAT SCRS (Anon., 2015).

Given the uncertainty on the 2015 assessment of blue shark North Atlantic stock, ICCAT recommended for continued monitoring of the fisheries by observer and port sampling programmes (ICCAT, 2015).

8.4 Commercial catch composition

The information available on blue shark composition in commercial catches is considered incomplete. Japanese catches (landings and discards) from tuna longliners in the North Atlantic are estimated to have fluctuated between 2000–4500 t in recent years. These are higher than reported landings of the target species (bluefin tuna) from Japanese longliners in this period (ICCAT, 2008). Another study of Japanese bluefin tuna longline fishing demonstrated that the ratio of blue shark to the target species was about 1:1 (Boyd, 2008). Data from observed fishing for bluefin tuna by a Chinese Taipei (Taiwanese) vessel in the southern North Atlantic found that blue shark accounted for 76% of shark bycatch, though no information was presented on the percentage of blue shark in the total catch (Dai and Jang, 2008). Blue shark and shortfin mako are estimated together to account for between 69% and 72% of catches from Spanish and Portuguese surface longliners in the North Atlantic (Oceana, 2008).

8.4.1 Conversion factors

Information on the length–weight relationship is available from several scientific studies (Table 8.2), as are the relationships between various length measurements (Table 8.3). 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 the 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). There have been various estimates of fin weight to body weight (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

For the North Atlantic stock, catches show a peak in 1987, decline to 2000 and then increase. With some exceptions (EU-Portugal, USA_LL, Chinese Taipei, and Venezuela) and only for the most recent years, the lack of catch and effort and size data is very high.

The cpue input data available for the models are comprehensively described and presented in the 2015 blue shark data preparatory meeting report (Anon., 2015). New cpue series were however provided prior to the 2015 blue shark stock assessment meeting. Table 8.4 shows the various cpue indices currently available, which have been considered for use in the assessment. The cpue indices show a relatively flat trend throughout the time-series, but with high variance (Table 8.5; Figure 8.5).

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 *et al.*, 2008). A survey from 1977–1994 conducted by the US NMFS documented a decline among juvenile males blue sharks by 80%, but not among juvenile females, which also occur in fewer numbers in the area, the western North Atlantic off the coast of Massachusetts (Hueter *et al.*, 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

The blue shark is common in pelagic oceanic waters throughout the tropical and temperate oceans worldwide. It has one of the widest ranges of all the shark species. It may also be found close inshore.

In a satellite telemetry study, Queiroz *et al.* (2010) described complex and diverse types of behaviour depending on water stratification and/or depth (Figure 8.6). Females tagged in the Western channel were able to spend up to 70 days in this 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 inhabits waters with a wide temperature range from 10–20°C.

The US National Marine Fisheries Service also conducts a Cooperative Shark Tagging Programme (CSTP; Kohler *et al.*, 1998; NMFS, 2006), with tagging in the NE Atlantic also being undertaken under the auspices of the Inshore Fisheries Ireland (formerly the Irish Central Fishing Board) Tagging Programme (Green, 2007 WD) and UK Shark Tagging Programme, and there have been other earlier European tagging studies (e.g. Stevens, 1976). Figure 8.7 shows the tag and release results presented by ICCAT (2012), highlighting the large number tagged to date, and the vast horizontal movements undertaken by blue shark in the Atlantic.

In Australian waters blue sharks exhibit oscillatory dive behaviour between the surface layers to as deep as 560–1000 m. Blue sharks were mainly in 17.5–20.0°C water and spent 35–58% of their time in <50 m depths and 10–16% of their time in >300 m (Stevens *et al*., 2010). The distribution and movements of blue shark are strongly influenced by seasonal variations in water temperature, reproductive condition, and availability of prey. The blue shark is often found in large single sex schools containing individuals of similar size.

Adult blue sharks have no known predators; however, subadults and juveniles are eaten by both shortfin mako and white shark as well as by sea lions. Fishing is likely to be a major contributor to adult mortality. A recent first estimation of fishing mortality rate via satellite tagged sharks being recaptured by fishing vessels ranged from 9 to 33% (Queiroz *et al*., 2010).

Various studies have compiled data on biological information on this species in the North Atlantic and other areas. Some of these data are summarized in Table 8.2 (length–weight relationships), Table 8.6 (growth parameters) and Table 8.7 (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 first assembled at the ICCAT 2014 Intersessional Meeting of the Shark Species Group (SCRS/2014/012) 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 North and South Atlantic stocks of blue shark, based on the latest biological information available gathered at the 2015 blue shark data preparatory meeting. To encompass a plausible range of values, uncertainty in the estimates of life history inputs (reproductive age, lifespan, fecundity, von Bertalanffy growth parameters, and natural mortality) was incorporated through Monte Carlo simulation by assigning statistical distributions to those biological traits in a Leslie matrix approach. Estimated productivity was high (rmax=0.31–0.44 yr^{-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 was assessed. Age at first maturity and growth coefficient substantially influenced the productivity of species (e.g. a low age at first maturity and high growth coefficient results in high productivity). Breeding periodicity also affected productivity (i.e. a longer breeding period decreased productivity). Biological parameters should be carefully considered 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).

8.8 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 North Atlantic Blue shark stock was assessed by ICCAT in 2015 using two different approaches (see ICCAT, 2015 for more details): Bayesian Surplus Production Model (BSPM) and length-based age-structured models: Stock Synthesis (SS3).

The Bayesian Surplus Production Models adjusted consistently estimated a posterior for r that was similar to the prior, and a posterior for K that had a long right tail with high mean and CV (ICCAT, 2015). The estimated biomass trajectory stayed close to K for most runs, and the estimated harvest rate was low (Figure 8.8). The inclusion of process error did not improve the results. When each cpue index was fitted separately, the posterior mean of K varied, but the CVs were large, implying that none of the indices were particularly informative about the value of K.

Several SS3 runs were essayed. Run 4 and 6 (see details below) runs which utilized multiplication factors to reduce the input sample size assigned to length composition data in the model likelihood resulted in reasonable convergence diagnostics, described below.

Model Run	Model Adjustments				
Preliminary Run 1	Natural weights used in model likelihood				
	Length composition input sample size (n = observed)				
	Abundance indices (inverse CV weighting; SCRS/2015/151)				
Preliminary Run 2	Same as Preliminary Run 1 + Adjust CV of S9 (ESP-LL-N)				
CV adjustment	Constant CV of 20% applied to S9 (ESP-LL-N)				
Preliminary Run 3	Same as Preliminary Run 2 + Adjust input sample size for length comp				
Sample size adjustments	Maximum length composition input sample size (n=200)				
Preliminary Run 4	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.01	0.01	0.1	0.1	0.1
Preliminary Run 5	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.0184	0.0478	0.0261	0.1373	0.2236
Preliminary Run 6	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.0019	0.0047	0.0046	0.0573	0.0403

Model fits to cpue and length composition data were similar for both models. The fitting to abundance tracked trends well and were within most annual 95% confidence intervals for many abundance indices, including S3 (JPLL-N-e), S4 (JPLL-N-l), S6 (US-Obs-cru), S7 (POR-LL), and S9 (ESP-LL-N) (Figures 8.9–8.10). Model fits tracked trends reasonably well for abundance index S2 (US-Obs), but were often outside annual 95% confidence intervals. Predicted abundance was flat for abundance indices S8 (VEN-LL) and S10 (CTP-LL-N), probably because of large 95% confidence intervals for S8 and high inter-annual fluctuations in the early years for S10. Indices S1 (US-Log) and S5 (IRL-Rec) were only included in the model for exploratory purposes, were not fit in the model likelihood (lambda = 0), and had no influence on model results or predicted values. Model fits to length composition were reasonable for aggregate data (Figure 8.11).

Both Preliminary Run 4 and Preliminary Run 6 resulted in sustainable spawning stock size and fishing mortality rates relative to maximum sustainable yield (Figures 8.12–8.14). However, Preliminary Run 6 (the model run with relatively less weight applied to the length composition data in the model likelihood) resulted in a relatively more depleted stock size, compared to Preliminary Run 4.

Both models suggested sustainable spawning stock size and fishing mortality rates relative to maximum sustainable yield. The model with a relatively lower sample size assigned to the length composition data resulted in a relatively more depleted stock size. However, model fits to length composition were insufficient for annual length composition data, for which a bimodal pattern was strong. This is related to spatial segregation of the population. It was suggested that more work should be done to improve fits to length composition data before using the model to develop management advice.

8.10 Quality of assessments

At the 2015 ICCAT assessment meeting considerable progress was made on the integration of new data sources (in particular size data) and modelling approaches (in particular model structure). Uncertainty in data inputs and model configuration was explored through sensitivity analysis, which revealed that results were sensitive to structural assumptions of the models. The production models had difficulty fitting the flat or increasing trends in the cpue series combined with increasing catches. Overall, assessment results are uncertain (e.g. level of absolute abundance varied by an order of magnitude between models with different structures) and should be interpreted with caution.

For the North Atlantic stock, scenarios with the BSP estimated that the stock was not overfished (B_{2013}/B_{MSY}=1.50–1.96) and that overfishing was not occurring (F_{2013}/F_{MSY}=0.04–0.50). Estimates obtained with SS3 varied more widely, but still predicted that the stock was not overfished (B_{2013}/B_{MSY}=1.35–3.45) and that overfishing was not occurring (F_{2013}/F_{MSY}=0.15–0.75). Comparison of results obtained in the assessment conducted in 2008 and the current assessment revealed that, despite significant differences between inputs and models used, stock status results did not change drastically (B_{2007}/B_{MSY}=1.87–2.74 and F_{2007}/F_{MSY}=0.13–0.17 for the 2008 base runs using the BSP and a catch-free age-structured production model).

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

Blue shark is a highly migratory species that is listed as 'Near Threatened' by the IUCN.

8.13 Management considerations

Based on the scenarios and models explored, ICCAT considered the status of the North Atlantic stock as unlikely to be overfished nor subject to overfishing. However, due to the level of uncertainty, no specific management recommendations were developed.

Catch data are highly unreliable. Some cpue series are existent, and where data are available, mainly reveal declines since the mid-1990s. Further work is required to explain the downward trends and to quantify removals from the stock.

The catch data are considered incomplete, and underestimates. Besides unaccounted discards and the substantial occurrence of finning, it becomes obvious that countries supply data to ICCAT that are not available to ICES. For accurate stock assessments of pelagic sharks, better data are required. In addition, reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic "shark nei" categories. In the absence of reliable landings and catch data, catch ratios and market information derived from observers can provide useful information for understanding blue shark fishery dynamics.

At the Northern stock it was observed smaller sized blue sharks appeared 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 Stock Synthesis 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.

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 status of this 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 the need for continued monitoring of the fisheries by observer and port sampling programmes.

8.14 References

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Table 8.1. Blue shark in the North Atlantic. Landings (t) by country 1978–2011 from ICCAT Task I catch data. These are considered underestimates, especially prior to 1997.

Stock	Country	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
North Atlantic	Belize																					
	Brasil																					
	Canada								320	147	968	978	680	774	1277	1702	1260	1494	528	831	612	547
	Cape Verde																+					
	China P.R.																					
	Chinese Taipei																					
	EU.Denmark											2	2	1	1		1	2	3	1	1	
	EU.España																			24497	22504	21811
	EU.France	4	12		9	8	14	39	50	67	91	79	130	187	276	322	350	266	278	213	163	399
	EU.Ireland																					66
	EU.Netherlands																					
	EU.Portugal												1387	2257	1583	5726	4669	4722	4843	2630	2440	2227
	EU.United Kingdom												1				+	12			1	+
	FR.St Pierre et Miquelon																					
	Japan																1203	1145	618	489	340	357
	Mexico																	+				
	Panama																					9
	Senegal																					
	Trinidad and Tobago																					

Stock	Country	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	U.S.A.			204		605	107	341	1112	1400	776	751	829	1080	399	1816	601	641	987	391	447	317
	UK.Bermuda																	3	1	1	2	8
	Korea Rep.																					
	Namibia																					
	South Africa																					
	Uruguay																					
	Venezuela																					
N.Atlantic TotalTotal		4	12	204	9	613	121	380	1482	1614	1835	1810	3028	4299	3536	9566	8084	8285	7258	29053	26510	25741
Mediterranean	EU.Cyprus																					
	EU.España																			146	59	20
	EU.France																					
	EU.Italy																					
	EU.Malta																1	1	1	+	+	+
	EU.Portugal																				2	
	Japan																5	7	1	1		
Med TOTAL		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	5.581	8.376	1.768	147.95	60.856	20.445
N.ATL AND MED TOTAL		4	12	204	9	613	121	380	1482	1614	1835	1810	3028	4299	3536	9566	8090	8293	7260	29201	26571	25761

Table 8.1. Cont. Blue shark in the North Atlantic. Landings (t) by country 1978–2011 from ICCAT Task I catch data. These are considered underestimates, especially prior to 1997.

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TOTAL			40664	35800	32765	37928	36305	43072	43888	50464	53901	58842	65193	73050	63174	56848	47173
	ATN		28174	21709	20066	22951	21742	22359	23217	26927	30723	35198	37178	38084	36786	37202	30379
	ATS		12444	14043	12682	14967	14438	20642	20493	23487	23097	23459	27799	34926	26347	19545	16740
	MED		45	47	17	11	125	72	178	50	81	185	216	40	42	100	53
Landings	ATN	Longline	27305	20699	19290	22880	21297	22167	23067	26810	30514	35031	36952	37777	36549	36882	30313
		Other surf.	732	905	708	70	380	126	104	63	80	63	59	100	109	74	58
	ATS	Longline	12444	14042	12678	14961	14339	20638	20434	23417	22708	23453	27785	34531	25878	19375	16564
		Other surf.	0	1	4	6	99	3	59	10	375	6	14	391	264	0	
	MED	Longline	44	47	17	10	43	71	83	48	81	18	50	40	41	68	53
		Other surf.	1	1	1	0	81	0	95	2	1	167	165	0	0	32	1
Discards	ATN	Longline	137	105	68	0	63	66	45	53	129	102	167	205	127	246	9
		Other surf.	0	0	0	0	1	0	0	0	1	1	1	2	1	0	
	ATS	Longline	0	0	0	0	0	0	0	60	14	0	0	4	206	169	176
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATN	Belize	0	0	0	0	0	0	0	0	0	114	461	1039	903	1216	
		Brazil	7	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Canada	624	1162	836	346	965	1134	977	843	0	0	0	0	1	0	
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		China PR	0	185	104	148	0	0	0	367	109	88	53	109	98	327	
		Chinese Taipei	165	59	0	171	206	240	588	292	110	73	99	148	94	121	81
		EU.Denmark	2	1	13	5	1	0	0	0	0	0	0	0	0	0	

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
		EU.Spain	24112	17362	15666	15975	17314	15006	15464	17038	20788	24465	26094	27988	28666	28562	25202
		EU.France	395	207	221	57	106	120	99	167	119	84	122	115	31	216	129
		EU.Ireland	31	66	11	2	0	0	0	0	0	0	0	1	3	2	1
		EU.Netherlands	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
		EU.Portugal	2081	2110	2265	5643	2025	4027	4338	5283	6167	6252	8261	6509	3768	3694	2913
		EU.United Kingdom	12	9	6	4	6	5	3	6	6	96	8	10	8	10	10
		FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
		Japan	273	350	386	558	1035	1729	1434	1921	2531	2007	1763	1227	2437	1808	2034
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	537	299	327	
		Mexico	0	6	0	0	0	0	0	0	0	0	0	0	0	0	
		Panama	0	0	0	0	0	0	254	892	613	1575	0	0	0	289	
		Senegal	0	0	456	0	0	0	0	43	134	255	56	0	5	12	
		Suriname	0	0	0	0	0	0	0	0	0	0	0	0	181	281	
		Trinidad and Tobago	0	0	6	3	2	1	1	0	2	8	9	11	11	8	
		U.S.A.	291	39	0	0	7	2	2	1	8	4	9	65	56	32	
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Venezuela	43	47	29	40	10	28	12	19	8	73	75	118	98	52	
Discards	ATN	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	21	14	9
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		U.S.A.	137	106	68	0	65	66	45	54	130	103	167	206	106	231	
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 8.2. 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
WD = (8.04021 x 10–7) LF ^ 3.23189	C	354	75–250 (LF)	García-Cortés and Mejuto, 2002
WR = (3.1841 x 10–6) LF ^ 3.1313	C	4529		Castro, 1983
WR = (3.92 x 10–6) LT ^ 3.41	Male	17		Stevens, 1975
WR = (3.184 x 10–7) LT ^ 3.20	Female	450		Stevens, 1975
WR = (3.2 x 10–6) LF ^ 3.128	C	720		Campana *et al.*, 2005
WD = (1.7 x 10–6) LF ^ 3.205	C	382		Campana *et al.*, 2005

Table 8.3(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
LF = 1.076 LS + 1.862 (n = 1043)	LF = 1.080 LS + 1.552 (n = 1276)	LF = 1.079 LS + 1.668 (n = 2319)
LT = 1.249 LS + 7.476 (n = 1043)	LT = 1.272 LS + 4.466 (n = 1272)	LT = 1.262 LS + 5.746 (n = 2315)
LUC = 0.219 LS + 4.861 (n = 1038)	LUC = 0.316 LS + 2.191 (n = 1264)	LUC = 0.306 LS + 3.288 (n = 2302)
LT = 1.158 LF + 5.678 (n = 1043)	LT = 1.117 LF + 2.958 (n = 1272)	LT = 1.167 LF + 4.133 (n = 2315)

Table 8.3(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	LF = (0.8313) LT + 1.3908	572	Kohler *et al.*, 1995
NE Atlantic	LF = 0.8203 LT –1.061		Castro and Mejuto, 1995
NW Atlantic	LF = –1.2 +0.842 LT	792	Campana *et al.*, 2005
NW Atlantic	LT = 3.8 + 1.17 LF	792	Campana *et al.*, 2005
NW Atlantic	LCF = 2.1 + 1.0 LSF	782	Campana *et al.*, 2005
NW Atlantic	LSF = –0.8 + 0.98 LCF	782	Campana *et al.*, 2005
NW Atlantic	LF = 23.4 + 3.50 LID	894	Campana *et al.*, 2005
NW Atlantic	LID = –4.3 + 0.273 LF	894	Campana *et al.*, 2005

Table 8.4. 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	JPLLl	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 8.5. 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 8.6. 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 8.7. 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	
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

Parameter	Values	Sample Size	Area	Reference
	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

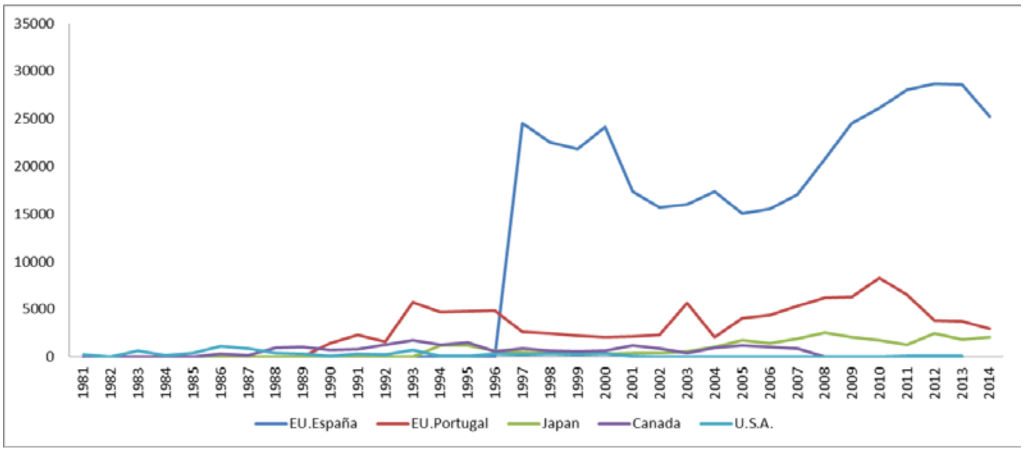


Figure 8.1. Blue shark in the North Atlantic. Preliminary estimates of landings of blue shark in the Atlantic for the four main countries (Source: ICCAT Task I data).

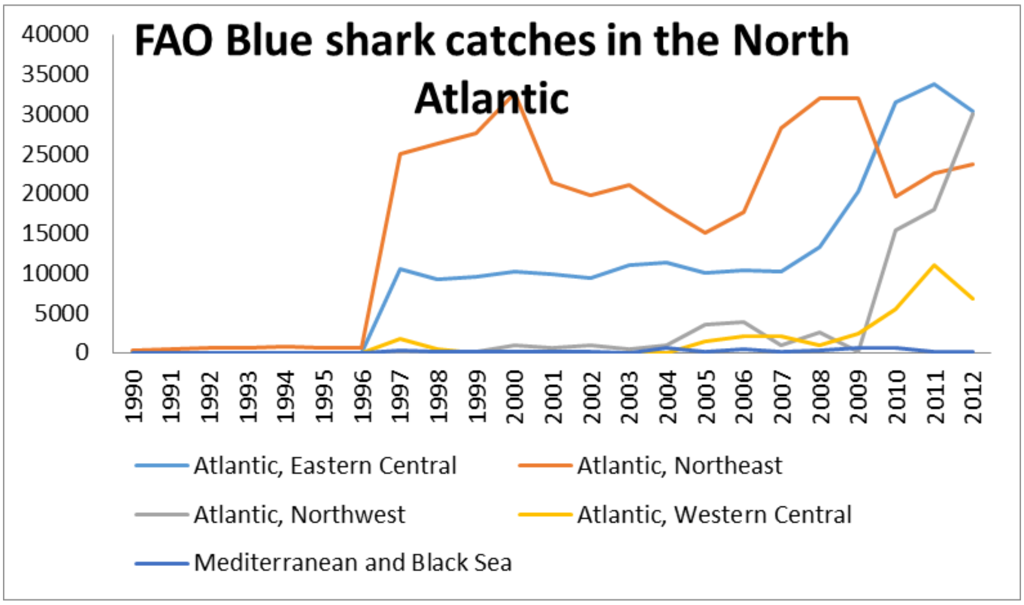


Figure 8.2. Blue shark in the North Atlantic. Preliminary estimates of landings of blue shark in the Atlantic Ocean for the different areas (Source: FAO, 2014).

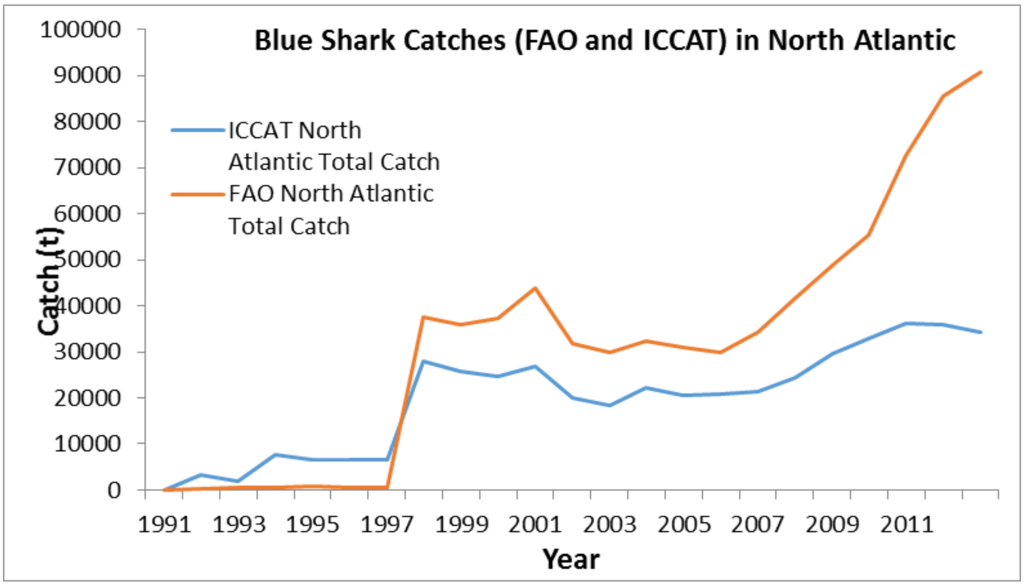


Figure 8.3. Blue shark in the North Atlantic. Blue shark landings in the North Atlantic from FAO and ICCAT data.

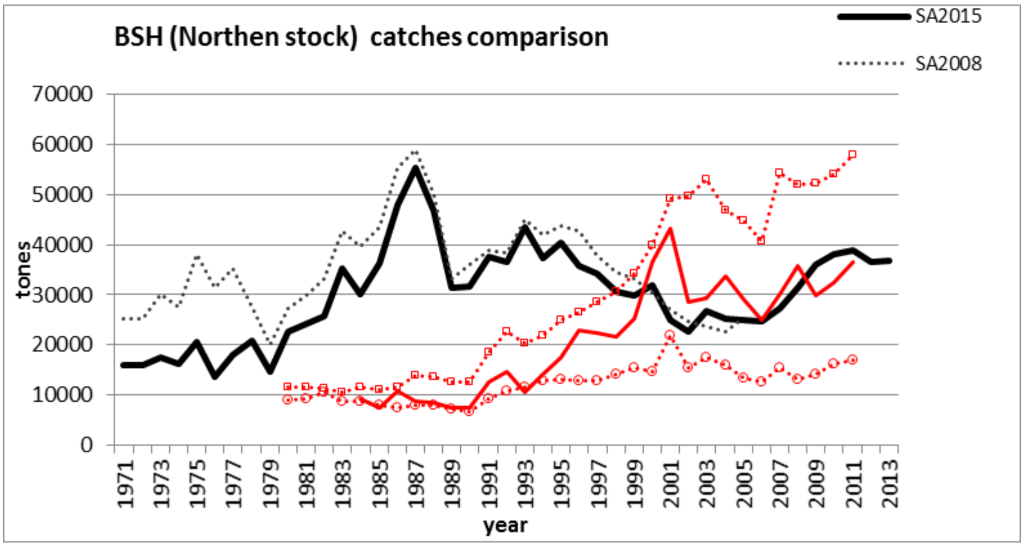


Figure 8.4. Blue shark in the North Atlantic. Comparison of various catch series for the North Atlantic stock of blue shark (1971–2013). In black, the stock assessment catches from the 2008 stock assessment and 2015 estimations. In red three catch series obtained using shark-fin ratios with three different approaches (area, effort, target level).

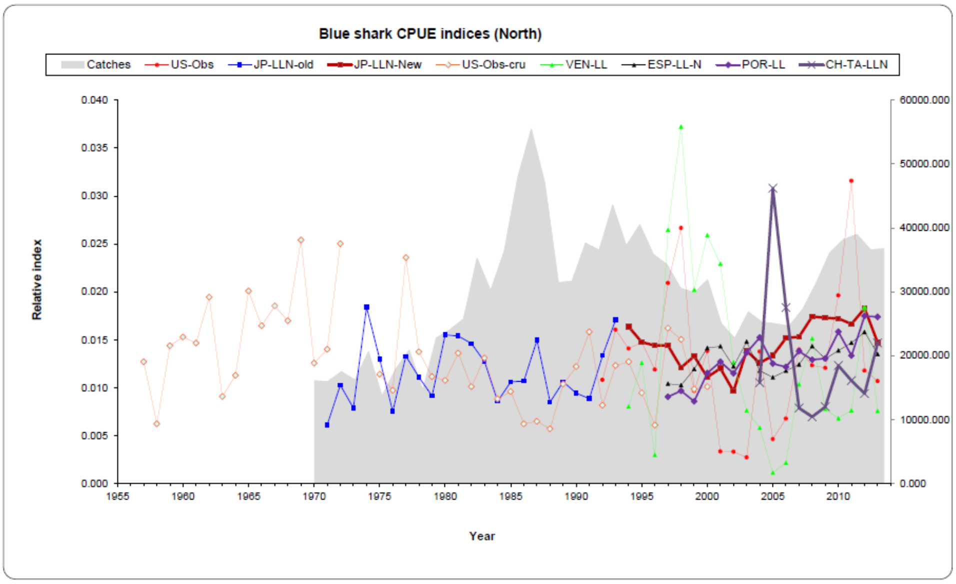


Figure 8.5. Blue shark in the North Atlantic. Indices of abundance and catches. Source: ICCAT (2015).

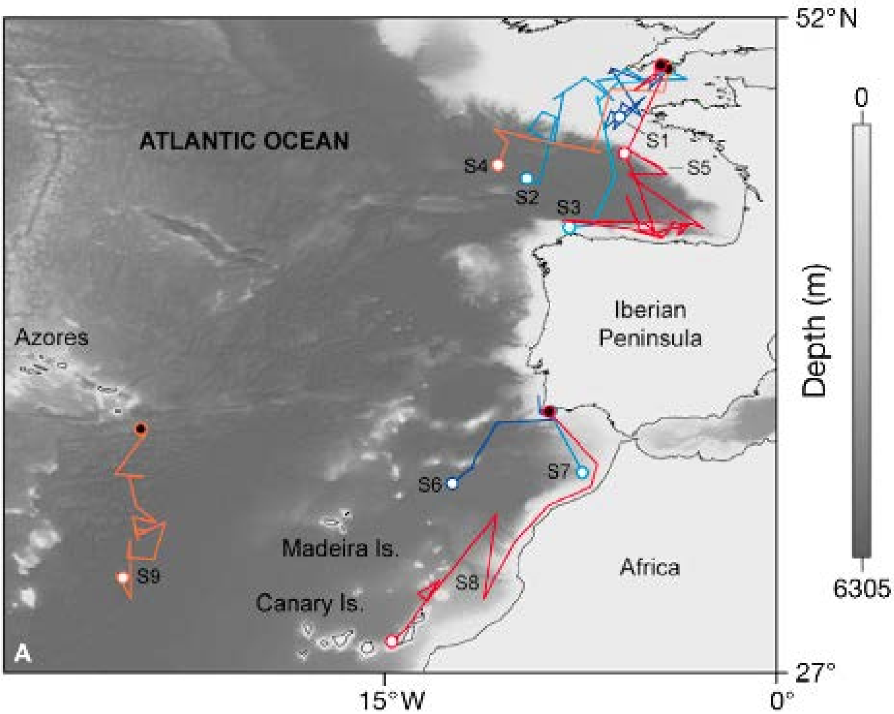
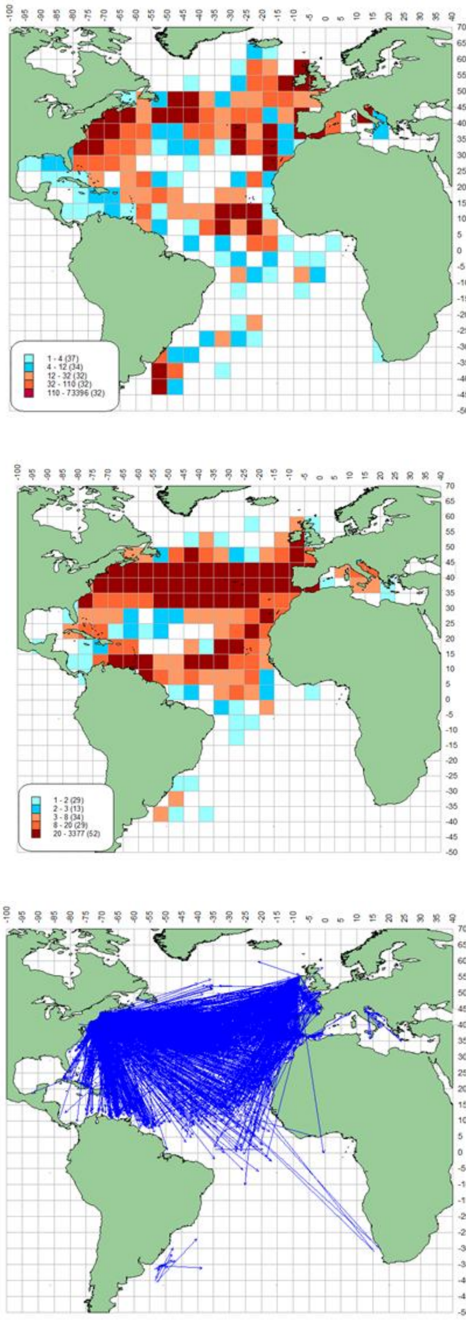


Figure 8.6. Blue shark in the North Atlantic. Pop-off satellite-tagged blue shark movement patterns. (A) General movements overlaid on bathymetry; black circles denote tagging locations and white circles the pop-up/capture locations. (B to J) Individual tracks overlaid on sea surface temperature maps; white circles are geolocated positions with date. Source: Queiroz *et al.* (2010).



a) b) c)

Figure 8.7. 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.

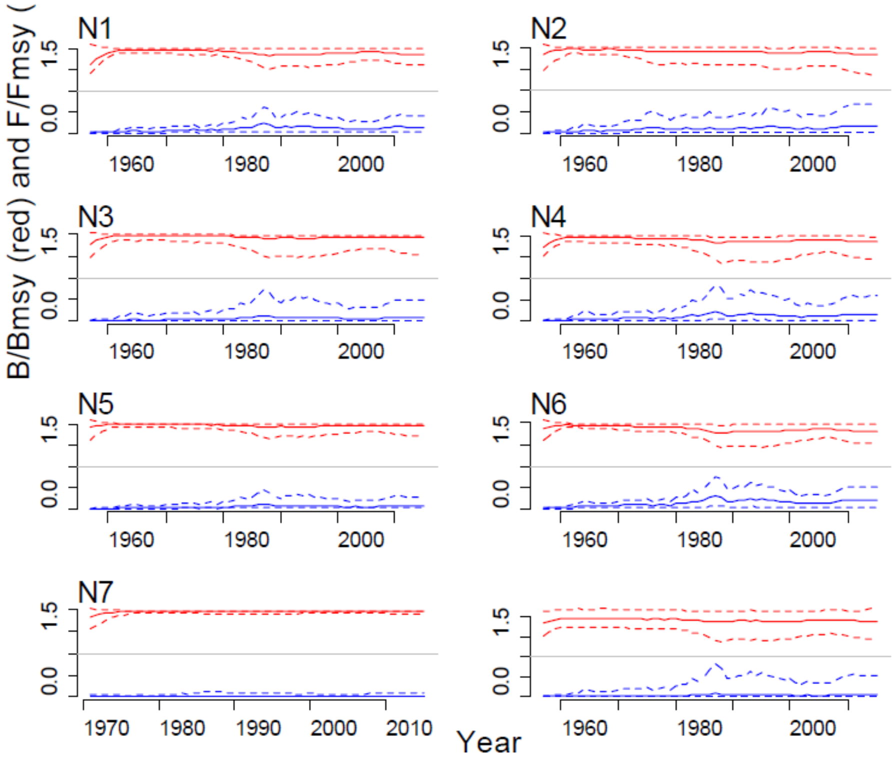


Figure 8.8. Blue shark in the North Atlantic. Estimated biomass relative to B_{MSY} (in red) and harvest rate relative to the MSY level (blue), for the BSP runs. Source: ICCAT (2015).

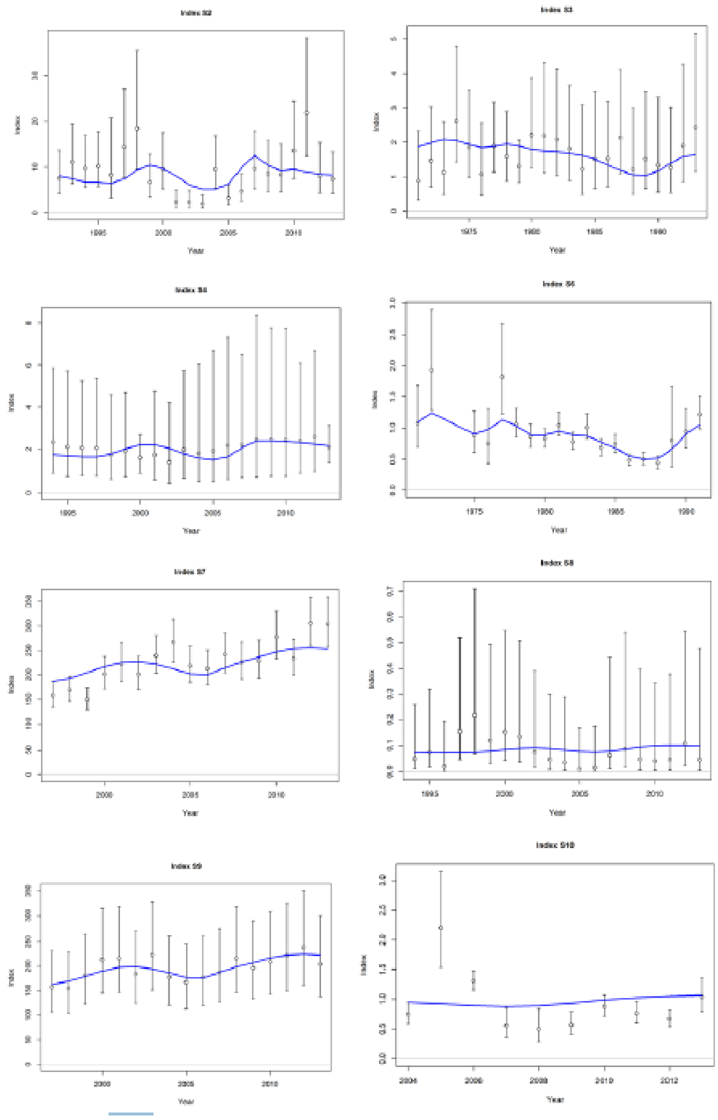


Figure 8.9. Blue shark in the North Atlantic. Preliminary Run 4 observed cpue (open circles ± 95% confidence intervals assuming lognormal error) and model predicted cpue (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, middle 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).

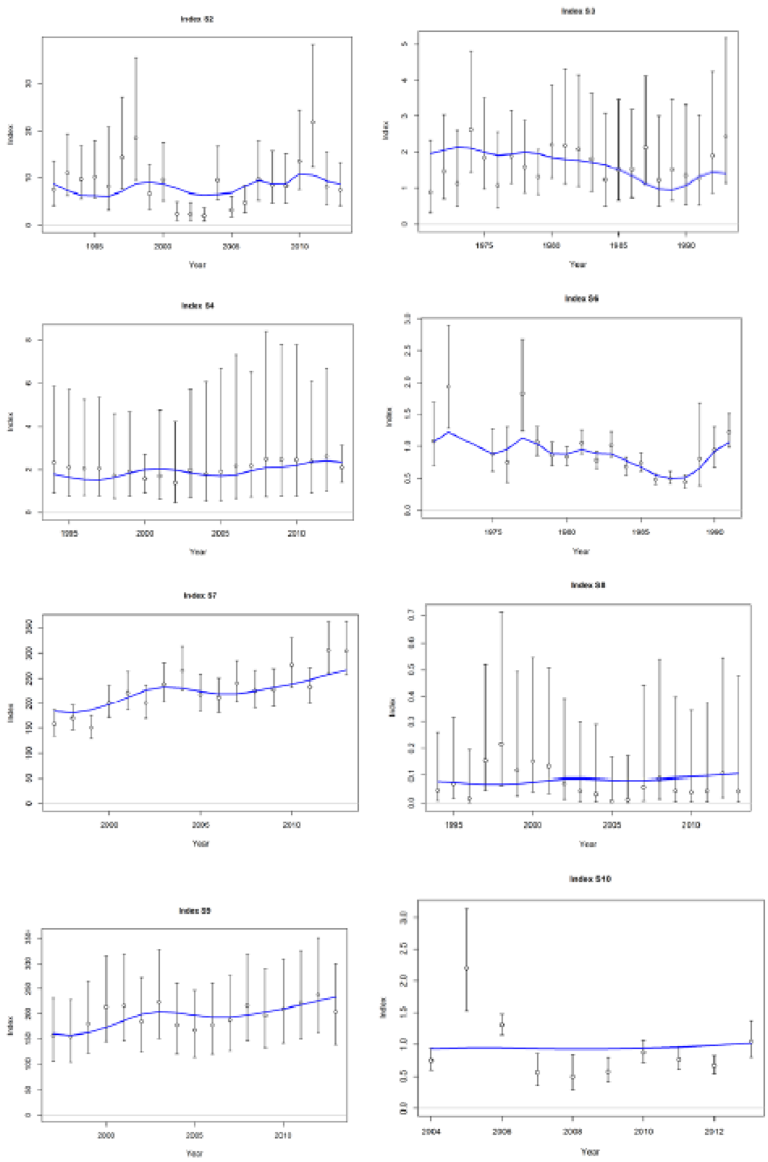


Figure 8.10. Blue shark in the North Atlantic. Preliminary Run 6 observed cpue (open circles ± 95% confidence intervals assuming lognormal error) and model predicted cpue (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, 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).

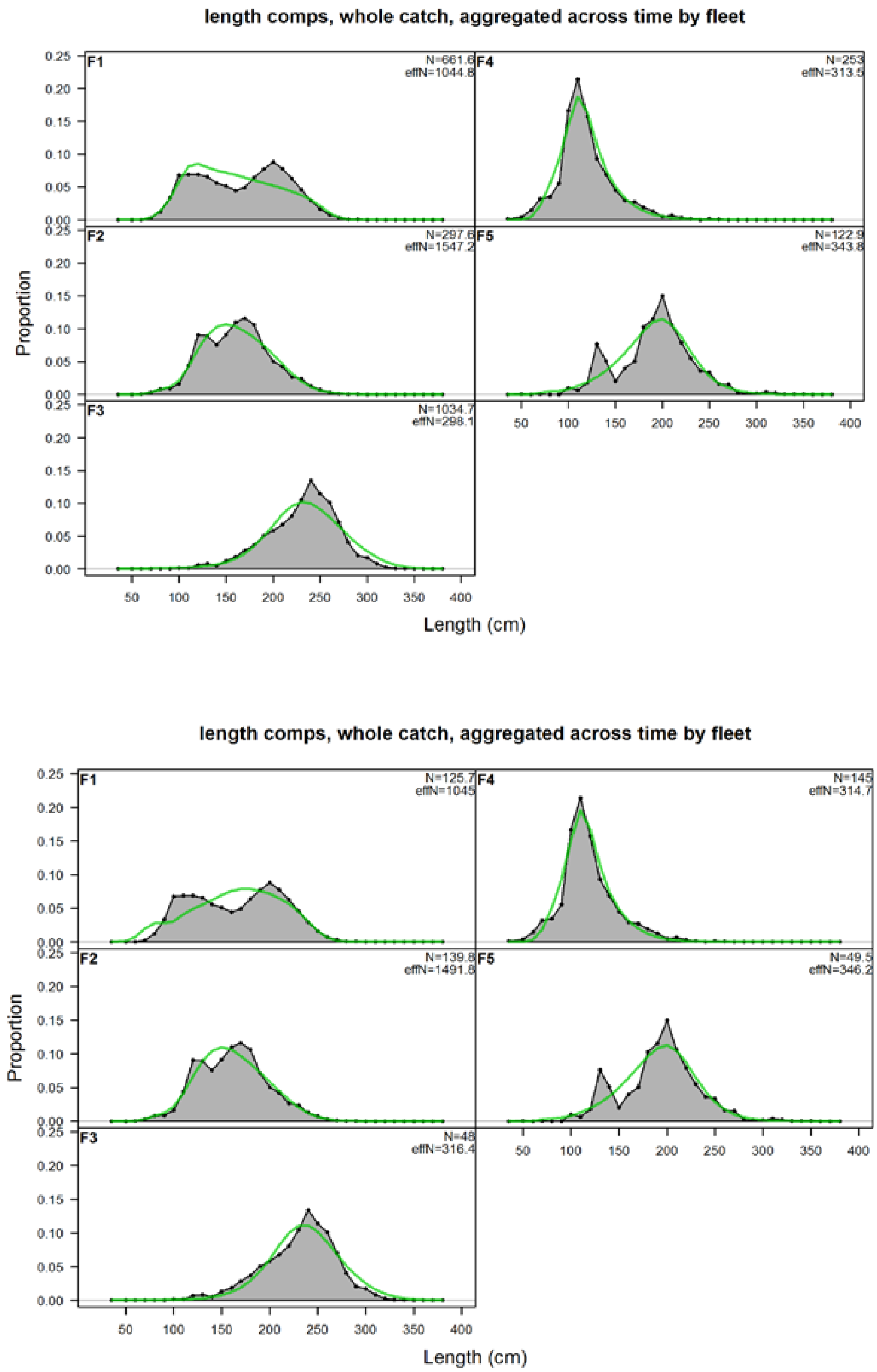


Figure 8.11. Blue shark in the North Atlantic. Model predicted (line) and observed (shaded) aggregated annual length compositions (female + male) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

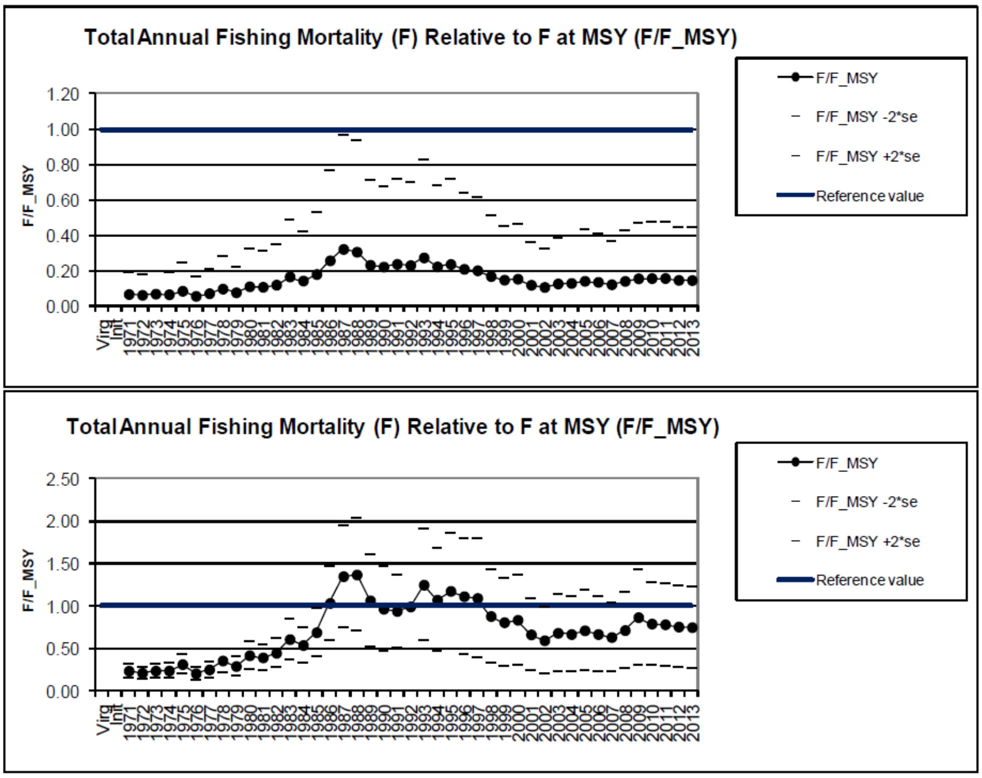


Figure 8.12. Blue shark in the North Atlantic. Estimated annual total exploitation rate in numbers (total fishing mortality for all fleets combined) relative to fishing mortality at MSY (F/F_{MSY}), obtained from Stock Synthesis output for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

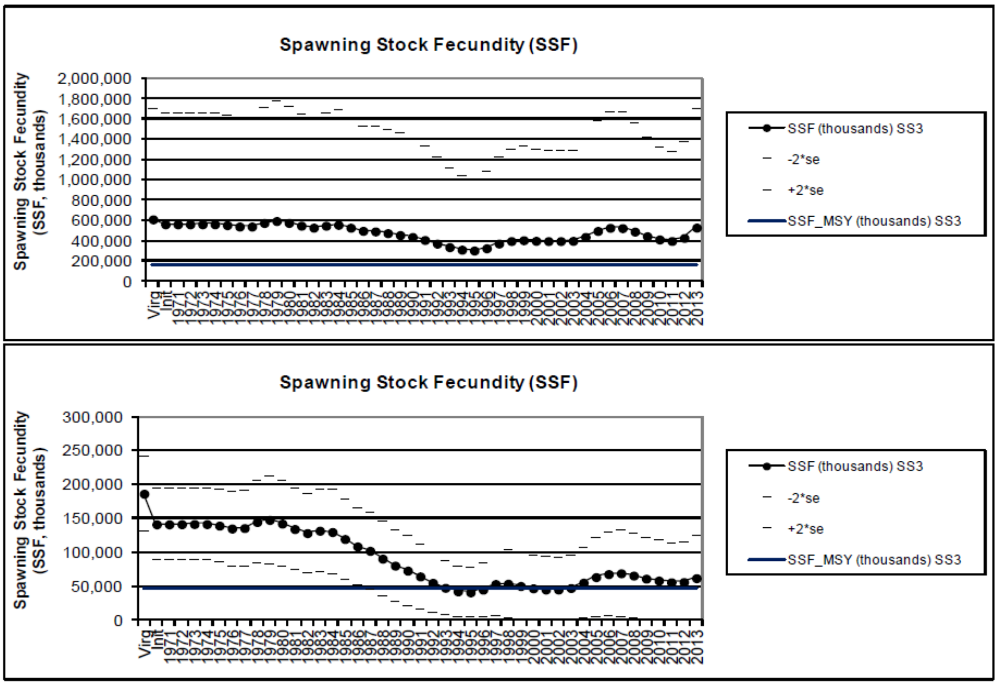


Figure 8.13. Blue shark in the North Atlantic. Estimated spawning stock size (spawning stock fecundity, SSF) along with approximate 95% asymptotic standard errors (+- 2*s.e.) relative to spawning stock size at MSY (SSFMSY) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

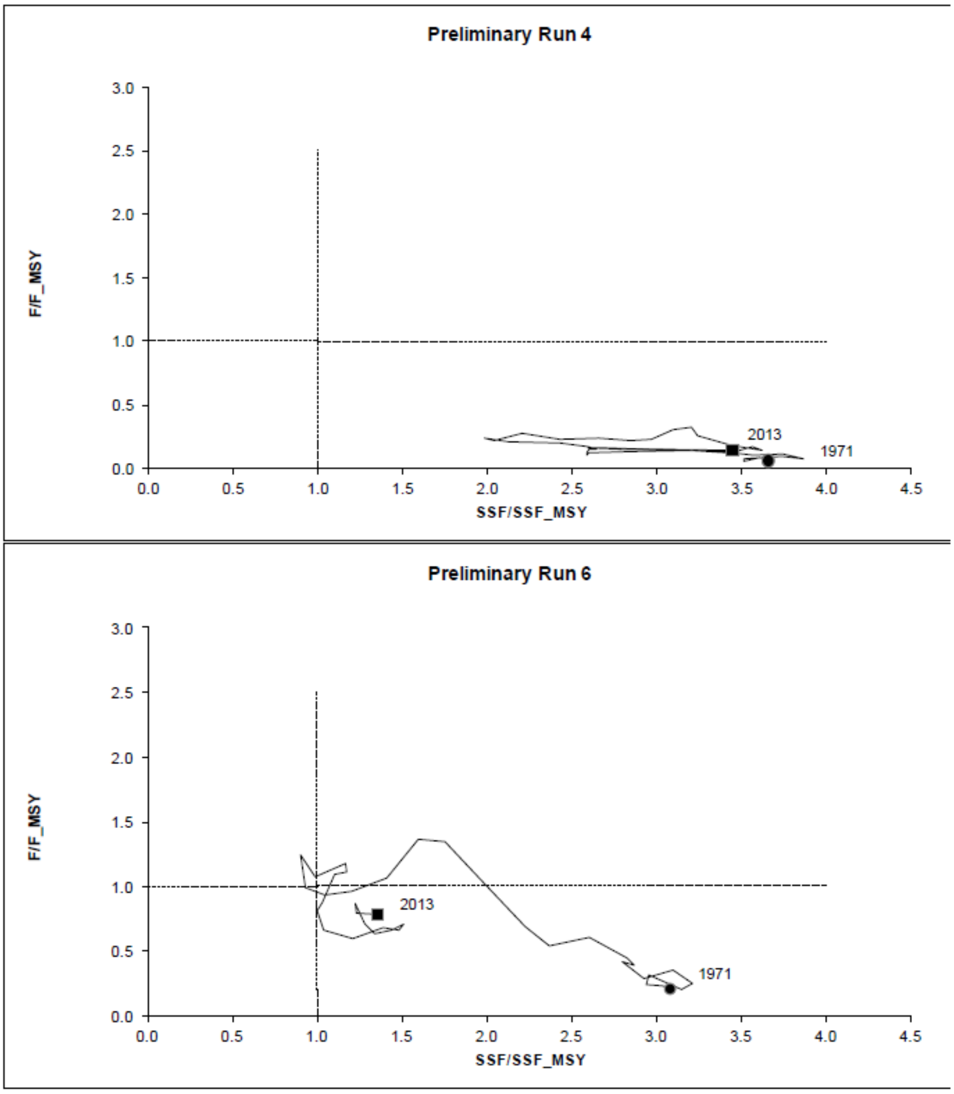


Figure 8.14. Blue shark in the North Atlantic. Kobe Phase plots for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). The circle indicates the position of the start year of the model (1971) and the square represents the end year of the model (2013). The horizontal (dotted) line identifies 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).

9 Shortfin mako in the North Atlantic (North of 5°N)

This section only contains minor edits from the previous year (ICES, 2014). Updates to landings data and other information will be undertaken next year.

9.1 Stock distribution

One stock of shortfin mako *Isurus oxyrinchus* is considered to exist in the North Atlantic. This is based on genetic analyses and tagging studies (e.g. Kohler *et al.*, 2002). The International Commission for the Conservation of Atlantic Tunas (ICCAT) tagging database contains over 9 200 releases and 1 200 recaptures (13% return rate), with *ca.* 60% of sharks still at large within two years (Figure 9.1). Releases and recaptures were concentrated in the northwest Atlantic. Genetic studies have found no evidence suggesting separate east and west populations in the Atlantic, whilst North Atlantic samples were distinct from samples from the South Atlantic and other oceans (Heist *et al.*, 1996; Schrey and Heist, 2002). Hence, the ICES area is only part of the North Atlantic stock.

Based on the oceanography of equatorial waters, and that other large pelagic species (e.g. swordfish, blue shark) have a southern stock boundary of 5°N, this is also suggested to be the southern limit of the North Atlantic shortfin mako stock. The stock area broadly equates with FAO Areas 27, 21, 31 and 34 (in part). The relationship between shortfin mako in the North Atlantic and Mediterranean Sea is unclear. The North Atlantic assessment does not include data from the Mediterranean Sea.

9.2 The fishery

9.2.1 History of the fishery

Shortfin mako is a highly migratory pelagic species that is a frequent bycatch in pelagic longline fisheries targeting tuna and billfish, 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 thus is normally retained (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 fish are released alive from these fisheries.

Shortfin mako is also taken in Mediterranean Sea fisheries (STECF, 2003). Tudela *et al.* (2005) observed 542 shortfin mako taken as a bycatch in 4140 km of driftnets set in the Alboran Sea between December 2002 and September 2003.

Traditionally, minimal catches of this species have been reported to ICES (7 to ~1000 t in the last 20 years). Landings data from ICCAT are given in the catch table (Table 9.1). The main country reporting landings of this species to ICES in 2012 was Portugal (Azores), where catch was 24 t. Small quantities (<2 t) were reported by France and UK.

9.2.2 The fishery in 2014

No new information and landings data should be regarded as preliminary.

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. The last ICCAT assessment (2012) recommends, as a precautionary approach, that the fishing mortality of shortfin mako should not be increased until more reliable stock assessment results are available for both the north and south stocks. The next ICCAT assessment for shortfin mako is planned for 2019.

9.2.4 Management applicable

There are no measures regulating the catches of shortfin mako in the North Atlantic.

EC Regulation No. 1185/2003 prohibits the removal of 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.

9.3 Catch data

9.3.1 Landings

Available landings data from ICCAT Task I catch data (total landings and discards by stock, flag and major gears) are given in Table 9.1. These values are considered underestimates, due to the inconsistent or generic reporting of shark catches by fleets. Catch series of "unclassified" shark groups represent about 20% on average (ranging from 11–32% from 1994–2002) of the total ICCAT Task I database of shark catches, and were not included here. At a recent inter-sessional meeting of the ICCAT shark species group in Uruguay (March 2014) it was noted that "*The coverage of Task I and II data of sharks has improved in recent years, especially for the blue, shortfin mako and porbeagle sharks; however, coverage for other shark species was still fragmentary*" (ICCAT, 2014).

In 2011, 3821 t of shortfin mako catch was reported to ICCAT (Figure 9.2) in the North Atlantic (85% from longline fleets, 5% from sport fishing, 10% from other fleets). Although this is a slight decrease on 2010 landings, landings had been relatively stable over recent years. The main countries reporting catches in the North Atlantic are Spain, Portugal, USA and Japan (Figure 9.3), accounting for 44%, 27%, 11% and 2% of total reported landings in 2011, respectively. National landings reported to ICES for 2012 were 26 t for the northeast Atlantic, with the majority of this from Area X by Portugal (the Azores: 24 t). Smaller amounts were reported by France and the UK.

In the Mediterranean Sea, total reported landings to ICCAT were just 2 t, from Spain and Cyprus. Since 1997, reported landings in the Mediterranean Sea have always been low (<9 t), with peaks in reported landings of in 2005 (17 t) and 2006 (10 t).

9.3.2 Discards

Although discard data are also given in Table 9.1, these are considered a large underestimate, with the USA longline being the only fleet to report a small amount of discards from 1987–1996 (1–38 t) and 2007–2010 (7–20 t). There are no reported discards from the Mediterranean Sea. Actual levels of shortfin mako bycatch is difficult to estimate, as available data are limited and documentation is incomplete. A report of the US pelagic longline observer programme stated that of the sharks caught alive, 23% were released alive and 61% retained (ICCAT, 2005).

Shortfin mako is a high value species, and many European fisheries 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 occur for this species as well, which may result in undocumented catches and mortality in some fleets. Finning regulations are in force in various fisheries, but the extent of finning in IUU fisheries is unknown.

9.3.3 Quality of catch data

Catch data are considered underestimates, and the extent of finning in high seas fisheries is unclear. The historical use of generic shark categories is problematic, although many European countries have begun to report species-specific data in recent years. Despite some important recovery of historical catch series in recent years, ICCAT considers that the overall catch is underestimated, particularly before 2000.

There have been major discrepancies between reported landings in databases from ICCAT, FAO and EuroStat. The ICCAT Secretariat consolidated these three data sources into a unique database, and currently progress is being made on its validation and the associated data mining task (analysis of equivalent data series at various aggregation levels; Palma *et al*., 2012). FAO data have been revised in recent years, and historical catch figures have increased from what was reported previously. The catches by FAO area (Figure 9.4) and the total North Atlantic catch are shown along with ICCAT catch totals (Figure 9.2) for comparison.

Previous ICCAT assessments of shortfin mako used two different estimates of landings for this stock, 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.

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*., 2014 WD). Discard survival in such fisheries can be influenced by several factors, including hook type, soak time and size of shark.

9.4 Commercial catch composition

No new information.

9.4.1 Conversion factors

Scientific estimates for various conversion factors for shortfin mako are summarised for length–weight relationships (Table 9.2) and different length measurements (Table 9.3). Shortfin mako can be 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).

9.5 Commercial catch and effort data

Cpue data were compiled at earlier ICCAT assessment meetings in 2004 and 2008. These data indicated a declining trend for the North Atlantic stock for the years 1975–2004. In the 2012 North Atlantic shortfin mako assessment, six cpue series from longline fleets (Portugal, Spain, USA, Uruguay, Japan and Brazil) and a cpue index from the US Recreational Fishery were presented (Figure 9.5).

Indices of abundance from the US pelagic longline logbook programme (1986–2010) and the US pelagic longline observer programme (1992–2010) showed a concave shape, marked by an initial decline until the late 1990s, followed by an upward trend to 2010 (Cortés, 2012). Data from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS; 1981–2010) showed high variability, with high catches in the mid-1990s, followed by a decline, then a stable trend over the last ten years (Babcock, 2010). Standardized cpue from logbook data of the Japanese tuna longline fishery in the North Atlantic Ocean (1994–2010) ranged from 0.07 to 0.1 between 1994 and 2005, and then showed a continuous increasing trend (Semba *et al*., 2012). In general, the available cpue series showed increasing or flat trends for the final years of each series (since the last stock assessment).

Although the relationship between Atlantic and Mediterranean Sea shortfin mako is unclear, Tudela *et al*. (2005) estimated cpue based on driftnetters from Al Hoceima and Nador fishing in the Alboran Sea. Di Natale and Pelusi (2000) reported data from the Italian large pelagic longline fishery in the Tyrrhenian Sea (1998–1999), and calculated a mean cpue of 1.1 kg per 1000 hooks.

9.6 Fishery-independent surveys

No fishery-independent data from the NE Atlantic are available.

Fishery-independent data are available from the NW Atlantic (Simpfendorfer *et al.*, 2002; Hueter and Simpfendorfer, 2008). Babcock (2010) provided an index of abundance of shortfin mako catch rates from the US East Coast from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS). A total of 711 shortfin mako were reported from 1981–2010. There were 252 686 trips of which about 0.2% caught at least one shortfin mako.

The NMFS of the USA also conducts a Cooperative Shark Tagging Programme (CSTP), which collaborates with the Shark Tagging Programme of Inland Fisheries Ireland (formerly the Irish Central Fisheries Board) (Green, 2007 WD; NMFS, 2006).

At the 2014 ICCAT Inter-sessional meeting of the shark subgroup, a Portuguese research project was presented on mitigation measures for shark bycatch in pelagic longline fisheries. An electronic tagging experiment will be carried out during this research project, so as to evaluate post-release mortality of shortfin mako.

9.7 Life-history information

Various studies have provided biological information for this species (see also Stevens, 2008). Data available for the North Atlantic stock are given in Table 9.2 (length–weight relationships), Table 9.4 (growth parameters), and Table 9.5 (other life-history parameters). There was also an update of life-history parameters in the report of the most recent inter-sessional meeting of the ICCAT shark sub-group. ICCAT intends to review the parameters in order to see if they can be used in the stock assessment models (see ICCAT, 2014).

9.7.1 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). They are 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 this species prefers clear water (Compagno, 2001).

9.7.2 Nursery grounds

Published records of potential nursery grounds are lacking. Buencuerpo *et al.* (1998) suggested that the western basin of the Mediterranean Sea was a nursery area. Stevens (2008) suggested that nursery areas would likely be situated close to the coast in highly productive areas, based on the majority of reports, with nursery grounds potentially off West Africa in the North Atlantic.

9.7.3 Diet

Shortfin mako feed primarily on fish, with a wide variety of both pelagic and demersal species observed in stomach contents (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 consume 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 diets 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).

9.8 Exploratory assessment models

9.8.1 Previous assessments

In 2004, ICCAT held an assessment meeting to assess stock status of shortfin mako (ICCAT, 2005). Overall, the quality and availability of data were considered limited and results considered provisional. Based on cpue data, it was likely that the North Atlantic stock of shortfin mako had been depleted to about 50% of previous levels. Stock capacity was likely be below MSY and a high to full level of exploitation for this stock was inferred from available data. It was considered that further studies were needed and in particularly the underlying assumptions of the model needed to be optimized before stronger conclusions could be drawn (ICCAT 2005, 2006).

The 2008 ICCAT assessment for North Atlantic shortfin mako used a Bayesian surplus production (BSP) model, an age-structured production model (ASPM) and a catch-free age structured production model. Results indicated that, for most model outcomes, stock depletion was about 50% of biomass estimated for the 1950s. Some model outcomes indicated that the stock biomass was near or below the biomass that would support MSY with current harvest levels above F_{MSY}, whereas others estimated considerably lower levels of depletion and no overfishing (ICCAT, 2011).

9.9 Stock assessment

Assessment of the status of the North Atlantic shortfin mako stock was conducted by ICCAT in 2012 with updated time-series of relative abundance indices and annual catches. Coverage of Task I catch data and number of cpue series had increased since the last stock assessment in 2008, with Task I data available for the main longline fleets. The 2012 assessment used the Bayesian Surplus Production Model (BSP) software that was used in the 2008 assessment. For the North Atlantic stock, cpue indices were used for the US longline logbook series, Japanese longline, Portuguese longline and Spanish longline (Figure 9.5). A number of sensitivity analyses and scenarios were conducted to evaluate the impact of the input data (such as catch reporting prior to 1997 being not well estimated) and model assumptions on model results (ICCAT, 2012).

Additionally, as in the 2008 assessment, a Catch-Free Age-Structured Production Model (CFASPM) was applied to the North Atlantic stock. The CFASPM derived all the fishery information from cpue data, rather than a combination of catches and cpue (ICCAT, 2012). A simple length-based method was also employed to check assumptions about selectivity made and for choosing starting or for fixing values of CFASPM model.

The results from the 16 BSP model runs gave very consistent results, despite initial inconsistencies between the catch and cpue data resulting in the model not fitting to the cpue trend very well. All found that the median of the current stock abundance was above B_{MSY} and the median F was smaller than F_{MSY} (except for the run that estimated catches from effort before 1997) (ICCAT, 2012).

The CFASPM also considered a number of scenarios and sensitivities explored, and as in the BSP model, for all runs, the estimated relative biomass fitted the cpue series poorly. The base run estimated a relative depletion of 71% of virgin conditions, with current fishing mortality estimated as 41% of what would be required to drive the stock to MSY (F/F_{MSY}=0.41) and current SSB was estimated at 2.04 times that producing MSY (SSB/SSB_{MSY}=2.04) (ICCAT, 2012). Across all scenarios considered, the estimates of SSB/SSB_{MSY} ranged from 1.63–2.04, the estimates of F/F_{MSY} ranged from 0.16–0.62 and the biomass depletion with respect to virgin conditions ranged from 0.55–0.71 (ICCAT, 2012).

The results indicated in general that the status of the stock is healthy and the probability of overfishing was low. However, they also showed inconsistencies between estimated biomass trajectories and input cpue trends, producing wide confidence intervals in estimated trajectories and other parameters (ICCAT, 2012). Taking into consideration results from the modelling approaches used in the assessment, the associated uncertainty, and the relatively low productivity of shortfin mako, the ICCAT shark subgroup recommended as a precautionary approach that fishing mortality of shortfin mako should not be increased until more reliable stock assessment results were available (ICCAT, 2012).

The next ICCAT assessment of shortfin mako is planned in 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.

In the 2012 assessment, the cpue indices were fairly consistent in showing a decline during the 1990s followed by an increase after 2000 (Figure 9.5), however this trend was not consistent with the catches, which were decreasing in the 1990s and stable after 2000 (ICCAT, 2012). Because of this inconsistency between catch and cpue data, the BSP model was not able to fit the trend in the cpue data very well, and the estimated trends in biomass relative to B_{MSY} and fishing mortality rate relative to F_{MSY} were very uncertain, with very broad 80% credibility intervals (ICCAT, 2012). The CFASPM also found that, in all runs, the estimated relative biomass fitted the cpue series poorly which necessitates the further improvement of the biological input parameters, and also the increased investigation and understanding of the cpue series (ICCAT, 2012).

9.11 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.

9.12 Conservation considerations

Shortfin mako was listed as 'Near Threatened' until 2008 when it was uplisted to 'Vulnerable' both globally and regionally in the North Atlantic in the IUCN Red List (Cailliet *et al*., 2009).

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).

9.13 Management considerations

Catch data of pelagic sharks are considered unreliable, as many sharks are not reported on a species-specific basis, and some fisheries may have only landed fins. As already stated, the landings data are unreliable and particularly pre-2000 should be considered an underestimate. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than 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.

The 2011 Report of the Standing Committee on Research and Statistics (SCRS) stated that, "Considering the quantitative and qualitative limitations of the information available to the Committee, the results presented in 2008, as those of the 2004 assessment (Anon. 2005), are not conclusive" (ICCAT, 2011). Furthermore, "The Commission should consider taking effective measures to reduce the fishing mortality of these stocks. These measures may include minimum or maximum size limits for landing (for protection of juveniles or the breeding stock, respectively); and any other technical mitigation measures such as gear modifications, time-area restrictions, or others, as appropriate".

In 1995 the Fisheries Management Plan for pelagic sharks in Atlantic Canada established a catch limit of 100 t annually for the Canadian pelagic longline fishery as well as advising release of live catch.

9.14 References

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Table 9.1. Shortfin mako in the North Atlantic (ATN) and Mediterranean (MED). Available landings (t) of shortfin mako by country from ICCAT Task I catch data. These data are considered underestimates, especially prior to 2000. Landings of <0.5 t are shown as +. Discard data marked * were not updated in 2013.

			1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Landings	ATN		797	953	2193	1526	3109	2019	3533	3798	2738	2546	2639	3377	3792	5174	3472	3370	4075	3559	4109	4181	3821	4877
	MED								6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	na
Landings	ATN	Longline	584	699	1523	1195	1663	1771	3369	3648	2645	2254	2424	3129	3792	4755	3172	3105	3907	3375	3571	3554	3257	
		Sport (inc. rod and reel)	210	250	667	318	1422	232	164	150	71	292	215	248	0	333	282	257	159	157	163	168	178	
		Other gear codes	3	4	3	13	25	15	12	18	21	22	12	18	103	86	18	7	9	26	375	459	386	
	MED	Longline							6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	
Landings	ATN	Belize																			23	28	69	
		Brasil										0												
		Canada					111	67	110	69	70	78	69	78	73	80	91	71	72	43	53	41	37	
		China P.R.										0							81	16	19	29	18	
		Chinese Taipei													84	57	19	30	25	23	11	13	15	
		EU.España							2416	2199	2051	1566	1684	2047	2068	3404	1751	1918	1816	1895	2216	2091	1667	
		EU.France																			15	2	0	
		EU.Portugal	314	220	796	649	657	691	354	307	327	318	378	415	1249	473	1109	951	1540	1033	1169	1432	1045	
		EU.United									2	3	2	1	1	1	0	0	0	1	15	0	0	

		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Kingdom																						
	FR.St Pierre et Miquelon																	1	2		4	0	
	Japan	157	318	425	214	592	790	258	892	120	138	105	438	267	572			82	131	98	116	85	
	Korea Rep.																					27	
	Maroc																					420	
	Mexico					10					10	16		10	6	9	5	8	6	7	8	8	
	Panama									1	0						0	49	33	39			
	Philippines									1									1				
	Senegal																	8	17	21	0	1	
	St. Vincent and Grenadines					0			3														
	Sta. Lucia																		0		0		
	Trinidad and Tobago									1		1	2	3	1	2	1	1	1	1	1		
	U.S.A.	326	415	972	663	1739	470	407	347	159	454	395	415	142	521	469	386	381	354	385	394	408	
	UK.Bermuda							1	2	2							0	0	0	0	0	0	
	Venezuela														58	20	6	11	2	35	22	20	
MED	EU.Cyprus																1	1	0	0	0	1	
	EU.España							6	7	5	3	2	2	2	2	2	4	1	0	0	1	2	
	EU.France																			0			

			1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
		EU.Portugal								1		1	5		0		15	5				0		
		Japan																		0				
Discards*	ATN	Longline	11	38	24	21	29	1											7	9	20	9		
		Other surf.									2								0	1	0	0		
Discards*	ATN	Mexico					1												0					
		U.S.A.	11	38	24	21	28	1											7	10	20	9		
		UK.Bermuda									2													
Total Landings and Discards	ATN		808	991	2217	1547	3138	2020	3533	3798	2740	2546	2639	3377	3792	5174	3472	3370	4082	3569	4129	4190	3821	4877
	MED								6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	na

Table 9.2. 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
Southwest Atlantic	W_D = (3.1142 x 10–5) L_F 2.7243	97	95–240	García-Cortés and Mejuto, 2002

Table 9.3. 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)

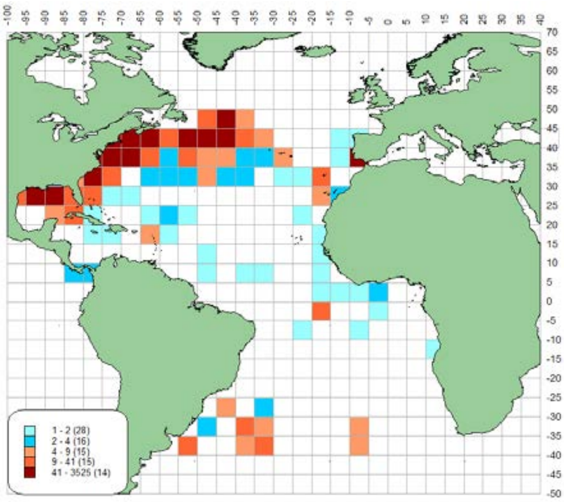
Table 9.4. Shortfin mako in the North Atlantic. Published growth parameters, assuming two vertebral bands formed annually. Data give von Bertalanffy growth paramters (Gompertz growth function) used, t_0 in cm. L_∞ in cm (Fork Length), k in years^{-1}.**

Area	L_∞	k	T_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**

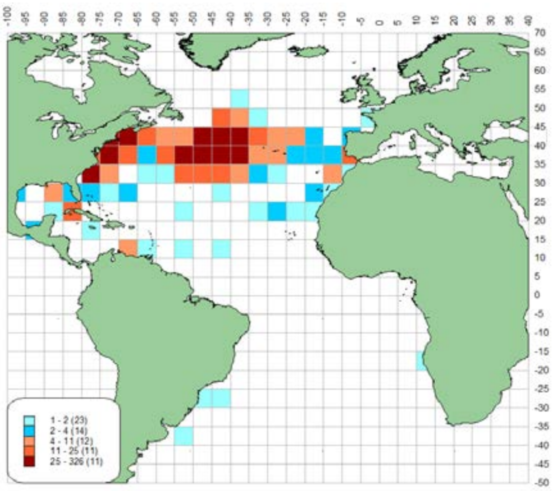
Table 9.5. Shortfin mako in the North Atlantic. Life-history information available from the scientific literature.

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
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

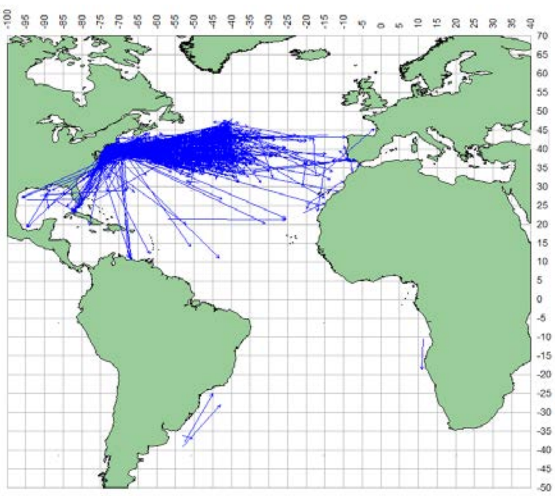
Parameter	Values	Sample Size	Area	Reference
Age-at-recruitment (year)	0–1			Stevens and Wayte, 1999
Male maximum length (L_T)	296 cm			Compagno, 2001
Female maximum length (L_T)	396 cm 408 cm (estimated)			Compagno, 2001
Lifespan (years)	11.5–17 (oldest aged)			Pratt and Casey, 1983
	45 (estimated longevity)			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



a)



b)



c)

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, (b) density of recoveries, and (c) straight displacement between release and recovery locations. Recaptures were 13.4%. Source: ICCAT (2014).

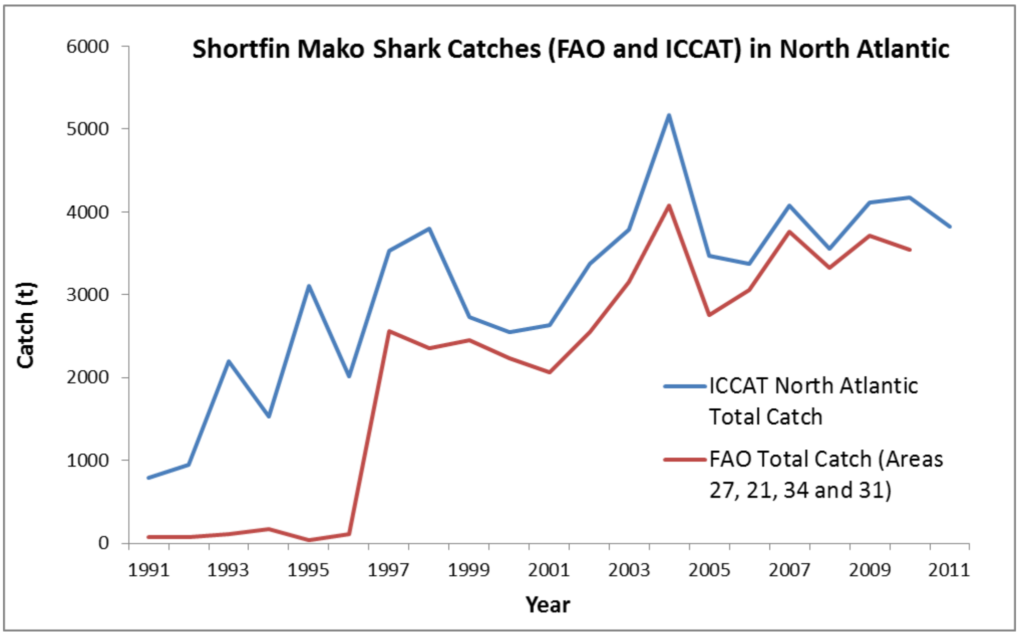


Figure 9.2. Shortfin mako in the North Atlantic. Total catches (t) of shortfin mako in the North Atlantic reported to FAO and ICCAT.

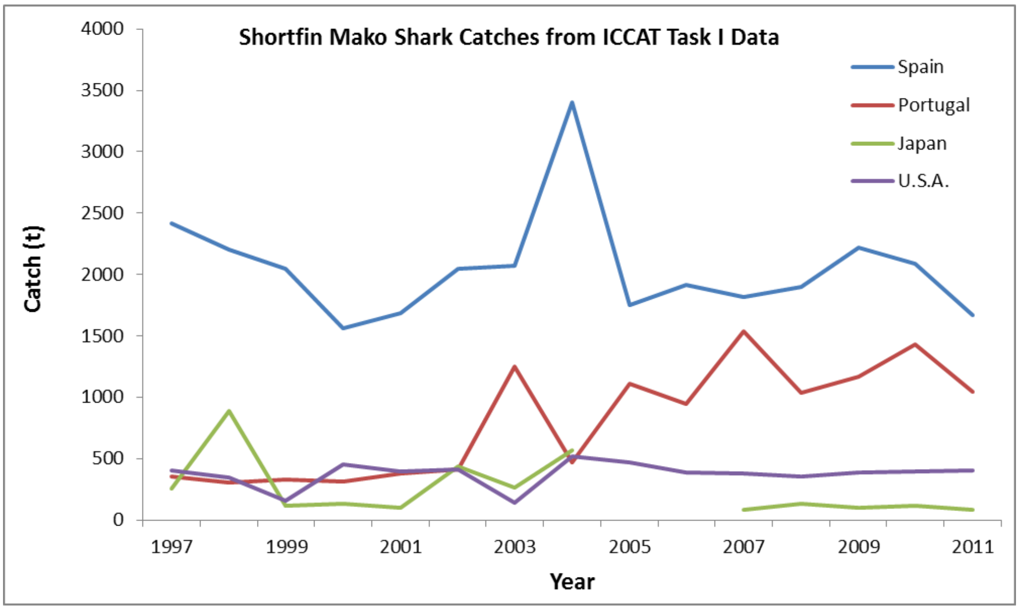


Figure 9.3. Shortfin mako in the North Atlantic. Total catches (t) made by the major countries (accounting for 84% of total landings) landing shortfin mako in the North Atlantic reported to ICCAT.

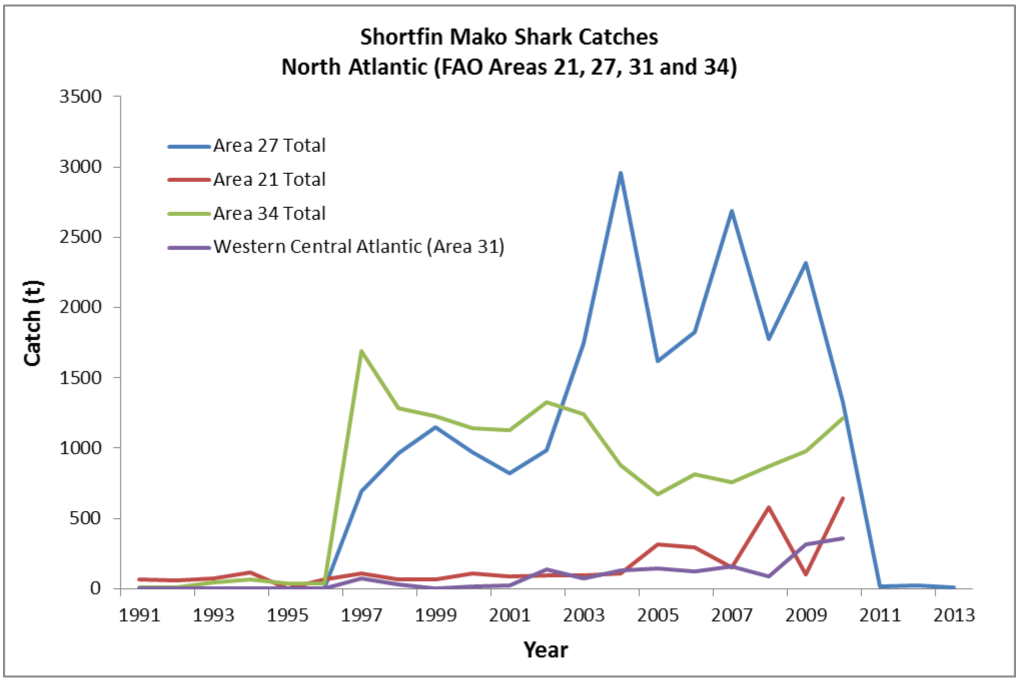


Figure 9.4. Shortfin mako in the North Atlantic. Total catches (t) of shortfin mako reported to FAO by major fishing area.

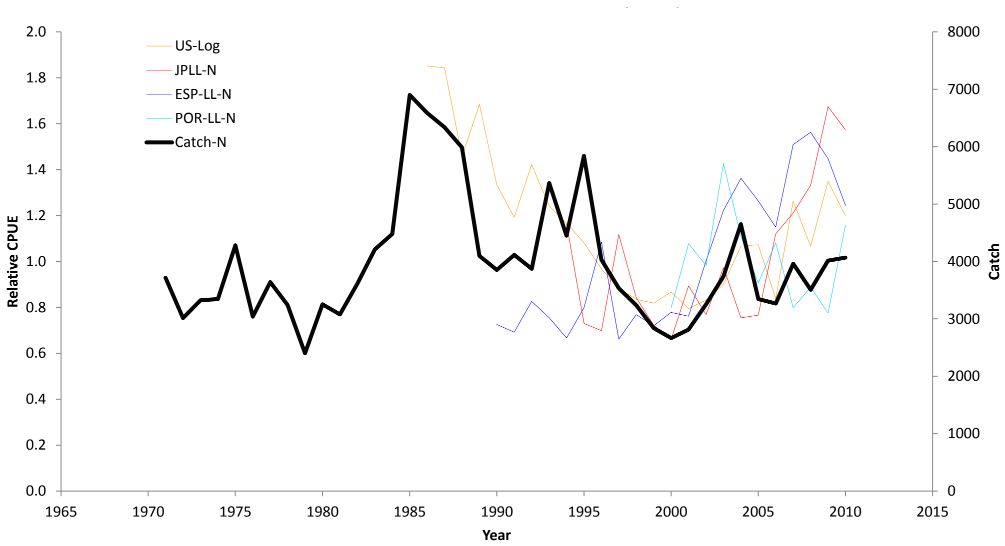


Figure 9.5. Shortfin mako in the North Atlantic. Indices of abundance for North Atlantic shortfin mako shark, along with total catches input into the Bayesian Surplus Production model used in the ICCAT 2012 assessment. Figure courtesy of ICCAT.

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 II–X (where Subareas IV and VI–X are important parts of the stock range, and Subareas II, III and V areas where tope tend to be an occasional vagrant). The stock also extends to 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 taken as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic set gears. Though tope is discarded in some fisheries, other fisheries land this species as bycatch.

Tope is also an important target species in recreational sea angling in several areas, with anglers, angling clubs and charter boat often having catch and release protocols.

10.2.2 The fishery in 2014

There were no major changes to the fishery noted in 2014.

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*".

10.2.4 Management applicable

It is prohibited to land tope that have been captured on longlines in European Union waters of ICES Division IIa and Subarea IV and in Union and international waters of ICES Subareas I, V, VI, VII, VIII, XII and XIV (EU Regulation 104/2015). This regulation also refers to a combined TAC of zero for spurdog and tope in Union and international waters of I, V, VI, VII, VIII, XII and XIV, but it has been anecdotally reported that the inclusion of tope within the spurdog TAC was an error and confirmation has been officially requested by this group.

In terms of UK fisheries, and following a stakeholder consultation in 2006, Department for Environment, Food and Rural Affairs (DEFRA) introduced a Statutory Instrument in 2008 (SI Number 2008/691, "The Tope Order") that prohibited 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.

10.3 Catch data

10.3.1 Landings

No accurate estimates of 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 and Figure 10.1. Landings indicate that France is one of the main nations landing tope (though data for 1980 and 1981 were not available). The UK 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.

No species-specific catch data for the Mediterranean Sea and off northwest Africa are available. The degree of possible misreporting or underreporting is not known. Overall available landings appear relatively stable from 1982 to 2003 at around 500 t per year and at 400 t per year since 2004, with a drop to ~300 t since 2011. Reported landings increased slightly in 2014, but it is believed that Portuguese landings of tope may include other species.

10.3.2 Discards

Though some discards information is available from various nations, data are limited for most nations and fisheries.

Preliminary studies from the UK Discard programme (Silva *et al*., 2013 WD) have indicated that juvenile (50–94 cm L_T) tope tend to be discarded in demersal trawl fisheries and larger (>94 cm L_T) individuals are usually retained (Figure 10.2). Tope caught in drift and fixednet fisheries are usually retained, with retained tope mainly from 70 to 124 cm L_T.

Following the ICES data call, the UK reported four individuals (three female, one male) as discarded compared to five retained observed during their discard programme in 2014. Three other nations (Ireland, mainland Portugal and Sweden) reported zero tope bycatch observed in 2014. As there was a specific data call for this discard information in 2015, it can be assumed that most of those countries not reporting bycatch of this species did not record any.

The low numbers of tope recorded in recent discard observer trips 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. The 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.

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).

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.

10.3.4 Discard Survival

Ellis *et al.* (2014 WD) 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 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 been reported in longline fisheries (Frick *et al.*, 2010; Coelho *et al.*, 2012).

10.4 Commercial catch composition

Limited new data are available. It is believed that an element of misreporting due to species mis-identification may occur.

10.5 Commercial catch and effort data

No data available.

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. This species is not sampled appropriately in beam trawl surveys (because of low gear selectivity). They are only caught occasionally in GOV trawl and other otter trawl surveys in the North Sea.

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. The Irish Groundfish surveys also record small numbers of tope, although one haul (40E2, VIa) in 2006 yielded 59 specimens (Figure 10.3). 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.

10.6.2 Trends in survey abundance

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. Hence, they are probably not sampled effectively in some scientific trawl gears, and survey data generally include a large number of zero hauls.

During the EVHOE scientific surveys, tope are caught in low but stable numbers. The spatial distribution and abundance across the time-series (1997–2014) is given in Figure 10.4 and Table 10.2. Similar to the locations reported during UK surveys, the majority of individuals were found at the entrance to St George's Channel and outer Bristol Channel. From this survey, abundance and swept area biomass estimates were calculated for the time-series (Figure 10.5). The abundance estimates for the whole

Celtic Sea (VIIg–k) has been variable and with a large variance around the estimates. In 2012, the estimated abundance was near its highest level and the biomass estimate for the Celtic Sea was also near its highest level of the time-series. Given the high variance, however, these values need to be treated with caution, especially as this species is only caught in low numbers in fishery-independent surveys.

The Irish Groundfish Survey catches tope in low numbers. Abundance varies annually. Most tope caught are now tagged and released.

A combined index from the Q1 and Q3 North Sea IBTS shows a pronounced increase in the most recent years (Figure 10.6), although there are large differences in abundance in earlier years.

The three survey indices are presented in Table 10.3. Following the ICES methodology for Data Limited Stocks, these surveys are standardised to their long-term mean and combined (Table 10.3, Figure 10.6). This combined index shows an overall increasing trend. The mean of the two most recent years shows an increase of 5% over the mean of the five preceding years.

Given the low and variable catch rates, WGEF do not consider that catch rates are wholly appropriate for informing on stock status. The proportion of stations at which tope are captured may be another informative metric for consideration.

10.6.3 Trends in distribution

Figure 10.4 shows the total tope abundance caught in French Q4 EVHOE survey in the Celtic Sea (1997–2014). The area of highest abundance appears to be moving north, from the Northern Bay of Biscay into the Southern Celtic Sea/Bristol Channel.

10.6.4 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). Irish surveys recorded 145 tope (2003–2009), of which 110 (76%) were male. English surveys recorded 90 tope, with 56 males (62%) and 34 females (38%). The lengths ranged from 40–163 cm L_T. The length–frequency distributions found between the surveys are 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.

Figure 10.8 shows the length distributions of tope caught in various UK surveys in 2004–2009. In the beam trawl survey (Figure 10.8a), 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) 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) and in the western IBTS survey (70–120 cm L_T; Figure 10.8d).

10.6.4.1 Recreational length distributions

A Scottish recreational fishery in the Mull of Galloway has recorded sex, length and weight of captured tope since 2009. While the number of tope tagged has declined, the number of mature fish of both sexes appears to have disproportionally declined (Figure 10.9). 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.

10.6.5 Tagging information

159 tope were tagged and released by CEFAS over the period 1961–2013, predominately in the Irish Sea and Celtic Sea (Figure 10.10; 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 (VIIa) 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.

In 2012 the UK (Scotland) started an electronic (archival data storage tags that record pressure and temperature) and conventional tagging programme for tope. As of June 2013, 13 tope had been tagged and there were two returns reported from France and Portugal (conventional tag). Further releases were planned in 2013.

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 38 July 2001 off Greystones (Ireland) as part of this programme, was caught on 9 May 2013 off Bastia, Corsica (Mediterranean Sea), showing a migration route of 3900 km in twelve years.

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).

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 in Ramonet *et al.* (2012 WD).

A genetic study (Chabot and Allen, 2009) on the eastern Pacific population including comparisons with samples from Australia, South and North America and UK, shows that there is little to no gene flow between these populations, meaning an apparent lack of migration.

10.7.1 Parturition and nursery grounds

Pups (24–45 cm L_T) are occasionally caught 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 (IVc), though they have also been recorded in the northern Bristol Channel (VIIf). The updated locations of pups caught in fisheries-independent surveys across the ICES region could usefully be collated in the near future.

The lack of more precise 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.

10.8 Exploratory assessment models

A study was made using data from the Irish Marine Sportfish Tagging Programme (Bal *et al*, 2015 WD). The approach, results and a discussion of the current state of the assessment are summarised below.

10.8.1 Data used

The capture–mark–recapture database used is based on 7551 tope caught and released year round by recreational fisheries over the period 1970 to 2014. There were 440 individual recapture records, although some fish were recaptured several times (486 recaptures in total). Observed recaptures come from both recreational and commercial fisheries. The tagging area was around Ireland (concentrated off the southwest coast), with recaptures made from across the ICES area.

As the aim of this study was to get preliminary estimates of the size of the population of tope off the southwest coast, it was necessary to estimate capture efficiency and fish survival, so as to use catch numbers (new catch plus recaptures) together with this parameters to feed a population dynamic model. For this it was necessary to give the data a discrete structure. Captures and recaptures that occurred from mid-June to mid-August were therefore considered for estimating population size. This period roughly coincides with the peak seasonal occurrence and is long enough to ensure having enough data for analyses. Fish first captured outside this period are used to estimate survival and capture probability only and do not enter type population estimates. As capture data are coming from recreational anglers only, recapture data coming from other fisheries were used only to get information about the state of sharks through time (i.e. dead or alive, 436 recaptures). Tope recaptured by fisheries other than recreational angling are assumed to be dead. Fish with unknown recaptures gears were assumed to have been recaptured by angler if the recapture date was between May and September and if the recapture location was near the Irish shore. Remaining unknown recaptures were assumed to correspond to commercial gears. The capture and recapture data used in the study are summarised in Figure 10.11.

10.8.2 Methodology

10.8.2.1 Cormack–Jolly–Seber Model

10.8.2.1.1 Generalities

To disentangle capture probability from survival probability, a Cormack-Jolly-Seber (CJS) model was applied to the capture–recapture data that can be summarized for each fish in capture–recapture histories.

The corresponding state–space model and data structures are summarized in Figure 10.12. State–space models are hierarchical models that decompose an observed time-series of observed response into a process (here, survival rate) and an observation error component (here, capture probability) (After Kery and Schaub, 2012).

In this exploratory assessment, the authors defined the latent variable $A_{i,y}$ which takes the value 1 if an individual *i* is alive and value 0 if an individual is dead year *y*.

Conditionally on being alive at occasion *y*, individual *i* may survive until occasion *y+1* with probability $\Phi_{i,y}(y = 1, ..., Y)$. The following equation defines the state process:

(1) $A_{i,y+1} | A_{i,y} \sim Bernouilli(A_{i,y} * \Phi_{i,y})$

The Bernoulli success is composed of the product of the survival and the state variable *z*. The inclusion of *z* insures that an individual dead remain dead and has no further impact on estimates.

If individual *i* is alive at occasion *y*, it may be recapture (*R*) with probability $p_{i,y}(y = 2, ..., Y)$. This can again be modelled as a Bernoulli trial with success probability $p_{i,y}$:

(2) $R_{i,y} | A_{i,y} \sim Bernouilli(A_{i,y} * p_{i,y})$

the inclusion of the latent variable *A* insures that an individual dead cannot be modelled again afterwards.

10.8.2.1.2 Specific modelling

To allow for more flexibility, survival is assumed to vary per year based on a random walk structure in the logit scale. Equation (2) is changed for the following equation starting on occasion 2:

(3) $A_{i,y+1} | A_{i,y} \sim Bernouilli(A_{i,y} * \Phi_y)$
$logit(\Phi_y) \sim Normal(logit(\Phi_{y-1}), \sigma_\Phi)$

with the following uninformative priors

$\Phi_1 \sim Unif(0, 1)$ and $\sigma_\Phi \sim Unif(0, 10)$

The capture probability of individuals as a fixed parameter in equation (1) thus change into the following equation:

(4) $R_{i,y} | A_{i,y} \sim Bernouilli(A_{i,y} * p)$

In the case of shark data, there is not a well-defined period of tagging and recapture as recreational anglers fish year round. On the other hand, the CJS approach needs the data to be discretised and a reference period over which the population is considered close is necessary. Not to lose information coming from sharks first caught outside the reference period chosen, they were included in the model to get better estimates of survival and recapture probabilities. To do so, the first year survival is corrected by the deviation (Δd_i) between the date the individual *i* was captured at and the following 15th of July (i.e. middle of the reference period chosen):

(5) $\Phi i,1 = \Phi 1\ \Delta di\ /365$

10.8.2.2 Deriving population size: the Jolly Seber approach

The best way of deriving population size estimates would be to add a third population dynamic components to the model described above and to fit the whole model in one go. This is called a Jolly-Seber (JS) model (Kery and Schaub, 2012).

Focusing on untagged fish population sizes (for computation cost only), the population size (*N*) may be derived as follow for occasion 1:

(6) $C_1 \sim \text{Binomial}(p, N_1)$ with uninformative prior for $N_1 \sim \text{Unif}(0, 300\,000)$

Then a population dynamic can be built using the probability of survival coming from the CJS model described above together on top of the estimate of catch probability. For the occasions following occasion 1, with *S* referring to survivors from the previous occasion *N* and *E* the new entrants to the population, *N* is estimated as follow:

(7) $S_y \sim \text{Binomial}(\Phi_y, N_{y-1})$
$N_y = S_y + E_y$

The series of *E* is given a Gamma random walk prior structure (gamma distribution in jags are parametrised with shape (α) and rate (β)) to capture rather smooth evolutions. Starting on occasion 3, the following apply:

(8) $E_y \sim \text{Gamma}(\alpha_{Ey}, \beta_{Ey})$
$\alpha_{Ey} = E_{y-1} \times \beta_{Ey}$
$\beta_{Ey} = E_{y-1} / \sigma_y^2$

with the following uninformative priors

$E_2 \sim \text{Unif}(0, 300\,000)$ and $\sigma_y \sim \text{Unif}(0, 30\,000)$

Trials made so far to fit the model in one go were unsuccessful, revealing a mismatch between the CJS and dynamic elements of the model. Bal *et al.* (2015 WD) suggested this was due to the fact that a fixed *p* for the whole time-series is not realistic.

As consequence, population estimates were given in two ways:

a) Omitting the underlying population dynamic and simply deriving *N* in the Bayesian model using parameter *p* and the total number of sharks captured the corresponding year;

b) The CJS model was fitted first. Posteriors were then used as informative priors to sequentially fit the population dynamic model described above, breaking feedbacks between the two parts. The figures are provided for illustrative purpose.

10.8.3 Computation details

Bayesian fitting, forecasting and the derivations were implemented using Markov Chain Monte Carlo algorithms in JAGS (Just Another Gibbs Sampler, Plummer, 2003; http://mcmc-jags.sourceforge.net) through the R software (R Development Core Team, 2013). Three parallel MCMC chains were run and 20 000 iterations from each were retained after an initial burn-in of 20 000 iterations. Chains thinning used equalled 5. Convergence of chains was assessed using the Brooks-Gelman-Rubin diagnostic (Gelman *et al.*, 2015).

10.8.4 Results

Results are composed of the following figures showing posterior density function of capture rate (Figure 10.13), yearly survival (Figure 10.14 and population size estimates from methods a (Figure 10.15) and b (Figure 10.16).

10.8.5 Discussion

The current estimated population of tope around Ireland has broadly been stable in recent years (although with some annual peaks with high variance in 2005–2007 requiring more detailed examination). The actual population size remains uncertain as shown by the scale difference coming from the two method used to infer population size (Figures 10.15 and 10.16).

In case of tope, building a model for both sexes would be interesting as there appeared to be captures and recaptures in different locations around Ireland. Their capture and survival probabilities are thus potentially different. Nonetheless, the quite low recaptures rate together with the fairly low number of known sex impedes our capacity to do so.

Although size and/or weight of sharks were originally available, they were not considered in the study as they appeared unreliable.

Preliminary studies have been unsuccessful in fitting a proper JS model in one go. Expert opinion on tagging and recapture effort could help address the fitting issues linked to some apparent mismatch between the CJS and population dynamic elements of the full model. In addition this could result in more realistic model with annual variations in both survival and capture probabilities. So far models are ready to do so. Information on the variability in fishing effort for commercial fisheries may also be included and should allow us to separate out the role natural survival variability from anthropogenic causes.

10.9 Stock assessment

Landing data (see Section 10.3) and survey data (see Section 10.6) are too limited to allow for a quantitative stock assessment of NE Atlantic tope. Several assessment methods have been applied to the South Australian stock (e.g. Punt and Walker, 1998; Punt *et al.*, 2000; Xiao and Walker, 2000).

Overall survey trends indicate that catch numbers have been relatively stable at a low level for the previous eight years. Cpue was higher in the IBTS in the 1990s, but no other surveys have that long a time-series for comparison.

When the ICES precautionary approach is applied to survey trends, an increase of up to 5% would be indicated. However, the precautionary buffer has not previously applied. It may be appropriate to apply it in this case, due to the lack of landings and fisheries data and uncertainty with regards stock status.

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 may not necessarily represent current population levels. 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, 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

The most recent IUCN Red List Assessment for Europe (Nieto *et al.*, 2015) identified tope as Vulnerable, and it is also listed as Vulnerable globally (Gibson *et al.*, 2008).

10.13 Management considerations

Tope is considered highly vulnerable to overexploitation, as they have a low population productivity, relatively low fecundity and protracted reproductive cycle. Furthermore, 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 off California. Evidence from these fisheries (see stock annex and references cited therein) suggests that targeted fisheries would need to be managed conservatively, exerting a low level of exploitation.

Australian fisheries managers have used a combination of a legal minimum length, a legal maximum length, legal minimum and maximum gillnet mesh sizes, closed seasons and closed nursery areas. However as tope is taken mainly in mixed fisheries in the ICES area, such measures may be of less utility.

10.14 References

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Table 10.1. Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2013. 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 Division IIIa–IV	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	na	na	na	32	22	na	na	26	26	13	31	13	14	18	12	17	16	10	11	12	8
Netherlands																					
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	na	na	na	8	10	31	36	94	28	22	18	14	21	15	15	19	25
UK (Scotland)																-	-	-	-	-	-
Total (IIIa–IV)	0	0	0	32	22	0	0	34	36	44	67	107	42	40	30	31	37	25	26	31	33
ICES Division V–VII																					
France	na	na	na	522	2076	na	na	988	1580	346	339	1141	491	621	407	357	391	235	240	235	265
Ireland	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Netherlands																					
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	na	na	na	63	51	28	23	21	21	21	55	45	47	53	48	49	38
UK (Scotland)																					
Total (VI–VII)				522	2076	0	0	1051	1631	374	362	1162	512	642	462	402	438	288	288	284	303
ICES Division VIII																					
France	na	na	na	na	237	na	na	na	63	119	52	103	97	66	39	34	38	34	40	54	44
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	-	-	-	+	+	+	+	+	+	+	+	1									0

ICES Division IIIa–IV	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
UK Scotland																					
Total (VIII)				0	237	0	0	0	63	119	52	104	97	66	39	34	38	34	40	54	44
ICES Division IX																					
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Total (IX)																					
ICES Division X																					
Portugal	18	na	na	24	15	51	77	42	24	29	24	24	24	34	23	56	81	80	115	116	124
Total (X)	18			24	15	51	77	42	24	29	24	24	24	34	23	56	81	80	115	116	124
Other/Unknown																					
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
CECAF area																					
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL LANDINGS	**18**	**0**	**0**	**578**	**2350**	**51**	**77**	**1127**	**1754**	**567**	**505**	**1397**	**675**	**782**	**554**	**523**	**593**	**427**	**469**	**485**	**504**

Table 10.1. (continued). Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2013. 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 limited for Northwest African waters.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Denmark	-	.	.	3	8	4	5	5	5	8	6	4	4	3	2	4	1	1	3
France	11	5	11		11	11	6	6	3	3	6	6	6	7	9	7	4	6	3
Netherlands																		0	0
Sweden	-	.	.	.	.	.	.	.	.	+	0	0	0	0					
UK (E&W)	14	22	12	14	13	10	13	11	8	10	13	5	2	1	1	4	1	0	1
UK (Scotland)	-	.	.	.	.	.	.	.	.	.	.	0	0	0	0	0	0	.	.
	25	27	23	17	32	25	24	22	16	21	25	15	12	11	13	15	7	7	7
ICES Division V–VII																			
France	314	409	312		368	394	324	284	209	181	293	155	187	259	278	199	226	209	215
Ireland	na	na	na	na	na	4	1	6	4	na	7	3	4	3	3	1	0	0	.
Netherlands		.	.	.	.	.	.	.	.	.	.	.	.	.	2	18	25	11	11
Spain	na	na	na	na	na	+	242	3	na	na	na	na	60	69	44	12	2	4	0
Spain (Basque country)	-	.	.	.	.	+	+	3	15	10	.	.	0	0	0				
UK (E&W)	39	34	41	62	98	72	60	55	65	65	74	44	26	22	15	13	15	17	19
UK (Scotland)												0	7	0	0	0	.	.	.
Total (VI–VII)	353	443	353	62	466	470	627	351	293	256	374	202	284	352	342	242	268	240	246
ICES Division VIII																			
France	78	40	46	+	71	58	49	60	16	29	40	28	35	74	57	39	39	55	42
Spain	na	na	na	na	na	9	13	10	na	na	na	na	21	33	11	4	1	5	6
Spain (Basque	-	.	.	.	.	9	6	10	10	14	12	1	12	14	12	17			

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
country)																			
UK (E&W)	0	0	0	0		1		3	8	6	5	0	0	0	0	0	0	0	
UK Scotland													0			0	.	.	.
Total (VIII)	78	40	46	0	71	77	68	83	34	49	57	29	69	121	80	60	40	61	48
ICES Division IX																			
Spain	na	na	na	na	na	na	na	na	76	na	na	na	96	85	88	89	12	49	54
Total (IX)																			
ICES Division X																			
Portugal	80	104	128	129	142	82	77	69	51	45	45	43	47	34	41	44	47	46	46*
Total (X)	80	104	128	129	142	82	77	69	51	45	45	43	47	34	41	44	47	46	46
Other/Unknown																			
France	-	.	.	386	.	2	.	.	.	.	.	.	.				0		
CECAF area																			
Portugal	-	.	.	.	2	1	2	98	na	na	na	na	na						
TOTAL LANDINGS	536	615	551	593	713	656	798	622	394	371	502	288	412	519	476	361	362	354	347

***Average of last three years due to believed misidentification.**

Table 10.2. Tope in the Northeast Atlantic. Presence/absence data of tope catches in the French EVHOE survey.

Year	Number of Hauls	Number of positive hauls	Mean number	Variance
1997	129	2	1	0
1998	125	2	1	0
1999	119	14	1.07	0.07
2000	121	8	1.00	0.00
2001	151	3	2.00	3.00
2002	153	2	1.00	0.00
2003	148	3	1.33	0.33
2004	138	4	1.00	0.00
2005	143	3	6.00	75.00
2006	129	1	1.00	NA
2007	145	3	1.00	0.00
2008	147	6	1.00	0.00
2009	136	3	2.00	3.00
2010	139	6	1.83	4.17
2011	151	5	1.40	0.80
2012	130	10	1.60	0.71
2013	140	3	1.33	0.33
2014	151	6	1.83	2.57

Table 10.3. Tope in the Northeast. Standardised survey indices for North Sea IBTS (combined), French EVHOE and Irish Groundfish survey.

YEAR	IBTS	IGFS	EVHOE	MEAN INDEX
2003	0.31	1.06	0.53	0.63
2004	3.90	0.76	0.57	1.74
2005	2.90	0.12	2.46	1.83
2006	0.55	3.22	0.15	1.31
2007	0.41	0.44	0.40	0.42
2008	0.58	0.95	0.80	0.78
2009	0.25	0.69	0.86	0.60
2010	0.16	2.05	1.55	1.25
2011	0.21	0.42	0.91	0.51
2012	0.05	0.64	2.40	1.03
2013	0.26	1.01	0.56	0.61
2014	1.35	0.65	1.42	1.14

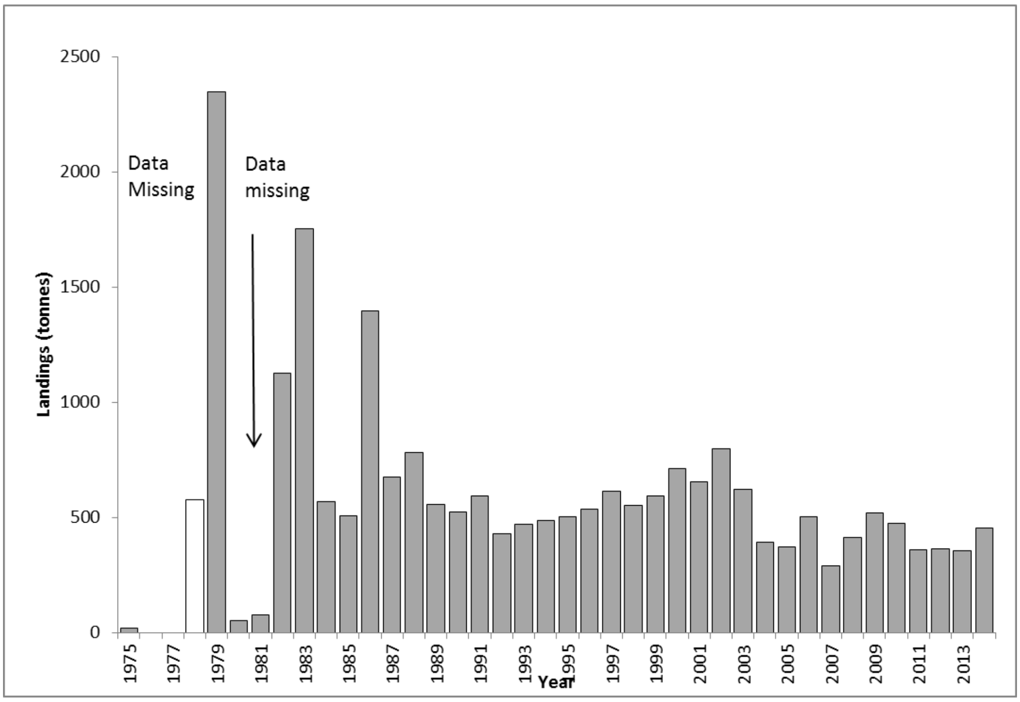

Figure 10.1. Tope in the Northeast Atlantic. Annual landings 1978–2014. These data are considered underestimates as some tope are landed under generic landings categories, and no species-specific landings data are available for the Mediterranean Sea and Northwest African waters. Not all data are available for recent years.

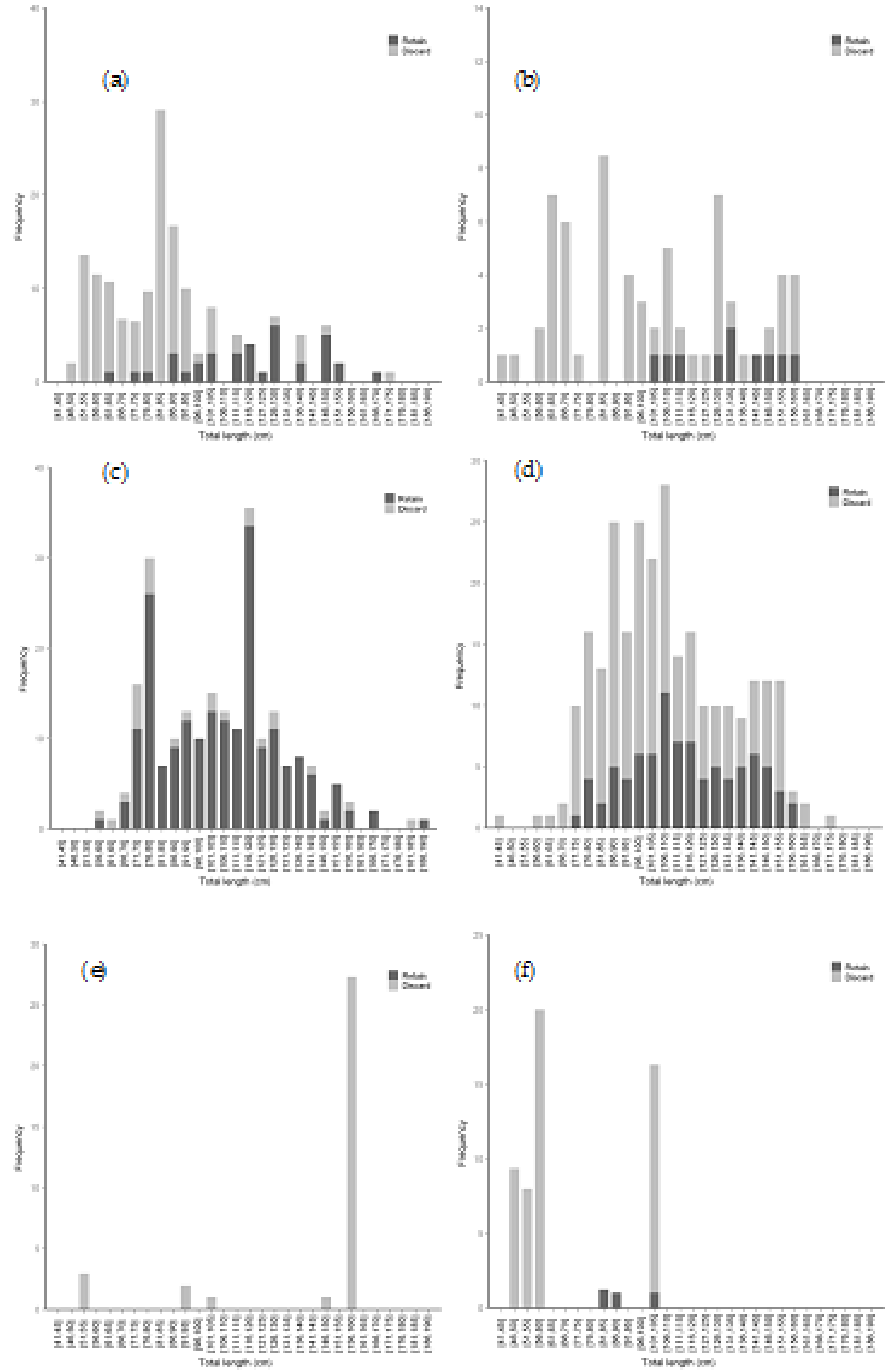

Figure 10.2. Tope in the Northeast Atlantic. Length–frequency of discarded and retained tope *Galeorhinus galeus* by (a) otter trawl (2002–2007) and (b) otter trawl (2008–2011), (c) gillnet (2002–2007), (d) gillnet (2008–2011), (e) beam trawl (2002–2011) and (f) *Nephrops* trawl (2002–2011) across both ecoregions, as recorded in the Cefas observer programme. Source: Silva *et al.* (2013 WD).

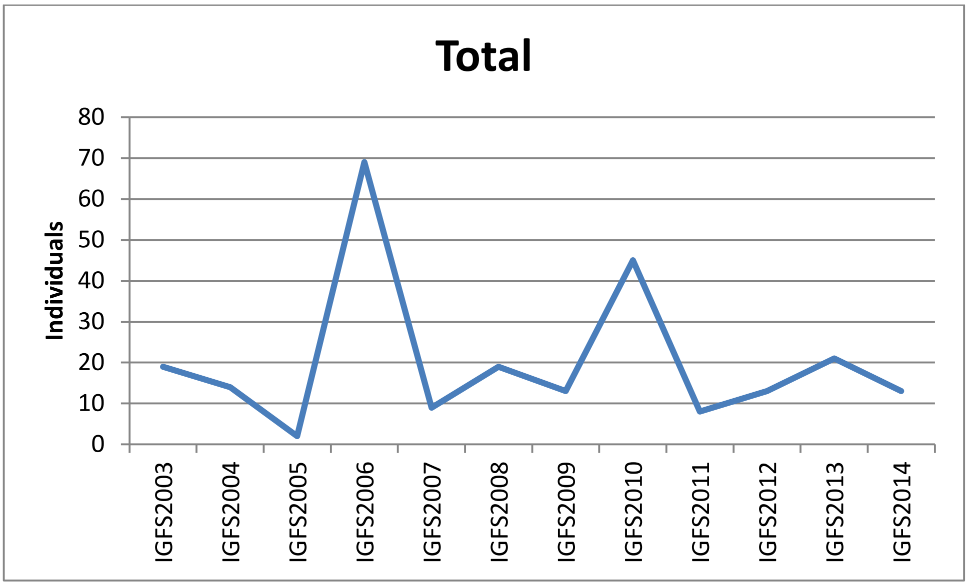

Figure 10.3. Tope in the Northeast Atlantic. Total number of tope caught during the Irish Groundfish Survey 2003–2014.

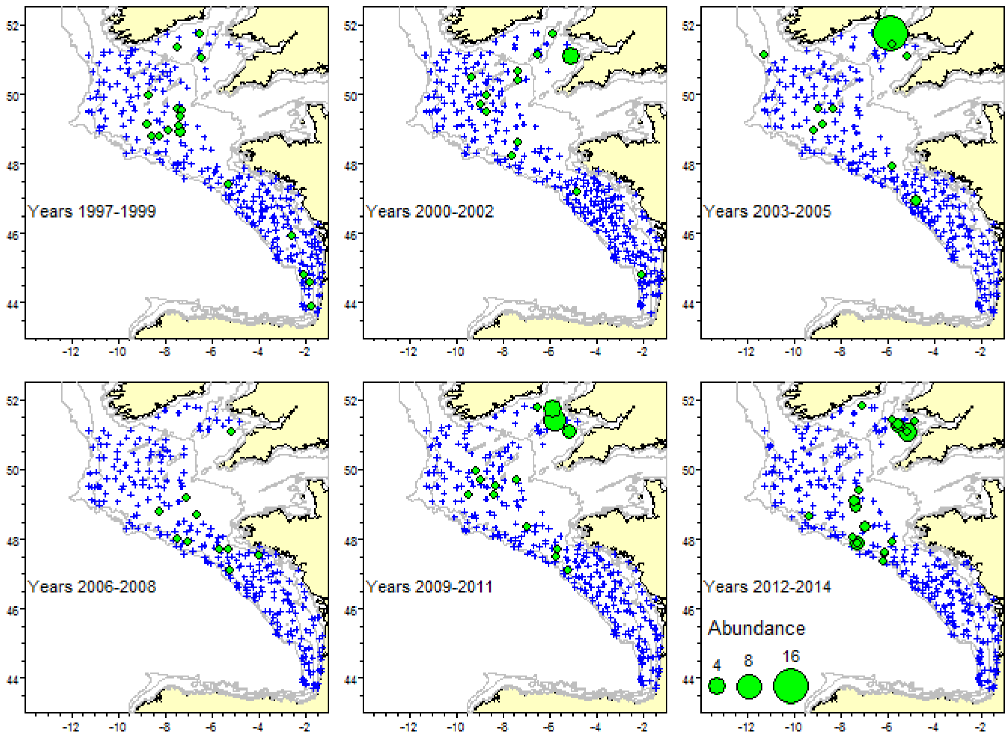

Figure 10.4. Tope in the Northeast Atlantic. Total tope abundance caught in French Q4 Evhoe survey in the Celtic Sea from 1997–2014.

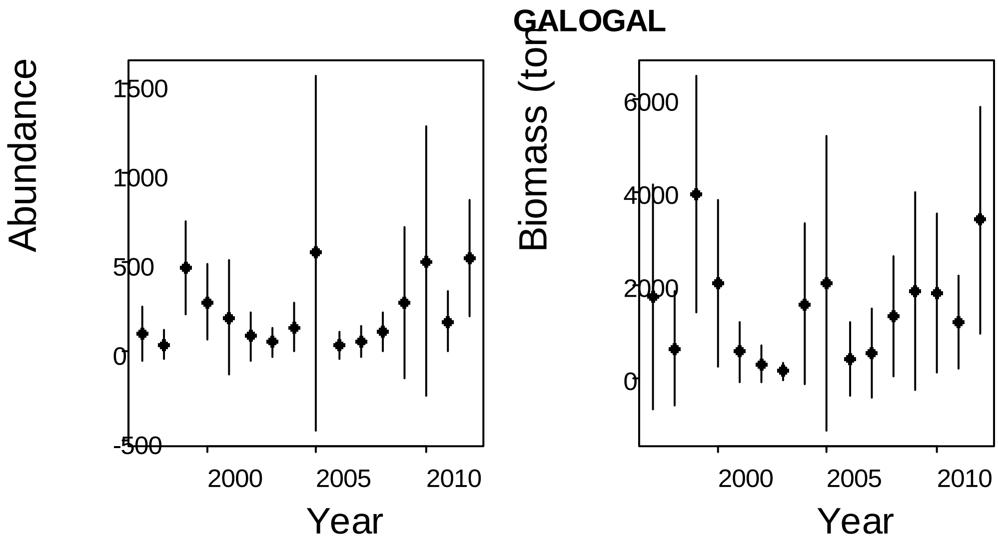

Figure 10.5. Tope in the Northeast Atlantic. Tope abundance and swept area biomass estimates made from French Q4 Evhoe survey in the Celtic Sea from 1997–2013.

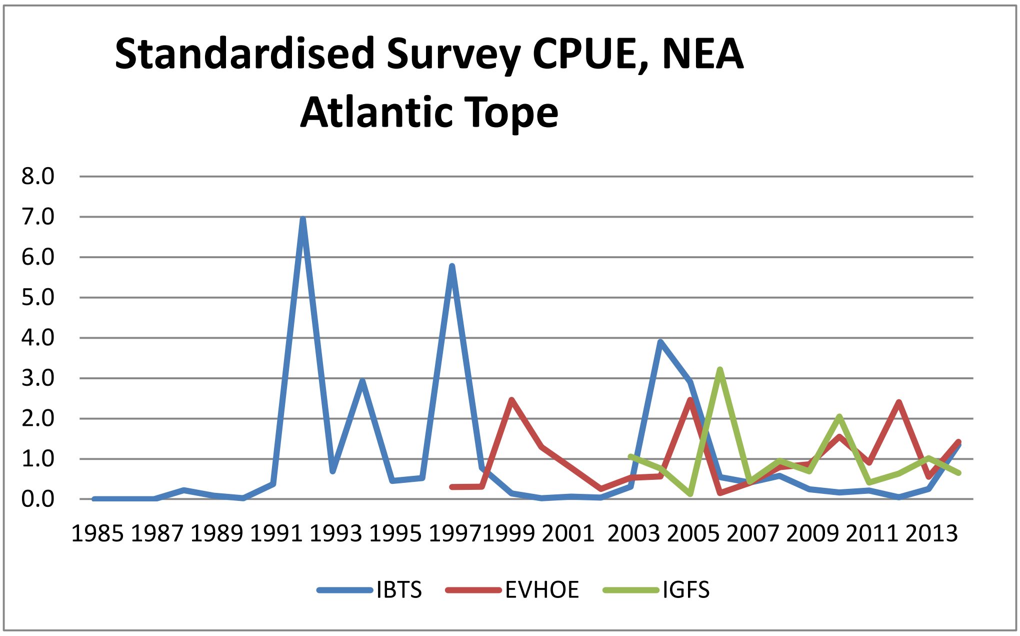

Figure 10.6. Tope in the Northeast Atlantic. Standardised survey cpue from North Sea IBTS, EVHOE and IGFS surveys.

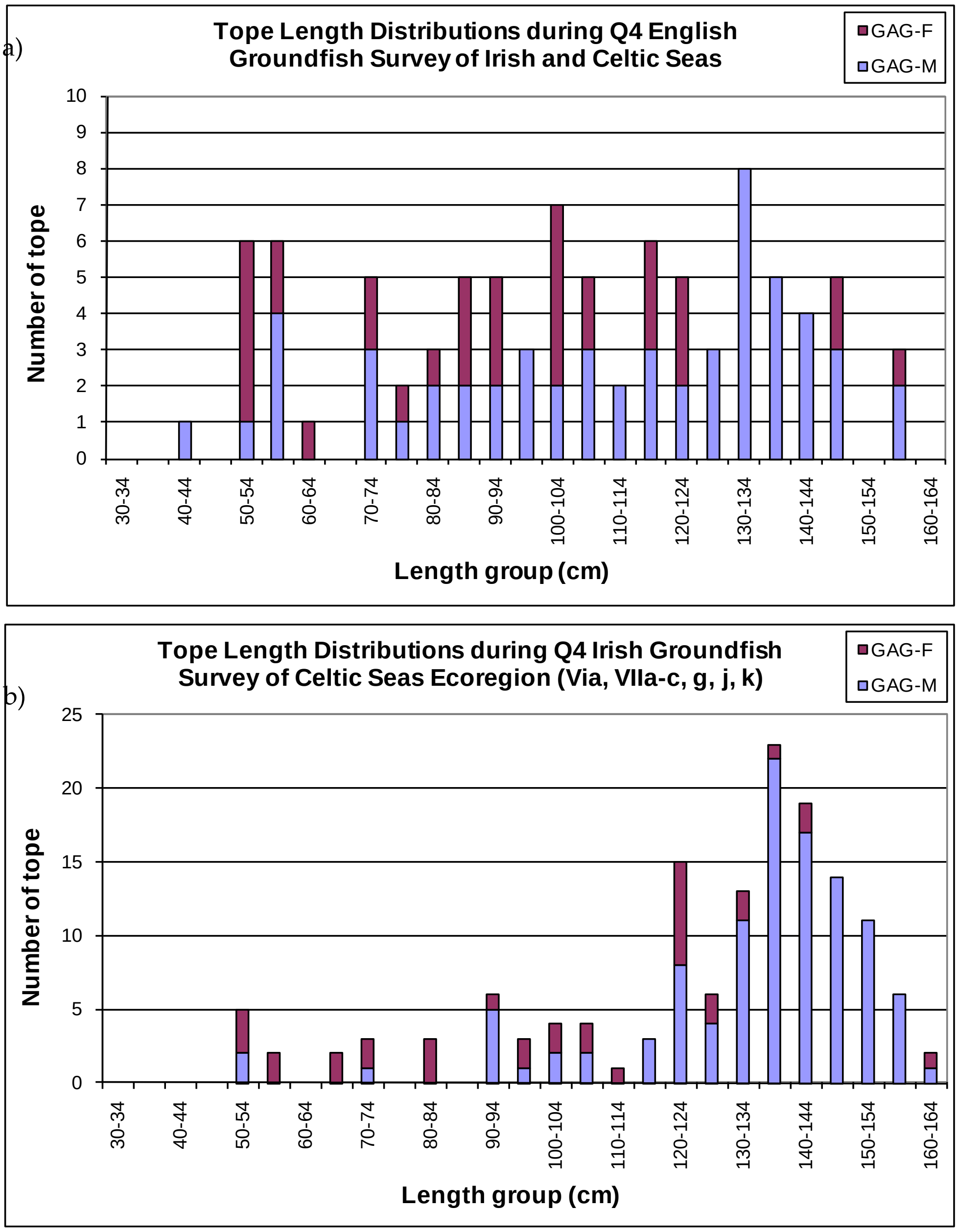

Figure 10.7. Tope in the Northeast Atlantic. Tope length distributions from a) English Groundfish Survey data, years 2004–2009, conducted in Q4 in Celtic and Irish Seas, and b) Irish Groundfish Survey data, years 2003–2009, conducted in Q4 in the Celtic Seas ecoregion (ICES Divisions VIa, VIIa–c, g, j, k).

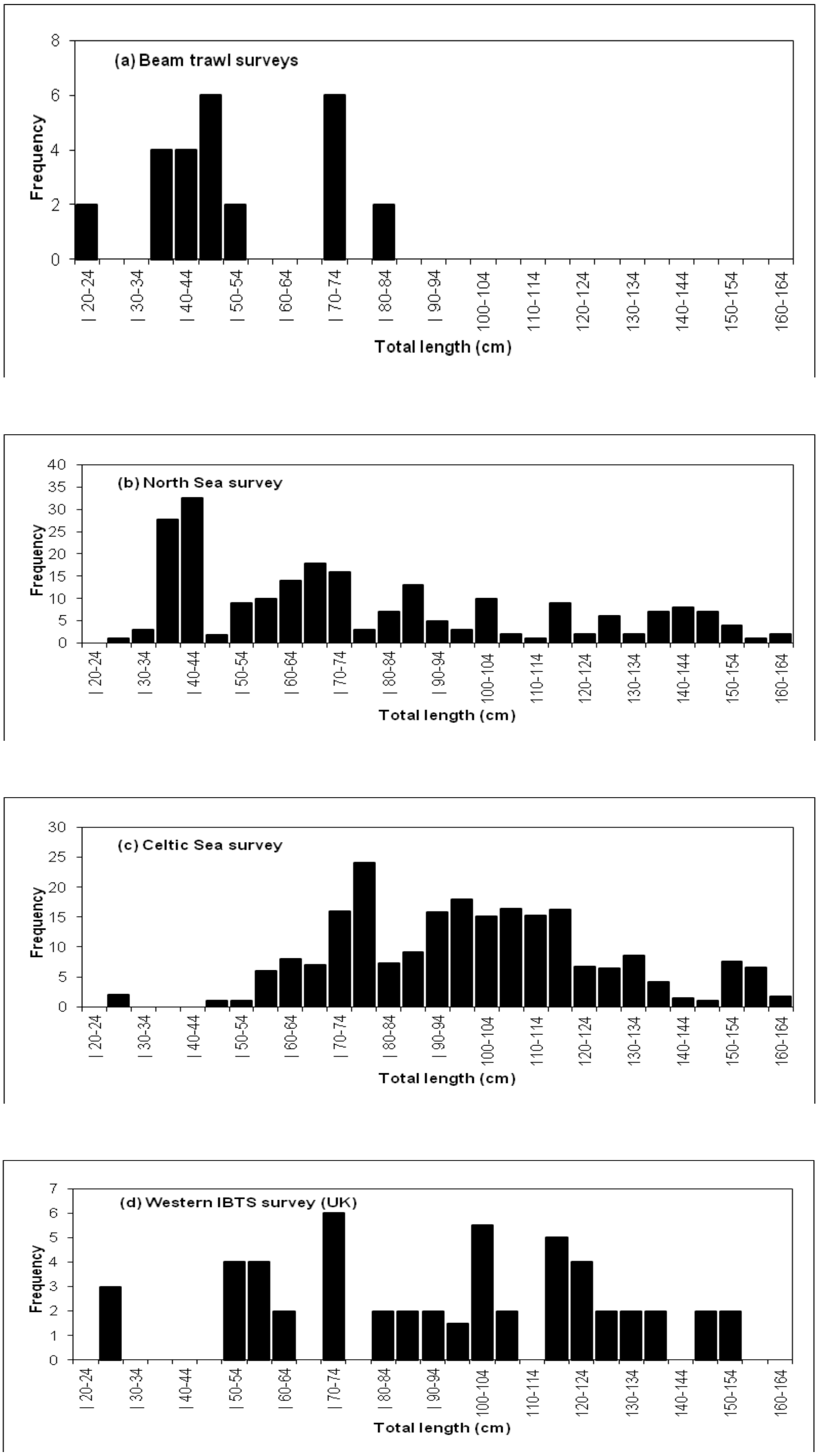

Figure 10.8. Tope in the Northeast Atlantic. Length–frequency distributions of tope from beam trawl survey (a), North Sea Suvey (b), Celtic Sea survey (c) and western IBTS survey/UK (d); years 2004–2009.

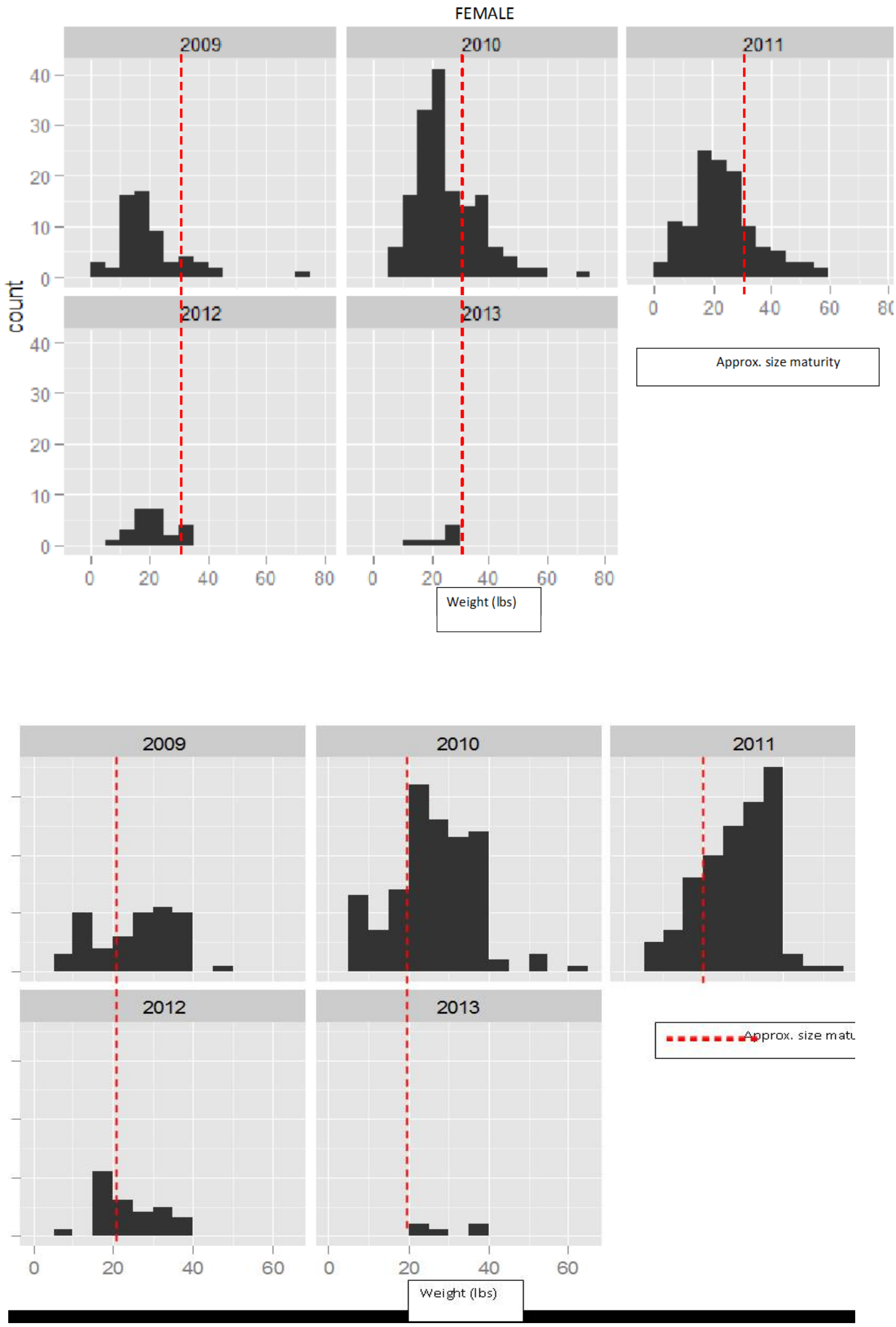

Figure 10.9. Tope in the Northeast Atlantic. Count by year of captures of female (top) and male (bottom) tope by recreational fishery in the Mull of Galloway, Scotland. The red lines show approximate weight-at-maturity. Source James Thorburne, University of Aberdeen. Unpublished data, 2014.

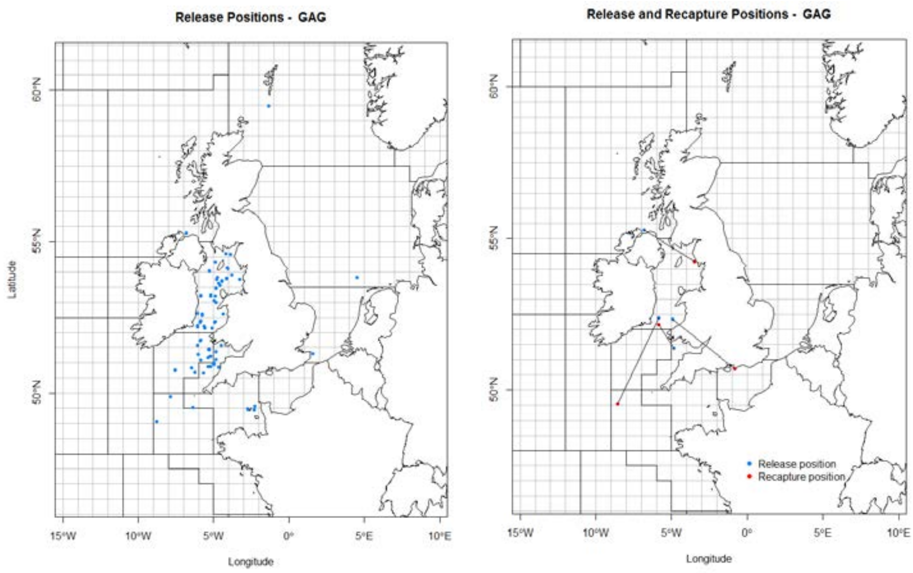

Figure 10.10. Tope in the Northeast Atlantic. Locations of tope *Galeorhinus galeus* (i) released and (ii) release and recapture positions for recaptured fish (2000–2013). Source: Burt *et al.* (2013 WD).

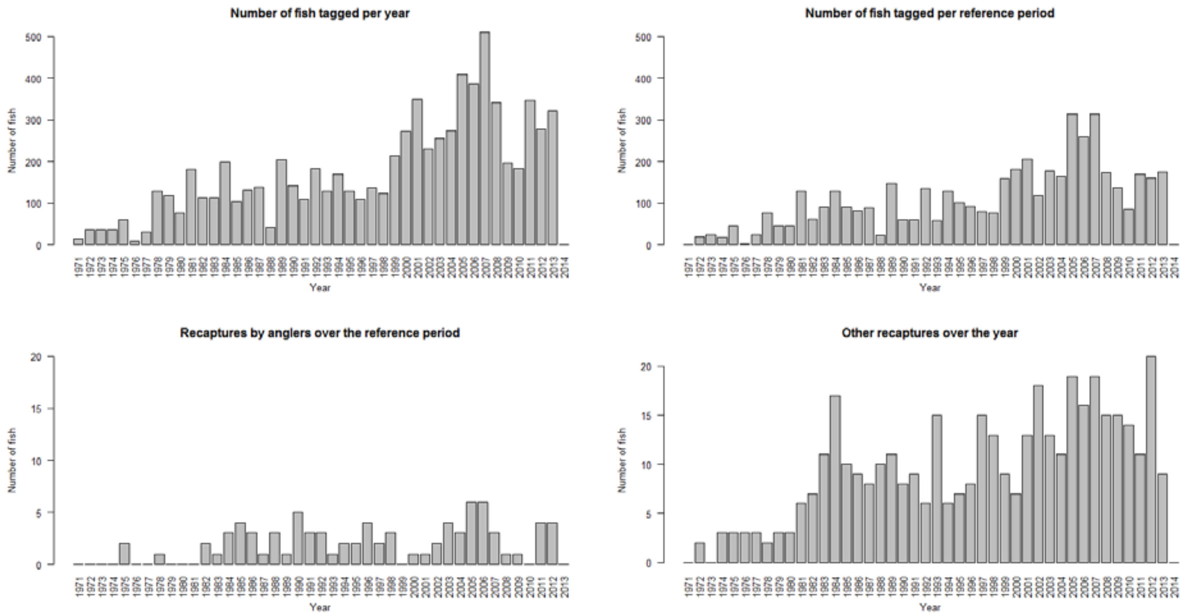

Figure 10.11. Tope in the Northeast Atlantic. Numbers captured, recaptured and newly captured per year, Tralee Bay. Source: Bal *et al.* (2015 WD).

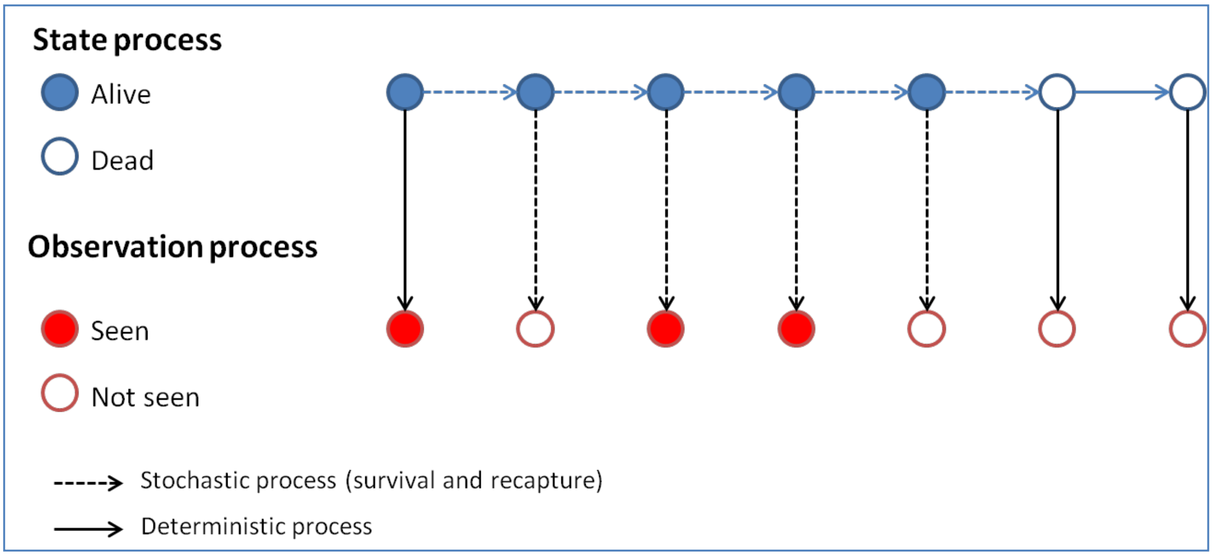

Figure 10.12. Tope in the Northeast Atlantic. Example of the state and observation process of a marked individual over time for the CJS model. The sequence of true states in this individual is A = [1, 1, 1, 1, 1, 0, 0] and the observed capture history is H = [1, 0, 1, 1, 0, 0, 0]. Source: Bal *et al.* (2015 WD).

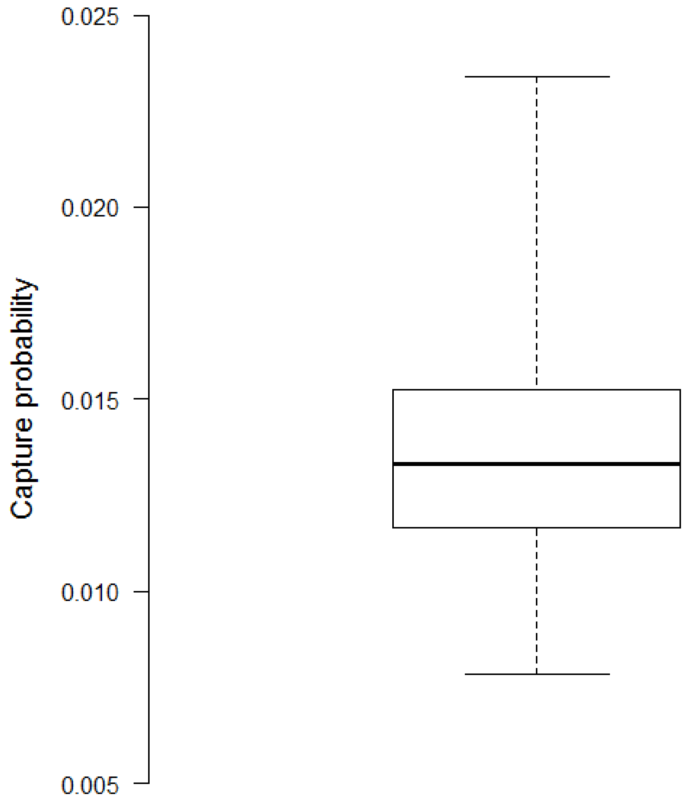

Figure 10.13. Tope in the Northeast Atlantic. Boxplot of the individual capture probability posterior. Source: Bal *et al.* (2015 WD).

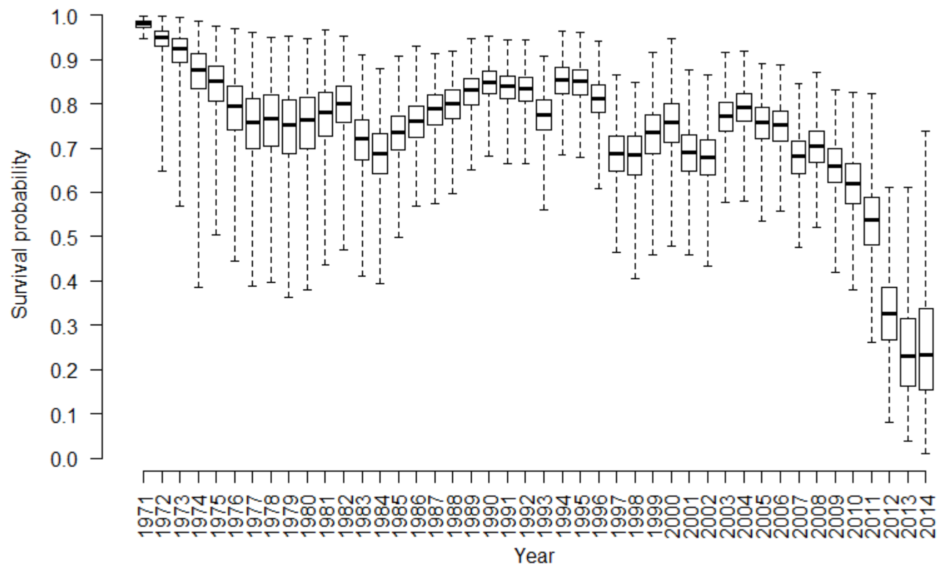

Figure 10.14. Tope in the Northeast Atlantic. Boxplot of annual survival probabilities posteriors. Source: Bal *et al.* (2015 WD).

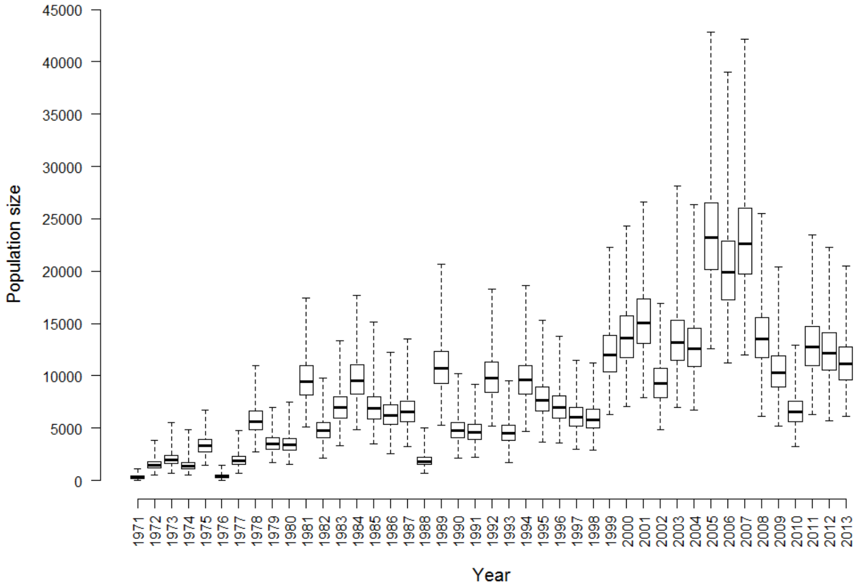

Figure 10.15. Tope in the Northeast Atlantic. Boxplot annual population sizes posteriors without population dynamics structure. Source: Bal *et al.* (2015 WD).

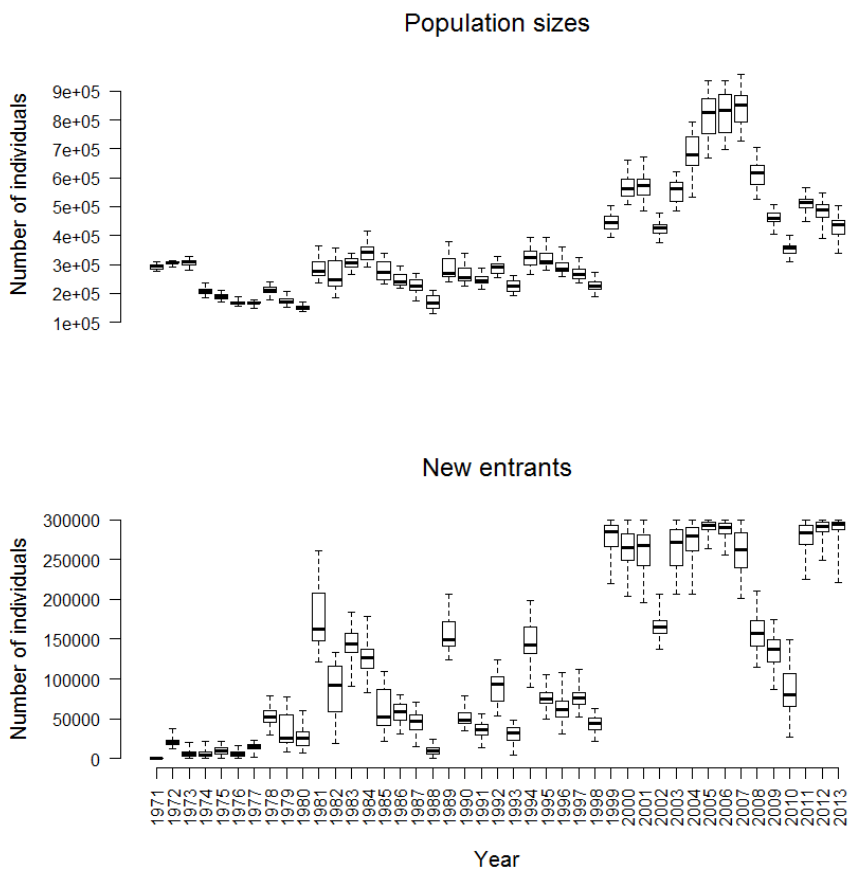

Figure 10.16. Tope in the Northeast Atlantic. Boxplot annual population sizes and number of entrant's posteriors with population dynamics structure. Source: Bal *et al.* (2015 WD).

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, *A. vulpinus* is the dominant species taken in the continental shelf fisheries of the ICES area.

There is little information on the stock identity of these circumglobal sharks. WGEF assumes there to be a single stock of *A. vulpinus* in the NE Atlantic and Mediterranean Sea, with this stock likely 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 the stock identity is included in the Stock Annex (ICES, 2009).

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 caught mainly as a bycatch in longline fisheries for tuna and swordfish but may also be taken in driftnet and 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.

Both species occur in the Mediterranean Sea. There are no target fisheries on thresher sharks but they are taken as a bycatch in various fisheries, including the Moroccan driftnet fishery in the southwest Mediterranean. They are caught by industrial and semi-industrial longline fisheries and by artisanal gillnet fisheries. In France, thresher shark specimens are caught incidentally by trawlers operating in the Gulf of Lions that target small pelagic fish and they were landed in two main ports (Sète and Port La Nouvelle). Additional bycatch of thresher sharks occurs in the Straits of Gibraltar.

11.2.2 The fishery in 2014

No new information.

11.2.3 ICES Advice applicable

ICES has never provided advice for stocks of these species.

11.2.4 Management applicable

Section 23 of Council Regulation (EU) 2015/104 of 19 January 2015 prohibits EU vessels in the ICCAT convention area either "*Retaining on board, transhipping or landing any part or whole carcass of bigeye thresher sharks (Alopias superciliosus) in any fishery*" of "*to undertake a directed fishery for species of thresher sharks of the Alopias genus*".

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.

11.3 Catch data

11.3.1 Landings

Landings of thresher sharks are reported irregularly and are rather variable; from 3–193 t in the NE Atlantic and the Mediterranean Sea (ICCAT and national data; Tables 11.1–11.2; Figure 11.1). There can be large discrepancies between those national landings data presented to ICES and those reported to ICCAT (Figure 11.1).

The main landing nations are Portugal, Spain and France, although the large quantities reported by Portugal to ICCAT in 2006 and 2007 still need to be verified.

The national landings of thresher sharks reported by France have typically ranged from 2–22 t. In 2000 and 2001, reported landings increased to 107–112 t, remained at levels <10 t until 2006 and then increased to levels of ca. 27–41 t. French landings reported to ICCAT are, however, sometimes greater. The values of the 2000 and 2001 landings are believed to be overestimates (Poisson and Séret, 2009).

Portuguese estimated national landings began in 1986 and have usually varied from 14–43 t annually, with high values in 2006 and 2007. These two years seem suspicious and require verification. It is possible that those figures were from the North and South Atlantic combined. No national landings were reported to WGEF from 2006, but were reported to ICCAT by Portugal in 2006–2011. For the CECAF area nominal estimated landings were between zero and at most two in 1998.

Spanish landings were first reported to WGEF in 1997, and after three years declined to 1 t and were null by 2001. After 2005 Spanish national landings were not reported to WGEF, apart from 2 t from the Basque Country in 2009.

Thresher sharks are taken occasionally in ICES Subarea IV and the main catches are from Subareas VI–IX, mainly from VIII (Table 11.2). Small (2 t or less) irregular landings have been reported by Denmark, Ireland and the UK, since 2000.

The overall estimated landings as reported by national data to WGEF ranged from just 3 t, the lowest level, in 1984 to 143 t in 2005. Landings reported to ICCAT are far greater, with the peak landings of 193 t in 1997, and the lowest level of 19 t in 2003. A distinctly better harmonization between these data is required.

11.3.2 Discards

No data available.

11.3.3 Quality of catch data

Thresher sharks have not routinely been reported at either a species-specific or generic level. The two species are recorded mixed or separately; however analysis of the available data seems to indicate that they are often mixed even when recorded under specific names. Also, some discrepancies are observed when different sources of data are compared (e.g. FAO, ICCAT, national data). Landings of thresher shark in coastal waters are most likely to represent *A. vulpinus*, but some of these landings may be reported as ‘sharks nei’.

11.3.4 Discard survival

Limited information on discard survival from European fisheries, but there have been several studies elsewhere in the world (Ellis *et al*., 2014 WD). 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.*, 2014 WD and references therein).

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 between 2003 and 2009 (Figure 11.2). 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 fisheries.

Ifremer implemented a small-scale pilot research programme (Alop project) in the Mediterranean Sea, in close collaboration with the fishing industry and especially with the trawler fishery targeting small pelagic fish in the Gulf of Lions.

The objectives of "Alop" project were (1) to monitor the landings and to reconstruct the landing time-series of thresher sharks, (2) to collect basic biological parameters and (3) to study the feeding ecology (isotope, fatty acids, and contaminants) of *A. vulpinus*.

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, and nursery grounds for these species are included in the Stock Annex.

Fernandez-Carvalho *et al.* (2011) provided the von Bertalanffy growth parameters for the bigeye thresher shark of the tropical NE Atlantic (Table 11.3) based on 117 specimens with total length (TL) ranging from 176–407 cm.

Fernandez-Carvalho *et al.* (2012) provided maturity information for bigeye thresher shark from the Atlantic. Significant differences were found in the size distribution and the sex ratio between the North and South Atlantic ($L_{50\%}$ were estimated as 206.09 cm TL for females and as 159.74 cm TL for males).

11.7.1 Movements and migrations

Under the "Alop" Project (see Section 11.5), information was also obtained from two tagged 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 Lion were observed; the female stayed in coastal shelf areas from July to September and moved to deeper waters afterwards, probably as a response to the seasonal cooling of the sea surface temperature. Another specimen (120 cm L_T) stayed most of the time at depths of 10–20 m but occasionally moved down to 800 m.

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 during summer of 1996. Distinct crepuscular vertical migrations were observed; specimens occurring at depths of 200–500 m during the day and from 80–130 m 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 to 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) also 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 tend to stay above the thermocline.

Cao *et al.* (2012) provided data for *A. superciliosus* and *A. vulpinus* around the Marshall Islands, 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.

11.7.2 Nursery grounds

Nursery areas for *A. superciliosus* occur off the southwestern Iberian Peninsula and Strait of Gibraltar (Moreno and Moron, 1992). Juveniles of *A. vulpinus* are also known to occur in the English Channel and southern North Sea (Ellis, 2004). Further information on potential nursery areas is given in the Stock Annex.

11.7.3 Diet

The two thresher species feed mostly on small schooling fish, including mackerels, clupeids as well as squid and octopus (General Fisheries Commission for the Mediterranean 2010: GFCM:SAC12/2010/Inf.12).

11.8 Exploratory assessments

No assessments have ever been made of thresher shark in the NE Atlantic, although they have been included as a part of Productivity-Susceptibility Analysis (PSA) for the pelagic fish assemblage (ICCAT, 2011). The lack of reliable landing estimates (see Section 11.3) and lack of fishery-independent survey data hamper the assessments of these stocks.

11.9 Stock assessment

No assessment has been undertaken, as a consequence of insufficient data. Species-specific landings are required and any assessment will need to be undertaken in collaboration with ICCAT.

11.10 Quality of assessments

No assessment has been undertaken.

11.11 Reference points

No reference points have been proposed for these stocks.

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 (IUCN, 2015).

11.13 Management considerations

There is an insufficient knowledge on the stock structure, as well as, on the stock status of the two thresher shark species occurring in the NE Atlantic. Liu *et al.* (1998) considered *Alopias* spp. to be particularly vulnerable to overexploitation and needing close monitoring because of their high vulnerability resulting from low fecundity and relatively high age of sexual maturity.

Ecological risk assessments 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, and that the common thresher is 10th in rank with a productivity rate of 0.141 (ICCAT, 2011).

In 2009, the International Commission for the Conservation of Atlantic Tuna (ICCAT, 2009) 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).

11.14 References

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Table 11.1. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Preliminary estimates of landings of thresher sharks by European countries from 1997 to 2011 (ICCAT data). Landings prior to 1997 are in combined sharks.

DATA SOURCE	ICCAT				ICCAT			ICCAT	ICCAT	ICCAT		TOTAL
Nation	Spain				Portugal			France	UK	Ireland		
Year	*A. vul.*	*A. sup.*	*Alopias* spp.	Total	*A. vul.*	*Alopias* spp.	Total	*A. vul.*	*A. vul.*	*A. vul.*	*Alopias spp.*	
1997	30	138	25	193								193
1998	44	104	27	175								175
1999	na	na	56	56	1		1					57
2000	8	21	23	52		2	2			+		54
2001	21	35	62	118		2	2					120
2002	11	38	25	74	22		22					96
2003	8	18	1	27	18		18				+	45
2004	16	38	7	61[(1)]	21		21	23			+	105
2005	na)	na	na	?[(1)]	na			19				19
2006	na	na	na	?[(1)]	95		95 [(2)]		+	+		95
2007	14	32	na	46	79	3	81[(2)]	37	1			165
2008	na	na	73	73	43		43	10	1			127
2009	28	50	na	78	43		43	32	1			154
2010	na	na	na		14		14	27	2			43
2011	na	na	na					41	1			42

(1) Spain previously reported 159 t in 2004 and 105 t in 2005; clarification of these catches is required.

(2) These landings require verification.

Table 11.2. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Estimates of landings of thresher sharks (*Alopias* spp.) by country and ICES subarea.

		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	IV												
France	VI–IX	3	6	2	7	12	10	9	13	14	14	11	13
Ireland	VI–VIII												
Portugal	VII–IX			7	11	103	13	14	31	13	12	16	7
Spain	VII–IX												
UK(E&W)	IV–VII												
Total		3	6	9	18	115	23	23	45	27	26	27	20

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Azores														0	0
Denmark	IV						.	.	+	.					
France	VI,VII, & IX	17	22	18	13	107	112	4	3	1	2	1	2	3	10
France	VIII									2	7	11	10	4	24
Ireland	VI													1	0
Ireland	VII						.	.	+	+			0	0	0
Portugal	VII - IX	13	37	24	12	15	25	21	17	33	80				
Spain (Basque Country)	VIII														2
Spain	VII–IX		53	54	36	1			3	84	54				
UK(E&W)	IV											0		0	0
UK(E&W)	VII												1	1	1
Total		30	113	98	61	123	137	25	23	120	143	12	13	8	36

		2010	2011	2012	2013	2014
Azores		.	.	.	.	.
Denmark	IV				.	.
France	VI,VII, & IX	4	4	6	9	na
France	VIII	21	36	27	24	na
Ireland	VI	0	0	0	.	.
Ireland	VII	0	0	0	.	.
Portugal	VII - IX	11	6	+	1	.
Spain (Basque Country)	VIII	0				.
Spain	VII - IX					.
UK(E&W)	IV	1	+	+	+	.
UK(E&W)	VII	1	1	1	1	2
Total		41	185	38	55	2

Table 11.3. Von Bertalanffy growth parameters for *Alopias superciliosus* from the tropical North-eastern Atlantic (from Fernandez-Carvalho *et al.*, 2011).

Sex	Model	Parameter	Estimate	SE	95% CI	
					Lower	Upper
Sexes combined	VBGF	L_{inf}	247	18.0	212	283
		k	0.09	0.02	0.05	0.13
	AIC = 860.4	L_0	106	4.8	96	115
	VBGF Fixed L_0	L_{inf}	212	5.9	200	224
	AIC = 870.7	k	0.17	0.01	0.14	0.20
Males	VBGF	L_{inf}	206	10.1	186	227
		k	0.18	0.05	0.09	0.27
	AIC = 322.6	L_0	93	9.5	73	112
	VBGF Fixed L_0	L_{inf}	201	6.4	188	214
	AIC = 321.3	k	0.22	0.03	0.16	0.27
Females	VBGF	L_{inf}	293	42.6	208	378
		k	0.06	0.02	0.02	0.10
	AIC = 537.2	L_0	111	5.3	100	121
	VBGF Fixed L_0	L_{inf}	223	9.7	204	243
	AIC = 550.2	k	0.15	0.02	0.11	0.18

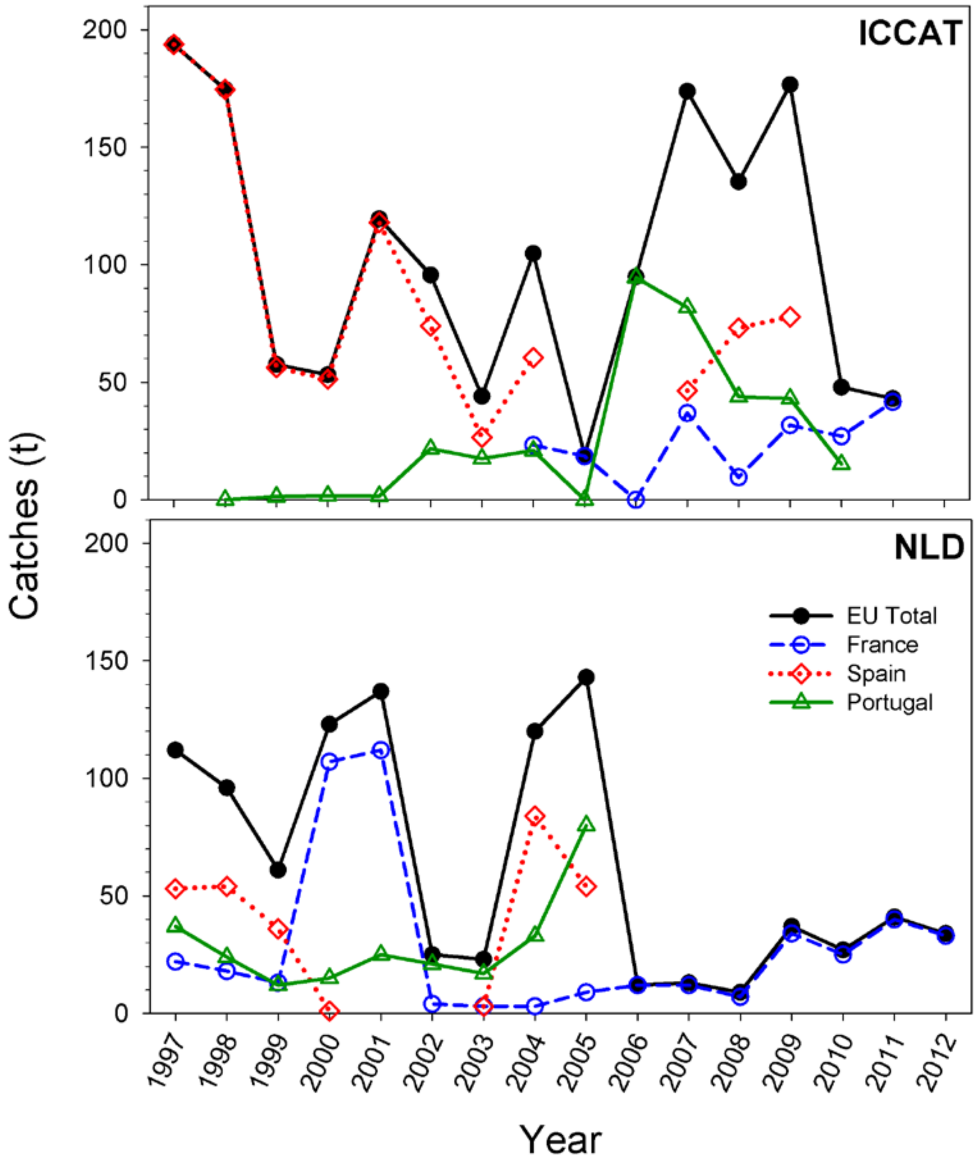

Figure 11.1. Thresher sharks in the Northeast Atlantic and the Mediterranean Sea. Preliminary estimates of landings as reported by Spain, Portugal and France to ICCAT (1997–2011, ICCAT database, upper panel) and national landings data (NLD) reported by these countries to WGEF (lower panel).

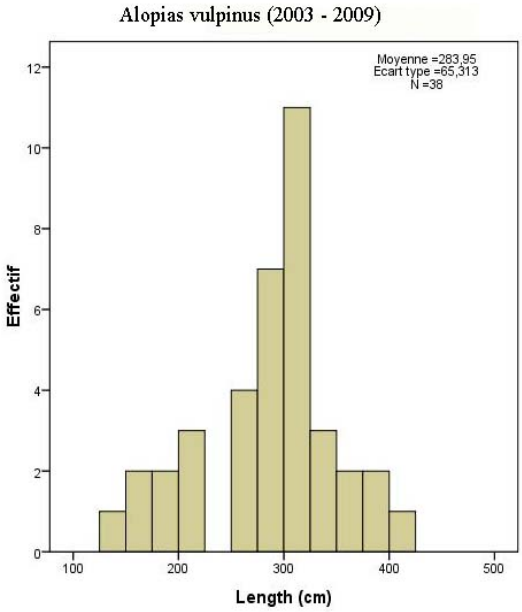

Figure 11.2. Thresher sharks in the Northeast Atlantic and the Mediterranean Sea. Length–frequency distributions for *Alopias vulpinus* sampled in the Divisions VIIIa–d in the framework of the Data Collection Regulation programme by observers on board French vessels between 2003 and 2009 (Fork length).

12 Other pelagic sharks in the Northeast Atlantic

This section only contains minor edits from the previous year (ICES, 2014). Updates to landings data and other information will be undertaken next year.

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 NE 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 which are limited. These species are found mostly in the south-western parts of the ICES areas (e.g. Iberian Peninsula), though some may occasionally range further north. Some of these species also occur in the Mediterranean Sea.

12.2 The fishery

12.2.1 History of the fishery

These pelagic sharks and rays are an incidental bycatch in tuna and billfish fisheries (mainly longline, but also purse-seine). Some of them, like the hammerheads and the 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 devil ray). Some of these species are an important bycatch in high seas fisheries (e.g. silky shark and oceanic whitetip) and others are taken in continental shelf waters of the ICES area (e.g. various requiem sharks and hammerhead sharks).

12.2.2 The fishery in 2014

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 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.

Article 12 of Council Regulation (EU) 2015/104 listed prohibited species which, if caught accidentally, should not be harmed, should be released promptly. It is prohibited for EU vessels to fish for, to retain on board, to tranship or to land these species, which include the following pelagic elasmobranchs:

- White shark *Carcharodon carcharias* in all waters;
- Manta rays (*Manta alfredi* and *Manta birostris*) in all waters; ;
- Mobulid rays *Mobula* spp. in all waters.

ICCAT recommend that Contracting Parties "prohibit, retaining on board, transshipping, 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) and all hammerhead sharks (Family Sphyrnidae, except bonnethead shark *Sphyrna tiburo*) (Recommendation 2010-08).

Article 23 of Council Regulation (EU) 2015/104 states that it is prohibited to retain on board, tranship or land any part or whole carcass of hammerhead sharks of the Sphyrnidae family (except for *Sphyrna tiburo*) in association with fisheries in the ICCAT Convention Area. This regulation also stipulates that it is prohibited to retain on board, tranship or land any part or whole carcass of oceanic whitetip shark *Carcharhinus longimanus* taken in any fishery, or to retain on board silky shark *C. falciformis* taken in any fishery.

12.3 Catch data

12.3.1 Landings

No reliable estimates of landings or catch are available for these species, as many nations that land various species of pelagic sharks have often recorded them under generic landings categories.

Species specific landings reported to ICES are given in Table 12.2 and amount to 765 t from 1999–2012. However, 98% (751 t) of these landings were made between 1999 and 2004. The main country reporting catch of these species during this period was Portugal, with 51 t of *Sphyrna* spp. and 331 t of *Carcharhinus* spp. across all areas. During the same period France also reported 331 t of *Carcharhinus* spp, and Spain reported 2 t of *Sphyrna* spp. Since 2004, Portugal has only reported 10 t of *Sphyrna zygaena* (2007–2011), and Spain 4 t of pelagic stingray.

Since 1997, landings are also recorded in the ICCAT database (Table 12.3), and these data may provide the best catch estimates available, with a total of 28 614 t between 1997 and 2011. In the Northeast Atlantic, Spain and Portugal are the main countries reporting these species, with Portugal reporting catches of 809 t and Spain 3562 t between 1997 and 2011. For Spain, the main catch reported was *Sphyrna* spp., totalling 2431 t across the time-series. Other countries reporting catch to ICCAT are Senegal (23 420 t), France (518 t), Netherlands (37 t), the UK (12 t) and China-Taipei (4 t). Requiem sharks comprise the largest proportion of the catch at 69% (22 434 t), followed by hammerhead shark at 30% (5950 t) and longfin mako shark at 1% (173 t).

There are few catch data for the other pelagic species (e.g. tiger shark, devil ray and pelagic stingray) in national datasets, nor in the ICCAT database, except for some sporadic records of tiger sharks (45 t of which 37 t was made by the Netherlands in 2007, and the rest by Spain) in the ICCAT database between 1997 and 2011. Dutch records for tiger shark are based on an incorrect species code being used.

Catch data are provided for the Spanish longline swordfish fisheries in the NE Atlantic in 1997–1999 (Castro *et al*., 2000; Mejuto *et al*., 2002). They show that 99% of the bycatch of offshore longline fisheries consisted of pelagic sharks (Table 12.4), although 87% was blue shark.

Available landings data from FAO FishStat for the NE Atlantic (Table 12.5) are considered to be underestimates, as a consequence of the inconsistent reporting; however this is the only database to report devil ray landings (17 t by Spain 2004–2011).

12.3.2 Discards

No data available. Some species are usually retained, although pelagic stingray is most often discarded.

12.3.3 Quality of catch data

Catch data are of poor quality, except for some occasional studies of the Spanish Atlantic swordfish longline fishery (e.g. Castro *et al*., 2000; Mejuto *et al*., 2002). 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 (e.g. *Carcharhinus* and *Sphyrna*).

Methods developed to identify shark species from fins (Sebastian *et al*., 2008; Holmes *et al*., 2009) could be used to gather data on species retained in IUU fisheries on the high seas, this information should aid in management and conservation.

12.3.4 Discard survival

There have been several studies on the at-vessel mortality of pelagic sharks in longline fisheries, although less data are available for purse-seine fisheries. These studies were reviewed in Ellis *et al.* (2014 WD).

12.4 Commercial catch composition

Data on the species and length composition of these sharks are limited.

12.5 Commercial catch and effort data

No cpue data are available to WGEF for these pelagic sharks in the ICES area. However Cramer and Adams, 1998; Cramer *et al*., 1998 and Cramer, 1999 provided catch rates for the Atlantic US longline fishery targeting tunas and swordfish; where cpue ranged from 2.7 individuals/1000 hooks in 1996 to 0.35 ind./1000 hooks in 1997. 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.

12.7 Life-history information

Little information is available on nursery or pupping grounds. Silky shark are 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 SE coast of the USA, suggesting offshore nurseries over the continental shelf (Seki *et al.*, 1998). Scalloped hammerhead nurseries are usually in shallow coastal waters.

The overall biology of several species has been reviewed, including white shark (Bruce, 2008), silky shark (Bonfil, 2008), oceanic whitetip (Bonfil *et al.*, 2008) and pelagic stingray (Neer, 2008). Other biological information is available in Branstetter, 1987; 1990; Stevens and Lyle, 1989; Shungo *et al*., 2003 and Piercy *et al*., 2007. A summary of the main biological parameters is given in Table 12.6.

Recent genetic analysis show that *Mobula mobular* from the Mediterranean Sea and adjacent NE Atlantic waters should be identical to the more wide-ranging *Mobula japonica* (Poortvliet *et al.*, in prep.). 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 (estimates varied from 200 to 500) of this "endangered" and protected ray were caught by fishermen of the Gaza Strip on 27 February 2013.

12.8 Exploratory assessments

No specific 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 sharks 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 would be a useful exercise.

12.9 Stock assessment

No stock assessments have been undertaken.

12.10 Quality of the assessment

No assessment has been undertaken.

12.11 Reference points

No reference points have been proposed for these stocks.

12.12 Conservation consideration

The IUCN have assessed devil ray as 'Endangered', white shark, longfin mako, oceanic white-tip, dusky shark and sandbar shark as 'Vulnerable' and silky shark as 'Near threatened'. Pelagic stingray, which is generally discarded, was assessed as 'Least Concern' (Gibson *et al*., 2008).

The following species are included in the Memorandum of Understanding for Sharks (MoU-Sharks) of the Convention of Migratory Species (CMS): *Carcharodon carcharias*, *Isurus paucus* and *Manta birostris*.

12.13 Management considerations

There is a paucity of the fishery data on these species, and this hampers the provision of management advice.

Some of the species are specified on various conservation initiatives. For example, white shark is listed on Appendix II of the Barcelona Convention, Appendix II of the Bern Convention, Appendices I/II of the CMS and Appendix I of CITES.

In 2013, *Carcharhinus longimanus*, *Sphyrna lewini*, *Sphyrna mokarran*, *Sphyran zygaena*, *Manta birostris* and *Manta alfredi* were listed on Appendix II of CITES (Conference of Parties 16, Bangkok). The implementation of these listings was delayed by 18 months (14 September 2014) to enable Range States and importing States to address potential implementation issues.

In 2012, a consortium of scientific institutions (AZTI, IEO, IRD and Ifremer) obtained a contact from the EC to review the fishery and biological data on major pelagic sharks and rays. The aim was to identify the gaps that could be filled up in the frame of the implementation of the EU shark action plan (EUPOA-Sharks) in order to improve the monitoring of major elasmobranch species caught by both artisanal and industrial large pelagic fisheries on the high seas of the Atlantic, Indian and Pacific Oceans. It reviews and prioritises the gaps identified to develop a research programme to fill them in, to support the formulation of scientific advice for management. The main gaps concern fishery statistics, which are often not broken down by species, a lack of size–frequency data and regional biological/ecological information. The final report was given to the DG-Mare of the EU in May 2013 (DG-Mare, 2013).

In 2013, the shark species group of ICCAT proposed the framework of a Shark Research and Data Collection Program (SRDCP) to fill up the gaps in our knowledge on pelagic sharks that are responsible for much of the uncertainty in stock assessments, and have caused constraints to the provision of scientific advice. The final report is available at ICCAT website (ICCAT, 2013).

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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).

FAMILY	COMMON NAME	SCIENTIFIC NAME	ICES SUBAREA			
			VII	VIII	IX	Notes
Lamnidae	White shark	*Carcharodon carcharias*	○	⦿	⦿	[1]
	Longfin mako	*Isurus paucus*	○	○	⦿	
Carcharhinidae	Spinner shark	*Carcharhinus brevipinna*	○	○	⦿	
	Silky shark	*Carcarhinus falciformis*	○	○	⦿	
	Blacktip shark	*Carcharhinus limbatus*	○	○	⦿	
	Oceanic whitetip	*Carcharhinus longimanus*	○	⦿	⦿	[2]
	Dusky shark	*Carcharhinus obscurus*	○	○	⦿	
	Sandbar shark	*Carcharhinus plumbeus*	○	⦿	⦿	
	Night shark	*Carcharhinus signatus*	○	○	⦿	
	Tiger shark	*Galeocerdo cuvier*	?	?	⦿	[3]
Sphyrnidae	Scalloped hammerhead	*Sphyrna lewini*	○	○	⦿	
	Great hammerhead	*Sphyrna mokarran*	○	○	?	
	Smooth hammerhead	*Sphyrna zygaena*	⦿	⦿	⦿	
Dasyatidae	Pelagic stingray	*Pteroplatytrygon violacea*	⦿	⦿	⦿	[4]
Mobulidae	Devil ray	*Mobula mobular*	⦿	⦿	⦿	[5]
	Giant manta	*Manta birostris*	○	○	?	

[1] Three records from the Bay of Biscay; [2] One individual stranded in Swedish waters; [3] Some unconfirmed sightings in northern Europe; [4] Two specimens recorded from the North Sea; [5] Individual specimens reported from the Bay of Biscay (capture) and Celtic Sea (stranding).

Table 12.2. Other pelagic sharks in the Northeast Atlantic. Summary of landing data reported to WGEF of hammerhead and requiem sharks in the ICES subareas from 1999 to 2013; reported landings post 2004 are limited.

Species	Country	ICES area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Hammerhead sharks (*Sphyrna* spp.)	Portugal	VIIIc	1											0	0	0	
		IX	6	8	4	5	5							0	0	0	
		IXa						18						0	0	0	
		X	1				2	1									
	Spain	IX a, b						2						0	0	0	
Sphyrna zygaena	Portugal	X									3	1	2	2	1	1	
Total *Sphyrna*			8	8	4	5	7	21			3	1	2	2	1	1	0
Requiem sharks (*Carcharhinus* spp.)	Portugal	VIb		1		1											
		IX		1		7	129	2									
		IXb						3									
		X	9	24	31	47	16	43									
		IX a, b						17									
	Spain	VIIIa															
	France		9	26	31	55	145	65									
Total Requiem			17	34	35	60	152	86									
Pelagic stingray	Spain	IXa													4		
Total pelgic sharks (all areas)			26	60	66	115	297	151	0	0	3	1	2	2	5	0,7	0

Table 12.3. Other pelagic sharks recorded in the ICCAT Task I Catch database for the Northeast Atlantic (1997–2012). Landings in 2011 and 2012 not yet available by country.

Country	Species Code	Scientific Name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Spain	CCP	*Carcharhinus plumbeus*													4	0		
	CCS	*Carcharhinus signatus*		2			0			0						2		
	FAL	*Carcharhinus falciformis*		10			1			4			59		20			3
	OCS	*Carcharhinus longimanus*		2		0	4	0							18	56		
	RSK	*Carcharhinidae*		158	60		100	80	86	97				28				
	SPZ	*Sphyrna zygaena*		3		1	4	1		12			2		0			
	SPK	*Sphyrna mokarran*		1														
	SPL	*Sphyrna lewini*		3					0	2								
	SPN	*Sphyrna* spp	353	343		312	249	363	231	364			103		113			
	SPY	*Sphyrnidae*												124				
	LMA	*Isurus paucus*		3		4	16	24	24	28			16		37	20		
	TIG	*Galeocerdo cuvier*	1	3		1	1	1	0	0			0		1			
Portugal	OCS	*Carcharhinus longimanus*										0		1	1	18		
	CCS	*Carcharhinus signatus*						1457			5247	1035	1343					
	CVX	*Carcharhiniformes*											483					
	RSK	*Carcharhinidae*							155			18	5			0		
	SPZ	*Sphyrna zygaena*							1			4			0	6		
	SPN	*Sphyrna* spp				0	0		6			17	6	5	10	42		
	LMA	*Isurus paucus*														1		
Senegal	WSH	*Carcharodon carcharias*														18		
	DUS	*Carcharhinus obscurus*													1	0		
	OCS	*Carcharhinus longimanus*													1			
	RSK	*Carcharhinidae*									154		37					
	SPN	*Sphyrna* spp									311	173	217					
	SPZ	*Sphyrna zygaena*						1428			7		4	103				

Table 12.3. Continued. Other pelagic sharks recorded in the ICCAT Task I Catch database for the Northeast Atlantic (1997–2012).

Country	Species Code	Scientific Name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
France	**RSK**	***Carcharhinidae***												**507**	**2**	**0**		
	SPL	***Sphyrna lewini***													**0**			
Netherlands	**TIG**	***Galeocerdo cuvier***											**37**					
United Kingdom	**SPL**	***Sphyrna lewini***													**12**	**0**		
Chinese Taipei	**FAL**	***Carcharhinus falciformis***												**1**	**3**			
		***Carcharhinus* spp. Total**	**0**	**172**	**60**	**0**	**104**	**1537**	**242**	**101**	**5401**	**1053**	**1927**	**536**	**48**	**94**	**200**	**17**
		***Sphyrna* spp. Total**	**353**	**349**	**0**	**313**	**253**	**1792**	**239**	**378**	**318**	**194**	**332**	**232**	**135**	**48**	**0**	**1**
		Total all species	**355**	**527**	**60**	**318**	**374**	**3354**	**505**	**508**	**5719**	**1247**	**2312**	**768**	**221**	**163**	**200**	**18**

Table 12.4. Other pelagic sharks in the Northeast Atlantic. Sharks bycatches of the Spanish swordfish longline fisheries in the NE Atlantic. Data from Castro *et al.*, 2000 and Mejuto *et al.*, 2002.

Shark bycatches of the Spanish longline swordfish fishery								
NE Atlantic	*Carcharhinus* spp.	*Sphyrna* spp.	*Galeocerdo cuvier*	*Isurus paucus*	*Mobula* spp.	Total bycatch	% sharks	% blue shark
1997	148	382	3	8		28 000	99.4	87.5
1998	190	396	5	8	7	26 000	99.4	86.5
1999	99	240	4	18	1	25 000	98.6	87.2

Table 12.5. Other pelagic sharks in the Northeast Atlantic. Reported landings (t) by country (Source FAO Fish-Stat) for Atlantic, northeast fishing area.

FAO FISHSTAT (2014)		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Country	Species																
Portugal	*Sphyrna zygaena*			8	8	4	5	7	20	3	13	9	7	5	4	0	0
Spain	*Mobula mobular*								1	3	3	2	1	3	4	5	0
	Sphyrna zygaena								5	10	< 0,5	3	2	1	< 0,5		
	Galeocerdo cuvier								2	4	5	3	2	-	< 0,5		
France	*Pteroplatytrygon violacea*																1
TOTAL		0	0		8	4	5	7	28	20	21	17	12	9	8	5	1

Table 12.6. 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 (years)	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
White shark *Carcharodon carcharias*	Cosmopolitan 0–1280 m	720	Ovoviviparous+ oophagy	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	Ovoviviparous	> 245 F			2	97–120			4.5
Silky shark *Carcharhinus falciformis*	Circumtropical 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
Spinner shark *Carcharhinus brevipinna*	Circumtropical 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
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 / –3.39	4.16–4.39

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity (years)	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
Dusky shark *Carcharhinus obscurus*	Circumglobal	420	Viviaparous	220–280	14–18	22–24	3–14	70–100	40	L∞ = 349 / 373 K= 0.039/ 0.038 T0 = –7.04/ –6.28	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 T0 = –2.54 / – 2.7	4.44–4.5
Tiger shark *Galeocerdo cuvier*	Circumglobal 0–350 m	740	Oviviviparous	316–323	8–10	13–16	10–82	51–104	50	L∞ = 388 / 440 K= 0.18 / 0.107 T0 = –1.13 / –2.35	4.54–4.63

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity (years)	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
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 T0 = –0.41 / – 0.75	4.0–4.21
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 / -2.86	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
Devil ray *Mobula mobular*	NE Atl. + Med. epipelagic	520	Ovoviviparous			25	1	≤ 166 DW			3.71

13 Demersal elasmobranchs in the Barents Sea

13.1 Ecoregion and stock boundaries

The ecology of the Barents Sea ecosystem (ICES Subarea I, extending into the eastern parts of Subarea II) has been described comprehensively by Jakobsen and Ozhigin (2012).

Lynghammar *et al*. (2013) reviewed the occurrence of chondrichthyan fish in the Barents Sea ecoregion. Skate species inhabiting offshore areas included thorny skate *Amblyraja radiata*, Arctic skate *Amblyraja hyperborea*, round skate *Rajella fyllae*, spinytail skate *Bathyraja spinicauda*, common skate *Dipturus batis* complex, sailray *Rajella lintea*, long-nose skate *Dipturus oxyrinchus* and shagreen ray *Leucoraja fullonica* (Andriashev, 1954; Dolgov, 2000; Dolgov *et al.*, 2005a; Wienerroither *et al.*, 2011), 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).

Stock boundaries are not known for the skates in this area. Neither are the potential movements of species between the coastal and offshore areas. The adjacent Norwegian coastal area has been included within the Barents Sea ecoregion. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

Amblyraja radiata is the dominant 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 portion 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 (Section 5), porbeagle (Section 6) and Greenland shark (Section 24). One chimaeroid (*Chimaera monstrosa*) also occurs.

13.2 The fishery

13.2.1 History of the fishery

All skate species in the ecoregion may be taken as bycatch in demersal fisheries, but there are no directed fisheries targeting skates in the Barents Sea. Detailed data on catches of skates from the Barents Sea are only available from bycatch records and surveys from 1996–2001 and 1998–2001, respectively (provided by Dolgov *et al.*, 2005a; 2005b). Bottom-trawl fisheries targeting cod *Gadus morhua* and haddock *Melanogrammus aeglefinus*, and longline fisheries targeting cod, blue catfish *An-*

arhichas denticulatus and Greenland halibut *Reinhardtius hippoglossoides* have a skate bycatch, which is generally discarded. 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 723–1891 t (average of 1250 t per year). *A. radiata* accounted for 90–95% of the total skate bycatch.

13.2.2 The fishery in 2014

No new information. Since 2012, Norwegian declared landings have increased. The reason for this increase is unknown.

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 discarded.

13.3 Catch data

13.3.1 Landings

For ICES Subarea I, landings data are limited and only available for all skate species combined (Table 13.1; Figure 13.1). Landings from the most westerly parts of the Barents Sea ecoregion fall within Subarea II (see Section 14). Russia and Norway are the main countries landing skates from the Barents Sea. Russian landings are not available since 2011.

Elasmobranch landings from ICES Subarea I 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 was landed (Dolgov, personal communication, 2006).

13.3.2 Discards

Dolgov *et al.* (2005b) estimated the total annual bycatch of skates from commercial trawl and longline fisheries in the Barents Sea to range from 723–1891 t, with *A. radiata* accounting for 90–95% of the total skate catch. *A. radiata* is also the predominant skate in catches of the Norwegian Reference Fleet operating in ICES Subarea I (Vollen, 2010 WD).

13.3.3 Quality of catch data

There are a lack of species-specific data in reported landings. Also, landings data do not reflect the total catch of skates from the Barents Sea, as some fleets discard skates due to their low commercial value.

The Norwegian oceanic reference fleet (commercial vessels) collects biological data for the Institute of Marine Research (IMR, Bergen). Some of the participating trawlers and longliners operate in the Barents Sea in part of the year. Personnel on board these vessels are obliged to measure the quantity of all fish species, including elasmobranchs. Data from 2008–2009 were analysed for species composition of elasmobranchs and reported to the WGEF (Vollen, 2010 WD). The results supported earlier findings regarding the dominance of *A. radiata* (>95% of both weight and numbers) in catches from ICES Subarea I (Table 13.2). It is concluded that most skates are discarded, as the yearly catch/vessel reported by the reference fleet is very high compared to corresponding numbers from the official Norwegian landings statistics. Future analysis of these data should include quantities and proportions of elasmobranchs in relation to commercial teleosts, such as cod and haddock.

13.3.4 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 were supported by data from the Norwegian Reference Fleet for 2008–2009 (Vollen, 2010 WD).

Dolgov *et al.* (2005b) reported the mean length and the sex ratio for four species of skate 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 *D. batis* complex in trawl and longline fisheries, respectively. 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) with catches comprised mainly males (41–56 cm

TL) and females (31–50 cm TL). The average length of males (41.6 cm) was greater than that of females (38.8 cm), 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 Norwegian coastal survey should be analysed and presented to the WGEF, as species identification improves.

13.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from deep trawl hauls (400–1400 m) along the continental slope (62–81°N) in 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. The 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 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. All skate species are recorded during these surveys, and length data collected. Some biological data are also collected on Russian vessels. However due to initial species identification problems, species-specific data should only be used from the years 2006–2007 onwards (applies 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 area also available. The information on the main elasmobranch 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 coverage in time and area.

A. radiata: The most common skate species in the Barents Sea. Widely distributed in the surveyed area, except in Arctic waters (Figure 13.2). Size distribution was similar in the two surveys, ranging from 5–65 cm (Figure 13.3).

A. hyperborea: The species was found in deeper waters along the shelf edge towards the Norwegian Sea and Polar basin, and in Arctic water in the deeper parts of the eastern Barents Sea (Figure 13.2). The size ranges from 6 to 85 cm. Only few specimens smaller than 38 cm were caught during the Q1 survey, although this size class was very numerous in the Q3 survey (Figure 13.3).

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 westwards, in the western part of the surveyed area (Figure 13.2). The recorded lengths ranged from 6 to 183 cm (Figure 13.3). The largest specimen exceeds the reported maximum length of 172 cm. Fewer small and more large individuals were caught in the Q1 survey than in the Q3 survey.

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).

13.6.5 Quality of survey data

Problem of species identification for skates is a major issue, especially with some of the earlier data. Williams (2007) gave a detailed description of identification issues for *A. radiata* vs. *R. clavata* in the Norwegian Sea ecoregion. Also, the occurrence of *D. batis* complex (possibly confused with *B. spinicauda*, see depth distribution of the two species in Dolgov *et al*. (2005a)) and *L. fullonica* in the Barents Sea have 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 use in assessments.

In order to improve 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 IMR includes workshops to educate staff as well as improved field guides and keys used for species identification.

13.7 Life-history information

Length data for *A. radiata*, *A. hyperborea*, *R. fyllae*, *D. batis* 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 assessments have been conducted.

13.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated, although taxonomic irregularities need to be addressed first.

13.10 Reference points

No reference points have been proposed.

13.11 Conservation considerations

See Section 12.11.

13.12 Management considerations

There are no TACs for any of the demersal skate stocks in this region. The elasmobranch fauna of the Barents Sea is little studied and comprises relatively few species. The most abundant skate in the area is *A. radiata*, which is widespread and abundant in this and adjacent waters. Further studies are required, particularly for some of the larger-bodied skates, which may be more vulnerable to overfishing.

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Table 13.1. Demersal elasmobranchs in the Barents Sea. Total landings (t) of skates from ICES Subarea I (1973–2014); "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

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	+	.	.	+	.	.	+	+
Iceland	.	.	.	3	3	.	.	.	.	.	.	1	8	.
Norway	30	26	2	1	4	13	4	72	15	9	31	109	171	157
Portugal	.	.	.	+	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	218	173	38	69	37	48	24	6	2	1	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	109	179	157

Table 13.2. Demersal elasmobranchs in the Barents Sea. Species composition of elasmobranch catches in ICES Subdivision I by the Norwegian Oceanic Reference Fleet (2008–2009). Total catch of elasmobranchs, presented both as percentage of biomass and percentage of catch. (Source: Vollen, 2010 WD).

Species	Total catch (% biomass)		Total catch (% numbers)	
	Longline	Trawl	Longline	Trawl
Amblyraja radiata	96.4	99.7	97.3	98.5
Amblyraja hyperborea	+	0	+	0
Dipturus batis complex	0.2	0	+	0
Rajella fyllae	0.1	0	0.2	0
Dipturus oxyrinchus	0	0.3	0	1.5
Bathyraja spinicauda	0.3	0	0.1	0
Rajiformes (indet.)	2.9	0	2.4	0

Figure 13.1. Demersal elasmobranchs in the Barents Sea. Reported landings (t) of skates from ICES Subarea I (1973–2014).

Q1 Q3

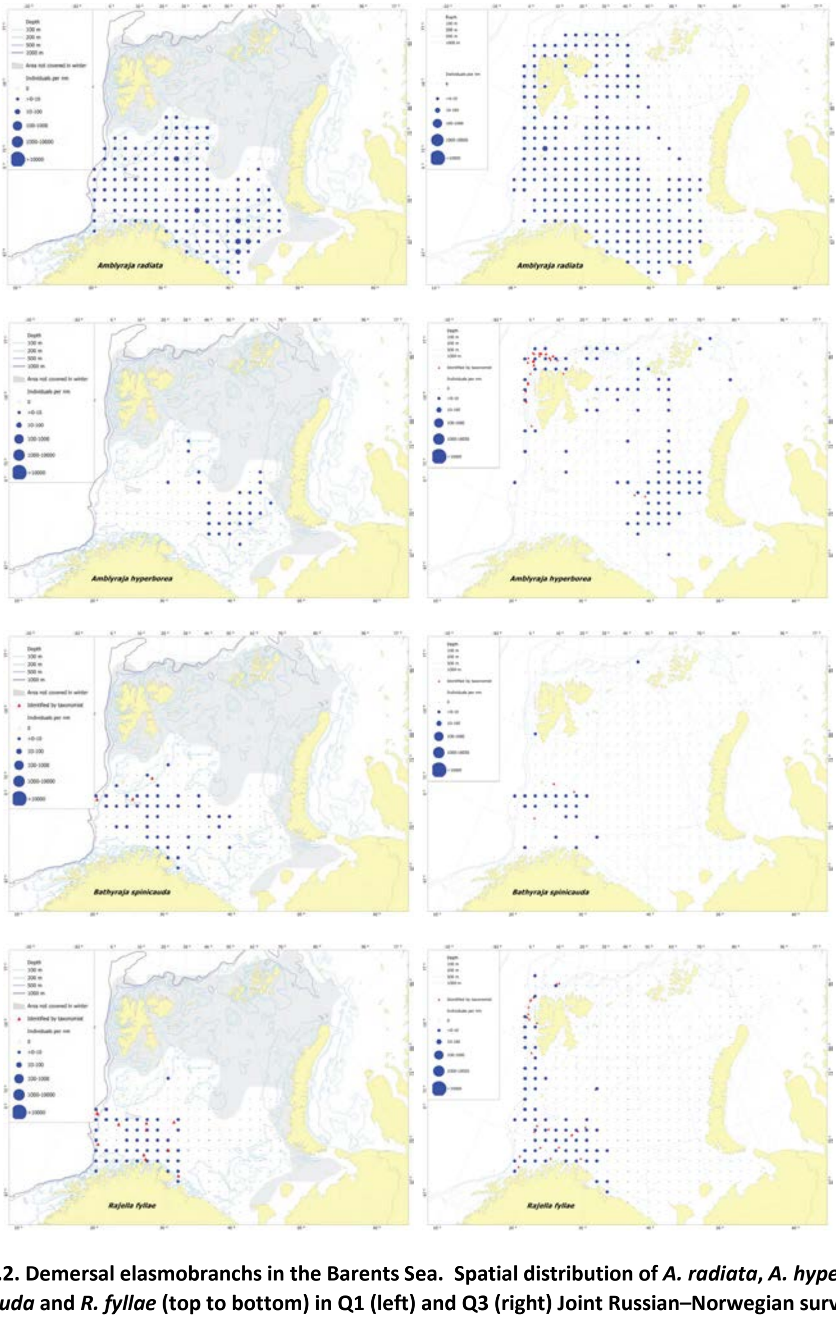

Figure 13.2. Demersal elasmobranchs in the Barents Sea. Spatial distribution of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Source: Wienerroither *et al*. (2011, 2013).

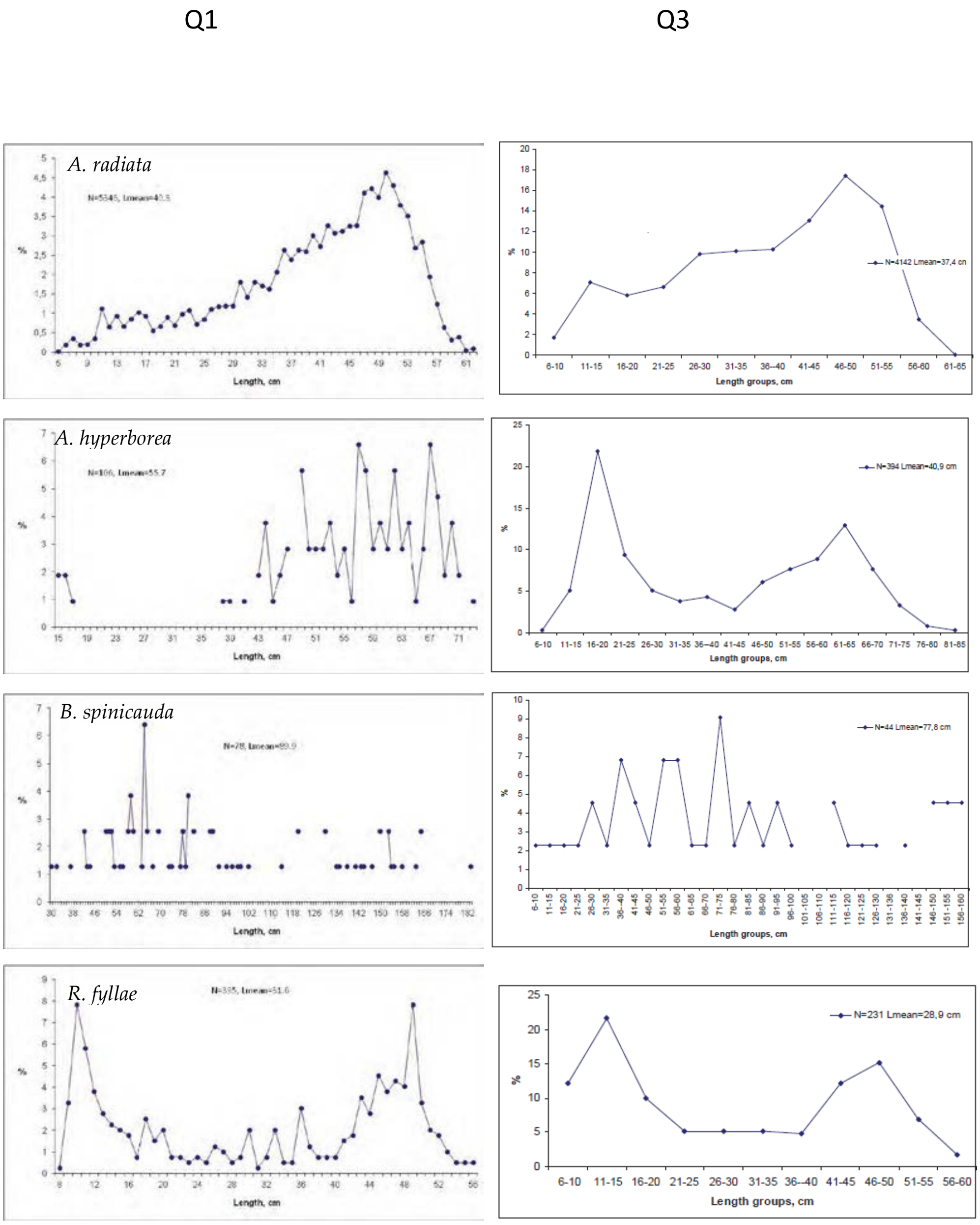

Figure 13.3. Demersal elasmobranchs in the Barents Sea. Spatial distribution of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Note that length distributions are not directly comparable between the two surveys. Source: Wienerroither *et al*. (2011, 2013).

14 Demersal elasmobranchs in the Norwegian Sea

14.1 Ecoregion and stock boundaries

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 *Dipturus batis* complex, sailray *Rajella lintea,* Norwegian skate *Dipturus nidarosiensis,* sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica,* round skate *Rajella fyllae*, arctic skate *Amblyraja hyperborea* and spinytail skate *Bathyraja spinicauda*. Long-nose skate *Dipturus oxyrinchus* is distributed mainly along the southern section of coastline, south of latitude 65°N. Records of *R. brachyura* and *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 numerous 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 *Etmopterus spinax* (Section 5), porbeagle *Lamna nasus* (Section 6), basking shark *Cetorhinus maximus* (Section 7), Greenland shark *Somniosus microcephalus* (Section 24), and black-mouth catshark *Galeus melastomus* and lesser-spotted dogfish *Scyliorhinus canicula* (Section 25).

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 adjacent areas.

14.2 The fishery

14.2.1 History of the fishery

There are no fisheries targeting skates in the Norwegian Sea, though they are caught in various demersal fisheries targeting teleost species.

14.2.2 The fishery in 2014

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 1973–2014 (Table 14.1; Figure 14.1). For ICES Subarea II, landings data are limited and, for skates, not species disaggregated. 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. 200–300 t per year for all fishing countries, with moderate fluctuations. The peak in the late 1980s resulted from Russian fisheries landing over 1900 t of skates in 1987, subsequently dropping to low levels two years later. This peak was 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.

Landings data (usually not discriminated at species level) have been provided by Norway, France, and Scotland in recent years. Russian landings have not been available since 2011.

14.3.2 Discard data

Vollen (2010 WD) reported on catch and discards by the Norwegian Reference Fleet in ICES Subarea II. More detailed results are given in Section 14.4.2.

14.3.3 Quality of catch data

Catch data are not species disaggregated.

14.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

14.4 Commercial catch composition

14.4.1 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. radiate*, with *fyllae*, *A. hyperborea* and *B. spinicauda* found in minor quantities (Vinnichenko *et al.*, 2010 WD).

A. 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 14.6.4.

14.4.2 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 II 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 between bottom trawl, bottom gillnet and longline. Whereas *A. radiata* made up the bulk 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 misidentifications issues should also be investigated. Catches of *A. radiata* were higher in Subarea II than in Subarea I for trawl catches (61 kg per 100 trawl hours for Subarea II; 43 kg per 100 trawl hours for Subarea I), 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 *D. batis* complex (possibly misidentified) and unidentified skates dominated the landed catches 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.

14.5 Commercial catch and effort data

Limited data available (but see above).

14.6 Fishery-independent surveys

14.6.1 Russian bottom trawl survey (RU-BTr-Q4)

Vinnichenko *et al.* (2010 WD) reported catches from the 2009 survey were dominated by *A. radiata* of 10–56 cm L_T (Figure 14.2b). In the size distribution, different size/age classes of the skate were very distinct. The mean length of males (37.7 cm) and females (37.4 cm) were similar and males slightly predominant (sex ratio = 1.05:1).

A. hyperborea of 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). Predominating were males of 46–50 cm and 61–75 cm, and females in the 56–65 cm and 76–80 cm length classes. The mean length of males (65.1 cm) and females (65.8 cm) were similar. Mostly males were caught (sex ratio = 5:1).

14.6.2 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.

Thirteen skate species and four species of shark were recorded inhabiting the coastal region (Table 14.3). Regularly occurring skates were *A. radiata, A. hyperborea, D. batis* complex, *D. nidarosiensis, D. oxyrinchus, Raja clavata, Rajella fyllae, L. fullonica*. Occasional or single observations were made of *B. spinicauda*, *R. lintea* and *L. circularis* (also *R. montagui*, *R. brachyura* were 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.*

Although no clear shifts in abundance over time were detected for any species, more robust assessment is necessary to better identify temporal trends in abundances.

14.6.3 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) 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. *A. radiata* and *A. hyperborea* were the dominant species north of 62°N (ICES Subarea II), whereas *E. spinax* was most numerous in the Norwegian Deep (Division IIIa). *B. 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).

14.6.4 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. All skates are recorded during these surveys, and data on length distributions as well as some biological data (on board of Russian vessels) are collected. As a result of initial problems with the 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 were presented by Vinnichenko *et al.* (2010 WD).

A. radiata was the dominant species in the August–September survey. Individuals varied from 5–61 cm L_T (Figure 14.2c), with most specimens 33–37 cm (Vinnichenko *et al.*, 2010 WD).

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. Males prevailed in the samples (1.7:1). Most males and females (over 70%) were immature, the rest were in developing stages or were mature (Figure 14.3). Unlike in the Barents Sea, no individuals at the active stage were reported in the area. The main prey were bottom decapods (spider crabs *Hyas* spp. and northern shrimp *Pandalus borealis*) and fish (capelin *Mallotus villosus* and Atlantic hookear sculpin *Artediellus atlanticus*), which accounted for 47% and 31% by weight, respectively (Figure 14.4).

14.6.5 Quality of survey data

The difficulties associated in 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 obtain any specimens of the *D. batis* complex, *L. fullonica*, *R. brachyura* or *R. montagui* in the Norwegian Sea: giving more credence to earlier misidentification issues. The two former species have been confirmed to exist in the area in historical times, whilst the two latter species have never been confirmed. *R. montagui* from central Norway was known from a museum specimen, but Lynghammar *et al.* (2014) identified it as *R. clavata*.

In order to achieve a better quality of survey data in future, 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 guides and keys used for species identification.

14.7 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 available in the literature (e.g. Berestovskii, 1994). Sampling of elasmobranch egg-cases was included in Norwegian trawl surveys from mid-2009, and may provide future information on nursery grounds.

14.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data.

14.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow to evaluate the status of the more frequent species, although taxonomic irregularities need to be addressed first.

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 (IUCN, 2014) listings for species occurring in this area include (assessment year in parentheses):

"Critically endangered": *D. batis* complex (2006);

"Endangered": *L. circularis* (2014);

"Vulnerable": *L. fullonica* (2014);

"Near threatened": *B. spinicauda* (2006), *D. nidarosiensis* (2014), *D. oxyrinchus* (2014) and *R. clavata* (2005).

Demersal elasmobranchs listed on the Norwegian Red List (Gjøsæter *et al.*, 2010), excluding species assessed as "Least concern", are *D. batis* complex ("Critically endangered") and *B. spinicauda*, *D. nidarosiensis* and *L. fullonica* (all "Near threatened").

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 occur in the Barents Sea (Section 13) and/or the North Sea (Section 15). Further investigations are required, and could also offer valuable additional information for managing the neighbouring ecoregions.

14.13 References

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Table 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subdivisions II, IIa and IIb from 1973–2014. "n.a." = no data available, "." = means zero catch, "+" = < 0.5 tonnes. Countries with only occasional catches are not included in the landings table: Denmark (1994), Belgium (1 tonne 1975), Sweden (+ in 1975), Netherlands (1979), Iceland (2001, 2011), Estonia (2002, 2005), and Ireland (2007).

	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	189

	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

	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	8	2	4	2	1	3	1	1	.	.
Germany	.	2	2	7	1	.	.	.	.	1	.	.	.	2
Norway	233	118	111	142	133	146	189	259	257	250	197	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	.	2	.	.	.	.	.	.	.	.	.
UK - E, W & NI	.	.	.	.	.	+	.	.	.	.	.	.	1	.
UK – Scotland	1	3	3	.	2	4	1	1	+	.	.	.	1	.
Other	4	5	.	.	4	.	1	.	.	.	2	.	.	.
Total	365	184	166	220	186	195	237	277	270	259	200	122	149	107

Table 14.2. Demersal elasmobranchs in the Norwegian Sea. Species composition of elasmobranch catches in ICES Subarea II by the Norwegian Oceanic (2008–2009) and Coastal Reference Fleet (2007–2008). Data for the Oceanic Reference Fleet refer to the total catch of elasmobranchs as percentage of biomass and percentage of numbers. Data for the Coastal Reference Fleet are percentage in numbers of landed catch and discarded catch. Adapted from Vollen (2010 WD).

	Oceanic Reference Fleet			Oceanic Reference Fleet			Coastal Reference Fleet	
	Total catch (% biomass)			Total catch (% numbers)			Landed	Discarded
Species	Lines	Nets	Trawls	Lines	Nets	Trawls	Nets	Nets
Skates								
Bathyraja spinicauda	0.5		0.4	0.2		0.5		
Amblyraja hyperborea	5.4			2.9			0.1	
Amblyraja radiata	79.5	6.3	55.1	78.9	7.8	54.5		1.8
Dipturus batis complex	0.2			0.1			38.7	0.4
Dipturus oxyrinchus	+		0.1	+		0.1	0.7	7.4
Dipturus nidarosiensis								+
Leucoraja fullonica	0.2	11.4	1.5	0.1	0.9	2.8		
Raja clavata		74.5	9.4		82.2	9.4	6.5	0.8
Rajella fyllae	2.2	0.6	3.2	3.8	1.1	5.5	0.7	1.1
Skates indet	3.6			5.0			33.4	18.2
Rajella lintea	0.2			0.1				2.0
Sharks								
Etmopterus spinax	1.0			3.3				4.2
Somniosus microcephalus								0.5
Squalus acanthias	0.2	0.3	+	0.1	0.4	0.1	7.9	7.3
Cetorhinus maximus								0.2
Lamna nasus							10.8	0.1
Galeus melastomus	1.4			2.2			0.1	11.3
Scyliorhinus canicula								0.3
Galeorhinus galeus								+
Chimaeras								
Chimaera monstrosa	5.6	6.9	30.3	3.4	7.5	27.2	1.1	44.5
Total skates	**91.8**	**92.8**	**69.7**	**91.0**	**92.1**	**72.7**	**80.1**	**31.7**
Total sharks	**2.6**	**0.3**	**0.0**	**5.6**	**0.4**	**0.1**	**18.8**	**23.8**
Total chimaeras	**5.6**	**6.9**	**30.3**	**3.4**	**7.5**	**27.2**	**1.1**	**44.5**

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
Dipturus batis complex	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
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
Number of samples	17	163	106	77	74	96	78	81	76	56	78	65	77	63			

***Probably misidentifications, the occurrence of the species in the area has not been confirmed (see Section 14.6.5).**

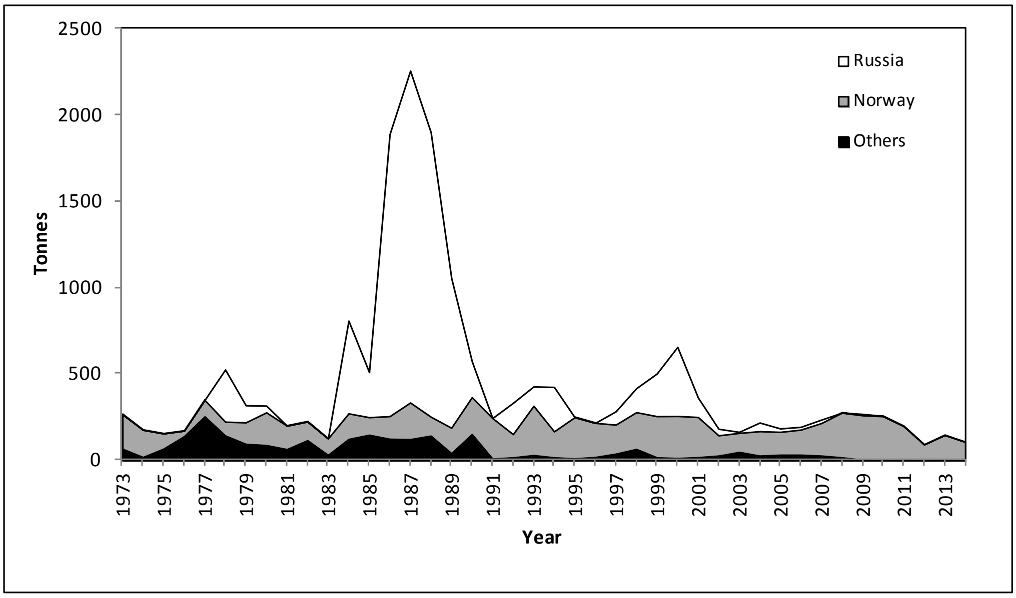

Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subdivisions II, IIa and IIb from 1973–2014.

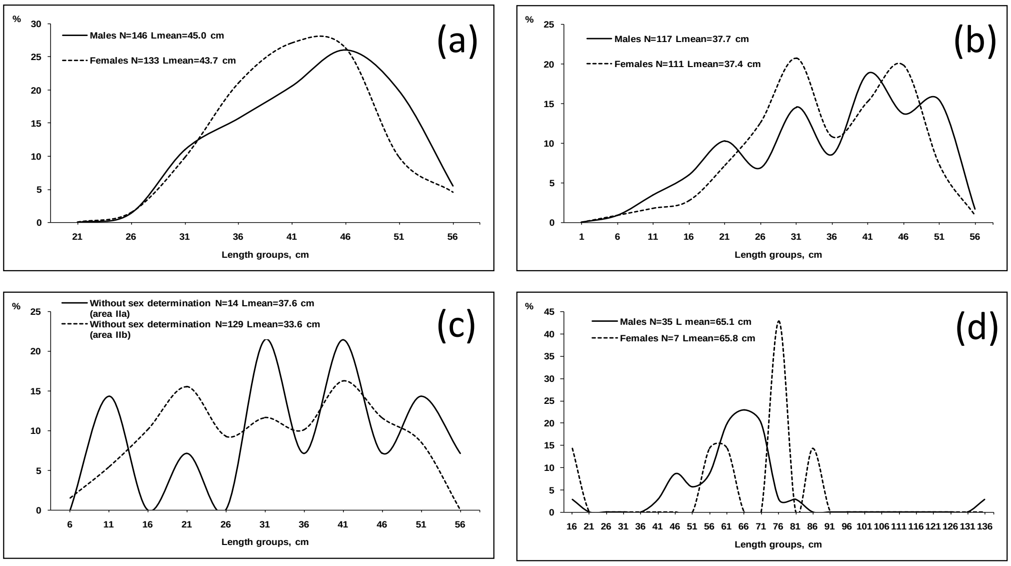

Figure 14.2. Demersal elasmobranchs in the Norwegian Sea showing the length composition of *A. radiata* in (a) commercial bottom-trawl catches in the Norwegian Sea in 2009, (b) Russian demersal survey (October–December 2009) and (c) the Norwegian Sea based on data from the joint Russian–Norwegian ecosystem survey (August–September 2009); and (d) length composition of *A. hyperborea* in the Norwegian Sea (Division IIb) from the Russian demersal survey (October–December 2009). Specimens exceeding 131 cm are probably typing errors or misidentifications. Source: Vinnichenko *et al.* (2010 WD).

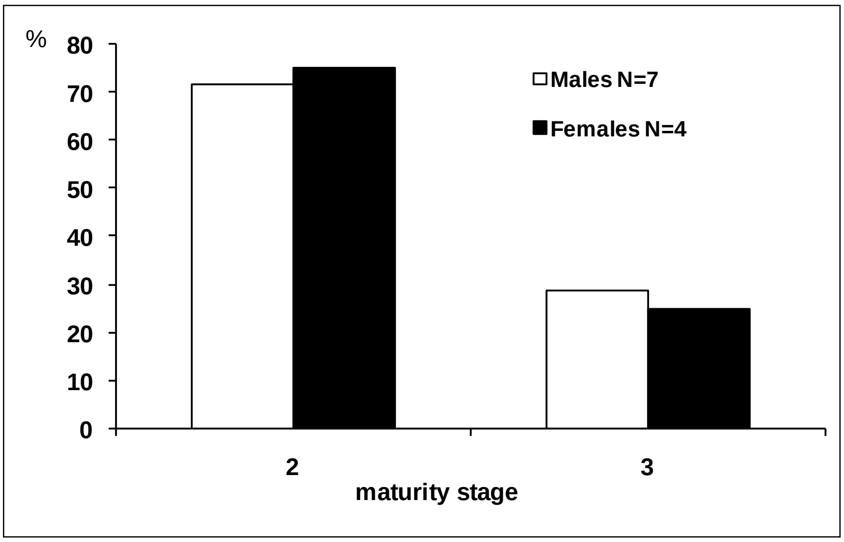

Figure 14.3. Demersal elasmobranchs in the Norwegian Sea. Proportion of *A. radiata* by maturity stage as recorded in bottom trawl catches in the Norwegian Sea in 2009. Source: Vinnichenko *et al*. (2010 WD).

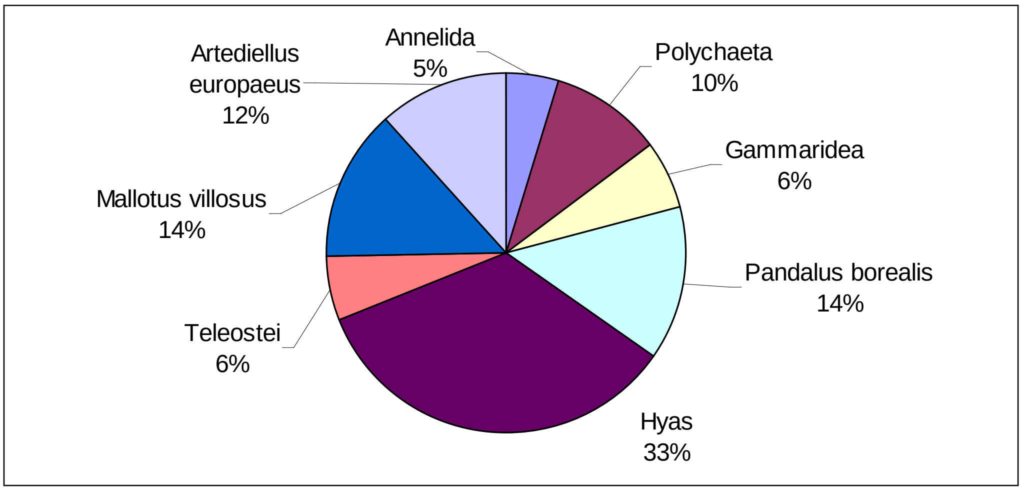

Figure 14.4. Demersal elasmobranchs in the Norwegian Sea. Food composition of *A. radiata* in the Norwegian Sea in November 2009 (% by weight; N=11 stomachs, 9.0% empty stomachs). Source: Vinnichenko *et al*. (2010 WD).

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 probably the most important skate for the commercial fisheries. Preliminary assessments on this species were presented in ICES (2005, 2007), based on research survey data. WGEF is still concerned over the possibility of misidentification of skates in some recent IBTS surveys, especially differentiation between *R. clavata* and starry ray *Amblyraja radiata*.

R. clavata in the Greater Thames Estuary (southern part of ICES Division IVc) is known to move into the eastern English Channel (Ellis *et al.*, 2008b). For most other demersal species in the North Sea ecoregion the stock boundaries are not well known. The stocks of cuckoo ray *Leucoraja naevus*, spotted ray *R. montagui* and *R. clavata* (northern North Sea) probably continue into the waters west of Scotland and, in the case of *R. montagui,* also into the eastern English Channel). The stock boundary of the common skate *Dipturus batis* complex is likely to continue to the west of Scotland and into the Norwegian Sea. Most specimens from the northern part of this ecoregion are likely to be *Dipturus* cf. *intermedia*, although the presence and extent of *Dipturus batis* (cf. *flossada*) in this region are unknown. Blonde ray *Raja brachyura* has a patchy distribution, occurring in the southern North Sea (presumably extending to the eastern English Channel) and northwestern North Sea (and this stock may extend to northwest Scotland).

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 tanglenets and longlines. For a description of the demersal fisheries see the Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES, 2009a) and the report of the DELASS project (Heessen, 2003).

The 25% bycatch ratio brought in by the EC (see also Section 15.2.4) for vessels over 15 m has restrained some fisheries and may have resulted in misreporting since 2007, both of area and species composition.

15.2.2 The fishery in 2014

Landings tables for the relevant species are provided in Tables 15.1–15.9. The landings generally peaked in the middle of the 1980s and declined steadily thereafter in the North Sea. A similar trend as observed for Area VIId although an increase was observed since 2005.

15.2.3 ICES Advice applicable

In 2012, ICES provided advice on the overall exploitation (landings and discards) of the skate assemblage, and also on individual species for 2013, 2014, and 2015. Individual advice has been given for each of the main stocks, on the basis of ICES approach to data-limited stocks. However, ICES did not advise that individual TACs be established for each species at that time, because the catch statistics for individual species were not reliable.

The advice stated that there should be no targeted fishery should be allowed for undulate ray *Raja undulata* (see Section 18 for further details) and *D. batis* complex, and measures should be taken to minimize bycatch.

Based on ICES approach to data-limited stocks, ICES advised that catches could be increased by a maximum of 20% for *R. clavata*, *R. montagui* and *L. naevus* and catches should be reduced by at least 20% for blonde ray *R. brachyura* and small-eyed ray *Raja microocellata* (see Section 18 for further details). For starry ray (thorny skate) *Amblyraja radiata,* ICES advised that catches should be reduced by 36%.

For the other species found in this region (Norwegian skate *Dipturus nidarosiensis,* long-nose skate *Dipturus oxyrinchus,* sandy ray *Leucoraja circularis,* shagreen ray *Leucoraja fullonica* and sailray *Rajella lintea*), ICES advised that catches should be reduced by at least 20%.

.2.3.1 State of the stocks

In 2012 WGEF provided a qualitative summary of the general status of the major species based on surveys and landings was given by WGEF. It should be noted that this perception has not changed.

D. batis complex: Depleted. It was formerly widely distributed over much of the North Sea but is now found only rarely, and only in the northern North Sea. The distribution extends into the west of Scotland and the Norwegian Sea [Note: This perception was based on comparisons of historical and contemporary trawl survey data].

R. clavata: The distribution area and abundance have decreased over the past century, with the stock concentrated in the southwestern North Sea where it is the main commercial skate species. Its distribution extends into the eastern Channel. Survey catch trends in Division IVc and VIId have been stable/increasing in recent years. The status of *R. clavata* in Divisions IVa, b is uncertain.

R. montagui: Stable/increasing. The area occupied has fluctuated without trend. Abundance in the North Sea is increasing since 2000, in the eastern Channel a slight increase can be observed during recent years.

A. radiata: Stable. Survey catch rates increased from the early 1970s to the early 1990s and have decreased since then.

L. naevus: Stable. Since 1990 the area occupied has fluctuated without trend. Abundance has decreased since the early 1990s, but has been stable in recent years.

R. brachyura: Uncertain. This species has a patchy occurrence in the North Sea. It is at the edge of its distributional range in this area.

15.2.4 Management applicable

In 1999 the EC first introduced a common TAC for “skates and rays”. 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 *D. batis* complex. WGEF is of the opinion that this measure is ultimately expected to improve our understanding of the skate fisheries in the area.

Council Regulation (EU) 2015/523 of 25 March 2015 amended the Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities. This stated that "*According to Article 3(1) of Council Regulation (EC) No 847/96 (1), when more than 75% of a precautionary TAC has been utilised before 31 October of the year of its application, a Member State with a quota for the stock may request an increase in the TAC. A request for a 10% increase of the 2014 TAC for skates and rays in the North Sea has been received by the Commission. The supporting biological information, submitted with the request, has been verified and validated by experts at the Commission's Joint Research Centre*".

The TACs for skates and rays for the different parts of the area in 2015 are: 1382 t for IIa and IV; 798 t for VIId; and 47 t for IIIa. The TAC does not apply for *D. batis* and *R. undulata,* or for *R. clavata* (Division IIIa) and "*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 a safe release of the species*". Some transfer (5%) between TAC areas of VIId and the Celtic Seas ecoregion is allowed, which may account for some of the overshooting of the TAC in VIId.

In 2015, the list of prohibited species on EU fisheries regulations (Council Regulation (EU) 2015/104) included:

- Thornback ray *Raja clavata* in Union waters of ICES Division IIIa;
- Starry ray *Amblyraja radiata* in Union waters of ICES Divisions IIa, IIIa and VIId and ICES Subarea IV;
- Common skate (*Dipturus batis*) complex (*Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia*) in Union waters of ICES Division IIa and ICES Subareas III, IV, VI, VII, VIII, IX and X.

Year	TAC	TAC for Areas IIa and IV	TAC for VIId	TAC for IIIa	Landings
1999	6060				3997
2000	6060				3992
2001	4848				4011
2002	4848				3904
2003	4121				3797
2004	3503				3237
2005	3220				3030
2006	2737				2845
2007	2190[1)]				3141
2008	1643[2)]				3025
2009	2755	1643	1044	68	3192
2010	2342	1397	887	58	2951
2011	2342[)]	1397	887	58	2672
2012	2340[)]	1395	887	58	2738
2013	2106	1256	798	52	3000
2014	2101	1256[3)]	798[3)]	47[3)]	2603
2015	2227	1382[4)]	798[5)]	47[6)]	

1) Considered as bycatch quota for vessels over 15 m. 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* complex) shall be reported separately.

3) Shall not apply to common skate (*Dipturus batis*) complex (*Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia*), undulate ray (*Raja undulata*) 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.

4) Shall not apply to common skate (*Dipturus batis*) complex (*Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia*), 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.

5) Shall not apply to common skate (*Dipturus batis*) complex (*Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia*), 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.

6) Catches of Cuckoo ray (*Leucoraja naevus*), Blonde ray (*Raja brachyura*), and Spotted ray (*Raja montagui*), Starry ray (*Amblyraja radiata*) shall be reported separately.

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.

Since 2009, Norway has a discards ban that applies to skates and sharks, as well as other fish, in the Norwegian Economic Zone. However, discarding of skates is likely to have continued, although the precise quantity is unknown.

15.3 Catch data

15.3.1 Landings

The landings tables for all rays and skates combined (Tables 15.1–15.4) were updated. Since 2008, EC member states are required to provide species-specific landings data for the main species of rays and skates (Tables 15.5–15.8).

Figure 15.1 shows the total international landings of rays and skates from IIIa and IV combined, and VIId since 1973, plus the TAC for recent years. Data from 1973 onwards are WG estimates. Figure 15.2 shows the landings by country for the whole North Sea ecoregion.

15.3.2 Discard data

Information on discards in the different demersal fisheries is being collected by several Member States, and were submitted to the Expert Group.

Length–frequency distributions of discarded and retained elasmobranchs (for the period 1998–2006) were provided by UK-England (ICES, 2006), with updated information in Ellis *et al*. (2010). Silva *et al*. (2012) investigated the UK skate catches, including those from the North Sea, and using observer data, discussed discarding patterns. In general, 50% retention occurred at 49–51 cm L_T. for the main commercial skate species, and nearly all skates with total length larger than 60 cm L_T were retained. *A. radiata* was generally discarded across the entire length range (12–69 cm L_T).

15.3.3 Quality of the catch data

In 2008 the EC asked Member States to start reporting their landings of skates and rays by (major) species. Official species-specific landings should therefore be available for six years now; however compliance with this varies from 0–100% by region and Member State (see Section 15.4.1). The quality of the species-specific data is discussed in Section 15.4.2.

Several nations have market sampling and discard observer programmes that can also provide information on the species composition, although comparable information is lacking for earlier periods. Updated analyses of these data are required.

The ongoing French project "RAIMEST", conducted by French fisheries regional committees, aims at improving existing knowledge on skates stocks in Division VIId, based on fisher knowledge. This work aims to improve knowledge on functional fishery areas and on the spatial characteristics of skate catches (presence of areas, species distribution, seasonality, individual size, etc.). Another goal is to define a correction coefficient to apply to declarative data (logbook) in this area.

15.3.4 Discard survival

Ellis *et al.* (2014 WD) provided a review of discard survival studies. Skates taken in coastal fisheries using trawls, longlines, gillnets and tanglenets generally show low at-vessel mortality (Ellis *et al*., 2008a), 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).

15.4 Commercial landings composition

15.4.1 Species and size composition

From 2008 onwards all EU countries are obliged to register species-specific landings for the main skate species. In the past, only France and Sweden provided landings data by species based on information from logbooks and auction. However, the accuracy of some of these data was doubtful. The landings for each country have been analysed to determine the percentage of landings that have been reported to species-specific level. It can be seen that this percentage varies between regions and countries (Tables 15.5–15.7). Belgium, France, the Netherlands, UK-England and UK-Scotland demonstrate a consistent high level of species-specific declaration for Areas IV and VIId; in 2014 they all declared > 75% of their landings in Area IV and Division VIId to species level respectively (Tables 15.6–15.7). Sweden mainly landed rays and skates from Area IIIa, and 100% of landings were declared at species level. Denmark, Germany and Norway (Areas IIIa, IV) had lower percentages of landings recorded to species levels, or did not declare any landings to species level (Tables 15.5–15.6), and species-specific landings data are required. Whilst the Norwegian Reference Fleet provides some information on species composition, this cannot be regarded as representative of the whole Norwegian fishery.

The species composition (percentage) for landings by the Dutch beam trawl fleet based on market sampling for 2000–2007 is presented in Table 15.9. Table 15.10 gives length compositions of these landings. Figure 15.3 shows the length–frequency of sampled Dutch skate and ray landings in 2012.

15.4.2 Quality of data

The WG is of the opinion that analyses of data from market sampling and observer programmes can provide reliable data on the recent species composition of landings and discards, and such data should be used to validate and/or complement reported landings data.

From 2008 onwards improved species-specific landings are available. Such data can be compared with market sampling and observer programmes to determine whether species identification has occurred correctly. The market sampling programme of the Dutch beam trawl fishery from 2000–2007 demonstrated that *R. montagui* and *R. clavata* are the most common species landed, followed by *R. brachyura* (Table 15.8). Since the species-specific landings data were available (from 2008 onwards), it appears that the percentage of *R. brachyura* has decreased in the Dutch landings (Table 15.6; ICES, 2009b, 2010, 2011a, 2012, 2014) compared with 2000–2007. It is likely that misidentification has occurred (especially between *R. montagui* and *R. brachyura*). This probably affects most nations reporting these two species.

Landings of white skate *Rostroraja alba* and *R. microocellata* as reported by France in ICES Area IV, Arctic skate *Amblyraja hyperborea* as reported by France in ICES Areas IV and VIId, and *D. oxyrinchus* as reported by the UK (England) in ICES Area VIId are likely the result of misidentification or incorrect use of species codes. Furthermore, landings of *L. circularis* reported by Belgium in ICES Area VIId are unlikely and are suspected to refer to *R. microocellata*, as both species are sometime known locally as 'sandy ray'. Very low landings (39 kg) of *R. alba* were reported by UK (England) in ICES Areas IV and VIId, but the accuracy of this species identification remains unclear.

These examples demonstrate that more robust protocols for ensuring correct identification, both at sea and in the market, and quality assurance of landings data are still needed. The species-specific landings data indicate that some nations still report a considerable proportion of unidentified ray and skate landings or do not report species-specific landing data at all.

In 1981 France reported exceptionally high landings for IV and VIId. This is likely to be caused by misreporting. Misreporting may also have taken place in 2007 as a consequence of limited quota and the 25% bycatch limitation.

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 indices for the most relevant species, based on North Sea IBTS surveys for the years 1977–2013, are shown in Figures 15.4 and 15.5, and Tables 15.11–15.13. Mean, maximum and minimum lengths per year for the North Sea IBTS survey are shown in Figures 15.6 and 15.7. Time-series of abundance indices for the most relevant species based on French CGFS and UK BTS surveys are shown in Figures 15.8 and 15.9. Data were extracted from the DATRAS database or supplied by national laboratories.

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 and summer, and from different beam trawl surveys (in summer). An overview of North Sea elasmobranchs based on survey data was presented in Daan *et al.* (2005), with distribution maps are provided in ICES (2005, 2006) and in Figure 15.10. Spatial distribution maps from the Beam trawl surveys were provided by WGBEAM (Figure 15.11).

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 seventies to the early eighties, 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*, these species increase in the most recent ten years in the Q1 and Q3 surveys. *D. batis* demonstrated an overall decline, supporting the findings of ICES (2006). *R. clavata* has largely remained stable in recent years, with one outlier in 1991 owing to a single exceptionally large catch (confirmed record).

15.6.2 Channel groundfish survey

Martin *et al.* (2005) analysed data from the Channel Groundfish Survey (CGFS) 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 continued in 2013, where high indices were noted for *R. clavata* and *R. undulata*. While most species fluctuate without 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 VIIe.

15.6.3 Beam trawl surveys

The UK (BTS-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). The primary target species for the survey are commercial flatfish (plaice and sole) 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.

Catch rates (n.h^{-1}) for this survey were updated, although the subsequent analyses omitted data collected prior to 1993 (Figure 15.9; Tables 15.11–15.13). The catches consist mostly of juvenile and subadult fish, which is likely to be an effect of the shallow area covered in this survey and that the gear (which has a chain mat) is less effective for catching larger skates.

R. clavata have broadly increased over the period, though the greatest catches and increase is from stations in IVc. Over the entire time-series, there have been a limited number of stations routinely fished in this division, although an increased number of sampling stations have been fished in recent years. So these data should be examined in future studies.

Although *R. brachyura* has generally increased over the period, catch rates for this species are low and variable. Catch rates for *R. montagui* have declined in recent years. Given that this survey generally catches juveniles of this species and of *R. brachyura*, it is unclear as to whether there may have been some identification issues involved in these contrasting trends.

Only small numbers of *R. undulata* are captured in this survey (VIId is the eastern part of their geographic range). The species was absent in 2006 and 2007 but was caught again in all subsequent years.

15.6.4 Other surveys

French surveys of coastal areas that aim to sample scallops and coastal fish nurseries and communities have a bycatch of skates. These surveys include Comor (dedicated to monitoring scallop abundance in VIId) NourSom (fish nurseries in the Baie de Somme, VIId) and NourSeine (fish nurseries in Baie de Seine, VIId).

As a part of the biological surveillance of the Penly nuclear power plant, Ifremer surveys the coastal area from Dieppe to the Baie de Somme. Since 1979, the sampling methodology has been standardized, using a stratified sampling scheme relying upon small meshed beam trawls. The surveys are conducted yearly in autumn and juvenile *Raja clavata* are commonly caught (mean length = 28.2 cm L_T; range = 15–45 cm L_T). Catches are mostly in the coastal area between Ault and Cayeux, which may be considered as a nursery ground for the species. Because this survey consists of a long time-series, it would appear interesting to describe the evolution of their catches over the last 30 years (Tetard *et al.*, 2015; Figure 15.12). For more details see Deschamps *et al.* (1981) and Schlaich *et al.* (2014).

15.7 Life-history information

Elasmobranchs are not routinely aged, although techniques for ageing are available (e.g. Walker, 1999; Serra-Pereira *et al.*, 2005). Limited numbers of species have been aged in special studies.

Updated length–weight conversion factors and lengths-at-maturity are available for nine skate species (McCully *et al.*, 2012). 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. For example, recent studies of the numbers of egg-cases laid by captive female *R. clavata* were 38–66 eggs over the course of the egg-laying season (Ellis, unpublished), whereas other studies using oocyte counts and the proportion of females carrying eggs have suggested that the fecundity may be >100.

15.7.1 Ecologically important habitats

Ecologically important habitats for the demersal elasmobranchs would include (a) oviposition (egg-laying) sites for oviparous species; (b) pupping grounds for viviparous species; (c) nursery grounds; (d) 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 and pupping grounds, although parts of the southern North Sea (e.g. the Thames area) are known to have large numbers of juveniles (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 usefully provide 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, 2011b). 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

Given the lack of longer term species-specific data from commercial fleets and limited biological information, the status of North Sea skates and rays have been evaluated based on survey data, including historical information.

15.8.1 GAM analyses of survey trends

In 2014, a GAM analysis focused on *A. radiata* in the IBTS-Q1 and IBTS-Q3 surveys and also *Scyliorhinus canicula* (see Section 25) in the CGFS, UK-BTS, IBTS-Q1 and IBTS-Q3 surveys. The length-based cpue per haul for the period 1977-Q1 2014 were used as input data. These variables were used to predict cpue in a GAM analysis (Wood, 2006). The cpue was given as n.hr^{-1}. Given the nature of the data, a negative binomial error distribution with a log link was assumed. Results, in terms of predicted mean cpue per year and length (at a given location with corresponding depth) and the spatial distribution of the catches, are given in Figure 15.13. The name of the survey was taken into account as a nuisance variable that describes the difference in catchability between surveys. Future work on these analyses could include converting the cpue indices to numbers per unit area (density estimates), but it should be noted that different ground gears and sweep lengths can be used in some surveys, which may influence catchability. Once the cpue estimates are analysed in terms of numbers per unit area, total biomass estimates can be further determined.

15.8.2 Estimation of abundance and spatial analysis–application of the SPANdex method

In 2007 the SPANdex approach was used to examine changes in abundance and distribution of four more common skate species in the North Sea (*A. radiata, L. naveus, R. clavata* and *R. montagui*).

Density surfaces (distribution based strata) were created using potential mapping in SPANS (Anon, 2003). Quarter 1 catch rate data from the North Sea IBTS survey (IBTS-Q1) employing a GOV demersal trawl, from 1980 to 2006 were used for the analysis.

The distribution maps of all four skate species demonstrated that these species have been restricted to the consistent areas. The area occupied (AO) changed over time (Figure 15.14). Overall, it is clear from this study that AO may not reflect population changes and should therefore be used with caution when being used as metric for population status.

15.8.3 Previous assessments of *R. clavata*

Under the DELASS project (Heessen, 2003), various analyses of survey data were conducted (ICES, 2002). The high frequency of zero catches in combination with a few, in some cases, high catches were analysed statistically using a two-stage model approach. First, the probability of getting a catch with at least one *R. clavata* was made using a GLM with a binomial distribution and a logit link function. Non-zero catches were then modelled using a Gamma distribution and a log link function.

ICES (2002) concluded that "*The North Sea stock of thornback ray has steadily declined since the start of the 20th century. One hundred years ago, the distribution area of the stock included almost the whole North Sea. Today, survey data demonstrate a concentration in the southwest North Sea (from the Thames Estuary to the Wash), and this reduced distribution area is confirmed by the steep decrease in the probability of a catch including thornback ray estimated by statistical models. Apparently, there are still patches left in the North Sea with stable local populations. Whether these areas are self-sustaining and whether the number of patches will remain high enough for a sustained North Sea population is, however, unknown*".

ICES (2005) subsequently undertook GIS analyses of survey data, and these studies also suggested that the stock was concentrated in the southwestern North Sea (see Sections 10.5 and 10.8 of ICES, 2005) and the stock area had declined.

From comparisons of recent survey data with data for the early 1900s it can be seen that, in the first decade of the 20th century, *R. clavata* was widely distributed over the southern North Sea, with centres of abundance in the southwestern North Sea and in the German Bight, north of Helgoland. The area over which the species is distributed in recent years is much smaller than 100 years ago. The species has disappeared from the southeastern North Sea (German Bight), and catches in the Southern Bight have become limited to the western part only (see also ICES, 2002).

15.9 Stock assessment

Assessment of these species follows the ICES procedure for data-limited stocks. Most stock fall into ICES category 3.2, use of survey trends.

15.10 Quality of assessments

Analyses of survey data for *R. clavata* undertaken by ICES (2002; 2005) may have been compromised by misidentifications in submitted IBTS data, and so the extent of the decline in distribution reported in these reports may be exaggerated. The distribution of *R. clavata* in the southern North Sea has certainly contracted to the southwestern North Sea, and they are now rare in the southeastern North Sea, where they previously occurred (as indicated by historical surveys). The perceived decline in catches in the northeastern North Sea may have been based, at least in part, on catches of *A. radiata*. Excluding questionable records from analyses still indicates that the area occupied by *R. clavata* has declined, with the stock concentrated in the southwestern North Sea, with catch trends in IVc more stable/increasing in recent times (ICES, 2007).

15.11 Reference points

No reference points have been proposed for *R. clavata* or other elasmobranch stocks in this ecoregion.

15.12 Conservation considerations

The *D. batis*-complex is 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.

Various elasmobranchs are contained in the Swedish Red List (Gärdenfors, 2010), with *R. lintea* considered Near Threatened, *R. clavata* and rabbit fish *Chimaera monstrosa* considered Endangered, and *D. batis* considered Regionally Extirpated.

The Norwegian Red List (Gjøsæter *et al.*, 2010) included 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

Demersal elasmobranchs are usually caught in mixed fisheries for demersal teleosts, although some inshore longline and gillnet fisheries target *R. clavata* in seasonal fisheries in the southwestern North Sea. Up to 2008 they were traditionally landed and reported in mixed categories such as "skates and rays". For assessment purposes, species-specific landings data are essential. Some doubts exist as to the quality of the data provided. Particularly the distinction between *R. montagui* and *R. brachyura* may need to be improved. Further sampling of commercial catches to validate species-specific landings is therefore required.

Landings have been at or above the TAC since 2006 (but slightly above in VIId, possibly due to transfer between VIId and VIIe) (Figure 15.1) and may now be restrictive for some fisheries. Since its introduction the TAC has gradually been reduced. In 2009–2013 there were three separate TACs (EU waters of Division IIa and Subarea IV combined; Divison IIIa; and Division VIId). Further reductions in TAC may induce regulatory discarding.

Discard survivorship can be high for inshore trawlers in the SW North Sea, as tow duration tends to be relatively short and line fisheries also have a high discard survival (Ellis *et al.*, 2008a, b). Discard survival from gillnet catches is also potentially high, depending on soak-time. Preliminary studies of survival from beam trawlers also indicated potentially high (>70%) survival for skates (Depestele *et al.*, 2014).

From 2008 onwards, species-specific landings data for the major skate species have been required. WGEF have noted an increasing proportion of skate landings reported to species, and whilst there are some inconsistencies, the overall proportions are in-line what would be expected given survey information. Continuation of such data collection would aid in species-specific fisheries management.

As a consequence of effort restrictions and high fuel prices, effort has reduced, but can also result in using different gears with different catchabilities for rays and skates. Also some fisheries may redirect effort to fishing grounds closer to port, which may affect more coastal species, such as. *R. clavata* occurring in the Thames estuary and the Wash in the southwestern North Sea.

The TAC for "skates and rays" should only apply to Areas IIIa, IV and VIId and not to IIa because only a part of IIa belongs to the present North Sea ecoregion.

Current TAC regulations have a condition so that "*up to 5%* [of the TAC for Union waters of VIa, VIb, VIIa–c and VIIe–k] *may be fished in Union waters of VIId*". Whilst it is pragmatic to allowing vessels in the English Channel (VIId,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 VIa, VIb, VIIa–c and VIIe–k (8032 t) is 401.6 t, which is more than half of the 2014 TAC for VIId (798 t). Whilst this is a theoretical maximum and unlikely to be realised, further studies of this issue are required.

Technical interactions of fisheries in this ecoregion are demonstrated in Table 15.14.

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Table 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division IIIa (in tonnes). "+" indicates landings <0.5 and "n.a." indicates not available.

Year	Denmark	Germany	Netherlands	Norway	Sweden	Total
1999	11	0	0	208	2	221
2000	41	0	0	123	2	166
2001	56	0	0	154	12	222
2002	22	0	0	159	13	194
2003	36	0	0	163	9	208
2004	129	0	0	85	20	234
2005	65	0	0	94	10	169
2006	26	1	0	51	18	95
2007	8	0	+	13	11	32
2008	5	0	0	23	6	34
2009	12	0	0	33	2	47
2010	12	0	0	24	10	45
2011	44	+	0	25	3	72
2012	16	0	0	18	3	37
2013	18	0	0	51	6	75
2014	14	+	0	39	3	56

Table 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea IV (in tonnes). Note that "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.

Year	Belgium	Denmark	France	Germany	Netherlands	Norway	Sweden	UK (E, W& NI)	UK (Scotland)	Total
1999	336	45	41	16	515	152	+	618	965	2688
2000	332	93	31	23	693	161	+	516	860	2709
2001	370	65	61	11	834	173	+	476	822	2812
2002	436	34	62	22	805	83	+	500	853	2794
2003	323	33	36	21	686	113	+	537	741	2490
2004	276	25	37	17	561	77	+	550	512	2055
2005	327	23	34	29	680	87	+	434	404	2018
2006	350	26	15	16	603	96	+	348	374	1801
2007	272	27	56	17	721	71	+	329	331	1825
2008	371	23	69	30	564	97	+	392	343	1889
2009	299	29	74	21	379	119	+	348	311	1580
2010	294	30	89	32	390	105	+	372	289	1602
2011	231	38	57	19	212	56	+	413	358	1383
2012	183	20	47	17	431	41	+	356	305	1401
2013	215	45	53	25	313	73	+	470	321	1515
2014	199	45	42	32	226	88	+	422	162	1216

Table 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division VIId (in tonnes). "+" indicates landings <0.5 and "n.a." indicates not available.

Year	Belgium	France	Germany	Netherlands	UK (E, W_& NI)	UK (Scotland)	Total
1999	93	558	0	0	437	0	1088
2000	69	693	+	0	355	0	1117
2001	79	729	0	0	169	0	977
2002	113	725	0	0	140	0	978
2003	153	796	0	0	186	0	1135
2004	96	695	0	0	157	0	948
2005	94	602	0	0	147	0	843
2006	109	687	0	13	139	2	948
2007	164	792	0	21	188	0	1165
2008	174	710	0	13	199	6	1102
2009	125	1270	0	10	152	8	1564
2010	111	1043	0	11	133	5	1303
2011	103	954	0	12	141	6	1217
2012	105	1010	0	14	166	4	1300
2013	131	1080	0	4	189	5	1409
2014	114	1018	0	6	193	0	1331

Table 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in the North Seas ecoregion (IIIa, IV, VIId) (in tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	Norway	Sweden	UK (E&W and NI)	UK (Scotland)	Total of submitted data
1999	429	56	599	16	515	360	2	1055	965	3997
2000	401	134	724	23	693	284	2	871	860	3992
2001	449	121	790	11	834	327	12	645	822	4011
2002	548	56	725	22	805	242	13	640	853	3904
2003	476	69	796	21	686	276	9	723	741	3797
2004	372	154	732	17	561	162	20	707	512	3237
2005	422	88	636	29	680	181	10	580	404	3030
2006	459	52	701	17	615	120	18	487	375	2845
2007	436	35	848	17	742	84	11	517	331	3022
2008	545	28	779	30	577	120	6	591	349	3025
2009	424	41	1344	21	389	152	2	500	320	3192
2010	405	42	1132	32	401	129	10	504	295	2951
2011	334	81	1011	19	224	81	4	555	365	2672
2012	288	36	1057	17	446	59	3	522	310	2738
2013	346	63	1133	25	317	124	6	659	326	3000
2014	312	59	1061	32	231	127	3	616	162	2603

Table 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Division IIIa in 2014.

Area IIIa	Species Categories	Weight (t)	% of national catch	% excluding generic categories
BELGIUM	*Raja brachyura*	0.0	7.7%	80.0%
	Raja clavata	0.0	1.9%	20.0%
	Skates and rays	0.0	90.4%	
	Total:	0.1	100.0%	
Percent of catch as species-specific landings:			9.6%	
DENMARK	Skates and rays	16.4	100.0%	
	Total:	16.4	100.0%	
Percent of catch as species-specific landings:			0%	
NORWAY	Skates and rays	28.0	100.0%	
	Total:	28.0	100.0%	
Percent of catch as species-specific landings:			0%	
SWEDEN	*Dipturus batis*	1.4	47.0%	47.0%
	Dipturus linteus	1.5	52.9%	52.9%
	Raja clavata	0.0	0.2%	0.2%
	Total:	2.9	100.0%	
Percent of catch as species-specific landings:			100%	
GERMANY	Skates and rays	0.1	100.0%	
	Total:	0.1	100.0%	
Percent of catch as species-specific landings:			0%	

Table 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Subarea IV in 2014.

Area IV	Species Categories	Weight (t)	% of national catch	% excluding generic categories
BELGIUM	*Raja brachyura*	58.0	31.7%	36.7%
	Leucoraja naevus	1.0	0.6%	0.6%
	Leucoraja circularis	0.1	0.0%	0.0%
	Raja montagui	9.2	5.0%	5.8%
	Raja clavata	89.8	49.0%	56.8%
	Skates and rays	25.0	13.7%	
	Total:	183.1	100.0%	
Percent of catch as species-specific landings:			86%	
DENMARK	Rajidae	19.9	100.0%	
	Total:	19.9	100.0%	
Percent of catch as species-specific landings:			0%	
FRANCE	*Rostroraja alba*	1.1	2.3%	3.6%
	Raja brachyura	0.4	0.9%	1.4%
	Raja clavata	28.4	60.2%	92.3%
	Leucoraja fullonica	0.0	0.1%	0.1%
	Raja hyperborea	0.1	0.2%	0.3%
	Raja microocellata	0.0	0.0%	0.0%
	Raja montagui	0.2	0.4%	0.6%
	Leucoraja naevus	0.5	1.1%	1.6%
	Raja undulata	0.0	0.0%	0.0%
	Skates and rays	16.4	34.7%	
	Total:	47.2	100.0%	
Percent of catch as species-specific landings:			65.3%	
GERMANY	Skates and rays	16.9	100.0%	
	Total:	16.9	100.0%	
Percent of catch as species-specific landings:			0%	
NETHERLANDS	*Dipturus batis*	2.4	0.6%	0.6%
	Leucoraja naevus	8.5	2.0%	2.0%
	Raja brachyura	58.4	13.5%	13.8%
	Raja clavata	175.1	40.6%	41.3%
	Raja montagui	179.7	41.6%	42.4%
	Skates and rays	7.4	1.7%	
	Total:	431.5	100.0%	
Percent of catch as species-specific landings:			98.3%	

Table 15.6. Continued.

Area IV	Species Categories	Weight (t)	% of national catch	% excluding generic categories
NORWAY	Skates and rays	69.1	100.0%	
	Total:	69.1	100.0%	
Percent of catch as species-specific landings:			0.0%	
SWEDEN	*Dipturus batis*	0.0	67.4%	67.4%
	Dipturus linteus	0.0	32.6%	32.6%
	Total:	0.0	100.0%	
Percent of catch as species-specific landings:			100.0%	
UK (E,W and NI)	*Amblyraja radiata*	0.1	0.0%	0.0%
	Dasyatis pastinaca	0.0	0.0%	0.0%
	Dipturus batis	0.2	0.1%	0.1%
	Leucoraja naevus	2.1	0.6%	0.6%
	Raja brachyura	14.3	4.0%	4.1%
	Raja clavata	316.2	88.9%	90.2%
	Raja microocellata	0.0	0.0%	0.0%
	Raja montagui	17.6	5.0%	5.0%
	Rostroraja alba	0.0	0.0%	0.0%
	Skates and rays	5.2	1.5%	
	Total:	355.8	100.0%	
Percent of catch as species-specific landings:			98.5%	
UK (Scotland)	*Dipturus batis*	0.7	0.2%	0.3%
	Dipturus oxyrinchus	1.1	0.3%	0.5%
	Leucoraja circularis	2.0	0.6%	0.9%
	Leucoraja fullonica	3.2	1.0%	1.4%
	Leucoraja naevus	119.8	39.2%	53.3%
	Raja brachyura	0.0	0.0%	0.0%
	Raja clavata	39.9	13.1%	17.8%
	Raja montagui	58.1	19.0%	25.8%
	Skates and rays	80.7	26.4%	
	Total:	305.4	100.0%	
Percent of catch as species-specific landings:			73.6%	

Table 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Division VIId in 2014.

Area VIId	Species Categories	Weight (t)	% of national catch	% excluding generic categories
BELGIUM	*Raja brachyura*	25.0	23.8%	27.2%
	Leucoraja naevus	0.4	0.4%	0.4%
	Leucoraja circularis	2.7	2.6%	3.0%
	Raja montagui	1.2	1.1%	1.3%
	Raja clavata	62.6	59.6%	68.2%
	Skates and rays	13.2	12.6%	
	Total:	105.1	100.0%	
Percent of catch as species-specific landings:			87.4%	
FRANCE	*Raja brachyura*	21.6	2.1%	2.7%
	Raja circularis	1.0	0.1%	0.1%
	Raja clavata	694.9	68.8%	87.9%
	Leucoraja fullonica	1.1	0.1%	0.1%
	Raja hyperborea	0.7	0.1%	0.1%
	Raja microocellata	7.2	0.7%	0.9%
	Raja montagui	25.1	2.5%	3.2%
	Leucoraja naevus	38.5	3.8%	4.9%
	Dipturus oxyrinchus	0.5	0.0%	0.1%
	Skates and rays	219.5	21.7%	
	Total:	1009.9	100.0%	
Percent of catch as species-specific landings:			78.3%	
NETHERLANDS	*Raja brachyura*	0.2	1.2%	1.5%
	Raja clavata	11.3	78.1%	95.5%
	Raja montagui	0.4	2.5%	3.0%
	Skates and rays	2.6	18.2%	
	Total:	14.4	100.0%	
Percent of catch as species-specific landings:			81.8%	

Table 15.7. Continued.

Area VIId	Species Categories	Weight (t)	% of national catch	% excluding generic categories
UK (E,W and NI)	*Amblyraja radiata*	0.0	0.0%	0.0%
	Dipturus batis	0.2	0.1%	0.1%
	Dipturus oxyrinchus	0.1	0.1%	0.1%
	Leucoraja circularis	0.0	0.0%	0.0%
	Leucoraja naevus	0.0	0.0%	0.0%
	Raja brachyura	36.7	22.1%	22.5%
	Raja clavata	117.9	70.9%	72.2%
	Raja microocellata	2.3	1.4%	1.4%
	Raja montagui	6.0	3.6%	3.7%
	Rostroraja alba	0.0	0.0%	0.0%
	Skates and rays	3.0	1.8%	
	Total:	166.2	100.0%	
Percent of catch as species-specific landings:			98.2%	
UK (Scotland)	*Raja clavata*	0.5	11.4%	11.4%
	Leucoraja fullonica	3.9	88.6%	88.6%
	Total:	4.3	100.0%	
Percent of catch as species-specific landings:			100.0%	

Table 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: Time-series of landings (t) by species for the years 2012–2014. Note that these are minimum estimates because species-specific landings data are not available for all countries and years.

YEAR	IIIA	IVA	IVB	IVC	IV	VIID	TOTAL
Raja clavata							
2012	0.0	40.2	75.3	533.9		887.1	1536.4
2013		40.3	39.8	260.7		996.3	1337.1
2014	0.3	5.5	115.5	531.2		1181.8	1834.3
Amblyraja radiata							
2012			0.0	0.1		0.0	0.1
2013		0.0	0.0	0.0		0.0	0.0
2014		0.0	0.0	0.0		0.3	0.3
Raja montagui							
2012		58.1	58.7	148.0		32.6	297.3
2013		84.6	39.5	92.4		26.1	242.6
2014		0.1	34.9	63.1	13.2	34.9	146.2
Leucoraja naevus							
2012		115.8	7.0	8.7		0.4*	131.9
2013	0	122.1	0.5	4.4		13.1*	140.1
2014		1.1	2.3	6.0	148.1	1.6*	159.1
Raja brachyura							
2012	0.0	1.8	24.0	105.4		83.4	214.6
2013	0.0	0.0	13.6	112.9		55.5	181.9
2014		0.1	26.1	90.9		91.6	208.8
Dipturus batis complex							
2012	1.4	0.7	0.7	2.0		0.2*	5.0
2013	1.7	0.5	0.0	0.0		0.0*	2.4
2014	1.2	0.3	0.1				1.5

*** These landings are not part of the stock area.**

Table 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: quantification of species composition (%) for North Sea skates and rays in Dutch beam trawl fishery based on market sampling.

Year	*A. radiata*	*L. naevus*	*R. brachyura*	*R. clavata*	*R. montagui*
2000	0.2	0.5	19.6	38.2	41.5
2001	0.2	0.5	13.8	37.7	47.8
2002			31.1	28.1	40.8
2003			26.9	27.0	46.1
2004			20.7	38.7	40.6
2005	0.2	0.2	29.8	23.3	46.5
2006			25.3	40.9	33.8
2007			28.9	33.6	37.4

Table 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: North Sea rays and skates. Length–frequency distributions in the Dutch beam trawl fleet (numbers in '000).

Country: the Netherlands
Gear: beam trawl
Category: landings

	Raja clavata						*Raja montagui*						*Raja brachyura*					
length	2000	2001	2005	2006	2007	2008	2000	2001	2005	2006	2007	2008	2000	2001	2005	2006	2007	2008
25																		
30	0.6	1.9	3.0	0.3	1.0	0.5	3.5	0.5	0.9	0.5		0.2						
35	9.4	11.2	7.8	8.6	7.1	3.0	34.2	6.3	4.7	2.5	0.4	0.2	1.2	1.0	0.3	1.5		
40	16.8	19.9	14.2	13.4	30.5	4.0	75.6	33.5	14.0	15.8	9.7	6.3	1.2	1.5	2.1	5.5	3.8	
45	17.5	20.3	11.2	26.2	27.2	8.5	85.9	60.3	36.9	52.5	32.2	16.1	1.2	3.3	6.0	3.9	7.2	0.1
50	23.0	36.4	18.2	40.0	36.0	15.2	58.3	72.5	47.6	59.6	52.6	45.4	2.7	5.6	7.7	3.5	3.8	0.6
55	16.0	35.3	12.9	26.6	30.9	17.7	42.7	54.6	49.9	34.6	50.8	58.9	3.1	4.9	9.6	7.7	5.1	0.7
60	12.1	22.8	14.7	20.0	19.1	16.6	26.1	42.4	44.2	25.3	40.5	71.7	0.6	5.3	6.8	7.5	5.1	0.8
65	5.3	15.3	5.7	16.7	17.5	14.9	10.4	16.1	13.7	4.7	12.4	26.1	1.0	3.6	8.0	7.6	6.1	0.7
70	5.3	5.2	6.2	11.8	12.3	14.6	2.0	2.3	0.9	1.1	0.5	1.2	1.6	2.1	6.1	4.5	5.9	0.5
75	4.7	5.5	5.2	8.1	6.9	9.8	0.3		0.1				1.8	2.7	3.1	5.4	6.8	0.8
80	3.7	3.5	2.2	3.7	5.4	5.0							1.6	1.9	4.2	5.1	8.2	0.5
85	3.4	2.3	1.8	1.9	1.8	2.9							1.1	1.5	3.1	2.3	6.0	0.5
90	1.2	0.6	0.7	0.9	1.0	0.9							0.5	1.9	2.4	2.0	2.8	0.4
95	0.8	0.3	0.1		0.1	0.4							0.1	0.6	1.6	1.2	2.6	0.2
100						0							0.1		0.2	0.3	0.1	0.0
105															0.3			0.0
110	0.1																	
sum	119.8	180.5	103.9	178.2	197	114.0	339.2	288.4	212.9	196.6	199.2	226.1	17.7	35.8	61.5	58.0	63.5	5.8

Table 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n/hr) for *Amblyraja radiata*, *Leucoraja naevus* and *Dipturus batis* complex. Information from IBTS Q1, IBTS Q3 (roundfish areas 1–7), and eastern Channel CGFS Q4 data in the period 1989–2015. All data are abstracted from DATRAS.

	Amblyraja radiata				*Leucoraja naevus*				*Dipturus batis complex*			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS
YEAR	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1977	1.87				0.22				0.004			
1978	1.66				1.79				0.007			
1979	3.39				0.06				0.003			
1980	0.72				0.06				0.000			
1981	2.53				0.36				0.000			
1982	0.62				0.10				0.000			
1983	1.64				0.44				0.129			
1984	4.27				0.26				0.048			
1985	2.10				0.50				0.027			
1986	3.63				0.38				0.016			
1987	8.29				0.19				0.000			
1988	3.00				0.62				0.007			
1989	7.25		0.00		0.74		0.00		0.000		na	
1990	4.96		0.00		0.53		0.05		0.000		na	
1991	3.95	7.87	0.04		0.44	0.29	0.00		0.031	0.003	na	
1992	7.28	2.28	0.00		0.75	0.41	0.00		0.000	0.000	na	
1993	11.22	1.68	0.00	na	0.81	0.11	0.00	na	0.010	0.000	na	na
1994	3.79	1.93	0.00	na	0.62	0.19	0.15	na	0.000	0.000	na	na
1995	8.02	1.85	0.00	na	0.53	0.09	0.07	na	0.000	0.000	na	na
1996	5.69	2.34	0.00	na	0.43	0.12	0.03	na	0.019	0.000	na	na

	Amblyraja radiata				*Leucoraja naevus*				*Dipturus batis complex*			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS
YEAR	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1997	4.82	2.18	0.00	na	0.27	0.42	0.08	na	0.000	0.000	na	na
1998	5.09	2.19	0.00	na	0.46	0.08	0.03	na	0.003	0.008	na	na
1999	6.72	2.76	0.04	na	0.33	0.38	0.00	na	0.007	0.089	na	na
2000	7.75	3.07	0.00	na	0.45	0.45	0.02	na	0.000	0.000	na	na
2001	2.68	5.18	0.00	na	0.31	0.57	0.00	na	0.000	0.000	na	na
2002	4.19	2.93	0.00	na	0.45	0.49	0.01	na	0.004	0.054	na	na
2003	4.61	3.41	0.02	na	0.25	0.29	0.00	na	0.000	0.007	na	na
2004	4.33	1.85	0.00	na	0.33	0.31	0.05	na	0.000	0.000	na	na
2005	3.70	2.10	0.00	na	0.33	0.40	0.02	na	0.006	0.014	na	na
2006	2.26	2.37	0.00	na	0.36	0.46	0.01	na	0.000	0.002	na	na
2007	4.22	3.82	0.00	na	0.44	0.33	0.00	na	0.046	0.000	na	na
2008	3.14	2.51	0.02	na	0.41	1.11	0.00	na	0.006	0.017	na	na
2009	1.33	2.98	0.00	na	0.35	0.59	0.02	na	0.013	0.013	na	na
2010	1.57	2.24	0.00	na	0.44	0.64	0.00	na	0.045	0.000	na	na
2011	1.28	2.41	0.00	na	0.41	0.61	0.03	na	0.052	0.019	na	na
2012	1.67	1.95	0.00	na	0.66	0.69	0.00	na	0.033	0.101	na	na
2013	1.19	1.43	0.00	na	0.78	0.53	0.00	na	0.084	0.065	na	na
2014	1.08	1.54	na	na	0.46	0.44	na	na	0.037	0.054	na	na
2015	1.90	na	na	na	0.76	na	na	na	0.052	na	na	na

Table 15.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n/hr) for *Raja clavata*, *Raja montagui*, *Raja brachyura*, *Raja microocellata* and *Raja undulata*. Information from IBTS Q1, IBTS Q3 (roundfish areas 1–7), and eastern Channel CGFS Q4 data in the period 1989–2015. All data are abstracted from DATRAS.

	Raja clavata				***Raja montagui***				***Raja brachyuara***						***Raja microocellata***				***Raja undulata***			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS (IVa)		IBTS (IVc)		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS
Year	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1977	0.26				0.03				0.000		0.000				na				na			
1978	1.18				0.38				0.000		0.000				na				na			
1979	0.91				0.00				0.000		0.056				na				na			
1980	0.35				0.03				0.000		0.000				na				na			
1981	0.64				0.00				0.000		0.000				na				na			
1982	0.64				0.40				0.000		0.194				na				na			
1983	1.65				0.23				0.019		0.000				na				na			
1984	1.90				0.60				0.333		0.014				na				na			
1985	0.98				0.40				0.000		0.000				na				na			
1986	1.34				0.23				0.000		0.000				na				na			
1987	2.37				0.20				0.000		0.000				na				na			
1988	0.32		2.26		0.13				0.000		0.000				na				na			
1989	1.85		2.95		0.30		0.54		0.000		0.125		na		na		na		na		na	
1990	1.36		1.65		0.21		0.62		0.000		0.000		na		na		na		na		na	
1991	42.44	1.27	1.09		2.48	0.36	0.16		0.000	0	0.000	0.000	na		na	na	na		na	na	na	
1992	2.17	1.22	1.27		0.28	0.4	0.02		0.223	0	0.313	0.000	na		na	na	na		na	na	na	
1993	0.53	1.04	1.26	3.82	0.30	0.41	0.36	0.74	0.133	0	0.021	0.000	na	0.48	na	na	na	0.064	na	na	na	0.115
1994	0.70	0.11	1.20	4.20	0.27	0.65	0.27	0.81	0.000	0	0.000	0.000	na	0.14	na	na	na	0.071	na	na	na	0.057

	Raja clavata				***Raja montagui***				***Raja brachyuara***						***Raja microocellata***				***Raja undulata***			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS (IVa)		IBTS (IVc)		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS
Year	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1995	0.12	0.04	1.21	2.54	0.63	0.21	0.24	1.63	0.000	0	0.000	0.000	na	0.10	na	na	na	0.063	na	na	na	0.015
1996	0.71	0.69	1.52	3.60	0.24	0.25	0.21	0.5	0.000	0	0.063	0.000	na	0.05	na	na	na	0.000	na	na	na	0.345
1997	1.14	0.27	2.31	4.24	0.70	0.00	0.86	0.92	0.000	0	0.000	0.000	na	0.03	na	na	na	0.195	na	na	na	0.046
1998	1.11	0.05	1.49	2.85	0.31	0.20	0.45	0.98	0.000	0	0.004	0.000	na	0.05	na	na	na	0.059	na	na	na	0.165
1999	0.40	0.14	2.10	4.97	0.24	0.99	0.04	0.79	0.030	0	0.063	0.000	na	0.27	na	na	na	0.189	na	na	na	0.402
2000	0.88	0.04	1.84	4.02	0.23	0.01	0.08	0.65	0.000	0	0.000	0.000	na	0.10	na	na	na	0.101	na	na	na	0.470
2001	0.90	0.17	1.56	5.25	0.18	0.10	0.06	0.3	0.000	0	0.000	0.000	na	0.20	na	na	na	0.000	na	na	na	0.173
2002	1.06	0.72	2.02	3.76	0.53	0.05	0.18	0.83	0.000	0	0.000	0.000	na	0.18	na	na	na	0.000	na	na	na	0.083
2003	1.03	0.05	3.29	4.06	0.46	0.09	0.16	0.78	0.015	0	0.088	0.000	na	0.15	na	na	na	0.000	na	na	na	0.157
2004	0.48	0.13	1.73	3.85	0.37	0.14	0.02	0.97	0.000	0	0.000	0.000	na	0.16	na	na	na	0.093	na	na	na	0.192
2005	1.03	0.05	3.36	4.58	0.65	0.36	0.20	0.31	0.030	0	0.000	0.000	na	0.31	na	na	na	0.000	na	na	na	0.165
2006	1.17	0.64	2.13	9.86	0.18	0.36	0.10	0.47	0.091	0	0.038	0.000	na	0.06	na	na	na	0.250	na	na	na	0.000
2007	0.52	0.13	2.76	4.54	0.66	0.76	0.45	0.3	0.121	0	0.269	0.045	na	0.21	na	na	na	0.052	na	na	na	0.000
2008	2.02	0.62	3.70	4.34	1.88	0.27	0.01	0.31	0.333	0	0.184	0.023	na	0.07	na	na	na	0.057	na	na	na	0.209
2009	2.58	0.71	2.89	4.27	0.98	0.90	0.00	0.25	0.044	0	0.179	0.125	na	0.17	na	na	na	0.050	na	na	na	0.261
2010	0.55	0.57	2.91	7.46	1.11	0.86	0.02	0.32	0.030	0	0.293	0.000	na	0.02	na	na	na	0.100	na	na	na	0.041
2011	0.19	0.35	3.06	9.11	0.78	1.01	0.22	0.49	0.022	0	0.085	0.209	na	0.13	na	na	na	0.200	na	na	na	0.350
2012	2.93	0.79	5.75	6.43	1.57	1.16	0.12	0.34	0.212	0.083	0.049	0.000	na	0.07	na	na	na	0.000	na	na	na	0.553
2013	1.06	2.24	6.46	8.56	1.51	1.33	0.16	0.3	0.091	0	0.748	0.000	na	0.21	na	na	na	0.011	na	na	na	0.308
2014	1.31	2.14	8.63	17.39	0.99	2.31	na	0.35	0.729	0	0.305	0.000	na	0.29	na	na	na	0.075	na	na	na	0.588
2015	1.82	na	na	na	1.19	na	na	na	0.268	na	0.024	na	na	na	na	na	na	na	na	na	na	na

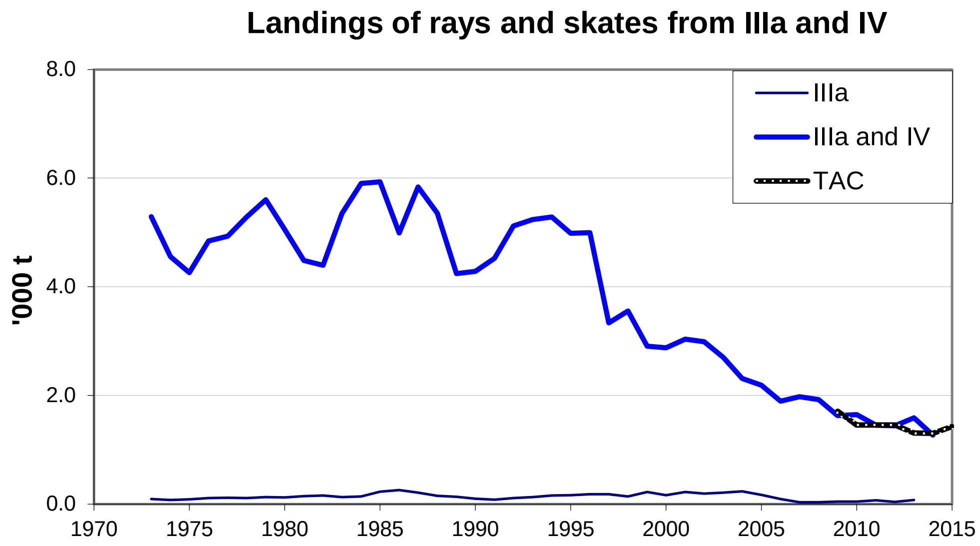
Table 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n/hr) for *Scyliorhinus stellaris*, *Scyliorhinus canicula* and *Mustelus* spp. Information from IBTS Q1, IBTS Q3 (roundfish areas 1–7), and eastern Channel CGFS Q4 data in the period 1989–2015. All data are abstracted from DATRAS.

	Scyliorhinus stellaris				*Scyliorhinus canicula*				*Mustelus spp*			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UKBTS
YEAR	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1977	na				0.00				0.00			
1978	na				0.09				0.01			
1979	na				0.05				0.00			
1980	na				0.35				0.00			
1981	na				0.00				0.00			
1982	na				0.18				0.00			
1983	na				0.30				0.00			
1984	na				0.35				0.06			
1985	na				0.40				0.00			
1986	na				0.54				0.00			
1987	na				0.33				0.00			
1988	na		0.74		0.27		18.09		0.01			
1989	na		0.98		0.31		25.25		0.00		na	
1990	na		0.56		1.44		13.89		0.06		na	
1991	na	na	0.44		0.55	0.84	15.43		0.02	0.04	na	
1992	na	na	0.23		0.93	1.96	28.13		0.01	0.23	na	
1993	na	na	0.12	0.000	0.48	0.92	22.80	10.91	0.14	0.54	na	na
1994	na	na	0.45	0.000	0.67	1.63	16.52	8.18	1.87	1.23	na	na
1995	na	na	1.08	0.059	1.26	0.40	17.01	7.13	0.70	0.00	na	na

	Scyliorhinus stellaris				*Scyliorhinus canicula*				*Mustelus spp*			
	IBTS		CGFS	UK BTS	IBTS		CGFS	UK BTS	IBTS		CGFS	UKBTS
YEAR	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3	Q1	Q3	Q4	Q3
1996	na	na	1.03	0.000	0.78	1.80	6.84	4.85	0.08	1.11	na	na
1997	na	na	1.04	0.029	0.91	0.83	32.71	12.38	0.10	0.48	na	na
1998	na	na	0.63	0.167	0.49	1.09	21.25	7.53	0.25	0.19	na	na
1999	na	na	0.94	0.027	1.17	1.80	27.55	6.18	1.99	0.33	na	na
2000	na	na	0.49	0.000	1.73	1.29	36.06	5.76	0.16	0.45	na	na
2001	na	na	0.42	0.327	1.49	1.57	20.28	6.45	0.68	0.00	na	na
2002	na	na	0.75	0.071	2.90	3.41	23.62	9.43	0.48	0.60	na	na
2003	na	na	1.35	0.072	4.07	1.68	37.46	4.51	0.56	0.43	na	na
2004	na	na	0.95	0.100	3.36	3.29	19.85	11.76	0.43	0.49	na	na
2005	na	na	1.54	0.092	2.79	3.22	35.74	13.66	0.32	0.35	na	na
2006	na	na	1.42	0.230	4.84	7.46	32.58	4.42	0.48	1.09	na	na
2007	na	na	2.54	0.111	5.69	2.90	55.59	12.53	0.65	0.76	na	na
2008	na	na	1.62	0.059	6.12	6.58	29.87	11.19	0.81	1.30	na	na
2009	na	na	1.19	0.000	5.78	6.87	26.91	8.60	0.79	1.13	na	na
2010	na	na	2.26	0.400	5.56	9.13	32.64	11.82	1.47	0.61	na	na
2011	na	na	1.69	0.022	4.14	8.29	27.10	7.25	0.72	0.83	na	na
2012	na	na	1.12	0.000	23.26	8.02	31.28	10.67	0.81	0.51	na	na
2013	na	na	2.06	0.051	19.00	18.29	30.06	12.22	0.84	1.25	na	na
2014	na	na	0.85	0.118	6.84	17.73	26.59	8.59	1.97	1.38	na	na
2015	na	na	na	na	14.00	na	na	na	0.63	na	na	na

Table 15.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Technical interactions of otter trawl (OT), beam trawl (BT), gillnet (GN), industrial (Ind). It is also recognized that there are interactions between skates and rays with cod fisheries in IVc and VIId.

		Cod 347d	Cod katt.	Had 34	Whg 47d	Sai 346	Ang 346	Ple 4	Ple 7d	Ple 3a	Sol 3a	Sol 4	Sol 7d	San 4	Nop 4	Nep stocks	Pan stocks	DemRays 347	DemSharks 347
Main gears	Cod 347d		L	H	H	M	??	M	M	M	M	M	M	L	L	H	??	L	L
	Cod kattegat	BT, OT		L	0	0	??	0	0	M	M	0	0	0	0	H	??	L	L
	Had 34	OT			H	M	??	L	0	L	L	L	0	L	L	H	??	L	L
	Whg 47d	OT				M	??	M	M	0	0	M	M	L	L	H	??	L	L
	Sai 346	OT					??	L	0	L	L	L	0	L	L	L	??	L	L
	Ang 346																	L	L
	Ple 4	BT		OT	BT	OT	??		0	0	0	H	0	L	L	L	??	H	H
	Ple 7d	BT			BT, OT		??			0	0	0	H	L	L	L	??	H	H
	Ple 3a	BT, OT	BT, OT	OT			??				H	0	0	0	0	L	??	L	L
	Sol 3a	BT,OT,GN	BT,OT,GN	OT	BT, OT					BT		0	0	0	0	L	??	L	L
	Sol 4	BT		OT	BT	OT		BT					0	0	0	L	??	H	H
	Sol 7d	BT			BT				BT					0	0	L	??	H	H
	San 4	Ind		Ind	Ind	Ind									M	0	0	L	L
	Nop 4	Ind		Ind	Ind	Ind								Ind		0	0	L	L
	Nep. stocks																H?	L	L
	Pan. stocks																	L	L
	DemRays 347							BT	BT			BT	BT						H
	DemShar 347																		



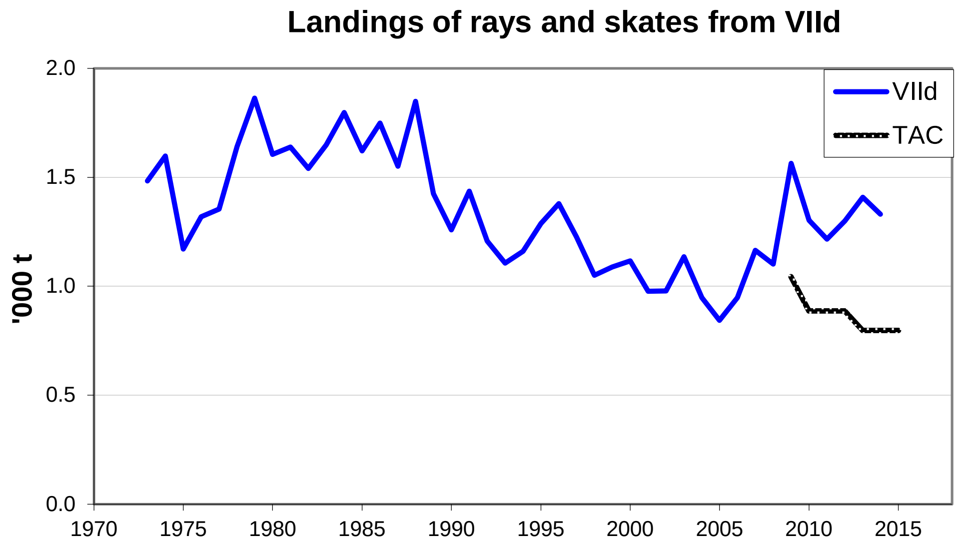


Figure 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates in IIIa and IV, and in VIId since 1973, based on WG estimates. TAC for both areas is added.

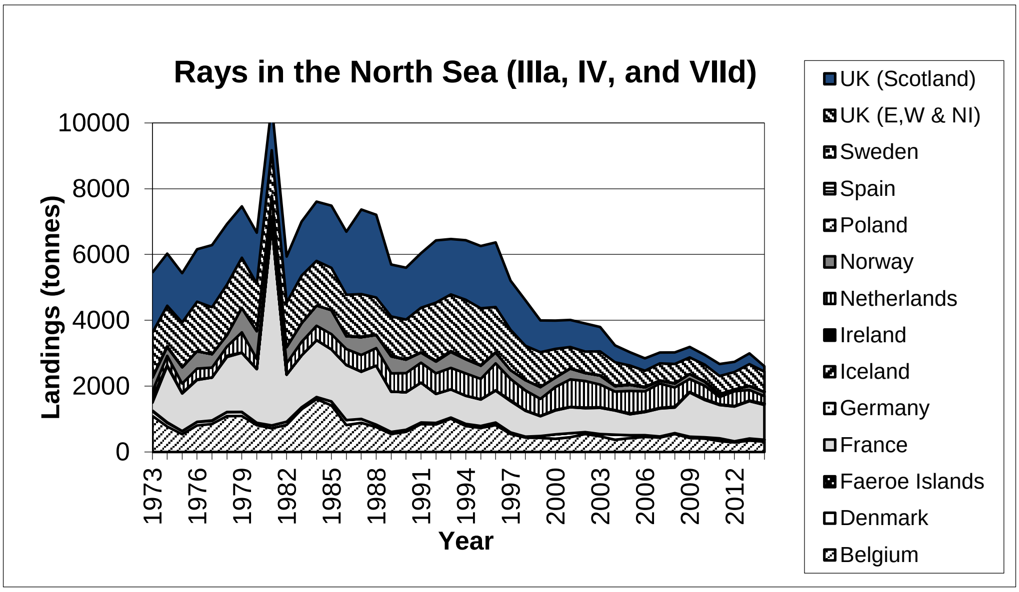


Figure 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings (t) of rays and skates from Skagerrak (IIIa), the North Sea (IV) and the eastern Channel (VIId).

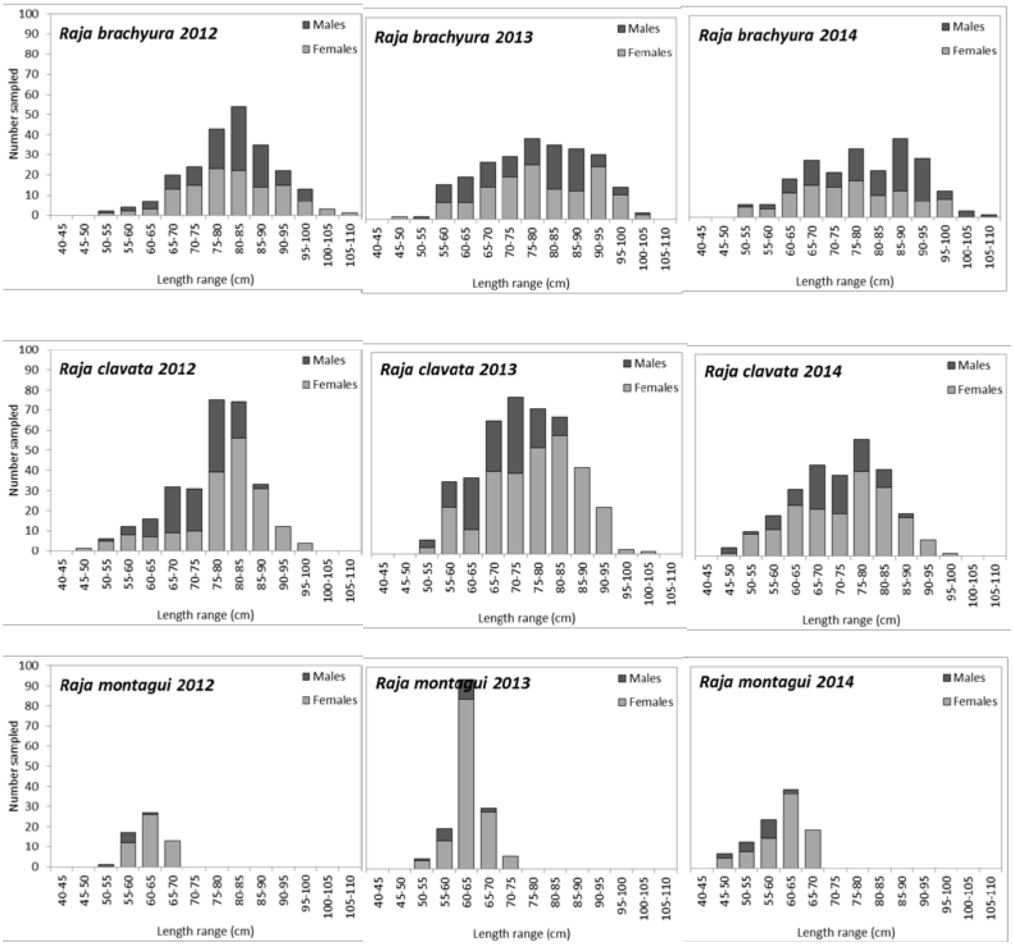


Figure 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length–frequency distribution of the number of *R. brachyura*, *R. clavata* and *R. montagui* individuals measured during the market sampling programme of the Dutch beam trawl fleet in 2012–2014.

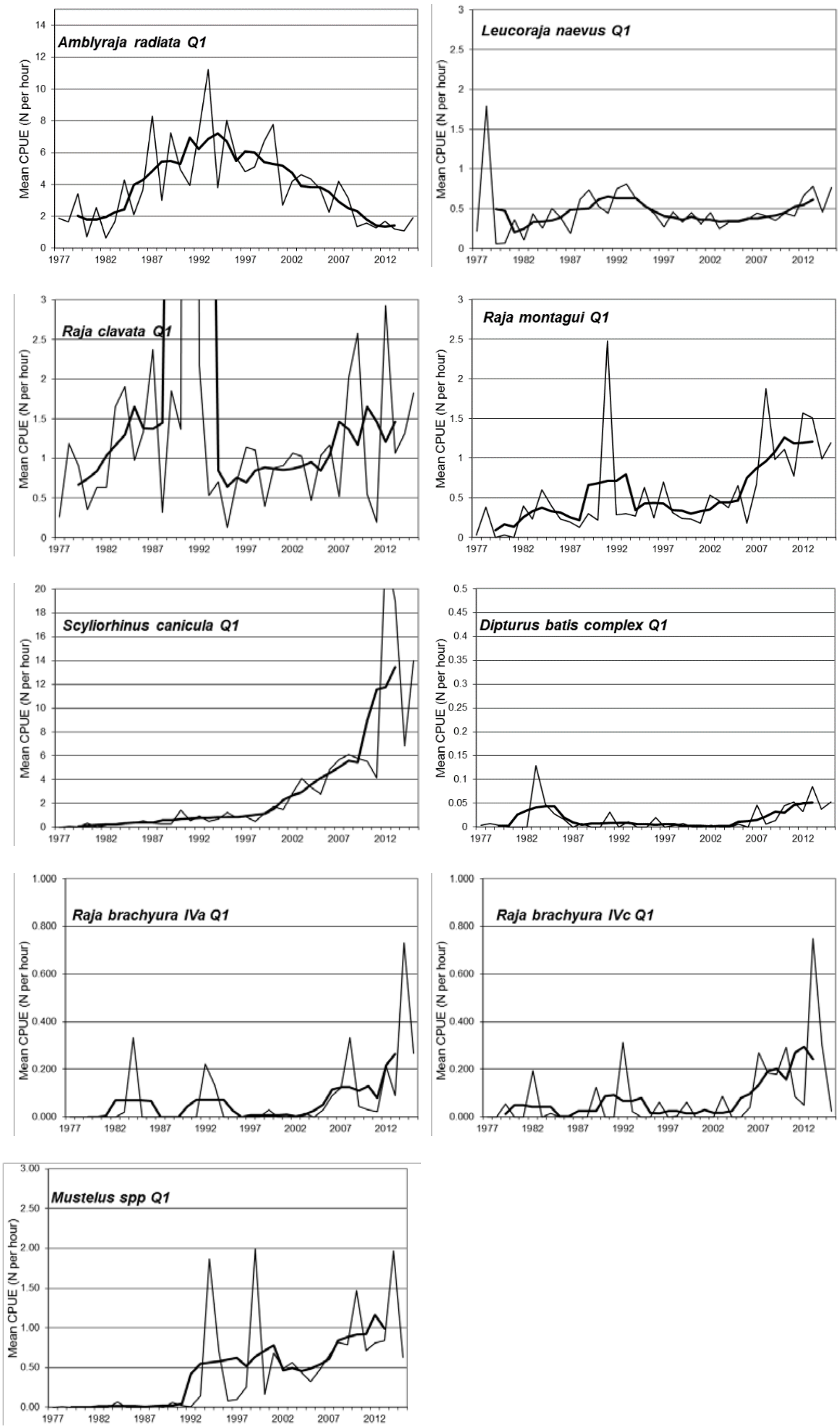


Figure 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and three year running mean during the North Sea IBTS-Q1 in the years 1977–2014 in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 21 May 2015.

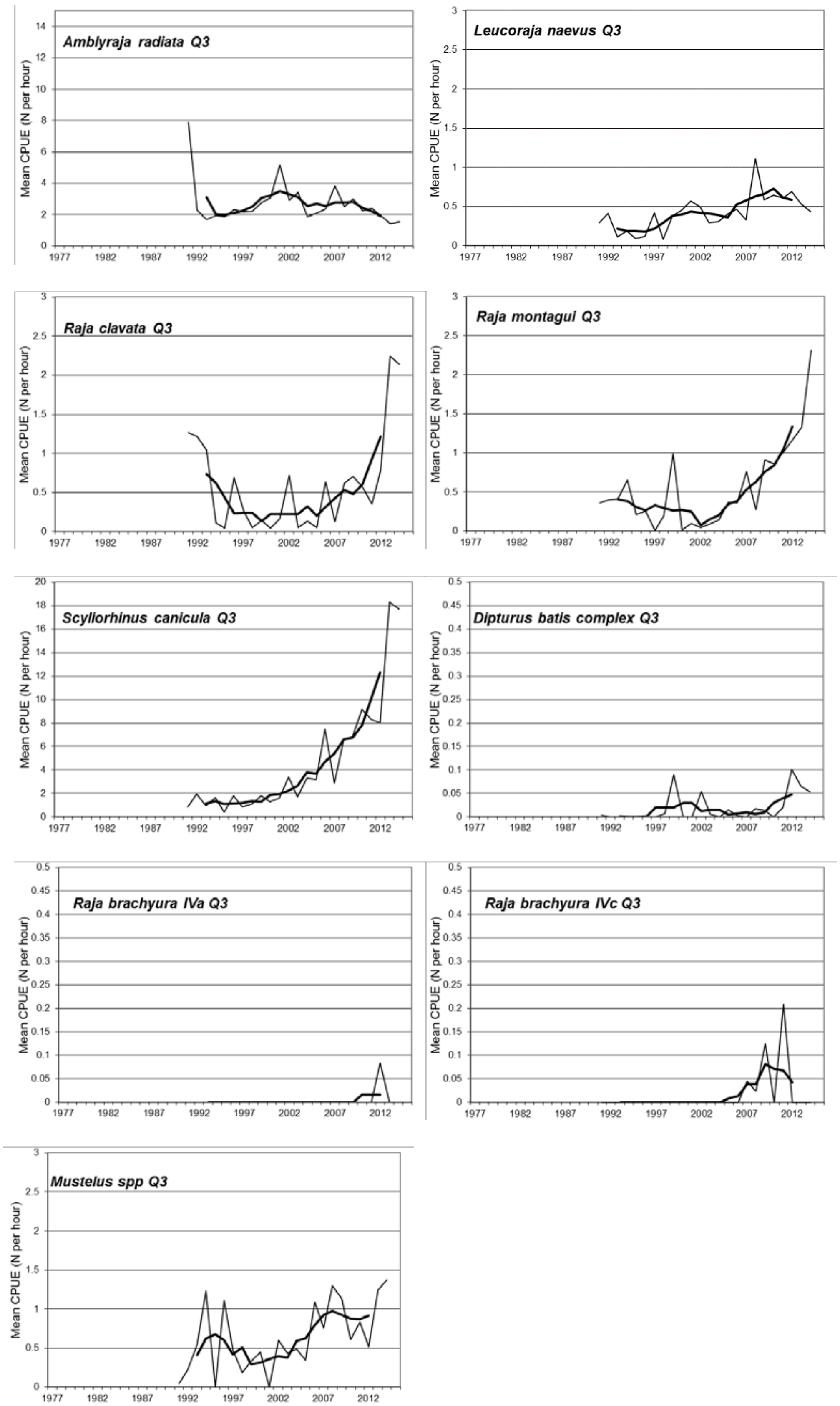


Figure 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and five year running mean during the North Sea IBTS-Q3 in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 21th May 2015.

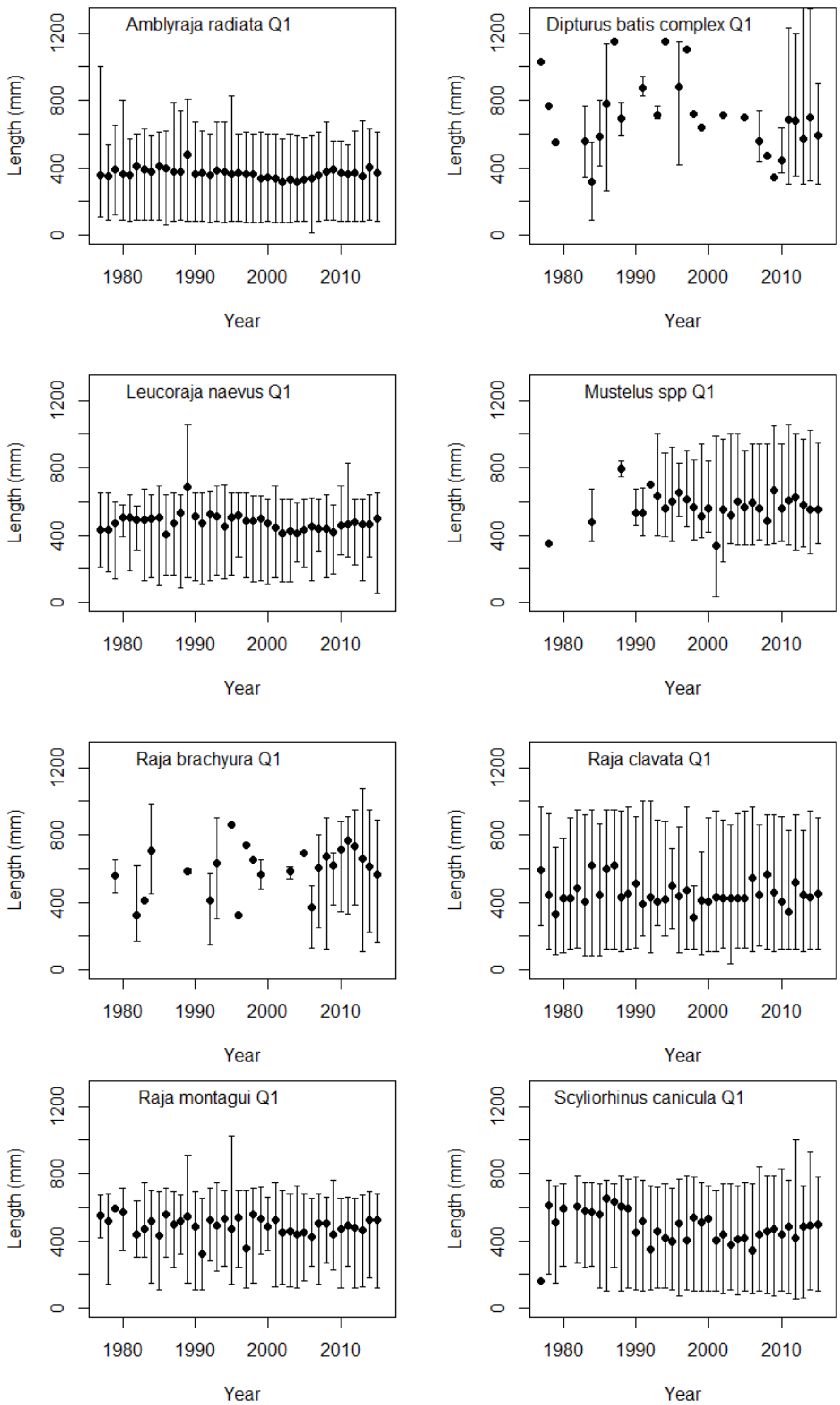


Figure 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average length (dots) and length range during the North Sea IBTS-Q1 in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 21th May 2015. NOTE: There are still some incorrect data in DATRAS, with some length records of all species (except *R. clavata*) that are >L_{max}.

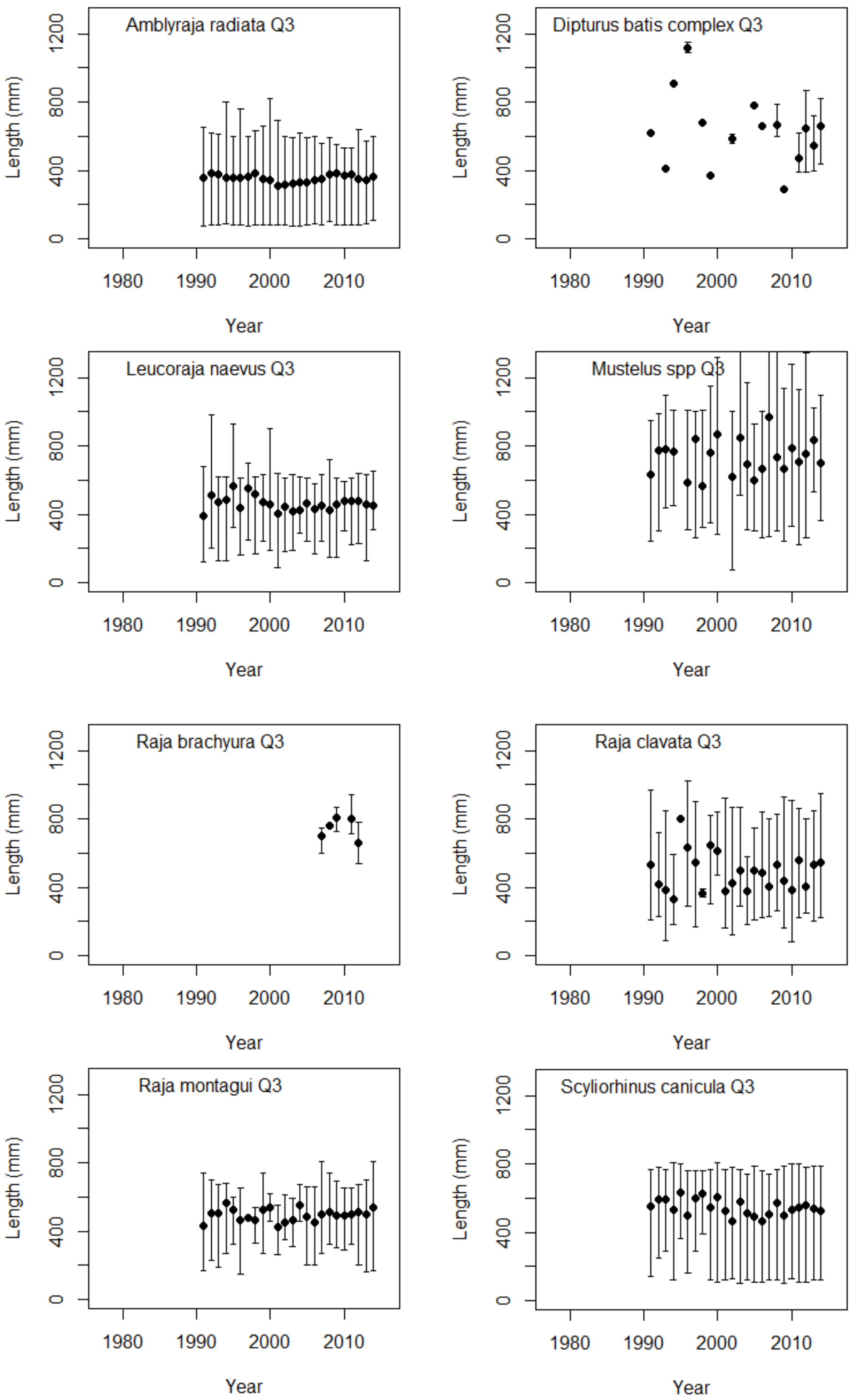


Figure 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average length (dots) and length range during the North Sea IBTS-Q3 in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 21th May 2015. Note: There are still some incorrect data in DATRAS, with some length records for *A. radiata* and *L. naevus* >L_{max}.

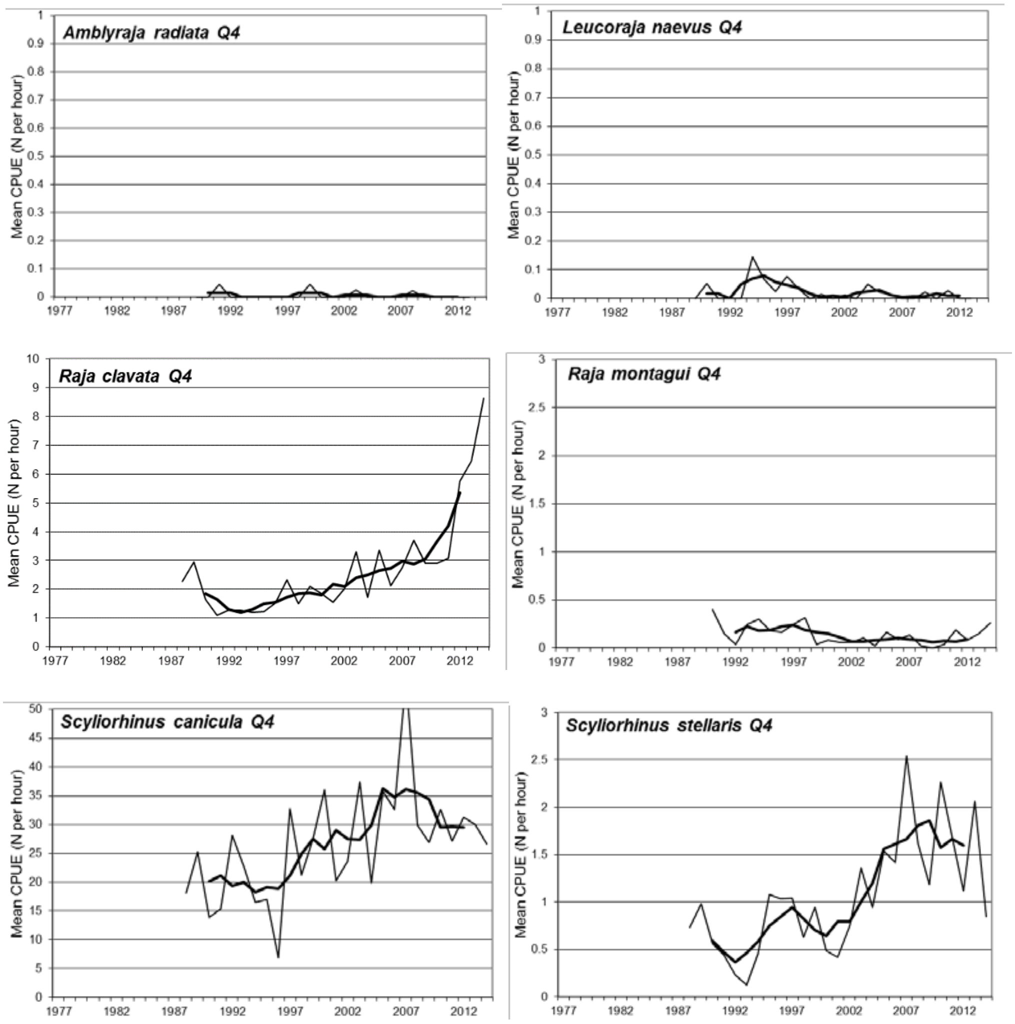


Figure 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and five year running mean during the Eastern Channel CGFS-Q4 survey. Data for *Amblyraja radiata* and *Leucoraja naevus* were extracted from the DATRAS database (selected for exchange data that were converted to cpue per length per statrec) on 20th June 2014 and do not contain the 2014 estimates. Data for the other species were obtained from Pascal Lorance 18 June 2015.

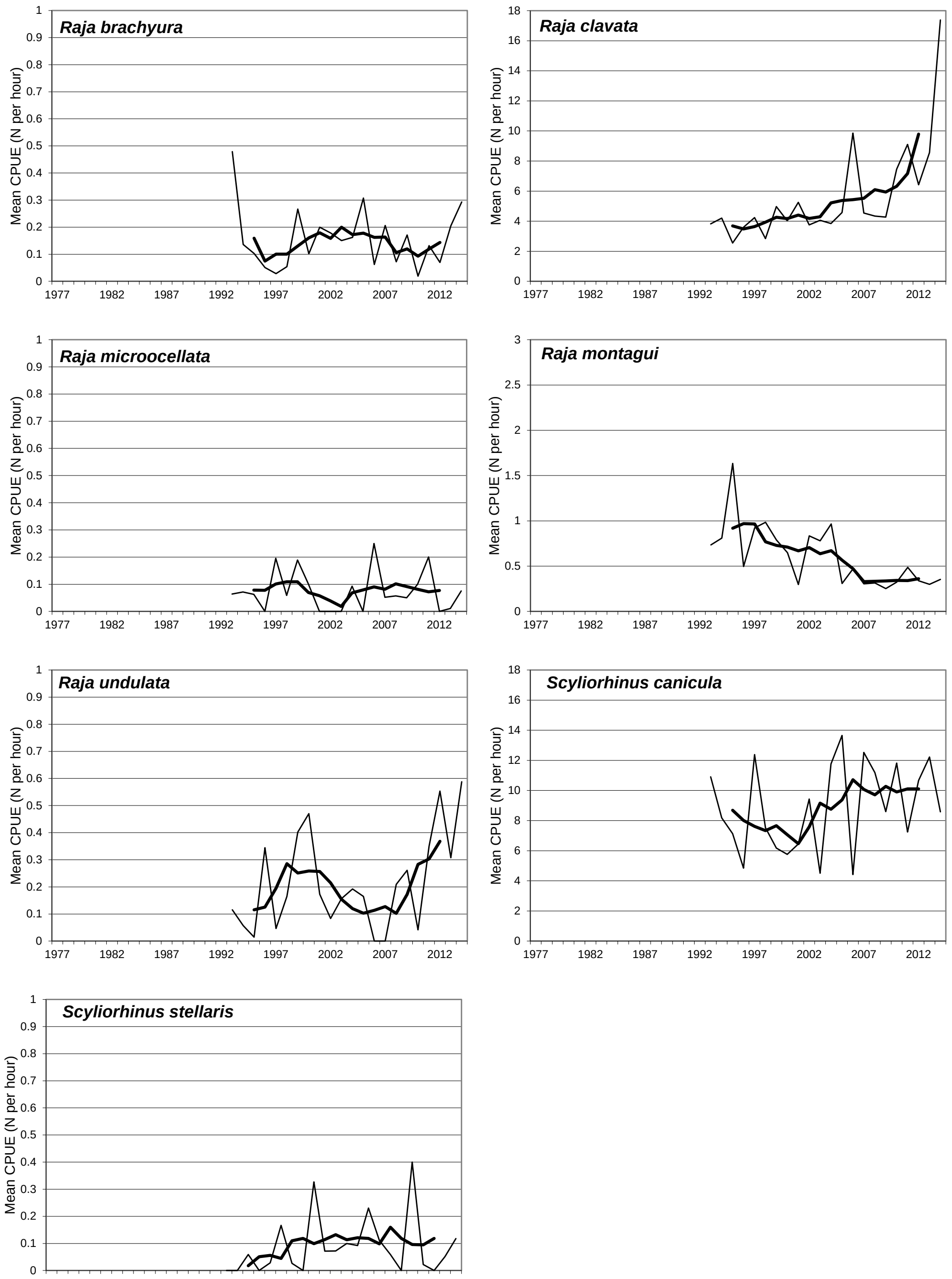


Figure 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and five year running mean during the UK BTS survey. Data obtained from J. Ellis on 18th June 2015.

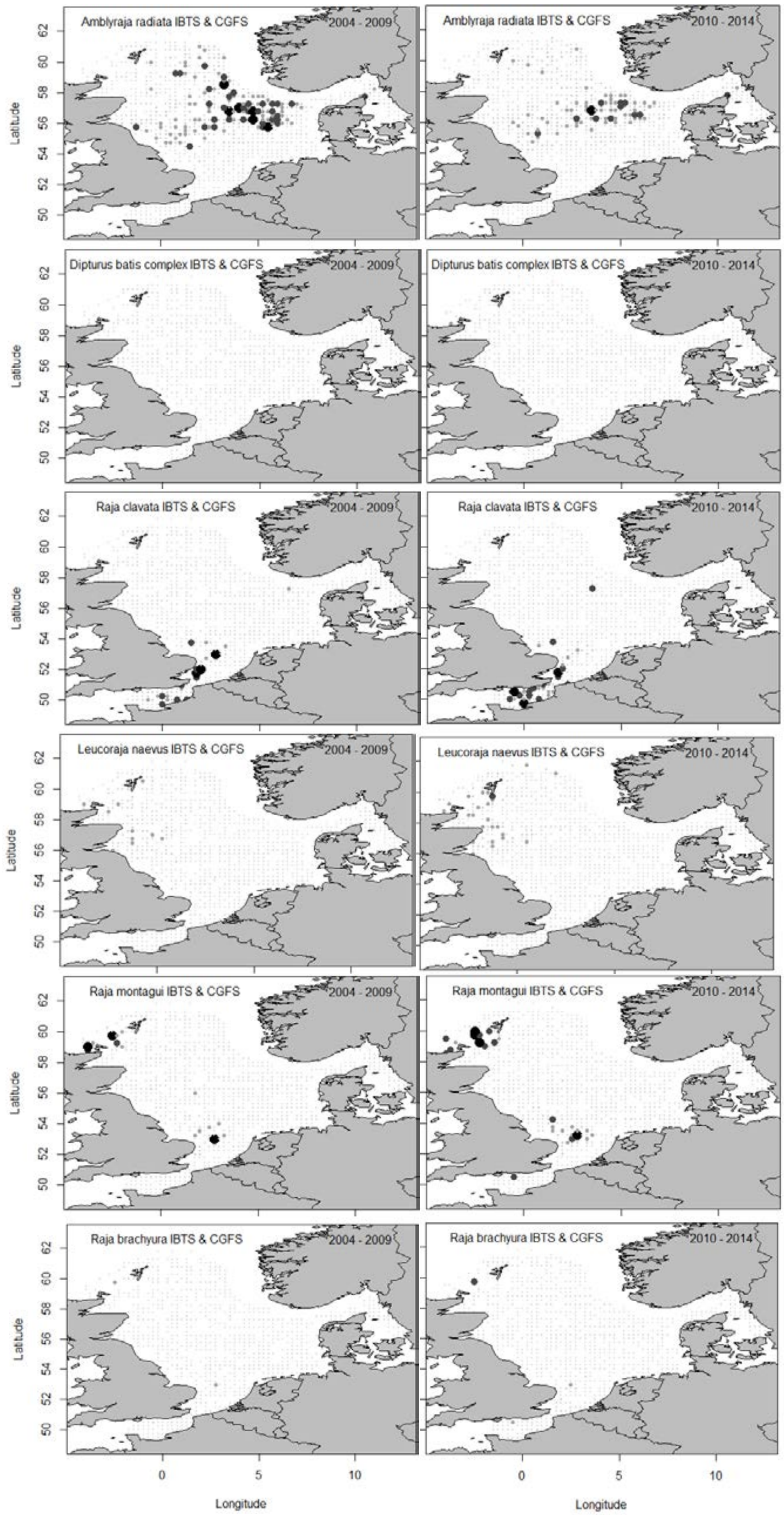


Figure 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots based on IBTS Q1, IBTS Q3, and eastern Channel CGFS Q4 data in the periods 2004–2009 (left panels) and 2010–2014 (right panels). All data are abstracted from DATRAS. Data for IBTS are extracted as cpue per length per statistical rectangle) on 20th June 2015, while data for CGFS are extracted as exchange data. Bubble scale is equal in all panels.

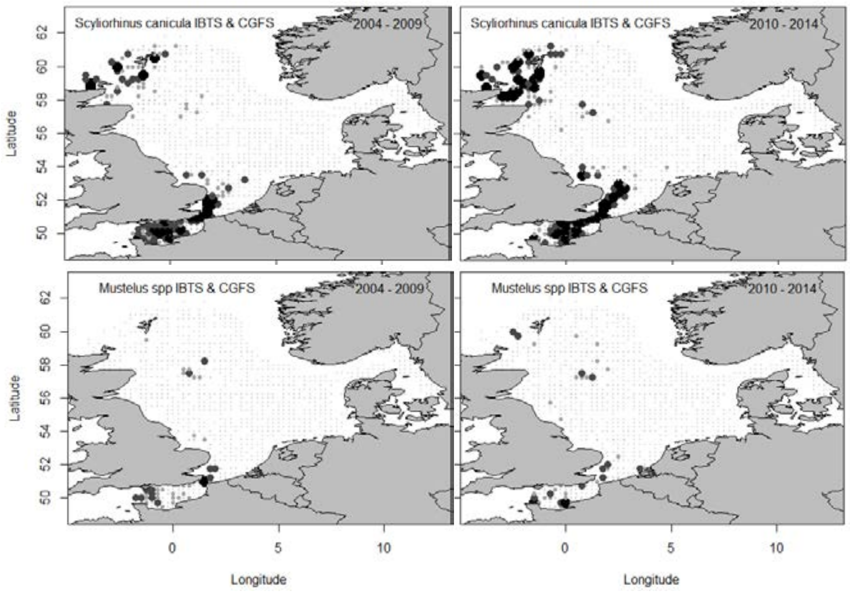


Figure 15.10. Continued.

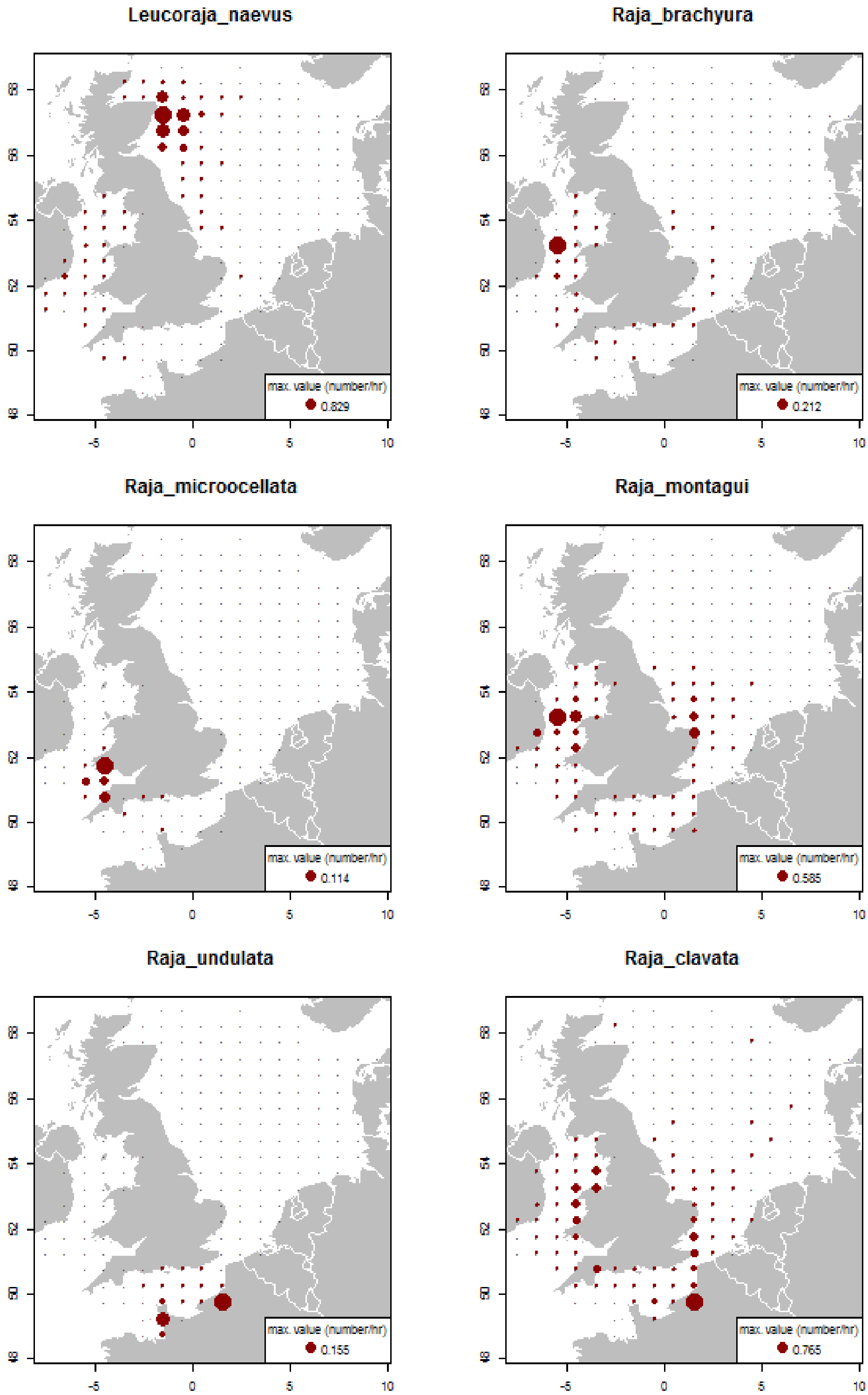


Figure 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: Spatial distribution data received on from WGBEAM, derived from all beam trawl surveys.

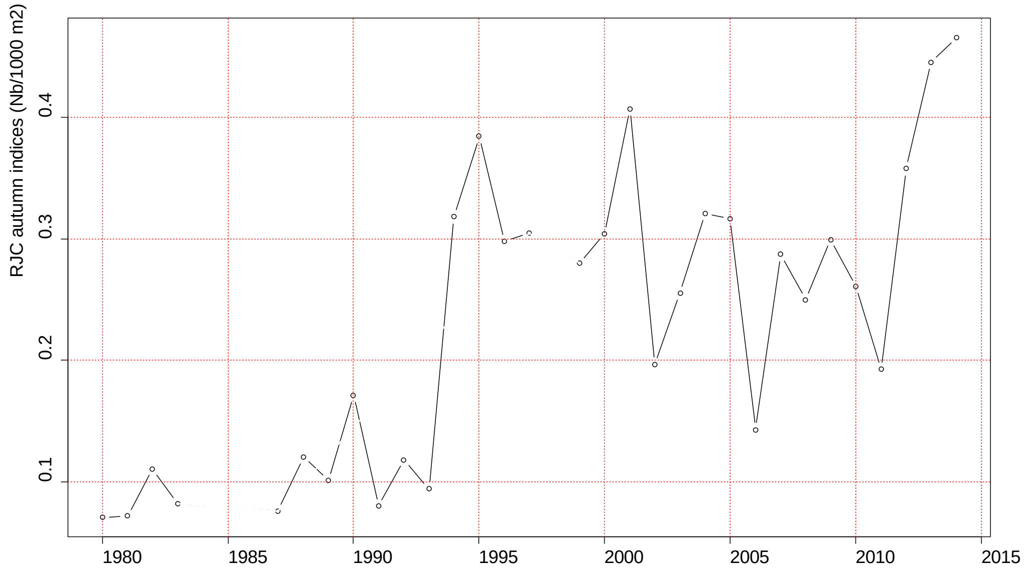


Figure 15.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: Catch rates of juvenile *Raja clavata* (N per 1000 m²) in autumn surveys in Baie de Somme (1980–2014). Source: Tetard *et al*. (2015).

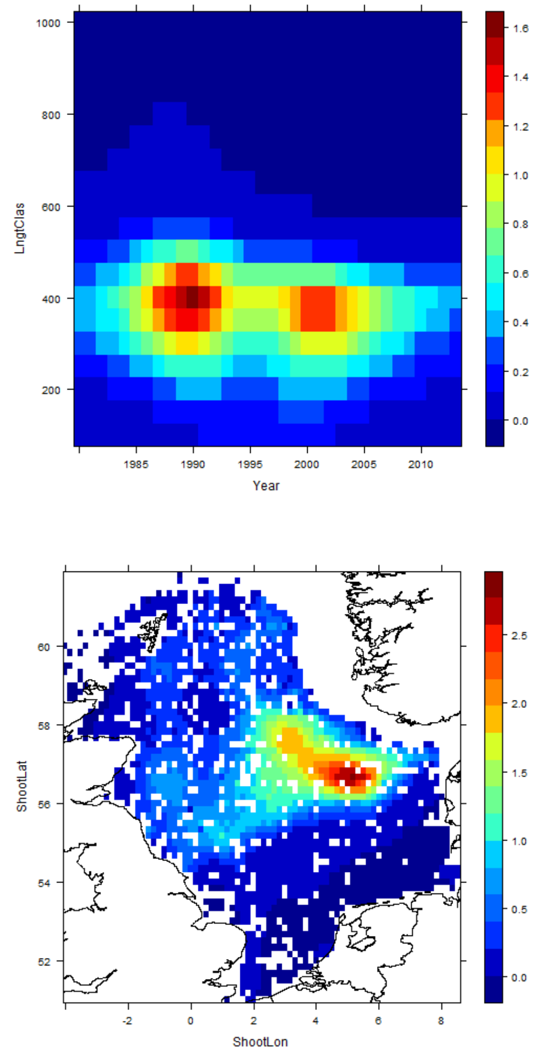


Figure 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Amblyraja radiata* in the North Sea. Results of GAM analysis of the IBTS-Q1 and Q3 data. Source: ICES (2014).

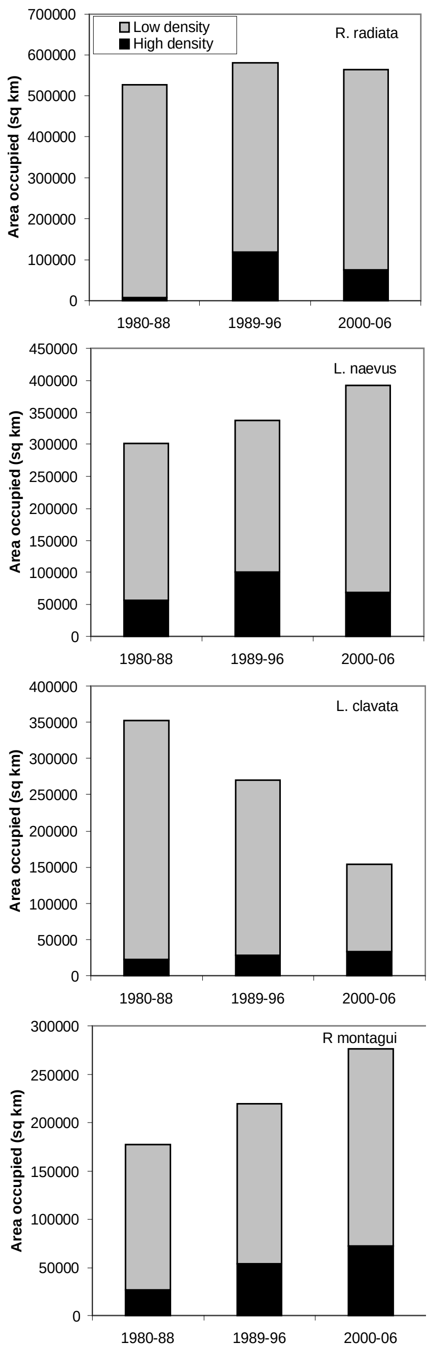


Figure 15.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Area occupied during three periods illustrated in the distribution maps for *Amblyraja radiata*, *Leucoraja naevus*, *Raja clavata* and *R. montagui*. Source: ICES (2007).

16 Demersal elasmobranchs at Iceland and East Greenland

16.1 Ecoregion and stock boundaries

The elasmobranch fauna off Iceland and Greenland is little studied and comprises 15 skates (and 22 shark and six chimaeroids). The number of species decreases as water temperature gets colder, and only a few elasmobranch species are common in Icelandic and Greenland waters.

The most abundant elasmobranch species in this ecoregion is starry ray (or thorny skate) *Amblyraja radiata*. In Icelandic waters others species include Arctic skate *Amblyraja hyperborea*, Jensen's skate *Amblyraja jenseni*, common skate *Dipturus batis*-complex, Norwegian skate *Dipturus nidarosienis,* shagreen ray *Leucoraja fullonica*, roughskin skate *Malacoraja spinacidermis,* Krefft's skate, *Malacoraja kreffti*, deep-water ray *Rajella bathyphila*, Bigelow's skate *Rajella bigelowi,* round skate *Rajella fyllae*, sailray *Rajella lintea* (former *D. linteus*) and spinytail skate *Bathyraja spinicauda.*

In Greenland waters skates and rays include the commonly found *R. fyllae, B. spinicauda* and *A. hyperborea* and rarer species such as *R. bathyphila*, *M. spinacidermis*, *R. lintea*, *A. jenseni* and *R. bigelowi* (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 *E. spinax*, longnose velvet dogfish *Centroselachus crepidater* and six gill shark *Hexanchus griseus* (Section 5); porbeagle *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*).

Chimaeras (rabbitfish *Chimaera monstrosa*, spearnose chimaera *Rhinochimaera atlantica*, large-eyed rabbitfish *Hydrolagus mirabilis*, *H. pallidus*, smalleyed abbitfish *Hydrolagus affinis*, narrownose chimaera *Harriotta raleighana*) all occur in the area.

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.

16.2 The fishery

16.2.1 History of the fishery

Skates and sharks are mainly a bycatch in fisheries, with Iceland the main fishing nation operating in the ecoregion. *Dipturus batis*-complex is taken 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 goes to local consumption, as *D. batis*-complex is a traditional food in Iceland, particularly at Christmas time. The remaining catch is processed and exported mainly to Belgium.

A. radiata is a bycatch in a variety of fishing gears around Iceland but was usually discarded. The increased landings since the 1990s is explained mostly by increased retention compensating for lower abundance of *D. batis*-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 t annually between 1995 and 2004. Thereafter, landings declined but have increased again to levels exceeding 1800 t since 2012. A relatively large share goes to local consumption.

16.2.2 The fishery in 2014

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

Reported landings of skates from Iceland (Division Va) and eastern Greenland (Subarea XIV) are given in Table 16.1, with these data comprising national data from Iceland, landings statistics from the Faroese national database (www.hagstova.fo), and data from the ICES database.

Icelandic national data for estimated landings of the *D. batis*-complex (1973–2014), *A. radiata* (1977–2014), *R. lintea* (2000–2014) and *L. fullonica* (1993–2014) were updated. Database entries for all species were updated with national landings data provided by Iceland for the years 2003–2014.

Prior to 1992 all skates, except *A. radiata* and *D. batis*-complex, were reported as '*Raja* rays nei'. *A. radiata* and *Dipturus batis*-complex have, on average, accounted for about 98% of the annual skate landings since 1992, since when it is thought that all species are reported to species level. 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 of *D. batis*-complex could also sometimes be *R. lintea.*

From 1973–2014, 13 countries reported landings of skates, demersal sharks and chimaeras from Divisions Va (Iceland) and XIVa and XIVb (East Greenland). Iceland is the main nation fishing in these areas.

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 since 2005 but increased to about 1900 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 Va. The share taken by Iceland from this area increased from <50% in the 1970s to nearly 100% from 1999 to 2014.

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 nation landings skates in this ecoregion now provides 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 of about 21 m, headline height of about 5.8 m, and a mesh size of 30 mm in the codend) on a 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 autumn groundfish survey (IS-SMH) is the main source of fishery-independent data for demersal elasmobranchs in Icelandic waters. Further, data can be compiled for some species from other surveys e.g. spring groundfish survey (IS-SMB), shrimp and flatfish surveys undertaken by MRI.

The IS-SMH survey covers the Icelandic shelf and slope at depths of 20–1500 m. It is a stratified systematic survey with standardized fishing methods. Small-meshed bottom trawls (40 mm in the coded) equipped with rock-hopper are towed at a speed of 3.8 knots for predetermined distance of 3 nautical miles (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 1996–2006, can be found in Björnsson *et al.* (2007).

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, with a widespread distribution over the Icelandic shelf and upper slope (see Figure 16.4 for the distribution in IS-SMH 2013). 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 (see Björnsson *et al*., 2007). Anecdotal information suggests that *A. radiata* undertakes seasonal migrations in relation with egg-laying activity, but this is unconfirmed. Trawl survey data may provide useful information on catches of viable skate eggcases 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. Length-at-50%-maturity ($L_{50\%}$) is 46.1 cm and 42.2 cm L_T for males and females, respectively. These values are lower in comparison to adjacent waters to the NW Atlantic stock (Templeman, 1987), but are 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

Abundance indices and biomass estimates for *A. radiata* 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 results indicate negative survey trends in major size groups in recent years (Jakobsdóttir, unpubl. material).

16.9 Stock assessment

No assessments have been undertaken for the skates in this ecoregion.

16.10 Quality of assessments

Exploratory analyses of survey trends have been conducted for *A. radiata*. However, the majority of commercial landings are taken in other gears than bottom trawl (Figure 16.1) and this should be considered.

16.11 Reference points

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

16.12 Conservation considerations

The *D. batis*-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). Further investigation into the *D. batis*-complex and other large-bodied skates in Iceland and East Greenland is required.

16.13 Management considerations

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species (22 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 negative survey trends for this species and needs to be investigated further.

16.14 References

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http://www.fisheries.is/main-species/cartilaginous-fishes/Accessed 18th June 2014.

http://www.fisheries.is/main-species/cartilaginous-fishes/grey-skate/ 18th June 2014.

http://www.fisheries.is/main-species/cartilaginous-fishes/starry-ray/18th June 2014.

http://www.hagstova.fo 18th June 2014.

Table 16.1. Demersal elasmobranchs at Iceland and East Greenland. Reported landings of skates from Iceland (Division Va) and East Greenland (Subarea XIV). Icelandic data from national data, Faroese landings from Faroes national statistics website (www.hagstova.fo), other data from the ICES database.

SCIENTIFIC NAME	NATION	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Dipturus batis-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
Dipturus batis-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	4	9	2	2	7	5	0
	Germany	0	0	0	1	3	1	2	0	9	0	0	1	0	7
	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 at Iceland and East Greenland. Reported landings of skates from Iceland (Division Va) and East Greenland (Subarea XIV). Icelandic data from national data, Faroese landings from Faroes national statistics website (www.hagstova.fo), other data from the ICES database.

SCIENTIFIC NAME	NATION	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Dipturus batis-complex	Iceland	82	59	120	145	167	137	117	127	128	117	125	130	153	219
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amblyraja radiata	Iceland	1211	1781	1491	1013	657	530	473	636	710	950	1329	1981	1719	1628
Dipturus linteus	Iceland	0	0	10	8	20	0	0	0	8	12	9	9	7	4
Leucoraja fullonica	Iceland	37	32	17	23	16	16	25	4	33	19	17	21	37	14
Raja rays nei	Faeroe Islands	2	2	0	8	9	16	7	11	n.a.	n.a.	0	5	6	na
	Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	France												0	0	0
	Iceland	0	0	0	0	0	8	0	10	0	0	0	0	0	0
	Norway	6	5	1	0	0	7	0	1	2	80	4	0	+	0
	Portugal	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Russian Federation	0	0	0	2	6	3	0	0	n.a.	n.a.	0	0	na	na
	Spain	0	0	15	0	0	0	0	0	0	0		0	0	0
	UK - Eng+Wales+N.Irl.	1	0	0	1	0	1	0	0	0	0	0	0	0	0
	UK - Scotland	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Raja raja clavata	France								0	0	0	1	0	0	0
Total		1340	1879	1655	1200	875	718	622	789	881	1178	1485	2146	1921	1865

Table 16.2. Demersal elasmobranchs at 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 at Iceland and East Greenland. Catch data of skates and rays in MRI annual autumn groundfish survey at Iceland (Division Va), 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 collection incomplete.

	2000		2001		2002		2003		2004		2005		2006		2007	
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O
Dipturus batis-complex	6	<1	1	<1	3	<1	3	<1	1	<1	4	<1	6	1	7	1
Amblyraja radiata	1589	48	1413	45	1442	49	1379	49	1957	51	1678	53	1716	52	1474	52
Rajella lintea	2	<1	0	0	0	0	0	0	0	0	0	0	2	<1	0	0
Amblyraja hyperborea	110	9	160	9	80	8	88	8	97	9	104	8	120	10	59	10
Rajella fyllae	24	4	54	8	53	8	77	6	37	6	53	7	81	8	44	8
Bathyraja spinicauda	7	2	11	2	10	2	25	1	12	2	16	2	21	2	7	2
Rajella bathyphila	1	<1	0	0	0	0	1	<1	0	0	1	<1	0	0	0	0
Rajella bigelowi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2008		2009		2010		2011*		2012		2013		2014			
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O		
Dipturus batis-complex	7	1	9	1	4	<1	1	1	0	<1	0	0	5	1		
Amblyraja radiata	1569	48	1590	39	1399	46	295	42	918	34	1142	41	1289	52		
Rajella lintea	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Amblyraja hyperborea	90	9	103	9	86	10	27	8	73	7	63	8	95	9		
Rajella fyllae	106	5	48	10	70	7	36	5	24	17	35	4	71	10		
Bathyraja spinicauda	18	2	11	2	1	2	2	0	11	1	4	2	11	2		
Rajella bathyphila	2	<1	0	0	0	0	0	0	0	0	0	0	0	0		
Rajella bigelowi	1	<1	0	0	0	0	0	0	0	0	0	0	0	0		

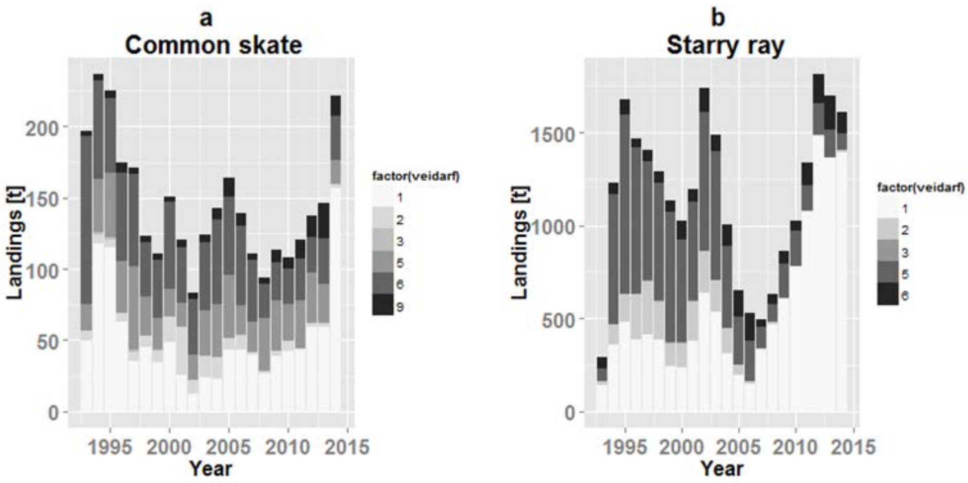

Figure 16.1. Demersal elasmobranchs at Iceland and East Greenland. Icelandic landings of (a) common skate *Dipturus batis*-complex and (b) starry ray *A. radiata* by fishing gear (1: longline, 2: gillnet, 3: handline, 5: Danish seine, 6: Bottom trawl, 9: *Nephrops* trawl). Note different scales at the y-axis.

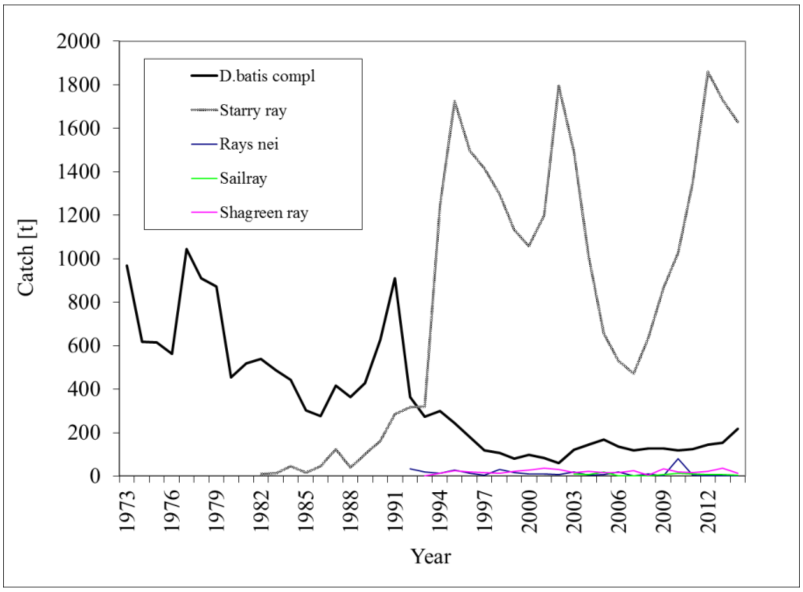

Figure 16.2. Demersal elasmobranchs at Iceland and East Greenland. Icelandic landings of skates (Division Va). Prior to 1992 all skates nei are assumed to belong to *Dipturus batis*-complex (see earlier reports). WG estimates of the most commonly reported skates, 1973–2013. (ICES, 2012, national landings data and Faroese statistical database www.hagstova.fo).

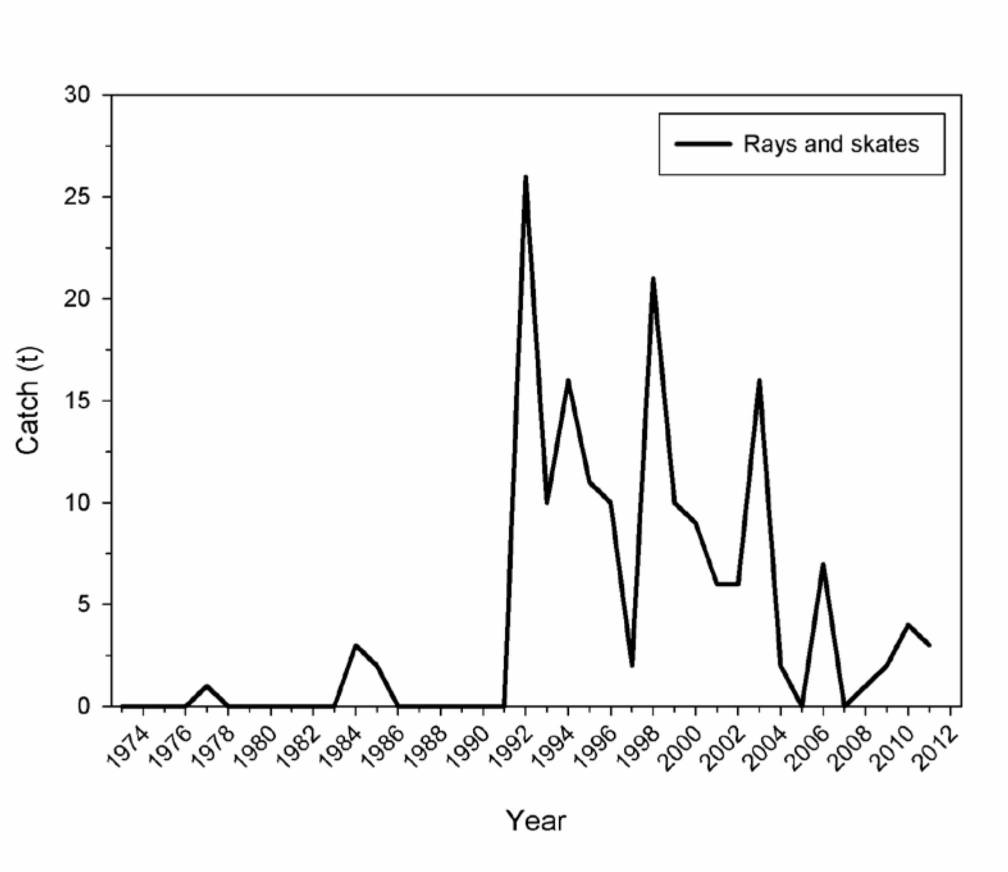

Figure 16.3. Demersal elasmobranchs at Iceland and East Greenland. Landings of skates from East Greenland (Subarea XIV).

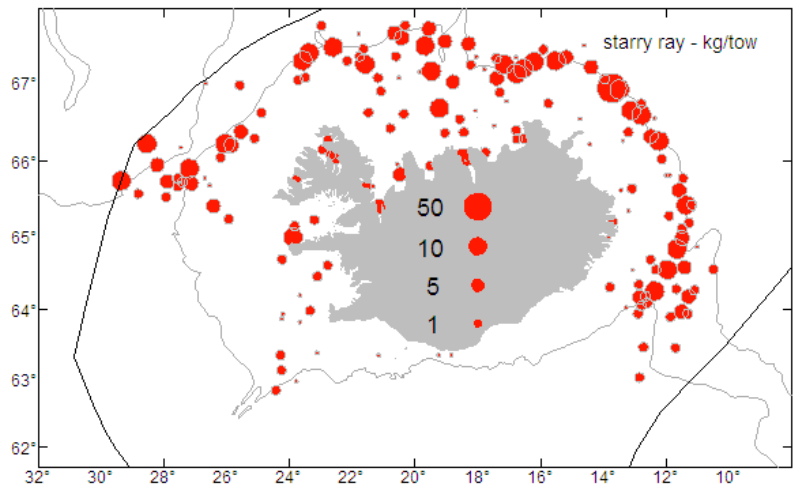

Figure 16.4. Demersal Elasmobranchs at Iceland and East Greenland. Spatial distribution of starry ray *A. radiata* in Icelandic waters (Division Va) from the 2013 autumn survey. Filled circle represent relative amount (kg per standardized tow).

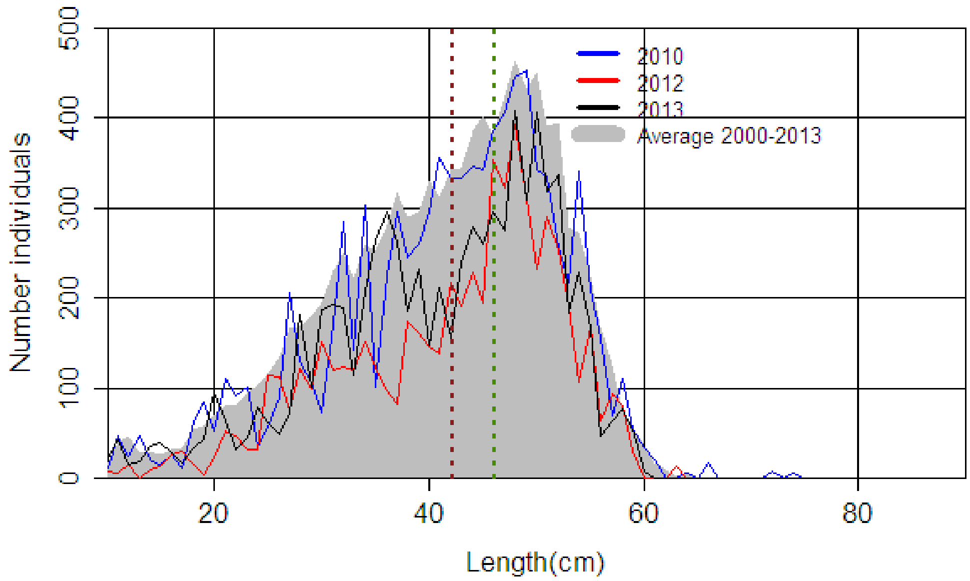

Figure 16.5. Demersal elasmobranchs at Iceland and East Greenland. Length distribution of starry ray *A. radiata* in Icelandic waters (Division Va) as observed in the annual autumn survey. Grey area shows average for years 2000–2013. Blue, red and black lines represent average for 2010, 2012 and 2013 respectively. Broken lines indicate length-at-maturity (L_{50}); green line: 46.1 cm, red line: 42.2 cm for males and females, respectively (Jakobsdóttir, unpubl.).

17 Demersal elasmobranchs at the Faroe Islands

17.1 Ecoregion and stock boundaries

The elasmobranch fauna off the Faroe Islands (ICES Divisions Vb1, Vb2) is little scientifically 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 (*Dipturus batis* 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 (leafscale 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 Vb, relating mostly to skates. Scottish vessels landed the largest portion of catches 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 prosecute 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 2014

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 *D. batis* 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 amount of discarding of skates and demersal sharks is unknown.

17.3.3 Quality of catch data

Species-specific information for commercial catches is lacking.

17.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

17.4 Commercial catch composition

17.4.1 Species and size composition

All skates in Division Vb, 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 split these landings by species. It is likely that catches include *D. batis*-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 being available to WGEF. Analyses of survey data may indicate the general status of the more frequent species.

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. 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 *D. batis* complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas, further investigation on the *D. batis* complex and other skates in the Faroe Islands is required, including the data analysis from fishery-independent sources.

17.14 References

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Table 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division Vb). Data were updated with ICES database landings data (ICES, 2012) for years 2000–2012 and also contain national landings data provided to the WG. Faroese landings for 2013 were extracted from Faroese national statistics database available on www.hagstova.fo.

WG Estimates of Landings (t) of Rays in ICES Area Vb

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
	UKEWNI	62	33	45	50	10	5	4	2	0	0	0	0	0
	UK - Scotland	322	205	205	226	164	99	104	66	11	32	20	1	1
Dipturus batis 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 Vb). Data were updated with ICES database landings data (ICES, 2012) for years 2000–2012 and also contain national landings data provided to the WG. Faroese landings for 2013 were extracted from Faroese national statistics database available on www.hagstova.fo.

WG Estimates of Landings (t) of Rays in ICES Area Vb

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	102	207	254	203	167	220	165	178	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
	UKEWNI	0	1	0	0	0	1	0	12	3	3	0	6	0
	UK - Scotland	0	1	0	1	2	0	5	1	5	4	4	5	7
Dipturus batis 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	217	295	298	292	198	243	232	208	196

Table 17.1. Continued. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division Vb). Data were updated with ICES database landings data (ICES, 2012) for years 2000–2012 and also contain national landings data provided to the WG. Faroese landings for 2013 were extracted from Faroese national statistics database available on www.hagstova.fo.

WG Estimates of Landings (t) of Rays in ICES Area Vb

Species	Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Raja rays nei	Faroe Islands	175	0	76	25	98	272	274	238	185	179	150	177	182	200	198
	France	2	0	0	1	5	10	7	19	8	9	5	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	11	10	16	5	4	11	0	0	0
	UKEWNI	0	23	2	0	2	15	5	0	0	0	0	0	0	0	0
	UK - Scotland	6	12	25	12	6	5	25	2	2	2	4	3	0	0	0
Dipturus batis complex	Norway	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
	France	4	2	2	2	3	5	2	3	1	0	0	0	0	0	0
	UK - Scotland	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0
Leucoraja naevus	France	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	UK - Scotland	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	0
	UK - Scotland	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	0
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
Rostroraja alba	France	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0
	UK - Scotland	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
	Total	233	89	129	55	122	308	324	272	212	200	170	200	182	201	198

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	–	–	–	–	–	**	+
Dipturus batis-complex	–	*	*	–	–	**	*
Leucoraja fullonica	–	+	+	–	–	*	+
Leucoraja circularis	–	–	*	–	–	–	+
Rajella fyllae	–	+	–	–	–	–	+
Rajella lintea	*	+	–	–	–	–	+
Raja clavata	–	+	–	–	–	–	+
Chimaera monstrosa	*	*	**	***	***	***	**

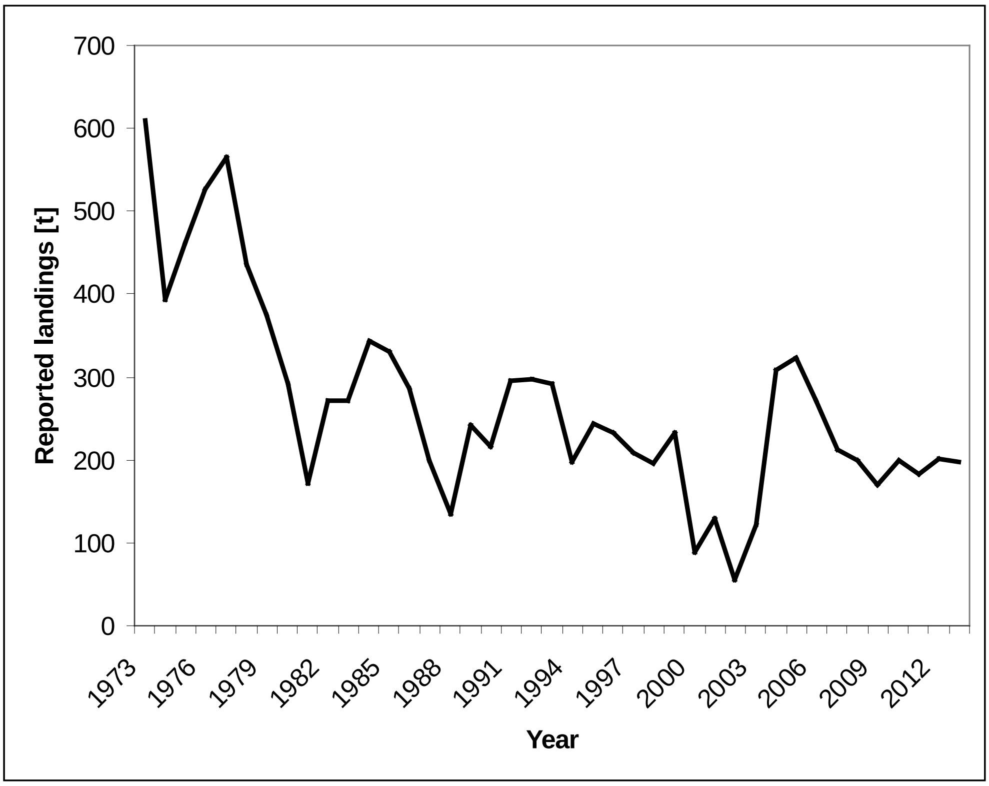

Figure 17.1. Demersal elasmobranchs at the Faroe Islands (Subarea Vb). Reported landings of skates (1973–2012) based on ICES database (ICES, 2012), national landings data and Faroese national statistics database (www.hagstova.fo).

18 Skates and rays in the Celtic Seas (ICES Subareas VI and VII (except Division VIId))

Advice for stocks in this ecoregion was last provided in 2014 and will next be provided in 2016. Therefore, this chapter only contains minor edits and updates to landings tables and figures. The advice for 2015 and 2016 is reproduced.

18.1 Ecoregion and stock boundaries

The Celtic Seas ecoregion covers west of Scotland (VIa), Rockall (VIb), Irish Sea (VIIa), Bristol Channel (VIIf), the western English Channel (VIIe), and the Celtic Sea and west of Ireland (VIIb–c, g–k). This ecoregion broadly equates with the area covered by the North Western Waters Advisory Council (NWWAC). The southwestern sector of ICES Division VIIk is contained in the oceanic Northeast Atlantic ecoregion.

Whereas some demersal elasmobranchs, such as spurdog (Section 2), tope (Section 10), smooth-hounds (Section 21) and lesser-spotted dogfish (Section 25), are widespread throughout this region, there are some important regional differences in the distributions of other species, especially the skates (Rajidae) which were described in earlier reports (see ICES, 2010), and are summarized in Table 18.1.

The stock identity for many of these species is not fully understood. Genetic studies have only been undertaken for a few species (e.g. *Raja clavata*, Chevolot *et al.*, 2006). There have been several tagging studies of skates in this ecoregion (Pawson and Nichols, 1994; Wearmouth and Sims, 2009; Ellis *et al.*, 2011; Ellis *et al.*, 2012a WD; Stéphan *et al.*, 2014a WD; Stephan *et al.*, 2014b; Wögerbauer *et al.*, 2014 WD).

Further studies to better understand stock structure are required, especially in the case of the offshore species, such as *Leucoraja naevus*, *L. fullonica and L. circularis* for which it is unclear the degree of connectivity of populations in the Celtic Sea, Irish Sea and off NW Scotland, with adjacent ICES Divisions in other ecoregions (IVa, VIII).

Further tagging studies could also be usefully undertaken to better understand the stock structure of species with patchy distributions, such as *Raja brachyura* and *R. undulata*. Preliminary results of skate tagging in the western English Channel have indicated high site fidelity for these species (Ellis *et al.*, 2011; Stephan *et al.*, 2014a WD; Stephan *et al.*, 2014).

18.2 The fishery

18.2.1 History of the fishery

Most skate species in the Celtic Seas ecoregion are taken as a bycatch in mixed demersal fisheries, which are either directed at flatfish or gadoids. The main countries involved in these fisheries are France, UK, Belgium and Ireland, with smaller catches by Spain, UK (Scotland), Norway and the Netherlands. The main gears used are otter trawl, beam trawl and bottom-set gillnets.

There are some localized, inshore fisheries targeting skates (e.g. *R. clavata*) using longline and tanglenets, and some trawl fisheries targeting various skate species in the southern Irish Sea (VIIa) and Bristol Channel (VIIf) at some times of year.

There is also a large recreational fishery for skates and rays, particularly for those species close to shore, with some ports having locally important charter boat fisheries. There is likely to be some retention of skates, although the levels of these catches are unknown.

18.2.2 The fishery in 2014

TAC and quota regulations were restrictive for some nations and fisheries, including the UK, France and the Netherlands, and the inclusion of common skate (*Dipturus batis*-complex) and undulate ray *R. undulata* on the prohibited species list has resulted in increased discarding of these species, especially in areas where they are locally common.

It has been suggested that the English gillnet fishery in the Celtic Sea has moved eastwards, due to increasing discarding of *Dipturus batis*-complex (see Bendall *et al.*, 2012) although further studies are required to examine the spatial distribution of fishing activity.

Landings tables for the relevant species are provided in Tables 18.2–18.3.

18.2.3 ICES advice applicable

ICES provided advice for several species/stocks in this region in 2014 as summarized below (and Section 18.9).

In 2010, ICES was asked to comment on the listings of common skate and undulate ray as 'prohibited species' on EC TAC and quota regulations.

For undulate ray, ICES advised "*There is no basis in the current or previous ICES advice for the listing of undulate ray as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion fisheries legislation … In view of the poor knowledge and patchy distribution of these populations, ICES recommends a precautionary approach to the exploitation of these populations of undulate ray*".

For common skate, ICES advised "*There is no basis in the current or previous ICES advice for the listing of the common skate (Dipturus batis) as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion fisheries legislation. In the Celtic Seas ecoregion, ICES considers that stocks of the common skate complex is depleted, and that protective management measures are required. There should be no target fishing on the common skate, and there should be a TAC set at 0*".

Stock	Assessment category	Landings Advice	Implied Landings in 2015 and 2016
Blonde ray *Raja brachyura* Divisions VIIa, f, g	5.2.0	reduce by 20%	897 t
Blonde ray *Raja brachyura* Division VIIe	5.2.0	reduce by 20%	310 t
Thornback ray *Raja clavata* Subarea VI	3.2.0	increase by a maximum of 20%	no more than 205 t
Thornback ray *Raja clavata* Divisions VIIa, f, g	3.2.0	increase by a maximum of 20%	no more than 1235 t
Thornback ray *Raja clavata* Division VIIe	5.2.0	landings should not increase	260 t
Small-eyed ray *Raja microocellata* Bristol Channel (Division VIIf,g)	3.2.0	reduce by 36%	188 t
Small-eyed ray *Raja microocellata* English Channel (Divisions VIId,e)	5.2.0	reduce by 20%	43 t
Spotted ray *Raja montagui* Subarea VI and VIIb,j	3.2.0	reduce by 11%	53 t
Spotted ray *Raja montagui* Divisions VIIa, e, f, g	3.2.0	reduce by 4%	1118 t
Cuckoo ray *Leucoraja naevus* Subareas VI–VII; Divisions VIIIa,b,d	3.2.0	reduce by 34%	1998 t
Sandy ray *Leucoraja circularis* Celtic Seas and adjacent areas	5.2.0	reduce by 20%	39 t
Shagreen ray *Leucoraja fullonica* Celtic Seas and adjacent areas	5.2.0	reduce by 20%.	186 t
Undulate ray *Raja undulata* Division VIIb,j	6.3.0	no targeted fishery on this stock...measures to mitigate bycatch should be developed and implemented	zero
Undulate ray *Raja undulata* Divisions VIId, e (English Channel)	6.3.0	no targeted fisheries. Any possible provision for bycatch to be landed should be part of a management plan.	zero
Common skate *Dipturus batis*-complex (flapper skate *Dipturus batis* cf. *flossada* and blue skate *Dipturus cf. intermedia*) Subarea VI and Divisions VIIa–c, e–j	6.3.0	no targeted fishery for these stocks and measures should be taken to minimize bycatch	zero
Other skates Subareas VI and VII, excl. Division VIId	5.2.0	reduced by 20%	789 t

18.2.4 Management applicable

A TAC for skates in VI and VIIa–c, 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). The history of the regulations is as follows:

Year	TAC for EC waters of VIa-b and VIIa-c, 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	1,2,3	Council Regulation (EU) No 43/2014 of 20 January 2014
2015	8032 t	1,2,3	Council Regulation (EU) No 104/2015 of 19 January 2015

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. However scientific advice received from the STECF on 2 March 2015 indicated that it was precautionary to allow a small bycatch quota for undulate ray (*Raja undulata*) in ICES Areas VIa, VIb, VIIa–c, VIId, VIIe–k and VIII (Council Regulation (EU) No 2015/523 of 25 March 2015 amended Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities).

3) Of which up to 5% may be fished in EU waters of VIId.

The update to the TAC regulations (Council Regulation (EU) 2015/523 of 25 March 2015 amending Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities) stated *R. undulata* "*shall not be targeted in the areas covered by this TAC. Bycatch … in area VIIe exclusively may be landed provided that it does not comprise more than 20 kilograms live weight per fishing trip…*" and remain under an overall TAC of 100 t.

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 Proposed management plans

A management plan for skates in the Celtic Seas ecoregion was under development through the North Western Waters Regional Advisory Council (NWWRAC). The plan was to manage skates in the Irish Sea (VIIa) and Celtic Sea (VIIg) by means of voluntary closed areas that would protect adults/juvenile fish during the egg-laying season. Proposals to manage skates with separate TACs and management for *Raja* spp. and *Leucoraja* spp. were not agreed. The plan has not yet been fully implemented, with just one closed area currently in place. The plan has not yet been evaluated by ICES.

In 2012 the NWWRAC submitted a special request to ICES for separate advice for the two species within the *Dipturus batis* complex. However it is not yet possible to provide advice on this basis.

Fishermen off North Devon have a voluntary seasonal closed area over what they consider to be a nursery ground.

18.3 Catch data

18.3.1 Landings

Landings data for skates (Rajidae) were supplied by all nations. Data for 2014 are considered provisional.

Landings by country are given in Table 18.2. 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 there are about 15 countries involved in the skate fisheries in this ecoregion, only six (France, UK (England, Wales and Northern Ireland), Belgium, Ireland, UK (Scotland) and Spain) have continually landed large quantities.

Landings are highly variable, with lows of approximately 14 000 t in the mid-1970s and 1990s, and highs of just over 20 000 t in the early and late 1980s and late 1990s. Although landings have fluctuated over most of the time-series, there has been a steady decline in landings since 2000. Annual reported landings have been less than 10 000 t since 2008 (noting that the TAC was established in 2009), and are now at their lowest level in the time-series at ca. 7500 t in 2013. Landings totals for 2014 are probably underrepresented due to limitations within the datacall system. Area summaries below, therefore only refer to 2013 landings.

West of Scotland (VIa)

Recent reported landings, at about less than 400 t, are at their lowest point since 1973, with almost all countries declaring less than preceding years. In contrast, average landings in the early 1990s were about 3000 t. Landings have been less than 1000 t since 2006, and less than 500 t for the last five years.

Rockall (VIb)

Reported landings from Rockall in the 1990s were about 500 t per year, but have been under 200 t for the last decade, and are now at their lowest level. The increased landings in the mid-1990s were a result of new landings of 300–400 t per year by Spanish vessels. These no longer appear to take place since no Spanish landings have been reported in this area in recent years. It is not clear what proportion of these catches may have been taken from Hatton Bank (VIb1 and XIIb). One to three Russian longliners fished in this area in 2008–2009, mainly catching deep-water species, including sharks, but also catching 7 t of deep-water skate species.

Irish Sea (VIIa)

Reported landings in the Irish Sea vary considerably, and ranged from over 1500 t in 1995 to ca. 5000 t in the late 1980s. Since 2006, annual landings have been <2000 t, and are now at just over 1000 t and their lowest level (except 2009). This may be as a result of reduced fishing effort and effort changes because of the cod recovery programme in the area, where whitefish boats have switched to *Nephrops* fishing, with the latter thought to have a lower skate bycatch. Most landings are from Ireland, UK and Belgium.

Bristol Channel (VIIf)

Following an increase in reported landings in the mid-1970s, skate landings in VIIf ranged from 1000–1600 t in recent years. Landings are predominantly from three countries (UK, France and Belgium) and are stable at just over 1000 t.

Western English Channel, Celtic Sea and west of Ireland (VIIb–c,e,g–k)

Annual reported landings from Divisions VIIb–c,j–k were in the general range of 500–1200 t from 1973–1995. Landings then increased during the period 1996–2003, with some annual landings of approximately 4000 t, however the level of misreporting in this period is unknown. Landings declined after 2007 to less than 1000 t per year, which is of a comparable magnitude to earlier landings, and are now just over 500 t.

Landings are consistently higher in the southern parts of this region (Divisions VIIe,g–h), and these have reduced from ca. 8000 t per year (from 1973–2000) to just over 4000 t in recent years and are now at their lowest level of the 40-year time-series.

18.3.2 Skate landing categories

Historically, most skate landings were reported under a generic landing category, although some nations (e.g. France) reported some species-specific landings data. There has been a legal requirement to report most skate landings to species level throughout this ecoregion since 2010. On average, 94% of the 2013 landings are 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, so as to better identify where improved training and/or market sampling may improve data quality.

18.3.3 Discards

There may be widespread discarding of skates, including of smaller (less marketable) individuals, prohibited species, as well as regulatory discards (when vessels have restrictive quota).

Discard information for skates taken in UK (English and Welsh) fleets were summarized (Ellis *et al.*, 2010; Silva *et al.*, 2012) and detailed analyses of discards data from other nations are required.

18.3.4 Discard survival

Studies in UK waters have examined the discard survival of various skates in a range of fisheries. Skate discard survival is approximately 55% in otter trawl fisheries (Enever *et al.*, 2009), but this is influenced by the other catch component of the trawl. In other areas, it has also been observed that *R. clavata* caught by inshore trawlers (which tend to have a short tow duration, due to the increased amount of weed in the water in inshore areas) tend to be lively on capture and commercially caught fish tagged and released have good return rates (Ellis *et al.*, 2008), indicating a higher discard survival from such fisheries.

Studies on beam trawlers indicate that survival of skates may be up to 50% when tow duration is <2 hours, but is likely to increase with higher tow duration. Inshore gillnet fisheries have a relatively high discard survival when soak time is short (survival is >95% when soak times are ca. 24 hours), but longer soak times (40–48 hours) resulted in greater mortality rates (Ellis *et al.*, 2014 WD). The soak times for offshore gillnet fisheries are generally greater, and so there is also an increased mortality, and also an increased incidence of scavenging by isopods (Bendall *et al.*, 2012; Ellis *et al.*, 2012a WD).

It should also be recognized that studies such as above are typically based on data collected by scientists at sea, with skates handled with due care and immediately after capture. Hence, the normal practices on commercial vessels, in terms of how the catches are processed and fish handled could result in reduced survival in comparison to scientific studies.

18.3.5 Quality of catch data

Historical skate landings were reported at the family level, and there have been improvements to species-specific landings data in recent years, although the current time-series is quite limited. Observer programmes to examine the catch and discards on commercial vessels continue to provide important information and further analyses of these data are required for most Member States. The future use of discards data will need to be explored in conjunction with estimates of discard survival.

Commercial species-specific catch data are either limited or are sampled in insufficient numbers to be used for evaluating the stocks at the current time, although this situation is continually improving. Concerns over species-specific issues are outlined in Section 18.4.3.

18.3.6 Case study: estimating the discards of *Raja undulata* in the English Channel (VIId,e)

Discards of *R. undulata* based on French on-board observations were estimated by raising observed discards to the total French fishing fleet in VIId and VIIe in 2013. Observed discards were raised to the total effort, in fishing days, by quarter and DCF level five métiers in VIId and VIIe separately using the R Cost package (see Leblanc *et al.*, 2014 WD for details). The overall discards were summed up for VIId and VIIe. The accuracy of estimates was evaluated using coefficient of variation, CV, and it was considered reliable for towed gears in VIId and VIIe and for longlines in VIId. Larger CVs were obtained for fixed net métiers probably due to the problem of effort-raising. The total discards of netters was estimated as raising the discards in observed fishing trips of these métiers by the proportion of observed to total discards for towed gears (i.e. assuming that the sampling proportion is the same for netters and towed gears).

The preliminary estimates of discards of *R. undulata* by French vessels (by DCF level five métier, towed gears only) in VIIe in 2013 were 116.3 t (OTB_CEP), 738.6 t (OTB_DEF), 5.7 t (OTT_CEP) and 14.9 t (TBB_DEF), with a total of ca. 875 t for these gears. Estimated discards for this species by French vessels (by DCF level five métier, towed gears and longline only) in VIId in 2013 were 20.3 t (LLS_DEF), 4.9 t (OTB_CEP), 38.9 t (OTB_DEF) and 2.2 t (TBB_DEF), with a total of 66.4 t for these gears combined.

In VIIe, the observed discards in netters were 95.1% of observed discards in towed gears. In VIId, this proportion was 0.85%. Therefore total discards by netters were estimated at 833 t (VIIe) and 4 t (VIId). The total estimated discards in VIId,e by all métiers was 1778 t in 2013, with comparable values estimated for both 2011 and 2012 (Leblanc *et al.,* 2014 WD).

Assuming a commercial size of *R. undulata* of 50 cm total length (L_T), the fraction of the total discards that was >50 cm was estimated using the length distribution of discards in towed gears and a relationship between weight (W, kg) and L_T of $W = 0.00000415 * L_T$ ^3.12428 (sexes combined, Dorel, 1986). This resulted in an estimated 620 and 15 t for active gears in VIIe and VIId respectively. As nets and longlines are more selective, all catches were assumed >50 cm. The total estimated discards of marketable *R. undulata* (i.e. regulatory discards), in 2013 was estimated to 1500 t.

18.4 Commercial catch composition

18.4.1 Species composition

National species-specific landings data were available in 2013 for Belgium, France, Ireland and the UK (Table 18.3). While landings data were provided by species in 2014, landings from generic categories were not provided by all countries due to limitations in the 2014 data call. It is not appropriate to infer species proportions from these data. Therefore the discussion below refers to landings up to 2013.

Within the waters off NW Scotland (VIa), Scottish landings were the highest (185 t) with catches dominated by *R. clavata* (56%), *R. montagui* (14%) and *L. naevus* (11.9%). Irish landings (94 t) were mainly of *R. clavata* (72%) and *R. brachyura* (12.5%). French skate landings (85 t) were dominated by *R. clavata* (33%), *L. naevus* (27%) and *R. montagui* (19%), with smaller quantities of *L. circularis,* and *L. fullonica*. *D. oxyrinchus* catches had reduced from 14.4% of identified skates in 2012, to 8.6% in 2013. The reported landings of *D. oxyrinchus* in this area needs further study, as it is unclear as to whether such landings may be misidentified *D. batis*-complex. Indeed, recent studies have questioned the accuracy of landing data for large, long-snouted skates (Iglésias *et al.*, 2010).

Within the Irish Sea (VIIa), Belgian landings (370 t) were dominated by *R. brachyura* (41%), *R. clavata* (49%) and *L. naevus* (10%), and Irish landings (411 t) also indicated a large proportion of these three species (*R. brachyura: 77%*, *R. montagui:* 6%, *R. clavata*: 13%). English landings (213 t) were dominated more by *R. clavata* (89%), although *R. brachyura* (4%) was still an important species. In contrast, French landings (5.8 t) were dominated by *R. montagui* (85.5%), and so there may still be some confusion between *R. brachyura* and *R. montagui*.

Skate landings in the western English Channel were comprised mostly of *R. brachyura, R. clavata, R. montagui* and *L. naevus,* and this was evident in landings from France (960 t) and England (550 t). These species also dominated the landings in the Bristol Channel (VIIf), although *R. microocellata* was also an important component in UK landings and, to a lesser extent, French landings. The latter species was also thought to be an important component of Belgian landings, although they continue to report catches as *L. circularis* (both species are known by the common name 'sandy ray'). The relative proportion of *Raja* spp. typically decreases further offshore in

VIIg,h, with Belgium, Ireland, France and the UK all reporting *L. naevus* as the main species (ca. 80% of landings) in VIIh.

18.4.2 Size composition

Although length data were not examined this year, length frequencies for the more common species have been shown in earlier studies (ICES, 2007, 2011; Johnston and Clarke, 2011 WD; Silva *et al.*, 2012).

18.4.3 Quality of data

A datacall for elasmobranch landings was carried out by ICES for the first time in 2015, relating to 2014 landings data. Landings figures were requested for all the stocks to be advised on in 2015. However, landings data for other stocks and generic categories of elasmobranchs were therefore not supplied by some nations. Although all countries answered the data call, not all supplied the additional data used by WGEF. This led to some countries potentially supplying a proportion of their total elasmobranch landings. Hence, 2014 landings data presented here are preliminary and will be updated during a revised data call in 2016.

There is still some concern over some of the species identifications being reported. Although several national laboratories are undertaking market sampling, more critical analyses of these data are required to ensure that species identification issues are resolved (e.g. Silva *et al.*, 2012) and that the methods of raising the data are appropriate and can allow for seasonal, geographical and gear-related differences in the species composition of skate landings to be examined. While there are market sampling programmes in place in several countries, skates are sometimes treated as low-priority species, so may not be sampled as effectively as they might be.

There are concerns that as certain species are added to the prohibited species list, these may be declared in generic categories or as morphologically similar species, rather than be declared to species level. Further studies to better understand landings of *Dipturus* spp. are required by those nations landing such taxa.

Although the quality of other species-specific appears to be improving, there are issues regarding:

- Belgian landings of *L. circularis* in VIIa,f,g are thought to represent *R. microocellata*, and efforts should be made to ensure such data are reported accurately in future years;
- Data for *R. brachyura* and *R. montagui* may be confounded, and all nations could usefully make attempts to improve the data quality for these species;
- Scotland and France both report landings of *R. alba* (a prohibited species), although it is possible that these landings refer to *L. fullonica.* Efforts should be made to ensure such data for these species are checked and reported accurately in future years;
- UK, Ireland, France and Belgium all reported landings of *A. radiata* and the UK also reports *A. hyperborea* from this ecoregion. Although the quantities involved are small, they are thought to represent other skate species of code errors.

18.5 Commercial catch and effort data

18.5.1 Case study: commercial landing per unit of effort

Irish raw lpue trends in effort units of fishing days and fishing hours at several aggregation levels were examined by Davie (2014 WD). Two levels of species aggregation were examined, a general skate category for all species reported by Irish fishers to provide a longer trend in targeting practices. This grouping was also disaggregated into four species (*Raja brachyura*, *R. clavata, R. montagui* and *L. naevus*) for the years 2011–2013, as the reporting of individual species has become standard practice.

These were examined firstly broken down by gear types then by métier. The methodology and specific details of all identified métiers is given in Davie and Lordan (2011) for trawl gears and Davie (2013) for other gear types. A total of 58 Irish targeted métiers were defined from this process, of which six may have skates as one of the main target species.

Spatial lpue estimates of the four species were examined by gear type, métier and for seasonal variability (quarter). The former two coupled with spatial trends. Reported landings were linked to vessel monitoring system (VMS) data to generate fishing effort and position data as per Gerritsen and Lordan (2011).

The text below focuses on lpues in fishing days within Divisions VIIa, VIIf, and VIIg.

In general terms, overall skate landings declined between 2003 and 2009, after which landings increased to a stable, higher level due to increased otter trawl landings, until 2013 when landings declined (Figure 18.2). Fishing effort in these areas are high (particularly VIIa and VIIg) and dominated by otter trawl effort. Overall a slight decline has occurred since 2011 (Figure 18.3). In general a decline on lpue trend was occurred over the last eleven years (Figure 18.4). Between gears, beam trawls showed the greatest lpue (≥100 kg per fishing day), although dropping below this in 2013. All other gears result in lower LPUEs, of which demersal otter trawlers have overall been the greatest.

Breaking landings into their constituent target métiers, the greatest landings over the period originated from skate-targeting métiers, most noticeably small mesh (80–99 mm) beam trawling for plaice *Pleuronectes platessa,* common sole *Solea solea* and skates within the Irish and Celtic Seas, and small mesh (70–99 mm) otter trawlers targeting plaice and skates in the same general areas (Figure 18.5). Smaller landings occurred in many other métiers where skates are a bycatch, the most noticeable of these the small mesh (80–99 mm) beam trawl métier targeting megrim *Lepidorhombus* spp., anglerfish *Lophius* spp., witch *Glyptocephalus cynoglossus* and lemon sole *Microstomus kitt* in the Irish and Celtic Seas. In 2012–2013, the picture appears to be shifting with increasing landings from the large mesh (≥100 mm) plaice and skate targeting otter trawl métier within the Irish Sea.

In relation to lpues the picture shifts quite dramatically by métier compared to gear based lpues. Removing the effort associated with the *Nephrops* otter trawl fisheries and focusing on métiers indicated a greater lpues being achieved by demersal trawl than beam trawl (Figure 18.6). By-métier lpues are much higher than the general gear categories. Values of over 1 t per day are achieved for the métier targeting both plaice and skates with larger mesh otter trawls in the Irish Sea.

Differences in lpue and trend were identified between the same fishing gear using large mesh and smaller mesh targeting the same two primary species. The large mesh Irish Sea plaice and skate métier shows a fluctuating increasing trend while the small mesh plaice and skate métier operating across a wider area has shown a more variable tend with sharp declines in the last two years. In comparison, lpues from small mesh beam trawling for skates, plaice and common sole within the Irish and Celtic Seas, although much lower, have remained more consistent over time, with a slight increasing trend. Such differences between trends highlight the importance of accounting for differing targeting behaviour of fishers. Individual species data were limited to the last three years.

Raja brachyura has, by far, the greatest lpue values of the four species, with each of the remaining species achieving less than 12 kg per fishing day for any one gear in the last two years (Figure 18.7). As with combined skate species, beam trawling has the greatest lpue values for all except *R. clavata*. For these, in the last year otter trawler (and demersal seine) lpues increase to above those of beam trawls. Breaking this down by targeting métiers, *R. brachyura* and *R. montagui* achieve the greatest lpues in large mesh Irish Sea focused plaice and skate otter trawling (Figure 18.8), followed by small mesh beam trawling for skate, plaice and sole in the Irish and Celtic Seas, and small mesh plaice and skate métier operating across a wider area. Lpues for *R. brachyura* appear to be stable or in slight decline (the last of the three métiers has declined) whilst *R. montagui* lpues have dropped. The greatest lpues for *L. naevus* were achieved by the small mesh beam trawling for skates, plaice and sole métier up until 2013, when levels dropped dramatically. While for *R. clavata*, higher lpues were obtained by the small mesh plaice and skate métier. Lpues for this species appear to be increasing. The varying importance of métiers and their differing trends highlights the importance of considering species separately. A combined group masks individual species targeting behaviours and lpue trends within métiers.

VMS based distribution maps of landings from 2011–2013 are given in Figures 18.9–18.16, where the first four are for beam trawls, the remainder are otter trawls. Within the areas of the Irish and Celtic Seas fished by the Irish beam trawl fleet, differences were observed in spatial distribution. Each of the four species has noticeable lpues within the *Nephrops* fishing grounds of the Irish Sea. *Raja brachyura* shows dominant lpues from this area and lower levels in several other isolated areas of VIIa. Lpues from the Celtic Sea are low. *R. montagui* had a similar, albeit more patchy lpue distribution. There was also a patch of higher lpue off the Welsh coast. At this patch *R. clavata* had also a high lpue and also in a patch close to the southeast Irish coast. In contrast, *L. naevus* had a patch of high lpue to the southwest of Ireland.

Otter trawl activity was far more diverse, covering a far greater range of fishing grounds. From this, a patch of *Raja clavata* high lpues was observed off the southeast coast of Ireland, in addition to areas in VIa and small coastal hot spots around the west of Ireland. Although there was a wide distribution of low levels of lpue of *R. brachyura*, there was a distinctive patch of high lpues within the Irish Sea in and around the *Nephrops* fishing grounds. There was also a small patch between the tip of southeast Ireland and southern tip of Wales. *Raja montagui* had the same high lpue value distribution within the Irish Sea, although there were also some other small areas of high lpue. *Leucoraja naevus* had high lpues further offshore within the area of VIIh,j in what appeared to be strips of fishing activity. In addition to this, there were patches to the west of Ireland resulting in higher lpues including an area between the Aran fishing grounds and the continental slope.

Using these maps, areas of species dominance could be identified, such as otter trawling in ICES rectangle 33E3 where *R. clavata* is the dominant skate landed. Making the assumption that *R. clavata* has consistently been the dominant skate species within this rectangle, landings and lpues could be reconstructed back in time. Taking the average (2011–2013) contribution of *R. clavata* to the species identified otter trawl landings from this rectangle and applying this to the total skate landings from the rectangles generated a *R. clavata* landings trend and subsequently lpue trend (Figure 18.17). The generated trend shows reduced landings and effort for this rectangle since 2007 although lpue remained high. Lpue dropped to lowest assumed levels of the eleven year period in 2012 and 2013.

Quarterly gear based lpue maps for each species are given in Figures 18.18–18.25, this time the beam and otter trawl figures are grouped for each species rather than by gear type. The maps combine the data for the period 2011–2013 to reduce annual variability of any seasonal distribution and maintain sufficient data for confidentiality. From these maps, no particular pattern in seasonal variability was apparent for *R. brachyura* or *R. montagui*. *Leucoraja naevus* and *R. clavata* showed some distinction between summer and winter. The lpue of *L. naevus* were greater between the Aran and slope fishing grounds during the first and last quarter, and higher values from beam trawling in the Irish Sea during quarter 2. *Raja clavata* had greater lpues during quarters 1 and 4 within the more inshore waters of the southeast Irish coast, in contrast to lower otter trawl lpues in VIa during the first quarter.

18.5.2 Recreational cpue

Data supplied by the Inshore Fisheries Ireland (Wögerbauer *et al.*, 2014 WD*)* shows that tag and recapture rates of *R. undulata* in Tralee Bay (VIIj) has significantly declined since the 1970s. Although these data do not allow for potential changes in effort, it suggests that this stock is overexploited (Figure 18.26).

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 (Figure 18.27). 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 demersal elasmobranchs for many parts of the ecoregion.

The manual for the SWIBTS was revised in 2010 to provide updated information on the various surveys and is also being updated this year. Definitions and measurements of the various groundgear and nets used in these surveys, and referred to in the sections below, can be found in these survey manuals.

Updated catch rate analyses for four surveys (French EVHOE Groundfish Survey EVHOE-WIBTS-Q4, Irish groundfish survey IGFS-WIBTS-Q4, Spanish Porcupine Groundfish Survey SpPGFS-WIBTS-Q4 and the UK (England) beam trawl survey Eng-WEC–BTS-Q1) were provided in 2014 (Figures 18.28–18.33), with other surveys providing supporting information (Figures 18.34–18.36). Individual stock sheets, providing the state of each stock based on survey trends in length and abundance were provided in ICES (2013b, Supplementary Material).

18.6.1 Southern and Western International Bottom Trawl Surveys

UK (Scotland), UK (Northern Ireland), Ireland, France and Spain undertake trawl surveys in the Celtic Seas ecoregion, as part of the internationally coordinated IBTS surveys for southern and western waters (Figure 18.27), with UK (England) a former participant. Although the trawl gears used in these surveys are not standardized (Table 18.4a), individual surveys can provide survey-specific indices. Most surveys are in Q4, with some nations also conducting surveys in Q1.

.6.1.1 French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4)

The French EVHOE survey has been carried out in Bay of Biscay since 1987 and in the Celtic Sea since 1995, when it came under the auspices of the IBTS. Mahé and Poulard (2005) undertook preliminary data analyses, and reported that 26 species of elasmobranch had been recorded in the Bay of Biscay and 19 species in the Celtic Sea.

This survey was used to provide information for 1997–2012 on the following species: *L. naevus, L. fullonica, R. montagui, R. clavata, L. circularis, R. brachyura* and *R. microocellata* in the Celtic Sea (Figure 18.28 a–g).

.6.1.2 Irish Groundfish Survey (IGFS-WIBTS-Q4)

The Irish Groundfish Survey has taken place since 2003. The survey has a random stratified design, with four depth strata. Approximately 185 stations are trawled annually around the Irish coast, with the exception of the Irish Sea, which is covered by Northern Ireland surveys. Fifteen skate species have been reported from this survey, as well as four species of dogfish and occasional pelagic and deep-water sharks. Analyses of these data were presented in earlier reports (see ICES, 2010, 2012) and this survey provides abundance indices for ICES Areas VIa and VIIafg, for the following species: *R. clavata, R. montagui* and *L. naevus* (Figure 18.29 a–f).

.6.1.3 Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4)

The annual Spanish Porcupine bottom trawl survey, which started in 2001, collects data on the distribution and relative abundance, and biological information of commercial fish in the Porcupine Bank Area (ICES Divisions VIIb,k). The target species for this survey are hake, anglerfish, white anglerfish, megrim, four-spot megrim, *Nephrops* and blue whiting. The survey follows a random stratified design with two geographical strata (northern and southern) and three depth strata (170–300 m, 301–450 m, 451–800 m). Stations are randomly allocated within each stratum. The gear used is a Porcupine baca 39/52 with 3 m vertical opening, 23 m wing spread and 134 m door spread, hauls last 30 minutes.

This survey provides information for *L. naevus, L. circularis* and *D. batis* complex (Figures 18.30–18.32; Fernández-Zapico *et al.*, 2013 WD; Ruiz-Pico *et al.*, 2014 WD). *Leucoraja circularis* occurrs in deeper waters around the Porcupine Bank (Figure 18.30), while *L. naevus* (Figure 18.31) occurs mainly on the shallower grounds close to the Irish shelf and on the central mound in the bank.

.6.1.4 UK (England and Wales) Western Groundfish Survey (EngW-WIBTS-Q4)

The UK (England and Wales) survey used a modified GOV trawl with standard groundgear 'A' on fine grounds, and groundgear 'D' on coarser grounds (2004–2011). Preliminary data analyses were presented at a previous meeting (ICES, 2010) and biological data from this survey were used to inform on the length-at-maturity for several skate species (McCully *et al.*, 2012).

This survey was discontinued in 2012, although in 2013 there was a trial to move this survey to Q1.

.6.1.5 UK (Northern Ireland) Groundfish Survey – October (NIGFS-WIBTS-Q4)

UK (Northern Ireland) has undertaken annual Q4 (and Q1, see below) trawl survey of the Irish Sea since 1992. The gear deployed is a commercial rock-hopper trawl fitted with a 20 mm liner in the codend and is towed for a set time period, (either 20 minutes or one hour) to allow comparison between tows and years. The Agri-Food and Biosciences Institute AFBI (NI) in Northern Ireland previously analysed available survey data from the northern VIIa (N) region (see NIEA, 2008; ICES, 2010).

The absence of participation from UK (Northern Ireland) precluded further analyses of these survey data in recent years.

.6.1.6 UK (Northern Ireland) Groundfish Survey – March (NIGFS-WIBTS-Q1)

UK (Northern Ireland) also undertake Q1 groundfish surveys in the Irish Sea (see above for further information).

.6.1.7 Scottish West Coast Groundfish Survey Q4 (ScoGFS-WIBTS-Q4)

The Scottish Quarter 4 west coast groundfish survey, began in 1990, covers a depth range of 20–500 m. The survey originally covered an area west of the British Isles, from 56–61°N and bounded by the 200 m depth-contour and the coast. Initially the survey area did not include the area of the Minch and the North Channel of the Irish Sea but gradually the spatial coverage has been altered until now it mimics the Quarter 1 survey.

The survey uses a GOV, which originally used groundgear 'C', now uses a variant of groundgear 'D'. A change of research vessel took place in 1998, and haul duration was reduced from 60 to 30 minutes at this time.

No updated analyses of these data were undertaken in recent years (1990–2009), although information was given in ICES (2010; Figure 18.36).

.6.1.8 Scottish West Coast Groundfish Survey Q1 (ScoGFS-WIBTS-Q1)

The UK (Scotland) Q1 west coast survey covers a similar area to the Q4 survey. No updated analyses of these data have been undertaken in recent years (1990–2009), although information was provided during previous meetings (ICES, 2010; Figure 18.36).

.6.1.9 Rockall survey (Rock-IBTS-Q3)

A Q3 survey of the Rockall Bank has also been conducted since 1991. During the period 1998–2004 this survey was conducted only in alternate years, with a deep-water survey along the shelf edge in VIa carried out in the intervening years. Since 2005, both surveys have been carried out annually.

The survey at Rockall has very low catch rates for all elasmobranchs. The most commonly caught demersal skates in this survey are *R. clavata,* and *D. batis*-complex, but the catch rates of even these are typically less than ten individuals per survey. The survey is therefore only useful as an indicator of whether a species is present in this part of Division VIb. Other demersal elasmobranchs which have caught occasionally in this survey include *L. circularis, L. fullonica, R. montagui, D. oxyrinchus* and *Rajella fyllae*. There are limited survey data for skates from the deeper water of Division VIb.

18.6.2 Beam trawl surveys

Three beam trawl surveys operate (or have operated) in this ecoregion (Table 18.4b), surveying the Irish Sea, Bristol Channel and western English Channel.

.6.2.1 UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3)

An annual survey with a 4 m beam trawl is undertaken in the Irish Sea and Bristol Channel each September (Parker-Humphreys, 2004a,b; Ellis *et al.*, 2005). The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in coastal water. Preliminary studies of survey data indicate that the gear used may not sample larger skates effectively, although this gear should be suitable for sampling smaller skate species (e.g. *R. montagui* and *L. naevus*) and juveniles and subadults of the larger species.

R. brachyura, R. clavata, R. microocellata (VIIf), *R. montagui* and *L. naevus* (VIIa) are all sampled during this survey and are used to provide abundance indices. Biological data from this survey have been used to examine the length-at-maturity for several skate species (McCully *et al.*, 2012).

Catch rates (ind.h^{-1}) are summarized (see Figure 18.33a–e), with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least 18 times during the 21 year time-series (1993–2013).

.6.2.2 UK (England) beam trawl in Start Bay, VIIe (Eng-WEC-BTS-Q4)

A beam trawl survey of a fixed station grid in and around the Great West Bay (between Start Point and Portland) during October (1989–2010), using 4 m beam trawl. It was usually undertaken on the commercial vessel FV *Carhelmar* (with twin beam trawls) although it was undertaken by RV *Corsytes* (single beam trawl) in occasional years. Detailed analyses of the demersal elasmobranchs taken in this survey were undertaken (Burt *et al.*, 2013) and summary data provided here (Figure 18.34). This survey is now discontinued, but it is considered that it provided adequate sampling of *R. brachyura, R. clavata* and *R. montagui*.

.6.2.3 UK (England) beam trawl in western English Channel (Eng-WEC-BTS-Q1)

A beam trawl survey (using twin 4 m beam trawls) is undertaken in the western English Channel during March. This survey has a random-stratified survey design. Information from this survey was used to examine the distribution of *R. undulata* (ICES, 2010; Ellis *et al.*, 2012b). Detailed analyses of the distribution and length ranges of demersal elasmobranchs taken in this survey (*L. naevus, R. brachyura, R. clavata, R. montagui* and *R. undulata*) were provided by Silva *et al.* (2014 WD), and provided here (Figures 18.35a–f).

18.6.3 Other sources of survey data

.6.3.1 UK Portuguese high headline trawl 1Q (PHHT-Q1)

This Q1 survey with Portuguese high headline trawl (PHHT) was undertaken in the Celtic Sea (ICES Division VIIe–j) from 1982–2003, although the survey grid was better standardized from 1987–2002. These data have been examined in previous years, and provide a useful perspective of the species present in the area at that time. For example, it provides additional information on the earlier distributions of *D. batis* complex and *L. fullonica*.

.6.3.2 Additional Irish surveys

An annual survey to collect maturity data for commercially important demersal fish, mainly whitefish and skates, took place during the spring spawning season (2004–2009). Different areas were surveyed each year, so annual trends cannot be derived. An annual deep-water trawl survey to the west of Ireland (2006–2009) over the depth range 500–1800 m. This may provide limited data for certain skate species.

18.6.4 Temporal trends in catch rates

Given the very recent introduction of species-specific landings and discard observer programmes, the status of demersal elasmobranchs of this ecoregion is 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 2014 under the ICES approach to data-limited stocks (Section 18.9).

18.6.5 Quality of data

.6.5.1 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 confused, and the identification of neonatal specimens of *R. clavata*, *R. brachyura* and *R. montagui* can also be problematic.

Many recent surveys in the ecoregion have attempted to ensure that data collected for the common skate complex be differentiated, and whereas national delegates have confirmed which species have been caught, survey data can only be uploaded to DATRAS for the complex, as the two species do not have valid taxonomic codes as yet. Work to clarify the taxonomic problems was discussed intersessionally and will hopefully be resolved by the IUZN soon.

.6.5.2 Gear performance

There are several scientific trawl surveys in the ecoregion using different types of trawl gears. Beam trawl surveys operate in VIIa,e,f, and this gear would appear to be a suitable sampling tool for lesser-spotted dogfish, juvenile smooth-hounds and smaller skates. However, this gear may not be appropriate to informing on larger skates.

The western IBTS surveys use a variety of trawl gears deemed appropriate to the grounds on which they fish, and so include trawls with rock-hopper discs or bobbins, as well as standard groundgears on fine ground. There is insufficient knowledge of the catchability of demersal elasmobranchs in these various gears.

.6.5.3 Degree of survey effort in relation to localized populations

Several demersal elasmobranch species that occur sporadically throughout much of the Celtic Seas ecoregion have certain sites where they are locally abundant. Localized depletions of the species at these sites could therefore have a major impact on the population as a whole. Hence, the status of such species may need to be monitored and assessed on a more localized scale.

In the case of *Raja microocellata*, which is locally abundant in the Bristol Channel (VIIf), there are many sampling stations in this area from the UK (England and Wales) beam trawl survey, and so WGEF should be able to monitor and evaluate their status.

However, some other species have more discrete areas in which they are abundant, and as such existing survey data may be limited. This is especially noteworthy for some of the more coastal species. More detailed studies of existing data are required to better inform on the status of:

- *Raja undulata* in Tralee Bay and southwest Ireland (VIIb,j; Figure 18.37) and the middle of the English Channel (VIId,e; Figures 18.38–18.40);
- *Raja brachyura* in areas of high abundance.

In some instances, it may be that available survey data will not be appropriate to evaluate some of these species, and dedicated inshore surveys using an appropriate gear and census method may be required if these stocks are to be better evaluated.

18.7 Life-history information

Various published biological studies provide maturity and age data for skates in the Celtic Seas (e.g. Fahy, 1989; Gallagher, 2000; Gallagher *et al.*, 2005; McCully *et al.*, 2012).

18.7.1 Ecologically important habitats

Ecologically important habitats for the demersal elasmobranchs would include (a) any oviposition (egg-laying) sites for oviparous species; (b) pupping grounds for viviparous species; (c) nursery grounds; (d) habitats of the rarer species, as well as other sites where there can be large aggregations (e.g. for mating or feeding).

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 rarer elasmobranch species, and further investigations on these are required. Wearmouth and Sims (2009) undertook a tagging study of *Dipturus batis*, and tagging studies have recently been undertaken for this complex in the Celtic Sea (Bendall *et al.*, 2012).

Juveniles of many species are found in most groundfish surveys and in discards, although usually in small numbers. Annual beam trawl surveys in September catch recently hatched *R. clavata* (ca. 10 cm L_T). Although catches of 0-groups tend to be low and may not be accurate indicators of recruitment, a more critical examination of these data could usefully be undertaken. However, for areas where elasmobranch catches are low, such as skates in VIIj, it will not be possible to estimate recruitment without dedicated surveys.

18.7.2 Case study: identification of potential nursery and possible spawning grounds

All countries funded under the EU Data Collection Framework collect at-sea observations on catch and discard levels of fish caught on commercial surveys. These observer programmes routinely collect species and length data from commercial and non-commercial species. Sex data may also be collected for certain species. A 2014 study (Johnston *et al.*, 2014 WD) looked at these data for selected skate species collected by Irish, UK and French observer programmes.

National programmes supplied data in different formats, so these were pooled into a common Excel spreadsheet, recording species, sex, length, number-at-length, and the latitude and longitude of the haul. Maps were created using ArcMap 10.2.

Maps were made of nominal nursery grounds and the locations of adult females during Q2. The latter was a proxy for spawning grounds, as direct measurements of maturity stage (i.e. of females with egg-cases exuding) are not made during DCF-funded observer programmes. Each of the grounds was made by mapping fish at appropriate size thresholds. There was no distinction made between landed and discarded fish and the size thresholds were:

Nominal nursery grounds: as a function of length-at-birth to length-at-birth + 15 cm.

Adult spawners: Females, greater than length at first maturity caught during Q2.

Biological references were taken from the following sources:

Species	Length- at- birth (cm)	Length at first maturity (cm)	Source
Dipturus spp.	20	115	McCully *et al.*, 2012
Leucoraja fullonica	21	75	McCully *et al.*, 2012
Leucoraja naevus	10	51	ICES, 2004
Raja brachyura	13	60	McCully *et al.*, 2012
Raja clavata	11.8	60	Ryland and Ajayi, 1984
Raja microocellata	14	57.5	Ryland and Ajayi, 1984
Raja montagui	12	57.3	Ryland and Ajayi, 1984
Raja undulata	-	70	Coelho and Erzini, 2002

Locations of finds of egg-cases of certain skate species along the Irish coastline were made available (Sarah Varian, pers. comm. 2013). These are illustrated where appropriate (Figures 18.41a–h).

Initial examination of these maps shows certain areas of local abundance for most species. Perhaps of more importance, gaps are shown in the distribution (e.g. *L. naevus* between catches in VI and VII), which may be useful for future refinements of stock identity. The overlap of potential protected areas to protect juvenile or spawning females with existing marine protected areas is illustrated in Figure 18.42.

18.8 Exploratory assessment models

18.8.1 Case study: The utility of catchability corrected survey biomass

Exploratory assessments of skate abundance, primarily in the Irish Sea (VIIa) are provided below, based on the work of Shephard *et al.* (2014 WD).

.8.1.1 Catchability corrected survey biomass

Species catchabilities from Fraser *et al.* (2007) were used to derive skate population biomass estimates from survey data, and combine these with discard and landings records to yield empirical estimates of Harvest Rate (HR). Survey-based HR estimates for each species were compared to values derived by fitting catch curves to fish length frequencies in the survey data and from an Irish discard observer scheme in the Irish Sea (ICES VIIa). Differences in the life histories of fish means that sustainable levels of fishing mortality (as HR) vary considerably among demersal fish species, and are likely to be low for most skates relative to teleosts. It is useful to be able to compare HR with appropriate reference levels for 'sustainable' mortality. Three precautionary HR reference points for each tested species, based on established approaches, and compare these estimated reference levels with observed annual HR values.

Three fisheries-independent surveys were analysed: the Irish Groundfish Survey (IGFS-WIBTS-Q4) in ICES VIIg, the Northern Ireland Groundfish Survey (NIGFS-WIBTS-Q4) in VIIa, and UK Beam Trawl Survey (Eng-WEC–BTS-Q1) in VIIa. Four species were considered: *Raja montagui*, *R. clavata*, *R. brachyura* and *Leucoraja naevus*.

i) Using survey data (2011–2012), catch numbers-at-length were converted to weight-(W) at-length using weight-at-length relationships ($W=\alpha L^{\beta}$), where the parameters α and β were obtained from the North Sea Q1 IBTS.

ii) Catch weights (kg) at length (cm) of each species in each trawl sample were raised from trawl swept-area (trawl wingspread multiplied by distance trawled, m) to 1 km^2, to derive a first estimate of density ($kg.km^{-2}$) at length for each unique haul.

iii) For the otter trawl surveys (IGFS and NIGFS), size (length)-based raising factors from Fraser *et al.* (2007) were applied to haul density estimates for 'small' (< length at maximum abundance in species length–frequency distribution) fish of each species to account for q in the survey GOV trawl. For each species in the GOV, we used q = 1 for 'large' fish. For the beam trawl survey (UK BTS), we used q = 1 for small fish and q = 0.75 for large fish by species.

iv) For each species in each year, catchability-corrected density-at-length was summed across all length groups by haul to produce individual haul estimates of species density ($kg\ km^{-2}$) by ICES rectangle.

v) For each species in each year, the mean of haul density estimates was calculated for each ICES rectangle. This produced a mean annual estimate of species density ($kg\ km^{-2}$) by rectangle. For each rectangle, mean annual species density estimates ($kg\ km^{-2}$) were then multiplied by the sea area of given rectangles (km^2) to produce an estimate of total biomass by rectangle (kg). These biomass estimates were summed across all study rectangles for each year to produce estimates of total biomass (TSB) for each species in the study area.

vi) Shephard *et al.* (2014 WD and *in press*) use a stratified re-sampling approach to account for uncertainty in survey catch and this is strongly recommended. Due to time constraints, we do not include uncertainty in the current analysis for Celtic Sea skates.

.8.1.2 Harvesting Rate HR

Catch data: Discard data for VIIa and VIIg came from an Irish observer programme that serves the Data Collection Regulation (EC No. 1639/2001). Fishing trips are sampled at a rate proportional to métier activity, with sampling coverage of the Irish fleet being approximately 1% during the study period. Sampling trips are selected randomly, and so the distribution of fishing activity sampled is considered representative of the population as a whole (Marine Institute, unpublished). Discard data were extracted by species, gear, quarter and year. If a sampled fishing trip included hauls outside study rectangles, then the proportion of the fishing effort inside the area was used. Discard weight was raised to Irish fleet level by dividing it by the proportion of total Irish effort covered by discard sampling. Discard records were raised by gear according to the proportion (range = 51–58% in the study period) of annual international effort by mobile gears (kilowatt hours = vessel engine power multiplied by time) in the study area recorded by Irish vessels (STECF, 2013). For years where effort for a given nation was not reported to STECF, the mean annual value for that nation was applied. Skate landings by nation for VIIa and VIIg were taken from the 2013 WGEF report (ICES, 2013b); data for each species was summed by year for each region.

HR calculation: For each species, annual (2011–2012) HR for the study area was then estimated, equal to:

$$HR_y = \frac{C_y}{C_y + B_y^{sur}}$$

where C_y is the total catch (landings and discards) and B_y^{sur} is the catchability-corrected survey-based estimate of total biomass.

.8.1.3 Validation using catch curves

The survey method used here was validated previously by comparing output estimates of TSB and HR for cod and whiting in a standard area (ICES VIIg) with independent estimates from analytical (age-structured) assessments for 'Celtic Sea cod' and 'whiting in Divisions VIIe–k' (Shephard *et al.*, in press). Estimates of HR for cod and whiting compared closely between age-structured and survey-based assessments. For the current analysis, we compared our survey-based estimates of HR to HR-converted F derived from catch curves. Catch curves for each of the two survey areas were derived from length–frequency data from the IGFS, the NIGFS and the IGFS and NIGFS combined, and from the Irish discard observer programme in VIIa.

.8.1.4 Precautionary reference levels

To gain some insight into the likely ecological significance of observed *HR* for non-target species, estimates for each species were compared to three sets of candidate reference levels: (i) from a meta-analysis of 245 fish species, Zhou *et al.* (2012) suggested that F_{MSY} could be estimated as 0.41 *M* for chondrichthyans, (M values for these elasmobranchs are provided in Table 18.5) (ii) for many of the demersal species in the Celtic Sea, Le Quesne and Jennings (2012) provided estimates of F_{40} (the *F* that reduces SSB-per-recruit to 40% of that in the absence of fishing). We used F_{40} estimates from Le Quesne and Jennings (2012, their Table S1) to derive a list of HR_{40} estimates. Finally, (iii) we used HR-converted F reference points for each species derived from the Gislasim method. For the current analysis, we average across these three reference points to derive a single precautionary HR reference point for each of the four case study species.

.8.1.5 Survey-based biomass and HR

Biomass and HR varied among species and among survey series, with greater biomass for *R. montagui* and *R. clavata*. *Raja brachyura* recorded some larger values of HR, while *L. naevus* tended to have lowest biomass and consistently high HR (Table 18.6).

.8.1.6 Catch curve HR

The quality of length–frequency data varied among surveys and species, with insufficient data for curve fitting in some cases (Figures 18.43–18.44). Catch curve estimates of HR were similar to survey-based estimates for *R. clavata*, but consistently higher than survey estimates for the other three species. Catch curve estimates of HR were also more consistent among dataseries than for the survey method. As with survey estimates, the greatest HR values were recorded for *L. naevus* (Table 18.7).

.8.1.7 Precautionary reference levels

The three approaches produced considerable differences in HR reference points (Table 18.7). Applying the mean HR reference point to survey-based HR estimates suggested that *R. montagui* and *R. clavata* may be exploited within sustainable limits, while *L. naevus* and *R. brachyura* are likely to be overexploited (Figure 18.45). HR estimates from catch curves were typically greater than survey-based estimates, but maintained the general suggestion that *R. montagui* and *R. clavata* stocks were in a better state for than *L. naevus* and *R. brachyura* (Figure 18.45).

.8.1.8 Discussion

Shephard *et al.* (in press) presented a survey-based approach for assessment of surveyed but data-poor fish species, and a simplified version of this approach was used here to estimate biomass and HR for four skate species in the Celtic Seas. These exploratory analyses indicated that *R. montagui* and *R. clavata* stocks may be exploited close to precautionary limits, but that *L. naevus* and *R. brachyura* may be overexploited. These results are broadly consistent with survey trends that suggest recent recovery in abundance of *R. clavata* and *R. montagui* (ICES 2013b). With further development, survey-based assessments may be able to help set precautionary targets, as well as evaluating status.

However, members of WGEF noted some important elements that should be further developed in the survey-based assessment approach:

Catchability coefficients: An improved definition of catchability coefficients *q* for skates in the different survey gears should be considered. Fraser *et al.* (2007) offered a valid starting point, but expert knowledge can be applied to account for e.g. declining catch rates of larger individuals in beam trawl gear.

Natural mortality and seasonal fishing pressure: The current calculation of a survey-based HR given in Shephard *et al.* (2014 WD, and *in press*) uses the following:

$$HR_y = \frac{C_y}{C_y + B_y^{sur}} \tag{1}$$

where C_y is the total catch (landings and discards) and B_y^{sur} is a survey-based estimate of total biomass. The denominator in equation 1 serves to “back-calculate” the biomass to the beginning of year *y*, accounting for mortality due to fishing. However, there are two problems with this: (a) natural mortality is ignored, which would positively bias HR_y, and (b) the total annual catch appears in the denominator instead of just that proportion taken prior to the survey, which would negatively bias HR_y.

If the survey is held late in the year (when most of the catch has taken place) the overall effect could be that HR_y is positively biased.

The following adjustments could address these problems:

$$HR_y = \frac{C_y}{\rho C_y e^{(\alpha+0.5\delta)M} + B_y^{sur} e^{\lambda M}} \qquad 2$$

where

$$\delta = \max\{\min(\lambda - \alpha ; \beta - \alpha) ; 0\} \qquad 3$$

and the additional parameters are as follows:

ρ the proportion of the catch taken prior to the start of the survey, which can, if appropriate, be calculated as:

$$\rho = \delta / (\beta - \alpha) \qquad 4$$

[note that if no catch is taken prior to the start of the survey and equation 4 is not used, ρ has to be set to zero];

α	the time the fishing season starts, expressed as a proportion of the year;
β	the time the fishing season ends, expressed as a proportion of the year;
λ	the time the survey starts, expressed as a proportion of the year; and
M	annual natural mortality.

Note that, typically, $\alpha = 0$ and, $\beta = 1$, so that equations 2 and 3 simplify to:

$$HR_y = \frac{C_y}{\rho C_y e^{0.5\lambda M} + B_y^{sur} e^{\lambda M}} \qquad 5$$

and if in addition equation 4 is used (if appropriate), equation 5 reduces further to:

$$HR_y = \frac{C_y}{\lambda C_y e^{0.5\lambda M} + B_y^{sur} e^{\lambda M}} \qquad 6$$

so that the only two additional parameters needed are λ and M compared to equation 1.

Spatial stratification of survey biomass estimates: Skates in the Celtic Seas show strong heterogeneity in their spatial distribution (Shephard *et al.*, 2012). Shephard *et al.* (2014 WD and *in press*) currently stratify survey data by ICES rectangle, but data-driven stratification would probably better capture distribution. For future work, WGEF suggest that survey haul stations could be allocated to categories of abundance based on historical catch. Biomass density (kg km^{-2}) can then be raised for these categories where the number of hauls in each category as a proportion of the total number of hauls in a given survey year is assumed to correspond to the proportion of the total survey area sampled by those hauls.

Catch curves: Shephard *et al.* (2014 WD and *in press*) validated their approach by comparing survey-based estimates of TSB and HR for cod and whiting with estimates from analytical (age-structured) stock assessments from the same area. In the current analysis, catch curves were used to produce an independent (the underlying data are the same, but the methods are independent) HR estimate for each Celtic Seas skate stock (Table 18.7). Catch curves are a widely accepted assessment method, but carry considerable assumptions. A key issue is subjectivity in selecting the range of length data to which to fit the curve. In theory, the curve should be fitted to the declining 'limb' of the length distribution (Figure 18.44), which is assumed to comprise length classes that are fully selected by the fishing gear, but identifying this 'limb' does not follow an objective rule.

Precautionary reference levels: Three alternative HR reference points were presented (Table 18.8). Each reference point was derived using a different method, and each makes assumptions about life history and how this constrains susceptibility to fishing pressure. Further work is required to identify and justify optimal HR reference points for each species. Reference points as calculated for each species by area and survey are presented in Table 18.9.

WGEF uses survey cpue time-series to describe trends in relative abundance of several skate species. Survey trends enable an evaluation of whether population state is likely to be declining, stable or improving relative to recent values. The new survey-based approach considered above has potential to provide a context for survey trends, by quantifying biomass and exploitation status with reference to MSY reference points. With further development of the method (see above), this would represent a significant step forward in the assessment of skate species.

18.8.2 Productivity–Susceptibility Analysis

A preliminary PSA of elasmobranchs in the Celtic Seas ecoregion was run in 2013 (McCully *et al*., 2013; McCully Phillips *et al*., 2015). Results of vulnerability scores and rankings within both fisheries of the Celtic Seas demersal elasmobranch stock were presented at WGEF 2013. Post-plenary discussion within the group, refinements to the expert scores and the methodology for accounting for confidence will be advanced further before the results are analysed with a view to aiding future assessment and advice. However, in general, the demersal skates falling under the 'skates and rays' quota seemed to group at a more productive and more susceptible level than those demersal elasmobranchs such as *Dipturus-batis* complex, *Rostroraja alba, Squatina squatina* and *Squalus acanthias*, which all currently have a zero TAC/prohibited status.

There was agreement within WGEF that, given the large amount of potential applications and value of PSAs to the group, this should be developed collaboratively and importantly, in association with industry. Their involvement would be key, especially in discussions around potential regional management or technical measures.

18.8.3 Previous assessments

Preliminary assessments of the Celtic Sea stock of *L. naevus* were made during the DELASS project, using GLM analyses of commercial cpue and EVHOE survey data, a surplus production model and catch curve analysis. The results of these exploratory assessments did not give consistent results. *Leucoraja naevus* had demonstrated signs of an increase in number, followed by a decrease in the 1990s (Heessen, 2003). Longer term cpue data and a better knowledge of the stock are required.

A GAM models were adjusted to Scottish Groundfish data for *R. clavata, L. naevus, R. montagui and S. canicula* in Divisions VIa, VIb and UK (English and Welsh) beam trawl survey for these species in VIIa/f was carried out by WGEF in 2007. More detailed information on the results and a description of the methods used were given in ICES (2007), with summary plots also included in ICES (2010).

18.9 Stock assessment

ICES provided stock-specific advice in 2014. The advice for 2015 and 2016 is outlined below. Most stocks belong to Category 3 of the ICES approach to data-limited stocks. Advice is generally therefore based on survey indices.

18.9.1 Blonde ray *Raja brachyura* in Subarea VI

Raja brachyura has a patchy distribution in Subarea VI. It is not encountered in sufficient numbers in surveys to derive trends in abundance/biomass. The stock likely extends to the northwestern North Sea (IVc) and may also continue along the west coast of Ireland.

18.9.2 Blonde ray *Raja brachyura* in Divisions VIIa, 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 but are now at their highest level in the last decade of >1 ind/hr (Figure 18.33a). However, this survey does not cover the whole stock area.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 897 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.3 Blonde ray *Raja brachyura* in Division VIIe

Raja brachyura has a patchy distribution in the western English Channel, and can be locally abundant on particular grounds, with the Channel Islands, Normano-Breton Gulf and Lyme Bay serving as important sites (Figure 18.35 c). The length–frequency distribution 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.

Mean catch rates in a previous beam trawl survey in Great West Bay (Burt *et al.*, 2013) were low as they were caught in a relatively low proportion of tows (Figure 18.34). This may be due to *R. brachyura* favouring particular grounds, for example they are commonly encountered around sandbanks in the area.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 310 t in 2015 and 2016. Discards are known to take place but have not been quantified and there is some discard survival.

18.9.4 Thornback ray *Raja clavata* in Subarea VI

The Irish Groundfish survey shows a steady increasing trend in catches of *R. clavata* in VIa (Figure 18.29a), with ~2 individuals per hour in 2013.

Earlier analyses of the Scottish surveys of VIa suggested stable/increasing catch trends (1985–2010; Figure 18.36b) although updated analyses were not available.

Based on the ICES approach to data-limited stocks, ICES advised that landings could be increased by a maximum of 20%. Based on best estimate of species-specific landings, this implies landings of no more than 205 t tonnes in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.5 Thornback ray *Raja clavata* in Divisions VIIa, f, g

The French EVHOE survey indicated fluctuating catch rates at low levels in the Celtic Sea (Figure 18.28d). Nevertheless, it should also be noted that this survey tends to sample offshore grounds, whereas *R. clavata* is a more inshore species.

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches reasonable numbers of *R. clavata* and they are observed regularly, although the gear used (4 m beam trawl with chain mat) may have a lower catchability for the larger individuals. This survey shows increasing catch rates in the last two years (Figure 18.33b).

The discontinued UK (England and Wales) westerly IBTS in the area caught large numbers of *R. clavata* in Liverpool Bay and the Bristol Channel, where groundgear 'A' is used, and provided samples of larger individuals (e.g. for maturity sampling). The UK (Northern Ireland) survey of the Irish Sea has also indicated low but stable catches, with the previous two years at the same level as the previous five, although this survey uses a rock-hopper trawl, and so the catchability may be low.

Based on the ICES approach to data-limited stocks, ICES advised that landings could be increased by a maximum of 20%. Based on best estimate of species-specific landings, this implies landings of no more than 1235 tonnes in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.6 Thornback ray *Raja clavata* in Division VIIe

Analyses of data from a discontinued beam trawl survey in the western English Channel (particularly in the Great West Bay area) was provided in 2012 which suggest stable catch rates (Figure 18.34). A similar pattern of catches is seen in the current UK beam trawl survey of the western English Channel, with most *R. clavata* captured in Lyme Bay with fewer records elsewhere (Figure 18.35d). Length–frequency showed a peak in the captures of presumably 0-group fish ≤20 cm (Figure 18.35d).

Based on the ICES approach to data-limited stocks, ICES advised that landings should not increase based on estimated species-specific landings; this would imply landings of 260 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.7 Small-eyed ray *Raja microocellata* in the Bristol Channel (Division VIIf,g)

Although occasional specimens of *R. microocellata* are caught in VIIa, the main concentration of this species is in VIIf, with larger individuals occurring slightly further offshore (VIIg). The youngest size class is not often taken in surveys, as 0-group fish tend to occur in very shallow water.

The UK (England and Wales) beam trawl survey in the Bristol Channel has previously indicated stable catch rates, although the mean catches from the last two years is below the previous five year average, with the lowest catch rate in twenty years (~1 individual per hour) seen in 2013 (Figure 18.33c).

This species may also occur in some inshore areas of southern and southwestern Ireland, although data are limited for these areas.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 36%. Based on estimated species-specific landings, this would imply landings of 188 t in 2015 and 2016. Discards are known to take place but have not been quantified and there is some discard survival.

18.9.8 Small-eyed ray *Raja microocellata* in the English Channel (Divisions VIId,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 Dournanenz, 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 (Figure 18.34). The low catch rates are probably related to the patchy distribution of the species in this area. Similarly, Silva *et al.* (2014 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.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 43 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.9 Spotted ray *Raja montagui* in Subarea VI and VIIb,j

Raja montagui is a widespread and small-bodied skate and is taken in reasonable numbers in a variety of surveys in the ecoregion.

Catches of *Raja montagui* in the Irish Groundfish survey in Via and VIIb,j are increasing with the mean catch rate of 2012–2013 at 1.85 individuals per hour, rising from 1.5 individuals per hour mean catch rate from 2007–2011 (Figure 18.29c).

Earlier analyses of the Scottish surveys of VIa suggested stable/increasing catch trends (Figure 18.36c), although updated analyses are not available.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 11%. Based on estimated species-specific landings, this would imply landings of 53 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.10 Spotted ray *Raja montagui* in Divisions VIIa, e, f, g

The French EVHOE survey generally indicated stable catch rates at low levels in the Celtic Sea, with a slight increase in numbers seen in recent years (Figure 18.28c).

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches reasonable numbers of *R. montagui* and they are observed very regularly, with mature individuals taken on the offshore stations on coarse grounds. This survey indicated a mean catch rate of 6.78 individuals per hour 2012–2013, the highest value of the time-series (Figure 18.33d).

Data from a now discontinued beam trawl survey in the western English Channel (particularly in the Great West Bay area) were provided in 2012 (Figure 18.34), which suggested that recent catches had increased in relation to the preceding five years, although catch rates were greater at the start of the time-series. A concurrent beam trawl survey of the western English Channel found this species was more commonly found in the English inshore coast strata from Lyme Bay to west of the Scilly Isles, with a peak in length for smaller individuals <22 cm L_T (Figure 18.35e).

Catches of *Raja montagui* in the Irish Groundfish survey in VIIafh were increasing with the mean catch rate of 2012–2013 at 1.89 individuals per hour, rising from 1.77 individuals per hour mean catch rate from 2007–2011 (Figure 18.29d).

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 4%. Based on estimated species-specific landings, this would imply landings of 1118 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.11 Cuckoo ray *Leucoraja naevus* in Subareas and Divisions VI, VII, and VIIIa,b,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. It is an offshore species that is also abundant in the Bay of Biscay (VIII) and northern North Sea (IVa), and the stock(s) may extend out of the Celtic Seas ecoregion.

In 2014 the stock of *L. naevus* was treated as one unit in Subareas and Divisions VI, VII, and VIIIa,b,d In 2015 the stock identity of *L.naevus* was examined in greater detail to determine if this stock unit was appropriate. While evidence was shown (Moriarty and Johnston, 2015 WD) that there is a break in stock distribution between ICES Divisions VIIbc and VIIj, there is no information as to whether this is a recent development, or the level of mixing between these areas. It was therefore agreed that the existing single-stock unit would be retained for assessment purposes. Further information on the *L. naevus* stock is therefore also available in Section 19.

The Spanish survey on the Porcupine Bank indicated recent decreases in catches (both in terms of biomass and abundance), with the 2013 level the lowest seen since the start of the time-series in 2001 (Figure 18.31 a,b).

The French EVHOE survey demonstrated peaks in relative abundance in 2001–2002 and 2007–2008, with the lowest catches in 2000. The relative abundance in the Celtic Sea/Biscay region has been stable in recent years, with catch rates similar to those seen in 2010 (Figure 18.28a).

The UK (England and Wales) beam trawl survey in VIIa catches small numbers of *L. naevus,* mostly on the offshore stations on coarse grounds. There is the indication of a decline from the start of the time-series, with the mean catch rates in the last two years (0.85 individuals per hour) lower than the average catches from the previous five years (Figure 18.33e).

The Irish Groundfish Survey mainly catches *L. naevus* in offshore areas. Trends in abundance are not very apparent, with fluctuating low annual catches. The mean catch rates in 2012–2013 were ~1 individual per hour in VIa (Figure 18.29e), and 0.46 individual per hour in VIIa,f–h (Figure 18.29f), there was a decrease in the catch rate for the latter area.

Earlier analyses of UK (Scotland) survey data for VIa suggested stable/increasing catch trends (Figure 18.36a), although more recent data were not available.

The different surveys demonstrated slightly different trends in relative abundance for this species, which further highlights the need to better understand the stock structure of this species. Whilst surveys indicated either stable or decreasing trends, no survey indicated increasing catch rates for this species in this area.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 34%. Based on estimated species-specific landings, this would imply landings of 1998 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.12 Sandy ray *Leucoraja circularis* in the Celtic Seas and adjacent areas

Leucoraja circularis is a large-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 IVa) and parts of the Bay of Biscay (VIII).

Only the Spanish Porcupine Bank survey covers an important part of the habitat of *L. circularis* and catches this species in any quantity (Figure 18.30a). Peak catches were in 2003. Overall, the limited time-series showed low and variable catch rates, with a stable but increasing trend in recent years, with ~1.0 kg per haul noted in 2013 (Figure 18.30b).

This species is taken only infrequently in other surveys, such as the EVHOE survey (Figure 18.28e) with some nominal records considered unreliable.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 39 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.9.13 Shagreen ray *L. fullonica* in the Celtic Seas and adjacent areas

Leucoraja fullonica is a large-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 IVa) and parts of the Bay of Biscay (VIII).

Although the UK PHHT Q1 survey seemed to catch *L. fullonica* regularly, albeit in small numbers, this survey was discontinued. More recent surveys by Ireland and UK (England) (the latter now also discontinued) have only caught occasional specimens (see ICES, 2010), which may reflect insufficient sampling of the main habitat, and possibly a gear effect.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 186 t in 2015 and 2016. Discards are known to take place but have not been quantified and there is some discard survival.

18.9.14 Common skate *Dipturus batis*–complex (flapper skate *Dipturus batis cf. flossada* and blue skate *Dipturus cf. intermedia*) in Subarea VI and Divisions VIIa–c, 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.

Although the nomenclature is still to be ratified, the smaller species (the form described as *D. flossada* by Iglésias *et al.*, 2010) will probably remain as *Dipturus batis* and the larger species may revert to *D. intermedia.*

Blue skate *Dipturus batis* (*D.* cf. *flossada*) is known to occur in parts of VIb (Rockall Bank), Celtic Sea (VIIe–k) and it likely extends into Subarea VIII. The northern limits to its distribution are unclear. Flapper skate *D.* cf. *intermedia* occurs in VIa, parts of VIb, and the northern North Sea (IVa). Smaller numbers are taken in the Celtic Sea (VIIe–k), although it's southerly and northerly limits are unknown. The bathymeric ranges of both species are poorly known, as is their western distribution ranges, although unspecified *D. batis* have been reported from the Mid-Atlantic Ridge. The two species overlap around the coast of Ireland.

Given that much of the data refer to the species-complex, both species are currently treated together until improved species-specific data are available. Overall, the common skate (*Dipturus batis*) complex is considered to be depleted in the Celtic Sea ecoregion.

Analyses of data from the Spanish Porcupine Bank Survey indicate low but stable catch rates of '*D. batis*' with an increased geographic distribution to the southeastern Bank (Figure 18.32a), with 15 individuals of *D. batis* found, and two specimens of *D. cf. intermedia* found in 2013 for the first time in the last three years surveys (Ruiz-Pico *et al.*, 2014 WD). There was an increase in biomass for *D. batis* to ~2kg per haul in 2013 (Figure 18.32b).

A previous examination of Scottish data (see ICES, 2010b; 2011) indicated some increase in the proportion of hauls in which *D. batis*-complex were observed (Figure 18.36d), although it should be recognized that catch rates were low and with wide confidence intervals. Updated analyses are required.

More detailed analyses of captures of '*D. batis*' from these and other surveys (e.g. the Irish western IBTS surveys are required). There are a few records from the UK western English Channel beam trawl survey, found from the western parts of the survey grid, including around the Scilly Isles (Figure 18.35a), with the observed length range representing immature fish (Silva *et al.*, 2014 WD).

ICES advised on the basis of the precautionary considerations that there be no targeted fishery for these stocks and measures should be taken to minimize bycatch.

Measures to minimize bycatch may include seasonal and/or area closures or technical measures. Such measures should be developed by stakeholder consultations, as part of a rebuilding plan, considering the overall mixed-fisheries context.

18.9.15 Undulate ray *Raja undulata* in Division VIIb,j

ICES advised on the basis of the precautionary considerations that there be no targeted fishery on this stock. This isolated stock has a very local distribution, mainly in Tralee Bay on the Southwest Irish coast; bycatch in this vicinity should be monitored and reduced to the lowest possible level. Measures to mitigate bycatch should be developed and implemented in consultation with the stakeholders. In Divisions VIIb and VIIj, ICES considers that it is appropriate that the species continues to be promptly released if caught.

18.9.16 Undulate ray *Raja undulata* in Divisions VIId, e (English Channel)

There is thought to be a discrete stock of *R. undulata* in the English Channel (VIId,e), with the main part of the range extending from the Isle of Wight to the Normano-Breton Gulf. This stock is surveyed, in part, by two different beam trawl surveys: the Channel beam trawl survey (see Section 15) and the western English Channel (Eng-WEC_BTS-Q1), as well as the French Channel Groundfish survey (see Section 15). The distribution and length ranges of *R. undulata* caught in the western English Channel survey are provided in Figure 18.35f. Catch rates are generally low and variable, partly due to the patchy distribution of this species.

Since ICES (2013) commented "*If ICES are to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered*" there has been a lot of dedicated surveys by French laboratories under the Raimouest and RECOAM projects.

LeBlanc *et al.* (2014 WD) summarized the project so far, and show that *R. undulata* is the main skate species caught in the Norman-Breton Gulf and is highly dominant in coastal waters (Figures 18.38–18.39); although it occurs in almost all the English Channel its distribution appears to be concentrated in the central region of the English Channel (Figure 18.38). Tagging studies indicate high site fidelity (Stéphan *et al.*, 2014 WD; Figure 18.40). In the Normano-Breton Gulf, 1488 *R. undulata* were tagged (656 females (29–103 cm L_T) and 832 males (28–99 cm L_T), with a 5% (n = 77) recapture rate. All the skates tagged in a region were recaptured in the same region, and distance travelled was short (<80 km). Given that the prohibited listing of the species deterred reporting of tags in some fisheries, the degree of exchange between the Normano-Breton Gulf and the south coast of England remains unclear. In the western English Channel 58.4% of the recaptured skates were taken at the release location (less than 5 km apart) and 75.3% in the western English Channel were recaptured less than 20 km from the release location. Complementary work will also be undertaken by the UK in 2014 on the English side of the Channel, which will assist in stock ID and to further our understanding of potential movements and exchange of this species in the English Channel.

Based on the decrease in the total skate landings from 2007–2008 to 2009–2010, the annual French landings of *R. undulata* were estimated as 300 t in the Western English Channel (VIIe) and as 160 t in the Normano-Breton Gulf. Furthermore, the estimated discards from the French fishing fleet in VIIe in 2013 was ~890 t (LeBlanc *et al.*, 2014 WD).

ICES advised on the basis of precautionary considerations that there should be no targeted fisheries on this stock. Any possible provision for bycatch to be landed should be part of a management plan, including close monitoring of the stock and fishery.

18.9.17 Other skates in Subareas VI and VII, excluding Division VIId

This advice 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 *R. clavata, R. brachyura,* and *R. microcellata* outside the defined stock boundaries. The advice only relates to species belonging to the Rajidae (skates), and does not refer to manta rays, stingrays, electric rays, or devil rays.

Based on the ICES approach to data-limited stocks, ICES advised that landings should be reduced by 20%. Based on estimated species-specific landings, this would imply landings of 789 t in 2015 and 2016. Discarding is known to take place but has not been quantified, and there is some discard survival.

18.10 Quality of assessments

Commercial data are insufficient for proceed using a full stock assessment, although data are improving.

Several updated analyses of temporal changes in relative abundance in fishery-independent surveys were carried out between 2012 and 2014. These surveys provide the most comprehensive time-series of species-specific information. For example the French and Scottish IBTS surveys and the UK (England and Wales) beam trawl surveys have been undertaken for 10–20 years. Several other surveys now operate in the area, but over a shorter time frame. There is also a wide spatial coverage of most parts of the ecoregion with otter trawl and/or beam trawl. Hence, fishery-independent trawl data are considered the most appropriate data for evaluating the general status of the more common demersal elasmobranchs.

However, it must be stressed that not all skates and rays are well sampled by these surveys, and even the most common species (*R. montagui*, *R. clavata*, *L. naevus*) may only occur in about 30% of hauls. There is also uncertainty regarding the mean catch rates, due to the large confidence intervals.

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, these surveys are not well suited for species with localized, coastal distributions (e.g. *R. undulata*, angel shark), patchy distributions (e.g. *R. brachyura*) or outer shelf distributions (e.g. *L. fullonica*).

18.11 Reference points

No reference points have been adopted. Methods for establishing precautionary reference points from using the catch-curve method described above (Section 18.8.1; Figure 18.45.

18.12 Conservation considerations

In 2015 the IUCN published a European Red List of Marine Fisheries (Nieto *et al.*, 2015). Skates and rays were listed as follows:

Species	IUCN Red List Category
Amblyraja radiata	Least concern
Dipturus batis	Critically Endangered
Dipturus nidarosiensis	Near Threatened
Dipturus oxyrinchus	Near Threatened
Leucoraja circularis	Vulnerable
Leucoraja fullonica	Critically Endangered
Leucoraja naevus	Least concern
Raja brachyura	Near Threatened
Raja clavata	Near Threatened
Raja microocellata	Near Threatened
Raja montagui	Least concern
Raja undulata	Near Threatened
Rajella fyllae	Least concern
Rostroraja alba	Critically Endangered

It should be noted that the above categories are applied on a Europe-wide scale and not regionally.

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 issues such as quota allocation and, for 2013, the poor weather in the last two months of the year. There is evidence that quota was restrictive for some nations in 2014.

It has been difficult for WGEF to deal with some of the elasmobranchs in this region adequately. This is as a result of the long history of aggregated species landings, limited knowledge of the species composition of skates in commercial landings (including taxonomic confusion in some datasets), and a poor knowledge of stock structure.

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 Table 18.10.

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. Preliminary analyses of recent survey data indicate that the relative abundance of this species in VIa and VIIa,f suggest it has been stable or increasing in recent years.

Cuckoo ray *Leucoraja naevus* is an important commercial species on offshore grounds in the Celtic Sea. Survey catch rates have decreased in some areas, but have shown more stability in other areas. Further studies to better define the stock structure are required to better interpret these contrasting abundance trends.

The relative abundance of spotted ray *Raja montagui* in this ecoregion appear to be increasing in recent years.

The main stock of small-eyed ray *Raja microocellata* occurs in the Bristol Channel, and catch rates have declined in the last two years.

The patchy distribution of blonde ray *Raja brachyura* means that existing surveys have low and variable catch rates. More detailed investigations of this species are required.

Other species

Council Regulations (EC) No 43/2009 of 16 January 2009 and (EU) No 23/2010 of 14 January 2010 banned the retention on board of three species of skate and this has been a controversial issue for some fisheries with regards *R. undulata* (in VIIe) and *D. batis (D. cf. flossada)* in some offshore areas.

Currently, interpretation of the prohibited species list may not allow commercial vessels to land fish for scientific purposes (including tagged fish), which has impacted on some recent scientific research programmes on these species.

Contemporary surveys occasionally record other skate species, although catch rates of these species are highly variable.

Historically, species such as *L. circularis, L. fullonica* and *D. oxyrinchus* 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. Hence studies to better examine the current status of these species in Subareas VI and VII should be undertaken. Future analyses should examine the long-term distribution and relative abundance of these species. In the first instance, data on the occurrences of these species should be collated from all surveys.

18.14 References

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Table 18.1. Skates and rays in the Celtic Seas. Preliminary identification of the occurrence of the various species in the ecoregion by ICES division (Eastern English Channel (VIId) also included). Symbols: ● = Present, ○ = absent; ⦿ = occasional vagrants reported from the area, or distribution might extend to this division; ⊗ = no recent records but occurred in the past;? = uncertain). Adapted from Whitehead *et al.* (1984); Ellis *et al.* (2005); ICES (2007; Table 1.4) and FishBase.

Scientific name	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk
Skates (Rajidae) occurring on the continental shelf and upper slope												
"*Dipturus batis*"-complex	●	●	●	●	●	⦿	●	●	●	●	●	●
D. batis (cf. flossada)	⦿	●	●	●	●	⊗	●	⦿	●	●	●	●
D. cf.intermedia	●	⦿	⦿	⦿	?	?	?	?	⦿	⦿	⦿	⦿
D. oxyrinchus	●	●	○	●	●	○	○	○	⦿	●	●	●
D. nidarosiensis	●	●	○	●	●	○	○	○	○	○	●	●
Leucoraja circularis	●	●	○	●	●	○	○	○	⦿	●	●	●
L. fullonica	●	●	⦿	●	●	○	⦿	⦿	●	●	●	●
L.naevus	●	●	●	●	●	⦿	●	●	●	●	●	●
Raja brachyura	●	⦿	●	●	⦿	●	●	●	●	●	●	○
R. clavata	●	●	●	●	●	●	●	●	●	●	●	⦿
R. microocellata	⦿	○	⦿	●	○	●	●	●	●	⦿	●	○
R. montagui	●	●	●	●	⦿	●	●	●	●	●	●	⦿
R. undulata	○	○	⦿	●	○	●	●	⦿	⦿	⦿	●	○
Rajella fyllae	●	●	○	●	●	○	○	○	○	●	●	●
Rostroraja alba	○	○	⊗	●	?	⊗	⊗	?	?	?	?	○
Demersal rays (Torpediniformes and Myliobatiformes) occurring on the continental shelf												
Torpedo marmorata	?	?	?	?	○	⦿	●	⦿	⦿	●	?	?
Torpedo nobiliana	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿
Dasyatis pastinaca	⦿	⦿	⦿	⦿	○	●	●	⦿	⦿	●	⦿	○
Myliobatis aquila	⦿	?	⦿	⦿	○	⦿	⦿	⦿	⦿	⦿	⦿	○
	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk

Table 18.2. Skates and rays in the Celtic Seas. Total landings (t) of skates (Rajidae) in the Celtic Seas ecoregion (VIa).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	13	10	3	4	.	.	.	2	1	2	.	.	2	1	3	2	3	.	2	.	1
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	+	+	+
Faroe Islands	107	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
France	736	907	777	918	653	839	730	583	2318	741	885	955	996	645	727	766	724	711	621	603	606
Germany	.	1	.	.	1	2	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Ireland	281	336	458	425	342	242	268	343	474	537	806	836	574	440	367	690	630	150	200	350	331
Netherlands	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	116	105	70	77	96	226	81	253	119	146	217	99	67	44	93	144	264	71	38	82	56
Poland	64	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	.	.	.	.	19	11	8	4	12	14	8	.	.	43	.	.
UK - (E,W&N.I.)	264	266	264	334	338	292	209	89	93	99	104	141	47	47	54	87	67	57	77	72	70
UK – Scotland	1302	1142	1393	1792	1724	1660	1540	1577	1496	1617	1818	2016	2034	1802	2111	2137	2499	2007	2026	1605	1419
Total	2883	2767	2965	3551	3154	3261	2829	2847	4501	3161	3841	4055	3726	2991	3370	3834	4187	2996	3007	2712	2483

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	2	7	1	2	2	4	2	4	2	8	9	4	4	0	.		0	0	0	0	0
Denmark	+	+	+	.	+	+	.	.	.	.	.	0		.	.	.	0	0	0		
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.		.	.	0	.					
France	437	553	526	384	333	NA	321	278	212	183	149	181	174	194	245	97	65	50	97	85	53
Germany	2	.	1	4	16	7	1	1	.	3	0	.	0	.	.	.	.	0			0
Ireland	265	504	681	596	488	388	274	238	311	364	363	186	176	119	109	81	111	88	103	94	81
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	0				0		0	0	
Norway	9	74	29	20	50	29	49	20	25	2	2	10	4	5	11	4	11	6	2	5	64
Poland	.	.	.	.	.	.	.	.	.	.	.	.	0								
Spain	.	.	47	58	69	34	2	.	9	27	14	14	0	0	4				8		0
Spain (Basque Country)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0	1			
UK - (E,W&N.I.)	101	138	101	69	157	67	108	65	114	159	66	26	18	5	1	4	1	1	0	1	13
UK – Scotland	1429	1980	2606	1879	1460	1324	1316	1263	1136	1307	1012	623	369	426	297	240	224	194	206	185	169
Total	2245	3256	3992	3012	2575	1853	2073	1869	1809	2053	1615	1043	744	750	667	427	412	341	416	371	380

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (t) of skates (Rajidae) in the Celtic Seas ecoregion (VIb).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Faroe Islands	2	95	43	43	24	15	61	44	.	23	22	18	2	6	.	.	.	.	.	.	.
France	125	423	39	44	10	20	1	0	4	8	10	6	6	4	1	2	0	3	13	0	4
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.		1	1	.	.	.	6
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
Norway	.	22	123	45	60	145	217	222	117	147	332	364	164	231	200	132	279	203	248	234	170
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Russian Federation	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	.	.	.	63	.	.	12	8	48	41	36	.	.	14	.	.
UK - (E,W&N.I.)	11	.	.	39	62	36	56	.	4	.	8	4	18	15	12	7	4	4	11	12	21
UK – Scotland	562	166	307	77	160	189	152	181	152	44	9	15	58	38	59	72	70	76	67	57	70
Total	700	706	512	248	316	405	487	447	340	222	381	419	256	342	313	250	354	286	353	303	295

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Estonia	.	.	.	.	.	.	.	56	1	.	.	.	.	.	.	.					
Faroe Islands	.	.	.	.	.	.	.	.	.	.	na	na	.	.	3						
France	0	0	0	0	0	0	7	5	5	2	6	15	0	17	17	12	0	0	6	2	
Germany	25	17	49	26	36	67	76	8	1	6	22	22	6	0	.	.	3	2			**0**
Ireland	23	60	68	23	15	28	20	10	1	18	7	9	24	14	15	4	3	10	8	12	**30**
Norway	272	176	95	101	98	59	120	80	44	61	46	39	82	81	66	91	120	56	89	93	**93**
Portugal	.	56	.	25	26	24	29	17	31	18	na	0	0								
Russian Federation	.	.	.	.	.	.	5	8	.	.	na	na									
Spain	.	.	328	410	483	322	347	158	36	46	1	0	0	0	0				4		**3**
UK - (E,W&N.I.)	28	73	175	105	134	147	156	120	92	47	48	20	20	9	0	0	0	0	0	1	**1**
UK – Scotland	98	97	83	91	101	123	204	97	79	146	164	59	51	30	26	35	33	34	18	41	
Total	446	479	798	781	893	770	964	559	290	344	294	164	183	151	127	143	159	102	125	149	127

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (t) of skates (Rajidae) in the Celtic Seas ecoregion (VIIa).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	296	365	278	195	236	212	177	151	206	230	233	246	372	425	545	390	271	298	209	230	107
France	1516	426	337	491	827	967	560	593	1985	617	440	788	1194	1578	1318	1009	641	712	890	642	550
Ireland	822	916	838	936	858	796	813	725	851	803	781	1067	1946	1416	1644	1911	1808	1811	1400	1301	679
Netherlands	1	1	3	1	1	.	1	+	+	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Norway	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain																					
UK - (E,W&N.I.)	1564	1533	1430	1163	1130	906	1045	1202	1113	1307	1133	1126	1103	976	1503	1435	1373	1378	1226	1150	1003
UK (Scotland)	62	69	53	39	47	52	58	132	82	89	87	192	219	224	321	210	171	227	163	107	96
Total	4265	3310	2939	2825	3099	2933	2654	2803	4237	3046	2674	3419	4834	4619	5331	4955	4264	4426	3888	3430	2435

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	224	218	265	298	398	542	504	724	997	830	860	860	593	680	295	250	274	471	430	370	217
France	330	293	282	151	285	NA	163	343	349	322	183	192	114	51	14	7	9	16	5	6	1
Ireland	514	438	438	593	692	827	759	807	1032	1086	825	786	645	721	515	370	557	500	496	411	429
Netherlands	n.a.	n.a.	n.a.	n.a.	4	4	6	+	+	+	+	.	0	.	.			0	0	0	
Norway	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	0	0	0	0	0	
Spain															4						0
UK - (E,W&N.I.)	748	606	789	824	1009	936	671	983	863	1184	533	1252	271	260	243	214	190	172	226	213	143
UK (Scotland)	86	42	55	80	52	33	86	80	68	67	38	30	65	13	1	2	9	1	2	3	0
Total	1902	1597	1829	1946	2440	2342	2189	2937	3309	3489	2439	3120	1689	1724	1071	844	1038	1161	1160	1003	791

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (t) of skates (Rajidae) in the Celtic Seas ecoregion (VIIf).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	182	273	280	184	106	75	127	189	167	130	139	98	177	209	129	172	268	135	155	128	96
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
France	.	242	426	569	720	680	873	896	856	837	648	377	306	330	247	464	366	326	607	663	565
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain (b)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK - (E,W&N.I.)	504	401	468	437	452	436	444	494	508	529	480	558	648	697	784	761	710	666	627	705	638
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	686	916	1174	1190	1278	1191	1444	1579	1531	1496	1267	1033	1131	1236	1160	1397	1344	1127	1389	1497	1299

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	117	108	89	116	121	103	90	91	117	134	210	208	138	206	184	193	143	175	185	149	136
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			0	0		
France	468	394	432	485	464	453	538	642	526	536	478	429	305	424	399	365.6	517	297	325	304	327
Germany	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	0			0
Ireland	.	.	.	.	1	.	.	.	1	1	15	8	6	2	4	3	2	1	1	1	1
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	0				0	0	0	0	
Norway	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0			0	0		
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0			
Spain (b)	.	.	8	10	12	1	.	3	.	.	.	.	0	0	0				0		0
UK - (E,W&N.I.)	630	589	676	664	624	560	613	691	920	766	609	631	653	620	639	546	680	682	708	598	392
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.			0		0	0	0	0	
Total	1215	1091	1205	1275	1222	1117	1241	1427	1564	1437	1312	1276	1101	1252	1226	1107	1342	1155	1219	1052	856

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (t) of skates (Rajidae) in the Celtic Seas ecoregion (VIIegh).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	259	238	209	529	308	208	206	254	318	271	182	215	211	311	224	227	355	242	97	183	209
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	1	+
France	5729	4095	6901	6602	6189	6095	6519	6796	7647	6765	7323	6561	6890	7771	7693	7986	7566	7734	7077	6477	5873
Germany	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	147	158	148	241	158	143	218	399	380	291	236	303	286	251	296	315	57	100	68	.	120
Netherlands	.	.	1	7	13	6	.	.	.	.	2	na	na	na	na	na	na	na	na	na	na
Norway	.	.	.	.	.	.	.	.	.	.	12	.	.	25	.	.	12	5	.	.	.
Poland	24	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain (b)	.	.	.	.	.	45	0	0	77	30	29	24	2	62	75	49	.	.	21		.
UK - (E,W&N.I.)	432	466	572	556	566	615	564	528	606	637	700	832	936	939	1061	1307	865	1211	638	751	735
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Total	6609	4985	7831	7935	7234	7112	7507	7977	9028	7994	8484	7935	8325	9359	9349	9885	8857	9293	7901	7412	6938

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	172	203	177	293	260	240	223	248	347	576	407	432	582	569	636	506	479	533	589	494	372
Denmark	0	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0			
France	5836	6029	6425	7093	6114	6098	5710	5603	5273	5588	4261	4517	3740	3741	3302	3719	3428	3193	2894	2693	1577
Germany	.	.	.	.	.	.	.	.	+	.	3	.		.	.	.	0	0			0
Ireland	106	162	349	479	446	408	203	481	729	838	844	334	315	285	214	198	174	316	315	221	285
Netherlands	na	na	na	na	9	na	7	7	11	.	.	.	1	.	.	1	2	1	1	2	
Norway	.	.	.	.	.	.	.	11	.	.	.	.	0	0	0			0	0		
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			0			
Spain (b)	.	.	312	932	1178	2647	1706	1142	653	31	15	9	1	1	3	.			109		1
Spain (Basque)																7	2	8			
UK - (E,W&N.I.)	869	997	953	1098	1167	796	932	880	775	804	811	1024	727	730	667	650	865	771	667	753	829
UK (Scotland)	.	.	.	2	.	2	.	2	.	.	149	3	1		3	3	7	7	3	1	
Total	6983	7391	8216	9897	9173	10191	8781	8374	7788	7837	6490	6318	5366	5326	4826	5082	4957	4830	4576	4164	3064

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas ecoregion (VIIbcjk).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	907	725	292	480	239	219	188	340	1120	203	169	198	344	346	456	462	427	781	541	546	298
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Ireland	266	321	314	320	265	268	239	269	336	271	325	296	220	226	419	332	633	350	400	619	602
Netherlands																				0	0
Norway																			0	0	0
Spain (b)	0	0	0	0	0	3	0	0	47	33	24	31	1	53	64	41	0	0	124	0	0
UK - (E,W&N.I.)	1	+	+	0	+	0	0	+	0	+	0	4	1	3	27	28	25	5	53	71	88
UK (Scotland)	0	0	0	0	0	1		1	0	0	0	1	+	1	+	1	13	14	15	10	34
Total	1174	1046	606	800	504	491	427	610	1503	507	518	530	566	629	966	864	1098	1150	1133	1246	1029

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	0	0	0	0	0	24	5	0	5	1	na	0	0	0	.		0	0	0	0	0
France	224	297	375	599	500	NA	568	362	272	192	101	257	255	391	421	262	249	139	166	185	29
Germany	18	3	4	9	17	10	21	7	+	3	15	17	0				0	1	1		0
Ireland	625	735	757	811	741	740	653	383	354	435	511	465	473	417	384	362	285	217	246	228	208
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Norway	0	0	0	0	0	0	0	0	0	0	0	0	15	4	0			0	6		
Spain (b)	0	0	1341	1676	1978	2419	2573	1205	2939	1281	7	16	19	11	1		0	0	184		23
UK - (E,W&N.I.)	201	361	469	468	376	352	597	545	373	350	364	269	176	172	83	90	94	99	72	83	101
UK (Scotland)	43	73	58	36	67	121	189	162	124	226	70	58	77	0	66	39	60	54	63	22	0
Total	1111	1469	3004	3599	3679	3666	4606	2664	4067	2488	1068	1081	1016	995	954	753	687	510	738	518	361

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas ecoregion (VII unspecified).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Spain														643	693	605	494	2	251	**0**
Spain (Basque Country)															0.8	0.0				
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	643	693	605	494	2	251	**0**

Table 18.2. (Continued). Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas ecoregion (total landings).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	750	886	770	912	650	495	510	596	692	633	554	559	762	946	901	791	897	675	463	541	413
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	1	.	2	+
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Faroe Islands	109	95	43	43	24	15	61	44	.	23	22	18	3	6	.	.	.	.	.	.	.
France	9013	6818	8772	9104	8638	8820	8871	9208	13930	9171	9475	8885	9736	10674	10442	10689	9724	10267	9749	8931	7896
Germany	18	1	.	.	1	2	1	.	.	.	.	.	1	.	.	1	1	0	0	0	13
Ireland	1516	1731	1758	1922	1623	1449	1538	1736	2041	1902	2148	2502	3026	2333	2726	3248	3128	2411	2068	2270	1756
Netherlands	1	1	4	9	14	6	1	+	+	+	2	na	na	na	na	na	na	na	na	na	na
Norway	120	127	193	122	156	371	298	475	236	293	561	463	231	300	293	276	555	279	286	316	226
Poland	88	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Russian Federation	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	48	0	0	187	82	64	75	15	175	194	134	0	0	202	0	0
UK - (E,W&N.I.)	2776	2666	2734	2529	2548	2285	2318	2313	2324	2572	2425	2665	2753	2677	3441	3625	3044	3321	2632	2761	2555
UK – Scotland	1926	1377	1753	1908	1931	1902	1750	1891	1730	1750	1914	2224	2311	2065	2491	2420	2753	2324	2271	1779	1620
Total	16317	13730	16027	16549	15585	15393	15348	16263	21140	16426	17165	17391	18838	19176	20489	21185	20104	19278	17671	16600	14479

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	515	536	532	709	781	913	824	1067	1467	1549	1485	1503	1316	1455	1115	949	896	1179	1204	1013	**725**
Denmark	.	+	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	**.**
Estonia	.	.	.	.	.	.	.	56	1	.	.	.	.	.	.	.	0	0	0	0	**0**
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	na	.	.	4	.	.	.	.	.	**.**
France	7295	7566	8040	8712	7696	6551	7307	7233	6637	6823	5178	5591	4587	4818	4398	4463	4267	3695	3493	3275	**1987**
Germany	45	20	54	39	69	84	98	16	2	12	40	39	7	.	.	.	4	3	1	0	**0**
Ireland	1533	1898	2294	2502	2382	2390	1909	1919	2428	2742	2565	1787	1640	1558	1240	1018	1132	1133	1169	966	**1033**
Netherlands	na	na	na	na	13	4	13	7	11	na	na	0	1	.	.	1	2	1	1	2	**0**
Norway	281	250	124	121	148	88	169	111	69	63	48	49	101	90	77	95	131	62	97	98	**157**
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**.**
Portugal	.	56	.	25	26	24	29	17	31	18	na	0	.	.	.	.	.	.	.	.	**.**
Russian Federation	.	.	.	.	.	.	5	8	.	.	na	na	.	.	.	.	.	.	.	.	**.**
Spain	0	0	2036	3086	3720	5423	4628	2508	3637	1385	37	39	20	12	655	700	608	503	307	251	**28**
UK - (E,W&N.I.)	2577	2764	3163	3228	3467	2858	3077	3283	3137	3310	2431	3222	1865	1796	1633	1504	1830	1725	1674	1650	**1479**
UK – Scotland	1656	2192	2802	2088	1680	1603	1795	1604	1407	1746	1433	773	562	469	393	319	332	290	292	252	**169**
Total	13902	15282	19044	20510	19981	19938	19854	17830	18828	17648	13217	13004	10099	10198	9514	9047	9201	8591	8237	7507	**5579**

Table 18.3. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	Scientific name	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIa	*Amblyraja radiata*			3.7		0.0							0.0	0.0	
	Dipturus batis	0.1								0.6	1.2	0.1			
	Amblyraja hyperborea			0.4											
	Dipturus oxyrinchus	3.1	13.9	7.4	0.9					2.8	4.5				
	Leucoraja circularis	1.1	0.7	0.8							0.4	0.1			0.0
	Leucoraja fullonica	1.6	2.6	2.2											
	Leucoraja naevus	27.7	34.5	23.1	12.0	7.4	5.4		0.5	62.8	51.7	22.1	0.1	0.0	
	Raja brachyura				0.4	0.7	11.8			7.3	1.9		0.3	0.1	0.4
	Raja clavata	15.9	36.9	28.3	43.4	64.6	68.2		7.4	45.9	62.8	104.7	0.3	0.1	0.5
	Raja microocellata														0.1
	Raja montagui	1.1	2.6	16.1	1.9	2.0	2.5			30.5	26.2	26.1			0.0
	Rostroraja alba									4.6	8.5	4.0			
	VIa Total Speciated	**50.4**	**91.3**	**82.0**	**58.6**	**74.7**	**87.9**		**7.9**	**154.4**	**157.2**	**157.2**	**0.7**	**0.3**	**1.1**
	VIa Total landings	**50.4**	**97.5**	**85.3**	**88.5**	**102.9**	**94.0**		**7.9**	**194.3**	**205.9**	**185.2**	**0.8**	**0.5**	**1.1**
VIb	*Dipturus batis*										1.7				
	Dipturus oxyrinchus		2.1						1.7	15.2	4.0				
	Leucoraja circularis	0.1	2.3	1.8	4.1						0.3	23.4			
	Leucoraja fullonica		1.1		0.6	3.0	4.4		1.5		0.7				
	Leucoraja naevus				0.2	0.3	0.1			1.4	5.0	4.2			
	Raja brachyura									0.3			0.1	0.3	
	Raja clavata		0.5		4.2	5.0	3.2			10.8	4.5	12.4			1.3
	Raja microocellata														
	Raja montagui	0.0					4.0			0.6	0.7	0.4			
	Rostroraja alba									1.9	0.2				
	VIb Total Speciated	**0.1**	**6.0**	**1.8**	**9.1**	**8.3**	**11.8**		**3.2**	**30.2**	**17.1**	**40.5**	**0.1**	**0.3**	**1.3**
	VIb Total landings	**0.1**	**6.0**	1.8	**9.6**	**8.3**	**11.8**		**3.6**	**33.6**	**18.0**	**41.3**	**0.1**	**0.3**	**1.3**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	**Scientific name**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**
VIIa	*Amblyraja radiata*							0.9		0.1						0.7	1.2	
	Dipturus batis							4.8								0.1	0.2	0.1
	Dipturus oxyrinchus																	
	Leucoraja circularis		5.1	1.3						0.2								0.0
	Leucoraja fullonica				0.0	0.0	0.0		0.1									
	Leucoraja naevus	36.8	35.9	35.1	1.5	0.3	0.4	9.5	12.9	4.3						5.1	7.4	1.3
	Raja brachyura	182.3	142.9	152.7	0.0	0.1	0.0	362.3	388.6	318.9						23.6	23.8	8.8
	Raja clavata	132.6	214.9	179.8	0.6	1.3	0.4	35.4	36.8	54.7			0.2		2.4	129.3	176.8	186.7
	Raja microocellata	2.2			0.0	0.0	0.0	0.1	0.0								0.0	0.2
	Raja montagui	50.0	15.3		13.5	3.7	5.0	49.3	35.0	24.1			0.0		0.0	8.1	10.7	1.2
	Rostroraja alba													0.2			0.0	
	VIIa Total Speciated	**403.9**	**414.0**	**369.0**	**15.6**	**5.3**	**5.8**	**462.3**	**473.4**	**402.2**			**0.3**	**0.2**	**2.4**	**166.8**	**220.1**	**198.3**
	VIIa Total landings	**471.3**	**430.3**	**370.2**	**15.8**	**5.3**	**5.8**	**500.5**	**496.1**	**410.7**			**1.1**	**1.7**	**3.2**	**171.9**	**226.2**	**213.0**
VIIb	*Amblyraja radiata*							0.2	0.6	0.1								
	Dipturus oxyrinchus					0.1		11.6				2.5						
	Leucoraja circularis				0.0	0.0	0.0					2.5			1.3			
	Leucoraja fullonica				0.0	0.0	0.0					0.1				2.1	4.5	2.3
	Leucoraja naevus				34.4	36.0	24.8	9.1	12.5	9.3		7.0	1.4			6.5	11.6	4.9
	Raja brachyura					0.0	1.7	36.1	32.9	38.6							0.0	
	Raja clavata				18.4	30.7	39.3	39.4	60.2	51.6			2.6	2.4	0.9	5.5	8.8	4.3
	Raja microocellata						0.0											
	Raja montagui				0.1	0.2	0.1	2.2	5.6	5.1							0.9	
	Dipturus nidarosiensis																0.0	
	VIIb Total Speciated				**52.9**	**67.1**	**65.9**	**98.5**	**111.8**	**104.6**		**12.2**	**4.0**	**2.4**	**2.2**	**14.1**	**25.9**	**11.5**
	VIIb Total landings				**53.0**	**67.6**	**66.1**	**118.8**	**122.4**	**106.8**		**12.2**	**4.0**	**2.4**	**2.2**	**14.1**	**25.9**	**11.5**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Netherlands			Spain		Scotland			UK (E,W&NI)		
Div	Scientific name	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIIc	*Dipturus batis*				0.3																
	Dipturus oxyrinchus						0.0	0.0													
	Leucoraja circularis				0.0	0.0	0.1								1.7		0.1				
	Leucoraja fullonica				0.0	0.1	0.2								0.9		0.1		0.7		0.1
	Leucoraja naevus				9.6	6.8	5.6	1.6	1.5	0.3					16.0				2.7	0.5	0.5
	Raja brachyura							0.2	0.1								9.0			0.3	
	Raja clavata				2.3	3.2	5.6	0.8	4.1						0.3	13.5	5.0	4.9		0.3	0.0
	Raja microocellata																				
	Raja montagui				0.2	0.2	0.8													0.1	
	VIIc Total Speciated				**12.5**	**10.3**	**12.2**	**2.6**	**5.6**	**0.3**				**0.0**	**18.8**	**13.5**	**14.1**	**4.9**	**3.3**	**1.2**	**0.6**
	VIIc Total landings				**12.5**	**10.3**	**12.2**	2.6	**5.6**	0.3					18.8	**13.5**	**14.1**	4.9	**3.3**	**1.2**	**0.6**
VIIe	*Amblyraja radiata*		0.0		0.0														0.2	0.5	0.8
	Dipturus batis				0.7		0.5												0.1	0.3	0.6
	Dipturus oxyrinchus				0.0	0.2	0.1													0.0	0.1
	Leucoraja circularis		0.4	1.1		1.2	1.7												0.4	0.3	0.3
	Leucoraja fullonica				2.1	2.5	1.7												3.4	1.3	1.9
	Leucoraja naevus	0.9	0.7	0.7	275.3	184.5	184.8						0.0		0.1				79.8	75.8	75.4
	Raja brachyura	3.5	4.3	5.0	210.9	144.2	192.1		0.4			0.2	0.1						204.6	175.4	222.3
	Raja clavata	3.3	4.4	4.5	96.9	107.3	186.6			0.2	0.5	0.4	1.5						98.0	127.4	151.2
	Raja microocellata	0.4			15.3	15.1	19.2												24.9	30.6	29.0
	Raja montagui	1.3	1.2	0.0	278.4	284.9	339.8				0.2		0.1		0.0				46.8	44.7	63.1
	Raja undulata				1.7		1.2													0.0	
	Rostroraja alba				12.3		3.5													0.0	0.0
	Rajella fyllae					0.0															
	Amblyraja hyperborea																			0.0	
	VIIe Total Speciated	**9.3**	**11.1**	**11.4**	**893.7**	**739.7**	**931.3**	**0.0**	**0.4**	**0.2**	**0.7**	**0.5**	**1.7**	**0.0**	**0.1**			**0.0**	**458.2**	**456.2**	**544.7**
	VIIe Total landings	**13.8**	**12.6**	**11.6**	**930.9**	**778.1**	**959.8**		**0.4**	**0.2**	**0.8**	**0.6**	**1.8**		**0.1**			**0.0**	**465.2**	**463.3**	**550.6**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	**Scientific name**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**
VIIf	*Amblyraja radiata*		0.2													2.8	12.9	
	Dipturus batis			0.2	0.2													
	Dipturus oxyrinchus				0.0	0.0	0.3										0.0	0.0
	Leucoraja circularis		36.1	28.5		0.9	0.6									0.1	0.5	
	Leucoraja fullonica				4.3	4.8	1.2									2.7	2.7	3.7
	Leucoraja naevus	19.7	16.8	17.5	71.3	71.2	62.6	0.8	0.1	0.8						19.3	22.7	26.8
	Raja brachyura	32.1	53.9	62.3	94.0	70.6	46.4	0.0	0.2				0.0			227.8	218.2	240.5
	Raja clavata	40.1	42.3	37.2	8.7	7.2	9.9	0.0	0.0							215.5	255.0	200.8
	Raja microocellata	30.7		1.1	10.1	13.3	12.9									164.2	175.4	106.8
	Raja montagui	13.2	19.2		98.3	150.9	167.5	0.1	0.0							23.1	19.3	17.7
	Rostroraja alba				0.1													
	VIIf Total Speciated	**135.9**	**168.5**	**146.9**	**286.9**	**319.1**	**301.3**	**1.0**	**0.4**	**0.8**			**0.0**			**655.6**	**706.7**	**596.3**
	VIIf Total landings	**174.6**	**185.1**	**148.6**	**296.7**	**325.3**	**303.8**	**1.5**	**0.6**	**0.8**			0.1			681.9	708.0	597.9
VIIg	*Amblyraja radiata*							0.6	1.2	0.2								
	Dipturus batis				0.0				0.1									
	Dipturus oxyrinchus				0.0	0.2	0.2		0.7			0.1				0.2	0.0	0.3
	Leucoraja circularis		79.5	70.6		11.1	13.0	0.0								0.2	0.0	0.7
	Leucoraja fullonica				16.2	13.5	10.4	1.5	0.6	0.3		0.8	0.2			8.6	10.2	12.8
	Leucoraja naevus	41.3	33.3	40.6	80.2	90.9	65.5	23.4	35.9	23.6		3.7	0.1	0.0		21.1	18.5	7.8
	Raja brachyura	101.3	208.2	191.6	43.7	13.2	6.4	20.0	32.6	47.2			0.3	0.5		19.1	17.4	11.6
	Raja clavata	128.5	183.3	173.8	92.4	85.9	79.4	84.4	101.2	102.8		0.0	0.1	0.2		30.0	33.9	21.8
	Raja microocellata	73.0			7.7	2.1	3.8	0.0								21.6	28.8	8.6
	Raja montagui	55.3	34.0	1.5	451.8	573.0	327.0	12.5	17.0	16.1						2.8	6.4	2.9
	Rostroraja alba				8.1													
	Rajella fyllae								0.1									
	VIIg Total Speciated	**399.5**	**538.2**	**478.1**	**700.2**	**789.9**	**505.6**	**142.4**	**189.4**	**190.2**	**0.0**	**4.6**	**0.6**	**0.8**	**0.0**	**103.6**	**115.2**	**66.5**
	VIIg Total landings	**519.2**	**576.0**	**482.8**	**704.1**	**794.6**	**507.7**	**283.9**	**303.4**	**206.8**		4.6	**1.8**	**2.8**	**0.5**	**115.2**	**115.2**	**66.6**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Netherlands			Spain		Scotland			UK (E,W&NI)		
Div	Scientific name	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIIh	*Amblyraja radiata*					0.8															
	Dipturus batis				0.1																
	Dipturus oxyrinchus				0.1	3.5	2.3								1.1				0.1	0.0	0.0
	Leucoraja circularis		0.0			14.1	13.1								1.6				0.0	0.1	0.4
	Leucoraja fullonica				114.7	112.7	107.3	3.6	3.1	1.4					12.2	0.1	0.0		57.3	20.1	42.9
	Leucoraja naevus	0.0	0.1		1318.4	1089.4	995.6	27.1	7.2	11.7					88.8	4.5	0.2		117.4	62.0	85.3
	Raja brachyura		0.0		7.4	20.3	27.9	0.0	0.1										3.8	1.3	0.9
	Raja clavata		0.0		16.7	8.8	6.9	0.4		1.2									2.8	1.6	1.5
	Raja microocellata				10.3	0.1	0.7												3.8	1.5	1.6
	Raja montagui				63.1	66.5	68.3	0.0							0.0				5.5	1.4	3.0
	Rostroraja alba				0.6		0.1													0.0	
	VIIh Total Speciated	**0.0**	**0.2**		**1531.4**	**1316.1**	**1222.2**	**31.1**	**10.4**	**14.3**				**0.0**	**103.8**	**4.6**	**0.2**		**190.6**	**88.1**	**135.6**
	VIIh Total landings	**0.0**	**0.2**		**1534.6**	**1321.2**	**1225.2**	**32.5**	**11.0**	**14.3**					**103.8**	**4.6**	**0.2**		**190.6**	**88.1**	**135.6**
VIIj	*Amblyraja radiata*								0.0												
	Dipturus batis				0.2		0.0														
	Dipturus oxyrinchus				3.3	2.5	10.0		0.4	0.0					1.1						
	Leucoraja circularis				6.3	8.9	10.3	0.1	0.1						3.3		0.9			0.3	0.2
	Leucoraja fullonica				3.1	5.1	4.0	2.1	2.1	1.0					14.2	3.5	3.8		11.6	15.3	18.0
	Leucoraja naevus				43.0	56.8	72.0	29.8	32.8	42.2					126.5	13.5	11.3		52.5	21.1	35.8
	Raja brachyura				0.0	1.4		8.5	11.2	14.0					0.1				0.0		0.0
	Raja clavata				10.7	6.7	9.7	38.6	48.2	46.8	0.1				2.3	18.0	28.4	13.4	14.2	6.3	
	Raja microocellata					0.0									1.9				0.1		7.9
	Raja montagui				1.6	2.0	0.4	10.7	17.4						3.9		0.1		2.9	2.1	8.9
	VIIj Total Speciated				**68.3**	**83.3**	**106.3**	**89.7**	**112.2**	**104.0**	**0.1**			**0.0**	**153.3**	**35.0**	**44.6**	**13.4**	**81.3**	**45.0**	**70.8**
	VIIj Total landings				**72.1**	**85.0**	**106.4**	**94.4**	**117.8**	**119.6**	**0.1**				**155.1**	**35.0**	**44.6**	**13.4**	**81.3**	**45.0**	**70.8**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Netherlands			Spain		Scotland			UK (E,W&NI)		
Div	**Scientific name**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**
VIIh	*Amblyraja radiata*					**0.8**															
	Dipturus batis				0.1																
	Dipturus oxyrinchus				0.1	3.5	2.3								1.1				0.1	0.0	0.0
	Leucoraja circularis		0.0			14.1	13.1								1.6				0.0	0.1	0.4
	Leucoraja fullonica				114.7	112.7	107.3	3.6	3.1	1.4					12.2	0.1	0.0		57.3	20.1	42.9
	Leucoraja naevus	0.0	0.1		1318.4	1089.4	995.6	27.1	7.2	11.7					88.8	4.5	0.2		117.4	62.0	85.3
	Raja brachyura		0.0		7.4	20.3	27.9	0.0	0.1										3.8	1.3	0.9
	Raja clavata		0.0		16.7	8.8	6.9	0.4		1.2									2.8	1.6	1.5
	Raja microocellata				10.3	0.1	0.7												3.8	1.5	1.6
	Raja montagui				63.1	66.5	68.3	0.0							0.0				5.5	1.4	3.0
	Rostroraja alba				0.6		0.1													0.0	
	VIIh Total Speciated	**0.0**	**0.2**		**1531.4**	**1316.1**	**1222.2**	**31.1**	**10.4**	**14.3**				**0.0**	**103.8**	**4.6**	**0.2**		**190.6**	**88.1**	**135.6**
	VIIh Total landings	**0.0**	**0.2**		**1534.6**	**1321.2**	**1225.2**	**32.5**	**11.0**	**14.3**					**103.8**	**4.6**	**0.2**		**190.6**	**88.1**	**135.6**
VIIj	*Amblyraja radiata*								**0.0**												
	Dipturus batis				0.2		0.0														
	Dipturus oxyrinchus				3.3	2.5	10.0		0.4	0.0					1.1						
	Leucoraja circularis				6.3	8.9	10.3	0.1	0.1						3.3		0.9			0.3	0.2
	Leucoraja fullonica				3.1	5.1	4.0	2.1	2.1	1.0					14.2	3.5	3.8		11.6	15.3	18.0
	Leucoraja naevus				43.0	56.8	72.0	29.8	32.8	42.2					126.5	13.5	11.3		52.5	21.1	35.8
	Raja brachyura				0.0	1.4		8.5	11.2	14.0					0.1				0.0		0.0
	Raja clavata				10.7	6.7	9.7	38.6	48.2	46.8	0.1				2.3	18.0	28.4	13.4	14.2	6.3	
	Raja microocellata					0.0									1.9				0.1		7.9
	Raja montagui				1.6	2.0	0.4	10.7	17.4						3.9		0.1		2.9	2.1	8.9
	VIIj Total Speciated				**68.3**	**83.3**	**106.3**	**89.7**	**112.2**	**104.0**	**0.1**			**0.0**	**153.3**	**35.0**	**44.6**	**13.4**	**81.3**	**45.0**	**70.8**
	VIIj Total landings				**72.1**	**85.0**	**106.4**	**94.4**	**117.8**	**119.6**	**0.1**				**155.1**	**35.0**	**44.6**	**13.4**	**81.3**	**45.0**	**70.8**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

VIIK	*DIPTURUS BATIS*	0.0																
	Dipturus oxyrinchus	0.2	0.0	0.0														
	Leucoraja circularis	0.0	0.0	0.1										0.8				
	Leucoraja fullonica	0.6	0.1	0.0													0.1	
	Leucoraja naevus	0.3	1.9	0.1	0.3	0.3						0.1						
	Raja brachyura		0.2			0.3	0.2											
	Raja clavata	0.1	0.3	0.1	0.4	0.0							1.5	1.3	1.0			0.2
	Raja microocellata		0.0															
	Raja montagui	0.1	0.0	0.0														
	VIIk Total Speciated	**1.3**	**2.5**	**0.3**	**0.6**	**0.6**	**0.2**				**0.0**	**0.1**	**1.5**	**2.1**	**1.0**		**0.1**	**0.2**
	VIIk Total landings	**1.3**	**2.8**	**0.3**	**0.7**	**0.6**	**0.2**					0.1	**1.5**	**2.1**	**1.0**		**0.1**	**0.2**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Percentage of skates (Rajidae) reported to species level, as reported in national landing statistics (tonnes). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	**Scientific name**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**
VIa	*Amblyraja radiata*	0.0	0.0	4.4	0.0	0.0	0.0		0.0	0.0	0.0	0.0	6.4	3.1	0.0
	Dipturus batis	0.1	0.0	0.0	0.0	0.0	0.0		0.0	0.3	0.6	0.1	0.0	0.0	0.0
	Amblyraja hyperborea														
	Dipturus oxyrinchus	6.2	14.3	8.6	1.0	0.0	0.0		0.0	1.4	2.2	0.0	0.0	0.0	0.0
	Leucoraja circularis	2.1	0.7	0.9	0.0	0.0	0.0		0.0	0.0	0.2	0.0	0.0	0.0	0.8
	Leucoraja fullonica	3.1	2.6	2.6	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja naevus	54.9	35.4	27.1	13.6	7.2	5.7		6.3	32.3	25.1	11.9	11.1	0.4	0.0
	Raja brachyura	0.0	0.0	0.0	0.4	0.7	12.5		0.0	3.8	0.9	0.0	33.1	25.3	40.1
	Raja clavata	31.4	37.9	33.1	49.0	62.7	72.5		94.1	23.6	30.5	56.5	45.1	25.8	44.7
	Raja microocellata	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	7.2
	Raja montagui	2.1	2.6	18.8	2.2	1.9	2.7		0.0	15.7	12.7	14.1	0.0	0.0	4.4
	Rostroraja alba	0.0	0.0	0.0	0.0	0.0	0.0		0.0	2.4	4.1	2.2	0.0	0.0	0.0
	VIa Total Speciated	**100.0**	**93.6**	**96.1**	**66.2**	**72.6**	**93.5**		**100.0**	**79.5**	**76.4**	**84.9**	**95.7**	**54.6**	**97.2**
	VIa Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
VIb	*Dipturus batis*	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	9.7	0.0	0.0	0.0	0.0
	Dipturus oxyrinchus	0.0	34.5	0.0	0.0	0.0	0.0		48.3	45.1	22.2	0.0	0.0	0.0	0.0
	Leucoraja circularis	94.0	38.1	100.0	43.1	0.0	0.0		0.0	0.0	1.5	56.6	0.0	0.0	0.0
	Leucoraja fullonica	0.0	18.5	0.0	6.3	36.5	37.6		42.8	0.0	3.7	0.0	0.0	0.0	0.0
	Leucoraja naevus	0.0	0.0	0.0	1.7	3.8	0.7		0.0	4.0	28.1	10.3	0.0	0.0	0.0
	Raja brachyura	0.0	0.0	0.0	0.0	0.0	0.0		0.0	1.0	0.0	0.0	100.0	100.0	0.0
	Raja clavata	0.0	9.0	0.0	43.9	59.7	27.5		0.0	32.0	25.2	30.1	0.0	0.0	100.0
	Raja microocellata	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Raja montagui	5.6	0.0	0.0	0.0	0.0	34.3		0.0	1.9	3.8	1.0	0.0	0.0	0.0
	Rostroraja alba	0.0	0.0	0.0	0.0	0.0	0.0		0.0	5.7	0.9	0.0	0.0	0.0	0.0
	VIb Total Speciated	**99.6**	**100.0**	**100.0**	**94.9**	**100.0**	**100.0**		**91.1**	**89.6**	**95.1**	**97.9**	**100.0**	**100.0**	**100.0**
	VIb Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	**Scientific name**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**
VIIa	*Amblyraja radiata*	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0			0.0	0.0	0.0	0.4	0.5	0.0
	Dipturus batis	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0			0.0	0.0	0.0	0.0	0.1	0.0
	Dipturus oxyrinchus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja circularis	0.0	1.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja fullonica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja naevus	7.8	8.3	9.5	9.8	5.9	7.4	1.9	2.6	1.1			0.0	0.0	0.0	2.9	3.3	0.6
	Raja brachyura	38.7	33.2	41.3	0.1	1.3	0.0	72.4	78.3	77.7			0.0	0.0	0.0	13.7	10.5	4.1
	Raja clavata	28.1	49.9	48.6	3.6	23.9	6.6	7.1	7.4	13.3			21.6	0.0	72.9	75.2	78.2	87.7
	Raja microocellata	0.5	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.1
	Raja montagui	10.6	3.5	0.0	85.8	68.7	85.5	9.8	7.1	5.9			2.6	0.0	1.4	4.7	4.7	0.6
	Rostroraja alba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	11.8	0.0	0.0	0.0	0.0
	VIIa Total Speciated	**85.7**	**96.2**	**99.7**	**99.3**	**99.9**	**100.0**	**92.4**	**95.4**	**98.0**			**24.3**	**11.8**	**74.3**	**97.1**	**97.3**	**93.1**
	VIIa Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**			**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
VIIb	*Amblyraja radiata*				0.0	0.0	0.0	0.1	0.5	0.1		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dipturus oxyrinchus				0.0	0.2	0.0	9.7	0.0	0.0		20.8	0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja circularis				0.1	0.1	0.0	0.0	0.0	0.0		20.8	0.0	0.0	59.6	0.0	0.0	0.0
	Leucoraja fullonica				0.0	0.0	0.0	0.0	0.0	0.0		1.1	0.0	0.0	0.0	15.1	17.3	19.6
	Leucoraja naevus				64.8	53.3	37.5	7.7	10.2	8.7		57.0	34.0	0.0	0.0	45.8	44.8	42.9
	Raja brachyura				0.0	0.0	2.5	30.4	26.9	36.1		0.0	0.0	0.0	0.0	0.0	0.2	0.0
	Raja clavata				34.8	45.4	59.4	33.2	49.2	48.3		0.0	66.0	100.0	40.4	39.1	33.9	37.4
	Raja microocellata				0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Raja montagui				0.1	0.2	0.1	1.8	4.5	4.8		0.0	0.0	0.0	0.0	0.0	3.6	0.0
	Dipturus nidarosiensis				0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.2	0.0
	VIIb Total Speciated				**99.8**	**99.2**	**99.7**	**82.9**	**91.3**	**97.9**		**99.7**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**99.9**
	VIIb Total landings				**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Netherlands			Spain		Scotland			UK (E,W&NI)		
Div	Scientific name	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIIc	*Dipturus batis*				2.4	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dipturus oxyrinchus				0.0	0.0	0.0	1.5	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja circularis				0.3	0.4	0.8	0.0	0.0	0.0					9.0	0.0	0.6	0.0	0.0	0.0	0.0
	Leucoraja fullonica				0.4	0.6	1.3	0.0	0.0	0.0					4.6	0.0	0.5	0.0	19.6	0.0	11.4
	Leucoraja naevus				77.0	66.2	45.7	60.7	26.0	100.0					85.1	0.0	0.0	0.0	80.4	37.5	87.6
	Raja brachyura				0.0	0.0	0.0	6.1	1.3	0.0					0.0	0.0	63.7	0.0	0.0	27.0	0.0
	Raja clavata				18.3	30.7	45.6	30.3	72.7	0.0					1.5	100.0	35.2	100.0	0.0	25.1	1.0
	Raja microocellata				0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Raja montagui				1.7	1.7	6.4	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	10.5	0.0
	Amblyraja radiata				0.0	0.2	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0
	VIIc Total Speciated				100.0	99.8	99.8	98.7	100.0	100.0					100.1	100.0	100.0	100.0	100.0	100.0	100.0
	VIIc Total landings				100.0	100.0	100.0	100.0	100.0	100.0					100.0	100.0	100.0	100.0	100.0	100.0	100.0
VIIe	*Amblyraja radiata*	0.0	0.1	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0				0.1	0.1	0.2
	Dipturus batis	0.0	0.0	0.0	0.1	0.0	0.1		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.1	0.1
	Dipturus oxyrinchus	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.0	0.0
	Leucoraja circularis	0.0	3.5	9.9	0.0	0.1	0.2		0.0	0.0	0.0	0.0	0.0		0.0				0.1	0.1	0.1
	Leucoraja fullonica	0.0	0.0	0.0	0.2	0.3	0.2		0.0	0.0	0.0	0.0	0.0		0.0				0.7	0.3	0.4
	Leucoraja naevus	6.4	5.4	6.3	29.6	23.7	19.3		0.0	0.0	0.0	0.0	2.7		78.0				17.2	16.4	13.7
	Raja brachyura	25.2	34.6	43.2	22.7	18.5	20.0		100.0	0.0	0.0	25.0	3.8		0.0				44.0	37.9	40.4
	Raja clavata	23.7	34.9	38.7	10.4	13.8	19.4		0.0	100.0	65.5	57.8	87.5		0.0				21.1	27.5	27.5
	Raja microocellata	3.1	0.0	0.0	1.6	1.9	2.0		0.0	0.0	0.0	0.0	0.0		0.0				5.3	6.6	5.3
	Raja montagui	9.1	9.7	0.1	29.9	36.6	35.4		0.0	0.0	24.4	0.0	4.7		22.0				10.1	9.6	11.5
	Raja undulata	0.0	0.0	0.0	0.2	0.0	0.1		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.0	0.0
	Rostroraja alba	0.0	0.0	0.0	1.3	0.0	0.4		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.0	0.0
	Rajella fyllae	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.0	0.0
	Amblyraja hyperborea	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0				0.0	0.0	0.0
	VIIe Total Speciated	**67.4**	**88.2**	**98.1**	**96.0**	**95.1**	**97.0**		**100.0**	**100.0**	**89.9**	**82.8**	**98.7**		**100.0**				**98.5**	**98.5**	**98.9**
	VIIe Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**				**100.0**	**100.0**	**100.0**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Spain		Scotland			UK (E,W&NI)		
Div	Scientific name	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIIf	*Amblyraja radiata*	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0			0.4	1.8	0.0
	Dipturus batis	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0			0.0			0.0	0.0	0.0
	Dipturus oxyrinchus	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0			0.0			0.0	0.0	0.0
	Leucoraja circularis	0.0	19.5	19.2	0.0	0.3	0.2	0.0	0.0	0.0			0.0			0.0	0.1	0.0
	Leucoraja fullonica	0.0	0.0	0.0	1.4	1.5	0.4	0.0	0.0	0.0			0.0			0.4	0.4	0.6
	Leucoraja naevus	11.3	9.1	11.8	24.0	21.9	20.6	54.5	16.5	100.0			0.0			2.8	3.2	4.5
	Raja brachyura	18.4	29.1	41.9	31.7	21.7	15.3	2.7	32.9	0.0			38.6			33.4	30.8	40.2
	Raja clavata	23.0	22.9	25.0	2.9	2.2	3.3	2.7	8.3	0.0			0.0			31.6	36.0	33.6
	Raja microocellata	17.6	0.0	0.7	3.4	4.1	4.2	0.0	0.0	0.0			0.0			24.1	24.8	17.9
	Raja montagui	7.6	10.4	0.0	33.1	46.4	55.1	5.4	8.6	0.0			0.0			3.4	2.7	3.0
	Rostroraja alba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0			0.0	0.0	0.0
	VIIf Total Speciated	**77.8**	**91.0**	**98.8**	**96.7**	**98.1**	**99.2**	**65.4**	**66.3**	**100.0**			**38.6**			**96.1**	**99.8**	**99.7**
	VIIf Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**			**100.0**			**100.0**	**100.0**	**100.0**
VIIg	*Amblyraja radiata*																	
	Dipturus batis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dipturus oxyrinchus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0		1.2	0.0	0.0	0.0	0.1	0.0	0.5
	Leucoraja circularis	0.0	13.8	14.6	0.0	1.4	2.6	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.2	0.0	1.0
	Leucoraja fullonica	0.0	0.0	0.0	2.3	1.7	2.0	0.5	0.2	0.2		17.9	10.0	0.0	0.0	7.5	8.9	19.2
	Leucoraja naevus	8.0	5.8	8.4	11.4	11.4	12.9	8.2	11.8	11.4		80.1	5.9	1.0	0.0	18.3	16.0	11.8
	Raja brachyura	19.5	36.1	39.7	6.2	1.7	1.3	7.0	10.8	22.8		0.0	14.4	16.9	0.0	16.6	15.1	17.4
	Raja clavata	24.8	31.8	36.0	13.1	10.8	15.6	29.7	33.3	49.7		0.8	4.9	8.8	0.0	26.1	29.4	32.7
	Raja microocellata	14.1	0.0	0.0	1.1	0.3	0.7	0.0	0.0	0.0		0.0	0.0	0.0	0.0	18.8	25.0	13.0
	Raja montagui	10.7	5.9	0.3	64.2	72.1	64.4	4.4	5.6	7.8		0.0	0.0	0.0	0.0	2.4	5.6	4.4
	Rostroraja alba	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rajella fyllae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	VIIg Total Speciated	**76.9**	**93.4**	**99.0**	**99.4**	**99.4**	**99.6**	**50.2**	**62.4**	**92.0**		**100.0**	**35.2**	**26.7**	**0.0**	**89.9**	**100.0**	**99.9**
	VIIg Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

		Belgium			France			Ireland			Netherlands			Spain		Scotland			UK (E,W&NI)		
DIV	SCIENTIFIC NAME	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2011	2012	2013	2011	2012	2013
VIIh	*Amblyraja radiata*	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0		0.0	0.0	0.0
	Dipturus batis	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0		0.0	0.0	0.0
	Dipturus oxyrinchus	0.0	0.0		0.0	0.3	0.2	0.0	0.0	0.0					1.1	0.0	0.0		0.0	0.0	0.0
	Leucoraja circularis	0.0	10.4		0.0	1.1	1.1	0.0	0.0	0.0					1.5	0.0	0.0		0.0	0.1	0.3
	Leucoraja fullonica	0.0	0.0		7.5	8.5	8.8	11.2	27.8	9.8					11.8	2.1	19.5		30.0	22.8	31.6
	Leucoraja naevus	100.0	45.4		85.9	82.5	81.3	83.2	65.7	81.4					85.6	97.9	80.5		61.6	70.5	62.9
	Raja brachyura	0.0	17.5		0.5	1.5	2.3	0.1	0.8	0.0					0.0	0.0	0.0		2.0	1.5	0.6
	Raja clavata	0.0	20.2		1.1	0.7	0.6	1.1	0.0	8.5					0.0	0.0	0.0		1.5	1.8	1.1
	Raja microocellata	0.0	0.0		0.7	0.0	0.1	0.0	0.0	0.0					0.0	0.0	0.0		2.0	1.7	1.2
	Raja montagui	0.0	0.0		4.1	5.0	5.6	0.1	0.0	0.0					0.0	0.0	0.0		2.9	1.6	2.2
	Rostroraja alba	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0		0.0	0.0	0.0
	VIIh Total Speciated	**100.0**	**93.4**		**99.8**	**99.6**	**99.8**	**95.7**	**94.3**	**99.7**					**99.9**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
	VIIh Total landings	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**					**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**
VIIj	*Amblyraja radiata*				0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dipturus batis				0.3	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dipturus oxyrinchus				4.6	2.9	9.4	0.0	0.3	0.0	0.0				0.7	0.0	0.0	0.0	0.0	0.0	0.0
	Leucoraja circularis				8.8	10.4	9.6	0.1	0.1	0.0	0.0				2.1	0.0	2.1	0.0	0.0	0.8	0.3
	Leucoraja fullonica				4.3	6.0	3.7	2.2	1.8	0.8	0.0				9.1	9.9	8.6	0.0	14.3	34.0	25.4
	Leucoraja naevus				59.6	66.8	67.6	31.5	27.9	35.3	0.0				81.6	38.5	25.4	0.0	64.6	46.7	50.5
	Raja brachyura				0.0	1.6	0.0	9.0	9.5	11.7	0.0				0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Raja clavata				14.8	7.9	9.1	40.9	40.9	39.1	100.0				1.5	51.5	63.6	100.0	17.5	13.9	0.0
	Raja microocellata				0.0	0.0	0.0	0.0	0.0	0.0	0.0				1.2	0.0	0.0	0.0	0.1	0.0	11.2
	Raja montagui				2.2	2.3	0.4	11.3	14.8	0.0	0.0				2.5	0.0	0.3	0.0	3.5	4.6	12.6
	VIIj Total Speciated				**94.7**	**97.9**	**99.9**	**95.0**	**95.3**	**87.0**	**100.0**				**98.9**	**100.0**	**100.0**	**100.0**	**99.9**	**100.0**	**100.0**
	VIIj Total landings				**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**				**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 18.3. Continued. Skates and rays in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics (t). Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.

VIIk	***Dipturus batis***	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**					**0.0**	**0.0**	**0.0**	**0.0**		**0.0**	**0.0**
	Dipturus oxyrinchus	17.4	0.3	2.7	0.0	0.0	0.0					0.0	0.0	0.0	0.0		0.0	0.0
	Leucoraja circularis	0.1	0.2	16.3	0.0	0.0	0.0					0.0	0.0	39.3	0.0		0.0	0.0
	Leucoraja fullonica	45.7	3.9	8.9	0.0	0.0	0.0					0.0	0.0	0.0	0.0		100.0	0.0
	Leucoraja naevus	20.4	67.6	37.3	37.8	44.2	0.0					100.0	0.0	0.0	0.0		0.0	0.0
	Raja brachyura	0.0	5.4	0.0	0.0	49.8	100.0					0.0	0.0	0.0	0.0		0.0	0.0
	Raja clavata	5.2	10.9	34.0	51.0	6.0	0.0					0.0	100.0	60.7	100.0		0.0	100.0
	Raja microocellata	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0		0.0	0.0
	Raja montagui	11.1	0.0	0.8	0.0	0.0	0.0					0.0	0.0	0.0	0.0		0.0	0.0
	VIIk Total Speciated	**100.0**	**88.4**	**100.0**	**88.8**	**100.1**	**100.0**					**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**
	VIIk Total landings	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**					**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**

Table 18.4a. Skates and rays in the Celtic Seas. Summary details of fishery-independent surveys using otter trawls in the Celtic Seas ecoregion. Adapted from ICES (2013a and references therein).

Country	Ireland	UK (Scot)	UK (Scot)	UK (Scot)	UK (NI)	UK (NI)	UK (Eng&Wal)	UK (Eng&Wal)	France	Spain
Acronym	IGFS-WIBTS-Q4	ScoGFS-WIBTS-Q1	ScoGFS-WIBTS-Q4	Rock-IBTS-Q3	NIGFS-WIBTS-Q1	NIGFS-WIBTS-Q4	EngW-WIBTS-Q4	PHHT-Q1	EVHOE-WIBTS-Q4	SpPGFS-WIBTS-Q4
Laboratory	MI	MSS	MSS	MSS	AFBI	AFBI	Cefas	Cefas	Ifremer	IEO
Research vessel	Celtic Explorer	Scotia	Scotia	Scotia	Corystes	Corystes	Endeavour	Cirolana/Endeavour	Thalassa	Vizconde de Eza
Gear type	36/47 GOV	36/47 GOV	36/47 GOV		Rock-hopper otter trawl	Rock-hopper otter trawl	36/47 GOV [34/45 GOV]	PHHT	36/47 GOV	BACA 40/52
Depth range	20–600	20–400	20–400		20–120	20–120	20–150		30–400	150–800
Trawl speed (knots)	4	4	4	4	3	3	4	4	4	3.5
Groundrope	Groundgears A&D	Bobbins	Bobbins	Bobbins	Rubber discs	Rubber discs	Groundgears A&D	Rock-hopper	Groundgear A	Synthetic wrapped wire core (double coat)
Survey area	VIA, VII	VI	VI	VIb	VIIA	VIIA	VIIA,E–H	VII	VIIF–J, VIII	VIIC
Station grid	Semi-random depth stratified	Semi-random, 1–2 tows per rectangle	Semi-random, 1–2 tows per rectangle		Fixed stations in strata	Fixed stations in strata	Fixed stations in strata	Fixed stations	Stratified random	Random stratified across 5 strata
Quarter	4	1	4	4	1	4	4	1 (4)	4	3–4
Time coverage	2003–	1992–	1992–		1992–	1992–	2003–2011	1988–2003	1997–	2001–
Coordination	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	-	IBTSWG	IBTSWG

Table 18.4b. Skates and rays in the Celtic Seas. Summary details of fishery-independent trawl surveys (WIBTS) in the Celtic Seas ecoregion.

Country	UK (Eng&Wal)	UK (Eng&Wal)	UK (Eng&Wal)
Acronym	EngW-BTS-Q3	Eng-WEC-BTS-Q4	Eng-WEC-BTS-Q1
Laboratory	Cefas	Cefas	Cefas
Research vessel	Endeavour [1]	FV Carhelmar	Endeavour
Gear type	4 m BT	4 m BT (twin)	4 m BT (twin)
Depth range	10–135		
Trawl speed (knots)	4	4	4
Survey area	VIIAF	VIIE (part)	VIIE
Station grid	Fixed	Fixed	Stratified random
Quarter	3	4	1
Time coverage	1988–present [2]	1988–2012[2]	2006–present
Coordination	WGBEAM	WGBEAM	

[1] **Endeavour used in recent years only. RV *Corystes* used previously.**

[2] **Grid standardized since 1993.**

Table 18.5. Skate and rays in the Celtic Seas. Preliminary estimates of M for skates in the Celtic Seas ecoregion. References are: [1] Du Buit (1976), [2] Ryland and Ajayi (1984), [3] Coelho and Erzini (2002) and [4] Gallagher (2000).

Species	Sex	Longevity	Reference	M_longevity	Age 50	Reference	M_maturity
Dipturis batis complex	Both	50	[1]	0.09	11.00	[1]	0.11
Leucoraja naevus	M	12		0.38	4.17		0.38
Leucoraja naevus	F	12	[1]	0.38	4.25	[4]	0.38
Raja brachyura	M	12		0.38	5.50		0.29
Raja brachyura	F	12	[2]	0.38	4.63	[4]	0.34
Raja clavata	M	12		0.38	6.13		0.25
Raja clavata	F	12	[2]	0.38	6.13	[4]	0.25
Raja microocellata	M	7		0.66			
Raja microocellata	F	9	[2]	0.51			
Raja montagui	M	8		0.58	3.41		0.47
Raja montagui	F	8	[2]	0.58	4.14	[4]	0.39
Raja undulata	M	12	.	0.38	7.66		0.19
Raja undulata	F	13	[3]	0.35	8.98	[3]	0.15

Table 18.6. Skate and rays in the Celtic Seas. Preliminary catch curve estimates of HR-converted (HR = 1-exp (-F)) fishing mortality (F=Z-M) for four skate species. Missing values are due to insufficient data.

IGFS Celtic Sea VIIg: Survey data	Catch curve	Summed	Female	Male	2011	2012	2013
Spotted Ray	*Raja montagui*	0.23	0.22	0.40	0.43	0.15	0.19
Thornback ray	*Raja clavata*	0.01	0.02	0.04			
Cuckoo ray	*Leucoraja naevus*	0.54	0.58	0.32			
Blonde ray	*Raja brachyura*	0.11					

NIGFS Irish Sea VIIa: Survey data	Catch curve	Summed	Female	Male
Spotted Ray	*Raja montagui*	0.71	0.17	0.11
Thornback ray	*Raja clavata*			
Cuckoo ray	*Leucoraja naevus*			
Blonde ray	*Raja brachyura*			

Irish Sea (VIIa): Observer data	Catch curve	Summed	Female	Male	2011	2012
Spotted Ray	*Raja montagui*	0.67	0.19	0.18	0.20	0.53
Thornback ray	*Raja clavata*					
Cuckoo ray	*Leucoraja naevus*	0.40				
Blonde ray	*Raja brachyura*	0.40	0.37	0.32	0.27	0.22

Table 18.7. Skate and rays in the Celtic Seas. Preliminary survey estimates of TSB and HR for four tested skate species. HR values coloured red are ≥ than precautionary reference levels, green are <reference levels.

Irish Sea (VIIa)	Survey method	2011		2012	
Common name	Latin name	TSB	*HR*	TSB	*HR*
Spotted Ray	*Raja montagui*	12982	0.03	8826	0.02
Thornback ray	*Raja clavata*	25976	0.01	24680	0.02
Cuckoo ray	*Leucoraja naevus*	2363	0.26	4629	0.10
Blonde ray	*Raja brachyura*	8037	0.09	7589	0.08
IGFS Celtic Sea VIIg	**Survey method**				
Spotted Ray	*Raja montagui*	2542	0.17	2317	0.22
Thornback ray	*Raja clavata*	255	0.65	368	0.55
Cuckoo ray	*Leucoraja naevus*	1704	0.27	313	0.67
Blonde ray	*Raja brachyura*	1237	0.27	58	0.82
VIIa and VIIg	**Survey method**				
Spotted Ray	*Raja montagui*	15524	0.05	11143	0.07
Thornback ray	*Raja clavata*	26231	0.03	25048	0.04
Cuckoo ray	*Leucoraja naevus*	4067	0.26	4942	0.19
Blonde ray	*Raja brachyura*	9274	0.12	7647	0.11

Table 18.8. Skate and rays in the Celtic Seas. Potential precautionary HR reference points for four skate species in ICES VIIa and VIIg.

	HR_{msy}	HR_{40}
Latin name	Zhou 2012	Le Quesne 2012
Raja montagui	**0.21**	**0.10**
Raja clavata	**0.14**	**0.09**
Leucoraja naevus	**0.14**	**0.11**
Raja brachyura	**0.14**	**0.08**

Table 18.9. Skates and rays in the Celtic Seas. Potential reference points and harvest ratios for skates, as calculated using different methodologies.

Stock (method)			**2011**		**2012**		***HR_{msy}***	***HR_{40}***
Irish Sea VIIa (Survey method)		*M*	TSB	*HR*	TSB	*HR*	Zhou 2012	Le Quesne & Jennings 2012
R. montagui		0.58	12982	0.03	8826	0.02	0.21	0.10
R .clavata		0.38	25976	0.01	24680	0.02	0.14	0.09
L. naevus		0.38	2363	0.26	4629	0.10	0.14	0.11
R. brachyura		0.38	8037	0.09	7589	0.08	0.14	0.08
VIIa and VIIg (Survey method)								
R. montagui			22828	0.04			0.21	0.10
R. clavata			28084	0.03			0.14	0.09
L. naevus			7422	0.16			0.14	0.11
R. brachyura			11488	0.10			0.14	0.08
IGFS Celtic Sea VIIg (Catch curve)	Summed	Female	Male	2011	2012	2013		
R. montagui	0.32	0.22	0.40	0.30	0.19	0.21	0.21	0.10
R. clavata	0.01	0.02	0.04				0.14	0.09
L. naevus	0.49	0.38	0.58				0.14	0.11
R. brachyura	0.25						0.14	0.08
NIGFS Irish Sea VIIa (Catch curve)	Summed	Female	Male					
R. montagui	0.71	0.24	0.24				0.21	0.10
R. clavata							0.14	0.09
L. naevus							0.14	0.11
R. brachyura							0.14	0.08
Irish Sea VIIa (Observer catch curves)	Summed	Female	Male	2011	2012			
R. montagui	0.67	0.19	0.18	0.20	0.53		0.21	0.10
R.clavata							0.14	0.09
L. naevus							0.14	0.11
R. brachyura	0.39	0.37	0.32	0.27	0.22		0.14	0.08

Table 18.10. Skates and rays in the Celtic Seas. Technical interactions.

Stock interaction table	Anglerfish budegassa VIIb-k, VIIIabd	Anglerfish piscatorius VIIb-k, VIIIabd	Cod VIIe-k	Haddock VIIb-k	Hake Northern	Herring Celtic Sea and Division VIIj	Herring VIa(S) and VIIbc	Horse Mackerel Western	Mackerel North East Atlantic	Megrim VII	Nephrops Area L: VIIbcjk	Nephrops Area M: VIIfgh+VIIa	Nephrops VIIIa,b	Plaice VIIbc	Plaice VIIe	Plaice VIIfg	Plaice VIIhjk	Sole VIIbc	Sole VIIe	Sole VIIfg	Sole VIIhjk	Sprat VIIde	Whiting VIIe-k	Seabass	Skates and rays	Pelagic and migratory sharks	Demersal sharks
Anglerfish budegassa VIIb-k, VIIIabd		H	L	L	M	0	0	0	0	M	M	L	M	L	L	L	L	L	L	L	L		L		H	L	H
Anglerfish piscatorius VIIb-k, VIIIabd	T		L	L	M	0	0	0	0	M	M	M	M	L	L	L	L	L	L	L	L		L		H	L	H
Cod VIIe-k	T	T		H	L	0	0	0	0	L	L	M	0	0	L	M	L	0	L	L	L	0	H/M		H	L	H
Haddock VIIb-k	T	T	T		L	0	0	0	0	L	M	M	0	L	L	L	L	L	L	L	L	0	H	0	H	L	H
Hake Northern	T	T	T			0	0	0	0	M	M	L	M	L		0	L	L		0	L		L		H	L	H
Herring Celtic Sea and Division VIIj	N	N	N	N	N		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	I	0
Herring VIa(S) and VIIbc	N	N	N	N	N	N		0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	L	0
Horse Mackerel Western	N	N	N	N	N	N	N		H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	L	0
Mackerel North East Atlantic	N	N	N	N	N	N	N			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	L	0
Megrim VII	T, BT	T, BT	T		T	N	N	N	N		H	M	M	L			L	L		L	L		L		H	0	H
Nephrops Area L: VIIbcjk	NT	NT	NT	NT	NT	N	N	N	N	NT		0	0	L	0	0	L	L	0	0	L	0	M		M	0	M
Nephrops Area M: VIIfgh+VIIa	NT	NT	NT	NT	NT	N	N	N	N	NT	N		0	0	0	0	L	0	0	L	L	0	M		M	0	M
Nephrops VIIIa,b	NT	NT	N	N	NT	N	N	N	N	NT	N	N		0	0	0	0	0	0	0	0	0	0		L	0	M
Plaice VIIbc			N			N	N	N	N		NT	N	N		0	0	0	L	0	0	0	0	L	0	H	0	M
Plaice VIIe	OT, BT	OT, BT	OT, BT	N		N	N	N	N		N	N	N	N		0	0	0	H	0	0	0	L		H	0	M
Plaice VIIfg	OT, BT	OT, BT	OT, BT	OT, BT	N	N	N	N	N		N	N	N	N	N		0	0	0	H	0	0	L		H	0	M
Plaice VIIhjk			BT, OT			N	N	N	N		NT	N	N	N	N	N		0	0	0	L	0	L	0	H	0	M
Sole VIIbc			N			N	N	N	N		N	N	N		N	N	N		0	0	0	0	L	0	H	0	M
Sole VIIe	BT, OT	BT, OT	BT, OT	N		N	N	N	N		N	N	N	N	BT, OT	N	N	N		0	0	0	L		H	0	M
Sole VIIfg	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	N	BT	N	NT	N	N	N	BT, OT	N	N	N		0	0	L		H	0	M
Sole VIIhjk			BT, OT			N	N	N	N		N	N	N	N	N	N	T, BT	N	N	N		0	L	0	H	0	M
Sprat VIIde	N	N	N	N				N	N		N	N	N	N	N	N	N	N	N	N	N		0				
Whiting VIIe-k	T	T	T	T		N	N	N	N		NT	NT	N	N	N	BT, OT		N	N	BT, OT				0	H	L	H
Seabass						N	N	N	N														0		L	L	L
Skates and rays	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	BT, OT	NT	NT	NT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	BT,OT	GN		L	H
Pelagic and migratory sharks	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	BT, OT				BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	BT, OT	BT, OT	N	BT,OT	T, GN	GN, BT		0
Demersal sharks	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	BT, OT	NT	NT	NT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	BT,OT	GN	BT,OT	N	

H; the stocks are taken together in most fisheries where they are taken and their fisheries linkage is therefore high; M: the stocks are taken together in some but not all important fisheries and their fisheries linkage is therefore medium; L: the stocks

T: Trawl; BT: Beam trawl; OT: Otter trawl; NT: Nephrops trawl; GN: Gillnet; N: none

Figure 18.1a. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas (ICES Subareas VI and VII (including VIId)), from 1903–2013 (Source: ICES).

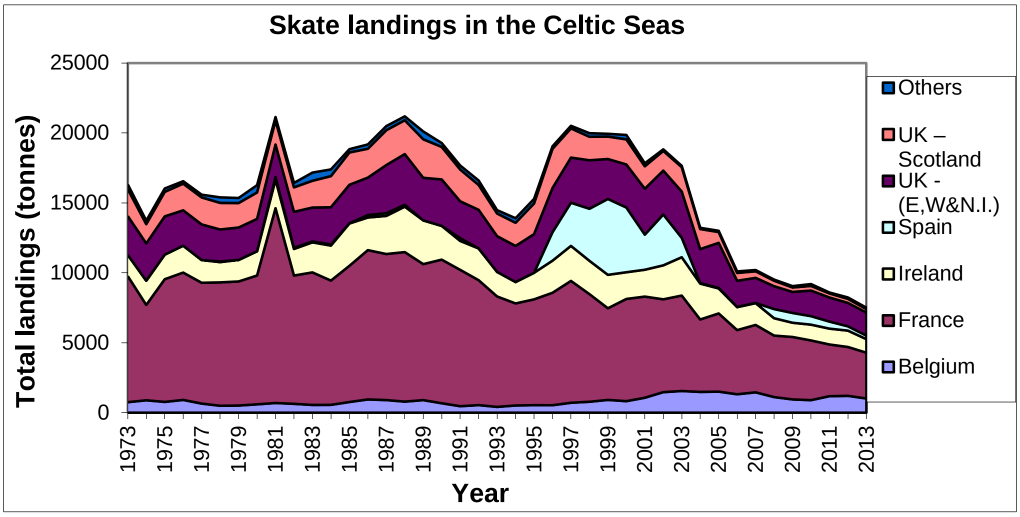


Figure 18.1b. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2013 (Source: ICES).

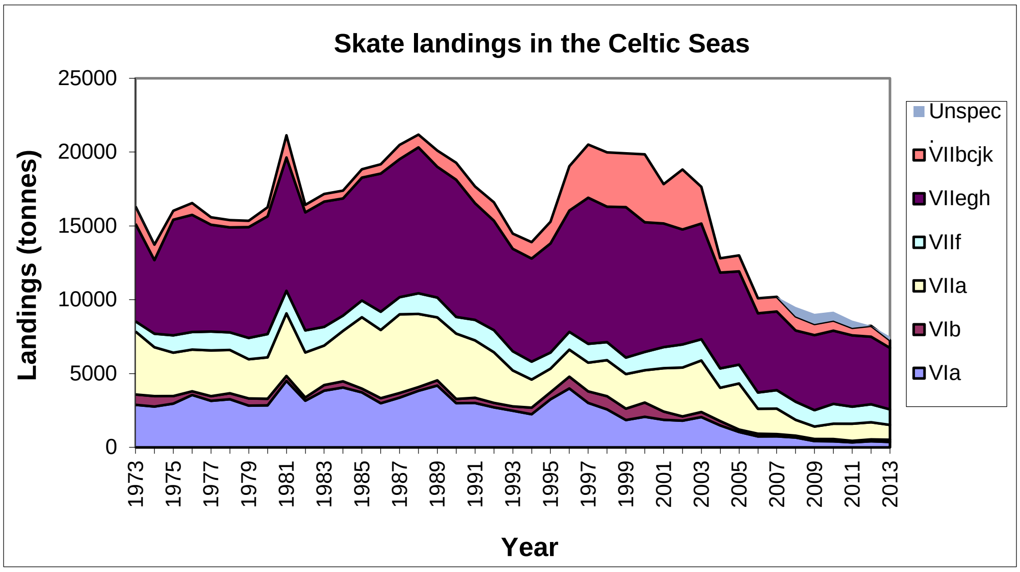


Figure 18.1c. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by ICES Division in the Celtic Seas from 1973–2013 (Source: ICES).

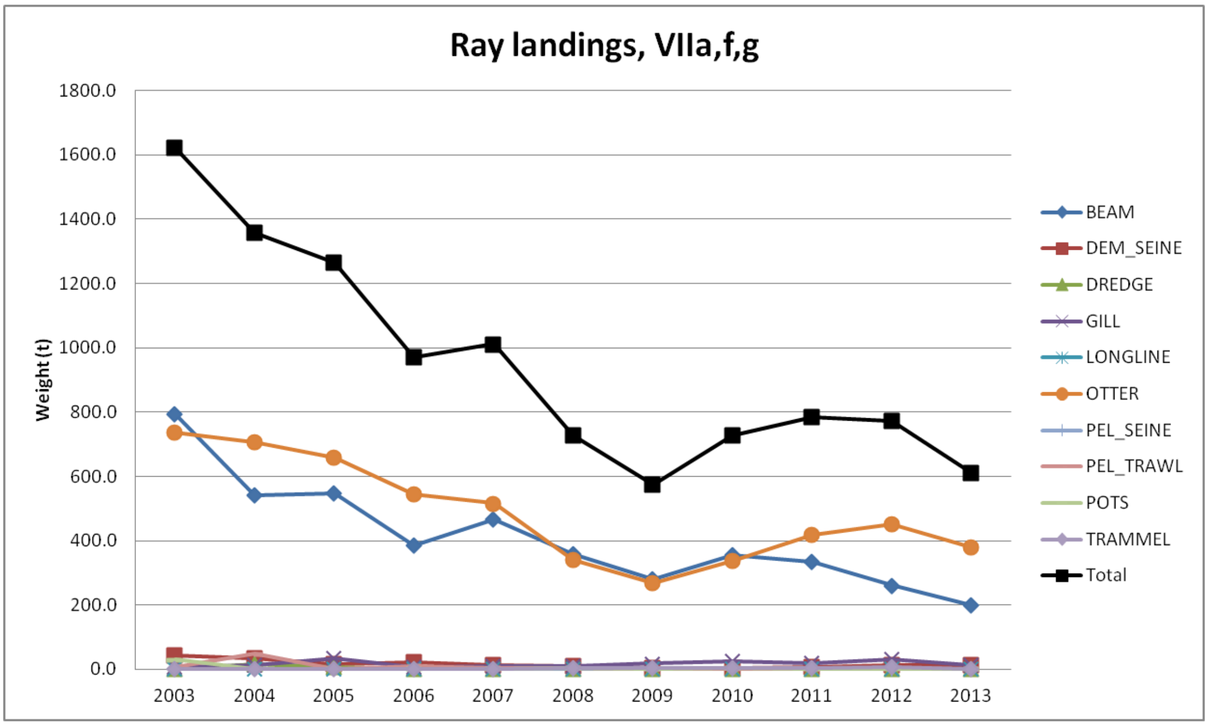


Figure 18.2. Skates and rays in the Celtic Seas. Landings by gear type of combined skate species within Divisions VIIa, VIIf, and VIIg, 2003–2013.

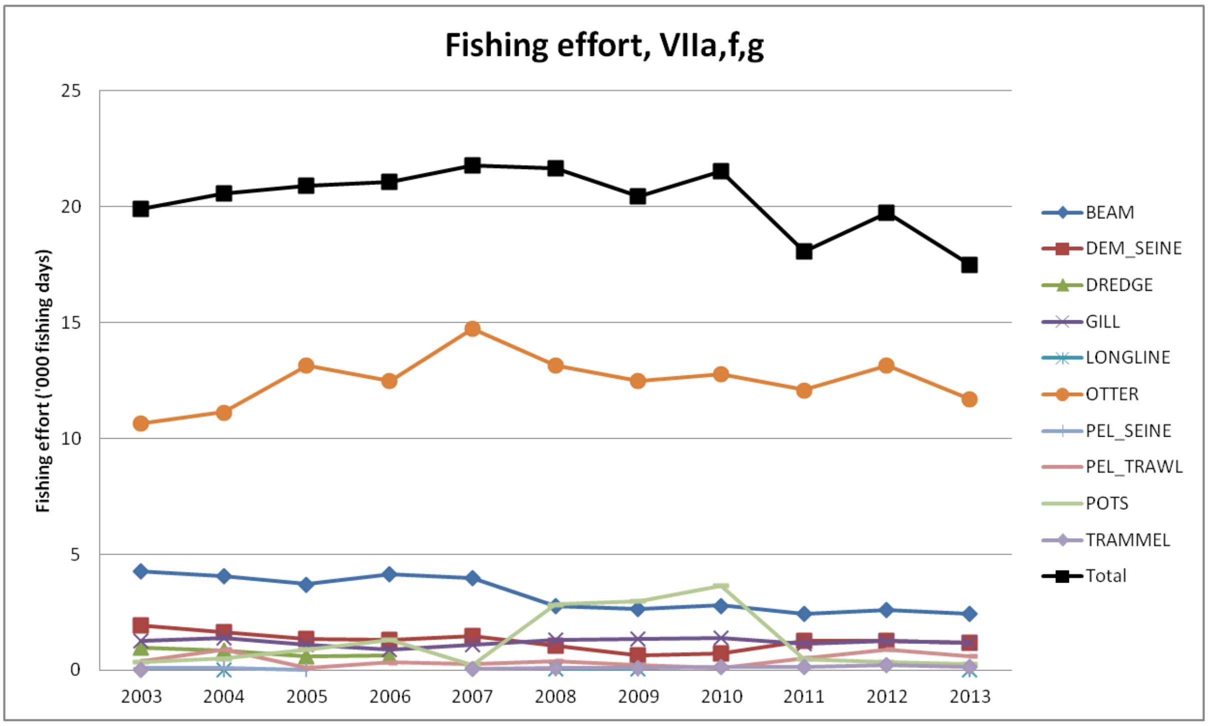


Figure 18.3. Skates and rays in the Celtic Seas. Fishing effort (in fishing days) by gear type within Divisions VIIa, VIIf, and VIIg, 2003–2013.

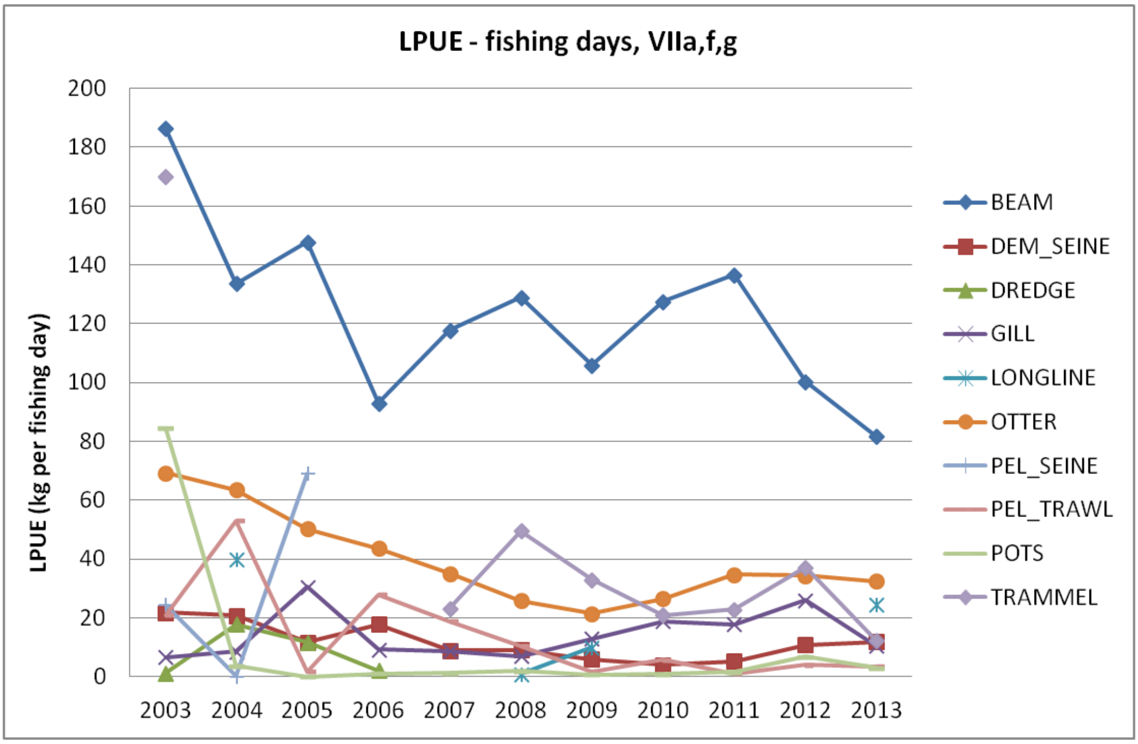


Figure 18.4. Skates and rays in the Celtic Seas. Irish lpue (in fishing days per kg) of combined skate species by gear types in Divisions VIIa, VIIf, and VIIg, 2003–2013.

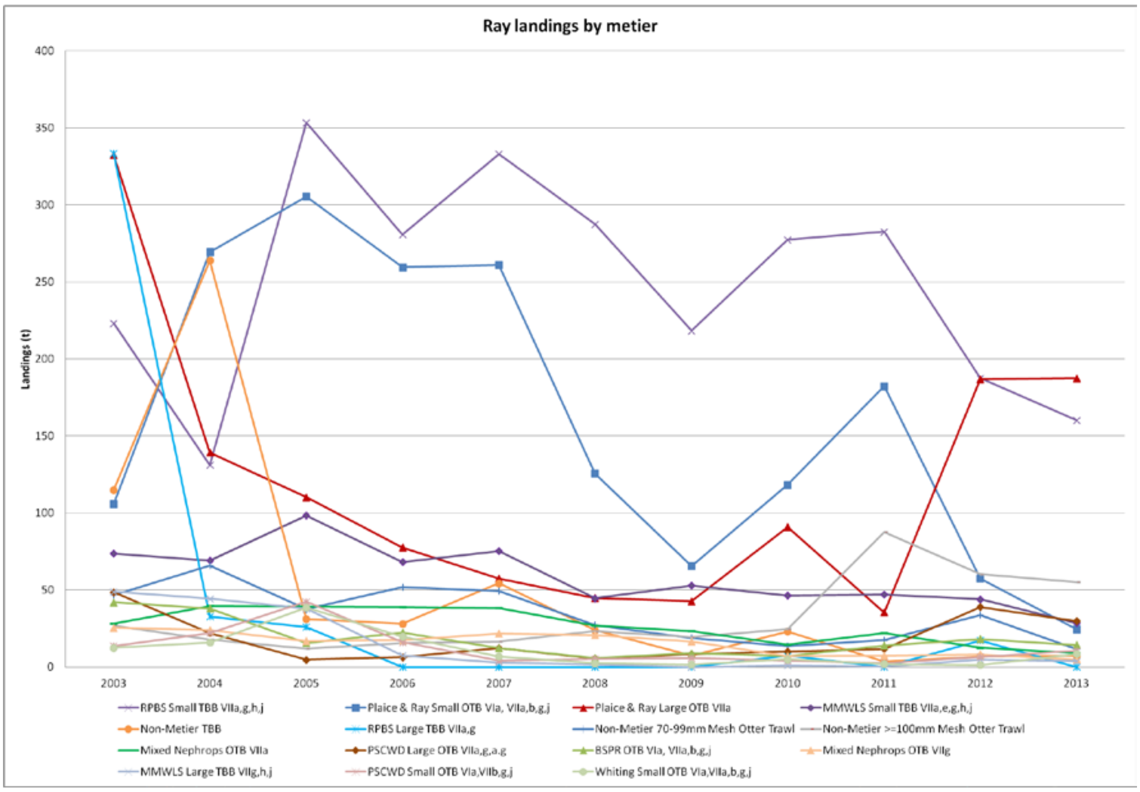


Figure 18.5. Skates and rays in the Celtic Seas. Landings of combined skate species by métier grouping (Davie and Lordan, 2011; Davie, 2014) in Divisions VIIa, VIIf, VIIg, 2003–2013.

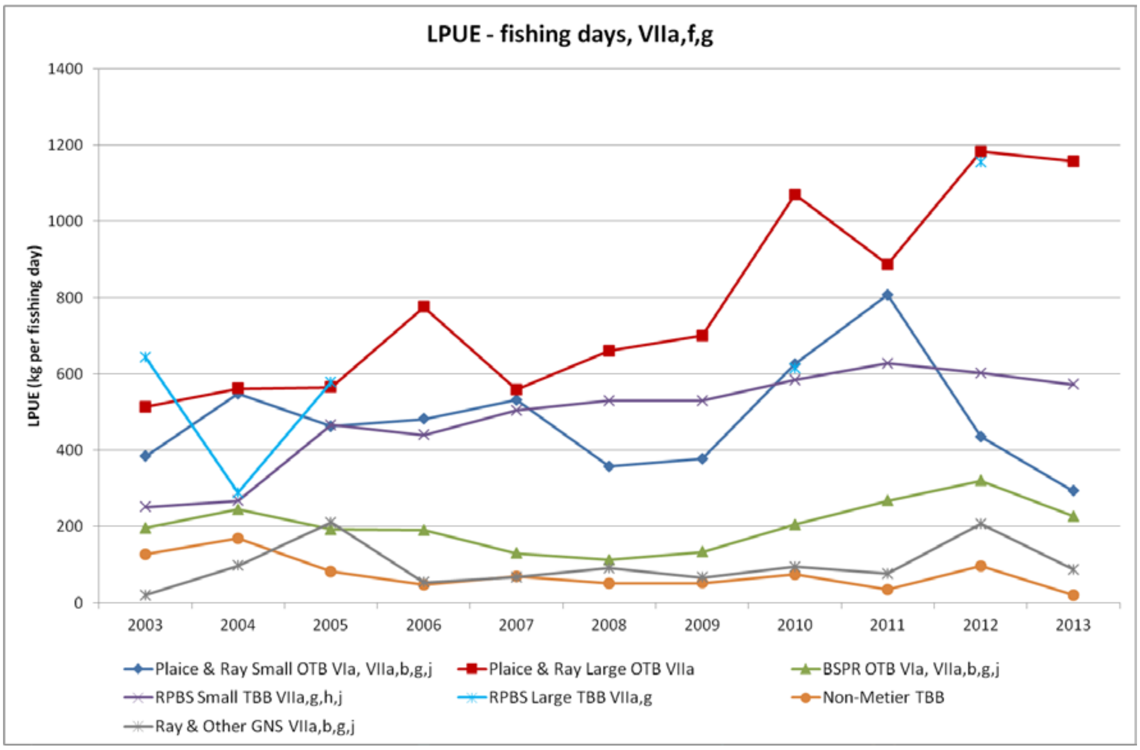


Figure 18.6. Skates and rays in the Celtic Seas. Irish lpue (in fishing days per kg) of combined skate species in Divisions VIIa, VIIf, and VIIg by targeting métiers (Table 1), 2003–2013.

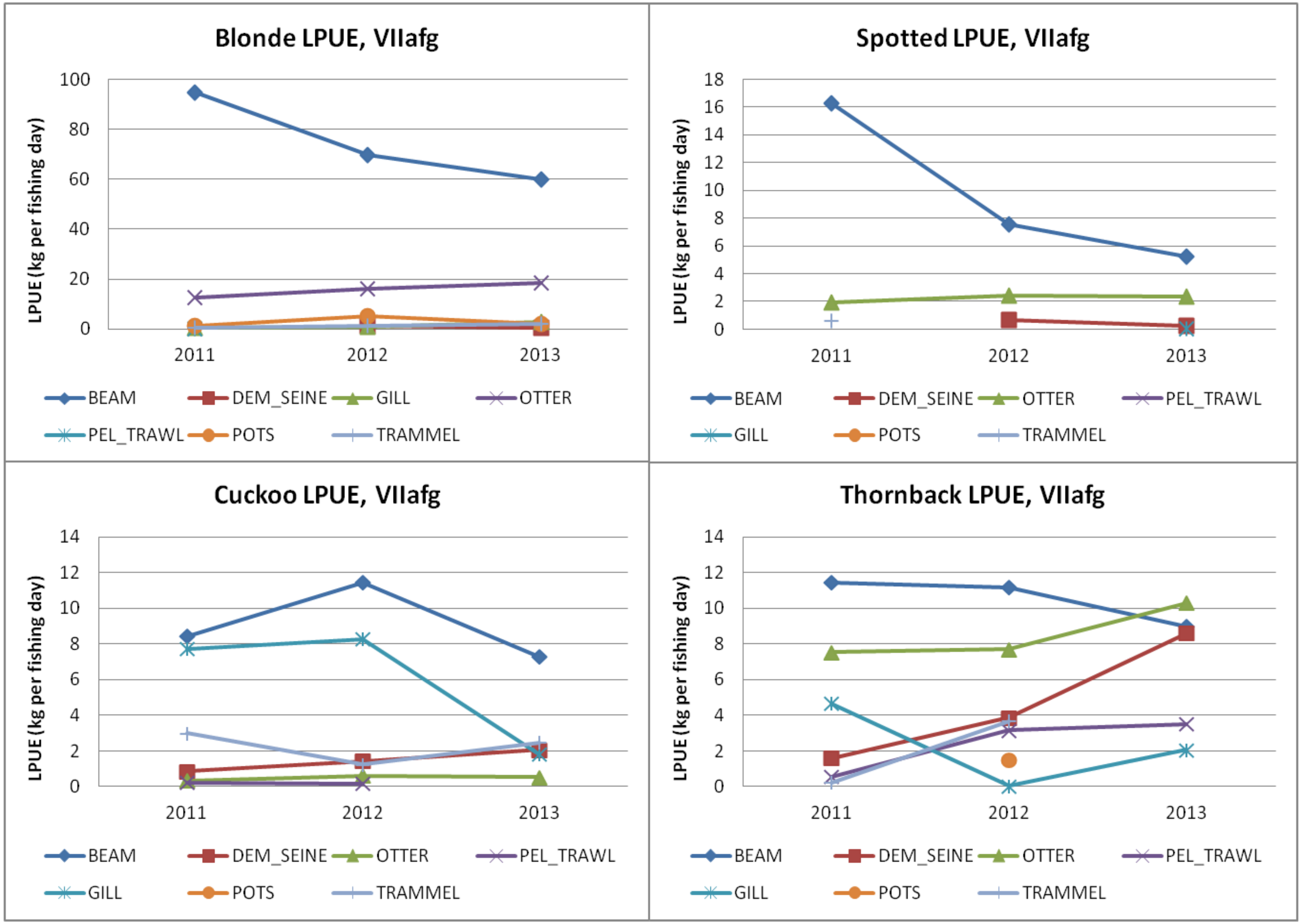


Figure 18.7. Skates and rays in the Celtic Seas. Irish lpue (in fishing days per kg) of the four skate species (blonde ray *R. brachyura,* thornback ray *R. clavata,* spotted ray *R. montagui* and cuckoo ray *L. naevus*) by gear type in Divisions VIIa, VIIf, VIIg, 2011–2013.

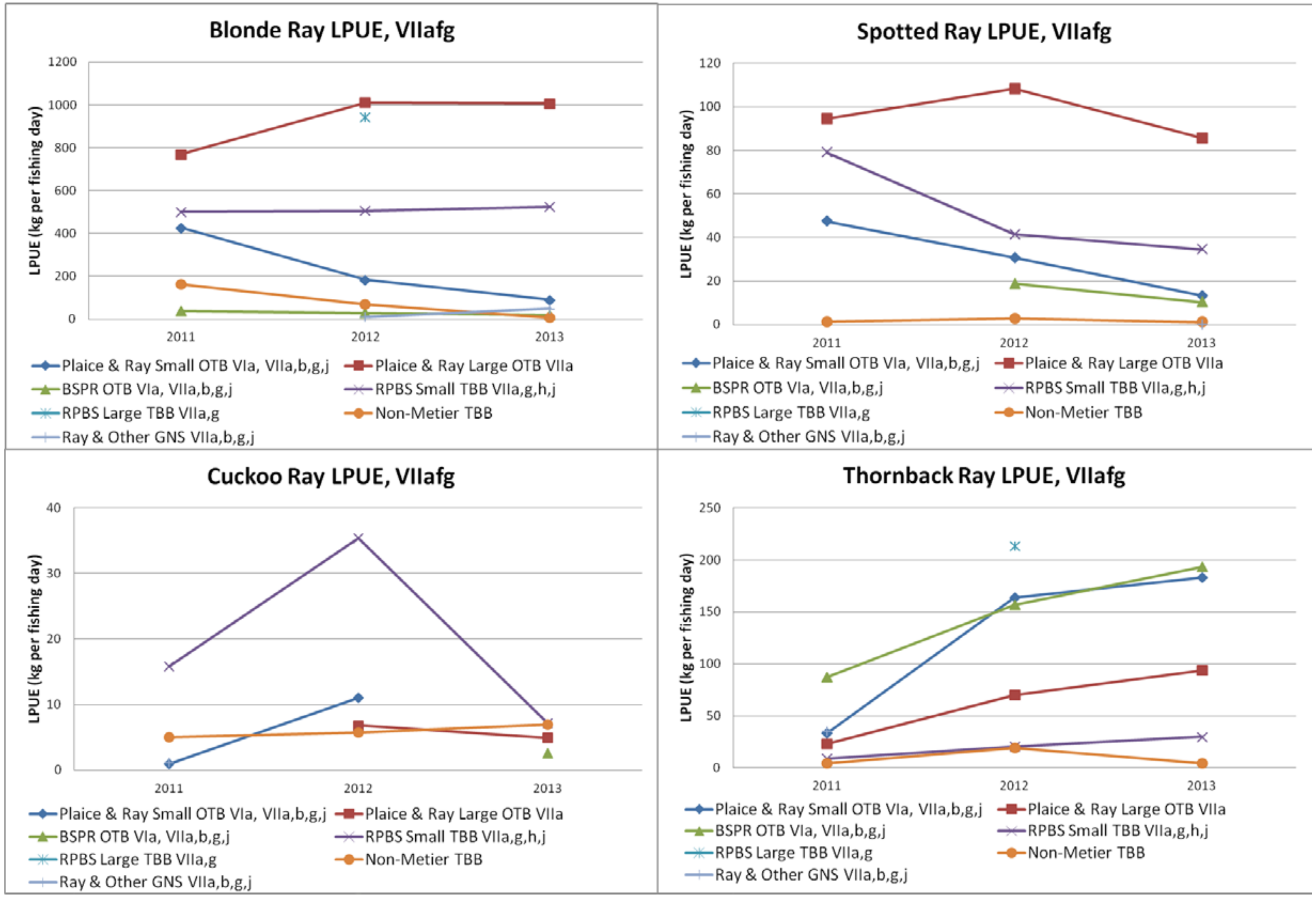


Figure 18.8. Skates and rays in the Celtic Seas. Irish lpue (in fishing days per kg) of the four skate species (blonde ray *R. brachyura,* thornback ray *R. clavata,* spotted ray *R. montagui* and cuckoo ray *L. naevus*) by targeting métiers in Divisions VIIa, VIIf, VIIg, 2011–2013.

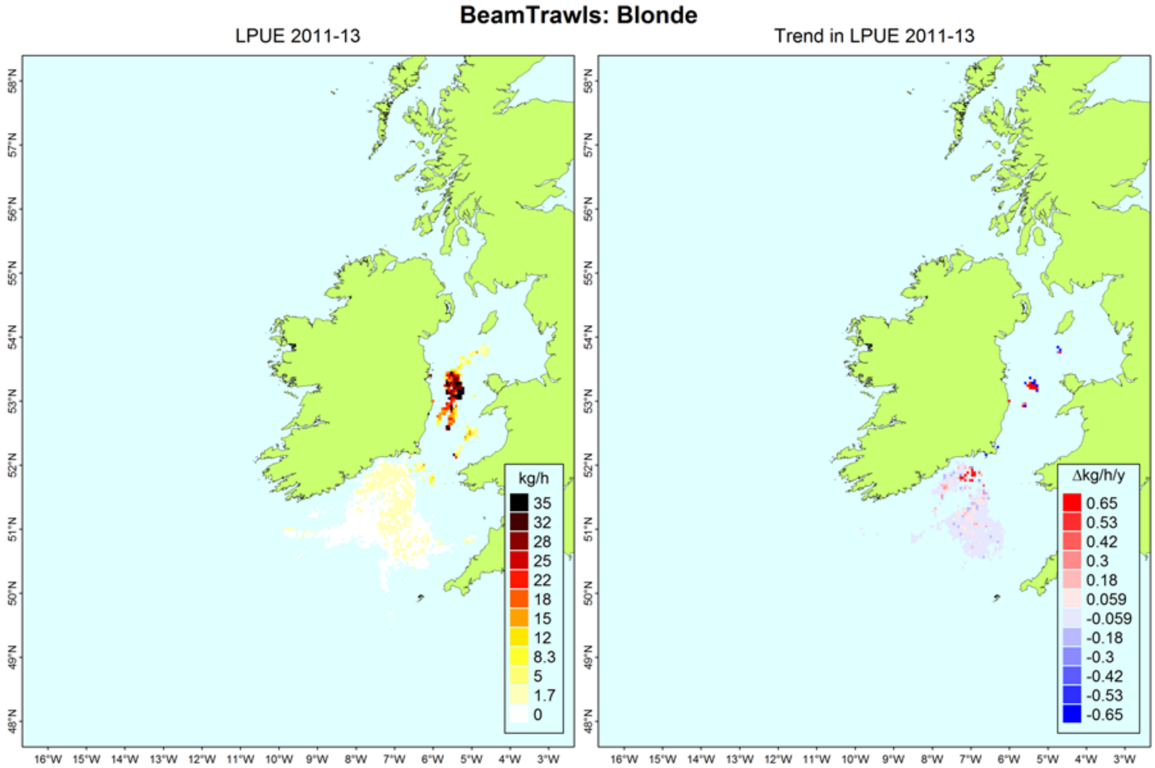


Figure 18.9. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. brachyura* landed by beam trawls, 2011–2013.

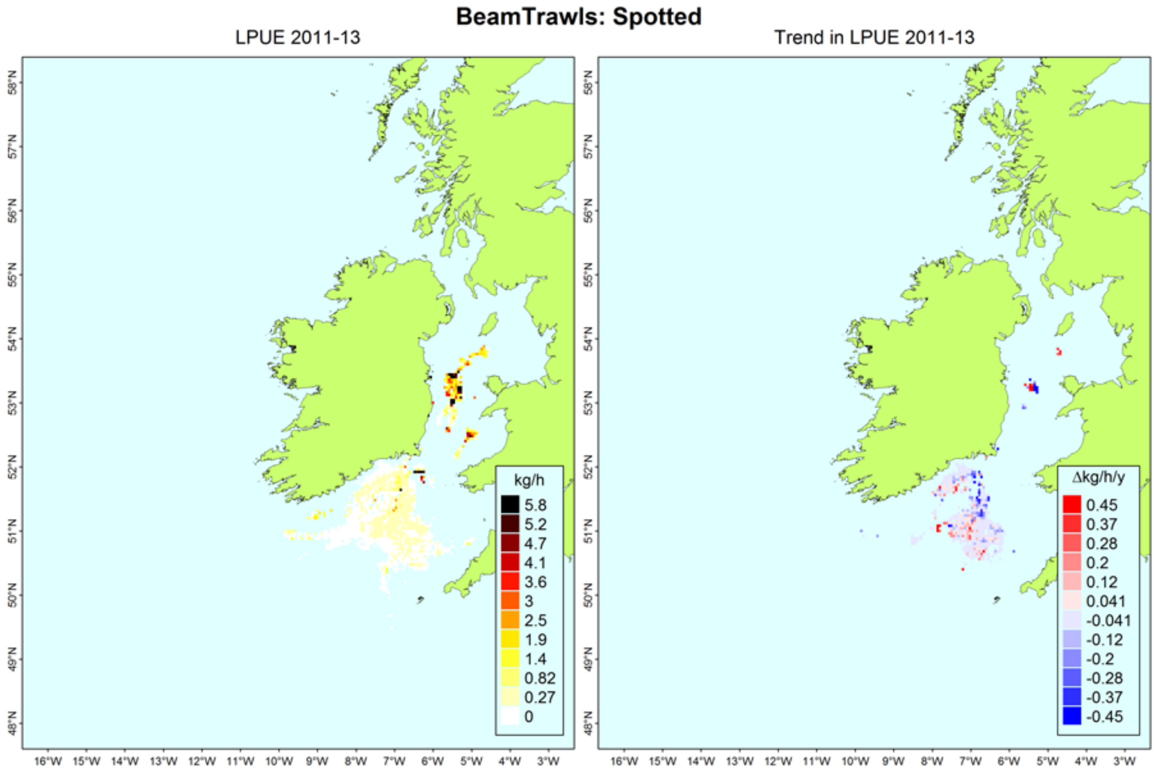


Figure 18.10. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. montagui* landed by beam trawls, 2011–2013.

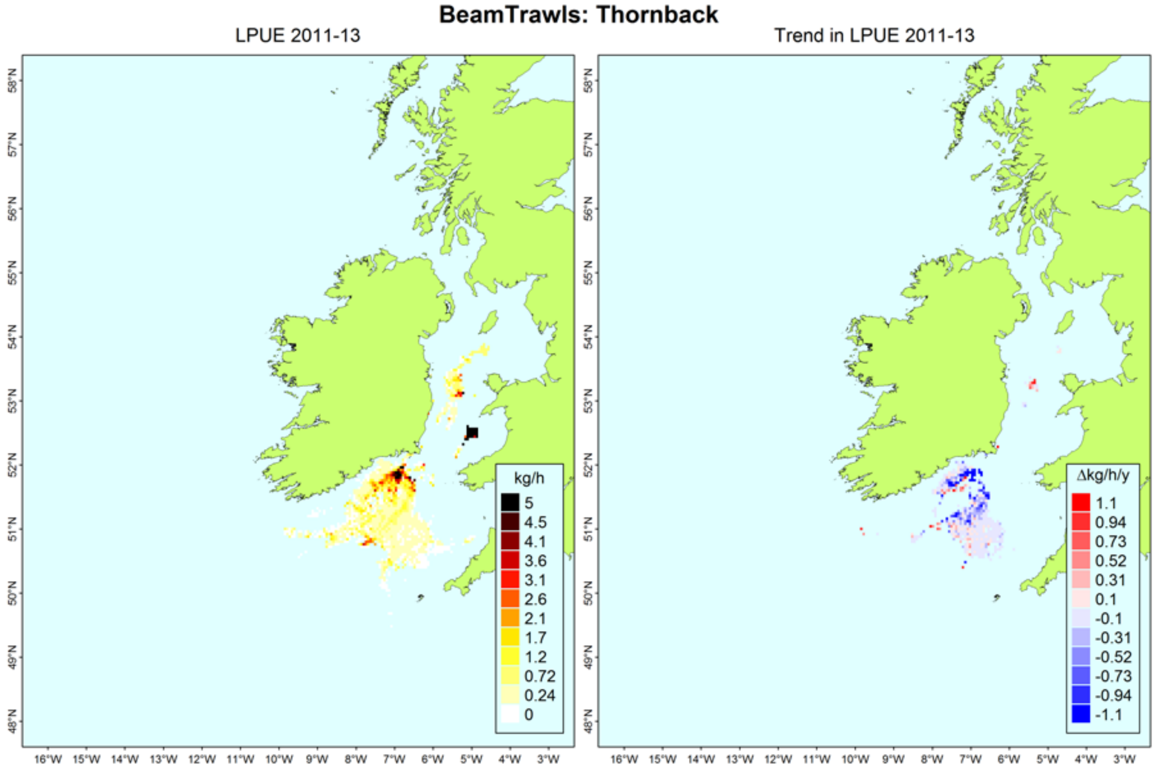


Figure 18.11. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. clavata* landed by beam trawls, 2011–2013.

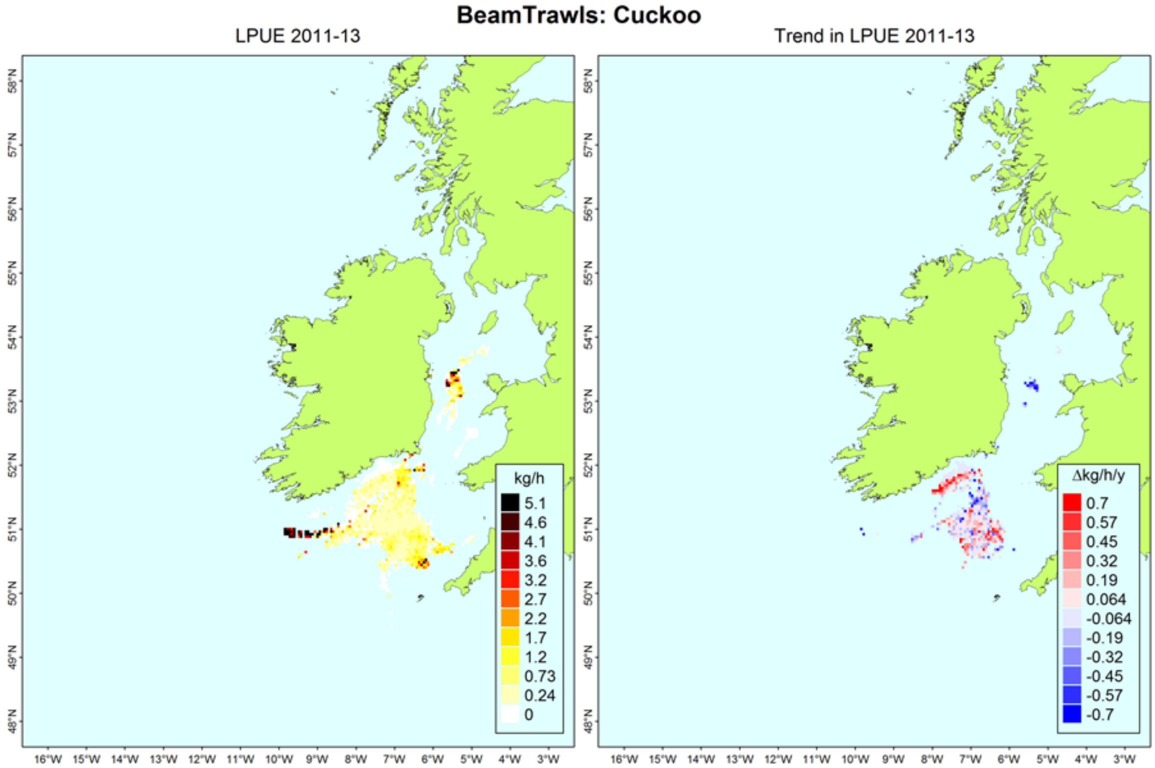


Figure 18.12. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *L. naevus* landed by beam trawls, 2011–2013.

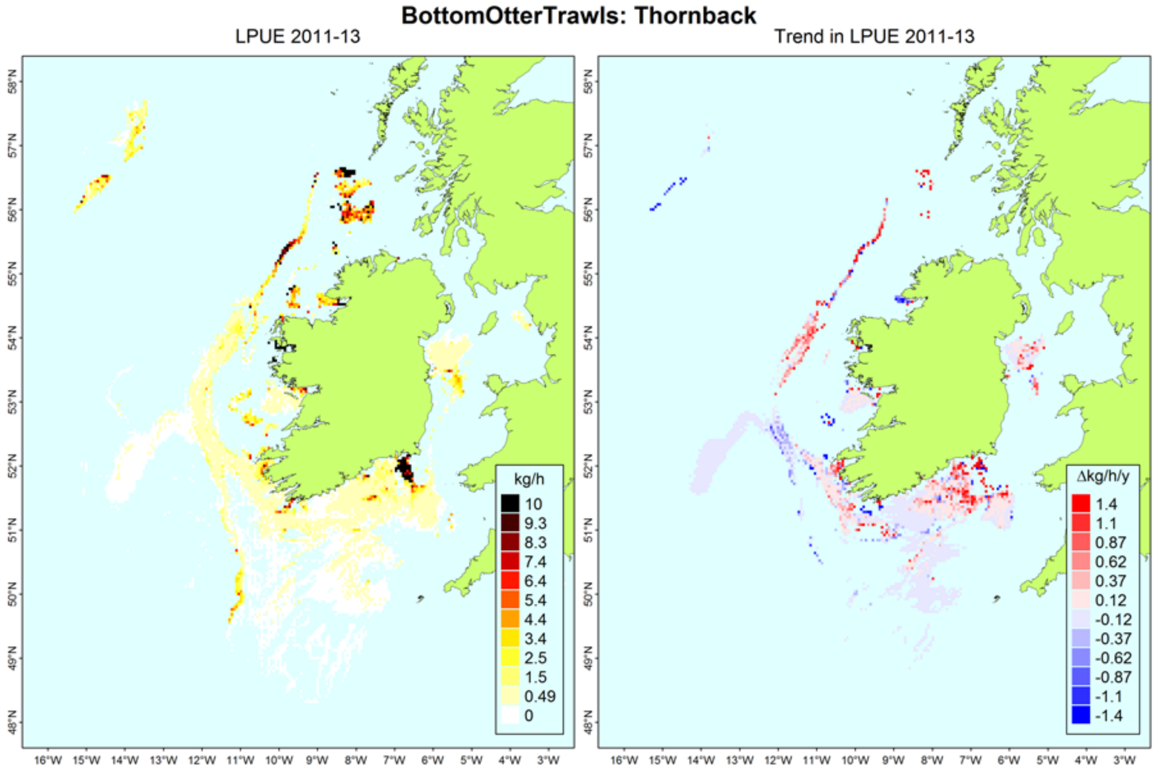


Figure 18.13. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. clavata* landed by otter trawls, 2011–2013.

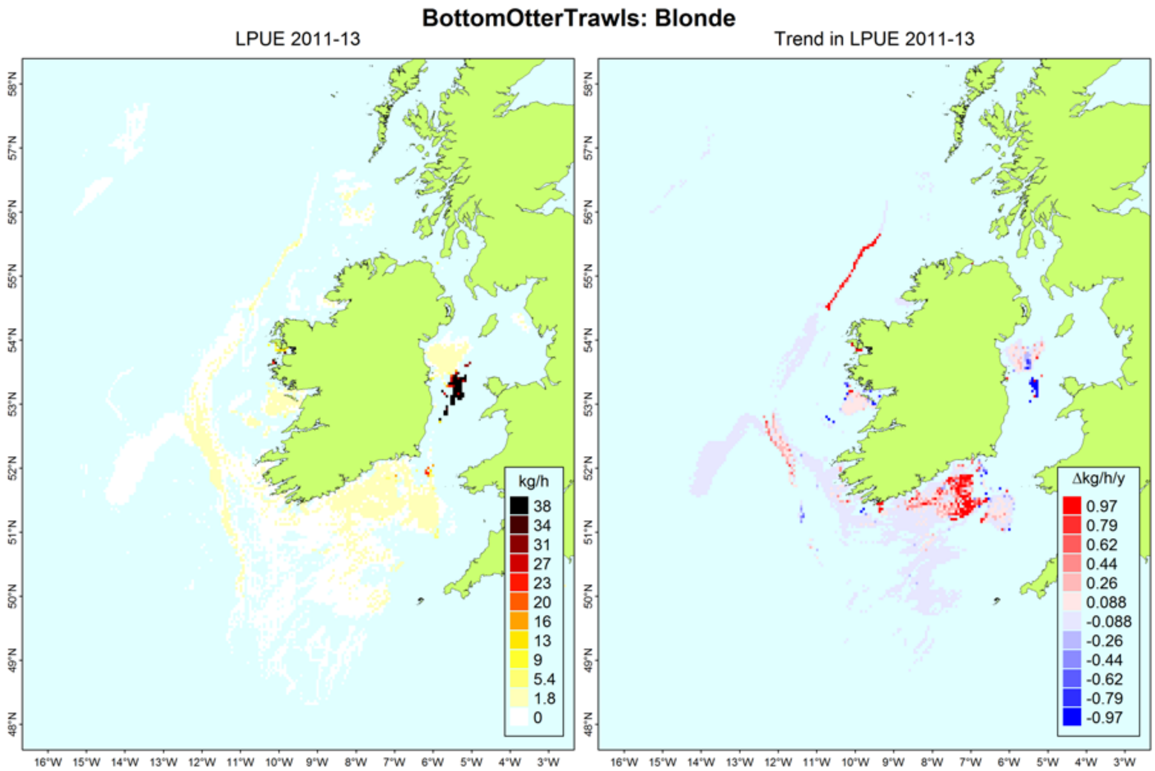


Figure 18.14. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. brachyura* landed by otter trawls, 2011–2013.

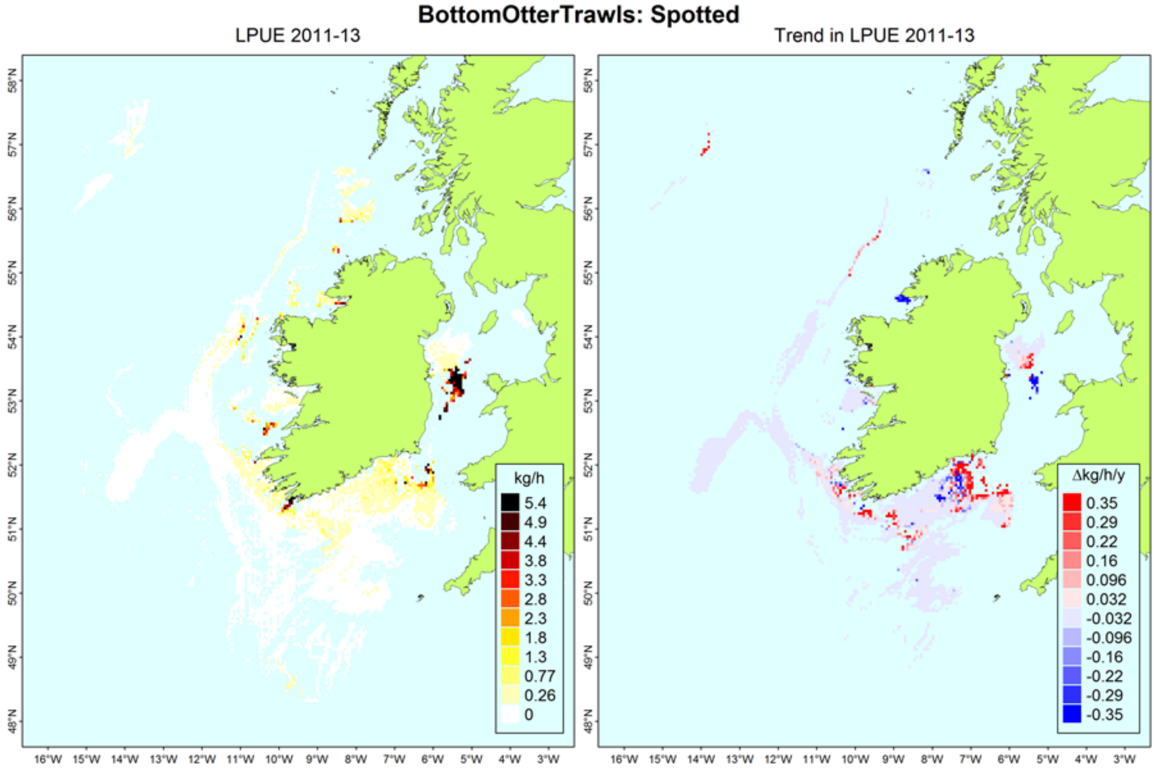


Figure 18.15. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *R. montagui* landed by otter trawls, 2011–2013.

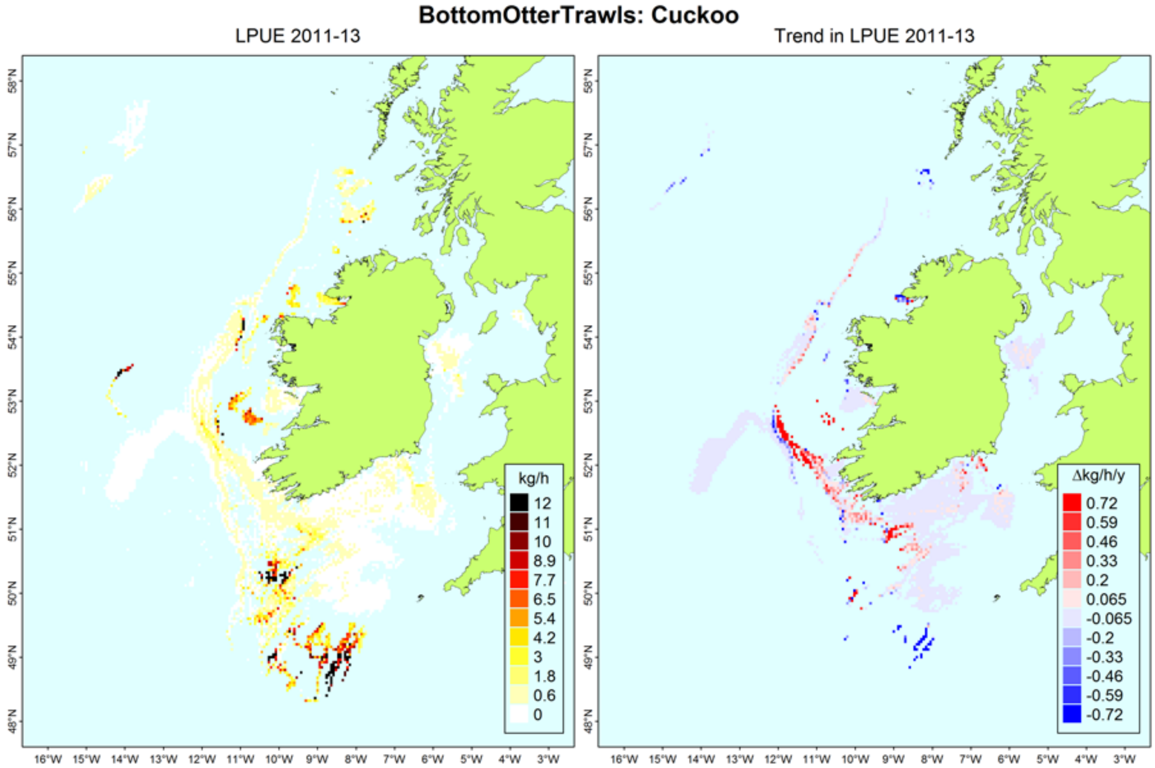


Figure 18.16. Skates and rays in the Celtic Seas. Lpue (kg/h) distribution and trend plots of *L. naevus* landed by otter trawls, 2011–2013.

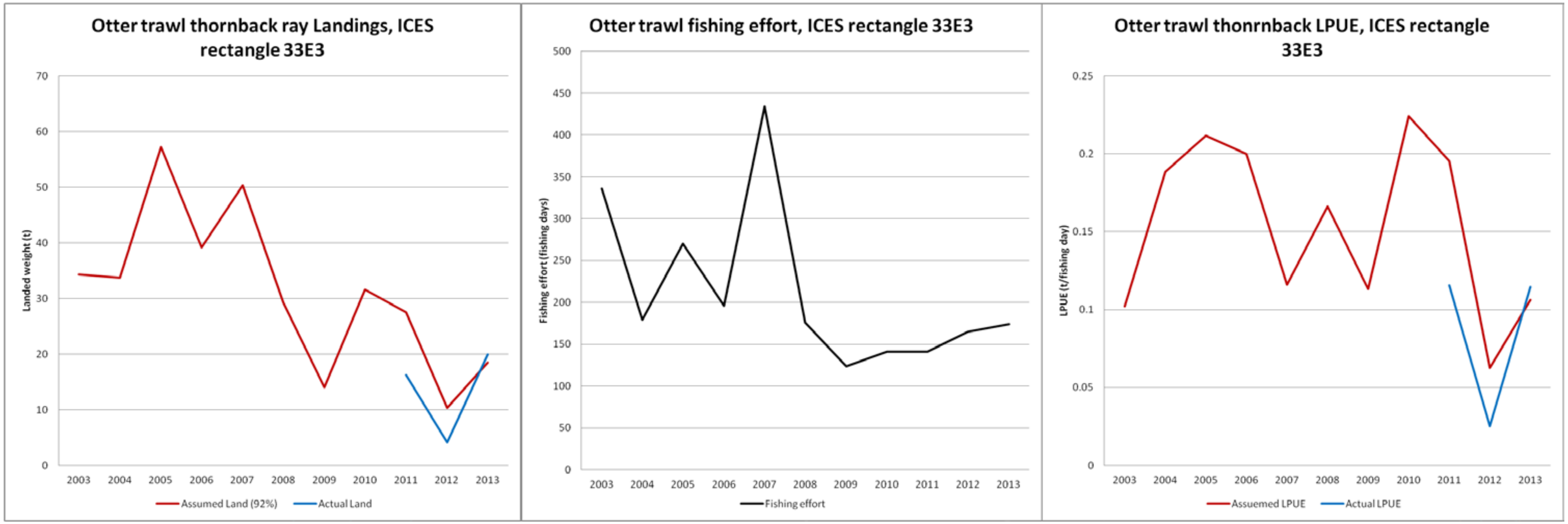


Figure 18.17. Skates and rays in the Celtic Seas. Otter trawl fishing effort (fishing day), *Raja clavata* landings (t) and lpue (t/fishing day) from ICES rectangle 33E3. Assumed landings and lpue values generated from average thornback contribution to skate composition from 2011–2013 (92%) applied back to 2003.

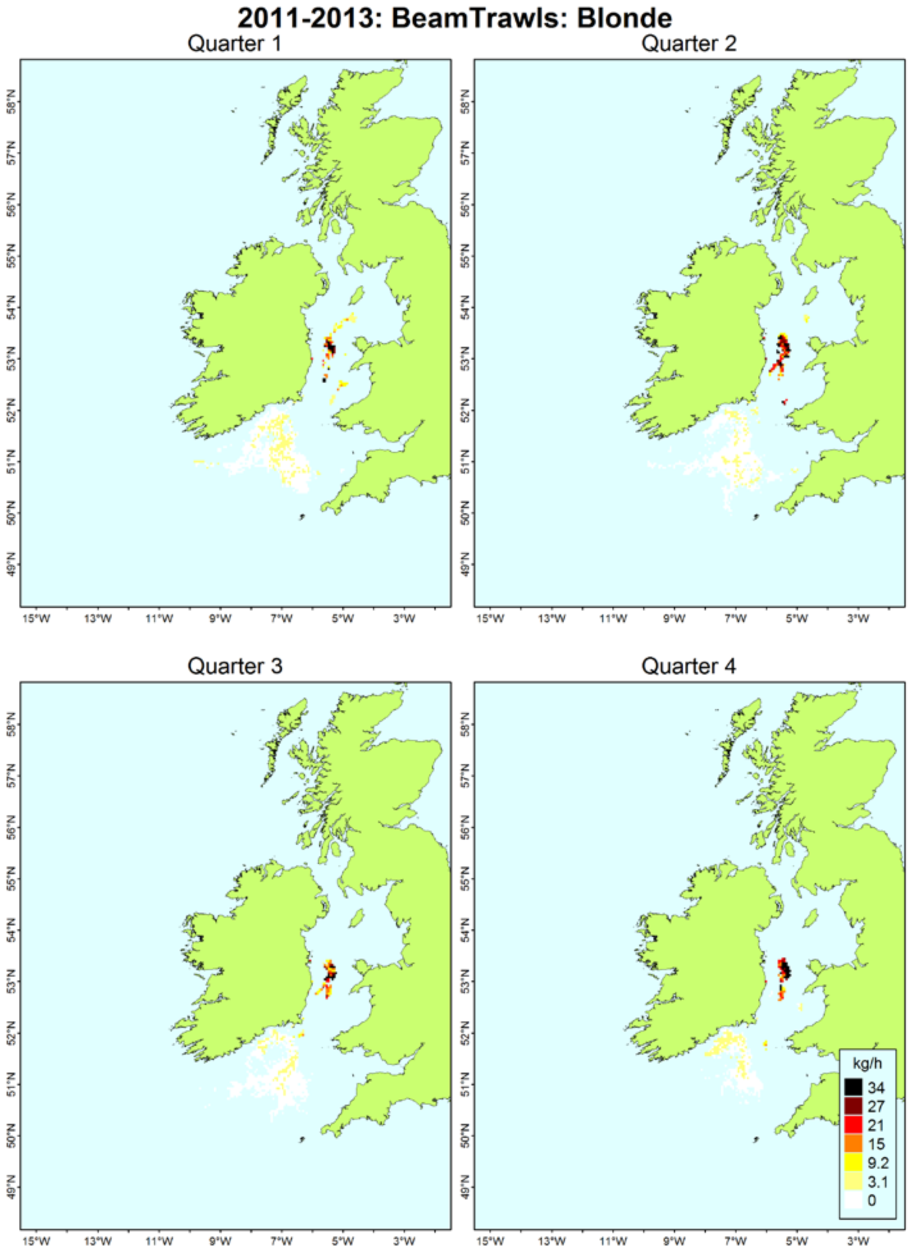


Figure 18.18. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. brachyura* landed beam trawls, 2011–2013.

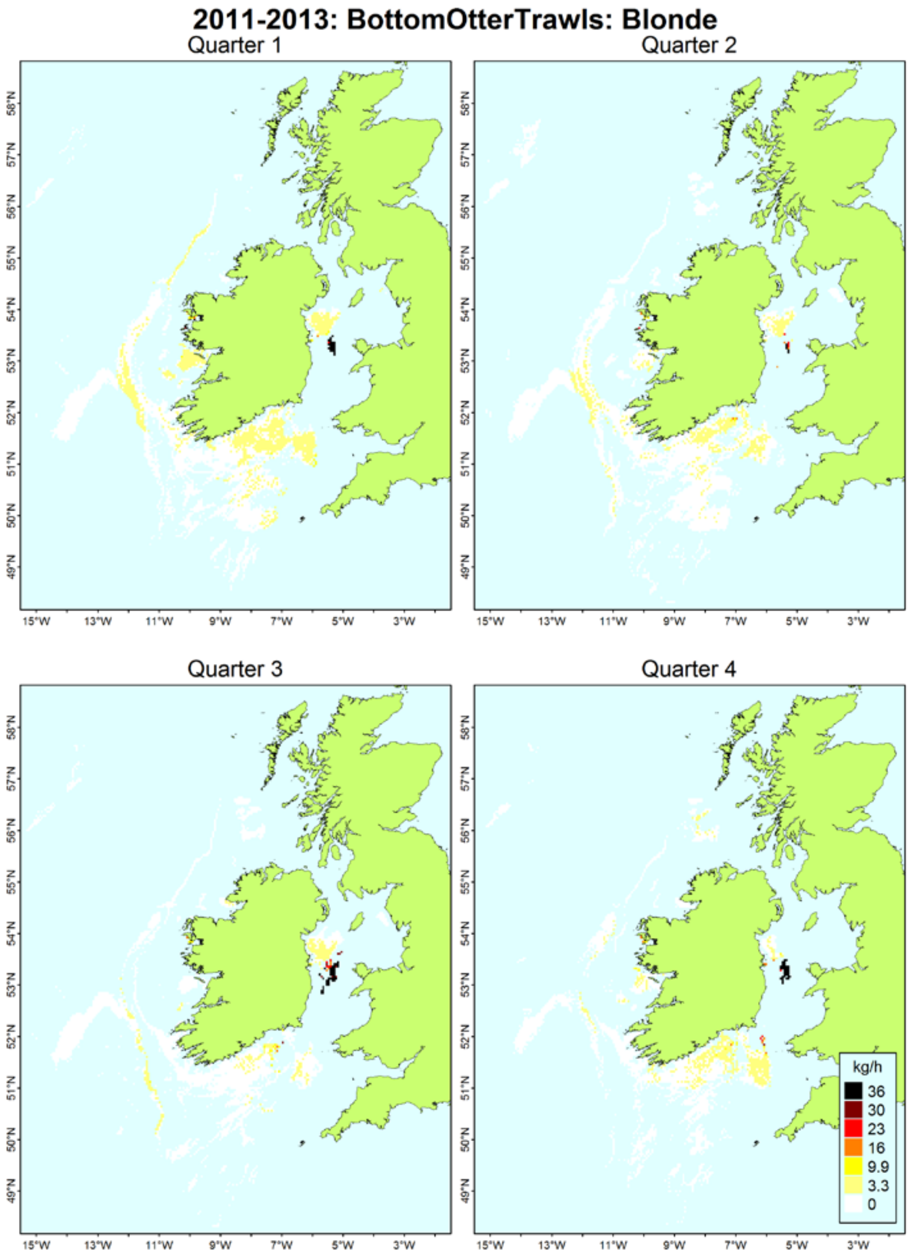


Figure 18.19. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. brachyura* landed otter trawls, 2011–2013.

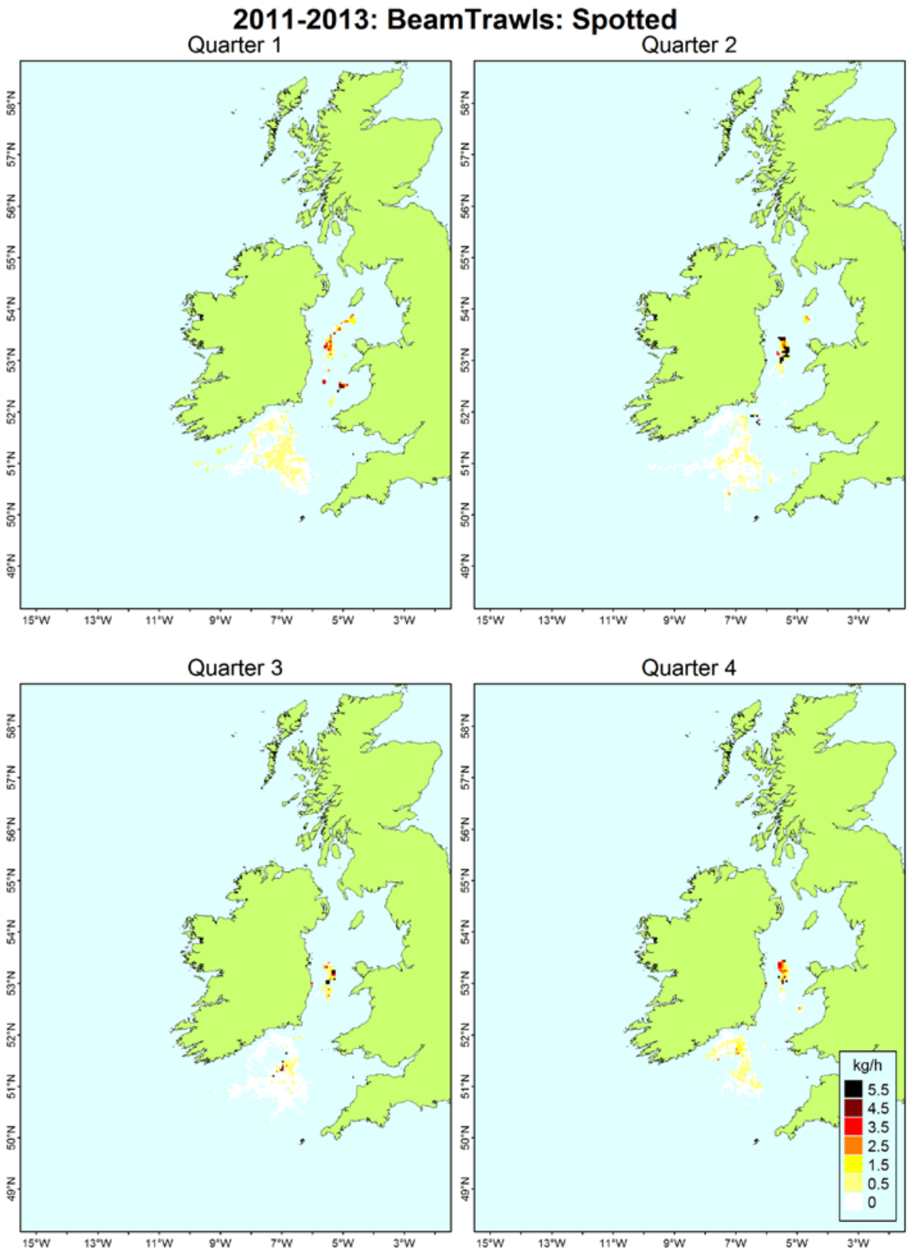


Figure 18.20. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. montagui* landed beam trawls, 2011–2013.

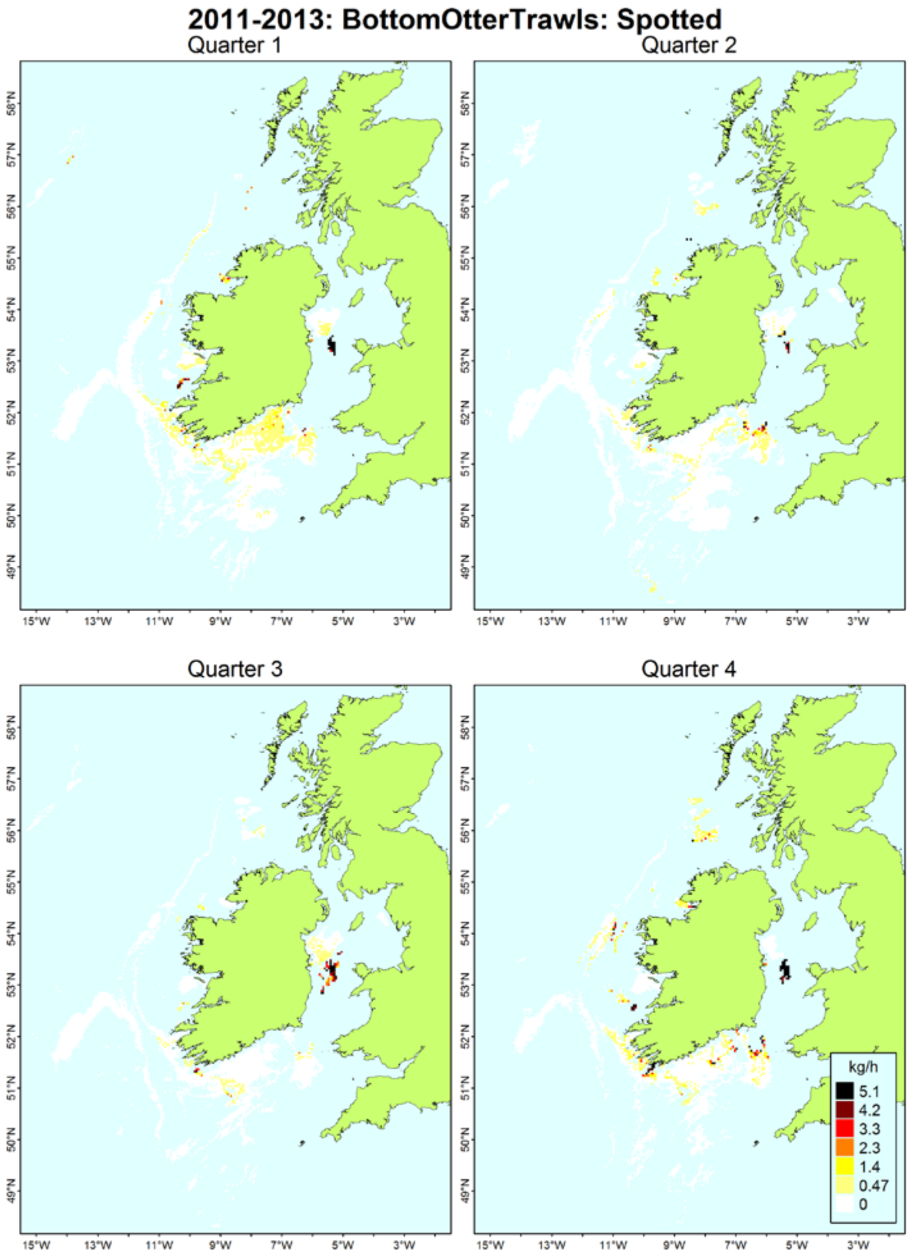


Figure 18.21. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. montagui* landed otter trawls, 2011–2013.

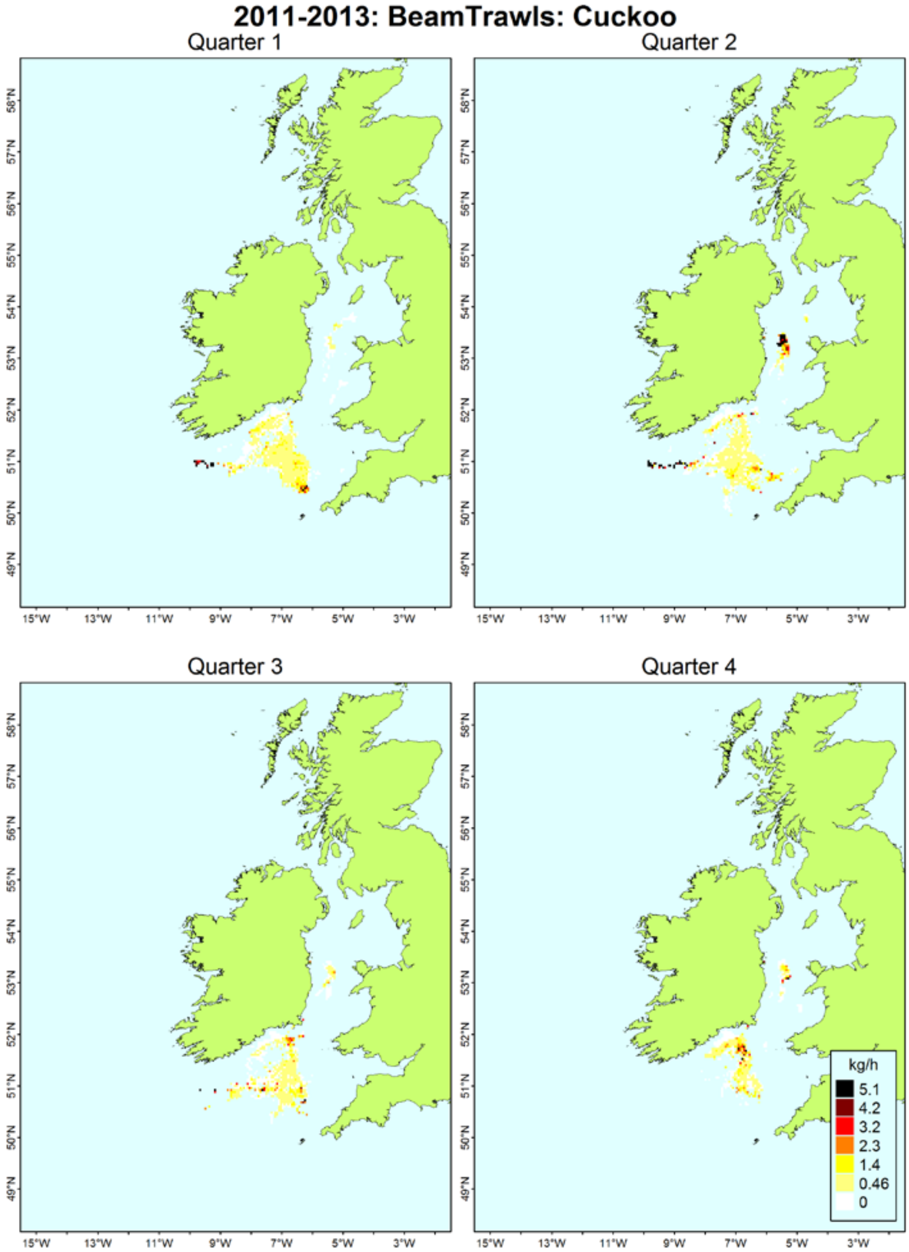


Figure 18.22. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *L. naevus* landed beam trawls, 2011–2013.

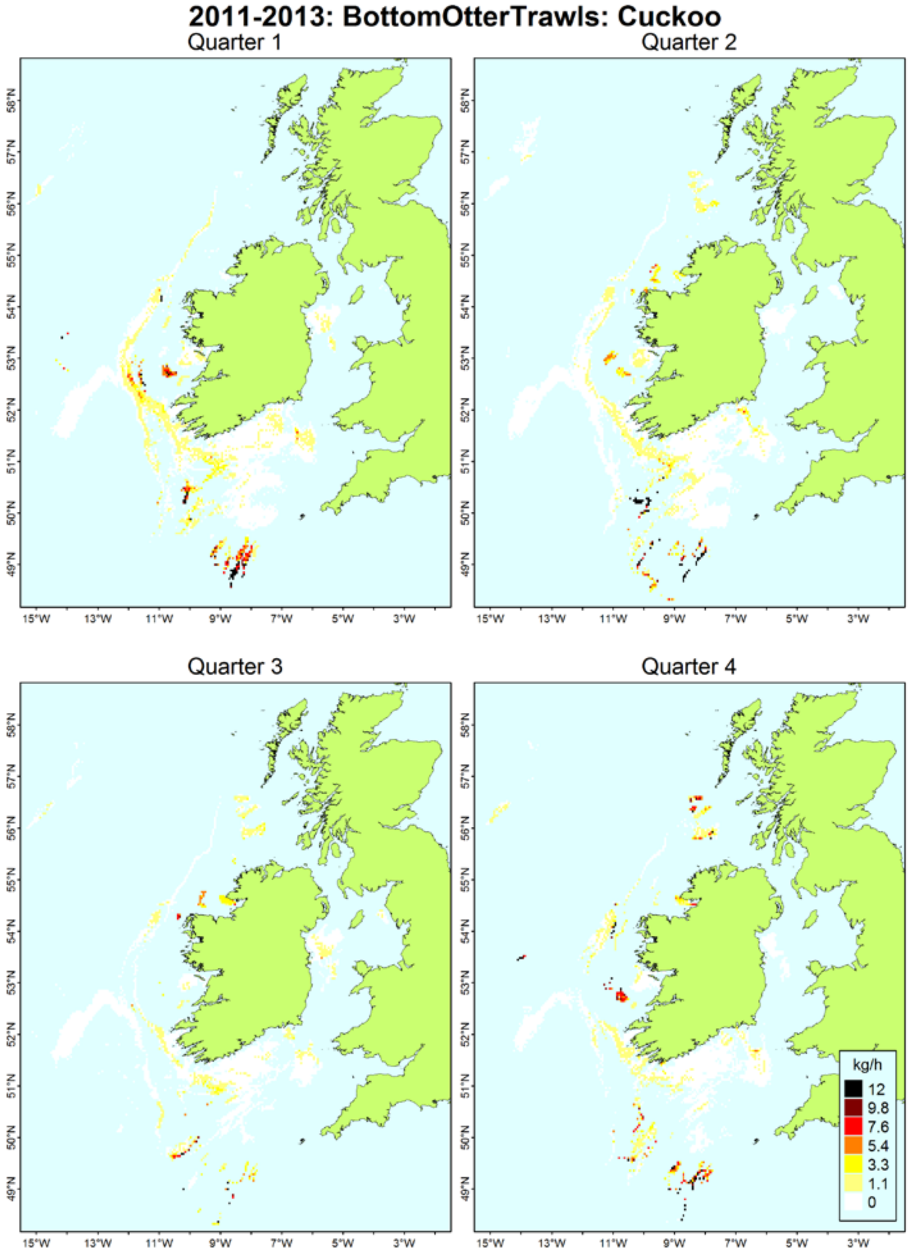


Figure 18.23. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *L. naevus* landed otter trawls, 2011–2013.

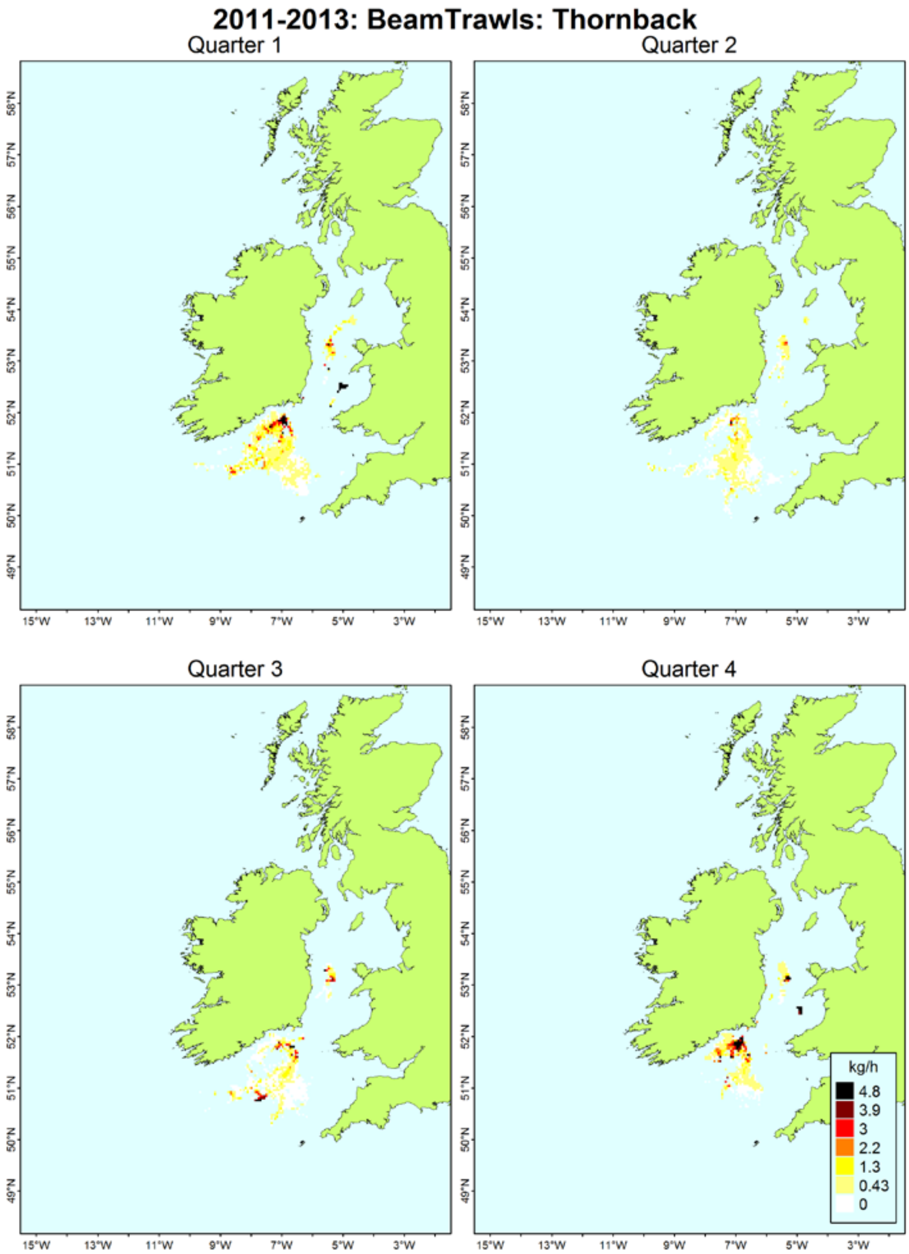


Figure 18.24. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. clavata* landed beam trawls, 2011–2013.

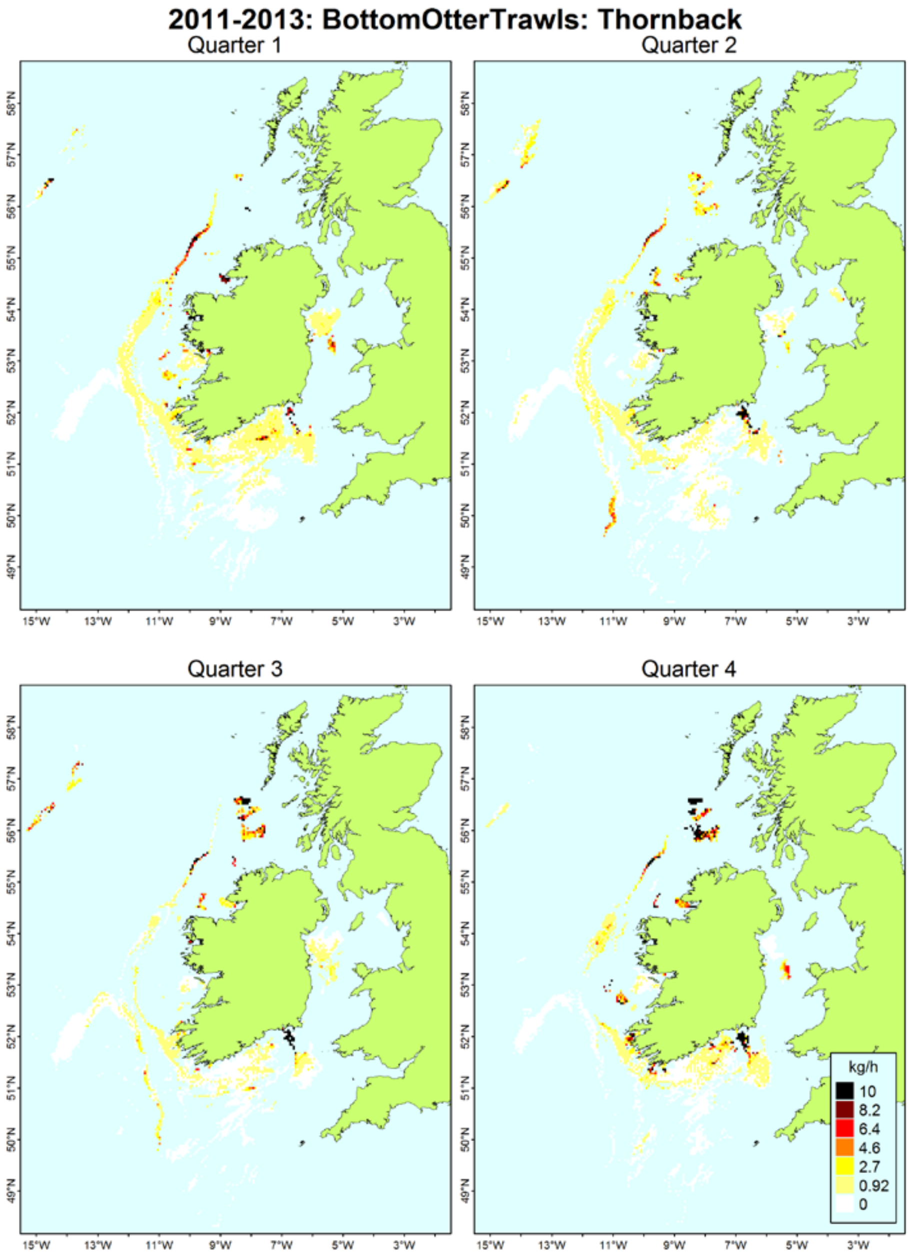


Figure 18.25. Skates and rays in the Celtic Seas. Quarterly lpue (kg/h) distribution plots of *R. clavata* otter trawls, 2011–2013.

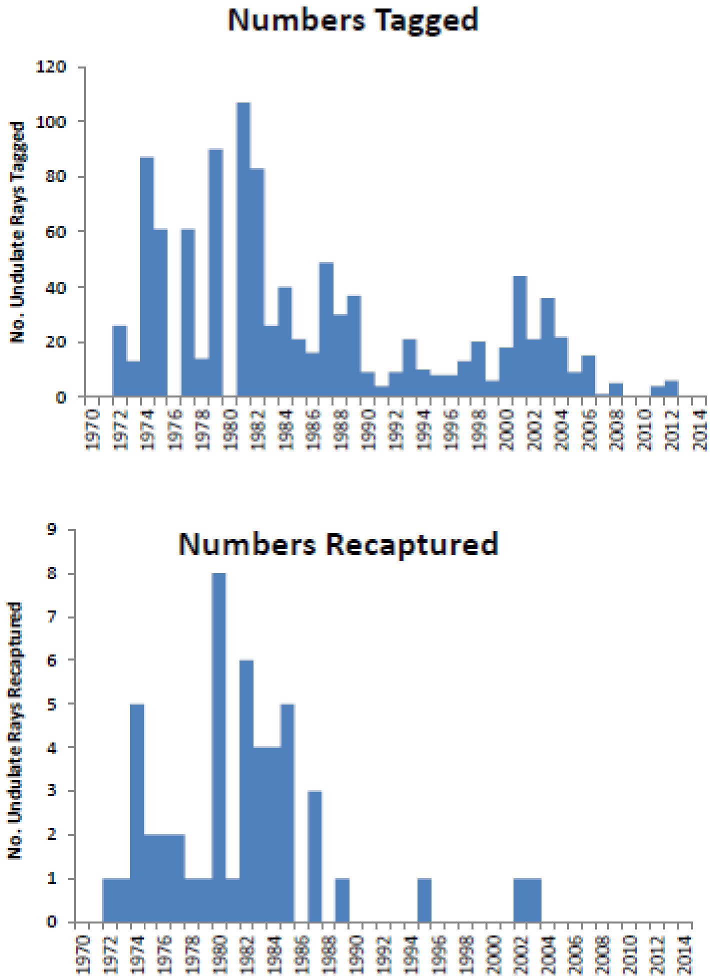


Figure 18.26. Skates in the Celtic Seas. Numbers of *Raja undulata* tagged (top) and recaptured (bottom) in Tralee Bay and surroundings, 1970–2014. Source: Wogerbauer *et al.*, 2014 WD.

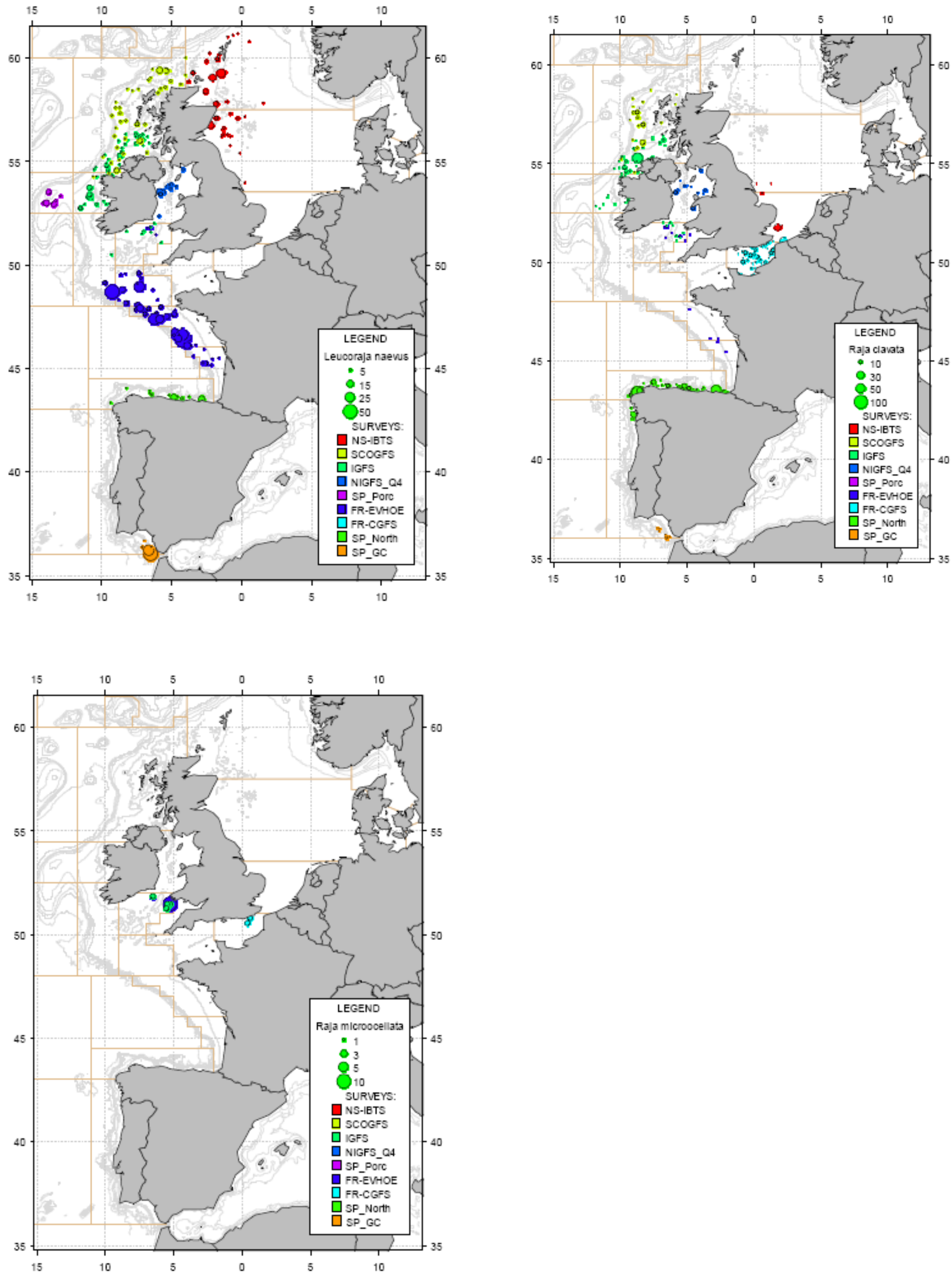


Figure 18.27. Skates and rays in the Celtic Seas. Catches, in numbers per hour, of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, small-eyed ray *Raja microocellata* in Q4 IBTS surveys in the southern and western areas in 2011. The catchability of the different gears used in these surveys is not constant; therefore these maps do not reflect proportional abundance in all the areas but within each survey (see ICES, 2013a for further details).

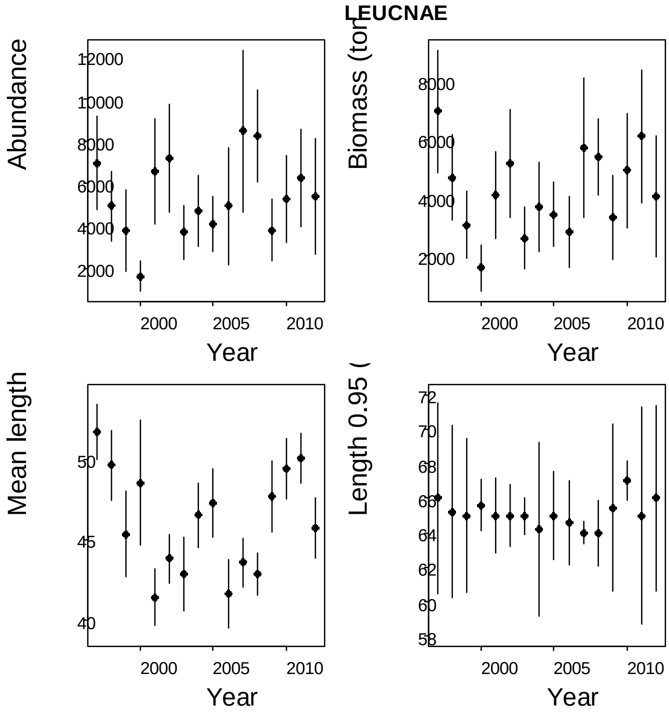


Figure 18.28a. Skates and rays in the Celtic Seas. a) Temporal trends in relative abundance (numbers), biomass, and mean length of *Leucoraja naevus* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

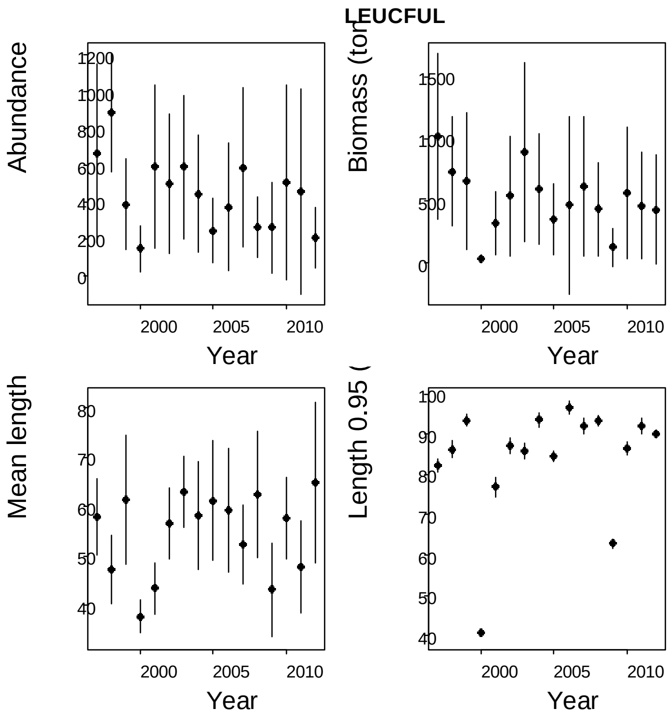


Figure 18.28b. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Leucoraja fullonica* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

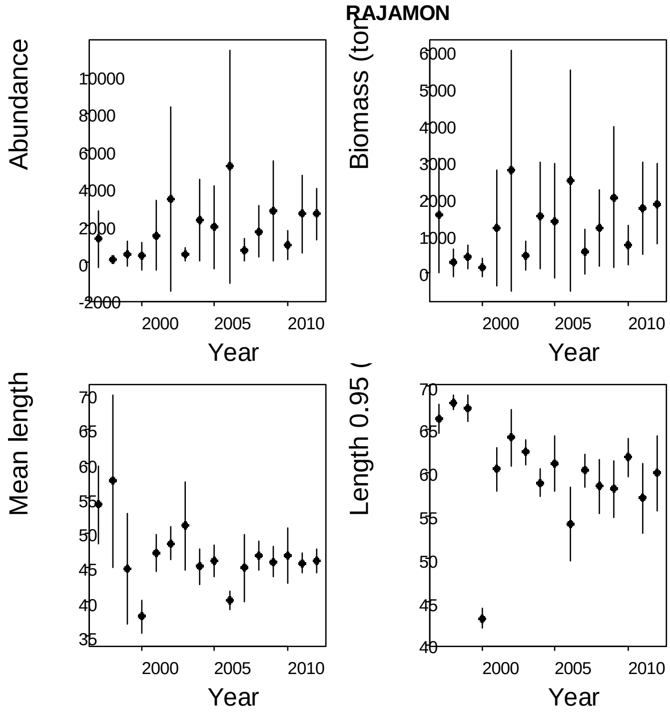


Figure 18.28c. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Raja montagui* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

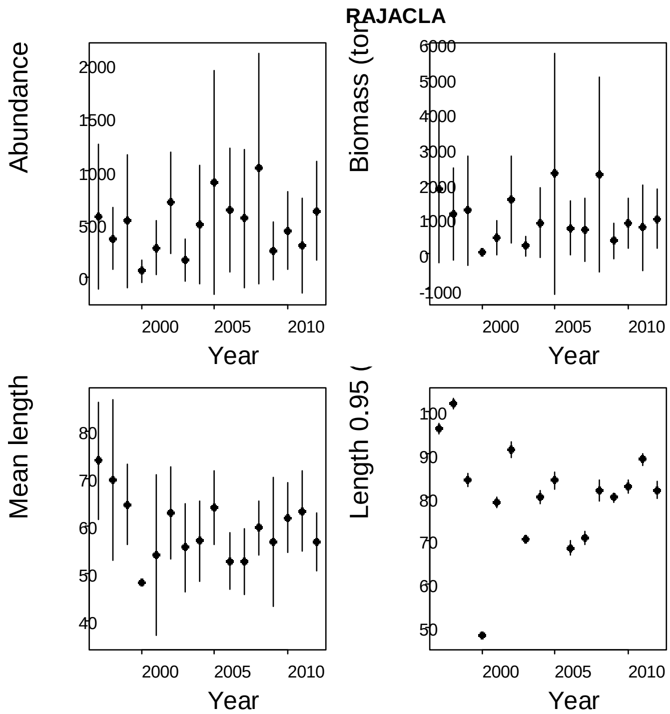


Figure 18.28d. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Raja clavata* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

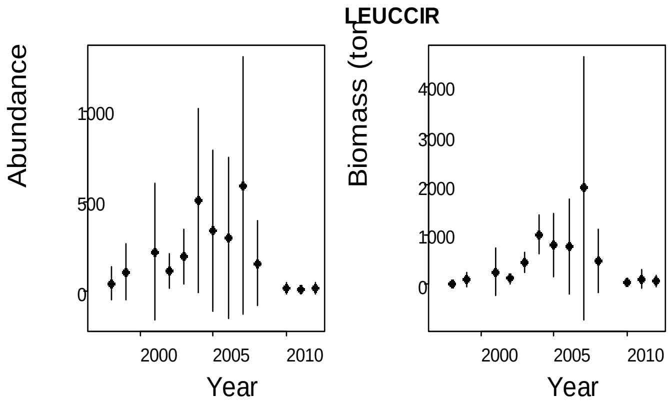


Figure 18.28e. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Leucoraja circularis* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

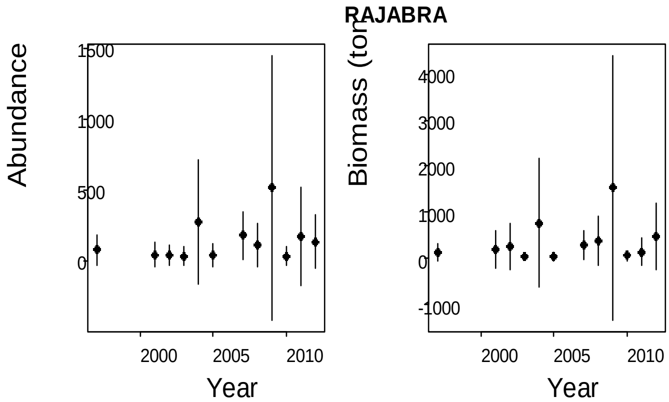


Figure 18.28f. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Raja brachyura* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

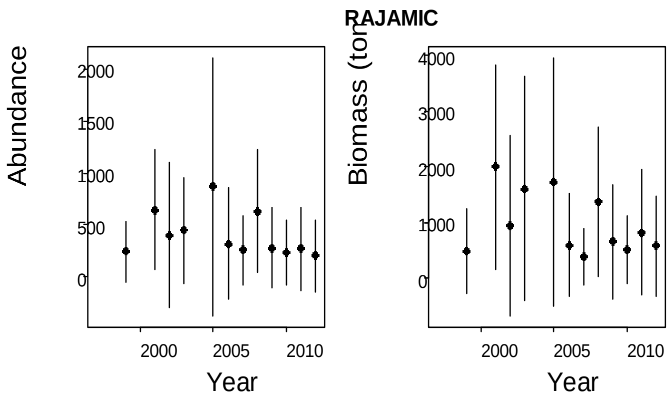


Figure 18.28g. Skates and rays in the Celtic Seas. Temporal trends in relative abundance (numbers), biomass, and mean length of *Raja microocellata* in the French Evhoe Q4 survey (EVHOE-WIBTS-Q4) of VIIg–k for 1997–2012.

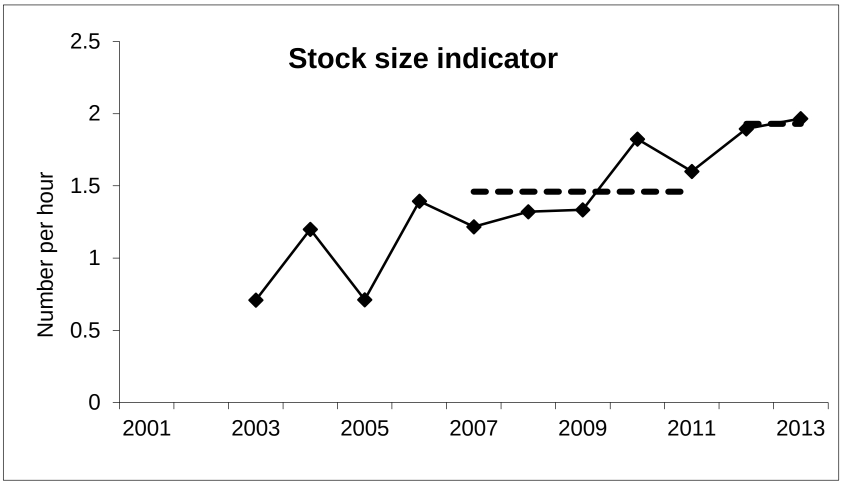


Figure 18.29a. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIa *Raja clavata* for 2003-2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

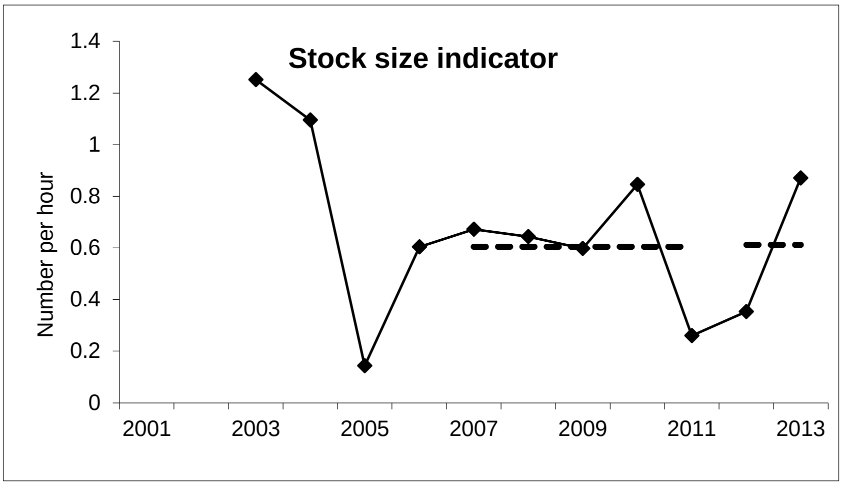


Figure 18.29b. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIIafh *Raja clavata* for 2003-2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

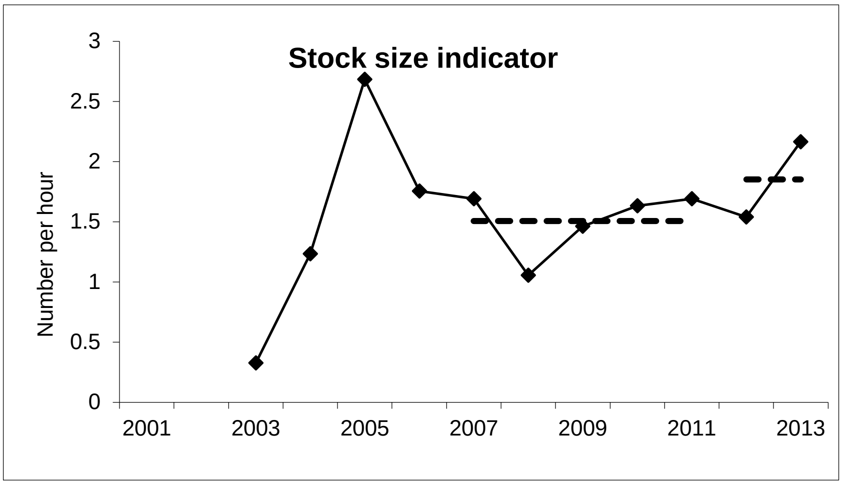


Figure 18.29c. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIa *Raja montagui* for 2003–2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

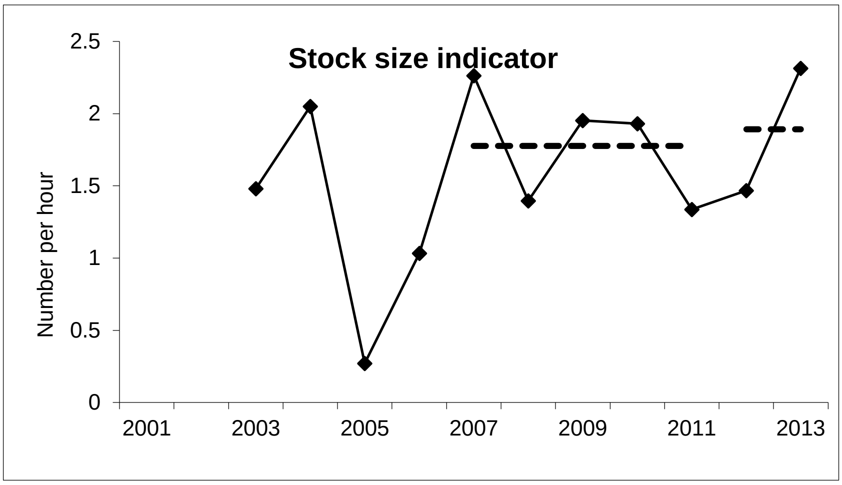


Figure 18.29d. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIIafh *Raja montagui* for 2003–2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

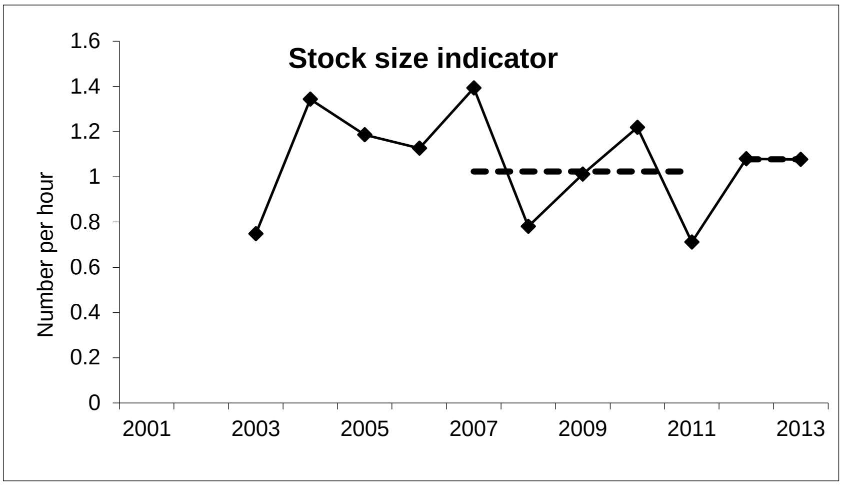


Figure 18.29e. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIa *Leucoraja naevus* for 2003–2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

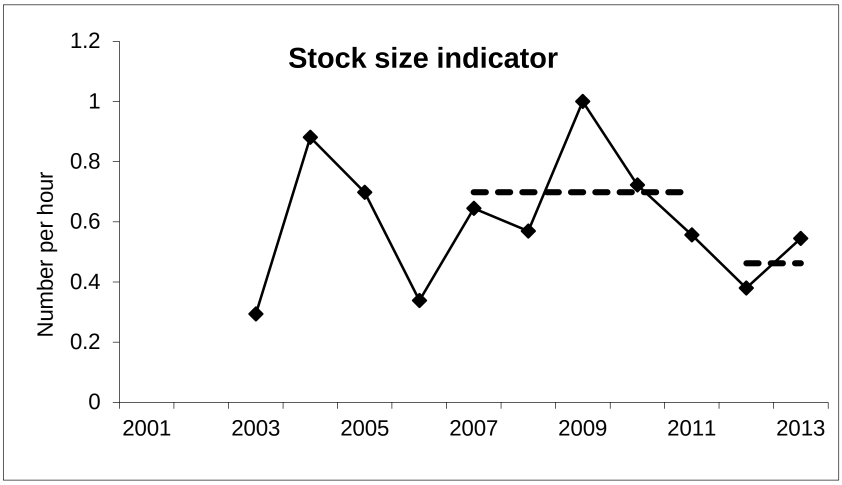


Figure 18.29f. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean cpue of VIIafh *Leucoraja naevus* for 2003–2013. Dashed lines give mean annual cpue for 2007–2011 and mean annual cpue for 2012–2013.

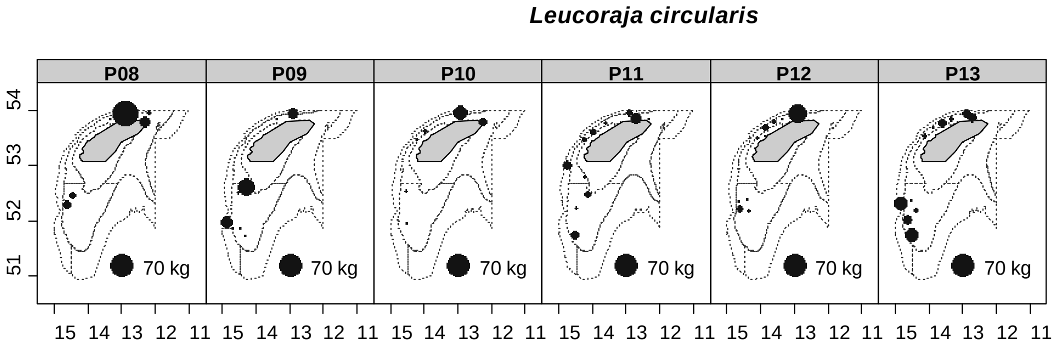


Figure 18.30a. Skates and rays in the Celtic Seas. Geographical distribution of sandy ray *Leucoraja circularis* catches (kg·haul^{-1}) in Porcupine survey time-series (2008–2013) (Ruiz-Pico *et al.*, 2014 WD).

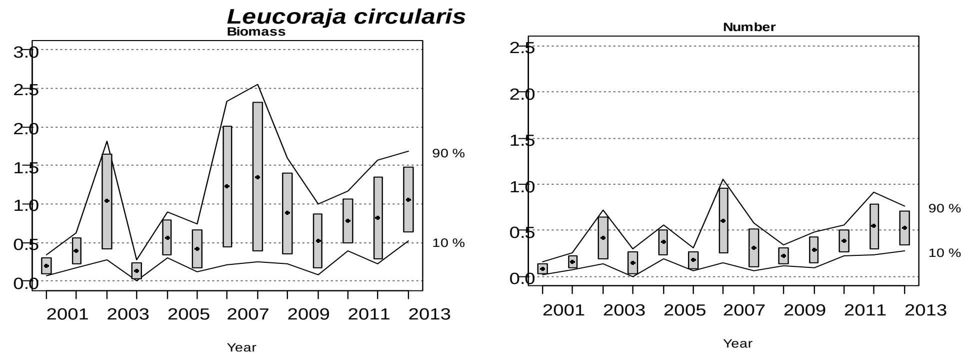


Figure 18.30b. Skates and rays in the Celtic Seas. Temporal changes sandy ray *Leucoraja circularis* biomass index (kg·haul^{-1}) during Porcupine survey time-series (2001–2013). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000) (Ruiz-Pico *et al.*, 2014 WD).

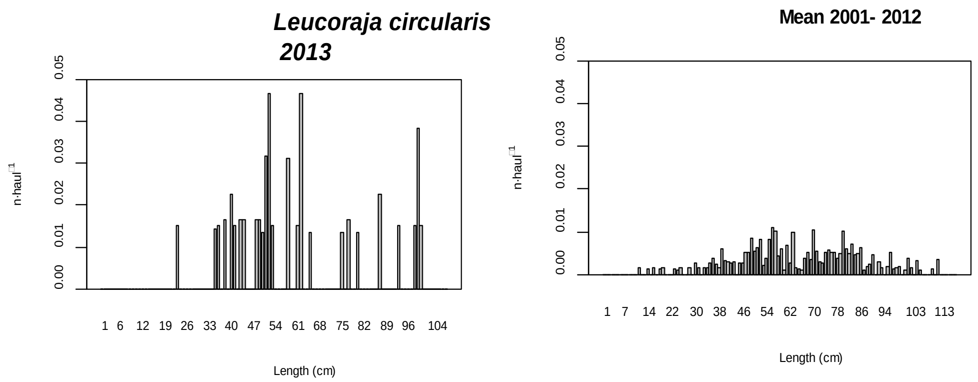


Figure 18.30c. Skates and rays in the Celtic Seas. Stratified length distributions of sandy ray *Leucoraja circularis* in 2013 Porcupine survey, and mean values during Porcupine survey time-series (2001–2012) (Ruiz-Pico *et al.*, 2014 WD).

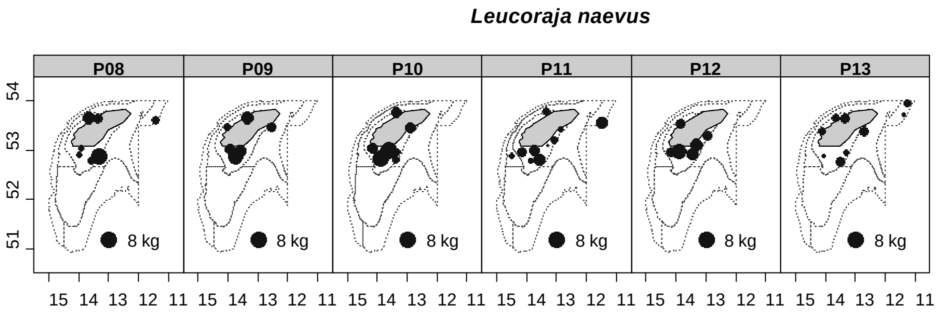


Figure 18.31a. Skates and rays in the Celtic Seas. Geographical distribution of cuckoo ray *Leucoraja naevus* catches (kg·haul^{-1}) in Porcupine survey time-series (2008–2013) (Ruiz-Pico *et al.*, 2014 WD).

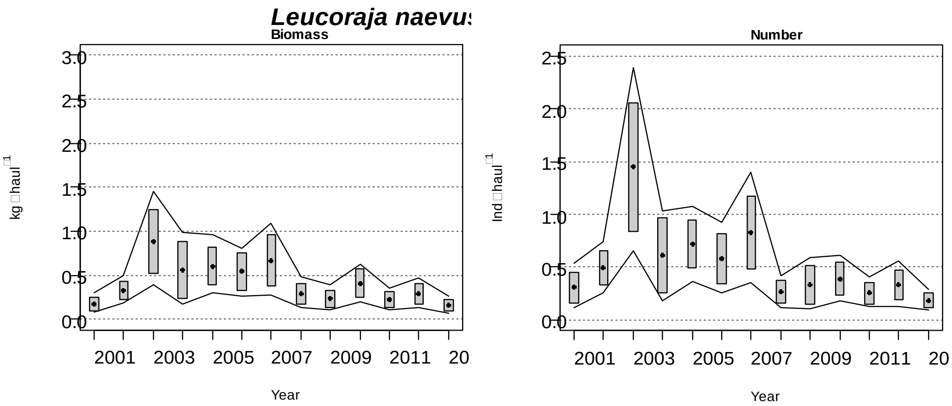


Figure 18.31b. Skates and rays in the Celtic Seas. Temporal changes in cuckoo ray *Leucoraja naevus* biomass index (kg.haul^{-1}) during Porcupine survey time-series (2001–2013). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000) (Ruiz-Pico *et al.*, 2014 WD).

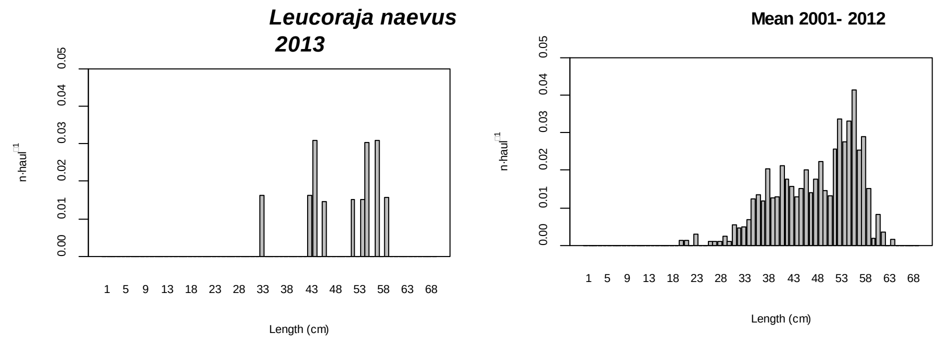


Figure 18.31c. Skates and rays in the Celtic Seas. Stratified length distributions of cuckoo ray *Leucoraja naevus* in 2013 in Porcupine survey, and mean values during Porcupine survey time-series (2001–2012) (Ruiz-Pico *et al.*, 2014 WD).

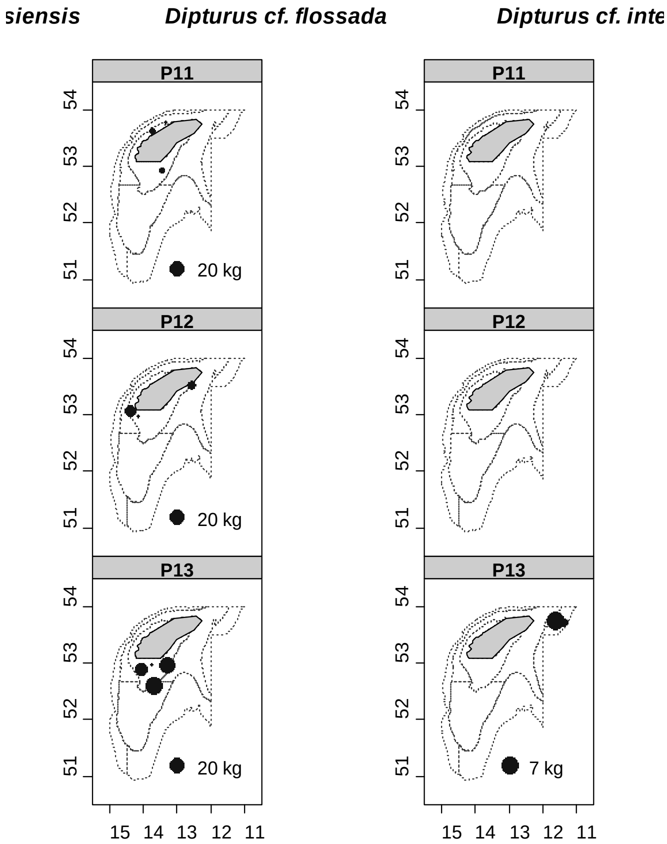


Figure 18.32a. Skates and rays in the Celtic Seas. Geographical distribution of *Dipturus* cf. *flossada* and *D.* cf. *intermedia* spp. (kg·haul^{-1}) in Porcupine survey time-series (2011–2013) (Ruiz-Pico *et al.*, 2014 WD).

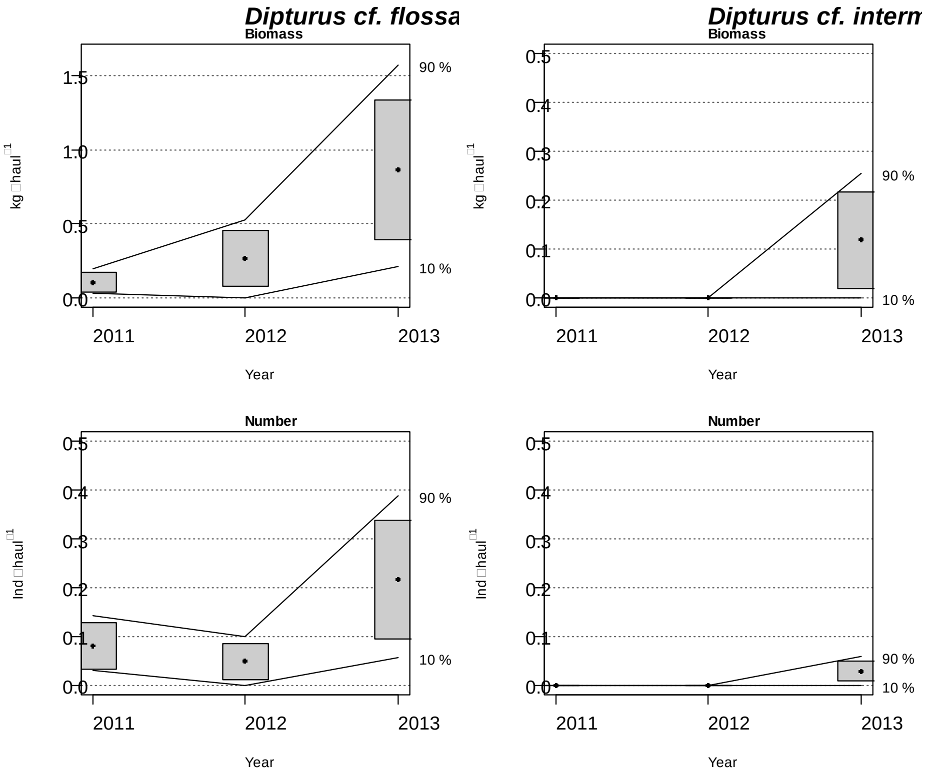


Figure 18.32b. Skates and rays in the Celtic Seas. Changes in *Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia*. Biomass index (kg·haul^{-1}) during Porcupine survey time-series (2011–2013). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (Ruiz-Pico *et al.*, 2014 WD).

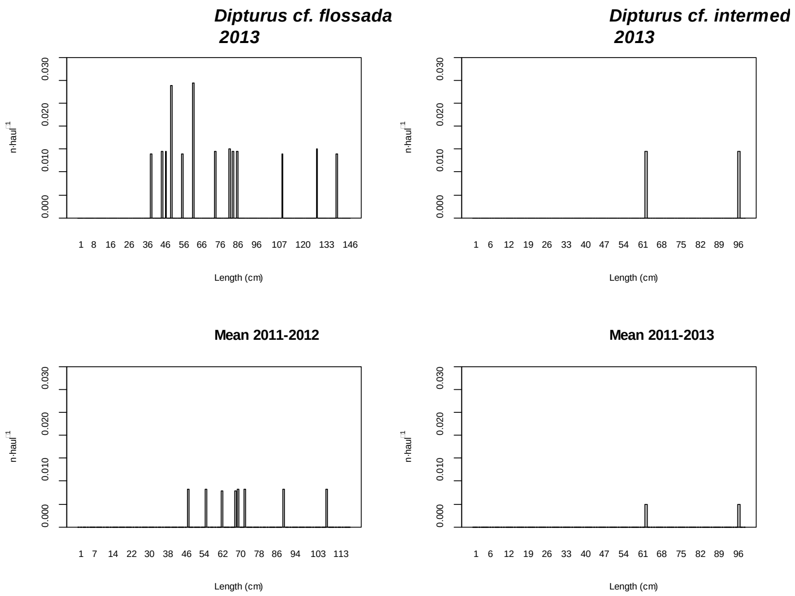


Figure 18.32c. Skates and rays in the Celtic Seas. Stratified length distributions of *Dipturus* cf. *flossada* and *Dipturus* cf. *intermedia* in 2013 Porcupine survey, and mean values during survey time-series (2011–2012) (Ruiz-Pico *et al.*, 2014 WD).

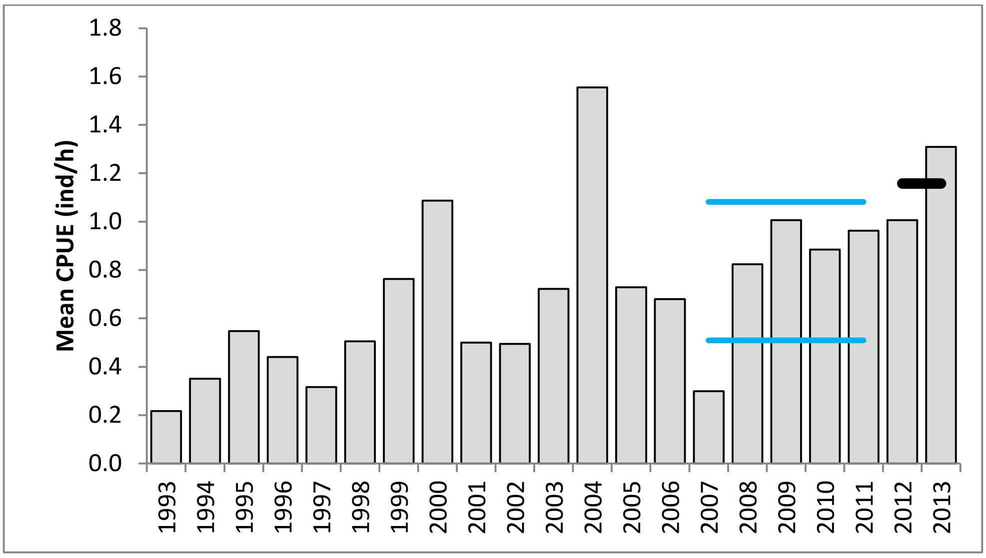


Figure 18.33a. Skates and rays in the Celtic Seas. Mean cpue (ind.h^{-1}) of VIIaf *Raja brachyura* in the UK VIIaf beam trawl survey (EngW-BTS-Q3). Blue lines give mean annual cpue 2007–2011; black line mean annual cpue 2012–2013.

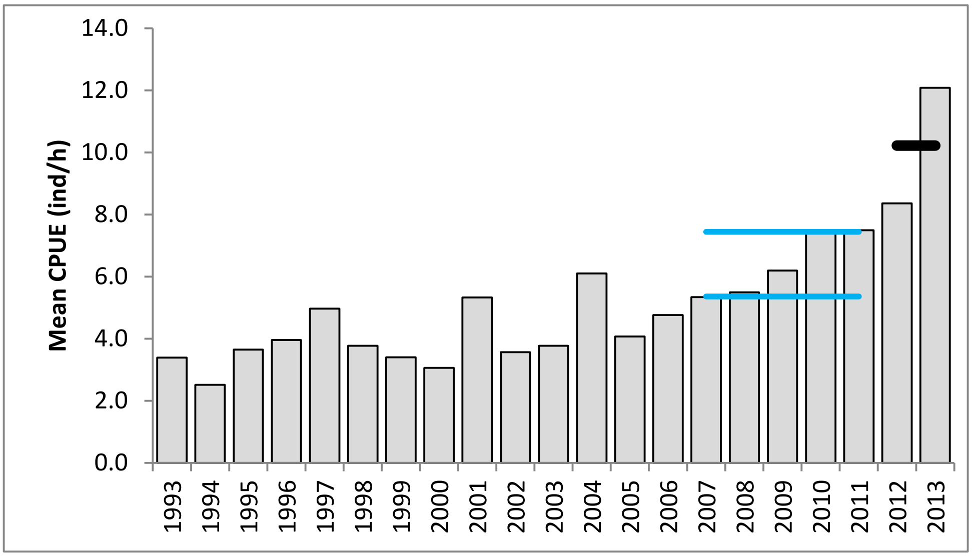


Figure 18.33b. Skates and rays in the Celtic Seas. Mean cpue (ind.h^{-1}) of VIIaf *Raja clavata* in the UK VIIaf beam trawl survey (EngW-BTS-Q3). Blue lines give mean annual cpue 2007–2011; black line mean annual cpue 2012–2013.

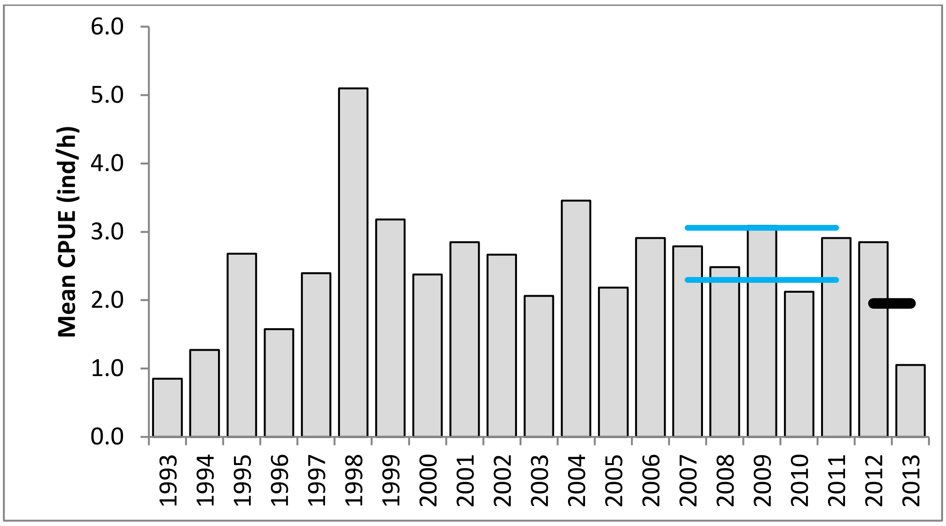


Figure 18.33c. Skates and rays in the Celtic Seas. Mean cpue (ind.h^{-1}) of VIIf *Raja microocellata* in the UK VIIaf beam trawl survey (EngW-BTS-Q3). Blue lines give mean annual cpue 2007–2011; black line mean annual cpue 2012–2013.

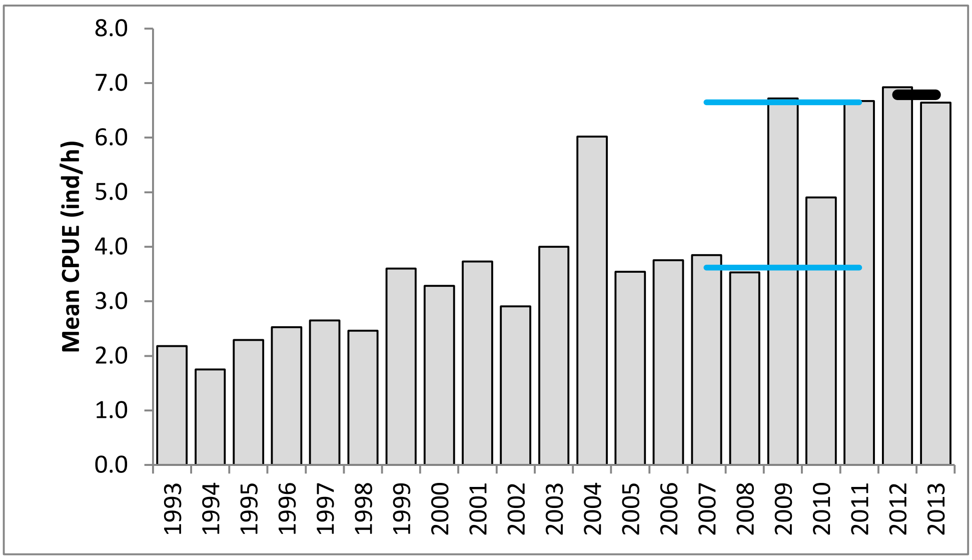


Figure 18.33d. Skates and rays in the Celtic Seas. Mean cpue (ind.h^{-1}) of VIIaf *Raja montagui* in the UK VIIaf beam trawl survey (EngW-BTS-Q3). Blue lines give mean annual cpue 2007–2011; black line mean annual cpue 2012–2013.

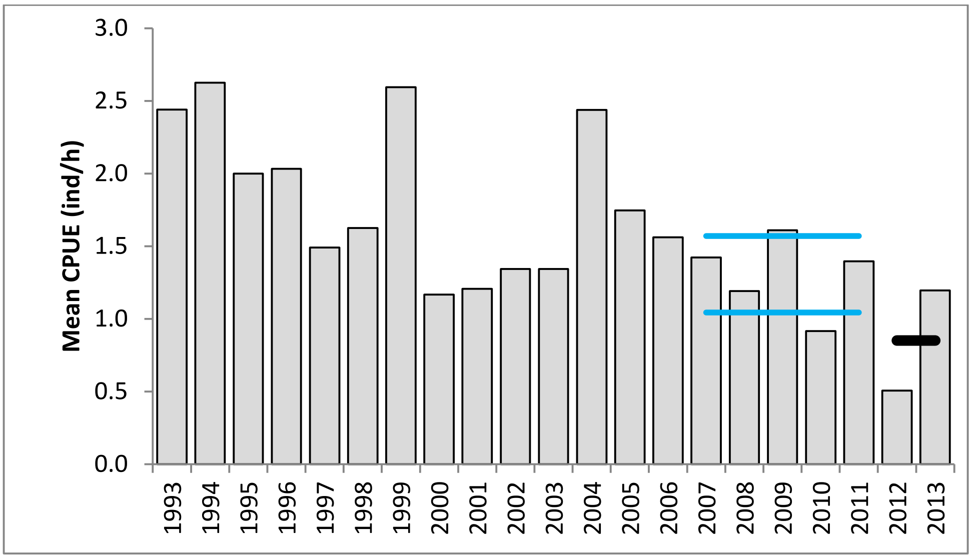


Figure 18.33e. Skates and rays in the Celtic Seas. Mean cpue (ind.h^{-1}) of VIIa *Leucoraja naevus* in the UK VIIaf beam trawl survey (EngW-BTS-Q3). Blue lines give mean annual cpue 2007–2011; black line mean annual cpue 2012–2013.

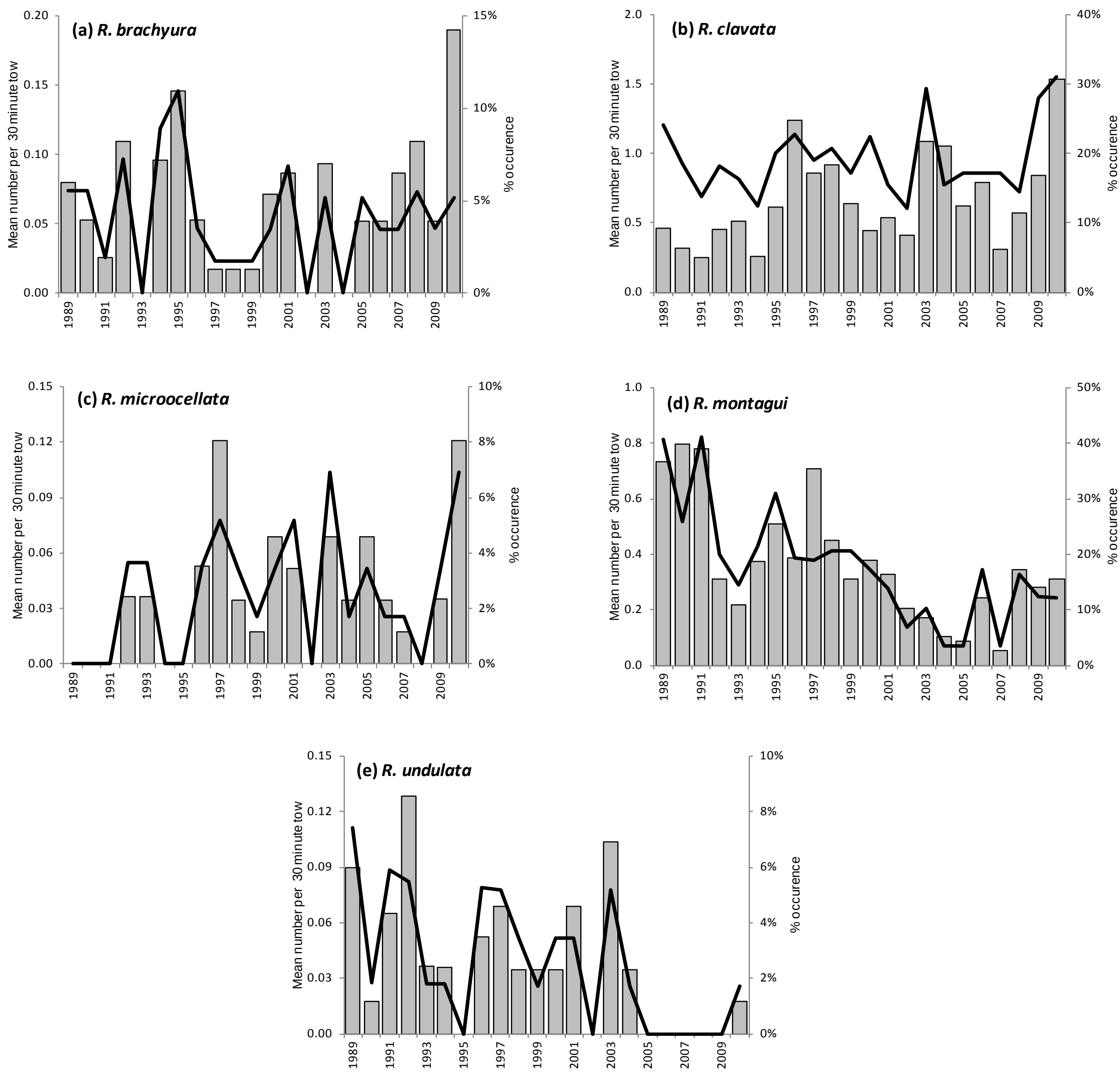


Figure 18.34. Skates and rays in the Celtic Seas. Trends in the mean relative abundance (numbers per 30 minute tow, grey columns) and frequency of occurrence (solid line) for five skate species caught in the Great West Bay (western English Channel) during the *Carhelmar* survey (1989–2010). Adapted from Burt *et al.* (2013).

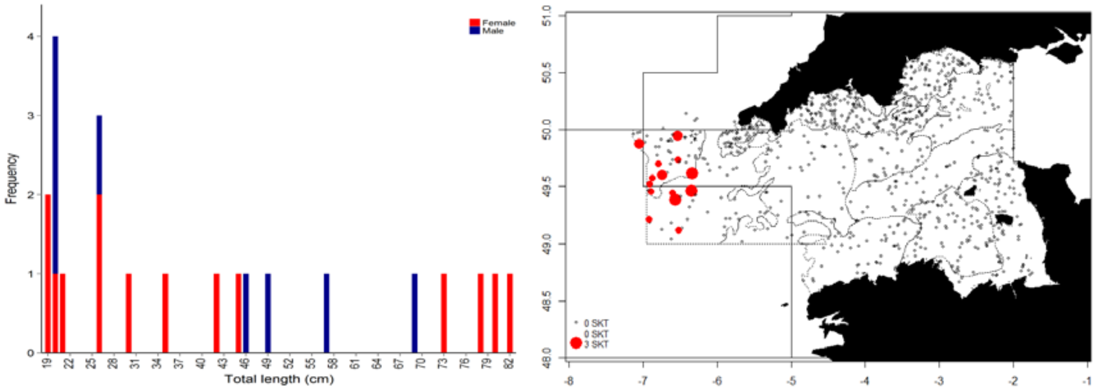


Figure 18.35a. Skates and rays in the Celtic Seas.: The distribution and relative abundance, and length–frequency by sex of common skate *Dipturus batis* complex in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

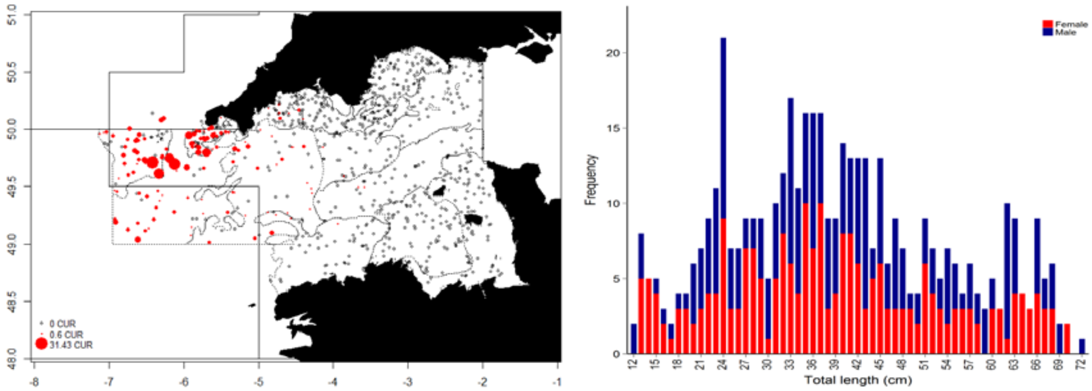


Figure 18.35b. Skates and rays in the Celtic Seas.: The distribution and relative abundance, and length–frequency by sex of cuckoo ray *Leucoraja naevus* in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

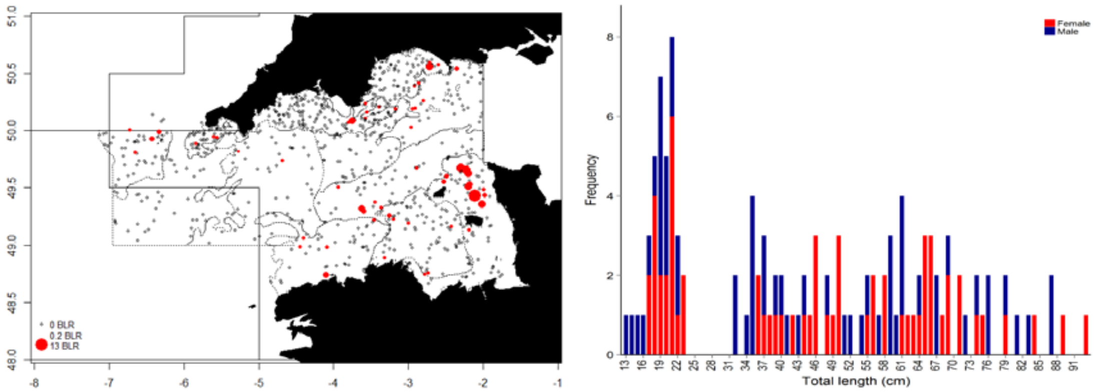


Figure 18.35c. Skates and rays in the Celtic Seas.: The distribution and relative abundance, and length–frequency by sex of blonde ray *Raja brachyura* in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

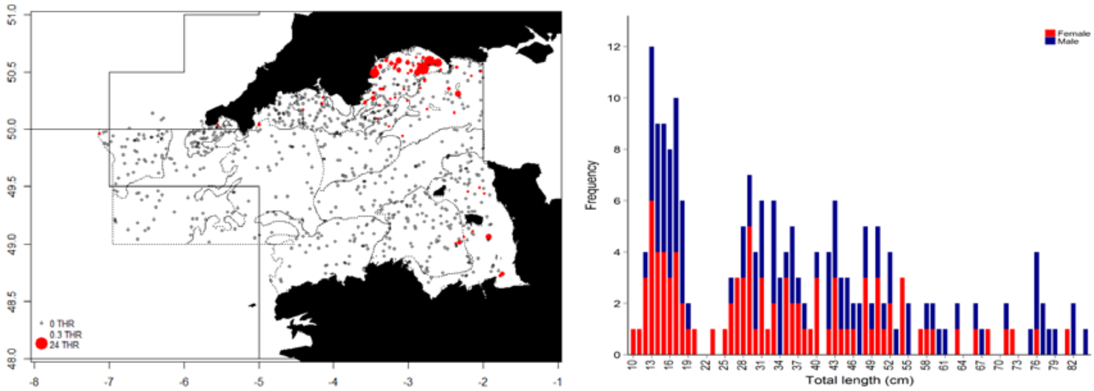


Figure 18.35d. Skates and rays in the Celtic Seas: The distribution and relative abundance, and length–frequency by sex of thornback ray *Raja clavata* in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

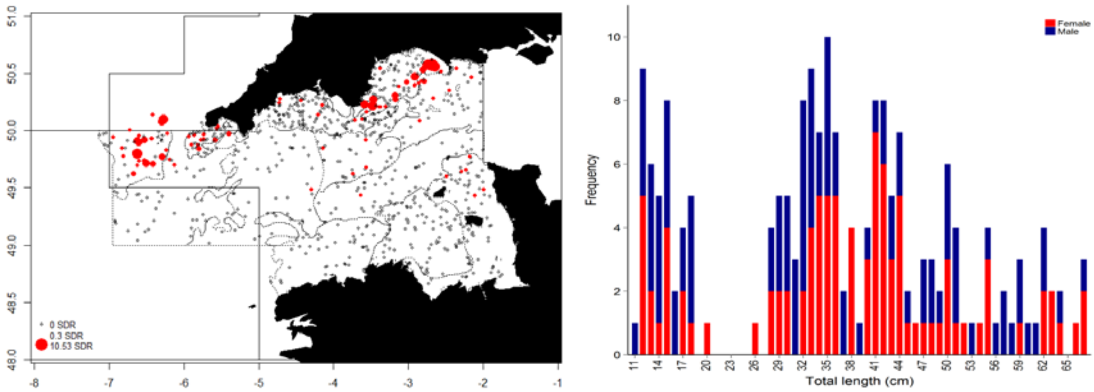


Figure 18.35e. Skates and rays in the Celtic Seas. The distribution and relative abundance, and length–frequency by sex of spotted ray *Raja montagui* in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

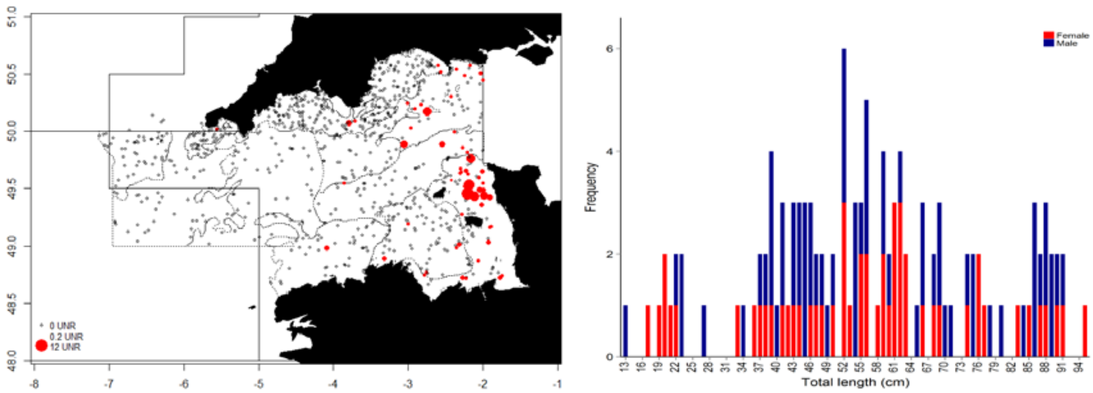


Figure 18.35f. Skates and rays in the Celtic Seas. The distribution and relative abundance, and length–frequency by sex of undulate ray *Raja undulata* in the western English Channel Q1 beam trawl survey Eng-WEC–BTS-Q1 (Silva *et al.*, 2014 WD).

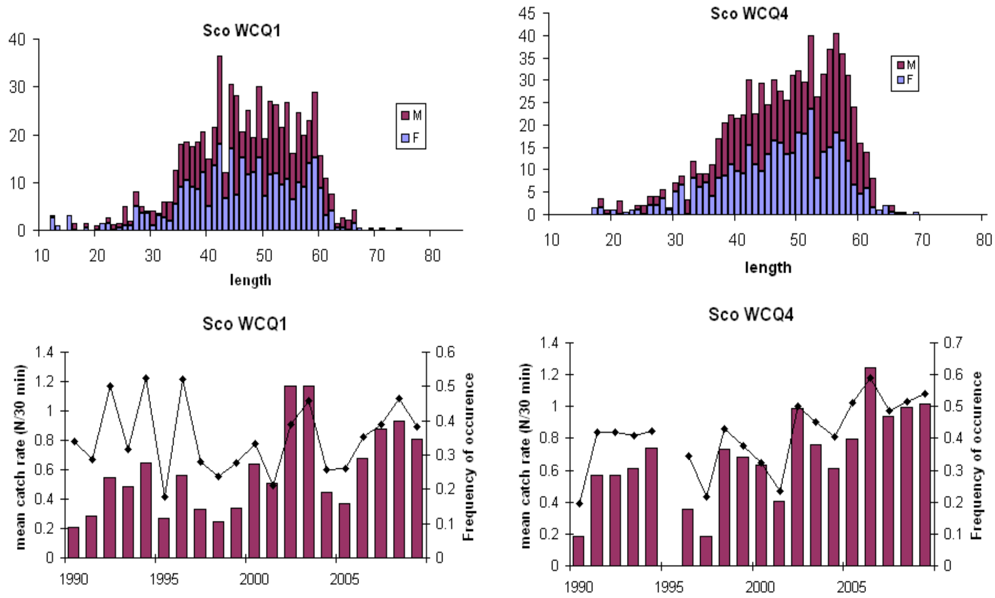


Figure 18.36a. Skates and rays in the Celtic Seas. Length–frequency distributions of *L. naevus* from the Scottish west coast surveys in Q1 (ScoGFS-WIBTS-Q1) and Q4 (ScoGFS-WIBTS-Q4) (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1} in those surveys between 1990 and 2009.

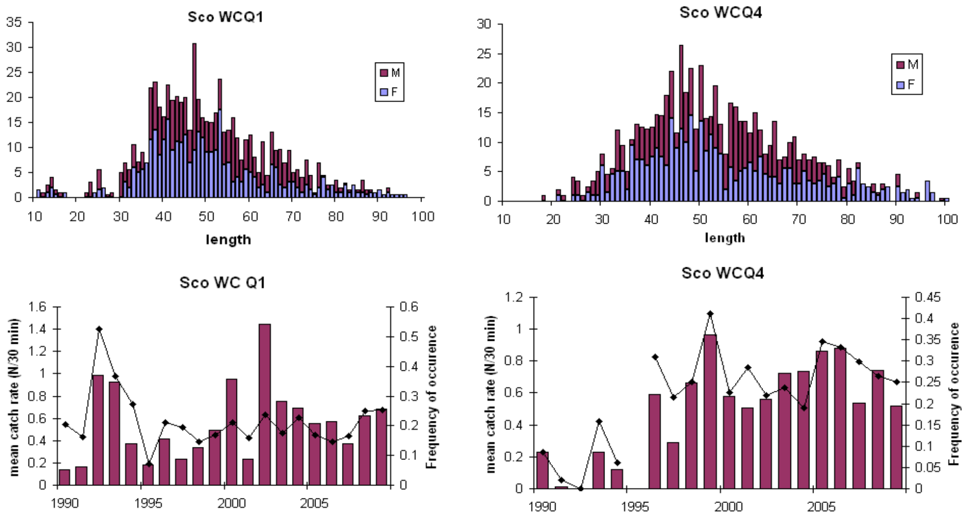


Figure 18.36b. Skates and rays in the Celtic Seas. Length–frequency distributions of *R. clavata* from the Scottish west coast surveys in Q1 (ScoGFS-WIBTS-Q1) and Q4 (ScoGFS-WIBTS-Q4) (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1} in those surveys between 1990 and 2009.

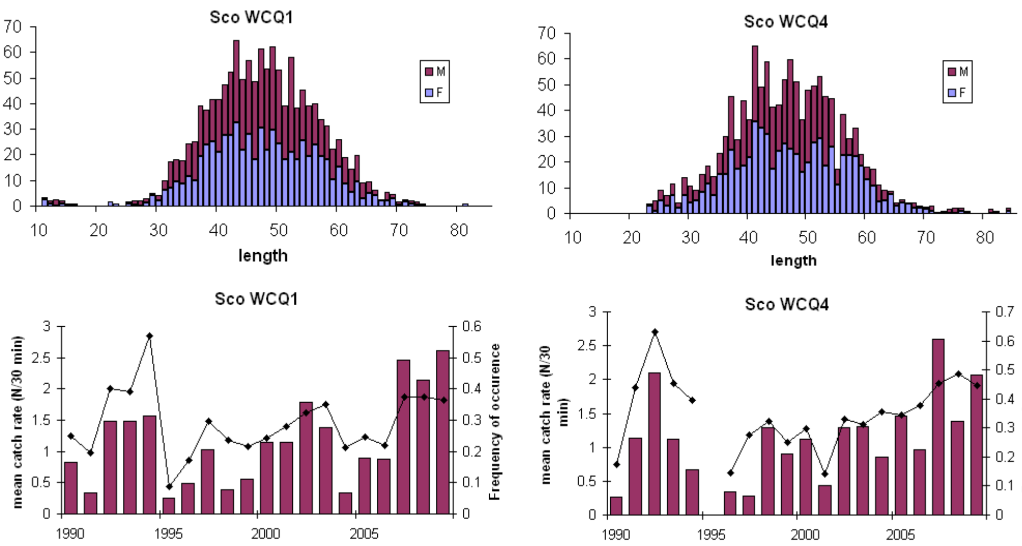


Figure 18.36c. Skates and rays in the Celtic Seas. Length–frequency distributions of *R. montagui* from the Scottish west coast surveys in Q1 (ScoGFS-WIBTS-Q1) and Q4 (ScoGFS-WIBTS-Q4) (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1} in those surveys between 1990 and 2009.

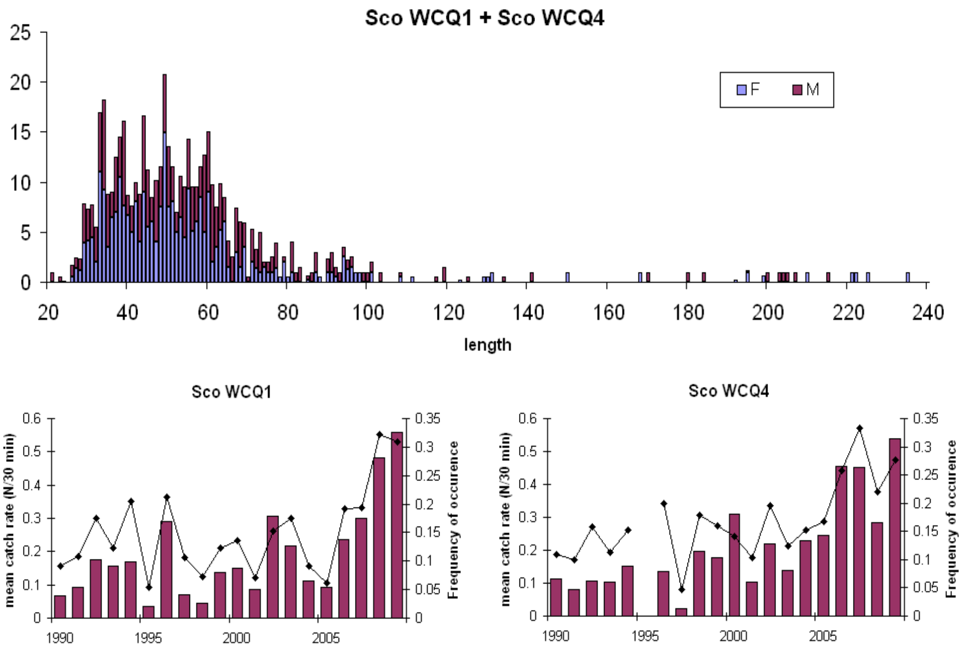
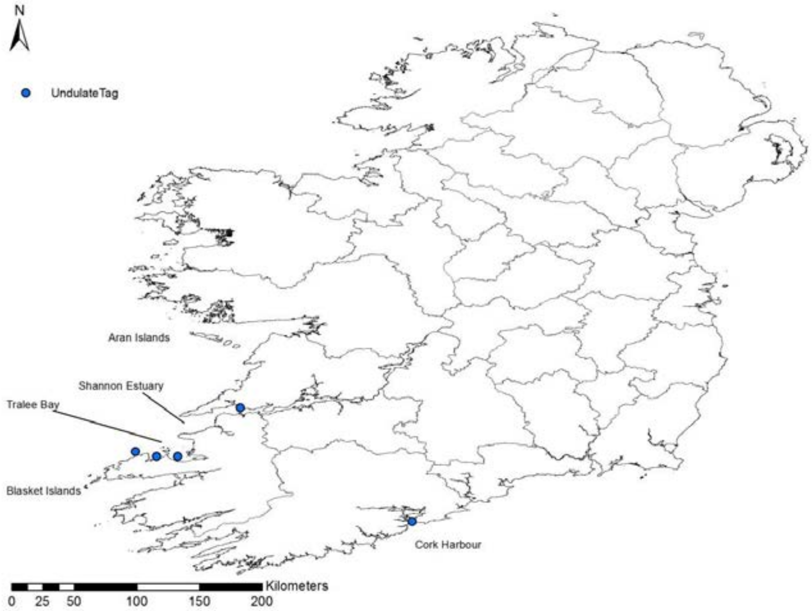


Figure 18.36d. Skates and rays in the Celtic Seas. Combined length–frequency distributions of *'D. batis'* from the Scottish west coast surveys in Q1 (ScoGFS-WIBTS-Q1) and Q4 (ScoGFS-WIBTS-Q4) (upper plot). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1} in those surveys between 1990 and 2009.



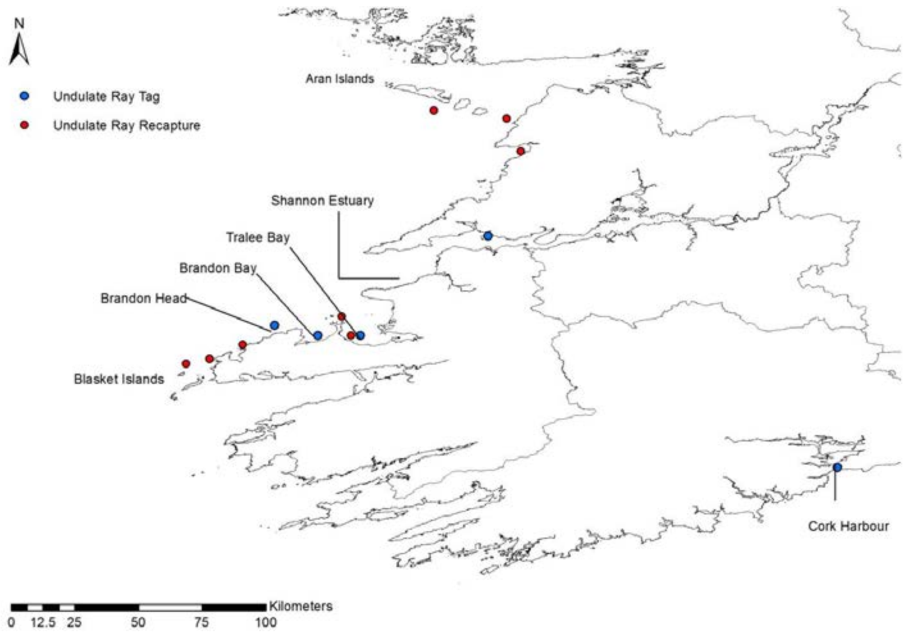


Figure 18.37. Skates and rays in the Celtic Seas. Undulate ray tagging locations (top) and recapture positions (bottom) 1972–2014 from IFI Marine Sportfish Tagging Programme (Wögerbauer *et al.*, 2014 WD).

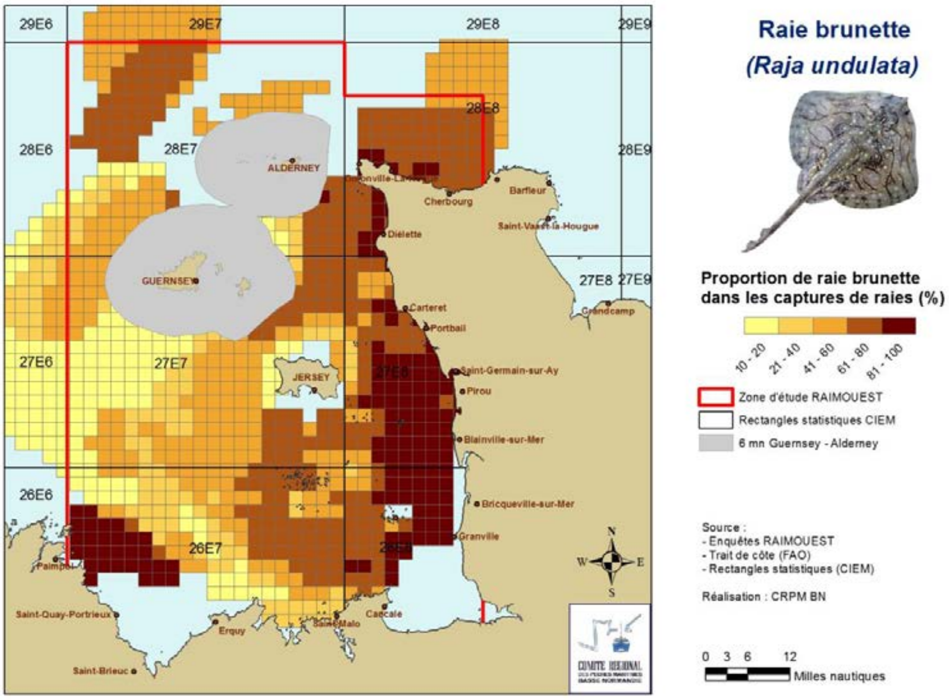


Figure 18.38. Skates and rays in the Celtic Seas.: Proportion of *R. undulata* in the total catch of rays in the Normand-Breton Gulf from enquiries with fishermen under the Raimouest project (LeBlanc *et al.*, 2014 WD).

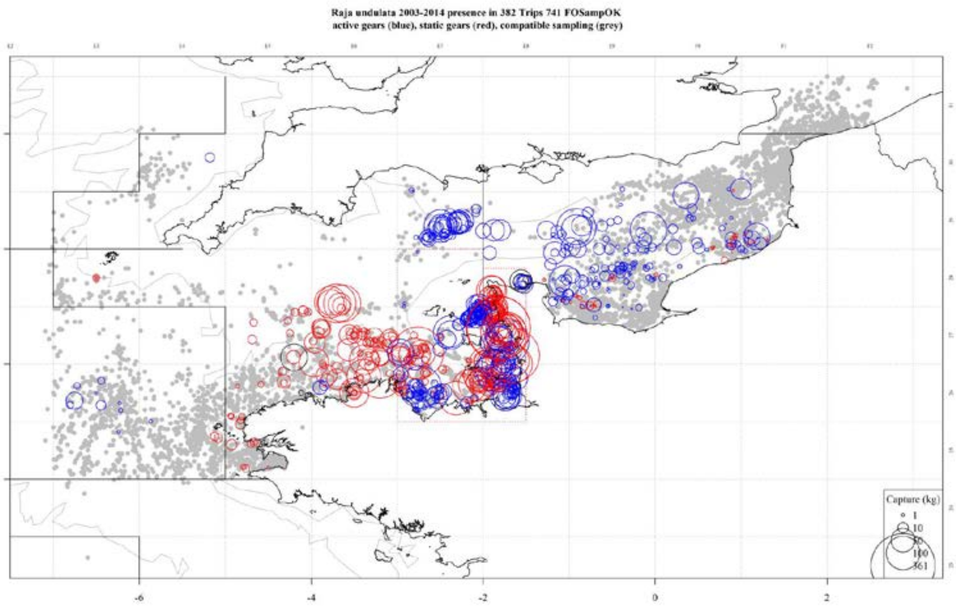


Figure 18.39. Skates and rays in the Celtic Seas. *R. undulata* catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears). Collated under the Raimouest project (LeBlanc *et al.*, 2014 WD).

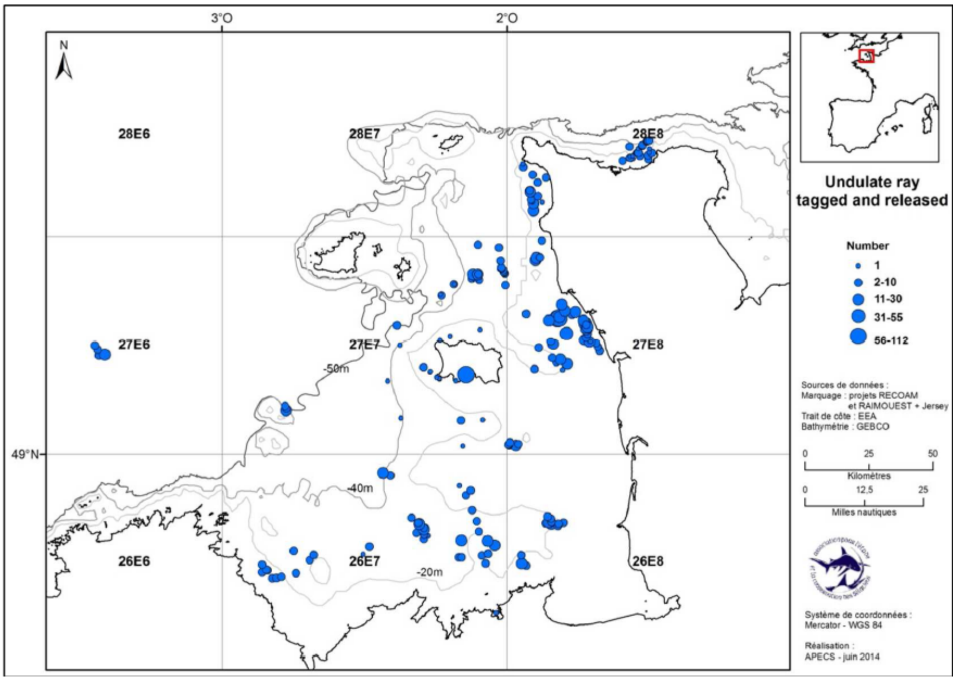


Figure 18.40. Skates and rays in the Celtic Seas.: Release positions and number (n = 1488) of *R. undulata* tagged in the Normano-Breton Gulf under the RECOAM project (Stephan *et al.*, 2014 WD).

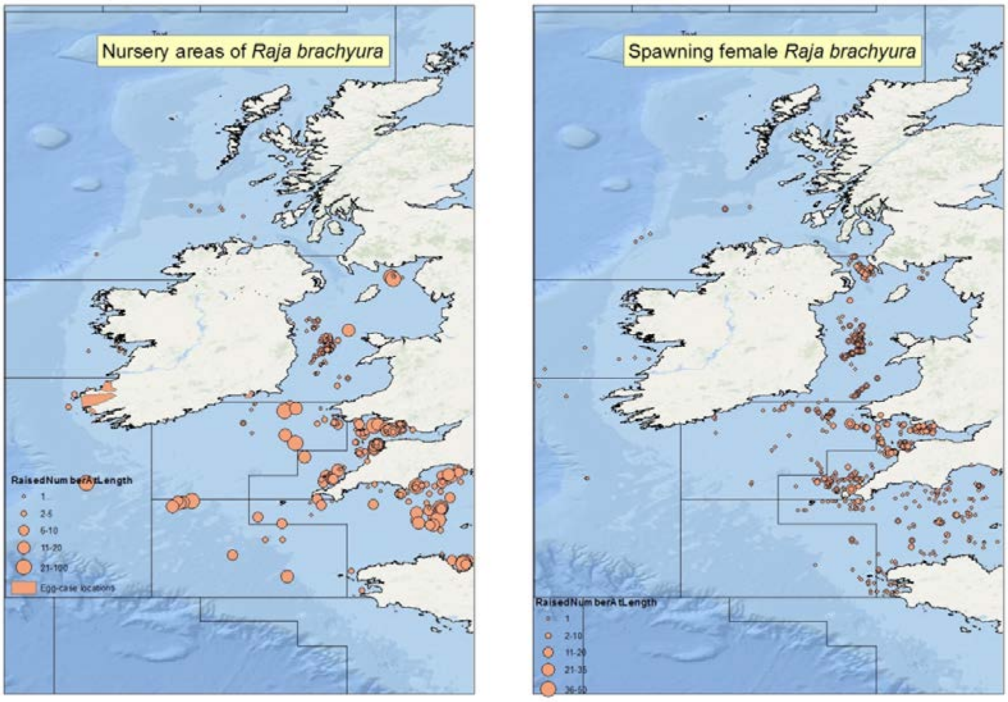


Figure 18.41a. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Raja brachyura*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only. Note: some of these data may be confounded with that of *R.montagui*.

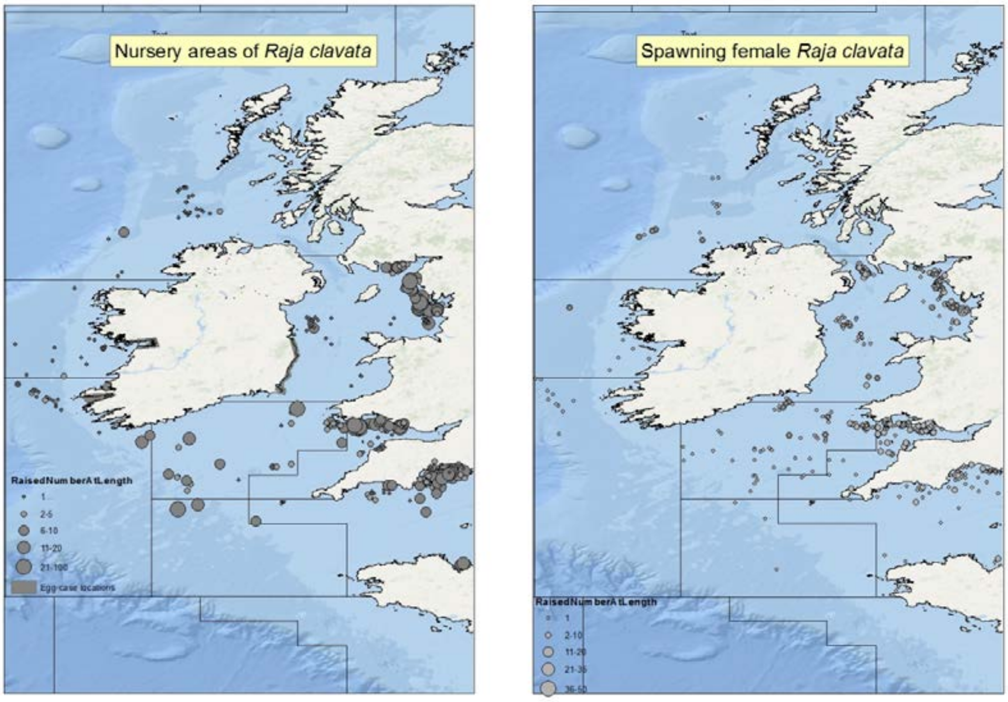


Figure 18.41b. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Raja clavata*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only.

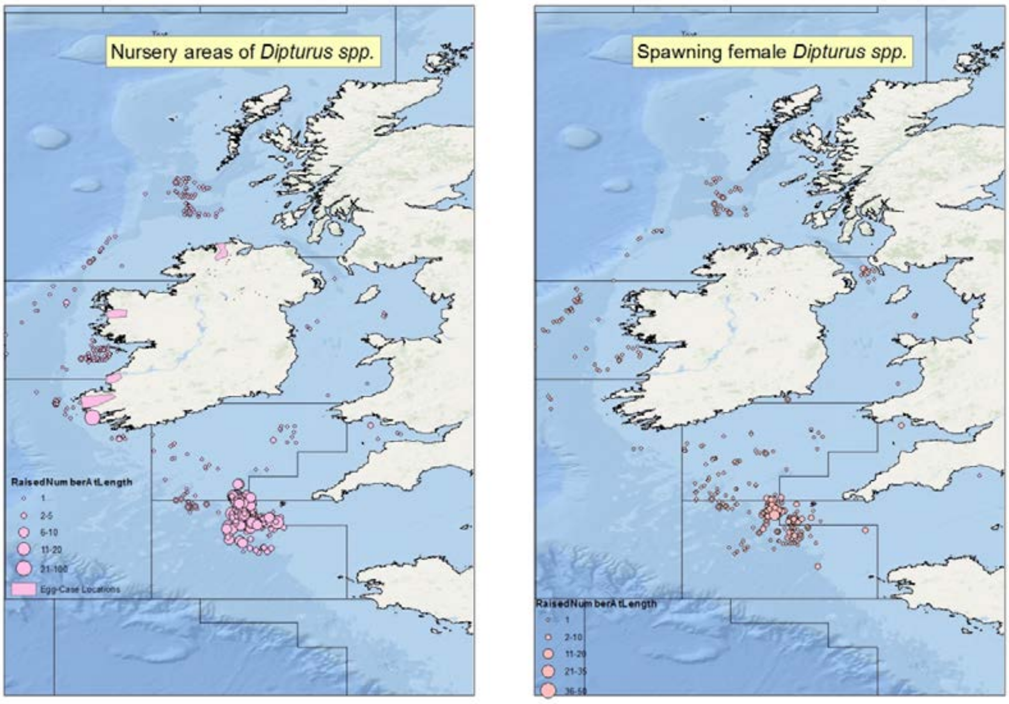


Figure 18.41c. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Dipturus batis* complex. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only.

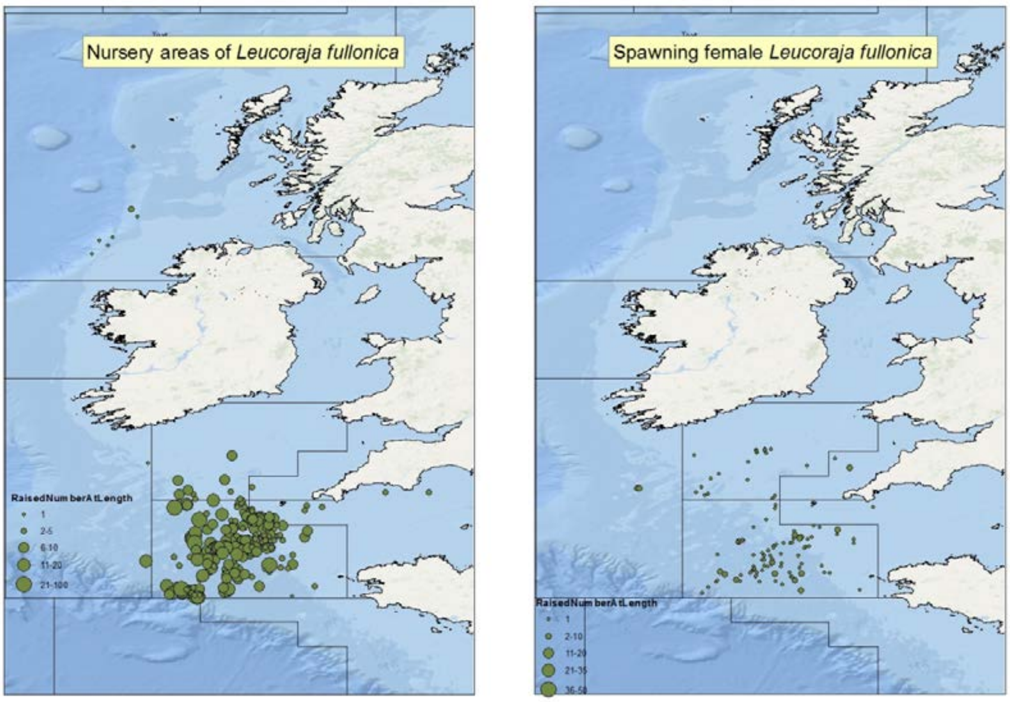


Figure 18.41d. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Leucoraja fullonica*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only.

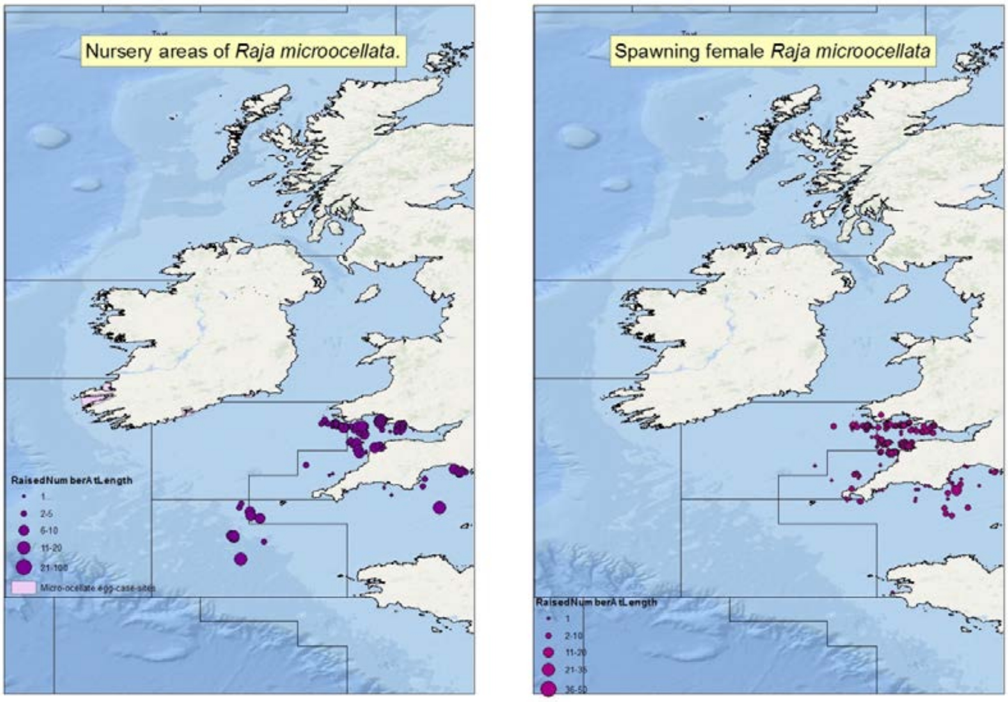


Figure 18.41e. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Raja microocellata*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only. Note: Offshore records of this species may represent misidentifications.

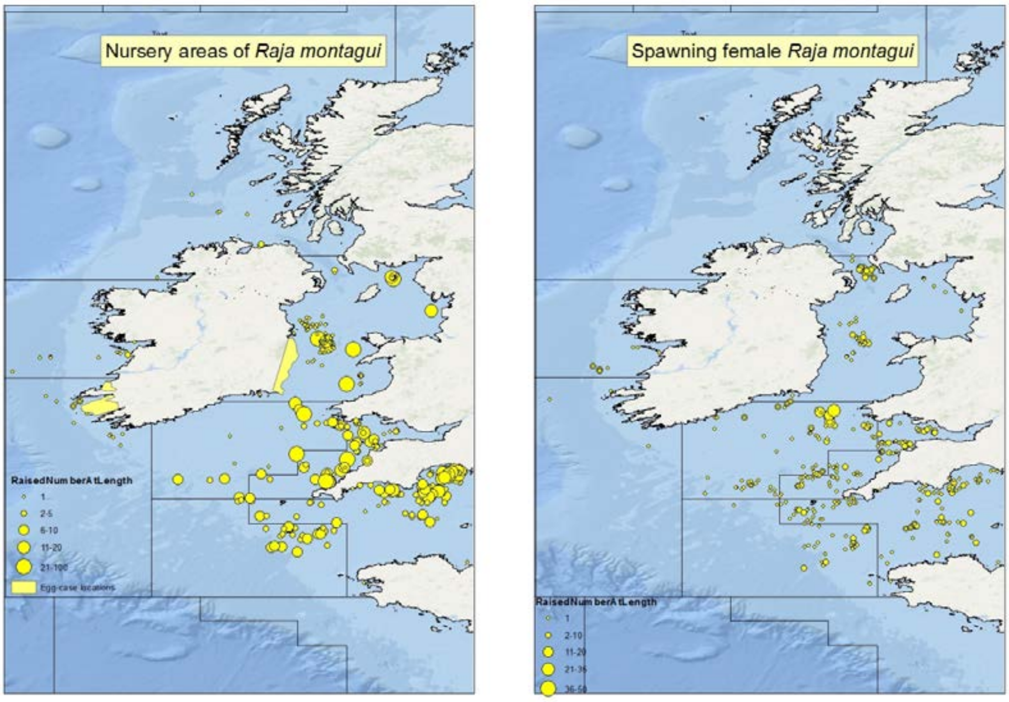


Figure 18.41f. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Raja montagui*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only.

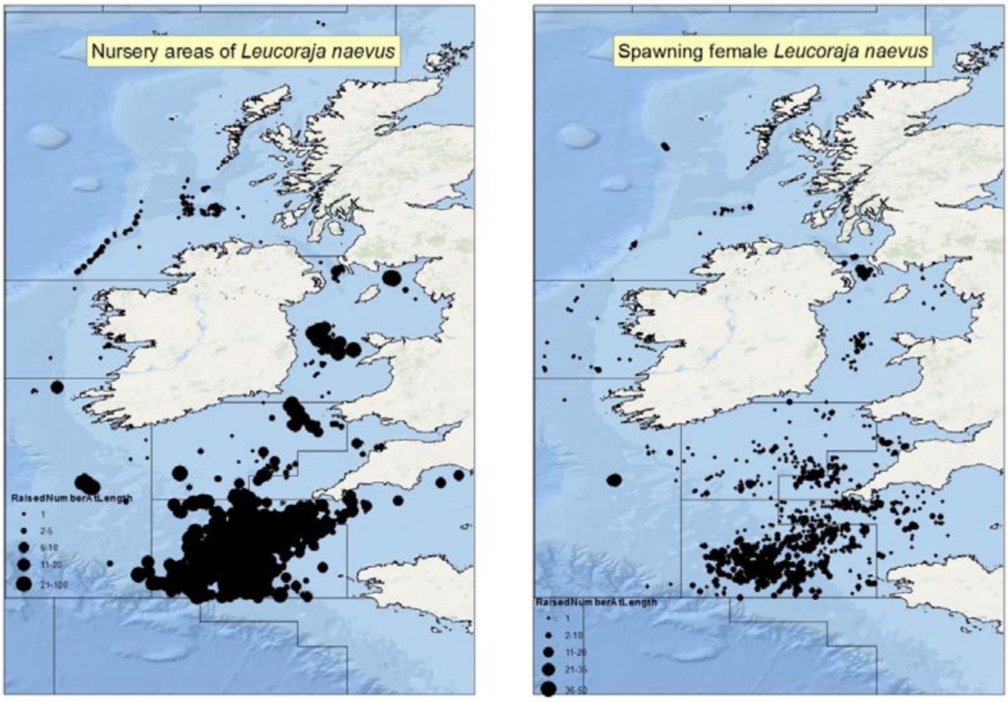


Figure 18.41g. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Leucoraja naevus*. Source: Irish, UK and French discard observer programmes, Subareas VI and VII only.

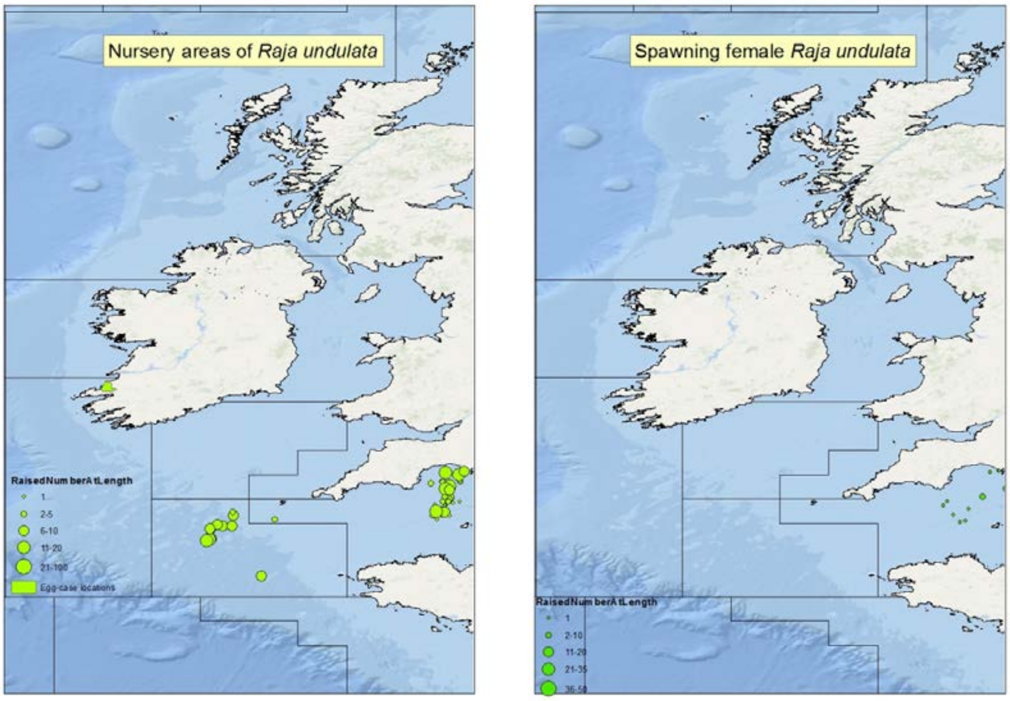


Figure 18.41h. Skates and Rays in the Celtic Seas. Nominal locations of potential nursery areas and areas with adult females during Q2 of *Raja undulata*. Source: Irish, UK and French discard observer programmes. Subareas VI and VII only. Note: Offshore records of this species may represent misidentifications and require validation.

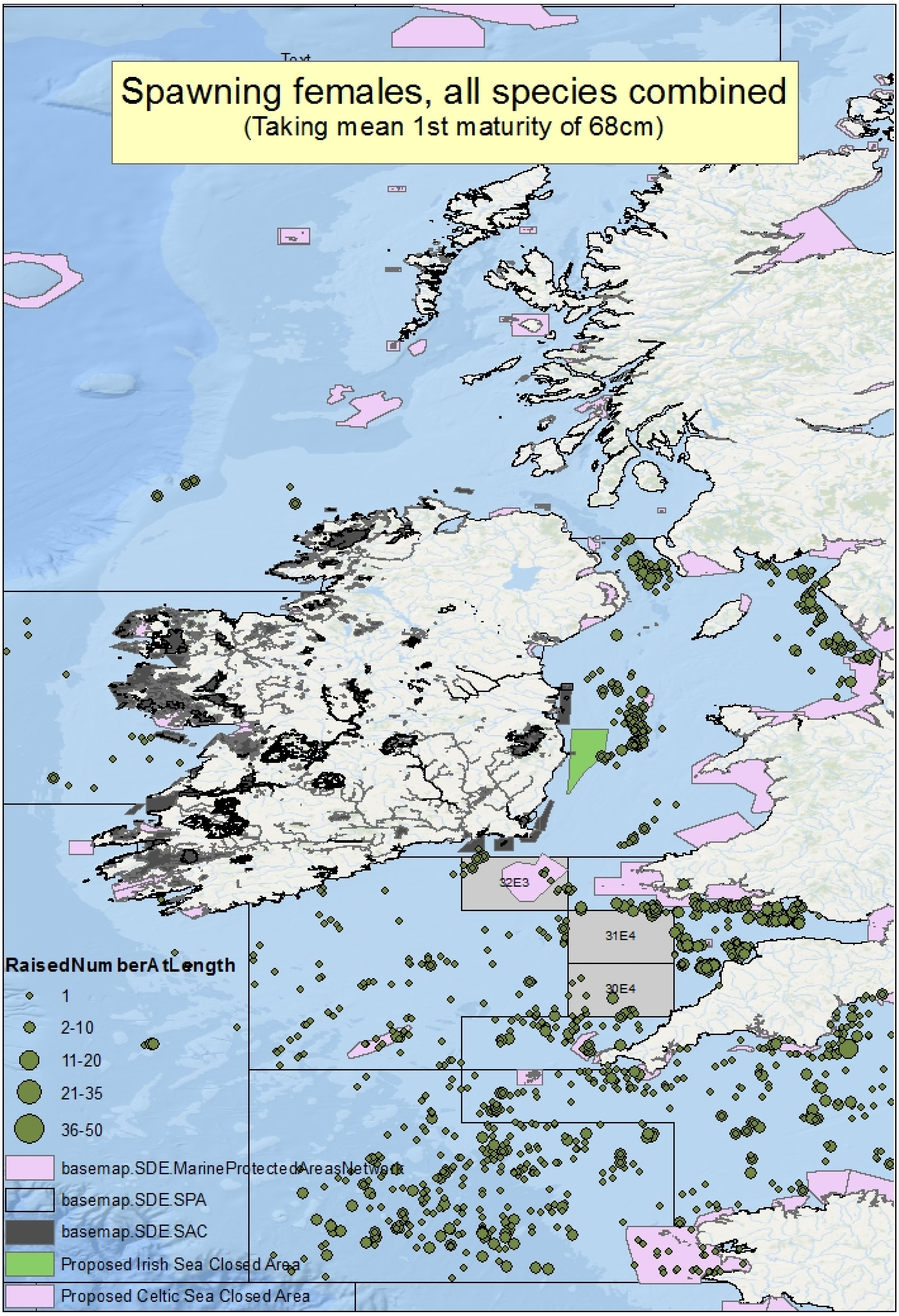


Figure 18.42. Skates and Rays in the Celtic Seas. Location of adult females, Q2, all species combined, with locations of existing and proposed conservation areas in VI and VII. Conservation areas includes MPAs, SPAs, SACs, and cod protection areas.

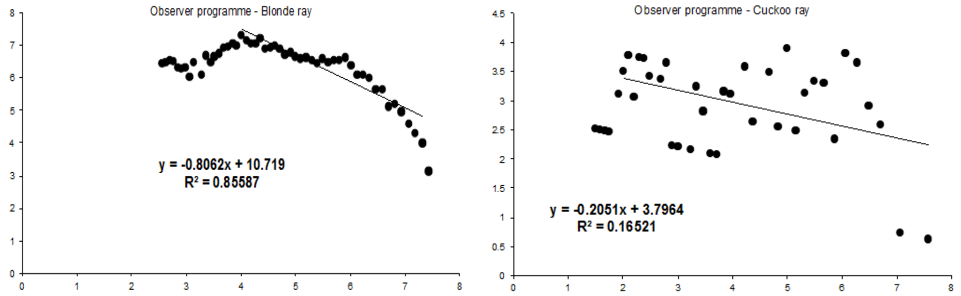


Figure 18.43. Skates and rays in the Celtic Seas. Catch curves from the Irish VIIa discard observer programme, and from combined NIGFS-WIBTS-Q4 (VIIa) and IGFS-WIBTS-Q4 (VIIg) survey data. The observer programme recorded insufficient data for thornback ray to fit a curve.

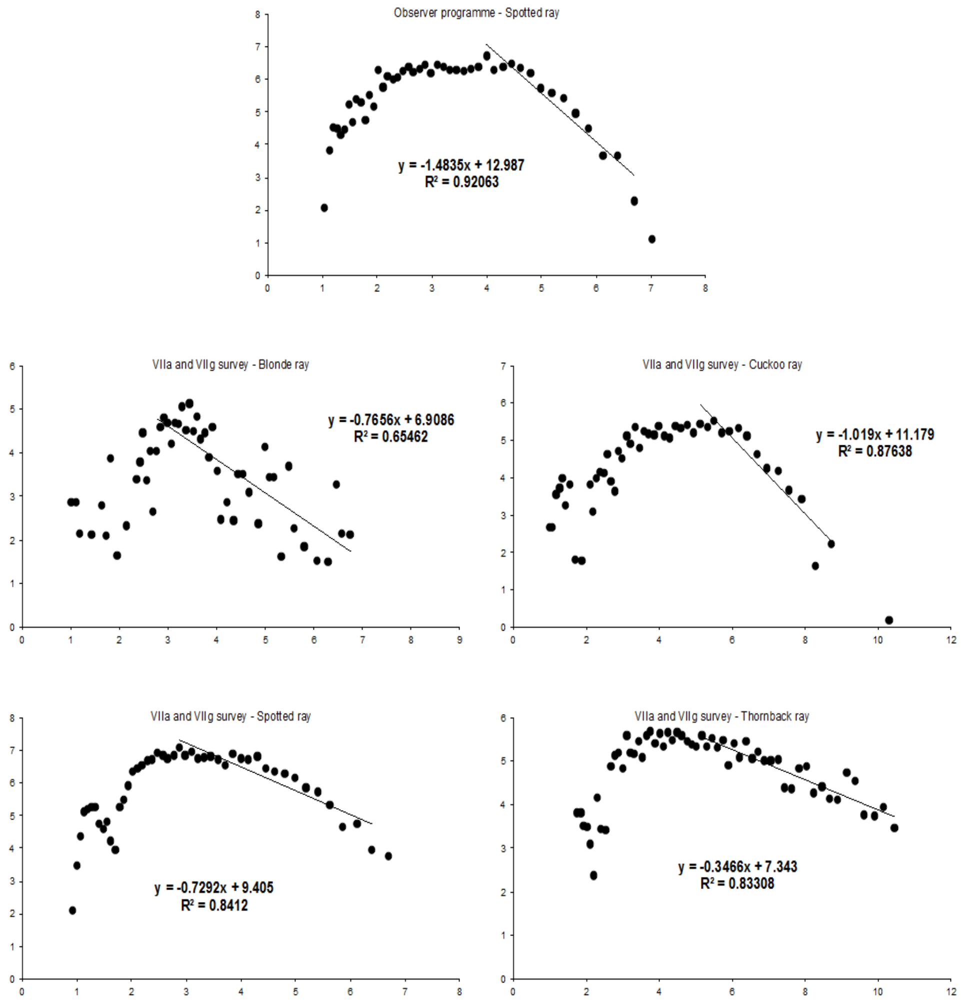


Figure 18.44. Skates and rays in the Celtic Seas. Catch curves from the Irish VIIa discard observer programme, and from combined NIGFS-WIBTS-Q4 (VIIa) and IGFS-WIBTS-Q4 (VIIg) survey data. The observer programme recorded insufficient data for thornback ray to fit a curve.

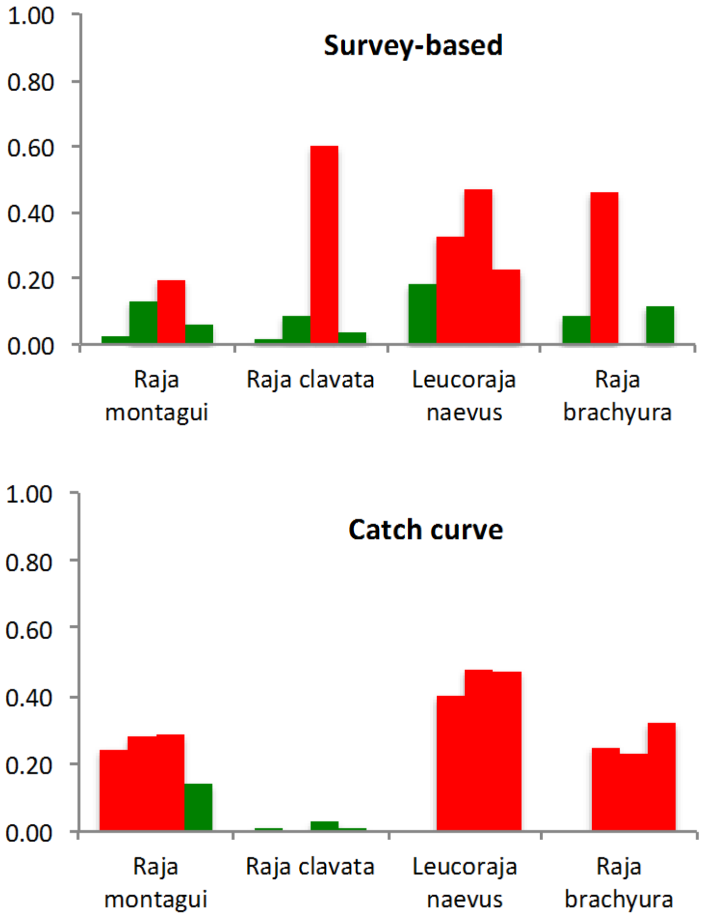


Figure 18.45. Skates and rays in the Celtic Seas. Survey- and catch curve-based estimates of HR (averaged for 2011–2012) for four skate species in the Celtic Seas (ICES VIIa and VIIg). Bars are coloured coded to indicate whether HR estimates are ≥ (red) or < (green) the mean of precautionary reference values (HR_{MSY} Mean, see Table 18.1.8).

19 Skates and rays in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa)

Advice for stocks in this ecoregion was last provided in 2014 and will next be provided in 2016. Therefore, this chapter only contains minor edits and updates to landings tables and figures. The advice for 2015 and 2016 is reproduced.

19.1 Ecoregion and stock boundaries

The Bay of Biscay and Iberian Waters ecoregion covers the Bay of Biscay (ICES Divisions VIIIa, b, d), including the Cantabrian Sea (ICES Divisions VIIIc), and the Spanish and Portuguese Atlantic coast (ICES Division IXa). This ecoregion broadly equates with the area covered by the South Western Waters Advisory Council (SWWAC).

The northern parts of the Bay of Biscay has a wide continental shelf with flat and soft bottoms 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 (ICES Division IXa) is also generally narrow, except for the area located between the Minho River and the Nazaré Canyon, and in the Gulf of Cadiz, where it is about 50 km wide, particularly to the east. The slope is mainly steep with a rough bottom, with canyons and cliffs.

Rajidae are widespread throughout this region but there are some important regional differences in their distribution as described in earlier reports (ICES, 2010). This is particularly evident for some skates and rays, which have a well-defined patchy distribution and limited dispersal (Carrier *et al*., 2004).

Skates and rays in this ecoregion include thornback ray (*Raja clavata*) and cuckoo ray (*Leucoraja naevus*) and the less common 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), long-nose skate (*D. oxyrinchus*), sandy ray (*Leucoraja circularis*) and white skate (*Rostroraja alba*).

Studies held in the centre off Portugal (IXa), and in the Cantabrian Sea (eastern parts of VIIIc) indicate spatial overlap between *R. clavata* and *L. naevus* (e.g. Sánchez, 1993). Both occur in areas deeper than 100 m depth, on grounds composed of soft sediment, between mud and fine sand (Serra-Pereira *et al*., 2014). *R. clavata* also occurs on other sediments, from rocky to sandy bottoms while *L. naevus*, according to the historical landings in the Bay of Biscay, is more abundant on the offshore trawlable fishing grounds (Sánchez *et al*., 2002). *R. clavata* and *R. brachyura* co-occur in areas with rocks surrounded by sand, at depths deeper than 100 m. Juveniles of *R. brachyura*, *R. montagui* and *R. clavata* are also known to co-occur on bottoms shallower than 100 m (Serra-Pereira *et al*., 2014). *R. undulata* and *R. microocellata* co-occur in the same areas, preferably shallower than 40 m depth and over sandy bottoms (Serra-Pereira *et al*., 2014).

Whilst the geographical distributions of the main skates and rays species in the ecoregion are fairly well known, the stock structures for most are still to be defined.

A tagging survey of *R. undulata* carried out in the Bay of Biscay (2012–2013) showed that migrations are mostly limited to 30 km, independent of time at liberty (Delamare *et al*., 2013 WD; Biais *et al*., 2014 WD). This result suggests that several local stocks may exist in European waters giving support to three separate units for stock assessment in the ecoregion (Divisions VIIIa–b; VIIIc and IXa).

For most other skate species, WGEF consider two management units in this ecoregion: Subarea VIII (Bay of Biscay) and Division IXa (Iberian waters). However, further studies to better understand stock structure of these species are required, which could make use of both tagging studies and molecular techniques.

19.2 The fishery

19.2.1 History of the fishery

Most skate species in the in the Bay of Biscay and Iberian Waters ecoregion are taken as a bycatch in mixed demersal fisheries, which are either directed at flatfish or gadiforms. The main fishing gears used are otter trawl, bottom-set gillnets and trammelnets.The main countries involved in these fisheries are France, Spain and mainland Portugal, as indicated below.

France

Skates and rays are traditional food resources in France, where directed fisheries were known to occur since the 1800s. In the 1960s, skates and rays were primarily taken as bycatch of bottom trawl fisheries operating off the northern part of the Bay of Biscay, the southern Celtic Sea and the English Channel. By this time *R. clavata* was targeted seasonally by some fisheries, being the dominant skate species landed in France. After the 1980s, *L. naevus* became the dominant species. Landings of the two species have declined since 1986.

Other skates and rays are also landed, including *L. circularis*, *L. fullonica*, *R. microocellata, D. batis* complex and *D. oxyrinchus*. There has been no large catches of *Rostroraja alba* in the past three decades by the French fleets.

The historical catches of skate species in coastal fisheries is poorly known. Species such as *R. brachyura* have not been reported as species-specific landings until the recent EU obligation. The same occurs with *Raja undulata* that was not reported separately before the ban of the landings.

Spain

The Spanish demersal fishery along the Cantabrian Sea (VIIIc) and Bay of Biscay (VIIIa,b,d) takes several skate species using different fishing gears. Most landings are bycatch from trawl fisheries targeting other demersal species (hake, anglerfish and megrim). Several skates occur in landings, with *L. naevus* and *R. clavata* the most common. Most skate species were traditionally landed under the same generic commercial category, especially those derived from artisanal gillnetters, due to their low commercial value. Along the Cantabrian Sea and Galician coast (VIIIc and IXa) there are also artisanal fisheries (gillnetters) operating in bays or shallow waters. Among the skate species, *R. undulata* is caught mainly in the coastal waters of Galicia (IXa North and VIIIc west). Other species caught in IXa North and VIIIc include *R. brachyura*, *R. microocellata*, R. *montagui*, *R. clavata* and *L. naevus*. The importance of the artisanal fleets in the Spanish skate landings is not fully known.

Mainland Portugal

Off mainland Portugal (IXa), skates are captured by trawlers, but mainly by the artisanal polyvalent fleet, which accounts for the highest reported landings. The artisanal fleet operates mostly with trammelnets but other types of fishing gears (e.g. longlines and gillnets) are also used. The landing composition of skate species varies between areas. The main species landed is *R. clavata*, but *R. brachyura*, *L. naevus* and *R. montagui* are also common. Before being prohibited, *R. undulata* was landed frequently, particularly at the northern landing ports. Other species (e.g. *R. microocellata*, *R. miraletus*, *D. oxyrinchus*, *R. alba* and *L. circularis*) are also caught, albeit less frequently (particularly the latter two species). Further details on fisheries in the IXa are reported in the Stock Annex.

19.2.2 The fishery in 2014

France

Landings and on-board observation data, confirmed that skates are primarily a bycatch in numerous fisheries operating in the Bay of Biscay. In landings statistics, more than 100 métiers report landings of *R. clavata* and *R. montagui* in the Bay of Biscay. Trammelnets are the main métier reporting *R. montagui*, with *R. clavata* taken mostly in the twin-trawl métier. For each species the DCF level six métiers represent less than 90% of total landings.

Spain

The preliminary results from the DCF pilot study in the Basque Country waters (VIIIc) conducted from 2011–2013, with the objective of describing and characterising coastal artisanal fisheries (trammelnets targeting mainly hake, anglerfish and mackerel), showed that several skate and ray species are caught as bycatch, particularly *R. clavata*, *R. montagui*, *L. naevus*, *L. fullonica*, *L. circularis*, *R. brachyura* and *R. undulata*. The coastal artisanal fleet consists of 55 small vessels using gillnets and trammelnets in different periods of the year. Vessels have a mean average length of 12.7 m and 82.4 kW average engine power. The proportion of rays in the total of sampled trips was 30% (2011), 35% (2012) and 16% (2013). The estimated landings of skates and rays in this fleet were 19.3 t in 2012 and 26.9 t in 2012 (Diez *et al.*, 2014 WD).

In the Cantabrian Sea (VIIIc) most skate and ray landings are bycatch from otter trawl (47%) and gillnet gears (43%), with the rest from longlines and other gears.

Mainland Portugal

Skates are mainly a bycatch in mixed fisheries, particularly from the polyvalent segment (representing 79% of landings) (Portuguese Directorate General for Natural Resources-DGRM). Polyvalent trawl vessels, depending on the fishing port, can represent 16% of the landed weight of skates. Nets or a combination of nets and traps account for the majority of the landed weight of skates within the polyvalent segment representing between 47–82%, followed by longline (3–52%). Methods to characterize the fishery were developed during the DCF-funded pilot study focused on skate catches in Portuguese continental fisheries (IXa) carried out from 2011–2013 (Maia *et al.*, 2013 WD). Further details are described in the Stock Annex.

19.2.3 ICES Advice applicable

Since 2014, ICES no longer provides general advice on skates, owing to the varied life-history traits of the various species, and species-specific advice is provided for the main stocks. Also, the generic skate TAC does not take into account that several stocks straddle the boundary with other management areas. For instance, *L. naevus* is a stock straddling Subareas VI and VII (excl. Division VIId) and Divisions VIIIa,b,d.

In 2014, ICES provided advice for 2015 and 2016 at the individual stock level for several species/stocks in this region. A summary of the advice can be found in the text below and in Table 7.3.18.0.

Skates and rays in Subareas VIII and IX

ICES uses the common term “skate” to refer to members of the family Rajidae. The term ray, formerly used by ICES to refer to Rajidae too, is now only used to refer to other batoid fish, including manta rays, sting rays, and electric rays. ICES only provides routine advice for Rajidae.

For the first time, in 2014, ICES gave quantitative advice for skates at a stock-specific level. Until then, landings data had been too incomplete and species composition was poorly known to allow ICES to provide quantitative advice per stock. A summary of the advice can be found in the table below:

Scientific name	Management unit	Advice	Advice (t)
Raja undulata	VIIIa,b	No target fishery, manage bycatch	-
Raja undulata	VIIIc	No target fishery, mitigate bycatch	-
Raja clavata	VIII	Reduce landings 20%	238
Leucoraja naevus	VIIIc	Increase landings 1%	347
Raja montagui	VIII	Reduce landings 20%	94
Raja montagui	IXa	Reduce landings 20%.	106
Leucoraja naevus	IXa	Reduce landings by 4%	46
Raja clavata	IXa	Increase landings 20%	911
Raja undulata	IXa	No target fishery, manage bycatch	-
Raja brachyura	IXa	Not to increase	200
Dipturus batis complex (*Dipturus* cf. *flossada*) (*Dipturus* cf. *intermedia*)	VIII, IXa	No target fishery, mitigate bycatch	-
Other skates	VIII, IXa	Reduce landings 20%	614

The advice in this table does not sum up to a generic advice for skates in Subareas VIII and IX, because it does not include stocks straddling with Subarea VII. Therefore this table should not be interpreted as advice in relation to a generic skate TAC in Subareas VIII and IX.

19.2.4 Management applicable

EC Council Regulation 2015/104 established a TAC for Rajidae of 3420 t in 2015 in Subareas VIII and IX.

RAJIDAE (Divisions VIII & IX)	2013		2014		2015	
	TAC	Landings	TAC	Landings	TAC	Landings
Belgium	8	0	7	3	7	
France	1441	1279	1298	1173	1298	
Portugal	1168	1103	1051	1015	1051	
Spain	1175	1168	1057	764	1057	
UK	8	0	7	0	7	
UE	3800	3549	3420	2955	3420	

This Regulation indicates that catches of *L. naevus*, *R. brachyura*, and *R. clavata* shall be reported separately. Scientific advice received from the STECF on 2 March 2015 indicated that it was precautionary to allow a small bycatch quota for *R. undulata* in Subarea VIII (Council Regulation (EU) No 2015/523 of 25 March 2015 amended Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities). The quota above does not apply to *R. undulata*, and this species shall not be targeted in the areas covered by this TAC. From 2015, a separate TAC of 25 t was established for *R. undulata* (France 9 t; Portugal 8 t; and Spain 8 t), with this TAC to allow some bycatch in area VIII to be landed, "*provided that it does not comprise more than 20 kilograms live weight per fishing trip*".

EC Council Regulation 2015/104 also prohibits landing the following demersal elasmobranchs that occur in this ecoregion: common skate (*Dipturus batis*) complex; guitarfishes (*Rhinobatidae*), angel shark (*Squatina squatina*) and white skate (*Raja alba*).

.2.4.1 Regional management measures

On 29-12-2011 the Portuguese Administration adopted a 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 bycath of less than 5% in weight.

On 22-08-2014 the Portuguese Administration adopted a national legislation (Portaria no 170/2014) that establishes a minimum landing length for all *Raja* spp. and *Leucoraja* spp. species at 52 cm total length (L_T).

19.3 Catch data

19.3.1 Landings

Rajidae landing data for the period 1996–2014 are given in Tables 19.1a–e and in Figures 19.1a–b. Tables 19.2 and 19.3 present species specific-landings based on official landings (see Section 19.10). It is important to highlight that misidentification still occur to a level likely to undermine the reliability of data.

Skates and rays in ICES Subarea VIII

Historically the 59.6% of landings in this area were assigned to France while 38.9% are from Spain and Basque Country fisheries combined. Since 1973, landings of skates and rays show no clear pattern, although there was a remarkable peak at the earlier years of the time-series (1973–1974) and also from 1982–1991.

From 2003 to 2013, landings in Subarea VIII have been between 2000–2800 t.y^{-1}. In 2013 the Divisions with the highest landings were VIIIa–b (72%), mostly from France (1220 t), which was similar to 2012. In Division VIIIc (25%) landings, mainly from Spain and Basque Country, reached 507 t in 2013. The Division VIIId represented the 3%) reached 59 t in 2013.

Skates and rays in ICES Division IXa

In the last three years (2012–2014), total landings have decrease in this area compared to the time-series since 1996, probably reflecting the Portuguese legislation adopted (see 19.2.4.1.). 2014 recorded the lowest landings of the time-series (1304 t). Reported landings from this area are from Portugal (82%) and Spain (18%). In 2014, the most important species in official landings data, in decreasing order, were *R. clavata, R. brachyura, L. naevus* and *R. montagui* (see Section 19.4.2 for more details).

The Spanish mean annual landings since 1999 were 342 t with a maximum of 549 t in 2011.

From the 1990s until 2010 the Portuguese mean annual landings were ca. 1500 tonnes. In 2013 and 2014, landings decreased to 1103 t and 1015 t, respectively, in line with the TAC assigned to Portugal. This decrease is also likely to reflect Portuguese regulations to reduce fishing effort on skates (see 19.2.4.1). Historical landings of *R. undulata* in Portuguese waters (Division IXa) have been estimated for the period 2003–2008 (Figueiredo *et al.*, 2015 WD; Maia *et al.*, 2015 WD).

19.3.2 Discards

Discard information is available for Basque OTB (Bottom Otter Trawler) fleet in Divisions VIIIa,b,d (Table 19.4a,b) and Spanish fisheries in VIII and IXa since 2003 (Table 19.4c). Estimates of discards from Portuguese OTB and Polyvalent fleets are also available (Tables 19.4d). Although there may be a widespread discarding of skates across fisheries, a proportion of these are likely to survive, particularly in the case of the polyvalent fleets using trammel and gillnets (depending on soak time).

Basque OTB fleet in VIII

In Subarea VIIIa,b,d, small specimens are commonly discarded. Since 2009, there is species-specific information of skate discards. This information indicates that *L. naevus* was the most discarded species with a peak of 22.7 t in 2013.

Analyses of discard estimates for the period 2009–2014 indicates that, depending on the year, this fleet discarded 4–23% of *L. naevus* catches and 0–11% of *R. clavata* (Table 19.4b).

Spanish fleet in IXa and VIIIc

Information on results of the Spanish discard sampling programme for the main elasmobranch species in VIIIc and IXa were updated. In recent years, *R. clavata* was the most frequently discarded species (Table 19.4c).

In 2013, preliminary discard estimates for the Spanish and Basque OTB fleet in VIII were 52 t of *L. naevus* (4% of landings) and 55 t of *R. clavata* (18% of landings).

Portuguese OTB fleet in IXa

Information on discards of elasmobranchs produced by the Portuguese bottom otter trawl fleet operating in Division IXa has been collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2013. Methodologies to estimate the probability of the species being caught in a haul and a specimen being discarded, as well as, the expected number of discarded specimens per haul are described in the Stock Annex.

Two fisheries were analyzed: i) the crustacean bottom otter trawl fishery (OTB_CRU) and ii) the demersal bottom otter trawl fish fishery (OTB_DEF). In both fleets, the probability of the species being caught in a haul and of a specimen being discarded, as well as the expected number of discarded specimens per haul, were both very low (Table 19.4d). The annual frequency of occurrence of rajids ranged from 0% to 9% in the crustacean fishery (Prista *et al.*, 2014 WD). In the demersal bottom otter trawl fish fishery, rajids occurred in 0 to 51% of the total number of sampled hauls, with *R. clavata* occurred in down to 21%. The frequency of occurrence of rajids in discards was low, with *R. clavata* occurring at maximum of 12% (Prista *et al.*, 2014 WD).

Polyvalent Portuguese fleet

Information on discards of Rajidae species produced by the Portuguese polyvalent fleet operating in the Division IXa was obtained from the DCF skate pilot study and from the DCF Portuguese trammelnet fishery pilot study. The addressed fisheries include: i) the net fisheries (trammel or gillnets) targeting a multi-species complex and ii) the trammelnets fishery targeting anglerfish. For analysis purposes the considered fisheries were categorized as operating shallower than 150 m in the case of multi-species net fishery and deeper than 150 m regarding the anglerfish trammelnets fishery. Results show that the frequency of occurrence of rajids was higher in nets operating shallower than 150 m, presumably due to a higher spatial overlap with the species' distributions. The probability of the species being caught in a haul and a specimen being discarded and the expected number of discarded specimens per haul were very low for all the species considered in the analysis (Table 19.4d). Methods are described in the Stock Annex.

French fleet

Discards in French fisheries were analysed using the COST format and R-package. Because skates are caught in small amount as bycatch in numerous métier, raising observed discards to the total fleet is problematic. A few characteristic on discards can however be described. Gillnet and trammelnet métiers discard a fraction of large fish, which might be considered as damaged fish (e.g. partly scavenged catch). These discards are dead discards. In trawl fisheries discarded skates have a much smaller mean size than landed skates, these are mostly discarded because of the low value of small rays, and some of these discards may survive.

19.3.3 Discard survival

Table 19.4e shows survivorship estimates for *R. clavata*, *L. naevus*, *R. montagui,* and *R. brachyura* based on onboard sampling observations on gill and trammelnet fisheries collected under the Portuguese DCF skate pilot study. Results indicate that the survivorship of all the species addressed after capture is high. Both mesh size and soak time affected survivorship. Methods for estimating survivorship are described in the Stock Annex.

In the case of *R. undulata*, from a total of 100 individuals sampled on board fishing vessels, 91% were found with "good" health status, 6% found with "moderate" health status and only 3% found in "poor" health status (Table 19.4f). These results indicate that the survivorship of *R. undulata* after immediate capture is potentially high. The size of the specimens influences the survivorship of this species. For the two size groups considered (<50 cm and > 50 cm) the percentage of individuals in "good" health status was high (83% and 92%, respectively), but a a lower proportion of smaller fish (< 50 cm) was noted. In general, for different soaking times and mesh sizes the survivorship of *R. undulata* is always very high (>82%). The method used to estimate the survivorship of this species is described in the Stock Annex.

19.4 Commercial catch compositions

19.4.1 Species and size composition

Subarea VIII

Length–frequency distributions of *R. clavata* and *L. naevus* from commercial Basque trawlers in VIIIa,b,d are presented in Figures 19.2a,b. Length–frequency distributions of *R. clavata* and *L. naevus* are also available from the Spanish trawl fleet in division VIIIb and *R. montagui* in VIIIc (Figures 19.3 a,b).

Divison IXa

Length–frequency distributions of *R. clavata, R. brachyura, R. montagui, R. microocellata* and *L. naevus* from the Portuguese commercial polyvalent and trawl fleet for the period 2008–2014 are given in Figures 19.3c–g. Length–frequency distributions were based on extrapolating to the total estimated landed weight of each species. Both length distributions and ranges are stable among years for both fleets. However, there are differences in length distributions between the polyvalent and trawl fleet fleets for some species: landings from the trawl segment tend to be composed by a higher density of smaller length classes than the polyvalent fleet, as in the case of *R. brachyura* and *R. microocellata*.

Length–frequency distribution of *R. undulata* collected on board of polyvalent vessels for the period 2008–2013 is presented in Figure 19.3h. In recent years the length structure of the population caught shifted to larger individuals.

In 2014 there were no new data on the length–frequency distribution of *R. clavata* from the Spanish commercial fleet in this area.

19.4.2 Quality of the catch composition data

Species composition of landings in Subarea VIII and Division IXa are presented in Tables 19.3 and 19.5. Only a small proportion of landings are reported as Rajidae or *Raja* spp.

From 2011 to 2013 there was a DCF pilot study (coordinated between AZTI-Tecnalia and IPMA). The main objective of the Basque Country pilot study was to characterize the main fishing parameters of the trammelnet fishery (fishing gear, métier, effort and lpue) and to identify the skates and rays species present in the landings as well as the biometric relationships as "wing weight/total weight" and total length/wing width" in order to precise the live weight of the landed skates and rays.

In the Portuguese official landings statistics only four commercial designations are adopted: *R. clavata*, *R. brachyura*, *R. montagui* and *L. naevus*. Thus skate species misreporting in landing ports persist. To circumvent this deficiency an extra effort in data collection was made under the DCF skate pilot study and robust estimators were developed to estimate landings per species (for more detail on methodology see stock annexes) for the period from 2008–2014. Table 19.5 presents the updated landings proportion of each Rajidae species.

A project on *R. undulata* in Portuguese waters (Division IXa) (UNDULATA Project (UNDULATA -Nº31-03-01 FEP186) started in June 2014 with the aim to improve the knowledge on the stock structure, abundance and the dynamics of the species (see Section 26; Figueiredo *et al.*, 2014 WD; Maia *et al.*, 2015 WD).

A datacall for elasmobranch landings was carried out by ICES for the first time in 2015, relating to 2014 landings data. Landings figures were not requested for all stocks. As a consequence, although all countries answered the data call, data that had not been specifically requested (including generic categories) were missing at the beginning of the meeting, and had to be requested afterwards in order to accurately provide total skate landings for this Ecoregion. Nevertheless, data should be revised in 2016. This issue should be considered in the next ICES datacall.

19.5 Commercial catch-effort data

19.5.1 Spanish data (VIII)

Only limited new data were provided.

A revised nominal lpue-series for the Basque Country's OTB DEF>=70 in Subarea VIII from 2001–2013 is presented (Table 19.6; Figure 19.4) and refers to the main ray species landed by the fleets: *L. naevus* and *R. clavata*. The *L. naevus* lpue has been above 100 kg.day^{-1} (except in 2002, 2009, 2010 and 2013). The lowest peak was observed in 2010 (44 kg.day^{-1}) and the highest in 2007 (169 kg.day^{-1}). Landings per effort of *R. clavata* in this area are smaller than those recorded for *L. naevus*, ranging from 14–29 kg.day^{-1}.

19.5.2 Portuguese data (IXa)

Fishery data collected under the Portuguese Pilot Sampling Programme on skates in Subarea IXa (EU DCR/NP) was used to develop a standardized lpue (Kg.trip^{-1}) time-series for the period 2008–2013. Standardized lpue time-series were developed for the most representative skate species; *R. clavata*, *R. montagui*, *R. brachyura* and *L. naevus* (Figure 19.5a). With exception of *L. naevus*, lpue standardisation was applied to the polyvalent fleet, which is the most representative fleet in terms of Rajidae landed weight. For *L. naevus*, lpue was standardized for both polyvalent and trawl fleets, since the two contribute with ~50% each for the species annual landings. The lpue time-series *R. clavata* and *R. montagui* show an increase trend, while for *R. brachyura* and, *L. naevus* lpue follows a stable trend along the entire considered period.

The index of abundance of *R. undulata* was estimated from the Portuguese polyvalent segment as the catch weight of the species per trip (fishing effort unit) using data collected on board of commercial vessels. Cpue standardisation was constrained to the polyvalent fleet, since this species is not frequently caught by the trawl segment. Despite the short range of the time-series, cpue has a stable trend (Figure 19.5b).

Methodological procedures are described in the Stock Annex.

19.5.3 Quality of the catch-effort data

Under DCF pilot study on rays and skates that lasted from 2009–2013, the quality of catch and effort data by species has greatly improved. Nevertheless since skates are caught in a high diversity of mixed fisheries, there is a need to maintain the monitoring programme of the catches.

19.6 Fishery-independent surveys

Groundfish surveys provide information on the spatial and temporal patterns in the species composition, biological aspects and relative abundance and biomass of several Rajidae species. Fishery-independent surveys operating in the Bay of Biscay and Iberian Waters are discussed briefly below (further details for Iberian waters are presented in the Stock Annex). It should be noted that existing survey data are limited for some skate species (e.g. *R. undulata, R. brachyura* and *R. microocellata*) as a result of their more coastal distribution and habitat specificity. More detailed studies of existing data are required to better inform on their status. In some instances, it may be required to have dedicated inshore surveys using an appropriate gear and census method in order to better evaluate these stocks.

19.6.1 French survey data (VIII)

From 1987 the EVHOE survey has been conducted in the Bay of Biscay on an annual basis with the exception of the years 1993 and 1996. It has been conducted in October and November, except in 1989, 1990, 1992 and 1994 where it took from mid-September to end-October and 1991 where it was carried out in May. In 1988 two surveys were conducted, one in May the other in October. Since 1997 the main objectives have been: i) the construction of time-series of abundance indices for all the commercial species in the Bay of Biscay and the Celtic Sea with an emphasis on the yearly assessed species where abundance indices at-age are computed; ii) to describe the spatial distribution of the species and to study their interannual variations; and iii) to estimate and/or update biological parameters (e.g. growth, sexual maturity, sex ratio).

Population indices from the French EVHOE survey were calculated for all elasmobranchs caught. Indices of abundance and biomass per year are only reliable for *L. naevus*. For other species, small numbers are taken with occasional hauls with higher catch, and some years without catch at all did not allow using the indices. A presence–absence indicator and maps of catches by sets of three years were presented and may be a useful approach to detect changes in habitats occupied by elasmobranchs.

19.6.2 Spanish survey data (VIIIc and IXa)

From 2010 to 2013 ITSASTEKA survey was carried out in the coastal waters of the Basque Country by AZTI-Tecnalia (Division VIIIc). The aim of this survey was the characterization of the demersal ecosystem, to obtain reliable data on the distribution and abundance of commercial fish, cephalopods and benthic invertebrates in this area. The ITSASTEKA survey covers a total of 7.21 km^2 in 23 fishing hauls.

The Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters (Division VIIIc and IXa) has covered this area annually since 1983 (except in 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranch. Survey design is randomly stratified with number of hauls allocated proportionally to strata area. An update of the results on four of the most important elasmobranch species sampled in the IEO Q4-IBTS survey on the Northern Iberian shelf (VIIIc and IXa North) is presented in a Working Document (Fernández-Zapico *et al*., 2014 WD). Depth stratification ranges from 70 m to 500 m, therefore catches of some shallower rays such us *R. undulata* are low and the survey cannot be used to estimate abundance or biomass indexes. More information on the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters is reported in the Stock Annex.

The Spanish bottom trawl survey IBTS-GC-Q1-Q4 (ARSA) in the Gulf of Cadiz (Division IXa) has been carried out in the spring and autumn from 1993–2014 The surveyed area corresponds to the continental shelf and upper-middle slope (depths of 15–800 m) and from latitude 6º20’W to 7º20’W, covering an area of 7224 km^2.

Note: In 2012, the R/V Miguel Oliver (owned by the Secretary General for Fisheries) replaced the R/V Cornide de Saavedra and an inter-calibration experience was performed. In 2013 the first survey on R/V Miguel Oliver was carried out after the results of the inter-calibration (Velasco, 2013). However, the results from this survey in 2013 departed from the trends in the previous years and the results had to be considered with caution.

19.6.3 Portuguese survey data (IXa)

The Portuguese Autumn Groundfish Survey (PT-GFS) 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). In these surveys, *R. clavata* is the most frequent skate species caught (88% of the total weight of skates).

The Portuguese crustacean surveys/ *Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29)) have also been conducted by IPMA and the main objective is to monitor the abundance and distribution of the main commercial crustaceans (*Nephrops norvegicus,* rose shrimp *Parapenaeus longirostris* and red shrimp *Aristeus antennatus*).

19.6.4 Temporal trends

French EVHOE Survey (VIII)

The abundance of *R. clavata* shows no clear temporal trend along the time-series but two peaks can be observed in 2001 and 2008, corresponding to 56 and 16 ind.h^{-1}, respectively (Figure 19.6a). In almost all years of the series, the abundance of *L. naevus* is higher than that of *R. clavata*. The abundance of *L. naevus* strongly fluctuates over the period with highest values in 2002, 2007, 2008 and 2011.

Figure 19.6b shows the geographical distribution (occupancy) of several skate species recorded in the French EVHOE survey in the Bay of Biscay (VIIIa, b) since 1987. The occupancy data are grouped each three years of the series since 1987.

L. naevus is distributed mainly in the northern area (Division VIIIa) of the Bay of Biscay near the continental slope, and less abundant in the survey record in the period from 1987 to 1994.

R. brachyura is found in very few hauls in the north of the VIIIa Division and always in waters near the coast. This species was absent in survey records from 1991 to 2010.

R clavata is commonly caught in few hauls only, being mainly distributed in the northern and central areas of the Bay of Biscay, near the coast and but also in waters in the middle areas of the continental shelf.

R. montagui is found mainly in northern waters of Division VIIIa and less frequently in the northern areas of Division VIIIb. As with *R. clavata,* it is distributed near the coast, but is also found in the middle areas of the continental shelf.

R. undulata is only found in a few hauls, always in shallower waters and near the coast, but its distribution goes from the northern parts of VIIIa to the southern parts of VIIIb. This species was absent in several periods of the historical series (1987, 2002–2004).

Basque Country (Spain) ITSASTEKA survey (VIIIc)

In 2014 the ITSASTEKA survey was not carried out so there are no new data from this survey (for more information about previous results see Figure 19.7, Table 19.7 and ICES, 2013).

Spanish IEO Q4-IBTS survey in VIIIc and IXa

The main skates and rays caught in 2014 and their respective percentages of the elasmobranchs stratified catch in the survey were: *R. clavata* (17%), *R. montagui* (6%), *L. naevus* (1.4%), *R. undulata* (0.33%), *R. brachyura* (0.04%) and *L. circularis* (0.04%). The most remarkable changes in 2014 compared to previous years for these species were the decrease of *R. clavata* and the increase of *R. montagui* in the central area of the Cantabrian Sea (Ruiz-Pico *et al*., 2015 WD).

Raja clavata is the most abundant skate in the area. After the high abundance value recorded in 2013, catches in 2014 decreased to levels similar to 2012, i.e. aproximately 4 kg.haul^{-1}. In IXaN, the stratified biomass also decreased to the low values observed earlier in the time-series. This survey is not considered to provide an adequate index of abundance for the species. *R. clavata* is widespread in the VIIIc Division and practically absent in IXaN Division and was found between 46–273 m depth in 2014. Stratified length distributions, biomass indices and geographic distribution of the catches are presented for *R. clavata* (Figures 19.8a–c).

There was no record of *R. montagui* in the IXaN Division in 2014 as in the other years of the time-series. However, in VIIIc Division, the biomass of *R.montagui* increased in relation to the two previous years, reaching the highest value (1.7 kg.haul^{-1}) of the last twelve years (Figure 19.9a–c).

Cuckoo ray *L. naevus* is not commonly caught in IXaN. In Division VIIIc and in 2014 the biomass of *L. naevus* showed an abrupt decrease (0.40 kg.haul^{-1}) in relation to the high value reached in 2013. Stratified length distributions, biomass indices and geographic distribution of the catches are presented (Figure 19.10a–c).

In 2014, *R. undulata*, *R. brachyura* and *L. circularis* were scarce and *Raja microocellata* was not caught.

Portuguese surveys (IXa)

Raja clavata biomass index estimates from the Portuguese Autumn Groundfish Surveys (PT-GFS) show a stable trend in the end of the time-series, around 0.35 kg.hr^{-1}, at high levels compared with the late 1990s early 2000s (Figures 19.11).

Leucoraja naevus biomass index estimates have been stable (around 0.1 kg.hr^{-1}) since 1998 apart from a high value registered in 2011 which showed a very high level of variability (Figure 19.12).

Raja montagui biomass index estimates from the Portuguese Autumn Groundfish Surveys (PT-GFS) show a stable trend (around 0.2 kg.hr^{-1}) along the whole time-series, particularly since 2008 (Figures 19.13).

Spanish (IBTS-GC-Q1-Q4 (ARSA) bottom trawl survey in the Gulf of Cadiz (IXa South)

In ARSA surveys, 21 different skate species have been caught. The most abundant were *L. naevus* and *R. clavata,* both species presenting similar catch rate values ($kg.hr^{-1}$) in the autumn survey along the time-series available. L*eucoraja naevus* showed an increasing trend since 1993 with the highest values in 2001, 2005 and in 2013, when the maximum is reached (1.2 $kg.hr^{-1}$). *Raja clavata* showed the highest indices in the last years of the series, reaching 1.4 $kg.hr^{-1}$ in 2013 (Figure 19.14a).

The abundance trend ($ind.hr^{-1}$) shows some variability along the years but, for both species, the abundance has been increasing since 1993 with the highest values observed in 2013 for *R. clavata* and in 2006 and 2013 for *L. naevus* (Figure 19.14b).

19.7 Life-history information

Studies on biological aspects, e.g. age and growth, reproduction, diet and morphometry, of the most frequently landed species, such as *Raja clavata*, *R. brachyura*, *R. undulata*, *L. naevus* and *R. montagui* caught in Portuguese Iberian waters are available (Division IXa). Table 19.8 compiles the main biological information collected. More information, including diet and trophodynamic modelling for the northern part of IXa, is available in the Stock Annex.

New data on the life-history traits of *R. undulata* in the Bay of Biscay were available (Stéphan *et al.*, 2014). The length of first maturity was estimated to be 81.2 cm 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 the small number of tagged *R. undulata* for which size-at-recapture was recorded were consistent with growth estimates in Portuguese waters.

19.7.1 Ecologically important habitats

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* were mainly found in sites deeper than 100 m with soft sediment. Those were also referred as habitat for egg deposition of this species. *Raja undulata* and *R. microocellata* are more coastal species, occurring preferentially on sand or gravel habitats. *Raja brachyura*, *R. montagui* and *R. clavata* potential nursery areas were located in coastal areas with rocks and sand seabed (Serra-Pereira *et al.*, 2014). More information is available in the Stock Annex.

Information from trawl surveys on catches of (viable) skate egg-cases is considered valuable for evaluate ecologically important habitats. Further information could be collected in trawl surveys.

19.8 Exploratory assessments

Previous analyses of the skates in this ecoregion have focused on commercial lpue data and survey data. Updated analyses were conducted in 2014 (see below).

19.9 Stock assessment

Given the limited time-series of species-specific landings, and that commercial and biological data are often limited, the status of the main skate stocks is based primarily on survey data. Further analyses of survey data (see Section 19.6) and catch rates were undertaken. In this section, data and analyses are summarised by stock units for which ICES provides advice are detailed.

.9.1.1 Thornback ray (*Raja clavata*) in Subarea VIII (Bay of Biscay and Cantabrian Sea) (rjc-bisc)

The Spanish IEO Q4-IBTS survey in VIIIc provides information on the stock status of *R. clavata* in Subarea VIII. The highest catch rate of the time-series was observed in 2013, being almost twice the value from the previous year. However, as mentioned before the use of a new research vessel during 2013 survey, affected species catchability, for that reason the results of 2013 should be treated with caution. Catches in the EVHOE survey are low and are not considered suitable for abundance or biomass trend analyses, for the whole time-series only occasional high catch values were registered. A presence-absence indicator was calculated (see Stock Annex) and did not show trend in the area occupancy of *R. clavata* in the Bay of Biscay since the late 1980s (Table 19.9).

.9.1.2 Thornback ray (*Raja clavata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) (rjc-pore)

The status of this stock is evaluated based on survey data derived from the Portuguese Autumn Groundfish Surveys (PT-GFS) and the Spanish ARSA survey in Gulf of Cadiz (Q1 SP-GCGFS and Q4 SP-GCGFS). The biomass index from the Portuguese Autumn Groundfish Survey (PT-GFS) is stable along the overall series. Both ARSA surveys series indicate a long-term increasing trend (from 1997 to 2014). In the 2014 autumn survey both abundance and biomass index were higher than in 2013 while in spring survey the values from 2014 were lower. Combined survey data suggest a stability of the series until 2005 and an increasing trend since then with a distinct maximum in 2013. Following ICES DLS approach for category 3 stocks, the annual trend on the combined surveys (each survey scaled to average for the overall period) is consistently increasing for the overall period. The ratio between the average biomass index for the last two years (2012–2013) and the average of the biomass index for the reference period (2007–2013) is 1.74.

Annual standardized lpue estimates determined for Portuguese polyvalent fleet for the period 2008–2013 show an increasing trend, consistent with the combined surveys trend (Figure 19.5a).

Annual mean length of the specimens caught during the Portuguese Groundfish Surveys is equal or above the mean of the series since 2008 (Figure 19.15).

.9.1.3 Cuckoo ray (*Leucoraja naevus*) in subareas VI, VII (Celtic Sea and West of Scotland) and Divisions VIIIa,b,d (Bay of Biscay) (rnj-678abd)

This stock straddles the northern parts of the Biscay ecoregion and the Celtic Seas ecoregion, and is addressed in more detail in Section 18. Earlier studies examining survey indicators suggested that the biomass had been stable. EVHOE survey information on abundance, biomass and mean length (Figure 19.16a,b) was used to assess the stock status of this species. The spatial distribution of the survey catches supported the view that a single stock occurs in VIIIa,b,d and VIIj,k (Figure 19.17).

.9.1.4 Cuckoo ray (*Leucoraja naevus*) in the Cantabrian Sea

The stock unit for this area is unclear. Spanish IEO Q4-IBTS survey recorded a decrease in catch rates compared to 2013, in which catches were nearly three times the value of the previous year in the stratified biomass. In 2014 *L. naevus* biomass was similar to 2009–2011 values. These values should be viewed in the context of the change in vessel (see Section 19.6.2).

.9.1.5 Cuckoo ray (*Leucoraja naevus*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) (rjn-pore)

The status of this stock is evaluated based on survey data derived from Portuguese Crustacean Surveys/ *Nephrops* TV Surveys (PT-CTS (UWTV (FU 28-29)) and Spanish ARSA surveys in Gulf of Cadiz (Q1 SP-GCGFS and Q4 SP-GCGFS). Both ARSA surveys series indicate a long-term increasing trend (1993 and 1997 to 2014) despite values in 2014 were lower that in 2013. The Portuguese Crustacean Surveys show cpue stability since the beginning of the series in 1997. Following ICES DLS approach for category 3 stocks, the annual trend on the combined surveys (each survey scaled to average for the overall period) is consistently increasing for the overall period. The ratio between the average biomass index for the last two years (2012–2013) and the average biomass index for the reference period (2007–2013) is 2.22.

Annual standardized lpue estimates determined for Portuguese trawl and polyvalent fleets for the period 2008–2013 show a stable trend for both segments, with a distinct maximum obtained in 2013 for the polyvalent Portuguese fleet (Figure 19.5a). No new estimates were provided for 2014.

Annual mean length of the specimens caught during the Portuguese Crustacean Surveys /*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29)) are stable since 2006 (Figure 19.18).

.9.1.6 Spotted ray (*Raja montagui*) in Subarea VIII (Bay of Biscay and Cantabrian Sea) (rjm-bisc)

Spotted ray is sporadically present in the EVHOE catches (see Stock Annex). The occurrence of this ray in the EVHOE catches does not suggest any recent change in abundance.

In 2014 the Spanish IEO Q4-IBTS survey recorded a high capture of this species in VIIIc Division, following the increasing trend of the two previous years and reaching the highest value (1.7 $kg.haul^{-1}$) of the last twelve years.

.9.1.7 Spotted ray (*Raja montagui*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) (rjm-pore)

The status of this stock is evaluated based on survey data derived from the Portuguese Autumn Groundfish Surveys (PT-GFS). Survey data suggest a stability of the whole series, with the last years' estimates above the average for the entire series.

Lpue time-series display some variability, with an increasing trend since 2011. Following ICES DLS approach for category 3 stocks, the biomass index increased: the ratio between the average biomass index for the last two years (2012–2013) and the average biomass index for the reference period (2007–2013) is 1.

Annual standardized lpue estimates determined for Portuguese polyvalent fleet for the period 2008–2013 show a stable trend with a distinct maximum in 2013 (Figure 19.5a).

Annual mean length of the specimens caught during the Portuguese Groundfish Surveys is equal or above the mean since 2008 (Figure 19.19).

There are no records of this specie in the Spanish IEO Q4-IBTS survey in IXa Division along the whole time-series.

.9.1.8 Undulate ray (*Raja undulata*) in Divisions VIIIa,b (Bay of Biscay) (rju 8ab)

The abundance indices time-series from the EVHOE survey are not informative for this stock because the distribution of undulate ray is mostly shallower than the area surveyed. It includes years with no catch and the number caught per years is very low.

Exploratory assessments were also presented by Biais *et al*. (2014 WD). A mark–recapture survey provided a biomass estimate in the Bay of Biscay, particularly for the Gironde Estuary and for the part of the stock formed by the larger fish (>65 cm L_T) (Biais *et al*., 2014 WD). The habitat surface (Figure 19.20) and density indices estimates (Table 19.10) were used to determine the biomass of fish larger than 65 cm, which ranged between 87–120 t in the whole central part of the Bay of Biscay.

The tagging survey also provided catch-at-age ratios, using the length distribution to get number-at-age using age slicing based on the von Bertalanffy growth curve parameters estimated by Moura *et al*. (2007) in the central Portugal (script in R from Kell and Kell, 2011). Ages between 9 and 10 are considered not affected either by the gear selectivity or by a possible decrease in vulnerability to the longline of the larger fish, at least in November–December (Table 19.11). The ratio obtained provided an estimate of the total mortality-at-age 4 in 2008, before the landing ban, and of the fishing mortality (0.17) using the natural mortality estimate as 0.27 in the central Portugal (Serra-Pereira *et al*., 2013 WD), assuming that the fishing mortality is negligible since the ban implemented in 2009.

Abundances-at-ages 4 and 5 in 2008 may also be estimated using the mark–recapture abundance estimates at ages 10 and 11 at the beginning of 2014 (ages 9 and 10 at the end of 2013) and considering that fishing mortality-at-age 5 is similar to age 4 in 2008 and that natural mortality is only acting over the population from 2009 onwards.

Based on these estimates, the catch and spawning biomass may be estimated in 2008 and in following years, making assumptions on the fishing mortality pattern in 2008. The aim was to investigate the biomass trend since the 2009 landing ban and the consistency of the mark–recapture estimates regarding in particular the 2008 catch for which a second estimate is available (Hennache, 2013; cited by Delamare *et al*., 2013 WD). The simulations were carried out for the low and the high abundance estimates which are provided by the mark–recapture survey (Table 19.12).

A flat fishing pattern was adopted above age 7, considering that when fish length is above 73 cm, the fishing effort is likely the same on all age groups and that the catchability fluctuations are negligible compared to other uncertainties. Fishing mortality-at-age 6 was fixed to the mean of fishing mortalities-at-ages 5 and 7 to smooth the transition between this two ages.

Fishing mortalities-at-ages 3 and younger ages are considered null. This latter assumption supposes that the fish are all discarded at these ages and that their survivorship is high. It is questionable as is the constant mortalities above age 7, but a fishing pattern with low fishing mortalities at younger ages is likely realistic. The general shape of the fishing pattern is then considered to be depicted.

Assuming this fishing pattern, fishing mortality-at-age 7 is the only missing value to estimate the stock numbers at all ages in 2008 from stock numbers-at-ages 5 and 6.

To estimate this fishing mortality-at-age 7, the constraint was set to have recruitment at age 0 lower than the estimate of egg number released by the females, calculated using sex ratio of tagging survey catch and fecundity estimates from Portuguese waters (Figueiredo *et al.*, 2014 WD). This constraint requires that the fishing mortality-at-age 7 is less than 0.76 for the low as well as the high abundances-at-ages 5 and 6 provided by the mark–recapture survey.

The corresponding catches are 43 t and 60 t in 2008, depending on whether the low or the high abundances-at-ages 5 and 6 are used. Catch in 2008 was estimated between 60 and 100 t by Hennache (2013), using action hall information (cited by Delamare *et al.*, 2013 WD). This latter catch is consequently estimated too high and/or the abundances are underestimated by the mark–recapture survey.

To estimate stock numbers in 2015, constant recruitments and numbers-at-ages being reduced only by natural mortalities were assumed. The spawning–stock biomass was estimated by adopting a knife edge ogive and age-at-maturity available (Stephan *et al.*, 2014 WD). Note that the constant recruitment assumption has no effect on the spawning biomass trend from 2008 to 2015 as maturity is estimated to occur at age 8.

Higher is the fishing mortality in 2008, lower is the spawning biomass in 2009 (at the beginning of the year) and consequently higher is the increase from 2009 to 2015 because the 2015 spawning biomass will be composed largely by year classes which were slightly or not exploited in 2008, according to the assumed fishing pattern. At half of the higher fishing mortality-at-age 7, according to the constraint on the egg number released by the females, the spawning biomass is estimated to have been multiplied by 4. According to the set of assumptions, the spawning biomass increases consequently largely from 2009 to 2015 and to values which are only slightly changed when the fishing mortality varies (about 190 t or 270 t when respectively low or high abundance estimate are used). Regarding the possibility that the abundances are underestimated by the mark–recapture survey, these values may be changed proportionally to any increase of the mark–recapture abundances, but the increasing spawning biomass trend is unchanged.

However, it must be underlined these results must be considered with caution, given that the numerous assumptions were made and particularly the complete effectiveness of the ban on landing associated with a high survivorship of discards (no fishing mortality from 2009 to 2015).

.9.1.9 Undulate ray (*Raja undulata*) in Division VIIIc (Cantabrian Sea) (rju 8c)

Scientific studies carried out in the eastern VIIIc area have been conducted to characterize the specific composition of the landed skates and rays, the species-specific cpue and the geographical distribution of the catches (Diez *et al.*, 2014). During the period 2011–2013, up to 118 trip/hauls of 21 vessels of the trammelnet fleet belonged to the nine main ports of the Basque Country were sampled. *Raja undulata* was the fifth most important species caught (5% of the total). The total estimated catches of this species in 2011 and 2012 were 1.3 t and 1.0 t respectively. The short time period does not allow inferring if the population levels are low or have declined. According to fishing interviews, this species is locally frequent and widely distributed in the coastal waters of the VIIIc, although not very abundant in catches. This situation may not have changed over the years.

.9.1.10 Undulate ray (*Raja undulata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) (rju 9a)

The compiled data on this species (Pilot Study on Skates included in DCF) for the period 2011–2013 showed that the species has a patchy distribution along the Portuguese continental coast being concentrated in specific coastal areas. Along the Portuguese continental waters, the species is more abundant between 30–40 m deep.

The stability on the length–frequency distribution and on the index of abundance from on-board observations along years suggests that the stock in Division IXa has not been severely impaired by previous exploitation.

Biological data and the relative high discard survivorship indicate that the resilience of the species to exploitation compared to other Rajidae species is at relative high level.

Given that patchy distribution of the species, the adoption of local management measures e.g. no fisheries on the hotspot of species concentration, will allow the monitoring of the stock.

.9.1.11 Blonde ray (*Raja brachyura*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) (rjh-pore)

Surveys indexes are considered not to be indicative of the stock status since this is a coastal species with a patchy distribution, and thus not recorded during groundfish surveys. Landing and effort data from Portuguese polyvalent fleet constituted the input data for evaluating the stock status.

Annual standardized lpue estimates determined for Portuguese polyvalent fleet for the period 2008–2013 show a stable trend (Figure 19.5a).

The yield per recruit (Y/R and potential spawning ratio (%SPR)) curves at long term for different levels of fishing mortality and age of first capture (TC) were estimated using the polyvalent fishing data as described in stock annex. The actual F (F_{CURR}=0.14) is at a level correspondent of about 30% of the virgin exploitable spawning biomass ($F_{30\%SPR}$=0.15) indicating that the stock has been exploited at a sustainable fishing rate (Figure 19.21).

.9.1.12 Common skate (*Dipturus batis*-complex) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters) rjb-89a

These species are only caught occasionally in the Subarea VIII and are inexistent in Division IXa.

Despite common skate (*Dipturus batis*) complex being a prohibited species in EU some individuals were occasionally landed in French fish markets in 2014, in Division VIIIa. Sampled specimens in fish markets included an adult female of *Dipturus* cf. *intermedia* (2 m total length) - a southerly record of the species in recent years; and small individuals of *Dipturus batis* (cf. f*lossada*) caught at the Glénan archipelago (southern Brittany). As these species are now mostly extirpated from the shelf seas of this area, fishermen generally are unable to accurately identify them. Available information does not change the perception of the stock status of these species that occur at low levels in this ecoregion.

.9.1.13 Other skates and rays in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters) rja 89a

The sandy ray, *Leucoraja circularis,* occurs on the deeper shelf and along the slope of the Bay of Biscay and has a minor expression on the Portuguese landings. Minor occurrences of the shagreen ray (*Leucoraja fullonica*) are observed to the North of Division VIIIa, being absent from Division IXa. Owing to higher abundance in the Celtic Sea these are most probably part of the stock of the Celtic Sea.

In Subarea VIII, occasional catches of the blonde ray (*Raja brachyura*) and the small-eyed ray (*Raja microocellata*) are found at the coast. These four species are caught in small numbers in the EVHOE survey to calculate population indices.

In Division IXa *Raja microocellata*, *Raja miraletus* and *D. oxyrinchus* have low expression in landings. The two latter species are caught in low numbers in Portuguese surveys.

19.9.2 Stock status

The following table provides a summary of stock status for the main species evaluated in 2014 and using ICES DLS approach.

Species	Nominal Stock Area	Perceived status
Thornback ray *Raja clavata*	VIII	Survey catch rates increasing in VIIIc but no trends in surveys in VIIIabd.
	IXa	Survey catch rates stable/increasing
Cuckoo ray *Leucoraja naevus*	VIII	Survey catch rates increasing
	IXa	Survey catch rates stable/increasing
Spotted ray *Raja montagui*	VIII	Uncertain. No trends are apparent from surveys.
	IXa	Survey catch rates stable/increasing
Undulate ray *Raja undulata*	VIII	Uncertain. Surveys available data are not informative for this stock
	IXa	Abundance index indicate stable trend. Species patchy distributed along IXa
Blonde ray *Raja brachyura*	IXa	Uncertain. Survey data are not informative for this stock. Lpue estimates show a stable trend from 2008–2013
Common skate *Dipturus batis* complex	VIII and IXa	Uncertain. Available information does not change the perception of the stock status, that is only caught occasionally in the Subarea VIII and are inexistent in Division IXa.
Other skates and rays	VIII and IXa	Uncertain. These species are cuagth in small numbers in surveys and commercial fisheries

19.10 Quality of assessments

No full analytic stock assessments have been conducted either for Divisions VIIIa–b, VIIIc or IXa, but an exploratory assessment is presented for *R. undulata* in the Bay of Biscay (VIIIa,b).

Lpue data for *L. naevus and R. clavata* are available for Divisions VIIIa, b, d since 2001. Since 2008 lpue were available for *R. clavata*, *R. microocellata*, *R. montagui*, *R. undulata* and *R. brachyura* in Division IXa.

In the last five years, a lot of effort has been made by the countries involved in the demersal elasmobranch fisheries on this ecoregion to provide species-specific landings of skates. As a result of this improvement in the data, 19 different species have been identified (plus a general category "Rajidae.") from catches of Subareas VIII and IX. A summary of the information available of the species-specific landings of skates and rays by country is shown in Tables 19.2 and 19.3.

Like surveys in other ecoregions, surveys in VIII and IXa were not specifically designed for elasmobranchs, producing a high frequency of zero-catch data. The fishing gear used in surveys is not the most appropriate to catch elasmobranchs, especially for species with patchy distributions. The survey effort in coastal areas is very scarce and does not cover a wide range of depths. Nevertheless, for some species, it is possible to estimate some valuable abundance data and by that get trends on abundance. An effort has been done to overcome these 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 (PT-GFS) in IXa (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 the 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 is better represents the geographical distribution of the species. Since, this methodology was proven to be adequate to model the abundance series of *R. clavata*, for 2014, standardized fishery-independent abundance indexes will be presented for the remaining species, in this division.

Undulate ray tagging has 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 moves that this species may make. This behaviour may be a benefit for obtaining mark–recapture stock estimate as the one provided for central part of the Bay of Biscay. Its results allow an exploratory analysis including a lot of assumptions. Consequently, it must be regarded as only indicative of the biomass trend.

19.11 Reference points

No reference points have been proposed for the stocks in this ecoregion.

19.12 Conservation considerations

IUCN lists angel shark, *D. batis* complex and *R. alb*a (NE Atlantic) as Critically Endangered, *R. undulata* and the guitarfish *Rhinobatos cemiculus* and *Rhinobatos rhinobatos* are listed as Endangered, and *L. circularis* as Vulnerable (Gibson *et al.*, 2008). Sawfish (*Pristis pectinata* and *P. pristis*) are also listed as Critically Endangered, and although the southernmost part of IXa is the northernmost part of the purported range of these species, the occurrence of these species in European Atlantic seas is questionable.

Species listed by the IUCN as Near Threatened include *D. oxyrinchus*, *L. fullonica*, *R. brachyura*, *R. clavata*, *R. microocellata* and *S. stellaris*. *L. naevus*, *R. miraletus*, and *R. montagui* are all listed as Least Concern (Gibson *et al*., 2008).

19.13 Management considerations

EC Council Regulation 39/2013 established a TAC of 3800 t in 2013 for Rajidae in Subareas VIII and IX. EC Council Regulation 43/2014 established a TAC of 3420 t in 2014.

The Council Regulation (EC) No 43/2009 of 16 January 2009 which bans the retention on board of three species of skates (see 19.2.4 Management applicable) has been a controversial issue in the affected countries. Despite an official answer from the EU Commission confirming this position, the fishing industry asked this measure to be reconsidered and other scientific studies to be conducted in order to assess the English Channel and Bay of Biscay and Iberia stock(s).

Spanish artisanal fishers operating in coastal waters of VIIIc and IXa and the French fisheries Ministry expressed surprise at this measure in 2009, as there is not enough information or evidence of declines in the populations of *R. undulata* in these subareas. In this sense, due to the coastal and shallow distribution of this species, there are not enough data from catches. Most of the catches of this species came from small artisanal vessels operating in bays or shallow waters. Although Spanish trawler fleets historically land the largest proportion of skates from the Cantabrian Sea and Bay of Biscay waters, they do not catch *R. undulata*, because trawling is banned in waters shallower than 100 m.

In order to answer this controversial management decision, in 2011 Portugal and Spain (Basque Country) developed a triennial pilot project, funded by the DCF, to study the fisheries catching skates and rays in the areas of the continental coast in Subarea VIII and Division IXa (Diez *et al.*, 2014 WD). The main objective of the study was to improve the quality of knowledge of the fisheries landing skates, filling the gaps in existing basic issues, such as fishery information, biology and economic importance. The data being collected will contribute to the future stock assessment of skates and rays from the Iberian ecoregion, and ensure the sustainability of the fisheries involved. The pilot study shares the same concept, goal, work plan and data analysis but is adapted to the particular "*modus operandi*" of the different fleets existing in the Subarea VIII and Division IXa.

On 29-12-2011 the Portuguese Administration adopted a national legislation (Portaria no 315/2011) that prohibits, along the whole continental Portuguese EEZ, during the whole month of May the catch, the maintenance on board and the landing of any skate species belonging to the Rajidae family. In addition, in each fishing trip a maximum of 5% bycatch, in weight, of those species is allowed to be maintained on board and to be landed.

On 22-08-2014 the Portuguese Administration adopted a national legislation (Portaria no 170/2014) that establishes a minimum sampling length for all *Raja* spp. and *Leucoraja* spp. species at 52 cm L_T.

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Table 19.1a. Skates and rays in the Bay of Biscay and Iberian Waters. Nominal landings (t) of skates and rays by division and country (Source: ICES). Total landings (t) of Rajidae in Divisions VIIIab.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	12	6	11	11	6	11	14	11	8	12	14			11	4	7	4		3
France	1535	1733	1503	1479	1206	1091	1106	1037	1170	1797	1296	1505	1395	1615	1393	1147	1228	1220	1113
Netherlands						1							0	0		0			
Spain	872	906	724	677	146	76	323	27	20	9	12	15	17	16	26	24	168	239* *	226
Spain (Basque Country)	*	*	*	*	297	337	*	252	242	278	218	199	283	224**	100**	154**	*	*	*
UK (E&W)	22	76	13	7	2	3	4	4		8	40			0	0	0	5	0	
UK (Scotland)										1		3	2	0		0			
Total	2442	2721	2251	2174	1657	1518	1447	1331	1440	2106	1581	1722	1697	1867	1524	1332	1405	1459	1343

*** Included in Spanish landings; * * Includes VIIId.**

Table 19.1b. Total landings (t) of Rajidae in Division VIIId.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium																0			
France	46	50	60	52	43	66	64	73	63	97	61	58	89	68	70	57	76	59	58
Spain	89	92	74	2	1	1	9	5	40	21	23	20	17	16	32	0	3	* * *	6
Spain (Basque Country)	*	*	*	*		2	*		1		1	2	0		0		*		*
UK (E&W)											3			0	0	0	0	0	0
UK (Scotland)												1	0	0					
Total	135	143	134	54	44	69	73	78	104	118	87	81	107	84	102	57	80	59	64

*** Included in Spanish landings; ** Included in Area VIIIab; * * * Preliminary landings.**

Table 19.1c. Total landings (t) of Rajidae in Division VIIIc.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium																			
France	0	0	1	1	1	0		0	0	0	0	1	0	1	0	0	1	0	2
Netherlands																			
Portugal	11	7	10	4	4	5			264										
Spain	0	321	345	226	424	978	352	1004	511	546	430	862	488	489	514	628	543	507	314
Spain (Basque Country)	*	*	*	*	5	16	*	21	21	20	14	9	23	22	21	25	*	*	*
UK (E&W)																			
UK (Scotland)																			
Total	11	328	356	231	434	999	352	1025	796	567	444	872	511	512	536	653	544	508	316

*** Included in Spanish landings.**

Table 19.1d. Total landings (t) of Rajidae in Division IXa.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
France																			
Portugal	1534	1512	1485	1420	1528	1591	1521	1598	1614	1303	1544	1443	1580	1473	1469	1490	1131	1103	1015
Spain	58	143	197	276	285	416	339	342	325	300	364	354	376	342	457	549	303	421	217
Total	1592	1655	1682	1696	1813	2007	1860	1940	1939	1602	1908	1797	1956	1815	1926	2039	1434	1524	1232

Table 19.1e. Combined Landings (t) of Rajidae in Biscay and Iberian Waters.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	12	6	11	11	6	11	14	11	8	12	14	0	0	11	4	7	4	0	3
France	1581	1784	1564	1532	1250	1157	1170	1110	1233	1894	1357	1564	1484	1684	1464	1204	1306	1279	1173
Netherlands						1								0			0	0	0
Portugal	1545	1519	1495	1424	1532	1596	1521	1598	1878	1303	1544	1443	1580	1473	1469	1490	1131	1103	1015
Spain	1019	1462	1340	1181	855	1471	1022	1378	895	876	829	1250	897	864	1029	1201	1017	1168	764
Spain (Basque Country)					302	354		273	264	298	233	210	306	246	121	178	*	*	*
UK (E&W)	22	76	13	7	2	3	4	4		8	43			0	0	0	5	0	0
UK (Scotland)										1	0	4	2	0			0	0	0
Total	4179	4846	4423	4155	3947	4593	3732	4374	4279	4393	4020	4471	4270	4279	4087	4081	3462	3549	2955

*** Included in Spanish landings.**

Table 19.2. Skates and Rays in the Bay of Biscay and Iberian Waters. Species-specific landings (skates and rays in t) by country in Subarea VIII, and Division XIa, all gears combined. These data are included in the Tables 19.1a to 19.1c. * (Data could include landings of *R. brachyura*). **consider by WGEF to be misidentified.

Country	year	Subarea	*L. naevus*	*R. clavata*	*R. montagui**	*D. batis*	*T. marmorata*	*D. oxyrinchus*	*L. circularis*	*L. fullonica*	*R. microocellat*	*R. undulata*	*D. pastinaca*	*M. aquila*	*R. asterias**	*R. brachyura*	R. miraletus	*R. alba*	*A. radiata**	*Raja spp.*
France	1999	VIII	319	75	46	1	24	0	17	0	0	0	0	2						0
France	2000	VIII	749	68	53	5	9	1	55	3	0	1	1	0						1
France	2001	VIII	637	37	62	4	3	0	47	7	1	2	1	0						1
France	2002	VIII	614	39	47	13	5	16	51	5	1	0	0	0						0
France	2003	VIII	654	49	58	4		1	44	4	2	0			0					
France	2004	VIII	749	97	67	4		0	46	4	0	0			0					201
France	2005	VIII	946	104	54	4		1	61	5	0	0			0					598
France	2006	VIII	668	139	61	4		2	36	4	0	0	2	1	0			0		607
France	2007	VIII	582	74	30	2		1	30	3			1							841
France	2008	VIII	775	82	41	5		3	56	5		0	2	0						502
France	2009	VIII	1096	177	64	1	26	1	20	45	3	2	3	1	0	3		4	0	237
France	2010	VIII	975	165	81	0	22	0	26	36	2			1		2		0	1	173
France	2011	VIII	875	107	65				16	32		0				20				69
France	2012	VIII	861	178	88	0	19	0	19	30	13	3	2	1	0	7		1	0	84
France	2013	VIII	754	203	112	0		0	19	30	20	0	3	1	1	28		0	0	86
France	2014	VIII	850	198	119	0									7					
Belgium	2002	VIII	15	6	0															
Belgium	2009	VIII	7	2	0											0				2
Belgium	2010	VIII	3		0						1					0				1
Belgium	2011	VIII	4		0				0							0				0
Belgium	2012	VIII	2	2	0				0							0				0
Belgium	2013	VIII	3	3					0											
Belgium	2014	VIII	5	3					0									0		

Country	year	Subarea	*L. naevus*	*R. clavata*	*R. montagui**	*D. batis*	*T. marmorata*	*D. oxyrinchus*	*L. circularis*	*L. fullonica*	*R. microocellata*	*R. undulata*	*D. pastinaca*	*M. aquila*	*R. asterias**	*R. brachyura*	R. miraletus	*R. alba*	*A. radiata**	*Raja spp.*
Spain (Basque Country)	2000	VIII	250	39	2	6				4		0								
Spain (Basque Country)	2001	VIII	230	85	5	8		0		26					0					
Spain (Basque Country)	2002	VIII	243	54	18															
Spain (Basque Country)	2003	VIII	230	38	4					12		0								
Spain (Basque Country)*	2004	VIII	202	46	6	3		0		7	0	0			0					
Spain (Basque Country)*	2005	VIII	229	52	7	3		0		8	0	0			0					
Spain (Basque Country)*	2006	VIII	179	41	5	3		0		6		0			0					
Spain (Basque Country)*	2007	VIII	161	37	5	2		0		5		0			0					
Spain (Basque Country)*	2008	VIII	236	52	7	4		0		8		0			0					
Spain (Basque Country)	2009	VIII	194	48						0										
Spain (Basque Country)	2010	VIII	88	33																
Spain (Basque Country)	2011	VIII	135	36																
Spain	2011	VIII	2		4															516
Spain	2012	VIII	160	269	21		0	0	6	0	0		0			0				268
Spain	2013	VIII	593	93	60															
Spain	2014	VIII	224	283	40													0		
UK (E & W)	2008	VIII	1								1					2				175
UK (E & W)	2009	VIII		0	0					0						0				0
UK (E & W)	2010	VIII	0		0					0	0									0
UK (E & W)	2011	VIII	0		0															
UK (E & W)	2012	VIII		2					0	0										
UK (E & W)	2014	VIII	0																	0
UK (Scotland)	2008	VIII			1															
UK (Scotland)	2009	VIII			0.3															
Spain	2011	IXa										0								526
Spain	2012	IXa	12	193	3		1	0	0	0	0		0			0				94
Spain	2013	IXa	11	7	144										194					
Spain	2014	IXa	0	215	2													0		

Country	year	Subarea	*L. naevus*	*R. clavata*	*R. montagui**	*D. batis*	*T. marmorata*	*D. oxyrinchus*	*L. circularis*	*L. fullonica*	*R. microocellat*	*R. undulata*	*D. pastinaca*	*M. aquila*	*R. asterias**	*R. brachyura*	R. miraletus	*R. alba*	*A. radiata**	*Raja spp.*
Portugal	2002	IXa	13	2																1505
Portugal	2003	IXa	18	351	56						78	126				578	2			
Portugal	2004	IXa	113	516	82						95	108				532	17	5		
Portugal**	2005	IXa	43	480	76						88	100				495	16	5		
Portugal**	2006	IXa	51	569	90						105	119				586	19	6		
Portugal**	2007	IXa	79	472	119						35	277				459				3
Portugal**	2008	IXa	50	745	144			72	1		19					193	4			
Portugal	2009	IXa	50	739	184			75	2		45					163	2			
Portugal***	2010	IXa	55	611	275			20	11		43					221	6			
Portugal***	2011	IXa	56	811	121			68	1		29					161	5			
Portugal***	2012	IXa	39	570	108			24	0		36					165	5			
Portugal***	2013	IXa	26	631	111			67	0		40					185	1			
Portugal***	2014	IXa	45	658	42			11									18	223		89

*** landings from 2004 to 2007 are based on the average species proportion of 2000–2003 ** landings from 2005 to 2008 are based in the species proportion of 2004; ***Based on official landings.**

Table 19.3. Skates and Rays in the Bay of Biscay and Iberian Waters. Species-specific official landings in 2014 as a percent of total landings in each ICES subdivision.

Species	ICES Division	
	VIII	IXa
L. naevus	62.41	3.50
R. clavata	27.97	66.96
*R. montagui**	9.18	3.34
D. batis	0.00	0.00
T. marmorata	0.00	0.00
D. oxyrinchus	0.00	0.82
L. circularis	0.00	0.00
L. fullonica	0.00	0.00
R. microocellata	0.00	0.00
*R. asterias**	0.00	0.00
R. miraletus	0.00	0.00
*A. radiata**	0.00	0.00
R. undulata	0.39	0.00
D. pastinaca	0.00	0.00
M. aquila	0.00	1.40
R. brachyura	0.03	17.15
Rostroraja alba	0.00	0.00
Raja spp.	0.01	6.84

*** Questionable species records that are in official landings.**

Table 19.4a. Skates and Rays in the Bay of Biscay and Iberian Waters. Elasmobranch discard estimates (t) of the Basque OTB (Bottom otter trawl) in Subarea VIII.

Subarea VIII	Rajidae	*L. naevus*	*R. clavata*
2003	76		
2004	64		
2005	13		
2006	10		
2007	n.a.		
2008	24		
2009		6	
2010	0	7	1
2011	0	18	3
2012	1	8	0
2013		23	3
2014	0	15	1

Table 19.4b. Skates and Rays in the Bay of Biscay and Iberian Waters. Estimate of the percentage of the elasmobranch discarded by the Basque OTB (Bottom otter trawl) in Divisions VIIIa,b,d.

	L. naevus	*R. clavata*
2009	4%	0%
2010	12%	5%
2011	17%	10%
2012	10%	0%
2013	23%	11%
2014	14%	4%

Table 19.4c. Skates and Rays in the Bay of Biscay and Iberian Waters. Discard estimations from the Spanish discard sampling programme in VIII and IXa Divisions. Weight discarded (tons) of demersal elasmobranchs (Bold) and CV of estimations (Italics) by fishing ground.

	Divisions (VIIIc–IXa)											
Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Leucoraja naevus	73.0	188	6.5	63.5	19.7	2.7	14.5	9.6	2.2	5.6	29.3	1.5
CV	*56.4*	*57.6*	*69.3*	*51.7*	*63.9*	*52.0*	*79.3*	*70.2*	*40.3*	*40.5*	38.5	
Raja brachyura	0.1	90.8	1.2	11.6	31.6	2.1	10.4	6.0	34.1	5.5	7.7	9.2
CV	*99.8*	*50.6*	*63.9*	*92.7*	*59.2*	*47.8*	*43.8*	*54.8*	*68.5*	65.1	49.1	
Raja clavata	0.0	1.0	9.9	54.5	10.9	5.5	36.0	32.4	50.6	29.6	54.6	95.
CV	-	*57.7*	*54.6*	*75.6*	*45.5*	*76.2*	*47.9*	*43.1*	*50.7*	28.9	39.0	
Raja montagui	26.0	1.3	0.2	0.7	0.4	1.2	1.6	0.0	1.4	4.1	5.2	1.3
CV	*66.1*	*69.8*	*99.6*	*75.8*	*99.8*	*94.0*	*70.3*	-	*47.5*	*63.8*	*89.8*	
Raja undulata												1.4
CV												

Table 19.4d. Skates and Rays in the Bay of Biscay and Iberian Waters. ***Raja clavata, Raja montagui, Raja brachyura*** **and** ***Leucoraja naevus*** **number of sampled hauls, number of hauls where the species occurred, probability of the species be caught in a haul and a specimen be discarded (pCD) and expected number of discarded specimens per haul in the Portuguese polyvalent and trawl segments, for the period 2004-2013. Polyvalent segment: i) nets operating at depths shallower than 150 m (i.e. trammel and gillnets) and ii) trammelnets operating deeper than 150 m. Trawl segment: i) Crustacean Fishery and ii) Demersal Fish Fishery.**

		Polyvalent Segment		Trawl Segment	
		Nets <150 m deep	Trammelnets >150 m deep	Crustacean Fishery	Demersal Fish Fishery
Raja clavata					
	nº of sampled hauls	41	57	665	1162
	nº of hauls in which the species occurred	21	21	13	100
	pCD	0.08	0.17	0.02	0.09
	Expected number of discarded specimens per haul	2	3	3	1
Raja montagui					
	nº of sampled hauls	41	57	665	1162
	nº of hauls in which the species occurred	17	13	2	22
	pCD	0.10	0.08	0.003	0.01
	Expected number of discarded specimens per haul	3	3	2	1
Raja brachyura					
	nº of sampled hauls	41	-	665	1162
	nº of hauls in which the species occurred	15	-	3	17
	pCD	0.04	-	0.005	0.01
	Expected number of discarded specimens per haul	4	-	3	1
Leucoraja naevus					
	nº of sampled hauls	41	57	665	1162
	nº of hauls in which the species occurred	4	22	4	16
	pCD	0.02	0.17	0.006	0.02
	Expected number of discarded specimens per haul	3	12	2	1

Table 19.4e. Skates and Rays in the Bay of Biscay and Iberian Waters. *Raja clavata, Raja montagui, Raja brachyura* and *Leucoraja naevus* percentage of individuals by health status (1=Good; 2=Moderate; 3=Poor) in relation to mesh size and soak time in the Portuguese polyvalent fleet. Total length range is indicated.

	Mesh Size (mm)	Soak Time (h)	Health Status			n	TL range (cm)
			1	2	3		
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 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
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
Leucoraja naevus	<180	<24	100%	0%	0%	1	53–53
	>180	<24	100%	0%	0%	1	61–61
		>24	58%	21%	21%	24	46–62

Table 19.4f. Skates and Rays in the Bay of Biscay and Iberian Waters. Percentage of individuals of *R. undulata* by health status by length class (cm), soak time (h) and mesh size (mm) in the Portuguese polyvalent fleet. Number of sampled individuals = 100; size range = 36–88 cm L_T.

		Length class (cm)		Soak Time (h)		Mesh Size (mm)	
Health Status	Total	<50	>50	<24	>24	<180	>180
1	91%	83%	92%	86%	92%	82%	93%
2	6%	0%	8%	7%	8%	9%	7%
3	3%	17%	0%	7%	0%	9%	0%

Table 19.5. Skates and Rays in the Bay of Biscay and Iberian Waters. Relative landed weight (%) for skate species (*Raja miraletus, Rostroraja alba, Raja clavata, Raja microocellata, Raja brachyura, Leucoraja circularis, Raja montagui, Leucoraja naevus* and *Dipturus oxyrinchus*), per fishing fleet (Portuguese polyvalent and trawl fleets) for 2008–2014.

	Polyvalent						
	2008	2009	2010	2011	2012	2013	2014
Raja miraletus	0%	0%	0%	0%	0%	0%	0%
Raja clavata	48%	48%	40%	55%	44%	55%	55%
Raja microocellata	2%	4%	3%	3%	4%	5%	4%
Raja brachyura	15%	11%	16%	13%	18%	20%	21%
Leucoraja circularis	0%	0%	1%	0%	0%	0%	0%
Raja montagui	10%	14%	19%	9%	9%	10%	11%
Leucoraja naevus	2%	3%	3%	3%	3%	2%	2%
Dipturus oxyrinchus	6%	5%	1%	4%	3%	5%	3%
Raja spp.	17%	15%	17%	13%	19%	3%	4%

	Trawl						
	2008	2009	2010	2011	2012	2013	2014
Raja miraletus	1%	0%	1%	0%	1%	0%	0%
Raja clavata	64%	60%	48%	66%	72%	66%	76%
Raja microocellata	0%	0%	2%	0%	0%	0%	2%
Raja brachyura	8%	12%	13%	5%	6%	8%	8%
Leucoraja circularis	0%	0%	0%	0%	0%	0%	0%
Raja montagui	10%	11%	18%	8%	11%	12%	4%
Leucoraja naevus	7%	6%	8%	8%	6%	4%	5%
Dipturus oxyrinchus	3%	6%	3%	8%	1%	8%	4%
Raja spp.	7%	5%	7%	5%	3%	2%	0%

Table 19.6. Skates and rays in the Bay of Biscay and Iberian Waters. Lpue (kg/day) of main elasmobranchs caught by the Basque Country OTB DEF >= 70 (Bottom otter trawl) in Subarea VIII.

	lpue (kg/day)	
	L. naevus	*R. clavata*
2001	112	27
2002	91	16
2003	136	19
2004	120	21
2005	134	23
2006	140	24
2007	169	29
2008	137	24
2009	84	18
2010	44	14
2011	115	25
2012	102	21
2013	80	21

Table 19.7. Skates and rays in the Bay of Biscay and Iberian Waters. Distribution of elasmobranch biomass (kg/30 min) by depth and type of substratum in the ITSASTEKA survey (VIIIc East) in 2013.

Depth (m)	Substrate	*L. naevus*	*R. clavata*	*R. montagui*	*R. undulata*	*T. marmorata*
26	fine sand	4	26		14	
32	fine sand		62	26		
38	medium sand		22	21		
49	fine sand		12	13		
52	fine sand	2	87			
53	coarse sand			14		2
70	fine sand		22	4		
71	fine sand		200	86		
90	fine sand		34	38		
93	mud		69			
94	coarse sand		22			
99	mud		15	71		
102	mud		7	3		
118	mud			2		
125	mud	0				
127	mud		57			
131	mud		6			
132	mud		17			
134	fine sand	3	24			
157	fine sand					
173	medium sand					
175	medium sand					
181	fine sand		16			
200	fine sand		20			
233	fine sand					
267	mud					
367	mud					

Table 19.8. Skates and rays in the Bay of Biscay and Iberian Waters. Life-history information): Table 2. 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						Period	Region	Source
									L∞ (cm)	k (y^{-1})	t0 (years)	Lmax (cm)	lmax (years)	l∞ longevity (years)			
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]
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).

Table 19.9. Skates and rays in the Bay of Biscay and Iberian Waters. Presence-absence indicator derived the EVHOE survey in the Bay of Biscay.

Year	Total number of hauls	Number of haul with catch of *R. clavata*	Proportion of haul with catch
1987	105	11	0.1
1988–1990	443	31	0.07
1991, 1992, 1994	286	19	0.07
1995, 1997, 1998	229	30	0.13
1999–2000	192	19	0.1
2002–2004	205	17	0.08
2005–2007	199	23	0.12
2008–2010	205	24	0.12
2011–2013	203	16	0.08

Table 19.10. Skates and Rays in the Bay of Biscay and Iberian Waters. Undulate ray in the Bay of Biscay - Abundance estimate of the stock potentially exploitable by the longliners in the central part of the Bay of Biscay according to the low (A1) and high (A2) estimates by mark–recapture in the Gironde estuary area.

Abundance in other areas are derived from these estimate by the following formula:

$$A\ (\text{area } x) = \frac{DI\ (\text{area } x)}{DI\ (GE)} . \frac{S\ (\text{area } x)}{S\ (GE)} . \ Ai\ (GE)$$

Where Ai is one of the two interval limits of the abundance estimated by mark–recapture in the Gironde Estuary (GE), Density index (DI) are area coefficients obtained by a variance analysis of standardized cpue and, Surface (S) is habitat area shown by the catch and tagging data.

Area	Surface (S in nm^2)	Density index (DI)	Abundance (A1)	Abundance (A2)
Gironde Estuary (GE)	560	1.45	10214	14 188
West Oléron (WO)	300	1.42	5348	7429
Pertuis d'Antioche (PA)	65	0.62	507	704
Pertuis Breton (PB)	180	0.78	1763	2449
Total	1105	-	17 832	24 770
Biomass (t)	-	-	87	120

Table 19.11. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja undulata* in the Bay of Biscay – Mean length-at-age and estimation of longline catch-at-age in November 2013 (chartered trip) with their log ratios.

Age	Mean length (Nov.)	Catch at age	Log catch ratio
5	66.1	7	−1.95
6	72.6	37	−1.67
7	78.2	95	−0.94
8	83.1	138	−0.37
9	87.3	215	−0.44
10	90.9	139	0.44
11	94.0	24	1.76
12	96.7	13	0.61
13	99.0	4	1.18

Table 19.12. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja undulata* in the Bay of Biscay-Stock number in 2008 derived from the 2014 mark–recapture abundance estimates (lower estimates in the upper table and higher estimates in the lower table), assuming no fishing mortality below age 4 and a flat fishing pattern above age 6 in 2008, no fishing from 2009 to 2015 (example given for half of the highest possible fishing mortality-at-age 7 and above in 2008 according to a recruitment constraint based on the number of eggs released). Biomass in 2009 and 2015 assuming constant recruitments.

Year	2008	2008	2008	2009	2014	2015	2015
Age	Stock Number	F	Catch (t)	Biomass (t)	Mark–recapture estimate	Stock Number	Biomass (t)
0	100 621	0.00	0	0		100 621	0
1	76 812	0.00	0	5		76 812	5
2	58 637	0.00	0	17		58 637	17
3	44 762	0.00	0	30		44 762	30
4	34 171	0.17	6	42		34 171	42
5	22 092	0.17	6	41		26 085	49
6	14 228	0.27	8	37		19 913	52
7	8254	0.38	8	28		15 201	52
8	4313	0.38	5	18	Lower	11 604	49
9	2253	0.38	3	11	estimates	8858	44
10	1177	0.38	2	7	5705	6762	39
11	615	0.38	1	4	3688	4355	28
12	321	0.38	1	2		2816	20
13	168	0.38	0	1		1633	13
Total	267 803		39	245		412 232	441
Spawning	8848		12	44		36 029	194
Year	2008	2008	2008	2009	2014	2015	2015
Age	Stock Number	F	Catch (t)	Biomass (t)	Mark–recapture estimate	Stock Number	Biomass (t)
0	139 771	0.00	0	0		139 771	0
1	106 698	0.00	0	7		106 698	7
2	81 451	0.00	0	23		81 451	23
3	62 178	0.00	0	42		62 178	42
4	47 465	0.17	8	58		47 465	58
5	30 687	0.17	8	58		36 234	68
6	19 764	0.27	11	52		27 660	73
7	11 465	0.38	11	39		21 115	72
8	5991	0.38	7	25	Higher	16 119	68
9	3130	0.38	4	16	estimates	12 305	62
10	1636	0.38	3	9	7925	9393	54
11	855	0.38	2	6	5124	6050	39
12	447	0.38	1	3		3911	28
13	233	0.38	1	2		2269	18
Total	371 999		55	340		572 620	613
Spawning	12 291		17	61		50 047	269

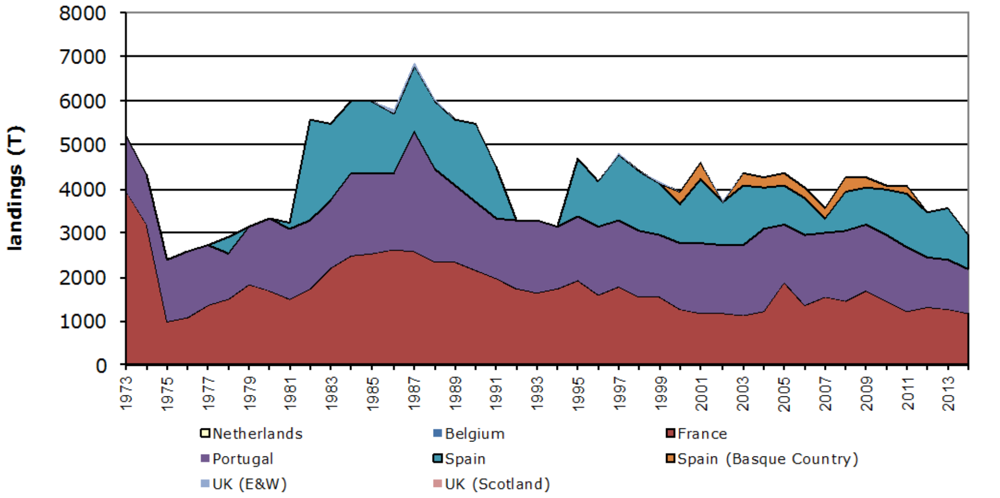


Figure 19.1a. Skates and rays in the Bay of Biscay and Iberian Waters. Historical trend in landings of Rajidae in Subarea VIII and Division IXa.

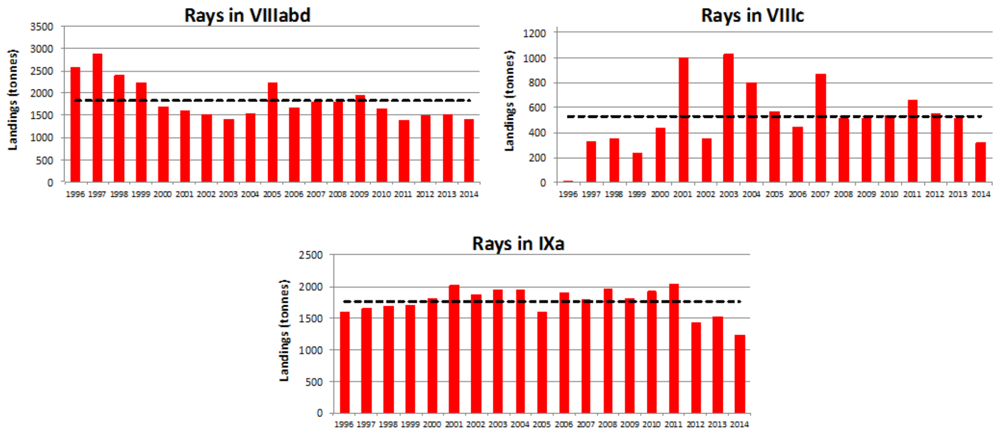


Figure 19.1b. Skates and rays in the Bay of Biscay and Iberian Waters. Historical trend landings of Rajidae in the ICES Divisions VIIIabd, VIIIc and IXa. Dashed line indicates the average of landings in the period.

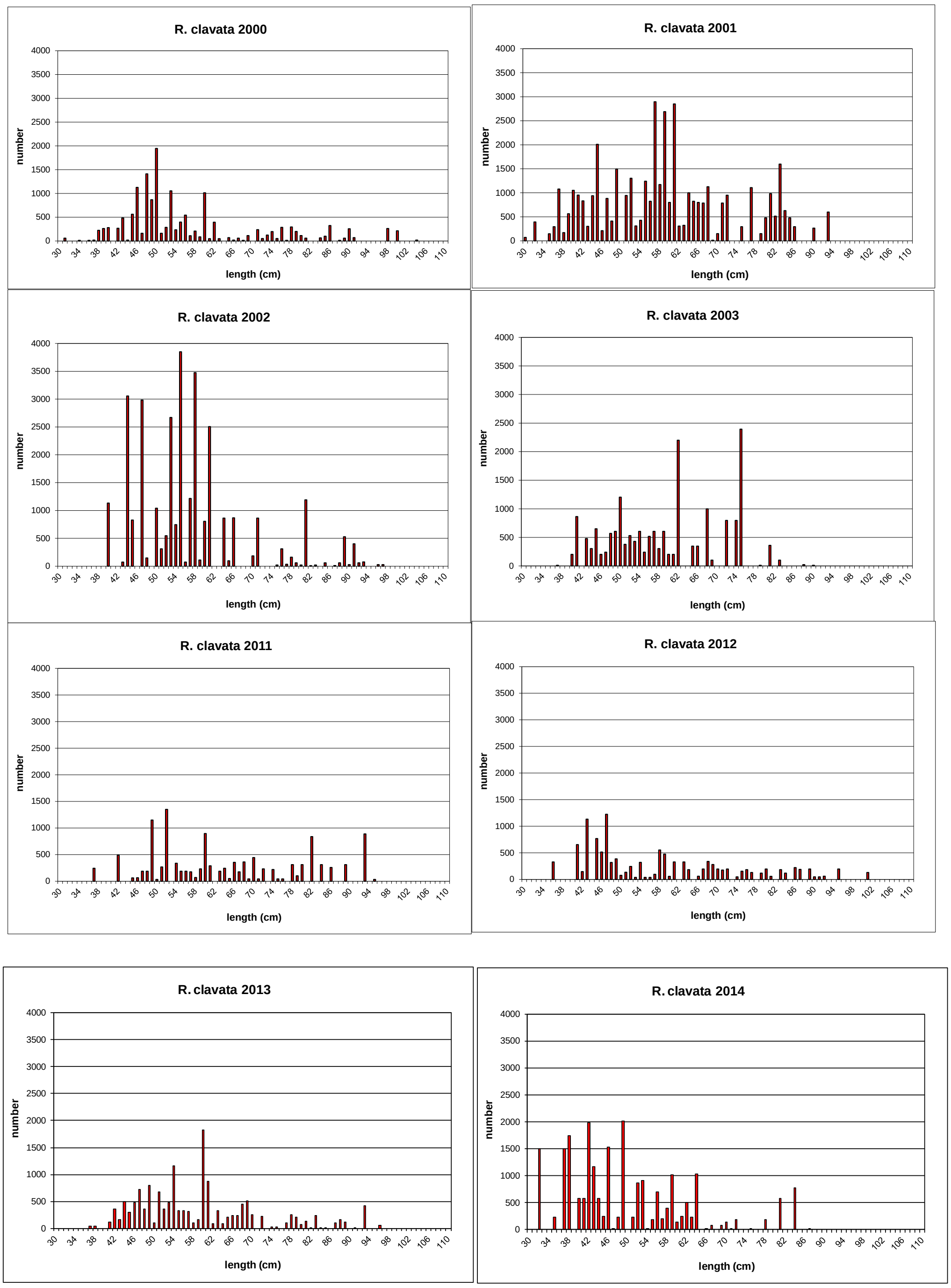


Figure 19.2a. Skates and rays in the Bay of Biscay and Iberian Waters. Length frequencies of *R. clavata* taken by the OTB Basque fleet in Subarea VIII from the period 2000–2003 and 2011–2014.

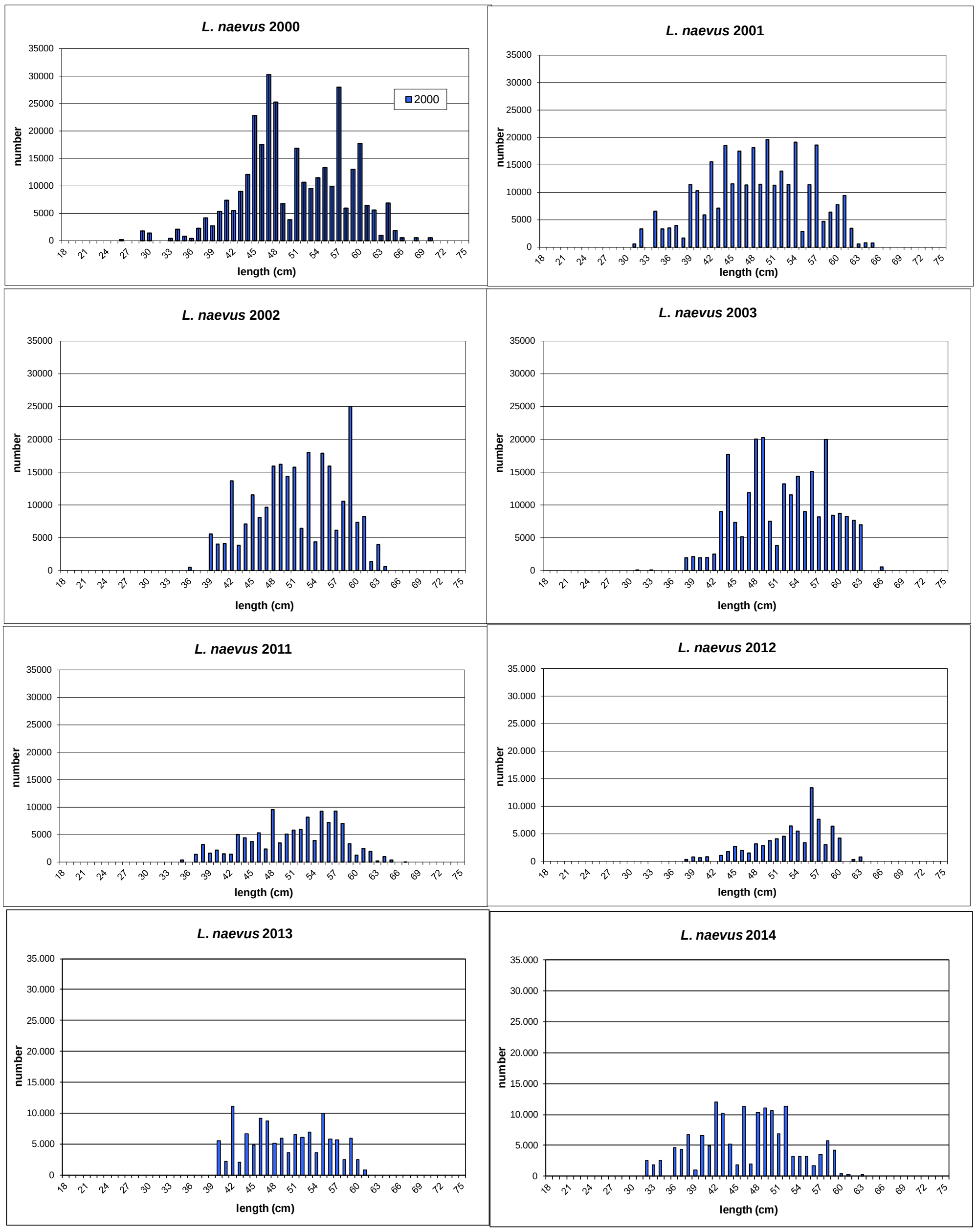


Figure 19.2b. Skates and rays in the Bay of Biscay and Iberian Waters. Length frequencies of *L. naevus* taken by the OTB Basque fleet in Subarea VIII from the period 2000–2003 and 2011–2014.

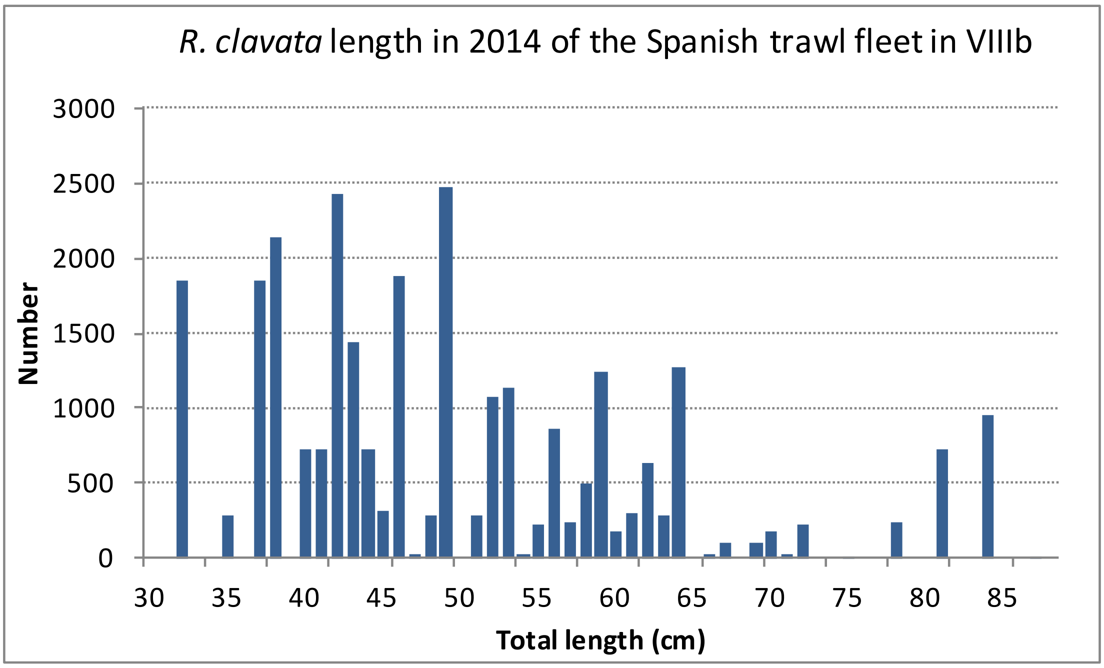


Figure 19.3a. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja clavata* landings from the Spanish otter trawl fleet in Division VIIIb in 2014.

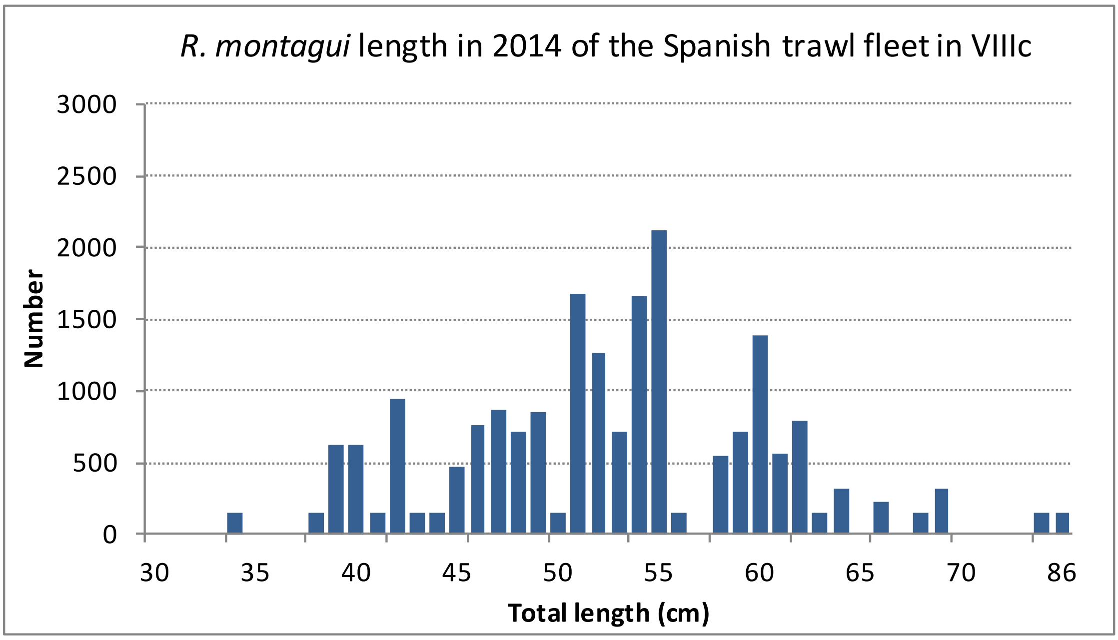


Figure 19.3b. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja montagui* landings from the Spanish otter trawl fleet in Division VIIIc in 2014.

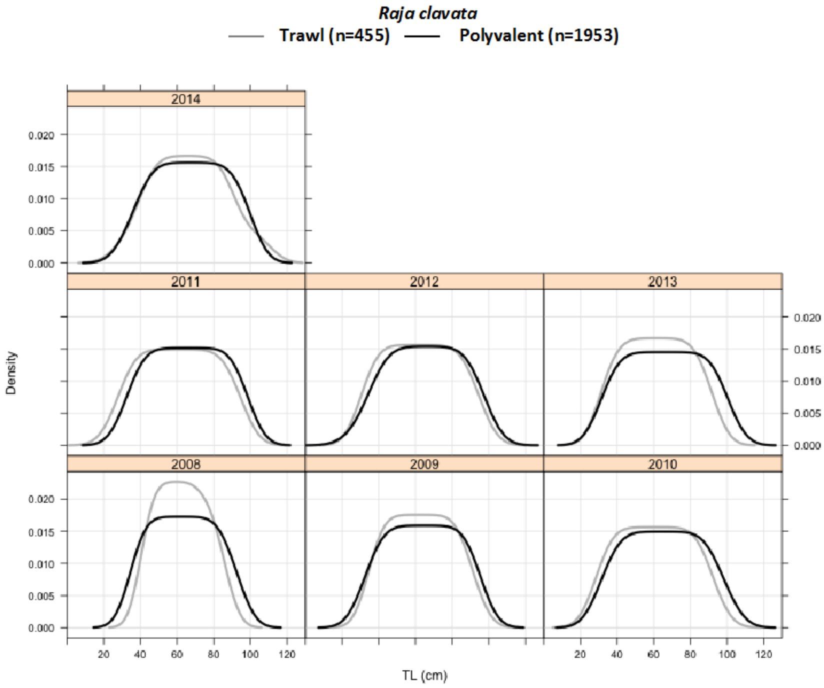


Figure 19.3c. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja clavata* for the period from 2008–2014 in mainland Portugal (IXa). Total number of sampled trips for each segment is indicated.

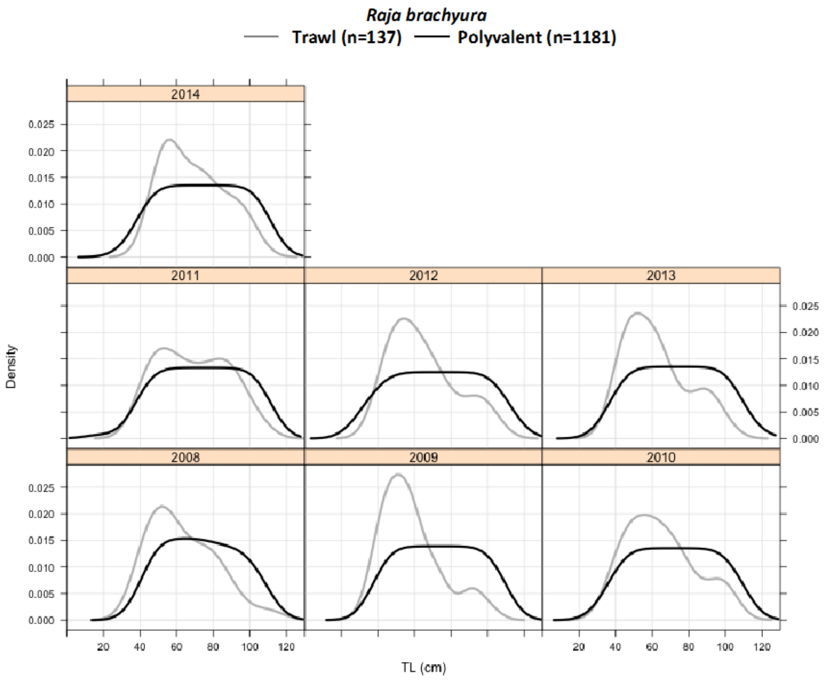


Figure 19.3d. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja brachyura* for the period from 2008–2014 in mainland Portugal (IXa). Total number of sampled trips for each segment is indicated.

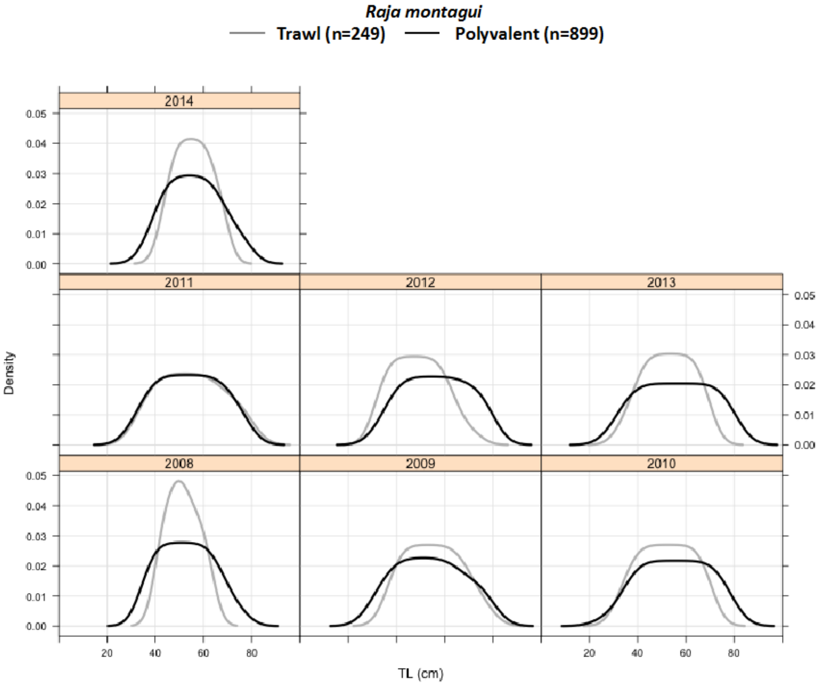


Figure 19.3e. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja montagui* for the period from 2008–2014 in mainland Portugal (IXa). Total number of sampled trips for each segment is indicated.

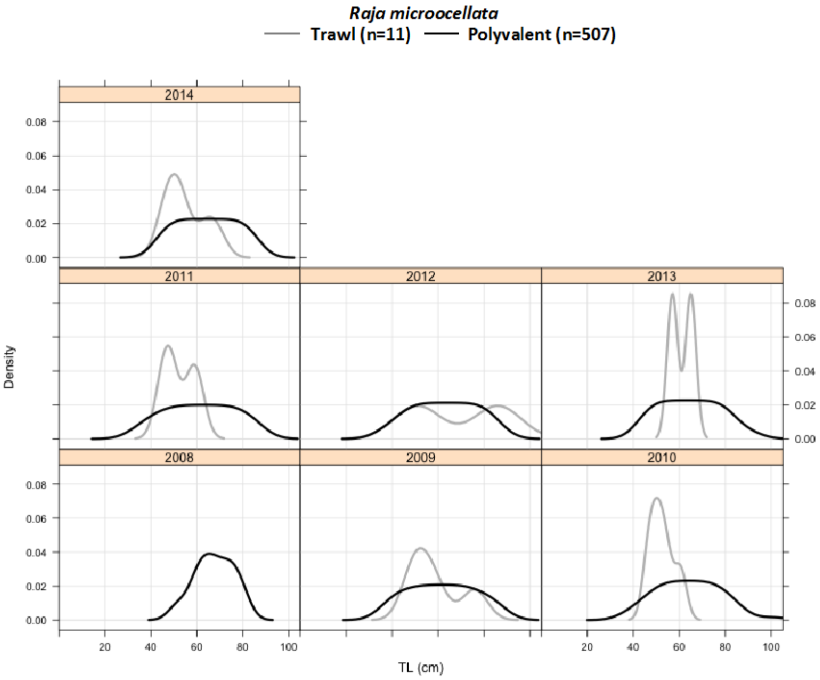


Figure 19.3f. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja microocellata* for the period from 2008–2014 in mainland Portugal (IXa). Total number of sampled trips for each segment is indicated.

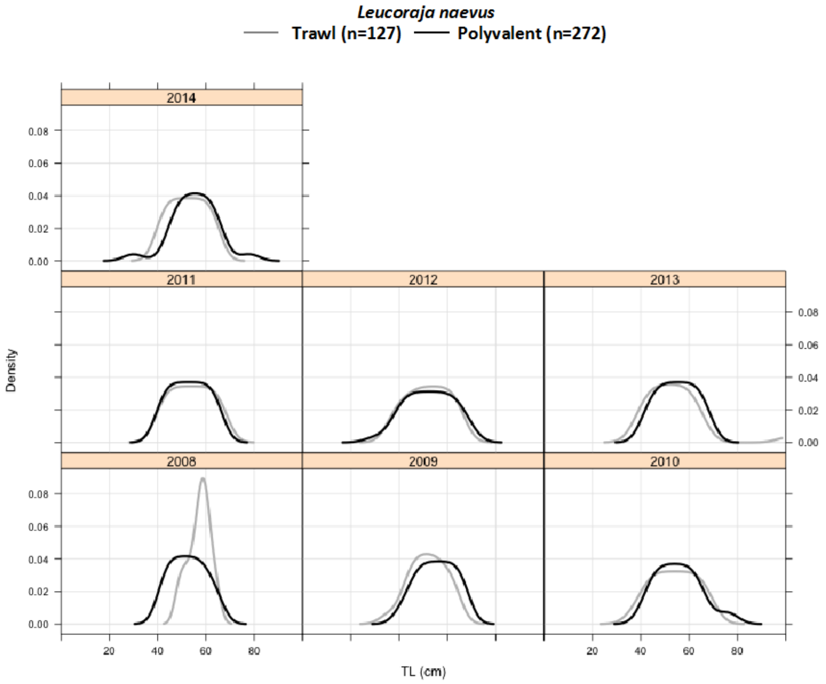


Figure 19.3g. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Leucoraja naevus* for the period from 2008–2014 in mainland Portugal (IXa). Total number of sampled trips for each segment is indicated.

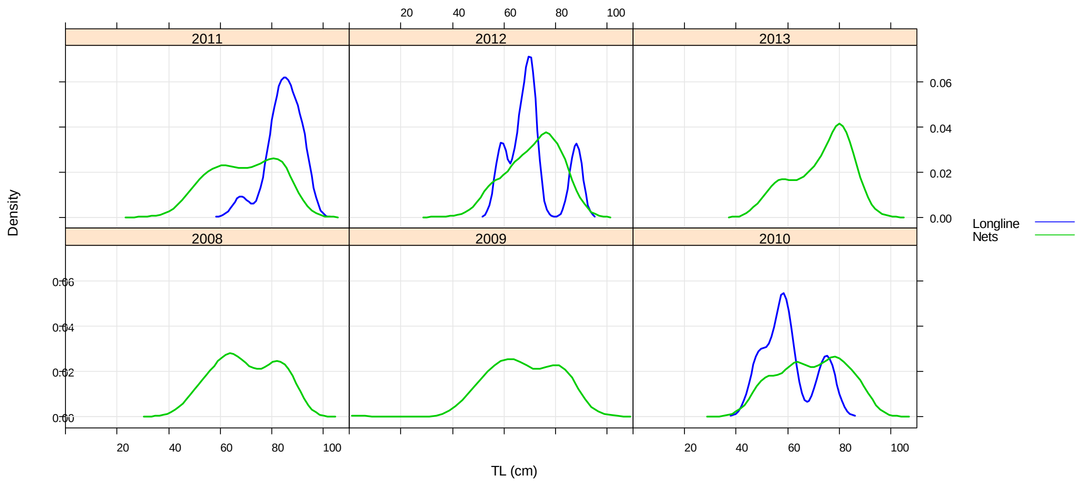


Figure 19.3h. Skates and rays in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja undulata* by fishing gear (longline and nets) for the period 2008–2013.

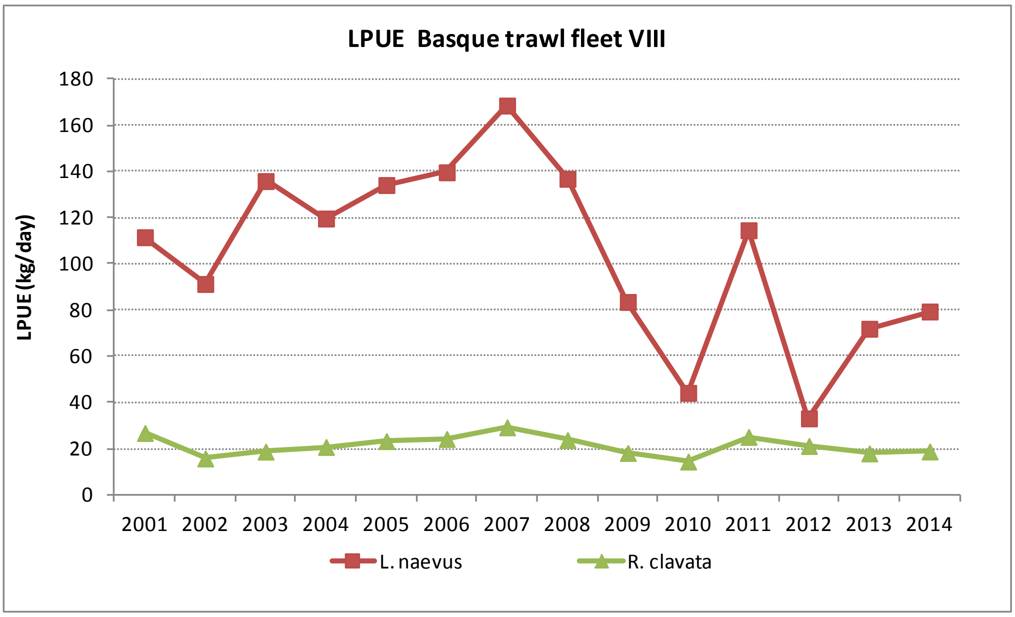


Figure 19.4. Skates and rays in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* and *Raja clavata* nominal lpue (kg.day^{-1}) of OTB Basque fleet in Subarea VIII (2001–2014).

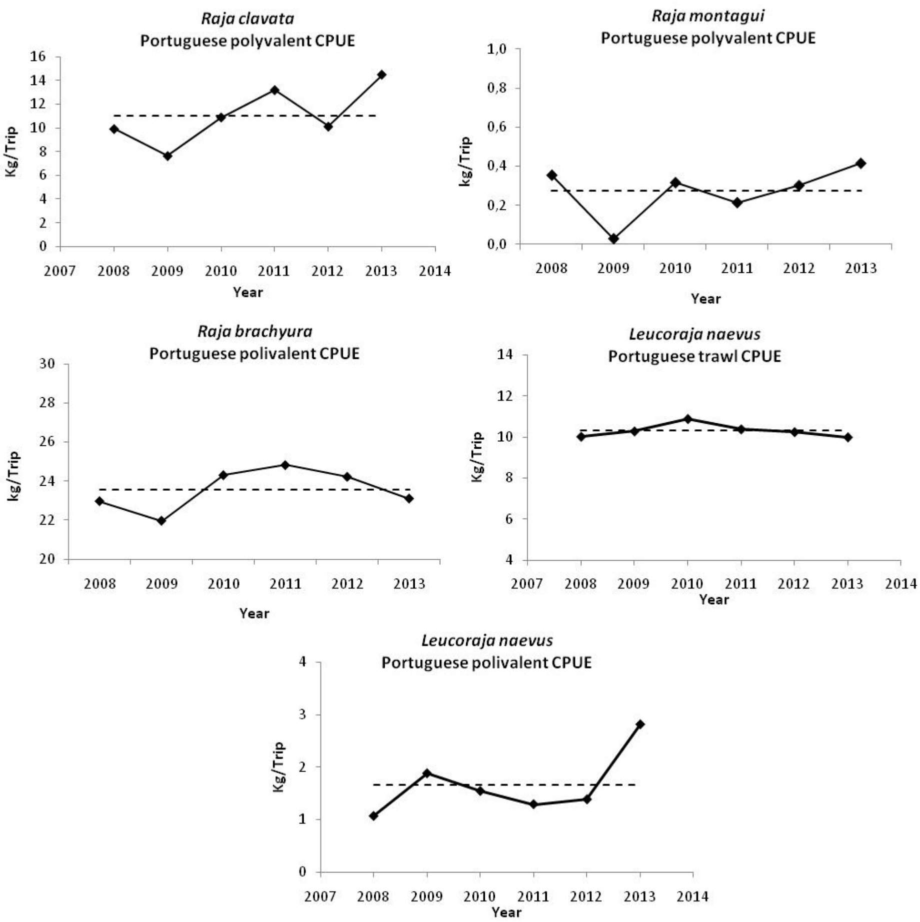


Figure 19.5a. Skates and rays in the Bay of Biscay and Iberian Waters. Standardized cpue (kg.trip^{-1}) by species for the period 2008–2013: *Raja clavata, Raja montagui, Raja brachyura* and *Leucoraja naevus*. The considered reference fleet is indicated. Dashed line: average of the entire time-series.

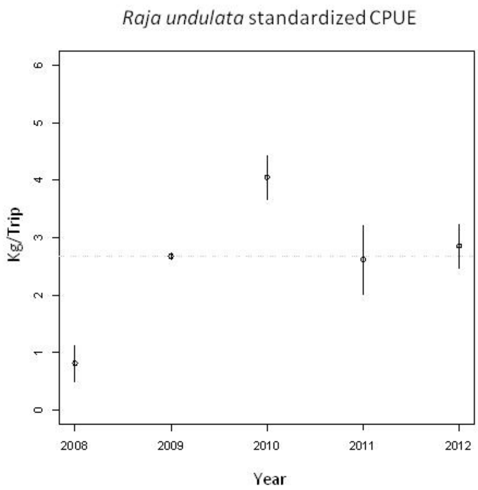
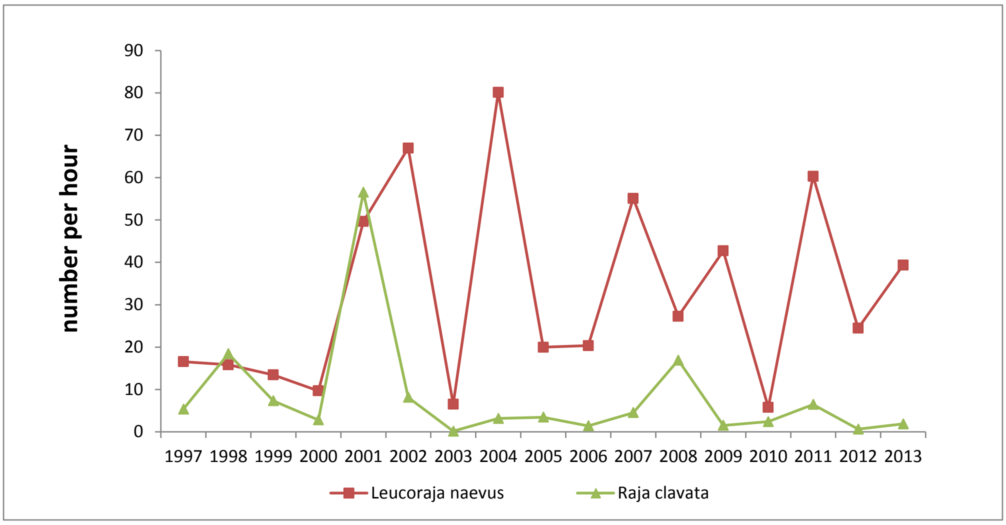


Figure 19.5b. Skates and rays in the Bay of Biscay and Iberian Waters. Standardized cpue (kg.trip^{-1}) of *Raja undulata* for the period 2008–2013. Dashed line: average of the entire time-series.



Figures 19.6a. Skates and rays in the Bay of Biscay and Iberian Waters. French EVHOE Survey indices (number per hour) of *L. neavus* and *R. clavata* in VIIIabd 1997–2013.

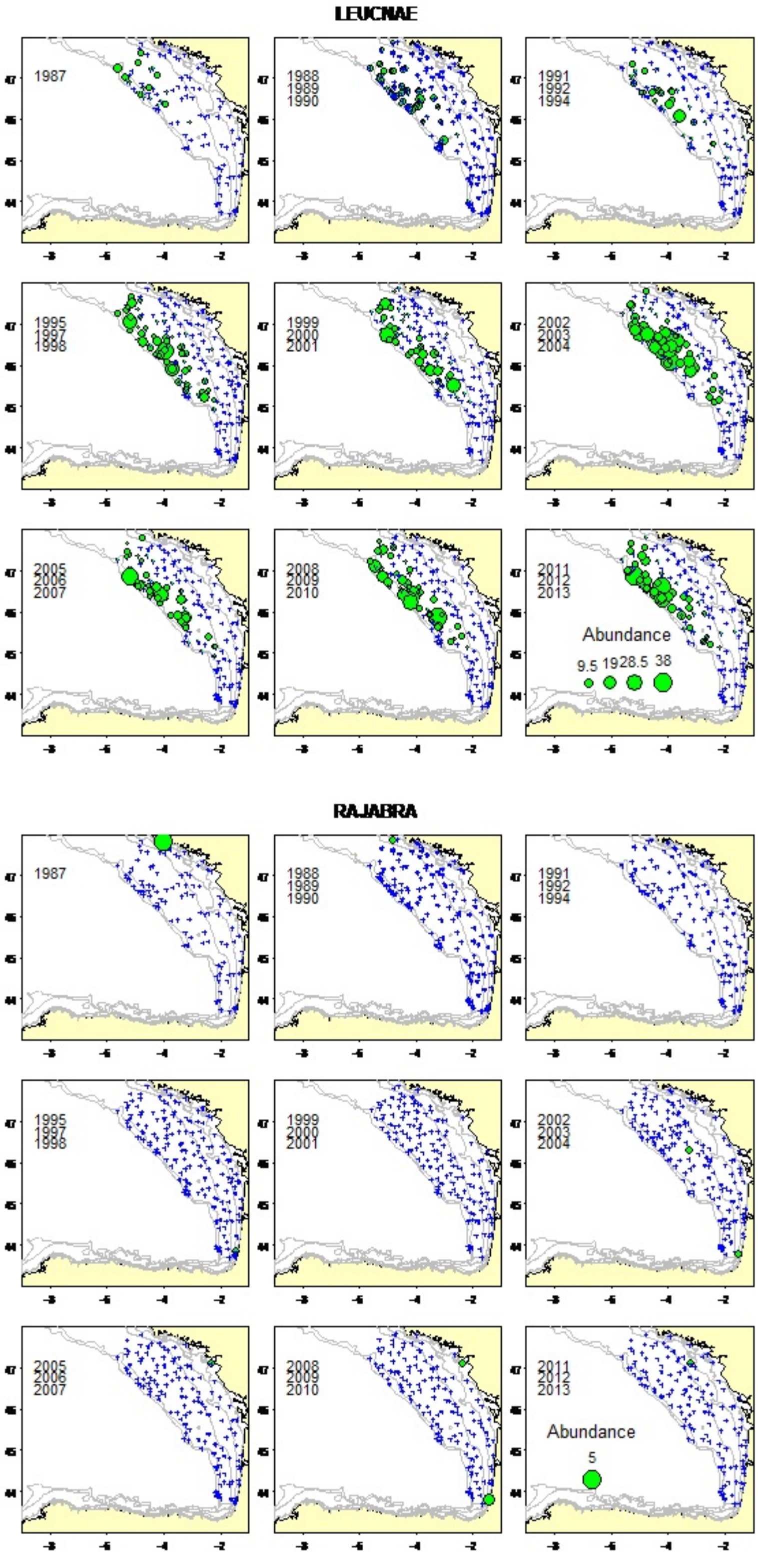


Figure 19.6b. Skates and rays in the Bay of Biscay and Iberian Waters. Geographical distribution of the abundance of ray species in the French EVHOE survey in Bay of Biscay (Divisions VIIIa, b) since 1987, showing *L. naevus* (top) and *R. brachyura* (bottom).

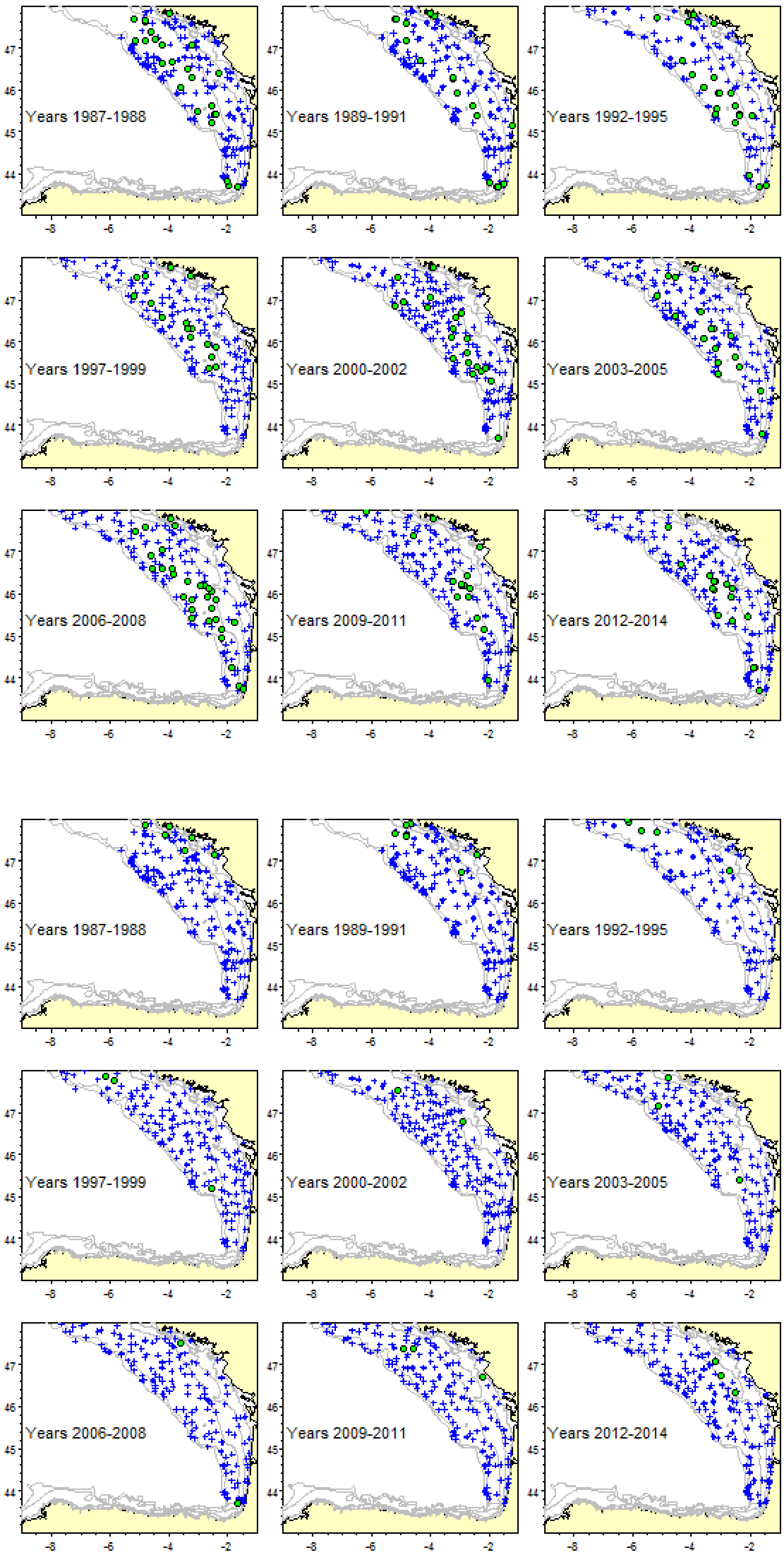


Figure 19.6b. (Cont.) Skates and rays in the Bay of Biscay and Iberian Waters. Geographical distribution of occurences *R. clavata* (top) and *R. montagui* (bottom) in the French EVHOE survey in Bay of Biscay (Divisions VIIIa, b) since 1987.

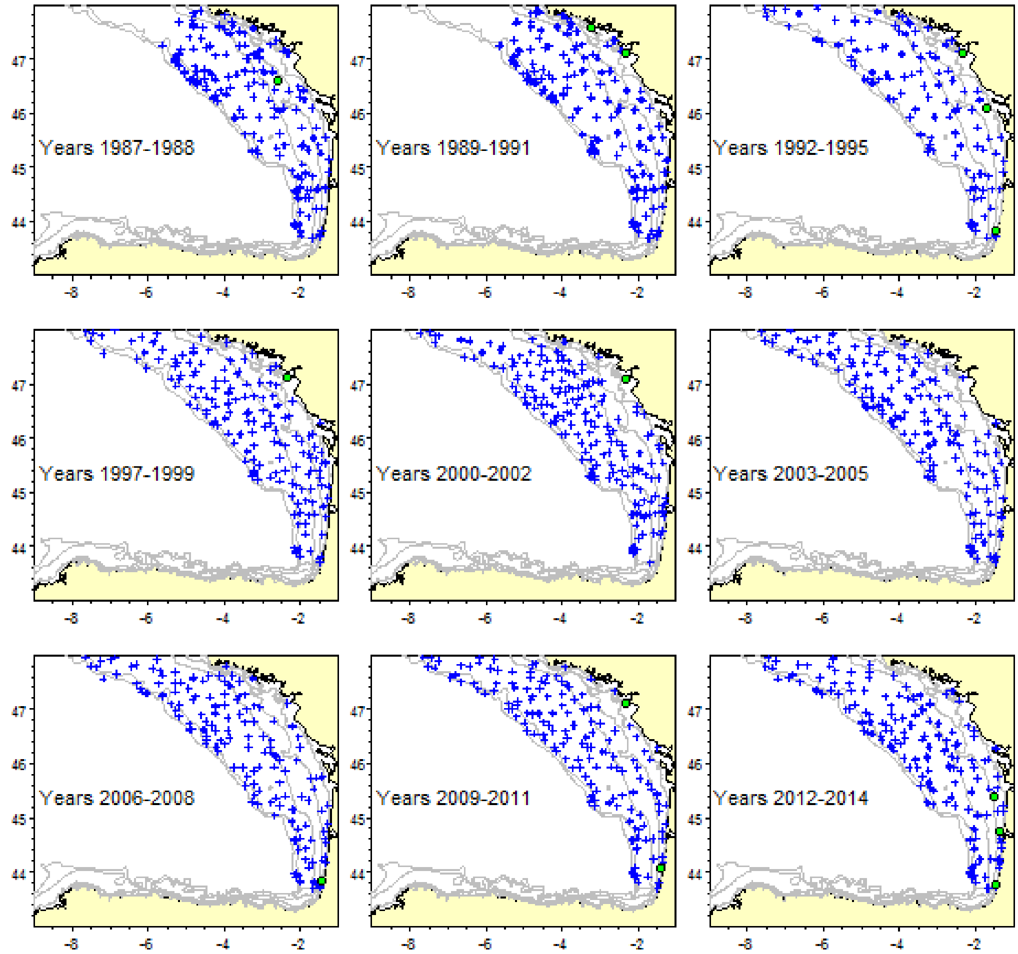


Figure 19.6b. (Cont.) Skates and rays in the Bay of Biscay and Iberian Waters. Geographical distribution of occurences of *R. undulata* in the French EVHOE survey in Bay of Biscay (Divisions VIIIa, b) since 1987.

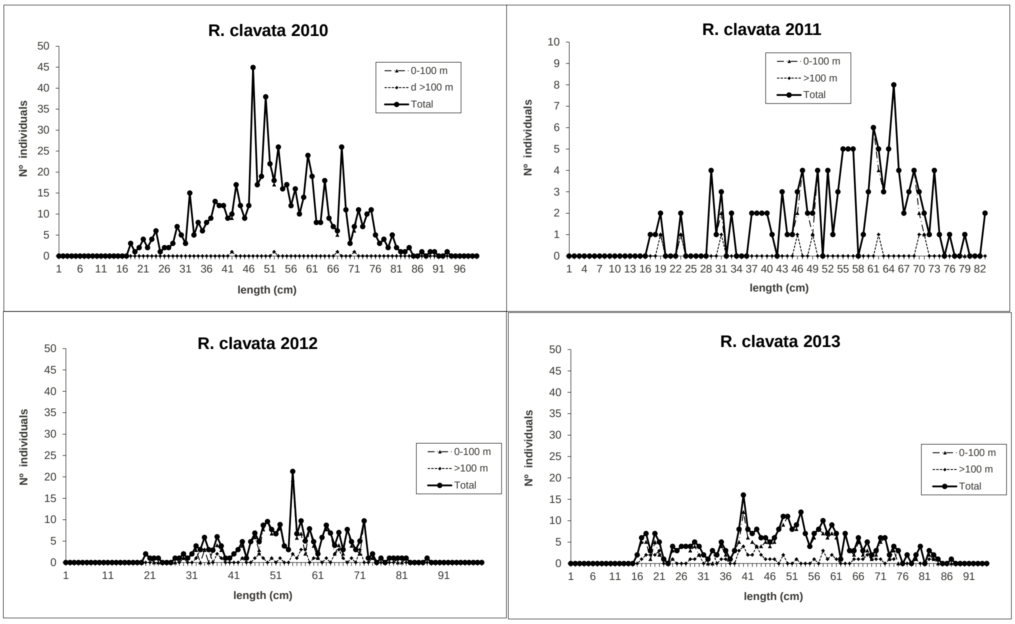


Figure 19.7. Skates and rays in the Bay of Biscay and Iberian Waters. Length distribution of *R. clavata* by depth strata in the ITSASTEKA survey (Eastern VIIIc) from 2010 to 2013.

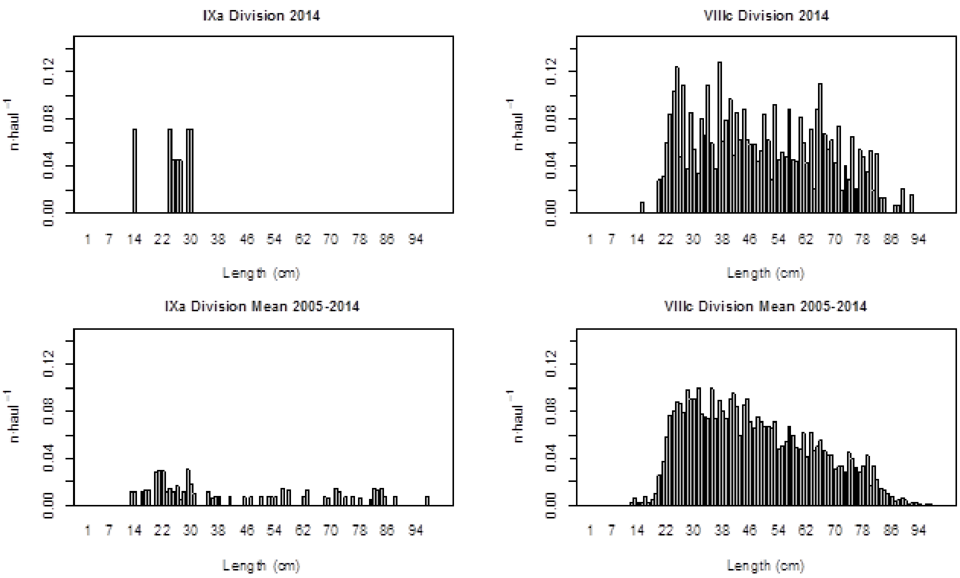


Figure 19.8a. Skates and rays in the Bay of Biscay and Iberian waters. Stratified length distribution of thornback ray (*R. clavata*) obtained from Spanish bottom trawl surveys time-series in ICES Divisions IXa and VIIIc, during 2014 and mean values during the period 2005–2014.

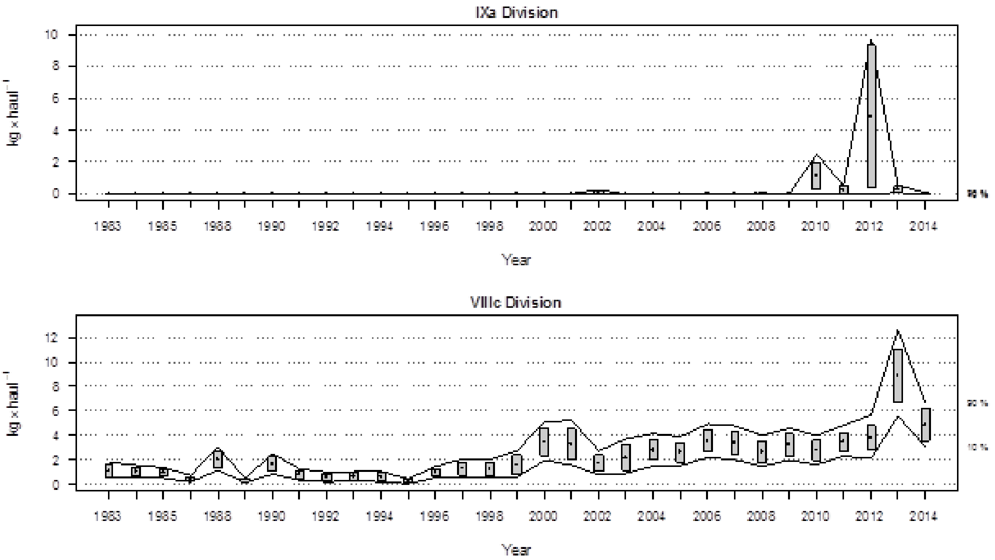


Figure 19.8b. Skates and rays in the Bay of Biscay and Iberian waters. Changes in thornback ray (*Raja clavata*) biomass indices, in ICES Division IXa and VIIIc, during North Spanish bottom trawl survey time-series (1983–2014). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

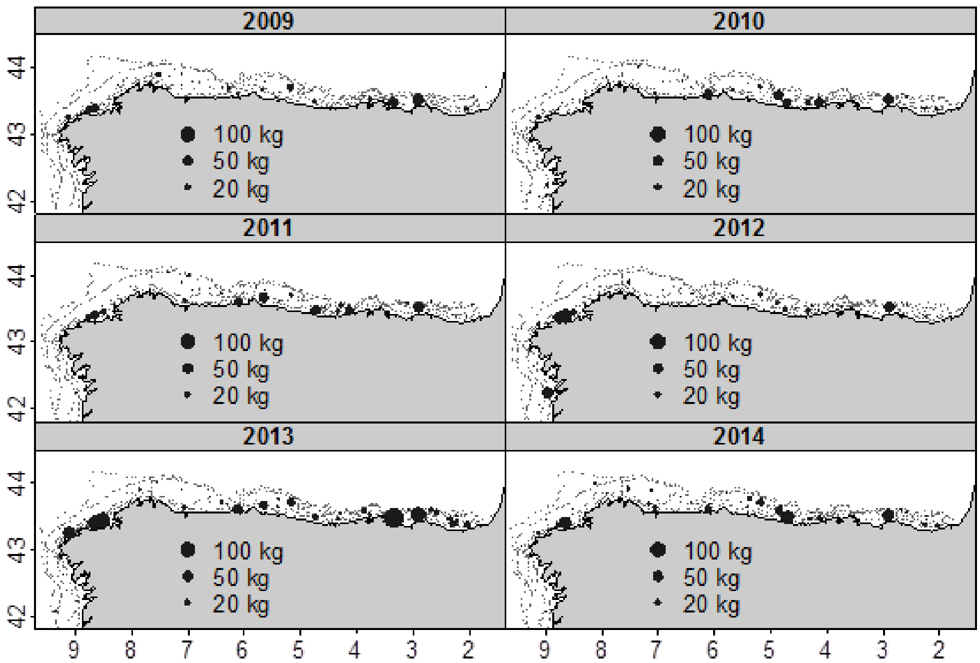


Figure 19.8c. Skates and rays in the Bay of Biscay and Iberian waters. Geographical distribution of thornback ray (*R. clavata*) catches (kg/30 min haul) in North Spanish continental shelf from bottom trawl surveys for the period (2009–2014).

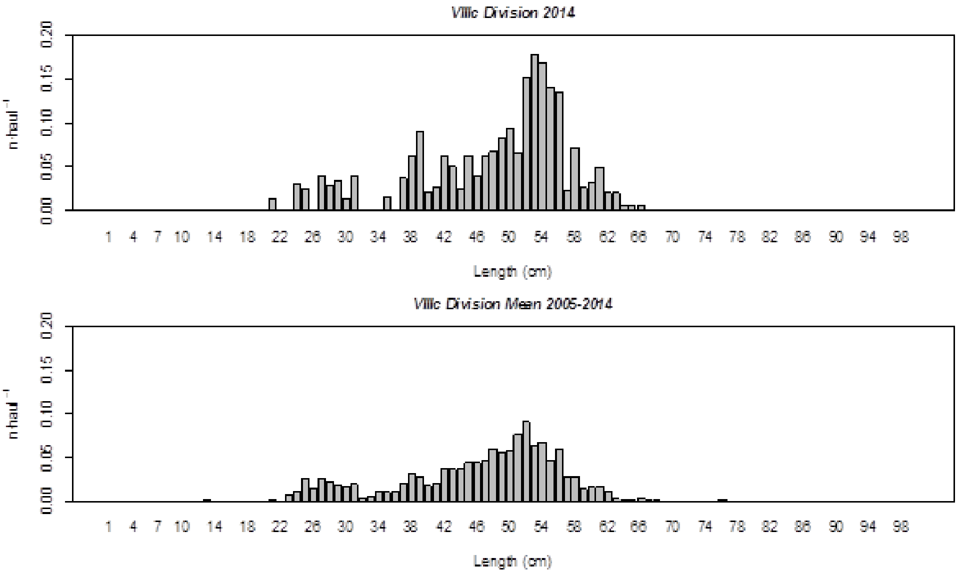


Figure 19.9a. Skates and rays in the Bay of Biscay and Iberian Waters. Stratified length distributions of spotted ray (*R. montagui)* in 2014 in VIIIc ICES Division covered by North Spanish shelf bottom trawl survey, and mean values for the period 2004–2014.

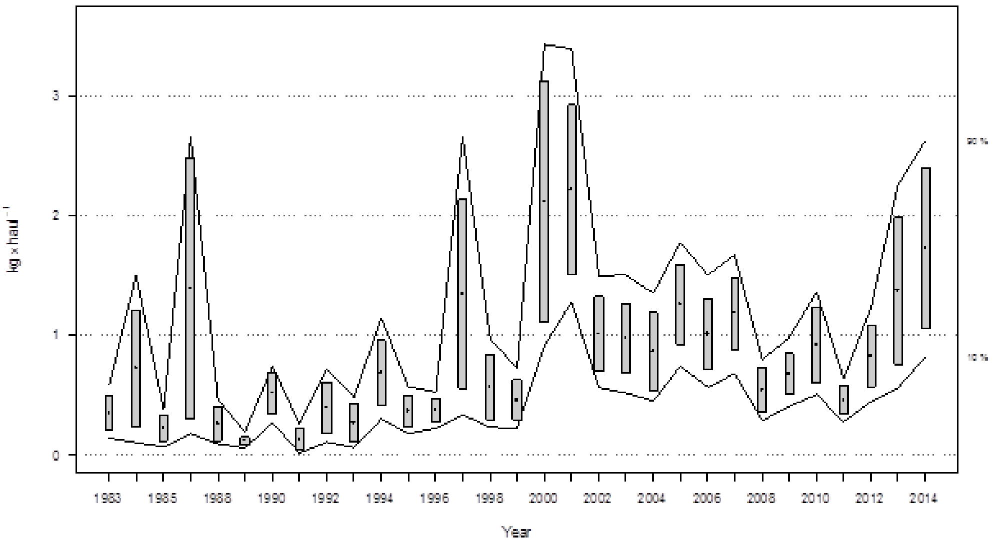


Figure 19.9b. Skates and rays in the Bay of Biscay and Iberian Waters. Changes in *Raja montagui* biomass index during North Spanish shelf bottom trawl survey time-series (1983–2013) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

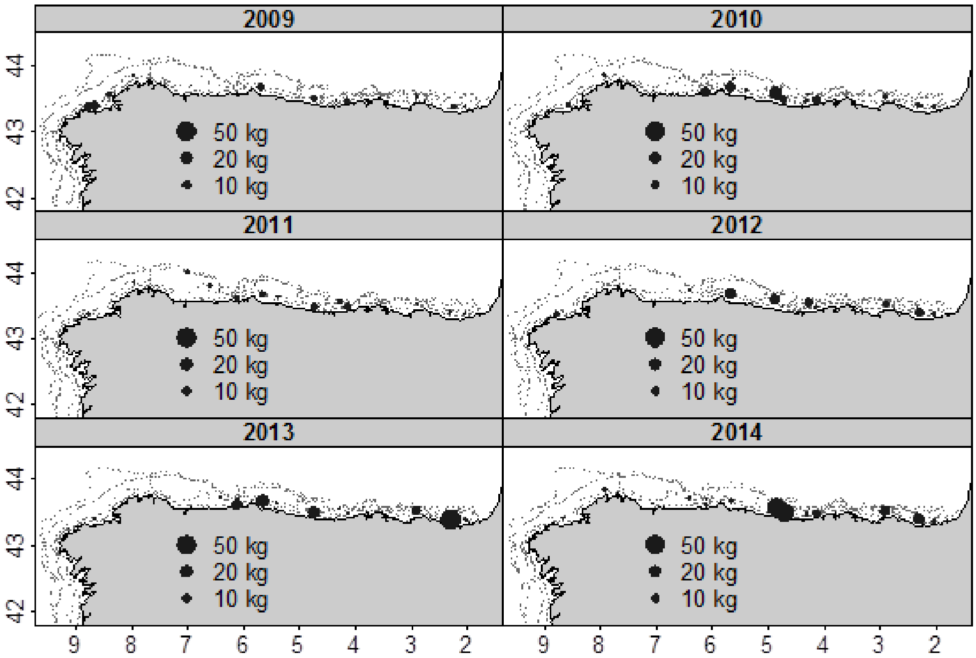


Figure 19.9c. Skates and rays in the Bay of Biscay and Iberian Waters. Geographical distribution of spotted ray (*R. montagui*) catches (kg/30 min haul) in North Spanish continental shelf bottom trawl surveys for the period (2009–2014).

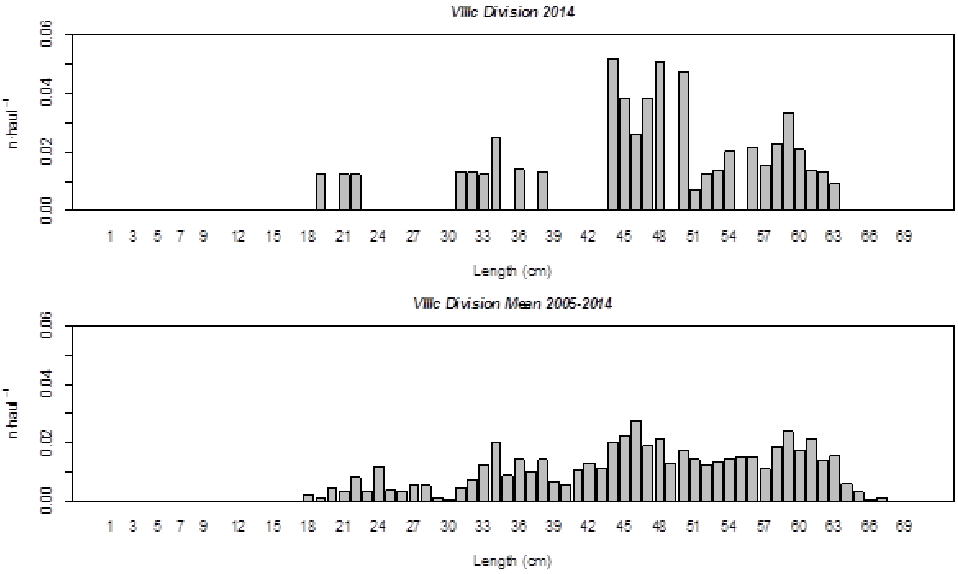


Figure 19.10a. Skates and rays in the Bay of Biscay and Iberian Waters. Stratified length distributions of *L. naevus* in 2014 in VIIIc ICES Division covered by North Spanish shelf bottom trawl survey, and mean values for the period 2004–2014.

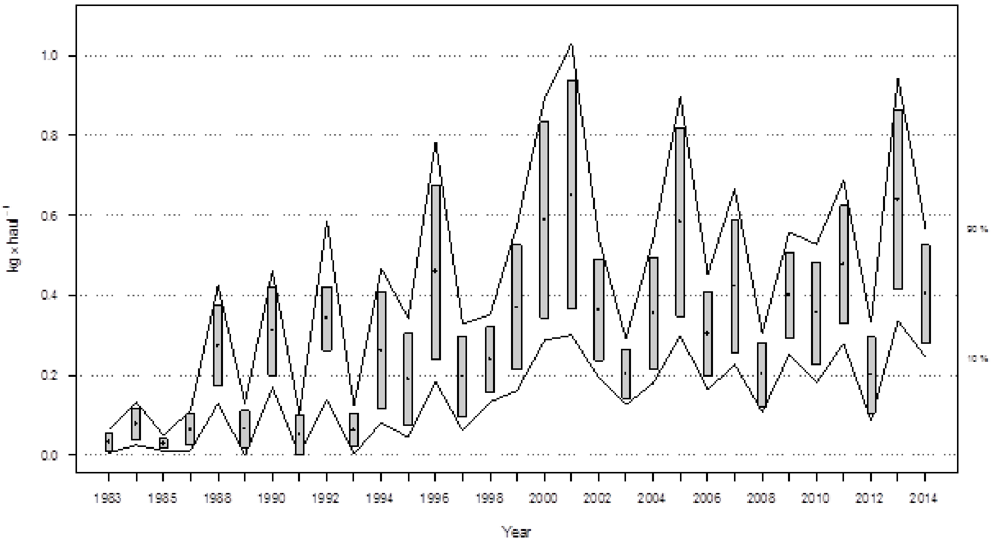


Figure 19.10b. Skates and rays in the Bay of Biscay and Iberian Waters. Changes in *Leucoraja naevus* biomass index during North Spanish shelf bottom trawl survey time-series (1983–2013) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

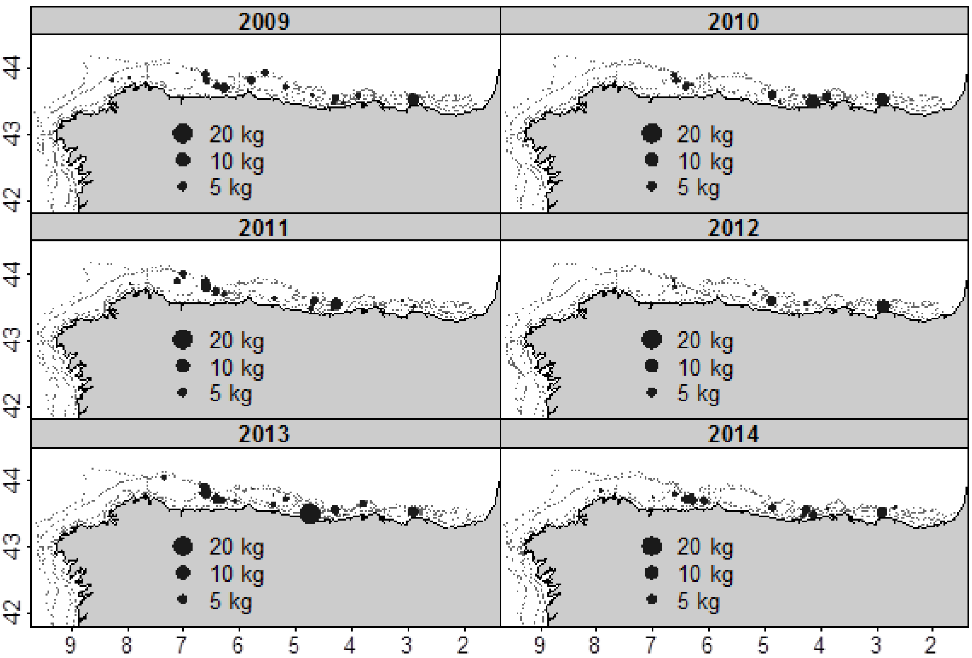


Figure 19.10c. Skates and rays in the Bay of Biscay and Iberian Waters. Geographical distribution of cuckoo ray (*L. naevus*) catches (kg/30 min haul) in North Spanish continental shelf bottom trawl surveys for the period (2009–2014).

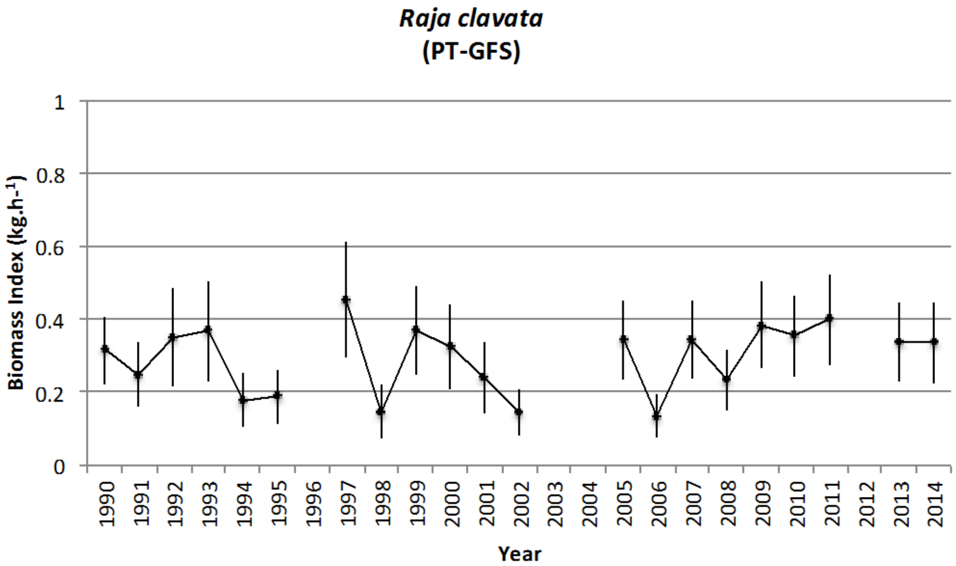


Figure 19.11. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja clavata* biomass indices ($kg.h^{-1}$) on PT-GFS, during 1990–2014. No survey was conducted in 2012.

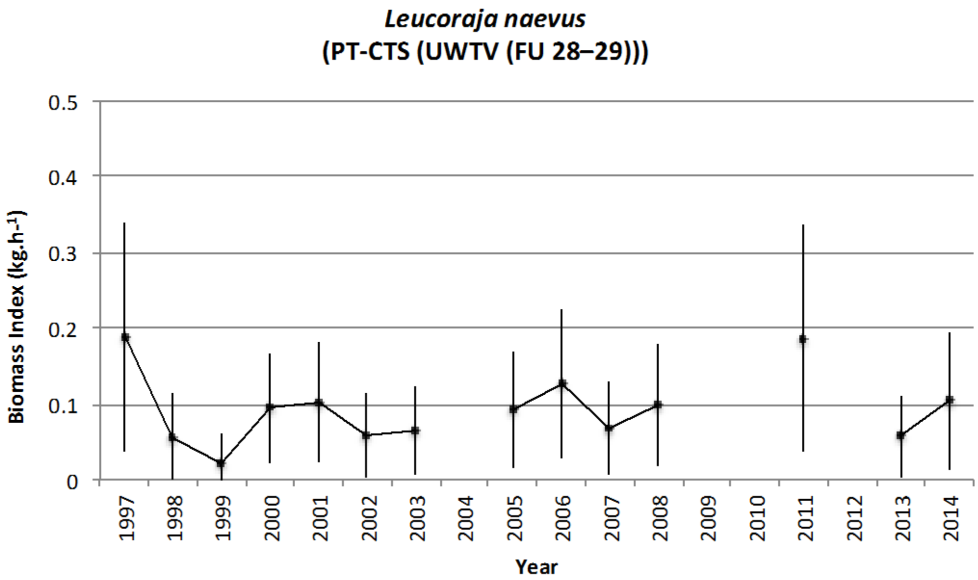


Figure 19.12. Skates and rays in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* biomass indices ($kg.h^{-1}$) on PT-CTS (UWTV (FU 28–29)) surveys, during 1997–2014. No survey was conducted in 2004, 2010 and 2012.

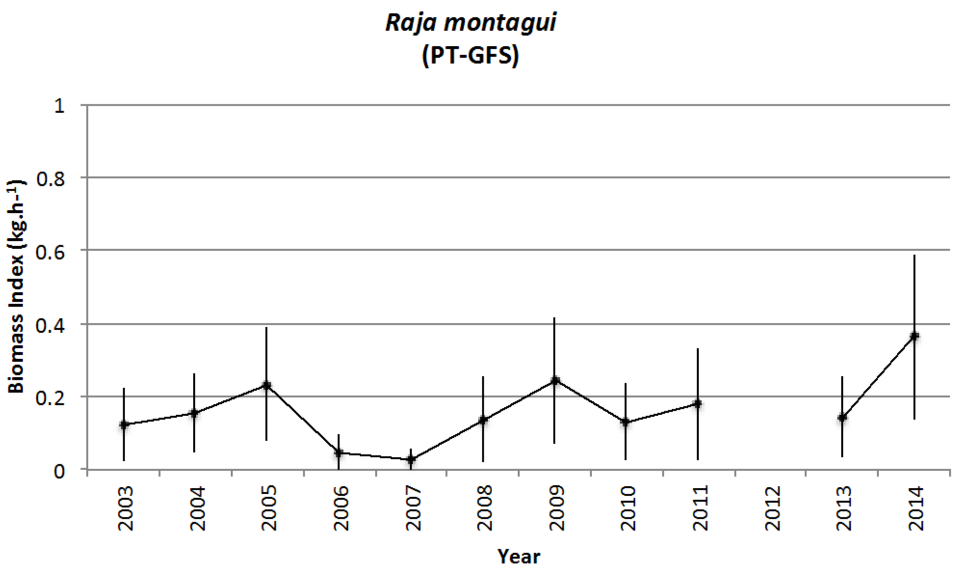


Figure 19.13. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja montagui* biomass indices (kg.h-) on PT-GFS surveys, during 2003–2014. No survey was conducted in 2012.

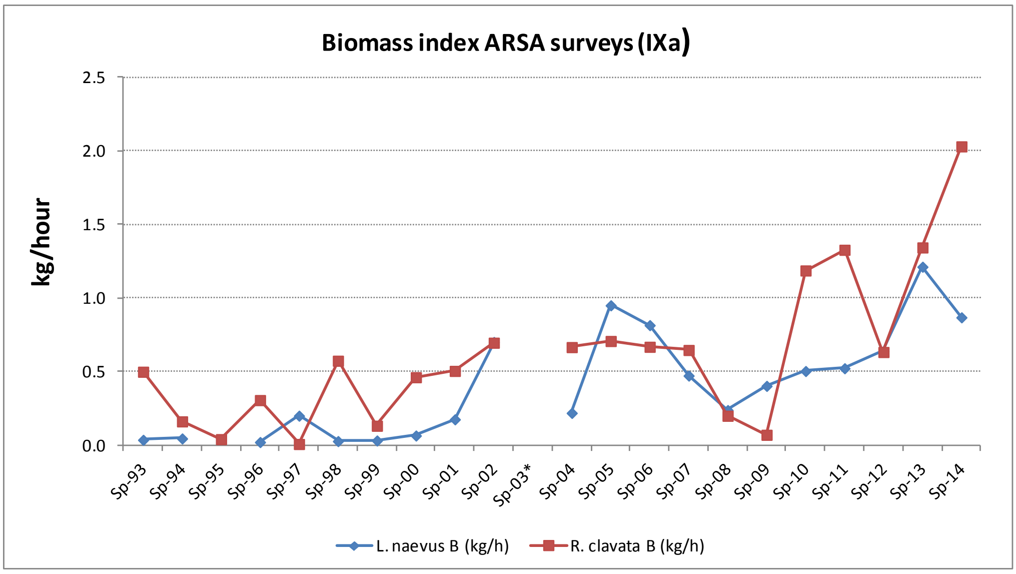


Figure 19.14a. Skates and rays in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as kg/hour from the Spanish bottom trawl survey ARSA carried out in autumn in the Gulf of Cadiz (IXa South) since 1993.

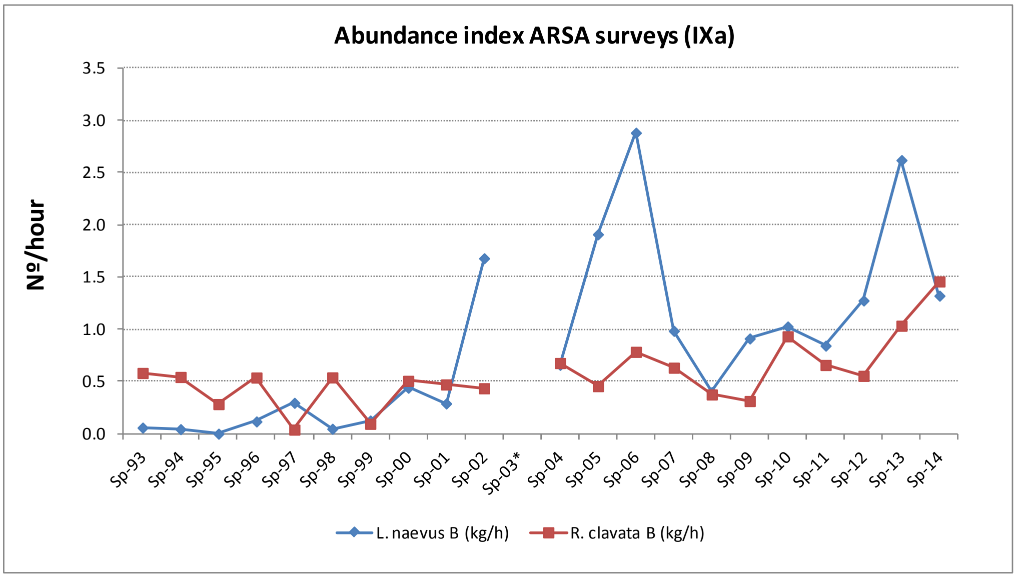


Figure 19.14b. Skates and rays in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as Nº/hour from the Spanish bottom trawl survey ARSA carried out in autumn in the Gulf of Cadiz (IXa South) since 1993.

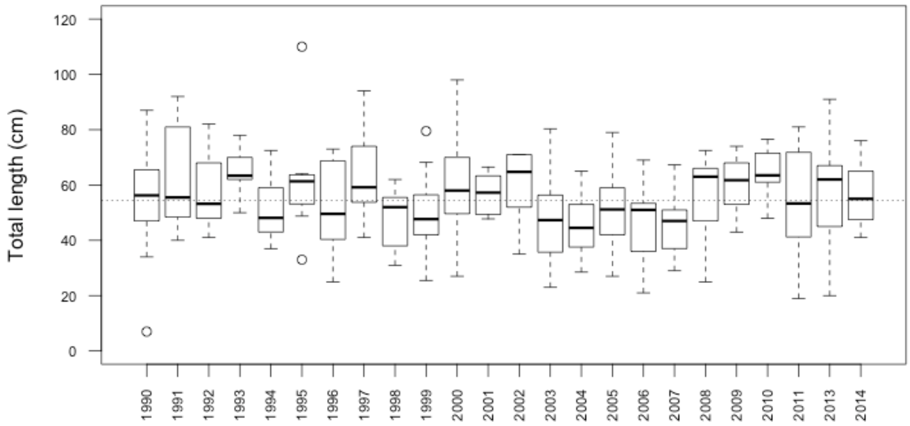


Figure 19.15. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja clavata* total length variation on PT-GFS surveys, during 1990–2014. No survey was conducted in 2012.

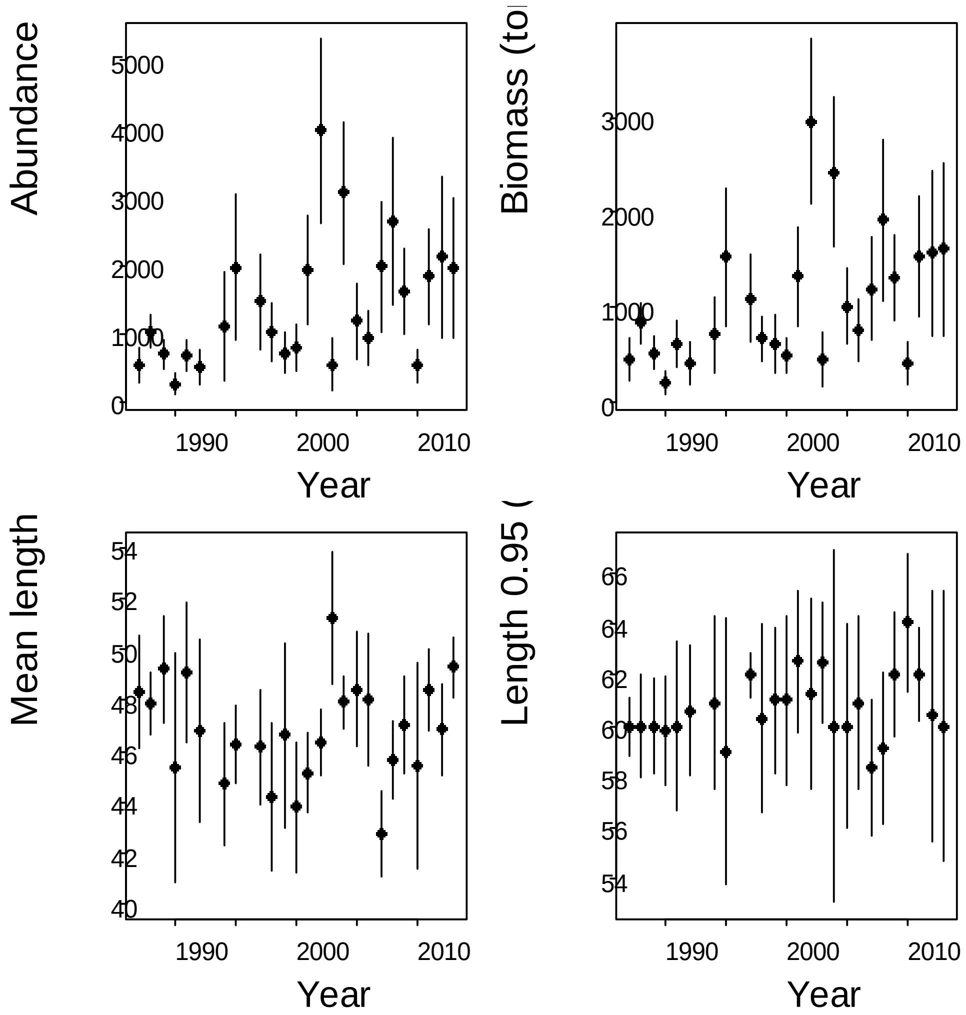


Figure 19.16a. Skates and rays in the Bay of Biscay and Iberian Waters. EVHOE survey indices 1987–2013 of the cuckoo ray in the Bay of Biscay (VIIIa,b,c). Abundance and biomass are raised to the total area surveyed (swept area method) but should be considered relative and not absolute estimates.

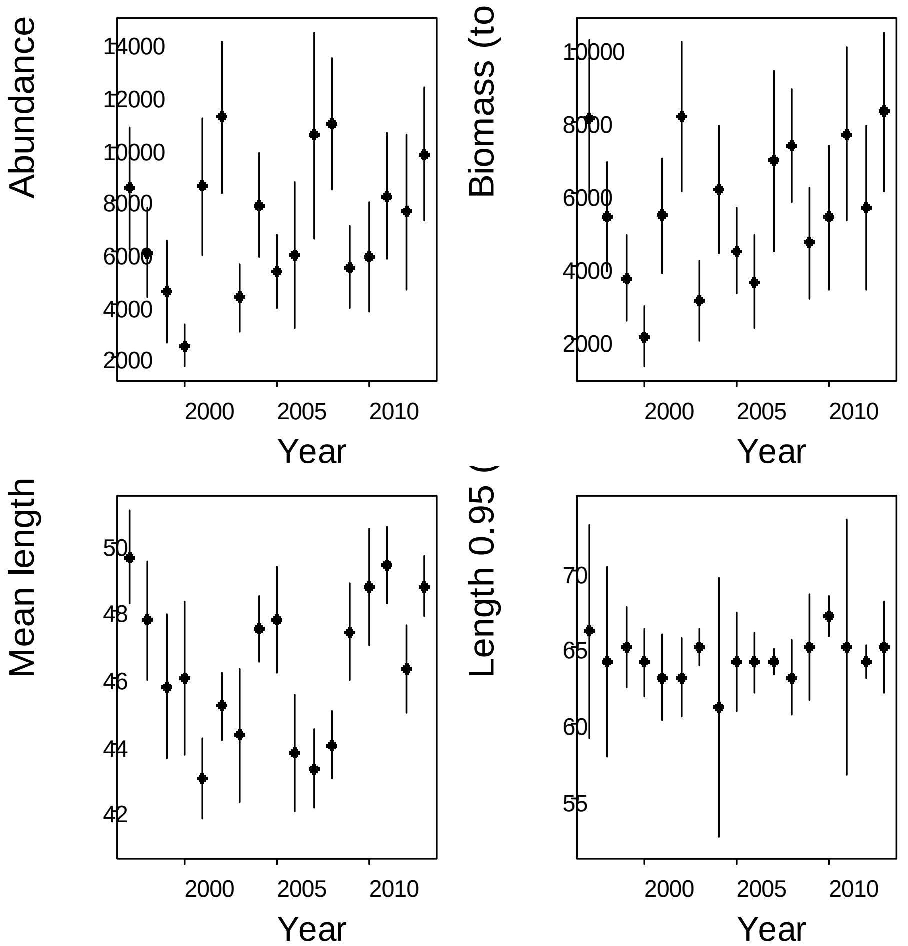


Figure 19.16b. Skates and rays in the Bay of Biscay and Iberian Waters. EVHOE survey indices 1987–2013 of the cuckoo ray in the Celtic Sea and Bay of Biscay (VIIj,k and VIIIa,b,c). Abundance and biomass are raised to the total area surveyed (swept area method) but should be considered relative and not absolute estimates.

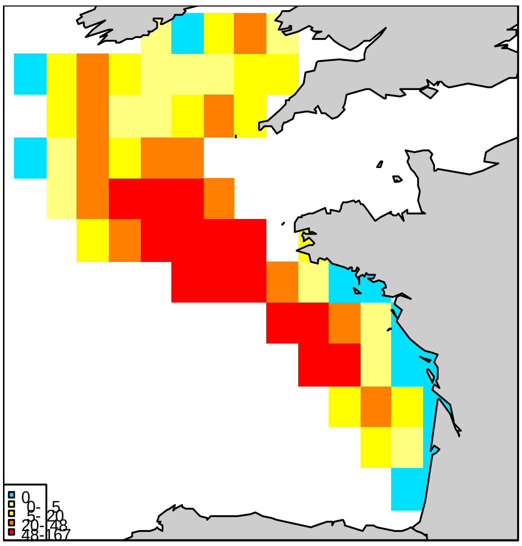


Figure 19.17. Skates and rays in the Bay of Biscay and Iberian Waters. Spatial distribution of the cuckoo ray (*Leucoraja naevus*) in ICES Divisions VIIIabc and VIIgk, based on catch in the EVHOE survey.

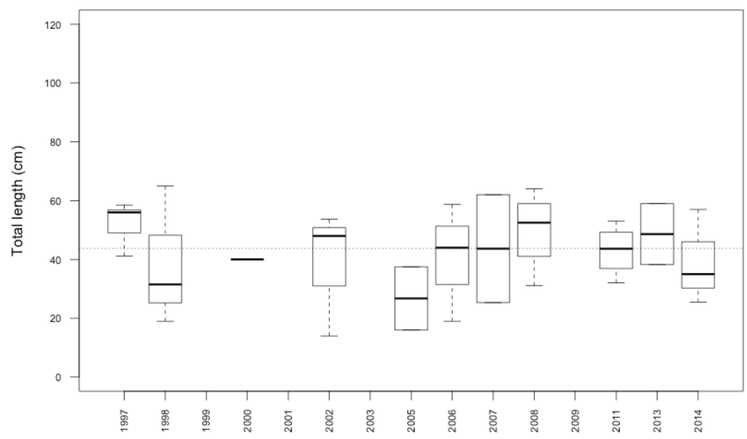


Figure 19.18. Skates and rays in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* total length variation on PT-CTS (UWTV (FU 28-29)) surveys, during 1997–2014. No survey was conducted in 2004, 2010 and 2012.

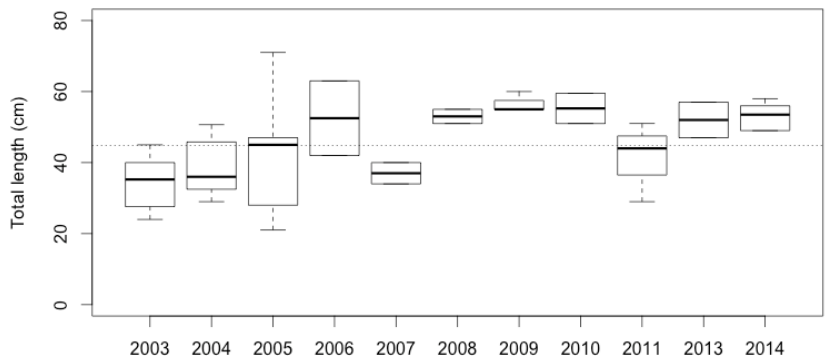


Figure 19.19. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja montagui* total length variation on PT-GFS surveys, during 2003–2014. No survey was conducted in 2012.

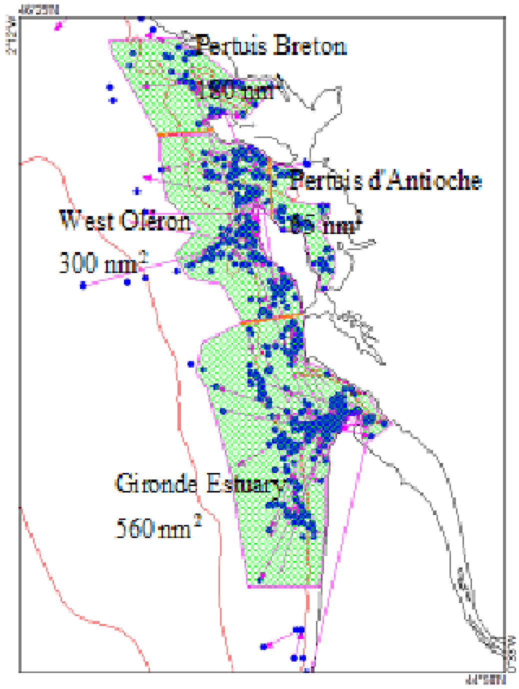


Figure 19.20. Skates and rays in the Bay of Biscay and Iberian Waters. Undulate ray habitat areas in the centre of the Bay of Biscay from 2011–2014 tagging and recapture positions.

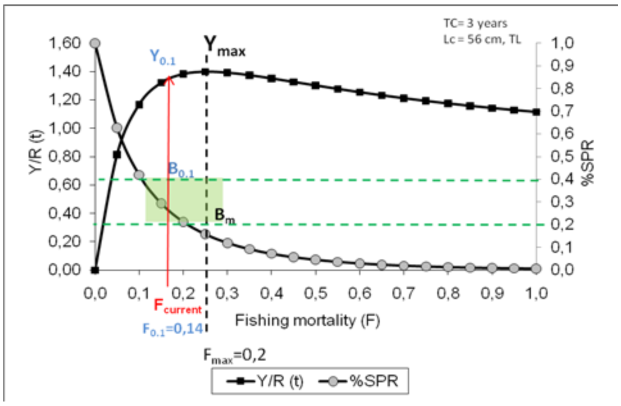


Figure 19.21. Skates and rays in the Bay of Biscay and Iberian Waters. *Raja brachyura* yield per recruit (Y/R and potential spawning ratio (%SPR) curves for different levels of fishing mortality and an age of first capture = 3 years (TC).Red line shows $F_{current}$. *Raja brachyura*.

20 Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge

20.1 Ecoregion and stock boundaries

The Mid-Atlantic Ridge (MAR; ICES Subareas X, XII, XIV) is an extensive and diverse area, which includes several types of ecosystem, including abyssal plains, seamounts, active underwater volcanoes, chemosynthetic ecosystems and islands.

The main species of elasmobranch observed in this ecoregion are deep-water species (*Centrophorus* spp., *Centroscymnus* spp., *Deania* spp., *Etmopterus* spp., *Hexanchus griseus*, *Galeus murinus*, *Somniosus microcephalus*, *Pseudotriakis microdon*, *Scymnodon obscurus*, *Centroscyllium fabricii* and various deep-water skates; see Sections 3 and 5), particularly whenever the gear fishes deeper than 600 m. As a consequence of their low commercial value or EU restrictive management measures, many of these species are discarded (ICES, 2005; Pinho and Canha, 2011 WD). In the Azores area, kitefin shark *Dalatias licha* and tope *Galeorhinus galeus* are the most important commercial elasmobranchs (see Sections 4 and 10, respectively).

This section focuses on the skates taken in Azorean waters. Of these, the most abundant in Subarea X is thornback ray *Raja clavata*. Other species also observed include *Dipturus batis* complex, *D. oxyrinchus*, *Leucoraja fullonica*, *Rajella bathyphila*, *Raja brachyura*, and *Rostroraja alba* (Pinho, 2005, 2014b WD). Other species of batoid, such as Bigelow's ray *Rajella bigelowi*, stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana* are also observed in this ecoregion (e.g. Santos *et al.*, 1997; Menezes *et al.*, 2006). These species are generally discarded if caught in commercial fisheries (Pinho and Canha, 2011 WD). Some of the scarcer elasmobranchs observed on MAR include *Bathyraja pallida* and *Bathyraja richardsoni* (ICES, 2005).

Stock boundaries are not known for most of the species in this area, neither are the potential movements of species that also occur on the continental shelf of mainland Europe. Genetic studies of *Raja clavata*, have indicated important differences between Azorean and the eastern Atlantic sea board (Chevolot *et al.,* 2006), indicating that mixing is limited. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

20.2 The fishery

20.2.1 History the fishery

In the context of this report, this area is mainly a natural deep-water environment exploited by small-scale fisheries in the Azorean islands EEZ and industrial deep-sea fisheries in international waters. The fisheries from these areas were described in earlier WGEF reports (ICES, 2005). Landings from the Azorean fleets have been reported to ICES. Landings from MAR remain very small and variable, or even absent, and few vessels find the MAR fisheries profitable at present.

Demersal elasmobranchs are caught in the Azores EEZ by a multispecies demersal fishery, using handlines and bottom longlines, and by the black scabbard fish fishery using bottom longlines (ICES, 2005). The most commercially important elasmobranchs caught and landed from these fisheries are *Raja clavata* and tope (Pinho, 2005, 2014a WD; ICES, 2005).

20.2.2 The fishery in 2013 and 2014

An expansion of the Azorean bottom longline fishery to the more offshore seamounts has been observed in recent years as a result of intensive fishing or overexploitation of important commercial demersal/deep-water stocks and also as a result of spatial management measures introduced. A shift from this fishery to the black scabbard fish has been observed during the recent years although with a very variable annual effort due to market issues.

The landings of demersal/deep-water sharks were very low due to the quota restrictions (Pinho, 2015 WD). There are no target fisheries, but discards of these species are expected to increase, particularly from the longliners, because of quota and local area restrictions to fishing being introduced in Subdivision Xa2 (Azores EEZ).

20.2.3 ICES advice applicable

ICES first provided advice for this ecoregion in 2012 (ICES, 2012), which is valid for 2013–2014 stating: *"As thornback ray is the dominant ray species at Azores and the Mid-Atlantic Ridge, the advice for skates and rays is based on the status of this species. Based on ICES approach to data-limited stocks, ICES advises that catches should be decreased by 36%. Because the data for catches are not fully documented and not reliable, ICES is not in a position to quantify the result. ICES does not advise that general or species-specific TACs be established at present. This is because a TAC is not the most effective means to regulate fishing mortality in these bycatch species. ICES advises that a suite of species- and fishery-specific measures be developed to manage the commercial fisheries on these species and achieve recovery of the depleted species. Such measures should be developed in collaboration between management authorities and all stakeholders. ICES could assist in this process. Species- and fishery-specific measures may include seasonal and/or area closures, technical measures, and tailored measures for target fisheries."*

20.2.4 Management applicable

NEAFC has adopted management measures for the MAR areas under its regulatory area. These include effort limitations, area and gear restrictions (http://www.neafc.org/measures). Those recommendations that are relevant to elasmobranchs in this region include:

- Recommendation III (2006): Since 2006 NEAFC has prohibited fisheries with gillnets, entangling nets and trammelnets in depths below 200 m and introduced measures to remove and dispose of unmarked or illegal fixed gear and retrieve lost gear to minimize ghost fishing;
- Recommendations IX (2007) and IX (2008): Bottom fishing (Bottom trawling and fishing with static gear, including bottom-set gillnets and longlines) was forbidden in some areas of Hatton Bank and Rockall Bank;
- Recommendation XVI (2008): The access to the new bottom fishing areas (considered as other areas not mapped as actual existing bottom fishing areas) was limited;

- Recommendation VII (2009) and REC VI (2010): Since 2009 effort was limited and set at 65% of the highest level put into deep-sea fishing in previous years for the relevant species;
- Recommendation XIV (2009): During 2009 five areas (including three seamounts), on the Mid-Atlantic Ridge in the high seas in the Northeast Atlantic, were closed temporarily to bottom fisheries (fishing gears which is likely to contact the seabed) under its policy for area management;
- Recommendation VI (2011): As an interim measure, no directed fishery for basking shark shall be undertaken in the Convention Area in 2011;
- Recommendation VII (2010). Directed fishing of spurdog (*Squalus acanthias*) is prohibited in the Regulatory Area by vessels flying its flag. Any incidental catches of this stock shall be promptly released unharmed to the extent possible.

Deep-water sharks are subject to management in Community waters and in certain non-Community waters for stocks of deep-sea species (EC no 2270/2004 article 1).

In 1998, the Azorean government implemented local management actions in order to reduce effort on shallow areas of 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 island areas, with fishing restrictions by gear (only handlines are permitted) and vessel type. During 2009 additional measures were implemented, including area restriction (temporary closure of the Condor Bank) and gear restriction by vessel type (licence and gear configuration).

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 (Portaria n.º 114/2014, 28th May). The new regulation expands the EU regulation adopted in 2005 to ban bottom trawling in the Azores and Madeiran waters and has the objective to protect deep-sea ecosystems (such as cold-water corals and seamounts) from the impact of bottom trawling and gillnet fishing.

Under the EU Common Fisheries Policy a box of 100 miles was created around the Azorean EEZ where only the Azorean fleets are permitted to line fish for deep-sea species (Regulation EC 1954/2003). TACs for deep-water sharks are in place for ICES Areas V, VI, VII, VIII, IX, X and XII (EC Reg. no 43/2014).

20.3 Catch data

20.3.1 Landings

The landings reported by each country and subarea are given in Tables 20.1–20.3. Historical total landings of skates reported for Areas X and XII are presented in Figure 20.1.

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

Information on the discarding of skates is not currently available.

Information on discards from observers in the Azorean longline fishery from 2004 to 2010, as reported to the WGDEEP (Pinho and Canha, 2011 WD) showed that for some species, such as deep-water sharks, the discards may be important. For species such as *Etmopterus* spp. and *Centrophorus* spp., all fish are discarded. Other species frequently caught and discarded include *Dalatias licha*, *Deania* spp., *Hexanchus griseus, Raja clavata* and *Dipturus batis*. Discard levels are probably due to the management measures introduced, particularly the TAC/quotas, minimum size and fishing area restrictions (zoning by fleet characteristics) that changed the fleet behaviour on targeting, expanding the fishing areas to more offshore seamounts and deeper strata. 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*). For demersal sharks, misidentifications are known to occur. Misidentified species, grouped as not specified elasmobranchs in the landings increased during 2012–2013.

20.3.4 Discard survival

Information on the discard survival of elasmobranchs 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. Landing statistics on rays and skates 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 samples of *Raja clavata* have been collected since 1990, however few individuals were sampled until 2004 (Pinho, 2015 WD). These data are presented this year for the first time but quality checks are required (Figure 20.2).

20.4.2 Length composition of discards

No information available.

20.4.3 Sex ratio of landings

No information available.

20.4.4 Quality of data

Only limited data are available. Improved data collation and quality checks (including for species identification) are required.

20.5 Commercial catch and effort data

No information available.

20.6 Fishery-independent surveys

Since 1995 the Department of Oceanography and Fisheries (DOP) has carried out an annual spring demersal bottom longline survey (ARQDACO(P)-Q1) around the Azores. An overview of the elasmobranch species occurring in the Azores (ICES Subarea X), their fisheries and available information on species distributions by depth were described by Pinho (2005; 2014a,b WD). This survey is not specifically designed to catch elasmobranchs, and so does not provide quantitative information for most species.

Raja clavata is one of the most commonly reported elasmobranch species in this survey (ICES, 2006). Relevant biological information available from surveys on this species were updated in 2014, including the annual abundance index (Figure 20.3) and length–frequency distribution (Figure 20.4). The absence of records of the youngest size classes in this survey can be attributed to a gear effect. Catches of other skates are insufficient to be informative of stock trends.

No data are available from 2014 onwards because the survey was disrupted.

Information on elasmobranchs recorded on MAR is available from the literature (Hareide and Garnes, 2001) and was summarized in ICES (2005).

20.7 Life-history information

Life history available for *Raja clavata* was resumed from the literature for the Azores and for Northeastern Atlantic. Based on this information natural mortality estimation was explored (Pinho *et al*., 2015 WD). Estimates of natural mortality vary between 0.2 and 0.5 per year depending on the method and the correspondent set of life-history parameters used. However, there is poor knowledge on the biology of the species for this ecoregion and available information is uncertain. The definitions of the appropriate set of life-history parameters for this species (that best describe the population dynamic) and for this ecoregion should be addressed in future work in order to provide more accurate data for exploratory assessments.

20.8 Exploratory assessment methods

No assessments have been conducted, as a consequence of insufficient data.

20.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may be informative for *Raja clavata* but do not allow the status of other skates to be evaluated.

20.10 Reference points

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

20.11 Management considerations

WGEF considers that the elasmobranch fauna of Mid-Atlantic Ridge in ICES Subareas X and XII is poorly understood. The species of demersal elasmobranchs are probably little exploited compared with continental Europe. The ecoregion is considered to be a sensitive area. Consequently, commercial fisheries taking demersal elasmobranchs in this area should not be allowed to proceed unless studies are conducted that can demonstrate what sustainable exploitation levels should be.

20.12 References

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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.

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Table 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea X.

ICES SUBAREA X													
Country	Species	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1996
Azores	Rajidae	48	29	35	52	43	32	55	62	71	99	117	71
France	Rajidae							1					
Spain	Rajidae							.					
Azores	Bluntnose six-gill shark	+	1	1	1	+	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Azores	Sharks	+	+	4	12	+	n.a.	138	256	328	n.a.	n.a.	328
Total		48	30	40	65	43	32	194	318	399	99	117	399

ICES SUBAREA X													
Country	Species	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Azores	Rajidae	99	117	103	83	68	70	89	72	47	62	71	72
France	Rajidae					2	.	.	.	.	-	-	.
Spain	Rajidae				24	29	-	-	-	.	-	-	
Azores	Bluntnose six-gill shark	n.a.	n.a.	n.a.	n.a.	n.a.	7	2	1	1	1	1	.
Azores	Sharks	n.a.	n.a.	6	18	22	n.a.	n.a.	n.a.	3	n.a.	11	18
Total		99	117	109	125	121	77	91	73	51	63	82	91

ICES SUBAREA X							
Country	Species	2009	2010	2011	2012	2013	2014
Azores	Rajidae	60	68	90.7	103	46	187
France	Rajidae	.	.	.	.	.	
Spain	Rajidae			.	.	.	
Azores	Bluntnose six-gill shark	.	0.6	.	0	0	0
Azores	Sharks	10	6.3	1.6	31	70	0
Total		71	75	92	134	116	187

Table 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XII.

ICES SUBAREA XII										
Country	Species	2001	2002	2003	2004	2005	2006	2007	2008	2009
UK	Rays and skates	1	1	6	1	.			0	0
UK	Sharks	-	6.7	-	-	113			0	0
Total		1	7	6	0.8	113	0	0	0	0

ICES SUBAREA XII						
Country	Species	2010	2011	2012	2013	2014
UK	Rays and skates	.	.	.	.	
Norway	Rajidae	.	.	.	.	
Total		0	0	0	0	

Table 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XIV.

ICES SUBAREA XIV										
Country	Species	2001	2002	2003	2004	2005	2006	2007	2008	2009
UK	Rays and skates	+	+	-	-	-			0	0
Norway	Rajidae						6	0	1	0
Total		0.3	0.4	-	-	-	6	0	1	0

ICES SUBAREA XIV						
Country	Species	2010	2011	2012	2013	2014
France	Rays and skates			0,484	.	
Germany	Rays and skates	0.02	0	0	0,047	0
UK	Rays and skates	+	.		.	
Norway	Rajidae		.		.	
Total		0.02	0	0,484	0	0

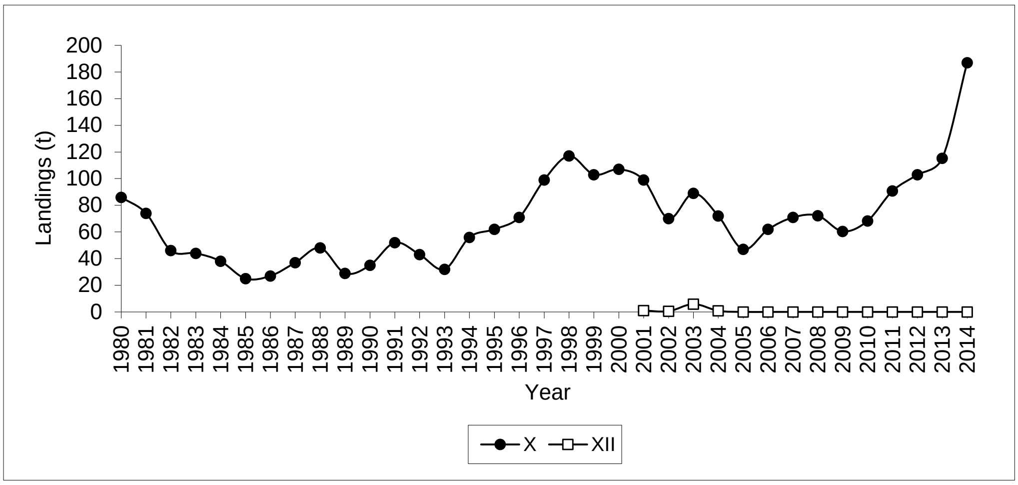

Figure 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Historical landings of rays from Azores (ICES Subarea X) and MAR (ICES Subarea XII).

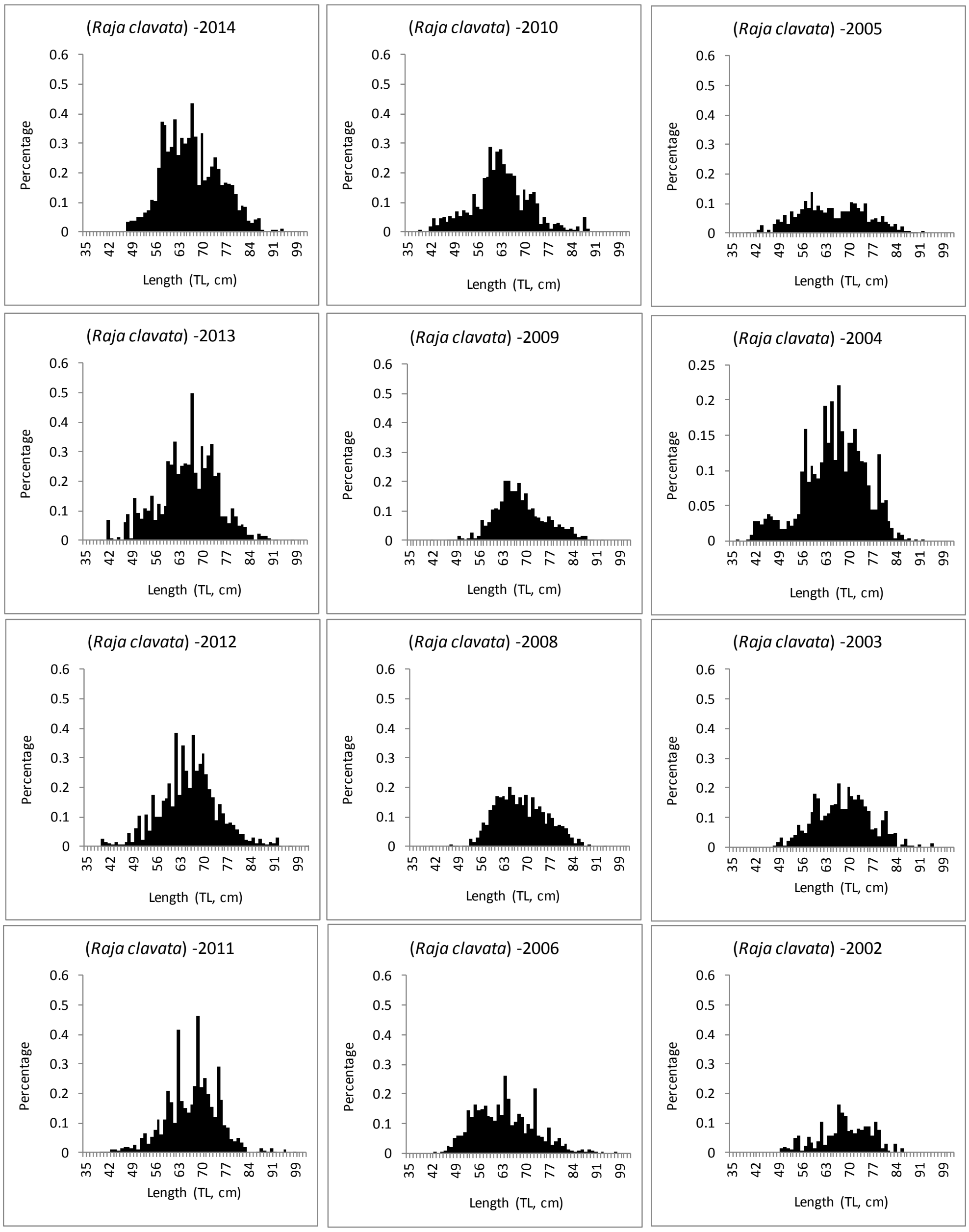

Figure 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* landed in the Azorean for the period 2002–2014.

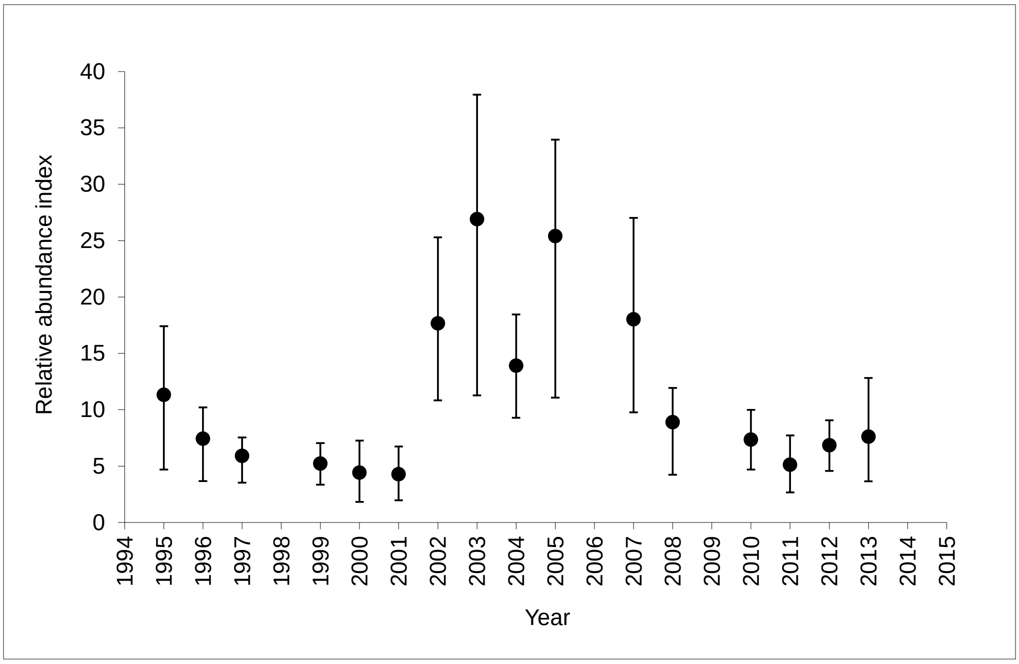

Figure 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Annual abundance, in numbers, of *Raja clavata* from the Azores (ICES Area X) from the Azorean demersal spring bottom longline survey (1995–2013).

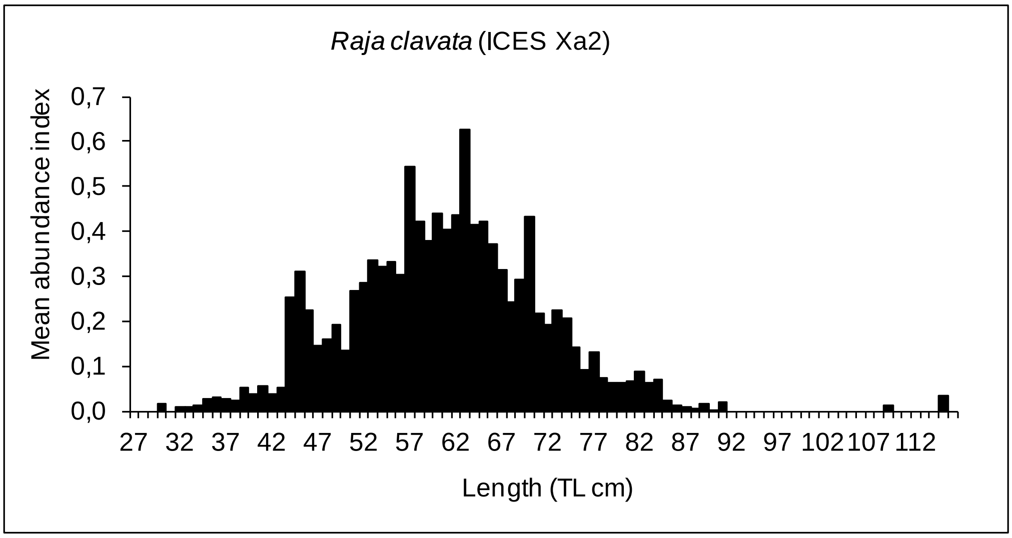

Figure 20.4. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* caught in the Azorean demersal spring bottom longline survey for the period 1995–2013.

21 Smooth-hounds in the Northeast Atlantic

21.1 Stock distribution

Three species of smooth-hound (Triakidae) occur in the ICES area. The most frequent species in the northern part of the area is starry smooth-hound *Mustelus asterias.* Common smooth-hound *Mustelus mustelus* may also occur in northern European seas, although no confirmed specimens have been found in recent years and historical records may be unreliable. Separating these two species on the presence or absence of spots is 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*.

A third species, black-spotted smooth-hound *Mustelus punctulatus,* occurs in the Mediterranean Sea (Quignard, 1972) and off NW Africa and may occur in the southernmost part of ICES Division IXa.

M. asterias is the dominant smooth-hound in northern European waters. The development of a molecular genetic identification technique has allowed the reliable identification and discrimination of Northeast 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). A further study from the North Sea and English Channel (McCully and Ellis, 2015 WD) that sampled 504 *Mustelus*, also found no specimens of *M. mustelus*.

Given the problems in separating *M. asterias* and *M. mustelus* and that data for these two species are confounded, data in this chapter are generally combined at genus level. Whilst assessments conducted by WGEF are based on *Mustelus asterias*, management advice should be applied at the genus level, so as to avoid potential identification problems associated with management and enforcement.

In the absence of dedicated scientific studies on stock units, WGEF considers there to be a single management unit of *Mustelus asterias* in the continental shelf waters of the ICES area, comprising ICES Subareas IV, VI–IX. This stock may extend to the northern part of the CECAF area and possibly the Mediterranean Sea.

Improved studies to better understand the stock unit(s) are required. There are several programmes that tag and release *M. asterias* in the North Sea and Celtic Seas ecoregions (e.g. Burt *et al.*, 2013 WD). In the North Sea, Sportvisserij Nederland and IMARES started a long-term tagging programme on starry smooth-hound, where over 2000 specimens tagged off the Netherlands, with over 80 recaptures made between 2001–2014 (Winter and Brevé, 2014). Cooperative large-scale analyses of all available tagging data are required. Additionally, tagging studies from the more southern parts of the distribution range could be usefully undertaken.

21.2 The fishery

21.2.1 History of the fishery

Smooth-hounds are taken as a seasonal bycatch in trawl, gillnet and longline fisheries. Though they are discarded in some fisheries, other fisheries land this bycatch, depending on market demands. Some 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 Seas.

21.2.2 The fishery in 2014

There were no major changes to the fishery noted in 2014. Information from the fishing industry suggests that the increased landings of smooth-hounds, since 2009, are partly to supply market demand for 'dogfish' given the current restrictions on spurdog.

21.2.3 ICES Advice applicable

ICES first provided advice for this stock in 2012, 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*".

21.2.4 Management applicable

There are no specific management measures for smooth-hounds.

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.) could be targeted in fixed nets of 120–219 mm and >220 mm mesh size (in regions 1 and 2), *Mustelus* spp. would be classed under 'all other marine organisms', and so can only be targeted in fixed nets of >220 mm. This has been queried by some fishermen.

21.3 Catch data

21.3.1 Landings

No accurate estimates of catch are available, as many nations that land smooth-hounds report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). Preliminary estimates of landings (Table 21.1; Figure 21.1) are increasing, with landings exceeding 3000 t since 2012. The main nations exploiting smooth-hounds are France (> 75% of landings in 2014) and England (> 17% of landings), and the English Channel and southern North Sea are important fishing grounds. The landings reported by Portugal 187 t (5% of landings in 2014) need further verification, and it is possible that they refer to another species (e.g. through a coding error or misreporting), as smooth-hounds are not common on their fishing grounds.

21.3.2 Discards

Although some discards data are available from various nations, data are limited for most nations and fisheries. Four countries reported preliminary estimates of discards, which ranged from 28 to 950 t in 2014. 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.

Earlier studies have indicated that juveniles are typically discarded (Figure 21.2), although the survival of these discards has not yet been evaluated (Silva *et al*., 2013 WD). Smooth-hounds taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and subadults (<70 cm L_T), and most these were nearly all discarded. Gillnet catches were comprised primarily of fish 60–110 cm L_T, with fish <55 cm L_T usually discarded. Otter trawl catches covered a broad length range, and smooth-hounds <50 cm L_T were usually discarded. The absence of full retention at length in these gears may be due to various factors (e.g. catch quality and local market value) influencing the discarding behaviour of fishers.

Silva *et al.* (2013 WD) also noted that a greater proportion of smooth-hounds were retained since landing opportunities for spurdog had become restrictive. Over the time period 2002–2005, the retention of *Mustelus* spp. ≥70 cm L_T was 1% and 39% in gillnet and otter trawl fisheries, respectively. In the period 2006–2011, however, retention increased to 73% (gillnets) and 49% (otter trawl).

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.

The availability of landings data from outside the ICES area (e.g. Mediterranean Sea) is limited, and the quality 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). Catch data are absent from off NW Africa.

Better estimates of discarding are required, with information on discard survival also needed, as a proportion of discarded smooth-hounds may survive.

21.3.4 Discard survival

Survival appears to be quite 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 been reported in longline fisheries (Frick *et al*., 2010a; Coelho *et al*., 2012).

21.4 Commercial catch composition

Studies to better understand the composition by size and sex (and species where there is spatial overlap) are required. Given the potential for sexual and sex-based segregation of smooth-hounds, appropriate levels of monitoring would be required to fully understand catch composition over appropriate spatial and temporal scales.

21.4.1 Length Composition of landings

To date, 504 starry smooth-hound samples (266 female, 238 male, Figure 21.3) were examined in a UK study (McCully Phillips and Ellis, 2015 WD), of which 286 (52–124 cm L_T) were landed by commercial vessels.

21.4.2 Length composition of discards

Silva *et al*. (2013 WD) analysed the discard and retention patterns of *Mustelus* spp. taken as bycatch in UK commercial fisheries. Beam trawlers caught proportionally more juveniles (most records were for fish of about 35–70 cm L_T), consequently, discarding was quite high (95–99%). High rates of discarding (of smaller fish, <65 cm L_T) were also apparent in otter trawls, where about 75–80% of the total catches were discarded in the Celtic Seas and North Sea, respectively. Gillnets were more selective for larger fish (with the majority of fish 60–100 cm L_T), where typically only the larger fish (>70 cm L_T) were retained.

21.4.3 Sex ratio of landings

Of 286 commercially landed samples from the southern North Sea and eastern English Channel in May–November, 155 were female and 131 were male (McCully Phillips unpublished). Due to smooth-hounds aggregating by sex and size, the sex ratio (and length–frequency) may vary over the year and area.

21.4.4 Quality of data

Mustelus length measurements may be collected as part of the concurrent sampling of the DCF. These data should be made available for future analysis.

21.5 Commercial catch and 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. Analyses of survey data need to be undertaken with care, as smooth-hounds are relatively large-bodied species (maximum size of *M. asterias* is about 140 cm L_T) and adults are strong swimmers. Hence, larger individuals may not be sampled effectively in IBTS surveys. Given their aggregating nature, some surveys may have a large number of zero hauls and a few hauls with relatively large numbers.

They are often caught in GOV trawl and other otter trawl surveys in the area. For further details of trawl surveys in the stock area, see Section 15 (North Sea ecoregion), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia). Summary details from IBTS 2011 are shown in Figure 21.4.

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 only occasionally records fish >100 cm L_T (Silva *et al.*, 2014 WD; Figure 21.5).

Although two species of smooth-hound have previously been reported in most surveys, the discrimination of these species was usually been based on the presence or absence of spots, which is not a reliable characteristic. WGEF consider that survey data for these two species should be combined in any analyses, and that starry smooth-hound *Mustelus asterias* is likely to be the only species in the Celtic Seas and North Sea ecoregions.

21.6.2 Survey trends

Trends in most of the fisheries-independent surveys have been increasing in recent years. Over the longer term time-series of each survey, all show an increasing cpue, which has been substantial in recent years. Of the six surveys providing an index, four reported a mean annual cpue for 2013–2014 ranging from 40–56% above that seen in the preceding five years (2008–2012).

The UK (England and Wales) beam-trawl survey of the Irish Sea catches reasonable numbers of smooth-hounds. The trend in abundance is derived from the catch rates from fixed stations (97 stations fished at least 19 years out of the 22 year time-series Figure 21.6; Ellis 2015 WD), and is currently at its highest level (since 1993) of 3.23 ind.h^{-1} (2013–2014). This was 40.5% above the mean average cpue for the preceding five years (2008–2012; 2.30 ind.h^{-1}).

The UK (England and Wales) beam-trawl survey of the southern North Sea and eastern English Channel catches lower numbers. The trend in abundance of smooth-hounds (derived from the catch rates from 76 fixed stations fished at least 18 years out of the 22 year time-series; Figure 21.7) has increased over the time-series, and they were also being observed in an increasing proportion of hauls until 2011 (ICES, 2011). Mean annual cpue for 2013–2014 (0.85 ind.h^{-1}) was just below the mean average cpue for the preceding five years (2008–2012; 0.88 ind.$^{-1}$). This slight (ca. 3% less) decrease should be viewed in the context of the longer term increase in cpue during the overall survey series, and the mean cpue observed in the last two years were both above the long-term mean.

The IBTS surveys of the North Sea, undertaken in Q1 and Q3 by seven and six countries respectively, catch relatively low numbers (which may relate to smooth-hounds being more abundant in only the southern parts of the area sampled by the IBTS). Nevertheless, the long-term trend in abundance of smooth-hounds has increased over both of the 24- (Q3) and 25-year (Q1) time-series. In the NSIBTS-Q1, the mean annual cpue for 2013–2014 (1.41 ind.h^{-1}) was far greater than the mean average cpue for the preceding five years (2008–2012; 0.92 ind.h^{-1}); this is a 52.7% increase, and the cpue is currently at its highest level of 1.97 ind.h^{-1} (2014). A similar trend is also seen in the NSIBTS-Q3, with the mean annual cpue for 2013–2014 (1.32 ind.h^{-1}) far greater than the mean average cpue for the preceding five years (2008–2012; 0.88 ind.h^{-1}); this is a 51.1% increase, and the cpue is currently at its highest level (1.38 ind.h^{-1} in 2014).

The increasing long-term trend is mirrored (albeit with lower catch rates) in the Irish Groundfish Survey with the mean annual cpue for 2013–2014 (0.08 ind.h^{-1}) exceeding the mean average cpue for the preceding five years (2008–2012; 0.05 ind.h^{-1}). Once again, cpue is currently at its highest level (0.11 ind.h^{-1} in 2014).

The EVHOE survey of ICES Areas VIIgk and VIIIabd has an 18-year time-series of data, however for three years of this survey, data were either available, or with zero catch; the lack of these records needs verification. Unfortunately, two of these years were in 2009 and 2010, thus when calculating the mean average cpue for the preceding five years, this is based on just three years data, which consist of high catch rates, based on a few large catches. The actual proportion of hauls where smooth-hounds were caught is at its highest level (ca. 16%; similar to that seen in 2012) of the time-series. The catch rates fluctuate highly across this survey series, from zero to more than 25 ind.h^{-1}.

The UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea also indicated an increase in mean catch rates in previous year's analyses, but recent data were not available to WGEF.

A further UK (England and Wales) beam-trawl survey of the western English Channel also encounters smooth-hounds in good numbers. Across the survey time-series (2006–2014), a total of 658 have been caught, accounting for 7.6% of the elasmobranch catch by numbers; the observed length range was 31–115 cm L_T (Silva *et al.*, 2014 WD). Standardised indices of relative abundance have not yet been developed for this survey.

Although smooth-hounds are not subject to routine biological sampling in any of the surveys, all UK (England and Wales) surveys tag and release starry smooth-hounds, and the individual weights and sex (all fish) and maturity (male fish only) are recorded prior to release (See Section 21.7.5).

21.7 Life-history information

Biological data are not collected under the Data Collection Regulations, however some *ad hoc* data are collected on fishery-independent surveys and there are some published studies resulting from biological investigations of *Mustelus* spp. in European seas, including from the NE Atlantic and Mediterranean Sea.

21.7.1 Habitat

The distribution of *Mustelus* spp. around the British Isles has been described, with more detailed studies on the habitat utilization only examined in the English Channel (Martin *et al.*, 2010; 2012).

21.7.2 Spawning, parturition and nursery grounds

Pups of *M. mustelus* are born at a size of 34–42 cm in the Mediterranean (Saidi *et al.*, 2008) and 36 to 45 cm off Senegal (Capapé *et al.*, 2006). Pups are taken in trawl surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas. Most of the records for *M. asterias* pups recorded in UK beam-trawl surveys are from the southern North Sea (IVc), parts of the English Channel and Bristol Channel (VIIf) (Ellis *et al.*, 2005).

Recent biological studies have indicated that full-term pups range in size from 205–329 mm L_T and pup size was positively correlated with maternal length (McCully Phillips and Ellis, 2015 WD; Figure 21.8). The smallest free-swimming neonate reported in 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 21.9), indicating either protracted spawning or asynchronous parturition for the stock as a whole (McCully Phillips and Ellis, 2015 WD).

Studies on other species of smooth-hound have shown high site fidelity of immature individuals on nursery grounds (Espinoza *et al.*, 2011).

21.7.3 Age and growth

Farrell *et al*. (2010a) studied the age and growth of *M. asterias* in the Celtic Seas ecoregion. Growth parameters for males (n = 106) were L_∞ = 103.7 cm L_T, L_0 = 38.1 cm, k = 0.195 $year^{-1}$). Growth parameters for females (n = 114) were (L_∞= 123.5 cm L_T, L_0= 34.9 cm, k = 0.146 $year^{-1}$). Estimates of longevity were 13 years (males) and 18.3 years (females).

Age and growth of *M. mustelus* has been studied in 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.

The length–weight relationship of *Mustelus* spp. caught during the Cefas tagging programme, 2000–2010 is illustrated in Figure 21.10.

21.7.4 Reproductive biology

Studies in the Celtic Seas ecoregion had indicated that the total length (and age) at 50% maturity for male and female *M. asterias* are 78 cm L_T (4–5 years) and 87 cm L_T (six years), respectively (Farrell *et al*., 2010b). Studies of *M. asterias* primarily from the southern North Sea and English Channel estimated 50% maturity for male and females at ca. 70 cm L_T and 82 cm L_T respectively (McCully Phillips and Ellis, 2015 WD; Figure 21.11).

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), and there may also be a resting period of a year between pregnancies, giving a two year reproductive period. However, within mature female fish sampled by McCully Phillips and Ellis (2015 WD), seventeen late gravid females with term pups (uterine fecundity 4–20) were also found to have numerous mature follicles (n = 6–22; follicle diameters 6–10 mm). This indicates that the reproductive cycle is likely to extend beyond one year, and coupled with the extended parturition periods (Section 21.7.2) either protracted spawning or asynchronous parturition for the stock as a whole also occurs. Further studies are required to confirm or reject this hypothesis, including more samples of fish from winter and spring.

The smallest mature female that Farrell *et al*. (2010a) reported was 83 cm; a lot larger than the smallest female (69 cm L_T; summarised below) recorded by McCully Phillips and Ellis (2015 WD). This is interesting, as the two studies use slightly different maturity keys, with Farrell *et al*. (2010a) assigning a female to be mature when oocytes were present, yellow, and countable at >3 mm in diameter, whereas Cefas maturity keys (Table I of McCully Phillips and Ellis, 2015 WD), which are comparable to those keys developed within ICES, assign a female as mature when the oocytes are slightly larger (>5 mm).

Total length-(cm) at-maturity estimates for starry smooth-hound (McCully Phillips and Ellis, 2015 WD):

	FEMALE	MALE
Smallest mature	69 cm	65 cm
50% maturity	81.9 cm	70.4 cm
Largest immature	87 cm	74 cm

The number of mature follicles ranged from 0–28 in the mature females. 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 ranged from 4–20, which exceeds the maximum uterine fecundity (18) found by Farrell *et al*. (2010a); however they stated 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. Uterine fecundity increased with total length (Figure 21.12). Furthermore there were also positive linear relationships identified between maternal length and average pup length and weight (Figure 21.8).

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), with fecundity increasing 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.

Studies on *Mustelus mustelus* in the Mediterranean 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.

21.7.5 Movements and migrations

Although the movements and migrations of smooth-hounds are not fully known, there have been relatively high numbers of *Mustelus* spp. tagged and released during various other elasmobranch research programmes in the UK (Burt *et al*., 2013 WD; Figure 21.13). The Sportvisserij Nederland and IMARES angler-led tagging programme reported 15 returns in 2013, from 746 smooth-hounds (Figure 21.14), with many more returns now available, these data on movements and distribution could usefully be updated in the future.

21.7.6 Diet and role in ecosystem

Mustelus spp. are primarily carcinophagous, predating on various crustaceans, including hermit crabs (Paguridae), stomatopods, brachyuran crabs, squat lobsters and shrimps, with teleosts occasionally eaten by larger individuals (Ellis *et al*., 1996; Morte *et al*., 1997; Jardas *et al*., 2007; Santic *et al*., 2007; Saidi *et al*., 2009; Lipej *et al*., 2011; McCully and Ellis, 2014). They can be important predators of commercial crustaceans, feeding on velvet swimming crab *Necora puber* and small edible crab *Cancer pagurus.*

21.7.7 Conversion factors

The relationship between total length and weight in the smooth-hounds sampled by sex and maturity stage are summarised below and in Figures 21.15 and 21.16 (McCully Phillips and Ellis, 2015 WD). The relationship for males differs slightly to that of females, largely driven by the larger maximum length of females and the weights of females about to give birth. Of note is the 119 cm outlier, which related to 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 from commercially landed specimens. Smooth-hounds are traditionally landed for the market gutted, and so conversion factors to length is also a useful parameter to augment data collected during market sampling programmes.

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 (incliding 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

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 may be applied to European species when relevant data are available.

21.8.2 Data exploration and preliminary assessments

Although no modelling or quantitative stock assessments have been undertaken, trends in relative abundance have been used to inform on current status (see Section 21.6).

21.9 Stock assessment

No quantitative stock assessment has been undertaken. The stock is evaluated on the basis of abundance trends in fishery-independent trawl surveys, as these are the longest time-series of standardised data available for the stock (Figure 21.17).

The abundance trends of the long-term time-series of six different surveys covering a large proportion of this species' distribution range consistently show an increase, which has been substantial in recent years.

Of the six surveys providing an individual survey index, four reported a mean annual cpue for 2013–2014 ranging from 40–56% above that seen in the preceding five years (2008–2012). These indices were standardised, and a mean index calculated using four different surveys, providing a 22-year standardised time-series. This gave a mean annual cpue for 2013–2014 of 2.3 ind.h^{-1}, which was a 33% increase from the preceding five years (2008–2012).

The Irish Groundfish Survey was excluded from the mean standardised survey index, as it did not begin until 2003, and thus by excluding this, and utilising the other five surveys, enabled a 22-year index to be calculated, thus informing on the interpretation of longer-term trends in relative abundance. However, this survey provides important supporting information and shows a similar increase in abundance for the north-western part of the stock area.

The EVHOE survey was also excluded from the mean standardised survey index, as again, it would reduce the time-series down to 18-years and thus hamper interpretation of longer term trends in abundance. Furthermore, three years of this survey had either missing or zero catch data, which need verification. However, this survey provides important supporting information, especially for the southern area (ICES Area VIIIabd) of the stock distribution (Figure 21.18). Although catch rates in 2013 and 2014 were at a low level for the time-series, the distribution of this species remains consistent and the proportion of hauls where smooth-hounds were present are at a high level for the time-series.

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 survey were plotted over the 18-year time-series (Figure 21.18). The number of stations catching smooth-hounds increased over the survey, however, the distribution of the catches has remained constant, occurring northwards of 46°N. There is no evidence from this survey to support the theory of a northward shift in the distribution, suggesting it is plausible that the recent increase in catch rates are a result of population growth.

21.11 Reference points

No reference points have been proposed for this stock.

21.12 Conservation considerations

The most recent IUCN Red List Assessment for European marine fishes (Nieto *et al.*, 2015) upgraded all three *Mustelus* spp. identifying them as increasing conservational importance. They are now listed as Near Threatened (*M. asterias*; previously Least Concern), and Vulnerable (*M. mustelus*; previously Least Concern and *M. punctulatus*; previously Least Concern).

21.13 Management considerations

Smooth-hounds appear to be increasing in relative abundance in trawl surveys, and also in commercial landings data. Given the potential expansion in fisheries for smooth-hounds (which may reflect an increased abundance and that fishing opportunities for *S. acanthias* are limited), further work to understand the dynamics of this stock is required.

It should be noted that smooth-hounds taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and subadults (<70 cm L_T), and these were nearly all discarded, as were smooth-hounds <50 cm L_T in the otter trawl fishery (Figure 21.2). Discard mortality is not known, and nor is the proportion of recruits that may survive to maturity and marketable size. Discard survival within this family is variable (Ellis *et al*., 2014 WD). Further studies on the mortality and survival rates of juveniles in these fisheries are needed to evaluate impacts on recruitment.

Smooth-hounds are also an important target species in some areas for recreational fisheries; though there are 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 used for their appropriate management.

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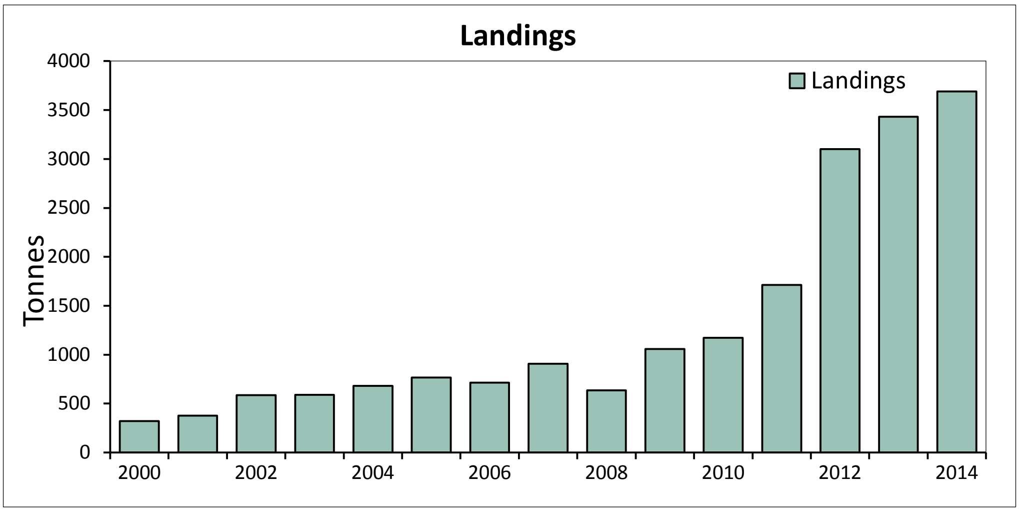
Table 21.1. Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1973–2014. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the northwestern African waters.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	
France	0	0	0	0	0	0	32	0	0	222	218	66	143	167
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	-
Portugal	.	.	.	.	.	.	.	.	.	.	.	.		-
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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													
France	119	64	117	126	93	90	102	138	145	228	187	197	0
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	
Portugal													
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0
	119	64	117	126	93	90	102	138	145	228	187	197	0

Table 21.1. (continued). Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1973–2014. These data 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 northwestern African waters.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	8	10	1
France	306	377	585	589	682	767	714	908	522	926	969	706	2695	2955	2825
Netherlands	.	.	.	.	.	.	.	.	.	.	8	3	11	20	15
Portugal	.	.	.	.	.	.	.	.	.	.	.	35	42	41	187
Spain	.	.	.	.	.	.	.	.	.	.	34	48	9	83	14
UK -E, W & NI	14	0	0	0	0	0	0	0	115	132	161	919	337	323	647
UK - Scotland	0	0	0	0	0	0	0	0	0	1	0	-	-	-	-
	320	377	585	589	682	767	714	908	637	1059	1172	1712	3101	3433	3690



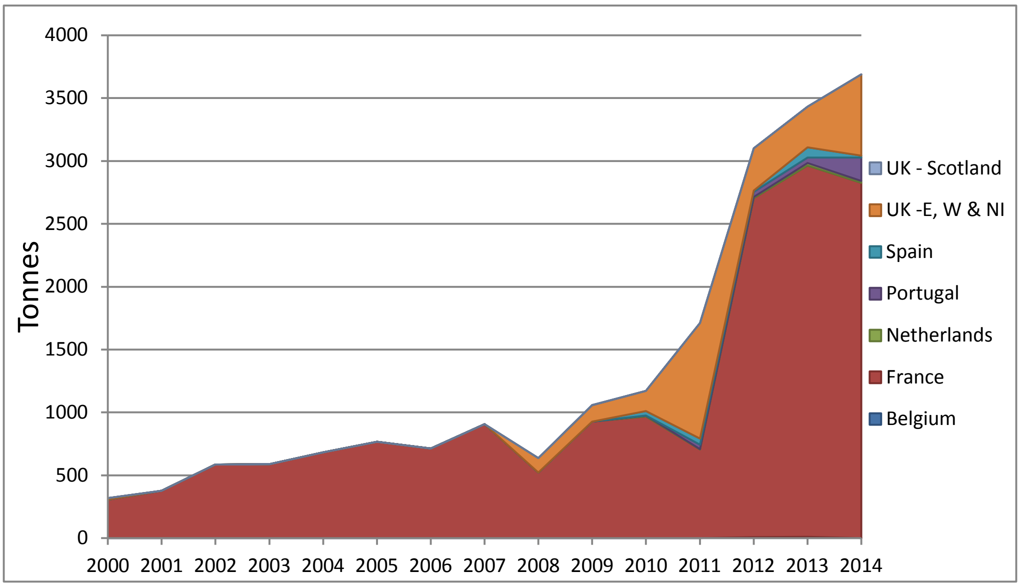
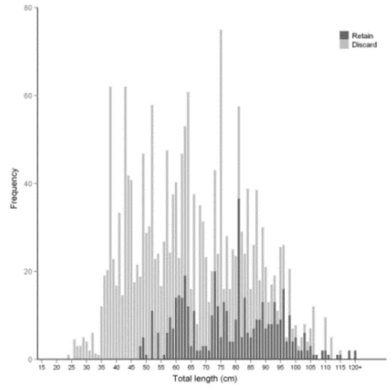


Figure 21.1. Smooth-hounds in the Northeast Atlantic. Working Group estimates of overall *Mustelus* spp. landings (top) and by country (bottom), 2000–2014. Data are considered underestimates.

A



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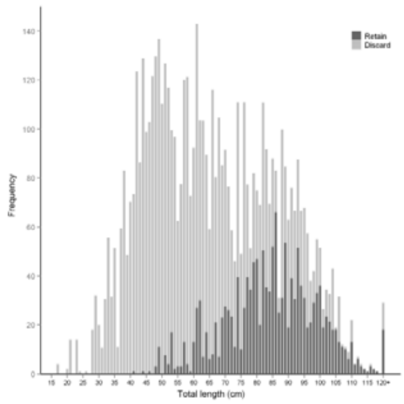

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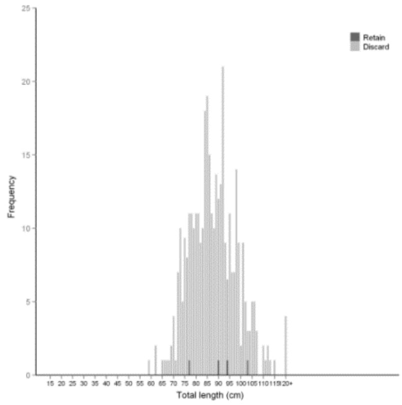

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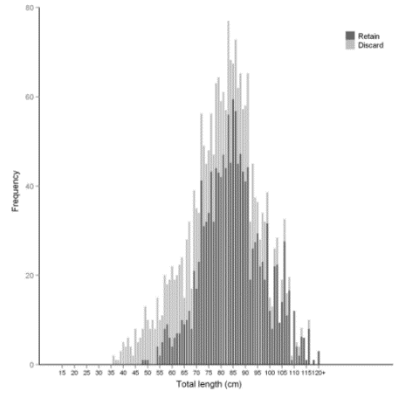

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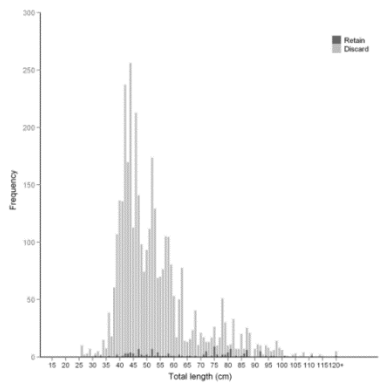

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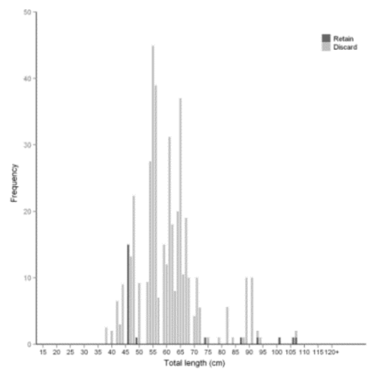


Figure 21.2. Smooth-hounds in the Northeast Atlantic. Length–frequency of discarded (pale grey) and retained (dark grey) smooth-hounds *Mustelus* spp. by (a) otter trawl (2002–2005), (b) otter trawl (2006–2011), (c) gillnet (2002–2005), (d) gillnet (2006–2011), (e) beam trawl (2002–2011) and (f) *Nephrops* trawl (2002–2011), as recorded in the Cefas observer programme. Data aggregated across ecoregions (Source: Silva *et al.*, 2013 WD).

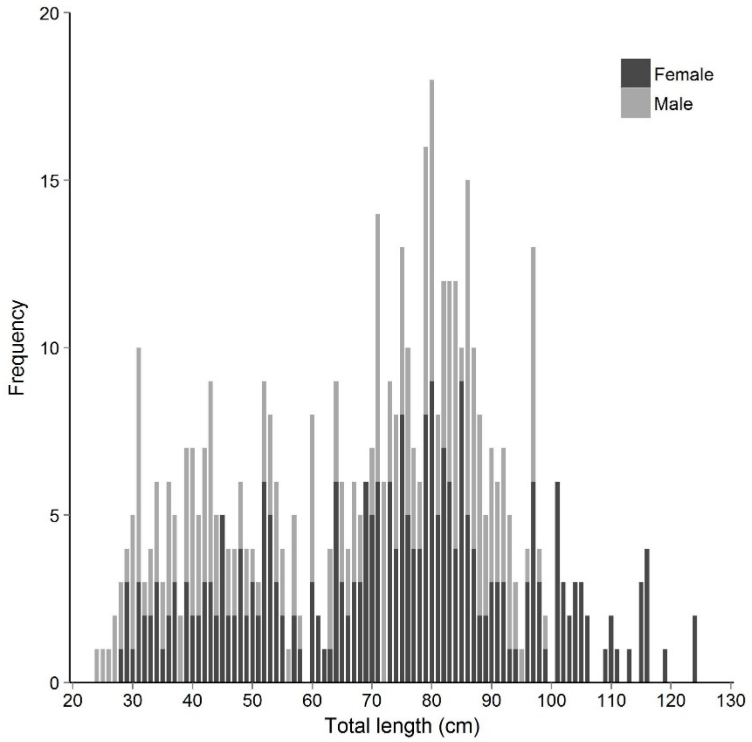


Figure 21.3. Smooth-hounds in the Northeast Atlantic. Number of starry smooth-hounds (n=504) biologically sampled by length and sex. Source: McCully Phillips and Ellis (2015 WD).

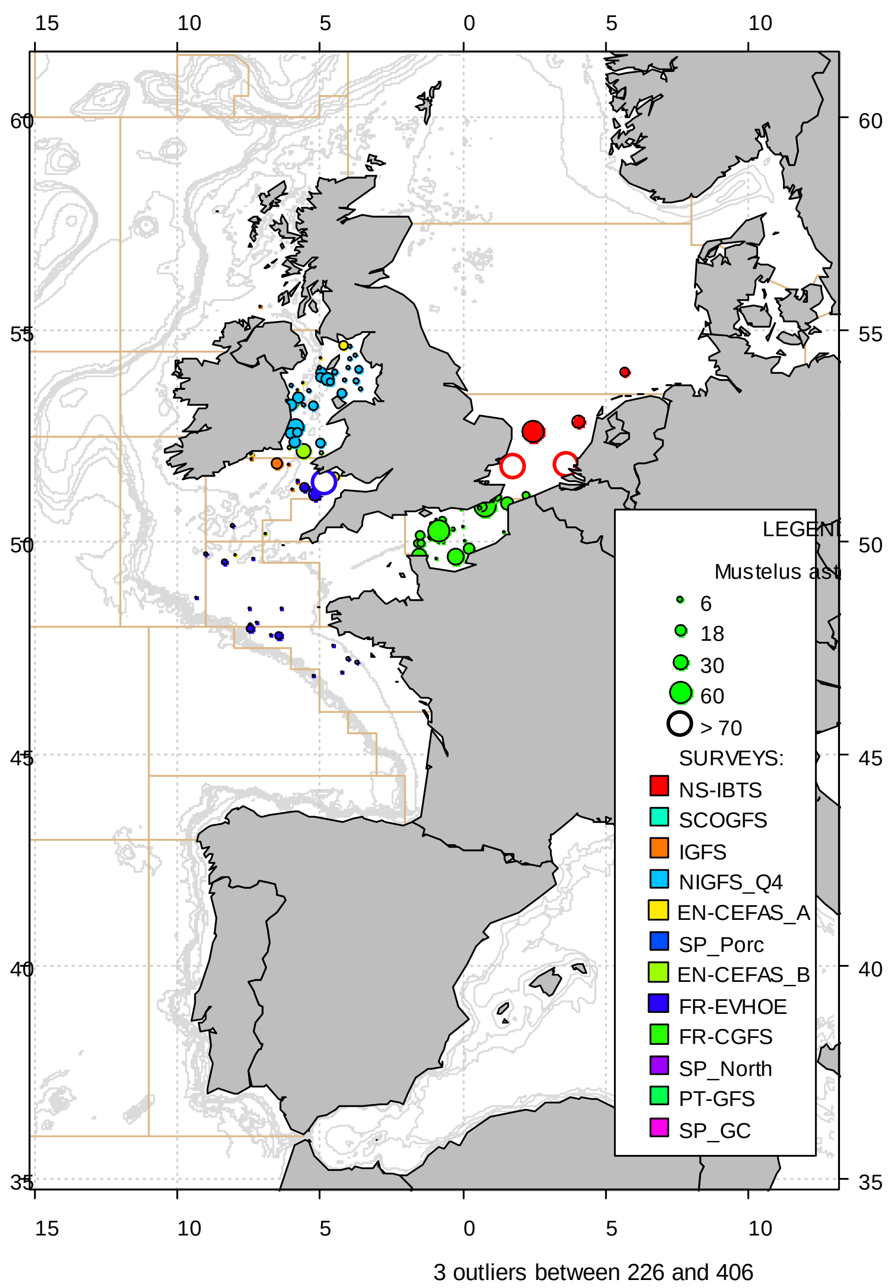


Figure 21.4a. Smooth-hounds in the Northeast Atlantic. Captures of *Mustelus asterias* as reported in the 2011 IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey. Source: ICES (2012).

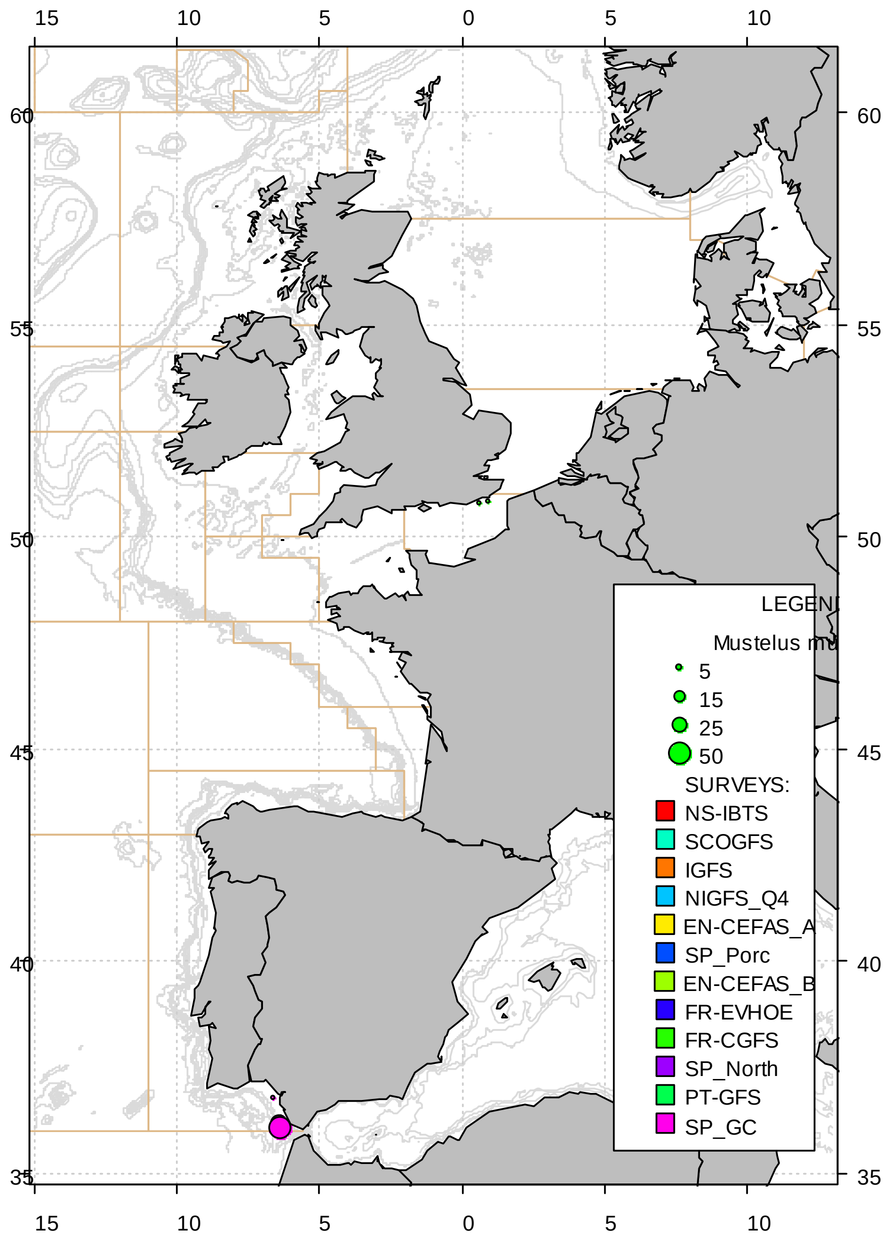


Figure 21.4b. Smooth-hounds in the Northeast Atlantic. Captures of *Mustelus mustelus* as reported in the 2011 IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey. Source: ICES (2012).

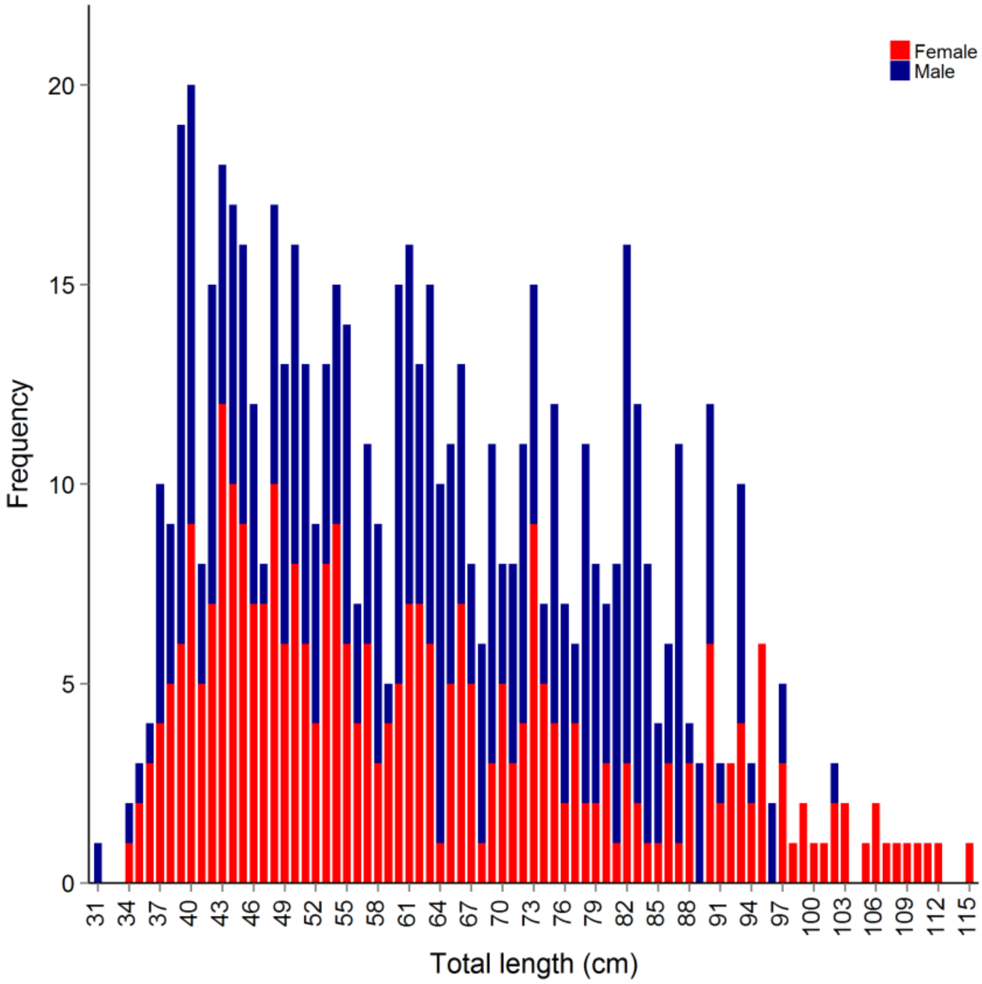


Figure 21.5. Smooth-hounds in the Northeast Atlantic. Length–frequency by sex of smooth-hounds *Mustelus* spp. From the UK Western Channel Q1 Beam-trawl survey. Source: Silva *et al.* (2014 WD).

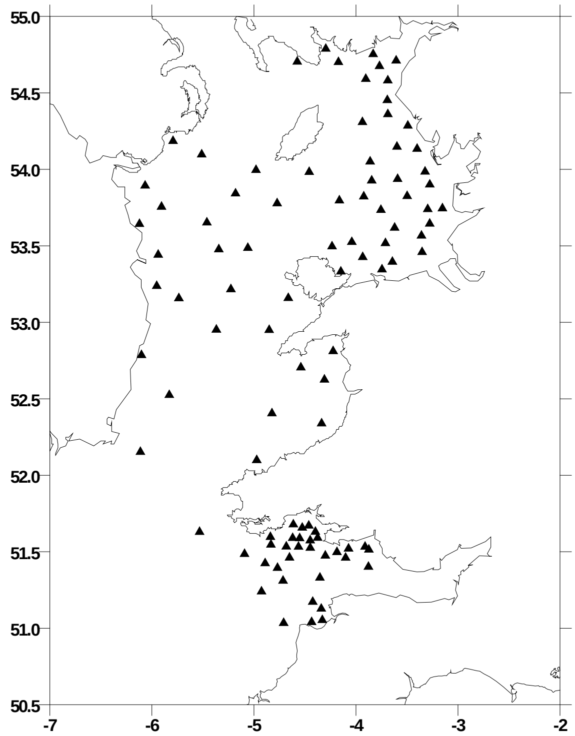


Figure 21.6. Survey grid of the Irish Sea and Bristol Channel, showing locations of fixed stations (n=97) sampled most consistently (1993–2014). Source: Ellis (2015 WD).

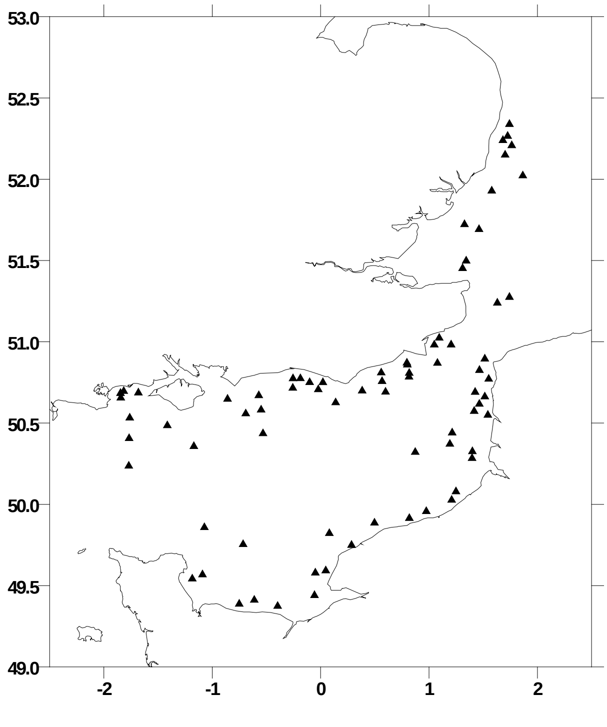


Figure 21.7. Survey grid of the eastern English Channel and southern North Sea, showing locations of fixed stations (n=76) sampled most consistently (1993–2014). Source Ellis (2015 WD).

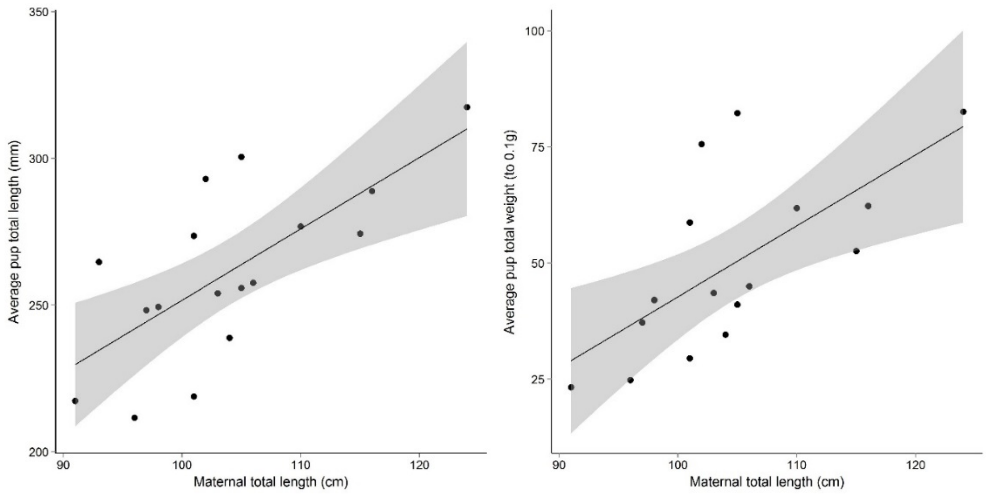


Figure 21.8. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and average length and weight of term pups. Source: McCully Phillips and Ellis (2015 WD).

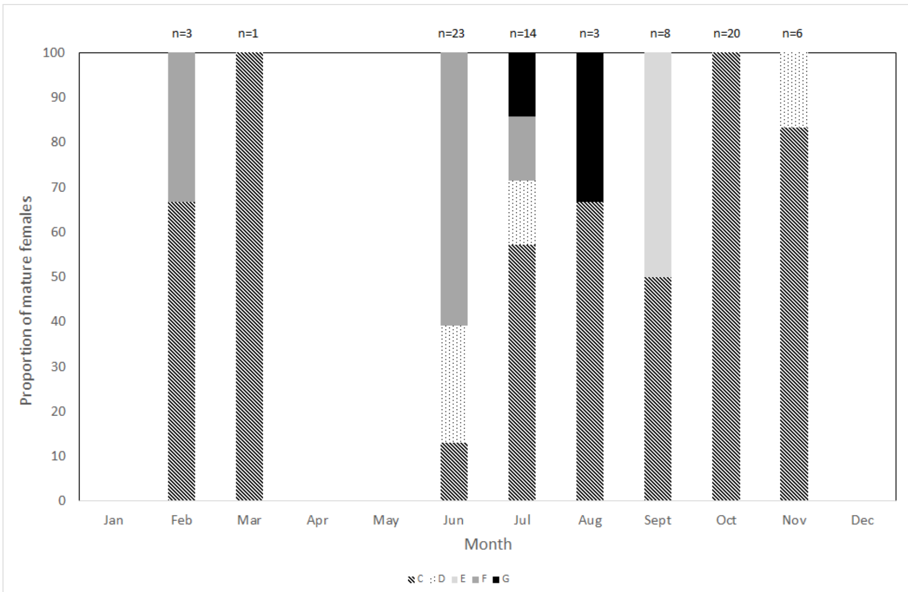


Figure 21.9. Smooth-hounds in the Northeast Atlantic. Percentage of mature females at each developmental stage (D: early gravid; E: mid-gravid; F: late gravid; G: post-partum) by month. Source: McCully Phillips and Ellis (2015 WD).

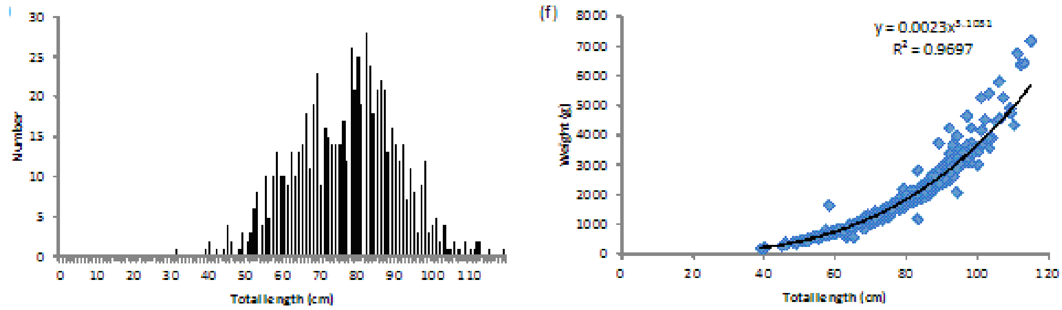
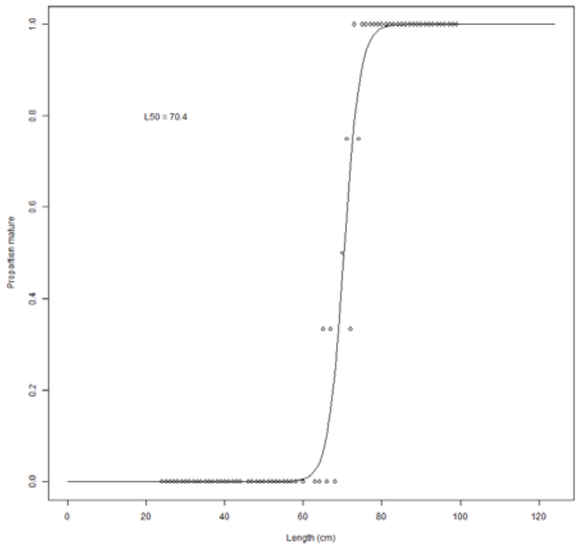


Figure 21.10. Smooth-hounds in the Northeast Atlantic. Length–frequency distributions of *Mustelus* spp. (n = 715), and the length–weight relationships for (*Mustelus* spp. (n = 508) tagged during the Cefas programme. Source: Burt *et al.* (2013 WD).



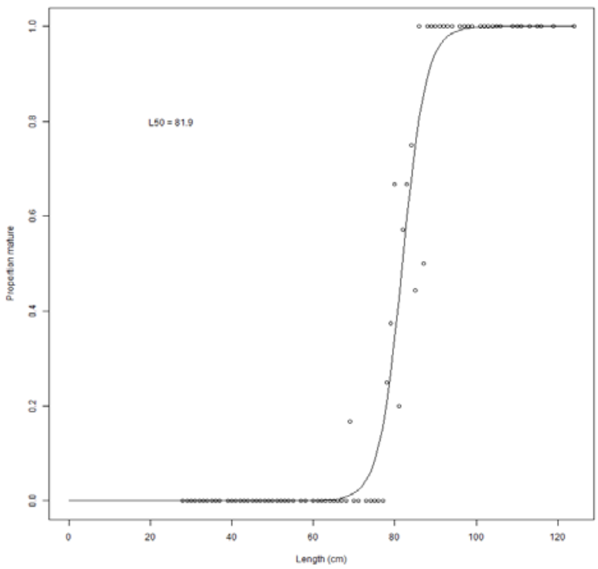


Figure 21.11. Smooth-hounds in the Northeast Atlantic. Maturity ogive for male (n= 237; L_{50} = 70.4 cm L_T) and female (n= 248; L_{50} = 81.9 cm L_T) *M. asterias*. Source: McCully Phillips and Ellis (2015 WD).

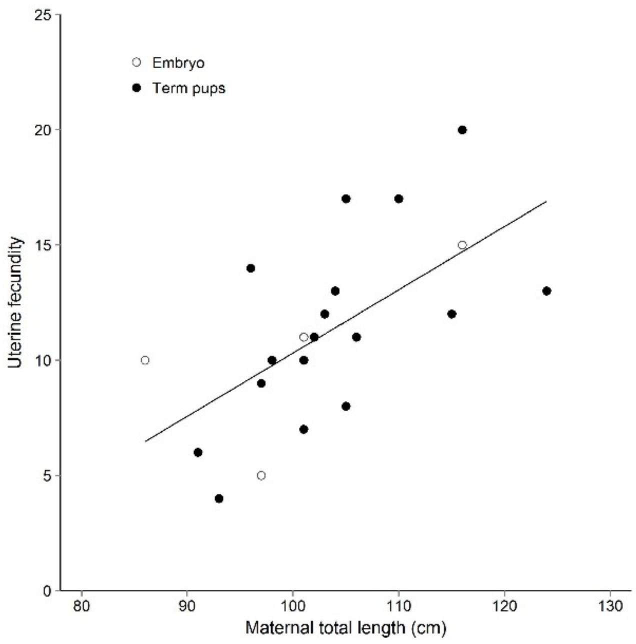


Figure 21.12. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and number of term pups produced. Source: McCully Phillips and Ellis (2015 WD).

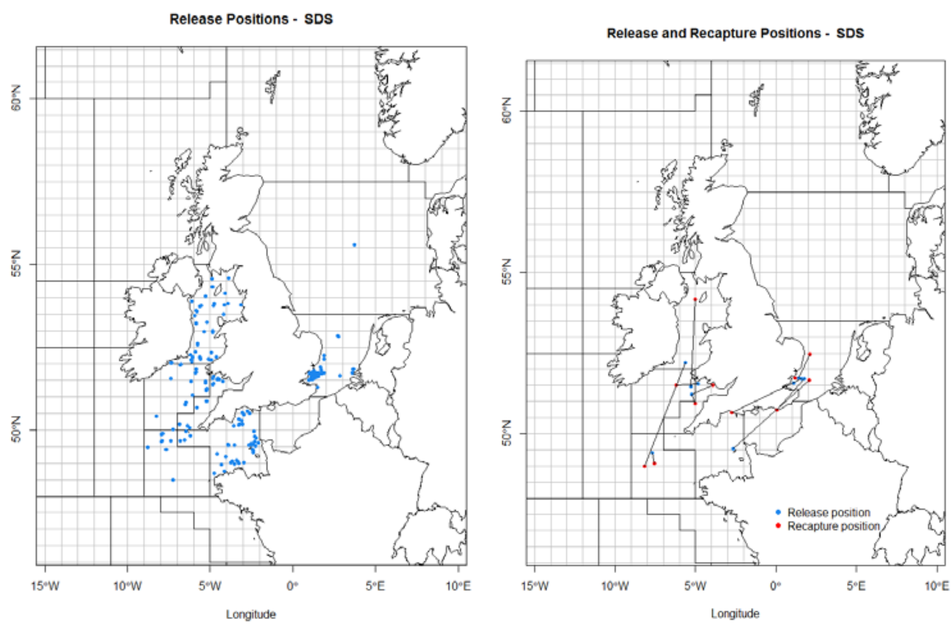


Figure 21.13. Smooth-hounds in the Northeast Atlantic. Locations of smooth-hound, *Mustelus* spp. (i) released and (ii) release and recapture positions for recaptured fish (2000–2013). Source: Burt *et al.* (2013 WD).

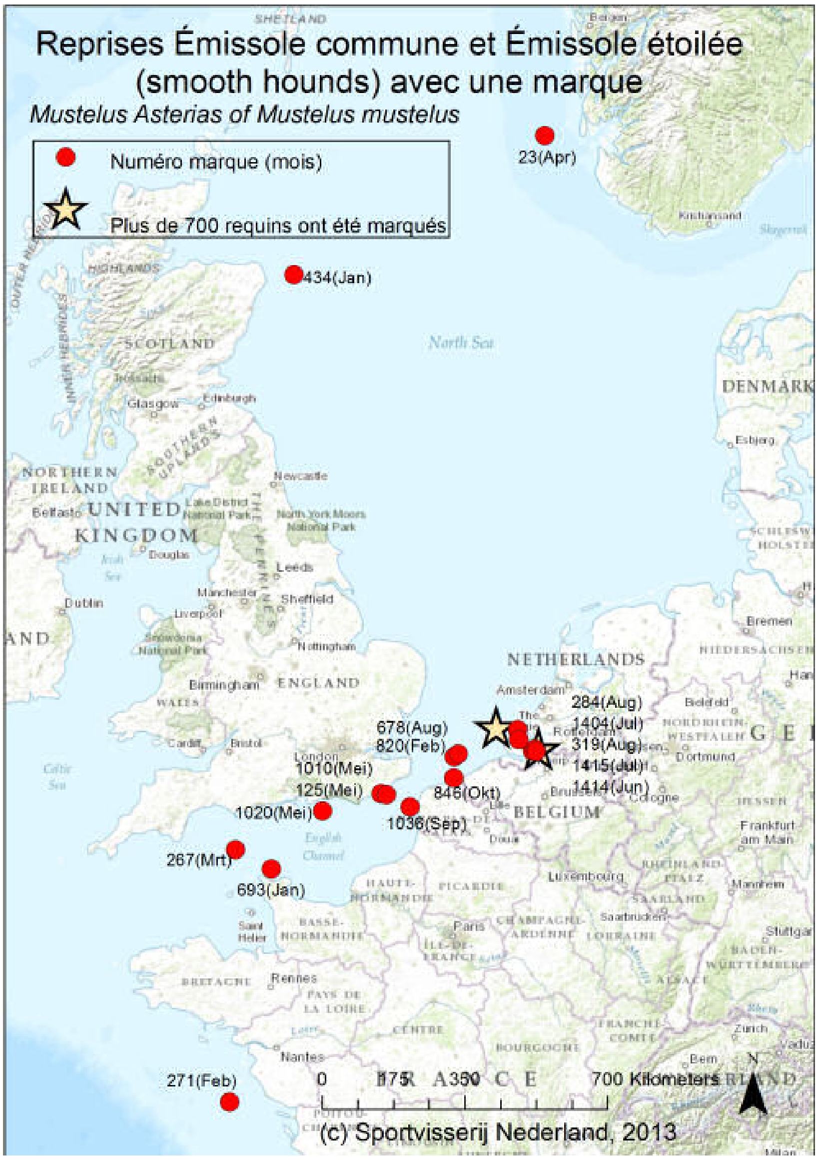


Figure 21.14. Smooth-hounds in the Northeast Atlantic. Recapture positions of smooth-hounds from the Dutch sport fishing tagging programme. Source: Niels Breve, Sportvisserij, Nederland.

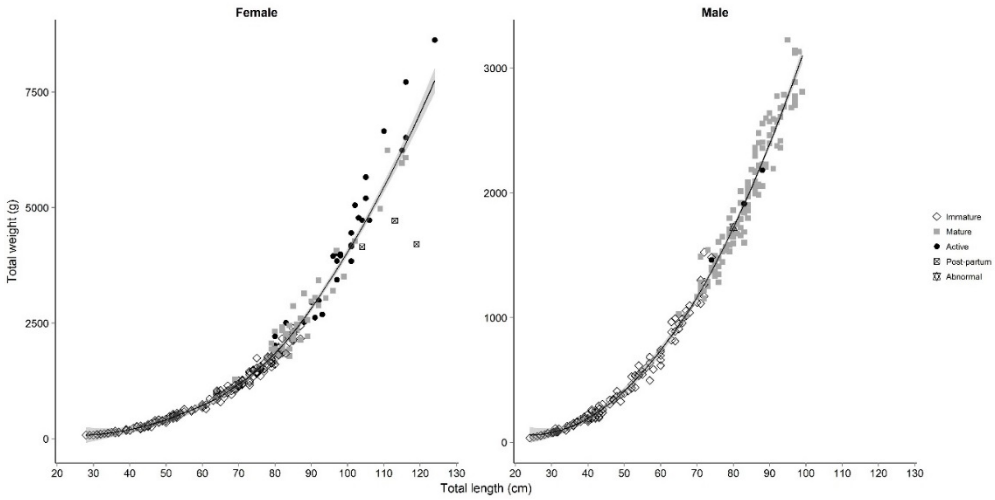


Figure 21.15. Smooth-hounds in the Northeast Atlantic. Length–weight relationship for female (n = 248) and male (n = 237) *M. asterias* by maturity stage (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015 WD).

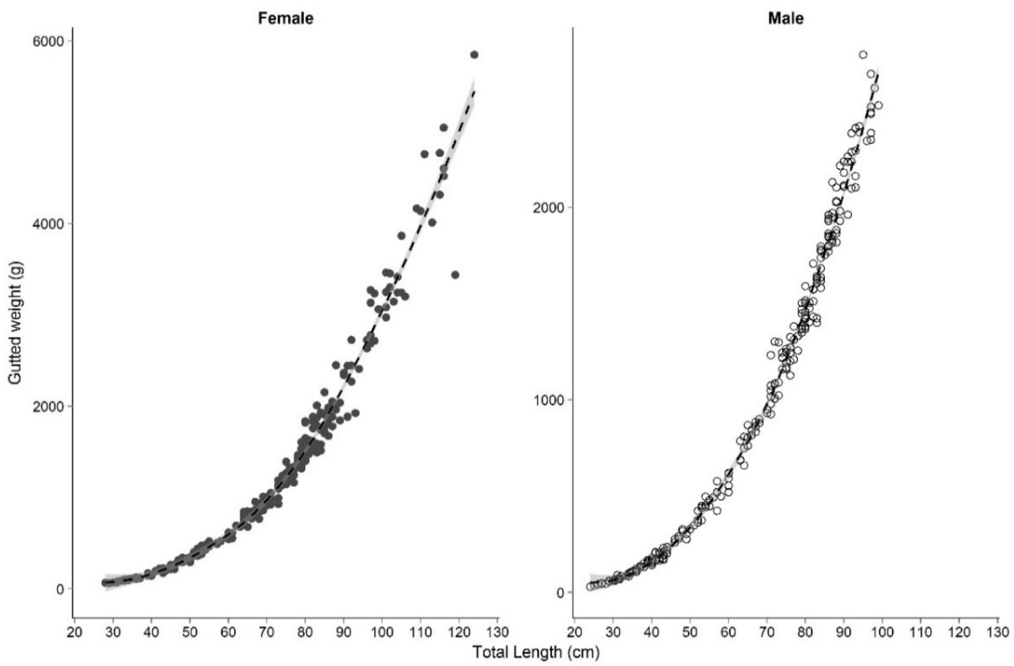
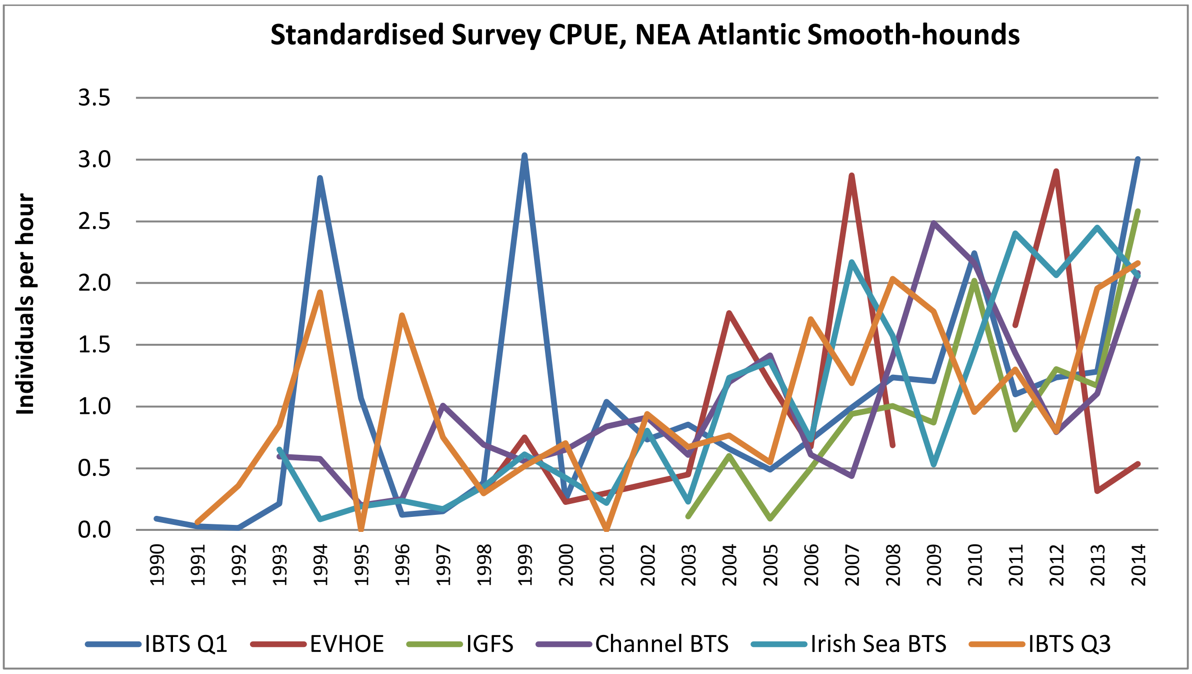


Figure 21.16. Smooth-hounds in the Northeast Atlantic.: Total length to gutted weight relationship for female (n = 249) and male (n = 235) *M. asterias* (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015 WD).



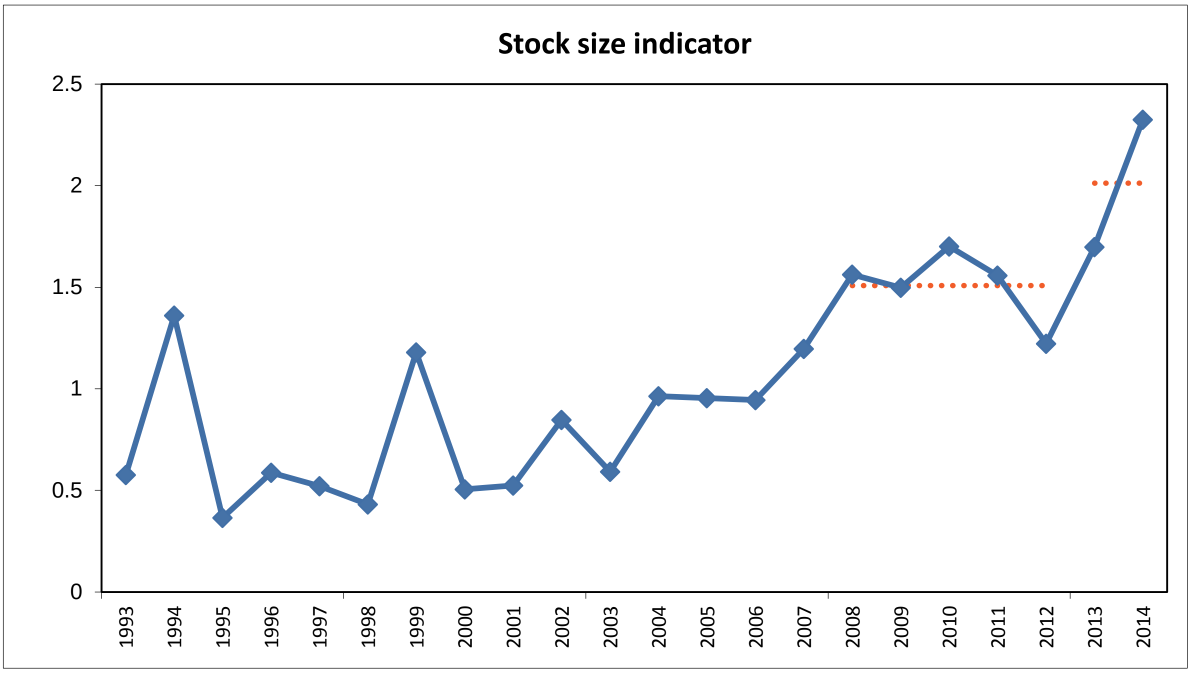


Figure 21.17. Smooth-hounds in the Northeast Atlantic. Individual standardised survey indices (top) and resultant overall stock size indicator of individuals per hour, using the mean standardised indices from four surveys (Q1 NSIBTS, Q3 NSIBTS, UK-7d-BTS and UK-7af-BTS; bottom).

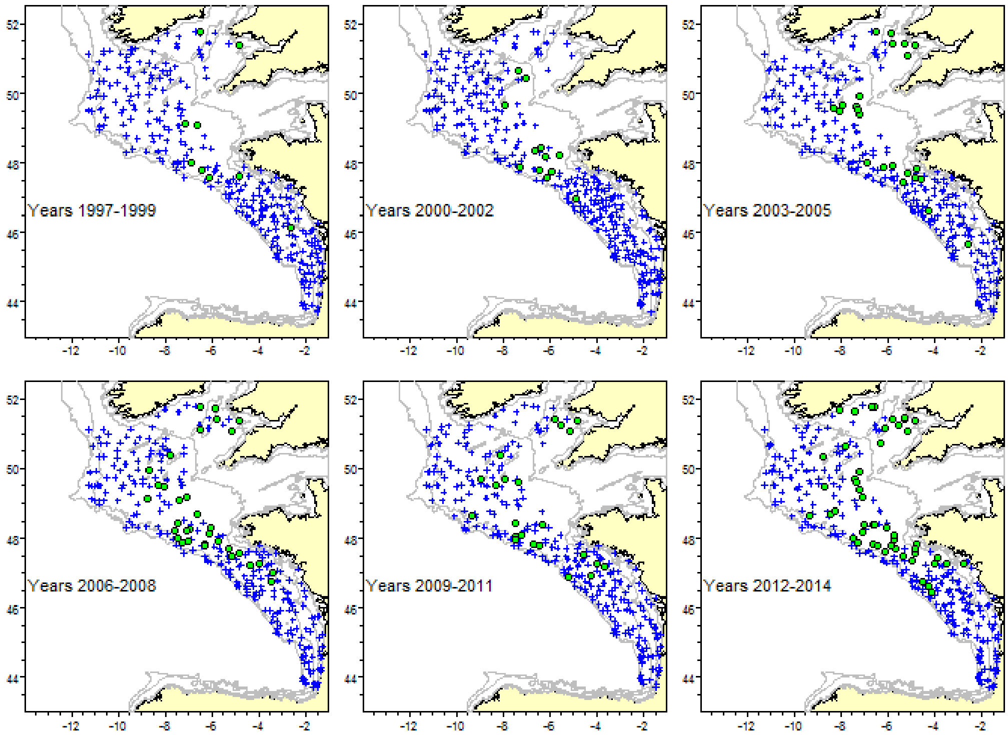


Figure 21.18. Smooth-hounds in the Northeast Atlantic. Distribution of *Mustelus* spp. in catches (green points *vs.* blue points for all sampling stations) in the Evhoe survey (1997–2014).

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, 1986). As such the species distribution covers parts of ICES Subareas IV and VI–IX.

The stock structure is not known, but available data for this and other species of angel shark indicate high site specificity and possibly localised stocks. Mark–recapture data for *S. squatina* have shown a high proportion of fish are recaptured from the original release location (Quigley, 2006), although occasional individuals can undertake longer-distance movements. Given that former populations in the southern North Sea and parts of the English Channel have not re-established 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 mixing (e.g. Gaida, 1997; Garcia *et al.*, 2015). STECF (2003) noted that angel sharks "*should be managed on smallest possible spatial scale*".

Given that this species is considered to be extirpated from parts of its North Atlantic range and highly threatened both in the ICES area and elsewhere in European waters, ICES provide advice at the species level.

Within earlier reports of the WGEF, information on angel shark was included within the more holistic chapters on the demersal elasmobranchs by ecoregion, but a dedicated chapter was introduced in 2014 (ICES, 2014).

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, including off 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.

22.2.2 The fishery in 2014

No new information, There are no target fisheries for angel shark and, although they may be a very occasional bycatch in some trawl and gillnet fisheries (Tully, 2011), these captures should be released.

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).

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 has subsequently been included on the list of Prohibited Species and it is prohibited for EU vessels to fish for, to retain on board, to tranship and to land angel shark in EU waters (Council Regulations (EC) 23/2010, 57/2011, 43/2012, 39/2013 and 43/2014, 2015/104).

Angel shark is also protected in UK waters as it is listed on the Wildlife and Countryside Act.

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). It is believed that the peak in UK official landings in 1997 from VIIj–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 estimated of landings. French landings declined from >20 t in 1978 to less than 1 t per year prior to the prohibition on landings.

Whilst some nominal records were available in French national landings data for 2012 and 2013, the reliability of these data is uncertain, due to the areas and quantities reported, and catch gears. Further analyses and clarification of these data are required, and as such they are not included here.

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 indicate that have been no reported angel sharks (Silva *et al.*, 2013), whilst observer trips conducted by the Sea Mammal Research Unit (SMRU) have 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) and were dead and, with estimated individual weights of 15–25 kg.

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.

22.3.3 Quality of catch data

Catch data are incomplete, as data are unavailable for the periods when angel shark were 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.

22.3.4 Discard survival

Limited data on the discard survival of angel shark caught in European fisheries. All three specimens observed by SMRU observers on tangle/trammelnet were dead, and soak times were 64–78 hours.

Other species have been studied elsewhere in the world. Fennessy (1994) reported at-vessel mortality of 60% for African angel shark *Squatina africana* caught in South African prawn trawlers. Braccini *et al.* (2012) reported at-vessel mortality of 25% for Australian angel shark *Squatina australis* captured in a gillnet fishery (where soak times were <24 hours).

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 the Irish Central Fisheries Board has been used by WGEF to inform on the status of angel shark (ICES, 2010).

The numbers of specimen fish caught by recreational fishers and reported to the specimen fish committee declined over the period 1958 to 2005 (Table 22.2), with an overall decline in the numbers caught also evident (Figure 22.2).

Other data from the Inland Fisheries Ireland (IRI) 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. Effort data for the recreational fisheries are not available.

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.

22.7 Life-history information

Limited life-history data are available (Table 22.3).

22.7.1 Habitat

Angel shark is a coastal species that has often been reported from sand bank habitats and other such topographic features. This ambush predator buries into the sand for camouflage. 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; Figure 22.3), 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). Angel sharks are thought to be nocturnally active (Standora and Nelson, 1977).

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 other angel shark species elsewhere in the world suggests that there may be an inshore migration in early sum, with parturition occurring during the summer.

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).

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 22.4; Wögerbauer *et al.*, 2014 WD). Occasional longer-distance movements have been reported, with fish tagged off Ireland recaptured off the south coast of England and 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 localised 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).

22.8 Exploratory assessment models

An exploratory stock assessment of the Tralee Bay (ICES Division VIIj) population, using data from the IFI Marine Sportfish Tagging Programme (see Section 22.5.1), was presented by Bal *et al.* (2014 WD). Following review, this model was updated in 2015 (Bal *et al.*, 2015 WD). Full details of the initial assessment are available in the 2014 report. The approach, results and a discussion of the current state of the assessment are summarised below.

22.8.1 Data used

The capture–mark–recapture database used is based on 1000 angel shark caught and released year round by recreational fisheries over the period 1970 to 2014. There were 164 individual recapture records, although some fish were recaptured several times (180 recaptures in total). Observed recaptures come from both recreational and commercial fisheries.

As the aim of this study was to get first estimates of the size of the population of angel shark off the southwest coast of Ireland, it was necessary to get estimates of capture efficiency and fish survival so as to used catch numbers (new catch plus recaptures) together with parameters to feed a population dynamic model. To reach this goal it was necessary for the data to have a discrete structure. Captures and recaptures that occurred from Mid-June to Mid-August were therefore considered for estimating population size. This period corresponds with the seasonal occurrence and is long enough to ensure having sufficient data for analyses. Fish first captured outside this period were used to help estimating survival and captures probabilities only, and did not enter population estimates. As capture data were from recreational anglers only, recapture data from other fisheries were used only to get information about the state of sharks through time (i.e. dead or alive, 78 recaptures). All fisheries besides recreational angling are assumed to result in dead removals from the stock. Nonetheless if a shark is caught during the reference period by a commercial fishery, it was considered as alive on the reference period and susceptible to being recaptured by angler. Fish with unknown recaptures gears were assumed to have been recaptured by anglers if the recapture date was between May and September and if the recapture location was near the Irish shore. Other unknown recaptures were assumed to correspond to commercial gears. The capture and recapture data used in the study are summarised in Figure 22.5.

22.8.2 Methodology

.8.2.1 Cormack-Jolly-Seber Model

.8.2.1.1 Generalities

To disentangle capture probability from survival probability, a Cormack-Jolly-Seber (CJS) model was applied to the capture–recapture data that can be summarized for each fish in capture-recapture histories.

The corresponding state–space model and data structures are summarized in Figure 22.6. State–space models are hierarchical models that decompose an observed time-series of observed response into a process (here, survival rate) and an observation error component (here, capture probability) (After Kery and Schaub, 2012).

In this exploratory assessment, the authors defined the latent variable $A_{i,y}$ which takes the value 1 if an individual *i* is alive and value 0 if an individual is dead year *y*.

Conditionally on being alive at occasion *y*, individual *i* may survive until occasion *y+1* with probability $\Phi_{i,y}(y = 1, ..., Y)$. The following equation defines the state process:

(1) $A_{i,y+1} \mid A_{i,y} \sim \text{Bernouilli}(A_{i,y} * \Phi_{i,y})$

The Bernoulli success is composed of the product of the survival and the state variable *z*. The inclusion of *z* insures that an individual dead remain dead and has no further impact on estimates.

If individual *i* is alive at occasion *y*, it may be recapture (*R*) with probability $p_{i,y}(y = 2, ..., Y)$. This can again be modelled as a Bernoulli trial with success probability $p_{i,y}$:

(2) $R_{i,y} \mid A_{i,y} \sim \text{Bernouilli}(A_{i,y} * p_{i,y})$

the inclusion of the latent variable *A* insures that an individual dead cannot be modelled again afterwards.

.8.2.1.2 Specific modelling

To allow for more flexibility, survival is assumed vary per year based on a random walk structure in the logit scale. Equation (2) is changed for the following equation starting on occasion 2:

(3) $A_{i,y+1} \mid A_{i,y} \sim \text{Bernouilli}(A_{i,y} * \Phi_y)$
$\text{logit}(\Phi_y) \sim \text{Normal}(\text{logit}(\Phi_{y-1}), \sigma_\Phi)$

with the following uninformative priors

$\Phi_1 \sim \text{Unif}(0, 1)$ and $\sigma_\Phi \sim \text{Unif}(0, 10)$

The capture probability of individuals as a fixed parameter in equation (1) thus change into the following equation:

(4) $R_{i,y} \mid A_{i,y} \sim \text{Bernouilli}(A_{i,y} * p)$

In the case of shark data, there is not always a well defined period of tagging and recapture, as recreational anglers can fish year round. On the other hand, the CJS approach needs the data to be discrete and a reference period over which the population is considered closed is necessary. Not to lose information coming from sharks first caught outside the reference period chosen, they were included in the model to get better estimates of survival and recapture probabilities. To do so, the first year survival is corrected by the deviation (*Δdᵢ*) between the date the individual *i* was captured at and the following 15th of July (i.e. middle of the reference period chosen):

(5)$\Phi_{i,1} = \Phi_1^{\Delta d_i / 365}$

.8.2.2 Deriving population size: the Jolly Seber approach

The best way of deriving population size estimates would be to add a third population dynamic components to the model described above and to fit the whole model in one go. This is called a Jolly Seber (JS) model (Kery and Schaub, 2012).

Focusing on untagged fish population sizes (for computation cost only), the population size (*N*) may be derived as follows for occasion 1:

(6) $C_1 \sim$ Binomial(p, N_1) with uninformative prior for $N_1 \sim$ Unif(0, 300 000)

Then a population dynamic can be built using the probability of survival coming from the CJS model described above together on top of the estimate of catch probability. For the occasions following occasion 1, with *S* referring to survivors from the previous occasion *N* and *E* the new entrants to the population, *N* is estimated as follows:

(7) $S_y \sim$ Binomial(Φ_y, N_{y-1})
$N_y = S_y + E_y$

The series of *E* is given a Gamma random walk prior structure (gamma distribution in jags are parametrised with shape (α) and rate (β)) to capture rather smooth evolutions. Starting on occasion 3, the following applies:

(8)$E_y \sim$ Gamma(α_{Ey}, β_{Ey})
$\alpha_{Ey} = E_{y-1} \times \beta_{Ey}$
$\beta_{Ey} = E_{y-1} / \sigma_y^2$

with the following uninformative priors

$E_2 \sim$ Unif(0, 300 000) and $\sigma_y \sim$ Unif(0, 30 000)

Trials made so far to fit the model in one go have been unsuccessful, revealing a mismatch between the CJS and dynamic parts of the model. This may be due to the fact that a fixed *p* for the whole time-series is not realistic.

As a consequence, population estimates are given in two ways:

a) The underlying population dynamics were neglected and *N* was derived in the Bayesian model using parameter *p* and the total number of sharks captured the corresponding year,

b) The CJS model was first fitted. Posteriors were then used as informative priors to sequentially fit the population dynamic model described above, breaking feedbacks between the two parts. The figures are provided for illustrative purposes only.

22.8.3 Computation details

Bayesian fitting, forecasting and the derivations were implemented using Markov Chain Monte Carlo algorithms in JAGS (Just Another Gibbs Sampler, Plummer, 2003; http://mcmc-jags.sourceforge.net) through the R software (R Development Core Team, 2013). Three parallel MCMC chains were run and 20 000 iterations from each were retained after an initial burn-in of 20 000 iterations. Chains thinning used equalled 5. Convergence of chains was assessed using the Brooks-Gelman-Rubin diagnostic (Gelman *et al.*, 2015).

22.8.4 Results

Results are composed of the following figures showing posterior density function of capture rate (Figure 22.7), yearly survival (Figure 22.8) and population size estimates from method a (Figure 22.9) and b (Figure 22.10).

22.8.5 Quality of the assessment

It is clear that the current population of angel shark around Ireland is very low compared to the whole historical time-series, although the actual population size remains uncertain, as shown by the scale difference coming from the two method used to infer population size (Figures 22.9 and 22.10). Nonetheless trends are robust and suggest an important decline starting in the 1980s.

Although some size and/or weight data were originally available, they were not considered in this study as they appeared unreliable.

For now, this approach has been unsuccessful in fitting a proper JS model in one go. Expert opinion on tagging and recapture effort may help by alleviating the fitting issues linked to some apparent mismatch between the CJS and population dynamic parts of the model. Additionally, this would result in a more realistic model with annual variations in both survival and capture probabilities. So far models are ready to do so. Information on the variability in fishing effort for commercial fisheries may also be included and should allow us to better differentiate natural survival variability from anthropogenic causes.

22.9 Stock assessment

Whilst no formal quantitative stock assessment has been undertaken, due to a lack of data, the WGEF perception of the stock is based largely on analyses of historical and contemporary trawl surveys.

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 were 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 (Table 22.4).

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. 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 (Gibson *et al.*, 2008), is listed on the OSPAR List of Threatened and Declining Species (OSPAR Commission, 2010) and is protected on the UK's Wildlife and Countryside Act.

22.13 Management considerations

Angel shark is thought to have declined dramatically in the northern parts of the ICES area and Mediterranean Sea, as evidenced from landings data, survey information and the decline in the numbers tagged in Irish waters. The status of angel shark and magnitude of any decline in the southern parts of the ICES area and northwest Africa remain uncertain.

Since ICES advised that this species should receive the highest protection possible, it has been listed as a prohibited species on European 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 with 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

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Table 22.1. Angel shark in the Northeast Atlantic. Reported landings (t) for the period 1978–2013. French landings from ICES and Bulletin de Statistiques des Peches Maritimes. UK data from ICES and DEFRA. Belgian data from ICES. UK landings for 1997 considered to be misreported fish.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	8	3	32	26	29	24	19	18.7	19.5	18	13
UK (E,W &N.I.)	.	.	.	.	.	.	.	.	.	.	.
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
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	9	13	14	12	11	2	2	1	1	1	1
UK (E,W &N.I.)	.	.	.	.	.	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	2005
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	2	1	2	+	1	+	+	+	+	+	2
UK (E,W &N.I.)	.	.	(47)	.	.	.	.	.	.	.	.
Total	2	1	2	0	1	0	0	0	0	0	2

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.
France	+	1	+	1	2	.	.	+	.
UK (E,W &N.I.)	+	+	.		+	+	.	.	0
Total	0	1	0	1	2	0	0	0	0

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 localised 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	$W = 0.0346.L^{2.7079}$ (n = 8)			Coull *et al.* (1989)
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 (1915) "*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]

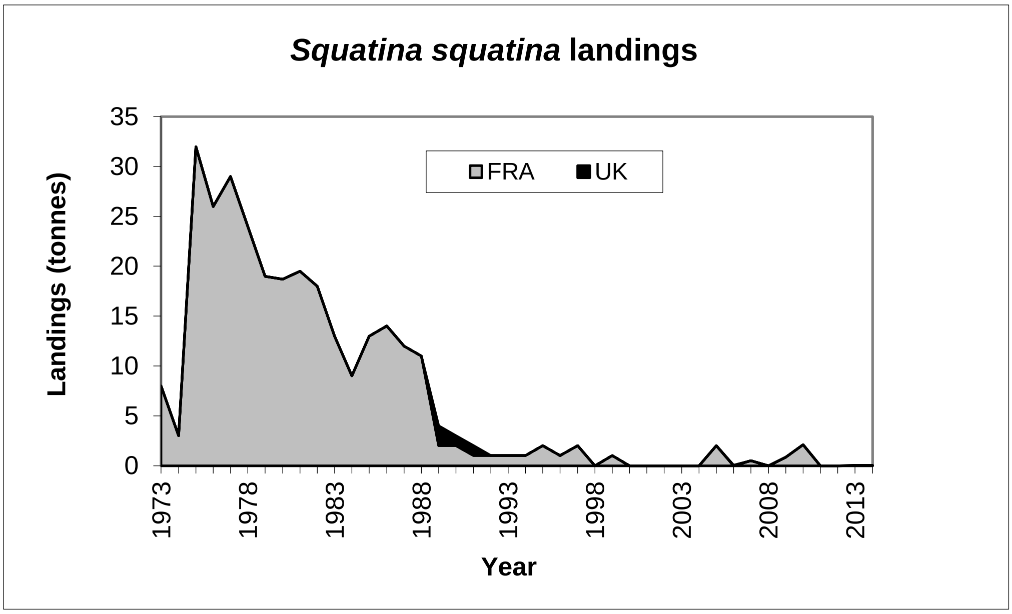

Figure 22.1. Angel shark in the Northeast Atlantic. Total landings of *Squatina squatina* (1973–2012). Angel shark has been listed as a non-retained/prohibited species on European fisheries regulations since 2009 and so this species is now reported very rarely in landing statistics.

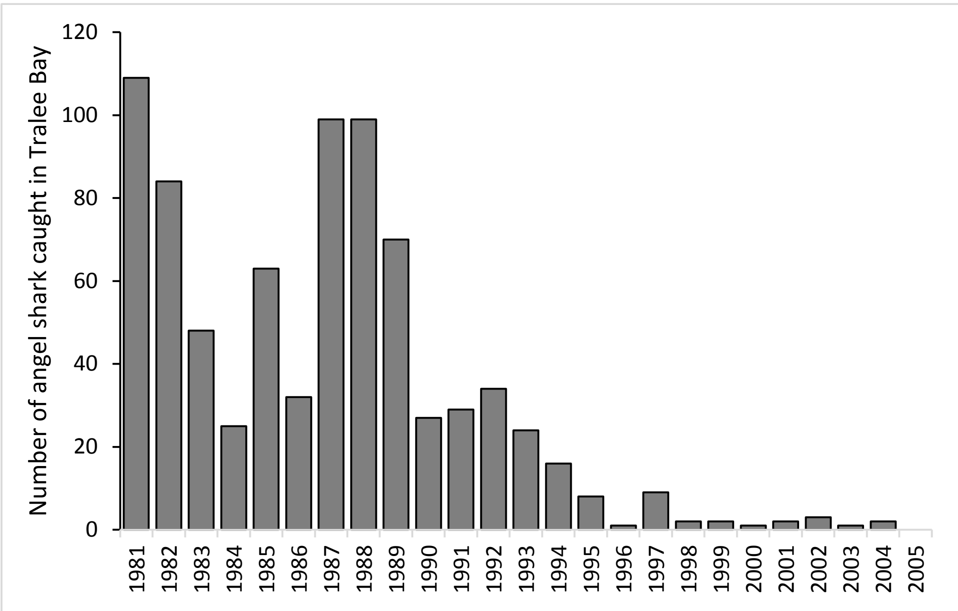

Figure 22.2. Angel shark in the Northeast Atlantic. Numbers of angel shark caught by two charter boats in Tralee Bay 1981–2005. Adapted from Irish Central Fisheries Board data presented in ICES (2008).

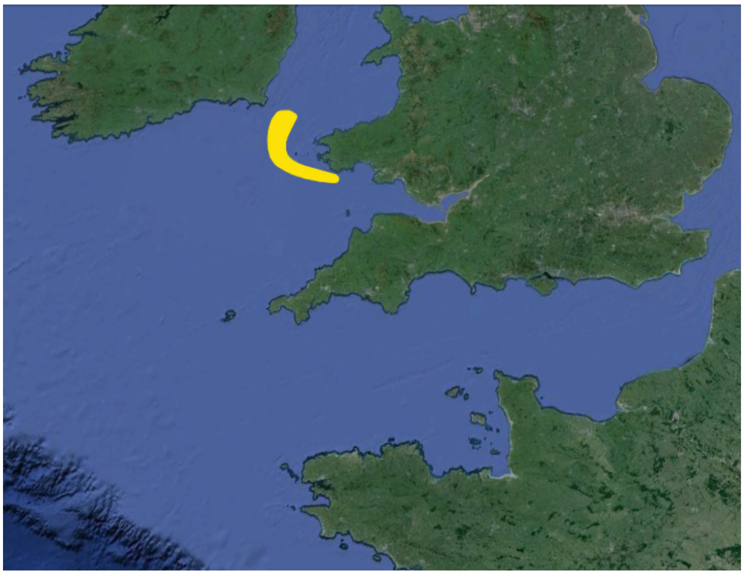

Figure 22.3. Angel shark in the Northeast Atlantic. The suspected over-wintering area off Pembrokeshire, where occasional individuals have been reported by French vessels.

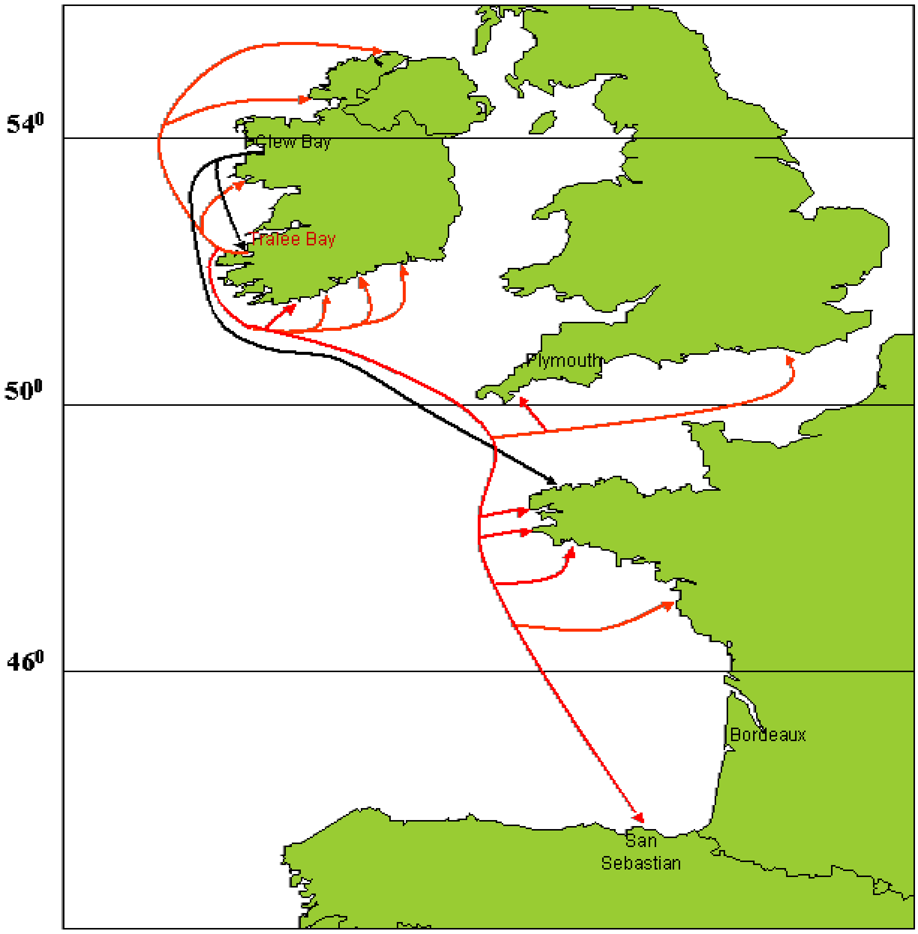

Figure 22.4. Angel shark in the Northeast Atlantic. Longer-distance movements of angel shark tagged off the west coast of Ireland, 1970–2006. Source: Irish Central Fisheries Board.

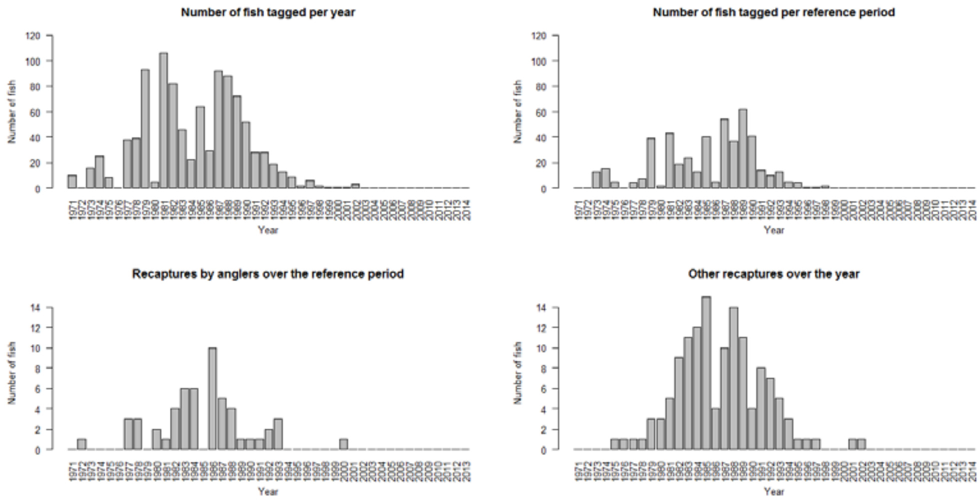

Figure 22.5. Angel shark in the Northeast Atlantic. Number of sharks captured, recaptured and newly captured per year, Tralee Bay. Source: Bal *et al.* (2014 WD).

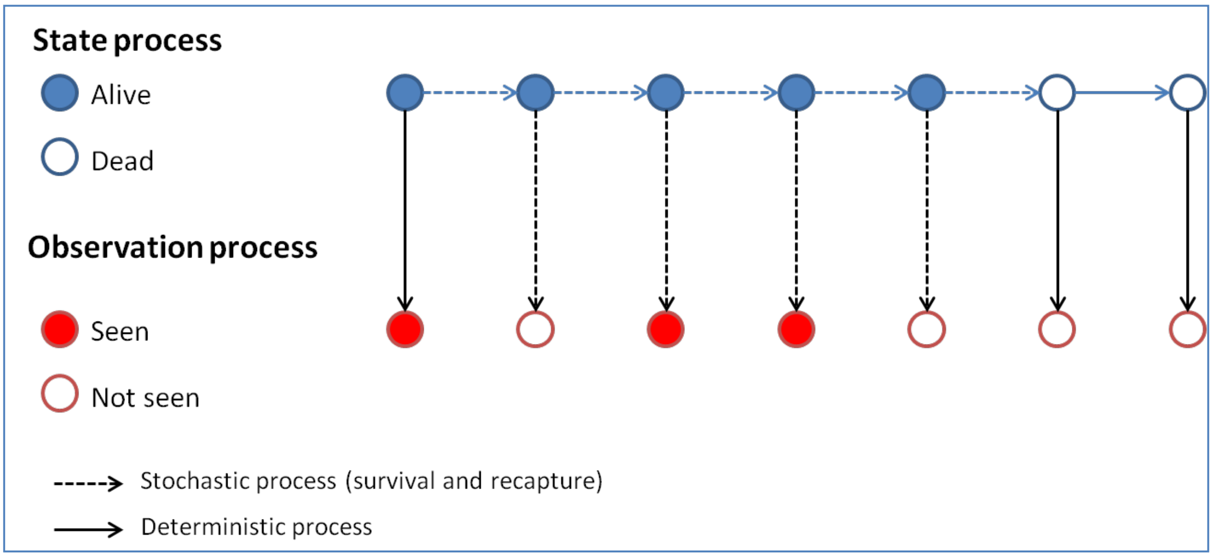

Figure 12.6. Angel shark in the Northeast Atlantic. Example of the state and observation process of a marked individual over time for the CJS model. The sequence of true states in this individual is A = [1, 1, 1, 1, 1, 0, 0] and the observed capture history is H = [1, 0, 1, 1, 0, 0, 0]. Source: Bal *et al.* (2015 WD).

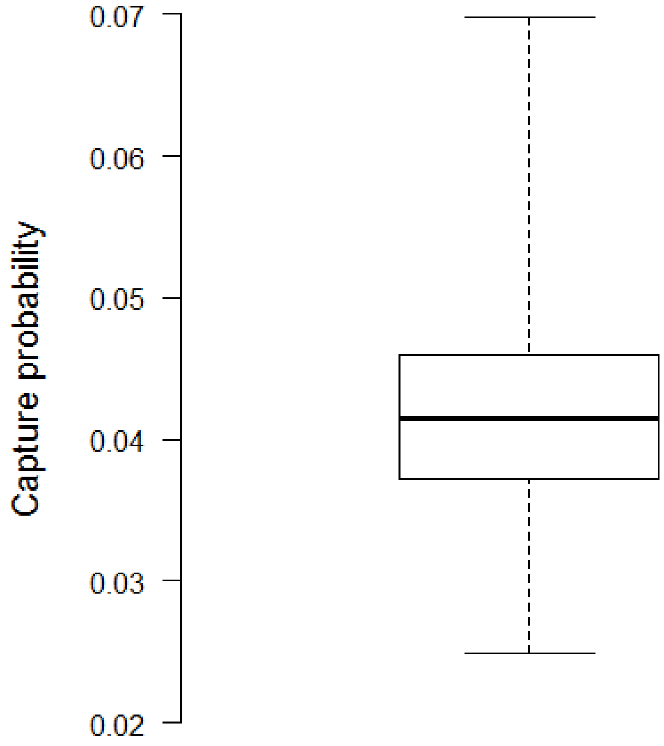

Figure 22.7. Angel shark in the Northeast Atlantic. Boxplot of the individual capture probability posterior. Source: Bal *et al.* (2015 WD).

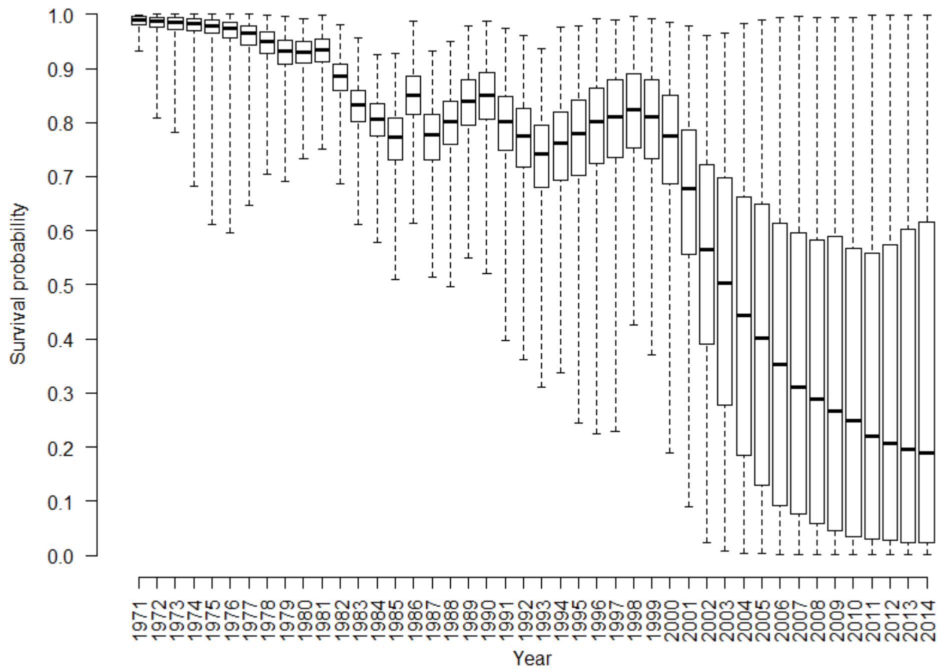

Figure 22.8. Angel shark in the Northeast Atlantic. Boxplot of annual survival probabilities posteriors. Source: Bal *et al.* (2015 WD).

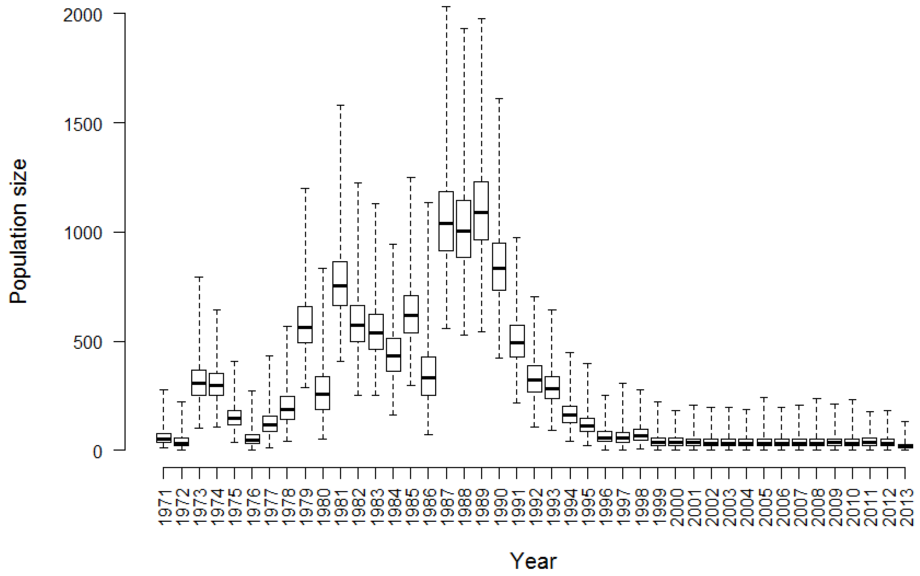

Figure 22.9. Angel shark in the Northeast Atlantic. Boxplot annual population sizes posteriors without population dynamics structure. Bal *et al.* (2015 WD).

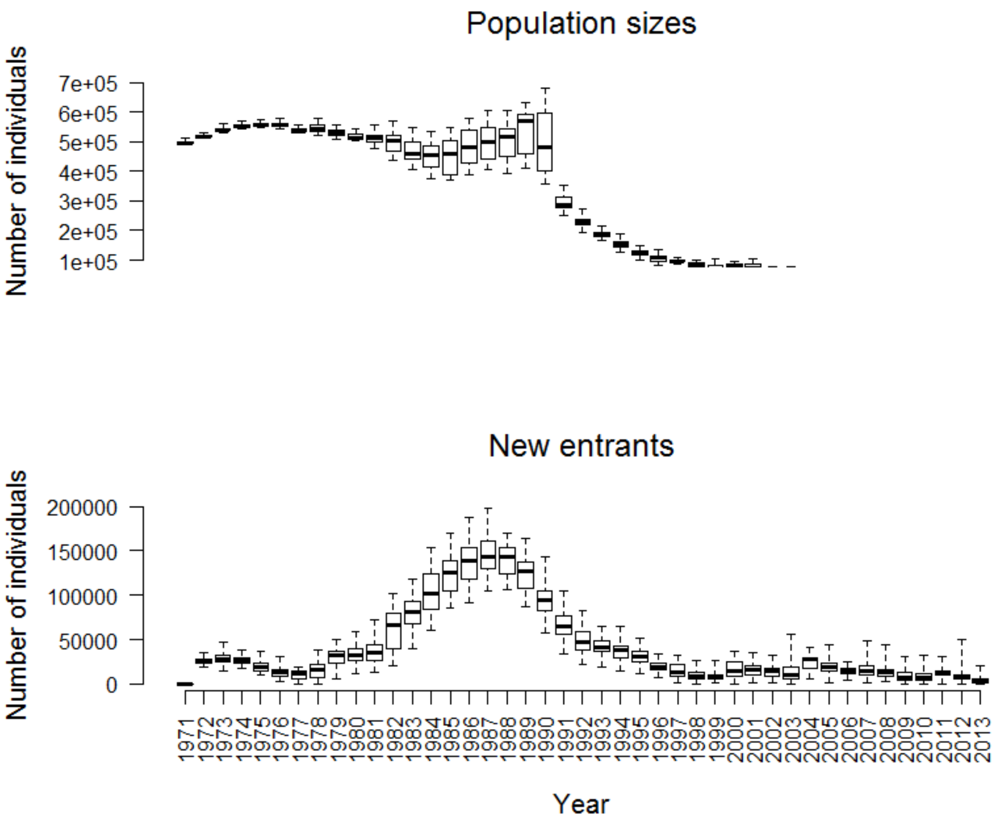

Figure 22.10. Angel shark in the Northeast Atlantic. Boxplot annual population sizes and number of entrants posteriors with population dynamics structure. Source: Bal *et al.* (2015 WD).

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 VII–IX, and may have extended into the southern parts of Subareas IV and VI. The stock structure within the overall distribution area is unknown. Given that this species is perceived as highly threatened throughout the ICES area (and elsewhere in European waters), and that data are extremely limited, ICES provides advice at the species level.

23.2 The fishery

23.2.1 History of the fishery

White skate is thought to have been the subject of targeted exploitation for much of the 19th century and early of the 20th century, 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 (see Ellis *et al.*, 2010).

In 1964, 59 t of white skates were landed in the port of Douarnenez (Brittany), as a result of a targeted longline fishery (Du Buit, pers. comm.). After this, the fishery collapsed along with the population. 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 2006–2007 sampling of large skates (*Dipturus* and *Rostroraja*) in French ports, it was observed that from 4110 skates sampled, only one specimen of white skate was identified (Iglésias *et al.*, 2010). Prior to white skate inclusion in the EU prohibited list, individuals were occasionally recorded in Portuguese landing ports (Serra-Pereira *et al.*, 2011).

23.2.2 The fishery in 2014

White skate may be a very occasional bycatch in some trawl and gillnet fisheries, although as a prohibited species the caught individuals should be released. There have been records of individuals fished in the English Channel (in 2013). As the species is largely unknown by fishermen and it does not have highly conspicuous morphological characters for its identification, individuals might occasionally be mixed with other skates.

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 minimise 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*".

23.2.4 Management applicable

Council Regulation (EC) 2015/104 states that it is prohibited for Union vessels to fish for, to retain on board, to tranship or to land white skate in Union waters of ICES Subareas VI, VII, VIII, IX and X. Council Regulation (EC) 2015/104 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 2010.

White skate is protected in UK waters, as it is listed on the Wildlife and Countryside Act.

23.3 Catch data

23.3.1 Landings

Nominal landings of white skate are contained within the relevant ecosystem chapters. White skate became increasingly rare in landings prior to the requirements for species-specific recording, and so there is great uncertainty on historical levels of exploitation. Some of the nominal landings reported for white skate are thought to refer to either other large-bodied skates (*Dipturus* spp.) or shagreen ray *Leucoraja fullonica*, as these species also have a pointed snout.

23.3.2 Discards

Limited data are available. Analyses of the discard observer programme for the English and Welsh fleets did not note any white skate (Silva *et al.*, 2012). In the Portuguese Pilot Study for Skates from a total of 20 fishing trips sampled, single specimens of white skate were recorded in two fishing trips on board trammelnet vessels, with these specimens 47 and -62 cm L_T. These two white skate were taken in an overall sample of 667 skates examined. There is uncertainty in the reliability of some nominal records of white skate recorded in other national observer programmes.

23.3.3 Quality of catch data

Both landing and discard data for white skate are very limited and may be confounded with other species.

Given the low abundance of this species and its high conservation interest, WGEF recommend that (i) any data on white skate collected from national observer programmes be verified whenever possible (e.g. photographed) and (ii) that ongoing DCF observer programmes collect information on health state (e.g. lively, sluggish, dead) of any discards of this species.

23.3.4 Discard survival

No data on the discard survival of white skate. Discard survival of skates has been examined for a range of other skate species, with survival potentially high in some fisheries (Ellis *et al.*, 2014 WD). 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-effort data

No data available.

23.6 Fishery-independent information

White skate 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 at the present time.

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, up to at least 2011. 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 Sea, where the smallest mature fish were 110 cm (male) and 120 cm (female). The youngest mature female in this study was reported as 17 years old and the oldest fish was thought to be 35 years old.

French fishers consider this species to live preferentially on hard bottoms, and so it may have been caught more frequently in setnets and longline fisheries (Iglésias, pers. comm).

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 primarily on comparisons between recent and historical data on catches in trawl surveys.

Historically, coastal trawl surveys around the British Isles reported white skate (Rogers and Ellis, 2000), whereas they have now disappeared from parts of their former range. Such longer-term declines in this species have also been 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

White skate is listed as Critically Endangered on the IUCN Red List (Gibson *et al.*, 2008). 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.

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.

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.

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24 Greenland shark *Somniosus microcephalus* in the Northeast Atlantic

24.1 Stock distribution

The known distribution range of Greenland shark *Somniosus microcephalus*, which has been defined primarily by observations of specimens caught in cold-water commercial fisheries, extends from the temperate North Atlantic 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 shark may be more widespread. The known distribution is also compromised by taxonomic problems in this genus (MacNeil *et al.*, 2012). The stock unit(s) are 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. In the early and mid-20th century, Greenland sharks were caught in large quantities as a source for liver oil. At that time, peak annual catches e.g. in Norway are thought to have been in the region 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 large-scale catches of Greenland sharks have been reported since (Nielsen *et al.*, 2014). Although the meat of Greenland shark can be toxic when fresh (e.g. Anthoni *et al.*, 1991; McAllister, 1968), it is eaten in some countries after curing.

Greenland shark is still targeted in small-scale artisanal fisheries in Iceland and Greenland. Artisanal fisheries target Greenland shark with hook and line, longline gear or gaffs, but it is also taken in seal nets and cod traps (Ebert and Stehmann, 2013). It is also a periodic bycatch of longline, trawl and gillnet fisheries in the cooler waters of the North Atlantic.

24.2.2 The fishery in 2014

National landings data are available from Iceland, where 60 t were landed in 2014. No data from other countries were reported.

24.2.3 ICES Advice applicable

ICES has not been asked to provide advice on Greenland shark.

24.2.4 Management applicable

Greenland shark is included in the list of deep-sea sharks on EC quota regulations for deep-sea fishes. There is a zero TAC for deep-sea sharks in EU vessels fishing in Union and international waters of ICES Subareas V–X (CEC, 2015).

24.3 Catch data

24.3.1 Landings

Limited landings data are available. More comprehensive landings data are available from Iceland (www.hagstofa.is and Marine Research Institute databases). Reported annual landings by Iceland (Table 24.1) from ICES Division Va and Subarea XIV have varied from about 2 t (2007) to 87 t (1998). Landings data accessed in 2015 for the present report showed some minor differences to that reported previously, and these differences should be investigated.

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 in lower 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 t 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 t (Gunnarsdóttir and Jørgensen, 2008).

24.3.3 Quality of catch data

As observers are not mandatory in the fisheries that may possibly have a bycatch of Greenland shark, levels of such bycatch are uncertain. In some areas there may be confusion with other members of the genus or even basking shark (MacNeil *et al.*, 2012).

24.3.4 Discard survival

No estimates on discard survival available. According to on-board observers, some Greenland sharks caught in offshore trawl and longline fisheries are released alive (MacNeil *et al.*, 2012).

24.4 Commercial catch composition

No information available.

24.5 Commercial catch and effort data

No information available.

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). No data on cpue 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). Catches are also reported from the annual German Greenland groundfish survey (59 individuals between 1981 and 2011). Trawl surveys conducted in the Barents Sea also encounter Greenland sharks. 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.

24.7 Life-history information

24.7.1 Habitat

Greenland shark show a marked preference for cold water with most observations from waters of -1.8 to 10.0°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). It occurs 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). 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 fjordal habitats (MacNeil *et al.*, 2012).

24.7.2 Spawning, parturition and nursery grounds

Limited information is available. Based on observations on two presumed neonatal specimens captured in a mid-water trawl off Jan Mayen Island, Kondyurin and Myagkov (1983) suggested that parturition may occur in the Norwegian Sea in July–August. The only captures of Greenland shark with near-term embryos were near fjords in the Faroe Islands. Specimens of presumed neonatal size have 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 waters (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 not known, but observations from tagging experiments indicate growth rates of 0.5–1 cm yr^{-1} (Hansen, 1963). Conventional vertebral ageing methods do not seem to be applicable to Greenland shark (MacNeil *et al.*, 2012).

24.7.4 Reproductive biology

Greenland shark is an aplacentally 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. Fecundity is uncertain, but may be ca. ten (Bjerkan and Koefoed, 1957; Ebert and Stehmann, 2013).

24.7.5 Movements and migrations

Studies using conventional and electronic (satellite and acoustic) tags have informed on their movements and migrations. Fisk *et al.* (2012) deployed 20 archival pop-off tags on Greenland sharks off Svalbard, Norway. The sharks displayed a broad vertical distribution (from 6 to more than 1500 m) but no obvious diel movements were noted. Average daily distances travelled also varied and most tags popped off less than 500 km from tagging sites. Two sharks travelled 725 and 980 km, respectively. Previous studies have also examined the behaviour of Greenland shark 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 shark feed on a wide variety of invertebrates, fish and marine mammals, indicating they are generalist feeders on both benthic and pelagic organisms (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014). As well as serving as important scavengers, including of whales (Leclerc *et al.*, 2011), they also predate on live organisms (including marine mammals) and are important predators in Arctic foodwebs (Leclerc *et al.*, 2012).

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, Greenland shark is listed as Near Threatened in the IUCN Red List (Kyne *et al.*, 2006). It is listed vulnerable in the Swedish Red List of endangered species (Svensson *et al.*, 2010).

The recently undertaken ‘European Red List of marine fishes’ is due to report later in 2015.

24.13 Management considerations

Stock status and many aspects of the biology of Greenland shark 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.

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Table 24.1. Greenland shark *Somniosus microcephalus*. Preliminary estimates of landings (t) for the period 1992–2014. Data sources: National Icelandic database (www.hagstofa.is; accessed 11/08/2015) and Marine Research Institute database. Greenland and Portuguese landings since 2006 from ICES database.

Year	Iceland (previous estimate	Iceland (recent estimates)	Greenland	Portugal	Total
1992		68			68
1993	43	41			41
1994	26	42			42
1995	32	43			43
1996	32	61			61
1997	62	73			73
1998	56	87			87
1999	52	51			51
2000	37	45			45
2001	36	57			57
2002	47	56			56
2003	62	55			55
2004	66	58			58
2005	54	53			53
2006	29	24		1	25
2007	2	2	17	1	20
2008	42	34		1	35
2009	26	25			25
2010	43	43			43
2011	18	16			16
2012	19	17			17
2013	6	6			6
2014	60				60

25 Catsharks (Scyliorhinidae) in the Northeast Atlantic

25.1 Stock distribution

This section addresses four species of catshark 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., *Galeus murinus*) are not included here (see Section 5). All catsharks are demersal and oviparous (egg-laying) species.

The stock units are not known, but tagging data indicate that movements are generally quite limited (e.g. Burt *et al*., 2013 WD for *S. stellaris;* Rodriguez-Cabello *et al*., 2004, 2007 for *S. canicula*). In relation to lesser-spotted dogfish, STECF (2003) assumed that "*separate stocks reside in separate ICES Divisions and that immigration and emigration from adjacent populations are either insignificant or on a par*" and that such species would best be managed as local populations (e.g. on the level of an ICES division or adjacent divisions).

Lesser-spotted dogfish: *S. canicula* is an abundant species occurring on a range of substrates (from mud to rock) on the European continental shelves and upper slopes, but is most abundant on the shelf. Its distribution ranges from Norway and the British Isles to the Mediterranean Sea and to Northwest Africa (Ebert and Stehmann, 2013).

This species is currently assessed over four management units (i) North Sea ecoregion (Subarea IV and Divisions IIIa and VIId), (ii) Celtic Seas and west of Scotland (Subarea VI and Divisions VI a–c, e–j), (iii) northern Bay of Biscay (Divisions VIIIa,b,d) and (iv) Atlantic Iberian waters (Divisions VIIIc, IXa).

Greater-spotted dogfish: *S. stellaris* is a common inshore shark of the Northeast Atlantic continental shelf 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 a larger-bodied catshark, growing to at least 130 cm.

This species is currently only assessed for the Celtic Seas and west of Scotland (Subarea VI and Divisions VI a–c, e–j), as this species is locally common within this region and data are limited in other parts of the species range.

Black-mouth catshark: *G. melastomus* is a small-sized shark (< 90 cm), found in the Mediterranean Sea and from northern Norway along the continental shelf, including the Faroes, south to Senegal (Ebert and Stehmann, 2013).

This species is currently assessed over two management units (i) Celtic Seas and west of Scotland (Subarea VI and Divisions VI a–c, e–j), and (ii) Bay of Biscay and Atlantic Iberian waters (Subarea VIII and Division IXa).

Atlantic catshark: *G. atlanticus* is a small catshark on the continental slopes living in depths of 330–790 m. Its distribution in the Eastern Atlantic ranges from Spain (off Galicia) 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).

25.2 The fishery

25.2.1 History of the fishery

Catsharks are a bycatch species of demersal trawl, gillnet and longline fisheries in the ICES area and, with the exception of seasonal, small-scale directed fisheries in some coastal areas, are not subject to target fisheries, as they are usually of low commercial value.

The retention patterns of catsharks in the North Sea and Celtic Seas ecoregions are highly variable, with varying proportions retained/discarded (Silva *et al*., 2013 WD). Some are landed for human consumption (more so in the southern parts of the ICES area) and 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 2014

No new information.

25.2.3 ICES Advice applicable

ICES advice for catsharks was included in the regional demersal elasmobranch advice (2006–2010).

In 2012, and based on ICES approach to data-limited stocks, ICES advised that "*catches could be increased by a maximum of 20%. Because the data for catches of lesser-spotted dogfish are not fully documented, ICES is not in a position to quantify the result. ICES does not advise that an individual TAC be set for this stock, at present*".

This advice applied to *S. canicula* in (a) Division IIIa (Skagerrak and Kattegat), Subarea IV (North Sea), and Division VIId (eastern Channel); (b) in Subarea VI and Divisions VIIa–c, e–j (Celtic Sea and west of Scotland); and (c) Divisions VIIIa,b,d (Bay of Biscay).

For Divisions VIIIc and IXa (Atlantic Iberian waters), based on ICES approach to data-limited stocks, ICES (2012) advised that "*catches should be decreased by 9%. Because the data for catches of lesser-spotted dogfish are not fully documented (due to the historical use of generic landings categories), ICES is not in a position to quantify the result. ICES does not advise that an individual TAC be set for this stock".*

25.2.4 Management applicable

Most of these species are not subject to fisheries management in EU waters.

Black-mouth dogfish *G. melastomus* was originally included in the list of deep-water sharks, but Council Regulation (EC) 1182/2013 removed this species from this list following the 2013 ICES advice. This advice 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. No management has been applied for this species since.

25.3 Catch data

25.3.1 Landings

Landings of catsharks were traditionally reported in category groups (e.g. dogfishes and hounds), though in recent years species-specific landings may 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 and considered preliminary. Future work within the scope of WKSHARK2 will further inform how best to allocate historic and recent grouped data (especially for Scyliorhinidae) to species-specific landings.

Landings data of *S. canicula* in the North Sea ecoregion are shown in Table 25.1a. It should be noted that data from Scotland may not be available due to aggregated records as dogfish, which may also include smooth-hounds.

Landings data from the Celtic Seas ecoregion (ICES Areas VI, VIIa–c,e–j) for lesser-spotted dogfish (Table 25.1b) are considered to be underestimated and should be viewed as preliminary. The proportion of species-specific data is unknown as both species *S. canicula* and *S. stellaris* occur in the area. Data prior to 2000 may be available for some countries but are not shown in this report.

Landings of *S. canicula* from the Biscay-Iberia ecoregion are given in Table 25.1c–d. Landings of this species in IXa are reported mostly by the Portuguese fleet (Table 25.1d).

Landings data for *G. melastomus* are given in Tables 25.1e. In Subarea VIII, the main landings were reported by Spain whereas, in Division IXa these are reported mainly by the Portuguese fleet. Since 2010, *G. melastomus* landings declined due to the introduction of a zero TAC for deep-water sharks, where this species was previously included. After the exclusion of this species from the deep-water sharks list in 2013, the Portuguese landings were reported in similar quantities comparatively to prior to 2009 (Table 25.1e).

Only France and Spain declare landings of *G. melastomus* in the Celtic Seas ecoregion (Table 25.1f). There are no reported landings of these figures prior to 2002. It is likely that this species was caught in deep-water fisheries prior to these years. Species-specific reported landings are considered to be underestimates of total landings as they may also be included in generic landings categories, by these and other countries.

25.3.2 Discards

Scyliorhinus canicula and other catsharks are often discarded from continental shelf fisheries (Silva *et al.*, 2013 WD). Although these data have not been collated and raised to fleet level, the high discard survival of species in this family, at least for continental shelf fisheries, means that landing data are likely to be more reflective of dead removals. Discard data for *G. melastomus* and *S. canicula* from the Iberian and Celtic Sea are available from Spanish onboard observations (Santos *et al.*, 2010 WD).

Discard information of *S. canicula* and *G. melastomus* is also available from several countries in Subarea VIII and Division IXa (Table 25.2a). For *S. canicula* discard estimates in the period 2009–2014 ranged from 33–195%, with trawlers being the main fleet considered. Discards of *G. melastomus* in subarea VIII and Division IXa have been higher than reported landings throughout the time-series. However, these preliminary estimates may be an artefact of raising factors applied to subsampling of commercial catches.

In the Portuguese crustacean bottom otter trawl fishery operating in ICES Division IXa the most frequent discarded demersal species were *G. melastomus* and *S. canicula*. Discard estimates for the artisanal fleet are not available, but proportions of discards by métier in sampled trips are presented in Table 25.2b. For further details regarding estimated total discarded weight, length distribution and sex ratio for both species please refer to ICES (2014) and Prista and Fernandes (2013).

Estimates of total discards of *G. melastomus* in French fisheries revealed uncertainties because of a high number of métiers catching the species and the variability within each métier. Estimates of quantities discarded were sensitive to the raising method. As there are no landings data for the observed vessels, only effort measures could be used as raising variables, and the various measures of effort available (number of trips, number of fishing operations, fishing time and days-at-sea) produced different results. Discard data require further analyses to identify the most reliable raising methods, and discards estimated are not presented in this report, except that the catch was fully discarded in the observed trips.

S. canicula is a bycatch in most French fisheries and a high number of DCF level 6 métiers catch it. The proportion of discards varies by métier, and raising methods are also problematic. An overall discarding rate (discards/landings) was calculated to 170%. This rate varied from 10% to 1000% across métiers.

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; Rodriguez-Cabello *et al*., 2005), and would presumably have high survival in coastal longline fisheries. There are no data for discard survival of these species in gillnet fisheries.

25.3.4 Quality of catch data

Accurate species-specific landings data are not currently available. The 2012–2014 French programme "Mislabelling of Chondrichthyans in French landings" aims to better evaluate the relative proportion of species mixed under a single landing name, as it is for *S. canicula*/*S. stellaris* (see above). Discard data are only available for some countries in Bay of Biscay and Iberian waters (VIII and IXa). Discard information is considered to be underestimated for all management units.

25.4 Commercial catch composition

Data from national observer programmes have provided information on the size distribution of the retained proportions of the catch. It is generally larger fish that are landed (Silva *et al*., 2013 WD).

The length distributions for *S. canicula* for France (Subareas VII–VIII; 2012–2014), Spain (OTB Basque fleet in Subarea VIII, 2000–2004 and 2011–2013) were shown in ICES 2014.

The length-distribution for *S. stellaris* caught by the French fleet in 2012–2014 was of 44–124 cm (ICES, 2014).

S. canicula caught by the Dutch beam trawl fleet included some smaller fish (35–40 cm L_T) in 2014 than in previous years (Figure 25.1a), but most sampled fish were in the 50–65 cm L_T size categories.

Length distributions of *S. canicula* from the Portuguese trawl and artisanal fleets were also presented (2009–2014) (Figure 25.1b). The length distributions and length ranges, were similar between nets and trawlers and among years. Length–frequency data collected under a DCF pilot study on trammel nets (GTR_DEF_>=100_0_0; 2012–2014), are presented in Figure 25.1c. Trammelnet length data shows no major differences on length frequencies between sexes or among years.

25.5 Commercial catch-effort data

Commercial catch and effort data have not been analysed for most scyliorhinid stocks in the ICES area.

<u>*S. canicula* (VIIIc):</u> Landings per unit of effort data from the Basque Country OTB fleet (Subarea VIII; Table 25.3) showed an increasing trend over the period 2001–2007, with a more stable trend (ca. 200 kg.day^{-1}) since 2009.

25.6 Fishery-independent information

25.6.1 Availability of survey data

Catsharks are a common component of many fishery-independent trawl surveys, including both IBTS and beam trawl surveys, and for further information see Section 15 (North Sea), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia).

25.6.2 Abundance trends for *S. canicula* in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak and Kattegat, Eastern English Channel)

<u>Surveys used:</u> Within this ecoregion, *S. canicula* is most abundant in the English Channel, southern North Sea and northwestern North Sea, with fewer specimens found in the central and eastern North Sea. Data available and considered were the Q1 and Q3 NSIBTS, UK-7d-BTS and CGFS.

<u>Results:</u> Overall, most surveys showed increase trends in the relative abundance of *S. canicula* in the North Sea ecoregion (Figure 25.2a) over the time-series. However, it should be noted that the mean annual cpue on the CGFS for 2013–2014 showed a slight (4%) decrease in comparison to the preceding five years (2008–2012). The remaining three surveys indicated an increase in the mean catch rates for 2013–2014 of 5–132% in comparison to the preceding five years (2008–2012). The length distribution in the Q1 and Q3 NSIBTS was stable throughout the time-series (Figures 25.2b).

25.6.3 Abundance trends for *S. canicula* in Subarea VI and Divisions VIIa–c, e–j (Celtic Seas and West of Scotland)

<u>Surveys used:</u> *S. canicula* is widespread in the Celtic Seas ecoregion, though it may be less abundant in deeper areas. Data from the UK Irish Sea BTS, suggests that *S. canicula* may occur over a range of habitats as they are common throughout the survey grid. Data available and considered were the French EVHOE, IGFS, Spanish Porcupine Bank survey and UK-7af-BTS.

<u>Results:</u> Some surveys showed an increase trend in the relative abundance of *S. canicula* over the time-series (Figure 25.3). However, it should be noted that the mean annual cpue on the EVHOE and IGFS for 2013–2014 showed a 46% and 4% decrease,

respectively, in comparison to the preceding five years (2008–2012). The remaining two surveys indicated increasing mean catch rates for 2013–2014 of 12% (UK-7af-BTS) and 134% (Spanish Porcupine Bank) in comparison to the preceding five years (2008–2012). The later increase may be explained by the high cpue in 2013 over the time-series (Fernández-Zapico *et al.*, 2015 WD).

Other surveys: Earlier analyses of the Scottish surveys in VIa suggested an increase in the catch trends (see ICES, 2010), but updated analyses are currently unavailable. Despite survey catch trends not been analysed in the UK-7e-BTS, *S. canicula* was by far the most abundant elasmobranch caught across the survey grid, over a wide length range (8–73 cm). This species, were most abundant in the outer parts of Lyme Bay, the Eddystone grounds and in parts of the Normano-Breton Gulf (Silva *et al.*, 2014 WD).

25.6.4 Abundance trends for *S. canicula* in Divisions VIIIa,b,d (Bay of Biscay)

Scyliorhinus canicula may be encountered in low numbers on the French EVHOE survey grid in the Bay of Biscay (VIII). The mean catch rate for 2013–2014 indicated a 37% decrease in comparison to the preceding five years (2008–2012) (Figure 25.4). The stock indicator is, however, above the long-term mean.

25.6.5 Abundance trends for *S. canicula* in Divisions VIIIc and IXa (Atlantic Iberian waters)

Surveys used: *S. canicula* is reported in surveys conducted by Spain and Portugal. Data here included are from Spanish IBTS-GC-Q1-Q4 (ARSA), North Spanish Shelf bottom survey and the Portuguese PT-GFS.

Results: The mean catch rate for 2013–2014 indicated an increase of 78% in the ARSA survey in comparison to the preceding five years. The Portuguese survey along the coast indicated a 2% decrease in the mean catch rate for 2013–2014 in comparison to the preceding five years (2007–2011; no survey was conducted in 2012) (Figure 25.5a). Although the Spanish IEO Q4 survey reports *S. canicula*, changes in the vessel used may have implications to the peak in 2013–2014. Therefore data for the last two years were excluded from indices calculation. Further analysis of the implications on catch rates may be needed (Figure 25.5b).

Other surveys: Previous Basque ITSASTEKA survey reported two demersal sharks (*G. melastomus* and *S. canicula*), the latter was the second most abundant species in the survey and often encountered in all trawl stations except areas of shallower waters where they were less abundant (depths <250 m) (ICES, 2014). This survey ceased in 2014 (for further information, see ICES, 2014).

25.6.6 Abundance trends for *S. stellaris* in Subareas VI and VII (Celtic Seas and West of Scotland)

Surveys used: *S. stellaris* has a more restricted distribution than *S. canicula*, with rocky and inshore grounds their preferred habitat. Hence, most surveys do not sample their main habitats effectively, resulting in low catch rates, especially of the smallest size groups. The catchability of larger individuals may also be low in some survey trawls. The UK-7af-BTS is one of the few surveys to encounter this species regularly, especially around Anglesey and Lleyn Peninsula and in Cardigan Bay.

Results: The UK-7af-BTS only catches low numbers of *S. stellaris*, but this species is captured regularly. Mean annual cpue for 2013–2014 (0.42 ind.h^{-1}) showed a 6% decrease in comparison to the preceding five years (2008–2012; 0.44 ind.h^{-1}). However, this slight "decrease" should be viewed in the context that this species' preferred habitats are limited to certain areas of the survey grid, and there is the indication of a longer-term increase over the entire time-series (Ellis, 2015 WD, Figure 25.6).

25.6.7 Abundance trends for *G. melastomus* in Subareas VI and VII (Celtic Sea and West of Scotland)

Surveys used: *Galeus melastomus* occurs on the outer continental shelf and upper slope, and is typically taken in those surveys operating in waters 300–700 m deep. In the Spanish Porcupine Bank survey, *Galeus melastomus* was the most abundant species in terms of biomass (Fernández-Zapico *et al*., 2015 WD).

Results: Mean catch rate for 2013–2014 indicated a 63% increase in comparison to the preceding five years (2008–2012; Figure 25.7).

25.6.8 Abundance trends for *G. melastomus* in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)

Surveys used: Data available were from the French EVHOE survey in VIII, Spanish IBTS-CG-Q1-Q4 (ARSA) and the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28-29))).

Results: Overall, surveys showed an increase trend in the relative abundance of *G. melastomus* (Figure 25.8a) over the time-series. However, it should be noted that the mean annual cpue on the French EVHOE for 2013–2014 showed a 23% decrease in comparison to the preceding five years (2008–2012). The remain two surveys indicated increasing mean catch rates for 2013–2014 of 10% (Portuguese) and 114% (ARSA) in comparison to the preceding five years (2008–2012).

Other surveys: The Spanish IEO Q4 survey catches *G. melastomus,* however data are here only shown as general trends and further analysis may be needed to understand the implications of vessel change in 2013 (Figure 25.8b). *G. melastomus* can be encountered in the standard survey grid (70–500 m depth), though they are commonly found in deeper and additional hauls to the survey (depths over 500 m). There seems to be no clear pattern to their geographical distribution. Length distribution of *G. melastomus* caught in 2014 ranged from 14–71 cm over standard stratification (70–500 m) (Ruiz-Pico *et al*., 2015 WD).

25.6.9 Other catshark stocks

S. stellaris is a coastal species that is only caught occasionally in the North Sea ecoregion. It is taken in small numbers during the UK-7d-BTS, which may be partially explained by the limited number of stations with coarser seabed within the survey grid. Although data are too limited to inform on trends in relative abundance, this species is present in most years (Ellis, 2015 WD).

25.7 Life-history information

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 age classes in survey data. Age and growth parameters are uncertain for all the species considered here.

The reproductive biology of *S. canicula* has been studied for the Bristol Channel (Ellis and Shackley, 1997). Males 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. The egg cases are often laid on erect, sessile invertebrates (e.g. bryozoans, poriferans and hydroids). 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).

Reproductive biology was studied for *Galeus melastomus* from specimens collected off 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.

25.8 Exploratory assessment models

Please refer to ICES 2014 for the latest GAM analysis of survey trends for *S. canicula* in the CGFS, UK-7d-BTS, IBTS-Q1 and IBTS-Q3 surveys, input data referred to the period 1977–Q1 2014.

Biomass indices of *S. canicula* for the Portuguese waters (IXa) were standardized using the catch rates by fishing haul obtained from Portuguese PT-GFS. In the standardization process of cpue, a generalized linear mixed model (GLMM) with Tweedie distributed errors was applied. Cpue index time-series was estimated based on the relationship between cpue and available predictive factor variables, selected depending on their significance after the model adjustment. In the essayed models logarithm of catch rate of the species in each haul (kg.h^{-1}) was the response variable. Apart from factor year, the final model included the variables depth strata (intervals of 100 meters) and fishing sector, the latter as the random variable. More details on the methodology used are presented in Figueiredo and Serra-Pereira (2012 WD) and Moura *et al.* (2015b WD).

Biomass indices of *G. melastomus* for the Portuguese waters (IXa) were standardized using the catch rates by fishing haul obtained from the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28-29))). Data were restricted to depths >500 m. In the standardization process of cpue, a generalized linear model (GLM) was applied. In the essayed models logarithm of catch rate of the species in each haul (kg.h^{-1}) was the response variable. The final model included the variables year and fishing sector and followed a Gaussian distribution.

25.9 Stock assessment

25.9.1 Approach

In the absence of formal stock assessments for these species, the following provides a summary of the evaluation of stock trends, following the ICES approach to data-limited stocks. All the data used were from scientific trawl surveys (see Section 25.6). Most stocks were in category 3 of this approach. In 2015, ICES assessments were undertaken to inform the advice for the following seven management units:

- Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak and Kattegat, Eastern English Channel);
- Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea VI and Divisions VIIa–c, e–j (Celtic Seas and West of Scotland);

- Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIa,b,d (Bay of Biscay);
- Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIc and IXa (Atlantic Iberian waters);
- Greater-spotted dogfish (*Scyliorhinus stellaris*) in Subareas VI and VII (Celtic Seas and West of Scotland);
- Black-mouth dogfish (*Galeus melastomus*) in Subareas VI and VII (Celtic Sea and West of Scotland);
- Black-mouth dogfish (*Galeus melastomus*) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters).

25.9.2 Lesser-spotted dogfish (*S. canicula*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak and Kattegat, Eastern English Channel)

The results of 2015 analyses indicated that survey indices increased by 5–132% for Q1 NSIBTS, Q3 NSIBTS and UK-7d-BTS with a decrease of 4% on the CFGS survey. The combined index (Figure 25.2a) showed that catch rates for 2013–2014 were 52% higher than the five preceding years (2008–2012).

25.9.3 Lesser-spotted dogfish (*S. canicula*) in Subarea VI and Divisions VIIa-c, e-j (Celtic Seas and West of Scotland)

The results of 2015 analyses indicated that survey indices decreased by 4–46% in the IGFS and EVHOE surveys, whilst indices for the UK-7af-BTS and Spanish Porcupine Bank survey increased by 12–134%. The combined index (Figure 25.3) showed that catch rates for 2013–2014 were 17% higher than the five preceding years (2008–2012).

25.9.4 Lesser-spotted dogfish (*S. canicula*) in Divisions VIIIa,b,d (Bay of Biscay)

The results of 2015 analyses indicated that survey indices in the EVHOE survey (Figure 25.4) for 2013–2014 were 37% lower than the five preceding years (2008–2012).

25.9.5 Lesser-spotted dogfish (*S. canicula*) in Divisions VIIIc and IXa (Atlantic Iberian waters)

The results of 2015 analyses indicated that survey indices increased by 78% in the ARSA survey, and decreased of 2% in the Portuguese PT-GFS. The combined index (Figure 25.5a) showed that catch rates for 2013–2014 were 18% higher than the five preceding years (2008–2012).

25.9.6 Greater-spotted dogfish (*S. stellaris*) in Subareas VI and VII (Celtic Seas and West of Scotland)

The results of 2015 analyses indicated that catches for 2013–2014 were 6% lower than the five preceding years (2008–2012), although this should be viewed over the context of a longer term increase (Figure 25.6).

25.9.7 Black-mouth dogfish (*Galeus melastomus*) in Subareas VI and VII (Celtic Sea and West of Scotland)

The results of 2015 analyses indicated that catches for 2013–2014 were 63% higher than the five preceding years (2008–2012) (Figure 25.7).

25.9.8 Black-mouth dogfish (*Galeus melastomus*) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)

The results of 2015 analyses indicated that survey indices in the four surveys examined (Figure 25.8a) showed that catches for 2013–2014 were 20% higher than the five preceding years (2008–2012).

25.10 Quality of the assessment

Although the trawl surveys used in this report were not designed to sample catsharks, *S.canicula* and *G. melastomus* have been sampled in large numbers. Overall survey data show good catch rates and are the best long-term available for species-specific data for all management units.

Commercial data are more problematic due to the widespread use of generic categories (e.g. "dogfish"), especially in earlier data. Although a greater proportion of the data are reported to species or genus level, the quality of these data have 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 on 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.

In relation to *G. melastomus*, fisheries-independent data in the Portuguese surveys suggest that this species may have been historically aggregated with *G. atlanticus*, where there may be some problems with misidentification of these two species (Moura *et al.*, 2015a 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 mainly distributed deeper than 500 m (data from depths ≥500 m were considered for assessment purposes).

Catsharks are mainly caught as bycatch species resulting on a high level of discarding, as species may have different levels of survivability means that the discarded fish should not be viewed as dead removals. 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* as a shallow water species, it can be assumed that its survivability may be equally high. However, for *G. melastomus* anecdotal information suggests this to be at a lower level. Further studies should be considered if more accurate information on the level of discarding are to be inferred for the two later species. Therefore, catch data may not be indicative of dead removals and assessment relies mostly on fisheries-independent survey trends.

25.11 Reference points

No reference points have been proposed for these species and stocks.

25.12 Conservation considerations

Both *S. canicula* and *G. melastomus* are listed as Least Concern, and *S. stellaris* and *Galeus atlanticus* as Near Threatened on the IUCN Red List (Gibson *et al.*, 2008).

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 are a low value, bycatch species, means that 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.

Catch rates of *S. canicula* are increasing in nearly all surveys analysed. 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 catch rates observed are a sign of a healthy ecosystem.

Discard survival of *Scyliorhinus* spp. is considered to be high, but estimates for discard survival for *Galeus* spp. are currently unavailable.

25.14 References

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Table 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea IV, and Divisions IIIa and VIId (North Sea, Skagerrak and Kattegat, Eastern English Channel). "n.a." indicates not available. NOTE: data for Scotland were reported as dogfish which may include smooth-hounds and the proportion of *Scyliorhinus* is uncertain.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	186	330	235	244	225	238	262	266	336	313	291	309	250	230 2)	323 2)
France	1633	1811	1899	1777	1472	1614	1492	1459	1406	1751	1999	2013	2053	2034	2177
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	32	29	37	37	47	36 2)	37 2)	45 2)
UK (E,W, NI)	n.a.	n.a.	n.a.	13	57	92	118	94	102	116	128	176	179	188 2)	154 2)
UK (Scotland)	.	.	1	5	3	22	6	3	2	3	3	.	10 1)	.	n.a
Total	1819	2141	2135	2039	1757	1966	1878	1854	1875	2220	2458	2545	2528	2489	2699

1) Registered as spotted dogfish.

2) Including *Scyliorhinus* sp.

Table 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*) in the Celtic Seas. NOTE: These data should be viewed with caution as some countries may have aggregated both *S. canicula* and *S. stellaris* as Scylirohinidae and the proportion of species-specific may be unknown as both species occur in this area.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium					377	392	389			317	320	382	236	217	141
France	4808	4922	4697	4361	4314	3937	3815	3881	3360	2456	2489	3850	2189	2380	2286*
Ireland	407	518	506	285	124	85	40	130	257	211	321	315	216	333	366*
Netherlands										7	1	2	4	4	+
Spain	77	46	50	20	21	41	13	17	4	0	21		53	26	18
Spain (Basque country)									2	1	4	4			
UK (E&W&NI)	11	.	.	88		325	126	11	269	329	238	259	227	404	418*
UK (Scotland)	.	.	37	8	33	55	42	40	6	15	12	9	7	0	
Total	5303	5486	5290	4762	4869	4835	4425	4079	3897	3336	3406	4821	2932	3364	3229

*** Including *Scyliorhinus* sp.**

Table 25.1c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIa,b,d (Bay of Biscay).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	0	3	8	7	9	11	10	8	9	10	13	13	18	24	28	28	32	23	26
France	610	694	816	407	773	846	753	1037	1174	1037	1118	1206	746	1125	1086	788	928	901	719
Spain	0	0	160	0	85	7	28	1	0	0	2	2	3	0	35	57	454	0	396
Spain (Basque Country)	223	270	336	254	247	277	353	318	255	335	319	249	384	415	270	285	*	309	*
UK (E&W)								2		3							5		
Total	833	967	1320	669	1115	1142	1145	1366	1438	1386	1452	1469	1150	1564	1419	1158	1420	1233	1142

*** Included in Spanish landings.**

Table 25.1d. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIc and IXa (Atlantic Iberian waters).

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
VIIIc	France	0	0	1	1	1	4	3	4	5	1	0	1	1	1		0	0	0	0
	Spain	417	458	375,6	448	167	187,6	65	114	88	143	168	150	149	132	181	180	350	395	269
	Spain (Basque Country)	11	8	8	9	5	10	52	65	63	66	73	59	47	30	56	121	*	*	*
	Total	428	466	385	458	173	201	120	183	157	211	241	210	198	162	237	301	350	395	269
IXa	Spain	3	6	19	34	30	39	39	69	86	88	92	118	76	67	99	130	143	176	195
	Portugal	667	691	689	882	757	734	673	658	677	385	185	157	120	450	444	551	544	520	521
	Total	670	697	708	916	787	773	712	727	763	472	276	275	196	518	543	681	687	696	716
VIIIc and IXa combined	France	0	0	1	1	1	4	3	4	5	1	0	1	1	1		0	0	0	0
	Spain	420	464	395	482	197	227	103	183	174	231	260	268	225	199	280	310	493	571	464
	Spain (Basque Country)	11	8	8	9	5	10	52	65	63	66	73	59	47	30	56	121	*	*	*
	Total	431	472	404	492	203	240	158	252	243	298	333	328	274	230	336	431	494	571	464

*** Included in Spanish landings.**

Table 25.1e. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) black-mouth dogfish (*Galeus melastomus*) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters).

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
VIII	France																	0	0	1
	Portugal												1	2						
	Spain							4	3	6	2	3	1	1	1	1	4	6	1	2
	Spain (Basque Country)	4	3	6	2	3	1	1	1	1	4	4	6	4	4	3	0			
	Total	4	3	6	2	3	1	5	4	7	6	7	8	7	5	4	4	6	1	2
IXa	Portugal	17	17	16	20	37	29	35	29	57	38	35	24	26	15	7	2	2	1	21
	Spain													25				2	4	0
	Total	17	17	16	20	37	29	35	29	57	38	35	24	51	15	7	2	4	5	21
VIII and IXa combined	Portugal	17	17	16	20	37	29	35	29	57	38	35	25	28	15	7	2	2	1	21
	Spain	0	0	0	0	0	0	4	3	6	2	3	1	26	1	1	4	8	5	2
	Spain (Basque Country)	4	3	6	2	3	1	1	1	1	4	4	6	4	4	3	*	*	*	*
	France																	0	0	1
	Total	21	20	22	22	40	30	40	33	64	44	42	32	58	20	11	6	10	6	23

*** Included in Spanish landings.**

Table 25.1f. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) black-mouth dogfish (*Galeus melastomus*) in Subareas VI and VII (Celtic Seas).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
France	.	.	.	.	.	.	.	2	1	.	3	4	1
Spain	9	1	.	1	.	.	2	.	.	0	.	.	6
Total	9	1	0	1	0	0	2	2	1	0	3	4	7

Table 25.2a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Discard of *S. canicula* and *G. melastomus* estimates by country in Subareas VIII and IXa.

S. canicula

	Spain (IXa, VIIIc, b)	Basque country (VIIIabd)	Portugal (Ixa)	France (VIIIabd)	Belgium (VIIIabd)	TOTAL
2003	1933	352				2285
2004	799	656				1455
2005	397	282				678
2006	1723	173				1896
2007	954	422				1376
2008	300	644				944
2009	954	1092				2047
2010	635	688				1323
2011	721	1060				1781
2012	753	905			34	1692
2013	1137	65			22	1224
2014	2081	508	140*	1246	192	4167

*** estimates from the trawl fleet only.**

G. melastomus

	Spain (IXa, VIIIc, b)	Basque country (VIIIabd)	Portugal (Ixa)	France (VIIIabd)	TOTAL
2003	589	0			589
2004	244	227			470
2005	527	5			533
2006	553	1			554
2007	1063	N.A.			1063
2008	226	23			249
2009	904	0			904
2010	1272	34			1306
2011	731	7			737
2012	1433	0	36*		1469
2013	749	3	17*		769
2014	1123	9			1131

*** estimates from the trawl fleet only.**

Table 25.2b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Discard proportion of *S. canicula* and *G. melastomus* from trips sampled under the Portuguese DCF program (IXa).

	G. melastomus	*G. melastomus*	*S. canicula*
	GNS, GTR	LLS (DWS)	GNS, GTR
2011	0.87 (14)	0.22	0.15
2012	1.00 (14)	0.68	0.16
2013	0.00 (14)	0.28	0.17
2014	1.00 (14)	1.00	0.34

Table 25.3. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Lpue (kg/day) of lesser-spotted dogfish (*Scyliorhinus canicula*) caught by the Basque Country OTB DEF >= 70 (Bottom otter trawl) in Subarea VIII.

Lpue (kg/day)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	133	146	209	171	214	278	282	244	209	203	209	205	189	196

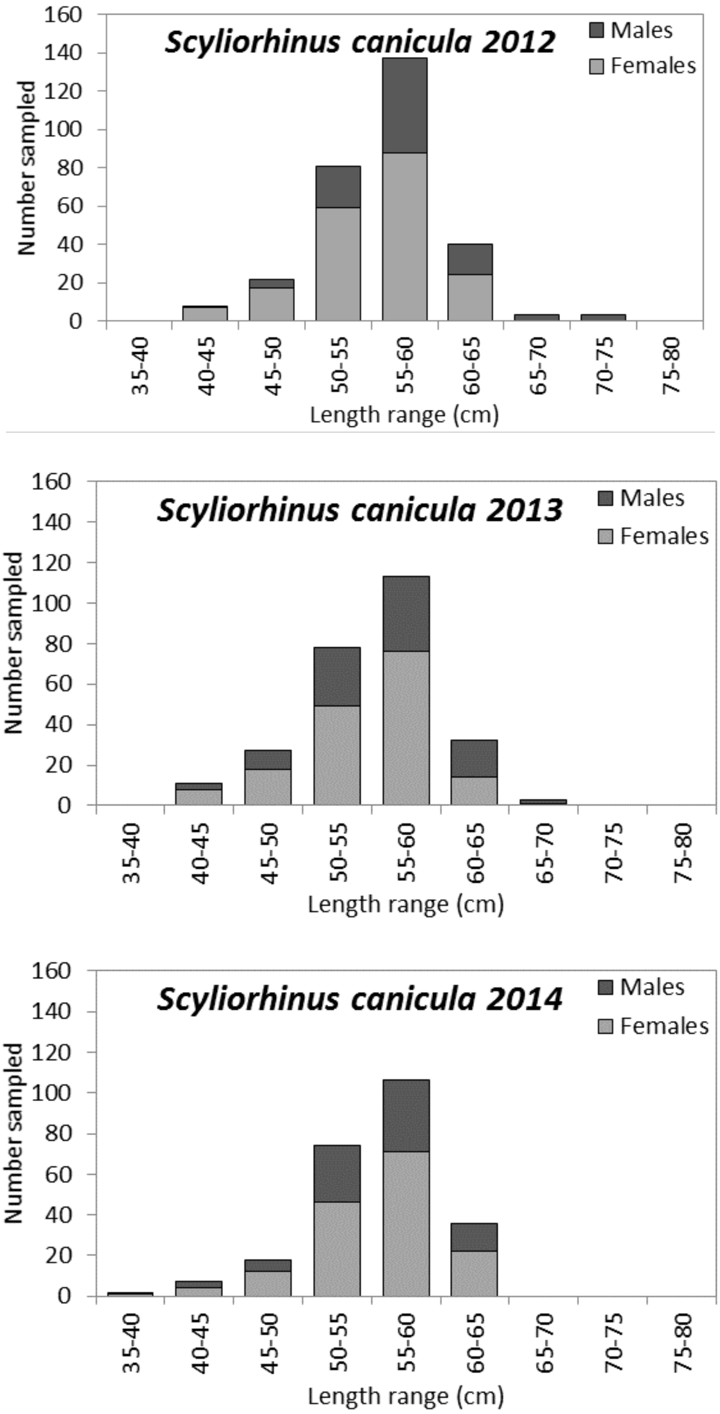


Figure 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length–frequency distribution of lesser-spotted dogfish (*Scyliorhinus canicula*) measured during a pilot market sampling programme of the Dutch beam trawl fleet in 2012–2014.

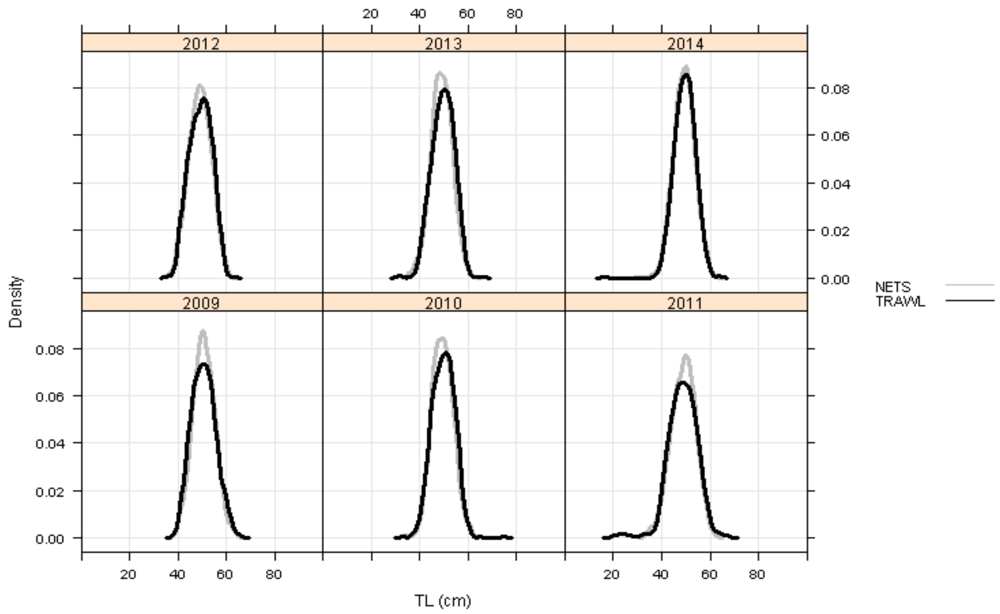


Figure 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length–frequency distribution of *S. canicula* from specimens sampled at Portuguese landing ports (2009–2014). The length frequencies were not raised to the total landings.

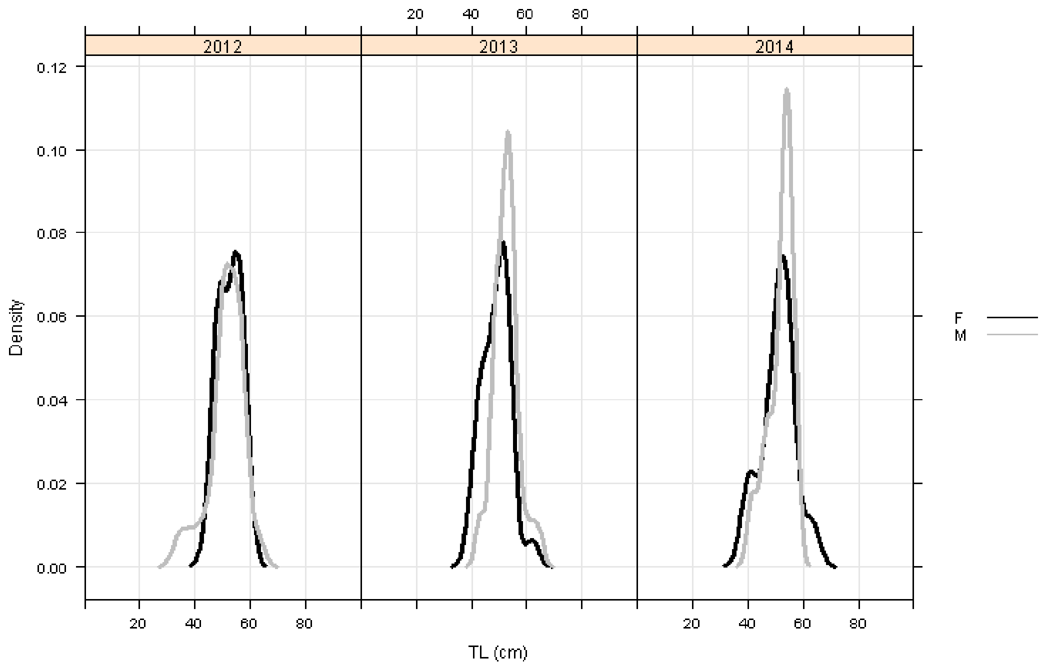
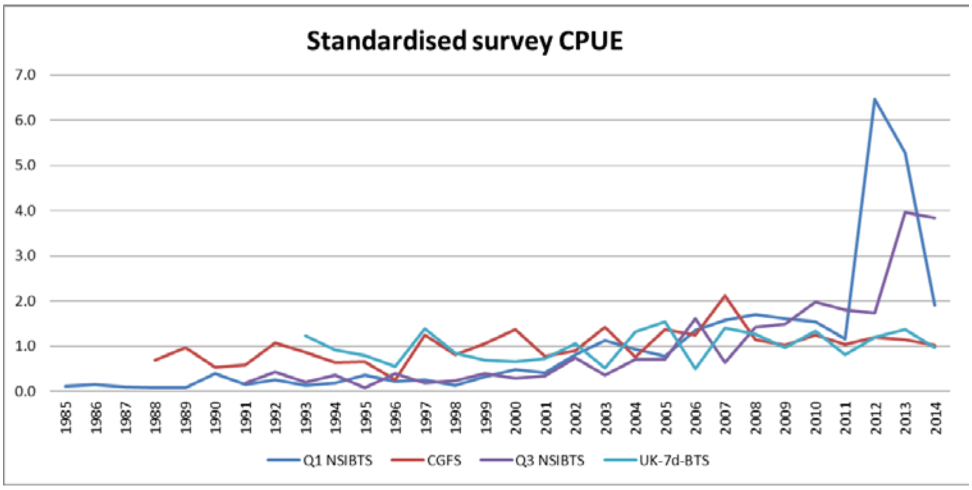


Figure 25.1c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequencies of *S. canicula* catches during the DCF pilot study on Portuguese trammelnet fisheries (GTR_DEF_>=100_0_0; on-board sampling 2012–2014).



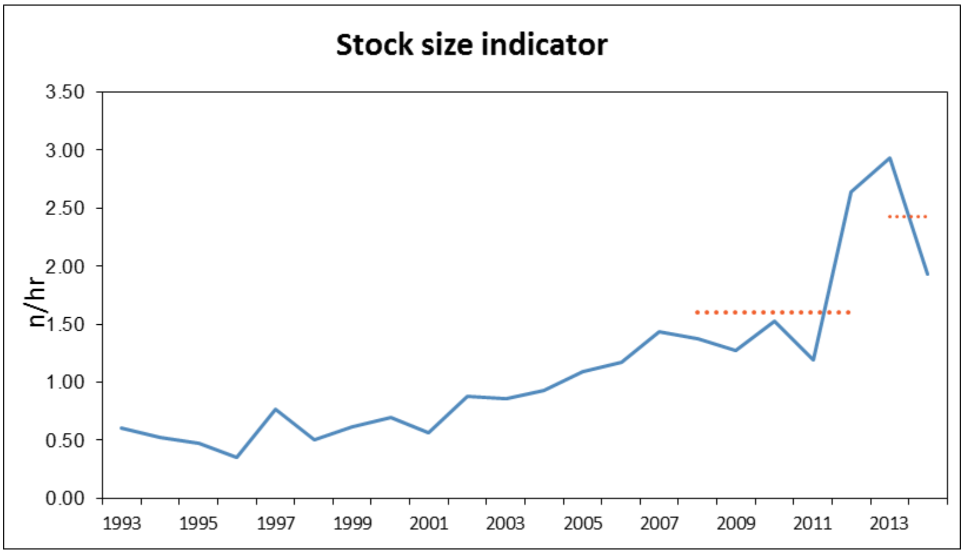


Figure 25.2a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the North Sea, Skagerrak, Kattegat and eastern Channel. Standardised survey indices from four surveys Q1 NSIBTS, Q3 NSIBTS, UK-7d-BTS and CGFS (top) and overall stock size indicator (bottom) for the time period 1993–2014. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

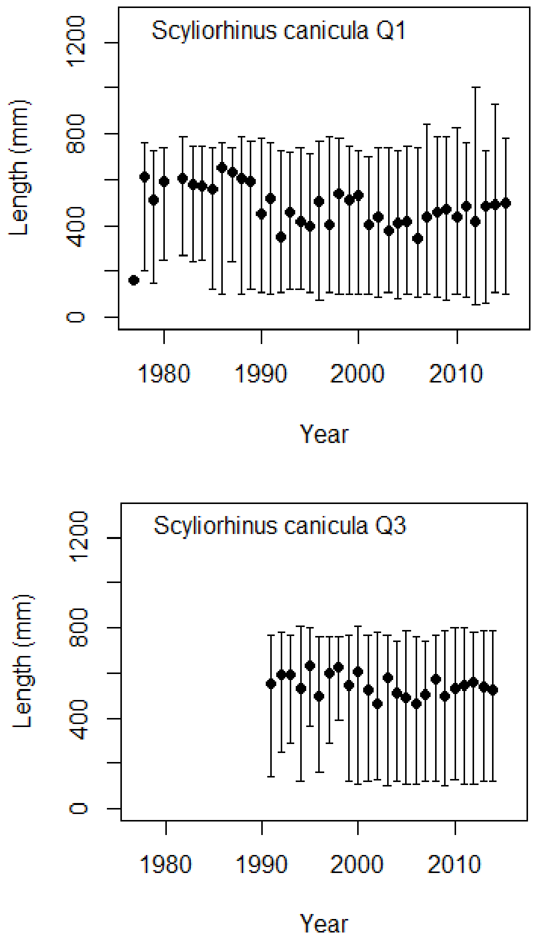
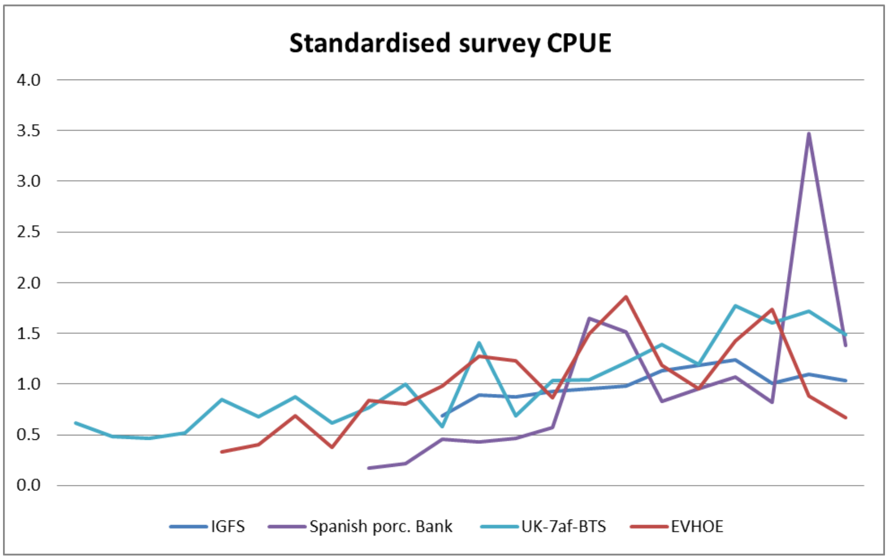


Figure 25.2b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Lesser-spotted dogfish (*Scyliorhinus canicula*) average length (dots) and length range during the Q1 NSIBTS (top) and Q3 NSIBTS (bottom) in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 19th June 2014 (Q1 NSIBTS) and 21th May 2015 (Q3 NSIBTS). NOTE: There are still some incorrect data in DATRAS, with some length records that are >L_{max}.



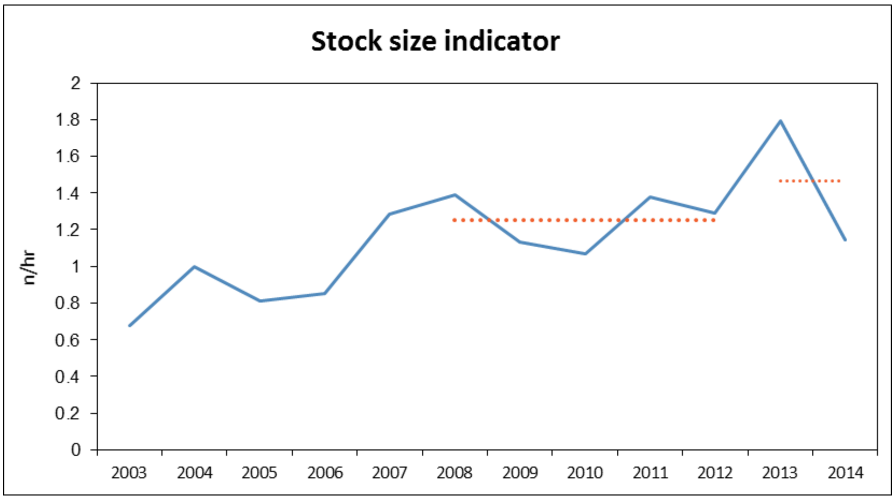


Figure 25.3. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the Celtic Seas Ecoregion. Standardised survey indices from four surveys IGFS, Spanish Porcupine Bank survey, UK-7af-BTSm EVHOE (top) and overall stock size indicator (bottom) for the time period 2003–2014. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

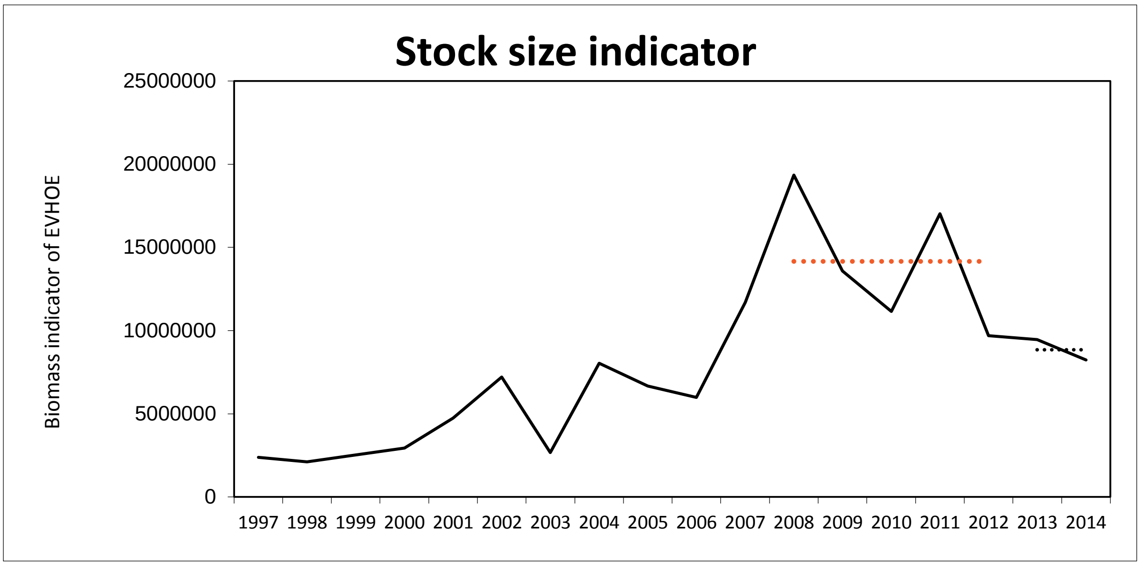
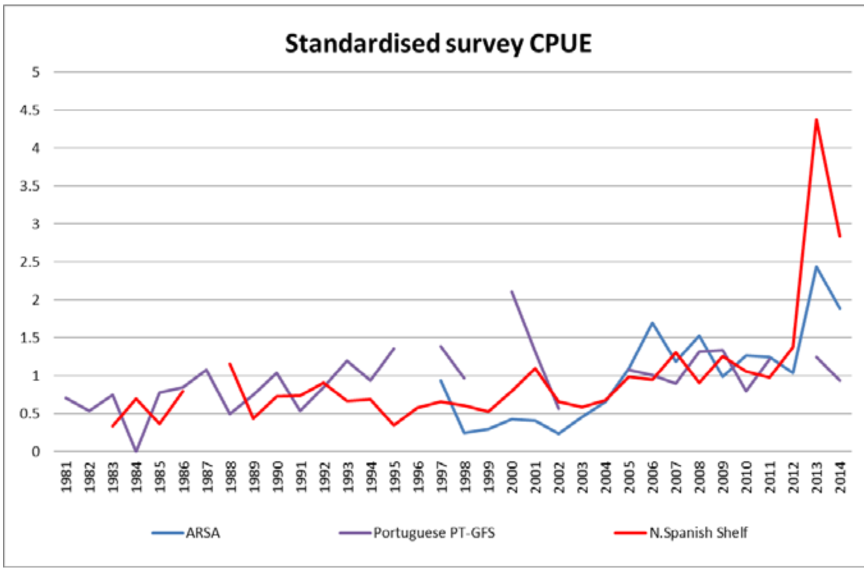


Figure 25.4. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Trends in the stock size of *Scyliorhinus canicula* in the Bay of Biscay, as estimated from the EVHOE survey.



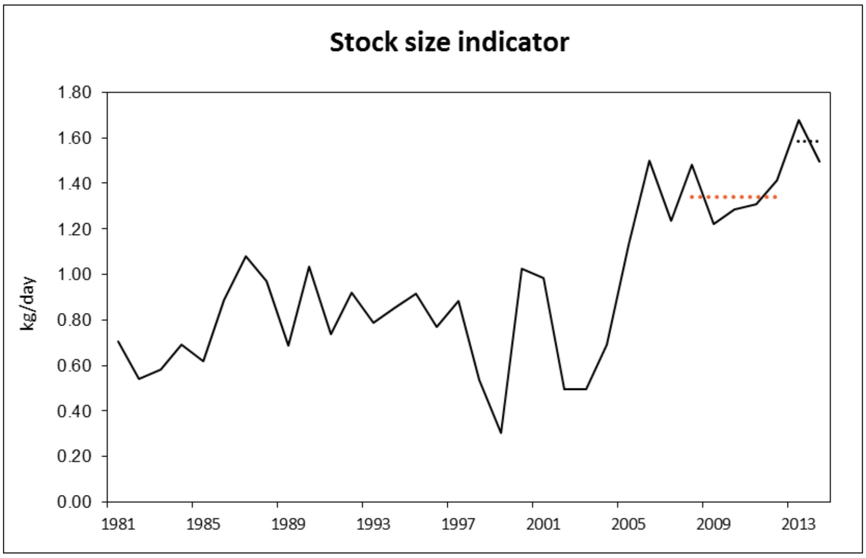


Figure 25.5a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the Atlantic Iberian waters (Divisions VIIIc and IXa). Standardised survey indices from three surveys ARSA, Portuguese PT-GFS and North Spanish Shelf bottom survey (top) and overall stock size indicator (bottom) excluding 2013–2014 from North Spanish Shelf bottom survey. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

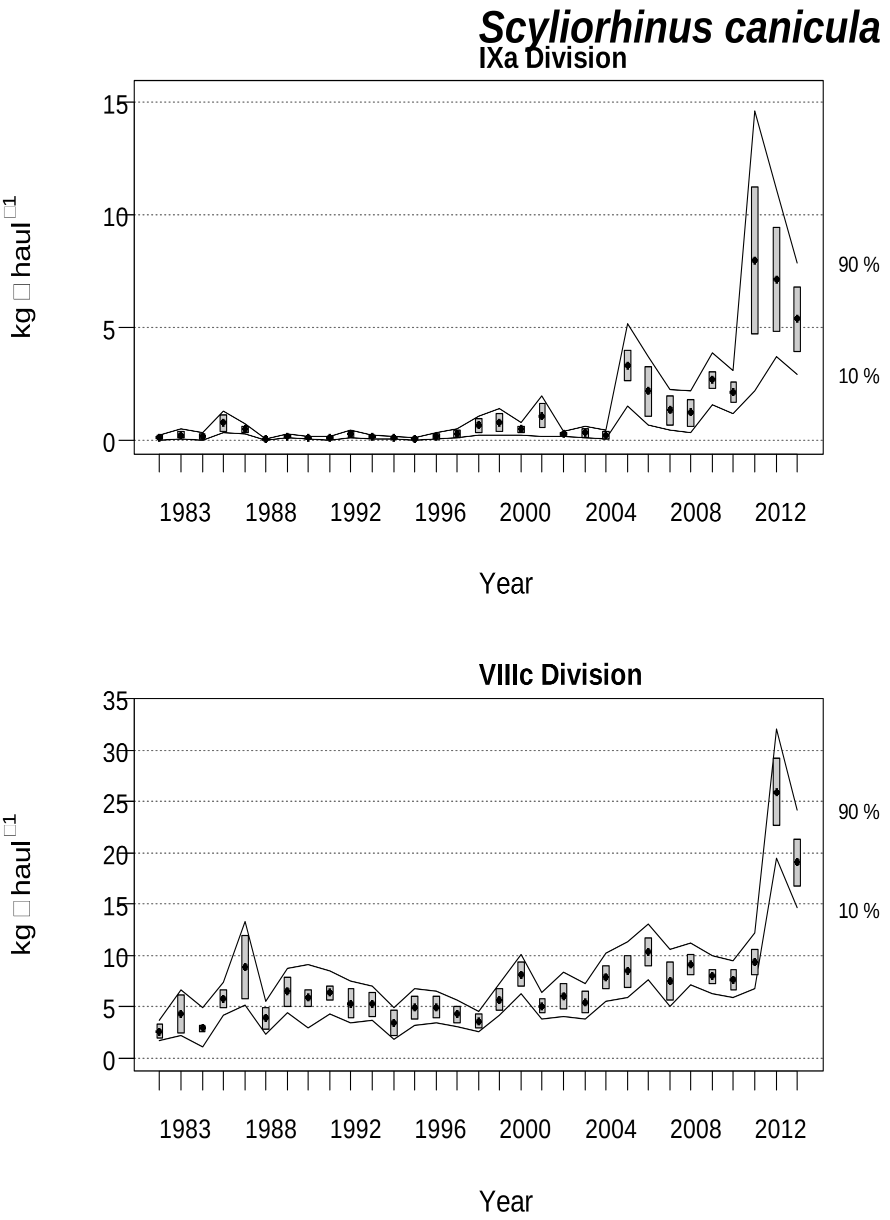


Figure 25.5b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in *Scyliorhinus canicula* biomass index during the North Spanish shelf bottom trawl survey time-series (1983–2014) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000).

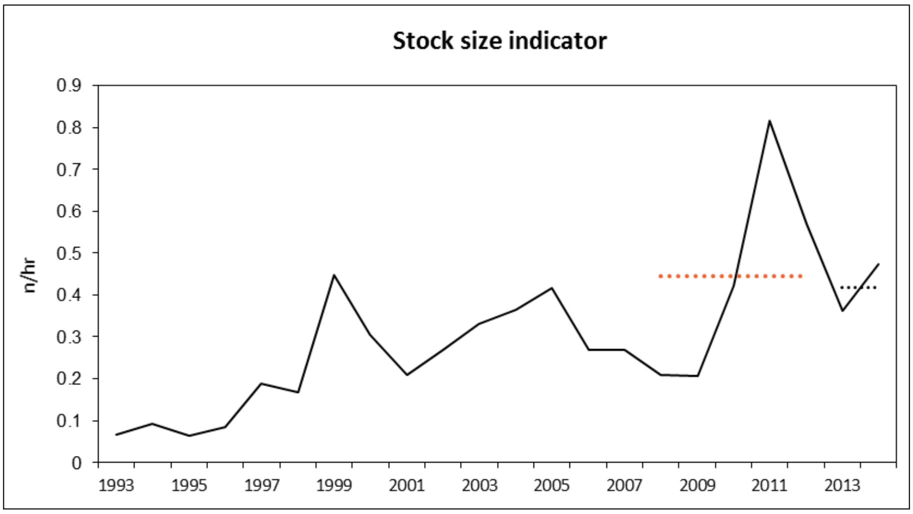


Figure 25.6. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus stellaris* in Subareas VI and VII (Celtic Seas and West of Scotland). Overall stock size indicator from UK-7af-BTS. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

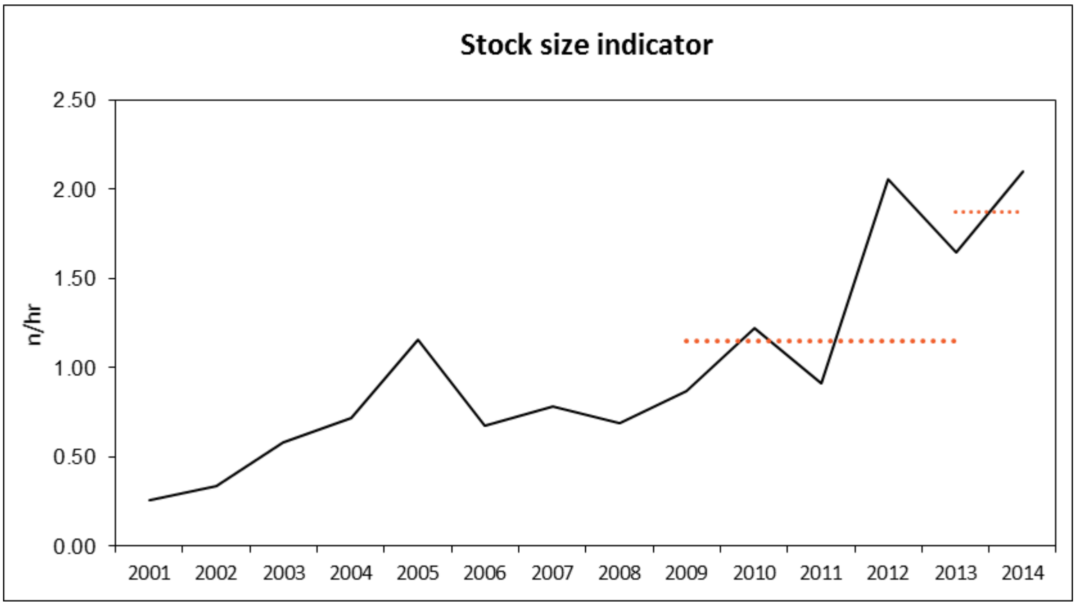


Figure 25.7. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Galeus melastomus* in Subareas VI and VII (Celtic Seas and West of Scotland). Overall stock size indicator from Spanish Porcupine Bank survey. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

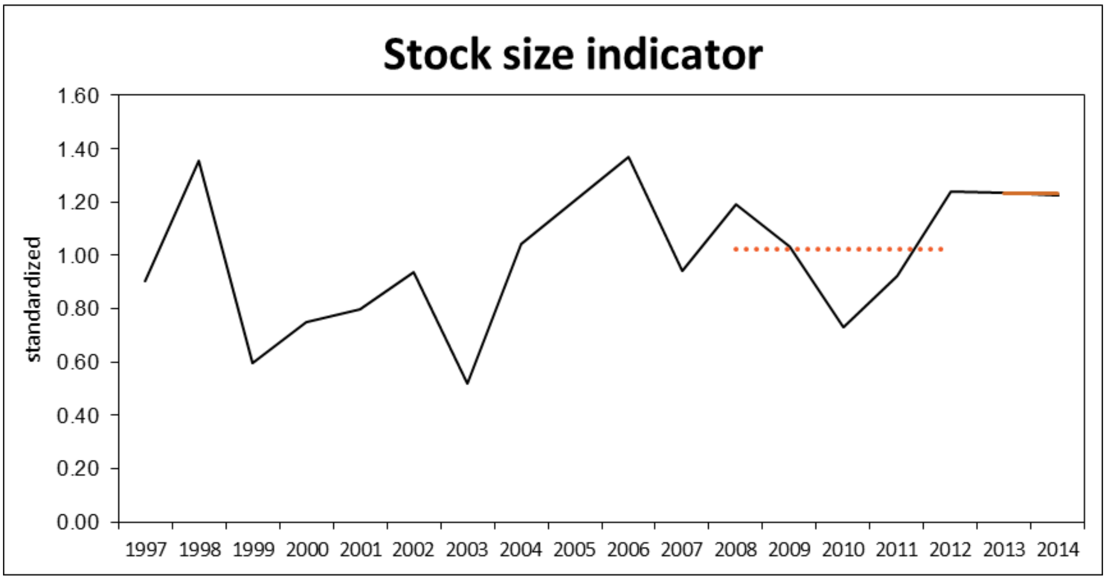


Figure 25.8a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Galeus melastomus* in Subareas VIII and Division IXa (Bay of Biscay and Atlantic Iberian Waters). Standardised survey indices for ARSA, Portuguese IXa, North Spanish shelf bottom trawl, EVHOE. Dotted lines indicate average of the last two years and the average catch for the preceding five years.

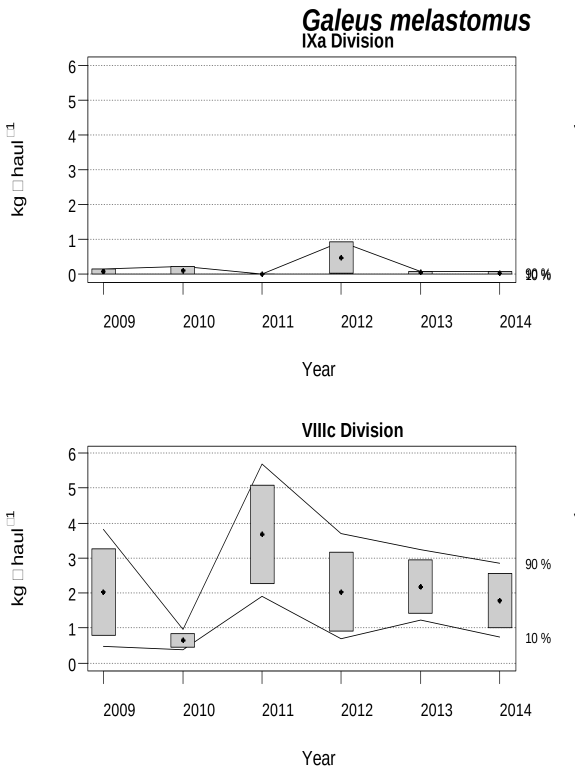


Figure 25.8b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in *Galeus melastomus* stratified biomass index (only with standard hauls between 70 and 500 m) during the North Spanish shelf bottom trawl survey between 2009 and 2014 in the two ICES divisions. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (P= 0.80 bootstrap iterations = 1000).

26 Other issues - New developments on the study of stocks of *Raja undulata* in the ICES area

26.1 Background

Undulate ray *Raja undulata* is a coastal, demersal species with a wide geographic distribution in the Northeast Atlantic and Mediterranean Sea (Stehmann and Bürkel, 1984), occurring at depths down to 100 m and being more abundant in inshore shallow sandy bottoms.

The stock structure of *R. undulata* is poorly known, but due to its patchy distribution, localised areas of abundance and limited observed movements, ICES considers the existence of five stocks units for management purposes: Southwest Ireland (ICES Divisions VIIb,j), English Channel (VIId,e), Bay of Biscay (VIIIa,b), Cantabrian Sea (VIIIc) and western Iberian waters (IXa).

In 2008, ICES advised (ICES, 2008b, c) for the North Sea and Celtic Seas ecoregions that "*Target fisheries for this species should not be permitted and measures should be taken to minimize bycatch*". This advice was driven by the absence of the species in the English beam trawl survey of the eastern English Channel in 2006 and 2007, despite its presence in preceding years (1993–2005), and the decrease of reported catches by recreational anglers in Tralee Bay (Ireland).

No management measures had been adopted by European Commission (EC) for the species 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). These measures proved controversial with some inshore fishing communities and various fisheries laboratories initiated studies to better understand various aspects of the dynamics of this species.

In 2015, Council Regulation (EU) 2015/523 of 25 March 2015 amended Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities. The new regulations introduced individual TACs for *R. undulata* ray in ICES Divisions VIId (11 t), VIIe (100 t) and VIII (25 t), noting that "*This species shall not be targeted in the areas covered by this TAC. Bycatch of undulate ray in Area VIII exclusively may be landed provided that it does not comprise more than 20 kilograms live weight per fishing trip and remain under the quotas shown*".

Within the ICES area, several scientific programmes have been developed for *R. undulata* stocks in ICES Divisions VIId–e, VIIIa-b and IXa. A summary of the main achievements reached by those projects, as well as, a proposal for future work are next presented.

26.2 Scientific programmes in the English Channel (ICES Divisions VIId–e) and Bay of Biscay (VIIIa–b)

In these areas, information on the biology, population structure and movements between ecologically important grounds of *R. undulata* were collected under the French RAIMOUEST, RAIEBECA and RECOAM projects (Biais *et al.*, 2014; Leblanc *et al.*, 2014; Stephan *et al.* 2014a,b). These projects were carried out in a partnership with the stakeholders and aimed to collect and improve information on skate fisheries along the French coasts of the Bay of Biscay and on English Channel, including the Normano-Breton Gulf (Figure 26.1). A brief summary of these projects results are reported below.

Under the RAIMOUEST project, data collected from regional landings and sales auctions previous to 2009 and on discard sampling (2012–2013) showed that *R. undulata* was the main skate species caught in the Normano-Breton Gulf. The data collected also provided an indicative level of *R. undulata* stock and allowed to identify nursery areas in the Normano-Breton Gulf (Leblanc *et al*., 2014). Under the scope of the tagging RAIEBECA and RECOAM projects, data collected from 2011 to mid-2014 in the Bay of Biscay contributed greatly to increase the knowledge on the spatial distribution, movements and biology of *R. undulata*.

The results obtained showed that *R. undulata* can be found all along the Atlantic French coast from the Loire estuary to the Spanish boarder, forming several discrete 'hot spots' of local abundance. The results obtained highly support that perception that this species has high site fidelity, generally only undertaking seasonal movements between deeper (>20 m deep) and shallow waters (Biais *et al*., 2014; Stephan *et al.* 2014a, b). In the Bay of Biscay and in the western English Channel, 48.7% and 58.4%, respectively of the skates marked and released, were later recaptured in the same location. Furthermore, 89.7% and 75.3% of the skates marked and released in the Bay of Biscay and in the western English Channel, respectively, were recaptured less than 20 km from their original release location.

The mark–recapture programme in the central part of the Bay of Biscay, allowed to estimate the biomass of *R. undulata* in the vicinity of the Gironde Estuary (restricting the population to specimens longer than 65 cm L_T). For the period 2013–2014, the biomass estimate varied from 51–70 t (Biais *et al*., 2014). For the Bay of Biscay and Western Channel, information on the reproductive biology (reproductive cycle, length at first maturity, length at 50% maturity ($L_{50\%}$ = 81.2 cm L_T in the Atlantic coast and 78.2 cm L_T in the western English Channel) and conversion factors were also obtained (Stephan *et al*., 2014b). Under the RECOAM project, information on the population genetic structure was analysed (Stephan *et al*. 2014a,b). For more details on the methodologies and results obtained see Biais *et al.* (2014); Leblanc *et al.* (2014); Stephan *et al.* (2014a,b) and Delamare *et al.* (2013) working documents.

A new French project "RAIMEST" is now taking place. This project is conducted by French fisheries regional committees and aims to improve existing knowledge on skate stocks in ICES Division VIId, based on fisher knowledge. In particular, the project aims to provide information on functional fishery areas and on the spatial characteristics of skate catches (presence of areas, species distribution, seasonality, individual sizes, etc.)

26.3 Scientific programme in Portuguese waters (IXa)

In ICES Division IXa, IPMA has initiated in 2014 the research project UNDULATA Nº31-03-01 FEP186) with the aim of improving the information, particularly on the estimation of historical landings in Portugal mainland and on the species current status.

Historical landings in IXa: In the Portuguese official landings, *R. undulata* was landed under a generic category that encompasses several Rajidae species. This situation thus limits the use of Portuguese official landings to evaluate historical landings of the species. Under UNDULATA Project landings of *R. undulata* for the period of 2003–2008 were estimated. The data used consisted on the landed weight by skate species, including *R. undulata*, collected from vessel trips sampled between 2003–2009 at the main Portuguese landing ports: Matosinhos, Póvoa do Varzim, Peniche and Portimão (DCF Portuguese program). The relative weights of *R. undulata* landed at each landing port for each of two main fishing segments (trawl and polyvalent) were estimated annually. The posterior relative weight median estimates, as well as the posterior interquartiles, were obtained through the adjustment of a Bayesian hierarchical GLM model using the sampling data available for each year and port. These estimates were then used to determine Portuguese historical annual landings of *R. undulata*. Due to the localized distribution of the species, in particular close association to shallow sandy bottoms, landing ports along the Portuguese continental were first grouped based on the topography and bottom type off their adjacent coastal areas. For each cluster, historical annual landings of *R. undulata* were calculated using the posterior estimates of relative landing weight of the species and the total Rajidae landings. The annual median estimates of *R. undulata* landed in Portugal mainland as well as the interquartile estimates are presented in Figure 26.2 and Table 26.1.

Density and abundance estimates in IXa: The mark–recapture programme under the UNDULATA project was implemented at Setúbal and Sesimbra (Centre of Portugal). In this area *R. undulata* is concentrated (further evidence that it forms local populations). In this region, the main seabed sediment is composed of clean fine sand. There are also areas with mixed type sediments such as mud, gravel and shells (EMODnet Seabed Habitat database http://www.emodnet-seabedhabitats.eu/). Initially a robust sampling design was adopted for the mark–recapture programme design that involved two main tagging periods, followed by a continuous monitoring of the area. In both cases, fishing vessels from Setúbal and Sesimbra were considered as the sea platforms to execute the program. The data collected from the tagging programme were considered insufficient to proceed with the analysis using tag/recapture methods. Nevertheless the information collected on board fishing vessels was used to estimate the abundance of *R. undulata* in the study area. An N-mixture model of spatially replicated counts (Royle, 2004) was used to estimate the density based on data of the number of specimens caught at fishing hauls performed by fishing vessels using trammelnets with mesh size <100 mm. The density estimates (number of specimens per square meter) increased from south to north and from west to east (see inset of Table 26.2). Estimates of *R. undulata* abundance for each subregion and of catchability are presented in Table 26.2 (Figueiredo *et al.*, 2015 WD).

26.4 Potential for future work

Although recent studies on *R. undulata* have clearly improved the available knowledge of its stocks along the ICES area, stock status and trends in all areas are still not well understood.

The lack of historical catch and effort data on *R. undulata* stocks and the limited survey coverage are barriers to the development of an analytical assessment based on fishery-dependent and -independent data. This deficiency was recently mentioned in the STECF report "Possible bycatch provisions for undulate ray in ICES Areas VIIde, VIIIab and IX (STECF-15-03)".

Since the information collected during research surveys is considered insufficient to monitor *R. undulata* stocks, WGEF considers that the development of collaborative partnership programmes between fishermen and scientists is highly relevant. This involves the design of fishery science programmes, which usually benefit from the fishermen's expertise. In case of *R. undulata* stocks, the cooperation with fishermen is also relevant for the programme because small-sized vessels (considered more appropriated to operate close to shore) operating simultaneously within the whole study area become available.

26.4.1 Outline of potential fishery-science project to estimate abundance/biomass of *R. undulata* stocks

The status of some stocks is evaluated using information collected from commercial vessels. This information is particularly relevant for stocks where fishery-independent sources are lacking or are considered unreliable. Fishery scientific surveys (e.g. sentinel fisheries) involve commercial vessels but follow a predefined scientific programme. In general the programme is defined by researchers in conjunction with fishers. The programme should be designed with the aim of obtaining reliable estimates on abundance and/or biomass, and should be accompanied by a sampling plan that guarantees the reproducibility of the adopted sampling design among surveys (and different vessels), the "control" of variables considered to influence abundance/biomass (e.g. gear type, vessel characteristics, skipper and/or crew expertise). The programme should also include a detailed cost breakdown that may consider financial compensation or incentives to participating vessels.

The sampling plan should be defined and the sampling periods agreed. The plan should also include a detailed list of geographic locations where the fishing operations should take place. The first year campaign could be considered experimental and the initial plan changed accordingly, but subsequently the plan should not be modified so that factors other than changes on the abundance/biomass of the stock significantly affect the final estimates.

A list of vessels engaged in the sentinel campaign should be pre-defined and their commitment to the programme guaranteed. An alternative list of vessels, with similar characteristics of those included in the list, may be also considered. In each campaign, vessels should strictly follow the adopted sampling plan and would likely require a special fishing permit in accordance with EU legislative framework. Vessels may be chartered (ensures greater mastery of the protocol) or the planned fishing operations could be supported financially.

The programme should include the participation of scientific on-board observers but, if that proves to be highly difficult, previously trained members of the crew may be considered as an alternative. Vessels are selected among those that can accommodate extra crew personnel (at least of one element).

Main aspects to be considered in the design of the sampling plan for *R. undulate*:

Fishing gear	Adoption of a standard gear that catches the species effectively; can operate in different depths and habitats; is not size selective
Study area	Wide coverage of stock area, including zones of less abundance and ability to operate in inshore and/or estuarine areas
Sampling period	Two pre-defined sampling periods should be considered and determined. These should be based on the available knowledge on the species dynamics and its life cycle. If one of the sampling periods is within the main reproductive season, changes on species behaviour should be considered.
Sampling design	Two approaches might be considered, (i) stratified simple random sampling or (ii) systematic sampling (spatial grid for the selection of fishing hauls e.g. one station every x cells).
Sampling effort	Total effort defined in accordance to the total budget assigned to the campaign. Human and technical resources available (number of nets or longlines, number of vessels, etc.) needs to be considered. Effort allocated to strata as a function of the variance of species density or abundance/biomass along the study area (e.g. species abundance varying along space) or with time (e.g. associated with species reproductive or ontogenetic behaviour).

Data requirements are summarised below:

Vessel	Vessel name and registration number Vessel technical characteristics (e.g. LOA, tonnage, power, etc.) Registration port Skipper identity and experience
Trip	Date and time of departure/arrival Fishing port of departure/arrival Observer's Identification
Environment condition	Tidal state, sea conditions (e.g. wave height, wind strength) Water temperature
Gear characteristics	Gear type, state (new, good state) For gillnet and trammelnets: length and height in meters, mesh in millimeters, number of net units, length of a net unit sheet For longline: length in meters, number, size and type of hooks, type of bait For trawl, dredge: gear dimensions, mesh size, trawling speed, presence of tickler chains, description of gear
Fishing haul	Operation ID Date/time of gear deployment and retrieval Geographic location of the fishing haul (including set and hauling) Fishing depth Soaking/trawling time
Biological data	From all the target species, data collected should include: Coordinates of the capture location Biometric measurements such as total length (from nose to tip of tail), width (from one wing to the other) and body weight Health status (lively, sluggish or dead) Sex Maturity stage (whenever possible) Collected tissue samples of specimen (if from live fish, in accordance with appropriate animal welfare protocols) Survivorship of discarded individuals If marked, the number of the mark should be recorded

26.5 References

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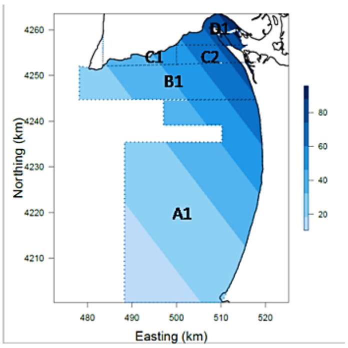
Table 26.1. Portugal mainland (ICES Division IXa) – Annual estimates of the posterior median, 25% and 97.5% quartiles of the total landed weight of *Raja undulata* for the period 2003–2008.

YEAR	MEDIAN	P2.5	P97.5
2003	164.3	137.1	197.0
2004	197.0	164.2	235.8
2005	171.7	141.2	208.4
2006	271.3	232.6	315.1
2007	156.7	132.3	185.6
2008	208.3	178.4	243.4

Table 26.2. Estimates of *Raja undulata* abundance by subregion and of catchability. Map of the study area with the estimated density (number of *R. undulata per* square meter).

SUB-REGION	ABUNDANCE ESTIMATE (N° OF SPECIMENS)	AREA ESTIMATE (KM2)	PC ESTIMATE
A1	34353.15	1139.147	0.0003558456
C1	1591.102	36.15782	0.01121087
C2	3591.321	53.92095	0.007517688
D2	4578.088	58.37388	0.00694421
B1	13612.26	293.2451	0.001382327
TOTAL	57725.921	1580.845	



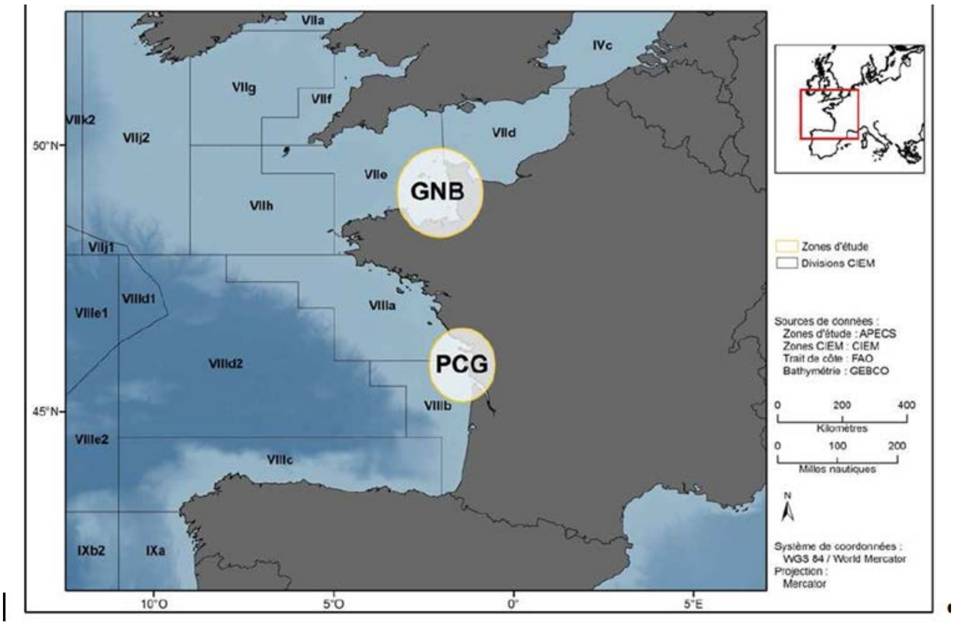


Figure 26.1. Map of study areas for French projects.

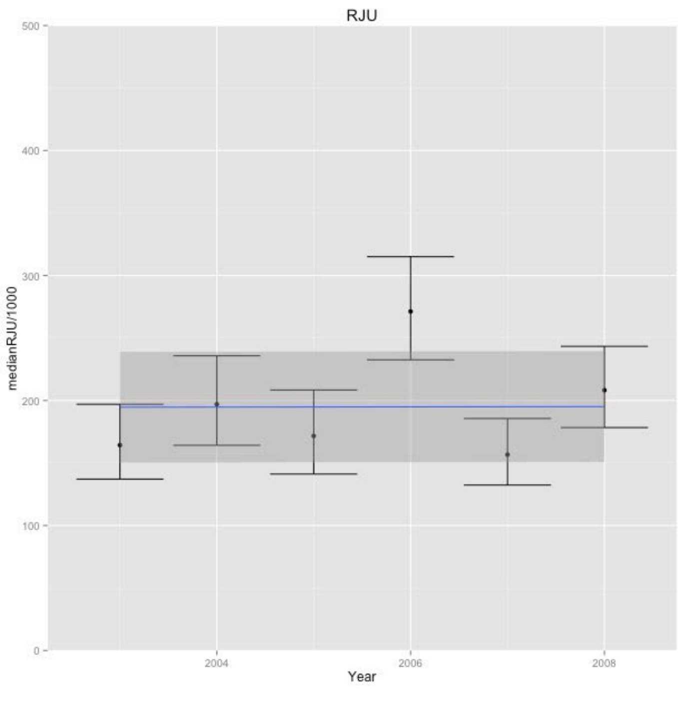


Figure 26.2. Portugal mainland (ICES Division IXa) – Annual estimates of the posterior median of the total landed weight of *Raja undulata* for the period 2003–2008. The vertical bars correspond to the 2.5% and 97.5% percentiles; 195 t corresponds to the mean of the historical annual landing estimates.

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Annex 2: WGEF Stock Annexes

The table below provides an overview of the WGEF Stock Annexes. Stock Annexes for other stocks are available in the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

STOCK ID	STOCK NAME	LAST UPDATED	LINK
bsk-nea_SA	Basking shark in the Northeast Atlantic (ICES Areas I–XIV)	June 2010	Basking shark I–XIV
cyo-nea_SA	Portuguese dogfish (*Centroscymnus coeloepis*)	June 2010	Portuguese dogfish NEA
dgs-nea_SA	Spurdog in the Northeast Atlantic	June 2011	Spurdog NEA
guq-nea_SA	Leafscale gulper shark (*Centrophorus squamosus*)	June 2010	Leafscale gulper NEA
por-nea_SA	Porbeagle in the Northeast Atlantic (Subareas I–XIV)	June 2010	Porbeagle NEA
rjb-89a_SA	Common skate (*Dipturus batis*-complex) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)	April 2014	Dipturus batis VIII&IXa
rjc-bisc_SA	Thornback ray (*Raja clavata*) in the Bay of Biscay VIIIa–c	June 2014	Thornback ray VIIIabc
rjc-echw_SA	Thornback ray (*Raja clavata*) in Division VIIe	June 2014	Thornback ray VIIe
rjc-pore_SA	Raja clavata in Western Iberian Waters (west of Galicia, Portugal, and Gulf of Cadiz) (ICES Division IXa)	June 2014	Raja clavata IXa
rje-ech_SA	Small-eyed ray (*Raja microocellata*) in Divisions VIId,e (English Channel)	June 2014	Small-eyed ray VIIde
rjh-pore_SA	*Raja brachyura* in Western Iberian Waters (west of Galicia, Portugal, and Gulf of Cadiz) (ICES Division IXa)	June 2014	Raja brachyura IXa
rjm-bisc_SA	Spotted ray (*Raya montagui*) in the Bay of Biscay	June 2014	Spotted ray BoB
rjm-pore_SA	*Raja montagui* in Western Iberian Waters (west of Galicia, Portugal, and Gulf of Cadiz) (ICES Division IXa)	June 2014	Raja montagui IXa
rjn-bisc_SA	Cuckoo ray (*Leucoraja naevus*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)	June 2014	Cuckoo ray VIII
rjn-pore_SA	*Leucoraja naevus* in Western Iberian Waters (west of Galicia, Portugal, and Gulf of Cadiz) (ICES Division IXa)	June 2014	Leucoraja naevus IXa
rju-9a_SA	*Raja undulata* in Western Iberian Waters (west of Galicia, Portugal, and Gulf of Cadiz) (ICES Division IXa)	June 2014	Raja undulata IXa
rju-ech_SA	Undulate ray *(Raja undulata*) in Divisions VIId,e (English Channel)	June 2014	Undulate ray VIIde
sck-nea_SA	Kitefin in the Northeast Atlantic and Mediterranean	June 2010	Kitefin shark

Annex 3: Working documents presented to WGEF 2015

Twenty-five working documents were submitted to the working group. These are listed below, with a brief summary. These summaries are from the working documents and do not necessarily imply agreement from WGEF. Relevant information, where used, is included in the relevant stock sections.

WD2015-01: Distribution of four skate species in ICES Subareas VI, VII and VIII-suggesting stock structure. Meadhbh Moriarty and Graham Johnston.

Methodology Summary: Catch data from the International Bottom Trawl Survey, and other fisheries surveys in ICES Subareas VI, VII and VIII were analysed (Figure 1). Surveys took place from 1997–2013, although not all areas were covered in all years. The density of the catches (number per kilometre square) of cuckoo ray, *Leucoraja naevus*; the *Dipturus* cf. *batis* complex; spotted ray, *Raja montagui*; and thornback ray, *Raja clavata* was calculated. The survey area was divided into 25 km² grids (nodes). Using the density of the catches, the relative abundance of each species at each of these nodes, was calculated. These were further graded into primary, intermediate, peripheral and unsuitable habitats. Both temporal and spatial changes were examined.

Results summary: Mapping of the grid node habitat grades suggested two distinct population spatial subunits of *L. naevus* : in the North West; and a Celtic Sea and South subunit, with the Irish Sea population as a sub unit of the Celtic Sea and south unit in the studied area.

For the *D. batis* skate complex, mapping of the grid node habitat grades suggested two distinct population spatial subunits: a Northwest, which presumably extends further north of Scotland, into the North Sea, and a Celtic Sea subunit (Figure 17).

For *R. montagui*, one population spatial subunit is suggested, situated in the northwest, and into the Irish Sea, which presumably extended further north of Scotland, into the North Sea. The spatial data along with the temporal trend would further suggest that the Irish Sea population is a subpopulation of the northern population; these two regions should therefore be considered as one spatial unit (Figure 26). For *R. clavata*, mapping of rhe habitat grades suggested one major population spatial subunit: situated in the northwest, and Irish Sea, which presumably extended further north of Scotland, into the North Sea (Figure 34). There is a second southern population which is quite small and may be particularly vulnerable due to its isolation from the larger northern population.

WD2015-02: 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. Ellis, J. R. and Bendall, V. A.

Abstract: Porbeagle *Lamna nasus* is an incidental bycatch species taken in Celtic Sea gillnet fisheries targeting gadiform fish. Catches peak from August to October. Biological observations were collected from 53 specimens (20 females and 33 males) that were retained as dead bycatch, and information on conversion factors and maturity are summarised. Other tissue samples were collected for ongoing biological studies.

WD2015-03: Skates in the English beam trawl survey of the eastern English Channel (VIId) and southern North Sea (IVc). Ellis, J. R.

Abstract: An annual 4 m beam-trawl survey is conducted in the eastern English Channel (VIId) and southern North Sea (IVc) each July, with the survey grid mostly standardised since 1993. Average catch rates of thornback ray *Raja clavata* increased over the time-series. Spotted ray *Raja montagui* and blonde ray *Raja brachyura* were caught in lower numbers with some variability in catch rates. The degree to which the juveniles of these species may have been confounded in some years is unclear. Other skates captured included small-eyed ray

Raja microocellata and undulate ray *Raja undulata*, although the stocks of these two species extend into the western English Channel (Celtic seas ecoregion).

WD2015-04: Catsharks in the English beam trawl surveys of the eastern English Channel and southern North Sea (VIId–IVc), and Irish Sea and Bristol Channel (Divisions VIIa,f). Ellis, J. R.

Abstract: Annual 4 m beam-trawl surveys are conducted in the eastern English Channel and southern North Sea (Divisions VIId and IVc) each July, and in the Irish Sea and Bristol Channel (Divisions VIIa, f) each September, with the survey grids mostly standardised since 1993 in both cases. Average catch rates of lesser-spotted dogfish *Scyliorhinus canicula* increased over the time-series in both surveys. Catch rates of greater-spotted dogfish *Scyliorhinus stellaris* also increased in the Irish Sea, but data from the eastern English Channel were too limited to inform on trends in relative abundance.

WD2015-05: Concentrations of mercury and other metals in porbeagle shark *Lamna nasus*. E. E. Manuel Nicolaus, Victoria A. Bendall, Thi Bolam, Thomas Maes and Jim R. Ellis.

Abstract: Concentrations of eleven metals in three tissues of porbeagle shark *Lamna nasus* (n=33) were determined. Hg concentrations in either the red or white muscle that exceeded the maximum levels established in European regulations for seafood were observed in 33.3% of specimens. Hg concentration, however, increased with length, and all fish >195 cm total length had concentrations >1.0 mg kg^{-1}, with a maximum observed value of 2.0 mg kg^{-1}. Several metals (As, Cu, Fe, Mn, Se, and Zn) were recorded in higher concentrations in red muscle than in nearby abdominal white muscle.

WD2015-06: Spatial overlap between Portuguese dogfish and the black scabbardfish off Portugal. Nuno Veiga, Teresa Moura, Ivone Figueiredo.

Abstract: Information about the spatial distribution of bycatch species and their spatial overlap with the target species is essential for the management of the fisheries involved. The present study used fishery-dependent data (vessel monitoring systems, logbooks and official daily landings) to study the spatial distribution and spatial overlap between the target species black scabbardfish *Aphanopus carbo* and the Portuguese dogfish *Centroscymnus coelolepis* one of the most common bycatch species taken by the longline fishery operating in Portugal mainland. The geostatistical method kriging was applied to estimate the distribution of the Portuguese dogfish in relation to black scabbardfish and by that to assess the relative impact of the fishery in this population. Results indicate that in fishing grounds where the *Aphanopus carbo* is more abundant, the relative occurrence of the Portuguese dogfish is low. These findings have implications on alternative management measures to be adopted in this particular fishery, namely on the minimization of deep-water shark bycatch.

WD2015-07: Recent observations on spurdog *Squalus acanthias* life history parameters in the North-East Atlantic. Silva, J. F. and Ellis, J. R.

Abstract: Spurdog *Squalus acanthias*, though formerly of commercial importance in the Northeast Atlantic, is currently under a zero total allowable catch (TAC). Much of the biological data for this stock were collected in the 1960s and 1970s, when the fishery was at its peak, but contemporary data for various life-history parameters have been more limited. The present study shows the preliminary results of recent biological investigations on spurdog (males and females), based on samples of dead bycatch provided by the fishing industry. These data include length–weight relationships by sex, maturity-at-length, fecundity-at-length, size of pups and overall diet composition.

WD2015-08: Reproductive characteristics and other life history parameters of starry smooth-hound *Mustelus asterias* in British waters. S. R. McCully Phillips and J. R. Ellis.

Abstract: The reproductive biology and other life-history parameters were investigated for *Mustelus asterias* in British waters, from both commercially sourced and research vessel samples. In total, 504 specimens (238 males, 24–99 cm total length (LT) and 266 females, 28–124 cm LT) were examined, with further information collected from 238 uterine pups. The lengths at 50% maturity were estimated as 70.4 and 81.9 cm LT for males and females, respectively. Ovarian fecundity ranged from one to 28, and uterine fecundity from four to 20. The number, mass and LT of pups were positively correlated to maternal LT. Full-term pups ranged from 205–329 mm LT, with the smallest free-living fish caught at 24 cm LT. Parturition occurred in February in the western English Channel and June–July in the eastern English Channel and southern North Sea, indicating either protracted spawning or asynchronous parturition for the stock as a whole. The reproductive cycle is thought to extend beyond one year. Developmental abnormalities observed included atresia in oocytes, uterine eggs that failed to develop, a partly developed pup and an abnormal male with a single aberrant clasper. Data relating to conversion factors, oocyte numbers and diameter, and gonado- and hepato-somatic indexes are presented, and the seasonality of the reproductive cycle discussed.

WD2015-09: Starry smooth-hound in the English beam trawl surveys of the eastern English Channel and southern North Sea (VIId–IVc), and Irish Sea and Bristol Channel (Divisions VIIa,f). Ellis, J. R.

Abstract: Annual 4 m beam-trawl surveys are conducted in the eastern English Channel and southern North Sea (Divisions VIId and IVc) each July and Irish Sea and Bristol Channel (Divisions VIIa,f) each September, with the survey grids mostly standardised since 1993 in both cases. Average catch rates of starry smooth-hound *Mustelus asterias* have increased over the time-series.

WD2015-10: Updating the Elasmobranchs Data from the Azorean Fisheries (ICES Area X). By Mário Rui Pinho.

Abstract: About 58 elasmobranch species are listed as occurring in the Azores. The species covers pelagic, benthopelagic and benthic habitats from shallow to deep-water strata in areas around coastal of the islands, banks and seamounts. However, only about 17 shark species are identified by the auctions on the landings. Elasmobranchs catches from the Azores (ICES Area X) are mainly bycatches from three main fisheries: the swordfish fishery, the demersal fishery and the black scabbardfish fishery. Biological sampling data are scarce because these species have low sampling priory. This paper updates the elasmobranchs landings from the Azores (ICES Area X) and resume the available sampling data to the landings, for 2015 WGEF meeting.

WD2015-11: Trends in the Northern European porbeagle fishery from 1950 to 1970. Gérard Biais, Kristin Helle and Nils Hareide.

Abstract: This WD presents new information on fishing effort and on social-economic factors that have ruled the catch trends of the Northern European porbeagle fishery from 1950 onwards to 1970. The quality of an assessment of the NEA porbeagle stock based on the Northern European catch decline is consequently questioned.

WD2015-12: Norwegian porbeagle longliner CPUE from 1950 to 1972. Gérard Biais, Karsten Kvalsund and Nils Hareide.

Abstract: This working document presents a cpue series of the Norwegian porbeagle fishery from 1950 to 1972 which was obtained by using personal logbooks of some fishermen. Most of the data are for the northern European waters, the historical Norwegian fishing zone. However, some data are also available for fishing days in the western European waters.

They show that Norwegian cpue (in tonnes/day) in this area were 70% higher than in the northern fishing area. The mean weight distribution shows also clearly that the western fishery was located on nursery areas. These cpue series were analysed by carrying out GLM. The annual coefficient series provided by this analysis shows a decreasing trend but not a declining one in the northern European waters. Between 1950–1954 and 1968–1972, the observed decrease is about 40%.

WD2015-13: Project UNDULATA-*Raja undulata* estimation of historical landings in Portugal mainland (ICES Division IXa). Catarina Maia, Ivone Figueiredo and Bárbara Serra-Pereira.

Abstract: The present work presents the Portuguese (ICES IXa) *Raja undulata* historical landings estimates for the period 2003–2008. The study was developed under the project UNDULATA. The estimation procedure was done under a Bayesian framework. The proportion of *R. undulata* in relation to the total landed weight of Rajidae was based on sampling data on species composition that was carried between 2003 and 2009 at the main ports landing Rajidae from Portuguese segments: trawl and polyvalent. The estimate of the overall landed weight of *R. undulata* in Portugal, for the period between 2003 and 2008, was relatively stable between years.

WD2015-14: Lesser spotted dogfish *Scyliorhinus canicula* in the Portuguese continental coast. Teresa Moura, Bárbara Serra-Pereira, Ivone Figueiredo.

Abstract: Data for the lesser spotted dogfish *Scyliorhinus canicula* in Portuguese continental waters (ICES Division IXa) are presented, particularly on the species biology, fisheries and research survey trends. This species is caught by the trawl and the artisanal fleets, within the latter trammel and gillnet are the fishing gears where it is mostly caught. Landing values along the time-series available are stable since 2005. Length data from specimens caught during the Portuguese Autumn Groundfish Surveys (PT-GFS) held between 1981 and 2014 showed no variation on the mean total length along the years. Annual standardized biomass index of *S. canicula* estimates based on the PT-GFS surveys were stable along the years (with exception of 2000 where catch rates were relatively high in most depth strata).

WD2015-15: Blackmouth catshark *Galeus melastomus* in the Portuguese continental slope. Teresa Moura, Célia Mateus, Bárbara Serra-Pereira, Ivone Figueiredo.

Abstract: Data for the blackmouth catshark *Galeus melastomus* in the Portuguese continental waters (ICES Division IXa) is presented, particularly on the species biology, fisheries and research survey trends. This species is caught by the trawl and the artisanal fleets, within the latter trammel and gillnet are the fishing gears where it is mostly caught. Landing values are not meaningful given the high discard rate, the zero TAC settled by the EC from 2010 to 2013, and the possible misidentification with *Galeus atlanticus*. Length data from specimens caught during the Portuguese crustacean surveys/Nephrops TV Surveys (PT-CTS (UWTV (FU 28–29)) held between 1997 and 2014 showed no variation on the mean total length along the years. Annual standardized biomass index of *G. melastomus* estimates based on the same survey series were stable along the years.

WD2015-16: Results from the pilot study on the Portuguese trammel nets fishery targeting anglerfish in ICES Div. IXa. Teresa Moura, António Fernandes, Ricardo Alpoim, Ivone Figueiredo and Manuela Azevedo.

Abstract: To evaluate the level of sharks bycatch and of discards and to increase the knowledge on the fishery, a pilot study on the Portuguese trammelnet fishery targeting anglerfish in ICES Division IXa (200–600 m deep) took place, under the PNAB/DCF, from May 2012 to December 2014. Ninety hauls were sampled on board of five vessels operating at three different geographical areas of the Portuguese continental coast. Eight of the species captured (68 individuals caught in 14 hauls) are included in the EU list of deep-water sharks (UE regulation 1182/2013). Vulnerability scores obtained in a productivity-susceptibility analysis conducted for this fishery indicated that all species are medium-highly vulnerable. The low frequencies of occurrence observed for all shark species are thought to be related to their depth range distribution, much broader than the depth range considered in this study. Most of the species are likely to occur deeper than 600 m. Results thus suggest that the fishery targeting anglerfish between 200 and 600 m has a low spatial overlap with most of the deep-water shark populations and consequently, a minor impact.

WD2015-17: Onboard data from the Portuguese deep-water longliners: study of the spatial overlap between deep-water sharks and the black scabbardfish. Nuno Veiga.

Abstract: A pilot study on board commercial fishing vessels from the Portuguese mainland black scabbard fishery was conducted to collect data to evaluate the spatial overlap between the target species, the black scabbardfish, and the two main bycatch species, the Portuguese dogfish and the leafscale gulper shark. Results prove that both deep-water sharks distribute deeper than the black scabbardfish in the Portuguese continental slope.

WD2015-18: Estimating the Yearly Size of the Population of Tope Shark off the Coast of Ireland. Bal. G., Johnston G., Roche W., O'Reilly S., Green P., Fitzmaurice P. and Clarke M.

Exploratory assessment models: In this document, we describe the current state of our research to perform a stock assessment of the Irish (ICES Division VIIj) population was presented using the data from the IFI Marine Sportfish Tagging Programme (see Section 22.5.1).

WD2015-19: Estimating the Yearly Size of the Population of Angel Shark off the Southwest Coast of Ireland. Bal. G., Johnston G., Roche W., O'Reilly S., Green P., Fitzmaurice P. and Clarke M.

Exploratory assessment models: In this document, we describe the current state of our research to perform a stock assessment of the Irish (ICES Division VIIj) population was presented using the data from the IFI Marine Sportfish Tagging Programme (see Section 22.5.1).

WD2015-20: UNDULATA Project-First Estimates of *Raja undulata* Abundance off Setúbal Peninsula. Ivone Figueiredo, Robert Dorazio, Catarina Maia, João Neves), Isabel Natário and Maria Lucília Carvalho.

Introduction: *Raja undulata* is a coastal skate that lives along the inner continental shelf of the Northeast Atlantic from northwest Africa to the British Isles, including parts of the Mediterranean Sea. In the coastal waters of the Portuguese mainland the species occurs along the continental shelf, being more frequently caught on grounds associated with sandy or coarse sandy bottoms (Serra-Pereira *et al*., 2014), not geographically detailed yet, north off Matosinhos and Aveiro, in the centre of Peniche, in the southwest coast off Setúbal and in the south Algarve.

WD2015-21: Results on main elasmobranch species captured during the 2001–2014 Porcupine Bank (NE Atlantic) bottom trawl surveys. O. Fernández-Zapico, F. Velasco, F. Baldó, C. Rodríguez-Cabello and S. Ruiz-Pico.

Abstract: This working document presents the results on the most significant elasmobranch species of the Porcupine Bank Spanish surveys in 2014 and updates the documents presented in previous years with the information in the whole historical series from 2001. The main species in biomass terms in this survey were *Galeus melastomus* (blackmouth catshark), *Deania calcea* (birdbeak dogfish), *Scymnodon ringens* (Knifetooth dogfish), *Dipturus nidarosiensis* (Norwegian skate), *Scyliorhinus canicula* (lesser spotted dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Hexanchus griseus* (bluntnose sixgill shark), *Dalatias licha* (Kitefin shark), *Leucoraja circularis* (sandy ray), *Dipturus cf. flossada*, *Leucoraja naevus* (cuckoo ray) and

Dipturus cf. intermedia (common skate). Biomass, distribution and length ranges were analysed for these species. All the species analysed increased its biomass in 2014, except *S. canicula* and *D. cf. flossada* that decreased. *D. calcea* individuals smaller than 65 cm were captured again in 2014 after not having been captured the previous year, although catches were very low. *Raja brachyura* was recorded for the first time in the survey area.

WD2015-22: Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. S. Ruiz-Pico, F. Velasco, C. Rodriguez-Cabello, A. Punzon, I. Preciado, O. Fernandez-Zapico, M. Blanco.

Abstract: This working document presents the results on the most significant elasmobranch species captured in the Spanish Groundfish Survey on Northern Spanish shelf in 2014. The main species in decreasing order of biomass are *Scyliorhinus canicula* (Lesser spotted dogfish), *Galeus melastomus* (Blackmouth catshark), *Etmopterus spinax* (Velvet belly), *Raja clavata* (Thornback ray), *Raja montagui* (Spotted ray) and *Leucoraja naevus* (Cuckoo ray). Biomass, distribution and length ranges were analysed. The majority of the species showed a decrease in biomass with regard to 2013 when highest values of the time-series were reached and a new vessel (R/V Miguel Oliver) was used. The results of this last survey, also on board of R/V Miguel Oliver, seem to return to the values previous to 2013.

WD2015-23: Spurdog in Norwegian waters: Recent trends in occurrence and composition in surveys and commercial catches. Albert, O.T and Vollen, T.

Introduction: Spurdog in the Northeast Atlantic is the only elasmobranch stock that is assessed by WGEF by means of an analytical assessment model. The model was benchmarked in 2010 (ICES, 2011) and is described by De Oliveira *et al*. (2013). Last assessment is from 2014 (ICES, 2014), and the next is scheduled for 2016.

WD2015-24: Spurdog in two Norwegian surveys. Vollen, T. and Albert, O.T.

This WD is an update and expansion of WGEF WD 2014-25 "Data on spurdog from two Norwegian surveys; the Shrimp survey and the Coastal survey, updated with new data in 2014".

WD2015-25: Natural mortality for Thornback (*Raja clavata*) stock from the Azores (ICES Xa2). Mário Rui Pinho, Ana Pabon, Helena Krug.

Abstract: Natural mortality (M) is one of the main parameters used for fish stock assessment. It has recently been suggested as a long-term target reference point for sustainable fishing mortality. However, it is a very uncertain and difficult parameter to estimate. In this study we explore several approaches to estimate natural mortality for *Raja clavata* from the Azores (ICES Area X). We explore particularly the methods (age-dependent and independent) related with population life history as a tool for data-limited stocks. Life-history information for *Raja clavata* from the Azores (ICES Area X) was collected from published literature and natural mortality estimated applying selected methods. Considering the uncertainty of the methods and the life-history parameters we use multiple methods and different set of parameters available for the species to estimate M, assessing the variability. Results show that for constant M (independent of age, length or weight) approach mean estimates from different methods varies between 0.2 and 0.5 per year. For variable natural mortality by length, age or weight methods mean values between 0.1 and 1.1 are estimated for the fully recruited fraction of the stock. Overall a very broad range of M estimates are provided by the different methods. Implications of this variability for the assessment are discussed.