ICES WGEF REPORT 2011

ICES ADVISORY COMMITTEE

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Report of the Working Group on Elasmobranch Fishes (WGEF)

20–24 June 2011

Copenhagen, Denmark

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

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Executive Summary

ICES Working Group on Elasmobranch Fishes, 2011 (Chair, Graham Johnston, Ireland) was held at ICES Headquarters, Copenhagen, Denmark from the 20–24 June 2011. Thirteen WG members attended, with ten more contributing via correspondence. One scientist from the Environmental Protection Agency (Tuscany Region), Italy attended as an observer to the group. Twelve ICES member states were represented.

2011 is not an assessment year for WGEF, who normally work on a two-year assessment cycle. However, following the introduction of a new model in the spurdog assessment in 2010, a benchmark assessment was carried out. The review process was carried out intersessionally, while a new assessment for spurdog was run during the meeting. Draft advice was also produced.

Updated information on the state of 18 other elasmobranch stocks was provided. The Commission Consultation Document on criteria and methodological standards on good environmental status of marine waters was reviewed, and WGEF provided a list of elasmobranch species that could act as potential indicators in the Marine Strategy Framework Directive (MFSD).

One special request was received from the Northeast Atlantic Fisheries Commission. Two stock assessments were requested, but these will be carried out in 2012. A list of elasmobranch species in the NE Atlantic was provided, along with a classification of each of these species into the categories requested by NEAFC.

Future planning for the group was agreed, including priority assessments in the years to come.

13 Working Documents were presented to the Group, mainly relating to survey results and port-sampling schemes.

Stock assessment results

- Spurdog (*Squalus acanthias*)

In addition updated data were provided for other deep-water sharks, shortfin mako (*Isurus oxyrhynchus*), tope (*Galorhinus galeus),* thresher (*Alopias vulpinus*), blue shark (*Prionace glauca)* and other pelagic sharks, and for demersal elasmobranchs in the Barents, Norwegian, Faroese, and Iceland and East Greenland ecoregions.

1 Introduction

1.1 Terms of Reference

2010/2/ACOM19 The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Graham Johnston, Ireland, will meet at ICES Headquarters, 20–24 June 2011 to:

a) 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;

b) Evaluate the status of the stocks in the table below (i.e. do update assessments);

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

d) Provide first draft of advice text for the stocks listed in the table below;

e) Finalize stock annexes for demersal elasmobranchs in the Celtic Seas, and demersal elasmobranchs in the North Sea; and blue shark in the Northeast Atlantic;

f) Intersessionally, obtain information from the Mareco project; and to examine this information for the Azores and Mid-Atlantic Ridge area at the 2011 meeting;

g) Intersessionally, cooperate with PGCCDBS to create a list of sampling requirements necessary for elasmobranch stock assessment, and provide PGCCDBS with appropriate protocols for their collection;

h) Evaluate the need of fisheries-independent data and propose solution for the near future based on WGNEACS work, in collaboration with WGDEEP and WGDEC.

ToR h) should be by correspondence prior to the meeting, and the deadline first week of March.

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

WGEF will report by 24 July 2011 for the attention of ACOM.

Table 1.1. Assessments planned by WGEF for 2011.

Fish Stock	Stock Name	Stock Coord.	Assess. Cood.	Perform assessment	Advice
skx-67-d	Demersal elasmobranchs in the Celtic Sea and West of Scotland			No	No
skx-347d	Demersal elasmobranchs in the North Sea, Skagerrak and eastern English Channel			No	No
skx-89a	Demersal elasmobranchs in the Bay of Biscay and Iberian waters			No	No
dgs-nea	Spurdog (*Squalus acanthias*) in the Northeast Atlantic			y	Update
por-nea	Porbeagle (*Lamna nasus*) in the Northeast Atlantic			No	No
bsk-nea	Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic			No	No
cyo-nea	Portuguese dogfish (*Centroscymnus coelolepis*) and leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic			No	No
sck-nea	Kitefin shark (*Dalatias licha*) in the Northeast Atlantic			No	No
skx-10	Demersal elasmobranchs in the waters of the Azores				Collate data

1.1.1 Additional Terms of Reference

In addition to the WGEF-specific terms of reference above there were certain generics ToRs that needed to be addressed by WGEF. These relate to the Marine Strategy Framework Directive, and other environmental indicators.

i) Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision;

j) Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status;

k) take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP);

l) provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes;

m) identify spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc.

Terms of Reference i–l are addressed in Section 21. Term of reference m) is dealt with in each chapter.

1.2 Special Requests

A special request from the Northeast Atlantic Fisheries Commission was received prior to the meeting. This additional Term of Reference is outlined below.

"A number of Northeast Atlantic elasmobranch species currently feature on the NEAFC list of deep-water species managed under deep-water demersal fish regulations. Others are highly migratory pelagic species and fisheries for these species are regulated by ICCAT. However, NEAFC is aware of species with North Atlantic distributions that fall into neither of these categories. ICES is requested to list Northeast Atlantic elasmobranch species and classify them as 1) Highly migratory and widely distributed, 2) Deep-water species, and 3) Elasmobranch species that have distributions within the NEAFC area and are not Category 1) or 2). ICES is further requested to provide advice on basking shark (*Cetorhinus maximus*) and porbeagle (*Lamna nasus*) within the NEAFC CA, with an evaluation of the need for management actions."

This Special Request is addressed in Annex 5.

1.3 Participants

The following WGEF members attended the meeting:

Tom Blasdale	UK (Scotland)
Guzman Diez	Spain (Basque Country)
Helen Dobby	UK (Scotland)
Jim Ellis	UK (England and Wales)
Ivone Figueiredo	Portugal
Graham Johnston (Chair)	Ireland
José De Oliveira	UK (England and Wales)
Harriet van Overzee	The Netherlands
Mario Rui Pinho	Portugal (Azores)
Francois Poisson	France
Fabrizio Serena (Observer)	Italy
Charlott Stenberg	Sweden
Tone Vollen	Norway

The following WGEF members assisted by correspondence:

Stephen Beggs	UK (Northern Ireland)
Gerard Bias	France
Maurice Clarke	Ireland
Enric Cortes	USA
Boris Frentzel-Byme	Germany
Henk Heessen	Netherlands
Sophy McCully	UK (England and Wales)
Kelle Moreau	Belgium
Bernard Seret	France
Francisco Velasco	Spain

1.4 Background and History

The Study Group on Elasmobranch Fishes (SGEF), having been first established in 1989, was re-established in 1995 and had meetings in that year, 1997 and 1999. 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, 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. 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. 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.

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), our 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. In addition, updates assessments were carried out for North Sea, Celtic Seas, and Biscay and Iberian demersal elasmobranchs and for deep-water siki sharks. 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, 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.

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, survey scientists and elasmobranch biologists.

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.

1.5 Planning of the work of the group

In 2009 WGEF presented a plan for the next two years. It was agreed that annual meetings are necessary. This is particularly important in the light of increasing numbers of Special Requests received by the Group.

Assessments of stock status will usually be conducted on a two year cycle. In order to facilitate the best assessments of each of the main species for which advice is sought, it was intended that the Group would deal with different species in different years.

In 2010 WGEF proposed that in years where advice is required (2012, 2014, etc), that the meetings remain at their current eight-day duration. However, where new assessments are not required (e.g. 2011), the meetings can be reduced to five days. This assumes that no addition Terms of Reference are added, or EC Special Requests, which may require additional time.

In 2012 special emphasis will be placed on the assessment of the demersal elasmobranchs. In particular, the time-series of species-specific landings that is now available for skates and rays will be examined.

1.6 ICES approach to F_{MSY}

Most elasmobranch species are slow growing, with low production. Some species, such as basking shark, are on several conservation groups' 'threatened' or 'endangered' lists. 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. For each assessed stock the ICES F_{MSY} approach is considered, the Group's approach and considerations outlined in the Stock Summary sheets.

1.7 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.

1.8 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 is taking 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, and for short-term management, a zero TAC may be more appropriate.

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, we would propose 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 2010 undulate ray, *Raya undulata* was placed on 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. However, to-date, there has been no change in the listing of this species.

1.9 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.

1.10 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.

1.11 Current ICES Working Groups of relevance to the WG

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 (see Section 2), tope (Section 10) and various skates and rays (Section 15). 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 smoothhounds. 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.

Working Group for the Celtic Seas Ecoregion (WGCSE)

Several elasmobranchs are taken in the waters covered by WGCSE, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 18). WGCSE should note that common skate *Dipturus batis,* 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 smalleyed ray *Raja microocellata,* as well as being an important nursery ground for various small sharks (e.g. smoothhounds and tope) and other rajids.

In 2009, the EC prohibited landings/retention of angel shark, white skate, common skate and undulate ray from this ecoregion (CEC, 2009). Angel shark was formerly abundant in parts of Cardigan Bay, the Bristol Channel and Start Bay, and is now rarely observed. Similarly, white skate may also be extirpated from most parts of the region. Common skate may be locally abundant on some offshore fishing grounds, and undulate ray are locally abundant in parts of the (western) English Channel, and so these measures may have caused controversy with some sections of the fishing industry.

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*. These assessments were updated with 2009 landings and survey data and expanded upon at this meeting.

Working Group on Fish Ecology (WGFE)

WGFE has often addressed elasmobranchs within their ToRs, and the participation of WGEF members in WGFE meetings to further develop collaborative research (e.g. on important elasmobranch habitats) should be encouraged.

International Bottom-trawl Survey Working Group (IBTSWG)

In 2009, IBTSWG continued to provide maps of the distribution of a variety of demersal elasmobranchs from the IBTS surveys in the North Sea and western areas (ICES, 2009a). WGEF considered that these plots provide useful information and hope that IBTSWG will continue such work in 2010.

WGEF recommend that IBTSWG compile comparable maps examining the overall distributions (all survey data combined) of lesser-known elasmobranchs, specifically *Dipturus batis, Raja brachyura, Leucoraja circularis* and *L. fullonica* using all available IBTS survey data.

Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS)

There have been improvements in the collection of biological information for skates in fishery-independent trawl surveys and in the provision of species composition for commercial skate catches. There are, however, some issues that need to be resolved, for example (i) ensuring accurate species-identification when reporting species composition from market sampling, and (ii) developing standardized and appropriate methods for raising species composition data.

One of the skate species for which ICES has been unable to provide advice is blonde ray *Raja brachyura*. This large bodied species has a patchy distribution and so is not sampled effectively in existing groundfish surveys. Given that this species is often landed with spotted ray *Raja montagui*, it is considered important that better differentiation between these species is required. Given the difficulties in separating these species, market sampling may still be required to get a more accurate species composition for these sister taxa.

WGEF has received two recommendations from PGCCDB. These are addressed in Annex 3.

Working Group on Fish Technology and Fish Behaviour (WGFTFB)

Annex 8 of ICES (2008b) provided a useful overview of technical issues relating to fisheries in the North Sea and Celtic Seas ecoregions, etc. It was noted that were *"Problems with the introduction of the 5% bycatch limits for dogfish (Squalus acathias) on* *west coast and North Sea grounds. They can be encountered in large congregations but it is almost impossible for vessels to identify them using sonar etc so they are difficult to avoid*".

WGFTFB also noted that "Regulations introduced at the start of 2008 preventing the targeting of spurdog have created problems, particularly for inshore gillnetters off the North Galway and Mayo coasts". Several of these vessels now spent more time potting for crab and lobster. The regulation also affected vessels operating in the southwest of the British Isles, including for trawlers which can sometimes catch large quantities of spurdog. Hence, this regulation will have led to some discarding (ICES, 2008b).

A maximum landing length (100 cm) was introduced for 2009.

Other elasmobranch issues discussed by WGFTFB include the switch from beam trawls to outrigger trawls (see Section 3.1.1. of ICES, 2008b). This change of gear, driven by the reduction in fuel consumption, may lead to increased catches of skates and rays, and WGFTFB noted that "*In terms of overall catch composition ray represented between 32.35%–45.07% (average 36.65%) of the total catch by weight for the four vessels*". It is thought that fishers may target skates with such gears in order to compensate for the reduction in catches of sole *Solea solea.* The move away from beam trawls may also allow vessels to fish inside 12 nm, where there can be large concentrations of skates.

WGEF recommend that WGFTFB be asked to further monitor developments in this fishery.

ICES 2008b also provided some information on the use of electropositive alloys (mischmetals) as a shark bycatch reduction method for longline fisheries (See various projects summarized in Section 19.13 of ICES, 2008b). Although some (but not all) of these studies demonstrated reduced hooking rates of elasmobranchs, the use of mischmetals in commercial operations may be limited by expense, hazardous nature, and its rapid dissolution in seawater.

A theme session entitled "Elasmobranch Fisheries: Developments in stock assessment, technical mitigation and management measures" was held at the 2010 ICES Annual Science Conference in Nantes, France. This was co-convened by members of WGEF and WGFTFB.

42 papers were submitted, on subjects ranging from biochemistry to the results of satellite tagging surveys, and included aspects of the stock assessment of several species. Papers were submitted on elasmobranch studies from throughout the ICES area, as well as on stocks in the Mediterranean Sea and the South Atlantic and Pacific oceans.

Working Group on the Bycatch of Endangered Species (WGBYC)

After three years as a study group (SGBYC) WGBYC became a full Working Group in 2011. The Group has expanded from its initial remit of examining cetacean bycatch, and its particular role in monitoring how EC Regulation 812/2004 is implemented at a national level, into examining the bycatch of other endangered species, including birds, reptiles and elasmobranchs. Having sent a representative to this group in January 2010, WGEF intends to continue providing expertise to the Group, and in working with the Group in elasmobranch conservation.

Working Group on Beam Trawl Surveys (WGBEAM)

WGBEAM carries out some analysis of catch rates and distribution of certain ray species from beam trawls in the North Sea and in the Irish Sea. This sort of analysis is very useful for this WGEF.

Working Group on the Northeast Atlantic Continental Slope Surveys (WGNEACS)

WGNEACS has expanded from a planning group. Its role is to coordinate deep-water surveys in the ICES area. There are three survey regions; Northern, Central and Southern. Results and analysis from these surveys is used in the assessment of deep-water shark species.

1.12 Other fisheries meetings of relevance to WGEF

Workshop on Sexual Maturity Staging of Elasmobranchs (WKMSEL)

This 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. 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.

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 short-fin mako. It is intended that these collaborations continue to usefully assess and update knowledge of pelagic shark species.

1.13 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 1.4 lists species occurring in the ICES area that are being considered within these fora.

Table 1.4. Species listed by Multilateral Environmental Agreements.

	Multinational Environmental Agreement			
Species	OSPAR	CMS	CITES	Bern
Spurdog *Squalus acanthias*	✓	App II	Proposed, Rejected 2010	
Gulper shark *Centrophorus granulosus*	✓			
Leafscale gulper shark *Centrophorus squamosus*	✓			
Portuguese dogfish *Centroscymnus coelolepis*	✓			
Angel shark *Squatina squatina*	✓			App III (Med)
Sawfish *Pristis pristis* and *P. pectinata*			App I	
Common skate *Dipturus batis*	✓			
White skate *Rostroraja alba*	✓			App III (Med)
Thornback ray *Raja clavata*	✓(North Sea)			
Spotted ray *Raja montagui*	✓ (North Sea)			
Giant devil ray *Mobula mobular*				App II (Med)
Basking shark *Cetorhinus maximus*	✓	App I and II	App II	App II (Med)
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	Proposed, Rejected 2010	App III (Med)
Blue shark *Prionace glauca*				App III (Med)

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, representing 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 the future conservation priorities and research needs of marine biodiversity (species and habitats) at risk in this region. To date, eleven elasmobranch species are listed (Table 1.3), either across the entire OSPAR region or in areas where they are declining. Background Documents that summarize the status of each of these species and propose actions and measures to be taken, including through ICES, are currently under development.

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 in all 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 strictly protecting the 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 (www.cms.int).

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 the 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 may be listed in Appendix I, essentially banning commercial international trade in their products. Appendix II of CITES 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 these species is closely monitored and allowed only after exporting countries provide evidence that such trade is not detrimental to populations of the species in the wild (e.g. where fisheries are regulated). Table 1.3 lists elasmobranch species occurring in the Northeast Atlantic that are listed in the Appendices or currently known to be proposed for listing. 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; several other ICES species are included in these lists. Decision 13.42 encourages parties to improve their 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).

1.14 ICES fisheries advice

ICES advice is now provided under the Maximum Sustainable Yield concept.

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.

1.15 Data availability

Provision of data prior to Working Group

WGEF members felt 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.

In almost all cases, members provided national catch data to the group before the new data deadlines proposed by ICES.

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 better 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.

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

French data

French data were not available in 2010 as a result of drastic changes in the reporting system. The French delegation has provided this year, the total estimated landings data and the estimated catch data per statistical area (ICES squares) for 2009 and 2010 and for all the elasmobranch species caught by the French fisheries. These datasets were provided by the SACROIS project (toward validated and qualified fishing statistics). This application is crossing different sources of fishing statistics (logbooks, declarative forms, sales notes, catch assessment surveys, VMS data, ...), and compile them into a single, verified and consistency controlled data flow, with the aim of displaying validated and qualified landings per species and effort dataseries.

Discards

Few discards data are available to WGEF, and 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 demersal and deep-water stocks is currently weak. In most of the cases, the identification of stock is based on the distribution and relative abundance of the species, limited knowledge of movements and migrations, reproductive mode, and consistency with management units. Therefore, the WG considers that the stock definitions proposed in the Report are mostly preliminary. 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 Section 1.15 of the 2010 WGEF report.

WGEF recommends that length frequency information both commercial and survey be made available to the group to enable length-based assessments to take place.

For 2012 WGEF recommends that length frequencies of ray and skate species collected during discard observer trips should be provided to the group no later than the 1st February 2012. These should include both discard and landings figures, by species, sex, and ICES division. Length frequencies collected from port sapling trips should also be collected. These data are already collected under the EU Data Collection Framework, and so should be made available by EU member states.

Differences in the methods of measuring fish were outlined in ICES 2010b.

Spatial data

Under ToR m, WGEF has been asked to identify spatial data available to the group. This is dealt with in each chapter.

Other issues–*Dipturus* complex

Two papers (Iglesias *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, mislabelled since the 1920s. *D. batis* is a confusion of *D. flossida* (blue skate) and *D. intermedia* (flapper skate). The distribution and relative proportions of these skates in the Northeast Atlantic are unknown, but it is expected that in some areas at least, the two species will overlap. This Report will therefore refer to the *Dipturus batis* complex, as an alternative to erroneously referring to the individual species each time.

Currently labs can only upload data to DATRAS for *D. batis*, and the Secretariat and IBTSWG are attempting to enable species-specific data to be input.

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

1.16 Methods and software

Many elasmobranchs are data poor, 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.

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.

1.17 Other issues

A special request from the EC (ToR h) to evaluate the need for fisheries-independent data in relation to WGNEACS was answered in a joint response from WGEF, WGDEEP, WGDEC and WGNEACS. It can be found at:

http://www.ices.dk/committe/acom/comwork/report/2011/Special%20Requests/EC%20Scientific%20surveys%20for%20deep%20water%20fisheries.pdf

1.18 Working documents presented

The following Working Documents were provided:

Clarke, M., Johnston, G. 2011. Proposals for management of rays in VI and VII. Working Document to WGEF WD 2011-01.

Diez, G., Quincoces, I., Arregi, L., Basterretxea, M., Galparsoro, I., Garmendia, J.M., Martínez, J., Rodríguez, J.G., Uriarte, A. 2011. Biomass index and length frequencies of demersal elasmobranch in the Basque Country coast (ICES Division VIIIc). Working Document to WGEF WD 2011-02.

Fernandes, A.C., Prista, N., Jardim, E., Silva, D., Ferreira, A., Abreu, P., Fernandes, P. 2011. Results from the 2010 Portuguese onboard sampling programme of the deep water longline fleet with an emphasis on elasmobranch species. Working Document to WGEF WD 2011-03.

Fernández-Zapico, O., Valesco, F., Baldó, F., Ruiz-Pico, S., Blanco, M. 2011. Results on main elasmobranch species captured during the 2001–2010 Porcupine Bank (NE Atlantic) bottom-trawl surveys. Working Document to WGEF WD 2011-04.

Figueiredo, I., Serra-Pereira, B. 2011. Portuguese continental artisanal mixed fisheries taking skates. Steps towards fishing effort estimation. Working Document to WGEF WD 2011-05.

Johnston, G., Clarke, M. 2011. A comparison of the length frequencies of two ray species in the Irish sea, 2008–2010, with the length frequencies measured in 1997. Working Document to WGEF WD 2011-06.

Maia, C., Serra-Pereira, B., Lagarto, N., Lago, J., Figueiredo, I. 2011. First results on the pilot sampling programme on skates landings from mainland Portugal. Working Document to WGEF WD 2011-07.

Pinho, M.R. 2011. Elasmobranchs information from the annual Azorean bottom longline survey (ICES AREA Xa2). Working Document to WGEF WD 2011-08.

Pinho, M.R., Canha, A. 2011. Elasmobranchs discards from the Azores longline fishery (ICES Subdivision Xa2). Working Document to WGEF WD 2011-09.

Pinho, M.R. 2011. Elasmobranchs fishery data from the Azores (ICES Area Xa2). Working Document to WGEF WD 2011-10.

Ruiz-Pico, S., Velasco, F., Punzón, A., Serrano, A., Rodríguez-Cabello, C., Blanco, M., Fernández-Zapico, O. 2011. Results on main elasmobranch species captured in the bottom-trawl surveys on the Northern Spanish Shelf. Working Document to WGEF WD 2011-11.

Serra-Pereira, B., Moura, T. Farais, I., Maia, C., Lagarto, N., Veiga, N., Figueiredo, I. 2011. Information on sharks, rays and skates landings from mainland Portugal. Working Document to WGEF WD 2011-12.

Vollen, T. 2011. Spurdog in two Norwegian bottom-trawl surveys. Working Document to WGEF WD 2011-13.

1.19 References

CEC. 2009. Council Regulation (EC) No 43/2009 of 16 January 2009 fixing for 2009 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. Official Journal of the European Union L 22; 205 pp.

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

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

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

Francis, M. P. 2006. Morphometric minefields-towards a measurement standard for chondrichthyan fishes. Environ Biol Fish (2006) 77:407–421.

Griffiths, A.M., Sims, D.W., Cotterell, S.P., El Nagar, A., Ellis, J.R., Lynghammar, A., McHugh, M., Neat, F.C., Pade, N.G., Queiroz, N., Serra-Pereira, B., Rapp, T., Wearmouth, V.J. and Genner, M.J. 2010. Molecular markers reveal spatially segregated cryptic species in a critically endangered fish, the common skate (*Dipturus batis*). Proceedings of the Royal Society B, 277: 1497–1503.

ICES. 2005. Report of the Working Group on Elasmobranch Fishes (WGEF). 14–21 June 2005, Lisbon, Portugal. ICES CM 2006/ACFM:03. 229 pp.

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

ICES. 2007. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–28 June 2007, Galway, Ireland. ICES CM 2007/ACFM:27. 318 pp.

ICES. 2008a. Report of the Working Group Elasmobranch Fishes (WGEF), 3–6 March 2008, Copenhagen, Denmark. ICES CM 2008/ACOM:16. 332 pp.

ICES. 2008b. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 21–25 April 2008, Tórshavn, Faroe Islands. ICES CM 2008/FTC:02. 265 pp.

ICES. 2009a. Report of the International Bottom-trawl Survey Working Group (IBTSWG), 30 March—3 April 2009, Bergen, Norway. ICES CM 2009/RMC:04. 241 pp.

ICES. 2009b. Report of the Planning Group on commercial Catches, Discards and Biological Sampling (PGCCDBS), 2–6 March 2009, Montpellier, France. ICES CM 2009/ACOM:39. 160 pp.

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

ICES, 2010b. Report of the Working Group on Elasmobranch Fishes (WGEF). 22–29 June 2010, Horta Portugal. ICES CM 2010/ACOM 19. 560pp.

Iglesias, S.P., Toulhaut, L. and Sellos, D.Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquatic Conserv: Mar. Freshw. Ecosyst. 15pp DOI: 10.1002/aqc.1083.

Johnston, G., Clarke, M., Blasdale, T., Ellis, J., Figueiredo, I., Hareide, N. R., and Machado, P. 2005. Separation of Species Data from National Landings Figures. ICES CM 2005/N:22, 16 pp.

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.

Analyses of microsatellite data conducted by Verisimmo *et al.* (2010, a WD submitted to WGEF) found genetic homogeneity between east and west Atlantic spurdog, but 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

Spurdog has a long history of exploitation in the northeast Atlantic and WG estimates of total landings are shown in Figure 2.1 and Table 2.1. The main exploiters of spurdog have historically been France, Ireland, Norway and the UK (Figure 2.2 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. The fishery has changed significantly in recent years. More restrictive quotas, a maximum landing length and bycatch regulations have meant that target fisheries have declined and recent landings are mainly taken as a bycatch in trawl, gillnet and seine fisheries. Further details of the historical development of the fishery can be found in the Stock Annex.

2.2.1 The fishery in 2010

The prohibition of directed fisheries for spurdog by EU vessels has resulted in a significant change in the spatial distribution of the landings. Although landings across all ICES subareas have shown a decline in recent years, those from the Celtic Seas area (Subareas VI and VII) have declined at a greater rate than those from Subareas II–IV. The latter area now accounts for over 55% of the total landings of northeast Atlantic spurdog.

Over 50% of the total reported landings in 2010 were by Norwegian vessels; with the majority of these taken 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 in line fisheries and, to a lesser extent, other trawl fisheries.

France was the only other country reporting significant landings of spurdog in 2010, at 348 tonnes, mainly from ICES Divisions VIId–k. No information was available on the fisheries in which these landings were taken.

Landings reported by other nations consisted of less than 5% of the total. Notably, the landings from UK vessels (which were traditionally one of the major exploiters of the spurdog stock) have now reduced to just over 5% of the total. In 2010, the TAC was restrictive for UK vessels.

Further general information on the mixed fisheries exploiting this stock and changes in effort can be found in ICES (2009 a, b) and STECF (2010).

2.2.2 ICES advice applicable

In 2010, ICES provided the following advice for spurdog:

PA considerations

'There is no additional information to change the perception of the stock, consequently ICES reiterates its advice for 2007–2010, that the stock is depleted and may be in danger of collapse. Targeted fisheries should not be permitted to continue, and bycatch in mixed fisheries should be reduced to the lowest possible level. The TAC should cover all areas where spurdog are caught in the northeast Atlantic and should be set at zero.'

MSY considerations

'There is insufficient information upon which to apply the MSY framework. The stock appears stable at a low level in the recent period, but this is a short period compared to the longevity of the species. Given the longevity of the species, the failure of recruitment and the likelihood that recovery will be slow, the MSY framework cannot be applied.'

2.2.3 Management applicable

The following table summarizes ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2011:

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)
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)	2828	-	-	2853
2008	No new advice	No new advice	631 (2,3)	-	-	2004 (2)	1737
2009	F=0	Stock depleted and in danger of collapse	316 (3,4)	-	104 (4)	1002 (4)	2561
2010	F=0	Stock depleted and in danger of collapse	0 (5)		0 (5)	0 (5)	1045
2011	F=0	Stock depleted and in danger of collapse	0 (6)		0	0 (6)	

(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 (*Et-*

mopterus 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 vessel;

Catches not complying with these conditions or exceeding these quantities shall be promptly released to the extent practicable.

(6) Catches taken with longlines of tope shark (*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, the TAC for spurdog has been retained at zero for 2011. No landings are permitted, in contrast to 2010 when 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 of 50%. Live specimens must be released, whereas dead specimens must be landed and sold. 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 is allowed to be caught and kept by the fisher during a 24-hour period. Special permits allowing vessels to fish for spurdog are no longer issued by the Swedish Board of Fisheries.

Many of the mixed fisheries which catch 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). These are described further in Section 1 of this Report.

2.2.4 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 2.1. Preliminary estimates of landings for 2010 were 1045 t although this figure does not include Faroese landings so this value is likely to be revised upwards next year. Some updates have been made to the WG estimates of pre-2010 total landings.

2.2.5 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 available to the WG this year. 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 being discarded.

No other new data were available for 2010 or 2011.

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

2.2.6 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.

Under-reporting 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 has 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. However, quotas in 2010 have certainly been restrictive for certain countries which is likely to have led to increased discard rates. Estimates of dead discards are not available.

2.3 Commercial length frequencies

2.3.1 Landings length compositions

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 5 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.

2.3.2 Discard length compositions

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 previously provided by UK (E&W) for a limited number of fleets but recent data have not been re-examined and are not included in the assessment. Further details can be found in the Stock Annex.

2.3.3 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. Over the past 20 years, UK landings have on average 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 are just above 5% of the total. 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.

2.4 Commercial catch-effort data

No commercial cpue data were available to the WG.

Norway is currently considering a sentinel fishery on spurdog. The design would be based on WGEF's descriptions of a sentinel fishery (Section 1.9 in ICES, 2010), and total landings of spurdog (sentinel fishery and bycatch) would be kept lower than 2010 landings. A sentinel fishery could provide a cpue-series as well as information on distribution, migrations, lengths, sex-ratios, maturity status and age of spurdog in Norwegian waters.

2.5 Fishery-independent information

2.5.1 Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. The following survey data were available to this meeting:

- 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 1977–2003.
- 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.

Further examination of survey data (catch rates, length frequencies and biological information) is presented in this section.

A recent (2009) 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.

2.5.2 Length frequency distributions

Length distributions (aggregated over all years) from the UK (E&W), Scottish and Irish groundfish surveys are shown in Figures 2.5–2.7.

The UK (E&W) groundfish survey length frequency (Figure 2.5) 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 2.6), 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 2.7). 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 these length frequencies 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 2.8), 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.

Previously presented length frequencies which have not been updated this year are displayed in the Stock Annex.

2.5.3 Cpue

Spurdog survey data are typically characterised by highly variable catch rates due to occasional large hauls and a significant proportion of zero catches. Time-series plots of frequency of occurrence (proportion of non-zero hauls) and catch rate (confidence intervals not shown) for the UK (E&W) and Irish surveys are shown in Figures 2.9–2.10. These short time-series show apparently stable frequency of occurrence and catch rates.

Average catch rate (in numbers per hour) from the NS-IBTS is shown in Figure 2.11. Although the time-series is noisy, it appears that average catch rates are lower in recent years than at the beginning of the time-series.

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 2.12–2.13).

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.

2.5.4 Statistical modelling

At the 2006 WG meeting, an analysis of Scottish survey data was presented which investigated methods of standardizing the survey catch rate to obtain an appropriate index of abundance. Following on from this, and the subsequent comments of the most recent Review Group, further analysis was conducted in 2009. The major concern was that given the large differences in size for this species, an index of abundance in $N.hr^{-1}$ was less informative than an index of biomass catch rates. The analysis was updated at the WG in 2009 to address these concerns.

Data from four Scottish surveys listed above (1990–2009 or 2010) 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, together with the associated information on gear type, haul time, depth, duration and location. Each survey dataset used in this analysis contains over 1000 hauls and the North Sea Q3 contains over 1500. 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 min.

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 explain the variation in catch-rate 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 analysis was conducted in stages: initially each survey was considered separately then the model fitted to all survey data combined. Because the aim was to obtain an index of temporal changes in the cpue, 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 and interactions terms were also investigated. Variables which explained greater than 5% of the deviance were retained in the model. All variables were included as categorical variables.

The model results, in terms of retained terms and deviance values are demonstrated in Table 2.4. Estimated effects are shown in Figure 2.14. The diagnostic plot for the final lognormal model fit is shown in Figure 2.15, 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;
- further attempts should be made to obtain sex-specific abundance indices.

2.6 Life-history information

Maturity and fecundity data were collected on the UK FSP survey. 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.

2.7 Previous analyses

2.7.1 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).

2.7.2 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.

2.8 Assessment

2.8.1 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 are provided in Appendix 2a at the end of this chapter. In 2011 WGEF updated the model based on the benchmark assessment. The results of this are presented here.

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. The approach is essentially 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 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 (a new feature compared to ICES, 2006) 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 proportions-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 this year 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 only estimable parameters considered are the total number of pregnant females in the virgin population ($N_0^{f,preg}$), Scottish survey selectivity-by-length-category (4 parameters), commercial selectivity-by-length-category for the two fleets (6 parameters, three reflecting non-target selectivity, and three target selectivity), extent of density-dependence in pup production (Q_{fec}), and constrained recruitment deviations (1960–2010). 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 invariant, as in the Punt and Walker (1998) approach, but growth variation could be included (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 this chapter). 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 (response R1.2).
- To address the concern that Scottish survey proportions-by-length-category data are dominated by the occasional large tow of spurdog when these occur, these data were re-calculated 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 (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.

2.8.2 Life-history parameters and input data

Calculation of the life-history parameters M_a (instantaneous natural mortality rate), l_a^s (mean length-at-age for animals of sex s), w_a^s (mean weight-at-age for animals of sex s), and P_a'' (proportion females of age a that become pregnant each year) are summarised in Table 2.5, and described visually in Figure 2.16.

Landings data used in the assessment are given in Table 2.6. 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 are explored in order to explore the sensitivity of model results to these allocations. 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 1990–2010, and is given in Table 2.7 along with the corresponding CVs. The proportions-by-length category data derived from these surveys, along with the actual sample sizes these data are based on, is given in Table 2.8 separately for females and males.

Table 2.9 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 2.10a and b for the two periods (1960 and 2005).

2.8.3 Summary of model runs

Category	Description	Figures	Tables
• Base case run		2.17–25, 2.29–30	2.11–15
• Retrospective	A 6-year retrospective analysis, using the base case run and omitting one year of data each time	2.26	
• Sensitivity			
Qfec	A comparison with an alternative Qfec value that reflects the upper bound within the 95% probability interval of Figure 2.17c, with a demonstration of the deterioration in model fit to the survey abundance index for higher Qfec values	2.27	
Targeting scenarios	A comparison of alternative assumptions about targeting: 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	2.28	2.11

2.8.4 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} 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 2.17. The optimum in Figure 2.17c indicates that the data does contain information about Q_{fec}, but the lack of a clearly defined optimum (the curve is flat around the optimum) indicates that this information is limited. Therefore, although the two periods of fecundity data are essential for the estimation of Q_{fec}, further information that would help with the estimation of this parameter would be useful. Figure 2.17d indicates a near-linear relationship between Q_{fec} and MSYR (defined in terms of the biomass of all animals $\geq l^{f}_{mat(0)}$), so additional information about MSYR levels typical for this species could be used for this purpose (but was not attempted here).

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 2.17c. 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 later show that higher Q_{fec} values are associated with a deterioration in the model fit to the Scottish survey abundance index.

Figure 2.18 shows the model fit to the Scottish surveys abundance index, Figure 2.19a to the Scottish and England & Wales commercial proportion-by-length-category data, and Figure 2.19b 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 2.19b indicates a poorer fit to the survey proportions compared to the commercial proportions.

Figure 2.20 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 separately in Figure 2.21a, but are combined in Figure 2.21b to demonstrate 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 (2011) total biomass levels relative to 1905 and 1955 (B_{depl05} and B_{depl55}), are shown in Table 2.11a ("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 2.11b. Table 2.12 provides a correlation matrix for some of the key estimable parameters (only the last five years of recruitment deviations are shown). Correlations between estimable parameters are generally low, apart from 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 2.22, 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 2.19). 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 1 in the stock annex) 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 2.23a 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 lie 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 2.23b.

Time–series trends

Model estimates of total biomass (B_y) and mean fishing proportion ($F_{prop5\text{-}30,y}$) are shown in Figure 2.24 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 2.11a), 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 2.25 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 2.13 provides a stock summary (recruitment, total biomass, landings and $F_{prop5\text{-}30,y}$).

2.8.5 Retrospective analysis

A 6-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 2.26 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.

2.8.6 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 2.17c) 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}=2.37) and upper bound (Q_{fec}=3.43). Model result are fairly sensitive to these options (Figure 2.27a), 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 2.27b. 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) are explored in this set of sensitivity analyses. The alternative scenarios are listed in Section 2.8.3, and results shown in Figure 2.28 and Tables 2.11a and b. These results indicate a general lack of sensitivity to alternative assumptions about targeting, with estimates of depletion levels ranging from 13–18% for B_{depl05}, and 16–23% for B_{depl55}.

2.8.7 Projections

The base case assessment is used as a basis for future projections under a variety of catch options. These are based on a proportion of the average landings for the period 2006–2010 (0.25, 0.5, 0.75 and 1), and a proportion of the TAC in 2009 (0.1 and 1), assuming that the catch in 2011 will be 142.2 tons (10% of the TAC in 2009). An additional catch option is included to explore consequence for the stock of returning to the levels of landings taken in the 1980s (average around 36000t). Results are given in Table 2.14, expressed as total biomass in future relative to the total biomass in 2011, and are illustrated in Figure 2.29a for the average catch options, and in Figure 2.29b for the 2009 TAC and $F_{prop,MSY}$ options. Further catch options related to multiples of status-quo F_{prop}, and to $F_{prop,MSY}$ (=0.029), assuming that the catch in 2011 will be 540 tons [based on the assumption of a zero catch by EC nations, with landings estimated for the Faroe Islands and Iceland (mean annual landings for 2006–2010) and Norway (estimated as 50% of2010 landings, given there will be a reduced target fishery, but that dead discards must be landed)], are given in Table 2.15.

2.8.8 Conclusion

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, with total biomass depletion levels in 2011 relative to 1905 ranging from 13 to 18%. The base case model is therefore presented as the final assessment model for spurdog, and a summary plot of 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 2.30, and Table 2.13.

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 last year's assessment is provided in Figure 2.31.

2.9 Quality of assessments

WGEF has attempted various analytic assessments of NE Atlantic spurdog using a number of different approaches (see stock annex 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.

2.9.1 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.

There are occasional slight (0–1%) inconsistencies in the total landings when measured by country and when measured by ICES Division. This is the result of some national revision of historical landing and the assigning of proportions of catches from generic *nei* categories as "spurdog". It is intended that these be completely reconciled before the next meeting.

2.9.2 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.

2.9.3 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.

2.9.4 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 likelihood surface does not have a well-defined optimum, and additional information, such as on appropriate values of MSYR for a species such as spurdog, would help with this problem. Further refinements of the model are possible, such as including variation in growth. 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);
- Information on likely values of MSYR for a species such as spurdog.

2.10 MSY considerations

Exploitation status is below $F_{prop,MSY}$, as estimated from the results of the assessment. However, biomass has declined to record low level in recent years and therefore to allow the stock to rebuild, catches should be reduced to the lowest possible level in 2012. Projections assuming status quo F_{prop} (linked to total assumed catch of 540 t in 2011) suggest that the stock will rebuild by 9–15% of its current (2011) level by 2015 (Table 2.15).

2.11 Reference points

$F_{prop,MSY}$=0.029, as estimated by the current assessment, assuming average selection over last three years, reflecting a non-target selection pattern.

2.12 Conservation considerations

In 2006 the IUCN categorised northeast Atlantic spurdog as Critically Endangered. This categorisation has not been subject to peer-review.

2.13 Management considerations

Perception of state of stock

All analyses presented in this 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%).

In addition, spurdog are less frequently caught in groundfish surveys than they were 20 years ago.

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.

Since 2009, there has been a maximum landing length (MLL) to deter targeting of mature females (see Section 2.10 of ICES, 2006 for simulations on MLL). Discard survival of such fish needs to be evaluated. 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.

Although there is no EU minimum landing size for spurdog, there is some discarding of smaller fish, and it is likely that spurdog of <40 or 45 cm are discarded in most fisheries. The survivorship of discards of juvenile spurdog is not known.

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Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2010).

Year	Landings (tonnes)	Year	Landings (tonnes)	Year	Landings (tonnes)
1947	16 893	1969	52 074	1991	29 562
1948	19 491	1970	47 557	1992	29 046
1949	23 010	1971	45 653	1993	25 636
1950	24 750	1972	50 416	1994	20 851
1951	35 301	1973	49 412	1995	21 318
1952	40 550	1974	45 684	1996	17 294
1953	38 206	1975	44 119	1997	15 347
1954	40 570	1976	44 064	1998	13 919
1955	43 127	1977	42 252	1999	12 384
1956	46 951	1978	47 235	2000	15 890
1957	45 570	1979	38 201	2001	16 693
1958	50 394	1980	40 968	2002	11 020
1959	47 394	1981	39 961	2003	12 246
1960	53 997	1982	32 402	2004	9365
1961	57 721	1983	37 046	2005	8356
1962	57 256	1984	35 193	2006	4054
1963	62 288	1985	38 674	2007	2853
1964	60 146	1986	30 910	2008	1737
1965	49 336	1987	42 355	2009	2561
1966	42 713	1988	35 569	2010	1045
1967	44 116	1989	30 278		
1968	56 043	1990	29 906		

Table 2.2. Spurdog in the NE Atlantic. WG estimates of total landings by nation (1980–2010).

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	1097	1085	1110	1072	1139	920	1048	979	657	750	582	393	447	335	396
Denmark	1404	1418	1282	1533	1217	1628	1008	1395	1495	1086	1364	1246	799	486	212
Faroe Islands	0	22	0	0	0	0	0	0	0	6	2	3	25	137	203
France	17 514	19 067	12 430	12 641	8356	8867	7022	11 174	7872	5993	4570	4370	4908	4831	3329
Germany	43	42	39	25	8	22	41	48	27	24	26	6	55	8	21
Iceland	36	22	14	25	5	9	7	5	4	17	15	53	185	108	97
Ireland	108	476	1268	4658	6930	8791	5012	8706	5612	3063	1543	1036	1150	2167	3624
Netherlands	217	268	183	315	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
Poland	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
Russia	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
Sweden	399	308	398	300	256	360	471	702	733	613	390	333	230	188	95
UK (E&W)	9229	9342	8024	6794	8046	7841	7047	7684	6952	5371	5414	3770	4207	3494	3462
UK (Sc)	4994	3970	3654	4371	4957	6749	6267	8043	8075	8024	7768	8531	9677	6614	4676
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

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	391	430	443	382	354	400	410	23	11	13	20	17	0	0	7	1
Denmark	146	142	196	126	131	146	156	107	232	219	82	68	0	0	0	15

Faroe Islands	310	51	218	362	486	368	613	340	224	295	225	271	241	122	462	0
France	1978	1607	1555	1286	998	4342	4304	2569	1705	1062	2426	715	453	366	577	348
Germany	100	38	21	31	54	194	304	121	98	138	144	6	0	0	1	0
Iceland	166	156	106	80	57	107	199	276	200	142	71	75	36	52	102	62
Ireland	3056	2305	2214	1164	904	905	1227	1214	1416	1076	940	614	558	163	214	26
Netherlands	0	0	0	0	0	28	39	27	10	25	41	34	28	26	5	7
Norway	3940	2748	1567	1293	1461	1643	1424	1091	1119	1054	1010	790	616	711	543	512
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	256	120	100	46	21	2	3	4	4	9	6	10	9	4	2	2
Russia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	28	95	372	363	306	135	17	71	106	16	15	29	4
Sweden	104	154	196	140	114	123	238	0	275	244	170	148	95	9	80	5
UK (E&W)	2354	2670	3066	4480	4461	3654	4516	2823	3109	1729	1887	434	386	91	194	8
UK (Sc)	8517	6873	5665	4501	3248	3606	2897	2120	3708	3342	1263	766	415	178	345	56
Total	21 318	17 294	15 347	13 919	12 384	15 890	16 693	11 020	12 246	9365	8356	4054	2853	1737	2561	1045

Table 2.3. Spurdog in the NE Atlantic. WG estimates of landings by ICES subarea (1980–2010).

Area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Baltic	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0
I and II	138	20	28	760	40	120	137	417	1559	2806	4296	6609	5063	5102	3124
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
V	45	27	18	27	5	22	9	41	6	73	182	133	336	335	364
VI	4590	4011	5052	7007	8491	12422	8107	9038	7517	6406	5407	6741	6268	5927	5622
VIIA	2435	3330	3469	3996	6333	6769	6453	7283	5528	3388	2701	2486	2613	2438	2310

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VIIB,C	704	925	424	1777	2178	1699	1197	2401	1579	893	369	293	316	2009	1175
VIID,E, F	6693	8210	5989	4664	2450	1280	1644	2892	2120	1634	1339	1122	852	785	800
VIIG-K	4793	5479	3881	6924	4902	4965	3870	8107	6176	4477	3860	2679	2870	2055	2843
VIII	739	1095	479	312	234	257	507	497	242	174	273	367	406	435	406
IX	0	0	0	0	0	0	1	4	1	2	4	4	2	5	7
X	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
Other or unspecified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	40 681	39 278	31 305	37 041	35 190	38 670	30 912	42 334	35 529	30 275	29 930	29 700	29 234	25 684	21 011

Area	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Baltic	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
I and II	2725	1853	582	607	779	894	462	357	440	423	685	498	312	337	230	189
III and IV	7347	5299	4977	3895	2705	2475	2516	1904	2395	2163	1019	742	550	490	554	383
V	484	217	320	442	545	879	1406	808	583	677	473	457	352	189	565	65
VI	5164	4168	3412	2831	2715	5977	5624	3169	3398	2630	2838	851	502	165	265	75
VIIA	1177	1555	1516	1704	2010	1562	1878	1529	2021	938	605	411	280	74	114	3
VIIB,C	1004	603	450	854	1037	1028	816	527	588	432	358	270	262	56	95	7
VIID,E, F	760	852	646	443	411	438	555	295	268	278	290	174	197	162	314	166
VIIG-K	2258	2328	3046	2683	1824	2161	2846	2130	2339	1739	1973	531	313	196	340	112
VIII	602	408	418	308	171	405	469	269	134	56	97	85	50	64	80	38
IX	5	2	2	2	3	19	8	11	5	14	7	35	9	4	2	2
X	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
XII	4	0	12	104	22	14	41	22	74	12	9	0	0	0	0	0
Other	5	12	10	6	4	1	2	0	0	0	0	1	0	0	2	5
Total	21 534	17 298	15 391	13 879	12 244	15 854	16 630	11 020	12 246	9365	8354	4054	2827	1737	2561	1045

Table 2.4. 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|)
			5384	6088.5		
as.factor(year)	20	59.26	5364	6029.3	5 %	9.28E-06
as.factor(month)	10	1015.62	5354	5013.7	69 %	< 2.20E-16
as.factor(roundarea)	19	388.71	5335	4625	26 %	< 2.20E-16

Lognormal model	Df	Deviance	Resid df	Resid dev	%	Pr(>F)
			1360	3676		
as.factor(year)	20	204.72	1340	3471.3	30%	1.84E-10
as.factor(Q)	3	316.33	1337	3155	47%	<2.20E-16
as.factor(roundarea)	17	155.28	1320	2999.7	23%	7.04E-08

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

Parameters	Description/values	Sources
Ma	Instantaneous natural mortality at age a: $M_a = \begin{cases} M_{pup} e^{-a \ln(M_{pup}/M_{adult})/a_{M1}} & a < a_{M1} \\ M_{adult} & a_{M1} \le a \le a_{M2} \\ M_{til} / [1 + e^{-M_{gam}(a-(A+a_{M2})/2)}] & a > a_{M2} \end{cases}$	
aM1, aM2	4, 30	expert opinion
Madult, Mtil, Mgam	0.1, 0.3, 0.04621	expert opinion
Mpup	Calculated to satisfy balance equation 2.7	expert opinion
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
□f, □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 $w_a^s = a^s (l_a^s)^{b^s}$	
af, bf	0.00108, 3.301	Bedford *et al.*, 1986
am, bm	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 $$P''_a = \frac{P''_{\max}}{1+\exp\left[-\ln(19)\frac{l^f_a - l^f_{mat50}}{l^f_{mat95} - l^f_{mat50}}\right]}$$ where $P''_{\max}$ is the proportion very large females pregnant each year, and l^f_{matx} the length at which x% of the maximum proportion of females are pregnant each year	
$P''_{\max}$	0.5	average from literature
l^f_{mat50}, l^f_{mat95}	80 cm, 87 cm	average from literature

Table 2.6. 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.

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

Table 2.7. Northeast Atlantic spurdog. Delta-lognormal GLM-standardised index of abundance (with associated CVs), based on Scottish groundfish surveys.

Year	Index	CV
1990	161.2	0.33
1991	94.3	0.33
1992	79.9	0.32
1993	152.5	0.32
1994	136.8	0.36
1995	52.4	0.46
1996	86.0	0.36
1997	54.9	0.36
1998	81.6	0.35
1999	178.7	0.34

2000	73.1	0.37
2001	95.8	0.34
2002	94.6	0.34
2003	88.5	0.35
2004	63.4	0.37
2005	80.4	0.37
2006	65.2	0.36
2007	91.0	0.33
2008	77.3	0.36
2009	65.2	0.37
2010	95.5	0.56

Table 2.8. 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	148	0.0314	0.1628	0.0866	0.1810
2008	232	0.0708	0.1590	0.0127	0.1047
2009	233	0.0427	0.1175	0.2547	0.1167
2010	3483	0.2101	0.2125	0.1145	0.0004
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	262	0.0048	0.1643	0.1555	0.2135
2008	395	0.0699	0.1482	0.0669	0.3678
2009	417	0.0252	0.1247	0.0719	0.2466
2010	2465	0.0035	0.1699	0.0817	0.2074

Table 2.9. 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 2.10a. 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 2.10b. 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 2.11a. 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		Tar 4: historic non-target		Tar 5: historic target	
$N_0^{f,preg}$	96 851	[2.1%]	92421	[2.3%]	102 650	[2.2%]
Q_{fec}	1.985	[2.0%]	2.039	[2.7%]	1.949	[1.7%]
q_{sur}	0.000638	[23%]	0.000576	[28%]	0.000651	[22%]
B_{depl05}	0.147	[29%]	0.181	[36%]	0.131	[28%]
B_{depl55}	0.182	[29%]	0.225	[35%]	0.160	[27%]

Table 2.11b. 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. [Note, estimates of M_{pup}, a_{fec} and b_{fec} are the same in all cases.]

	Base case	Tar 4: historic non-target	Tar 5: historic target
M_{pup}	0.757		
a_{fec}	-12.615		
b_{fec}	0.184		
$F_{prop,MSY}$	0.0291	0.0298	0.0276
MSY	20451	20461	20848
B_{MSY}	964562	928275	1018670
M_{SYR}	0.0294	0.0308	0.0285

Table 2.12. 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}	$\varepsilon_{r,06}$	$\varepsilon_{r,07}$	$\varepsilon_{r,08}$	$\varepsilon_{r,09}$	$\varepsilon_{r,10}$	q_{sur}
$N_0^{f,preg}$	1																	
$S_{c2,non\text{-}tgt}$	-0.11	1																
$S_{c2,tgt}$	-0.01	0.00	1															
$S_{c3,non\text{-}tgt}$	-0.23	0.41	0.01	1														
$S_{c3,tgt}$	-0.04	0.02	0.08	0.08	1													
$S_{c4,non\text{-}tgt}$	-0.30	0.42	0.01	0.88	0.10	1												
$S_{c4,tgt}$	-0.18	0.07	0.10	0.21	0.56	0.25	1											
S_{s1}	0.03	-0.05	-0.01	-0.14	-0.10	-0.15	-0.16	1										
S_{s2}	0.06	-0.06	-0.01	-0.16	-0.11	-0.17	-0.17	0.48	1									
S_{s3}	0.08	-0.05	-0.01	-0.10	-0.05	-0.12	-0.10	0.39	0.51	1								
S_{s4}	0.03	-0.04	-0.01	-0.09	-0.07	-0.09	-0.10	0.31	0.39	0.33	1							
Q_{fec}	-0.01	0.05	0.01	0.21	0.20	0.21	0.27	-0.14	-0.12	-0.01	-0.05	1						
$\varepsilon_{r,06}$	-0.01	0.00	0.00	-0.01	-0.01	0.00	-0.01	0.00	-0.03	-0.03	0.00	-0.02	1					

$\varepsilon_{r,07}$	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.06	0.00	0.00	-0.01	-0.01	1				
$\varepsilon_{r,08}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.06	0.00	0.00	-0.01	-0.01	-0.02	1			
$\varepsilon_{r,09}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.08	0.00	0.00	-0.01	-0.01	-0.02	-0.03	1		
$\varepsilon_{r,10}$	0.00	0.00	0.00	0.01	0.01	0.01	0.01	-0.19	-0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.03	1	
q_{sur}	-0.31	0.02	0.00	-0.06	-0.18	-0.05	-0.17	-0.09	-0.23	-0.36	-0.34	-0.63	0.03	0.02	0.02	0.01	0.01	1

Table 2.13. 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)	Landings (t)	F_{prop} (5-30)
1980	196123	590253	40968	0.099
1981	180034	567214	39962	0.100
1982	169733	544593	32402	0.084
1983	167345	529071	37046	0.099
1984	156293	507699	35194	0.098
1985	145836	487006	38674	0.112
1986	143275	462173	30910	0.093
1987	139216	444368	42354	0.133
1988	132127	414346	35569	0.120
1989	133005	391026	30277	0.108
1990	123984	372287	29906	0.113
1991	129712	354182	29563	0.118
1992	120583	335885	29046	0.122
1993	105758	317280	25637	0.115
1994	100848	301877	20851	0.099
1995	89672	290570	21318	0.103
1996	90014	278687	17295	0.087
1997	89358	270496	15347	0.079
1998	87617	263735	13919	0.073
1999	85152	257825	12385	0.066
2000	83878	252959	15889	0.086
2001	83214	244254	16693	0.094
2002	82582	234562	11020	0.065
2003	85268	230603	12247	0.073
2004	86102	225376	9364	0.057
2005	86379	223005	8357	0.052
2006	84558	221503	4055	0.025
2007	86102	224343	2853	0.018
2008	89726	228490	1737	0.010
2009	93155	233813	2561	0.015
2010	110930	239255	2384	0.014

Table 2.14. Northeast Atlantic spurdog. Assessment projections under different future catch options. Estimates of total biomass relative to the total biomass in 2011 are shown, assuming that the catch in 2011 is 142.2 tons. 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.

wgef 2011	Catch Options							
	1	2	3	4	5	6	7	8
	zero	Cav 05-09	0.75Cav	0.50Cav	0.25Cav	TAC09	0.1TAC09	C80's
Catch	0	3913	2934	1956	978	1422	142.2	36000
Point estimates								
2011	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02
2012	1.06	1.04	1.05	1.05	1.06	1.05	1.06	0.90
2013	1.09	1.06	1.07	1.08	1.08	1.08	1.09	0.78
2014	1.12	1.08	1.09	1.10	1.11	1.11	1.12	0.66
2015	1.16	1.09	1.11	1.12	1.14	1.13	1.15	0.54
2016	1.19	1.11	1.13	1.15	1.17	1.16	1.19	0.43
2017	1.22	1.13	1.15	1.18	1.20	1.19	1.22	0.30
2018	1.26	1.15	1.17	1.20	1.23	1.22	1.26	0.20
2019	1.30	1.17	1.20	1.23	1.26	1.25	1.29	0.15
2020	1.33	1.18	1.22	1.26	1.29	1.28	1.33	0.10
Point estimates - 2 standard deviations								
2011	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.00
2012	1.04	1.02	1.03	1.03	1.04	1.04	1.04	0.80
2013	1.07	1.03	1.04	1.05	1.06	1.06	1.07	0.59
2014	1.09	1.03	1.05	1.07	1.08	1.08	1.09	0.38
2015	1.12	1.04	1.06	1.08	1.10	1.10	1.12	0.17
2016	1.15	1.05	1.08	1.10	1.13	1.12	1.14	0.00
2017	1.17	1.05	1.09	1.12	1.15	1.14	1.17	0.00
2018	1.20	1.06	1.10	1.14	1.17	1.16	1.20	0.00
2019	1.23	1.07	1.12	1.16	1.20	1.18	1.23	0.00
2020	1.26	1.08	1.13	1.18	1.22	1.20	1.25	0.00
Point estimates + 2 standard deviations								
2011	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
2012	1.08	1.06	1.07	1.07	1.07	1.07	1.08	1.00
2013	1.12	1.09	1.09	1.10	1.11	1.10	1.11	0.97
2014	1.15	1.12	1.12	1.13	1.14	1.14	1.15	0.94
2015	1.19	1.14	1.15	1.17	1.18	1.17	1.19	0.92
2016	1.23	1.17	1.19	1.20	1.21	1.21	1.23	0.89
2017	1.28	1.20	1.22	1.23	1.25	1.24	1.27	0.88
2018	1.32	1.23	1.25	1.27	1.29	1.28	1.31	0.48
2019	1.36	1.26	1.28	1.30	1.33	1.32	1.35	0.33
2020	1.40	1.29	1.31	1.34	1.37	1.35	1.40	0.25

Table 2.15. Northeast Atlantic spurdog. Further assessment projections under status quo F_{prop} scenarios. Estimates of total biomass relative to the total biomass in 20110 for different future catch options, assuming that the catch in 2011 is 540 tons. Point estimates are shown 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.

WGEF2011	Medium-term projections						
	1	2	3	4	5	6	7
	zero	$0.2F_{prop,sq}$	$0.4F_{prop,sq}$	$0.6F_{prop,sq}$	$0.8F_{prop,sq}$	$1.0F_{prop,sq}$	$F_{prop,MSY}$
ave Catch	0	126	251	376	500	624	5535
Point estimates							
2012	1.03	1.03	1.03	1.03	1.03	1.03	1.03
2013	1.06	1.06	1.06	1.06	1.06	1.06	1.04
2014	1.09	1.09	1.09	1.09	1.09	1.09	1.05
2015	1.12	1.12	1.12	1.12	1.12	1.12	1.06
2016	1.16	1.15	1.15	1.15	1.15	1.15	1.07
2017	1.19	1.19	1.18	1.18	1.18	1.18	1.08
2018	1.22	1.22	1.22	1.21	1.21	1.21	1.09
2019	1.26	1.25	1.25	1.25	1.24	1.24	1.10
2020	1.29	1.29	1.29	1.28	1.28	1.27	1.11
2021	1.33	1.33	1.32	1.32	1.31	1.31	1.12
Point estimates - 2 standard deviations							
2012	1.02	1.02	1.02	1.02	1.02	1.02	1.02
2013	1.04	1.04	1.04	1.04	1.04	1.04	1.02
2014	1.07	1.07	1.06	1.06	1.06	1.06	1.02
2015	1.09	1.09	1.09	1.09	1.09	1.09	1.02
2016	1.12	1.12	1.12	1.11	1.11	1.11	1.03
2017	1.15	1.14	1.14	1.14	1.14	1.13	1.03
2018	1.17	1.17	1.17	1.16	1.16	1.16	1.04
2019	1.20	1.20	1.19	1.19	1.19	1.18	1.04
2020	1.23	1.23	1.22	1.22	1.21	1.21	1.05
2021	1.26	1.25	1.25	1.25	1.24	1.24	1.05
Point estimates + 2 standard deviations							
2012	1.04	1.04	1.04	1.04	1.04	1.04	1.04
2013	1.08	1.08	1.07	1.07	1.07	1.07	1.05
2014	1.11	1.11	1.11	1.11	1.11	1.11	1.07
2015	1.15	1.15	1.15	1.15	1.15	1.15	1.09
2016	1.19	1.19	1.19	1.19	1.18	1.18	1.10
2017	1.23	1.23	1.23	1.22	1.22	1.22	1.12
2018	1.27	1.27	1.27	1.26	1.26	1.26	1.14
2019	1.32	1.31	1.31	1.30	1.30	1.30	1.16
2020	1.36	1.35	1.35	1.35	1.34	1.34	1.18
2021	1.40	1.40	1.39	1.39	1.38	1.38	1.19
"ave Catch" is the average for the period 2012-2021							

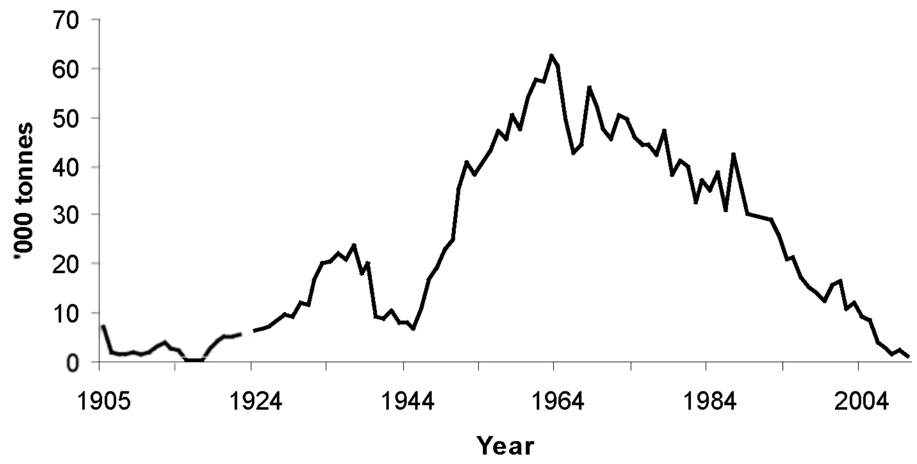


Figure 2.1. Spurdog in the NE Atlantic. WG estimates of total international landings of NE Atlantic spurdog (1905–2010).

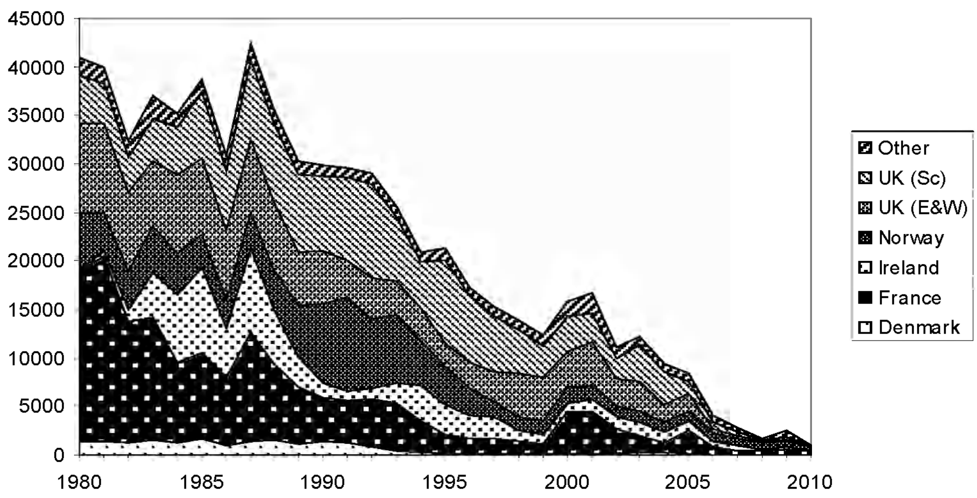


Figure 2.2. Spurdog in the NE Atlantic. WG estimates of landings by nation (1980–2010).

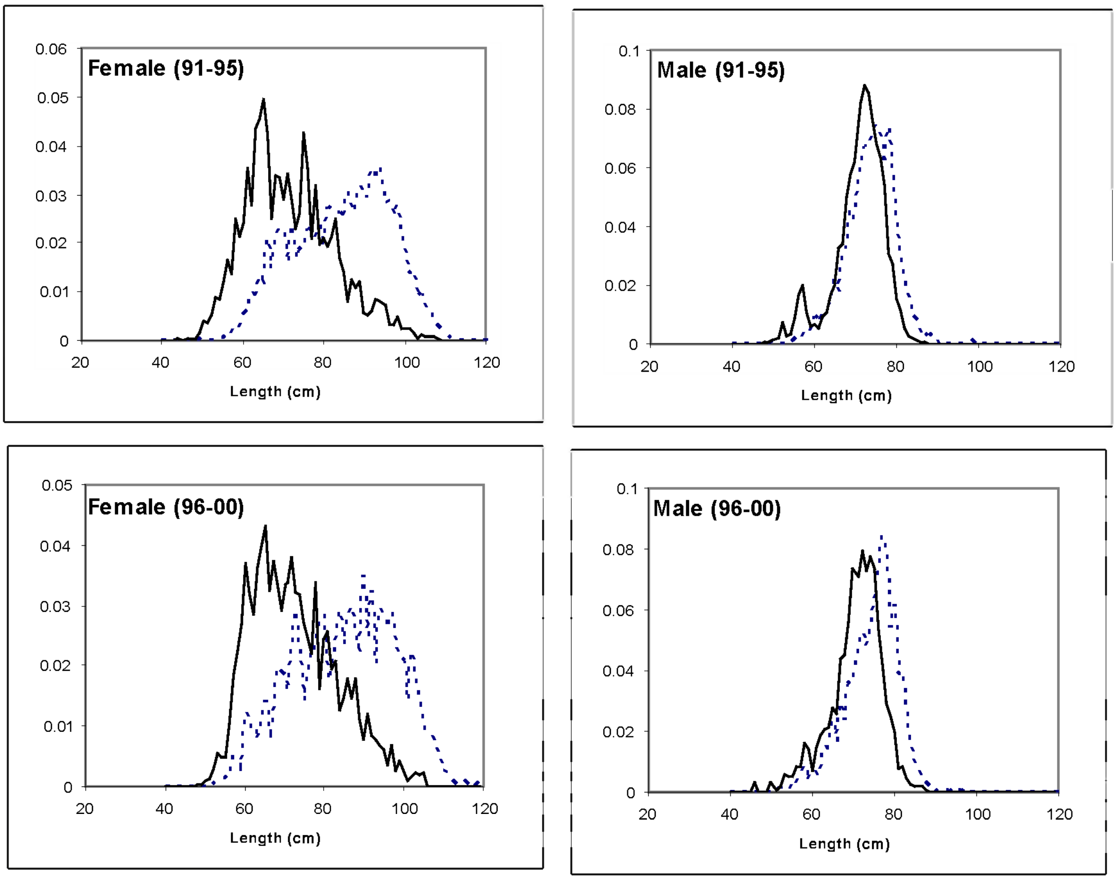


Figure 2.3. Spurdog in the NE Atlantic. Comparison of length frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK (E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.

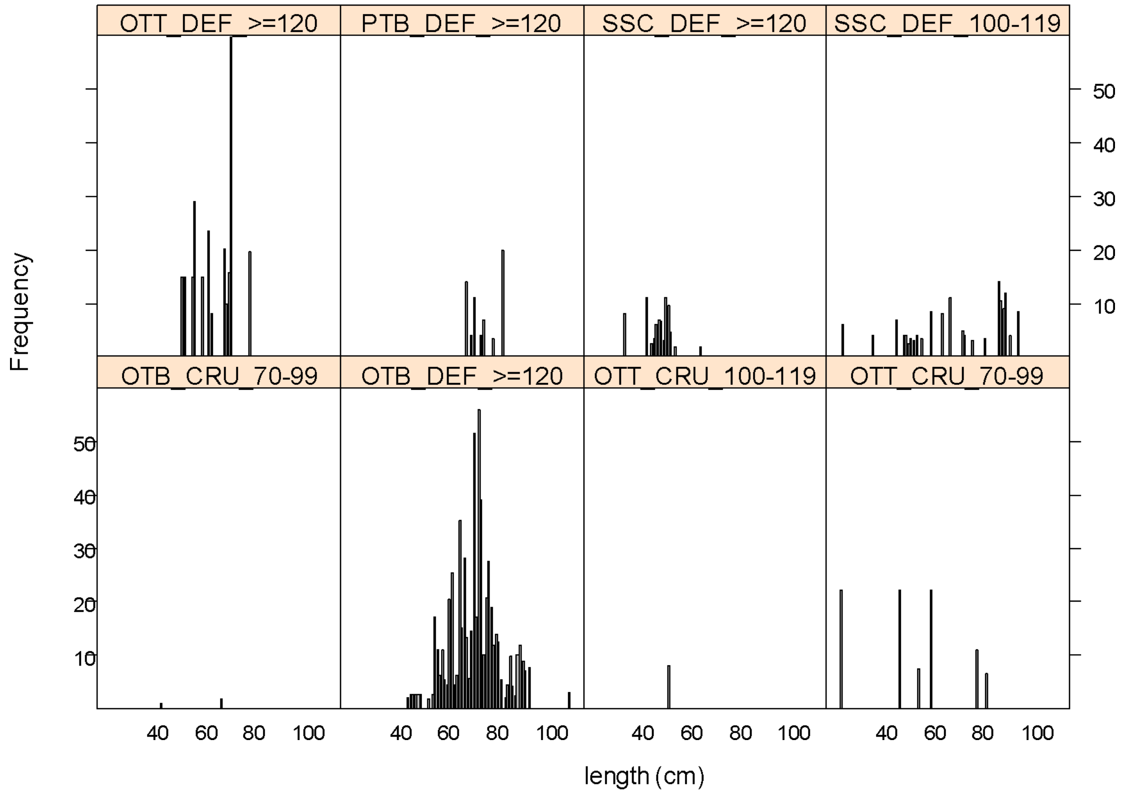


Figure 2.4. Spurdog in the NE Atlantic. Length distributions of spurdog caught on Scottish observer trips in 2010. Data are aggregated across trips for each gear category. Gear codes relate to gear type, target species and mesh size. OTT – Otter trawl twin; PTB – Pair trawl bottom; SSC – Scottish Seine;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

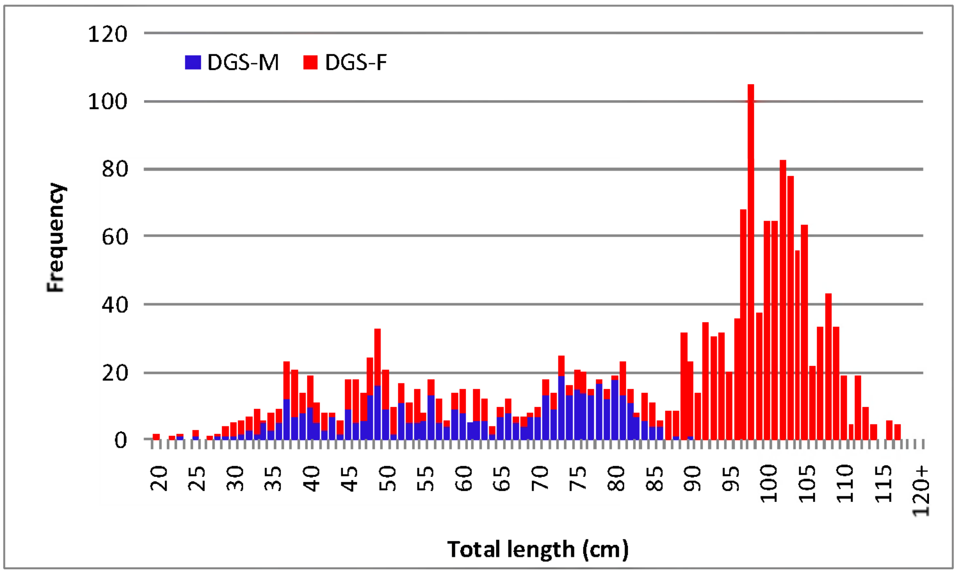


Figure 2.5. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid and additional tows). Length distribution highly influenced by a single haul of large females.

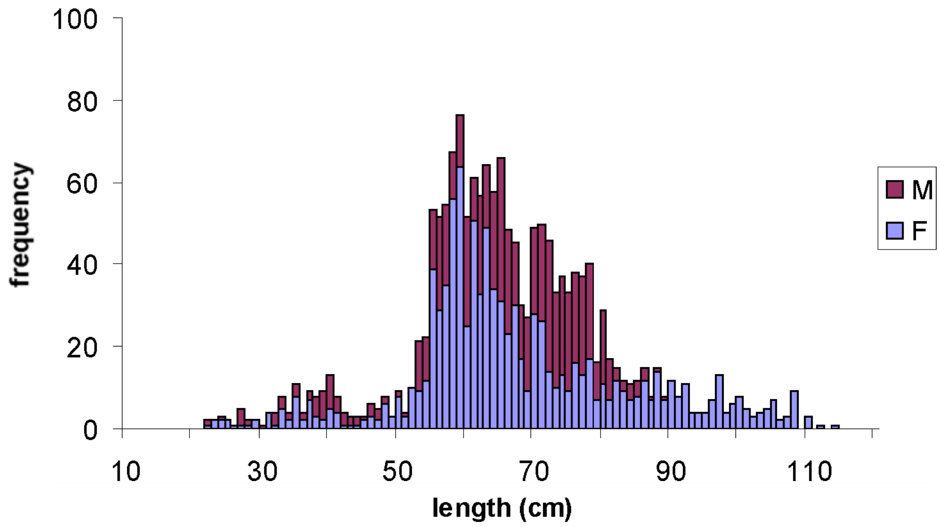


Figure 2.6. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Irish Q3 Celtic Seas groundfish survey (2003–2009).

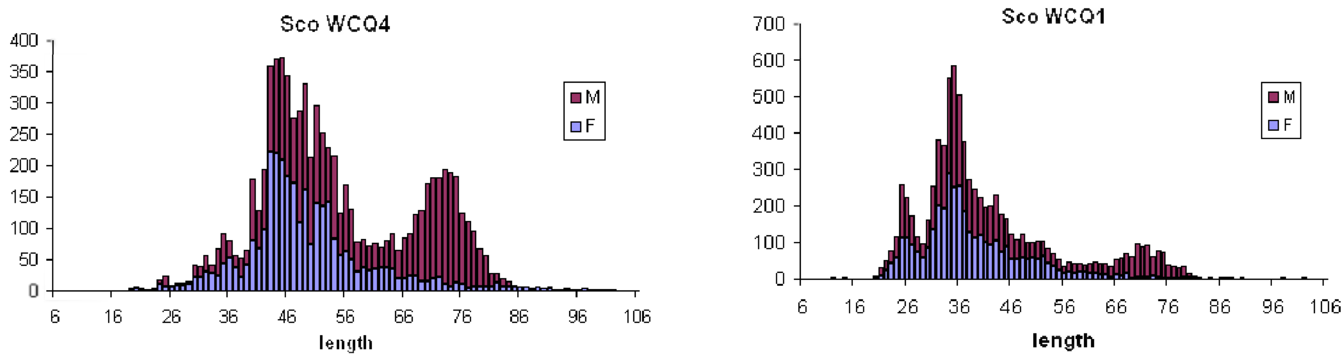


Figure 2.7. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Scottish Q1 and Q4 groundfish surveys (1990–2010). Length frequency distributions highly influenced by a small number of hauls containing many small individuals.

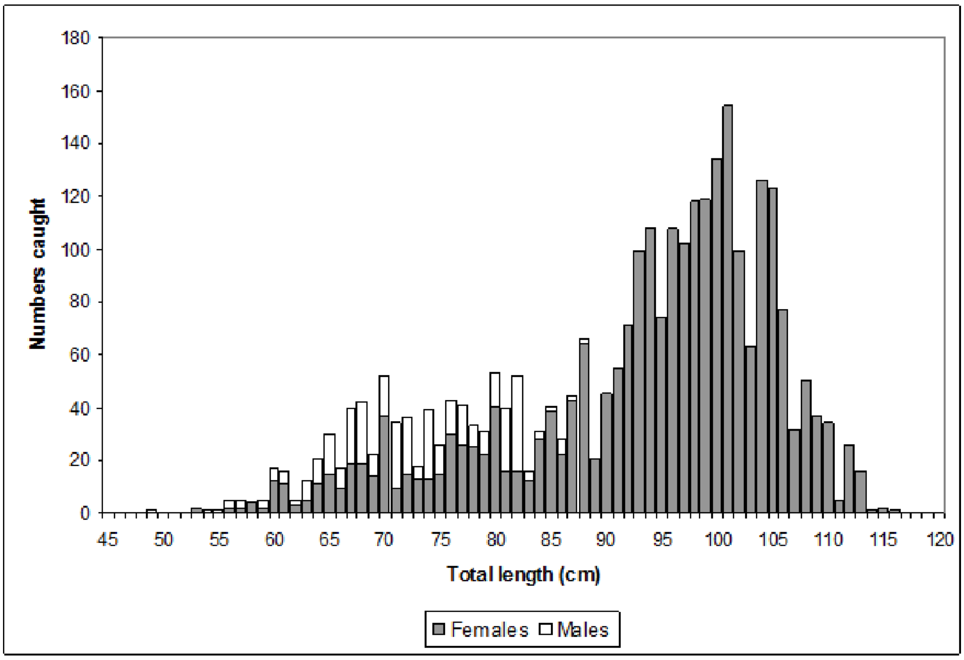


Figure 2.8. Spurdog in the NE Atlantic. Total length frequency of male and female spurdog taken during the UK (E&E) FSP survey, raised for those catches that were sub-sampled (n = 2517 females and 356 males).

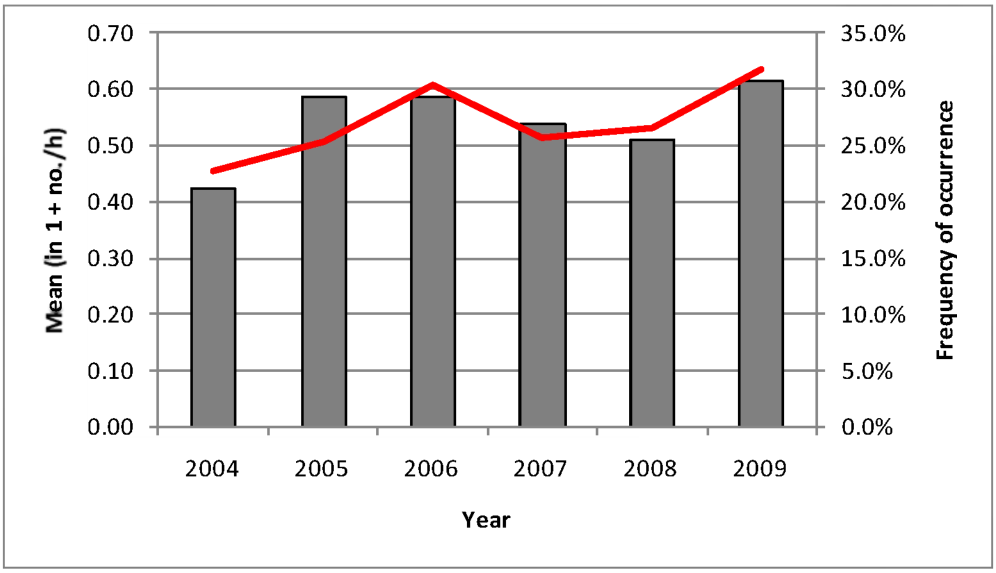


Figure 2.9. Spurdog in the NE Atlantic. Catch rate in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid tows), giving the mean (ln 1 + no.h-1, grey columns) and frequency of occurrence (red line).

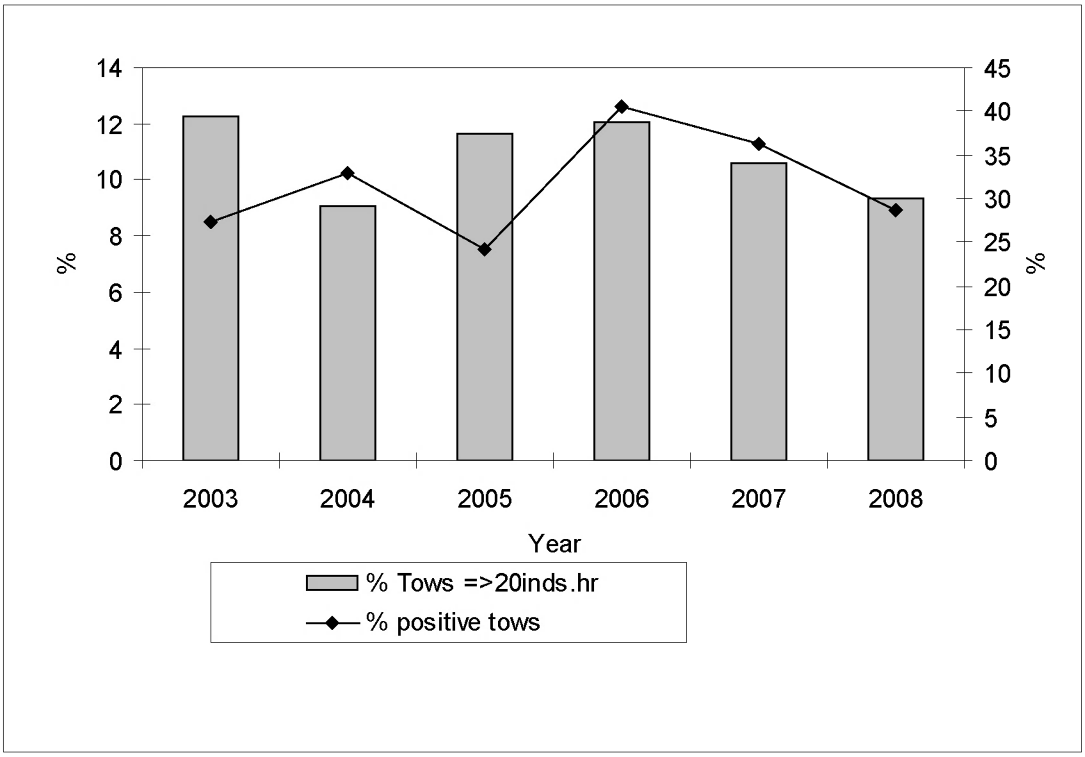


Figure 2.10. Northeast Atlantic Spurdog. Proportion of survey hauls in Irish Q3 groundfish survey 2003–2008, ICES Area VII, in which nominal cpue was ≥ 20 per 1-hour tow, and percentage of tows in which spurdog occurred.

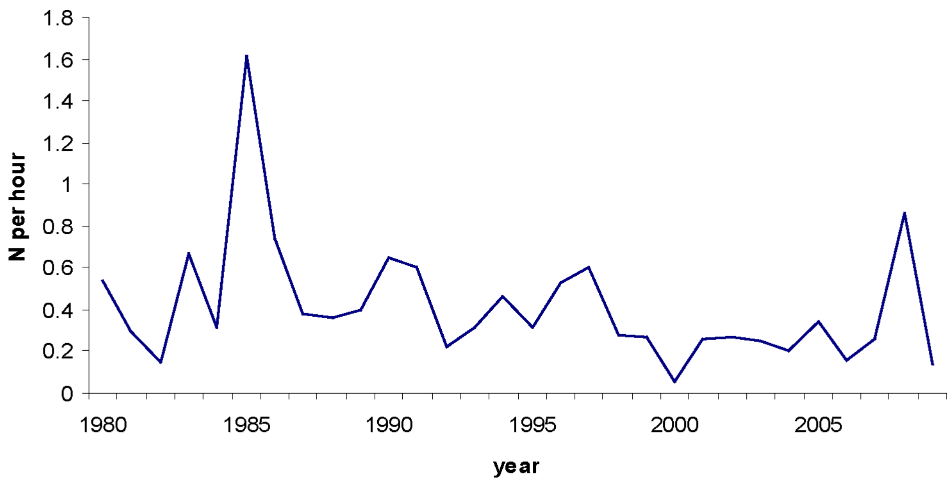
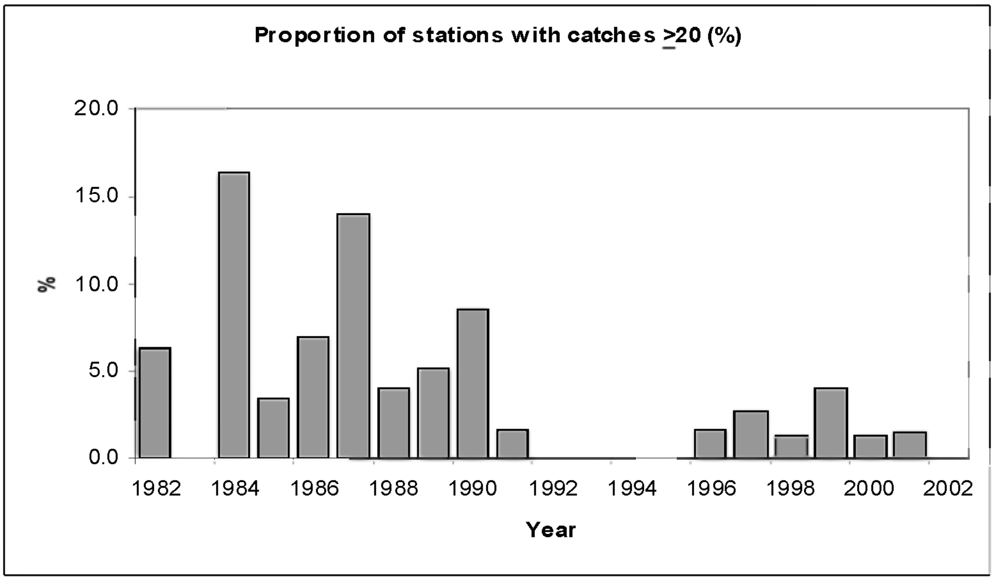


Figure 2.11. Spurdog in the NE Atlantic. Average catch rate in numbers per hour from the North Sea IBTS.



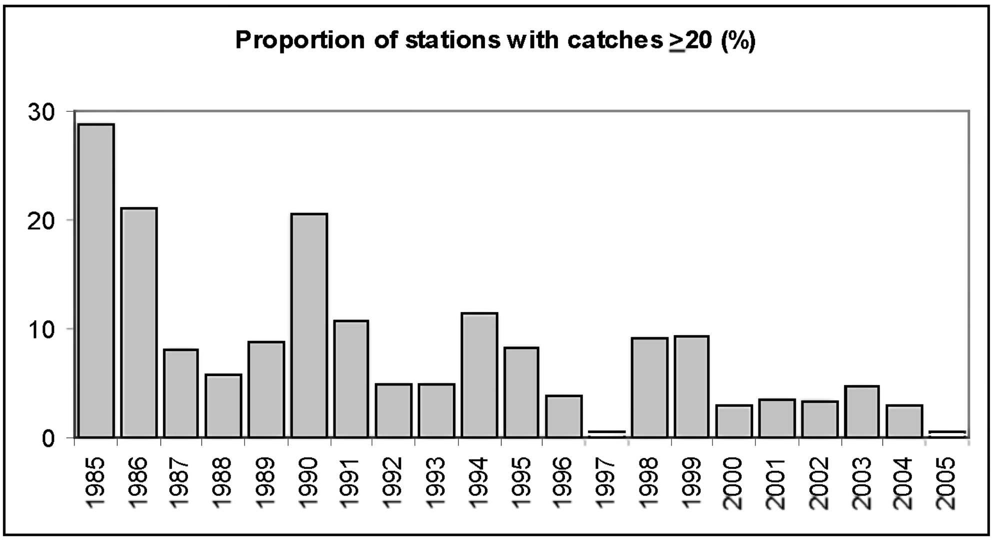
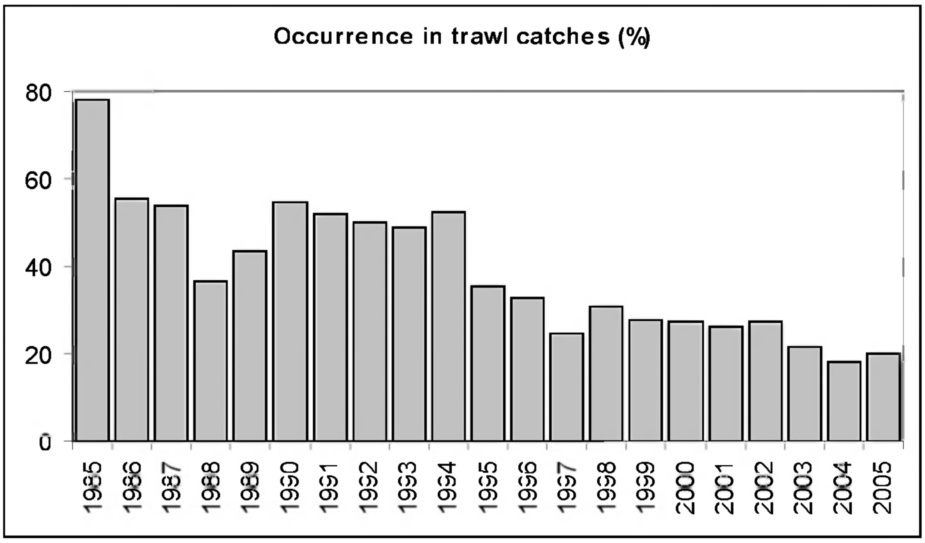


Figure 2.12. Spurdog in the NE Atlantic. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h–1. (Source: ICES, 2006).

a)



b)

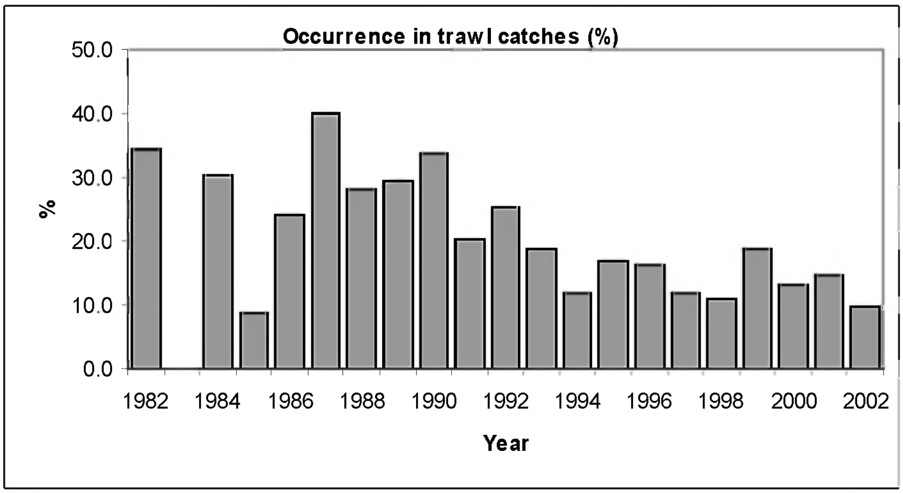


Figure 2.13. Spurdog in the NE Atlantic. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).

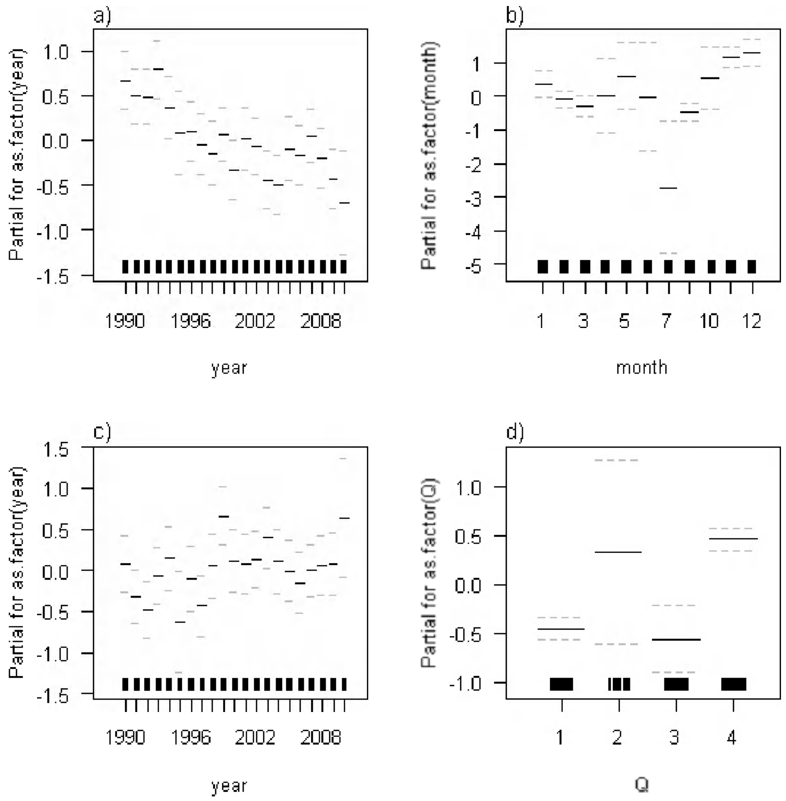


Figure 2.14. Northeast Atlantic spurdog. Estimated year and quarter effects (± 1 s.e.) from the delta-lognormal GLM: binomial model shown in a) and b), and lognormal results in c) and d) (log scale).

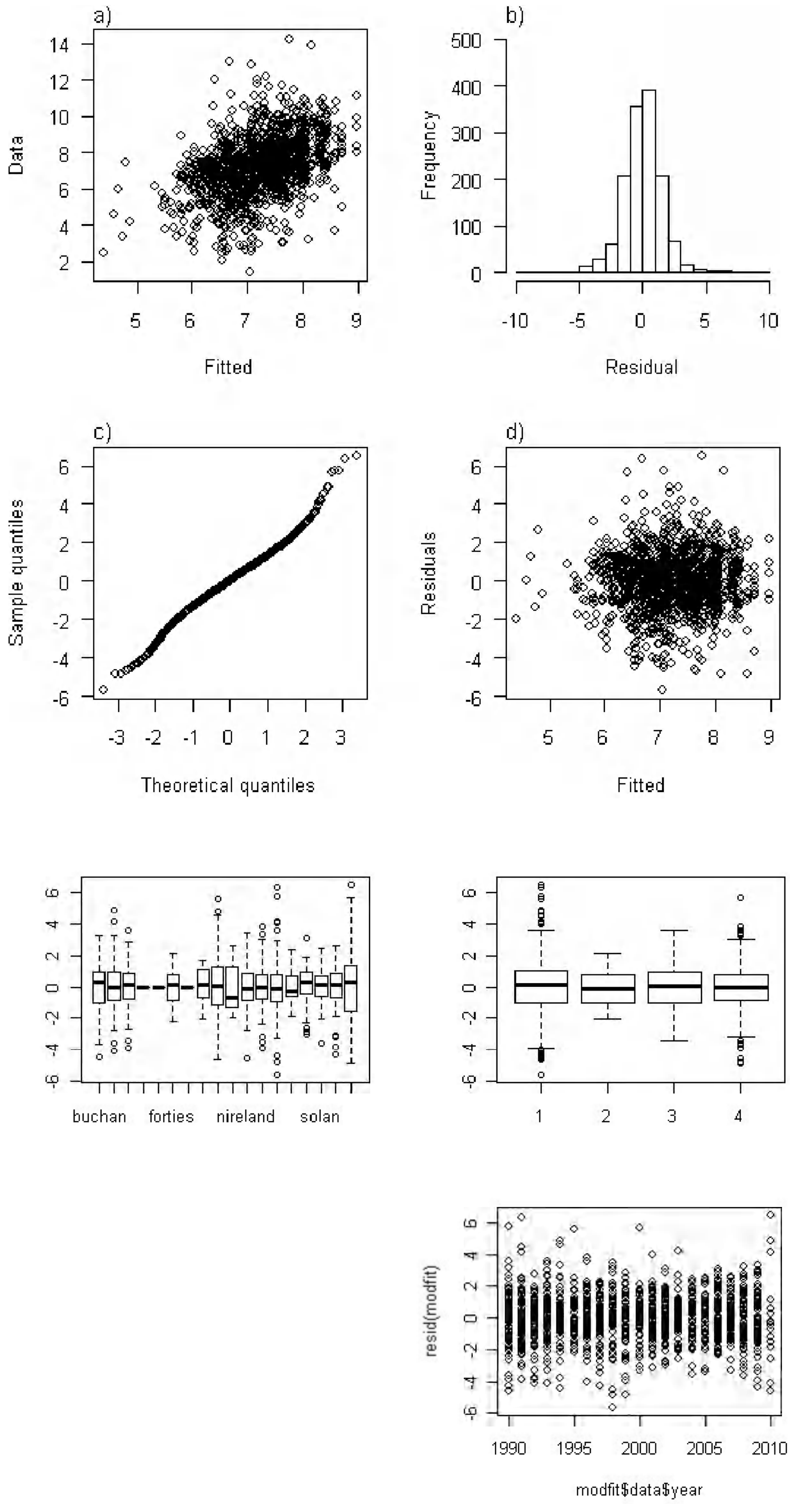


Figure 2.15. Northeast Atlantic spurdog. Analysis of Scottish survey data. Residual plot of final lognormal model fit: a) observed vs. fitted values, b) histogram of residuals, c) normal Q-Q plot, d) residuals vs. fitted values and e), f) and g) residuals vs area, quarter and year.

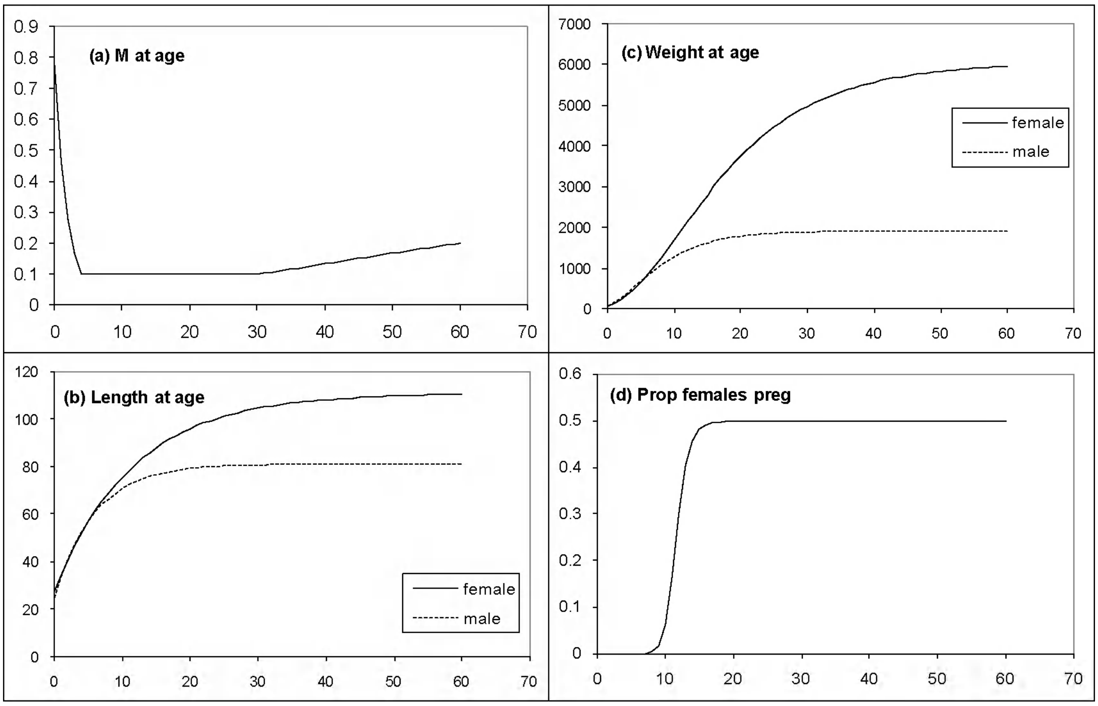


Figure 2.16. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.5.

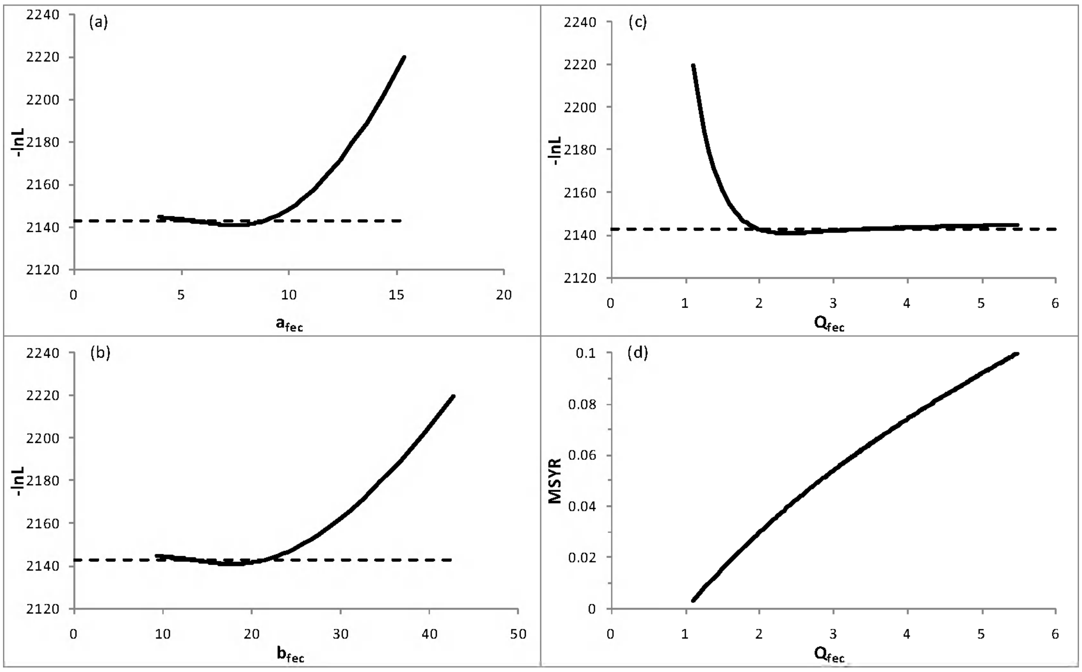


Figure 2.17. Northeast Atlantic spurdog. Negative log-likelihood (-ln*L*) for a range of (a) a_{fec} and (b) b_{fec} values, with (c) corresponding Q_{fec}. Plot (d) shows MSYR (MSY/B_{MSY}) vs. Q_{fec}. Using the likelihood ratio criterion, the hashed line in plots (a)-(c) indicate the minimum –ln*L* value + 1.92, corresponding to 95% probability intervals for the corresponding parameters for values below the line.

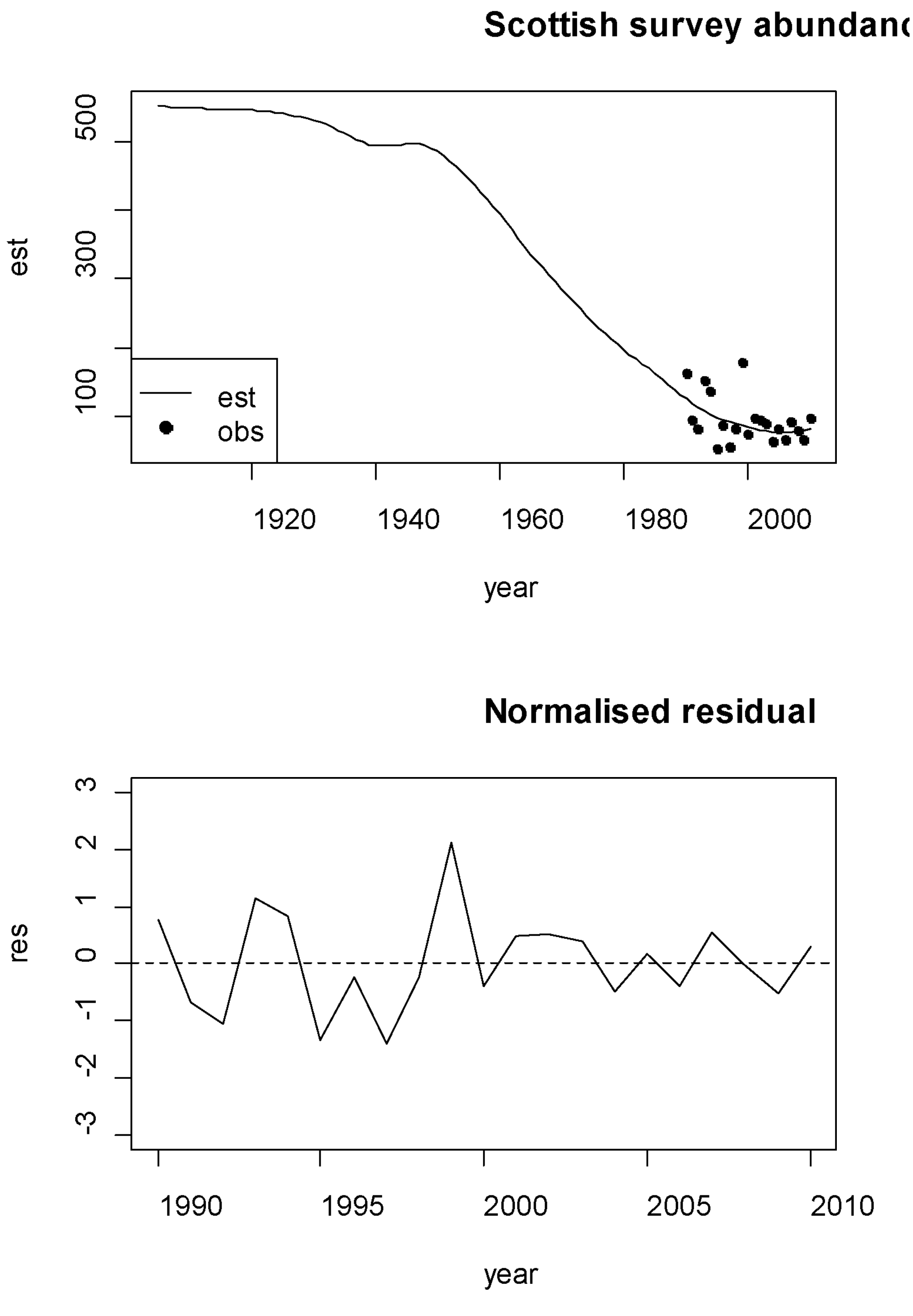


Figure 2.18. Northeast Atlantic spurdog. A Model fit to the Scottish surveys abundance index (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in equation 2.9b) (bottom).

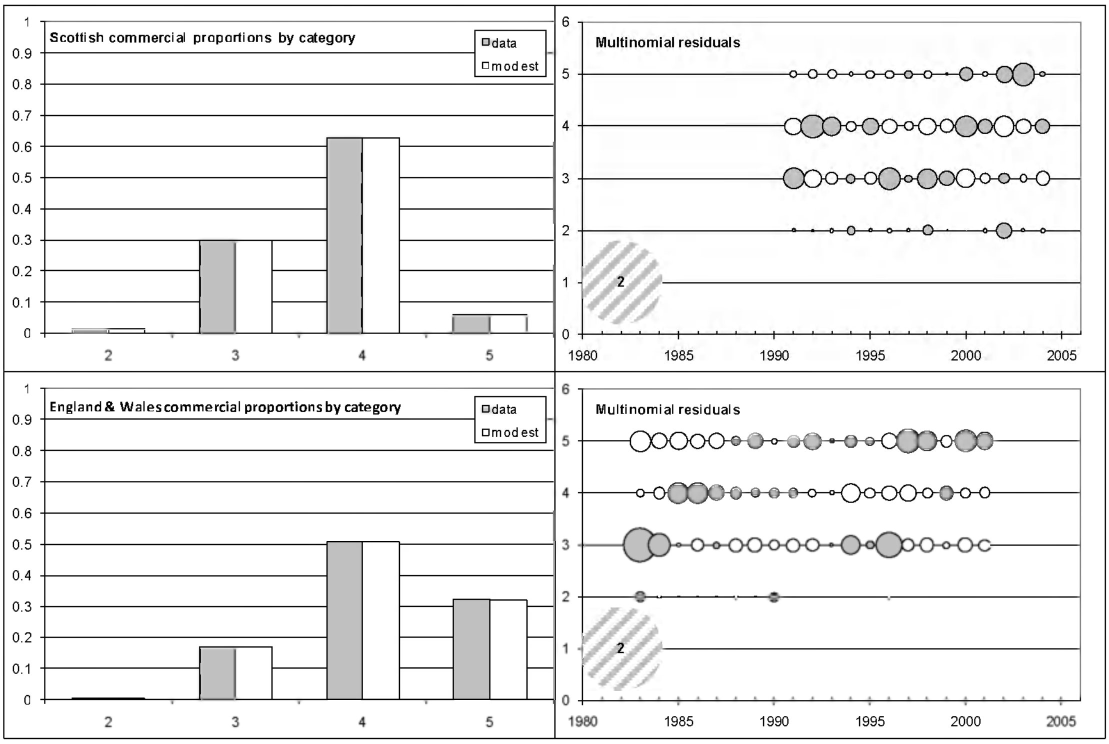


Figure 2.19a. Northeast Atlantic spurdog. Model fits to the Scottish (top row) and England & Wales (bottom row) commercial proportions-by-length category data for the base-case run. The left-hand side plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The right-hand side plots show multinomial residuals ($\varepsilon_{pcom,j,y,L}$ in equation 2.10b), with grey bubbles indicating positive residuals (not the same interpretation as residuals in Figure 2.18), 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.

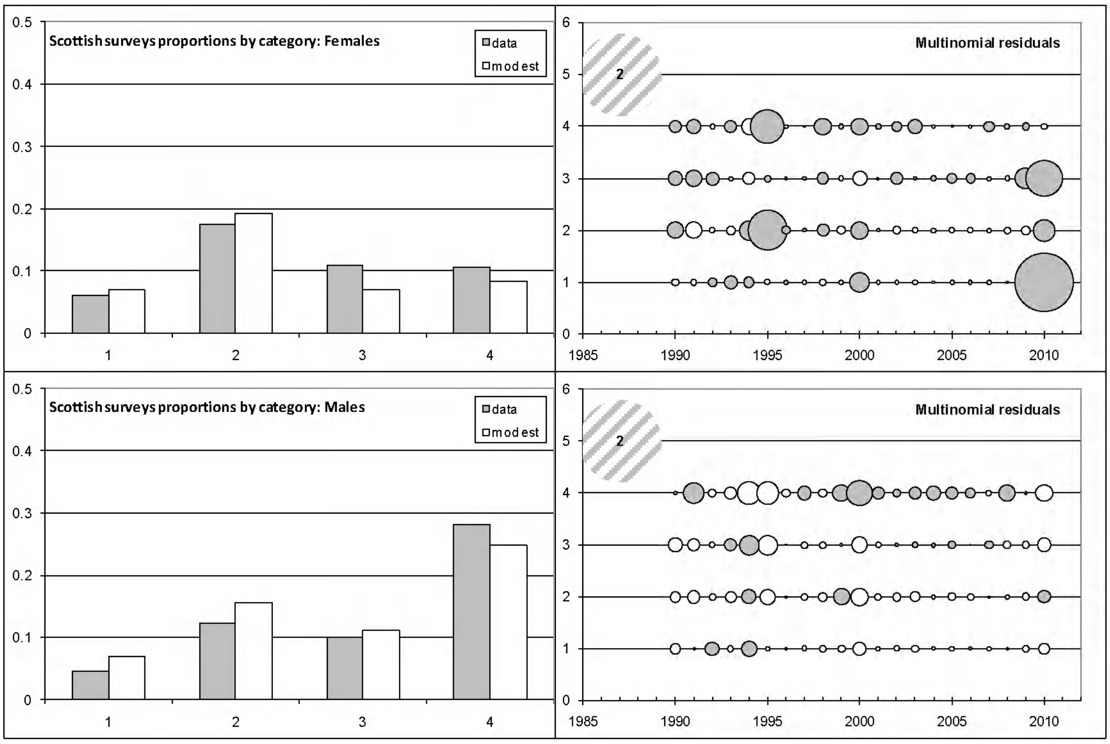


Figure 2.19b. Northeast Atlantic spurdog. Model fits to the Scottish survey proportions-by-length category data for the base-case run for females (top row) and males (bottom row). A further description of these plots can be found in the caption to Figure 2.19a. Length categories considered are 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70+ cm.

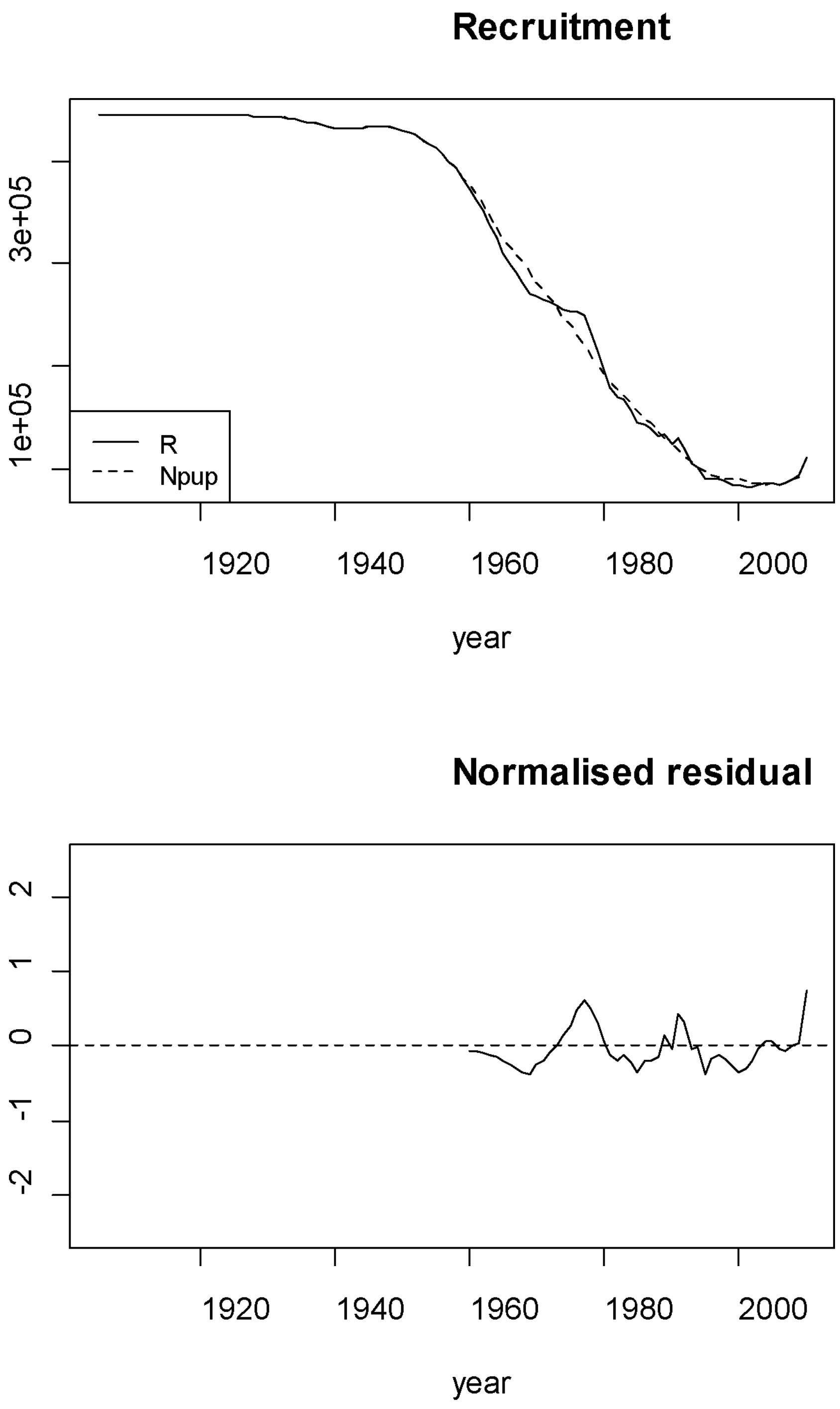


Figure 2.20. Northeast Atlantic spurdog. A comparison of the deterministic (N_{pup}) and stochastic (R) versions of recruitment (equations 2.2a–c) (top panel) with normalised residuals ($\varepsilon_{r,y}/\sigma_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model) (bottom).

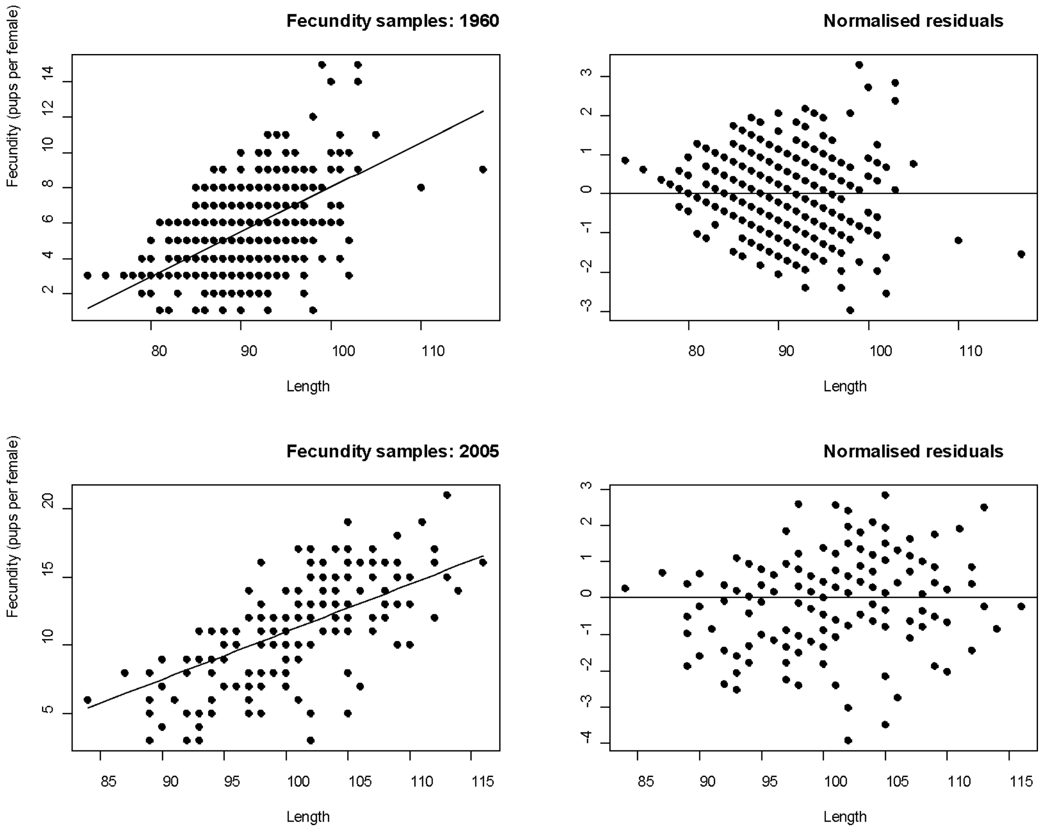


Figure 2.21a. Northeast Atlantic spurdog. Fecundity data from two periods: top–1960 and bottom–2005, with fits shown on the left, and normalised residuals ($\varepsilon_{fec,k,y}$ in equation 2.11b) on the right.

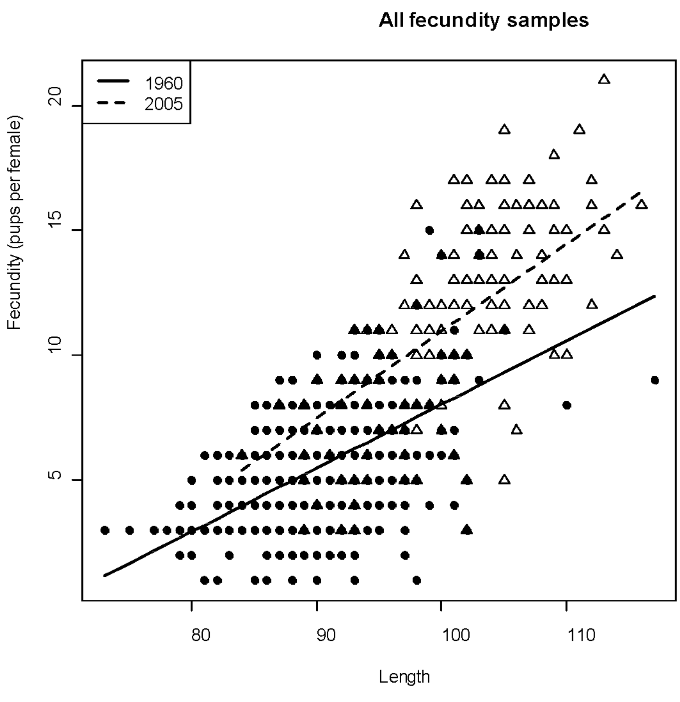
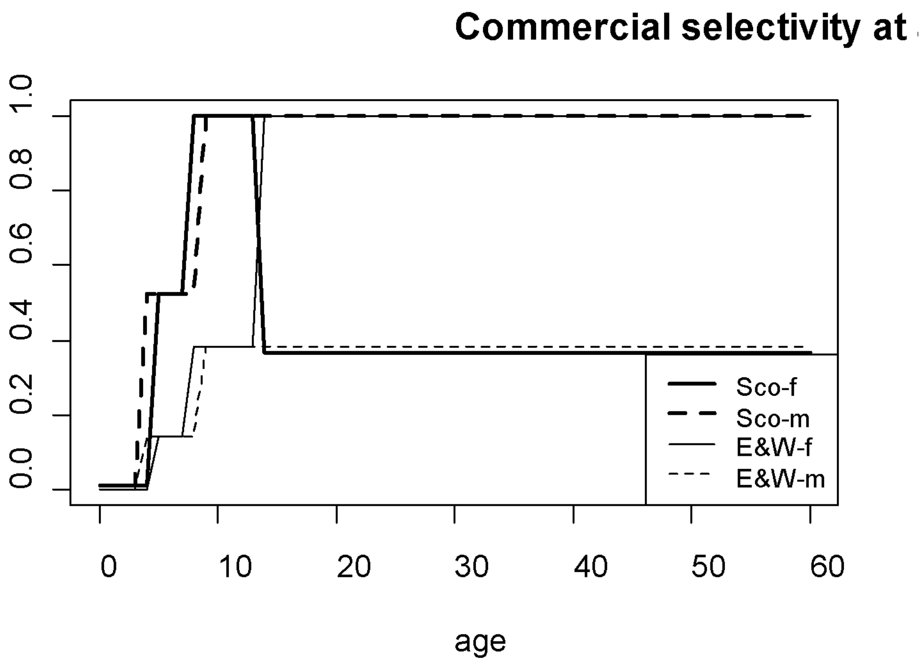


Figure 2.21b. Northeast Atlantic spurdog. Plotting all the fecundity data together, with the fitted curves (open triangles=1960, solid circles=2005; note overlap of triangles with circles).



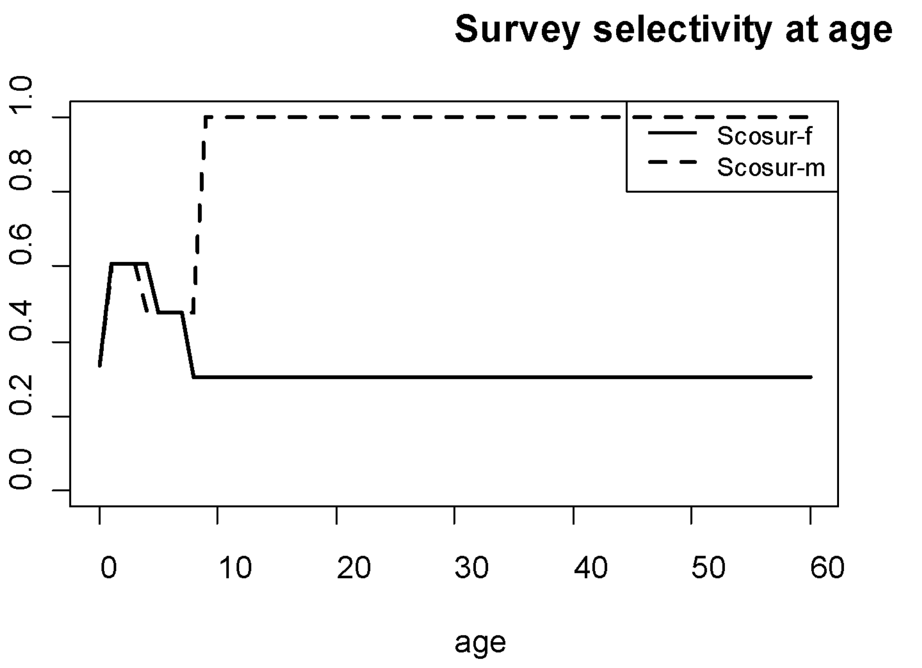


Figure 2.22. Northeast Atlantic spurdog. Estimated commercial (top panel) and survey (bottom) selectivity-at-age curves for the base-case run. The two commercial fleets considered have Scottish (Sco) and England & Wales (E&W) selectivity, which differ by sex because of the life-history parameters for males and females (Table 2.5). The survey selectivity relies on Scottish survey data.

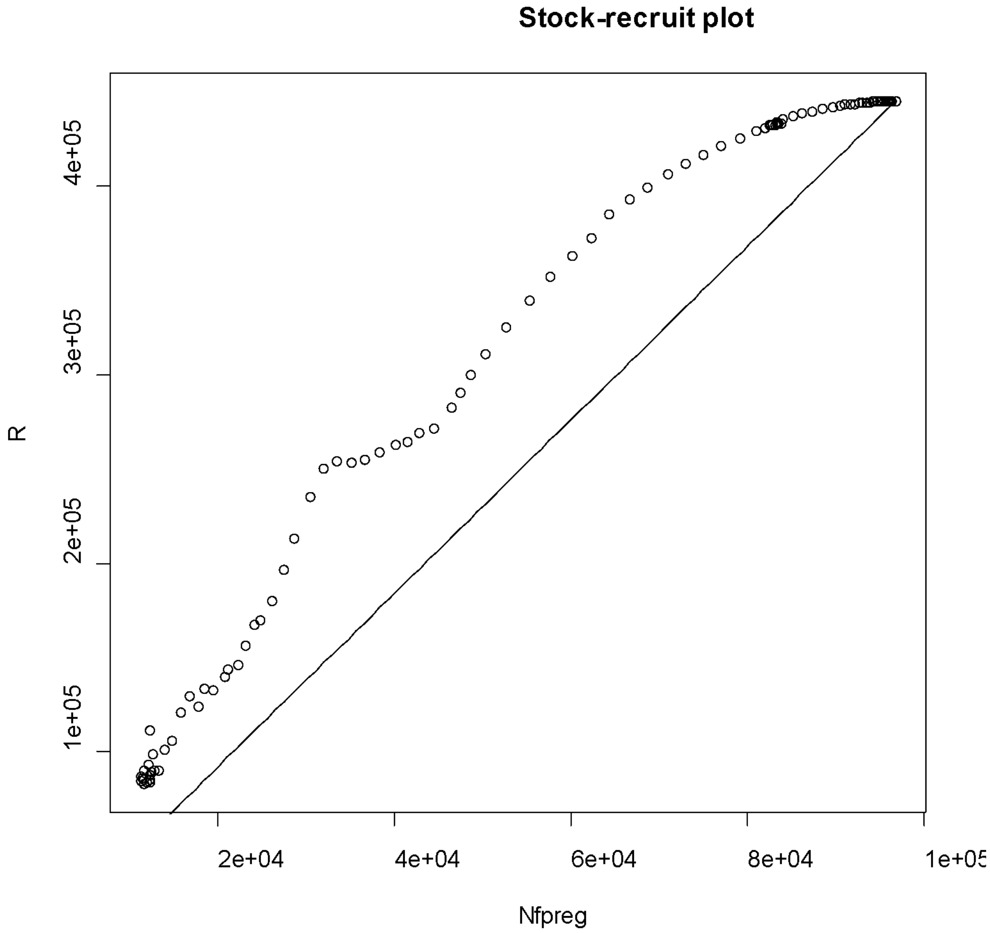


Figure 2.23a. Northeast Atlantic spurdog. A plot of recruitment (*R*) vs. number of pregnant females (open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).

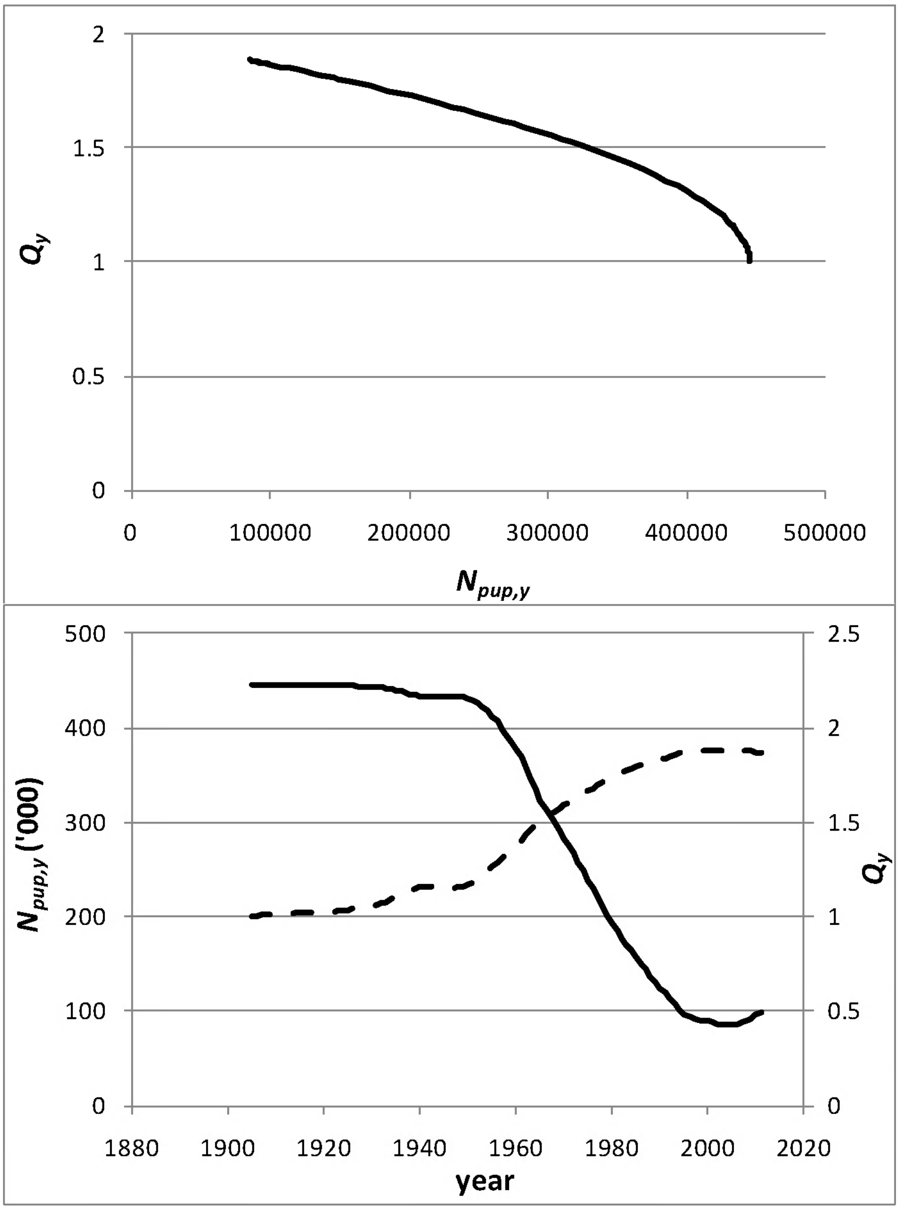


Figure 2.23b. Northeast Atlantic spurdog. A plot of the density-dependent factor Q_y (equation 2.2b) against the number of pups $N_{pup,y}$ (top), and both plotted against time (bottom; solid line for $N_{pup,y}$, and hashed line for Q_y).

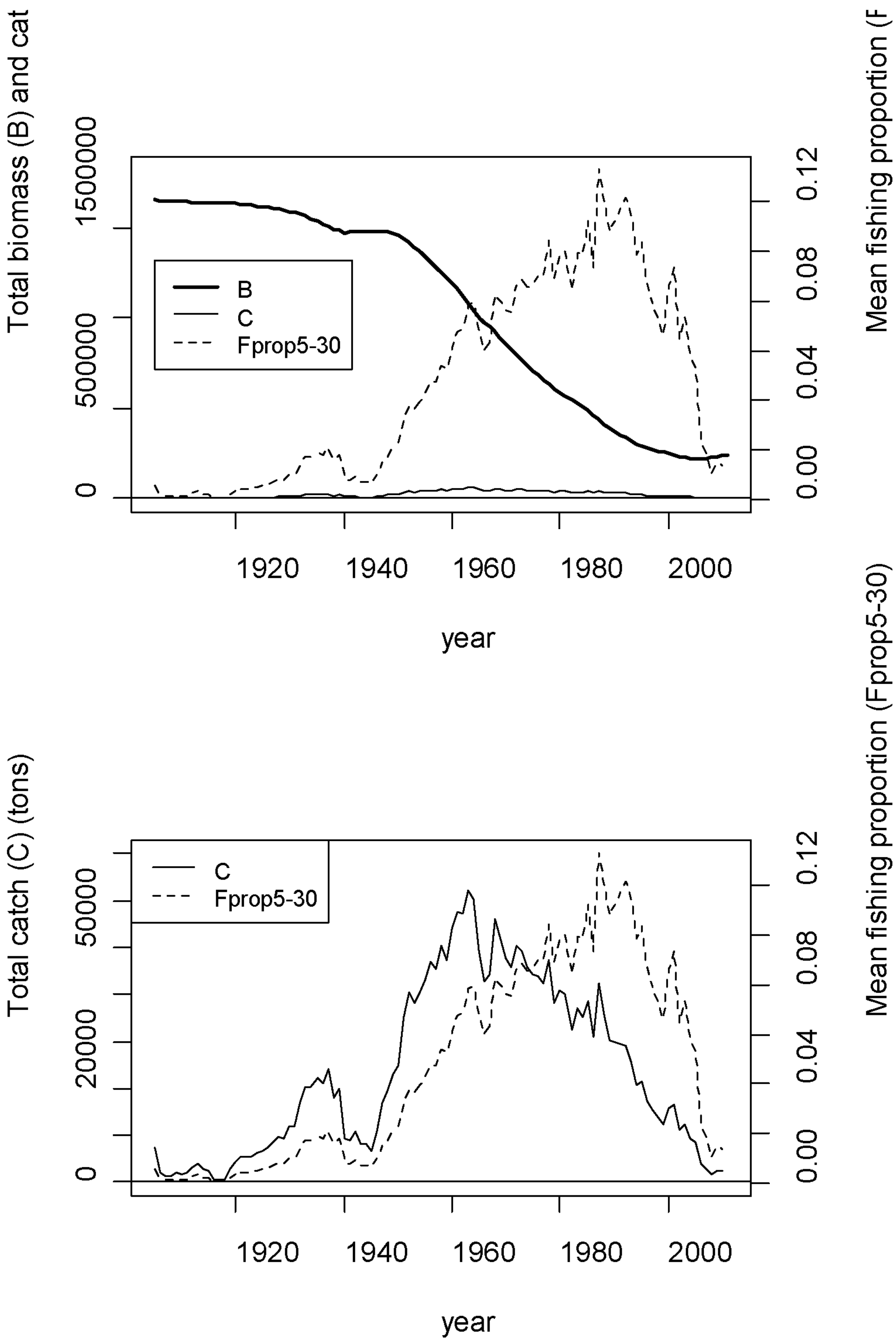


Figure 2.24. Northeast Atla ntic spurdog. Estimates of total biomass (*B*) and mean fishing proportion ($F_{prop5\text{-}30}$) are shown in the top panel together with observed total annual catch (*C*), with the bottom panel repeating the information, but without the total biomass to show more detail in *C*.

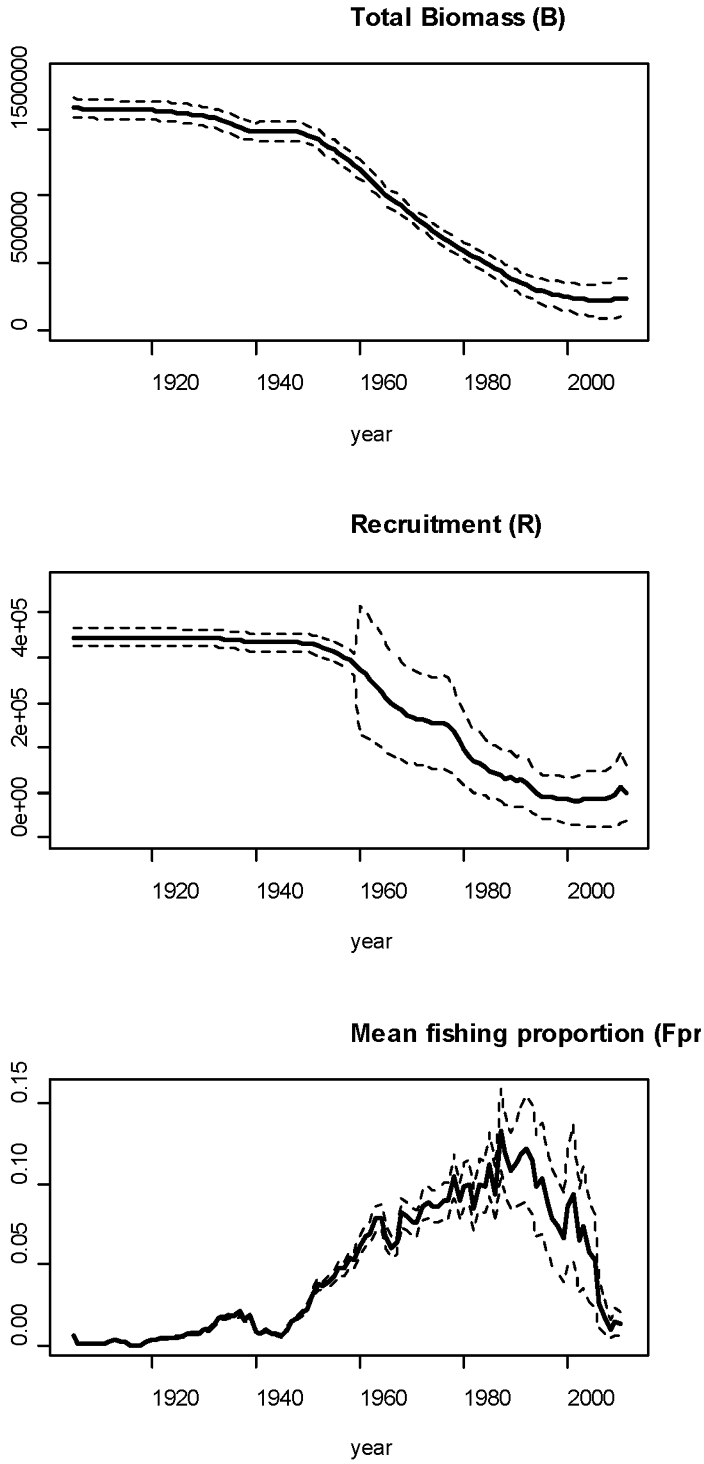


Figure 2.25. Northeast Atlantic spurdog. Total biomass (*B*), recruitment (*R*) and mean fishing proportion ($F_{prop5\text{-}30}$) together with approximate 95% probability intervals (±2 Hessian-based standard deviations).

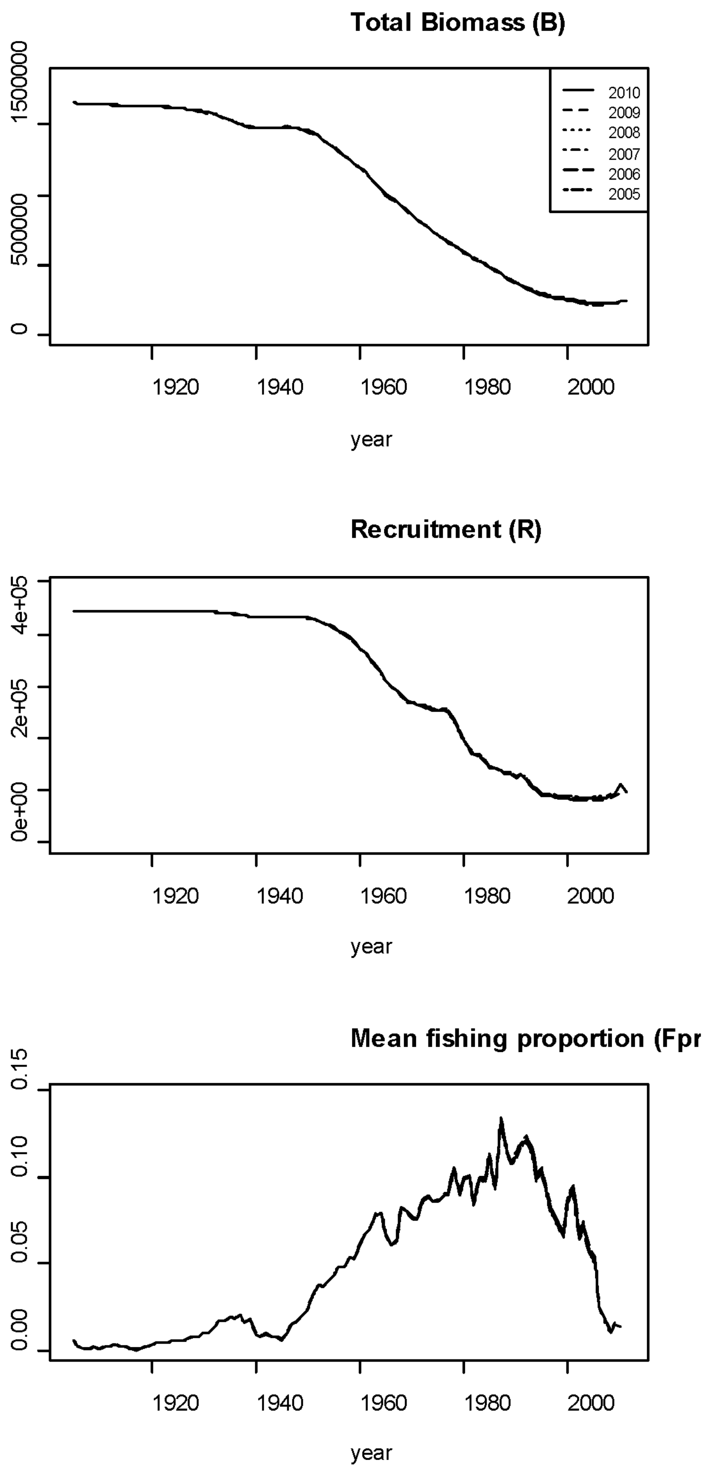


Figure 2.26. Northeast Atlantic spurdog. A repeat of Figure 2.25 (omitting probability intervals for clarity), giving a 6-year retrospective comparison (the model was re-run, each time omitting a further year in the data).

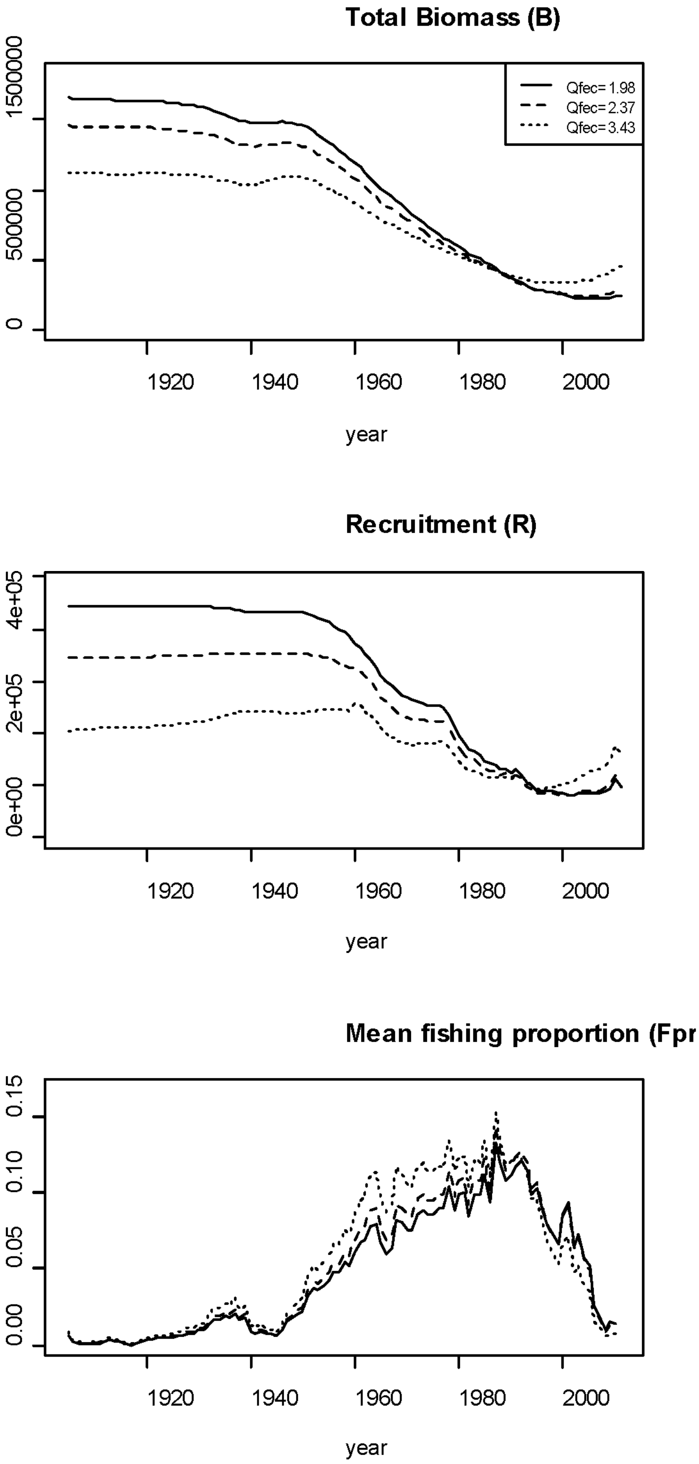


Figure 2.27a. Northeast Atlantic spurdog. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production (Q_{fec}). Three alternative values are considered, related to the smallest, optimum (in terms of lowest –ln*L*) and largest value of Q_{fec} below the hashed line in Figure 2.17c (respectively 1.98 [base case], 2.37 and 3.43).

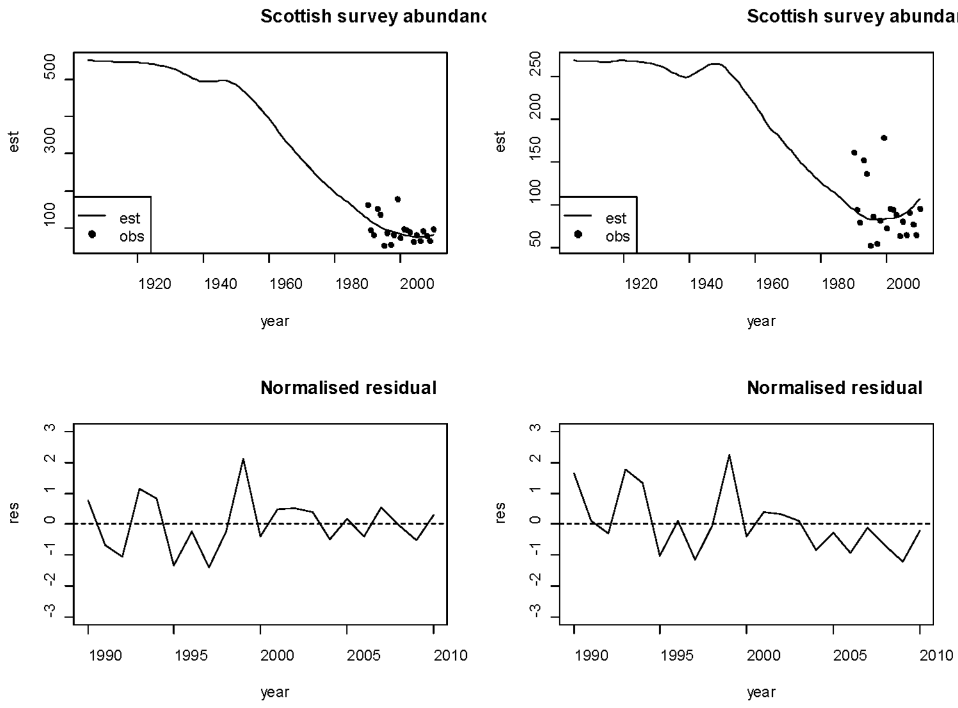


Figure 2.27b. Northeast Atlantic spurdog. A demonstration of the deterioration of the model fit to the Scottish survey data as Q_{fec} increases. Left-hand side: Q_{fec}=1.98; right-hand side: Q_{fec}=3.43.

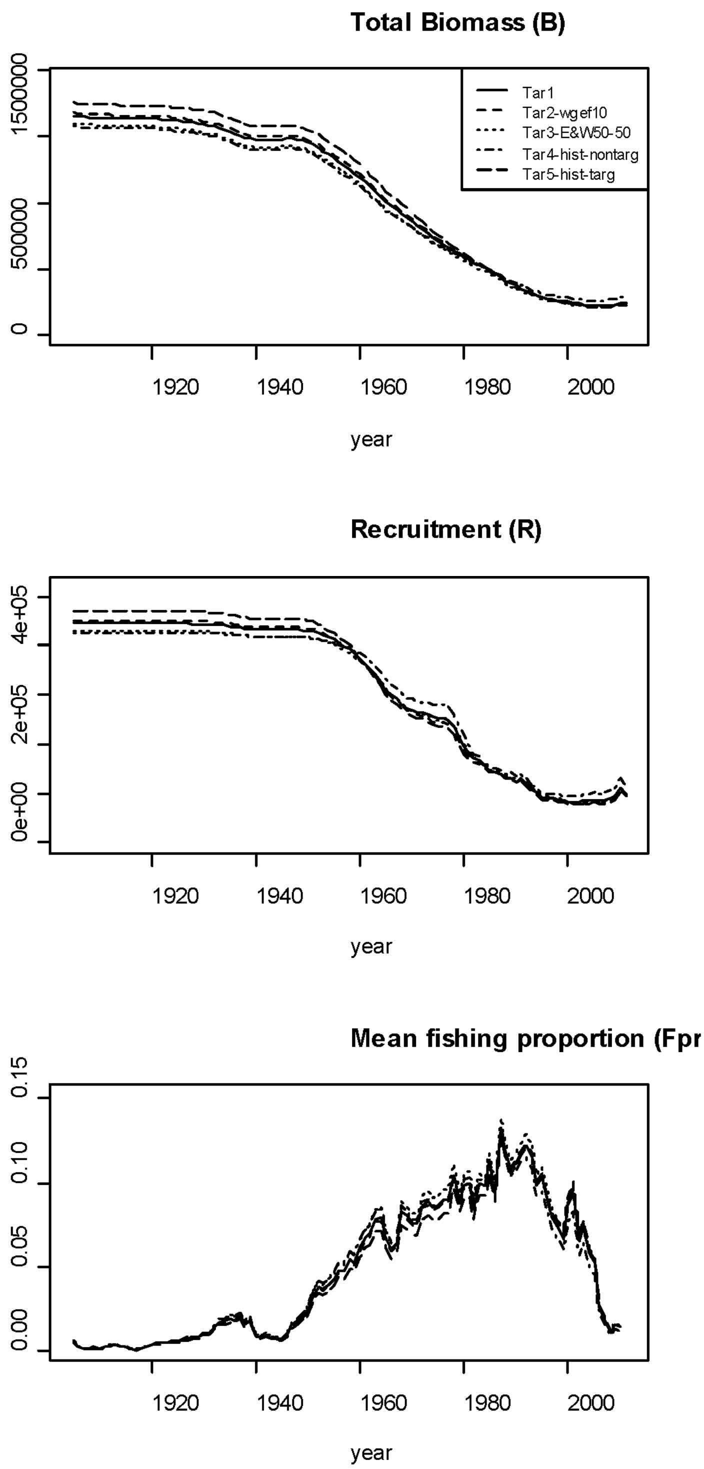


Figure 2.28. Northeast Atlantic spurdog. A comparison of the alternative targeting scenarios, where fishing is defined as either "non-target" (Scottish selectivity) or "target" (England & Wales selectivity). Tar 1 is the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980-4), 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 1980-4), 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).

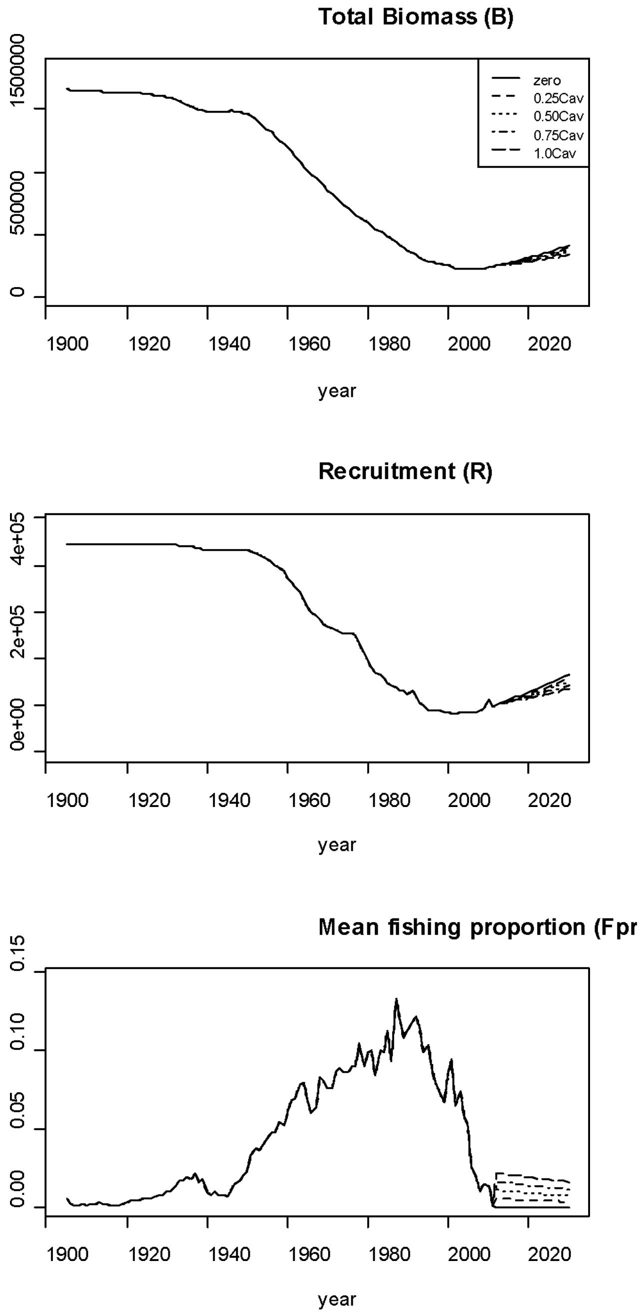


Figure 2.29a. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the average catch for 2005–2009 (Cav=3913 tons).

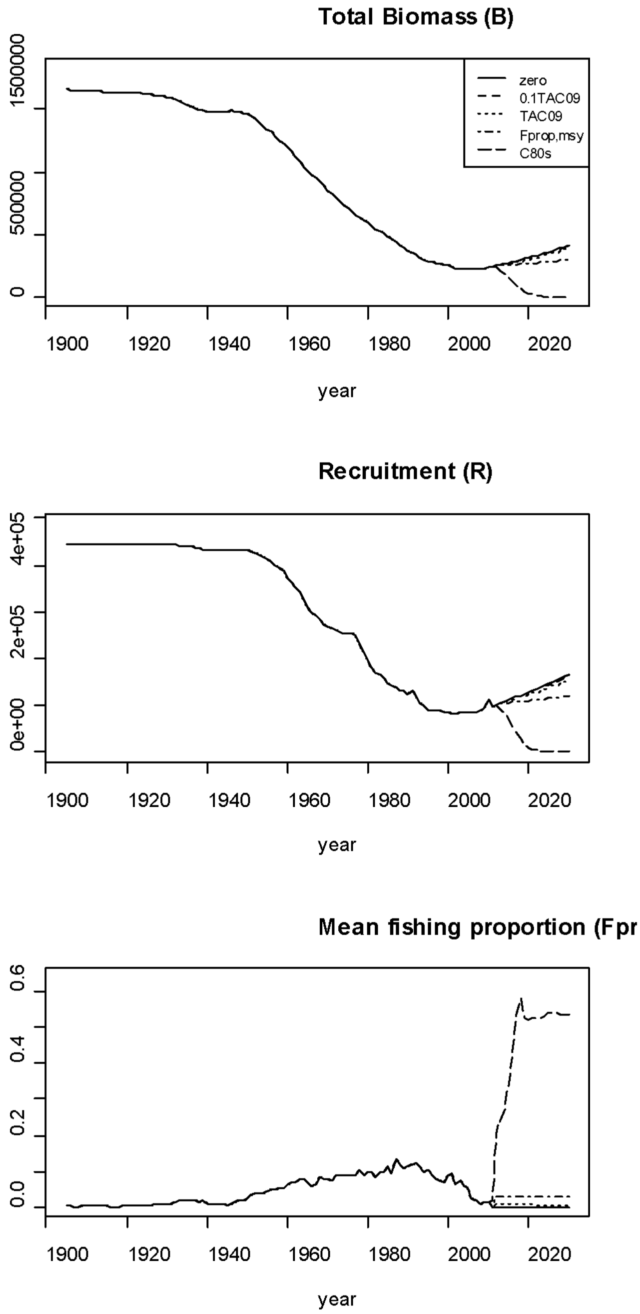


Figure 2.29b. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the 2009 TAC (TAC09=1422 tons). These are shown together with zero exploitation, exploitation at $F_{prop,MSY}$., and exploitation at the average catch level of the 1980s (C80s).

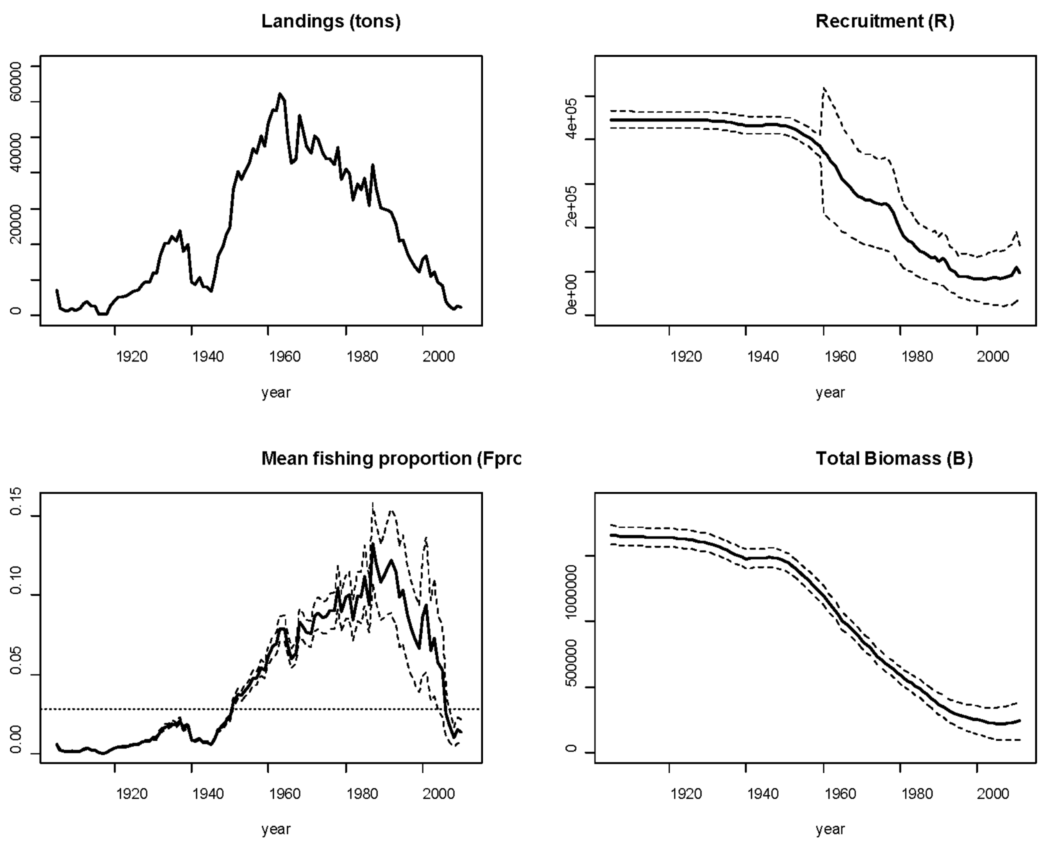


Figure 2.30. Northeast Atlantic spurdog. Summary four-plot for the base-case, showing long-term trends in landings (tons), recruitment (number of pups), mean fishing proportion (average ages 5–30, dotted horizontal line=F_{MSY}=0.028) and total biomass (tons). Hashed lines reflect estimates of precision (±2 standard deviations).

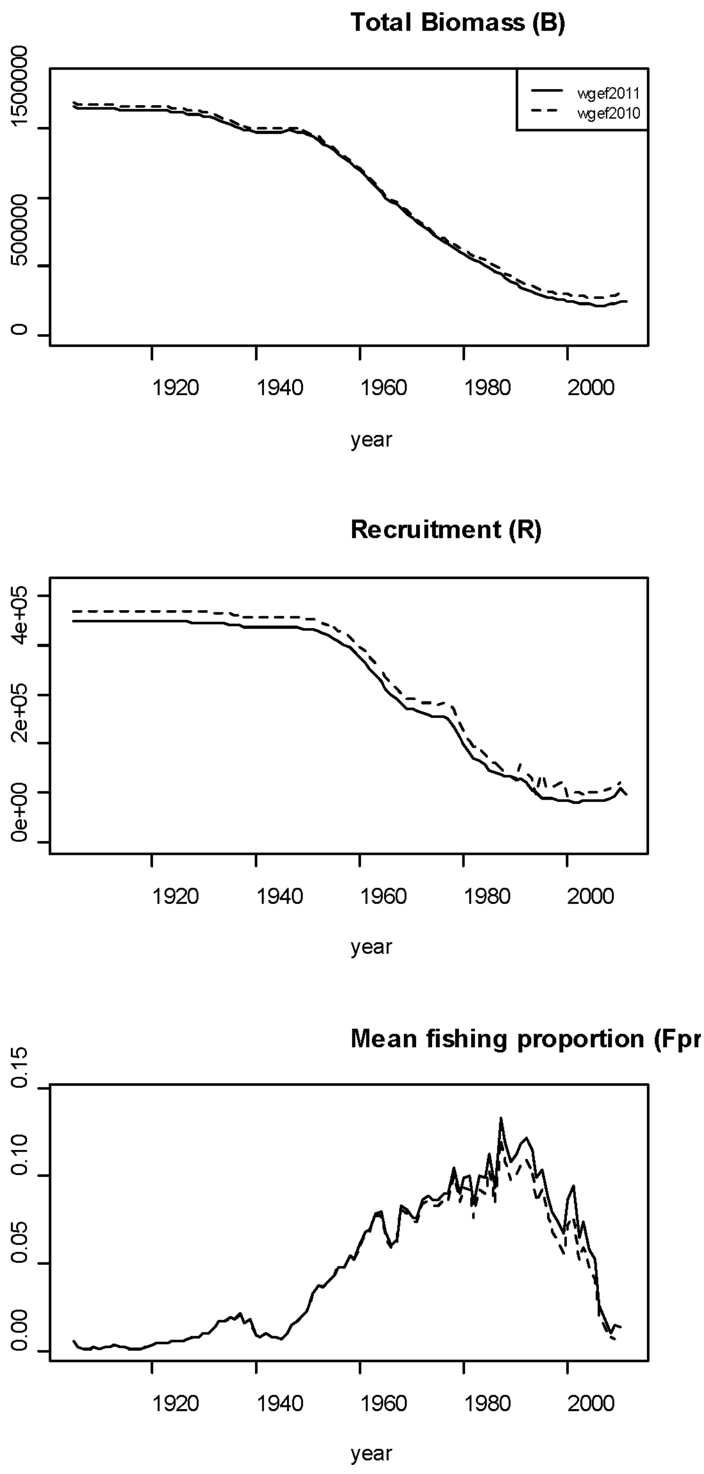


Figure 2.31. Northeast Atlantic spurdog. Comparison with last year's assessment.

Appendix 2: 2010 spurdog benchmark review

This appendix documents the comments made by the two external reviewers of the 2010 Spurdog model and assessment. It also includes how these comments were addressed by WGEF 2011.

Review 1

Let me begin by thanking you for the opportunity to review and comment on the assessment methodology for the Inter Benchmark Protocol Review for Northeast Atlantic spurdog. My overall impressions are that the methodology is sound, modern and appropriately applied. The working group has carefully considered the available data and appears to have crafted a synthetic model that appropriately handles the major sources of uncertainty in the data. The model also appears to capture the salient stock dynamics since 1905 although the model results are highly sensitive to several parameters. The WGEF has explored many of these uncertainties using profile likelihood methods. The WGEF is well aware of the weaknesses of the assessment, weaknesses that are driven primarily by the underlying data gaps, rather than the appropriateness of the model. There is a common tendency for reviewers to belabour obvious data gaps, to question the many necessary decisions for model application, and to request information about the model that may have been provided in an earlier version but subsequently was excluded (often because earlier reviewers suggested it was not necessary). Having sat on the other side of the review process for many years, I will try to restrain these tendencies and press only for the most critical issues.

The primary basis for this review was the ICES WGEF Report 2010 (ICES 2010). The De Oliveira *et al*. (2010) paper and spurdog stock annex 2010 were also reviewed but the WGEF report appears to include most of the relevant documentation on methodology. Unless otherwise specified, my references will be to the WGEF report.

Data issues

Commercial landings and discards

Overall, the available data for landings, discards and fishery independent surveys are incomplete and variable in quality. One of the primary strengths of this assessment is a long time-series of landings. The derivation of the overall time-series (Table 2.1) and the overall two fleet series (Table 2.6) appears to have required a fair number of assumptions to disaggregate landings by Scottish and England/Wales fisheries. The hindcast of landings from 1905 to 1979 based on the ratio from 1980–1984 is necessary but probably has little influence on the results. The commentary in Section 2.2.6 is instructive as it suggests potential biases in the series. The implementation of more stringent management measures since 2001 are likely to have changed fishing patterns and induced more discarding. The paucity of discard information is a problem for gauging the efficacy of management measures and assessing stock status. In US fisheries since 2000, the discards of spiny dogfish often exceeded landings during the period when target quotas and individual trip limits were set at very low values. It would be highly desirable to increase the observer sampling coverage in fleets that catch spurdog; particularly as the stock and fishermen respond to lower TACs.

The WGEF does not appear to have estimated total discards. The text implies that discarding patterns have probably changed so it may not be prudent to hindcast trends to earlier data. However, the discards could have important scaling implication for overall stock size, particularly in recent years. Additional investigation of any historical data sources may be warranted[R1.1].

Commercial length frequencies

It is unfortunate that the Scottish and UK size frequencies cannot be strictly compared owing to the absence of raising factors for the UK fleet. At face value these differences suggest a much different force of mortality between the fleets, a factor that must have been instrumental in the decision to model each country's landings separately in the model.

The large fraction of fish above 100 cm and overall size frequency is not consistent with a heavily exploited stock, particularly if such patterns had consisted for several decades prior to the late 1990s. The size composition of the landed females in the UK looks similar to the pre-exploitation size frequency distribution in the US. The Scottish fleet size frequencies however are more consistent with expected patterns for a moderately exploited stock. As noted in the text, this unusual pattern may be the artifact of a single large tow. I would strongly recommend that the WGEF attempt to resolve this influence and develop appropriately weighted size frequencies for the UK landingsR1.2.

The absence of length frequency samples from other countries should be addressed if possible. Similarly, differences among gears and seasonal variations in availability may have important implications for harvesting. In the US large female dogfish are seasonally available to near-shore fisheries. Reliance on such data alone can give a distorted picture of the size and sex composition of the landings and the resource as a whole[R1.3].

Fishery independent surveys

Thirteen separate surveys are listed in Section 2.5.1 and it appears that eight are still ongoing. The stock annex did not provide any additional information (perhaps I missed it) but it would be appropriate to ensure that all surveys identify by sex and develop size frequencies. I am not familiar with the details of these surveys but I presume they are design based, with random allocation of stations within strata, or perhaps a systematic design[R1.4]. As in the commercial size frequencies the WGEF notes the dominant influence of single tows (Figures 2.5 and 2.7). Dogfish/spurdog do segregate by size and sex so it would be useful to look at the patterns without the extreme tows[R1.5]. The populations near Scotland are similar in size and sex composition to those near Nova Scotia.

The GLM analyses of the Scottish sea indices are important (Figures 2.14–2.15). Was a similar analysis done (and is it appropriate) for the North Sea IBTS (Figure 2.11)[R1.6]?

It is unfortunate that there are no surveys or size composition information between 1952 and 1975. The removals were consistent over an extraordinarily long period, so even a snap shot of the historical pattern would be interesting[R1.7].

Life-history comments

I agree with the statements regarding the overall stock structure in the NE (Section 2.1) and the other justification in the stock annex. Over-interpretation of tagging data that fails to distinguish differences in fishing mortality, time at large, and reporting rates, often leads to inappropriately defined "stocks".

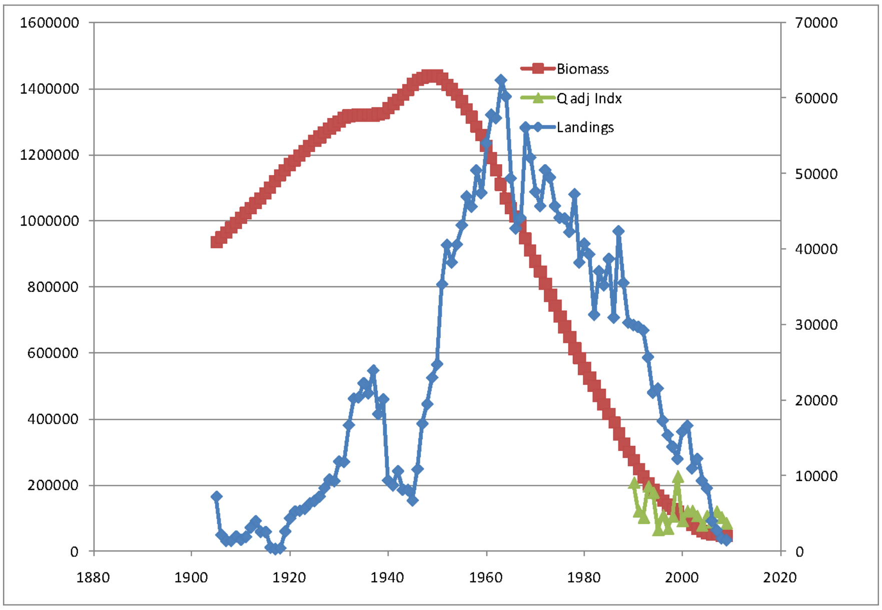
Table 2.5 and Eq. 2.7: The M_{pup} estimate is based on a Leslie matrix model with an eigen value of one. However no values are reported. In Figure 2.16 it appears that M_{pup} is about 0.7. For spiny dogfish I have estimated a similar value of ~0.4[R1.8]. I see that your proportion of females pregnant caps at 0.5. I presume this aliases the 2-yr gestation time and effectively puts half of the females "off line" in any given year[R1.9]. In Table 2.5 I was not sure what the ln(19) means in the equation for Pa''[R1.10].

There may be a labelling problem in Figure 2.21b: the solid line doesn't seem to go with the open triangles nor is there agreement with Figure 2.21a[R1.11].

Given the foregoing comments on the size composition of commercial landings and surveys, it would be useful to generate some expected size frequencies based on a length-based equilibrium life-history model. I realize the assessment model uses four bins but the upper bin may be obscuring information related to size-selective mortality[R1.12].

Modelling concerns

Overall this implementation of the Punt and Walker model seems appropriate and well executed. As a quick heuristic check I did a simple 3 parameter (B(0), r, q) mass balance model using the 1905–2009 landings (Table 2.6) and tuned it to 1990–2009 GLM indices for the Scottish survey (Table 2.7). The model was B(t+1)= rB(t)-C(t) with B(t)=q I(t). I got an initial biomass of 943 933 mt and a q of 0.000811. This contrasts with the base model estimates of about 1.6 M mt (Figure 2.25) and q=0.000923. My "r" parameter was 1.016903. At any rate it convinced me that the model scale was appropriate and it looks similar to the Qfec=3.98 plot.



The WGEF model appears to incorporate a manageable degree of complexity. The density-dependent formulation pup reproduction is indeed useful and provides a useful control variable for analyzing model behaviour (e.g. Figures 2.17 and 2.27a, 2.27b). The WG insights into the confounding of parameters were appreciated, as it reduces fruitless searching of parameter space. It would be useful to plot the Qy and $N_{pup,y}$ outputs over time to get a better handle on the density dependent process [R1.13].

The time trend in Figure 2.23 is probably consistent except near the origin. What is the reason for the sharp change in slope when N_{fpreg} is about 40 000[R1.14]?

The premise of a virgin stock in 1905 is a strong assumption but reasonable. My linear model has the population increase to about 1.44 M mt by 1949. The WGEF model has a higher initial condition, and controls population size via a more realistic stock recruitment process.

I'm not sure if I understand the derived survey and commercial selectivity patterns. The strong domes for both above 15 yr (Figures 2.22 and 2.28a) seem odd for a species such as spurdog. Is there any hypothesis for this effect? Mature females do seem to be absent from the Scottish survey but not in the IBTS. Is the low selectivity aliasing movement out of the survey area[R1.15]. Was there any sensitivity analyses to the fixing the selectivity to 1 for the oldest ages. If selectivity for fish above 85 cm is set to one in Eq 2.5a then can selectivity exceed one for smaller size groups, resulting in an $S_{com,j,a}$ that is less than one for 85 cm and up in Eq 2.5b[R1.16].

All of the model implementation details and construction of the likelihood functions seem appropriate. The WG seems to have chosen an appropriate set of sensitivity analysis scenarios for consideration. The model does not have much of a retrospective pattern but this may because there is not too much data to disagree with in Tables 2.7 and 2.8. The size comp info in Table 2.9 is not affected by the truncation and there is not much trend in the last five years of data in Tables 2.7 and 2.8.

In summary, spurdogs are a complicated species to model. Differences in growth, maturation, and distribution of males and females are important for understanding the dynamics of this species. The WG has chosen a reasonably compact set of parameters to describe the population. The approach is consistent with some severe data limitations, well acknowledged in Section 2.9. One major concern would be the importance of the dome-shaped selectivity patterns on the assessment. These are particularly important when applying the contemporary selectivity to the historical data. It could severely overestimate the historic abundance and therefore exaggerate the estimated decline[R1.17].

Thank you again for the opportunity to comment.

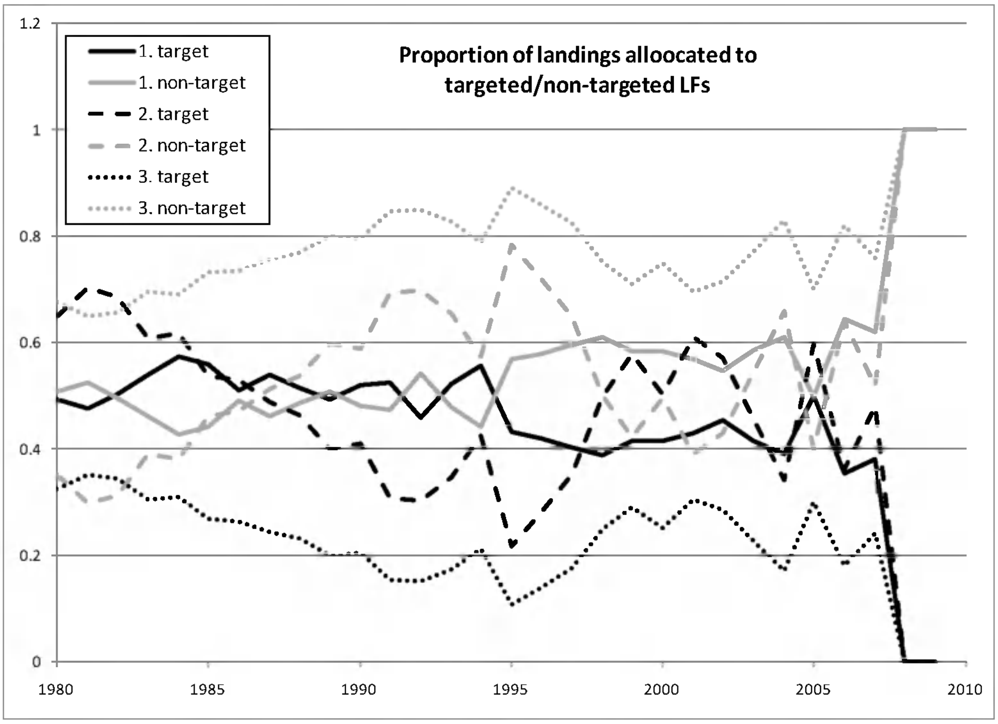
Response to comments by Reviewer 1

R1.1 Discarding patterns are thought to have changed since the introduction of restrictive management measures in the North Sea (from 2007) and elsewhere (from 2008). There are limited discard data available, but these have not been considered sufficiently representative to be raised up to fleet level and therefore are not included in the assessment. However, it is acknowledged that an appraisal of recent discarding (of dead fish) is required to get improved estimates of recent removals from the stock (following the introduction of the more restrictive management measures). Information on discard survival is very limited for this species.

R1.2 Due to the lack of appropriate raising procedures, commercial length frequencies for England and Wales (E&W) are thought to be heavily biased towards targeted fisheries. The approached used up until now was to simply raise all E&W landings to these length frequencies, and to use this together with the Scottish length frequencies to raise the remaining landings (total minus E&W and Scotland) in proportion to the E&W-Scottish split in the landings.

In order to address some of the concerns expressed by the reviewer, raising is instead performed by defining target and non-target fisheries, where the E&W length frequency is considered to represent a target fishery (i.e. for larger fish, particularly the female component of the stock), and the Scottish data representing a non-target fishery. An analysis of the E&W landings for the period for which E&W length frequencies were available (1983–2001) indicated that approximately half the E&W landings were by target fisheries (lines, and part of the gillnet catch), so only half the E&W landings are raised by the targeted LF, and the remainder by the non-targeted LF for the period 1980–2007. All the Scottish landings are considered non-target for the period 1980–2007. Considering the period 1980–2007, landings for all remaining nations apart from Denmark, France, Ireland, Norway and Sweden are considered non-target. Landings for France and Sweden are treated in the same way as E&W (half target, half non-target), while landings for Norway are treated as exclusively targeted (as they are known to have targeted spurdog, and their national minimum landing size would also have resulted in proportionally more large fish being landed). Landings for Denmark are treated in the same way as E&W until 1992, then as exclusively non-target from 1993, while landings for Ireland are considered exclusively targeted from 1982–2005, and non-target outside this period.

In order to provide a third alternative to what is proposed above (option 1) and what has been used until now (option 2), option 3 is similar to option 2, except that only half the E&W landings are allocated the E&W LF, with the remainder allocated the Scottish LF. The remaining landings are then allocated LFs in proportion to the E&W and Scottish landings associated with the E&W and Scottish LFs, skewing the LFs towards non-target fisheries compared to option 2. For 2008 onwards, all options assume a non-target selection. The figure below illustrates the three options considered, with option 1 adopted as the baseline.



R1.3 This is partly addressed by R1.2. The WG has been unable to obtain historic length frequency samples from other countries.

R1.4 All the existing trawl surveys considered by WGEF are internationally-coordinated through the ICES International Bottom Trawl Survey Working Group (IBTSWG). The descriptions of the surveys, in terms of the gears and sampling grids, are described in the reports of the IBTSWG and in the survey manuals (see http://datras.ices.dk/Documents/Manuals/Manuals.aspx). Some surveys have been discontinued, and have not been included in the model, and several other surveys in the western IBTS are of too short a time-series for inclusion at the present time (although these surveys catch spurdog relatively frequently and may so provide useful abundance trends in the future). Further studies of North Sea IBTS and the UK (Northern Ireland) surveys of the Irish Sea need to be undertaken. Some surveys have not consistently provided sex-disaggregated information.

R1.5 In order to reduce the dominant influence of the occasional tows with large numbers of spurdog, the WG has recalculated the length frequencies by using the same area stratification that was used for the delta-lognormal GLM standardisation of the survey abundance indices. Numbers by length category and sex are summed across stations within each stratum and the proportions by length category and sex calculated; these are then averaged across all strata each year. Those strata that result in fewer than 100 dogfish being available over all years for a particular survey are ignored in this analysis.

R1.6 Although the survey data used to derive the abundance index for the assessment model covers some of the major areas of spurdog stock distribution (central/northern North Sea, a subset of the N Sea IBTS, and west of Scotland), the WG agrees that it would be useful to extend the analysis to other surveys in the future. This would require all relevant survey data to be collated ahead of the WG.

R1.7 Some historical survey information is available, but is not always available electronically. Additionally, as spurdog were not considered an important commercial species in the first part of the 20th century, catches were sometimes recorded using qualitative descriptors and/or fish were not regularly measured in early surveys. Tagging studies were undertaken in the 1960s, but recorded data from such surveys may be skewed towards larger fish. Given the issues of temporal differences in size composition, gear selectivity and potential bias in some surveys, these data may not be useful for use in the assessment, although it is acknowledged that they could provide a useful snapshot.

R1.8 M_{pup} is effectively a model estimate that is dependent on the estimates of the fecundity parameters a_{fec} and b_{fec}; the estimate for this year's assessment is 0.76, and is included in new Table 2.11b along with other parameters of interest (e.g. MSY parameters).

R1.9 This is the correct interpretation; an appropriate note is now included in the relevant table.

R1.10 The ln(19) is a constant usually included in the formulation of a sigmoid curve to ensure that the curve is at 95% of its maximum for the relevant value on the x-axis (in this case for ℓ^{f}_{mat95}). This is a standard formulation, so should not require further explanation.

R1.11 This problem has arisen due to formatting issues within ICES when converting word documents to pdf. In this case, the figures did not convert properly, leading to the interpretation problems noted by the reviewer.

R1.12 Splitting the 85+ length category any further would not be possible for the surveys and for the Scottish commercial fleet, due to the already low numbers in this category. It may be possible for the England and Wales commercial fleet, but this has not been attempted. The suggestion of comparison with expected size frequencies from a length-based equilibrium life-history model has not yet been attempted, but is one the WG should attempt in future.

R1.13 Figure 2.23b, now included in the report, shows the plot requested.

R1.14 This sharp change can also be seen in the estimates of recruitment shown in Figure 2.20 of the report. This reflects the recruitment needed to fit the length frequency patterns seen in the proportions by length category data from the commercial fleets; and later also from the surveys. Appropriate comments can be inserted into the report to this effect.

R1.15 That females are not taken in the Scottish western IBTS is thought to be due to the low spatial overlap between this component of the stock and the survey stations. Mature females have been caught in surveys of coastal waters of VIIa in Q4, and might also occur in coastal waters (e.g. sea lochs) in VIa.

R1.16 Selectivity parameters are estimated for each of the length categories except for the category with the highest selection (Eq 2.5b). Forcing flat-topped selection will lead to model misspecification for the fit to the Scottish commercial proportions by length category data, particularly because flat-topped selection is estimated (not forced) for the England and Wales length-category data (note that L_∞ for males < the largest length category).

R1.17 See R1.16 and R1.15. Furthermore, Figure 2.28b (ICES 2010) explored sensitivity to historical selection and found limited sensitivity to this alternative assumptions. This is explored further in the report this year, and again finds that results are relatively insensitive to alternative targeting scenarios.

Review 2

1 Summary

My personal opinion is that there is strong evidence that spurdog is overexploited, and that a main issue is how well can the recovery plan be monitored. In addition there are likely to be valuable lessons for other shark species and data poor stocks from the assessment.

Management advice is that "Targeted fisheries should not be permitted to continue, and bycatch in mixed fisheries should be reduced to the lowest possible level. The TAC should cover all areas where spurdog are caught in the Northeast Atlantic and should be set at zero." Therefore lack of data, particularly of discards, and biases due to changes in fishing behaviour in response to management are a problem for the main stock assessment model that relies on commercial catch and effort data[R2.1].

I have tried to keep to the same structure as [Reviewer 1's] review, in order to make it easier to combine our comments into a single document, if desired. I also agree with his main points "that the methodology is sound, modern and appropriately applied" and that "paucity of discard information is a problem for gauging the efficacy of management measures and assessing stock status". However, I would go further in that the main problem is not a stock assessment problem, but a problem related to data, management and knowledge of spurdog biology.

I also think that further studies of the commercial length frequencies should be conducted and agree that "the absence of raising factors for the UK fleet" and "length frequency samples from some countries" are problems that should be addressed. Size data could provide important insights into changes in and differences between targeting by fisheries, and could also be used to develop indicators of population abundance and exploitation level.

2 Data

Data such as catch and effort, catch-at-size and survey data are available. However, since spurdog is a bycaught species problems exist due to historical misreporting and because estimates of total discards are not routinely available.

2.1 Catch per unit of effort

The assessment benefits from the availability of survey data. The diagnostics however could have included plots of

- the standardised deviance residuals against the fitted values to check for systematic departures from the assumptions underlying the error distribution;
- the dependent variable against the linear predictor function as a check of the assumed link function[R2.2].

See Ortiz and Arocha (2004).

A standardisation exercise as conducted for cpue would be very useful in order to evaluate factors affecting catch-at-size.

3 Life history

The assumptions about life-history characteristics and behaviour of spurdog are very important. For example population segregation and aggregation of mature (especially pregnant) females can make some shark species highly vulnerable to fisheries particularly when stocks are seriously depleted. Also the population structure of catches appears to vary greatly in time and space. Therefore successful management needs to consider how the biology can impact on the assessment and management.

Although the Stock Annex is referred to a lot, I only found a template not the data[R2.3].

4 Modelling

The main assessment method is based on sound methodology that has been used both in Australia for sharks and the IWC for cetaceans. It is an age- and sex-structured model that also includes the biology, i.e. length-based, maturation, pup-production and growth processes. It is therefore more able to incorporate biological process, important for providing advice on sustainability. However, including more processes also requires better data and knowledge. Otherwise uncertainty can actually increase compared to a simpler model.

Assessments using simpler methods are becoming increasingly important for monitoring and management. For example for longer-lived species a truncated size composition, with only a small percentage of mature fish, can be an indication of overfishing. Shark species are increasingly attracting interest from a range of stakeholders and data rather than assessment-based rules may be a step towards opening up the debate to such stakeholders. Therefore the data and simpler model-based approaches should be investigated to see if they could provide indicators of stock status. It is also likely that such methods would be of use for many other ICES stocks[R2.4].

A variety of indicators have been proposed to monitor stocks, e.g. mean size. Punt *et al.* (2001) in a study of various indicators showed that those based on the mean length or mean weight of the catch perform better, because these quantities change in a more predictable manner with abundance than cpue. I would have liked a range of indicators based on the data to have been considered. Not only would this have been a check of the assessment model used it would help validate such approaches for other stocks considered by WGEF[R2.5].

This could be used in the future as part of an adaptive management plan. For example where the current management plan is kept in place until a positive signal is seen in an appropriate indicator. Such an adaptive management plan would first have to be evaluated using Management Strategy Evaluation to ensure that the indicator tracked population size give uncertainty about the dynamics, ability to implement management measures and to monitor fisheries and populations. The various assessment runs already provide a set of robustness trials that could be the basis of such an exercise. The results from such an exercise would have potentially important benefits for many stocks. Particularly since use of complex assessment methods for "data-rich" stocks don't appear to be correlated with sustainability[R2.6].

5 Reference points

I agree strongly with

"As with any stock assessment model, the exploratory assessment relies heavily on the underlying assumptions, particularly with regard to life-history parameters (e.g. natural mortality and growth), and on the quality and appropriateness of input data. The inclusion of two periods of fecundity data has provided valuable information that allows estimation of Qfec, and projecting the model back in time is needed to allow the 1960 fecundity dataset to be fitted. Nevertheless, the likelihood surface does not have a well-defined optimum, and additional information, such as on appropriate values of MSYR for a species such as spurdog, would help with this problem. Furthermore, the change in selection for the Scottish survey data around 2000 is currently unexplained and needs further investigation. 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."

However, the only reference point quoted is a single point estimate of F_{MSY}. Biomass and yield reference points should also be calculated and estimates of uncertainty provided. Such estimates should include both estimation error (e.g. CVs) but also uncertainty due to lack of knowledge. This can be done based on the various scenarios that were run. The biomass and yield reference points should also be compared to the historical time-series. However in my opinion MSY based reference points are less relevant to this stock than conservation reference points. Also reference points mainly make sense within a management framework. In this case to monitor the recovery of the stock, e.g. what is the reference point which would cause a non-zero TAC to be set?[R2.7]

I also agree with "Improved estimates for biological data (e.g. growth parameters, reproductive biology and natural mortality); information on likely values of MSYR for a species such as spurdog". This is just as true for all stocks assessed by ICES, as it attempts to provide advice on MSY since there is a marked difference between providing advice under the ICES PA framework, which mainly related to collapsed and recovering stocks, compared to providing advice for a stock being managed to MSY. In the former case recovery mainly depends upon the luck of recruitment and reducing effort. However as ICES move into MSY based management, the underlying assumptions about stock dynamics play an increasingly important role in the development of appropriate targets.

Response to comments by Reviewer 2

R2.1 The assessment model relies on a combined survey index of abundance derived from Scottish groundfish surveys, not on commercial cpue.

R2.2 Diagnostic plots including the suggested figures were included in Figure 2.15. Further residual plots are included in this year's report.

R2.3 All the data used in the assessment were given in the report itself.

R2.4 We agree that alternative indicators of stock status, based on data and simpler model-based approaches would merit further investigation; it would be useful to consider this in a context wider than just spurdog (as it may also have applications for developing metrics under the Marine Strategy Framework Directive), and in a framework that would allow simulation testing of these indicators to evaluate their utility for management; such a study is currently beyond the focus of WGEF (see also R2.5 and R2.6).

R2.5 Given the aggregating nature of spurdog (and some other elasmobranchs), whereby surveys may happen to sample either a large aggregation of juveniles or adult fish in any given year, simple metrics of 'mean size' or the 'proportion of mature fish' may be highly variable and not indicative of wider stock status (see Section 11 of ICES 2011). Hence, further exploratory investigations on methods to derive simpler metrics that are representative of stock status are still required.

R2.6 We agree that Management Strategy Evaluation would provide the appropriate framework for evaluating indicators of stock status; developing such an MSE framework is time consuming and currently beyond the focus of WGEF.

R2.7 The development of appropriate reference points is the next area of development for spurdog, having just undergone a benchmark assessment. This could feed into the development of a management plan for the stock.

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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 exploited in the ICES area. This section deals with *Centrophorus squamosus* and *Centroscymnus coelolepis*, which have been the two species of greatest importance to commercial fisheries.

In some of European fisheries landings data for both species were combined for most of the time since the beginning of the fishery. In the past these two species has been assigned to a generic term "siki".

3.1.1 Leafscale gulper shark

Leafscale gulper shark (*Centrophorus squamosus*) 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 live as a demersal shark on the continental slopes (depths between 230–2400 m) or have a more pelagic behaviour, occurring in the upper 1250 m of oceanic water in areas with depths around 4000 m (Compagno and Niem, 1998). Available evidence suggests that this species is highly migratory (Clarke *et al.*, 2001; 2002). Recent information revealed that in contrast to other NE Atlantic areas, where males are predominant, the sex ratio at the Faroes was approximately 1:1 (Vinnichenko and Fomin, 2009 WD). Available information reveals that pregnant females and pups are found in Portugal, both the mainland (Moura *et al.*, 2006 WD) and Madeira, whereas pre-pregnant and spent females are found in the northern areas (Clarke *et al.*, 2001; 2002; Garnes, pers. comm.) and in the Faroes (Vinnichenko and Fomin, 2009, WD). 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 (*Centroscymnus coelolepis*) is widely distributed in the NE Atlantic. Stock structure and dynamics are poorly understood. Specimens below 70 cm have been recorded very rarely in the NE Atlantic. There is a lack of knowledge of migrations, though it is known that females move to shallower waters for parturition and vertical migration seems to occur (Clarke *et al.*, 2001). The same size range and maturity stages exist in both the northern and southern ICES continental slopes. This information may suggest that, contrary to leafscale gulper shark, this species is not so highly migratory, though it is widely distributed. Preliminary genetic work (Moura *et al.*, 2008 WD) did not reject the null hypothesis that there was no significant difference between the northern and southern areas. In another study on genetic population structure of the Portuguese dogfish within the eastern Atlantic Ocean (including the northern sector of the mid-Atlantic ridge) found no evidence of genetic population structure was found (Verisimo *et al.*, 2010 WD). In both studies the authors expressed some concerns on how to interpret the results. Although the microsatellites are considered a powerful tool for stock discrimination, the number used could be insufficient to infer about existence of a single, well-mixed population.

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.

Information on Russian fisheries on sharks and skates in 2009 was presented by Vinnichenko *et al.* (2010 WD). Leafscale gulpershark predominated in the catches (57%) from one longliner targeting deep-water sharks on the slopes of the Lousy, Bill-Baileys and Føre Banks (ICES Division Vb) at depths ranging from 700 to 1150 m deep. In whole surveyed area the total number of fishing days was 22 and 389 000 hooks were set. At the Rockall Bank (Sub-Division VIb1) a total of 1.1 t of deep-water sharks were caught by one longliner operating during 13 days (a total of 409 000 hooks were set) at depth ranging from 175 to 970 m depths. The species caught included the Portuguese dogfish and Leafscale gulper shark. At the Reykjanes Ridge (Subdivisions XIIa1 and XIVb1) a total of 0.5 t of deep-water sharks (greater lantern shark, birdbeak dogfish and Portuguese dogfish) were caught by one longliner operating during seven days at depths between 450–850 m (a total of 50 000 hooks were set).

3.2.2 ICES advice applicable

In 2010 ICES advised a zero catch for Portuguese dogfish and Leafscale gulper shark. This advice is valid for 2011 and 2012.

3.2.3 Management applicable

The annual TACs that have been adopted for deep-sea sharks in Community waters and international waters at different ICES subareas are summarized in the table below. The deep-sea shark category includes the following species: Deep-water catsharks (*Apristurus* spp.); Frilled shark (*Chlamydoselachus anguineus*) Gulper shark (*Centrophorus granulosus*) Leafscale gulper shark (*Centrophorus squamosus*) Portuguese dogfish (*Centroscymnus coelolepis*) Longnose velvet dogfish (*Centroscymnus crepidater*) Black dogfish (*Centroscyllium fabricii*); Birdbeak dogfish (*Deania calcea*); Kitefin shark (*Dalatias licha*); Greater lanternshark (*Etmopterus princeps*); Velvet belly (*Etmopterus spinax*); Blackmouth catshark (Blackmouth dogfish) (*Galeus melastomus*); Mouse catshark (*Galeus murinus*); Six-gilled shark (*Hexanchus griseus*); Sailfin roughshark (Sharpback shark) (*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

(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.

Council Regulation (EC) No 1568/2005 bans 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. This ban does not cover Subareas VIII or IX. In 2006, the ban on gillnetting applied to waters deeper than 200 m, but this was revised to 600 m, in 2007, following advice from STECF.

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.

3.3 Catch data

3.3.1 Landings

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.

Landings have declined from around 10 000 t from 2001 to 2004, to about 1400 t in 2008 (Figures 3.1 and 3.2). In 2008 landings were the lowest since the fishery reached full development in the early 1990s and is slightly lower than TACs available (1715 t), although the TAC does include other deep-water shark species.

In recent years (2009 onwards), some countries did not report the landings of the two species separated or even the two combined it is evident that the landings have been strongly reduced in recent years. The restrictive measures adopted by EU seem to have deterred the commercial exploitation of deep-water shark but it is also likely that misreporting problems have increased.

Since 2009 (Table 3.3), no new information on deep-water shark catches made by Russian vessels has been reported to WGEF.

3.3.2 Discarding

New discard data were only provided by Portugal (ICES Xa) and Spain (Celtic Sea and Iberian waters).

The onboard sampling programme of Portuguese commercial vessels that operate deep-water set longlines to target black scabbardfish (métier LLD_DWS_0_0_0) is included in the EU DCF/NP. The programme is carried out by IPIMAR/INRB, I.P. and started in mid 2005. In 2010, nine fishing trips carried out by four longline vessels were sampled. All vessels departed from Figueira da Foz and fished ca. 30 miles offshore. Sampling goals were fixed at three trips per quarter and sampled trips and vessels were selected in a quasi-random way (Fernandes *et al.*, WD 2001). Reasons for the reduced geographical coverage and the low number of sampled vessels and trips were already mentioned in previous working documents that include detailed information on gear and fleet characteristics (Fernandes *et al.*, WD 2008; WD 2010).

Table 3.4 presents haul information of sampled trips. Overall, these results are similar to previous data reported for the 2005–2009 period, with exception of fishing time which was previously reported as the difference between the beginning of retrieving and the end of setting and here is reported as the difference between the middle of retrieving and the middle of setting.

The mean percentage of discards was of 8.1%. (s.d=3.5). Elasmobranchs constituted an average of 3.7% (sd=1.45) of discards and of 2.6% (sd=0.93) of landings. Results obtained (Table 3.5) show that the set longline fishery targeting black scabbardfish continues to be very selective for *Aphanopus carbo* with landings and discards of elasmobranchs representing a small part of the total catch. The main deep-water sharks landed alternates between *Deania calcea* and *Centrophorus squamosus*. *Etmopterus pusillus* constitutes the major part of elasmobranch discards.

In more recent years there has been an increase of *Centrophorus squamosus* by Spanish fleets fishing grounds on the Celtic Sea (VI–VII) and on the Iberian waters (VIIIc–IXa), particularly in the latter. In both cases the levels of coefficient of variation are quite high, particularly at Celtic Sea fishing ground (>75%).

Despite the lack of discard information for the remaining NE deep-water fisheries it is expected that discarding has increased, as a consequence of EU TAC restrictions.

Discard data, as well as better estimates of discards are required for all deep-water fisheries. The actual sampling levels required by DCF are considered inadequate for these stocks.

3.3.3 Quality of the catch data

Historically, very few MS presented landing data disaggregated by species. Portugal has supplied species-specific data for many years. Since 2003 onwards other MS 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 are likely to have changed recently 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 high misidentification problems. Samples collected covered 1.1% of the total landed weight (Serra-Pereira *et* *al.*, 2011WD). In subchapter Other deep-water sharks more detailed information is given.

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

3.4 Commercial catch composition

3.4.1 Species composition

For the latest information on species composition see WKSHARK 2011.

WGEF first attempted to separate the landings of these species into their components in 2006 (ICES 2006). Certain assumptions were made on their relative proportions based on data available at the time.

These data included:

- Official logbooks;
- Skipper's private logbooks;
- Deep-water survey results, both trawl and longline;
- Observer trips;
- The proportions of the two species found during gillnet retrieval surveys.

These proportions were then applied to the siki shark landings category for different countries and years, (ICES 2006–ICES 2010).

The composition of generic landings was also estimated based on the criteria adopted in 2005 WGEF. The allowed a split of all generic elasmobranch "nei" landings from the Northeast Atlantic in the period 1973–2003 (Figueiredo *et al.*, WD 2005).

A Workshop, WKSHARK (ICES 2011) was held to collate any further information on the proportions of the two siki species, and also to examine methods for updating the splitting ratios used by nation or by gear. New data were received from the UK, Ireland, Norway and Spain, from trawl, longline and gillnet fisheries. French data was provided after the meeting data, but was also examined.

Initial examination of these data showed greater variation in catches than expected, with the proportion of *C. squamosus* to *C. coelolepis* varying considerably on both a temporal and spatial level. There were also differences between these data and data used by WGEF to split the siki stocks. This meant that extra time was needed to analyse the data. Requests for greater resolution in the data were made in some cases.

It was possible to show correlations between some vessel data and benthic features, such as sea-mounts and ridges. These can be used to extrapolate which species were caught based on known depth preferences between the siki species.

While further information was received it was not possible to analyse these data in the short term. Further analysis will take place before WGEF 2012.

Splitting ratios used have therefore not been updated, and the species composition proportions used have not been updated since WGEF2010.

3.4.2 Length composition

New length frequency information for Leafscale gulper (Figure 3.3) and for Portuguese dogfish (Figure 3.4) is provided for the Portuguese longline fishery operating in ICES Division IXa (Serra-Pereira *et al.*, 2011 WD). The frequency length distributions do not differed from previous ones (Figueiredo and Moura, 2010 WD).

3.4.3 Quality of catch and biological data

WGEF reiterates the necessity for nations undertaking scientific fisheries for deep-water species that can take large quantities of fish (e.g. deep-water sharks) should ensure that these catches are reported accordingly.

WGEF considers that despite the efforts done up to now to improve the quality of data and in particularly on species composition a lot of uncertainties persist on historical data.

In most recent years, WGEF considers that landing data are likely to include misreporting and misidentification errors.

3.5 Commercial catch-effort data

In 2006, WGEF summarized all the available cpue series.

In 2008 a standardized lpues for Leafscale gulper shark and Portuguese dogfish in ICES IXa were presented (Figueriedo *et al.*, 2008 WD). In this study cpue analysis were based on two data sources: i) catch rate analysis taking into consideration VMS data (2000–2004) and ii) a longer series of daily landing data for which no spatial information included (1995–2006). The main conclusion was that to analyse commercial catch rate data of deep-water shark species it is necessary to have information on the fishing locations. Furthermore the efforts done to circumvent the unavailability of VMS data for the period other than 2000–2004 by considering other variables, proved to be inefficient in "capturing" the effect of the fishing location. Fishing location factor was particularly significant in the case of Portuguese dogfish catch rates (Figueiredo *et al.*, 2008 WD).

In 2010 French standardised landings per unit effort (lpue) for combined Portuguese dogfish and Leafscale gulper shark species was presented for the period 2000–2009. Data was on a haul by haul basis which was derived from skippers' personal logbooks (tallybooks) from the deep-water trawlers operating to the west of the British Isles. Following, the results obtained with EC-logbook data (Biseau, 2006WD), lpues were estimated in five small areas. Exploratory data analysis revealed that the presence of Portuguese dogfish and leafscale gulper sharks in tallybook hauls varied somewhat temporally and spatially. There seemed to be a decrease in occurrence on the eastern shelf edge (area edge6) between 2000 and 2009, with consistent presence primarily in the northern area at the end of the time-series (area new5). In general, highest catches were obtained in area new5 (Figures 3.5 and 3.6). Abundance indices could not be derived for all five small areas probably owing two strong year to year variations in catch per area and poor estimation of the vessel effect. In some cases a single vessel contributed to most of the landings in some areas/years. In area edge were more than one vessel have operated the standardised cpue biomass index indicates a decrease over time of (Figure 3.7). The abundance in recent years is between one half and one third of the abundance in 1993–1996. Lpues for Portuguese dogfish together with Leafscale gulper shark is considered stable over the last 5–7 years (Lorance and Trenkel, 2010 WD).

3.6 Fishery-independent surveys

Marine Scotland Science has conducted deep-water surveys in Subarea VI at depths ranging from 300–1900 m since 1996. In 2010 the survey did not take place due to vessel´s technical problems.

Ireland carries out a deep-water survey each year in Area VI and VII, concentrating on NW Ireland–west of Scotland, and the Porcupine area to the west of Ireland. Fishing takes place at 500 m, 1000 m, 1500 m and 1800 m. The survey took place in September from 2006–2008 and in December 2009. After this the survey no surveys were held.

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

A preliminary study on trends in abundance and distribution of deep-water sharks to the west of the British Isles from trawl surveys was presented at 14th European Elasmobranch Association (EEA) Scientific Conference at the Marine Institute in Galway (10–12 November 2010). An update version of this work is expected to be presented at next WGEF meeting

3.7 Life-history information

No new information since 2006.

3.8 Assessments

3.8.1 Exploratory assessment

No exploratory assessments were carried f*or Centroscymnus coelolepis* and for *Centrophorus squamosus* during 2011.

Details of previous assessments are in the stock annex.

3.9 Reference points

WGEF was not able to propose appropriate reference points for advice under the MSY framework. Methodologies for establishing MSY reference points and/or proxies for similar data-poor stocks will be investigated by other ICES working groups in 2011 and WGEF 2011 will use this work as a basis to develop reference points for deep-water sharks.

3.10 Management considerations

No management advice is given in 2011.

3.11 Spatial information

Some landings information by gear and statistical rectangle is available.

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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.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
IV a	0	12	8	10	140	63	98	78	298	227	81	55
Va	0	0	0	0	1	1	0	0	0	0	5	0
Vb	0	0	140	75	123	97	198	272	391	328	552	469
VI	0	8	6	1013	2013	2781	2872	2824	3639	4135	4133	3471
VII	0	0	0	265	1171	1232	2087	1800	1168	1637	1038	895
VIII	0	0	6	70	62	25	36	45	336	503	605	531
IX	560	507	475	1075	1114	946	1155	1354	1189	1311	1220	972
X	0	0	0	0	0	0	0	0	0	0	0	0
XII	0	0	0	1	2	7	9	139	147	32	56	91
XIV	0	0	0	0	0	0	0	0	0	9	15	0
Unknown Area												
	560	527	635	2509	4626	5152	6455	6512	7168	8182	7705	6484

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
IV a	1	3	10	16	5	4	4	3	1	1	1
Va	1	0	0	0	0	0	0	0	0	0	0
Vb	410	475	215	300	229	239	195	590	171	24	46
VI	3455	4459	3086	3855	2754	1102	638	737	621	54	43
VII	892	2685	1487	3926	3477	842	323	94	111	4	4
VIII	361	634	669	746	674	376	208	23	27	105	1
IX	1049	1130	1198	1180	1125	1033	1325	517	463	21	5
X	0	0	0	0	0	1	0	0	0	0	0
XII	890	719	1416	849	767	134	0	1	0	0	0
XIV	0	0	12	4	0	0	0	61	0	0	0
Unknown Area						1323	34	0	0	0	0
	7059	10105	8093	10876	9031	5054	2727	2025	1393	209	100

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.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
France	0	0	140	1288	3104	3468	3812	3186	3630	3095	3177	3079
UK (Scotland)	0	20	14	24	165	469	743	801	576	766	1007	625
UK (England and Wales)	0	0	0	104	80	174	387	986	1036	2202	1494	1019
Ireland	0	0	0	0	0	0	0	33	5	0	3	2
Iceland	0	0	0	0	1	1	0	0	0	0	5	0
Spain (Basque C)	0	0	0	0	0	0	0	0	286	473	561	450
Portugal	560	507	481	1093	1128	946	1155	1354	1189	1314	1260	1036
Germany	0	0	0	0	148	91	358	92	164	106	40	214
Estonia	0	0	0	0	0	0	0	0	0	0	0	0
Latvia	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0
Russia												
Spain (Galicia)	0	0	0	0	0	0	0	0	0	0	0	0
Faeroe Island	0	0	0	0	0	3	0	60	282	226	158	54
Norway	0	0	0	0	0	0	0	0	0	0	0	5
Total	560	527	635	2509	4626	5152	6455	6512	7168	8182	7705	6484

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	3519	3684	2103	1454	1189	866	744	855	802	52	73
UK (Scotland)	623	2429	1184	1594	1135	802	184	86	49	30	21
UK (England and Wales)	413	320	335	4027	3610	1533	537	23	7	0	0
Ireland	138	454	577	493	764	381	113	36	8	0	0
Iceland	0	0	0	0	0	0	0	0	0	0	0
Spain (Basque C)	280	608	621	719	563	359	78	0	0	84	0
Portugal	1108	1151	1198	1180	1125	1033	1072	522	463	43	6
Germany	265	431	518	640	0	79	0	0	0	0	0
Estonia	0	0	53	4	0	0	0	0	0	0	0
Latvia	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	14	40	28	0	0	0	1	62	0	0
Poland	0	0	8	0	0	0	0	0	0	0	0
Russia							0	500	0	0	0
Spain (Galicia)	572	615	1381	737	626	0	0	0	0	0	0
Faeroe Island	23	0	0	0	0	0	0	0	3	0	0
Norway	118	399	75	0	19	0	0	0	0	0	0
Total	7059	10105	8093	10876	9031.4	5053	2727	2023	1393	209	100

	2003	2004	2005	2006	2007	2008	2009
France	0	0	0	0	0	0	0
UK (Scotland)	0	1	1	1	1	2	1
UK (England and Wales)	0	0.27	0	0	0	2	1
Ireland	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0
Spain (Basque C)	0	0	0	0	1	1	0
Portugal	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0
Latvia	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Russia				0	0	0	0
Spain (Galicia)	0	0	0	0	0	0	0
Faeroe Island	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Total	0	0.81	1	1	2	5	2

Table 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). 2009 Russian research and fisheries in the Northeast Atlantic - Total catches of deep-water sharks by ICES Divisions, in which either Portuguese dogfish or Leafscale gulper were referred to have been caught (Vinnichenko *et al.*, 2010 WD).

ICES Area	Total catch	Species
Vb	98	Leafscale gulper (57%)
VIb1	1	Portuguese dogfish & Leafscale gulper
XIIa1, XIVb1	1	Portuguese dogfish

Table 3.4. Portuguese longliner (ICES Division IXa) -.Descriptive statistics of haul information. (sd = Standard Deviation)

	n	Mean	SD	min	Max
Number of hooks	9	9091	932.6	8000	10000
Fishing time (hours)	9	42.64	3.53	40	51.5
Fishing depth (m)	7	1171	37.2	1133	1243

Table 3.5. Portuguese longliner (ICES Division IXa) - Descriptive statistics of species lengths sampled in landings and in discards (SD = Standard Deviation)

	To be landed					Discarded				
Scientific name	***n***	**Mean**	**SD**	**min**	**Max**	***n***	**Mean**	**SD**	**min**	**Max**
Alepocephalus bairdii	-	-	-	-	-	18	55	16.88	44	81
Aphanopus carbo	1373	109.1	1.80	80	131	-	-	-	-	-
Caelorinchus caelorhincus	-	-	-	-	-	4	24.8	1.66	23	25
Centrophorus granulosus	3	107.8	-	99	117	-	-	-	-	-
Centrophorus squamosus	45	109.3	3.05	85	125	1	65.0	-	-	-
Centroscymnus coelolepis	36	106.1	12.21	71	116	-	-	-	-	-
Centroscymnus crepidater	-	-	-	-	-	3	60.8	-	48	80
Chlamydoselachus anguineus	-	-	-	-	-	1	146.0	-	-	-
Deania calcea	72	92.4	1.96	66	111	2	50.5	-	29	71
Etmopterus pusillus	-	-	-	-	-	227	43.8	0.22	29	50
Galeus melastomus	3	67.2	-	63	70	4	65.0	-	56	70
Lepidopus caudatus	-	-	-	-	-	2	105.0	-	98	111
Loliginidae, Ommastrephidae	1	48.0	-	-	-	-	-	-	-	-
Notacanthus chemnitzii	-	-	-	-	-	1	89.0	-	-	-
Phycis blennoides	6	62.5	-	48	77	2	44.5	-	32	56
Prionace glauca	-	-	-	-	-	23	100.8	48.33	68	146
Scymnodon ringens	20	96.0	21.36	80	112	-	-	-	-	-
Synaphobranchus kaupii	-	-	-	-	-	10	57.2	22.05	42	65
Trachyrincus scabrus	-	-	-	-	-	2	24.5	-	24	25

Table 3.6. Spanish discard data (Celtic Sea and Iberian ICES Division IXa) - Weight discarded (tons) of and CV of estimations (Italics) by fishing ground.

Fishing Ground	Species	2003	2004	2005	2006	2007	2008	2009	2010
Celtic Sea	*Centrophorus squamosus*	**0.0**	**0.0**	**0.0**	**3.2**	**0.0**	**67.3**	**61.1**	**0.0**
(Subareas (VI-VII))		-	-	-	*99.5*	-	*65.7*	*86.3*	-
Iberian Waters	*Centrophorus squamosus*	**0.0**	**0.0**	**4.5**	**4.1**	**0.0**	**0.0**	**95.6**	**28.7**
(Divisions (VIIIc-IXa))		-	-	*89.5*	*80.6*	-	-	*55.4*	*47.9*

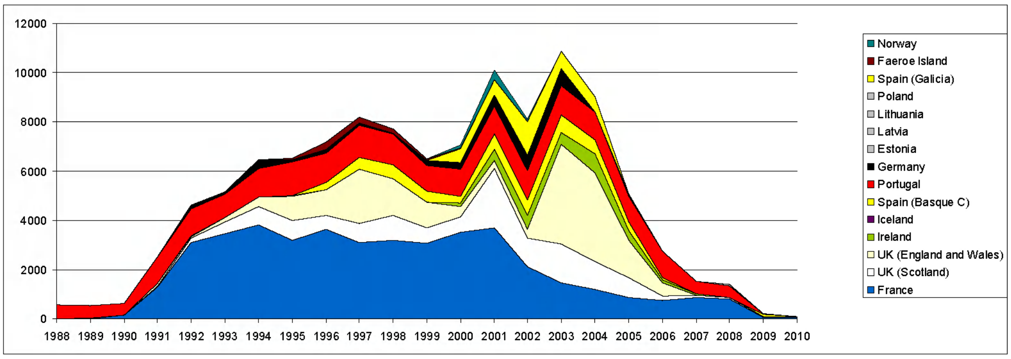


Figure 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by country.

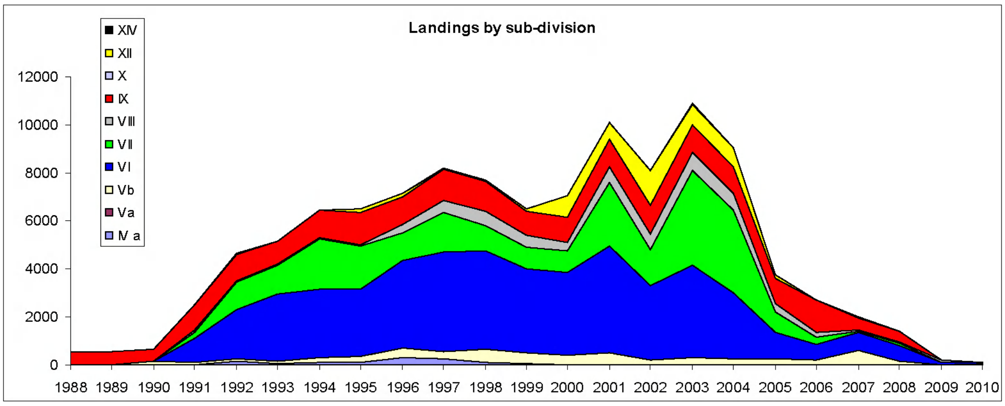


Figure 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by ICES Subarea.

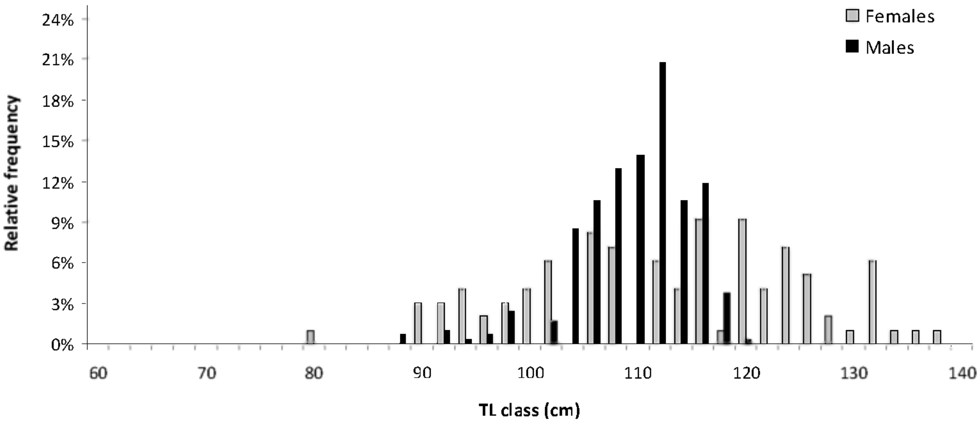
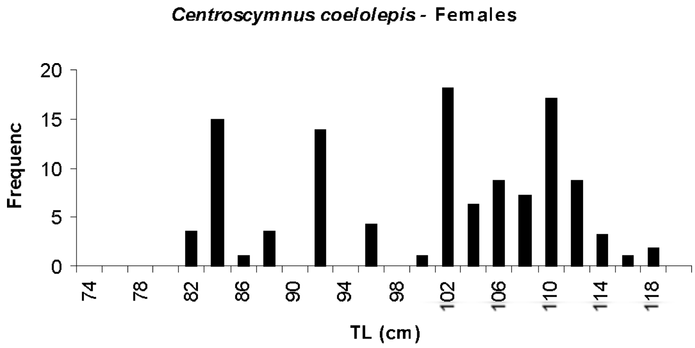
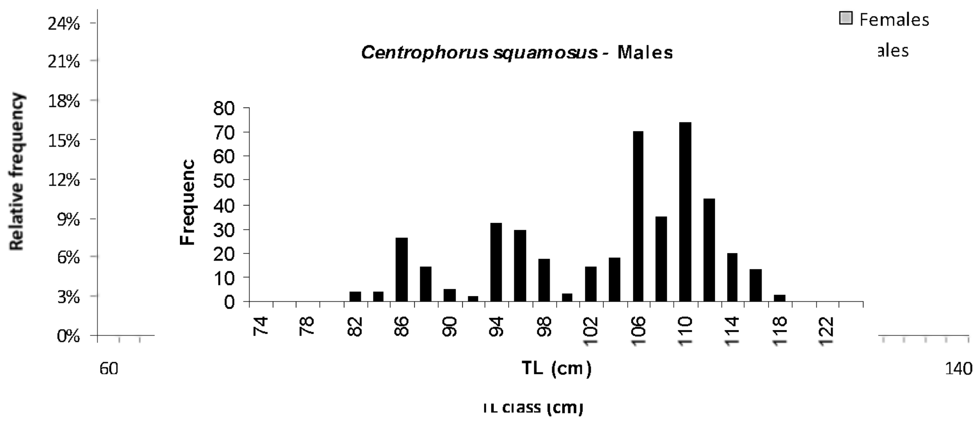


Figure 3.3. Deep-water sharks - Leafscale gulper shark in the Northeast Atlantic (ICES Division IXa). Length frequency distribution by sex (2 cm length class; number of sampled trips: 17).





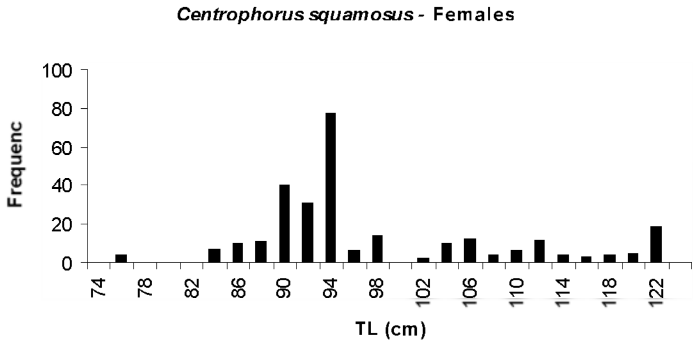


Figure 3.4. Deep-water sharks - Portuguese dogfish in the Northeast Atlantic (ICES Division IXa) Length frequency distribution by sex (2 cm length class; number of sampled trips: 17).

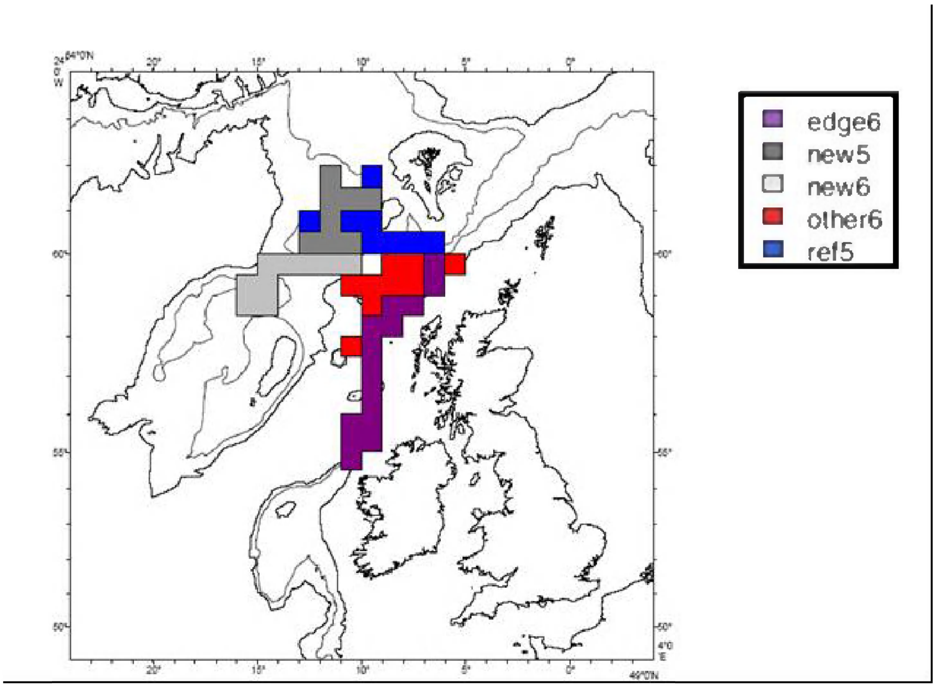


Figure 3.5. Portuguese Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French trawlers. Small areas defined for the estimation of lpue from French tallybook. Purple: edge6; red: other6; dark grey:new6; light grey new5; blue: ref5.

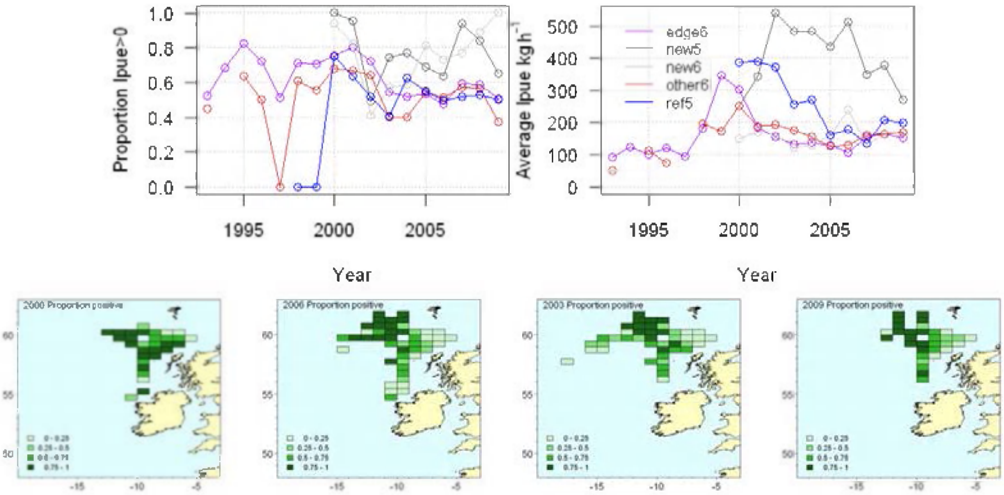


Figure 3.6. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French trawlers Occurrence (proportion of haul with lpue>0) and average lpue for the positive (with catch of siki) haul of siki sharks in tallybook hauls per area (top panels) and spatial distribution of the proportion of positive hauls (bottom panels, not all years shown).

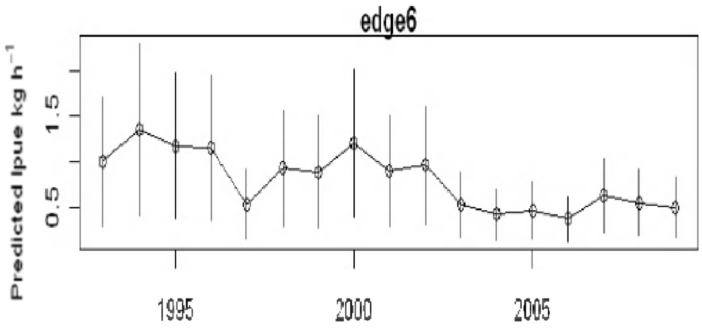


Figure 3.7. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Standardised cpue for area edge6 for the period 1993–2009. Vertical bars are 95% confidence intervals.

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 resource seems to be more abundant in the southern area of the Mid-Atlantic Ridge (ICES Area 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 is considered as a management unit (ICES Subarea X).

4.2 The fishery

4.2.1 History of the fishery

The directed fishery on the Azores stopped at the end of the 1990s because it was not profitable. Kitefin shark in the North Atlantic is currently a bycatch in other fisheries. A detailed description of the fisheries can be found in Heessen, 2003 and ICES, 2003.

4.2.2 The historic fishery

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 the 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.

4.2.3 The fishery in 2009 and 2010

Kitefin from the Azores is now a bycatch from different demersal/deep-water mixed hook and line fisheries, with landings in the period 2004–2011 usually 10 t or less. (WD Pinho, 2011).

4.2.4 ICES advice applicable

The advice provided by ICES for 2009 and 2010 is the same as provided in 2006, for 2007 and 2008. In 2006 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*" The TAC was again set at zero.

4.2.5 Management applicable

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). 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 is 2472 t. In Subarea X the TAC is 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 for 2010 (EC Reg. no 1359/2008).

There is a network of closed areas in Azorean waters, and these are summarized in Section 20.

For 2009 the 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 a seamount (condor seamount) was closed to demersal/deep-water fisheries under a multidisciplinary project to study its dynamic (http://www.condor-project.org/).

4.3 Catch data

4.3.1 Landings

The landings reported from each country, for the period 1988–2010 are given in Table 4.1 and total historical landings 1972–2010 in Figure 4.1.

4.3.2 Discards

New information on discards was presented to WGEF (WD Pinho, 2011). *Dalatias licha* occurred on 23% of the sampled sets. A total bycatch of 300 individuals (50 individuals by year on average) was observed during the period 2005–2010, from which about 15% were discarded and 85% used on board as bait. Scattered and lower level of kitefin discards were reported from the Spanish trawl fleets operating on the Iberian waters (Division VIIIc, IXa; Santos *et al.*, 2010) and also reported for 2011.

4.3.3 Quality of catch data

Deep-water sharks taken in the Azores are usually gutted, finned, beheaded and also skinned. Only the trunks and, in some cases, the livers are used. Species misidentification is a problem with deep-water sharks. The Azorean landings 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 surveys (the Azorean longline survey ARQDACO(P)-Q1) rarely catch kitefin shark (only 48 individuals were caught during the last fifteen years), because the survey is not designed for the species, and will not provide relevant information for the assessment (WD Pinho, 2011).

4.7 Life-history information

There is no new information available.

Individuals less than 98 cm are not observed in the region suggesting that probably spawning and juveniles occurs in deep water or 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}.

4.8.2 Stock assessment

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

4.9 Quality of assessments

No new assessments were undertaken.

4.10 Reference points

In common with other deep-water stocks, U_{lim} is set at 0.2* virgin biomass and U_{pa} is set at 0.5* virgin biomass (ICES, 1998).

4.11 Management considerations

Preliminary assessment results suggest that the stock may be depleted, to about 50% of virgin biomass. However, further analysis is required to better understand the status of the stock, particularly analysing the effect of liver oil prices on the fishery.

There are no fishery-independent surveys with which to monitor any stock recovery. The Working Group considers that the development of a fishery must not be permitted before data become available in order to have a more precise idea about the sustainable catch. If an artisanal, sentinel fishery was to be established it should be accompanied by a scientifically robust data collection.

Evaluating the status of kitefin shark in the closed areas around the Azores could be usefully evaluated.

A seamount (Condor) was also closed to fisheries for a two year period (2010–2011) with a multidisciplinary research (ecological, oceanography and geological) for characterization of its dynamic Portaria n.º 48/2010 de 14 de Maio de 2010.

4.12 References

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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

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

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

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

Country	Subarea	2009	2010
France	VII, VIII	.	.0
UK Scotland	Vb, VI	.	.0
UK (E&W)	VI, VII,VIII	.	.0
Ireland	X	.	.0
Germany	VII	.	.0
Portugal	VI, IXa	.	.0
Portugal (Azores)	X	6	2
Total		6	2

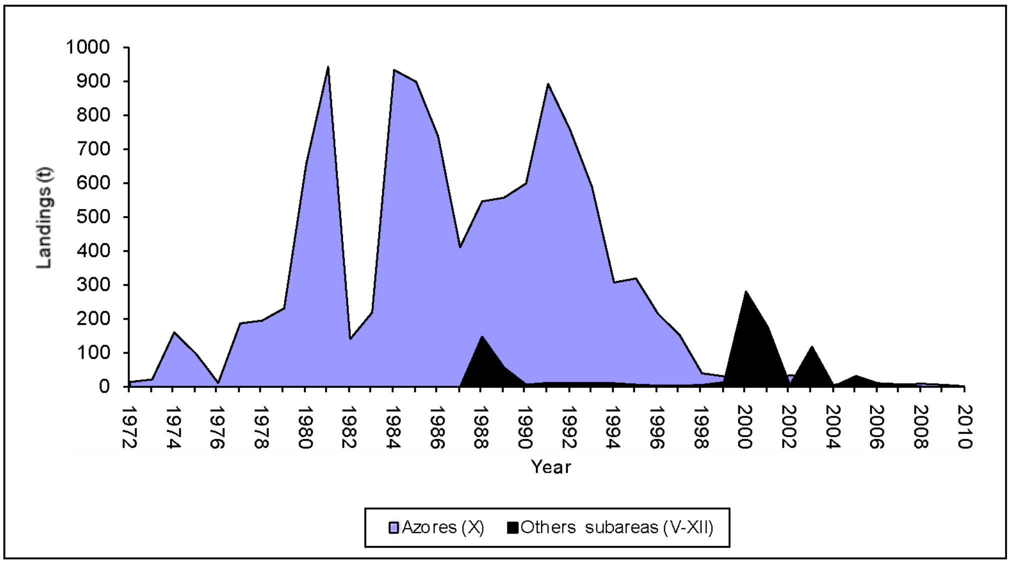

Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin by ICES statistical areas.

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

5.1 Stock distributions

The present section includes information about deep-water elasmobranch species other than Portuguese dogfish and leafscale gulper shark (see Section 3) and kitefin shark (see Section 4). Little information exists on the majority of the species presented here other than annual landings data for some species, which are probably incomplete. In addition, it is likely that the available data for some species may be unreliable due to problems with species identification. For example gulper shark may be sometimes confounded due to morphological similarity with other similar species such as *C. niaukang*, *C. lusitanicus* and *C. harrissoni* (Compagno *et al.*, 2005).

The species and generic landings categories for which landings data are presented are: Gulper shark (*Centrophorus granulosus*), birdbeak dogfish (*Deania calcea*), longnose velvet dogfish (*Centroselachus (Centroscymnus) crepidater*), black dogfish (*Centroscyllium fabricii*), velvet belly (*Etmopterus spinax*), blackmouth catshark (*Galeus melastomus*), Greenland shark (*Somniosus microcephalus*), lantern sharks *nei* (*Etmopterus* spp.), and 'aiguillat noir' (may include *C. fabricii*, *C. crepidater* and *Etmopterus* spp.).

14 species of skate (Rajidae) are known from deep water in this area: 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 (*Dipturus lintea*), Norwegian skate (*Dipturus nidarosiensis*) and blue pygmy skate (*Neoraja caerulea*). Most of these species are poorly known. Species such as *Dipturus batis* complex (see Section 21.1) and *Leucoraja fullonica* may occur in deep water, but their main areas of distribution extend to much shallower waters and they are not considered in this section.

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. More detailed accounts of fisheries that catch these species can be found in the stock annex.

5.2.2 The fishery in 2010

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

Reported catches in the directed Portuguese longline fishery for gulper sharks reduced to zero in 2010 but it is possible that the fishery has continued with catches being misreported as *C. lusitanicus* to which TACs do not apply.

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

In EC waters, a combined TAC is set for a group of deep-water sharks. These include Portuguese dogfish, leafscale gulper shark, birdbeak dogfish, kitefin shark, greater lanternshark (*Etmopterus princeps*), velvet belly, black dogfish, gulper shark, black-mouth catshark, mouse catshark (*Galeus murinus*) and Iceland catshark (*Apristurus* spp.). In Subarea XII, rough longnose dogfish (*Deania histricosa*) and arrowhead dog-fish (*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 will be permitted.

Deep-water skates are included in EU TACs for "Skates and Rays *Rajidae*". In EU wa-ters 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

Gulper shark *Centrophorus granulosus*

Reported landings of gulper shark are presented in Table 5.1 and in Table 5.10. Five European countries have reported landings: UK (England and Wales), UK (Scotland), France, Spain and Portugal.

Almost all landings in recent years have been from the Portuguese longline fishery in Subarea IX. Until 2008, annual landings from this fishery were around 100 tonnes however, in 2009, Portuguese landings reduced to 2 tonnes. This may be a result of restrictive quotas for deep-water sharks but it is also possible that gulper shark land-ings may have been misidentified as other morphologically very similar species such as *C. lusitanicus*.

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 consid-ered 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 Table 5.2 and in Table 5.10. It is likely that landings reported as this species include other species in the same ge-nus, particularly in Portuguese landings from Subareas IX and X (Pinho, 2010 WD).

Four European countries have reported landings of birdbeak dogfish: UK (England and Wales), UK (Scotland), Spain and Portugal from Subareas IX and VII. In 2005, the total reported landings for all subareas reached 194 tonnes however this declined to 66 tonnes in 2008 and zero in 2009.

Catches of this species by Russian deep-water longline fisheries in the Faroese Fish-ing 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.

Longnose velvet dogfish *Centroselachus* (*Centroscymnus*) *crepidater*

Reported landings of longnose velvet dogfish are presented in Table 5.3 and in Table 5.10. 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.

Six European countries have reported landings: UK (England and Wales), UK (Scotland), France, Spain, Portugal and Ireland, from Subareas VI, VII, VIII and IX. Highest catches (400 tonnes) were recorded in 2005 and came principally 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 Table 5.4 and in Table 5.10. 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: UK (England and Wales), Iceland, France and Spain, from Subareas IVa, Vb, VII and XII.

France has reported the majority of the landings of black dogfish in the ICES area, since 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.

In 2008, only France reported catch of black dogfish, mainly from Subarea Vb with a total catch of 137 tonnes. There have been no reported landings since 2008.

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.

Velvet belly *Etmopterus spinax*

Reported landings of velvet belly are presented in Table 5.5 and in Table 5.10. Four European countries have reported landings of velvet belly: Denmark, UK (England and Wales), UK (Scotland) and Spain, from Subareas IV, VI, VII and VIII. Greatest landings are from Denmark. Landings began in 1993, peaked in 1998 at 359 t and have since declined. UK landed 8 t in 2007 since when there have been no reported catches.

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.

Lantern sharks *nei Etmopterus* spp.

Reported landings of lantern sharks *nei* are presented in Table 5.6 and in Table 5.10. Three European countries have reported landings: France, Spain and Portugal, from Subareas IV, Vb, VI, VII and IX.

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. In recent years, 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. Landings of these species may also be included in the grouped category "*Aiguillat noir*" and other mixed categories.

Few landings data have been reported since 2003.

Blackmouth dogfish *Galeus melastomus*

Reported landings of blackmouth dogfish are presented in Table 5.7 and in Table 5.10. Three European countries have reported landings: Ireland, Spain and Portugal, in Subareas VI, VII, VIII, IXa and X.

Portuguese landings began in 1990, rose to 35 t in 1996 and have remained steady at that level. Spanish landings began in 1996, peaked at 35 t in 2002, have since declined to low levels and not been reported in recent years.

In the southern Portuguese coast (ICES IXa) two catsharks species *Galeus melastomus* and *Galeus atlanticus* are caught by trawlers and longliners, however to low or no commercial value, these species are most of the times discarded at sea (Coelho and Erzini, 2008).

"*Aiguillat noir*"

This is a generic category only used by France to record landings on small, deep-water squaliform sharks, including black dogfish, 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 are presented in Tables 5.8 and 5.10.

Greenland shark *Somniosus microcephalus*

Landings were reported from Icelandic fisheries in Subareas Va and XIV. The catch reached 91 tonnes in 1998 and has since declined. Landings in 2009 were 24 tonnes. Landings are presented in Tables 5.9 and 5.10.

Centrophorus lusitanicus

Reported landings of this species in Portuguese landings in 2009 and 2010 data are believed to refer to misidentified *C. squamosus* (see Serra-Pereira *et al*., WD 2011).

5.3.2 Discards

New information on discarding from the Azorean observer programme was provided in Pinho and Canha, WD 2011.

Table 5.0. 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

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, most species were considered to be reliably identified; however, reported landings of gulper shark are still considered to be unreliable and have been added to landings of siki sharks.

5.4 Commercial catch composition

5.4.1 Species and size compositions

No new information is available.

5.5 Commercial catch-effort data

No new information is available.

5.6 Fishery-independent surveys

A summary of available survey data is given in the stock annex.

5.7 Life-history information

No new information is available.

5.8 Exploratory assessment models

No assessments undertaken.

5.9 Quality of assessments

No assessments undertaken.

5.10 Reference points

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

5.11 Management considerations

No management advice is given in 2011.

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

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Portugal	1056	801	958	886	344	423	242	291	187	95
Spain	.	.	.	.	.	.	.	.	.	.
Total	1056	801	958	886	344	423	242	291	187	95

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Portugal	54	96	159	203	89	62	104	132	93	15	7
Spain			8		n.a.	n.a.	0				
Total	54	96	167	203	89	62	104	132	93	16	54

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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spain	.	.	5	n.a.	n.a.	n.a	.	.	.	.	.
UK (England and Wales)	.	.	.	+	+	47	19	.	.	.	.
UK(Scotland)	.	1	+	3	38	2	0	.	.	.	.
Portugal	13	37	67	72	157	145	74	44	66	18	5
Total	13	38	72	75	195	194	94	44	66	18	5

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

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ireland	.	.	.	.	.	.	.	.	.	2	.	.	.
France	.	.	.	.	13	10	8	6	0	2	4	.	.
UK (Scotland)	.	.	.	.	.	21	7	97	128	95	.	.	.
UK (England and Wales)	.	.	.	.	.	+	+	113	281	13	.	.	.
Portugal	.	.	1	3	4	2	1	.	.	.	4	20	
Spain	.	.	85	68	n.a.	n.a.	n.a.	n.a.	.	.	.	.	.
Total	.	.	86	71	17	33	16	216	409	112	8	20	.

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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	382	395	47	90	49	.	35	.	137	.	.
Iceland	.	.	+	+	n.a.	.	.	.	.	.	.
UK (England and Wales)	.	.	.	+	+	5	.	.	.	.	.
Spain	85	91	n.a.	n.a.	n.a.	.	.	.	.	.	.
Total	467	486	47	90	49	5	35	0	137		

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

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	10	8	32	359	128	25	52	.	.	.	.	.	.
UK (England and Wales)	.	.	.	.	.	.	.	.	.	.	8	.	.
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	8
Spain	.	.	.	.	.	.	.	85	n.a.	n.a.	.	.	.
Total	10	8	32	359	128	25	52	85	n.a.	n.a.	8	.	8

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

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	846	2388	2888	2150	2043	+	+	+	+	+	+	.	.
Spain	.	.	.	.	.	.	38	338	99	n.a.	n.a.	.	.
Portugal	+	+	+	+	.	.	+	.	.	.	+	+	+
Total	846	2388	2888	2150	2043	+	38	338	99	+	+	+	+

Table 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of blackmouth dogfish.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ireland	.	.	.	+	1	.	.	.	.	.	.
Spain (Basque c.)	+	.	.	.	+	.	4	.	.	4	.
Spain	4	1	35	1	.	4	.	.	28		.
Portugal	39	36	52	29	57	38	29	26	15	12	7
Total	43	37	87	30	58	41	32	26	43	16	7

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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	249	266	29	54	56	12	4	1	.	.	.
Total	249	266	29	54	56	12	4	1	.	.	.

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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Iceland	45	57	56	55	58	54	24	3	34	26	43
Total	45	57	56	55	58	54	24	3	34	26	43

Table 5.10. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings by species.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Gulper Shark	1056	801	958	886	344	423	242	291	187	95	54
Birdbeak Dogfish	.	.	.	.	.	.	.	.	.	.	13
Black Dogfish	.	.	.	.	.	.	.	.	.	.	467
Longnose Velvet Dogfish	.	.	.	.	.	.	.	.	.	.	86
Velvet Belly	.	.	.	27	+	10	8	32	359	128	25
Blackmouth Dogfish	17	17	16	20	37	29	39	32	28	25	43
Lantern Shark NEI	.	.	.	.	846	2388	2888	2150	2043	+	38
Aiguillat noir	.	.	.	.	.	.	.	.	.	.	123
Greenland Shark	54	58	68	41	42	43	61	83	91	55	45
Angular Roughshark	.	.	.	.	.	.	.	.	.	.	.
Total	1127	876	1042	974	1269	2893	3238	2588	2708	303	894

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Gulper Shark	96	167	203	89	62	104	132	93	16	7
Birdbeak Dogfish	38	72	75	195	194	94	44	66	17	3
Black Dogfish	486	47	90	49	5	35	.	137	.	.
Longnose Velvet Dogfish	71	17	33	16	216	409	112	8	20	.
Velvet Belly	52	85	n.a.	n.a.	8	.	8	.	.	.
Blackmouth Dogfish	37	87	30	58	41	32	26	43	16	7
Lantern Shark NEI	338	99	+	+	+	.	.	.	.	.
Aiguillat noir	165	11	37	21	5	.	.	.	.	.
Greenland Shark	57	56	55	58	54	24	3	34	26	43
Angular Roughshark	.	.	.	75	99	52	0	0	54	.
Total	1340	641	523	561	684	751	325	381	149	60

5.12 References

Coelho, R. and Erzini, K. 2008. Effects of fishing methods on deep-water shark species caught as bycatch off southern Portugal Hydrobiologia, 606(1): 187–193.

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

6.1 Stock distribution

WGEF consider 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.

Although porbeagle also occurs in the Mediterranean, there is no evidence of mixing with the NE Atlantic stock.

The information used to identify the stock unit is in the Stock Annex.

6.2 The fishery

6.2.1 History of the fishery

The main countries catching porbeagle were France and, to a lesser extent, Spain, UK and Norway. The only regular, directed 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, Danish and Faroese target fisheries. In addition, the species is 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.

6.2.2 The fishery in 2010

No fishery has been allowed since the implementation of a zero TAC in 2010.

6.2.3 ICES advice applicable

The advice is biennial and consequently the 2010 advice remains valid for 2011 and is cited below:

In 2010, ICES reiterated the precautionary advice it gave in 2008 for 2009 and 2010:

'Given the state of the stock, no targeted fishing for porbeagle should be permitted and bycatch should be limited and landings of porbeagle should not be allowed.'

6.2.4 Management applicable

In 2010, EC Regulation 23/2010 prohibited fishing for porbeagle in EU waters and, for EU vessels, to fish for, to retain on board, to tranship and to land porbeagle in international waters.

EC Regulation 40/2008 established a TAC for porbeagle taken in EC and international waters of I, II, III, IV, V, VI, VII, VIII, IX, X, XII and XIV of 581 t (CEC, 2008). In 2009, the TAC was reduced to 436 t (a decrease of 25%) and regulations stated that "*A maximum landing size of 210 cm (fork length) shall be respected*" (CEC, 2009).

In 2007 Norway banned all direct fisheries for porbeagle, based on the ICES advice. Specimens taken as bycatch can be landed and sold as before.

It is forbidden to catch and land porbeagle in Sweden since 2004.

EC Regulation 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.

In 2007 Norway banned all direct fisheries for porbeagle, based on the ICES advice. From 2007–2011 specimens taken as bycatch must be landed and sold. From 2011, live specimens must be released, whereas dead specimens can (not must) be landed and sold. Also, the number of specimens landed must be reported in addition to weight. From 2011, the regulations also include recreational fishing.

6.3 Catch data

6.3.1 Landings

Tables 6.1a, b and Figures 6.1–6.2 show the historical landings of porbeagle in the Northeast Atlantic. In 2009, France remained the major contributor as in preceding years.

In 2010, a total of 20 t were landed. The catches reported in Table 6.1b represent the amount of porbeagle caught incidentally mainly by gillnet in Norway and by pelagic trawlers in France, these two countries caught 12 and 7 tonnes respectively.

Note that these data need to be treated as underestimates and with some caution (see Section 6.3.3).

More detailed information on landings is presented in stock annex.

6.3.2 Discards

Discards are thought to be limited, although some métiers (e.g. gillnet fisheries in the Celtic sea) can be seasonally important.

No information is available on the discards of the non targeted fishery, although as a high value species, it is likely that specimens caught as bycatch were landed and not discarded before quota was restrictive.

Because the EU adoption of a maximum landing size, some large fish were discarded by boats of the directed fishery in 2009 but there is no account of the number these discards.

6.3.3 Quality of catch data

Landings data are incomplete and further studies are required to better collate or estimate historical catch data (more information is available in the stock annex). Recent data are lacking as dead bycatch are discarded (i.e. removals from the stock).

6.4 Commercial catch composition

Only limited length frequency data are available for porbeagle. However, length distributions by sex are available for 2008 and 2009 (Hennache and Jung, 2010) for the French target fishery (Figure 6.3). They can be considered to be representative of the current international catch length distribution, given the high contribution of the French fishery to these catches.

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 has decreased since 1993 (Table 6.2).

Sampling of the catches of the French fishery carried out in 2009 highlight the dominance of porbeagle (89% of catch weight), with other species including blue shark (10%), common thresher (0.6%), tope (0.3%).

6.4.1 Conversion factors

Length–weight relationships are available from different areas and for different periods (Table 6.3). The conversion factors collected from the French targeted fishery landings has been updated using data from the 2009 sampling.

6.5 Commercial catch-effort data

A new cpue series was presented at the 2009 WGEF for the French targeted fishery (Biais and Vollette, 2009). It is based on 17 boats which have landed porbeagle more than 500 kg per year for more than six years after 1972 and more than four years from 1999 onwards (to include a boat which has entered recently in the fishery, given the limited number of boats in recent years). This series is longer than the previous ones (in stock annex) and it provides catch and effort (days at sea) by vessel and month. A GLM analysis was carried out at 2009 ICCAT-ICES porbeagle stock assessment meeting to get a standardized cpue series. This series has not been updated with the 2009 data because the French logbook data were not available at the time of the 2010 WGEF meeting.

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 style, quarter, bait and also spatial effects by including seven zones.

The nominal and the standardized catch rate series of the French fleet demonstrate higher values occurring at the end of the 1970s (Figure 6.4). Since then, cpue has varied between 400–900 kg per day without displaying any trend.

Spanish data were more variable (Figure 6.5), possibly as porbeagle is only a bycatch in this fishery, and so the fleet may operate in areas where there are fewer 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.

6.7 Life-history information

The life-history information (including the habitat description) is presented in stock annex.

It was updated in 2010 with information on migration, provided by a limited number of pop-up satellite tags which were attached to porbeagle from the Northwest coast of Ireland (Saunders *et al.*, 2010). The Irish tagging programme is continuing (Saunders, pers. comm.).

Some information has also been included on sex-ratio segregations, the likelihood of a nursery ground in the Saint Georges Channel, the diet and on life-history parameters according to the recent work made by the NGO APECS (Hennache and Jung, 2010).

France (Ifremer and IRD) and the United Kingdom (Cefas) are cooperating on a porbeagle tagging survey in June–July 2011. The aim of the survey is to gain more information on the pupping areas of the Northeast Atlantic porbeagle stock and/or on the movement of immature sharks. A French fishing boat has been chartered by the French Fishery Ministry for this survey, and staffed by Ifremer, IRD and Cefas scientists. Their aim is to deploy up to 18 pop-up satellite archival transmitting tags (PSATs). The tags will be deployed on mature females (8), with the remainder split between males and juveniles. The tagging areas are the shelf edge in the West of Brittany and the Celtic Sea. The pop-up archival transmitting tags are provided by the French Fishery Ministry (4), by the Regional Council of Pays de Loire (6) and by the UK Department of Environment, Food and Rural Affairs (Defra, 8).

Defra is also funding a fishery science Partnership (FSP) project on porbeagle in 2011.

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).

6.8.2 Stock assessment

The 2009 assessments have not been updated since.

**** BSP model***

The BSP model uses catch and standardized cpue data (see Section 6.5.2 in ICES, 2009 (WGEF) report and ICCAT, 2009). Because the highest catches occurred in the 1930s and 1950s, long before any cpue data were available to track abundance trends, several variations of the model were tried, either starting the model run in 1926 or 1961, and with a number of different assumptions. An informative prior was developed for the rate of population increase (r) based on demographic data of the NW Atlantic stock. The prior for K was uniform on log K with an upper limit of 100 000 t. This upper limit was set to be somewhat higher than the total of the catch series from 1926 to the present (total catch= 92 000 t). All of the trials demonstrated that the population continued to decline slightly after 1961, consistent with the trend in the French cpue series.

The model runs used the most biologically plausible assumptions about unfished biomass or biomass in 1961. The relative 2008 biomass (B2008/BMSY) can be estimated between 0.54 and 0.78 and the relative 2008 fishing mortality rates (F2008/FMSY) between 0.72 and 1.15.

****ASP model***

An age-structured production model was also applied to the NE Atlantic stock of porbeagle to provide contrast to the BSP model (see ICCAT, 2009). The same input data used in the BSP model were applied but incorporating age-specific parameters for survival, fecundity, maturity, growth, and selectivity. The stock–recruitment function is also parameterized in terms of maximum reproductive rate at low density.

Depending on the assumed F in the historic period (the model estimated value was considered to be unrealistic), the 2008 relative spawning–stock fecundity

(SSF2008/SSFMSY) was estimated between 0.21 and 0.43 and the 2008 relative fishing mortality rate (F_{2008} /F_{MSY}) between 2.54 and 3.32.

The conclusions of these assessments were that the exploratory assessments indicate that current biomass is below B_{MSY} and that recent fishing mortality is near or possibly above F_{MSY}. However, the lack of cpue data for the peak of the fishery adds considerable uncertainty in identifying the current status relative to virgin biomass.

6.8.3 Stock projections

The projections (using the BSP model) were that sustained reductions in fishing mortality would be required if there is to be any stock recovery. Recovery of this stock to B_{msy} under zero fishing mortality would take ca. 15–34 years. Although model outputs suggested that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and the recovery to B_{MSY} within 25–50 years under nearly all model scenarios (Table 6.4).

Yield and Biomass per Recruit

A yield-per-recruit analysis using FLR (www.flr-project.org) was conducted by the ICCAT/ICES WG.

The effects of different selection patterns on the NE Atlantic porbeagle stock were evaluated: flat-topped and dome-shaped curves and with maximum selectivity at either age 5 or 13 (age 13 corresponds to age-at-maturity of females and to the current maximum landing length of 210 cm fork length).

The analysis demonstrates that both potential stock size and yields are increased if fishing mortality is reduced on immature fish. If the fishing mortality on individuals greater than 210 cm is reduced to 0, the stock levels are slightly improved at expense of yield (Table 6.5).

6.9 Quality of assessments

The assessments (and subsequent projections) conducted at the joint ICCAT/ICES meeting that are be summarized in this report must be considered exploratory assessments, using several assumptions (carrying capacity for the SSB model, F in the historic period in the ASP model).

Hence, it must be noted that:

- There was a lack of cpue data for the peak of the fishery.
- Catch data are considered underestimates, as not all nations have reported catch data throughout the time period.
- The cpue index for the French fleet is for a targeted fishery that actively seeks areas where catch rates of porbeagle are higher. Furthermore, the index (catch per day) does not allow many factors to be interpreted, such as fishing strategies, including searching behaviour and patterns, fleet dynamics (e.g. more vessels may operate when good catches are made), changes in numbers of vessels (aggregations may be easier to find when more vessels are operating), number of lines and line deployments per day, and the number of hooks. Hence, this series may not be reflective of stock abundance.

Consequently, the model outputs should be considered highly uncertain (ICCAT report).

6.10 Reference points

No reference points have been proposed for this stock.

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.

6.11 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.*, 2006a, b).

In 2010, Sweden (on behalf of the member states of the European Community) proposed that porbeagle be added to Appendix II of CITES. This proposal did not get the support of the required majority at the fifteenth CITES Conference of Parties in Doha.

6.12 Management considerations

WGEF/ICCAT considered all available data in 2009. This included updated landings data and further analyses of cpue from the French fishery. Further analyses of these data should be undertaken in future. No new information which could alter our perception of the stock was presented in 2010 or 2011.

Stock projections based on the BSP model demonstrates that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and that the recovery to B_{MSY} within 25–50 years under nearly all model scenarios. However, management should account for both the uncertainty in the input parameters for this assessment and the low productivity of the stock.

WGEF reiterates that this species has a low productivity, and is highly susceptible to overexploitation.

The Norwegian and Faroese fisheries have ceased and have not resumed. That no fisheries had developed before restrictive quotas were putting in place is considered by WGEF to indicate that the stock had not recovered. The time that has elapsed since the end of the northern fisheries is probably longer than the generation time of the stock, so recovery may have taken place although not detected. However in the absence of any quantitative data to demonstrate stock recovery, and in regard of this species' low reproductive capacity, WGEF considers the stock is probably still depleted.

WGEF considers that target fishing should not proceed without a programme to evaluate sustainable catch levels.

The maximum landing length (MLL) had been adopted by EC. It constituted a potentially useful management measure in targeted fisheries, as it should deter targeting areas with mature females. However, there are potential benefits from reducing fishing mortality on juveniles. Furthermore, given the difficulties in measuring (live) sharks, studies to identify a body dimension (e.g. interdorsal space, or length of dorsal fin) that is correlated with total/fork length and that can be measured more easily in the field are required.

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

Further studies on porbeagle bycatch and post-release survivorship of any discarded porbeagle are required.

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.

There are no fishery-independent survey data. In the absence of target fisheries, a dedicated longline survey covering the main parts of the stock area could usefully be initiated.

6.13 References

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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 (1971–2010). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.

	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
Sweden			.	.	3	.	.	5	1	8	5	6	5	9
UK (E,W, NI)		4	14	15	16	25	.	.	1	3	2	1	2	5
UK (Scot)	7	15	13	.	.	.	.	.	.	.	.	.	.	.
Japan			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	991	1755	985	744	1063	1185	834	763	864	932	777	636	616	484

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	72	114	56	33	33	46	85	80	91	93	86	72	69	85
Faroe Is	12	12	33	14	14	14	7	20	76	48	44	8	9	7
France	196	208	233	341	327	546	306	466	642	824	644	450	495	435
Germany	.	.	.	.	.	.	.	.	1	.	.	.	.	2
Iceland	1	1	1	1	1	.	.	1	3	4	5	3	2	3
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	80	24	25	12	27	45	35	43	24	26	28	31	19	28
Portugal	.	.	3	3	2	2	1	0	1	1	1	1	1	1
Spain	23	26	30	61	40	26	46	15	21	49	17	39	23	22
Spain (Basque Country)	.	.	.	.	.	.	.	.	.	.	.	20	12	27
Sweden	10	8	5	3	3	2	2	4	3	2	2	1	1	1
UK (Eng,Wal & NI)	12	6	3	3	15	9	.	.	.	.	0	.	.	1
UK (Scot)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	2	NA
Total	406	399	389	471	462	690	482	629	862	1047	827	628	633	612

Table 6.1b. (continued). Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2010). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Denmark	107	73	76	42	21	20	4	3	2	2	4	0
Faroe Is	10	13	8	10	14	5	19	21	13	0	4	0
France	273	361	339	439	394	374	246	185	347	221	299	7.1
Germany	0	17	1	3	5	6	5	0		0	0	0
Iceland	3	2	4	2	0	1	0	1	0	0	1	0.5
Ireland	8	2	6	3	11	18	3	4	8	7	0	0
Netherlands	.	0			0		0		0	0	0	0
Norway	34	23	17	14	19	24	11	27	10	12	10	12
Portugal	0	15	4	11	4	57	10	6	2	1	0	0
Spain	15	11	23	49	22	9	10	26	6	32	0	0
Sweden	1	1	1	.	.	5	0	.	1	0	0	0
Spain (Basque Country)	41	38	45	16	22	10	11	5	16	13	3	0
UK (Eng,Wal & NI)	6	7	10	7	25	24	24	11	26	12	10	0
UK (Scot)	.	.	1	.	.	.	.	.	.	1	0	0.3
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	498	563	535	596	537	553	343	289	431	301	331	20

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		
1999		
2000	Data not available by weight category	
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.

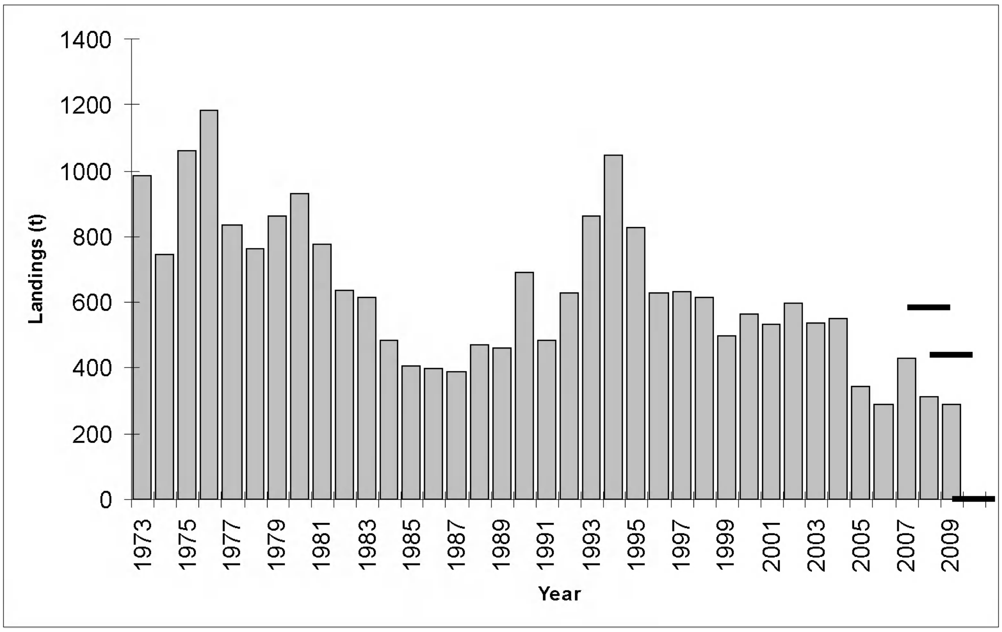
Stock	L-W relationship	Sex	n	Length range	Source
NW Atlantic	W = (1.4823 x 10–5) LF 2.9641	C	15	106–227 cm	Kohler *et al.*, 1995
NE Atlantic (Bristol Channel)	W = (1.292 x 10–4) LT 2.4644	C	71	114–187 cm	Ellis and Shackley, 1995
NE Atlantic (N/NW Spain)	W = (2.77 x 10–4) LF 2.3958	M	39		Mejuto and Garcés, 1984
	W = (3.90 x 10–6) LF 3.2070	F	26		
NE Atlantic (SW England)	W = (1.07 x 10–5) LT 2.99	C	17		Stevens, 1990
NE Atlantic (Biscay / SW England/W Ireland)	W = (4 x 10–5) LF 2.7316	M	564	88–230 cm	Hennache and Jung, 2010
	W = (3 x 10–5) LF 2.8226	F	456	93–249 cm	
	W = (4 x 10–5) LF 2.7767	C	1020	88–249 cm	

Table 6.4. Average probabilities across the five most credible BSP model runs for the Northeast Atlantic porbeagle population (ICCAT, 2009).

Total catch in tons	Probability of some increase within 10 years	Probability of stock rebuilding to BMSY within: 20 years	50 years
0	1.00	0.478	0.946
100	1.00	0.414	0.872
200	0.98	0.368	0.754
300	0.89	0.326	0.596
400	0.72	0.286	0.464

Table 6.5. Fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the F0.1 level for a flat-topped selection pattern with maximum selection-at-age 3.

Selection Pattern	Age Max Selection	Maximum Landing Length	F	Yield	Biomass	SSB
Domed	5	No	211%	68%	202%	120%
Flat	13	No	211%	79%	280%	176%
Domed	13	No	279%	68%	295%	178%
Flat	5	Yes	150%	84%	134%	105%
Domed	5	Yes	217%	67%	206%	120%
Flat	13	Yes	698%	35%	377%	191%
Domed	13	Yes	698%	35%	377%	191%



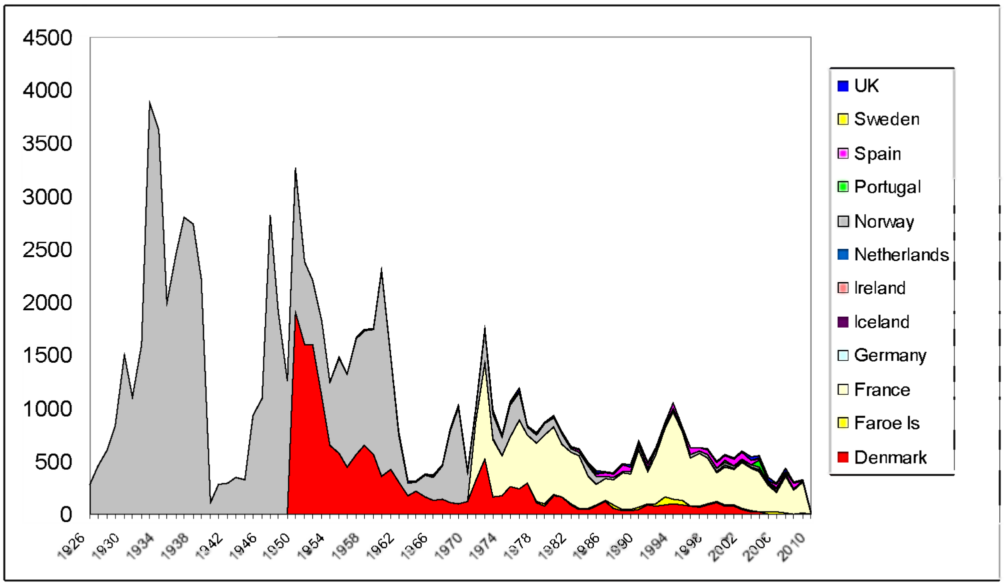


Figure 6.1. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2010 (top, black lines indicates 2008–2010 TAC) and longer term trend in landings (1926–1970) for those fleets reporting catches.

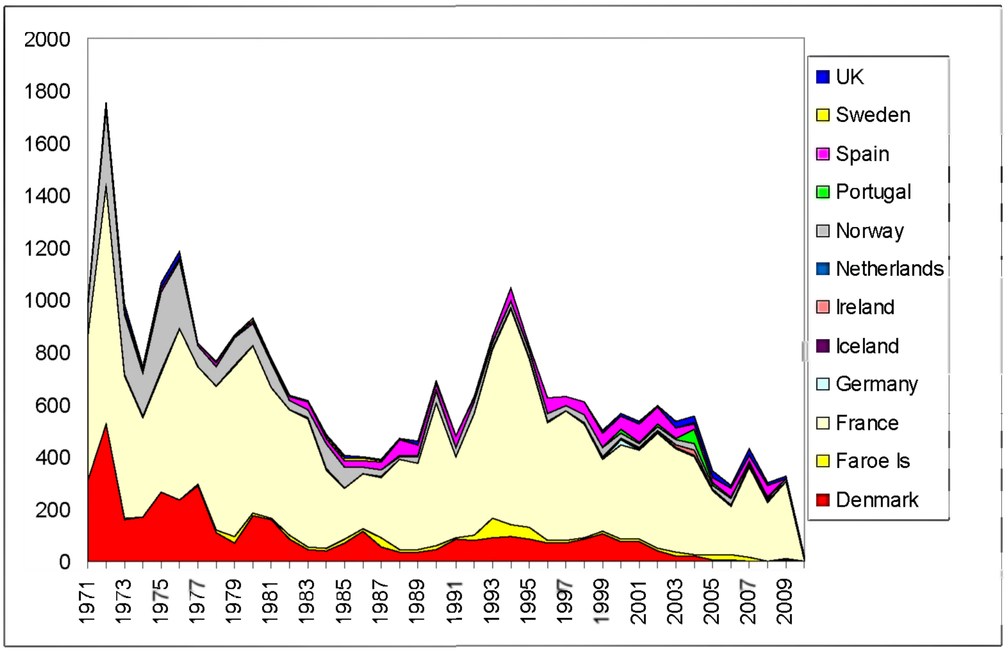


Figure 6.2. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2010 by country.

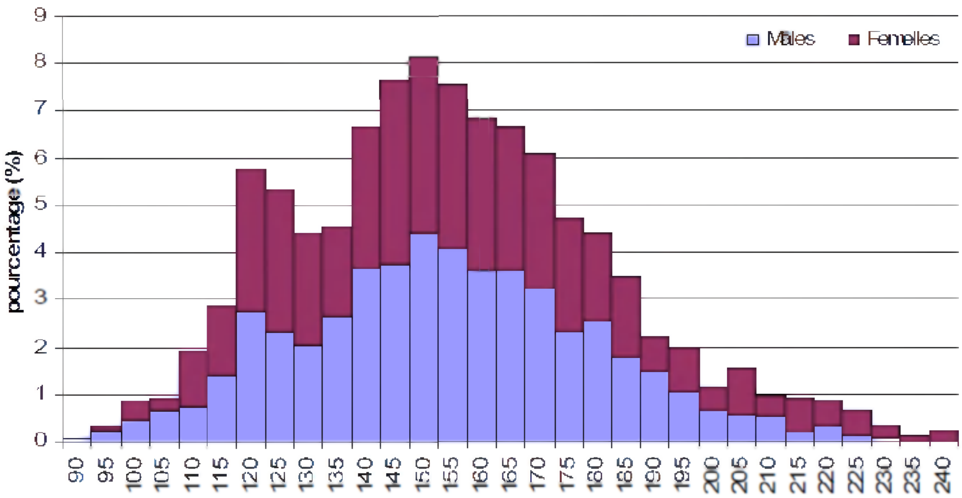


Figure 6.3. Porbeagle in the NE Atlantic. Length–frequency distribution of the landings of the Yeu porbeagle targeted fishery in 2008–2009 (n =1769). Source: Hennache and Jung, 2010.

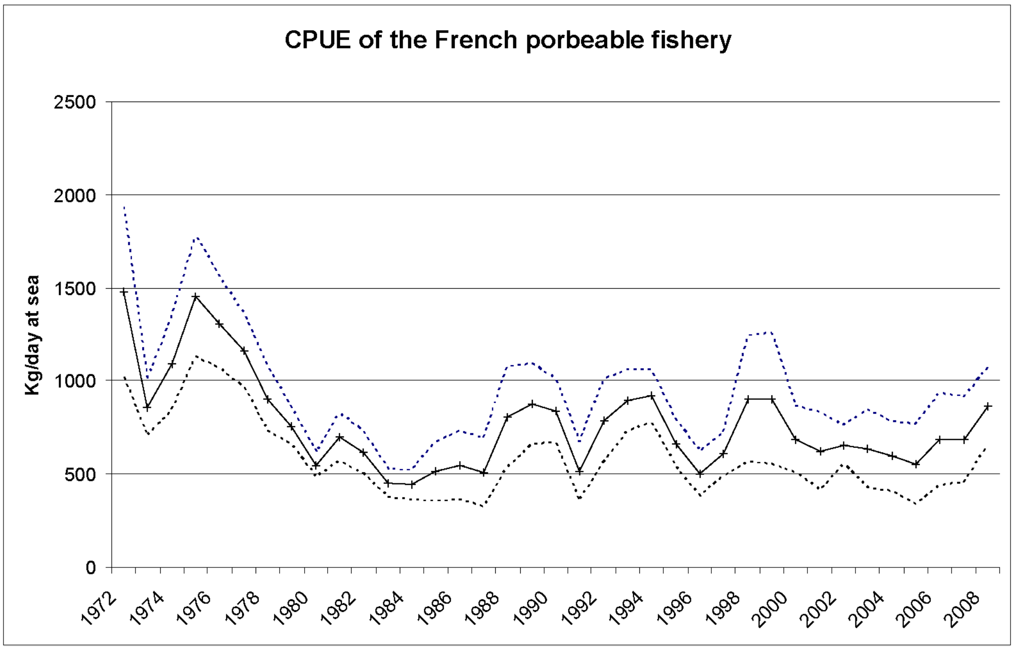


Figure 6.4. Porbeagle in the NE Atlantic. Nominal cpue (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (± 2 SE of ratio estimate). From Biais and Vollette, 2009.

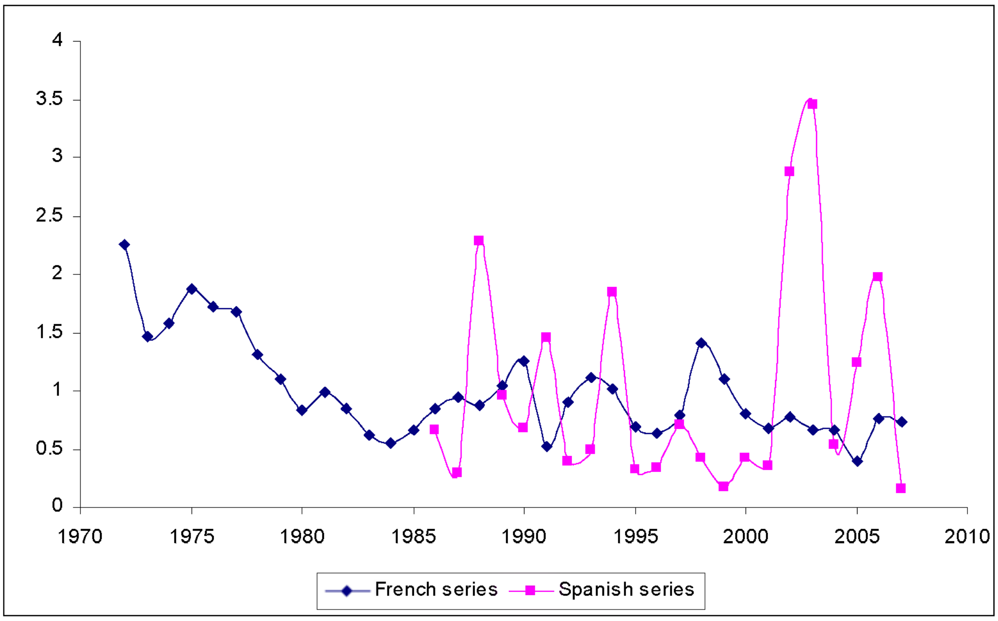


Figure 6.5. Porbeagle in the NE Atlantic. Temporal trends in standardized cpue for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the NE Atlantic (1986–2007).

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

7.1 Stock distribution

In the eastern Atlantic, basking shark *Cetorhinus maximus* is present from Iceland, Norway and as far north as the Russian White Sea (southern Barents Sea) extending south to the Mediterranean (Compagno, 1984; Konstantinov and Nizovtsev, 1980). WGEF considers that basking shark in the ICES area exist as a single management unit. However, the WGEF is aware of recent tagging studies demonstrating both transatlantic and transequatorial migrations, as well as migrations into tropical areas and mesopelagic depths (Gore *et al.*, 2008; Skomal *et al.*, 2009). 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 fully determined.

7.2 The fishery

7.2.1 History of the fishery

The fishery for basking sharks goes back as far as the middle or end of the 1700s, both in Norwegian, Irish and Scottish waters (Moltu, 1932; Strøm, 1762; 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. All fisheries stopped during the mid-1800s when the sharks 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, catches ranged between 1266 and 4266 sharks 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 sharks were taken each year from 1951 to 1955 (an average of 1475/year), but there was a decline in catch records from 1956. Average annual catches were 489 individuals from 1956–1960, 107 individuals from 1961–1965, then about 50–60 individuals per annum for the remaining years of the fishery (Parker and Stott, 1965; McNally, 1976).

The Scottish fishery started up in the 1940s. In all ~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 caught by Norway and Scotland, and of these Norway landed 12 014 individuals with an annual maximum of 1748 individuals landed in 1979 (Figure 7.1).

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.

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

7.2.2 The fishery in 2010

There was no directed fishery for basking sharks in Norway, UK or Ireland in 2010.

There was no bycatch of basking shark landed in 2010.

7.2.3 ICES advice applicable

ICES advice has been zero TAC since 2006. In 2010, the advice was: "Zero TAC. Basking shark should remain on the prohibited species list of the EU TAC regulation."

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 Areas I–XIV, and the ban has continued in 2007–2010. Live specimens caught as bycatch have to be released immediately, although dead or dying specimens can be landed. From 2009, if basking shark is landed, both number of individuals and weight has to be reported.

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 Areas I–XIV from 1977–2010 are presented in Table 7.1, and Figure 7.1. Landings of basking sharked peaked in 1979 at a total of 5266 t, and declined rapidly towards 1988. A new peak in landings was seen in 1992, with 1697 t basking shark landed. Since the ban in direct fishery in 2006/2007, yearly landings have been <40 t.

Reported landings data come from UK (Gue.; 1984 and 2010), Portugal (1991–2010), France (1990–2010) and Norway (1977–2010). Most catches are from Subareas I, II and IV and are taken by Norway. For Portugal and France the reported landings were between 0.3 and 2 t.

Catch in numbers from Scotland and Norway (2007–2010) are presented in Figure 7.2. 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 were revised during ICES WGEF 2008. Table 7.2 demonstrates old and revised numbers.

Table 7.3 demonstrates the proportions (%) of basking sharks caught by various gears as reported to the Directorate of Fisheries in Norway from 1990–2009. Harpoon was the major gear during most of the 1990s, but remained at a relatively low level from 2000, except for 2005 which was the last year with directed fishery. After the ban of directed fishery was introduced in 2006, bycatch has been taken in gillnets only.

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 discarding in non-directed fisheries. 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 (1994) estimated 77–120 sharks were caught annually in the gillnet fishery in the Celtic Sea (Berrow, 1994). Berrow and Heardman (1994) received 28 reports on sharks being entangles in fishing gear around the Irish coast in 1993. In the Isle of Man, bycatch in herring and pot fishery (entanglement in ropes) amounts to 14–20 sharks annually. Bonfil (1994) estimated that 50 sharks 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 reported basking sharks that were incidentally caught in fixed entanglementnets in Spanish waters between 1988 and 1998, three sharks were sold on 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.

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 Subdivision II. The Norwegian Coastal Reference Fleet is made up by a group of selected vessels that, for economic compensation, provides detailed information on catches and general fishing activity. In 2009, the Reference Fleet included 18 vessels <15 m that covered the Norwegian coast.

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

In Norway, the only recording of basking shark known through media is a specimen that was caught in gillnets, and released, in June 2011 outside Ingøy, Finnmark, Northern Norway.

The requirement for EU fleets to discard all basking sharks caught as bycatch means that information cannot be obtained on these catches. A better protocol for recording and obtaining scientific data from bycatches is necessary for assessing the status 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 catch statistics were unchanged from 1977 to 1999, but from 2000–2008 the revised catch figures are applied.

Further information on the revision of the conversion factor is included in the Stock Annex.

7.4 Commercial catch composition

There is some information on minimum, maximum and median weights of livers and fins and corresponding live weights of individual basking sharks caught in Norway during 1992–1997. This information is included in the Stock Annex.

7.5 Commercial catch-effort data

There are no effort or cpue data available for the latest years, as there has been no targeted fishery.

Cpue data from the Norwegian fishery in 1965–1985 can be found in the Stock Annex.

7.6 Fishery-independent surveys

Several countries, e.g. Norway, Denmark and Ireland, conduct scientific whale counting surveys. During these surveys observations of basking sharks should also be noted. A number of Norwegian commercial vessels also regularly report observations of whales. A request for reporting the sightings of basking sharks might yield useful effort-related data.

7.7 Life-history 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 (Figure 7.3). 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 7.3). 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 in Irish waters throughout the winter period and were active and did not hibernate.

Skomal *et al.* (2009) shed further light on apparent winter disappearance of the 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.*, 2003). 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.

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" (IUCN, 2011).

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 population 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 Spatial information

The current satellite tagging programmes should in future be able to provide information on basking shark movement.

7.14 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 1977–2010. "."=zero catch, "+" = <0.5 t.

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
I & II	3680	3349	5120	3642	1772	1970	967	873	1465	1144	164	96
III & IV	.	.	.	.	.	.	734	1188	.	.	.	10
Va	.	.	.	.	.	.	.	.	.	.	.	.
Vb	.	14	.	83	28	.	.	.	.	.	.	.
VI	.	.	.	.	.	.	.	.	.	.	.	.
VII	.	278	139	.	.	186	60	1	.	.	.	.
VIII	.	.	7	.	.	.	.	.	.	.	.	.
IX	.	.	.	.	.	.	.	.	.	.	1	.
X	.	.	.	.	.	.	.	.	.	.	.	.
XII	.	.	.	.	.	.	.	.	.	.	.	.
XIV	.	.	.	.	.	.	.	.	.	.	.	.
TOTAL	3680	3641	5266	3725	1800	2156	1761	2062	1465	1144	165	106

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
I & II	593	781	533	1613	1374	920	604	792	425	55	31	117
III & IV	.	116	220	84	.	157	23	.	43	.	.	.
Va	.	.	.	.	.	.	.	.	.	.	.	.
Vb	.	.	.	.	.	.	.	.	.	.	.	.
VI	.	.	.	.	.	.	.	.	.	.	.	.
VII	.	.	.	.	.	.	.	.	.	.	.	.
VIII	.	1	+	+	.	+	1	+	2	1	1	1
IX	+	.	+	+	+	1	1	1	1	.	1	1
X	.	.	.	.	.	.	.	.	.	.	.	.
XII	.	.	.	.	.	.	.	.	.	.	.	.
XIV	.	.	.	.	.	.	.	.	.	.	.	.
TOTAL	593	897	753	1697	1374	1078	629	793	471	56	33	119

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I & II	80	54	128	72	87	6	26	4	.	.
III & IV	.	+	.	.	.	.	.	.	.	.
Va	.	.	.	.	.	.	.	.	.	.
Vb	.	.	.	.	.	.	.	.	.	.
VI	.	.	.	.	.	.	.	.	.	.
VII	.	.	.	.	1	+	.	+	+	.
VIII	.	.	.	.	+	+	+	2	.	.
IX	2	1	1	1	2	.	8	.	.	.
X	1	.	.	26	.	.	3	.	.	.
XII	.	.	.	.	.	.	.	.	.	.
XIV	.	.	.	.	.	.	.	.	.	.
TOTAL	83	55	129	99	90	7	38	7	+	0

Table 7.2. Norwegian landings of liver (kg) and fins (kg) of basking shark (*Cetorhinus maximus*) during 1977–2007, 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 ICES WGEF 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 basking sharks caught in different gears as reported to the Norwegian Directorate of Fisheries from 1990–2010.

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**	-	-	-	-	-	-	-	-	-

* These driftnets for salmon were banned after 1992.

** No catch.

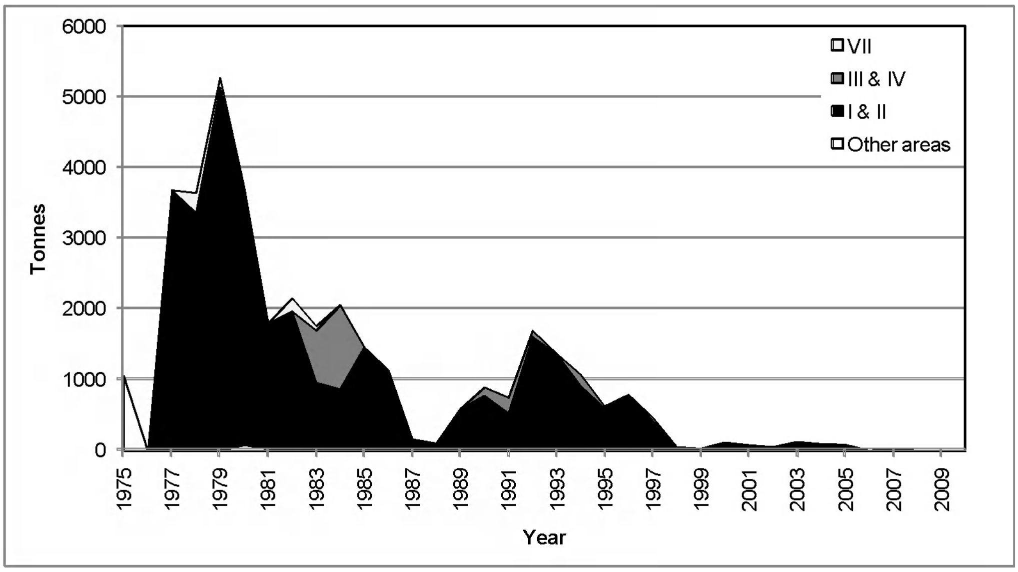

Figure 7.1. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2010.

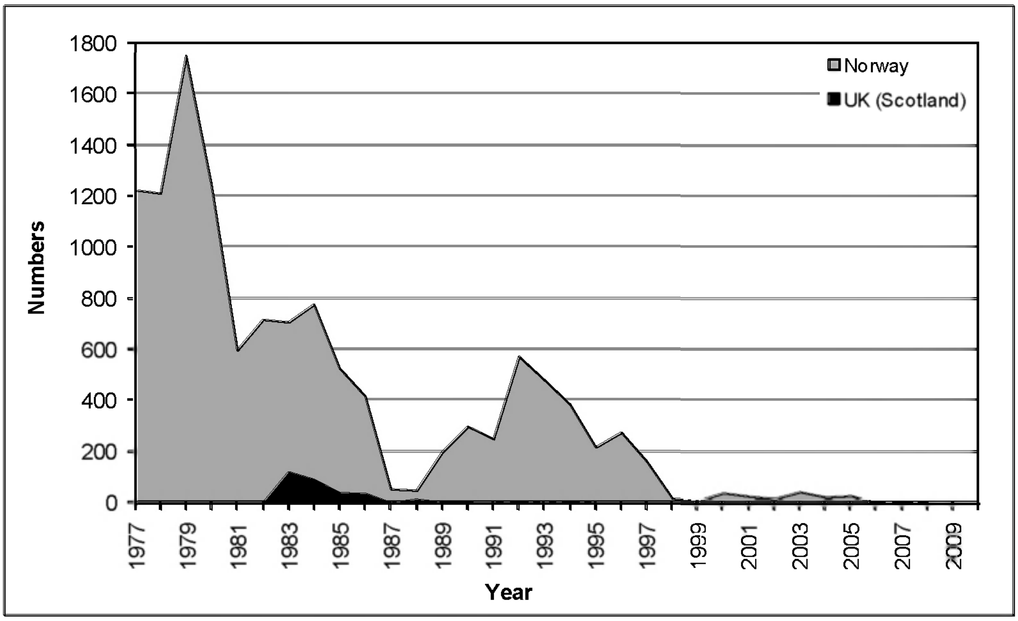

Figure 7.2. Basking sharks in the Northeast Atlantic. Numbers of basking sharks caught by Norway and Scotland from 1977–2010 in ICES Areas I–XIV from 1977–2010.

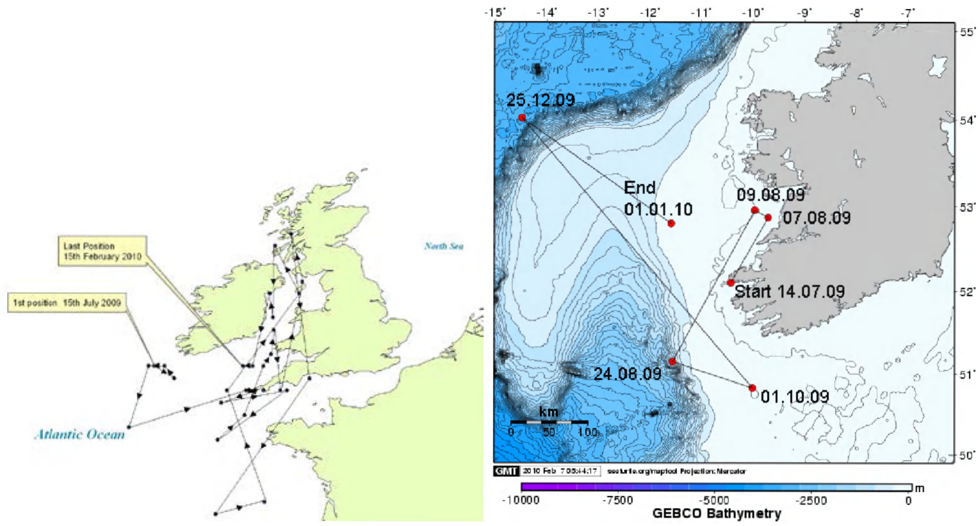

Figure 7.3 Geolocations from basking shark A (left, sex=male) and B (right, sex=unknown). Source Berrow and Jackson, 2010.

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). Thus the ICES area is only part of the stock. ICCAT, 2008 considered that the 5°N parallel was the most appropriate division between North and South Atlantic stocks of blue shark. This decision was based on the oceanographic features of the region and to facilitate comparison with fisheries statistics from tuna-like species for which North Atlantic stocks are also assumed to have 5°N as a southern stock boundary.

Assessment of this stock is considered to be the responsibility of ICCAT. WGEF presents a section on blue shark here, to help summarize available data and aid the assessment process in ICCAT.

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 the available data are limited, it offers some information on the situation in fisheries and trends. Although there are no large-scale directed fisheries for this species, it is a major bycatch in many fisheries for tunas and billfish, where it can comprise up to 70% of the total catches and thereby exceed the actual catch of targeted species (ICCAT, 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.

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).

8.2.2 The fishery in 2010

The artisanal directed pelagic sharks longline fishery based in the Basque country (Spain) seemingly ended its activity as no shark was landed at the port of Ondarroa in 2010.

Reported catches in 2010 by ICES member were around 140 tonnes which represent a significant decrease as the level of the catches averaged around 1 thousand tonne between 2005 and 2009.

8.2.3 Advice applicable

ACOM has never provided advice for blue shark in the ICES area. ICCAT is the responsible agency for assessment of this species. No specific management advice has been provided by ICCAT for this stock, to date.

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 quantify landings of blue shark in the North Atlantic. This is because reporting of data is incomplete. Furthermore it is difficult to identify landings and discards separately. Because blue shark is a low value species, reported landings underestimate real removals. Several attempts have been made to estimate landings. Data reported to ICCAT are not considered a reliable estimate of landings, and are not presented in the ICCAT assessment of 2008. In addition, it is thought that landings data for blue shark are unreliable as a result of the amount of pelagic sharks that are or have been reported under the generic "sharks *nei*" category (Johnston *et al.*, 2005). Two other estimates of landings for this stock were prepared (Figure 8.1), the tuna ratio and the fin trade index. The tuna ratio estimates derive from logged observations of shark catches relative to tuna catches and are considered conservative by ICCAT because they do not consider all fisheries (ICCAT, 2008). The fin trade index is inferred from systematic trade observations of shark fins in the Asian market and used to calculate caught shark weights based on catch effort data from the ICCAT database (Clarke *et al.*, 2006; ICCAT, 2008).

Available landings data from FAO FishStat are presented in Table 8.1. These values are underestimates, as a consequence of the inconsistent or generic reporting of shark catches. Estimated catches of blue shark from the ICCAT shark subgroup are given in Table 8.2. These data include reported landings of blue shark and estimated landings from (a) the ratio of shark catches to tuna and tuna-like species, and (b) from fin trade data. Reported landings of blue shark are underestimated more so in the early part of the time-series (prior to 1997), with official landings and estimates of a comparable magnitude in more recent years, with annual landings in the region of 20 000–43 000 t.

In the ICES area, blue shark is reported predominantly from French, Portuguese and Spanish fisheries in Subareas VII–XII, with smaller quantities taken in Subareas II–VI.

Because catch data are unreliable, several methods have been used to estimate removals. Figure 8.2 summarizes previous approaches to estimate total catches. Revised catch estimates were available from estimates derived from analyses of the shark fin trade (ICCAT, 2008). Three different methods were used to apply Hong Kong derived shark fin trade estimates to the Atlantic; the Atlantic as a proportion of total sea area, the Atlantic catch of tuna and billfish to total catch thereof, the Atlantic longline effort to total longline effort. The effort–scaled series was the preferred option because it does not consider a constant relationship between tuna and shark catches, and can be used to segregate catches between the North and South Atlantic. These effort scaled estimates are shown in Figure 8.1. These estimates and the tuna ratio estimates vary widely, especially since the mid 1990s. Recent catches are variously estimated at between 27 000 t and 60 000 t, depending on the method used. The fin ratio estimates, based on effort scaling are different from those previously presented to ICCAT (Clarke *et al.*, 2006; Figure 8.2).

8.3.2 Discards

The low value of blue shark means that it is not always retained for the market. The most valuable parts of the blue shark are its fins. In some fisheries the fins of blue sharks are retained and the carcasses discarded, although various national and EC measures have been brought in to prevent this practice, generally referred to as finning. 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 very widespread in fisheries taking blue shark.

Discard estimates are available only for fisheries from USA, Canada and UK (Bermuda). Numbers for the latter country are negligible. USA reported discards in quantities of 63–1136 t.year^{-1}, averaging about 390 t.year^{-1} over time (ICCAT, 2006). Discards from Canadian fisheries have been estimated at about 1000 t annually in recent years (ICCAT, 2008) compared with estimated annual landings of about 2000 t.

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 bycatch 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. Data are available for one observed fishing trip on a Japanese bluefin longliner in 1997. On this trip, 186 blue sharks were caught compared with 166 bluefin tuna (Boyd, 2008).

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 recent 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".

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 haulback after a soak during the night was lower than that during day longline sets: 100% (Boggs, 1992), 80–90% (Campana *et al*., 2005), 69% (Diaz and Serafy, 2005), and 87% (Francis *et al*., 2001).

8.3.3 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 reported to other agencies (ICCAT, 2008). Further work needs to be done to harmonize reporting of catch data. 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 in the near future to gather data on species targeted by illegal fishers, this information will greatly assist in management and conservation.

8.4 Commercial catch composition

Incomplete information is available on blue shark composition in commercial catches. 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 shark are estimated together to account for between 69% and 72% of catches from Spanish and Portuguese surface longliners in the North Atlantic (Oceana, 2008). This species is thought to be an insignificant bycatch in Mexican tuna and shark directed fisheries in the Gulf of Mexico.

8.4.1 Conversion factors

Information on the length–weight relationship is available from several scientific studies (Table 8.3) and information on length–length relationships is summarized in Table 8.4. 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:

$$W_R = 0.4 + 1.22\ W_D$$
$$W_D = 0.2 + 0.81\ W_R$$

For gutted fish from French fisheries the DW/RW 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 (see: Mejuto and García-Cortés, 2004; Santos and Garcia, 2005; Hareide *et al.*, 2007), however the discussion about a useful ratio is still ongoing.

8.5 Commercial catch-effort data

In 2008, the following cpue series were available and used for stock assessments by ICCAT:

- US longlines 1986–2007;
- Japanese longlines 1971–2006;
- Irish recreational fisheries 1989–2005;
- US longlines 1957–1986;
- Venezuelan longlines 1994–2007;
- Spanish swordfish longlines 1997–2007.

Details of these series are available in ICCAT, 2008 and are presented in Figure 8.3.

The longer time-series demonstrated steady trends until the mid-1990s. The only exception to that is the US logbook series that demonstrates a large decline from very high levels in 1985. Downward trends since the mid-1990s are apparent from Irish coastal recreational fisheries, Venezuelan longliners, US mid-east coast recreational fisheries and the US commercial longliners, though not from Canadian bluefin tuna and bigeye tuna/swordfish fisheries. However the Canadian data were not used for assessment purposes by ICCAT. Data from the Japanese tuna longline fishery demonstrated a similar peak to the Irish data from the mid-1990s. There is no obvious abundance signal in the Spanish longline cpue, though this series only began after the declines in the other series were already demonstrating marked declines.

Most time-series declined to lowest observed levels in 2004 and 2005, with slight increases afterward. The US Spanish and Japanese commercial indices displayed lower decline in recent years than the other series. These cpue series were assigned weightings before they were included in the stock assessments conducted by ICCAT. These weightings were based on the spatial area of the North Atlantic. Series from fisheries with broader spatial extents received greater weightings than those with more restricted spatial coverage.

8.6 Fishery-independent surveys

No fishery-independent information from research vessel surveys is available, and although such data exist for parts of the NW Atlantic (Hueter *et al.*, 2008), there are no scientific fishery-independent data from the NE Atlantic. A Survey from 1977–1994 conducted by the US NMFS documented a decline among juvenile males blue sharks by 80%, however this decline did not display among juvenile female animals, 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 and in estuaries. Recent satellite telemetry data revealed that 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 makos and white sharks as well as by sea lions. Fishing is likely to be a major contributor to adult mortality.

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 8.5 (Growth parameters), and Table 8.3 (Length–weight relationship) and Table 8.6 (other life-history parameters). 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 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). Based on life-history information, blue shark is considered to be among the most productive shark species (ICCAT, 2008).

8.8 Exploratory assessment models

8.8.1 Previous assessments

In 2004, ICCAT completed a preliminary stock assessment (ICCAT, 2005). Although the North Atlantic Stock appeared to be above biomass in support of MSY, the assessment remained highly 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 for this species was highly recommended.

In 2008, three models were used in assessments 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.

Preliminary modelling 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 found that the stock size estimate was sensitive to the weighting of the Irish cpue series. Equal weighting of this and the other series produced a stock size at around B_{MSY}. All other sensitivity analyses found similar results to the base case run, with the stock well above MSY levels.

The age structured biomass model displayed varying 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 is very wide (long tail). This is probably because there is not enough information in the data to allow the model to provide a more narrow range of plausible values than the one started with and thus provide a more precise estimate of the biomass of the stock.

Preliminary runs of an age structured model not requiring catch information estimated $F>F_{MSY}$, but still low. These runs demonstrated some depletion, with current SSB estimated at around 83% of virgin levels.

8.8.2 Stock status

In 2008, ICCAT tentatively 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 well below those corresponding to the level at which MSY is reached. However, ICCAT, 2008 pointed out that the results are 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 can be expected to be of great importance. ICCAT did not have time to conduct a sensitivity analysis of the input data and assumptions (ICCAT, 2008).

Owing to these underlying weaknesses, no firm conclusions could be drawn from the preliminary assessments conducted by ICCAT. ICCAT, 2008 stated that most models used predicted this stock was not overfished, and that overfishing was not occurring. However, ICCAT did not use these assessments to make conclusions about stock status and has not provided management advice based on these analyses.

8.9 Quality of assessments

A full evaluation of the sensitivity of results to the results of the 2008 ICCAT assessment was not conducted (ICCAT, 2008). The main difficulties are with regard to the input data, rather than the models used. In particular, further analyses could be conducted into the weighting procedures used and the sensitivity to catch data. The models do not always follow the trends in the cpue series available, especially the longer time-series. Even the best estimates of catch data available only generated very low estimates of fishing mortality. This is because the stock size was estimated to be considerably high. Further analyses are required before any firm conclusions can be drawn about stock status for this species.

8.10 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.

8.11 Management considerations

The stock status of blue shark in the North Atlantic remains unclear. 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 obviously incomplete. Besides unaccounted discards and the substantial occurrence of finning, it becomes obvious that countries supply data to ICCAT that is 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.

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 that this species is a significant bycatch, especially in tuna and billfish fisheries, better data should be made available by the countries whose fleets catch it.

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Table 8.1. Blue shark in the North Atlantic. Reported landings (t) by country (Source FAO FishStat: Catch 1950–2008).

Country	Fishing area	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Benin	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	.
China	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-	-
Ghana	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	.
Liberia	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	.
Panama	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	.
Russian Federation	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	-
Senegal	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-	-
Channel Islands	Atlantic, Northeast	.	.	.	.	.	.	.	.	.	.	.
Denmark	Atlantic, Northeast	-	-	8	2	4	3	3	4	2	2	1
France	Atlantic, Northeast		12	12	.	9	8	14	39	50	67	91
Ireland	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-	-
Netherlands	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Northeast	.	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Northeast	.	.	.	.	.	.	.	.	.	.	.
United Kingdom	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-	-
Canada	Atlantic, Northwest	-	-	-	-	-	-	-	-	-	-	-

Country	Fishing area	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Portugal	Atlantic, Northwest	.	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Northwest	-	-	-	-	-	-	-	-	-	-	-
China	Atlantic, Western Central	-	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Western Central	.	.	.	.	.	.	-	-	-	-	-
Spain	Atlantic, Western Central	-	-	-	-	-	-	-	-	-	-	-
Trinidad and Tobago	Atlantic, Western Central	.	.	.	.	.	.	.	.	.	.	.
Venezuela, Boliv Rep of	Atlantic, Western Central	.	.	.	.	.	.	.	.	.	.	.
	total	0	12	20	2	13	11	17	43	52	69	92

Table 8.1. Cont.

Country	Fishing area	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benin	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	6	4
China	Atlantic, Eastern Central	-	-	-	-	.	.	.	.	.	.
Ghana	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.
Liberia	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.
Panama	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.
Russian Federation	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-
Senegal	Atlantic, Eastern Central	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	10483	9123
United Kingdom	Atlantic, Eastern Central	-	-	-	-	-	-	-	-	-	-
Channel Islands	Atlantic, Northeast	.	.	.	.	.	.	.	.	.	1
Denmark	Atlantic, Northeast	2	2	1	1	<0.5	1	2	3	1	1
France	Atlantic, Northeast	79	130	187	276	322	350	266	278	213	163
Ireland	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-
Netherlands	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Northeast	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Northeast	.	.	.	.	.	.	.	.	12 315	12 963
United Kingdom	Atlantic, Northeast	-	-	-	-	-	-	-	-	-	-
Canada	Atlantic, Northwest	-	-	-	-	-	-	-	12	11	21

Country	Fishing area	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Portugal	Atlantic, Northwest	.	.	.	.	.	.	.	.	.	.
Spain	Atlantic, Northwest	-	-	-	-	-	-	-	-	-	-
China	Atlantic, Western Central	-	-	-	-	-	-	-	-	-	-
Portugal	Atlantic, Western Central	-	-	-	-	-	-	-	-	-	17
Spain	Atlantic, Western Central	-	-	-	-	-	-	-	-	1700	418
Trinidad and Tobago	Atlantic, Western Central	.	.	.	.	.	.	.	.	.	.
Venezuela, Boliv Rep of	Atlantic, Western Central	.	.	.	.	.	.	.	.	.	.
	Total	81	132	188	277	322	351	268	293	24 729	22 711

Table 8.1. Cont.

Country	Fishing area	1999	2000	2001	2002	2003	2004
Benin	Atlantic, Eastern Central	27	.	.	.	9	7
China	Atlantic, Eastern Central	.	.	750	420	600	.
Ghana	Atlantic, Eastern Central	.	.	.	.	.	.
Liberia	Atlantic, Eastern Central	76	70	.	.	.	25
Panama	Atlantic, Eastern Central	177	22	-	-	-	-
Portugal	Atlantic, Eastern Central	.	351	557	668	1292	661
Russian Federation	Atlantic, Eastern Central	-	-	-	-	-	-
Senegal	Atlantic, Eastern Central	.	.	.	456	.	.
Spain	Atlantic, Eastern Central	9225	9336	7958	7159	7789	9955
United Kingdom	Atlantic, Eastern Central	-	-	-	-	-	-
Channel Islands	Atlantic, Northeast	<0.5	-	-	-	-	1
Denmark	Atlantic, Northeast	1	2	1	13	6	1
France	Atlantic, Northeast	230	395	205	112	134	103
Ireland	Atlantic, Northeast	67	31	66	11	2	<0.5
Netherlands	Atlantic, Northeast	-	-	-	-	-	-
Portugal	Atlantic, Northeast	887	1133	1006	1209	2169	1514
Spain	Atlantic, Northeast	12 586	14 776	9404	8507	8185	7359
United Kingdom	Atlantic, Northeast	-	12	9	6	4	6
Canada	Atlantic, Northwest	54	624	581	836	346	965

Country	Fishing area	1999	2000	2001	2002	2003	2004
Portugal	Atlantic, Northwest	.	169	-	-	48	-
Spain	Atlantic, Northwest	-	-	-	-	-	-
China	Atlantic, Western Central	-	-	-	-	-	-
Portugal	Atlantic, Western Central	-	-	-	8	-	-
Spain	Atlantic, Western Central	.	.	.	.	.	.
Trinidad and Tobago	Atlantic, Western Central	.	.	.	6	3	2
Venezuela, Boliv Rep of	Atlantic, Western Central	.	.	.	.	.	9
	Total	23 330	26 921	20 537	19 411	20 587	20 608

Table 8.1. Cont.

Country	Fishing area	2005	2006	2007	2008	2009
Benin	Atlantic, Eastern Central	6	6	5	.	.
China	Atlantic, Eastern Central	.	.	472	111	105
Ghana	Atlantic, Eastern Central	.	.	.	21	.
Liberia	Atlantic, Eastern Central	.	.	.	.	.
Panama	Atlantic, Eastern Central	-	254	891	1134	1574
Portugal	Atlantic, Eastern Central	1440	1754	2212	3479	4075
Russian Federation	Atlantic, Eastern Central	1	-	-	-	.
Senegal	Atlantic, Eastern Central	.	.	43	134	255
Spain	Atlantic, Eastern Central	7138	6036	4320	4625	9903
United Kingdom	Atlantic, Eastern Central	.	.	-	62	91
Channel Islands	Atlantic, Northeast	-	-	-	1	<0.5
Denmark	Atlantic, Northeast	<0.5	1	1	-	
France	Atlantic, Northeast	120	134	167	109	118
Ireland	Atlantic, Northeast	<0.5	-	<0.5	<0.5	<0.5
Netherlands	Atlantic, Northeast	-	-	1	-	1
Portugal	Atlantic, Northeast	1990	2627	3283	2746	3433
Spain	Atlantic, Northeast	5408	6069	10 684	13 107	12 422
United Kingdom	Atlantic, Northeast	5	3	6	5	5
Canada	Atlantic, Northwest	1134	977	843	-	
Portugal	Atlantic, Northwest	-	11	71	70	70

Country	Fishing area	2005	2006	2007	2008	2009
Spain	Atlantic, Northwest	1150	1387	-	2214	.
China	Atlantic, Western Central	-	-	-	1	1
Portugal	Atlantic, Western Central	3	1	2	32	33
Spain	Atlantic, Western Central	1310	1972	2034	842	2140
Trinidad and Tobago	Atlantic, Western Central	1	1	<0.5	2	8
Venezuela, Boliv Rep of	Atlantic, Western Central	26	10	18	7	71
	Total	19 732	21 243	25 053	28 344	34 305

Table 8.2. Blue shark in the North Atlantic. Estimated landings (t) of blue shark 1971–2006 based on reported landings, and as estimated from the ratio of sharks to tuna and tuna-like species, and as estimated by fin trade data (Source: ICCAT Shark Subgroup).

Year	Estimated catch (tuna ratio)	Estimated catch (fin trade data)	ICCAT landings	Fin trade estimates as a proportion of estimated landings	ICCAT landings as a proportion of estimated landings
1971	25 332	-	-	-	-
1972	25 274	-	-	-	-
1973	30 163	-	-	-	-
1974	27 593	-	-	-	-
1975	37 993	-	-	-	-
1976	31 411	-	-	-	-
1977	35 396	-	-	-	-
1978	27 506	-	4	-	0.00
1979	20 108	-	12	-	0.00
1980	27 202	11 392	-	-	-
1981	29 968	12 528	204	0.42	0.01
1982	33 318	13 972	9	0.42	0.00
1983	42 717	13 923	613	0.33	0.01
1984	39 644	15 982	121	0.40	0.00
1985	43 572	14 720	380	0.34	0.01
1986	55 374	18 265	1162	0.33	0.02
1987	58 923	14 906	1467	0.25	0.02
1988	50 284	13 312	867	0.26	0.02
1989	33 242	14 268	832	0.43	0.03
1990	36 129	14 543	2348	0.40	0.06
1991	38 966	21 847	3533	0.56	0.09
1992	38 307	27 604	2343	0.72	0.06
1993	45 057	20 497	7879	0.45	0.17
1994	41 925	27 341	15 407	0.65	0.37
1995	43 885	31 977	13 298	0.73	0.30
1996	42 760	40 539	15 781	0.95	0.37
1997	37 813	42 765	43 028	1.13	1.14
1998	34 617	43 228	39 450	1.25	1.14
1999	33 105	49 068	38 529	1.48	1.16
2000	31 021	51 183	42 721	1.65	1.38
2001	27 713	56 859	37 223	2.05	1.34
2002	25 983	46 826	34 040	1.80	1.31
2003	26 493	47 695	40 059	1.80	1.51
2004	25 510	46 509	39 207	1.82	1.54
2005	25 707	52 759	23 149	2.05	0.90
2006	26 795	61 845	19 796	2.31	0.74

Table 8.3. Blue shark in the North Atlantic. Length–weight relationships for *Prionace glauca* 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	Sex	n	Length range (cm)	Source
NE Atlantic	WD = (8.04021 x 10-7) LF 3.23189	C	354	75–250 (LF)	García-Cortés and Mejuto, 2002
NW Atlantic	WR = (3.1841 x 10-6) LF 3.1313	C	4529		Castro, 1983
Atlantic	WR = (3.92 x 10-6) LT 3.41	Male	17		Stevens, 1975
Atlantic	WR = (3.184 x 10-7) LT 3.20	Female	450		Stevens, 1975
NW Atlantic	WR = (3.2 x 10-6) LF 3.128	C	720		Campana *et al.*, 2005
NW Atlantic	WD = (1.7 x 10-6) LF 3.205	C	382		Campana *et al.*, 2005

Table 8.4(a). Blue shark in the North Atlantic. Length–length relationships for male, female and both sexes combined of *Prionace glauca* from the NE Atlantic and Straits of Gibraltar (Buencuerpo *et al.*, 1998).

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)

L_S = standard length; L_F = fork length; L_T = total length; L_{UC} = upper caudal lobe length.

Table 8.4 (b). Blue shark in the North Atlantic. Length–length relationships for both sexes combined of *Prionace glauca* 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 8.5. Blue shark in the North Atlantic. Von Bertalanffy growth parameters from various studies. (L_{∞} in cm (TL), k in years-1, t_0 in years).

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 8.6. 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 (LT)	30–50 cm			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

Parameter	Values	Sample Size	Area	Reference
Female length-at-maturity	220–320 cm (LF)			Campana *et al.*, 2002
	170–190 cm (LF)			Francis and Duffy, 2005
	> 185 cm (LF)			Pratt, 1979
Longevity (years)	16–20			Skomal and Natanson, 2003
Natural mortality (M)	0.23		Worldwide	Campana *et al.*, 2005 (mean of various studies)
Productivity (R2m) estimate: intrinsic rebound	0.061 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Potential rate of increase per year	43% (unfished)		NW Atlantic	Campana *et al.*, 2005
Population doubling time TD (years)	11.4 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Trophic level	4.1	14		Cortés, 1999

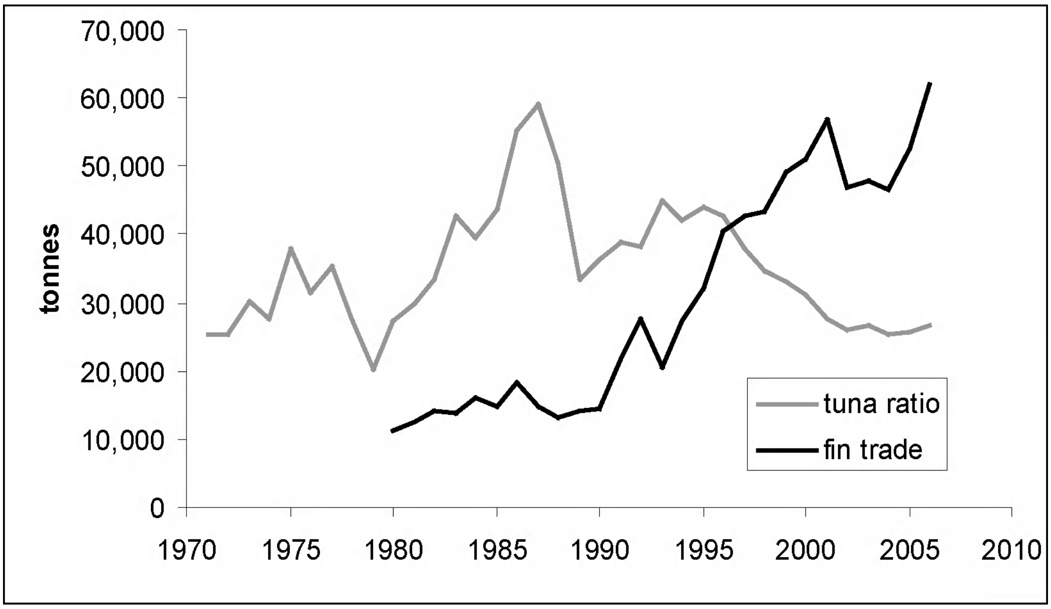

Figure 8.1. Blue Shark in the North Atlantic. Two estimates of catch, as presented by ICCAT 2008. Tuna ratio: resulting from application of the method of estimating catches using the ICCAT reported data and the ratio of tunas to shark catch; fin trade: based on the medians scaled to effort partitioned into north and south management units based on effort in the ICCAT database.

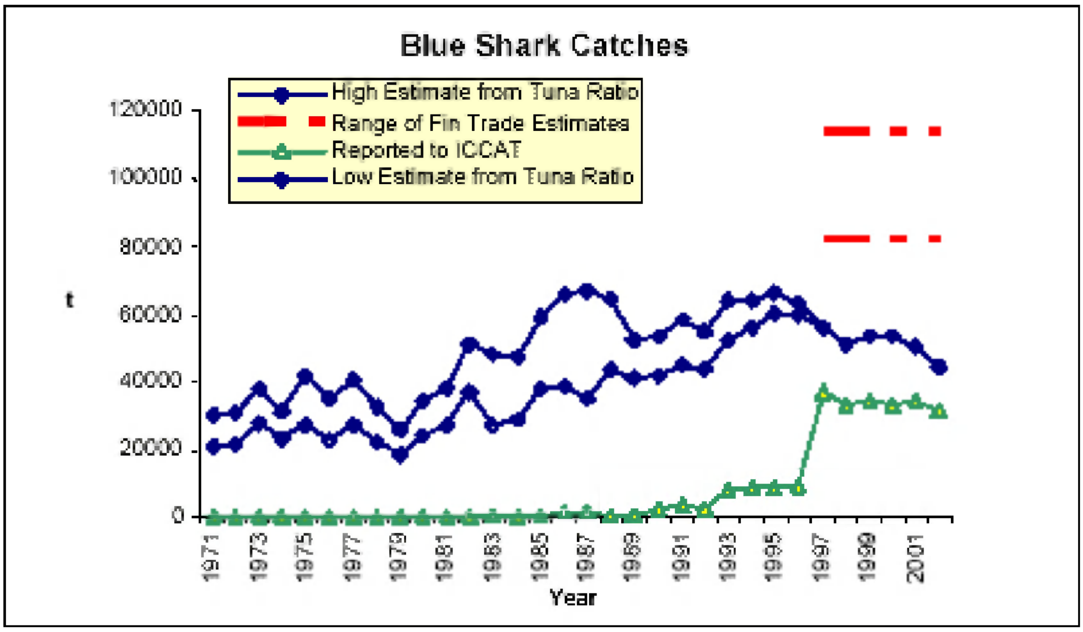

Figure 8.2. Blue shark in the Atlantic. Comparison of shark catch reported to ICCAT with estimates resulting from tuna to shark ratios and from fin trade data for blue sharks in the Atlantic. Source: ICCAT.

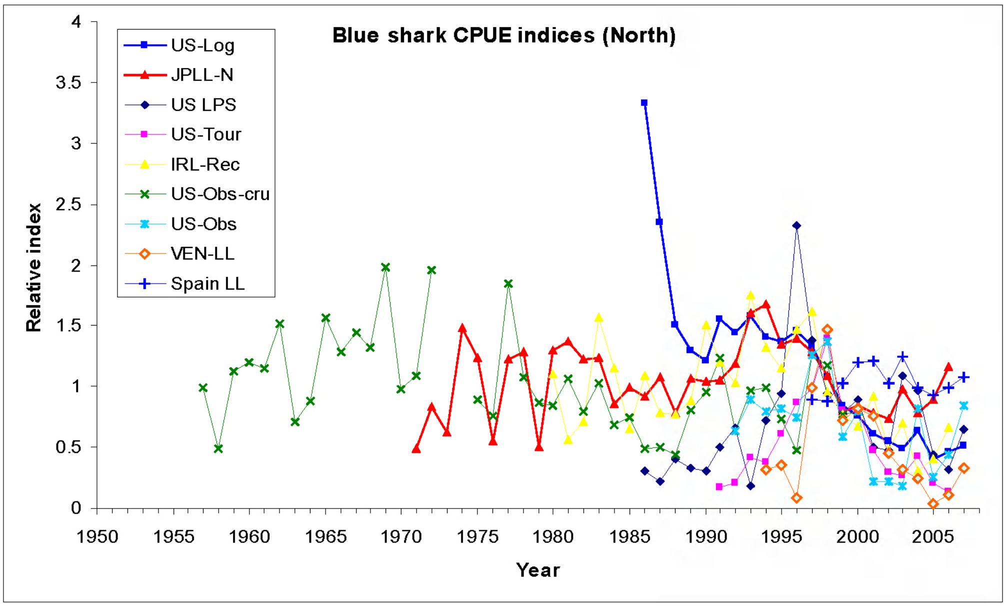

Figure 8.3. Blue Shark in the North Atlantic. Cpue indices used in ICCAT assessment in 2008. Indices presented on a relative scale.

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

9.1 Stock distribution

There is considered to be a single-stock of shortfin mako *Isurus oxyrinchus* in the North Atlantic. This conclusion is based on genetic analyses and tagging studies (e.g. Kohler *et al.*, 2002). Tagging studies conducted by NMFS (1962–2003), tagged 6309 shortfin mako from the NW Atlantic. In all 730 (11.6%) recaptures were made, of which transatlantic movements were recorded. Genetic studies (Heist *et al.*, 1996; Schrey and Heist, 2002) have found no evidence to suggest separate east and west populations in the Atlantic; however the North Atlantic population appears to be isolated from those of other oceans. Therefore, 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) have a southern stock boundary of 5°N, this is also suggested to be the southern limit of the North Atlantic shortfin mako stock. Hence, 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.

9.2 The fishery

9.2.1 A history of the fishery

Shortfin mako is a highly migratory pelagic species that is caught frequently as a bycatch, mostly in surface longline fisheries that traditionally target tuna and billfish, and in other high seas tuna fisheries. Like porbeagle shark, 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, although in relatively small quantities and some of these fish are released.

They are also taken in Mediterranean 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.

9.2.2 The fishery in 2009

No new information.

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.

9.2.4 Management applicable

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 FAO FishStat are presented in Table 9.1. These values are considered underestimates, because of the inconsistent or generic reporting of shark catches. Estimated catches of shortfin mako from the ICCAT shark subgroup are given in Table 9.2. These data include reported landings of shortfin mako and unspecified mako, and estimated landings from (a) the ratio of shark catches to tuna and tuna-like species, and (b) from fin trade data. Reported landings of shortfin mako and unspecified mako sharks are thought to be underestimated in the early part of the time-series (prior to 1997), with official landings and estimates of a comparable magnitude in more recent years, with annual landings in the region of 4500 t.

In the ICES area, shortfin mako is reported predominantly from Portuguese and Spanish fisheries in Subareas VIII, IX, and X, although there are records from as far north as Hatton Bank (northwest of Ireland) from Japanese tuna longliners (Boyd, 2008). Given that there can be confusion between shortfin mako and porbeagle; further studies to clarify the northern range of shortfin mako are required.

At recent ICCAT assessment meetings regarding also the shortfin mako, two other estimates of landings for this stock were prepared (Figures 9.1 and 9.2), the tuna ratio and the fin trade index. These figures depict the order of magnitude the estimates deviate and are much higher than actual reported landings. The tuna ratio estimates derive from logged observations of shark catches relative to tuna catches and are considered conservative by ICCAT, because they do not consider all fisheries (ICCAT, 2008). The fin trade index is inferred from systematic trade observations of shark fins in the Asian market and used to calculate caught shark weights based on catch effort data from the ICCAT database (Clarke *et al.*, 2006; ICCAT, 2005 and 2008).

9.3.2 Discards

Estimates of shortfin mako bycatch are difficult, 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 in some fisheries shortfin mako sharks are landed for their meat, finning (i.e. the practice of removing a fin or fins of a shark and returning the remainder of the shark's carcass to the sea) may occur for this species as well, which may result in undocumented catches and mortality in some fleets. Observations on fin trade markets in Asia and the numbers of fins traded there leads to estimated annual landings of 4000–6000 t of North Atlantic shortfin mako. The effect of finning bans in the US and Canada (since 1994) and the EU (since 2003) need to be evaluated.

9.3.3 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 in recent years.

9.4 Commercial catch composition

No new information.

9.4.1 Conversion factors

Scientific estimates for the length–weight relationship for shortfin mako are summarized in Table 9.3, conversion factors for different length measurements in Table 9.4. Shortfin mako can be landed in various forms, whole, dressed, with or without heads, fins only, etc. 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-effort data

Cpue data were compiled at the ICCAT assessment in 2004 (ICCAT, 2005) and in 2008, and these indicated a declining trend for this species in the North Atlantic for the years 1975–2004. Further analyses and interpretation of these data are required. These datasets include commercial data from Japanese, Spanish, Chinese (Taiwan), Canadian and US longline fisheries. Some of these indices have revealed a rapid increase in recent years, with such an increase incompatible with the known population productivity of shortfin mako. Hence, these data may be affected by changes in catchability (e.g. changes in the spatial distribution, target species, fishing depths, or fishing gear used by the fleets and/or a contraction in the range of the population), changes in reporting or regulations, or that there has been immigration from adjacent areas.

Matsunaga and Nakano, 2005 analysed observer data of bycatch from Japanese tuna longline fisheries in the Atlantic. The catch of shortfin mako was low in the central Atlantic (eight specimens recorded), but quite high in the Northwest Atlantic (710 specimens recorded), with a cpue of >0.8 (number of catches per 1000 hooks).

Buencuerpo *et al.*, 1998 investigated shortfin mako landings made by the Spanish longline and gillnet fisheries, fishing in waters from the NW African coast northwards to the Iberian Peninsula and the Straits of Gibraltar. In total, 5947 *Isurus* were landed into Algeciras fish market from 175 landings between July 1991 and July 1992, and they comprised 11.6% of the total catches.

Although the relationship between Atlantic and Mediterranean 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 on data from the Italian large pelagic longline fishery in the Tyrrhenian Sea (1998–1999), and calculated a cpue of 1.1 kg per 1000 hooks.

9.6 Fishery-independent surveys

Few sources of fishery-independent information are available, mainly from the NW Atlantic (e.g. Simpfendorfer *et al.*, 2002; Hueter *et al.*, 2008). No fishery-independent data from the NE Atlantic are available.

9.7 Life-history information

Only a few studies have compiled data on biological information on this species. Data available for the North Atlantic stock is given in Table 9.3 (Length–weight relationships), Tables 9.5 (growth parameters), and 9.6 (other life-history parameters). The

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

9.7.1 Habitat

Shortfin mako is a common, extremely active, offshore littoral and 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 below 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. However, 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 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). 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 might 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.

Shortfin mako sampled off southwest Portugal had teleosts as the principal component of their diet (occurring in 87% of the stomachs and accounting for over 90% of the contents by weight), whereas crustaceans and cephalopods were also relatively important in their diet; other elasmobranchs were only present occasionally (Maia *et al.*, 2006). 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).

9.7.4 Life-history parameters

The life-history parameters of the shortfin mako from studies to-date are summarized in Table 9.6.

9.8 Exploratory assessment models

9.8.1 Previous assessments

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

9.8.2 Stock assessment

Assessments were undertaken in 2008, using a Bayesian surplus production (BSP) model, an age structured production model (ASPM) and a catch-free age structured production model. For details of these models and model outputs see ICCAT 2008.

9.9 Quality of assessment

Preliminary 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.

ICCAT 2008 noted that "Although both the quantity and quality of the data available to conduct stock assessments has increased with respect to that available in 2004, they are still quite uninformative and do not provide a consistent signal to inform the model. Unless these and other issues can be resolved, the assessments of stock status for this and other species will continue to be very uncertain."

9.10 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.

9.11 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. It is clear that the landings data presented in this report are underestimates. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic "*nei*" categories.

ICCAT, 2005 used three sources of data when assessing pelagic shark stocks; reported data (i.e. the declared landings made by each member state to ICCAT and the FAO), tuna ratios (estimated catches in relation to declared landings of tuna and tuna-like species) and market data (based on the amount of sharks or fins traded in the large Asian market).

The 2006 Report of the Standing Committee on Research and Statistics (SCRS) suggested that, if the status of this stock was to be improved, then reductions in effective fishing effort would be most beneficial to shortfin mako, given that the basis for recommending catch limits was hampered by the uncertainty of catches (ICCAT, 2006). Technical measures (e.g. modifications to fishing gear, restrictions on fishing areas and times, minimum or maximum sizes for allowable retained catch) were also suggested as having potential benefits to the stock (ICCAT, 2006).

In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Atlantic population of the shortfin mako as threatened and is considering its addition to Schedule 1 under the Species at Risk Act (SARA; DFO, 2006). A catch limit of 100 t annually for the Canadian pelagic longline fishery as well as release of live catch is advised. The US National Marine and Fisheries Service NMFS is currently assessing the Atlantic shortfin mako stock to determine possible threat level (NMFS, 2006).

The shortfin mako was listed as Lower Risk Near Threatened until 2008 when it was listed as Vulnerable both globally and regionally in the NE Atlantic in the IUCN Red List (Gibson *et al.*, 2008).

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Table 9.1. Shortfin mako in the North Atlantic. Available landings (t) of shortfin mako by country. Landings of 'Mako sharks' assumed to be shortfin mako (Source FAO FishStat). These data are considered underestimates. Reported Data for 2008 are not complete.

Fishing area	Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Atlantic, Western Central	Mexico	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Western Central	Portugal	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Western Central	Spain	-	-	-	-	-	-	-	-	-	-	73
Atlantic, Western Central	Trin & Tob	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Western Central	USA	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Western Central	Venez. & Boliv.	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Northwest	Canada	-	-	-	-	-	-	-	-	-	67	110
Atlantic, Northwest	Portugal	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Northwest	Spain	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Northwest	USA	6	2	7	20	64	59	71	115	5	-	-
Atlantic, Northeast	Portugal	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Northeast	Spain	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Northeast	UK	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Eastern Central	Benin	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Eastern Central	China	-	-	-	-	-	-	34	45	23	27	19
Atlantic, Eastern Central	Côte d'Ivoire	.	.	.	.	.	.	.	.	.	15	.
Atlantic, Eastern Central	Panama	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Eastern Central	Philippines	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Eastern Central	Portugal	.	.	.	.	.	.	.	.	.	.	.
Atlantic, Eastern Central	Spain	-	-	-	-	-	-	-	-	-	-	-
Atlantic, Eastern Central	Vanuatu	-	-	-	-	-	-	-	-	-	-	-
	Total	6	2	7	20	64	59	105	160	28	109	202
Mediterranean Sea	Portugal	-	-	-	-	-	-	-	-	-	-	-
Mediterranean Sea	Spain	-	-	-	-	-	-	-	-	-	-	6

Table 9.1. Cont.

Fishing area	Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Atlantic, Western Central	Mexico	.	.	10	16	.	10	6	9	5	8	.
Atlantic, Western Central	Portugal	<0.5	-	-	-	-	-	-	-	-	-	.
Atlantic, Western Central	Spain	33	.	.	.	134	63	-	94	105	127	.
Atlantic, Western Central	Trin & Tob	.	1	.	1	2	3	1	2	1	1	.
Atlantic, Western Central	USA	-	-	5	5	-	-	5	-	-	-	.
Atlantic, Western Central	Venez. & Boliv.	.	.	.	.	.	.	58	20	6	11	.
Atlantic, Northwest	Canada	69	70	78	69	78	73	80	91	71	72	.
Atlantic, Northwest	Portugal	.	.	10	-	-	9	-	1	<0.5	30	.
Atlantic, Northwest	Spain	-	-	-	-	-	-	-	212	212	-	.
Atlantic, Northwest	USA	-	-	19	19	20	16	33	14	10	52	.
Atlantic, Northeast	Portugal	.	160	183	186	107	541	328	603	729	1.222	482
Atlantic, Northeast	Spain	-	-	-	-	-	-	254	93	91	119	.
Atlantic, Northeast	UK	<0.5	2	3	2	1	1	1	<0.5	<0.5	-	.
Atlantic, Eastern Central	Benin	.	.	3	1	.	.	.	1	.	.	.
Atlantic, Eastern Central	China	74	126	191	22	208	260	.	.	.	99	.
Atlantic, Eastern Central	Côte d'Ivoire	.	10	9	15	15	30	15	14	22	25	.
Atlantic, Eastern Central	Panama	-	25	1	-	-	-	-	-	<0.5	2	.
Atlantic, Eastern Central	Philippines	-	3	-	-	-	-	-	.	-	-	.
Atlantic, Eastern Central	Portugal	.	.	42	42	68	151	42	216	225	165	.
Atlantic, Eastern Central	Spain	-	-	-	-	-	-	468	523	604	420	.
Atlantic, Eastern Central	Vanuatu	-	-	-	-	-	-	52	12	13	1	.
	Total	176	397	554	378	633	1157	1343	1905	2094	2354	482
Mediterranean Sea	Portugal	-	-	1	6	-	<0.5	31	15	5	-	.
Mediterranean Sea	Spain	7	5	3	2	2	2	2	2	5	1	.

Table 9.2. Shortfin mako in the North Atlantic. Estimated landings (t) of shortfin mako 1971–2006 based on reported landings of shortfin mako and mako (unspecified), and as estimated from the ratio of sharks to tuna and tuna-like species, and as estimated by fin trade data (Source: ICCAT Shark subgroup).

Year	Estimated catch (tuna ratio)	Estimated catch (fin trade data)	ICCAT landings (shortfin mako & mako unspecified)	Fin trade estimates as a proportion of estimated landings	ICCAT landings as a proportion of estimated landings
1971	3717	-	200	-	0.05
1972	3014	-	168	-	0.06
1973	3322	-	263	-	0.08
1974	3345	-	346	-	0.10
1975	4280	-	389	-	0.09
1976	3038	-	92	-	0.03
1977	3642	-	465	-	0.13
1978	3241	-	299	-	0.09
1979	2402	-	313	-	0.13
1980	3253	1105	474	0.34	0.15
1981	3079	1216	999	0.39	0.32
1982	3614	1356	1723	0.38	0.48
1983	4209	1352	941	0.32	0.22
1984	4480	1551	1776	0.35	0.40
1985	6900	1429	3801	0.21	0.55
1986	6589	1773	1957	0.27	0.30
1987	6336	1447	1039	0.23	0.16
1988	5985	1292	1563	0.22	0.26
1989	4098	1385	1647	0.34	0.40
1990	3852	1411	1348	0.37	0.35
1991	4114	2128	1326	0.52	0.32
1992	3871	2689	1441	0.69	0.37
1993	5364	1996	2967	0.37	0.55
1994	4510	2663	2025	0.59	0.45
1995	6202	3114	2988	0.50	0.48
1996	4790	3956	1714	0.83	0.36
1997	3792	4173	5212	1.10	1.37
1998	4255	4218	4560	0.99	1.07
1999	3311	4788	3982	1.45	1.20
2000	2955	4994	4779	1.69	1.62
2001	2855	5512	4648	1.93	1.63
2002	3521	4539	4959	1.29	1.41
2003	4206	4624	7254	1.10	1.72
2004	3689	4509	6981	1.22	1.89
2005	3807	5114	4269	1.34	1.12
2006	3564	5996	3839	1.68	1.08

Table 9.3. Shortfin mako in the North Atlantic. Length–weight relationships for *Isurus oxyrinchus* from different populations.

Stock	L (cm) W (kg) relationship	Sex	n	Length range (cm)	Source
Central Pacific	log W (lb) = –4.608 + 2.925 x log LT				Strasburg, 1958
Cuba	W = 1.193 x 10–6 x LT 3.46	C	23	160–260 (LT)	Guitart, 1975
Australia	W = 4.832 x 10–6 x LT 3.10	C	80	58–343 (LT)	Stevens, 1983
South Africa	W = 1.47 x 10–5 x LPC 2.98	C	143	84–260 (LPC)	Cliff *et al.*, 1990
NW Atlantic	WR = (5.2432 x 10–6) LF 3.1407	C	2081	65–338 (LF)	Kohler *et al.*, 1995.
NW Atlantic	W = 7.2999 x LT (m) 3.224	C	63	2.0–3.7 m (LT)	Mollet *et al.*, 2000
southern hemisphere	W = 6.824 x LT (m) 3.137	C	64	2.0–3.4 m (LT)	Mollet *et al.*, 2000
NE Atlantic	WD = (2.80834 x 10–6) LF 3.20182	C	17	70–175 (LF)	García-Cortés and Mejuto, 2002
Tropical east Atlantic	WD = (1.22182 x 10–5) LF 2.89535	C	166	95–250	García-Cortés and Mejuto, 2002
Tropical central Atlantic	WD = (2.52098 x 10–5) LF 2.76078	C	161	120–185	García-Cortés and Mejuto, 2002
Southwest Atlantic	WD = (3.1142 x 10–5) LF 2.7243	C	97	95–240	García-Cortés and Mejuto, 2002

Lengths in cm, and weights in kg unless specified in equation. W_R = round weight; W_D = dressed weight.

Table 9.4. Shortfin mako in the North Atlantic. Length–length relationships for male, female and both sexes combined from the NE Atlantic and Straits of Gibraltar (Source: 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 = 1.086 LS + 1.630 (n=852)	LF = 1.086 LS + 1.409 (n=911)	LF = 1.086 LS + 1.515 (n=1763)
LT = 0.817 L S + 0.400 (n=852)	LT = 1.209 LS + 0.435 (n=681)	LT = 1.207 LS + 0.971 (n=1533)
LUC = 3.693 L S + 13.094 (n=507)	LUC = 3.795 L S + 10.452 (n=477)	LUC = 3.758 LS + 11.640 (n=1054)
LT = 1.106 LF + 0.052 (n=853)	LT = 1.111 LF – 0.870 (n=911)	LT = 1.108 LF – 0.480 (n=1746)

Table 9.5. Shortfin mako in the North Atlantic. Growth parameters from two studies. Formation of two vertebral bands annually assumed and von Bertalanffy growth function used t_0 in years.

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**

** Gompertz growth function used, t_0 in cm. L_∞ in cm (Fork Length), k in years–1.

Table 9.6. 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 (T_L)	296 cm			Compagno, 2001
Female maximum length (T_L)	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)			
Growth parameters	61.1 cm year–1 first year 40.6 cm year–1 second year 5.0 cm month–1 in summer 2.1 cm month–1 in winter	262	NE Atlantic (Portugal)	Maia *et al.*, 2007
Maximum age (estimated from von Bertalanffy growth eqn.)	28			Smith *et al.*, 1998
Productivity (R2m) estimate: intrinsic rebound	0.051 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Potential rate of increase per year	8.5%		Atlantic	Cortés, 2000
Population doubling time T_D (years)	13.6 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Generation time (years)	~ 9		Atlantic	Cortés, 2000
Trophic level	4.3	7		Cortés, 1999

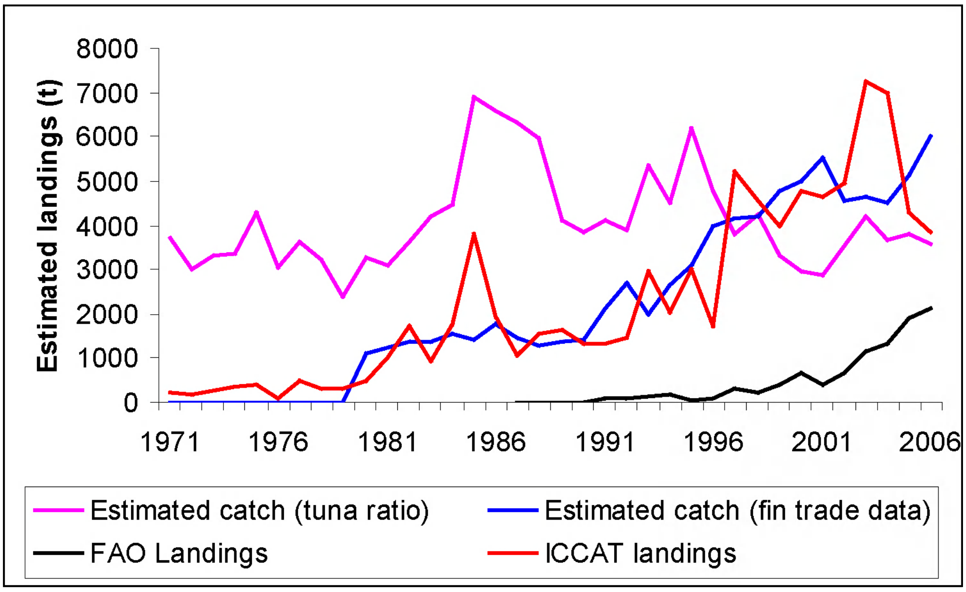

Figure 9.1. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Available landings (tonnes) from North Atlantic by FAO Areas 27, 21 and 34. Reporting was minimal for the years 2005 and 2006. (Source: ICCAT).

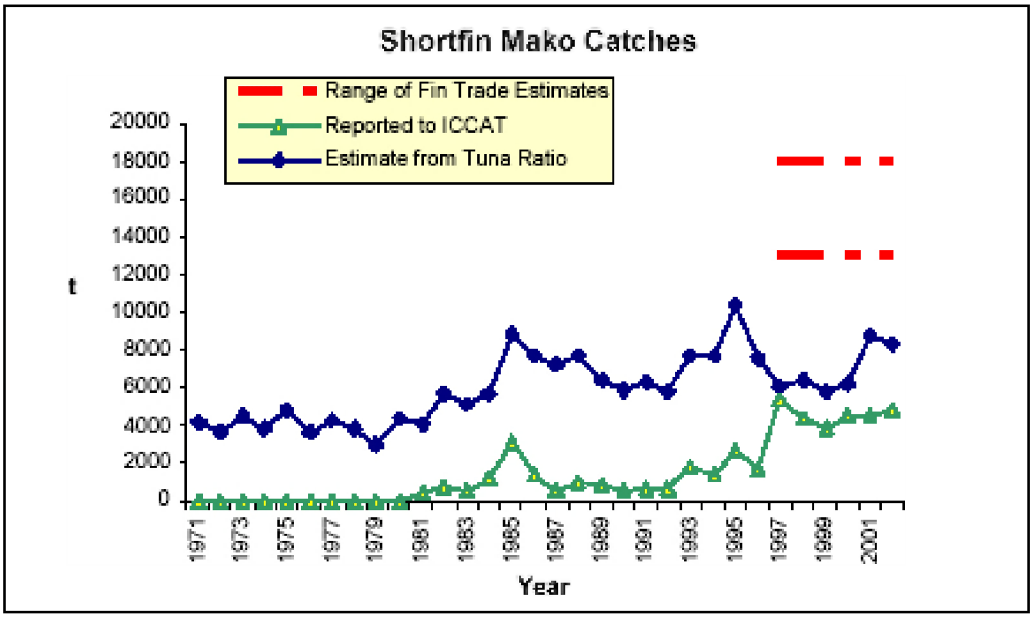

Figure 9.2. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Comparison of landed weights from data reported to ICCAT, from data raised to catches of tunas and from fin trade estimates (ICCAT 2005).

10 Tope in the Northeast Atlantic and Mediterranean

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 northwestern Africa and Mediterranean Sea. The stock area therefore, 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 Mediterranean Sea (Subareas I–III) and northern part of the CECAF area.

The information used to identify the stock unit is summarized in the Stock Annex 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 are taken as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic set gears. Though tope are discarded in some fisheries, other fisheries land this bycatch.

Tope is also an important target species in recreational sea angling and charter boat fishing in several areas, with most anglers and angling clubs following catch and release protocols.

10.2.2 The fishery in 2010

There were no major changes to the fishery noted in 2010.

10.2.3 ICES Advice applicable

ICES have not provided advice for this stock.

10.2.4 Management applicable

Some Sea Fisheries Committees in the UK are considering local bylaws to deter targeted fisheries establishing in UK coastal waters.

In terms of UK fisheries, and following a stakeholder consultation in 2006, Defra introduced a Statutory Instrument in 2008 (SI Number 2008/691) that prohibited fishing for tope other than by rod and line (with rod and line anglers fishing from boats not allowed to land their catch) and established a tope bycatch limit of 45 kg per day for commercial fisheries targeting other species.

10.3 Catch data

10.3.1 Landings

No accurate estimates of catch are available, as many nations that land tope will report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). 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, and data for 2009 and 2010 are not yet available, but will be updated next year). The UK also land tope, although species-specific data are lacking for the earlier years. Since 2001, Ireland, Portugal and Spain have also declared species-specific landings, although some recent data were not available for Spanish fisheries, other than for the Basque fleet.

No species-specific catch data for those parts of the stock in the Mediterranean Sea and off Northwest Africa are available. The degree of possible misreporting or under-reporting is not known. Overall available landings appear relatively stable in recent years, at 500 $t.y^{-1}$ or less since 2004. However, the absence of some recent national data restricts the interpretation of recent trends.

10.3.2 Discards

Though some discards information is available from various nations, data are limited for most nations and fisheries. Preliminary studies have indicated that juvenile tope tend to be discarded in demersal trawl fisheries and larger individuals are usually retained. Tope caught in drift and fixed net fisheries are usually retained.

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 recent publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Transversal Workshop on Selectivity Improvement and Bycatch Reduction, WGEF believes that better collaboration is required between these two groups, to share information and better understand elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

10.4 Commercial catch composition

No new data available.

10.5 Commercial catch-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.

More recently, Q4 IBTS surveys in the Celtic Seas ecoregion have been observed to sample small numbers of tope, with some nations tagging and releasing specimens where possible (ICES, 2008). Irish IBTS surveys also record small numbers of tope, although one haul (40E2, VIa) in 2006 yielded 59 specimens. Southern and western IBTS surveys may cover a large part of the stock range, and more detailed analyses of these data are required.

10.6.2 Cpue

Analyses of catch data would need to be undertaken with care, as tope is a relatively large-bodied species (up to 200 cm length 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 IBTS surveys, and survey data generally include a large number of zero hauls.

10.6.3 Length distributions

In 2009, data were presented on length distributions found in the Celtic Sea Ecoregion during fisheries independent surveys conducted by England and Ireland during quarter 4 (Figure 10.2). 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. The length distributions found between the surveys are noticeably different, with many more large males found in the Irish survey; 75% of the males were greater than 130 cm. The English surveys have a more evenly distributed length range.

10.7 Life-history information

Much biological information is available for tope in European seas and elsewhere in the world. These are summarized in the Stock Annex 2009.

Pupping and nursery grounds: Pups (24–45 cm length) are occasionally taken in groundfish surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas (Figure 10.3). Most of the records for pups recorded in UK surveys are from the southern North Sea (IVc), though they have also been recorded in the northern Bristol Channel (VIIf).

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

10.8.1 Previous studies

No previous assessments of NE Atlantic tope have been made. 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).

10.8.2 Data exploration and preliminary modelling

Landings data (see Section 10.3) and survey data (see Section 10.6) are insufficient to allow for an assessment of this species at the present time.

10.8.3 Stock assessment

No assessment was undertaken, as a consequence of insufficient data.

10.9 Quality of the assessment

No assessment was undertaken, as a consequence of insufficient data.

10.10 Reference points

No reference points have been proposed for this stock.

10.11 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 in South America).

Tope are also 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.

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 the species are mainly taken in mixed fisheries in the ICES area, many of these measures are of less utility.

10.12 References

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Table 10.1. Tope in the Northeast Atlantic and Mediterranean. Reported species-specific landings (tonnes) for the period 1978–2010. 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	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-
France	32	22	na	na	26	26	13	31	13	14	18	12	17
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	8	10	31	36	94	28	22	18	14
UK (Scotland)													-
Total (IIIa–IV)	32	22	0	0	34	36	44	67	107	42	40	30	31
ICES Division V–VII													
France	522	2076	na	na	988	1580	346	339	1141	491	621	407	357
Ireland	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	63	51	28	23	21	21	21	55	45
UK (Scotland)													
Total (VI–VII)	522	2076	0	0	1051	1631	374	362	1162	512	642	462	402
ICES Division VIII													
France	na	237	na	na	na	63	119	52	103	97	66	39	34
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	+	+	+	+	+	+	+	+	1				
UK (Scotland)													
Total (VIII)	0	237	0	0	0	63	119	52	104	97	66	39	34
ICES Division IX													
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na
Total (IX)													
ICES Division X													
Portugal	24	15	51	77	42	24	29	24	24	24	34	23	56
Total (X)	24	15	51	77	42	24	29	24	24	24	34	23	56
Other													
France	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	-	-	-	-	-	-	-	-	-	-	-	-	-
CECAF area													
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-
Total landings	578	2350	51	77	1127	1754	567	505	1397	675	782	554	523

Table 10.1. (continued). Tope in the Northeast Atlantic and Mediterranean. Reported species-specific landings (tonnes) for the period 1978–2010. 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.

ICES Division IIIa–IV	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	-	-	-	-	-	-	-	-	3	8
France	16	10	11	12	8	11	5	11		11
Sweden	-	-	-	-	-	-	-	-	-	-
UK (E&W)	21	15	15	19	25	14	22	12	14	13
UK (Scotland)	-	-	-	-	-	-	-	-	-	-
Total (IIIa–IV)	37	25	26	31	33	25	27	23	17	32
ICES Division V–VII										
France	391	235	240	235	265	314	409	312		368
Ireland	na	na	na	na	na	na	na	na	na	na
Spain	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-
UK (E&W)	47	53	48	49	38	39	34	41	62	98
UK (Scotland)										
Total (VI–VII)	438	288	288	284	303	353	443	353	62	466
ICES Division VIII										
France	38	34	40	54	44	78	40	46	+	71
Spain	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-
UK (E&W)					0	0	0	0	0	
UK (Scotland)										
Total (VIII)	38	34	40	54	44	78	40	46	0	71
ICES Division IX										
Spain	na	na	na	na	na	na	na	na	na	na
Total (IX)										
ICES Division X										
Portugal	81	80	115	116	124	80	104	128	129	142
Total (X)	81	80	115	116	124	80	104	128	129	142
Other										
France	-	-	-	-	-	-	-	-	386	-
UK (E&W)	-	-	-	+	+	-	-	-	-	-
CECAF area										
Portugal	-	-	-	-	-	-	-	-	-	2
Total landings	593	427	469	485	504	536	615	551	593	713

Table 10.1. (continued). Tope in the Northeast Atlantic and Mediterranean. Reported species-specific landings (nearest tonne) for the period 1978–2010. 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.

ICES Division IIIa–IV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Denmark	4	5	5	5	8	6	4	4	3	3
France	11	6	6	3	3	6	6	6	na	
Sweden	-	-	-	-	+	0	0	0	0	
UK (E&W)	10	13	11	8	10	13	5	2	1	1
UK (Scotland)	-	-	-	-	-	-	0	0	0	0
Total (IIIa–IV)	25	24	22	16	21	25	15	12	4	5
ICES Division V–VII										
France	394	324	284	209	181	293	155	187	na	
Ireland	4	1	6	4	na	7	3	4	3	3
Spain	+	242	3	na	na	na	na	60	69	44
Spain (Basque country)	+	+	3	15	10	.	.	.	0	0
UK (E&W)	72	60	55	65	65	74	44	26	22	15
UK (Scotland)							0	7	0	0
Total (VI–VII)	470	627	351	293	256	374	202	284	93	62
ICES Division VIII										
France	58	49	60	16	29	40	28	35	na	
Spain	9	13	10	na	na	na	na	21	33	11
Spain (Basque country)	9	6	10	10	14	12	1	12	14	12
UK (E&W)	1		3	8	6	5	0	0	0	0
UK (Scotland)								0		
Total (VIII)	77	68	83	34	49	57	29	69	47	23
ICES Division IX										
Spain	na	na	na	76	na	na	na	96	85	88
Total (IX)										
ICES Division X										
Portugal	82	77	69	51	45	45	43	47	34	41
Total (X)	82	77	69	51	45	45	43	47	34	41
Other										
France	2	-	-	-	-	-	-	-		
UK (E&W)	-	-	-	-	-	-	-	-		
CECAF area										
Portugal	1	2	98	na	na	na	na	na		
Total landings	656	798	622	394	371	502	288	412	179	131

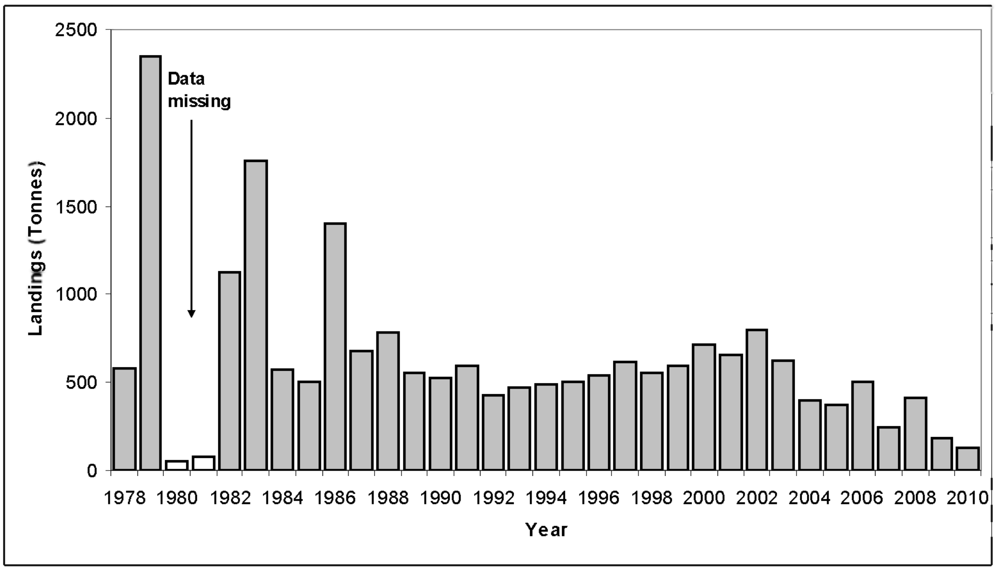
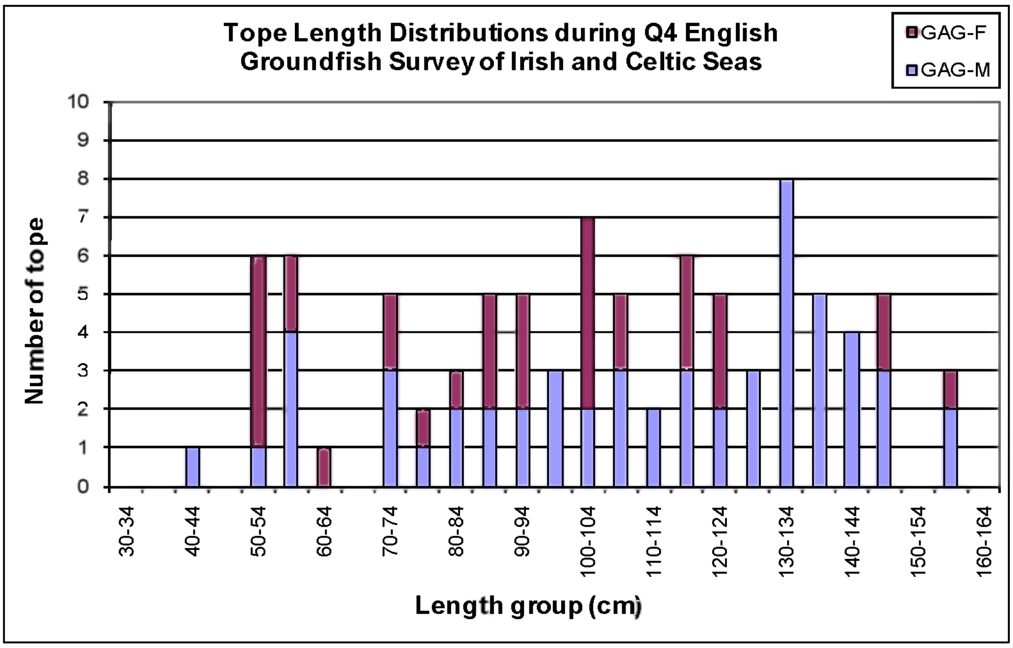


Figure 10.1. Tope in the Northeast Atlantic and Mediterranean. Annual landings of tope. These data are considered underestimates as some tope are landed under generic landings categories, and no species-specific landings data are available for the Mediterranean Sea and Northwest African waters. Not all data are available for recent years.



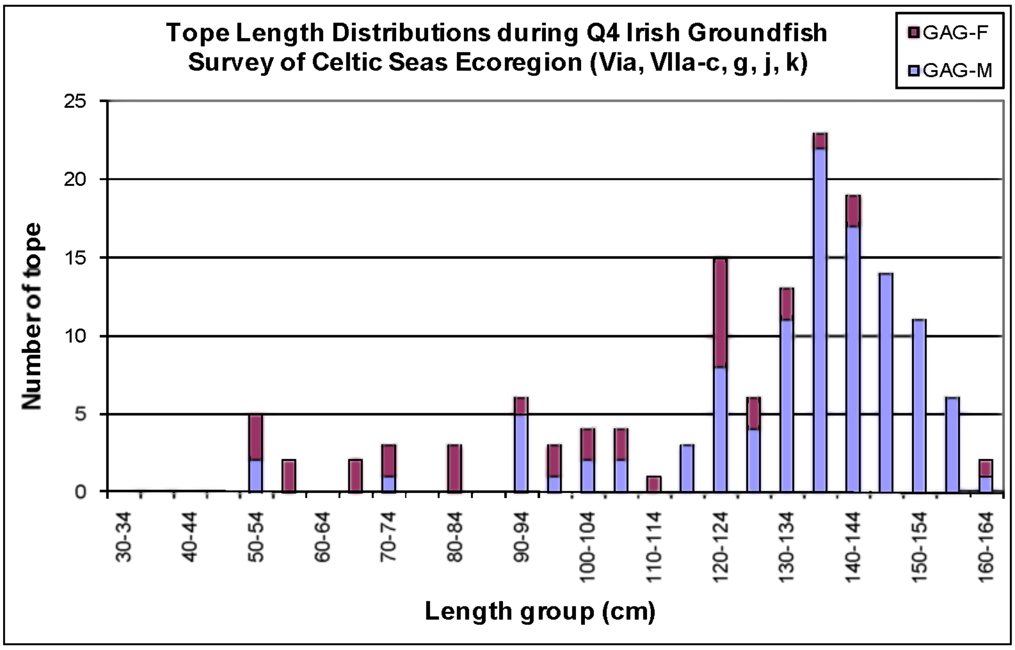


Figure 10.2. Tope length distributions from a) English Groundfish Survey data, years 2004–2009, conducted in Q4 in Celtic and Irish Seas, and b) Irish Groundfish Survey data, years 2003–2009, conducted in Q4 in the Celtic Seas Ecoregion (ICES Divisions VIa, VIIa–c, g, j, k).

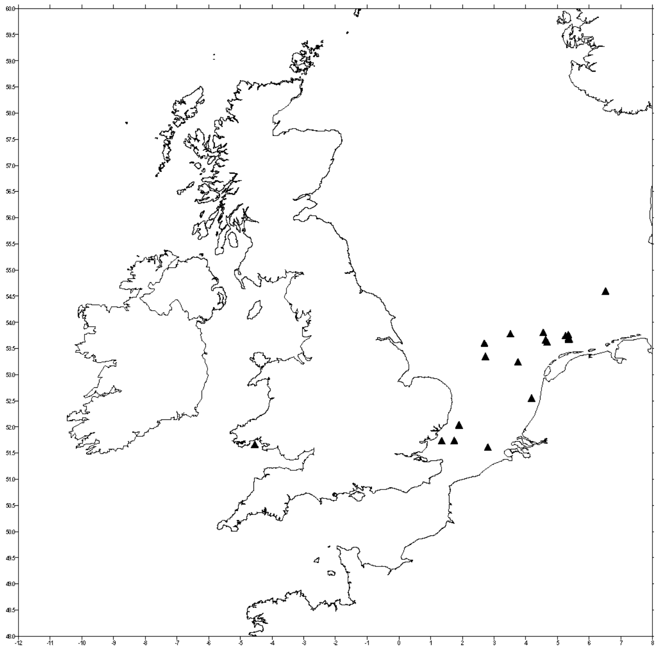


Figure 10.3. Tope in the Northeast Atlantic and Mediterranean. Sites where tope pups (24–45 cm total length) have been reported during UK surveys.

11 Thresher sharks in the Northeast Atlantic and Mediterranean Sea

11.1 Stock distribution

Two species of thresher shark occur in the ICES areas: 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, and WGEF assumes there to be a single NE Atlantic and Mediterranean stock of *A. vulpinus*. This stock probably extends 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 2009.

11.2 The fishery

11.2.1 History of the fishery

There are no target fisheries for thresher sharks in the NE Atlantic; although they are taken as a bycatch in longline and driftnet fisheries. Both species are caught mainly in longline fisheries for tuna and swordfish, although they may also be taken in driftnet and gillnet fisheries. The fisheries data for the ICES area are scarce, and they are unreliable, because it is likely that the two species (*Alopias vulpinus* and *A. superciliosus*) are mixed in the records.

Both species occur in the Mediterranean Sea. There are no targeted fisheries 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 and in France, thresher sharks are caught incidentally mainly by the trawlers targeting small pelagic operating in the Gulf of Lions, landed in two major harbours (Sète and Port La Nouvelle). Additional bycatch of these sharks will occur in the Straits of Gibraltar.

Further information on the stock identity is included in the Stock Annex 2009.

11.2.2 The fishery in 2010

No new information.

11.2.3 ICES Advice applicable

ICES has never provided advice for this stock.

11.2.4 Management applicable

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.

11.3 Catch data

11.3.1 Landings

The landings are irregularly reported and rather variable: from 3–213 t in the NE Atlantic and the Mediterranean Sea (ICCAT and national data; Tables 11.1–11.2; Figure 11.1). There are large discrepancies between national landings data presented to

WGEF, and that reported to ICCAT. The main landing nations are Portugal, Spain and France, although the large quantities reported by Portugal to ICCAT in 2006 and 2007 need to be verified.

Thresher sharks are taken occasionally in Subarea IV, but the main catches seem to occur in Subareas VII–IX (Table 11.2).

Small (2 t or less) irregular landings have been reported by Denmark, Ireland and the UK, post 2000. The countries with more consistent estimated landings are France, Portugal and Spain. The national reported landings, of thresher sharks in French waters have typically ranged from 2–22 t, however in 2000 and 2001, reported landings increased to 107–112 t, yet have been <5 t since 2002, excluding a 10 t landing in 2009. However, the French landings reported to ICCAT are larger, at between 9–32 t since 2002. The values of the 2000 and 2001 landings are believed to be an overestimate (Poisson and Séret, 2009).

Portuguese (ICES Area VII–IX) estimated national landings began in 1986 at 7 t, they peaked two years later in 1988, then remained relatively stable ranging from 7–37 t annually, until 2005, when another surge increased this to 80 t (85 t were reported to ICCAT by Portugal). No national landings have been reported to WGEF since, yet catches of 108, 101, 53, and 71 t were reported to ICCAT by Portugal in 2006, 2007, 2008 and 2009 respectively. The Portuguese area off West Africa has nominal estimated landings between zero and at most two in 1998.

Spanish landings began in 1997 at 53 t, and after three years this fell to just one tonne, then to zero by 2001. However, began again in 2003 and in 2004 the landings were an estimated 84 t, falling to 54 t in 2005, with no national landings reported to WGEF after this year, apart from 2 t from the Basque Country in 2009. Similarly, like Portugal, landings of 55 t in 2007, 81 t in 2008 and 90 t in 2009, have however been reported by Spain to ICCAT.

Consequently, 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. However, landings reported to ICCAT are far greater, with the peak landings of 213 t in 1998, and the lowest level of 60 t in 2003. Better harmonizations between these data are 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, although such data collection has improved in recent years.

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*'.

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

Following the recent publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Transversal Workshop on Selectivity Improvement and Bycatch Reduction, WGEF believes that better collaboration is required between these two groups, to share information and better understand elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

11.4 Commercial catch composition

Some length frequency distributions for *A. vulpinus* have been collected under the Data Collection Regulation (DCR) programme by observers on board French vessels between 2003 and 2009 (Figure 11.2).

11.5 Commercial catch-effort data

There are very limited cpue data available for the ICES area. ICES and ICCAT could usefully cooperate to collate and interpret commercial catch data from high seas fisheries.

11.6 Fishery-independent surveys

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

However Ifremer has 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 aims of the '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 the common thresher shark. Incentive and compensatory measures will be initiated to encourage fishers to release the individuals alive at sea after tagging.

The first item of the programme is still ongoing and the landing time-series has been corrected and completed significantly. Unfortunately because of the drastic reduction of the catches of sardines and anchovies since 2009, the majority of the boats targeting previously these species switched to demersal fish, only one was operating last year which has considerably reduce the number of individual caught. The two other items of the programme have been consequently cancelled for the time being.

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 2009.

No new data were available on their biology.

11.7.1 Habitat

Nakano *et al*. (2003) conducted an acoustic telemetry study to identify the short-term horizontal and vertical movement patterns of two immature female *Alopias superciliosus* in the eastern tropical Pacific Ocean during summer of 1996. They demonstrated very distinct crepuscular vertical migrations, staying between 200–500 m during the day and between 80–130 m at night, with slow ascents and relatively rapid descents during the night, the deepest dive being 723 m. Estimated mean swimming speed over the ground ranged from 1.32 to 2.02 km h^{-1}.

11.7.2 Nursery grounds

Nursery areas for *A. superciliosus* are suspected off the southwestern Iberian Peninsula and Strait of Gibraltar (Moreno and Moron, 1992), and juvenile *A. vulpinus* are also known to occur in the English Channel and southern North Sea (Ellis, 2004).

Further information on potential nursery areas is included in the Stock Annex 2009.

11.7.3 Diet

It is reported that these two species feed mostly on small schooling fish, including mackerels, clupeids also squids and octopuses (General Fisheries Commission for the Mediterranean 2010: GFCM:SAC12/2010/Inf.12).

11.8 Exploratory assessment models

11.8.1 Previous studies

No previous assessments have been made of thresher shark in the NE Atlantic. The lack of landings data (see Section 11.3) and absence of fishery-independent survey data preclude assessments of these stocks at the present time.

11.8.2 Stock assessment

No assessment was undertaken, as a consequence of insufficient data. Species-specific landings are required and any assessment will need to be undertaken in collaboration with ICCAT.

11.9 Quality of assessments

No assessment was undertaken, as a consequence of insufficient data.

11.10 Reference points

No reference points have been proposed for these stocks.

11.11 Conservation considerations

In 2006, the IUCN Red List classified thresher shark as Data Deficient (IUCN, 2006), but their status was re-evaluated in 2007 (Camhi, 2008; Camhi *et al.*, 2009), and both species are now listed as vulnerable.

11.12 Management considerations

The lack of accurate fishery data does not allow determining the stock structures and the status of both thresher shark species occurring in the NE Atlantic. However, Liu *et al.*, 1998 consider that *Alopias* spp. are particularly vulnerable to overexploitation and in need of close monitoring because of their high vulnerability resulting from its low fecundity and relatively high age of sexual maturity.

In 2009 The International Commission for the Conservation of Atlantic Tuna (ICCAT) recommend 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."

Precautionary management measures could be considered for the NE Atlantic thresher sharks, attributable to the fishing effort for large pelagic fish in the region.

11.13 References

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Table 11.1. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Landings of thresher sharks by European countries from 1997 to 2009 (ICCAT and national data). Landings prior to 1997 are in combined sharks.

Data source	ICCAT				ICCAT			ICCAT	Nationdata	Nation. data	Nationdata	Total
Nation	Spain				Portugal			France	UK	Ireland	DK	
Year	*A. vul.*	*A. sup.*	*Alopias* spp.	Total	*A. vul.*	*Alopias* spp.	Total	*A. vul.*	*A. vul.*	*A. vul.*	*A. vul.*	
1997	30	148	34	212								212
1998	44	114	55	213								213
1999	15	Na	66	81	1		1					82
2000	14	36	48	98		2	2					100
2001	25	62	77	164		2	2					166
2002	13	43	27	83	111		111					194
2003	13	22	7	42	18		18			+	+	60
2004	18	38	12	68	24	+	24	23		+		115
2005	Na	Na	Na	?[2]	85		85	19	+			104
2006	Na	Na	Na	?[2]	108		108 [3]		+			108
2007	16	39	Na	55	98	3	101	37	1			194
2008	na	Na	81	81	53		53	10	1	+		145
2009	31	59	na	90	71	na	71	32	2			195

(1) Data from ICCAT document SCRS/2001/049 providing the landings of thresher sharks by the Spanish longline fleet in 1999; as the unidentified threshers (*Alopias* spp) reported in the ICCAT database are so similar to the sum of *A. vulpinus* and *A. superciliosus*; these are assumed to reflect the same landings.

(2) Spain previously reported 159 t in 2004 and 105 t in 2005; clarification of these catches is required.

(3) 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
Azores													
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
Portugal	W Africa				+	+	+	+	1	+	+		
Spain (Basque Country)	VIII												
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	2010
Azores														0	0	0
Denmark	IV						.	.	+	.						
France	VI,VII, IX	17	22	18	13	107	112	4	3	1	2	1	2	3	10	4
France	VIII									2	7	11	10	4	24	21
Ireland	VI													1		
Ireland	VII						.	.	+	+			0	0		
Portugal	VII–IX	13	37	24	12	15	25	21	17	33	80					
Portugal	W Africa	+	1	2	+											
Spain (Basque Country)	VIII														2	0
Spain	VII–IX		53	54	36	1			3	84	54					
UK(E&W)	IV											0		0	0	1
UK(E&W)	VII												1	1	1	1
Total		30	113	98	61	123	137	25	23	120	143	12	13	8	36	27

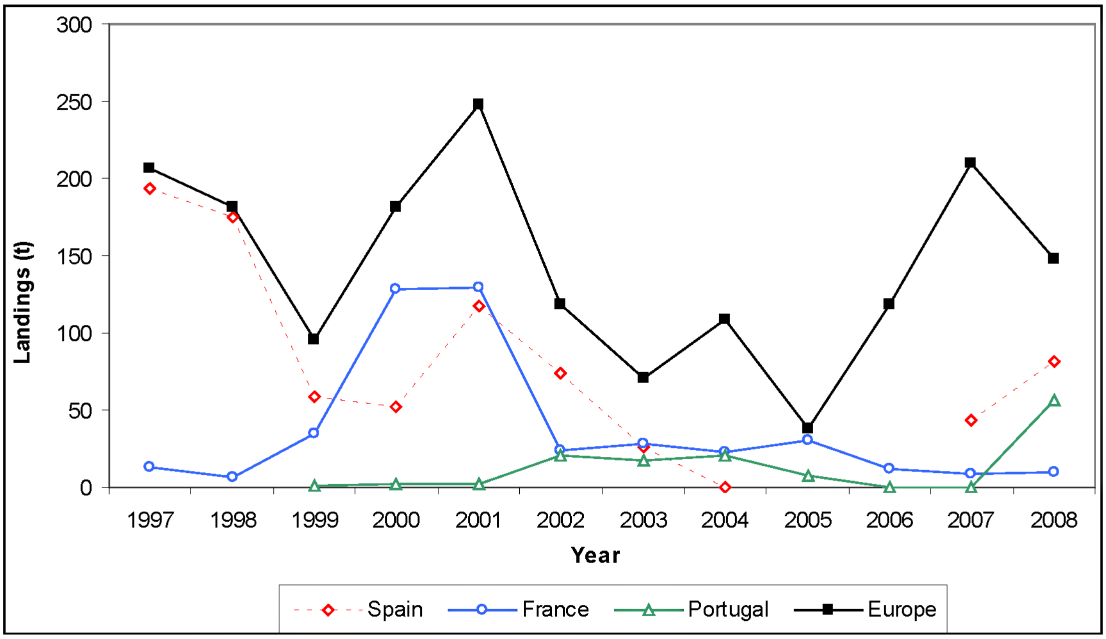

Figure 11.1. Thresher sharks in the Northeast Atlantic and the Mediterranean Sea. Reported landings of thresher sharks by Spain, Portugal and France (1997–2008, ICCAT and national data). Spanish data (2005–2006) are lacking, and recent Portuguese landings need verification.

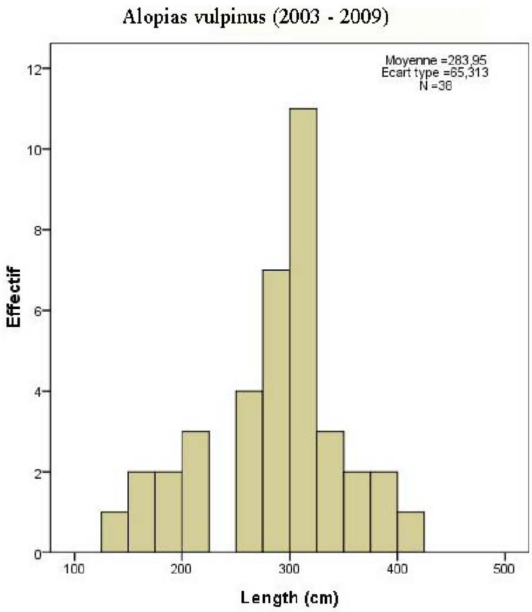

Figure 11.2. Length frequency distributions for *Alopias vulpinus* sampled in the Divisions VIIIabcd in the framework of the Data Collection Regulation programme by observers on board French vessels between 2003 and 2009 (Lengths are fork length over the body).

12 Other pelagic sharks in the Northeast Atlantic

12.1 Ecosystem description and stock boundaries

In addition to the pelagic species discussed in previous sections (see Sections 6–11) several other pelagic sharks and rays occur in the ICES areas, including:

Lamniformes	White shark	*Carcharodon carcharias*
	Longfin mako	*Isurus paucus*
Carcharhiniformes	Spinner shark	*Carcharhinus brevipinna*
	Silky shark	*Carcarhinus falciformis*
	Oceanic whitetip	*Carcharhinus longimanus*
	Dusky shark	*Carcharhinus obscurus*
	Sandbar shark	*Carcharhinus plumbeus*
	Night shark	*Carcharhinus signatus*
	Tiger shark	*Galeocerdo cuvier*
	Scalloped hammerhead	*Sphyrna lewini*
	Great hammerhead	*Sphyrna mokarran*
	Smooth hammerhead	*Sphyrna zygaena*
Myliobatiformes	Pelagic stingray	*Pteroplatytrygon violacea*
	Devil ray	*Mobula mobular*

Many of these taxa, including many of the hammerhead sharks (*Sphyrna* spp.) and requiem sharks (*Carcharhinus* spp.) are mainly tropical to warm temperate species, and often coastal, pelagic species. There is limited information 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 *I. paucus, C. falciformis* and *C. longimanus* are truly oceanic, and are likely to have either North Atlantic or Atlantic stocks, although once again, data are lacking. Within the ICES area, these species are also found mostly in the southern parts of the ICES areas (e.g. off the Iberian Peninsula), though some may occasionally occur further north. Some of these species also occur in the Mediterranean Sea.

In terms of the North Atlantic pelagic ecosystem, this is affected by the subtropical anticyclonic Atlantic gyre, and it is influenced by subtropical water intrusions and subject to strong seasonality. ICES 2007 provides a more detailed description of this ecosystem.

12.2 The fishery

12.2.1 The history of the fishery

These pelagic sharks and rays are taken as bycatch in tuna and swordfish fisheries (mainly by longliners, but also by purse-seiners). Some of them, like the hammerheads and the requiem sharks, could constitute a noticeable component of the bycatch and are landed, but other are only sporadically recorded (e.g. white shark, tiger shark, pelagic stingray 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 2010

No new information.

12.2.3 ICES advice applicable

ICES do 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.

EC Regulation No 43/2009 prohibits Community vessels to fish for, to retain on board, to tranship and to land white shark (*Carcharodon carcharias*) in all Community and non-Community waters; and also prohibits third-country fishing vessels to fish for, to retain on board, to tranship and to land white shark in all Community waters.

12.3 Catch data

12.3.1 Landings

No accurate estimates of catch are available, as many nations that land various other species of pelagic sharks will record them under generic landings categories. There are few records in the ICCAT database. Reported species-specific landings are given in Table 12.1. Portugal and Spain have reported landings of hammerheads and the requiem sharks in ICES Subareas VI, VIII, IX and X, totalling 86 t in 2004; but since 2005, the national data do not record any of these sharks. Since 1997, landings are also recorded in the ICCAT database (Table 12. 2) for the NE Atlantic mainly by Spain and Portugal, totalling 259 t of hammerheads in 2007, with incomplete data available for 2005–2010. Data on requiem shark species are scare and variable. Total landings of requiem sharks varied from 4–305 t for the period 1997–2007, with 4 t recorded in 2000 (excluding any landings from the 'Requiem sharks nei' group, and from Portugal), and 305 t reported the following year (excluding Portuguese landings). Landings for *Carcharhinus falciformis* and *C. longimanus* are sporadically reported by Spain (Table 12.2), ranging from 1–183 t between 1997–2007. Some landings of longfin mako are reported by Spain, varying from 8–65 t for the period 1997–2007. Catch data are provided by Castro *et al.*, 2000 and Mejuto *et al.*, 2002 for the Spanish longline swordfish fisheries in the NE Atlantic in 1997–1999 (Table 12.3).

There are few catch data for the other pelagic species (e.g. tiger shark, manta ray and pelagic stingray) in national datasets, nor in the ICCAT database, except for some sporadic records of 3–8 t for tiger sharks (1997–2007) and 0–163 t (recorded by Spain in 2007) of silky sharks, during the same period.

Studies by Castro *et al.*, 2000 and Mejuto *et al.*, 2002 demonstrate that 99% of the bycatch of offshore longline fisheries consist of pelagic sharks (Table 12.3), although the bulk of them are blue sharks (87%).

Available landings data from FAO Fishstat (Atlantic, Northeast) are presented Table 12.4. These values are underestimates, as a consequence of the inconsistent reporting of catches. Information for 2009/2010 is not yet available.

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 and biological data

Catch data are of poor quality, except for some occasional studies, such as those of Castro *et al.*, 2000 and Mejuto *et al.*, 2002, which relate to the Spanish swordfish longline fishery in the Atlantic. Biological data are not collected under the Data Collection Regulations, although some generic biological data are available (see Section 12.7). Field identification of some of these genera (e.g. *Carcharhinus* and *Sphyrna*) can be problematic.

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

12.4 Commercial catch composition

Data on the species and length composition of these sharks are limited.

12.5 Commercial catch-effort data

No cpue data are available 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.

12.6 Fishery-independent surveys

No fishery-independent data are available for these species.

12.7 Biological parameters

A summary of the main biological parameters are given in Table 12.5.

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). The scalloped hammerhead nurseries are usually in shallow coastal waters.

The overall biology of several species has recently 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.

12.8 Stock assessment

12.8.1 Previous studies

No previous assessments have been made of these stocks in the NE Atlantic. Cortés *et al.* (2010) have undertaken an Ecological Risk Assessment for eleven pelagic elasmobranchs (blue shark, shortfin mako, longfin mako, bigeye thresher, common thresher, oceanic whitetip, silky, porbeagle, scalloped and smooth hammerhead, and pelagic stingray). Comparable analyses for the NE Atlantic pelagic species could usefully be undertaken.

12.8.2 Stock assessment

No assessment was undertaken, as a consequence of insufficient data.

12.9 Quality of the assessment

No assessment was undertaken, as a consequence of insufficient data.

12.10 Reference points

No reference points have been proposed for this stock.

12.11 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 have conservation status: 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.

12.12 Spatial information

12.13 References

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Table 12.1. Other pelagic sharks in the Northeast Atlantic. Summary of available landing data of hammerhead and requiem sharks in the ICES Subareas from 1999 to 2004; no records have been reported since 2004.

ICES	Hammerhead sharks *Sphyrna* spp.							Requiem sharks *Carcharhinus* spp.							Total
	Portugal					Spain	Total *Sphyrna*	Portugal					Spain	Total Requiem	pelagic sharks
Year	VIIIc	IX	IXa	X	Total	IXa, b		VIb	IX	IXb	X	Total	IXa, b		
1999	1	6		1	8		8				9	9		9	17
2000		8			8		8	1	1		24	26		26	34
2001		4			4		4				31	31		31	35
2002		5			5		5	1	7		47	55		55	60
2003		5		2	7		7		129		16	145		145	152
2004			18	1	19	2	21		2	3	43	48	17	65	86

Table 12.2. Other pelagic sharks in the Northeast Atlantic. NE Atlantic landings of hammerhead sharks, requiem sharks and longfin mako by Spain and Portugal recorded on the ICCAT database. OCS: *Carcharhinus longimanus*-FAL: *Carcharhinus falciformis* LMA: *Isurus paucus*-SPK: *Sphyrna mokarran*-SPL: *Sphyrna lewini*-SPN: *Sphyrna* spp-SPZ: *Sphyrna zygaena* SPY: *Sphyrnidae* etc. nei.

ICCAT	Spain												Portugal			France	Total
NE Atlantic	SPN	SPL	SPK	SPZ	SPY	Total *Sphyna*	FAL	OCS	RSK	Total Requiem	LMA	Total Spain	SPN	SPZ	RSK	RSK	
1997	805			22		827	+	4	173	177	27	1031					1031
1998	735	3	1	14		753	11	9	257	277	8	1038					1038
1999									161	161		161					161
2000	583			5		588	1	3		4	20	612	+				612
2001	473	+		10		483	1	7	297	305	51	839	+				839
2002	520	+		12		532	30	1	162	193	65	790					790
2003	379	+		+		379	+	1	187	188	62	629	10	8	169		816
2004	500	2		13		515	4		177	181	51	747	20				767
2005													32	12	304		348
2006													32	18	26		76
2007	218	+		3		221	163	20		183	64	468	24	14	5		511
2008					198	198			120	120		318	27	6		507	858

Table 12.3. 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 bycatches	% 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 12.4. Other pelagic sharks in the Northeast Atlantic. Reported landings (t) by country (Source FAO Fish-Stat) for Atlantic, Northeast fishing area. These data are considered underestimates.

Species	Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Devil fish	Spain	-	-	-	-	-	-	1	3	3	2	1	3	0
Smooth hammerhead	Portugal	.	8	8	4	5	7	20	3	13	9	7	5	0
Smooth hammerhead	Spain	-	-	-	-	-	-	5	10	<0.5	3	2	1	0
Oceanic whitetip shark	Portugal	-	-	-	-	-	-	-	-	-	-	1	0	0
Stingrays nei	France	5	6	10	7	10	11	14	20	13	8	1	5	4
Stingrays nei	Portugal												0,1	0,5
Stingrays nei	Spain													2
Tiger shark	Spain	-	-	-	-	-	-	2	4	5	3	2	0	0

Table 12.5. Other pelagic sharks in the Northeast Atlantic. Preliminary compilation of life-history information for NE Atlantic sharks.

	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
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

	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
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
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 skate species inhabiting the offshore area of the Barents Sea ecoregion are thorny skate *Amblyraja radiata*, Arctic skate *Amblyraja hyperborea*, round skate *Rajella fyllae*, spinytail skate *Bathyraja spinicauda*, common skate *Dipturus batis* complex, sailray *Dipturus linteus*, longnose skate *Dipturus oxyrinchus* and shagreen ray *Leucoraja fullonica* (Andriyashev, 1954; Dolgov, 2000; Dolgov *et al.*, 2004b). Few of them occur in great abundances. All species may be taken as bycatch in demersal fisheries, but there are no directed fisheries targeting skates in the Barents Sea. *A. radiata* is the dominant species, comprising 96% by number and about 92% by biomass of skates caught in surveys or as bycatch. The following most abundant species are *A. hyperborea* and *R. fyllae* (3% and 2% by number, respectively), and the remaining species are scarce (Dolgov *et al.*, 2004b; Drevetnyak *et al.*, 2005).

With regards to sharks, the Greenland shark *Somniosus microcephalus* is distributed in the Barents Sea ecoregion (see Section 5), and spurdog *Squalus acanthias* (see Section 2) is present in coastal areas (Williams *et al.*, 2008).

All skate species occurring in the offshore areas are also found in the coastal areas of this ecoregion, with the exception of *D. oxyrinchus* and *D. linteus.* In addition, the thornback ray *Raja clavata* is present in the coastal areas (Williams *et al.*, 2008).

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, D. linteus*) is lower and the portion of cold-water species (*A. hyperborea*) is higher in the Barents Sea.

Stock boundaries are not known for the species 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.

13.2 The fishery

13.2.1 History of the fishery

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.*, 2004a; 2004b). Bottom-trawl fisheries mainly target cod *Gadus morhua* and haddock *Melanogrammus aeglefinus*, and longline fisheries target cod, blue catfish *Anarhichas denticulatus* and Greenland halibut *Reinhardtius hippoglossoides*. These are conducted through all seasons and have a skate bycatch, which is generally discarded. Dolgov *et al.*, 2004a 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 2010

No new information.

13.2.3 ICES advice applicable

ICES has never provided advice for any of the demersal elasmobranch stocks within this ecoregion.

13.2.4 Management applicable in 2010

There are no TACs for any of the demersal elasmobranch species in this region.

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.

13.3 Catch data

13.3.1 Landings

For ICES Subdivision I, landings data are limited and only available for all skate species combined (Table 13.1 and Figure 13.1). Landings from the most westerly parts of the Barents Sea ecoregion fall within Subarea II, and are described in Section 14. Russia and Norway are the main countries landing skates from the Barents Sea.

Elasmobranch landings in ICES Subdivision I have generally been low, but there have been large fluctuations in Russian landings. The peak in Russian landings in the 1980s corresponds to an experimental fishery for skates, whereby bycatches were landed as opposed to discarded (Dolgov, personal communication, 2006).

13.3.2 Discards

Initial estimates by Dolgov *et al.*, 2005 indicate that the total annual bycatch of skates from commercial trawl and longline fisheries in the Barents Sea ranged from 723–1891 t. *A. radiata* accounted for 90–95% of the total skate catch. *A. radiata* also dominated catches (and presumably discards) by the Norwegian Reference Fleet in ICES Subdivision I in 2008–2009 (Vollen, 2010 WD).

13.3.3 Quality of catch data

There is a lack of species-specific data in the landings categories. Landing data do not reflect the true catches of skates in the commercial fishery in the Barents Sea as some fleets still discard skates of low commercial value.

The Norwegian oceanic reference fleet (commercial vessels) collect biological data for the Institute of Marine Research (IMR) in Bergen, and some of these vessels are trawlers and longliners operating in the Barents Sea in various parts 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 WG (Vollen, 2010 WD). The results supported earlier findings of dominance of *A. radiata* (>95% of both weight and numbers) of catches in ICES Subdivision 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 with 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.

According to personal communication, there may be some unreported pole and line catches of the Greenland sharks *S. microcephalus* in the Russian coastal areas (Vinnichenko *et al.*, 2010 WD).

13.4 Commercial catch composition

13.4.1 Species and size composition

Generally, larger skates are more often caught in longline fisheries than in the trawl fisheries.

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%). Other species occurring were *R. fyllae*, *A. hyperborea*, *B. spinicauda* and *D. batis* (complex). These findings were supported by data from the Norwegian Reference Fleet from 2008–2009 (Vollen, 2010 WD).

Vinnichenko *et al.* (2010 WD) reported on Russian commercial catches by bottom trawl in 2009, and found that *A. radiata* was the dominating species. *A. radiata* with length 21–56 cm occurred (Figure 13.2). The catches were dominated by large males and females 36–55 cm in length. Owing to the presence of small females with the length of 21–30 cm in catches, the average length of females was less (44.7 cm) than that one of males (46.6 cm). The catches were slightly dominated by males. The sex ratio was 1.1:1, which is in accordance with Dolgov *et al.* (2005), who described a 1:1 sex ratio in commercial catches for all skate species except *A. hyperborea*, of which males dominated in the longline fishery (see ICES, 2007 for further information).

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. These are presented in Section 13.6.4.

13.5 Commercial catch-effort data

Relative 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 of 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 survey cruises (RU-BTr-Q4) were available from Dolgov *et al.*, 2004b and Drevetnyak *et al.*, 2005 covering the years from 1998–2001, and describing the distribution and habitat utilization of skates (*A. radiata*, *A. hyperborea*, *R. fyllae*, *D. batis* (complex), *B. spinicauda* and *D. linteus*) in the Barents Sea. These results were summarized in ICES, 2007.

Vinnichenko *et al.* (2010 WD) reported on catches of *A. radiata* from 2009 survey cruises in October–December (RU-BTr-Q4). Individuals of 8–61 cm in length were found, but catches were dominated by males with 41–56 cm length and females as long as 31–50 cm (Figure 13.3). The average length of males was greater than that one of females, 41.6 cm against 38.8 cm. The sex ratio was approximately equal, 1.02:1.

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. These are presented in Section 13.6.4.

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, 2007 and Williams *et al.*, 2007 WD and 2008. The results were summarized in ICES, 2007 and 2008. New data from this survey should be analysed, and presented to the WGEF, as some of the issues regarding species misidentification have been solved.

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. Results were summarized in ICES, 2009, in the Norwegian Sea ecoregion (Section 14).

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 cruises 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)), practically 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 data on length distributions as well as some biological data (on board of Russian vessels) are collected. As a consequence of problems with the species identification, species-specific data should only be used from the years 2006–2007 onwards (Norwegian data). Analyses of data from these surveys are not completed, but some data were presented from the 2009 surveys by Vinnichenko *et al.*, (2010 WD).

A. hyperborea: Fish of 11–80 cm length occurred in the catches in August–September 2009. The catches were dominated by males 60–69 cm in length and 26–35 cm, and females as long as 51–65 cm (Figure 13.4). The mean length of males was significantly lower than that one of females, 52.4 cm against 56.3 cm. In the catches males predominated, the sex ratio was 1.5:1.

B. spinicauda: individuals of 86–140 cm length occurred in the catches in August–September 2009. They were feeding on herring and capelin.

A. radiata: Individuals with the length of 11–56 cm occurred in catches in February 2009 (Figure 13.5). The length of males was mainly 46–55 cm; that of females 36–50 cm. At that, the percentage of small fish was low. The average length of males (43.8 cm) was much larger, than that one of females (35.2 cm). The sex ratio in catches was approximately equal (1.01:1).

In August–September 2009, *A. radiata* of 7-57 cm in length were recorded (Figure 13.6). In the length distribution, different size/age classes of *A. radiata* were well-pronounced. The mean length of males was much greater and equalled 41.8 cm; of females 38.0 cm. The catches were dominated by males and the sex ratio was 1.2:1.

Vinnichenko *et al.* (2010 WD) also reported on compiled data for *A. radiata* from the 2009 Russian surveys (October–December) and the 2009 joint Russian–Norwegian surveys (February and August–September). By the data averaged for the year, males predominated in samples, and the sex ratio was 1.2:1. More than half of all the individuals (55–60%) were maturing, 35–40% of the fish were represented by mature individuals and only 2–3% were active or advanced (Figure 13.7). In September, the fatness of males as long as 51–56 cm was much lower, than that one of females with 46–55 cm length, 4.6–5.1% against 7.4–8.0%. In feeding, various fish species and decapods traditionally prevailed (39% and 35% by weight, respectively; Figure 13.8). Among fish, capelin and haddock juveniles were intensively consumed, among the decapods, the northern shrimp *Pandalus borealis* and crabs *Hyas* spp.

13.6.5 Quality of survey data

The difficulties associated in identifying skate species are a serious concern when considering the validity of the data used in this assessment. Williams *et al.*, 2007 WD gave a detailed description of this issue for the Norwegian Sea ecoregion. There are concerns about misidentification with regard to skates (*Rajidae*), and in particular the possible confusion between *A. radiata* and *R. clavata*. The survey data for skates must be thoroughly examined before these are used in assessments.

In order to achieve a satisfactory quality of survey data in future, better identification practices, using appropriate identification literature, needs to be put in place. Ongoing work to improve future sampling at the Institute of Marine Research includes workshops to educate staff as well as improve 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.* (2004a, 2004b) and Vinnichenko *et al.* (2010 WD; see ICES, 2007, 2010). Some biological information is available in the literature (e.g. Berestovsky, 1994).

13.7.1 Ecologically important habitats

No information available.

Sampling of elasmobranch egg cases will be included in Norwegian trawl surveys from mid-2009, and may provide future information on nursery grounds.

13.8 Exploratory assessment models

No assessments have been conducted.

13.9 Quality of assessments

No assessments have been conducted.

13.10 Reference points

No reference points have been proposed.

13.11 Conservation considerations

Listings other than "Least concern" on the International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species (IUCN, 2011) :

"Critically endangered": *D. batis* (complex).

"Near threatened": *B. spinicauda, D. oxyrinchus, L. fullonica, R. clavata, R. brachyura, D. nidarosiensis* and *S. microcephalus*.

Demersal elasmobranchs listed on the Norwegian Red List, other than "Least concern" (Sjøtun *et al.*, 2010):

"Critically endangered": *D. batis* (complex), *Squalus acanthias*

"Near threatened": *B. spinicauda, D. nidarosiensis, L. fullonica* and *Somniosus microcephalus*.

13.12 Management considerations

The elasmobranch fauna of the Barents Sea is little studied and comprises relatively few species. The most abundant demersal elasmobranch in the area is *A. radiata*, which is widespread and abundant in this and adjacent waters. Further and more extensive studies are required, particularly for some of the larger-bodied species (e.g. larger skates), which could be more vulnerable to overfishing. Issues regarding misidentification of some species during surveys needs to be resolved before sound and reliable advice can be given for elasmobranchs in the Barents Sea ecoregion.

13.13 Spatial information

There is no high resolution information available from this area.

There are time-series available from the Joint Russian–Norwegian surveys. These data should be made available to the group to assess potential changes in survey abundance and species composition.

13.14 References

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Table 13.1. Demersal Elasmobranchs in the Barents Sea. Total landings of skates and rays from ICES Area 27 Subdivision I, 1973–2010. Total landings (tonnes). "n.a." = no data available, "." = means zero catch, "+" = <50 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	.	.	.	1	.	.	.	.	.	.	.	.	.
France	.	.	.	81	49	44	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	1	3	4	8	2	2	2	1	10	11
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
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
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	.	2	.	.	.	.
Iceland	.	.	.	.	.	.	.	1	.	.	+	1	.
Norway	3	14	7	4	1	5	24	29	72	9	27	3	13
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	2137	2364	2051	1235	246	n.a.	399	390	369	n.a.	n.a.	399	790
Spain	.	.	.	.	.	.	.	.	.	7	.	.	.
UK - E & W	+	2	.	+	.	.	.	.	.	.	.	.	.
UK – Scotland	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	2140	2380	2058	1239	247	5	423	420	443	16	27	403	803
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	
France	.	.	.	.	.	.	.	.	.	.	.	.	
Germany	.	.	.	.	.	.	.	.	+	.	.	+	
Iceland	.	4	.	.	.	3	3	.	.	.	.	.	
Norway	21	12	30	26	2	1	4	13	4	72	15	9	
Portugal	.	.	.	.	.	+	.	.	.	.	.	.	
USSR/Russian Fed.	568	502	218	173	38	69	37	48	24	6	2	n.a.	
Spain	.	.	.	.	.	.	.	.	.	.	.	.	
UK - E & W	+	.	.	.	.	.	.	.	.	.	.	.	
UK – Scotland	.	.	.	.	.	.	.	.	.	.	.	.	
Total	589	518	248	199	40	1	4	13	28	72	17	9	

Table 13.2. Demersal elasmobranchs in the Barents Sea. Species composition of elasmobranch catches in ICES Area 27, Subdivision I by the Norwegian Oceanic Reference Fleet. Total catch of elasmobranchs, presented both as percentage of biomass and percentage of catch. (Source: Vollen, 2010 WD).

	Total catch (% biomass)		Total catch (% numbers)	
Species	Longlines	Trawl	Longlines	Trawl
Amblyraja radiata	96,4	99,7	97,3	98,5
Amblyraja hyperborea	+		+	
Dipturus batis (complex)	0,2		+	
Rajella fyllae	0,1		0,2	
Dipturus oxyrinchus		0,3		1,5
Bathyraja spinicauda	0,3		0,1	
Skates indet	2,9		2,4	

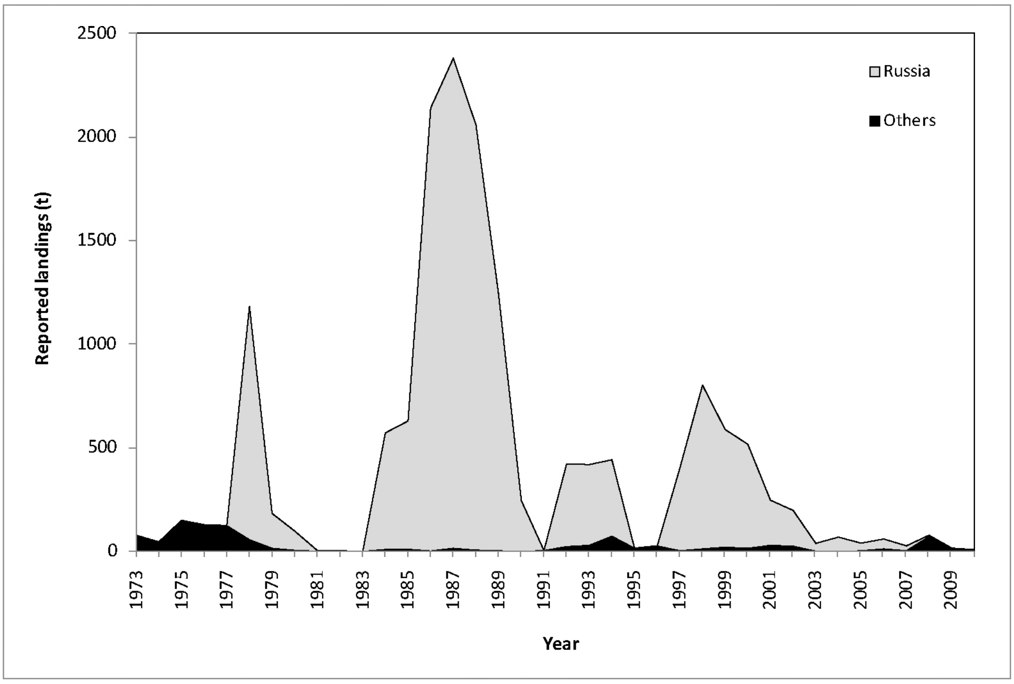

Figure 13.1. Demersal elasmobranchs in the Barents Sea. Skates and rays from ICES Area 27, Subdivision 1, 1973–2010. Total landings (tonnes).

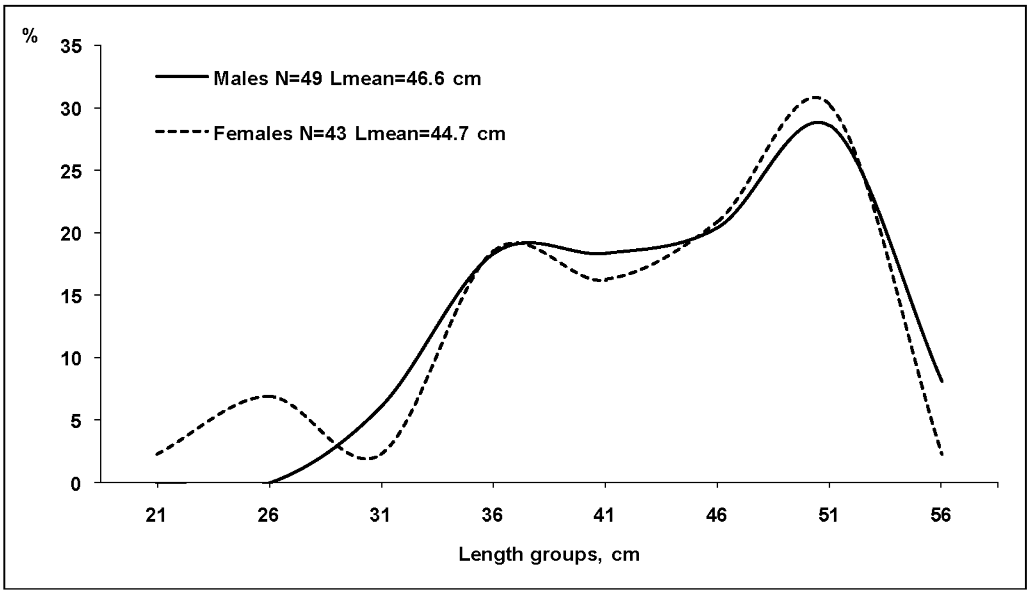

Figure 13.2. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* from commercial bottom-trawl catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).

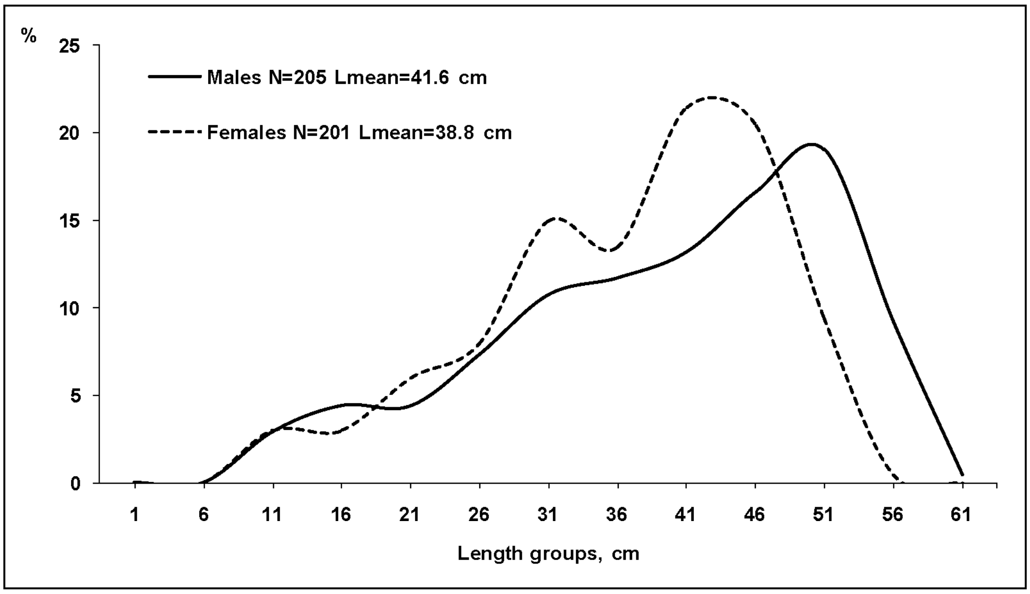

Figure 13.3. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).

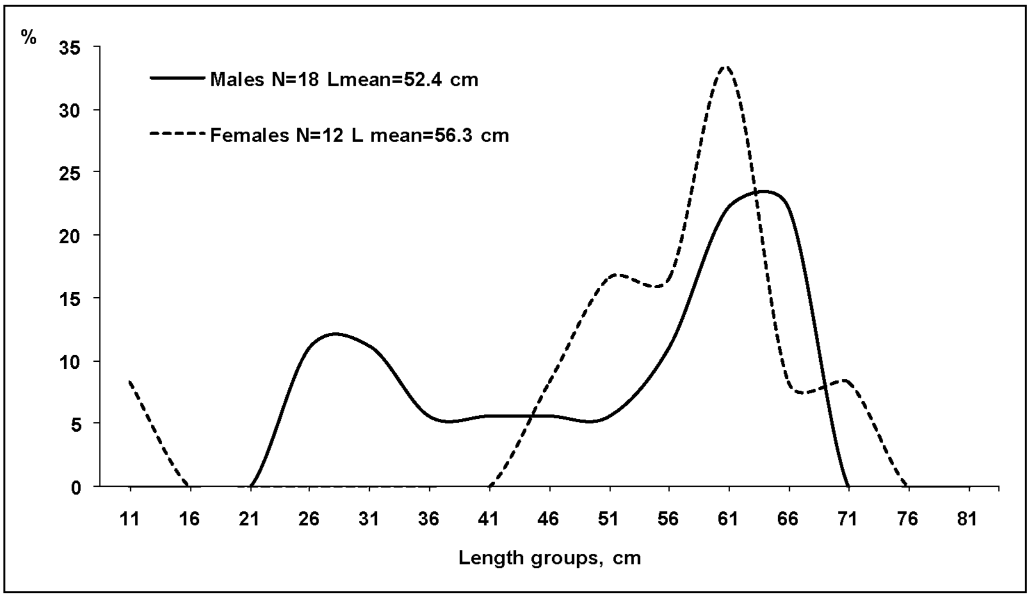

Figure 13.4. Demersal elasmobranchs in the Barents Sea. Length composition of *A. hyperborea* in the Barents Sea (Area I) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.*, 2010 WD).

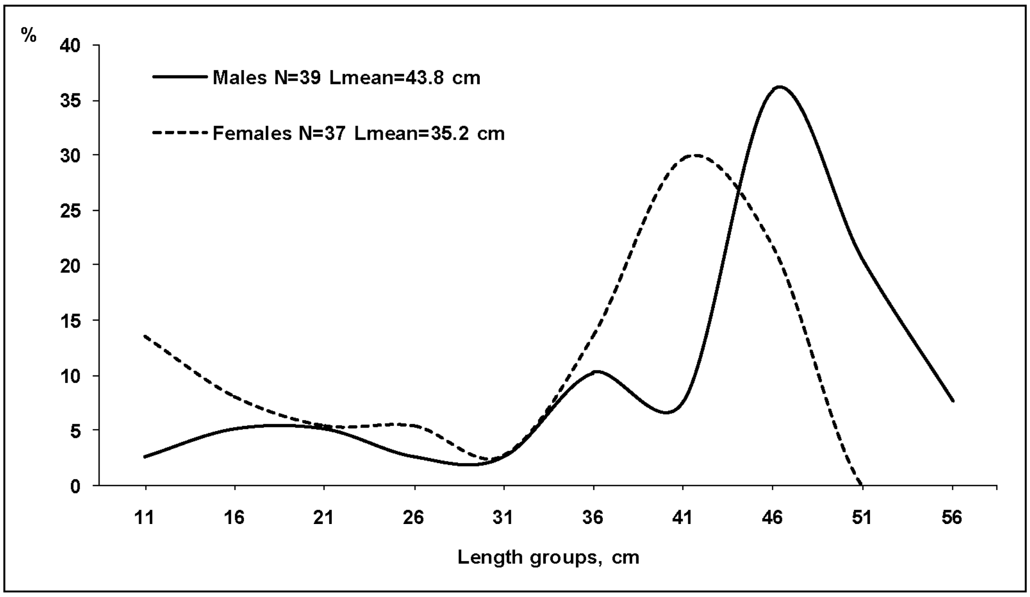

Figure 13.5. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the joint Russian–Norwegian winter survey (February 2009). (Source: Vinnichenko *et al.*, 2010 WD).

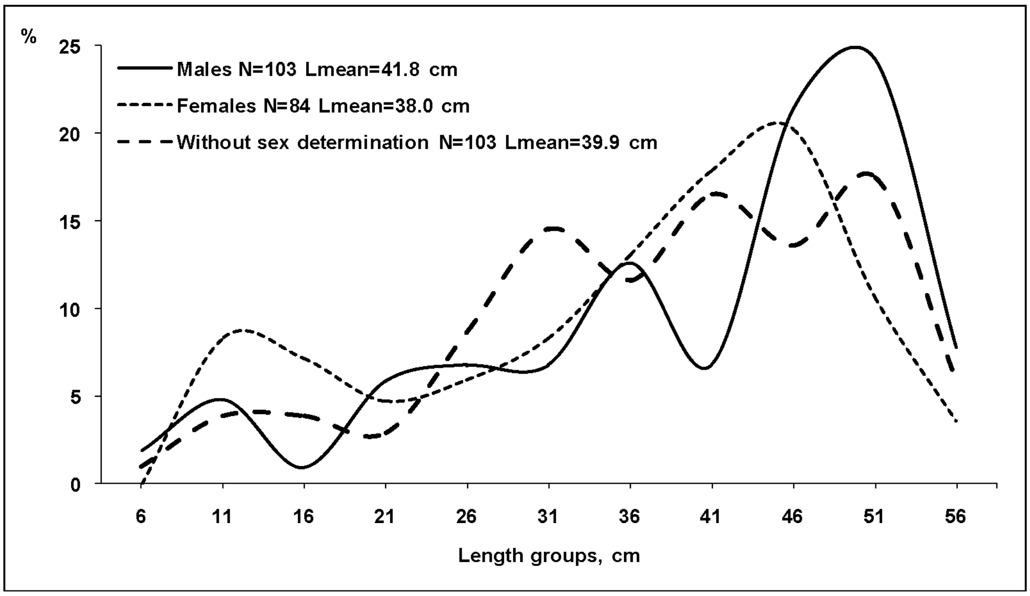

Figure 13.6. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Subarea I) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.*, 2010 WD).

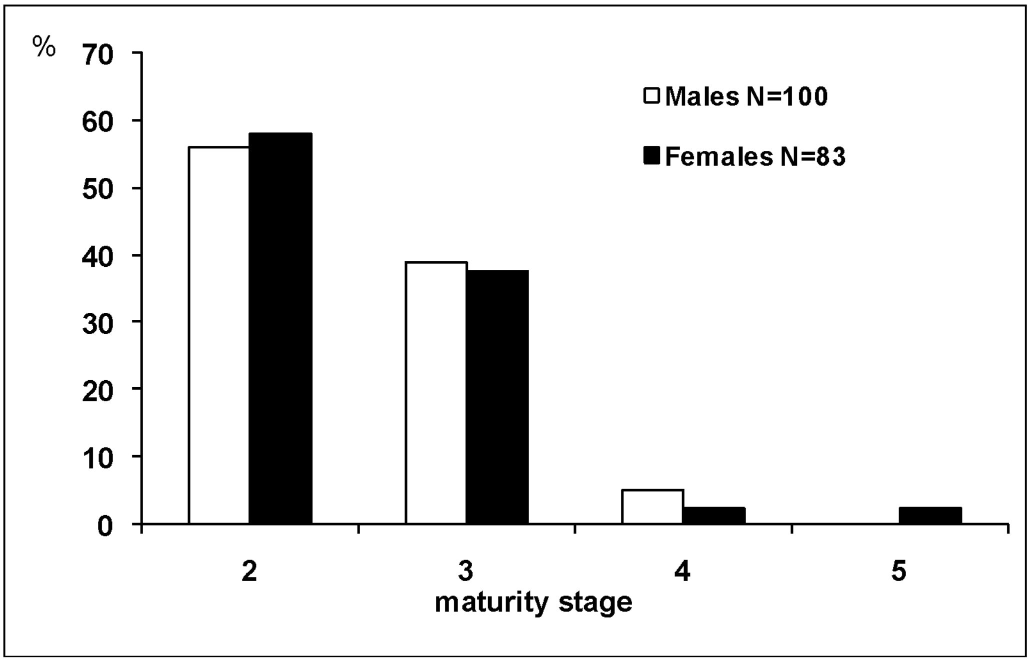

Figure 13.7. Demersal elasmobranchs in the Barents Sea. Maturity of *A. radiata* in bottom trawl catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).

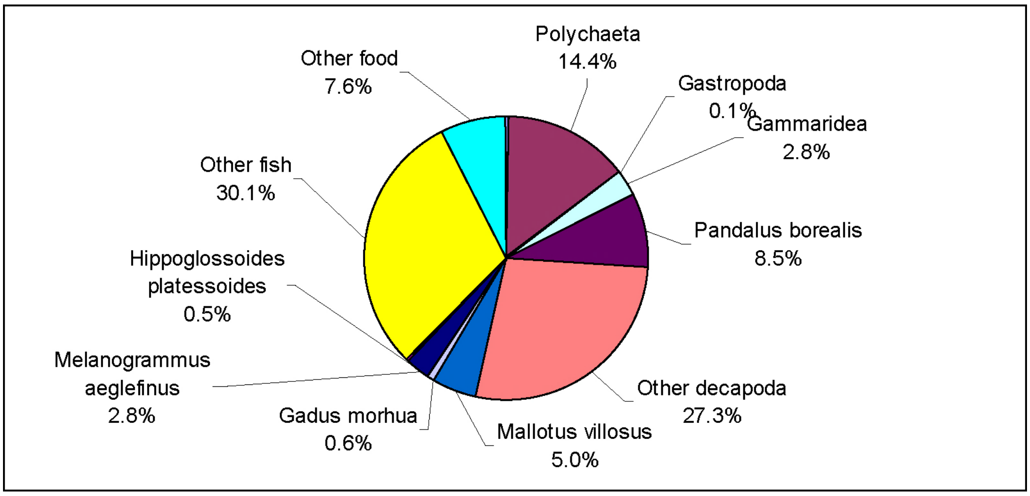

Figure 13.8. Demersal elasmobranchs in the Barents Sea. Food composition of *A. radiata* in the Barents Sea (Area I) in 2009, % by weight (N=169, 27% empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).

14 Demersal elasmobranchs in the Norwegian Sea

14.1 Ecoregion and stock boundaries

17 demersal elasmobranch species have been reported in the Norwegian coastal area included in the Norwegian Sea ecoregion (Williams *et al.*, 2008; Vollen, 2009 WD; 2010 WD). In the coastal areas, thorny skate *Amblyraja radiata* is the most abundant skate species (Williams *et al.,* 2007 WD). While more abundant in the north, this species does occur in fairly large numbers at all latitudes along the coast. The other species found in the coastal area are thornback ray *Raja clavata,* spotted ray *Raja montagui,* blonde ray *Raja brachyura,* common skate *Dipturus batis* (complex), sailray *Dipturus linteus,* 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* (see also Stehmann and Bürkel, 1984). Long-nose skate *Dipturus oxyrinchus* is distributed mainly along the southern section of coastline, south of latitude 65°N.

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 (Skjaeraasen and Bergstad, 2001; Vollen, 2009 WD). These species of skates are particularly abundant north of 70°N (Vollen, 2009 WD).

Sharks in the Norwegian Sea ecoregion include spurdog *Squalus acanthias* (see Section 2) and several deep-water species (see Section 5), such as velvet belly lantern shark *Etmopterus spinax,* blackmouth catshark *Galeus melastomus* and Greenland shark *Somniosus microcephalus* (Williams *et al.*, 2007 WD; Vollen, 2009 WD). Other species occasionally reported in Norwegian fisheries include lesser spotted dogfish *Scyliorhinus canicula,* porbeagle *Lamna nasus* and basking shark *Cetorhinus maximus* (Vollen, 2010 WD).

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 is no directed fishery on skates and rays in the Norwegian Sea, though they are caught in mixed fisheries targeting various teleost species. Landings data for skates are demonstrated in Table 14.1 and Figure 14.1 for the years 1973–2010.

14.2.2 The fishery in 2010

No new information.

14.2.3 ICES advice applicable

ICES has never provided advice for any of the demersal elasmobranch stocks within this ecoregion.

14.2.4 Management applicable

There are no TACs for any of the demersal skate species in this region.

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.

14.3 Catch data

14.3.1 Landings

For ICES Subdivision II, landings data are limited and, for skates, not species disaggregated (Table 14.1and Figure 14.1). This area 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, at about 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 as a consequence of an experimental fishery, when skate bycatch was landed, whereas normally they are discarded (Dolgov, pers. comm., 2006). Russia and Norway are the main countries landing skates from the Norwegian Sea.

Norwegian landings of shark were reported by species for 2010. Landings of blackmoth dogfish *Galeus melastomus* were 9 tonnes. Other sharks landed in this area include porbeagle, spurdog and lesser spotted dogfish *Scyliorhinus canicula.* These are reported in Sections 6, 2 and 5, respectively.

Landings data (usually not resolved to species level) have been provided by Norway, France, and Scotland in recent years. Russian landings were provided for 2009 (Vinnichenko *et al.*, 2010 WD) and extracted from Fish Stat for earlier years.

14.3.2 Discard data

Vollen (2010 WD) reported on catch and discards by the Norwegian Reference Fleet in ICES Subdivision II. More detailed results are given in Section 14.4.2.

14.3.3 Quality of catch data

Catch data are not species disaggregated.

14.4 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 50–900 m depths in February–November. *A. radiata* made up the bulk of bycatch. *R. fyllae*, *A. hyperbora* and *B. spinicauda* were found in minor quantities (Vinnichenko *et al.*, 2010 WD).

A. radiata of 27–58 cm in length were recorded in the commercial catches by bottom trawl. The catches primarily comprised males of 41–55 cm and females of 36–50 cm length (Figure 14.2).

The percentage of small individuals was much lower than in the Barents Sea. The mean length of females was also considerably less (43.7 cm) than that one of males (45.0 cm). In the catches males were somewhat prevailing, the sex ratio was 1.1:1.

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. 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 Subdivision II were dominated by *A. radiata* and *R. clavata* (possibly misidentified; Table 14.3; Vollen, 2010 WD). For vessels in the Oceanic Reference Fleet, bycatch of elasmobranchs differed between bottom trawl, bottom gillnets and longlines. Whereas *A. radiata* made up the bulk of trawl and longline catches (55% and 79% by numbers, respectively), *R. clavata* dominated gillnet catches (82%). This was probably influenced by the dominance of northerly stations in trawl and longline data, vs. southerly stations in gillnet data, but possibly also misidentifications, and should therefore be investigated more thoroughly. Catches of *A. radiata* were higher in this area than in ICES Subdivision I for trawl catches (61 kg/100 trawl hours for Area II vs. 43 kg/100 trawl hours for Area I), but lower for longline catches (119 kg/10 000 hooks vs. 135 kg/hooks, respectively).

The data from the Coastal Reference Fleet demonstrated that *D. batis* (complex) 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-effort data

No information.

14.6 Fishery-independent surveys

14.6.1 Russian bottom-trawl survey (RU-BTr-Q4)

Vinnichenko *et al.* (2010 WD) reported on catches from the 2009 survey cruise, where *A. radiata* dominated the catches. Fish of 10–56 cm in length were recorded (Figure 14.3). In the size distribution, different size/age classes of the skate were very distinct. The mean length of males and females was practically the same, 37.7 cm and 37.4 cm. In the catches males slightly predominated. The sex ratio was 1.05:1.

A. hyperborea of 17–138 cm in length were recorded in the catches (Figure 14.4). Predominating were males as long as 46–50 cm and 61–75 cm, as well as females with the length of 56–65 cm and 76–80 cm. The mean length of males and females was practically the same, 65.1 cm and 65.8 cm, respectively. In the catches males were mainly found, the sex ratio was 5:1.

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. These are presented in Section 14.6.4.

14.6.2 Norwegian coastal survey (NOcoast-Aco-4Q)

The distribution and diversity of elasmobranchs in northern Norwegian coastal areas was summarized by Williams (2007) and Williams *et al.* (2007 WD; 2008) based on survey data from 1992–2005). 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 (as illustrated in Fiskeridirektoratet, 2004).

Thirteen skate species and four species of sharks were recorded as inhabiting the coastal region (Table 14.2). 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, D. linteus, R. montagui, R. brachyura and L. circularis*. Four species of shark were identified: *E. spinax, G. melastomus* and *S. acanthias,* as well as one specimen of *S. microcephalus.*

No clear shifts in abundance over time were detected for any species. A 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) at the continental slope (62–81°N), the Barents Sea and 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. A total of nine species were recorded; six skates and three sharks. *A. radiata* and *A. hyperborea* were the dominating species north of 62°N (ICES Subdivision II), whereas *E. spinax* were most numerous in the Norwegian Deep (ICES Subdivision IIIa). *B. spinicauda* and *R. fyllae,* also occurred frequently in the catches in all areas. Recordings of *R. clavata* were considered to be misidentification 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. The cruises 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)), practically 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 some years, data on elasmobranchs are missing. The August–September survey started in 2003. All skate species 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 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 completed, but some data were presented from the 2009 surveys by Vinnichenko *et al.* (2010 WD).

A. radiata was the dominating species in the August–September cruise. Individuals with 5–61 cm length occurred in the catches (Figure 14.5). The average length was 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). The most of males and females (over 70%) were immature, the rest of them were maturing and mature (Figure 14.6). Unlike the Barents Sea, in that area, there were no individuals which were close to the active stage. In feeding prevailing were bottom decapods (crabs *Hyas* spp. and the northern shrimp (*Pandalus borealis*)) and fish (capelin (*Mallotus villosus*) and Atlantic hookear scuplin (*Artediellus atlanticus*)), 47% and

31% by weight, respectively (Figure 14.7).

14.6.5 Quality of survey data

The difficulties associated in identifying skate species are a serious concern when considering the validity of the data used in this assessment. A detailed description of this issue was given in Williams *et al.*, 2007 WD, and summarized in ICES, 2007. There are concerns about misidentification with regard to skates (*Rajidae*), and in particular the possible confusion between *A. radiata* and *R. clavata*. The survey data for skates must be thoroughly examined before these are used in assessments.

In order to achieve a satisfactory quality of survey data in future, better identification practices, using appropriate identification literature, needs to be put in place. Ongoing work to improve future sampling at the Institute of Marine Research includes workshops to educate staff as well as improve guides and keys used for species identification.

14.7 Life-history information

Length data are available for *A. radiata* and *A. hyperborea* in Vinnichenko *et al.* (2010 WD; see ICES, 2010). Some biological information is available in the literature (e.g. Berestovsky, 1994).

14.7.1 Ecologically important habitats

No information available.

Sampling of elasmobranch egg cases will be 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 the general status of the more frequent species to be evaluated, although taxonomic irregularities need to be addressed first.

14.10 Reference points

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

14.11 Conservation considerations

Listings other than "Least concern" on the International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species (IUCN, 2011):

> "Critically endangered": *D. batis* (complex).
>
> "Near threatened": *B. spinicauda, D. oxyrinchus, L. fullonica, R. clavata, R. brachyura, D. nidarosiensis* and *S. microcephalus*.

Demersal elasmobranchs listed on the Norwegian Red List, other than "Least concern" (Sjøtun *et al.*, 2010):

> "Critically endangered": *D. batis* (complex), *Squalus acanthias*

"Near threatened": *B. spinicauda, D. nidarosiensis, L. fullonica* and *Somniosus microcephalus.*

14.12 Management considerations

There are no TACs for any of the demersal skates in this region. 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 Spatial information

There is no high resolution information available from this area.

There are time-series' available from the Joint Russian–Norwegian surveys. These data should be made available to the group to assess potential changes in survey abundance and species composition.

14.14 References

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Table 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Area 27, Subdivisions II, IIa and IIb from 1973–2010. Ireland (1 ton in 2007), Denmark (+ in 1994 and Sweden (+ in 1975) are not included in the landings table). "n.a." = no data available, "." = means zero catch, "+" = <50 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	.	.	1	.	.	.	.	.	.	.	.	.	.
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.
Faroe Islands	.	.	.	5	2	1	1	.	.	.	.	.	.
France	.	.	1	68	61	18	2	1	12	109	2	6	5
Germany	+	1	52	12	59	114	84	85	53	7	2	112	124
Iceland	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	2	.	.	.	.	.	.
Norway	201	158	89	34	99	82	126	191	137	110	96	150	104
Portugal	.	.	.	34	39	.	.	.	.	.	.	.	.
USSR/Russian Fed.	.	.	.	.	.	302	99	39	.	.	.	537	261
Spain	.	.	.	.	.	.	.	.	.	.	28		17
UK – E, W & NI	65	18	14	20	90	10	6	2	+	+	.	5	1
UK - Scotland	2	1	.	+	1	+	.	.	.	.	.	.	+
Total	268	178	157	173	351	527	320	318	202	226	128	810	512
	1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.
Faroe Islands	4	.	15	.	42	.	2	.	.	.	.	.	.
France	11	21	42	8	56	11	15	9	7	8	6	8	5
Germany	102	95	76	32	52	.	+	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	133	214	112	148	216	235	135	286	151	239	198	169	214
Portugal	.	.	.	.	.	.	.	22	11	.	10	28	46
USSR/Russian Fed.	1633	1921	1647	867	208	n.a.	181	112	257	n.a.	n.a.	77	139
Spain	5	.	9	.	.	.	.	.	.	3	.	3	15
UK - E, W & NI	2	4	.	2	1	+	1	+	+	1	4	.	+
UK - Scotland	+	2	+	+	+	+	+	+	.	+	+	+	+
Total	1890	2257	1902	1057	575	246	334	429	426	251	218	285	419
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.
Estonia	.	.	.	5	.	.	.	.	.	.	.	.	
Faroe Islands	.	.	.	.	2	12	15	13	9	13	4	n.a.	
France	.	5	4	7	2	7	8	.	4	2	1	3	
Germany	.	2	.	2	2	7	1	.	.	.	.	1	
Iceland	.	.	4	.	.	.	.	.	.	.	.	.	
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	
Norway	239	244	233	118	111	135	133	146	189	259	257	251	
Portugal	10	6	3	.	8	2	1	14	13	2	.	.	
USSR/Russian Fed.	247	400	113	38	6	50	20	16	20	.	8	n.a.	
Spain	6	.	7	11	32	.	2	.	.	.	.	.	
UK - E, W & NI	1	+	.	.	.	.	.	+	.	.	.	.	
UK - Scotland	1	1	1	3	3	.	2	4	1	1	+	.	
Total	504	658	365	184	166	149	141	150	194	217	244	255	

Table 14.2. 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.

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
Dipturus linteus	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			

Table 14.3. Demersal elasmobranchs in the Norwegian Sea. Species composition of elasmobranch catches in ICES Area 27, Subdivision I by the Norwegian Oceanic and Coastal Reference Fleet. Data for the Oceanic Reference Fleet is Total catch of elasmobranchs as percentage of biomass and percentage of numbers. Data for the Coastal Reference Fleet is percentage in numbers of landed catch and discarded catch.

	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
Chimaera monstrosa	5,6	6,9	30,3	3,4	7,5	27,2	1,1	44,5
Amblyraja radiata	79,5	6,3	55,1	78,9	7,8	54,5		1,8
Raja clavata		74,5	9,4		82,2	9,4	6,5	0,8
Amblyraja hyperborea	5,4			2,9			0,1	
Dipturus batis (complex)	0,2			0,1			38,7	0,4
Dipturus linteus	0,2			0,1				2,0
Rajella fyllae	2,2	0,6	3,2	3,8	1,1	5,5	0,7	1,1
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		
Bathyraja spinicauda	0,5		0,4	0,2		0,5		
Skates indet	3,6			5,0			33,4	18,2
Squalus acanthias	0,2	0,3	+	0,1	0,4	0,1	7,9	7,3
Galeorhinus galeus								+
Galeus melastomus	1,4			2,2			0,1	11,3
Scyliorhinus canicula								0,3
Etmopterus spinax	1,0			3,3				4,2
Cetorhinus maximus								0,2
Lamna nasus							10,8	0,1
Somniosus microcephalus								0,5
Total chimaeras	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

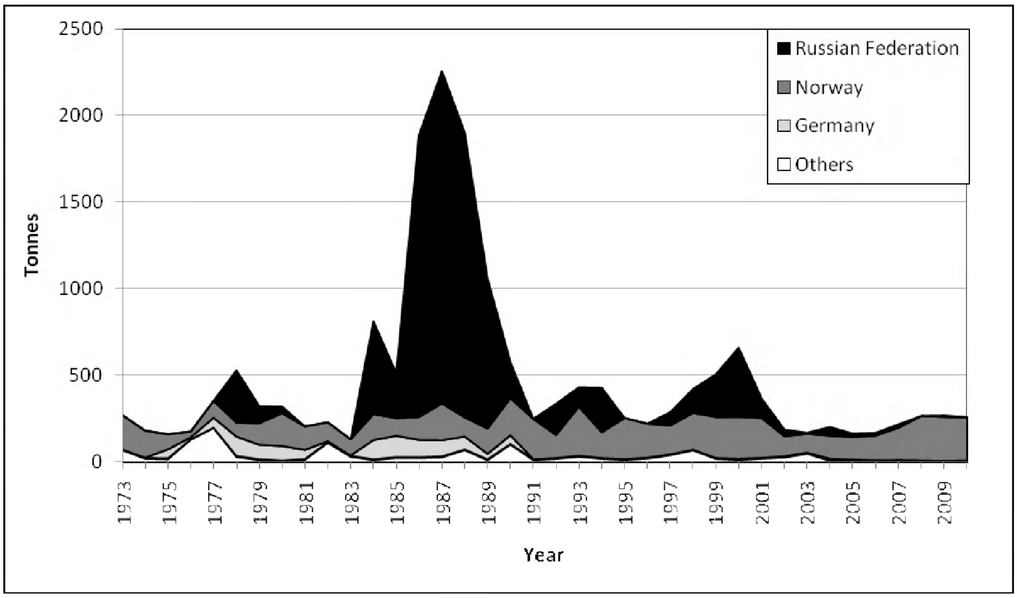

Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Area 27, Subdivisions II, IIa and IIb from 1973–2010.

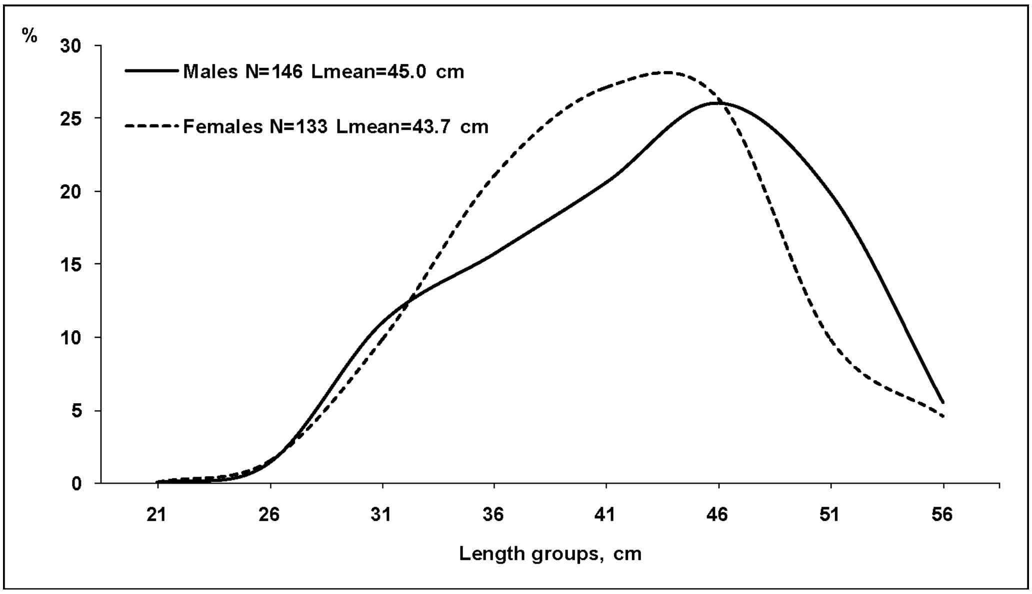

Figure 14.2. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* from commercial bottom-trawl catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).

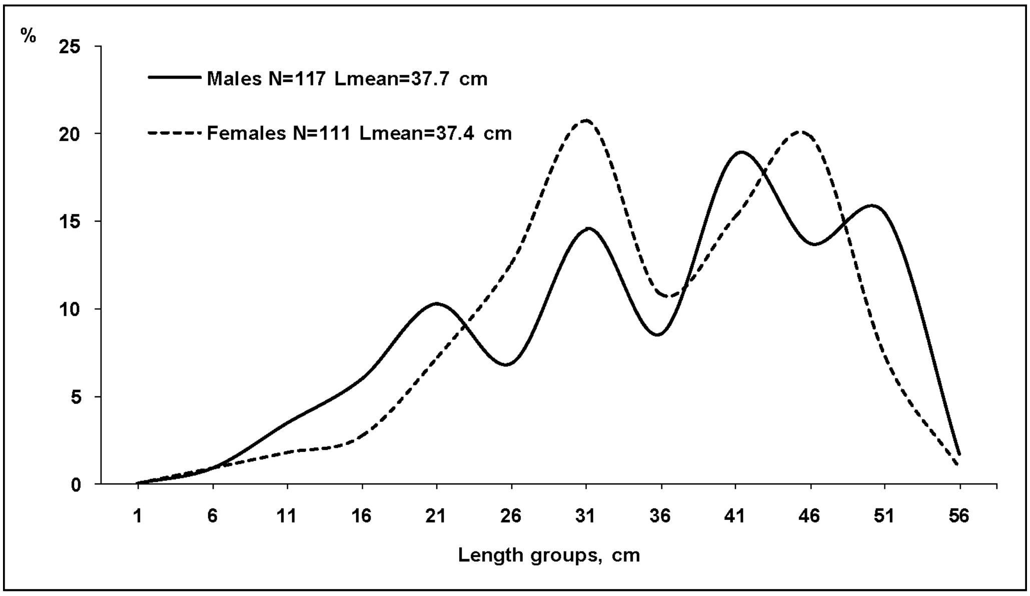

Figure 14.3. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).

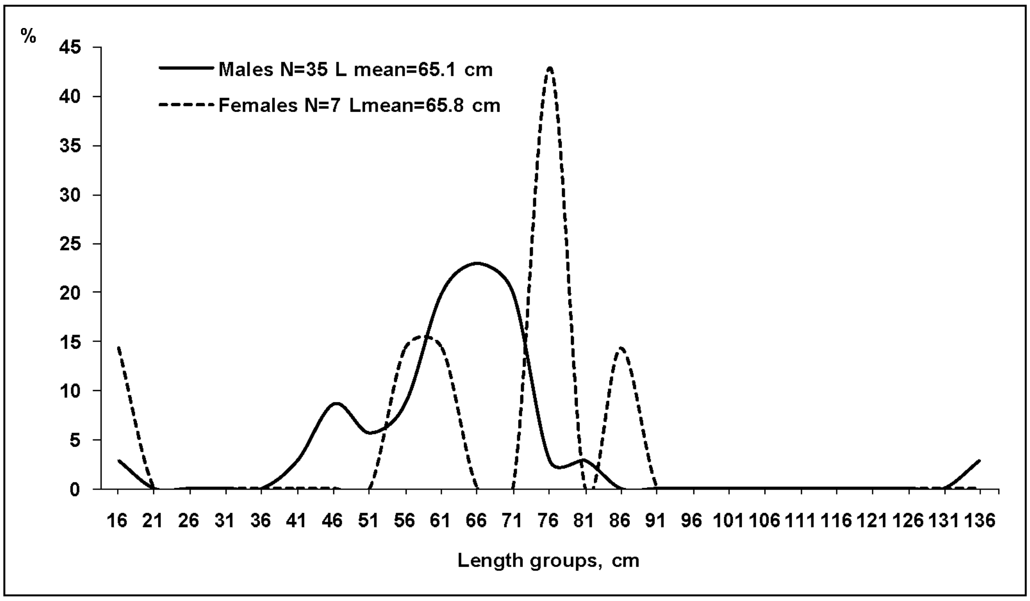

Figure 14.4. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. hyperborea* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).

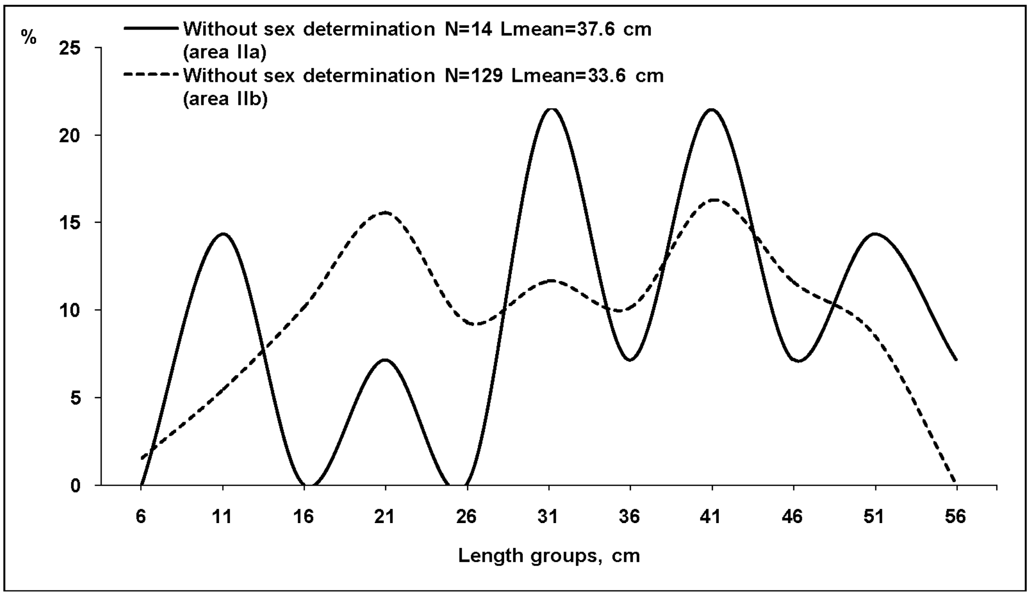

Figure 14.5. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Area IIa and IIb) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.*, 2010 WD).

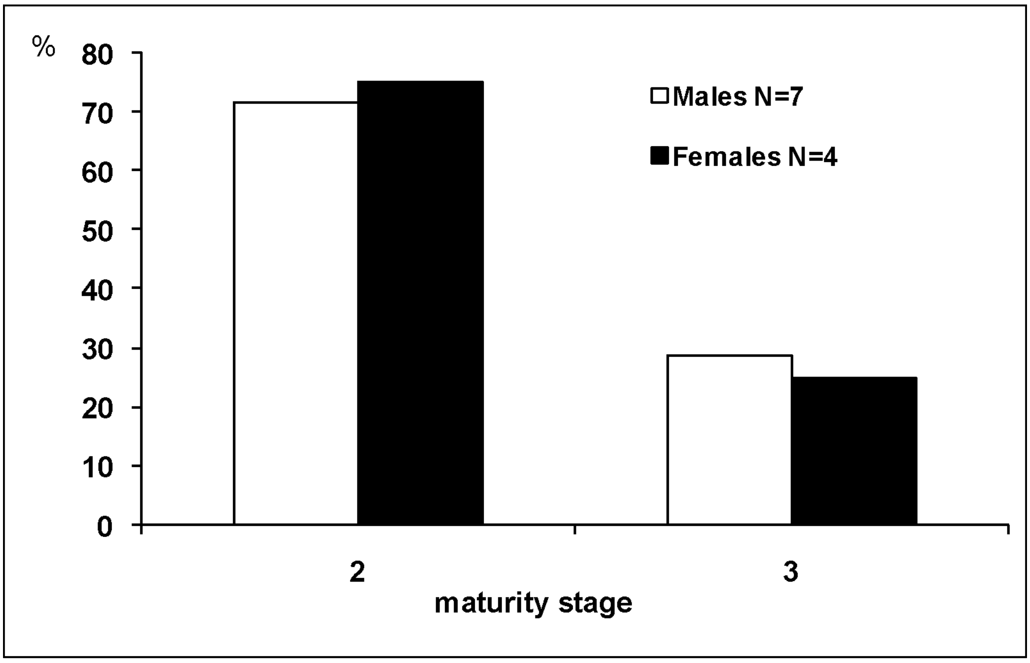

Figure 14.6. Demersal elasmobranchs in the Norwegian Sea. Maturity of *A. radiata* in bottom-trawl catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).

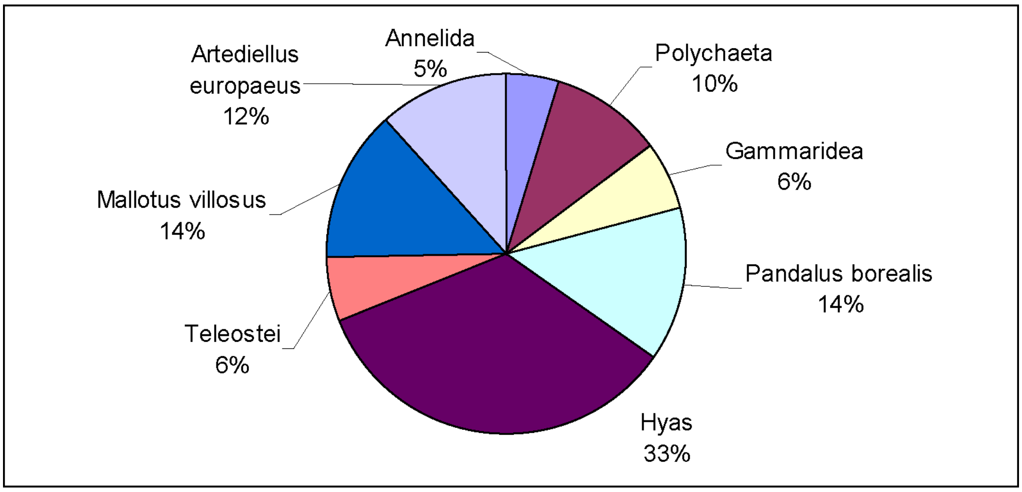

Figure 14.7. Demersal elasmobranchs in the Norwegian Sea. Food composition of *A. radiata* in the Norwegian Sea in November 2009 (% by weight; N=11 stomachs, 9.0 % empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).

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 seven demersal shark species. Thornback ray *Raja clavata* is probably the most important ray for the commercial fisheries. Preliminary assessments for this species were presented in ICES, 2005 and ICES, 2007a, based on research vessel surveys. WGEF is still concerned over the possibility of misidentifications of skates in some of the recent IBTS surveys, especially between *R. clavata* and starry ray (or thorny skate) *Amblyraja radiata*.

R. clavata in the Greater Thames Estuary (southern part of ICES Division IVc) are known to move into the eastern English Channel (VIId). For most other demersal species/stocks in the North Sea ecoregion the stock boundaries are not well known. The stocks of cuckoo ray *Leucoraja naevus*, spotted ray *R. montagui*, *R. clavata* and lesser-spotted dogfish *Scyliorhinus canicula* probably continue into the waters west of Scotland (and for *R. montagui* and lesser-spotted dogfish also into the eastern English Channel). The stock boundary of the common skate *Dipturus batis* species complex (see Section 21.1) is likely to continue to the west of Scotland and into the Norwegian Sea. Blonde ray *R. brachyura* has a patchy distribution in the southern and northwestern North Sea. The stock boundary of smooth hound *Mustelus* sp. is not known.

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 longline. 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, 2009) and the report of the DELASS project (Heessen, 2003).

The 25% bycatch ratio brought in by the EC (see also Section 15.2.4) has restrained some fisheries and may have resulted in misreporting since 2007, both of area and species composition.

15.2.2 The fishery in 2010

Landings tables for the relevant species are provided in Tables 15.1–15.9.

WGFTFB (ICES, 2007b) mentioned in their report a significant bycatch of skates in outrigger trawls. This was based on a Belgian study of three Belgian beam trawlers and one Eurocutter during 12 months in 2006–2007 while fishing with outrigger trawls as an alternative for beam trawls (Vanderperren, 2008). In the overall catch, skates were most important in terms of weight (32–45%). It cannot, however, be excluded that these vessels were targeting skates.

15.2.3 ICES Advice applicable

In 2008 ICES provided advice for 2009 and 2010 for these stocks, stating that "Target fisheries for common skate *D. batis* and undulate ray *R. undulata* should not be permitted, and measures should be taken to minimize bycatch". Furthermore no fisheries should be permitted for angel shark *Squatina squatina*. *Status quo* catch was advised for spotted ray *R. montagui*, starry ray *A. radiata*, cuckoo ray *L. naevus*, thornback ray *R. clavata* in division IVc, smooth hound *Mustelus* spp. and lesser-spotted dogfish *S. canicula*. No advice was given for blonde ray *R. brachyura*, and thornback ray *R. clavata* in Division IVa, b.

In 2010 ICES provided advice for 2011 and 2012 for these stocks, stating that "No targeted fishery for *R. undulata* and *D. batis* complex". Furthermore, zero catch was advised for angel shark *Squatina squatina*. *Status quo* catch was advised for spotted ray *R. montagui*, starry ray *A. radiata*, cuckoo ray *L. naevus*, thornback ray *R. clavata* in Divisions IVc and VIId, lesser spotted dogfish *S. canicula* and smooth hound *Mustelus* spp. For thornback ray *R. clavata* in Divisions IVa, b ICES stated "Reduce catch from recent level". No advice was given for blonde ray *R. brachyura*.

15.2.3.1 State of the stocks

In the absence of defined reference points, the status of the stocks of demersal skates and rays and demersal sharks cannot be assessed. Therefore a qualitative summary of the general status of the major species based on surveys and landings is given. It should be noted that this perception (from 2010) has not changed compared with previous reports of WGEF:

Common skate *D. batis* – is 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.

Thornback ray *R. clavata* – 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.

Spotted ray *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.

Starry ray *A. radiata* – stable. Survey catch rates increased from the early 1970s to the early 1990s and have decreased slightly since then.

Cuckoo ray *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.

Blonde ray *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.

Undulate ray *R. undulata* – uncertain, reason for concern. Mainly limited to Division VIId where it merges with Division VIIe. Occasional vagrants in Division IVc. The biology of the species gives rise to concern. It has a patchy and localized distribution (where it can be locally abundant), possibly forming discrete stocks which make this species sensitive to local depletion. Additionally, the species disappeared from the English beam trawl survey in Division VIId in 2006–2007 but was caught again in 2008 and 2009.

Lesser-spotted dogfish *S. canicula* – abundance increasing in IV and Division VIId, area occupied in IV is increasing.

Smooth hound *Mustelus* spp. – abundance appears to have been increasing in recent years both in survey catches and in commercial and recreational fisheries, but the stock status is uncertain. Identification by species is considered unreliable in the surveys. Farrel *et al*. (2009) only found *M. asterias* in the area.

Angel shark *S. squatina* – is extirpated in the North Sea. It may still occur in Division VIId.

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*. WGEF is of the opinion that this measure is ultimately expected to improve our understanding of the skate fisheries in the area.

The TAC for skates and rays for 2011 for the different parts of the area was the same as in 2010: 1397 t for IIa and IV, 887 t for VIId and 58 t for IIIa. The TAC does not apply for *D. batis* and *R. undulata* for Area VIId and for *D. batis* for Areas IIIa, IIa and IV. "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 rapid and safe release".

Year	TAC	Landings
1999	6060	3997
2000	6060	3992
2001	4848	4011
2002	4848	3899
2003	4121	3799
2004	3503	3237
2005	3220	3030
2006	2737	2845
2007	2190 [1)]	2688
2008	1643 [2)]	2450
2009	2755 [3)]	3171
2010	2342 [4)]	2914
2011	2342 [4)]	

[1)] Considered as bycatch quota. These species shall not comprise more than 25% by live weight of the catch retained on board.

[2)] Catches of Cuckoo ray (*Leucoraja naevus*), Thornback ray (*Raja clavata*), Blonde ray (*Raja brachyura*), Spotted ray (*Raja montagui*), Starry ray (*Amblyraja radiata*) and Common skate (*Dipturus batis*) shall be reported separately.

[3)] This includes a shared TAC of 1643 t for Areas IIa and IV; a TAC of 1044 t for VIId and a TAC of 68 t for IIIa.

[4)] This includes a shared TAC of 1397 t for Areas IIa and IV; a TAC of 887 t for VIId and a TAC of 58 t for IIIa.

Within the North Sea area, the Kent and Essex Sea Fisheries Committee (England) has 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 skates and rays 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 15.5–15.7). Landings data of lesser-spotted dogfish and smooth hound are presented in Tables 15.8–15.9.

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 countries. During the discard sampling observer programme of the Dutch beam trawl fleet for the period 2002–2010 the main discarded ray species were *A. radiata*, *R. clavata* and *R. montagui*. The length frequency distribution of these discards is presented in Figure 15.3. Note that as the purpose of the 2009 and 2010 observer trips was to validate self-sampling trips, the data are not necessarily representative for the Dutch beam trawl fleet.

Length frequency distributions of discarded and retained elasmobranchs, covering the period from 1998–2006, were provided by UK (England) and illustrated in ICES, 2006, with updated information provided in Ellis *et al*. (2010a).

15.3.3 Quality of the catch data

In 2008 the EC asked Member States to start reporting their landings of rays by (major) species. Official species-specific landings are therefore available for two years now. The quality of the species data is discussed in 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.

15.4 Commercial landings composition

15.4.1 Species and size composition

From 2008 onwards all countries are obliged to register species-specific landings. In the past, only France and Sweden provided landings data by species based on information from logbooks and auction. However, the accuracy of the data provided remains 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 countries (Tables 15.5–15.7). Belgium, the Netherlands and UK (E, W & NI) demonstrate a consistent high level of species-specific declaration for the different ICES areas; in 2010 for Areas IV and VIId 72% and 61% of Belgian landings, 100% and 86% of Dutch landings and 92% and 90% of UK (E, W & NI) landings were declared up to species level respectively. For UK (Scotland) and France the percentage of species-specific declaration differs by area. France declared 10% and 54% of its landings to species level for Areas IV and VIId respectively, and UK (Scotland) declared 56% and 21% of its landings to species level for Areas IV and

VIId respectively. Norway mainly landed rays and skates from Area IV for which 25% of was reported down to species level. Denmark (Areas IV and IIIa) and Sweden (Area IIIa) declared no species down to species level.

The species composition (percentage) for landings by the Dutch beam trawl fleet based on market sampling for 2000–2007 is presented in Table 15.10. Table 15.11 gives length compositions of these landings. Figures 15.4–15.5 show the length frequency of sampled Dutch shark and ray landings in 2010.

There are no specific effort data for North Sea skates.

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.

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 demonstrates that *R. montagui* and *R. clavata* are the most common species landed followed by *R. brachyura* (Table 15.10). According to the species-specific landings data the percentage of *R. brachyura* has considerably decreased in the Dutch landings in 2008–2010 (Table 15.6) 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 *Raja asterias and Rostroraja alba* as reported by France in ICES Areas IV and VIId, *Amblyraja hyperborea* as reported by the UK (E, W and NI) in ICES Areas IV and VIId, and *Dipturus oxyrinchus* as reported by the UK (E, W and NI) in ICES Area VIId are likely the result of misidentification. Furthermore, landings of *Leucoraja circularis* reported by Belgium in ICES Area VIId are unlikely and could possibly have been *Raja microocellata*. Landings of *Raja alba* reported by UK (Scotland) in ICES Area IV are also very unlikely, and could possibly have been *Leucoraja fullonica*.

These examples demonstrate that more robust protocols for ensuring correct identification are needed, both at sea and in the market. The species-specific landings data also demonstrate that some nations still report a considerable proportion of unidentified ray and skate landings.

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

No new analyses were undertaken this year.

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. Distribution maps are provided in ICES, 2005 and ICES, 2006.

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). Spurdog has clearly declined markedly over time, whereas lesser-spotted dogfish and smooth hounds have increased markedly. *A. radiata* appears to have increased from the late seventies to the early eighties, possibly followed by a decline. The same pattern also seems to apply to *L. naevus* and *R. montagui*. *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).

In 2007 two methods, the GAM method and SPANdex modelling methods, were undertaken to examine the changes in abundance and spatial variation in the more commonly occurring skate species in the North Sea. Both methods are explained briefly in Sections 15.8.1 and 15.8.2. A further detailed explanation on these analyses can be found in ICES, 2007a.

Time-series of the most relevant species, based on North Sea IBTS surveys for the years 1977–2010, are shown in Figure 15.6. Data were extracted from the DATRAS database.

15.6.2 Beam trawl surveys

Ellis *et al.*, 2005 analysed catches from UK surveys. Lesser-spotted dogfish demonstrated a small increase in the eastern Channel. *A. radiata* demonstrated an increase in the North Sea in the period 1982–1991. *D. batis* was not caught in the North Sea since 1991, whereas in the 1980s they were still caught sporadically.

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 are demonstrated. An apparent trend for lesser-spotted dogfish distribution to be increasing towards the Straits of Dover and into the North Sea was evident, whereas the SE English coast is an important habitat for *R. clavata*.

The UK (BTS-Q3) started in the late 1980s, although the survey grid was not standardized until 1993. The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in relatively shallow water. Lesser-spotted dogfish, *R. brachyura*, *R. clavata*, *R. montagui* and *R. undulata* are all sampled during this survey. Smoothhounds caught by the gear tend to be juveniles. For a description of the survey see Ellis *et al.*, 2005, Parker-Humphreys, 2005 and Ellis (WD2010-16).

Catch rates ($n.h^{-1}$) for this survey have been summarized in Ellis (WD2010-16), with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least 12 times during the 17 year time-series (1993–2009; Figure 15.7). For lesser spotted dogfish mainly adults are being caught, whereas for the other species the catches mostly consist of juvenile fish, which is likely to be an effect of the shallow area covered in this survey.

Although *R. brachyura* have generally increased over the period, there are only low catch rates for this species. Catch rates for *R. montagui* have declined in recent years. Given that this survey generally catches juveniles of these species, it is unclear as to whether there are identification issues involved in these contrasting trends. *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 fished routinely in this division, although an increased number of sampling stations have been fished in recent years, and these data should be examined in future studies. 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 the following years.

Distribution plots for six selected ray species: *R. brachyura*, *L. naevus*, *L. microocellata*, *R. montagui*, *R. clavata*, *and R. undulata* based on international offshore BTS data of 1996, 2000, 2005 and 2010 are presented in (Figures 15.8–15.11; ICES, 2011).

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 some species have been aged in special studies.

Some information on maturity-at-length exists and should be combined for different countries, to maximize the sample sizes.

Demographic modelling requires more accurate life-history parameters, in terms of age–length keys 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.

In 2011, a tagging programme will commence in the Netherlands during which approximately 300–500 *M. asterias* individuals will be tagged by recreational fishers.

15.7.1 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).

Little is known about the presence of egg-laying and pupping grounds.

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, 2011). The Netherlands already collects data on viable elasmobranch egg cases.

Surveys may be able to provide information on the locations of nursery grounds and other juvenile habitats, and these should be further investigated to identify sites where there are large numbers of 0-groups and where these life-history stages are found on a regular basis.

Little is known about the habitats of the rarer elasmobranch species, and further investigations on these are required.

15.7.2 Recruitment

No information is available on recruitment, although parts of the southern North Sea (e.g. the Thames area) are known to have large numbers of juveniles (Ellis *et al.*, 2005).

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 demersal elasmobranchs has been evaluated from analyses of survey data, including historical information.

15.8.1 GAM analyses of survey trends

The GAM analysis focused on the most abundant species caught in the IBTS-Q1 across this ecoregion: *R. clavata*, *L. naevus*, *A. radiata* and lesser-spotted dogfish. Only 'filtered' IBTS-Q1 data (see ICES, 2007a) were used and, as haul and depth data were not available at the WG, the model effects were year and statistical rectangle only.

The results of the fitted GAMs differ per species. For *R. clavata* the fitted GAM demonstrates an increase through the 1980s, followed by a decline to the mid-1990s then a subsequent increase (Figure 15.12). Catch rates are estimated to be highest across a small number of statistical rectangles in the southwestern North Sea specifically those around the Thames estuary and the Wash. The fitted GAMs of the *L. naevus*, *A. radiata* and the lesser-spotted dogfish also demonstrate some fluctuations over the 25-year period (Figures 15.13–15.15). In recent years the fitted GAMs for the *A. radiata* decreased, for the lesser-spotted dogfish increased and for the *L. naevus* stabilized. The highest catch rates of these species are found in the central North Sea, the western North Sea and off the east coast of Scotland respectively and further around Orkney and Shetland.

Further exploration of these survey data (in terms of individual model fit, residual patterns, interaction terms, etc) was not as thorough as would be ideal. However, general trends in estimated year effect appeared to be relatively robust to distributional assumptions although the actual magnitude of fluctuations in year effect and smoothness of the function were less so. Additionally, the consistency of spatial effects between years was not explored.

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 (*A. radiata, L. naveus, R. clavata* and *R. montagui*) demonstrated that the species have been restricted to the consistent areas (Figures 15.16–15.19). The area occupied (AO) changes over time (Figure 15.20). 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 Quality of assessments

Analyses of survey data for *R. clavata* undertaken by ICES in 2002 and 2005 (ICES, 2002 and 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, 2007a).

15.10 Reference points

No reference points have been proposed for *R. clavata* or other elasmobranch stocks in this ecoregion.

15.11 Conservation considerations

Squatina squatina is considered by IUCN as critically endangered, and considered as extirpated in the North Sea by WGEF. Also *Dipturus batis* is considered critically endangered by IUCN. OSPAR has listed *Squatina squatina*, *Dipturus batis*, *Raja montagui*, and *Raja clavata*.

In 2008 angel shark was added to the Wildlife and Countryside act in the United Kingdom, and is protected under legislation in inshore waters (within 6 nm of the coast).

In Sweden a number of demersal and deep-water elasmobranchs are contained in the Swedish Red List: velvet belly *Etmopterus spinax*, Greenland shark *Somniosus microcephalus*, *D. batis*, *D. linteus*, *R. clavata,* and rabbit fish *Chimaera monstrosa*. In the updated Redlist from 2010 *D. batis* is considered regionally extinct. Furthermore, since 2004 fishing for and landing of lesser-spotted dogfish, *R. clavata* and *D. batis* is prohibited and since 2008 rays and skates should be landed whole for easier identification. However, there is no good field identification guide for skates and rays occurring in Swedish waters which makes it likely that a lot of species-specific data are missing.

In Norway a number of demersal elasmobranchs are listed on the Norwegian Red List (2010) including various skates: *D. batis* (complex) is considered critically endangered, and *B. spinicauda*, *D. nidarosiensis* and *L. fullonica* are considered near threatened.

15.12 Management considerations

Demersal elasmobranchs are usually caught in mixed fisheries for demersal teleosts, although some inshore fisheries target *R. clavata* in seasonal fisheries in the southwestern North Sea. Up to 2008 they have traditionally been landed and reported in mixed categories such as "skates and rays" and "sharks". 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.

Since a TAC was introduced for North Sea "skates and rays" in 1999 it has generally been higher than the landings (Figure 15.1), although landings have been at or above the TAC since 2006 and may have become restrictive for some fisheries. Since its introduction the TAC has gradually been reduced. In 2009, 2010 and 2011 there were three separate TACs for Areas IIa and IV combined, for IIIa and for VIId.

Current TACs are less than the landings and if fishers do not change, their practices must either lead to an increase of discarding and/or to misreporting. WGEF therefore stated in its 2008 Report that "the current TAC should not be reduced any further at this time".

Discard survivorship could be high for inshore trawlers in the SW North Sea, as tow duration tends to be relatively short and line fisheries should also have a high discard survival (Ellis *et al*., 2008a, b). Discard survival from gillnet catches will likely be affected by soak-time. Discard survival from offshore fleets is unknown. The survival of *S. canicula* is considered high (Revill *et al*., 2005).

From 2008 onwards, species-specific landings data for the major skate species have been required. Information on the catches of the next couple of years should demonstrate what effect the low TAC will have on the fisheries.

As a consequence of effort restrictions, and high fuel prices, effort may divert to small inshore fisheries that may target skates. The main areas of *R. clavata* occur 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.

Technical interactions of fisheries in this ecoregion are demonstrated in Table 15.12.

15.13 Spatial information

Spatial information is available for surveys. However, in this instance we need to explore SPANDEX methods and other GIS methods to map the abundance in 2012.

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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. "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	.	.	.	.	.	.	.	.	.	.	.	.
Denmark	11	41	56	22	36	129	65	26	8	5	12	12
Germany	.	.	.	.	.	.	.	1	.	.	.	.
Iceland	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	+	.	.	.
Norway	208	123	154	159	163	85	94	51	13	23	33	24
Sweden	2	2	12	13	9	20	10	18	11	6	2	10
UK (E, W_& NI)	.	.	.	.	.	.	.	.	.	.	.	.
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.
Total of submitted data	221	166	222	194	208	234	169	95	32	34	47	45

Table 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea IV. Note that "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	336	332	370	436	323	276	327	350	272	371	299	294
Denmark	45	93	65	34	33	25	23	26	27	23	29	30
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	n.a.
France	41	31	61	62	36	37	34	15	56	69	74	89
Germany	16	23	11	22	21	17	29	16	17	30	21	+
Iceland	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	.	.	.	.	.	.	.	.	119	.	.	.
Netherlands	515	693	834	805	686	561	680	603	721	564	379	389
Norway	152	161	173	83	113	77	87	96	71	97	119	102
Poland	.	.	.	.	.	.	.	.	.	.	.	.
Sweden	+	+	+	+	+	+	+	+	+	+	+	+
UK (E, W_& NI)	618	516	476	500	537	550	434	348	329	392	348	372
UK (Scotland)	965	860	822	853	741	512	404	374	331	343	311	289
Total of submitted data	2688	2709	2812	2794	2490	2055	2018	1801	1944	1889	1580	1565

Table 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division VIId. "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	93	69	79	113	153	96	94	109	164	174	125	111
France	558	693	729	725	796	695	602	687	792	710	1270	1043
Germany	.	+	.	.	.	.	.	.	.	.	.	.
Ireland	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	13	21	13	10	10
Spain	.	.	.	.	.	.	.	.	.	.	.	.
UK (E, W_& NI)	437	355	169	140	186	157	147	139	188	199	152	133
UK (Scotland)	.	.	.	.	.	.	.	2	.	6	8	5
Total of submitted data	1088	1117	977	978	1135	948	843	948	1165	1102	1564	1303

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). "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	429	401	449	548	476	372	422	459	436	545	424	405
Denmark	56	134	121	56	69	154	88	52	35	28	41	42
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	n.a.
France	599	724	790	725	796	732	636	701	848	779	1344	1132
Germany	16	23	11	22	21	17	29	17	17	30	21	+
Iceland	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	.	.	.	.	.	.	.	.	119	.	.	.
Netherlands	515	693	834	805	686	561	680	615	742	577	389	399
Norway	360	284	327	242	276	162	181	120	84	120	152	126
Poland	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	.	.	.	.	.	.	.
Sweden	2	2	12	13	9	20	10	18	11	6	2	10
UK (E&W and NI)	1055	871	645	640	723	707	580	487	517	591	500	504
UK (Scotland)	965	860	822	853	741	512	404	375	331	349	320	295
Total of submitted data	3997	3992	4011	3904	3797	3237	3030	2845	3141	3025	3192	2914

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 2010.

Area IIIa	Species Categories	Weight (t)	% of national catch	% excluding generic categories
DENMARK	Skates and rays	11.5		
	Total:	11.5		
Percent of catch as species-specific landings:			0%	
NORWAY	Skates and rays	24.0		
	Total:	24.0		
Percent of catch as species-specific landings:			0%	
SWEDEN	Skates and rays	9.7		
	Total:	9.7		
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 2010. "*" are considered unreliable.

Area IV	Species Categories	Weight (t)	% of national catch	% excluding generic categories
BELGIUM	*Raja brachyura*	43.6	14.8%	20.6%
	Raja clavata	133.8	45.5%	63.3%
	Raja montagui	30.6	10.4%	14.5%
	Leucoraja circularis	0.1	0.0%	0.1%
	Leucoraja naevus	3.1	1.1%	1.5%
	Skates and rays	82.6	28.1%	
	Total:	293.9	100.0%	
Percent of catch as species-specific landings:			71.9%	
DENMARK	Skates and rays	30.3		
	Total:	30.3		
Percent of catch as species-specific landings:			0%	
FRANCE	*Dasyatis pastinaca*	0.0	0.0%	0.3%
	*Raja asterias**	0.0	0.0%	0.1%
	*Rostroraja alba**	3.9	4.4%	43.6%
	Dipturus batis	0.5	0.6%	6.0%
	Raja clavata	3.1	3.5%	34.9%
	Raja microocellata	0.1	0.1%	1.0%
	Leucoraja fullonica	0.2	0.2%	1.7%
	Leucoraja circularis	0.2	0.3%	2.7%
	Raja montagui	0.1	0.1%	1.2%
	Leucoraja naevus	0.7	0.8%	7.9%
	Dipturus oxyrinchus	0.0	0.0%	0.1%
	Raja undulata	0.0	0.0%	0.3%
	Skates and rays	79.9	90.0%	
	Total:	88.7	100.0%	
Percent of catch as species-specific landings:			10.0%	
NETHERLANDS	*Raja brachyura*	11.4	2.9%	2.9%
	Raja clavata	194.5	50.0%	50.2%
	Raja montagui	181.4	46.6%	46.8%
	Leucoraja naevus	0.3	0.1%	0.1%
	Skates and rays	1.3	0.3%	
	Total:	388.9	100.0%	
Percent of catch as species-specific landings:			99.7%	

Table 15.6. Continued.

Area IV	Species Categories	Weight (t)	% of national catch	% excluding generic categories
NORWAY	*Dipturus batis*	25.0	24.5%	100%
	Skates and rays	77.0	75.5%	
	Total:	102.0	100.0%	
Percent of catch as species-specific landings:			24.5%	
UK (E, W & NI)	*Amblyraja hyperborea**	2.3	0.6%	0.7%
	Amblyraja radiata	0.0	0.0%	0.0%
	Dipturus batis	2.3	0.6%	0.7%
	Dipturus nidarosiensis	0.0	0.0%	0.0%
	Leucoraja naevus	3.3	0.9%	1.0%
	Raja brachyura	20.8	5.6%	6.1%
	Raja clavata	296.7	79.8%	86.6%
	Raja microocellata	0.0	0.0%	0.0%
	Raja montagui	17.2	4.6%	5.0%
	Skates and rays	29.0	7.8%	
	Total:	371.7	100.0%	
Percent of catch as species-specific landings:			92.2%	
UK (Scotland)	*Raja alba**	23.7	8.2%	14.7%
	Dipturus batis	0.7	0.2%	0.4%
	Raja clavata	22.6	7.8%	14.0%
	Raja brachyura	2.3	0.8%	1.4%
	Leucoraja circularis	0.1	0.0%	0.1%
	Leucoraja naevus	77.9	26.9%	48.3%
	Raja montagui	34.0	11.8%	21.1%
	Skates and rays	127.9	44.2%	
	Total:	289.3	100.0%	
Percent of catch as species-specific landings:			55.8%	

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 2010. "*" are considered unreliable.

Area VIId	Species Categories	Weight (t)	% of national catch	% excluding generic categories
BELGIUM	*Raja brachyura*	24.1	21.7%	35.5%
	Raja clavata	38.1	34.2%	56.1%
	Raja montagui	3.5	3.1%	5.1%
	*Leucoraja circularis**	1.7	1.5%	2.5%
	Leucoraja naevus	0.5	0.4%	0.7%
	Skates and rays	43.5	39.0%	
	Total:	111.3	100.0%	
Percent of catch as species-specific landings:			61.0%	
FRANCE	*Dasyatis pastinaca*	0.1	0.0%	0.0%
	*Raja asterias**	0.2	0.0%	0.0%
	*Rostroraja alba**	9.4	0.9%	1.7%
	Dipturus batis	0.1	0.0%	0.0%
	Raja clavata	404.0	38.7%	72.4%
	Raja microocellata	18.7	1.8%	3.4%
	Leucoraja fullonica	2.6	0.2%	0.5%
	Raja brachyura	70.1	6.7%	12.6%
	Leucoraja circularis	0.1	0.0%	0.0%
	Raja montagui	32.6	3.1%	5.8%
	Leucoraja naevus	19.7	1.9%	3.5%
	Raja undulata	0.4	0.0%	0.1%
	Skates and rays	485.4	46.5%	
	Total:	1043.4	100.0%	
Percent of catch as species-specific landings:			53.5%	
NETHERLANDS	*Raja brachyura*	0.0	0.2%	0.2%
	Raja clavata	8.9	85.0%	98.5%
	Raja montagui	0.1	0.6%	0.8%
	Leucoraja naevus	0.0	0.4%	0.5%
	Skates and rays	1.4	13.7%	
	Total:	10.5	100.0%	
Percent of catch as species-specific landings:			86.3%	

Table 15.7. Continued.

Area VIId	Species Categories	Weight (t)	% of national catch	% excluding generic categories
UK (E, W & NI)	*Amblyraja hyperborea**	0.0	0.0%	0.0%
	Dipturus batis	0.1	0.0%	0.1%
	*Dipturus oxyrinchus**	1.5	1.1%	1.3%
	Leucoraja circularis	0.0	0.0%	0.0%
	Leucoraja fullonica	0.1	0.1%	0.1%
	Leucoraja naevus	0.1	0.1%	0.1%
	Raja brachyura	25.1	18.9%	21.0%
	Raja clavata	85.1	64.2%	71.2%
	Raja microocellata	2.3	1.7%	1.9%
	Raja montagui	5.2	4.0%	4.4%
	Rostroraja alba	0.1	0.0%	0.1%
	Skates and rays	13.1	9.8%	
	Total:	132.7	100.0%	
Percent of catch as species-specific landings:			90.2%	
UK (Scotland)	*Raja clavata*	1.1	21.0%	100.0%
	Skates and rays	4.1	79.0%	
	Total:	5.2	100.0%	
Percent of catch as species-specific landings:			21.0%	

Table 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings of *Scyliorhinus canicula* in IIIa, IV and VIId. "n.a." indicates not available.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	n.a.	n.a.	n.a.	n.a.	226	238	265	n.s.	338	313	293
France	1633	1811	1899	1777	1472	1614	1492	1459	1406	1751	1999
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	37	37
UK (E,W&NI)	n.a.	n.a.	n.a.	13	57	92	118	94	102	116	128
UK (Scotland)	.	.	1	5	3	22	6	3 [1)]	2 [1)]	3 [1)]	3 [1)]
	1633	1811	1900	1795	1758	1966	1881	1556	1848	2220	2460

[1)] **Registered as spotted dogfish.**

Table 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings of smooth-hounds in IIIa, IV and VIId. "n.a." indicates not available.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium					12	13	10	n.s.	12	8	5
France	146	261	478	459	587	630	722	787	668	987	978
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	0
UK (E,W&NI)						169		123	114	131	161
	146	261	478	459	598	811	731	910	794	1127	1144

Table 15.10. 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

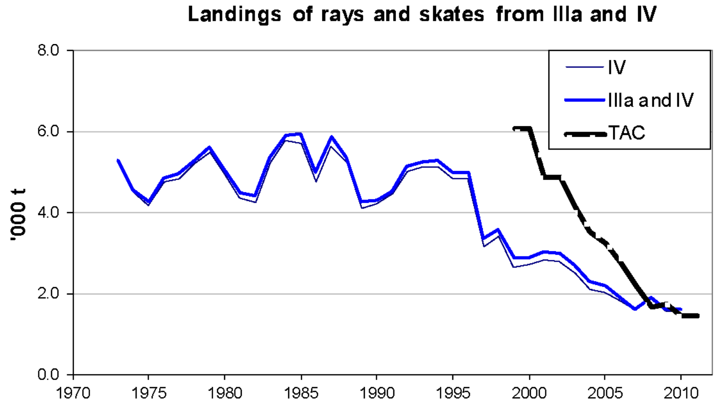
Table 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: North Sea rays and skates. Length frequency distributions (numbers in '000).

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 15.12. 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.

Main gears	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
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																		



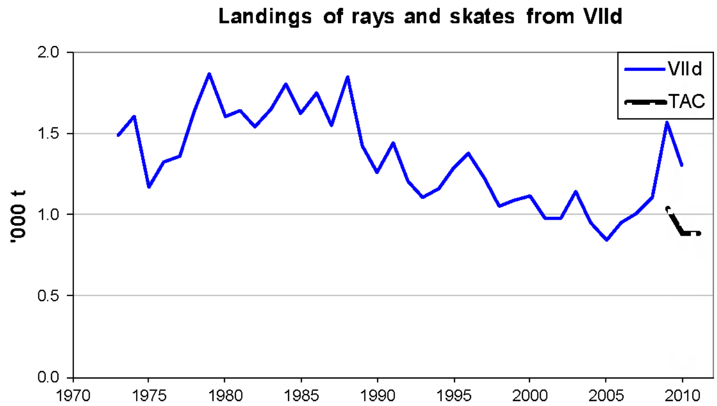


Figure 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates in IIIa and IV, and in VIId since 1973, based on WG estimates. TAC for both areas is added. The exceptional high value reported by France for 1991 has been omitted from these graphs.

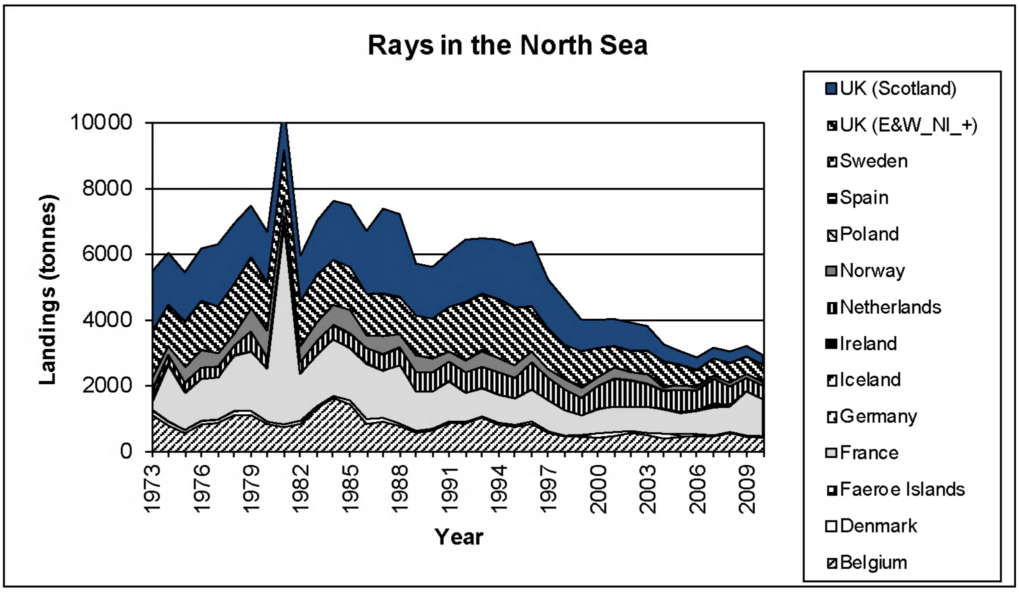


Figure 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings (t) of rays and skates from Skagerrak (IIIa), the North Sea (IV) and the eastern Channel (VIId).

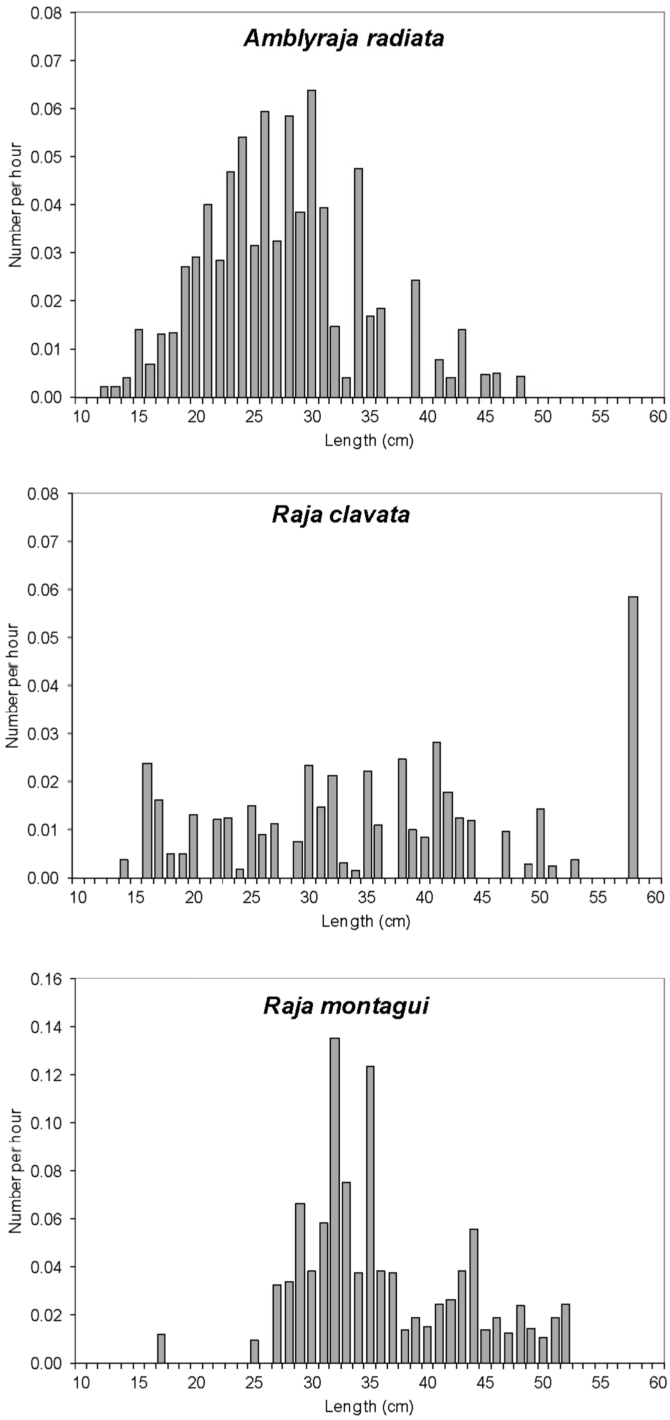


Figure 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length frequency distribution of the average number of *A. radiata, R. clavata* and *R. montagui* discarded per hour by Dutch beam trawl vessels for the period 2002–2010. Note that as the purpose of the 2009 and 2010 observer trips was to validate self-sampling trips, the data are not necessarily representative for the Dutch beam trawl fleet.

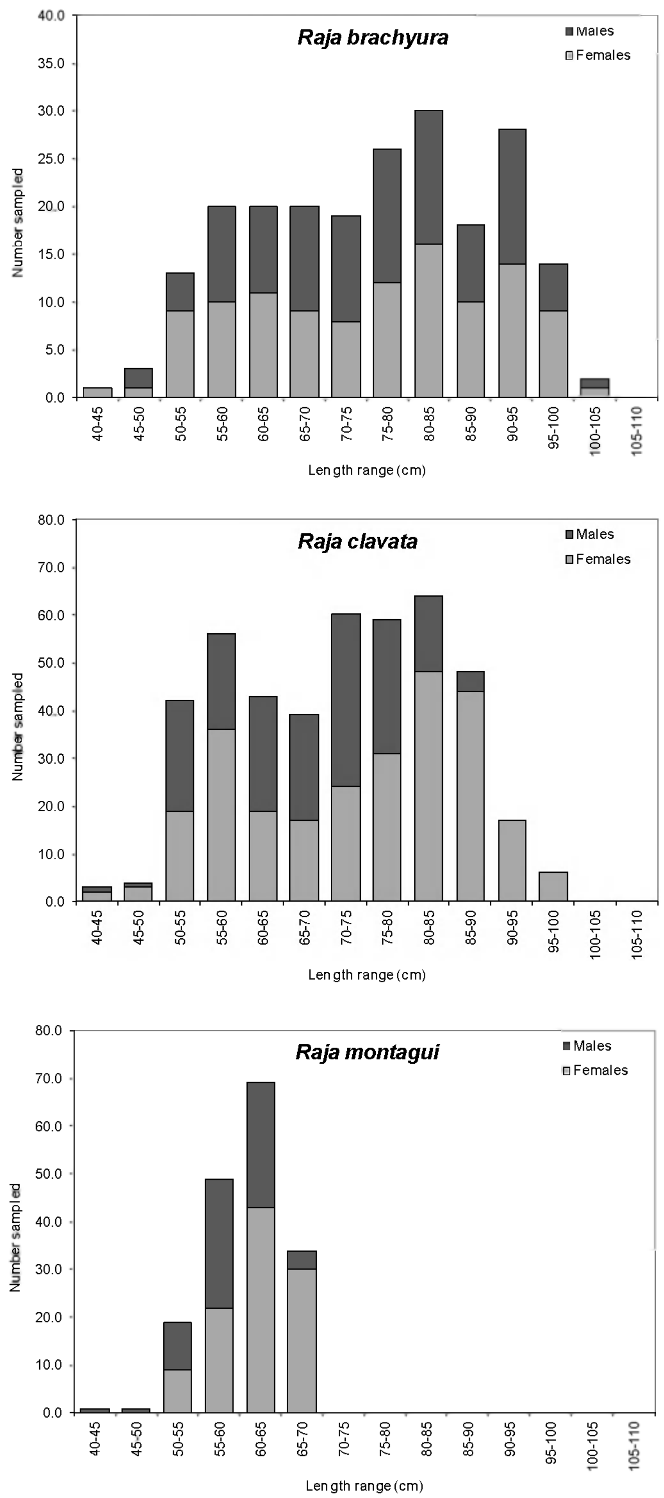


Figure 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length frequency distribution of the number of *R. brachyura, R. clavata* and *R. montagui* individuals measured during the market sampling programme of the Dutch beam trawl fleet.

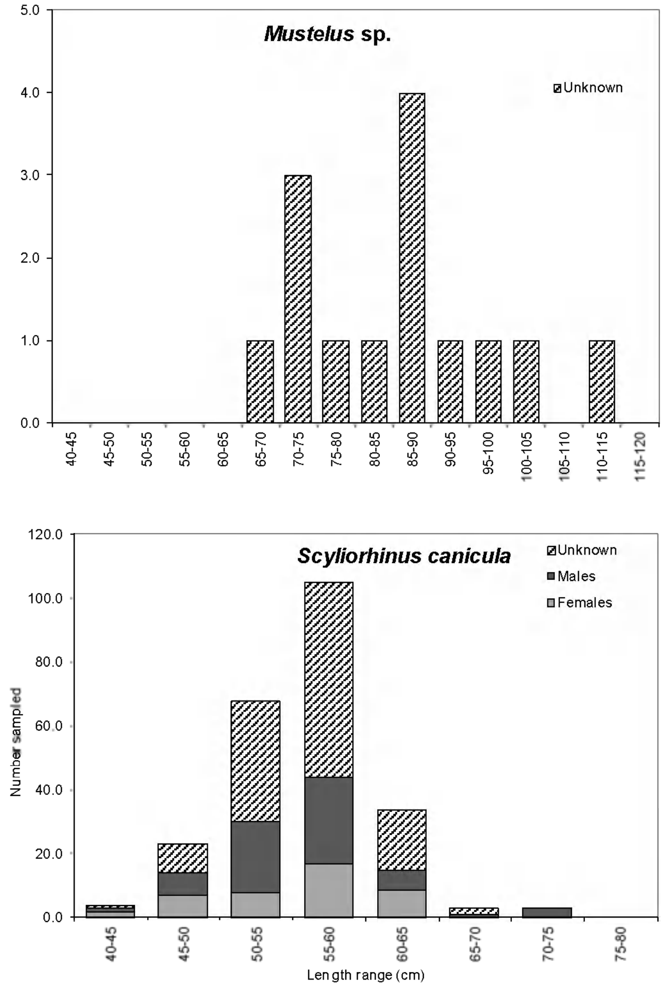


Figure 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length frequency distribution of the number of *Mustelus* sp. and *S. acanthias* individuals measured during a pilot market sampling programme of the Dutch beam trawl fleet.

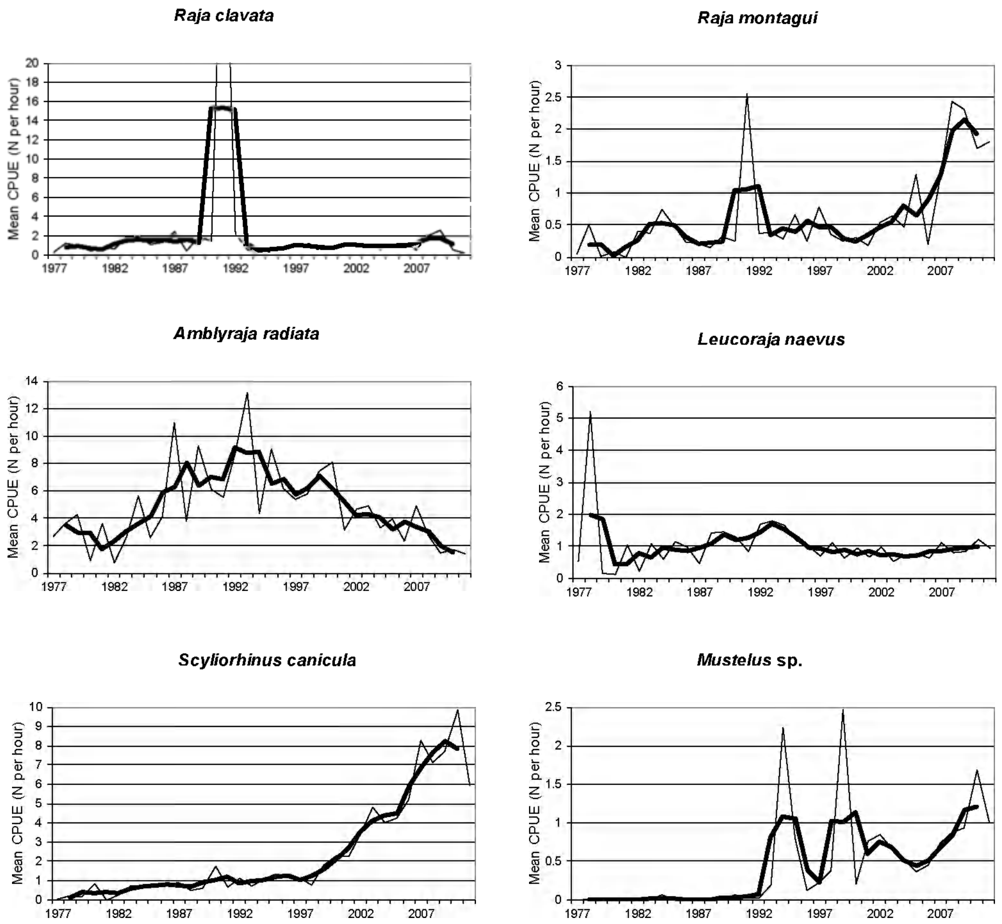


Figure 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and three year running mean during the North Sea IBTS-Q1 in the years 1977–2010 in roundfish areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec).

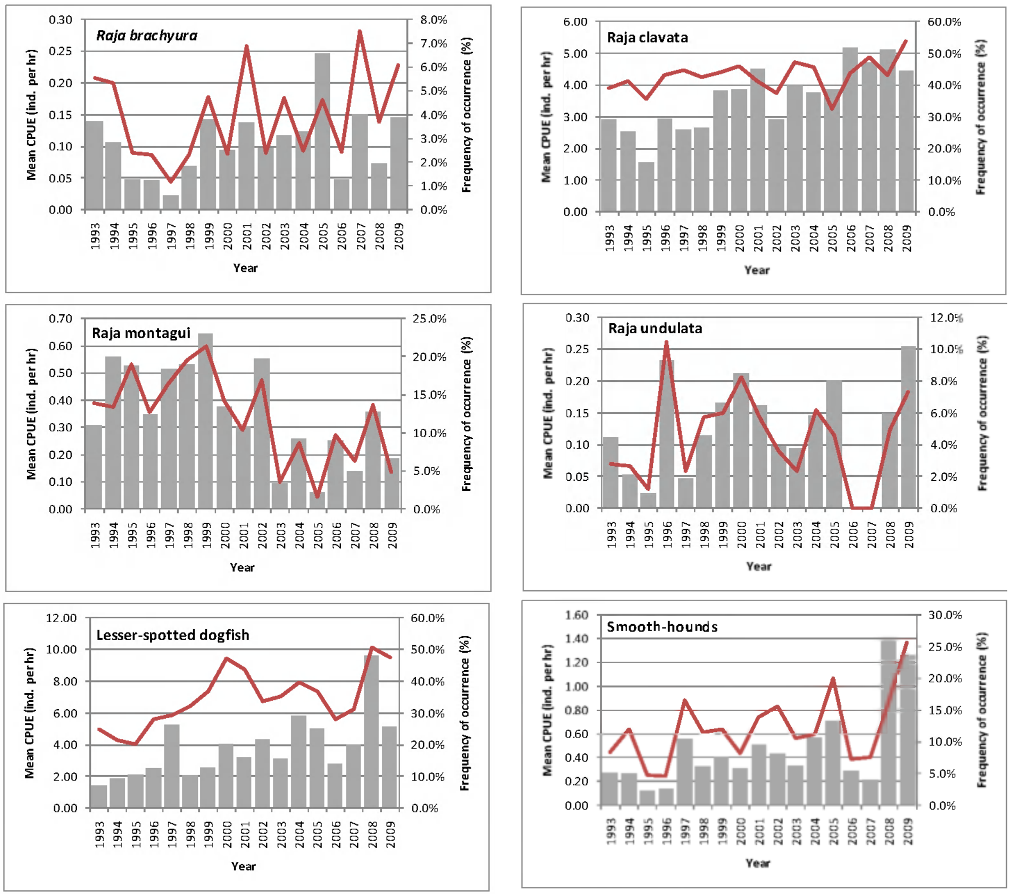


Figure 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Catch rates of the Cefas beam trawl survey in the eastern Channel 1993–2009 for *R. brachyura*, *R. montagui*, *R. clavata*, *R. undulata*, *S. canicula* and *Mustelus* spp.

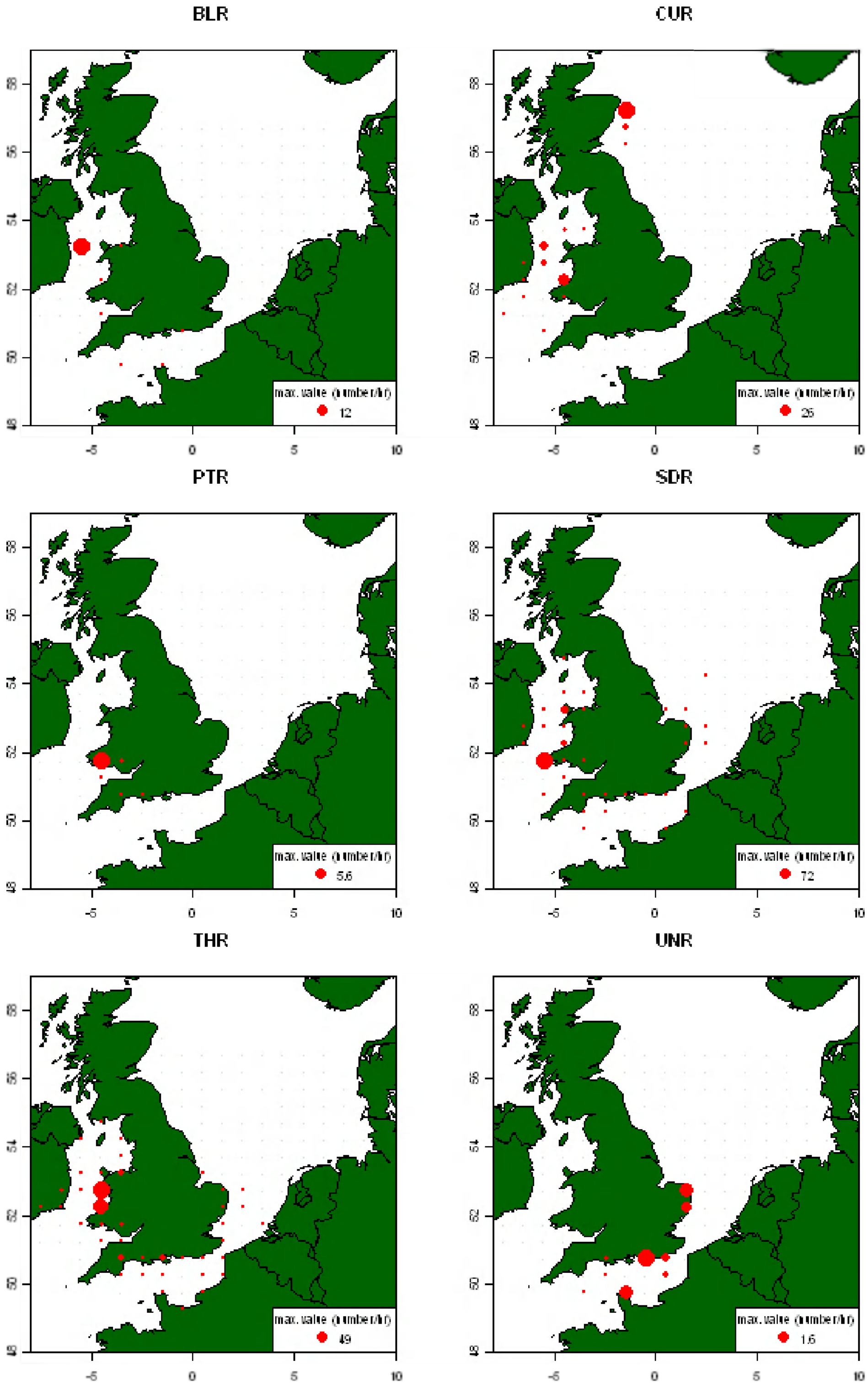


Figure 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 1996 (Source: ICES, 2011).

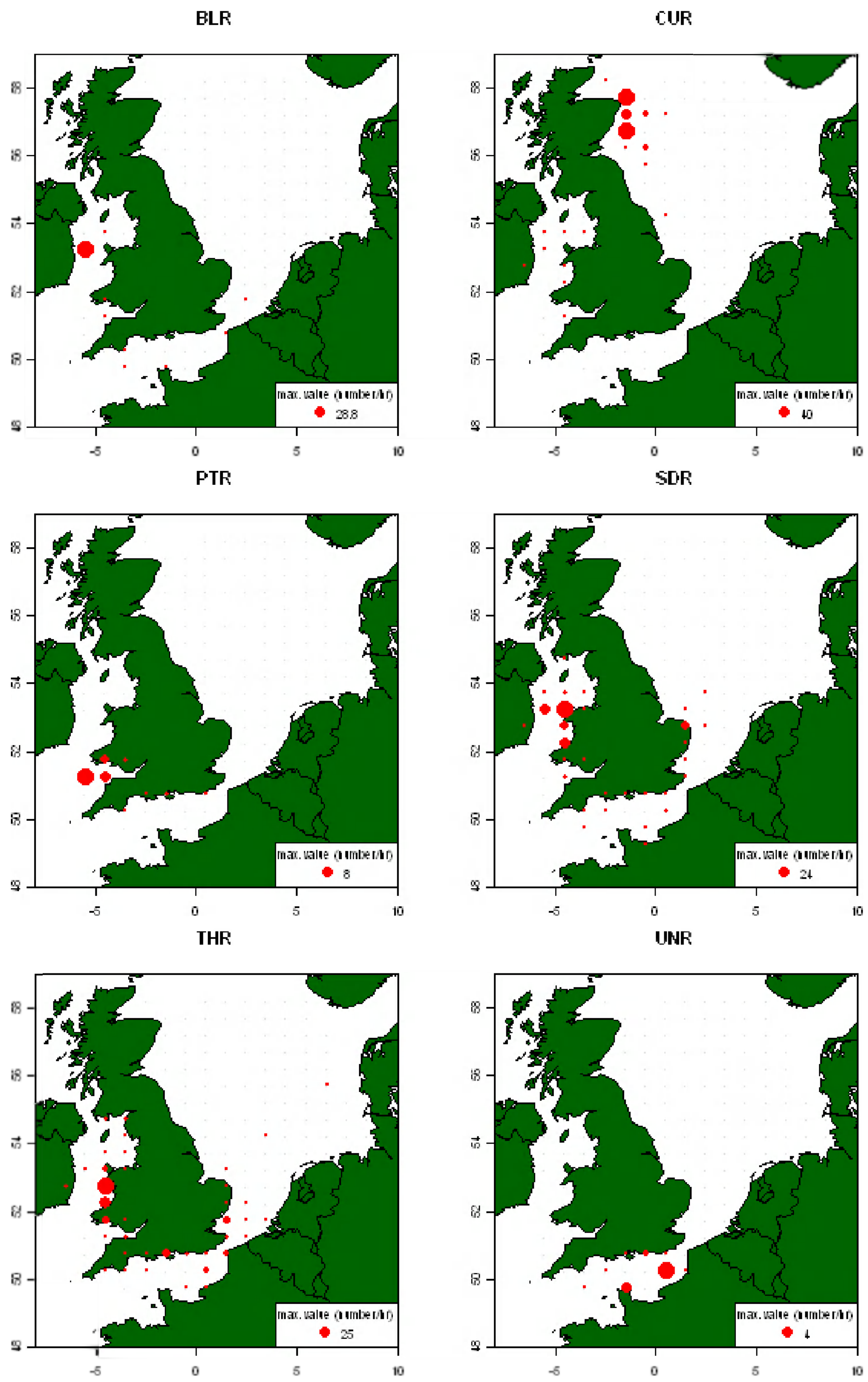


Figure 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2000 (Source: ICES, 2011).

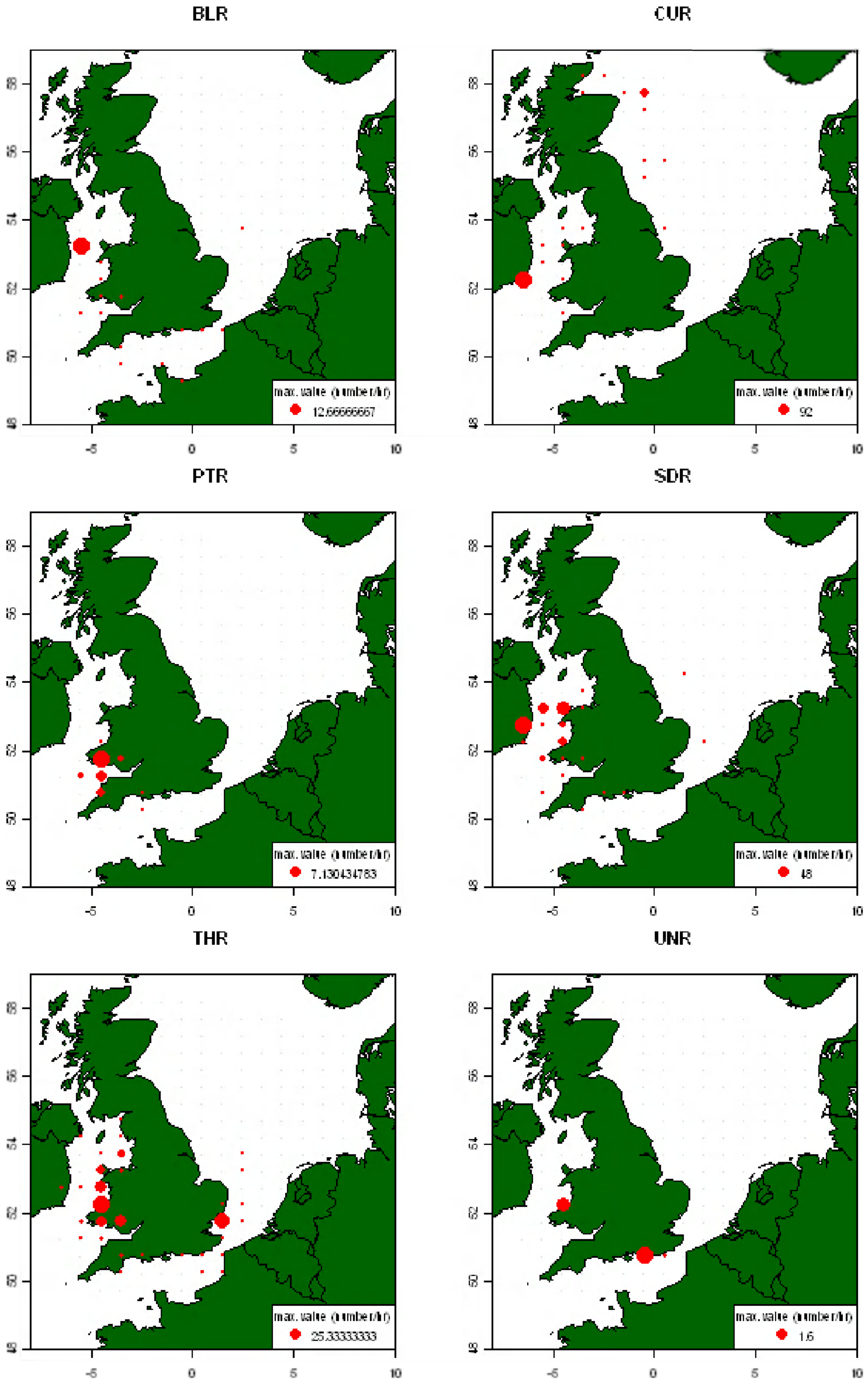


Figure 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2005 (Source: ICES, 2011).

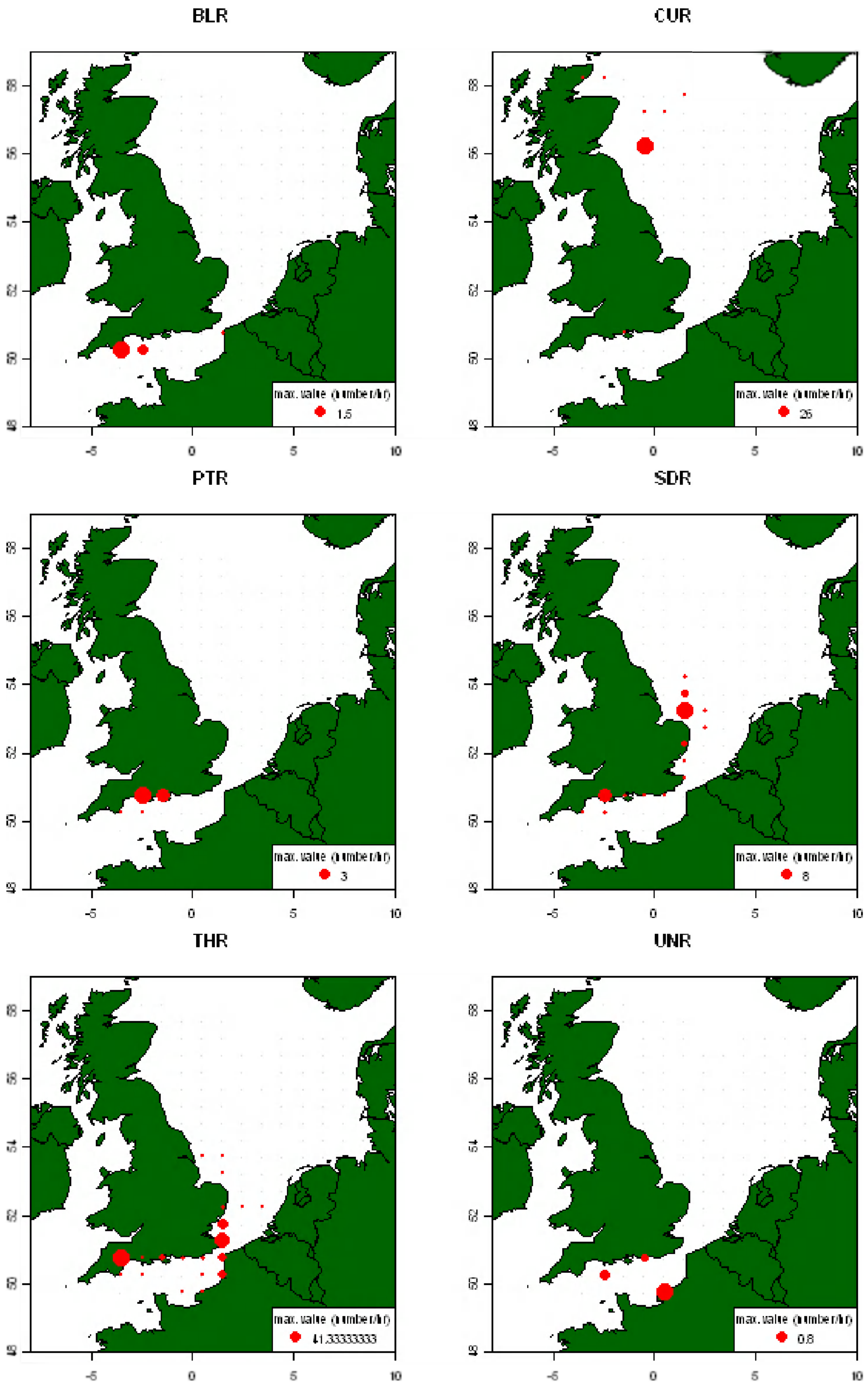


Figure 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2010 (Source: ICES, 2011).

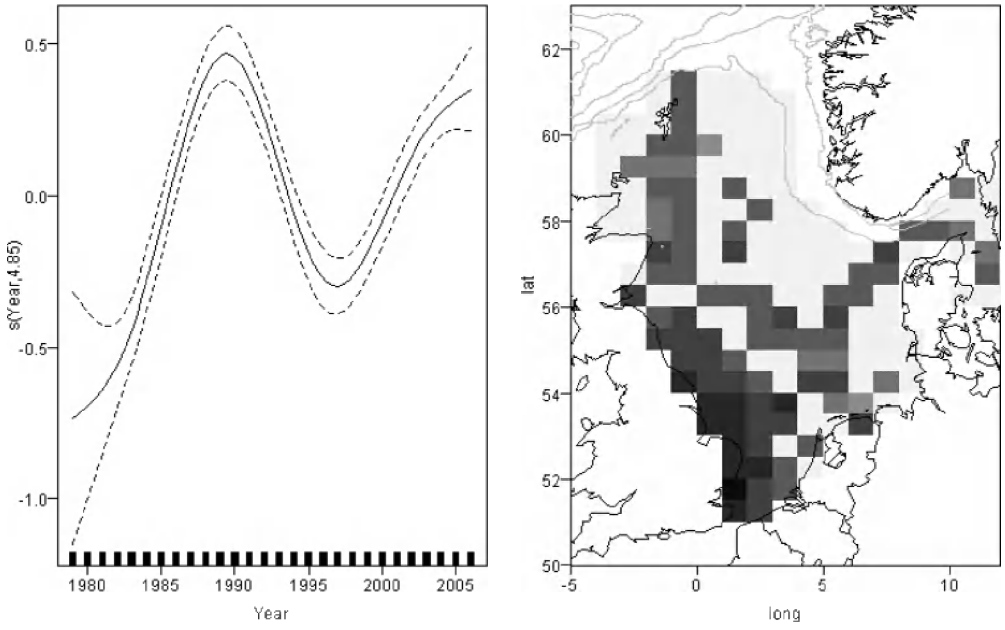


Figure 15.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Thornback ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007a).

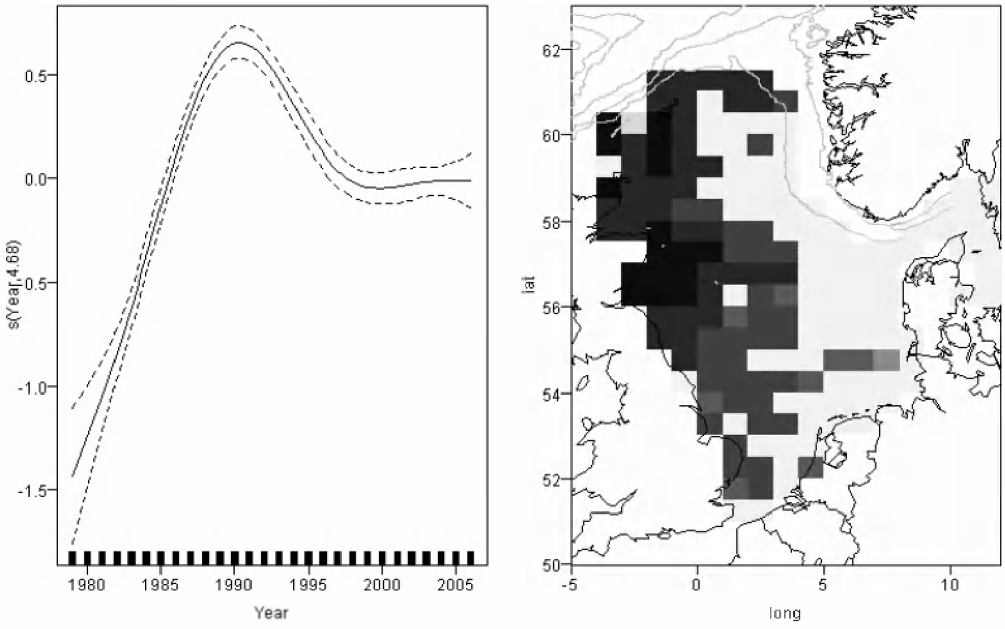


Figure 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Cuckoo ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007a).

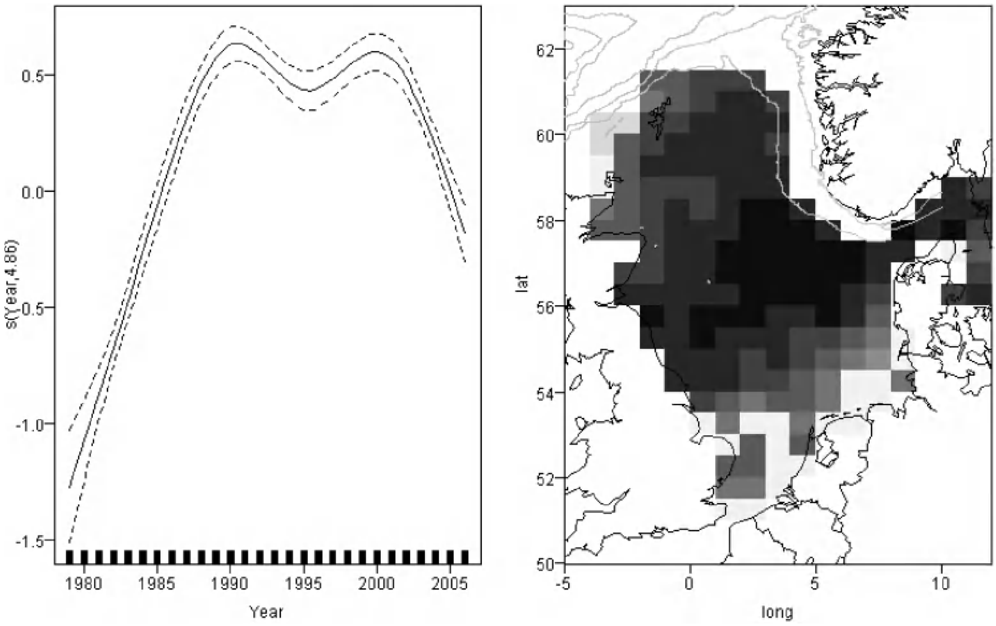


Figure 15.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Starry ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007a).

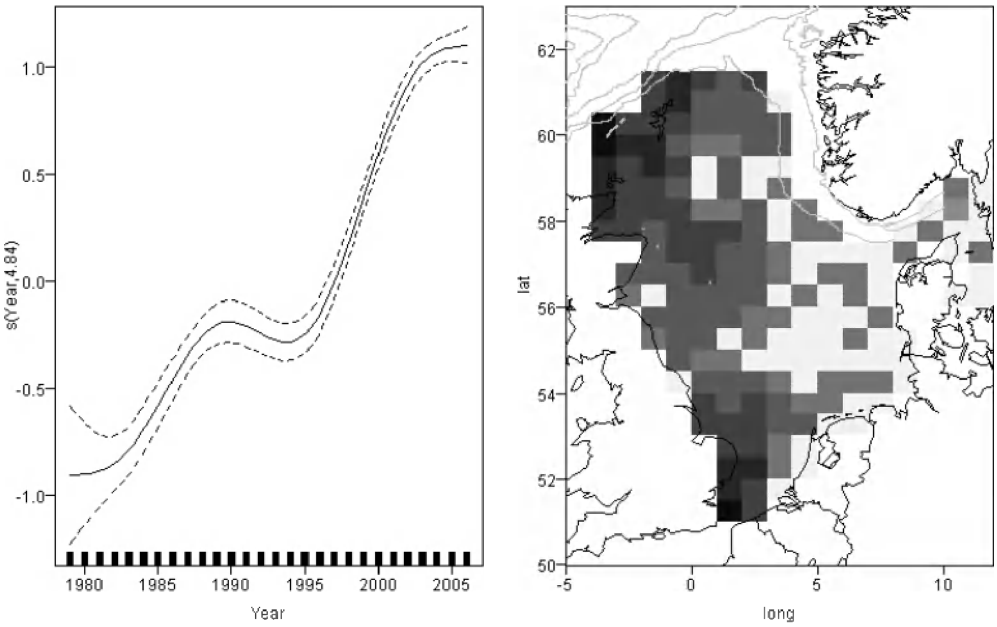


Figure 15.15. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Lesser spotted dogfish in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007a).

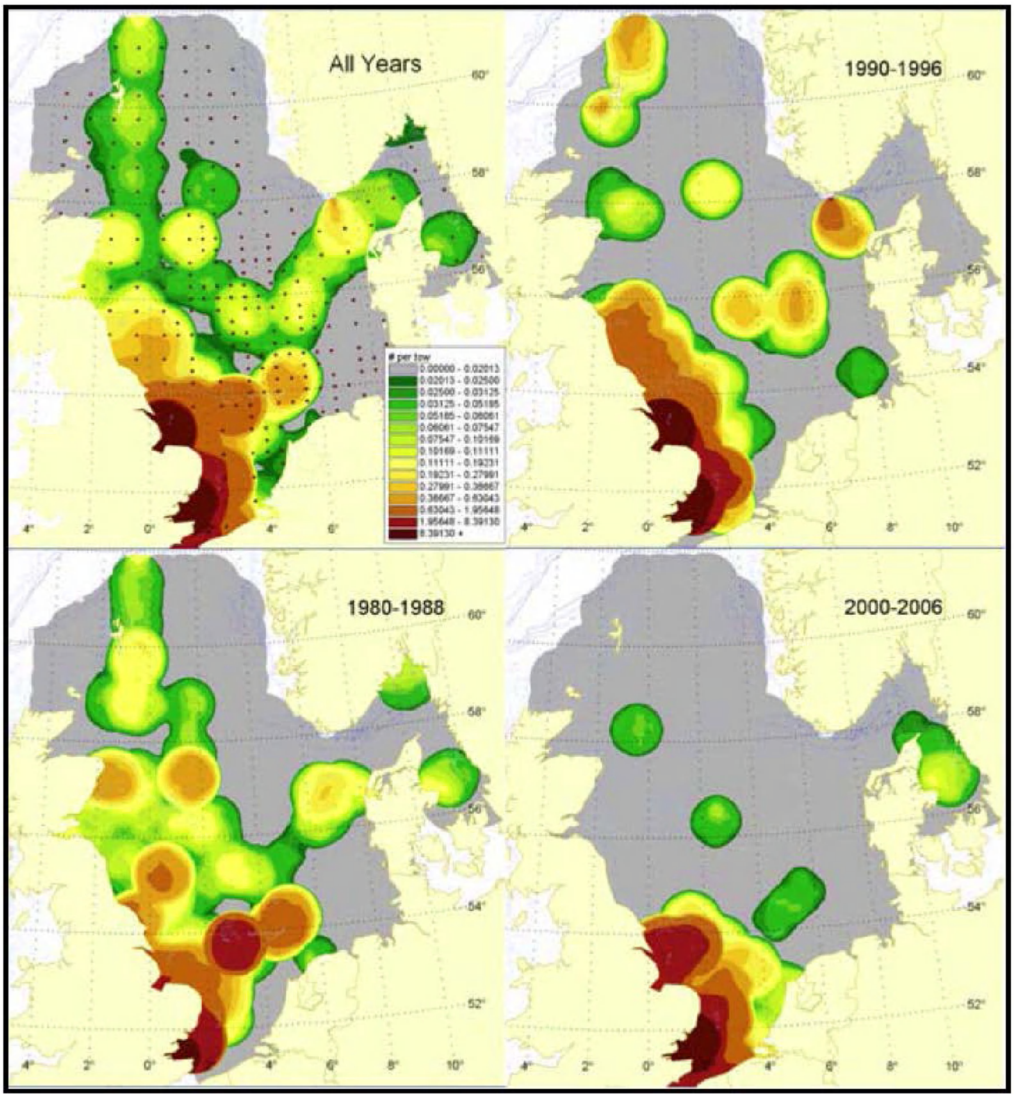


Figure 15.16. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja clavata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007a).

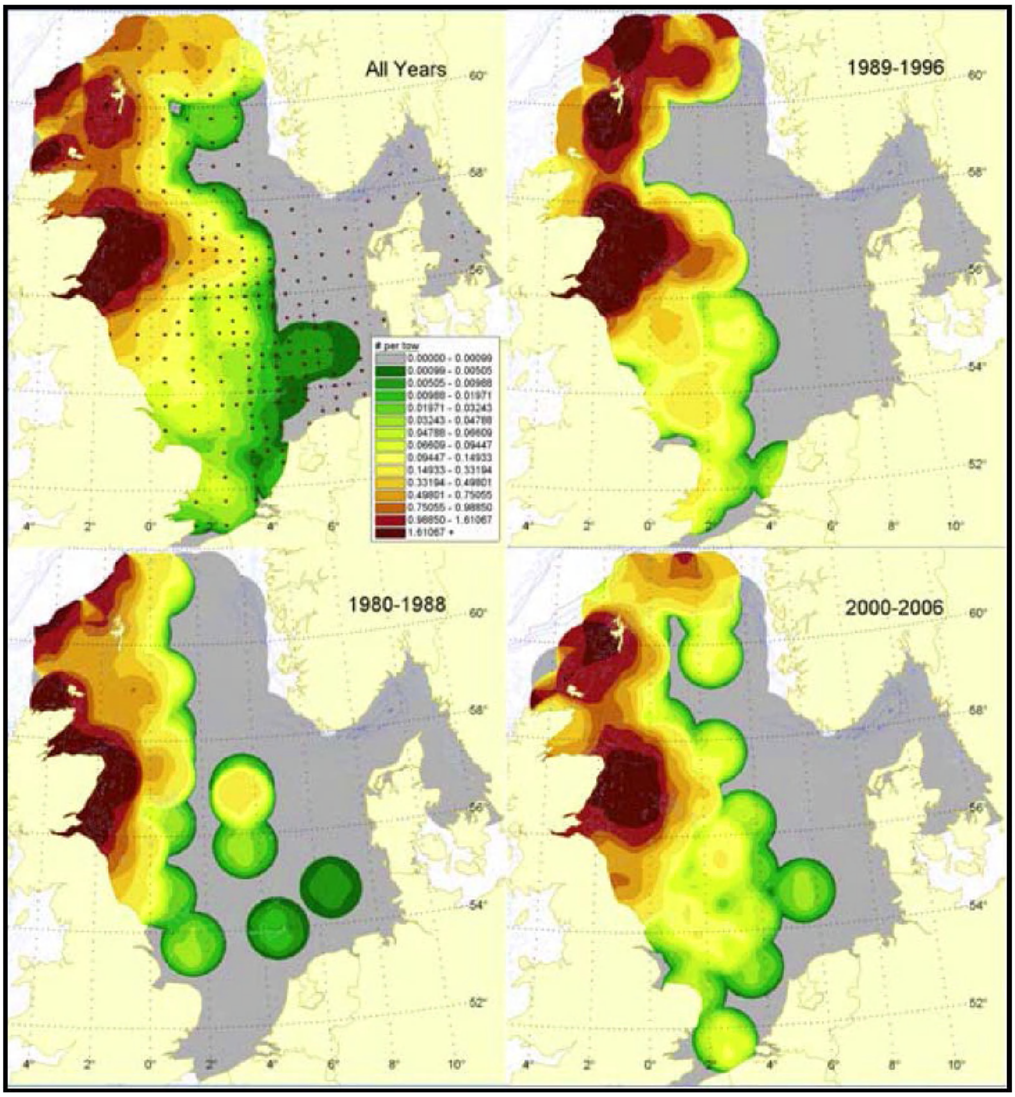


Figure 15.17. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Leucoraja naevus* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007a).

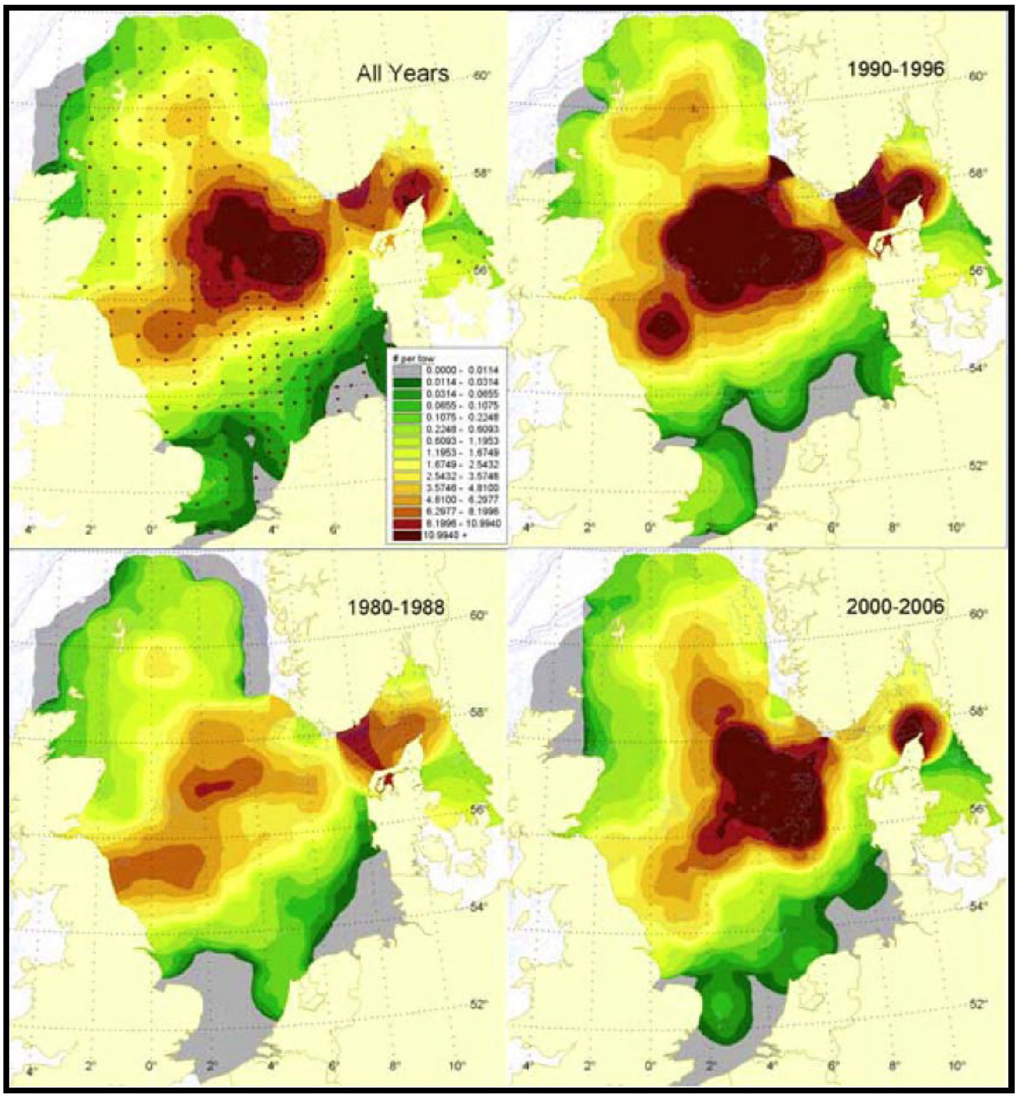


Figure 15.18. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Amblyraja radiata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007a).

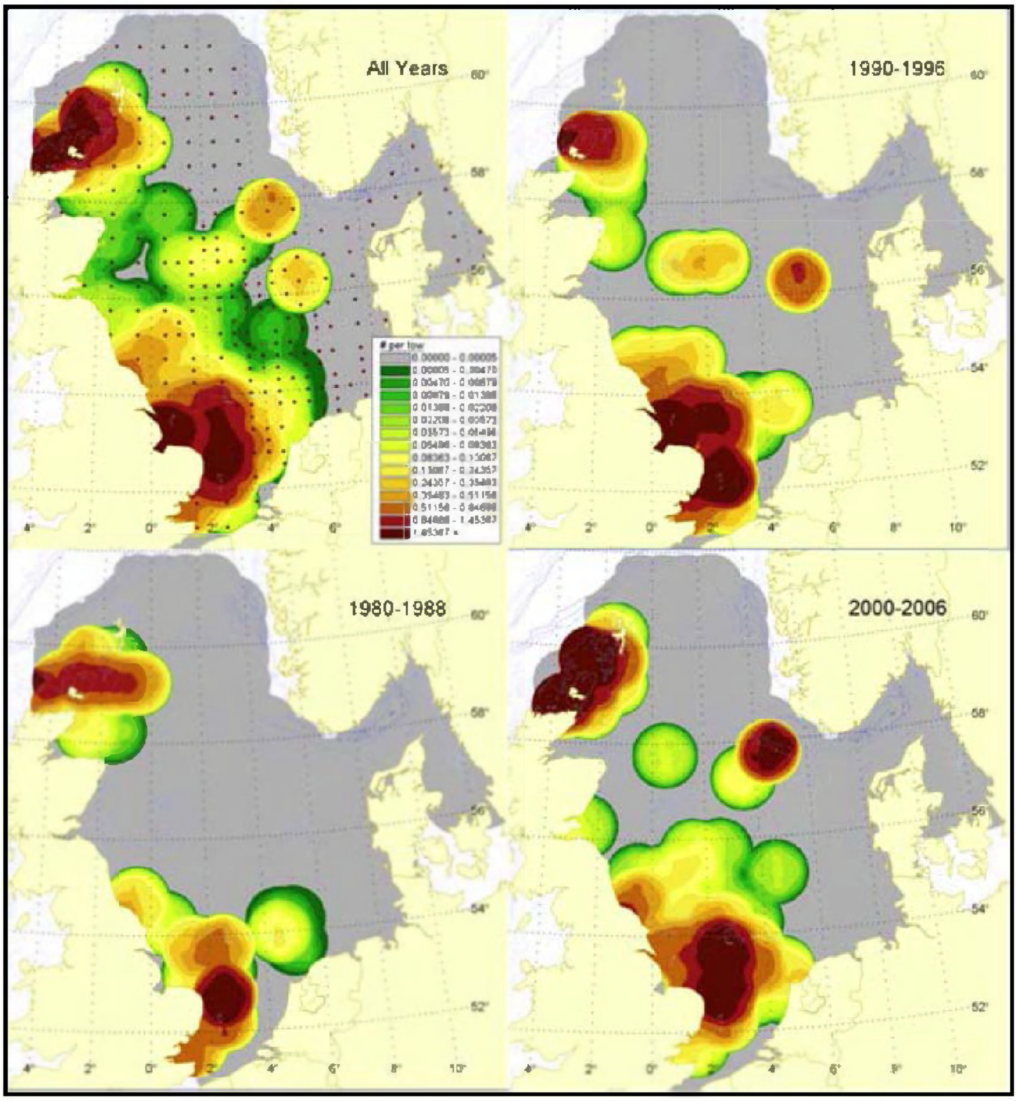


Figure 15.19. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja montagui* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007a).

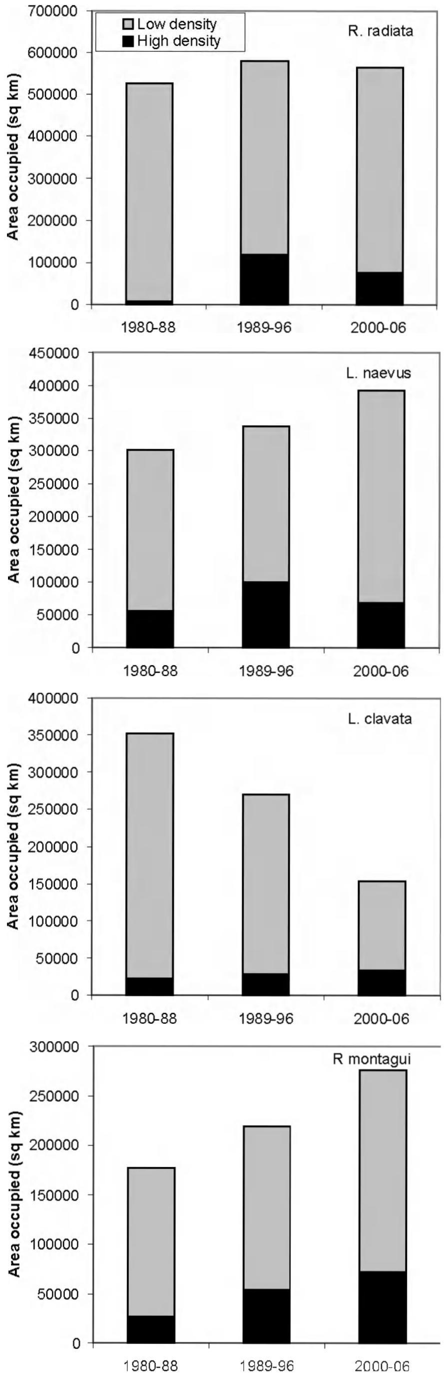


Figure 15.20. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Area occupied during three periods illustrated in the distribution maps for *Amblyraja radiata, Leucoraja naevus, Raja clavata* and *R. montagui* (Source: ICES, 2007a).

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 relatively few species. The number of species decreases as the water temperature gets colder, and only a few elasmobranch species are common in Icelandic waters. Skates occurring in the area include spinytail skate *Bathyraja spinicauda*, deep-water ray *Rajella bathyphila*, round skate *Rajella fyllae*, Arctic skate *Amblyraja hyperborea*, starry ray (or thorny skate) *Amblyraja radiata* and roughskin skate *Malacoraja spinacidermis* with Jensen's skate *Amblyraja jenseni*, Norwegian skate *Dipturus nidarosienis* shagreen ray *Leucoraja fullonica*, common skate the *Dipturus batis* species-complex and sailray *Dipturus linteus* also recorded off Iceland.

Dogfish and sharks in this ecoregion include spurdog (Section 2), Portuguese dogfish and leafscale gulper shark (Section 3), birdbeak dogfish *Deania calcea*, black dogfish *Centroscyllium fabricii*, Iceland catshark *Apristurus laurussonii*, smalleye catshark *Apristurus microps*, mouse catshark *Galeus murinus*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*, Greenland shark *Somniosus microcephalus* and velvet dogfish *Zameus squamulosus* (Section 5), porbeagle (Section 6) and basking shark (Section 7).

Chimaeras (rabbitfish *Chimaera monstrosa*, spearnose chimaera *Rhinochimaera atlantica*, large-eyed rabbitfish *Hydrolagus mirabilis*, smalleyed rabbitfish *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 are a bycatch in demersal fisheries, with Iceland the main fishing nation operating in the region. Common skate is taken with a variety of fishing gears throughout the year, and catches peak in May and June. They used to be fairly common in Icelandic waters, but landings are now only about 10% of what was landed 50 years ago. A large part of the landed catch goes to local consumption as common skate is a traditional food in Iceland, the bulk of it is eaten on December 23rd. The other part of the landed catch is processed in a variety of ways and mainly exported to Belgium where it is eaten fresh. Icelanders prepare the skate by salting or fermenting it, like with the Greenland shark. However, the shark is eaten raw whereas the skate is always boiled.

A. radiata has always been a bycatch in a variety of fishing gears around Iceland but until recently were usually discarded. The increase in landings in recent years can therefore mostly be explained by increased retention. The landed catch has grown from virtually nothing in 1980 to more than 1000 t annually between 1995 and 2004. Landings have declined again in recent years. A relatively large share goes to local consumption.

16.2.2 The fishery in 2010

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 (Subarea Va) and eastern Greenland (XIV) are given in Table 16.1. Icelandic national data for estimated landings of common skate the *D. batis* species-complex (1906–2010), starry ray *A. radiata* (1973–2010), sail-ray *D. linteus* (2000–2010) and shagreen ray *L. fullonica* (1993–2010) were made available to the group in 2010 and updated in 2011. Table 16.1 contains national data from Iceland and data from the ICES database.

Prior to 1992 all skates, with the exception of *A. radiata* and the *D. batis* species-complex, were reported as '*Raja* rays nei'. *A. radiata* and the *D. batis* species-complex have accounted for about 47% of the landings since 1992 when it is thought that all species were reported to species level. Only small quantities of *L. fullonica*, *D. linteus* and *B. spinicauda* have been reported. Fishers do not usually distinguish between *L. fullonica* and *D. linteus* in Icelandic waters. Therefore the landings of *D. linteus* are likely to be underestimated and landings of *L. fullonica* overestimated as it is, at least sometimes, *D. linteus*. Landings of the *D. batis* species-complex could also sometimes be *D. linteus*. *L. fullonica* is relatively rare in Icelandic waters.

From 1973–2010, 13 countries (Belgium, Faroe Islands, France, Germany, Greenland, Iceland, Ireland, Netherlands, Norway, Portugal, Russia, Spain and UK) have reported landings of skates, demersal sharks and chimaeras from Subareas 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* species-complex have decreased but landings of *A. radiata* have increased in later years. Landings of *A. radiata* have been under 1000 t since 2005 (Table 16.1, Figures 16.1 and 16.2). Ninety-three per cent of the skate landings came from Subarea Va. The share taken by Iceland from this area increased from <50% in the 1970s to nearly 100% from 1999 to 2010.

Information on bycatch of elasmobranchs in East Greenland waters is unavailable but several species are probably taken and discarded in the fishery for cod, shrimp and Greenland halibut *Reinhardtius hippoglossoides*. Anecdotal information indicates that some Greenland sharks taken in the shrimp fishery are landed in Iceland, but the amount is not known.

16.3.2 Discards

No information regarding discards was available.

16.3.3 Quality of catch data

The major nation fishing skate in this area now provides species-specific information.

16.4 Commercial catch composition

16.4.1 Species and size composition

No information regarding the length distribution or sex ratio from commercial landings was available.

16.4.2 Quality of data

No data available.

16.5 Commercial catch-effort data

No data available.

16.6 Fishery-independent surveys

16.6.1 Availability of survey data

Since 1998, the Greenland surveys (GR-GHXIVB) have covered the area between 61º45'–67ºN at depths from 400–1500 m. The area between 63–64ºN north 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 rock-hopper groundgear. These data were presented to WGEF in a working paper by Jørgensen (ICES, 2006) and are summarized in Table 16.2.

Examination of Icelandic survey data is still to be undertaken.

16.7 Life-history information

No new information.

16.7.1 Ecologically important habitats

No information available. Trawl survey data may provide useful information on catches of viable skate eggcases and/or on nursery grounds.

16.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data.

16.9 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.

16.10 Reference points

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

16.11 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 and rays are reported to species. The most abundant demersal elasmobranch in the southern parts of the area is *A. radiata*, which is widespread and abundant in this and adjacent waters.

As species, the *D. batis* species-complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas. Further investigation into the *D. batis* species-complex and other skates in Iceland and east Greenland is required, including from fishery-independent sources.

16.12 Spatial information

There is no high resolution spatial information available from this area. Numbers-at-length by species in national trawl surveys may be available but these data have not been available to WGEF.

16.13 References

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

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

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

Jørgensen, O. A. 2006. Elasmobranchs at East Greenland, ICES Division 14B. Working paper ICES Elasmobranch WG. June 2006.

Electronic references

http://www.fisheries.is/main-species/cartilaginous-fishes/

http://www.fisheries.is/main-species/cartilaginous-fishes/grey-skate/

http://www.fisheries.is/main-species/cartilaginous-fishes/starry-ray/

Table 16.1. Demersal Elasmobranchs at Iceland and east Greenland. Reported landings of skates from Iceland (Subarea Va) and E. Greenland (XIV) that are not reported in other sections. Data from ICES database except for starry ray and common skate for the years 1973–1991 and 2009–2010, which contains Icelandic national data as well.

WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA VA AND XIV														
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Dipturus batis	Iceland	364	275	188	333	442	424	403	196	229	245	185	178	120
Amblyraja radiata	Iceland	0	0	0	0	0	0	0	0	0	9	12	46	15
Raja rays nei	Belgium	59	51	62	36	41	23	27	36	28	11	15	15	19
	Faroe Islands	80	56	43	35	75	27	37	21	25	23	73	24	21
	Germany	76	41	49	41	37	10	2	1	2	2	4	3	2
	Norway	1	0	63	4	2	3	2	3	6	1	10	3	5
	UK - England & Wales	385	187	195	106	5	0	0	0	0	0	0	0	0
	UK - Scotland	5	8	14	8	0	0	0	0	0	0	0	0	0
Total		970	618	614	563	602	487	471	257	290	291	299	269	182

WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA VA AND XIV														
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Dipturus batis	Iceland	108	130	152	152	222	304	363	274	299	245	181	118	108
Amblyraja radiata	Iceland	44	125	39	100	163	286	317	294	1206	1749	1493	1430	1252
Leucoraja fullonica	Iceland	0	0	0	0	0	0	0	2	12	24	19	16	12
Raja rays nei	Belgium	18	22	20	22	6	9	6	3	0	0	0	0	0
	Faroe Islands	0	8	2	2	16	5	2	3	4	9	2	2	7
	Germany	1	0	0	0	1	3	1	2	0	9	0	0	1
	Norway	0	0	0	0	0	0	25	8	8	7	10	2	19
	Portugal	0	0	0	0	0	0	0	0	0	0	0	1	0
	UK - Eng+Wales+N.Irl.	0	0	0	0	0	0	1	2		4	0	0	1
Total		171	285	213	276	408	607	715	588	1529	2047	1705	1569	1400

WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA Va AND XIV													
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Dipturus batis	Iceland	80	94	82	59	120	145	167	137	117	127	128	117
	Norway	0	3	0	0	0	0	0	0	0	0	0	0
Amblyraja radiata	Iceland	996	1076	1211	1781	1491	1013	657	530	473	636	868	1029
Dipturus linteus	Iceland	0	0	0	0	10	8	20	0	0	0	8	12
Leucoraja fullonica	Iceland	21	27	37	32	17	23	16	16	25	4	33	19
Raja rays nei	Faroe Islands	5	0	2	2	0	8	9	16	7	11	n.a.	n.a.
	Germany	0	7	0	0	0	0	0	0	0	0	0	0
	Iceland	0	0	0	0	0	0	0	8	0	10	0	0
	Norway	8	3	6	5	1	0	0	7	0	1	2	4
	Portugal	0	0	1	0	0	0	0	0	0	0	0	0
	Russian Federation	0	0	0	0	0	2	6	3	0	0	n.a.	n.a.
	Spain	0	0	0	0	15	0	0	0	0	0	0	0
	UK - Eng+Wales+N.Irl.	2	0	1	0	0	1	0	1	0	0	0	0
	UK - Scotland	0	0	0	0	1	0	0	0	0	0	0	0
Total		1112	1210	1340	1879	1655	1200	875	718	622	789	1039	1181

Table 16.2. Demersal Elasmobranchs at Iceland and east Greenland. Demersal elasmobranch species captured during groundfish surveys at east Greenland during 1998–2005. Total number, observed maximum weight (kg), depth range (m) and bottom temperature range ºC and most northern position (decimal degrees; adapted from 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	65.46ºN
Rajella bathyphila	57	45.3	476–1493	0.3–4.1	65.44ºN
Rajella fyllae	117	4.8	411–1449	0.8–5.9	65.46ºN
Amblyraja hyperborea	12	23.4	520–1481	0.5–5.4	65.47ºN
Amblyraja radiata	483	22.1	411–1281	0.8–6.6	66.21ºN
Malacoraja spinacidermis	3	3.1	1282–1450	2.3–2.7	62.25ºN
Apristurus laurussoni	3	0.7	836–1255	1.7–4.3	65.22ºN
Centroscyllium fabricii	812	128	415–1492	0.6–5.1	65.40ºN
Somniosus microcephalus	9	500	512–1112	1.4–4.9	65.35ºN

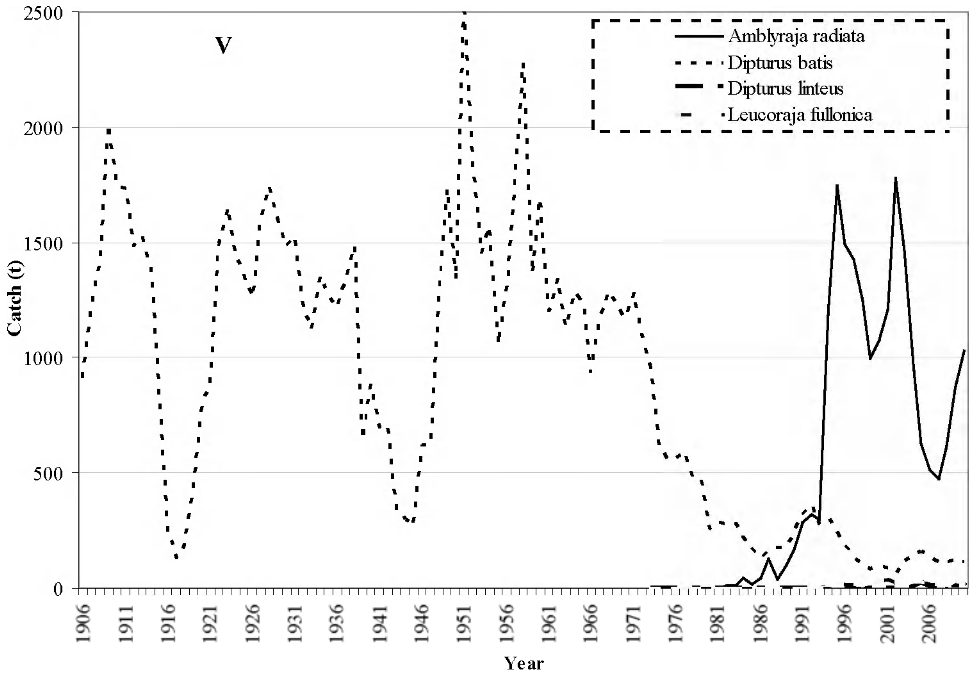


Figure 16.1. Demersal Elasmobranchs at Iceland. WG estimates of the most commonly reported rays and skates in Va, 1906–2010.

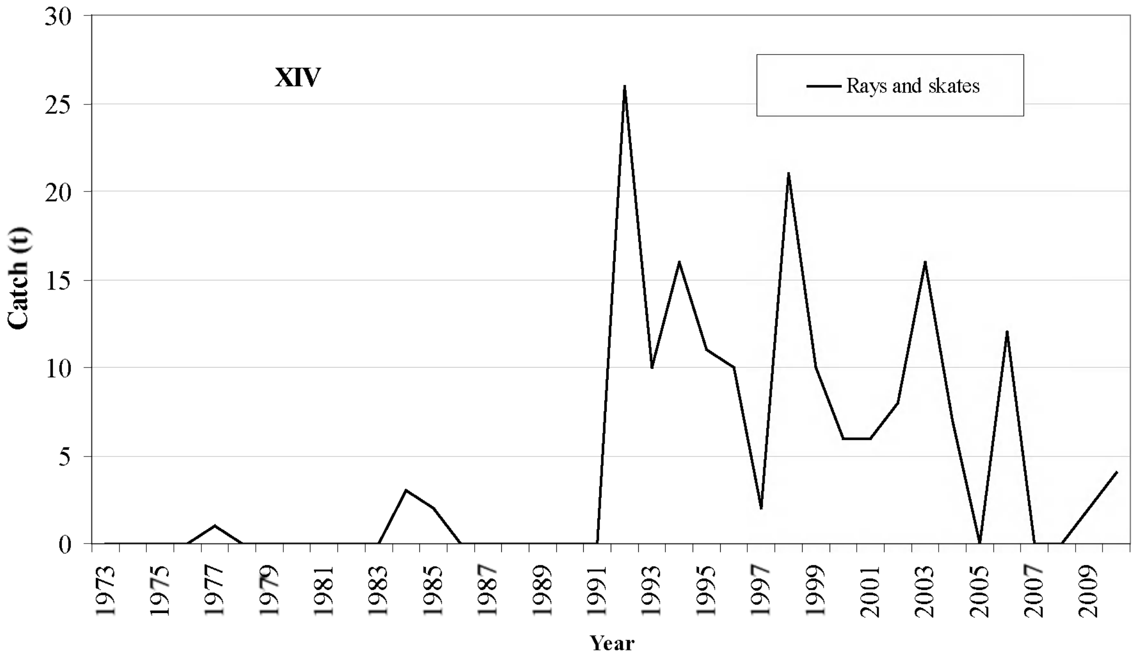


Figure 16.2. Demersal Elasmobranchs at east Greenland. WG estimates of the most commonly reported rays and skates in XIV, 1973–2010.

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 studied in the scientific literature, though it is likely to be somewhat similar to that occurring in the northern North Sea and off NW Scotland and Iceland. Skates recorded in the area include common skate the *Dipturus batis* species-complex, sailray *Dipturus linteus*, 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*, Arctic skate *Amblyraja hyperborea*, starry ray (thorny skate) *Amblyraja radiata*, white skate *Rostroraja alba* and common stingray *Dasyatis pastinaca*. Demersal sharks include several deep-water species (Leaf-scale gulper shark *Centrophorus squamosus*, black dogfish *Centroscyllium fabricii*, bird-beak dogfish *Deania calcea*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*, Greenland shark *Somniosus microcephalus*, mouse catshark *Galeus murinus* and blackmouth catshark *Galeus melastomus*; see Section 5) and spurdog *Squalus acanthias* (Section 2). 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, ten countries (Belgium, Denmark, Faroe Islands, France, Germany, Netherlands, Norway, Poland, UK and Russia) have reported landings of demersal elasmobranches from Division Vb. Faroese vessels include trawlers and, to a lesser extent, longliners and gillnetters. Norwegian vessels fishing in this area are longliners targeting ling, tusk and cod. UK vessels include a small number of large Scottish trawlers that are occasionally able to obtain quotas to fish in Faroese waters targeting gadoids and deep-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 UK. Demersal elasmobranchs likely represent a minor to moderate bycatch in these fisheries.

In 2007, a Russian longliner started fishing 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).

17.2.2 The fishery in 2010

In 2010 there were landings reported from three countries (France, Norway and Scotland). Data from the Faroe Islands were not available at the time of the meeting. Detailed info about the Russian fishery can be found in ICES 2010.

17.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

17.2.4 Management applicable

The majority of the area is managed by the Faroes through an effort based system which restricts days fishing 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, mainly unidentified, are presented in Table 17.1. French reported landings of the *D. batis* species-complex do not represent the entire catch of this species as an unknown quantity is included in the category of unidentified rays for all counties. Total landings of skates combined is shown in Figure 17.1.

WGEF noted a large decline in the Faroese landings in 2009 and have no new data for 2010.

17.3.2 Discards

The amount of discarding of skates and demersal sharks from this area is unknown.

17.3.3 Quality of catch data

Species-specific information for commercial catches is lacking.

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 included the *D. batis* species-complex, *L. fullonica*, *R. clavata* and *A. radiata.*

No information regarding size composition or sex ratio from commercial landings was available.

17.4.2 Quality of data

Information on the species and length composition is required.

17.5 Commercial catch-effort data

No information available to WGEF.

17.6 Fishery-independent surveys

No survey data from this area were available to the Working Group. 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.

17.7.1 Ecologically important habitats

No information available. Trawl survey data may provide useful information on catches of viable skate eggcases and/or on nursery grounds.

17.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data being available to WGEF.

17.9 Quality of assessments

No assessments have been conducted to date. Analyses of survey trends may allow the general status of the more frequent species to be evaluated.

17.10 Reference points

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

17.11 Management considerations

Total international reported landings of skates declined from 1973–2003 but increased to above the average of the time-series in 2004. Without further information on the fisheries such as better differentiation of species, amounts of discards, sizes caught, it is not possible to provide information on the pattern of exploitation or on the status of stocks.

The elasmobranch fauna off the Faroe Islands is little studied in the scientific literature, 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.

As species, the *D. batis* species-complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas. Further investigation into the *D. batis* species-complex and other skates in the Faroe Islands is required, including from fishery-independent sources.

17.12 Spatial information

There is no high resolution spatial information available from this area. Numbers-at-length by species in national trawl surveys may be available but these data have not been available to WGEF.

17.13 References

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

Magnussen, E. 2002. Demersal fish assemblages of the Faroe Bank: Species composition, distribution, biomass spectrum and diversity. Marine Ecology Progress Series 238: 211–225.

Vinnichenko V.I. 2008. Russian deep-sea investigations and fisheries in the Northeast Atlantic in 2007. Working Document for the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources, ICES, 9 p.

Table 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division Vb).

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
	UK - Eng+Wales+N.Irl.	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	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

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
	UK - Eng+Wales+N.Irl.	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	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).

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
Raja rays nei	Faroe Islands	175	0	76	25	98	272	274	238	185	178	18	na
	France	2	0	0	1	5	8	6	20	8	6	5	0
	Germany	1	1	0	0	2	1	0	0	0	0	0	0
	Norway	45	50	21	15	5	0	11	10	16	5	4	11
	UK - Eng+Wales+N.Irl.	0	23	2	0	2	15	5	0	0	0	0	0
	UK - Scotland	6	12	25	12	6	5	25	2	2	2	4	3
Dipturus batis	Norway	0	0	0	0	0	0	0	0	0	4	0	0
	France	4	2	2	2	3	2	1	2	1	0	0	0
	UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	5
Leucoraja naevus	France	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	2
Dipturus oxyrinchus	France	0	0	3	0	0	0	0	0	0	0	0	0
Raja clavata	France	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
Raja montagui	France	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

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
Leucoraja circularis	France	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
Rostroraja alba	France	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	2
	Total	233	89	129	55	122	304	323	272	213	196	33	24

Table 17.2. Demersal elasmobranchs at the Faroe Islands. Elasmobranchs taken 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	<100 m	100-200 m	200-300 m	300-400 m	400-500 m	>500 m	Total
Galeus melastomus	–	+	*	*	**	**	*
Galeorhinus galeus	–	+	–	–	–	*	+
Squalus acanthias	–	*	*	**	*	**	*
Etmopterus spinax	–	+	–	–	*	**	*
Centroscyllium fabricii	–	–	–	–	*	–	+
Amblyraja radiata	–	–	–	–	–	**	+
Dipturus batis	–	*	*	–	–	**	*
Leucoraja fullonica	–	+	+	–	–	*	+
Leucoraja circularis	–	–	*	–	–	–	+
Rajella fyllae	–	+	–	–	–	–	+
Dipturus linteus	*	+	–	–	–	–	+
Raja clavata	–	+	–	–	–	–	+
Chimaera monstrosa	*	*	**	***	***	***	**

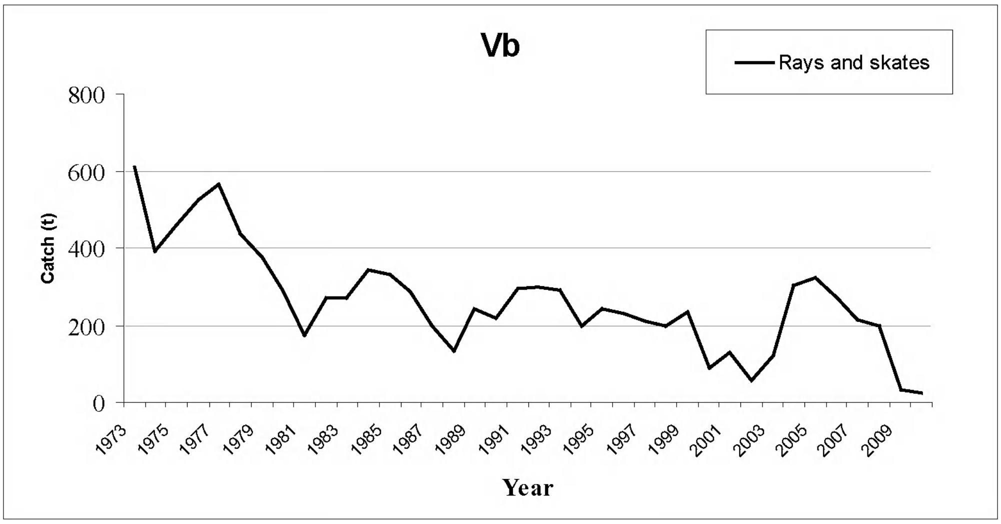


Figure 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates and rays from Division Vb based on ICES FISHSTAT and data from France.

18 Demersal elasmobranchs in the Celtic Seas (ICES Subareas VI and VII (Except Division VIId))

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 Northwestern Waters RAC. 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) and lesser-spotted dogfish, 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 2010c), and are summarized in Table 18.1.

Although there have been some tagging studies of skates in the Bristol Channel and Irish Sea (e.g. Pawson and Nichols, 1994), which have indicated some mixing between the Irish Sea and Bristol Channel, and some genetic studies of *R. clavata* (Chevolot *et al.*, 2006), the stock identity for many of these species is poorly known. Further studies on stock structure are required, especially for some of the offshore species such as *L. naevus*, for which it is unclear as to the degree of connectivity of populations in the Celtic Sea, Irish Sea and off NW Scotland, as well as 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 undulate and blonde ray.

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 Ireland, UK, France, Spain, with smaller catches by Belgium and Germany. 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, rays and dogfish, particularly for those species close to shore, with some ports having locally important charter boat fisheries. Whereas many anglers return tope, smooth-hounds and greater-spotted dogfish, there is likely to be some retention of skates, although the levels of these catches are unknown.

18.2.2 The fishery in 2010

There is no new information relating specifically to elasmobranchs. TAC and quota regulations may have been restrictive for some fisheries, and the inclusion of common skate (the *Dipturus batis*-complex) and undulate ray *Raja undulata* on the prohibited species list will have resulted in increased discarding of these species in areas where they may be locally common.

Landings tables for the relevant species are provided in Tables 18.2–18.5.

18.2.3 ICES advice applicable

ICES provided advice for several species/stocks in this region in 2010, as summarized below:

Species that should be retained on the Prohibited Species List:

- White skate (Subarea VII);
- Angel shark (Subareas VI–VII) rare in this ecoregion, and near extirpated from parts of its former range.

No targeted fisheries

- Common skate (Subareas VI; VII) depleted;
- Undulate ray (Divisions VIId,e; VIIj) stock status uncertain, locally common in discrete areas.

Reduce from recent catch level

- Cuckoo ray (Subareas VI; VII).

Status quo catch

- Thornback ray (Divisions VIa; VIIa,f,g; VIIe);
- Spotted ray (Divisions VIa; VIIa,f,g; VIIe);
- Small-eyed ray (Division VIIf);
- Lesser-spotted dogfish (Subareas VI; VII);
- Smooth-hounds (Subarea VII).

No advice

- Blonde ray (Divisions VIa; VIIa; VIIe; VIIf);
- Sandy ray (Areas VI; VIIb,c,h–k);
- Shagreen ray (Areas VI; VIIb,c,g–k);
- Long-nose skate (Subareas VI–VII);
- Norwegian skate (Subarea VI);
- Greater-spotted dogfish (Divisions VIIa,e,f).

ICES was also 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"*.

18.2.4 Management applicable

A TAC for skates and rays in VI and VIIa–c, e–k was first established for 2009 and set at 15 748 t. This was reduced by 15% in 2010 to 13 387 t, and by a further 15% to 11 379 t for 2011. 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

1) Catches of cuckoo ray (*Leucoraja naevus*), thornback ray (*Raja clavata*), blonde ray (*Raja brachyura*), spotted ray (*Raja montagui*), small-eyed ray (*Raja microocellata*) sandy ray (*Leucoraja circularis*), shagreen ray (*Leucoraja fullonica*) should be reported separately.

2) Does not apply to undulate ray (*Raja undulata*), common skate (*Dipturus batis*), Norwegian skate (*Dipturus nidarosiensis*) and white skate (*Rostroraja alba*). Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

3) Of which up to 5% may be fished in EU waters of VIId.

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 (2010c).

18.3 Catch data

18.3.1 Landings

Landings data were supplied by all nations, with 2009 data for France also supplied this year. Data for 2010 are considered provisional.

18.3.1.1 Skates

Landings tables for skates (Rajidae) by country are provided in Tables 18.2a–h. Landings for the entire dataseries available are shown in Figure 18.1(a–c). Where species-specific landings have been provided they have been included in the total for the relevant year. Although there are about 15 countries involved in the fisheries in this ecoregion, only six of these (Belgium, France, Ireland, UK (England and Wales), UK (Scotland) and Spain) have continually landed large amounts of skates.

Landings appear as a series of peaks and troughs, 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 in recent years.

West of Scotland (VIa)

Reported landings in this Division are at their lowest point since 1973, with almost all countries declaring less than previous landings. Average landings of around 3000 t in the early 1990s are now down to less than 1000 t.

Rockall (VIb)

Reported landings of skates from Rockall have usually been less than 500 t per year, but are now down to just under 200 t. 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 with no Spanish landings 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 of skates in the Irish Sea vary considerably, and ranged from over 1500 t in 1995 to ca. 5000 t in the late 1980s. Recent landings are generally less than 2000 t. This may be as a result of 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 skate landings in the mid-1970s, skate landings in VIIf have ranged from 1000–1600 t in recent years. Landings in this area are predominantly from three countries (UK, France and Belgium).

Western English Channel, Celtic Sea and west of Ireland (VIIb–c,e,g–k)

Annual reported skate 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. Landings subsequently declined to approximately 1000 t per year, which is of a comparable magnitude to earlier landings. The level of misreporting in the period 1996–2003 is unknown.

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 ca. 5000 t in recent years.

18.3.1.2 Skate landing categories

Historically, most skate landings have been reported under a generic landing category, although some nations (e.g. France) have reported some species-specific landings. Available species-specific data were shown in ICES (2010c) and species-specific data continue to be reported. Although the quality of these data were not been appraised this year, the species-specific landings data will be evaluated next year.

18.3.1.3 Dogfish

Although there are reasonable landings data for spurdog (Section 2) and, to a lesser extent, tope (Section 10), data for other demersal sharks are more limited, and often included in generic landings categories. Nominal landings are provided for lesser-spotted dogfish (Table 18.3), *Mustelus* spp. (Table 18.4; Figure 18.2) and angel shark *Squatina squatina* (Table 18.5; Figure 18.2)

Landings tables for lesser-spotted dogfish are underestimates, as it was not possible to disaggregate this species from the generic categories under which it is often declared and the lack of consistency by which it is categorized. As a consequence of the lack of species-specific landings data for demersal sharks, and the absence of market sampling, it is not currently possible to differentiate the landings of demersal shark species in most areas.

Angel shark (historically termed monkfish) *Squatina squatina* is increasingly rare, and this species was rarely reported in landings data prior to it being listed as a prohibited species (Table 18.8, Figure 18.3). It is believed that the peak in UK landings in 1997 from VIIj–k were either misreported anglerfish (also called monkfish) or hake, as *S. squatina* is more of a coastal species. These figures have been removed from the landings data. French landings have declined from >20 t in 1978 to less than 1 t per year prior to the prohibition on landings.

18.3.2 Discards

Preliminary discard information from the Irish and UK fleets were presented in earlier reports (see ICES, 2010c), and updated analyses of discard information will be undertaken next year.

18.3.2.1 Discard survival

Lesser-spotted dogfish have high rates of discard survival from trawl fisheries (Revill *et al.*, 2005; Rodríguez-Cabello *et al.*, 2005).

Recent and ongoing studies in UK waters have been examining the discard survival of various skates in some fisheries, and it can be approximately 55% in otter trawl fisheries (Enever *et al.*, 2009). 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 much higher discard survival from such fisheries.

Further studies to examine discard survival of rajids taken in other gears (e.g. gillnets and beam trawlers) are ongoing; additional information will be available for 2012.

18.3.3 Quality of catch data

No new information. Analyses of the quality of species-specific landings will be undertaken next year.

18.4 Commercial catch composition

18.4.1 Species composition

No new information presented. See ICES (2010c) for further information.

Most nations are reporting increased proportions of 'skates and rays' to species level, and preliminary analyses of some of these data indicate there is broad agreement with the known distributions of the species, but there are still some identification issues (e.g. *Raja brachyura-R. montagui, Dipturus* spp, and *Raja microocellata-Leucoraja circularis*). Such issues were discussed by ICES (2010c) and will be reappraised next year.

18.4.2 Size composition

Market sampling data are available for these species for recent years, as well as the data for the retained portions of the catch from discard observer trips. While elasmobranch sampling effort has increased, it is recommended that emphasis be placed on the sampling of these species as part of ongoing sampling programmes so that long-term trends may be detected. Species identification is still considered to be an issue. Length frequencies for the most abundant species in the sampled skate catches were provided in ICES (2007).

Johnston and Clarke (2011 WD) provided information on the length frequencies of some skate species taken in Irish fisheries, and French data (2009–2010) for *R. montagui* (Figure 18.3) and *Leucoraja fullonica* (Figure 18.4) were also presented. Updated analyses of such commercial data should be undertaken next year.

18.4.3 Quality of data

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 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, in some of these skates are treated as low-priority species, so these species are not sampled as effectively as they might be.

18.5 Catch per unit of effort

18.5.1 Commercial cpue

There were no new commercial cpue data available. See ICES (2010c) for analyses of earlier data.

18.5.2 Recreational cpue

No new information available. Information from the Irish Central Fisheries Board has been used by WGEF to inform on the stock status of undulate ray and angel shark (see ICES 2010c for further information).

18.6 Fishery-independent surveys

Groundfish surveys can provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance of various demersal elasmobranchs, and several fishery-independent surveys operate in the Celtic Seas ecoregion, as discussed below.

Updated analyses for some of the surveys were provided. Other surveys were not updated, due to time constraints, and all surveys will be subject to more detailed analyses next year.

18.6.1 Southern and Western International Bottom-trawl Survey in Q4

UK (Scotland), UK (England and Wales), 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 (see Figure 18.5). Although the trawls used in these surveys are not standardized (see Table 18.6), individual surveys should be able to provide survey-specific metrics. Most surveys are in Q4, with some nations also conducting surveys in Q1.

The manual for the SWIBTS was revised in 2010 to provide updated information on the various surveys (ICES, 2010a,b).

18.6.1.1 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 IBTS. Mahé and Poulard (2005) undertook preliminary analyses of these data, and reported that 26 species of elasmobranch had been recorded in the Bay of Biscay and 19 species in the Celtic Sea. Revised analyses of these survey data should be undertaken in future WGEF meetings.

18.6.1.2 Irish Groundfish Survey (IGFS-WIBTS-Q4)

Preliminary analyses of these data were presented last year (ICES, 2010c). Although the short time period of the survey limits analyses of temporal trends in relative abundance at the present time, important information on the species composition, size distribution, spatial distribution of approximately 16 species are available, with biological information also available for various skates.

18.6.1.3 Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4)

The Spanish Porcupine bottom-trawl survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in the Porcupine Bank Area (ICES Division VIIb–k). The primary target species for this survey are hake, anglerfish, white anglerfish, megrim, four-spot megrim, *Nephrops* and blue whiting. The survey time-series started in 2001 and since then it has been performed annually every autumn. It 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 allocated at random according to the strata surface. 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.

Updated information was provided for this survey (Fernández-Zapico *et al.*, 2011 WD). This Working Document presented the results on nine of the most commonly reported elasmobranchs taken in the survey series (2001–2010), including black-mouth dogfish (Figure 18.6), lesser-spotted dogfish (Figure 18.7), *L. naevus* (Figure 18.8) *L. circularis* (Figure 18.9), and *D. batis* (Figure 18.10). The other elasmobranchs caught were deep-water sharks, and these data are discussed in Section 5. Lesser-spotted dogfish and cuckoo ray occur mainly on the shallower grounds close to the Irish shelf and on the central mound in the bank, with black-mouth dogfish and *L. circularis* occurring in deeper waters around the Bank.

18.6.1.4 UK (England and Wales) Western Groundfish Survey (EngW-WIBTS-Q4)

The UK (England and Wales) survey has only used standardized gears (GOV trawls with groundgear A on fine grounds, and groundgear D on coarser grounds) since

2004, and preliminary analyses of these data were presented last year (ICES, 2010c). Although the short time period of the survey restricts the interpretation of temporal trends in relative abundance at the present time, important information on the species composition, size distribution, spatial distribution of approximately 15 species are available, with biological information also available for various skates.

18.6.1.5 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 survey does not extend into the deeper water of the North Channel or into soft muddy sediments in water deeper than 100 m between the Irish Coast and the Isle of Man. A stratified survey design with fixed station positions is employed with the survey area divided into nine strata defined by depth and substratum. The species composition of the catch at each station is determined, and biological information recorded for each abundant species. Gear, towing and sampling procedures are standardized for the complete time-series.

AFBI (NI) previously analysed available survey data from the northern VIIa (N) region (see NIEA, 2008; ICES, 2010c), and updated analyses of these data will be undertaken next year.

18.6.1.6 UK (Northern Ireland) Groundfish Survey - March (NIGFS-WIBTS-Q1)

UK (Northern Ireland) has also undertaken Q1 groundfish surveys in the Irish Sea (see above for further information).

18.6.1.7 Scottish West Coast Groundfish Survey Q4 (ScoGFS-WIBTS-Q4)

The Scottish Quarter 4 west coast groundfish survey began in 1990 and has 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 (see below).

The survey uses a GOV with heavy groundgear 'C', although there may be a shift to using a groundgear more akin to groundgear D in future. In 1998, a change of research vessel took place and at the same time haul duration was reduced from one hour to 30 minutes.

Summary data for the more frequent elasmobranchs taken in this survey are shown in Figure 18.11.

18.6.1.8Scottish West Coast Groundfish Survey Q1 (ScoGFS-WIBTS-Q1)

UK (Scotland) also undertakes a Q1 west coast survey covering a similar area to the Q4 survey, and results from this survey were presented last year (ICES, 2010c). This survey reports results to the IBTSWG.

Summary data for the more frequent elasmobranchs taken in this survey are shown in Figure 18.11.

18.6.1.9 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 being 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 elasmobranchs in this survey are *R. clavata,* black-mouth dogfish and *'D. batis'*, 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 occasionally been caught on this survey include *L. circularis, L. fullonica, R. montagui, D. oxyrinchus* and *Rajella fyllae*. There is little useful survey information from the deeper water of Division VIb.

This survey reports results to the IBTSWG.

18.6.2 Beam trawl surveys

18.6.2.1 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). Updated information on this survey was provided this year. The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in coastal water. Lesser-spotted dogfish, *R. brachyura, R. clavata, R. microocellata, R. montagui* and *L. naevus* are all sampled during this survey. Preliminary studies of survey data indicate that this gear may not sample large skates effectively, though 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. Smooth-hounds caught by the gear also tend to be juveniles.

Catch rates ($n.h^{-1}$) for this survey have been summarized (Figures 18.12), with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least 13 times during the 18 year time-series (1993–2010).

18.6.2.2 UK (England) beam trawl in Start Bay, VIIe (Eng-WEC-BTS-Q4)

There is also a 4 m beam trawl survey undertaken in and around the Great West Bay (between Start Point and Portland) during October. This survey samples a fixed grid of stations. It has usually been undertaken on the commercial fishing vessel *Carhelmar* (with twin beam trawls) although for a small number of years was undertaken on RV *Corsytes* (single beam trawl). Detailed analyses of the demersal elasmobranchs taken in this survey are still required, and should be undertaken next year.

18.6.2.3 UK (England) beam trawl in western English Channel (Eng-WEC_BTS-Q1)

There is also a beam trawl survey (using twin 4 m beam trawls) in the western English Channel during March. This survey has a random-stratified survey design. Information from this survey has been used to help inform on the distribution of undulate ray (ICES, 2010c). Detailed analyses of the demersal elasmobranchs taken in these surveys are still required, and should be undertaken next year.

18.6.3 Other sources of survey data

18.6.3.1 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 most standardized from 1987–2002. These data have been examined in previous years, and can provide a useful perspective of the species present in the area at that time.

18.6.3.2 Additional Irish surveys

An annual survey to collect maturity data on commercially important species 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) covered an area of the continental shelf to the west of Ireland, at depths of 500–1800 m. This may provide information on certain skate species.

18.6.4 Temporal trends in catch rates

Given the very recent initiation of species-specific landings and discard observer programmes, temporal trends in the demersal elasmobranchs of this ecoregion are based primarily on the evaluation of fishery-independent trawl surveys. The available survey data have been used to evaluate the general status of the stocks in the absence of a more formal stock assessment. ICES (2010c) presented a more thorough overview of stock status, with a brief summary given below.

18.6.4.1 Blonde ray *Raja brachyura*

Raja brachyura has a patchy distribution, and can be relatively abundant in some parts of the Irish Sea and Bristol Channel. Mean catch rates in the Irish Sea and Bristol Channel (e.g. as observed in the UK beam trawl survey) are low and variable (Figure 18.12). More detailed analyses of these data are required, and more replicate trawl stations in areas of higher local abundance could be considered.

18.6.4.2 Thornback ray *Raja clavata*

The French EVHOE survey generally indicated stable catch rates in the Celtic Sea (Mahé and Poulard, 2005). Although the UK PHHT survey indicated a slight decreasing trend in relative abundance, much of this survey is in deeper waters than the main distribution of the species.

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches reasonable numbers of *R. clavata* and they are observed very regularly, although the gear used (4 m beam trawl with chain mat) may have a lower catachability for the larger individuals. This survey would indicate stable or increasing catches (Figure 18.12). The UK (England and Wales) westerly IBTS in the area is currently of too limited temporal coverage with which to examine annual trends in catches, although this survey can catch good numbers of *R. clavata* in Liverpool Bay and the Bristol Channel, where groundgear 'A' is used, and helps provide 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 (see ICES, 2010c), although this survey uses a rock-hopper trawl, and so the catchability may be low.

The UK (Scotland) survey of VIa would also suggest stable/increasing catch trends, although this survey uses a trawl with bobbins, and such a groundgear (which is required to be able to fish on coarse grounds) may not sample skates effectively.

Further analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) are required.

18.6.4.3 Small-eyed ray *Raja microocellata*

Although occasional specimens of *R. microocellata* are caught in VIIa, the main concentration of this species is in VIIf, with some larger individuals occurring in the slightly deeper waters of VIIgh. There are also localized concentrations in parts of VIIe and in some inshore areas of Ireland.

The UK (England and Wales) beam trawl survey in the Bristol Channel would indicate that the VIIf stock is stable/increasing (Figure 18.12). The smallest size class is not often taken in the survey, as 0-group fish tend to occur in very shallow water.

The UK (England and Wales) westerly IBTS survey only has a few stations in the Bristol Channel, although reasonable catches of *R. microocellata* are typically reported at these sites, and this facilitates the collection of maturity information for larger individuals. Fewer individuals were observed in the 2010 survey (ICES, 2011).

Further studies of this species in VIIe (from UK beam trawl surveys) and from the Irish Groundfish Survey are required.

18.6.4.4 Spotted ray *Raja montagui*

R. montagui is a widespread and small-bodied skate and is taken in reasonable numbers in a variety of surveys in the ecoregion.

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 would indicate stable or increasing catches. The UK (Northern Ireland) survey of the Irish Sea also indicated stable/increasing catches, although this survey uses a rock-hopper trawl, and the catchability may be low. The UK (Scotland) survey of VIa also suggested stable/increasing catch trends.

18.6.4.5 Cuckoo ray *Leucoraja naevus*

L. 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. As an offshore species that is also abundant in the Bay of Biscay (VIII) and northern North Sea (IVa), it is possible that the stock or stocks extend out of the Celtic Seas ecoregion.

The French EVHOE survey demonstrated a peak in relative abundance in 2002, with the lowest catches in 2000. The relative abundance in the Celtic Sea/Biscay region may have increased in recent years as reported from the French EVHOE survey (Mahé and Poulard, 2005), but catches are variable. This survey also indicated a decreasing trend in the mean length of this species in the Bay of Biscay.

The UK PHHT Q1 survey demonstrated large fluctuations in mean catch rates, with a peak in 1996, followed by a sharp decline to low levels since 1997 (See Figure 18.18 in ICES, 2007).

The Spanish survey on the Porcupine Bank revealed an increased relative abundance in 2003 (Figure 18.8a) followed by a gradual decline, although catch rates in the last three years are comparable with those observed at the start of the time-series.

The UK (Scotland) survey of VIa also suggested stable/increasing catch trends.

The UK (England and Wales) beam trawl survey in VIIa catches reasonable numbers of *L. naevus,* mostly on the offshore stations on coarse grounds. There is the indication of a slight decline from the start of the time-series, with stable catch rates for much of the time-series followed by a low mean catch rate in 2010 (Figure 18.12). *L. naevus* is less abundant in the inner parts of the Bristol Channel (although they are one of the more common species in the more offshore Celtic Sea, VIIg–j) and so those survey stations in VIIf were excluded from analysis.

Different surveys demonstrate slightly different trends in relative abundance for this species, which further highlights the need to better understand stock structure.

18.6.4.6 Sandy ray *Leucoraja circularis* and shagreen ray *L. fullonica*

Leucoraja circularis and *Leucoraja fullonica* are large-bodied offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys.

Only the Spanish Porcupine Bank survey covers an important part of the main habitat of *L. circularis* and catches this species in any quantity (Figure 18.9). Peak catches were in 2003. Overall, the limited time-series has low and variable catch rates, with a declining trend in recent years. This species is taken only infrequently in other surveys, with some nominal records are considered unreliable.

Although the UK PHHT Q1 survey seemed to catch *L. fullonica* regularly, albeit in small numbers, this survey has been discontinued. Recently initiated surveys by Ireland and UK (England and Wales) have only caught occasional specimens (see ICES, 2010c), which may reflect insufficient sampling of the main habitat, and possibly a gear effect.

18.6.4.7 Lesser-spotted dogfish *Scyliorhinus canicula* and greater-spotted dogfish *S. stellaris*

Lesser-spotted dogfish is abundant and widespread over most parts of the Celtic Seas ecoregion. Like many elasmobranchs it often aggregates by size and sex, and these aggregations can result in occasional large catches.

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches large numbers of lesser-spotted dogfish, and they are abundant throughout the survey grid, suggesting they occur over a range of habitats. This survey indicates increasing catches (Figure 18.12).

The Spanish Porcupine Bank survey demonstrates an increasing trend for *Scyliorhinus canicula* to the west of Ireland, with the highest catch levels in the time-series occurring during the 2007 survey (Figure 18.7).

The French EVHOE survey demonstrated a general increase in the Celtic Sea/Bay of Biscay (Mahé and Poulard, 2005), with this study indicating that the increase was associated with an increase in the abundance of smaller individuals.

In terms of other westerly IBTS surveys, the UK (Northern Ireland) survey of the Irish Sea in VIIa and the UK (Scotland) survey of VIa both suggested increasing catch trends.

Greater-spotted dogfish is larger than lesser-spotted dogfish and also tends to have a more restricted, inshore distribution than lesser-spotted dogfish. The preferred habitats for this species include rocky, inshore grounds. Hence, most surveys will not sample effectively the main parts of their range, resulting in low catch rates.

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches small numbers of greater-spotted dogfish (although the catchability for the larger individuals may be low), and they are captured regularly around Anglesey, Lleyn Peninsula and in Cardigan Bay. This survey indicates low but stable catches (Figure 18.12). The UK (England and Wales) westerly IBTS survey also has stations along the west coast of Wales. Although they are captured regularly in this survey, catches comprise few individuals. These UK surveys have tagged and released a number of greater-spotted dogfish in recent years, which will it is to be hoped provide further information to aid in stock identification.

18.6.4.8 Smooth-hound *Mustelus* spp.

Although two species of smooth-hound are reported in most surveys, the discrimination of these species has 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 by far the more common of the two species in this ecoregion.

The UK PHHT survey in the Celtic Sea demonstrated a peak in the relative abundance of *Mustelus* spp. in 2000. Although this peak was not apparent in the French survey in 2000, this species has also increased in recent years, peaking in 2004 (ICES 2007).

The UK (England and Wales) beam trawl survey would indicate that smooth-hounds are increasing in relative abundance, and are also being observed in an increasing proportion of hauls (Figure 18.12). The *Mustelus* spp. taken in this survey are generally juveniles, and the small proportion of mature fish is due to a low catchability.

The UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea has indicated an increase in mean catch rates (ICES, 2010c). The UK (England and Wales) and Irish groundfish survey also catch reasonable numbers of smooth-hounds (see ICES, 2010c), and these data should be analysed when more of a time-series has been established. Larger smooth-hounds, including mature fish, are also taken in these surveys.

Although smooth-hounds are not subject to routine biological sampling in any of the surveys, the EngW-WIBTS-Q4 survey tags and releases smooth-hounds, and the individual weights and maturity (of male fish) are recorded prior to release.

18.6.4.9 Other species

Other skate species taken in these surveys include '*Dipturus batis*', and other *Dipturus* spp. These species are most often reported from surveys operating in deeper waters and on the outer continental shelf.

Preliminary analyses of data from the Spanish Porcupine Bank Survey indicate low and catch rates of '*D. batis*' (Figure 18.10), which were highest at the start of the time-series. A preliminary examination of Scottish data (Figure 18.11d) indicates some increase in the proportion of hauls in which they were observed, although it should be recognized that catch rates are low and with high confidence intervals. More detailed analyses of captures of '*D. batis*' from these and other surveys (e.g. the Irish western IBTS surveys are required). The EngW-WIBTS-Q4 survey caught more *Dipturus* cf. *flossada* in 2010 than in previous years.

One specimen of angel shark was captured in Cardigan Bay during the 2009 UK (England and Wales) beam trawl survey, confirming the continued presence of this species in the area. Dedicated inshore surveys with an appropriate survey gear would probably be necessary if the current status of this species is to be evaluated.

18.6.5 Size composition of demersal elasmobranchs

Updated length frequency data were provided for various species taken in the Spanish Porcupine survey (see Figure 18.6b–18.10b). Comparable information from Irish, English and Welsh, and Scottish surveys were presented last year (ICES, 2010c), and further analyses will be undertaken next year.

18.6.6 Localized populations

Several demersal elasmobranch species that occur sporadically throughout much of the Celtic Seas region 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 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 (VIIj) and the middle of the English Channel (VIId,e);
- *Scyliorhinus stellaris* off Anglesey and the Lleyn Peninsula (VIIa);
- *Squatina squatina* in Tralee Bay;
- *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.

18.6.7 Quality of data

18.6.7.1 Species identification in surveys

The genus *Mustelus* is a problematic taxon, and it is likely that there is some confusion between *M. asterias* and *M. mustelus* in all surveys. Hence, analyses for these species should use aggregated data for the two species: *Mustelus* spp. Tope may also be misidentified as smooth hounds.

There are several identification problems with certain skate species that lead to uncertainty in the quality of both survey and commercial data. *Raja clavata* and *A. radiata* may be confused (although *A. radiata* does not occur over much of this ecoregion), as can *R. montagui* and *R. brachyura*. Neonatal specimens of *R. clavata*, *R. brachyura* and *R. montagui* can also be problematic. It is hoped that the production of a photo-id key may help alleviate these problems.

All surveys in the area should be prepared to ensure that data collected for the common skate complex are differentiated in future surveys, although it is unlikely that historical information from areas where both species occur can be re-assigned to the new species names.

18.6.7.2 Gear performance

There are several scientific trawl surveys in the ecoregion. 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.

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). It is recommended that data from these sources be examined at future meetings of the WGEF.

Preliminary analyses of length-at-maturity for various skate species were presented in the 2006 report, and updated information on the length-at-maturity and the length–weight relationships for a variety of skates taken in UK (English and Welsh) surveys were summarized last year (ICES, 2010c).

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).

Little is known about the presence of egg-laying and pupping grounds, although neonatal specimens of *Mustelus* spp. (with fresh umbilical scars) have been observed in Cardigan Bay and the Bristol Channel.

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.

18.7.2 Recruitment

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 thornback rays (ca. 10 cm total length). 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.

18.8 Exploratory assessment models

18.8.1 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. *L. 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 analysis of survey data was carried out by WGEF in 2007. This used 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. Summary plots were included in ICES (2010c) and in ICES advice, with more information on the results and a description of the methods used given in ICES (2007).

18.8.2 Stock status

In the absence of formal stock assessments for the species and stocks in this ecoregion, the following provides a summary of the qualitative evaluation of stock status for the main species.

Species	Nominal stock Area	Perceived status
Common skate *Dipturus batis* complex	VI	Depleted. The stock likely extends into IIa, IVa and V. Both blue skate *Dipturus* cf. *flossada* and flapper skate *D.* cf. *intermedia*) occur in this subarea.
	VII	Depleted. Reported as lost from the Irish Sea (based on Brander, 1981), but occasional individuals have been reported from the northwestern Irish Sea (e.g. North Channel, Belfast Lough), and WGEF consider this species to be 'near-extirpated' in VIIa. Occasional individuals recorded in Bristol Channel. More widespread in Celtic Sea (VIIg–j), where blue skate *Dipturus* cf. *flossada* is the main species.

Species	Nominal stock Area	Perceived status
Long-nose skate *Dipturus oxyrinchus*	VI, VIIb,c,j,k	Uncertain. Stock area likely extends outside the ecoregion.
Norwegian skate *Dipturus nidarosiensis*	VI, VIIb,c,j,k	Uncertain. Stock area likely extends outside the ecoregion.
Blonde ray *Raja brachyura*	VIa	Uncertain. No trends are apparent from surveys.
	VIIa	Uncertain. No trends are apparent from surveys. Locally abundant off SE Ireland.
	VIIe	Uncertain. Locally abundant in parts of area.
	VIIf	Uncertain. No trends are apparent from surveys.
Thornback ray *R. clavata*	VI	Survey catch rates stable/increasing.
	VIIa,f,g	Survey catch rates stable/increasing.
	VIIe	Uncertain
Small-eyed ray *R. microocellata*	VIIf	Survey catch rates stable/increasing.
	VIIe	Uncertain. Stock may extend into VIId, relationship with population in VIIf unclear.
Spotted ray *R. montagui*	VI	Survey catch rates stable/increasing.
	VIIa,f,g	Survey catch rates stable/increasing.
	VIIe	Uncertain
Undulate ray *R. undulata*	VIIj	Uncertain. Locally common in discrete areas.
	VIId,e	Uncertain. Locally common in discrete areas.
Cuckoo ray *Leucoraja naevus*	VI	Uncertain. The stock area is not known, and may merge with Subareas IV and VII. Survey catches in VIa are increasing.
	VII	Uncertain. The stock area is not known, and may merge with Subareas VI and VIII. French lpue in the Celtic Sea has declined. Survey catches appear stable.
Sandy ray *L. circularis*	VI, VIIb,c,h–k	Uncertain. Survey catch rates in Division VIIj low and variable, possibly declining in recent years.
Shagreen ray *R. fullonica*	VI, VIIb,c,g–k	Uncertain. There is a poor signal from surveys for this species.
White skate *Rostroraja alba*	VII	Considered to be near-extirpated from this ecoregion (which is the northern part of the geographical distribution).
Lesser-spotted dogfish *Scyliorhinus canicula*	VI and VII	Survey catch rates increasing.
Greater-spotted dogfish *S. stellaris*	VIIa,e,f	Locally common. Survey catches appear to be increasing in VIIa, but there is a poor signal in other areas due to low catches.
Starry smooth-hound *Mustelus asterias*	VII	The stock area is not known, but may merge with Subareas IV, VI and VIII. Increasing in most surveys.
Angel shark *Squatina squatina*	VI,VII	Rare in this ecoregion, and near extirpated from parts of its former range.

18.9 Quality of assessments

Commercial data are insufficient for a full stock assessment. Species-specific catch data are not fully available. There has been the introduction of species-specific recording of landings in recent years, and there is some historical information on species composition for earlier time periods.

Several updated analyses of temporal changes in relative abundance in fishery-independent surveys were carried out in 2010. 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 survey 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 (spotted ray, thornback ray, cuckoo ray) 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. 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. It is recommended that any analyses of smooth-hounds use the combined data for *M. asterias* and *M. mustelus.*
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*).

18.10 Reference points

No reference points have been proposed for these stocks.

18.11 Conservation considerations

Angel shark is listed on the UK Wildlife and Countryside Act, which gives it legal protection in the inshore waters of England and Wales (out to 6 nm).

IUCN list angel shark, "*Dipturus batis*" and *Rostroraja alba* (NE Atlantic) as Critically Endangered, *Raja undulata* is listed as Endangered and *Leucoraja circularis* as Vulnerable.

Species listed by the IUCN as Near Threatened include *Dipturus oxyrinchus, Leucoraja fullonica, Raja brachyura, Raja clavata, Raja microocellata* and *Scyliorhinus stellaris.*

Leucoraja naevus, Raja montagui, Rajella fyllae, Scyliorhinus canicula and *Mustelus asterias* are all listed as Least Concern (Gibson *et al*., 2008).

18.12 Management considerations

A TAC was only introduced in 2009 for the main species in this region.

Technical interactions for fisheries in this ecoregion are shown in Table 18.7.

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.

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 in recent years.

Cuckoo ray *Leucoraja naevus* is an important commercial species in the Celtic Sea. Survey catch rates declined in the Celtic Sea during the 1990s, though have been stable/increasing in various areas in more recent years. Abundance trends are not consistent between the different surveys and further studies to better define the stock structure are required.

The relative abundance of lesser-spotted dogfish *Scyliorhinus canicula*, smooth-hounds *Mustelus* spp. and spotted ray *Raja montagui* in this ecoregion appear to be stable/increasing.

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 the common skate complex in offshore areas.

Currently, interpretation of the prohibited species list may not allow commercial vessels to land fish for scientific purposes (including tagged fish), which will potentially affect ongoing scientific research programmes on these species.

Other species

Contemporary surveys occasionally record other skate species, although catch rates of these species are highly variable.

The absence of *R. alba* and near-absence of *S. squatina* in contemporary surveys, as noted by ICES, 2006 is cause for concern.

There are anecdotal and historical reports suggesting that localized populations of white skate *Rostroraja alba* were targeted in fisheries in the western English Channel, Baie de Douarnenez (Brittany) and off the Isle of Man, and this species is now very rarely observed in the region. Further studies to determine whether viable populations of *R. alba* remain in this ecoregion are required.

Localized populations of angel shark in Start Bay (VIIe) and Cardigan Bay (VIIa) have declined severely and this species is now reported only infrequently in the area, though it was previously more common (Rogers and Ellis, 2000). Landings of this species have almost ceased, with only occasional individuals landed. Tagging studies from the Irish Central Fisheries Board demonstrate that these sharks can migrate further than previously thought. Although they are considered to be only abundant in Tralee Bay, and many tagged fish from this area have been returned from nearby areas along the west coast of Ireland, there have also been reported recaptures from the English Channel, France and Spain (Green, 2007). Landings of this species have almost ceased, with only occasional individuals landed. It is an inshore species, distinctive, and may have a relatively good discard survivorship. Given the concern over *S. squatina* in this and adjacent ecoregions, the ban on retaining this species will hopefully benefit their stock(s).

Historically, species such as *L. circularis, L. fullonica, "D. batis"* and *D. oxyrinchus* may have been more widely distributed in shelf seas. These species are now encountered only infrequently in surveys on the inner 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 next year. 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. IBTS should be requested to compile and provide WGEF with any available data for the westerly IBTS and other national surveys.

18.13 Spatial information

The demersal elasmobranchs from much of the Celtic Seas ecoregion are monitored during internationally coordinated trawl and beam trawl surveys. Survey data are mostly collected in Q3/Q4, with some nations also conducting surveys in Q1. Survey data can be used to provide point source information for numbers-at-length for the main species, with much of these data available by sex.

Information on nursery grounds may be inferred by the presence of the smallest length classes, although the identification of nursery grounds should also be based on the persistence of such size classes (i.e. they are observed regularly in surveys).

Some elasmobranchs have patchy distributions, and increased sampling of such areas is needed to better delineate their preferred habitats.

Information on the distribution of egg-cases is very limited, and there are no surveys in Q2 (during which some species rajids are known to spawn). Spawning grounds are unknown at the present time.

Although electronic tagging has helped improve our understanding of *Raja clavata* in the North Sea, such studies have not been widely conducted in the area (but see Wearmouth and Sims, 2009).

18.14 References

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Table 18.1. Demersal elasmobranchs 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"	●	●	●	●	●	⦿	●	●	●	●	●	●
D. nidarosiensis	●	●	○	●	●	○	○	○	○	○	●	●
D. oxyrinchus	●	●	○	●	●	○	○	○	⦿	●	●	●
Leucoraja circularis	●	●	○	●	●	○	○	○	⦿	●	●	●
L. fullonica	●	●	⦿	●	●	○	⦿	⦿	●	●	●	●
L.naevus	●	●	●	●	●	⦿	●	●	●	●	●	●
Raja brachyura	●	⦿	●	●	⦿	●	●	●	●	●	●	○
R. clavata	●	●	●	●	●	●	●	●	●	●	●	⦿
R. microocellata	⦿	○	⦿	●	○	●	●	●	●	⦿	●	○
R. montagui	●	●	●	●	⦿	●	●	●	●	●	●	⦿
R. undulata	○	○	⦿	●	○	●	●	⦿	⦿	⦿	●	○
Rajella fyllae	●	●	○	●	●	○	○	○	○	●	●	●
Rostroraja alba	○	○	⊗	●	?	⊗	⊗	?	?	?	?	○
Demersal sharks (Scyliorhinidae, Trikidae, Squatinidae) occurring on the continental shelf												
Galeus melastomus	●	●	⦿	●	●	○	⦿	⦿	●	●	●	●
Scyliorhinus canicula	●	●	●	●	●	●	●	●	●	●	●	●
S. stellaris	●	⦿	●	●	?	●	●	●	●	●	●	○
Mustelus spp.	●	●	●	●	●	●	●	●	●	●	●	●
Squatina squatina	●	?	●	●	○	⊗	●	●	●	●	●	○
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. Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	13	10	3	4	.	.	.	2	1	2	.	.	2	1	3	2	3	.	2
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
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
Netherlands	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	116	105	70	77	96	226	81	253	119	146	217	99	67	44	93	144	264	71	38
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
UK – Scotland	1302	1142	1393	1792	1724	1660	1540	1577	1496	1617	1818	2016	2034	1802	2111	2137	2499	2007	2026
Total	2883	2767	2965	3551	3154	3261	2829	2847	4501	3161	3841	4055	3726	2991	3370	3834	4187	2996	3007
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	.	1	2	7	1	2	2	4	2	4	2	8	9	4	4	0	.		0
Denmark	+	+	+	+	+	.	+	+	.	.	.	.	.	0		.	.	.	
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	0	.	
France	603	606	437	553	526	384	333	NA	321	278	212	183	149	181	174	194	245	97	65
Germany	.	.	2	.	1	4	16	7	1	1	.	3	0	.	0				
Ireland	350	331	265	504	681	596	488	388	274	238	311	364	363	186	176	119	109	81	111
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0				0
Norway	82	56	9	74	29	20	50	29	49	20	25	2	2	10	4	5	11	4	11
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0				
Spain	.	.	.	.	47	58	69	34	2	.	9	27	14	14	0	0	4		
Spain (Basque Country)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0
UK - (E,W&N.I.)	72	70	101	138	101	69	157	67	108	65	114	159	66	26	18	5	1	4	1
UK – Scotland	1605	1419	1429	1980	2606	1879	1460	1324	1316	1263	1136	1307	1012	623	369	426	297	240	224
Total	2712	2483	2245	3256	3992	3012	2575	1853	2073	1869	1809	2053	1615	1043	744	750	667	427	412

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
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
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.		1	1	.	.
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	22	123	45	60	145	217	222	117	147	332	364	164	231	200	132	279	203	248
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
UK – Scotland	562	166	307	77	160	189	152	181	152	44	9	15	58	38	59	72	70	76	67
Total	700	706	512	248	316	405	487	447	340	222	381	419	256	342	313	250	354	286	353

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Estonia	.	.	.	.	.	.	.	.	.	56	1	.	.	.	.	.	.	.	
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	na	na	.	.	3		
France	0	4	0	0	0	0	0	0	7	5	5	2	6	15	0	17	17	12	0
Germany	.	6	25	17	49	26	36	67	76	8	1	6	22	22	6	0			
Ireland	.	24	23	60	68	23	15	28	20	10	1	18	7	9	24	14	15	4	1
Norway	234	170	272	176	95	101	98	59	120	80	44	61	46	39	82	81	66	91	120
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	0.5	0	0	0	0		
UK - (E,W&N.I.)	12	21	28	73	175	105	134	147	156	120	92	47	48	20	20	9	0	0	0
UK – Scotland	57	70	98	97	83	91	101	123	204	97	79	146	164	59	51	30	26	35	33
Total	303	295	446	479	798	781	893	770	964	559	290	344	294	164	183	151	127	143	154

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	296	365	278	195	236	212	177	151	206	230	233	246	372	425	545	390	271	298	209
France	1516	426	337	491	827	967	560	593	1985	617	440	788	1194	1578	1318	1009	641	712	890
Ireland	822	916	838	936	858	796	813	725	851	803	781	1067	1946	1416	1644	1911	1808	1811	1400
Netherlands	1	1	3	1	1	.	1	+	+	+	+	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
UK (Scotland)	62	69	53	39	47	52	58	132	82	89	87	192	219	224	321	210	171	227	163
Total	4265	3310	2939	2825	3099	2933	2654	2803	4237	3046	2674	3419	4834	4619	5331	4955	4264	4426	3888
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	230	107	224	218	265	298	398	542	504	724	997	830	860	860	593	680	295	250	274
France	642	550	330	293	282	151	285	NA	163	343	349	322	183	192	114	51	14	7	9
Ireland	1301	679	514	438	438	593	692	827	759	807	1032	1086	825	786	645	721	515	370	557
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4	4	6	+	+	+	+	.	0				
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0		
Spain																	4		
UK - (E,W&N.I.)	1150	1003	748	606	789	824	1009	936	671	983	863	1184	533	1252	271	260	243	214	190
UK (Scotland)	107	96	86	42	55	80	52	33	86	80	68	67	38	30	65	13	1	2	9
Total	3430	2435	1902	1597	1829	1946	2440	2342	2189	2937	3309	3489	2439	3120	1689	1724	1071	844	1038

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	182	273	280	184	106	75	127	189	167	130	139	98	177	209	129	172	268	135	155
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	242	426	569	720	680	873	896	856	837	648	377	306	330	247	464	366	326	607
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	686	916	1174	1190	1278	1191	1444	1579	1531	1496	1267	1033	1131	1236	1160	1397	1344	1127	1389
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	128	96	117	108	89	116	121	103	90	91	117	134	210	208	138	206	184	193	143
Denmark	1	.	.	.	.	.	.	.	.	.	.	.	.	.					
France	663	565	468	394	432	485	464	453	538	642	526	536	478	429	305	424	399	366	517
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0				
Ireland	.	.	.	.	.	.	1	.	.	.	1	1	15	8	6	2	4	3	2
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0				0
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0		
Spain (b)	.	.	.	.	8	10	12	1	.	3	.	.	.	.	0	0	0		
UK - (E,W&N.I.)	705	638	630	589	676	664	624	560	613	691	920	766	609	631	653	620	639	546	680
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.			0		0
Total	1497	1299	1215	1091	1205	1275	1222	1117	1241	1427	1564	1437	1312	1276	1101	1252	1226	1107	1342

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	259	238	209	529	308	208	206	254	318	271	182	215	211	311	224	227	355	242	97
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.
France	5729	4095	6901	6602	6189	6095	6519	6796	7647	6765	7323	6561	6890	7771	7693	7986	7566	7734	7077
Germany	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ireland	147	158	148	241	158	143	218	399	380	291	236	303	286	251	296	315	57	100	68
Netherlands	.	.	1	7	13	6	.	.	.	.	2	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
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	6609	4985	7831	7935	7234	7112	7507	7977	9028	7994	8484	7935	8325	9359	9349	9885	8857	9293	7901
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	183	209	172	203	177	293	260	240	223	248	347	576	407	432	582	569	636	506	479
Denmark	1	+	0	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	6477	5873	5836	6029	6425	7093	6114	6098	5710	5603	5273	5588	4261	4517	3740	3741	3302	3719	3428
Germany	.	.	.	.	.	.	.	.	.	.	+	.	3	.		.	.	.	.
Ireland	.	120	106	162	349	479	446	408	203	481	729	838	844	334	315	285	214	198	174
Netherlands	na	na	na	na	na	na	9	na	7	7	11	.	.	.	1	.	.	1	2
Norway	.	.	.	.	.	.	.	.	.	11	.	.	.	.	0	0	0		
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain (b)	.	.	.	.	312	932	1178	2647	1706	1142	653	31	15	9	1	1	3	.	.
Spain (Basque Country)																		7	2
UK - (E,W&N.I.)	751	735	869	997	953	1098	1167	796	932	880	775	804	811	1024	727	730	667	650	865
UK (Scotland)	.	1	.	.	.	2	.	2	.	2	.	.	149	3	1		3	3	7
Total	7412	6938	6983	7391	8216	9897	9173	10191	8781	8374	7788	7837	6490	6318	5366	5326	4826	5082	4957

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	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
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	266	321	314	320	265	268	239	269	336	271	325	296	220	226	419	332	633	350	400
Netherlands																			
Norway																			0
Spain (b)	0	0	0	0	0	3	0	0	47	33	24	31	1	53	64	41	0	0	124
UK - (E,W&N.I.)	1	+	+	0	+	0	0	+	0	+	0	4	1	3	27	28	25	5	53
UK (Scotland)	0	0	0	0	0	1		1	0	0	0	1	+	1	+	1	13	14	15
Total	1174	1046	606	800	504	491	427	610	1503	507	518	530	566	629	966	864	1098	1150	1133
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	0	0	0	0	0	0	0	24	5	0	5	1	na	0	0	0	.		0
France	546	298	224	297	375	599	500	NA	568	362	272	192	101	257	255	391	421	262	249
Germany	0	7	18	3	4	9	17	10	21	7	+	3	15	17	0				
Ireland	619	602	625	735	757	811	741	740	653	383	354	435	511	465	473	417	384	362	285
Netherlands	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	0	0	15	4	0		
Spain (b)	0	0	0	0	1341	1676	1978	2419	2573	1205	2939	1281	7	16	19	11	1		0
UK - (E,W&N.I.)	71	88	201	361	469	468	376	352	597	545	373	350	364	269	176	172	83	90	94
UK (Scotland)	10	34	43	73	58	36	67	121	189	162	124	226	70	58	77	0	66	39	60
Total	1246	1029	1111	1469	3004	3599	3679	3666	4606	2664	4067	2488	1068	1081	1016	995	954	753	687

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VII unspecified).

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spain																	643	693	605
Spain (Basque Country)																		0.8	0.0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	643	693	605

Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings 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
Belgium	750	886	770	912	650	495	510	596	692	633	554	559	762	946	901	791	897	675	463
Denmark	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	1	.
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	13 930	9171	9475	8885	9736	10 674	10 442	10 689	9724	10 267	9749
Germany	18	1	.	.	1	2	1	.	.	.	.	.	1	.	.	1	1	0	0
Ireland	1516	1731	1758	1922	1623	1449	1538	1736	2041	1902	2148	2502	3026	2333	2726	3248	3128	2411	2068
Netherlands	1	1	4	9	14	6	1	+	+	+	2	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
Poland	88	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Russian Federation	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	48	0	0	187	82	64	75	15	175	194	134	0	0	202
UK - (E,W&N.I.)	2776	2666	2734	2529	2548	2285	2318	2313	2324	2572	2425	2665	2753	2677	3441	3625	3044	3321	2632
UK – Scotland	1926	1377	1753	1908	1931	1902	1750	1891	1730	1750	1914	2224	2311	2065	2491	2420	2753	2324	2271
Total	16 317	13 730	16 027	16 549	15 585	15 393	15 348	16 263	21 140	16 426	17 165	17 391	18 838	19 176	20 489	21 185	20 104	19 278	17 671
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	541	413	515	536	532	709	781	913	824	1067	1467	1549	1485	1503	1316	1455	1115	949	896
Denmark	2	+	.	+	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.
Estonia	.	.	.	.	.	.	.	.	.	56	1	.	.	.	.	.	.	.	0
Faroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	.	na	.	.	4	.	.
France	8931	7896	7295	7566	8040	8712	7696	6551	7307	7233	6637	6823	5178	5591	4587	4818	4398	4463	4267
Germany	0	13	45	20	54	39	69	84	98	16	2	12	40	39	7	.	.	.	.
Ireland	2270	1756	1533	1898	2294	2502	2382	2390	1909	1919	2428	2742	2565	1787	1640	1557.940	1240.360	1018	1130
Netherlands	na	na	na	na	na	na	13	4	13	7	11	na	na	0	1	.	.	1	2
Norway	316	226	281	250	124	121	148	88	169	111	69	63	48	49	101	90	77	95	131
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Portugal	.	.	.	56	.	25	26	24	29	17	31	18	na	0	.	.	.	.	.
Russian Federation	.	.	.	.	.	.	.	.	5	8	.	.	na	na	.	.	.	.	.
Spain	0	0	0	0	2036	3086	3720	5423	4628	2508	3637	1385	37	39	20	12	655	700	607
UK - (E,W&N.I.)	2761	2555	2577	2764	3163	3228	3467	2858	3077	3283	3137	3310	2431	3222	1865	1796	1633	1504	1830
UK – Scotland	1779	1620	1656	2192	2802	2088	1680	1603	1795	1604	1407	1746	1433	773	562	469	393	319	332
Total	16 600	14 479	13 902	15 282	19 044	20 510	19 981	19 938	19 854	17 830	18 828	17 648	13 217	13 004	10 099	10 198	9514	9047	9195

Table 18.3. Demersal elasmobranchs in the Celtic Seas. Nominal landings (tonnes) of lesser-spotted dogfish (*Scyliorhinus canicula*) in ICES Subareas VI and VII. These data are considered estimates, as this species is often reported under generic landings categories, and some landings (for bait in pot fisheries) may not be reported.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium															377	392	389			317	320
France	5395	5255	4509	4332	4353	4309	4182	4591	4568	46	4808	4922	4697	4361	4314	3937	3815	3881	3360	2456	2489
Ireland	.	.	.	.	.	1487	465	796	886	470	407	518	506	285	124	85	40	130	257	211	321
Netherlands																				7	1
Spain	.	.	.	.	.	.	51	73	22	67	77	46	50	20	21	41	13	17	4	0	21
Spain (Basque country)																			2	1	4
UK (E&W)	.	.	.	.	.	.	.	.	.	.	11	.	.	88		325	126	11	269	329	238
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	37	8	33	55	42	40	6	15	12
Total	5395	5255	4509	4332	4353	5796	4698	5460	5476	583	5303	5486	5290	4762	4869	4835	4425	4079	3897	3336	3406

Table 18.4. Demersal elasmobranchs in the Celtic Seas. Nominal landings (tonnes) of smooth hounds (*Mustelus* spp.) in ICES Subareas VI and VII. (These data may include a quantity of tope).

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Belgium	0	0	0	0	0	0	0	0	0
France	75	22	95	173	165	107	125	200	148
Ireland	0	0	0	0	0	0	0	0	0
Netherlands									
Spain (Basque country)	0	0	0	0	0	0	0	0	0
Spain									
UK - Eng+Wales+N.Irl.	0	0	0	0	0	0	0	0	0
Total	75	22	95	173	165	107	125	200	148
	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Belgium	0	0	0	0	0	0	0	0	0
France	145	144	215	252	324	394	824	513	623
Ireland	0	0	0	0	0.5	0.5	0.5	0.5	0.5
Netherlands									
Spain (Basque country)	0	0	0	0	5	7	4	6	20
Spain									
UK - Eng+Wales+N.Irl.	0	0	0	0	0	0	0	12	74
Total	145	144	215	252	329	401	828	531	717
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belgium	0	0	8	8	3		5	10	7
France	654	809	894	943	943	1009	1087	2575	2669
Ireland	0.5	0.5	2	35	0	0	1		0.7
Netherlands								1	
Spain (Basque country)	24	36	17	9	18	9	14	19	20
Spain									10
UK - Eng+Wales+N.Irl.	54	67	56	171	10	28	56	62	113
Total	732	930	977	1166	975	1047	1163	2667	2819

Table 18.5. Demersal Elasmobranchs in the Celtic Seas. Landings of *Squatina squatina*. 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
Belgium	0	0	0	0	0	0	0	0	0	0
France	8	3	32	26	29	24	19	18.7	19.5	18
UK (E,W &N.I.)	0	0	0	0	0	0	0	0	0	0
Total	8	3	32	26	29	24	19	18.7	19.5	18
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
Belgium	0	0	0	0	0	0	0	0	0	0
France	13	9	13	14	12	11	2	2	1	1
UK (E,W &N.I.)	0	0	0	0	0	0	2	1	1	0
Total	13	9	13	14	12	11	4	3	2	1
	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Belgium	0	0	0	0	0	0	0	0	0	0
France	1	1	2	1	2	+	1	+	+	+
UK (E,W &N.I.)	0	0	0	0	(47)	0	0	0	0	0
Total	1	1	2	1	2	0	1	0	0	0
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**		
Belgium	0									
France	+	+	2	+	0.5	+	0.9	2.1		
UK (E,W &N.I.)	0	0	0	0.0	0.0	0.0		0.0		
Total	0	0	2	0.0	0.5	0.0	0.9	2.1		

Table 18.6a. Demersal elasmobranchs in the Celtic Seas. Summary details of fishery-independent surveys using otter trawls in the Celtic Seas ecoregion. Adapted from ICES (2009, 2010b).

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–	1988–2003	1997–	2001–
Coordination	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	IBTSWG	-	IBTSWG	IBTSWG

Table 18.6b. Demersal elasmobranchs in the Celtic Seas. Summary details of fishery-independent trawl surveys (WIBTS) in the Celtic Seas ecoregion. Adapted from ICES (2009, 2010b).

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]	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
Initiated (for quarter)	1988 [2]	1988 [2]	
Coordination	WGBEAM	WGBEAM	

[1] **Endeavour used in recent years only. RV Corystes used previously.**

[2] **Grid standardized since 1993.**

Table 18.7. Demersal elasmobranchs 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

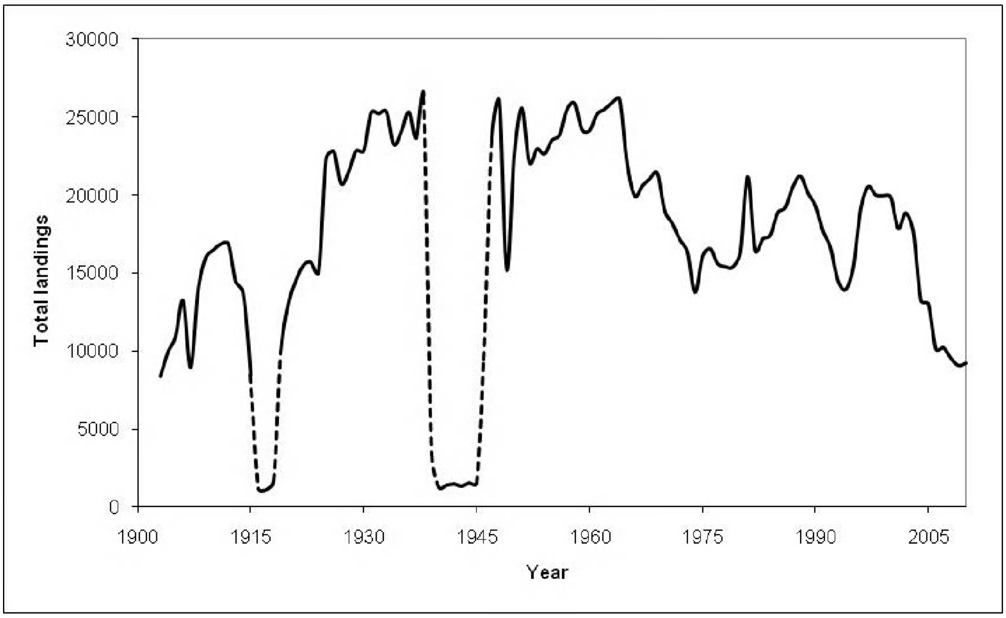


Figure 18.1a. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas (ICES Subareas VI and VII (including VIId)), from 1903–2010 (Source: ICES).

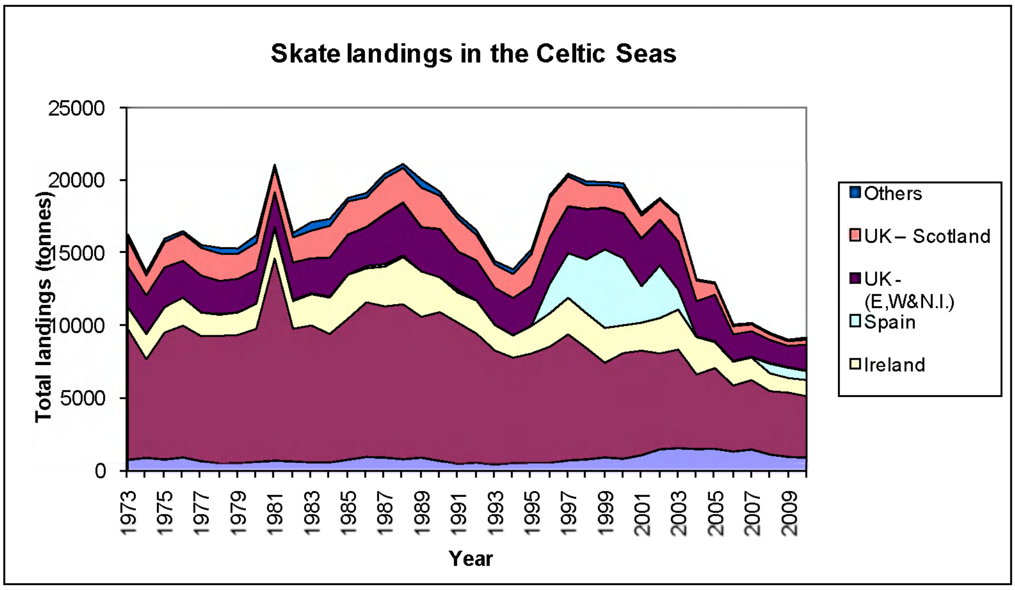


Figure 18.1b. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2009 (Source: ICES).

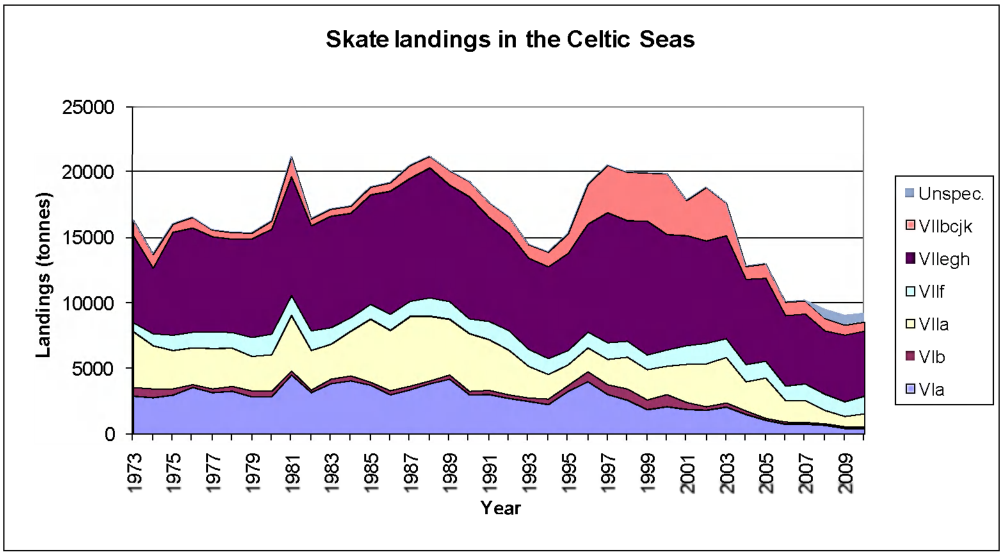
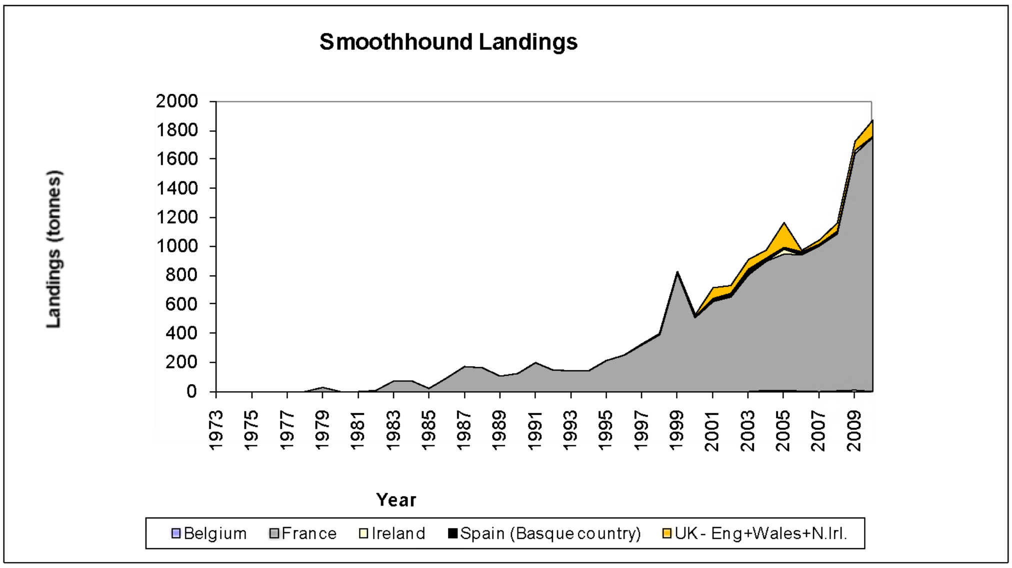


Figure 18.1c. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by ICES Division in the Celtic Seas from 1973–2009 (Source: ICES).



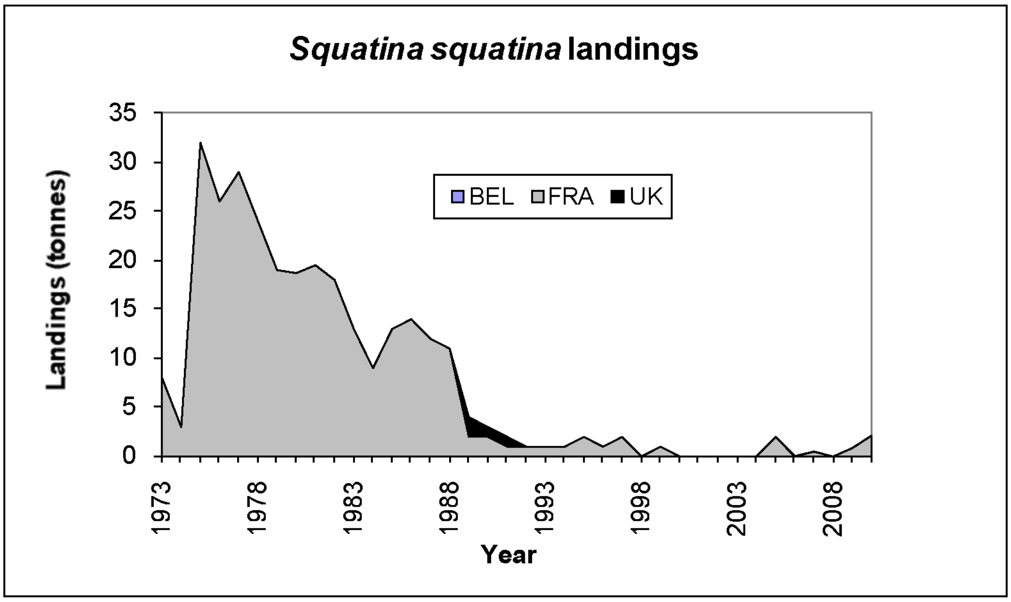


Figure 18.2. Demersal elasmobranchs in the Celtic Seas. Total landings of *Mustelus* spp. (1973–2010, top) and *Squatina squatina* (1973–2010, bottom). It should be noted that landings of smoothhounds at the start of the time-series may under represent true catches, as an unknown quantity may have been landed under generic dogfish landing categories. Angel shark is now on a prohibited species list and only nominal landings are reported in 2009–2010. (Source: ICES and Bulletin de Statistiques des Peches Maritimes).

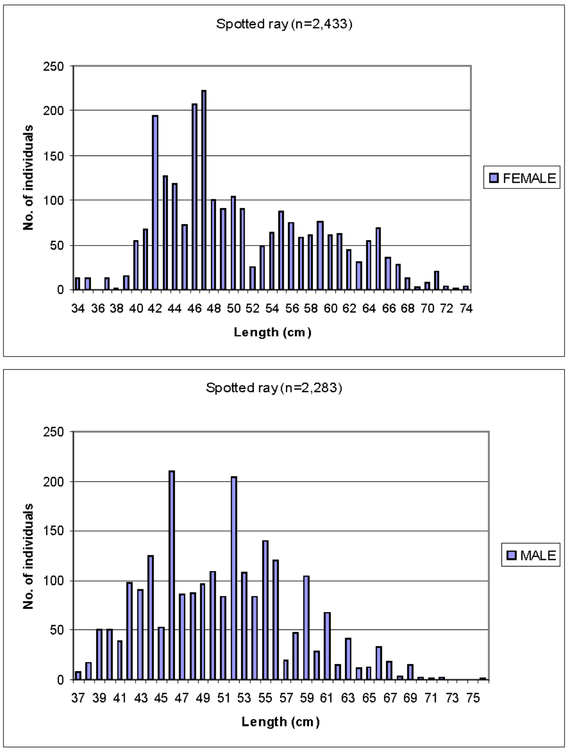


Figure 18.3a. Demersal elasmobranchs in the Celtic Seas. Length frequency of male and female spotted ray (*Raja montagui*) in the Celtic Sea in 2009, sampled from commercial catches (Source: Ifremer).

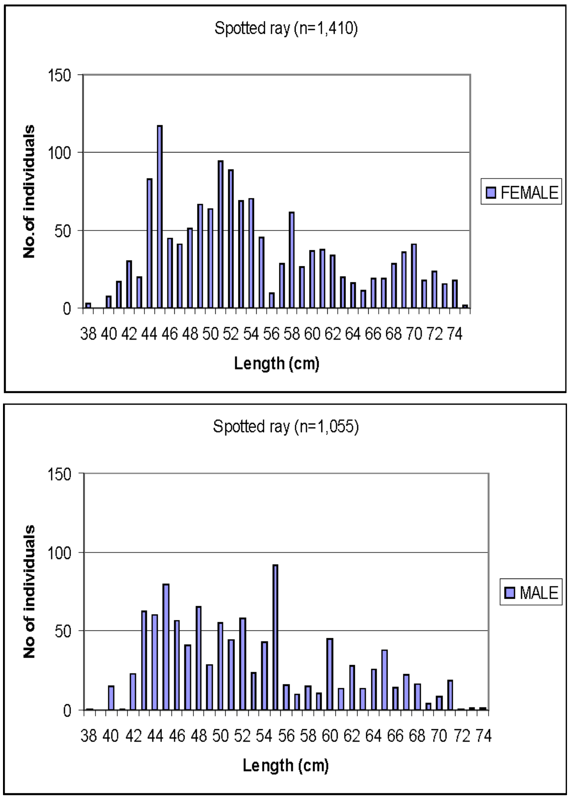


Figure 18.3b. Demersal elasmobranchs in the Celtic Seas. Length frequency of male and female spotted ray (*Raja montagui*) in the Celtic Sea in 2010, sampled from commercial catches (Source: Ifremer)

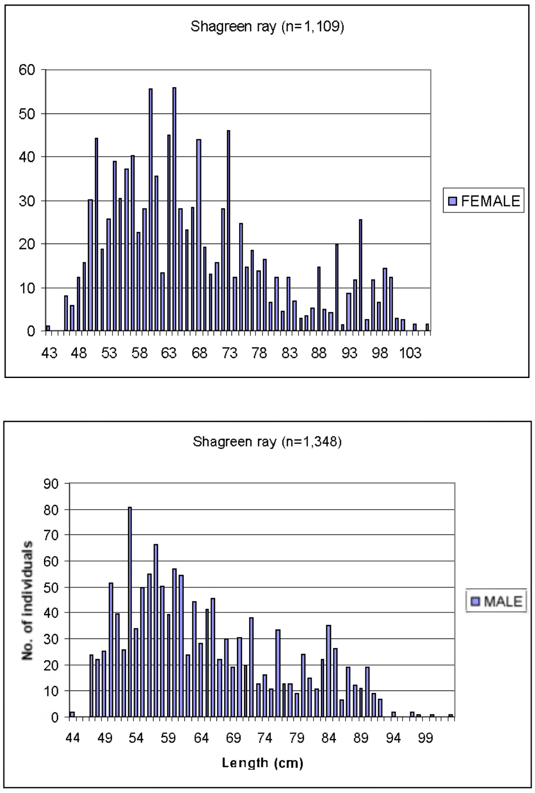


Figure 18.4a. Demersal elasmobranchs in the Celtic Seas. Length frequency of male and female shagreen ray (*Leucoraja fullonica*) in the Celtic Sea in 2009, sampled from commercial catches (Source: Ifremer).

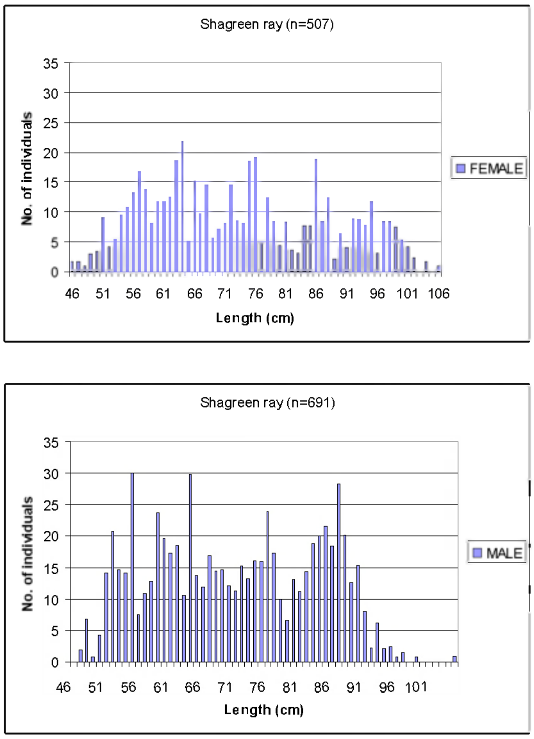


Figure 18.4b. Demersal elasmobranchs in the Celtic Seas. Length frequency of male and female shagreen ray (*Leucoraja fullonica*) in the Celtic Sea in 2010, sampled from commercial catches (Source: Ifremer).

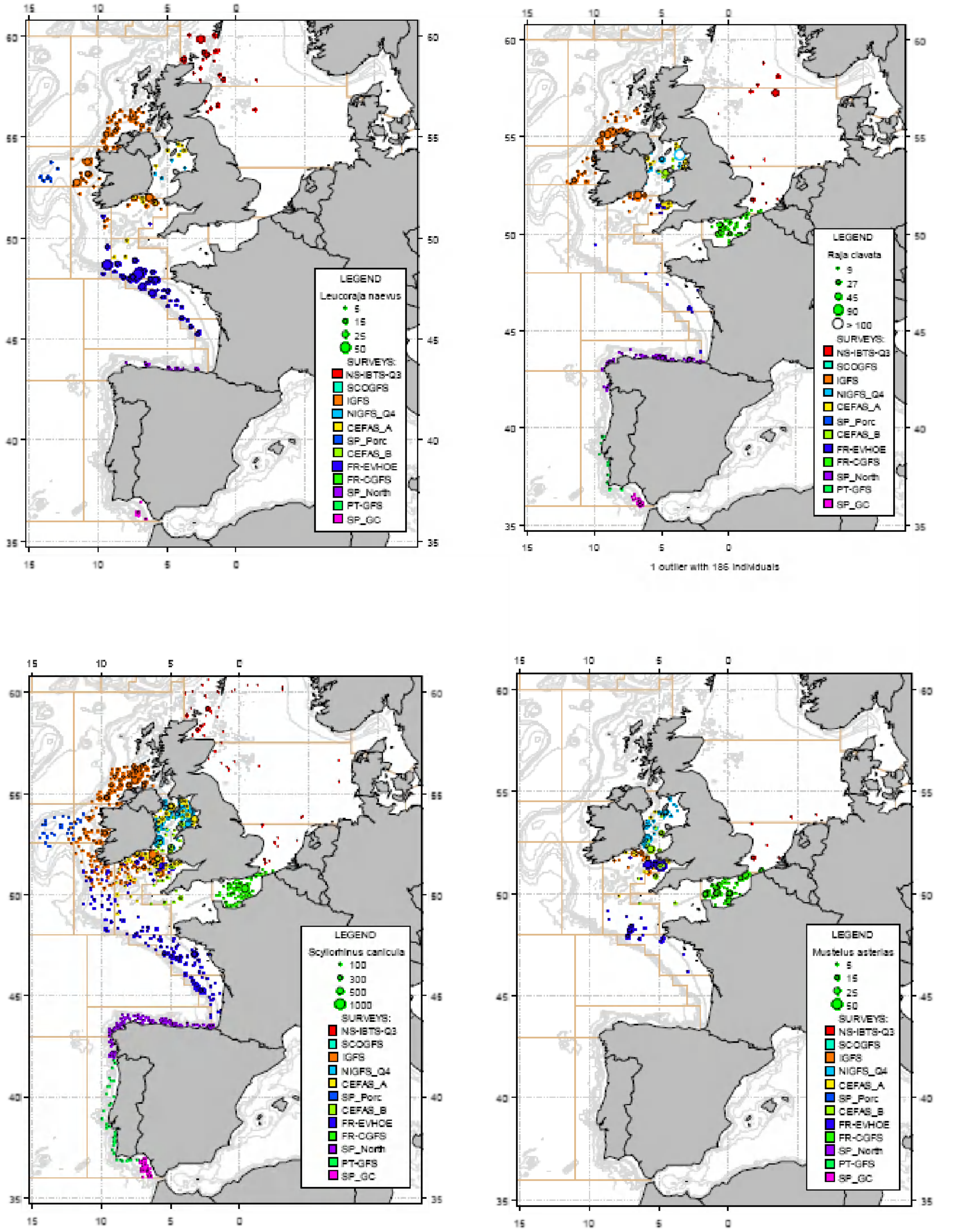


Figure 18.5. Demersal elasmobranchs in the Celtic Seas. Catches, in numbers per hour, of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, lesser-spotted dogfish *Scyliorhinus canicula* and starry smooth-hound *Mustelus asterias* in Q4 IBTS surveys in the Southern and Western Areas in 2009. 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 (Source: ICES, 2011).

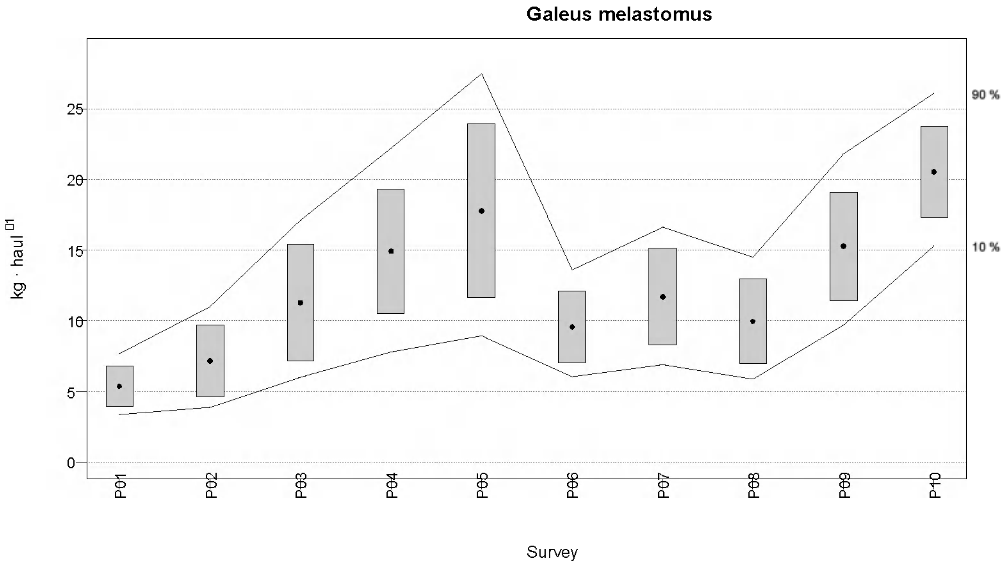


Figure 18.6a. Demersal elasmobranchs in the Celtic Seas. Changes in black-mouth dogfish (*Galeus melastomus*) biomass index during Porcupine Survey time-series (2001–2010). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

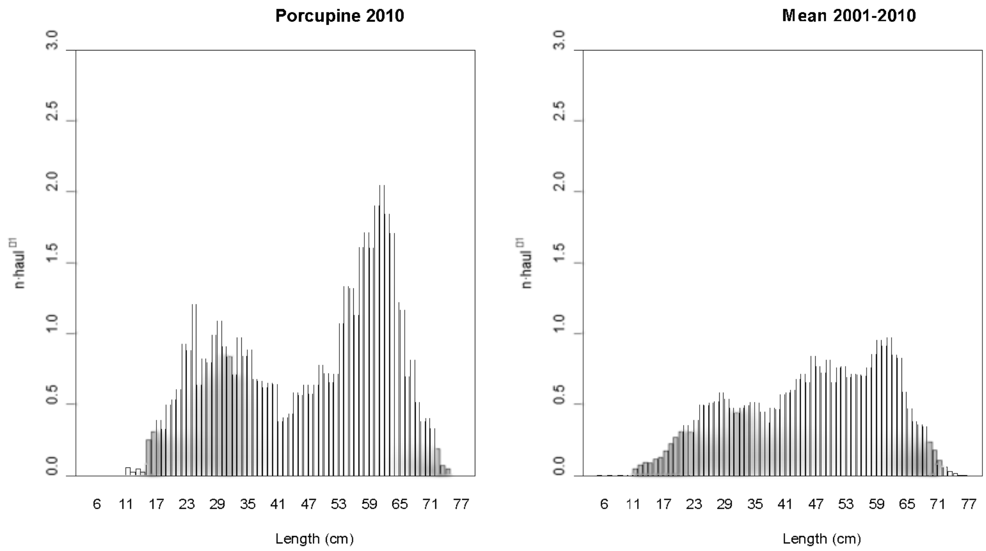


Figure 18.6b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of black-mouth dogfish (*G. melastomus*) in 2010 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2010).

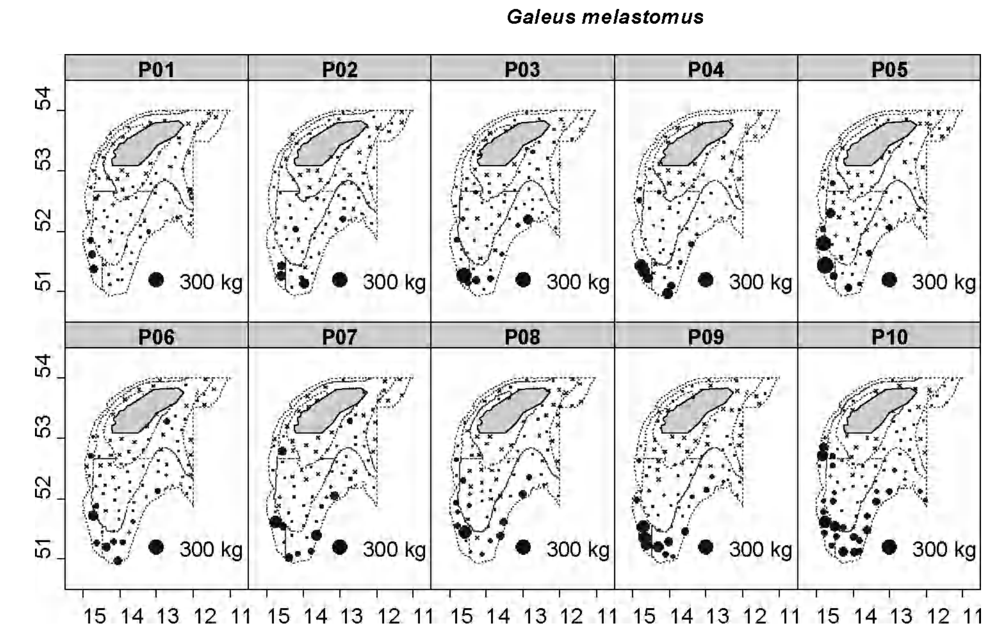


Figure 18.6c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of black-mouth dogfish (*G. melastomus*) catches (kg·haul⁻¹) during Porcupine surveys time-series (2001–2010).

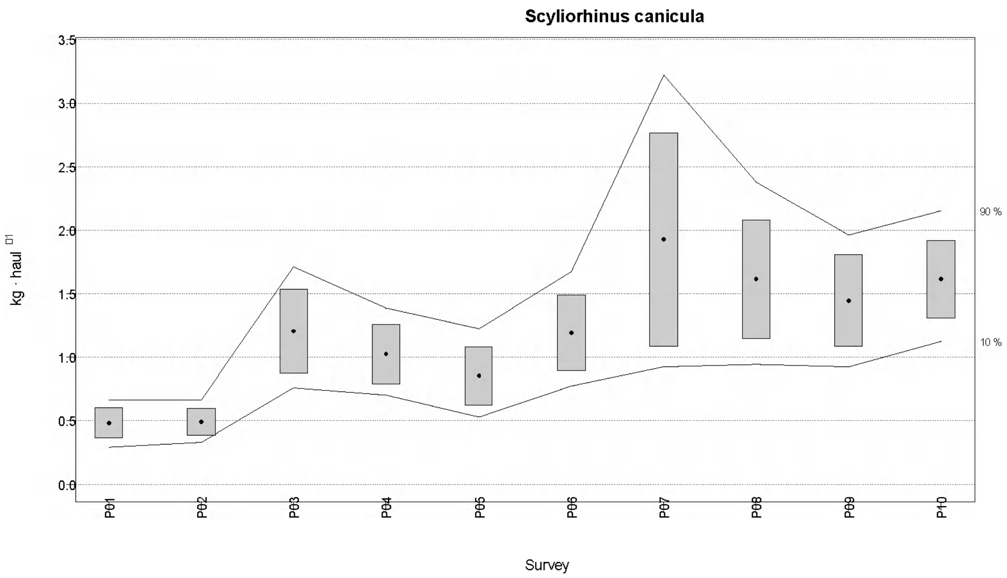


Figure 18.7a. Demersal elasmobranchs in the Celtic Seas. Changes in lesser-spotted dogfish (*Scyliorhinus canicula*) biomass index (kg·haul⁻¹) during Porcupine Survey time-series (2001–2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

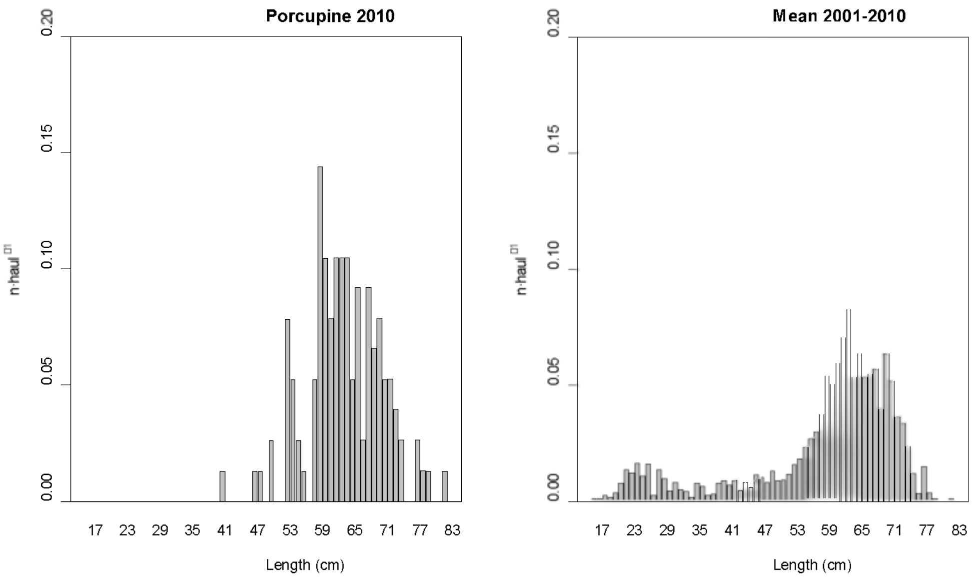


Figure 18.7b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of lesser spotted dogfish (*S. canicula*) in 2010 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2010).

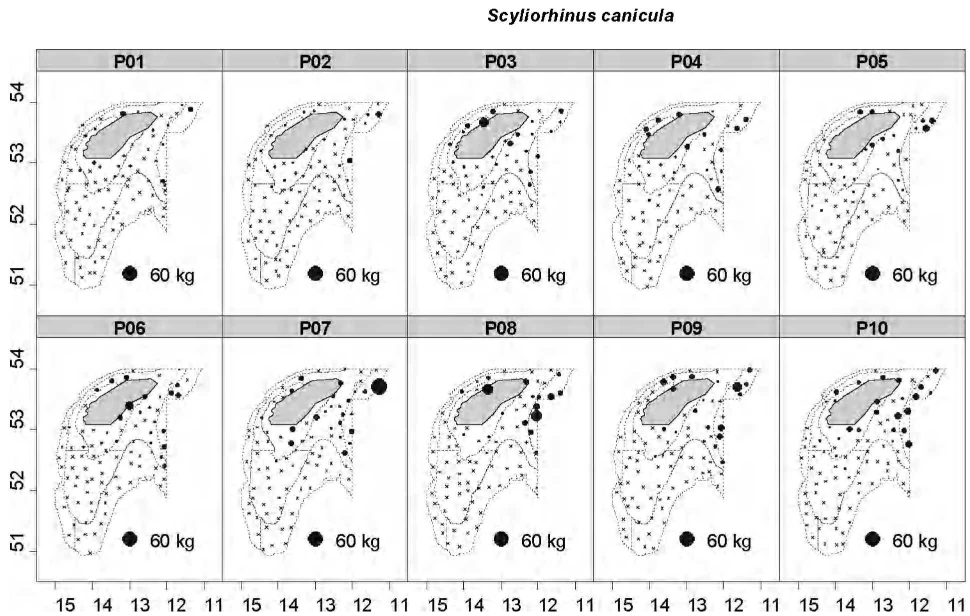


Figure 18.7c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of lesser spotted dogfish (*S. canicula*) catches (kg·haul^{-1}) in Porcupine surveys (2001–2010).

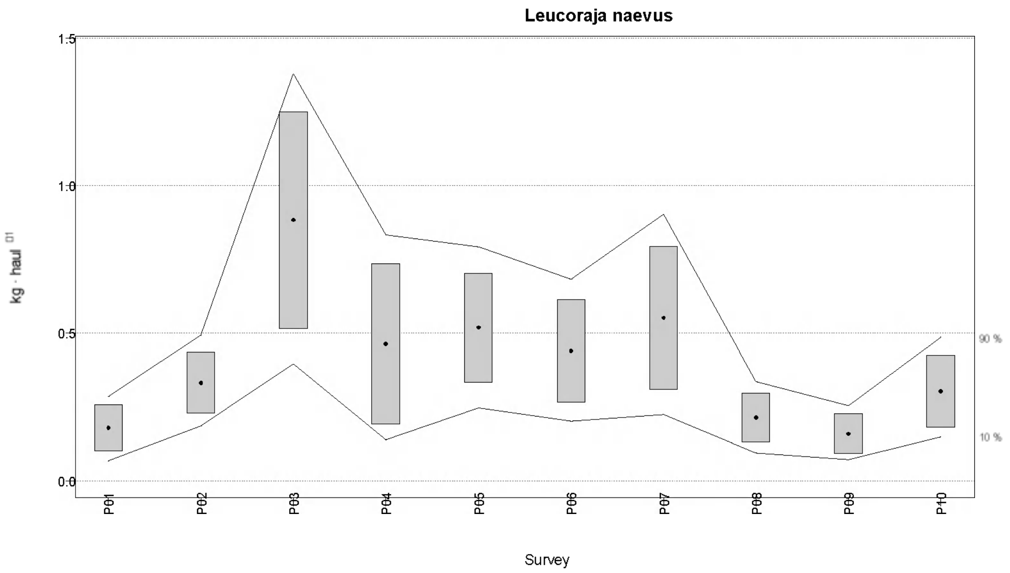


Figure 18.8a. Demersal elasmobranchs in the Celtic Seas. Changes in *Leucoraja naevus* biomass index (kg·haul⁻¹) during Porcupine Survey time-series (2001–2010). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

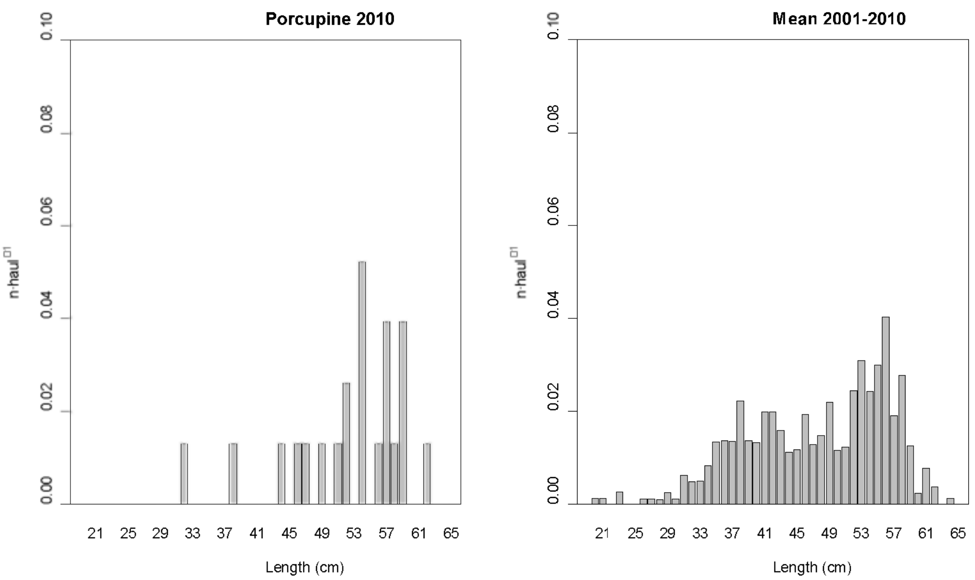


Figure 18.8b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of cuckoo ray (*L. naevus*) in 2010 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2010).

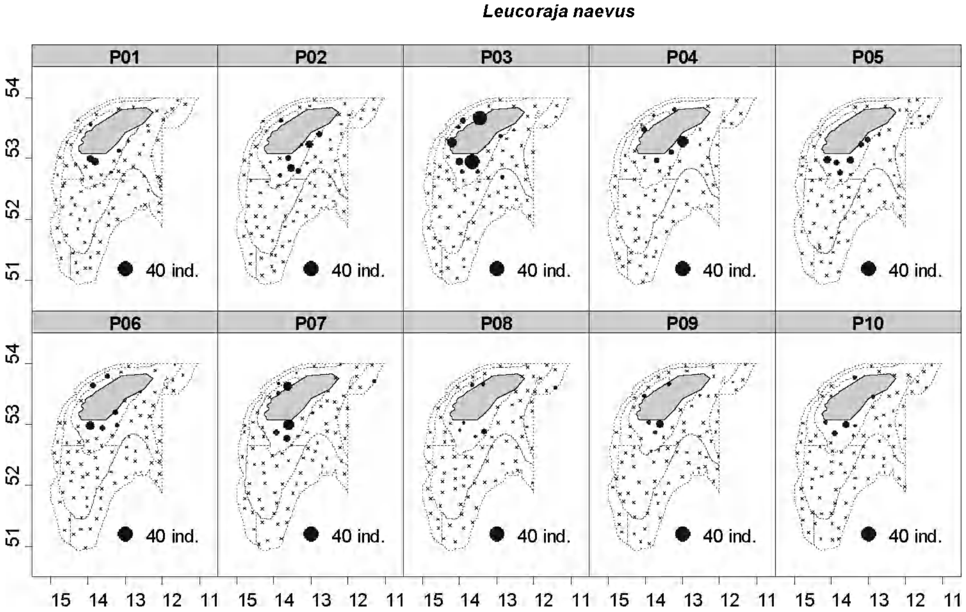


Figure 18.8c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of *Leucoraja naevus* catches (ind haul⁻¹) during Porcupine surveys time-series (2001–2010).

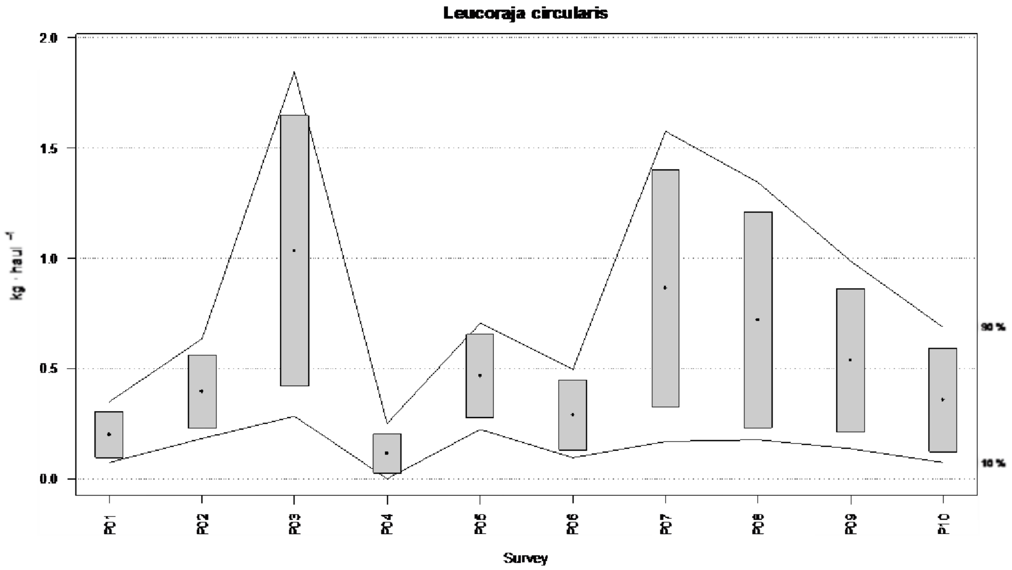


Figure 18.9a. Demersal elasmobranchs in the Celtic Seas. Changes in sandy ray (*Leucoraja circularis*) biomass index (kg·haul⁻¹) during Porcupine Survey time-series (2001–2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

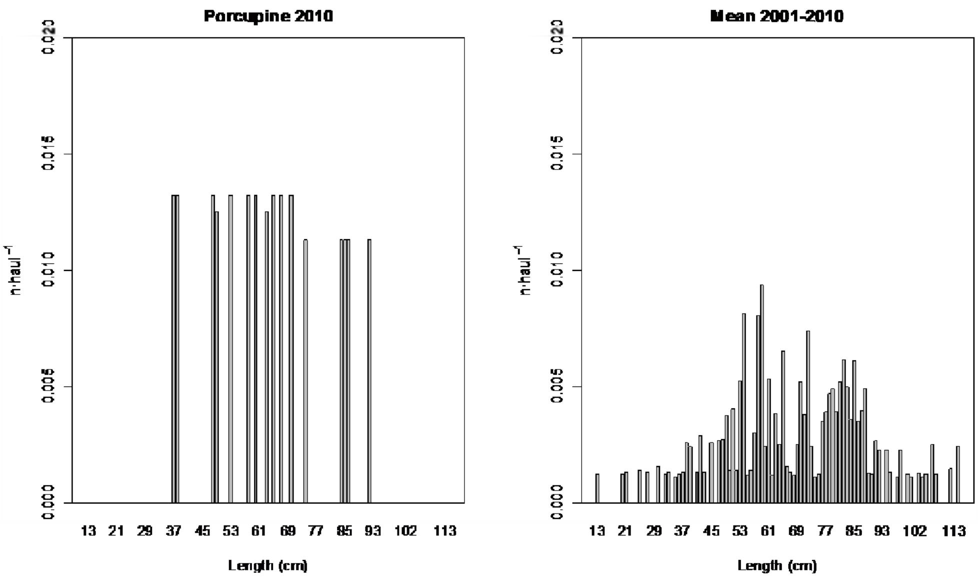


Figure 18.9b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of sandy ray (*L. circularis*) in 2010 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2010).

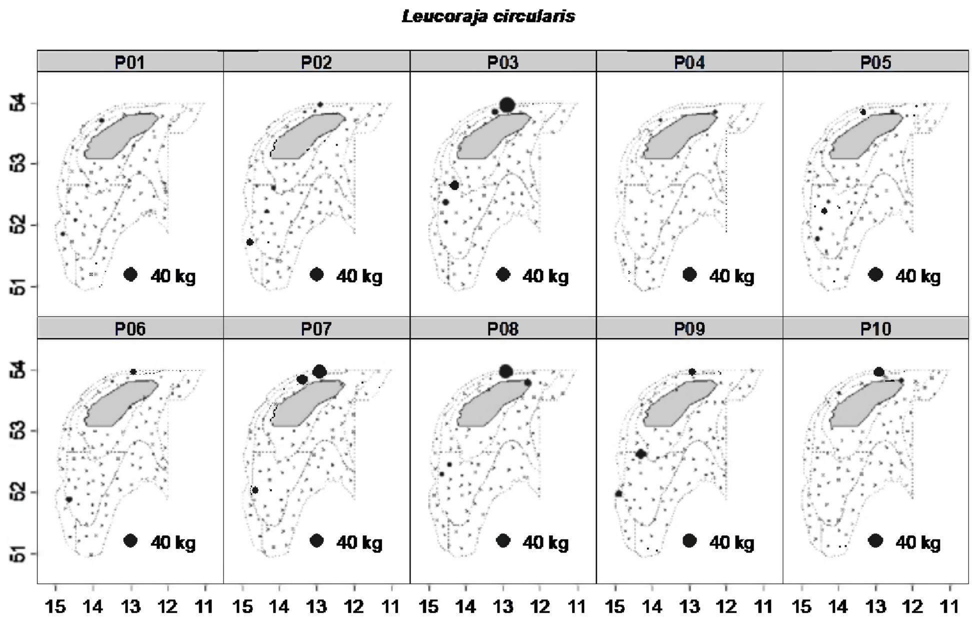


Figure 18.9c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of sandy ray (*L. circularis*) catches (kg·haul⁻¹) in Porcupine surveys (2001–2010).

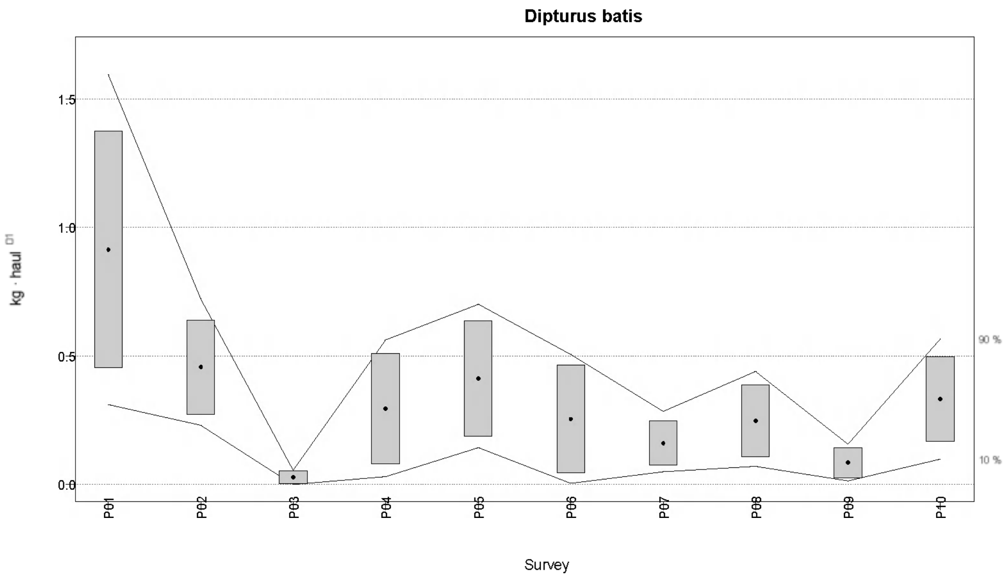


Figure 18.10a. Demersal elasmobranchs in the Celtic Seas. Changes in common skate complex ('*Dipturus batis*') biomass index (kg.haul^{-1}) during Porcupine Survey time-series (2001–2010). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

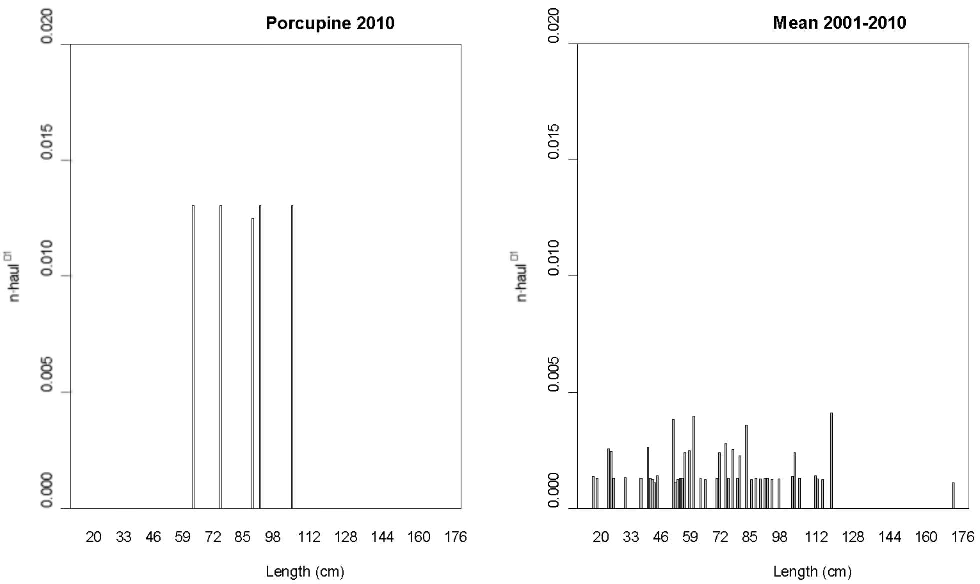


Figure 18.10b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of common skate complex ('*D. batis*') in 2010 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2010).

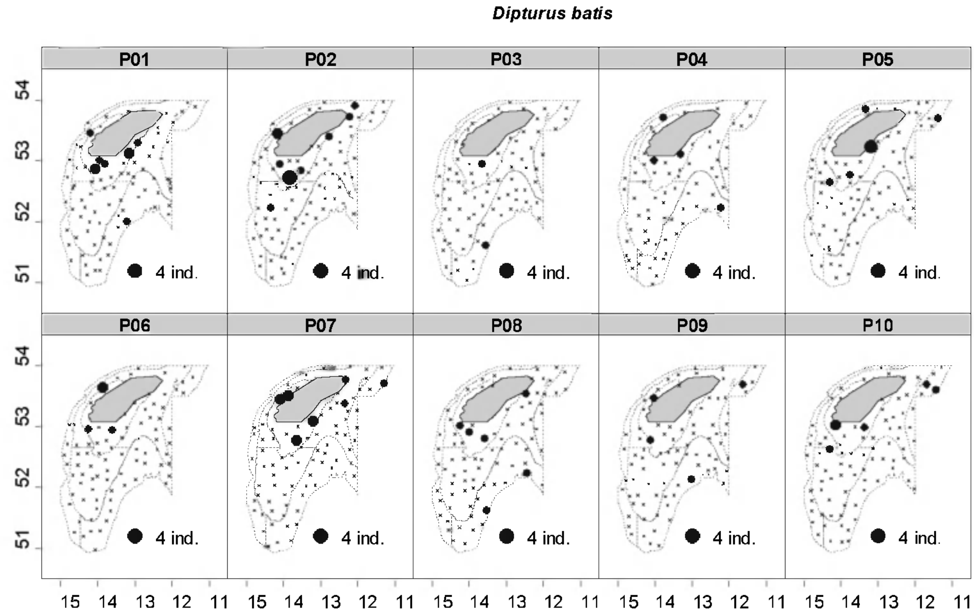


Figure 18.10c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of common skate complex (*'D. batis'*) catches (ind. haul^{-1}) in Porcupine surveys (2001–2010).

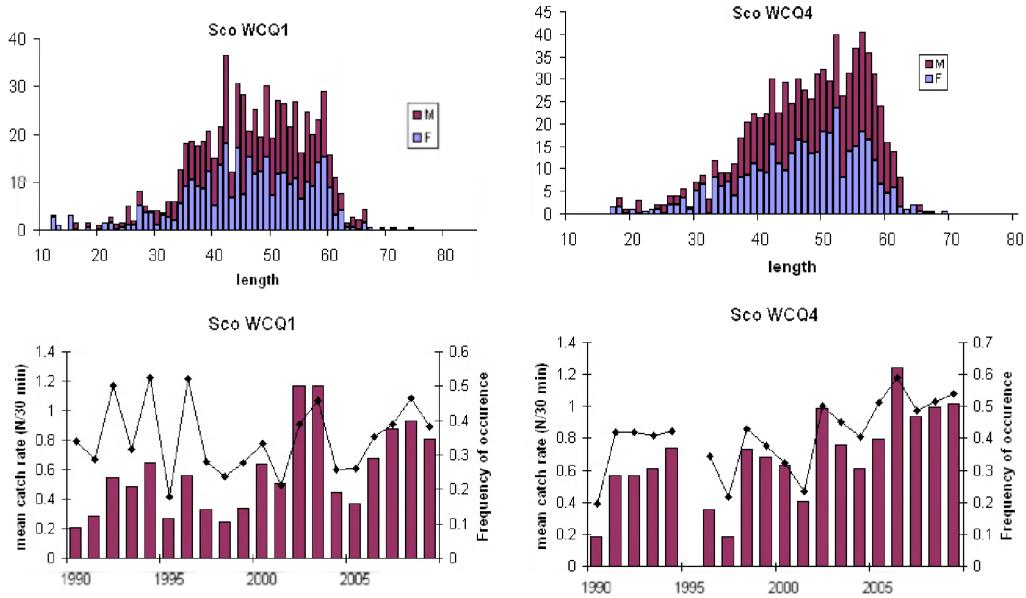


Figure 18.11a. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *L. naevus* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1}.

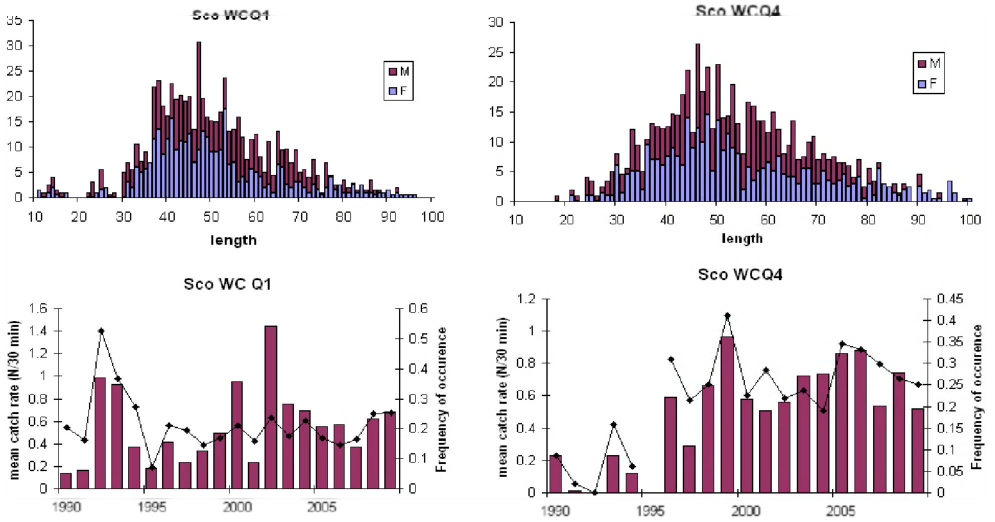


Figure 18.11b. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *R. clavata* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1}.

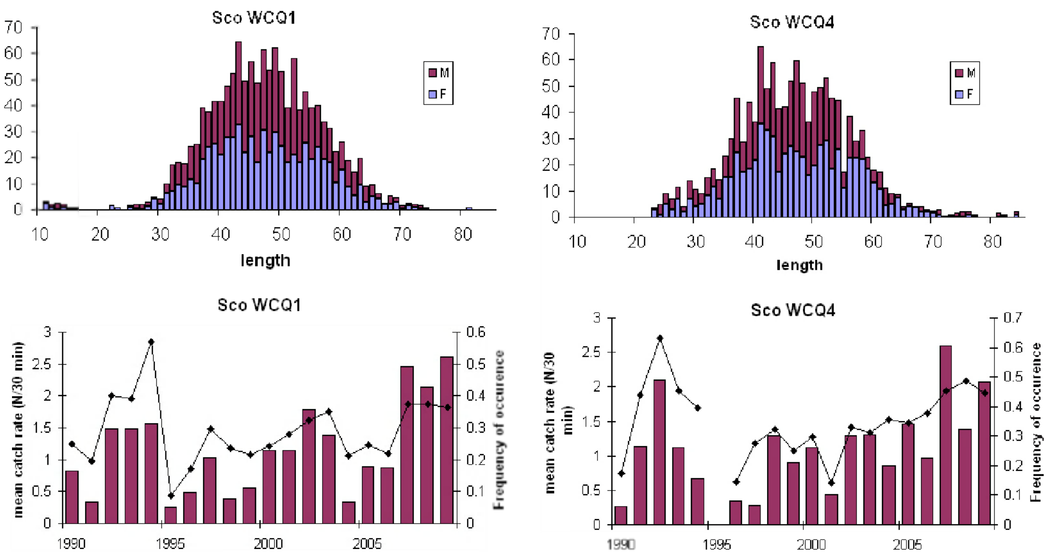


Figure 18.11c. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *R. montagui* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min^{-1}.

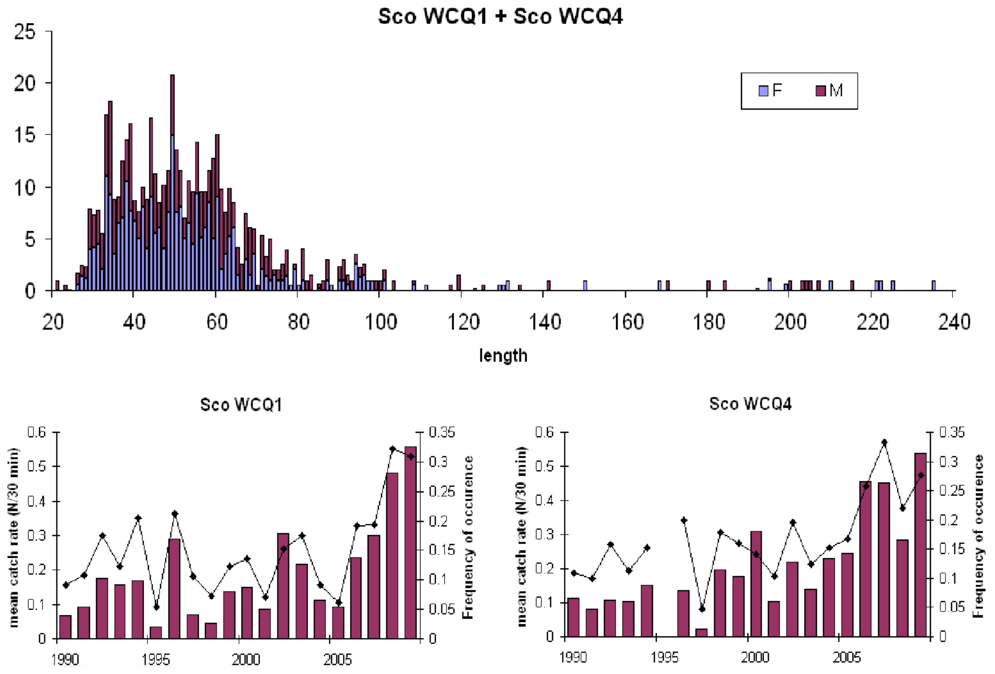


Figure 18.11d. Demersal elasmobranchs in the Celtic Seas. Combined length frequency distributions of 'D. batis' from the Scottish west coast surveys in Q1 and Q4 (upper plot). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min⁻¹.

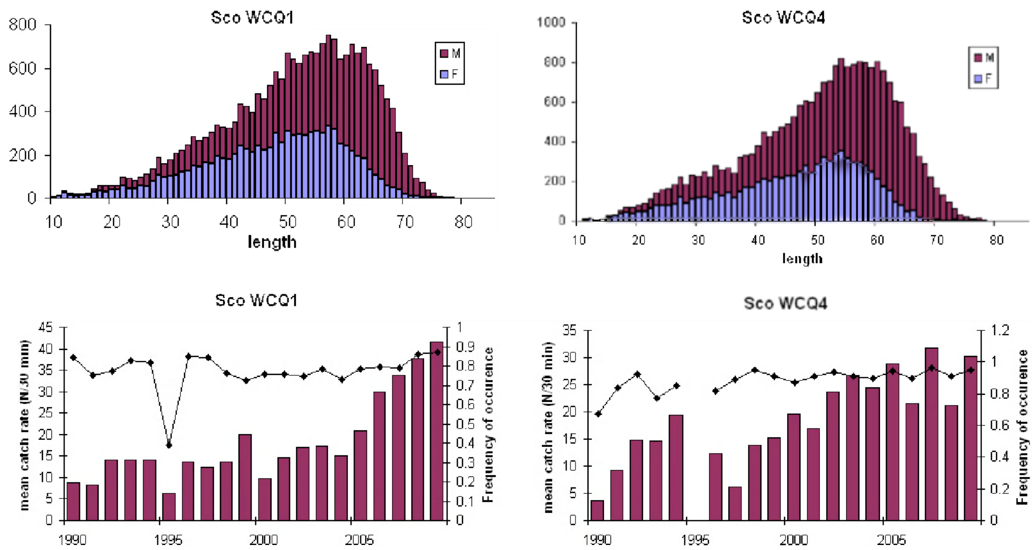


Figure 18.11e. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of lesser-spotted dogfish from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min⁻¹.

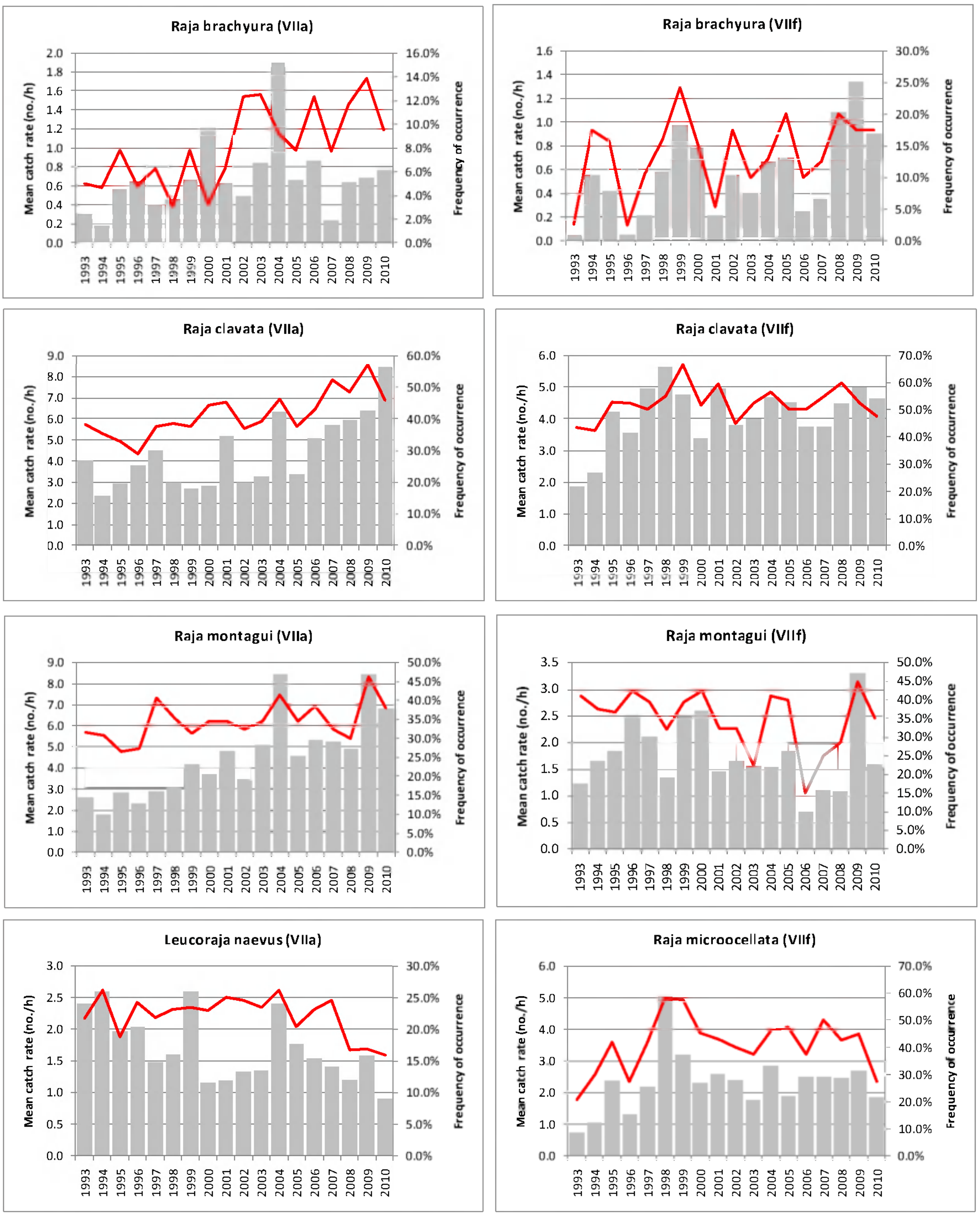


Figure 18.12a. Demersal elasmobranchs in the Celtic Seas. Mean catch rates (no.h^{-1}, columns) and frequency of occurrence (red line) of *R. brachyura*, *R. clavata* and *R. montagui* in the Irish Sea (VIIa, left panel) and Bristol Channel (VIIf, right panel), and *R. microocellata* in VIIf and *L. naevus* in VIIa. Data from the UK 4 m-beam trawl survey in the Irish Sea and Bristol Channel (1993–2010).

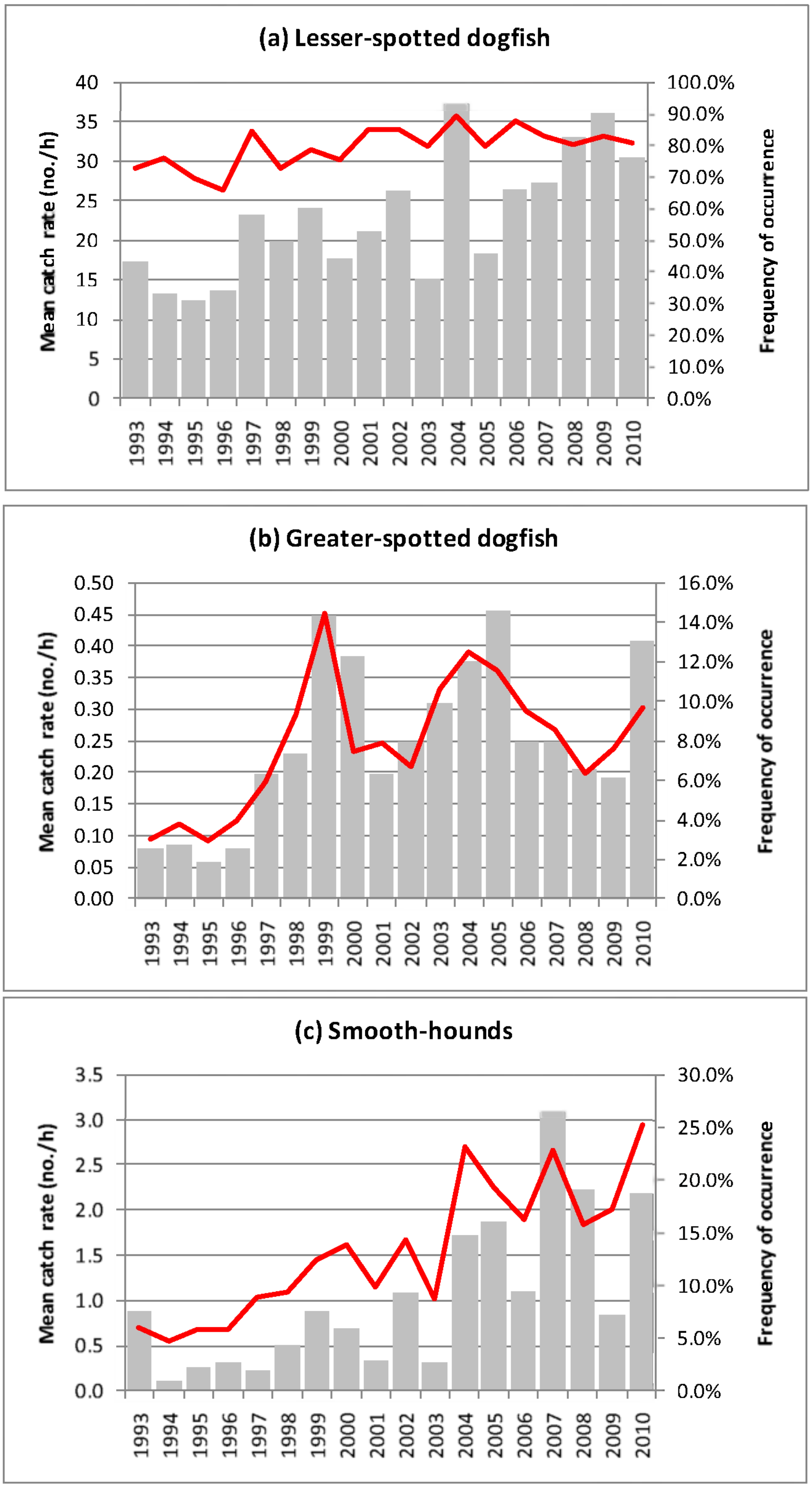


Figure 18.12b. Demersal elasmobranchs in the Celtic Seas. Mean catch rates (ind.h^{-1}, columns) and frequency of occurrence (red line) of (a) lesser-spotted dogfish, (b) greater-spotted dogfish and (c) smooth-hounds from the UK 4 m beam trawl survey in the Irish Sea and Bristol Channel (1993–2010).

19 Demersal elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa)

19.1 Ecoregion and stock boundaries

The Cantabrian Sea (ICES VIIIc Division) is the southern part of the Bay of Biscay (ICES Divisions VIIIa, b, d). In contrast to the more northerly Bay of Biscay, which has a wider continental shelf with flat and soft bottoms more suitable for trawlers, the Cantabrian Sea has a narrow continental shelf with some remarkable bathymetric features (canyons, marginal shelves, etc.). The Portuguese continental shelf is 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.

No management stocks are defined for any of the three main demersal species landed either from the Bay of Biscay or Iberian waters. The geographical distribution of these species is fairly well known, but their stock structure is still unknown. Trying to describe the distribution of each species and to identify self-containing stocks, WGEF decided to consider the following stock units for demersal elasmobranch species in Bay of Biscay and Iberian Waters: Divisions VIIIa, b, VIIIc, VIIId and IX. The main commercial species and stock units are:

Skates and rays

Thornback ray (*Raja clavata*): As biological and fisheries data are most accurate and comprehensive for the Bay of Biscay region (VIII) and Portuguese Iberian waters (IXa), the same areas should be used in preliminary assessments of this species.

Cuckoo ray *Leucoraja naevus*: As biological and fisheries data are most accurate and comprehensive for the Celtic Sea (VIIe–k) and Bay of Biscay Bay (VIII), the same areas should be used as preliminary assessment areas for this species. The relationship between *L. naevus* in VIII and VIIe–k is unknown.

Other skates species in the area include blonde ray *Raja brachyura,* smalleyed ray *R. microocellata,* brown ray *R. miraletus,* spotted ray *Raja montagui,* undulate ray *R. undulata,* shagreen ray *Leucoraja fullonica,* common skate *Dipturus batis* complex, long-nose skated *D. oxyrinchus* and white skate *Rostroraja alba.* Some of these species have patchy distributions.

Dogfish

Populations of lesser-spotted dogfish (*Scyliorhinus canicula*) would best be assessed as local populations, as a consequence of the availability of fisheries statistics and biological data, assessing this species within the ICES divisions mentioned above.

19.2 The fishery

19.2.1 History of the fishery

In order to facilitate the reading of this section, the structure of text includes separate fishery descriptions for the three main countries involved in the area (Spain, Portugal (mainland) and France).

Spain

The Spanish demersal fishery along the Cantabrian Sea and Bay of Biscay takes many species of skates with a wide variety of gears, but most of the landings come from the bycatch of fisheries targeting other demersal species such as hake, anglerfish and megrim. Although a wide number of skates and demersal sharks can be found in the landings, historically the most commercial elasmobranchs are two species of skate (*L. naevus* and *R. clavata*) and lesser-spotted dogfish. The fact that some elasmobranchs have a low commercial value and are taken as a bycatch means that traditionally these species were landed together in the same category especially in artisanal vessels (gillnetters). There is also along the Cantabrian sea and Galicia coast (VIIIc and IXa) a fishery of small artisanal vessels (gillnetters) operating in bays or shallow waters, but the "*modus operandi*" of these fleets make very difficult to get reliable information about the landings of elasmobranch species associated to this fisheries (mainly coastal rays and *Scyliorhinus* spp).

Mainland Portugal

Off mainland Portugal (IXa), lesser-spotted dogfish is caught mainly by coastal trawlers and by the artisanal fishing fleet. This species, along with greater-spotted dogfish *S. stellaris,* are landed in the major ports of Division IXa under the generic name of *Scyliorhinus* spp. Although it is believed that *S. canicula* is the dominant species in the landings, the composition of this mixture is not known.

Skates and rays are captured mainly by the artisanal polyvalent fleet, which primarily uses trammelnets. The artisanal fleet also uses different types of fishing gear, such as longline and gillnets, and account for the highest landing records (75% of the annual skate and ray landings). The mixed nature of the fisheries catching skates results in a serious problems on the estimation of important fishery parameters.

French skate fisheries

Skate are a traditionally food resource in France, and France has had directed fisheries for skate since the 1800s. Since the 1960s, skate have been taken primarily as bycatch of bottom-trawl fisheries operating in the northern part Bay of Biscay, the southern Celtic Sea and English Channel. *R. clavata* was often the target of directed seasonal fisheries in the past, and was the dominant skate in the French landings, but in the 1980s *L. naevus* replaced *R. clavata* as the dominant skate. The landings of both have declined since 1986.

Other skate are also landed include sandy ray *Leucoraja circularis, L. fullonica,* smalleyed ray *Raja microocellata, D. batis* complex and *D. oxyrinchus*. *Rostroraja alba* is now rarely caught.

19.2.2 The fishery in 2010

No new information.

19.2.3 ICES Advice applicable

In 2010 ICES provided advice for 2011 to 2012 for the demersal elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa). Regarding *S. canicula* ICES recommended *landings less than 1.7 thousand t and for skates and rays less than 4200 t for the main species and no target fishery on Raja undulata and Dipturus batis complex.*

19.2.4 Management applicable

The Council Regulation (EC) No 23/2010 established a TAC of 5459 t in 2010 for Rajidae of Divisions VIII and IX.

RAJIDAE	TAC	Landings
Divisions VIII and IX	2010	2010
Belgium	11	4
France	2070	1474
Portugal	1678	1524
Spain	1688	1118
UK	12	0.4
UE	5459	4121

This Regulation indicated that: Catches of cuckoo ray (*Leucoraja naevus)* and thornback ray (*Raja clavata*) shall be reported separately. Council Regulation (EC) No 43/2009 also states that "Angel shark in all EC waters may not be retained on board" and that catches "shall be promptly released unharmed to the extent practicable" These also apply to undulate ray (*Raja undulata*), common skate (*Dipturus batis* complex) 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.

19.3 Catch data

19.3.1 Landings

Skates and rays

Landings for the period 1996–2010 are given in Table 19.1a–e. Historically the main countries reporting international landings since 1973 in Bay of Biscay and Iberian waters are France, Spain and Portugal. France provided estimated catch for 2009 and 2010 for the Working Group.

French and Spanish and Basque Country (Spain) skate landings come mainly from Divisions VIIIa, b and c. Landings of skates since 1973 display no clear pattern (Figure 19.1a), although there was a remarkable peak in landings in the earlier years (1973–1974) and from 1982–1991. The reduction in observed landings from 1992–1995 and in 2007 coincides with a misreporting period of Spanish landings (Figure 19.1). The increase observed from 2008 onwards coincides with the reporting of French and Spanish landings that were not available in 2007 and 2009 respectively. However, in 2010 total landings in this subarea were reduced due to French and Basque Country (Spain) reported fewer landings than in previous years. The annual landings of skates by Portugal in Division IXa remain very stable since 1996; at around 1500 t, although in 2009 the landings decreased to 1300 t. Spanish landings in this Division since 1998 were between 200 and 450 $t.y^{-1}$.

Species-specific landings of skates in Subarea VIII and Division IXa have been provided in 2010 by all countries. According to these data (Table 19.5) historically the most important species landed in the last years in decreasing order are *L. naevus, R. clavata, R. brachyura, R. montagui and R. undulata*. Since 2010 and due to the legislation

(Council Regulation (EC) No 43/2009) banning the land of *R. undulata* this species is not reported in national landings.

Lesser-spotted dogfish

Landings reported to the WG are shown in Table 19.2. As with skates, French and Spanish (Basque Country) landings of lesser-spotted dogfish come mainly from Divisions VIIIa, b. Trawlers of Spain in Subarea VIII landed 552 t of lesser-spotted dogfish in 2010 (Table 19.2e). In Division VIIIc (Table 19.2c) only Spanish and Basque Country landings are significant, but despite a slight increase observed in 2010, since 1999 landings have been reduced strongly. On the other hand, due to the much reduced effort of the trawler fleet in VIIId than in other areas, landings in this Division are historically not significant.

Historically most of the landings of lesser-spotted dogfish in IXa came from the Portuguese fleet (Table 19.2d). From 1996 to 2004, the Portuguese landings were between 600–700 $t.y^{-1}$ but an important reduction of this country's landings can be observed since 2005, and only 75 t were reported by Portugal in 2010.

The total historical landings of lesser-spotted dogfish in Biscay and Iberian waters since the peak of 2000 have been established at around 1650 $t.y^{-1}$ (Table 19.2; Figure 19.2).

Other demersal sharks

The information about the historical landing series of other elasmobranch species such as smooth hounds and angel shark are poor. Of these species, only smooth hounds are landed in significant quantities in Subarea VIII, mainly by the French and Spanish fleets. There has been a noticeable increase in landings of *Mustelus* spp. in French landings in Division VIII since the mid-1990s (Table 19.3a) and especially in the period from 2008 to 2010. The increase in 2009 was also important in the Spanish (Basque) fleets that landed 166 t.

In Division IXa the landings of smooth hounds (Table 19.3b) come mainly from the Portuguese vessels, and only in 2009 and 2010 France and Spain reported landings of this species. The historical trend demonstrates a saw tooth profile with the lowest record of 36 t in 2006.

Angel shark landings in Subarea VIII have always been very low, and after the revision of French data in the historical series, only 2.6 t of this species have reported in landings since 1996 (Table 19.4a).

19.3.2 Discards

The information of historical series of discards of main demersal elasmobranch of the Basque OTB (Bottom Otter Trawler) fleet in Divisions VIIIa, b, c, d since 2003 were also updated in this section (Table 19.6).

OTB Basque fleet

Skates and rays: only smaller skates are usually discarded, and the trend of discards of these species demonstrates a decrease since 2004.

Since 2009 there is specific information of discards for these species. This new information indicates that *L. naevus* was the more discarded species, reaching 6–7 $ton.y^{-1}$, while less than 1 t of *R. clavata* was discarded by this fleet in 2010 (Table 19.6).

Lesser-spotted dogfish: Although this species is the most important elasmobranch species landed by this fleet, the estimated discards since the first year of series have been higher than the landings. Estimates of discard higher than 600 t were reached in 2004, 2008, and 2010 with a peak of 1092 t in 2009.

Blackmouth catshark is landed in "small" amounts, however discards were higher than landings in 2005, 2009 and 2010 and especially in 2004 in which were estimated discards of 226 t. This important discard seems not to be reliable and might be due to an overestimation of the estimates in the subsamples because this species is very scarce in the catches.

Information on the results of the Spanish discard sampling programme for the main elasmobranch species in VIIIc and IXa was updated in 2010. The results of the Spanish programme demonstrate that by far *S. canicula* and *G. melastomus*, are the species most important in the discarded catch. Also *E. spinax* and *L. naevus* reveal important discard figures in some years, and deep-water sharks (*C. squamosus* and *D. calceus*) are especially prominent in 2009 and 2010 due to a zero TAC (Table 19.7).

19.3.3 Quality of the catch data

France reported to the Working Group landings for 2009 that were not available in 2010. These data have been updated in the national landing tables. Non-reported data in 2007 are still not resolved for some countries.

19.4 Commercial catch compositions

19.4.1 Species and size composition

Length frequencies of *L. naevus* and *S. canicul*a by sex in 2010 are provided from the French demersal trawl fleet landings catches in Bay of Biscay (Figures 19.3a and b). In the framework of the French DCR programme, the National "Observer programme at sea"; ObsMER started to sample shark and skate bycatch from the domestic fisheries since 2003. Length frequency distributions of *Raja clavata*; *Raja brachyura, Raja montagui, Leucoraja naevus, Raja undulata, Raja microocellata*, in the three main Portuguese (ICES IXa) landing ports: Peniche, Matosinhos and Sines is presented in Figures 19.4–19.6 (Serra-Pereira *et al*., 2011 WD).

19.4.2 Quality of the catch data

Most of the countries involved in the fisheries in Divisions IXa and Subarea VIII have provided the specific composition of landings (Table 19.5). However the specific identification of landings of less common rays as well as smooth hounds especially in artisanal fleets it is a problem that still remains for these species. It is still necessary to standardize the historical time-series of effort and lpue by species, of trawler fleets and also to provide reliable effort and lpue data from the artisanal fleets (gillnetters) fishing for coastal skates. It is advisable to initiate studies for the correct determination of biological cycles and reproductive aspects for the main ray species caught in Iberian waters. In ICES Subarea IXa in 2009 and 2010, 73 tonnes of species from the genus Mustelus were landed in 29 Portuguese landing ports. Landings at Peniche represented 22.3%, Nazaré 15.8% and Sesimbra 13%. Landings by landing port are presented in Figure 19.7 (only landing ports with annual landings higher than 1 tonne were considered). The identification of Mustelus at a species level is difficult and is likely to cause problems with misidentification, which has been identified in this area

(Table 19.8). There is poor identification at species level and data are likely to be a combination of both *Mustelus mustelus* and *Mustelus asterias*.

19.5 Commercial catch-effort data

A nominal lpue and effort series of data since 1994 of the Basque Country's OTB and PTB operating in Subarea VIII has been updated this year (Table 19.9).

The lpue data are referred to the main elasmobranch species landed by the fleets: lesser-spotted dogfish, rajidae (*L. naevus* and *R. clavata* combined), spurdog and smooth hounds.

In OTB, since 1994 landings of lesser-spotted dogfish have been on average 300 $t.y^{-1}$. The lpue of this species demonstrates a continuous increase since the first year of the series with minimum in 1994 (20 kg/day) and a maximum in 2009 (191 kg/day). In rajidae the best lpue (201 kg/day) was reached in 1998 but since then a continuous decrease has been observed until 2004. From this year onwards, the lpue recovers slightly to reach 96 kg/day in 2009 but decreases again in 2010. Landings of spurdog in VIII have been historically very scarce, which is why the lpue of this species are very low. In 2010 only 0.18 kg/day were reached; the lowest value of the series. The trend of lpue of smooth hound was very stable from 1998 to 2007 (on average 10 kg/day) but in 2008 and 2009 the lpue increased strongly due to the increase of landings. However in 2010 lpue decreases at levels around the average of the period 1998–2007 and only 16 kg/day were recorded.

Elasmobranch landings and lpue in PTB have been historically much lower than in OTB. The overall trend of this lpue doesn't demonstrate any significant change compared with the analysis carried out in 2010.

Under a Portuguese pilot sampling programme (ICES Subarea IXa) annual lpue estimates and standard deviations were determined for *Raja clavata* , *Raja microocellata* , *Raja montagui*, *Raja undulata* and *Raja brachyura* for each fishing method in 2008 and 2010. Lpue was not determined for species with a minor frequency of occurrence on the sampled trips. For each sampled fishing trip, the data available did not allow to estimate lpue by fishing haul when more than one fishing gear was used. This deficiency mainly derives from the fact that landings from fishing trips are not separated by fishing operation. Fishing day was the unit of fishing effort used. The data for other units of fishing effort seemed to contain a high level of subjectivity. For example the soaking time for some fishers corresponds to the time interval between when the gear enters the water and the hauling of the last gear whereas for others it only corresponds to the time when the whole gear is fishing. Future improvements on sampling design of the pilot study will include the clarification of those inconsistencies and this should reduce the variability between the fishing effort data (Figure 19.8).

19.6 Fishery-independent surveys

19.6.1 Availability of survey data

An update of the results on four of the most important elasmobranch species sampled in the Spanish bottom-trawl survey (IEO Q4-IBTS survey) on the Northern Iberian shelf is presented in a Working Document (Ruiz-Pico *et al.*, 2011).

Also, results of biomass index and length frequencies of main elasmobranch sampled in the survey ITSASTEKA carried out by first time in summer of 2010 in the coastal waters of the Basque Country by AZTI-Tecnalia (ICES Divisions VIIIc) were presented in a Working Document (G. Diez *et al.*, 2011). The aim of this survey is 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.

Portuguese Surveys in Subarea IX continued in 2010 and results were presented in the annual meeting of IBTS Working Group.

19.6.2 Spanish IEO Q4-IBTS survey

The Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters has covered this area annually since 1983 (except in 1987), obtaining abundance indices and length distributions (see Figures 19.9a, 19.9b, and 19.3c) for the main commercial species and elasmobranch. Survey design (Figure 19.20) is randomly stratified with number of hauls allocated proportionally to strata area.

The result of this survey demonstrates relatively high abundances of *S. canicula*, *R. clavata* and *L. naevus* in the VIIIc Division since 2000. In Division IXa only *S. canicula* is relatively abundant, being present in all the years of the series, while *L. naevus* does not appear in this area and *R. clavata* is scarce and has appeared mainly since 2001. Their length distributions do not present remarkable changes in either of the ICES divisions covered in the survey. This year's working document includes historical series of abundance and distribution of three additional elasmobranchs (*Galeus spp*, *E. spinax* and *R. montagui*). Figures of biomass index and length frequencies of these species are not revealed in this chapter.

Lesser-spotted dogfish

The differences in biomass between the IXa and VIIIc Divisions from 2006 to 2010 were lower than in the previous period due to the marked increase in the former division. In 2010, the IXa Division demonstrated high biomass in contrast to the decreasing trend in the previous four years. In this survey the VIIIc Division exhibited similar sizes to the mean values of the last ten year series (Figure 19.21).

Skates and rays

R. clavata made up about 22% of the total elasmobranchs stratified biomass caught in 2010, dwelling in depths between 35 and 697 m in the overall time-series. In 2010, the IXa Division demonstrated the highest peak of biomass of *R. clavata* of the time-series, as many as 129.5 times more abundant in the standard hauls than in 2009. However, in the VIIIc Division, the biomass was slightly lower than 2009, but it was within the large amounts of the last ten years (Figure 19.22).

L. naevus species represented about 3% of the elasmobranchs total stratified biomass caught, with a depth range from 35 to 590 m in the overall time-series. In 2010 the VIIIc Division revealed a slight decrease in the biomass of *L. naevus*, but no clear trend was found in the last ten years *L. naevus* was not found in IXa Division, (Figure 19.23).

R. montagui represented about 22% of the total elasmobranchs stratified biomass caught in 2010. The depth distribution of this species extends from 35 to 564 m but does not seem to distribute as deep as *R. clavata* in the Cantabrian Sea.

The geographic distribution of *S. canicula*, *R. clavata* and *L. naevus* along the Cantabrian Sea (Division VIIIc) is shown in Figures 19.24a, b and c.

19.6.3 Basque Country (Spain) ITSASTEKA survey

The ITSASTEKA survey covered a total of 7.21 km^2 in 23 fishing hauls. Among 72 different species of fish and cephalopods caught in the survey only three demersal sharks (*G. melastomus, M. mustelus and S. canicula)* and three rays (*Leucoraja naevus, Raja clavata* and, *Raja montagui*) were identified. However, despite the small number of shark and rays species, the catches of elasmobranch (kg/km^2) reached 36% of total biomass of fish and cephalopods. *S. canicula* and *R. clavata* were the second and fourth species by abundance in the survey (Table 19.10).

S. canicula was found in almost all trawling stations. Younger individuals smaller than 30 cm were found only at depths >100 m but larger ones were found at all depths (Figure 19.25). *R. clavata* was found in 12 trawling stations, at depths <100 m in fine sand and muddy grounds. *L. naevus* was the ray species less abundant, only found in four trawling stations always at depths <100 m. Ray species were very rare in deeper bottoms. On the contrary, *M. mustelus* and *G. melastomus* were only caught in trawling stations deeper than 100 m deep.

19.7 Life-history information

No new information is available to WGEF 2011.

19.7.1 Ecologically important habitats

No new information of trawl surveys could usefully provide information on catches of (viable) skate egg-cases, and IBTSWG should be asked to consider this.

19.7.2 Recruitment

No information was provided to the WGEF 2011

19.8 Exploratory assessment models

No new information is available to WGEF 2011.

19.8.1 Exploratory analyses

Further analyses of survey data (see above) and catch rates were undertaken.

Divisions VIIIa, b, d

Lesser spotted dogfish

According to the historical commercial lpue series, the abundance of lesser-spotted dogfish in Divisons VIIIa, b and d has been increasing since 1994. Updated information of lpue from trawler fleets indicate that the lpue for *S. canicula* in Subarea VIII has been increasing from 1994 to 2010. The increase of discard in 2009 could also indicate high abundance of small individuals in Subarea VIII. The misreporting in last year's landings data, from some countries that have historically contributed significantly did not allow an appropriate analysis of the trends in landings.

Rajidae

Despite a slight increase of commercial lpue of rays (mainly *L. naevus* and *R. clavata*) from 2005 to 2009, this period still demonstrates the lowest values of the historical series. In 2010 the values of lpue decreased again, perhaps indicating a reduction in abundance of these species. Commercial landings of rays reveal a slight increase in this subarea since 2007. The historical series seems to be stable at around 4000 t.year^{-1}.

Other elasmobranchs

The landings of smooth hounds (*Mustelus* spp.) clearly demonstrated that in Subarea VIIIa, b and d, landings have increased strongly since 2008. The commercial lpues demonstrate the same trend from 2007 to 2009, although there is an important decrease in 2010.

Since 1996 landings of less frequent elasmobranch species as *Squatina squatina* are negligible.

Division VIIIc

Lesser spotted dogfish

Landings of this species have declined since 1996; however the interpretation of trends from this series is not reliable due to the lack of reported data in 2007 and 2008. However, the IBTS survey in this division indicates that after an important peak in 2006, lesser spotted dogfish demonstrate the best abundance index of the series since this year.

Rajidae

Excluding the year 2007 (in which significant misreportings happened), the landings of rays since 2004 has demonstrated a decrease after two peaks in 2001 and 2003. The historical time-series of abundance from surveys in VIIIc demonstrate an irregular increase of the abundance of *R. clavata* since 1996. The biomass index of *L. naevus* displays continuous sawtooths in the series, however despite these fluctuations the trend of series indicates an increase since 1983.

Other elasmobranchs

No information is available for other elasmobranch for this Division.

Divisions IXa

Lesser-spotted dogfish

In this Division, lesser-spotted dogfish is essentially a bycatch from other fisheries, so the decrease in landings registered during the last few years could be related to changes in effort distribution, targeting different species, and perhaps better discrimination of Rajidae species at Portuguese landing ports. According to the IBTS survey in Northern IXa there has been an increase in the abundance index since 2006, and similarly the Portuguese Winter Groundfish Survey in Southern IXa indicates that *S. canicula* is relatively abundant, being present in all the years of the series.

Rajidae

The historical landings from this division have been quite stable over the last 20 years, and have always been >1500 t.y^{-1}, except in 2007 where data are lacking for Spain. According to the IBTS survey in Northern IXa and Winter Groundfish Survey in Southern IXa, *L. naevus* does not appear in this area, and *R. clavata* is scarce and has appeared mainly since 2001.

Other elasmobranchs

Smooth hounds do not exhibit any clear trend in this area, for which only national landings of Portugal are available until 2008. In 2009 and 2010 France and Spain reported landings of this species for the first time.

19.9 Quality of assessments

No stock assessments have been conducted.

Current existing commercial data (effort, lpue, landings) are not appropriate. Effort and lpues do not cover the whole area of the ecoregion and are only available for Divisions VIIIa, b and d.

Commercial data of lpue, landings are available for few species (*S. canicula* and *S. acanthias*), but are not yet covering a long enough time period, and in the case of rays and smooth hounds, lpues are not available at a species-specific level. As many of the catches of demersal elasmobranch in this ecoregion come from mixed fisheries, it is necessary to provide standardized effort data at species level.

In the last two years a lot of effort has been made by the countries involved in the demersal elasmobranch fisheries of this ecoregion in order to provide species-specific landings of rays and smooth hounds. As a result of this improvement in the data quality, it has identified 19 different species usually landed (plus a general category "*Rajidae* spp.") from catches of Subareas IX and VIII. A summary of the information available of the species-specific landings of rays by country is shown in Table 19. 5. However for most of the ray species and smooth hounds, this information cannot provide a long enough historical time-series to perform a new design for the national landing tables yet.

Under the DCF sampling programme taking place in landing ports along the Portuguese continental coast, misidentification problems were recognized for some species of ray. The misidentification of ray species differs among landing ports. In order to try to resolve this problem, the correction of landings by species was inferred from sampling data taken under the scope of DCF, in which the species were correctly identified in the field, or from the analysis of the species composition by fishing trips (daily landings). The results of this study were presented in a Working Document (Serra-Pereira *et al.*, 2011). Based on 605 sampled trips collected along the Portuguese mainland coast (covering 1.1% of the skates total landing), the ratios by species were estimated for 2009 and 2010 per fishing segment (Table 19.12). The estimator used first extrapolates the weight by species to each fishing segment by landing port, then to the total landed weight by fishing segments covering all landing ports. Only landing ports for which more than five samples were collected by fishing segment for each year were included in the analysis.

Although there are valuable data on abundance series of elasmobranch from surveys, in general they are not specifically designed for elasmobranch sampling. The fishing gear used in surveys is not the most appropriate to the sampling of 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.

19.10 Reference points

No reference points have been proposed for the stocks in this ecoregion.

19.11 Conservation Considerations

The Council Regulation (EC) No 43/2009 of 16 January 2009 which bans the retention on board of three species of skate (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 stock(s).

Spanish artisanal fishers operating in coastal waters of IXa and VIIIc 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 and landings obtained during the surveys or from the Spanish trawler fleets which historically land the largest proportion of skates from the Cantabrian Sea and Bay of Biscay waters, but do not fish for *R. undulata*, because trawling is banned in waters shallower than 100 m. Most of the catches of this species come from small artisanal vessels (gillnetters) operating in bays or shallow waters.

In order to answer this controversial management decision, from this year, Portugal and Spain (Basque Country) are developing a triannual pilot project funded by the DCF to study the fisheries catching skates in the areas of the continental coast in ICES Subareas IXa, VIII. The main objective of the study is to improve the quality of knowledge of the fisheries which land skates, filling the gaps in existing basic issues, such as fishery information, biology and economic importance, and thereby ensuring the sustainability of this fishery while contributing to the future stock assessment of skates at Iberian ecoregion. 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 Subareas IXa and VIII.

IUCN list angel shark, *Dipturus batis* and *Rostroraja alb*a (NE Atlantic) as Critically Endangered, *Raja undulata* and the guitarfish *Rhinobatos cemiculus* and *Rhinobatos rhinobatos* are listed as Endangered, and *Leucoraja circularis* as Vulnerable. Sawfish (*Pristis pectinata* and *P. pristis*) are also listed as Critically Endangered, and the southernmost part of IXa is the northernmost part of the purported range of these species.

Species listed by the IUCN as Near Threatened include *Dipturus oxyrinchus*, *Leucoraja fullonica*, *Raja brachyura*, *Raja clavata*, *Raja microocellata* and *Scyliorhinus stellaris*. *Leucoraja naevus*, *Raja miraletus*, *Raja montagui*, *Scyliorhinus canicula* and *Mustelus asterias* are all listed as Least Concern (Gibson *et al.*, 2008).

19.12 Management considerations

The Council Regulation (EC) No 23/2010 established a TAC of 5459 t in 2010 for Rajidae in Divisions VIII and IX. Quotas in 2010 have not been reached for any of the countries that have reported national landings.

The main constraints for the management of demersal elasmobranchs, is the low quality of data that could be used in future in assessment models (see comments in Section 19.9).

Records of *Squatina squatina* in the ecoregion have been practically disappeared since 1996. A more intensive sampling of small artisanal fleets fishing in sand or mud bottoms in coastal waters could provide better information on the status and distribution of this species in the area.

19.13 Spatial information available

The main source of information on the spatial abundance and distribution of demersal elasmobranchs in the Iberian ecoregion comes from the series of data from ongoing surveys - Spanish IEO Q4-IBTS and ITSATEKA (see Section 19.6.1). In both cases the spatial distribution provided to the WGEF 2011 is restricted to the Cantabrian Sea (VIIIc), and no more information is available this year for IXa and VIIIa, b, d. Portuguese results from the IBTS surveys in Subarea IX will be provided next year.

Catches of elasmobranchs by statistical rectangle is also a complementary source for mapping distributions. A historical time-series from 2005 of catches of *S. canicula* and *Rajidae* spp. by statistical rectangle and fishing gear has been provided to the WGEF (Table 19.12). The series has been obtained from the analysis of the Basque OTB logbooks operating in Bay of Biscay (Subarea VIII).

19.14 References

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Table 19.1. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of skates and rays by division and country (Source: ICES).

Table 19.1a.	Total landings (t) of Rajidae in Divisions VIIIab														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	12	6	11	11	6	11	14	11	8	12	14	.	.	11	4
France	1535	1733	1503	1479	1206	1091	1106	1037	1170	1797	1296	1505	1395	1617	1404
Netherlands	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.
Spain	872	906	724	677	146	76	323	27	20	9	12	.	17	16	26
Spain (Basque Country)	*	*	*	*	270	337	*	252	242	278	218	199	283	224	100
UK (E&W)	22	76	13	7	2	3	4	4	.	8	40	0	0	+	+
UK (Scotland)	.	.	.	.	.	.	.	.	.	1	.	3	2	.	.
Total	2442	2721	2251	2174	1657	1518	1447	1331	1440	2106	1581	1707	1697	1869	1534

*** Included in Spanish Landings.**

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
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	46	50	60	52	43	66	64	73	63	97	61	58	89	67	70
Spain	89	92	74	2	1	1	9	5	40	**	**	.	.	.	.
Spain (Basque Country)	*	*	*	*	0	2	*	.	1	.	1	2	+	.	+
UK (E&W)	.	.	.	.	.	.	.	.	.	.	3	.	.	+	+
UK (Scotland)	.	.	.	.	.	.	.	.	.	.		1	+	+	.
Total	135	143	134	54	44	69	73	78	104	97	64	61	89	67	71

*** Included in Spanish Landings.**

**** Included in Area VIIIab.**

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
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	+	+	1	1	1	+	+	+	+	+	+	1	+	1	+
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portugal	11	7	10	4	4	5	.	.	264	.	.	.	.	.	.
Spain	0	321	345	226	424	978	352	1004	511	546	430	n.a.	486	489	514
Spain (Basque Country)	*	*	*	*	5	16	*	21	21	20	14	9	23	22	21
UK (E&W)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	11	328	356	231	434	999	352	1025	796	567	444	10	509	512	536

*** 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
France	n.a.	n.a.	n.a.	n.a.	.	.	.	.	.	.	.	.	.	.	.
Portugal	1534	1512	1485	1420	1528	1591	1521	1598	1614	1303	1544	1555	1580	1314	1524
Spain	58	143	197	276	285	416	339	342	325	300	364	n.a.	345	342	457
Total	1592	1655	1682	1696	1813	2007	1860	1940	1939	1602	1908	1555	1925	1656	1981

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
Belgium	12	6	11	11	6	11	14	11	8	12	14	.	.	11	4
France	1581	1784	1564	1532	1250	1157	1170	1110	1233	1894	1357	1564	1484	1686	1474
Netherlands	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Portugal	1545	1519	1495	1424	1532	1596	1521	1598	1878	1303	1602	1555	1580	1314	1524
Spain	1019	1462	1340	1181	855	1471	1022	1378	895	855	806	na	849	848	997
Spain (Basque Country)	*	*	*	*	302	354	*	273	264	298	233	210	306	246	121
UK (E&W)	22	76	13	7	2	3	4	4	.	8	43	.	.	.	.
UK (Scotland)	.	.	.	.	.	.	.	.	.	1	.	3	2	.	.
Total	4179	4846	4423	4155	3947	4593	3732	4374	4279	4372	4055	3333	4221	4105	4121

Table 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of Lesser-spotted dogfish by division and country (Source: ICES).

Table 19.2a.	Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Divisions VIIIab														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	.	.	.	.	.	.	.	.	9	10	13	.	.	24	28
France	568	645	762	405	426	426	360	503	708	798	879	821	932	1046	1023
Spain	0	0	63	0	7	7	28	1	0	0	2	n.a.	1	+	34.8
Spain (Basque Country)	223	270	336	254	247	277	353	318	254	335	318	247	218	415	270
UK (E&W)	.	.	.	.	.	.	.	2	.	3	.	.	.	.	.
Total	791	915	1161	660	681	711	741	824	971	1147	1211	1068	1151	1485	1356

Table 19.2b.	Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Area VIIId														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	5	4	5	2	4	5	3	7	7	10	5	4	10	8	11
Spain	.	.	97	.	78	.	.	.	.	*	*	n.a.	.	.	.
Spain (Basque Country)	.	.	.	.	.	.	1	0	1	0	2	2	+	.	+
Total	5	4	103	2	83	5	4	7	7	10	7	6	10	8	11

*** Included in area VIIIab**.

Table 19.2c.	Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Area VIIIc														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	.	.	1	1	1	4	3	4	5	1	0	1	1	.	+
Spain	417	458	375,6	448	167	187,6	65	114	88	143	168	n.a.	149	132	181
Spain (Basque Country)	11	8	8	9	5	10	52	65	63	66	73	59	47	30	56
Total	428	466	385	458	173	201	120	183	157	211	241	60	198	161	237

Table 19.2d.	Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Division IXa														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spain	3	6	19	34	30	39	39	69	86	88	92	n.a.	76	67	11
Portugal	667	691	689	882	757	734	673	658	677	385	185	157	120	66	75
Total	670	697	708	916	787	773	712	727	763	472	276	157	196	134	86

Table 19.2e.	Combined Landings (t) of Lesser-Spotted Dogfish (*Scyliorhinus canicula*) in Biscay and Iberian Water														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	.	.	.	.	.	.	.	.	9	10	13	.	.	24	28
France	573	648	768	408	431	435	366	513	720	809	884	826	944	1054	1034
Spain	420	464	555	482	283	234	132	184	174	231	262	n.a.	226	199	226
Spain (Basque Country)	234	278	344	263	253	287	405	384	318	401	392	308	265	445	325
UK (E&W)	.	.	.	.	.	.	.	2	.	3	.	.	.	.	.
Portugal	667	691	689	882	757	734	673	658	677	385	185	157	120	66	75
Total	1894	2081	2356	2036	1723	1690	1576	1741	1898	1839	1735	1291	1555	1788	1689

Table 19.3. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of smooth hounds by subarea and country (Source: ICES).

Table 19.3a.	Smooth hounds unident. (*Mustelus* spp.)-ICES Subarea VIII														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.
France	97	115	158	48	142	149	188	321	407	394	437	354	665	799	747
Portugal	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.
Spain (Basque Country)	53	56	57	46	61	58	85	58	56	54	62	45	82	166	61
UK (E&W)	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Total	150	170	214	94	203	207	273	379	463	448	500	399	748	965	808

Table 19.3b.	Smooth hound (*Mustelus mustelus*)-ICES Division IXa											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Portugal	76	41	43	45	51	44	44	36	57	42	34	38
France	.	.	.	.	.	.	.	.	.	.	3	.
Spain	.	.	.	.	.	.	.	.	.	.	.	24
Total	76	41	43	45	51	44	44	36	57	42	37	63

Table 19.4. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of angel shark by subarea and country (Source: ICES).

Table 19.4a.	Angel shark (*Squatina squatina*) - ICES Subarea VIII														
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	+	+	+	+	+	+	+	+	+	+	+	.	.	1	.
UK (E&W)	.	.	.	.	.	.	.	.	.	.	0	0	0	.	.
Total	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	1	0

Table 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Species-specific landings (rays and skates 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	T. marmorata	D. Batis	D. oxyrinchus	L. circularis	L. fullonica	L. naevus	R. clavata	R. microocellata	R. montagui *	R. undulata	D. pastinaca	M. aquila	R. asterias**	R. brachyura	R. miraletus	R. alba	A. radiata**	R. alba	Raja spp.
France	1999	VIII	24	1	0	17	0	319	75	0	46	0	0	2							0
France	2000	VIII	9	5	1	55	3	749	68	0	53	1	1	0							1
France	2001	VIII	3	4	0	47	7	637	37	1	62	2	1	0							1
France	2002	VIII	5	13	16	51	5	614	39	1	47	0	0	0							0
France	2003	VIII		4	1	44	4	654	49	2	58	0			0						
France	2004	VIII		4	0	46	4	749	97	0	67	0			0						201
France	2005	VIII		4	1	61	5	946	104	0	54	0			0						598
France	2006	VIII		4	2	36	4	668	139	0	61	0	2	1	0			0			607
France	2007	VIII		2	1	30	3	582	74		30		1								841
France	2008	VIII		5	3	56	5	775	82		41	0	2	0							502
France	2009	VIII	26	1	1	20	45	1096	177	3	64	2	3	1	0	3		4	0		237
France	2010	VIII	22	0	0	26	36	975	165	2	81			1		2			1	0	173
Belgium	2002	VIIIa,b						15	6		0										
Belgium	2009	VIIIa,b						7	2		0					0					2
Belgium	2010							3		1	0					0					1
Spain (Basque Country)	2000	VIII		6			4	250	39		2	0									
Spain (Basque Country)	2001	VIII		8	0		26	230	85		5				0						
Spain (Basque Country)	2002	VIII						243	54		18										
Spain (Basque Country)	2003	VIII					12	230	38		4	0									
Spain (Basque Country)*	2004	VIII		3	0		7	202	46	0	6	0			0						
Spain (Basque Country)*	2005	VIII		3	0		8	229	52	0	7	0			0						

Country	year	Subarea	T. marmorata	D. Batis	D. oxyrinchus	I. circularis	L. fullonica	L. naevus	R. clavata	R. microocellata	R. montagui *	R. undulata	D. pastinaca	M. aquila	R. asterias**	R. brachyura	R. miraletus	R. alba	A. radiata**	R. alba	Raja spp.
Spain (Basque Country)*	2006	VIII		3	0		6	179	41		5	0			0						
Spain (Basque Country)*	2007	VIII		2	0		5	161	37		5	0			0						
Spain (Basque Country)	2008	VIII		4	0		8	236	52		7	0			0						
Spain (Basque Country)	2009	VIII					0	155	42												50
Spain (Basque Country)	2010	VIII						58	23												41
Portugal	2002	IXa						13	2												1505
Portugal	2003	IXa						18	351	78	56	126				578	2				
Portugal	2004	IXa						113	516	95	82	108				532	17	5			
Portugal**	2005	IXa						43	480	88	76	100				495	16	5			
Portugal**	2006	IXa						51	569	105	90	119				586	19	6			
Portugal**	2007	IXa						79	472	35	119	277				459					3
Portugal	2008	IXa				33		19	418		155	52				340					557
Portugal	2009	IXa			19	2		66	562	51	96	220				244	4	11			3
Portugal	2010	IXa				40		9	813		93					379					190
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 (Scotland)	2009	VIII									0.3										

*** 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.**

Table 19.6. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Elasmobranch discard estimates of OTB (Bottom otter trawl) in Subarea VIII.

	Scyliorhinus canicula		*Galeus melastomus*		*Rajidae spp.*	
	landings	estimated	landings	estimated	landings	estimated
Subarea VIII	(t)	discard (t)	(t)	discard (t)	(t)	discard (t)
2003	368	348	1	0	239	76
2004	299	654	1	227	191	64
2005	396	275	4	5	248	13
2006	383	173	4	1	205	10
2007	309	417	6	N.A.	199	N.A.
2008	400	641	4	23	255	24
2009	434	1092	1	0		
2010	325	688	3	34	41	0

	Leucoraja naevus		*Raja clavata*	
	landings	estimated	landings	estimated
Subarea VIII	(t)	discard (t)	(t)	discard (t)
2003				
2004				
2005				
2006				
2007				
2008				
2009	154	6		
2010	58	7	23	1

Table 19.7. Demersal elasmobranchs 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
Centrophorus squamosus	0.0	0.0	4.5	4.1	0.0	0.0	95.6	28.7
	-	-	89.5	80.6	-	-	55.4	47.9
Dalatias licha	0.0	0.0	1.3	2.6	0.0	0.0	0.0	3.6
	-	-	102.6	100.2	-	-	-	99.7
Deania calcea	8.0	51.4	5.5	22.8	1.8	17.9	31.9	154
	65.8	81.3	61.4	84.5	69.9	96.6	55.2	62.4
Etmopterus spinax	0.5	332	5.6	1.8	1.7	19.5	45.2	27.2
	0.0	90.8	49.5	68.5	59.4	58.9	76.3	58.4
Galeus melastomus	383	244	527	553	1063	226	1010	1205
	36.6	54.8	36.0	60.7	36.7	28.5	61.7	50.8
Leucoraja naevus	39.9	188	6.5	63.5	19.7	2.7	16.5	9.5
	77.2	57.6	69.3	51.7	63.9	52.0	77.0	71.0
Mustelus asterias	0.0	28.1	18.0	0.0	0.0	0.0	0.0	0.0
	-	99.7	95.7	-	-	-	-	-
Raja brachyura	0.1	90.8	1.2	11.6	31.6	2.1	13.0	5.9
		50.6	63.9	92.7	59.2	47.8	45.5	55.0
Raja clavata	0.0	1.0	9.9	54.5	10.9	5.5	40.0	31.8
	-	0.0	54.6	75.6	45.5	76.2	44.4	43.6
Raja montagui	14.9	1.3	0.2	0.7	0.4	1.2	2.0	1.5
	89.2	0.0	125.4	0.0	0.0	98.6	73.7	88.1
Scyliorhinus canicula	1131	799	397	1723	954	300	1014	607
	43.8	38.6	34.2	63.8	23.3	32.7	38.1	22.0

Table 19.8. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Landing ports covered by DCF Sampling Programme and the codes in use for the genus *Mustelus* and the species *Mustelus mustelus* in 2009 and 2010. SDV: *Mustelus* spp; SMD: *Mustelus asterias*.

	Mustelus spp.		*Mustelus mustelus*	
Landing port	DCF Sampling Programme	Landing port denomination	DCF Sampling Programme	Landing port denomination
Peniche	SDV	SMD	-	-
Póvoa do Varzim	-	-	-	-
Sesimbra	SDV	SDV or SMD	-	-
Vila Real de Sto António	SDV	SDV	-	-
Setubal	-	-	SMD	SMD

Table 19.9a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Effective effort (fishing days = trips*(days/trip)), landings (t), and lpue (landings in kg/day) of main elasmobranchs caught by the Basque Country OTB (Bottom otter trawl) in Subarea VIII.

OTB (Bottom otter trawl)									
		Scyliorhinus canicula		*Rajidae* spp		*Squalus acanthias*		smooth hounds	
	effort	Landings	lpue	Landings	lpue	Landings	lpue	Landings	lpue
	(days)	(t)	(kg/days)	(t)	(kg/days)	(t)	(kg/days)	(t)	(kg/days)
1994	5619	115	20	180	32	32	6	34	6
1995	4474	203	45	505	113	23	5	25	6
1996	4378	212	49	477	109	45	10	35	8
1997	4286	247	58	554	129	34	8	38	9
1998	3002	308	103	604	201	25	8	28	9
1999	2337	237	101	367	157	12	5	27	11
2000	2227	228	102	273	123	38	17	28	13
2001	2707	239	88	301	111	10	4	33	12
2002	3617	389	107	281	78	27	7	50	14
2003	3363	368	109	239	71	8	3	40	12
2004	4232	299	71	191	45	5	1	35	8
2005	3697	396	107	248	67	4	1	41	11
2006	2979	383	128	205	69	6	2	47	16
2007	2780	309	111	199	71	6	2	32	11
2008	2967	400	135	255	86	1	0	71	24
2009	2274	434	191	219	96	1	0	154	68
2010	1844	325	177	121	66	0	0	30	16

Table 19.9b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Effective effort (fishing days = trips*(days/trip)), landings (t), and lpue (landings in kg/day) of main elasmobranchs caught by the Basque Country PTB (Bottom Pair trawl) in Subarea VIII.

PTB (Bottom Pair trawl)									
		Scyliorhinus canicula		*Rajidae* spp		*Squalus acanthias*		smooth hounds	
	effort	Landings	lpue	Landings	lpue	Landings	lpue	Landings	lpue
	(days)	(t)	(kg/day)	(t)	(kg/day)	(t)	(kg/day)	(t)	(kg/day)
1994	362	1	3	0	0		0	0	1
1995	959	0	0	1	1	0	0	2	2
1996	1332	1	1	5	4	0	0	8	6
1997	1290	2	2	5	4	0	0	9	7
1998	1482	3	2	9	6	3	2	18	12
1999	1787	6	3	8	4	3	2	12	7
2000	1214	3	2	8	6	1	1	22	18
2001	3402	7	2	14	4	1	0	13	4
2002	4045	5	1	16	4	6	2	20	5
2003	3845	9	2	15	4	6	2	13	3
2004	3944	14	4	12	3	2	0	10	3
2005	3421	4	1	5	1	3	1	11	3
2006	3228	7	2	9	3	3	1	14	4
2007	2724	15	6	4	2	5	2	10	4
2008	2342	8	3	5	2	1	0	9	4
2009	1771	10	5	2	1	1	1	11	6
2010	2255	10	4	1	1	0	0	8	3

Table 19.10. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters Distribution of elasmobranch biomass (kg/km²) by depth and type of substratum in the ITSASTEKA survey.

depth (m)	substratum	Station	*S. canicula*	*R. clavata*	*R. montagui*	*G. melastomus*	*L. naevus*	*M. mustelus*
30	fine sand	23–24	23	338	6			
50	fine sand	39–40	139	334	67		5	
53	fine sand	45–46		266	22		5	
53	coarse sand	3–4	28	10	5			
72	fine sand	1–2	329	377	86		2	
75	fine sand	47–48	21	72	6			
86	fine sand	11–12	18	55	26			
90	mud	9–10	70	189			9	
97	coarse sand	41–42	166	46	39			
100	mud	5–6	37	18	15			
100	mud	31–32	34	23	5			
122	mud	29–30	134					7
128	mud	21–22	258					
134	mud	19–20	22					
161	fine sand	37–38	291			30		
169	medium sand	35–36	305			1		
171	medium sand	17–18	217					
171	fine sand	13–14	160					
185	fine sand	33–34	81					
203	fine sand	15–16	78	19				
260	mud	27–28	159			87		
359	mud	25–26	25			228		
Total			2598	1746	277	346	21	7

Table 19.11. Demersal elasmobranchs 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, Dipturus oxyrinchus, Raja undulata* and Rajidae), per fishing segment (Portuguese artisanal and trawl fleets) for 2009 and 2010.

2009 (sampling trips, n= 334)			2010 (sampling trips, n= 271)	
	TOTAL		TOTAL	
Species	Artisanal	Trawl	Artisanal	Trawl
Raja miraletus	0%	1%	1%	2%
Rostroraja alba	1%	0%	0%	3%
Raja clavata	36%	66%	42%	49%
Raja microocellata	6%	1%	4%	1%
Raja brachyura	21%	13%	21%	8%
Leucoraja circularis	0%	0%	1%	0%
Raja montagui	7%	9%	8%	14%
Leucoraja naevus	6%	4%	3%	9%
Dipturus oxyrinchus	2%	1%	0%	0%
Raja undulata	20%	6%	19%	5%
Rajidae	0%	0%	0%	11%
Sampled weight (kg)	6807	6647	5066	6174
N samples	251	83	191	99

Table 19.12. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical series of *S. canicula* and *Rajidae* spp. catches (kg) of Basque Country fleets by statistical rectangle and fishing gear in Subarea VIII. Landings in kg.

S. canicula								
Statistical rec.	Gear	2005	2006	2007	2008	2009	2010	Total
15E8	LLS						47	47
	OTB		60			105		165
16E3	OTB				60			60
16E6	OTB	56						56
16E7	OTB				580			580
	PTB			50				50
16E8	OTB	23545	22518	17238	9535	12708	5906	91450
	PTB		28	101		154	11	294
17E0	OTB				104			104
17E7	OTB	105	164			135	285	689
	PTB							
17E8	OTB	64529	54865	24777	30463	67782	44050	286466
	PTB	44	149	78		462	24	757
18E5	OTB				135			135
18E6	OTB	165			52			217
	PTB							
18E7	OTB	5952	3596	5130	4619	7949	3061	30307
	PTB		26	27			35	88
18E8	OTB	36104	39916	26550	37114	60249	45700	245633
	PTB	354	963	2701	15	337	38	4408
19E1	OTB				180			180
19E6	OTB	3937	5322	3273	1624	2302	406	16864
	PTB	44		11		30		85
19E7	OTB	53678	53767	63445	52448	67118	57386	347842
	PTB	419	605	527	155	100	145	1951
19E8	OTB	44805	35080	33861	47733	45872	31761	239112
	PTB	215	432	3155	116	143	22	4083
19E9	OTB			15				15
20E5	OTB		40		45		182	267
20E6	OTB	27576	24275	21247	29420	34384	11734	148636
	PTB		101			195		296
20E7	OTB	32897	37089	22507	61661	65213	13023	232390
	PTB	485	660	2292	26	290	201	3954
20E8	OTB	2774	841	1384	2181	4243	165	11588
	PTB		11	562	10			583
21E4	PTB		12					12
21E5	OTB	2686	6424	2600	2216	2819	423	17168
	PTB		42					42
21E6	OTB	6169	6884	7017	6137	13618	5709	45534
	PTB						264	264

S. canicula

Statistical rec.	Gear	2005	2006	2007	2008	2009	2010	Total
21E7	OTB	4469	5118	1713	3988	4826	1707	21821
	PTB	73	30	60				163
21E8	OTB	1618	798	4664	3089	2048	59	12276
	PTB	70		54				124
22E4	OTB	462		42				504
	PTB	72	498					570
22E5	OTB	9748	7463	5402	3723	997	1455	28788
	PTB							
22E6	OTB	5540	2791	1787	5145	358	240	15861
	PTB	14						14
22E7	OTB			75	105			180
22E8	OTB		238					238
23E4	OTB		66	196	56	264	555	1137
	PTB	10	126					136
23E5	LLS	25						25
	OTB		1210	1411			1215	3836
23E6	OTB		26					26
23E8	OTB	126						126
24E4	LLS		100					100
25E0	OTB		144	30			30	204
25E2	LLS				672			672
25E3	LLS				224			224
26E2	LLS				64			64
26E4	LLS				60			60
26E5	LLS	175	150		100			425
	GXX						67	67
17E6	OTB						742	742
15E6	GXX						28	28
18E1	OTB						78	78
24E1	LLS							
19E5	OTB						14	14

Rajidae spp								
Statistical rec.	Gear	2005	2006	2007	2008	2009	2010	Total
15E8	LLS						34	34
	OTB		0			15		15
	GXX						42	42
16E3	OTB				0			0
16E6	OTB	0						0
16E7	GXX		0					0
	LLS	0	0					0
	OTB				10			10
	PTB			0				0
16E8	LLS	0	0				0	0
	OTB	458	2007	1538	323	288	619	5233
	PTB	0	0	20	0	0	0	20
17E0	OTB				0			0
17E7	GXX		0					0
	LLS	0	0					0
	OTB	32	0			30	30	92
	PTB			11				11
17E8	LLS	0	0					0
	OTB	2230	2213	1607	3569	2536	1164	13319
	PTB	22	14	21	0	0	0	57
18E5	LLS		0					0
	OTB				0			0
18E6	LLS	0	0					0
	OTB	210			156			366
	PTB		11					11
18E7	LLS	0	160	352		32		544
	OTB	5849	2839	2270	3046	3814	993	18811
	PTB	25	189	10	0	42	22	288
18E8	LLS	32	32					64
	OTB	6222	11997	3936	6692	6841	3337	39025
	PTB	26	359	94	86	232	121	918
19E1	LLS		0					0
	OTB				180			180
19E6	LLS	0	0					0
	OTB	4762	5065	1889	4083	2633	520	18952
	PTB	60	90	20	0	120	0	290
19E7	LLS	1568	576	480	896	992	32	4544
	OTB	75328	58958	77151	55755	53670	38924	359786
	PTB	1041	2365	854	1018	467	254	5999
	GXX						20	20
19E8	LLS	0	0				0	0
	OTB	5454	6359	3877	7206	8583	2948	34427

***Rajidae* spp**								
Statistical rec.	Gear	2005	2006	2007	2008	2009	2010	Total
	PTB	34	33	143	43	0	0	253
19E9	OTB			180				180
20E5	LLS	0				0		0
	OTB		20		0		154	174
20E6	LLS	0	224		64		32	320
	OTB	52421	34921	39712	57990	40587	11735	237366
	PTB	11	1174	550	0	60	0	1795
20E7	LLS	0	192	192	64	32	832	1312
	OTB	32342	35176	16036	37580	32037	7790	160961
	PTB	981	2060	3061	1226	277	483	8088
	GXX						10	10
20E8	LLS	32	0		32	35		99
	OTB	1523	0	262	966	2368	359	5478
	PTB	15	0	12	22			49
21E4	PTB		0					0
21E5	LLS		0					0
	OTB	4187	7620	4584	1672	5082	1072	24217
	PTB	0	0	0		0	0	0
21E6	LLS	2082	224	224	1600	395	1344	5869
	OTB	15704	10980	12452	16722	20787	5814	82459
	PTB	25	37	64		0	0	126
21E7	LLS	858	710	652	1120	2147	768	6255
	OTB	1834	3119	932	2937	3500	1011	13333
	PTB	0	200	63	12		0	275
21E8	LLS		0					0
	OTB	1222	22	197	40	240	15	1736
	PTB	0	0	0				0
22E4	LLS	0						0
	OTB	674		0	22	154		850
	PTB	0	0	15	0	0	0	15
22E5	LLS	32	0		64			96
	OTB	12834	8052	4650	5503	3808	2515	37362
	PTB	0	0		0	0		0
22E6	LLS	276	696	124	192	0	160	1448
	OTB	7167	4188	2440	3211	1096	1691	19793
	PTB	86	25					111
22E7	LLS	110		60		0	96	266
	OTB			0	0			0
	PTB	0	0					0
22E8	OTB		224					224
23E4	LLS	396		96	96	32		620
	OTB		138	144	248	902	1382	2814
	PTB	0	0	0	0			0
23E5	LLS	512	160	220	160	351	64	1467

***Rajidae* spp**

Statistical rec.	Gear	2005	2006	2007	2008	2009	2010	Total
	OTB		1675	1366	22	616	1038	4717
	PTB	14	0	0		0		14
23E6	LLS	64	32	0		0	32	128
	OTB		0		110		44	154
	PTB	0	0					0
23E8	OTB	14						14
24E4	LLS	244	30	60	64	221	256	875
	PTB		0					0
25E0	LLS		210	30				240
	OTB		14	60			0	74
25E2	LLS	1596	664	2072	756	671	832	6591
25E3	LLS	592	1014	638	248	382	1152	4026
25E1	LLS	104	330	150				584
25E4	LLS	192	352	96	256	94	808	1798
15E7	LLS	0					62	62
	GXX						1130	1130
17E6	LLS	0	0					0
	OTB						0	0
24E2	LLS	270	120	150		105		645
26E1	LLS	1022	248	636	720	0	904	3530
24E3	LLS	434	218	150	120			922
29E2	LLS	120	90	60	810	60	96	1236
24E5	LLS	0	30	32			64	126
26E3	LLS	1076	530	120	92	166	160	2144
18E2	LLS	0	0					0
17E5	LLS	0	0					0
16E5	LLS		0					0
20E4	LLS	0						0
19E3	LLS		0					0
23E7	PTB		0					0
23E3	LLS					0		0
25E5	LLS					32		32
19E2	LLS				0			0
21E2	LLS				30			30
15E6	GXX						115	115
18E1	OTB						75	75
24E1	LLS						172	172
19E5	OTB						0	0

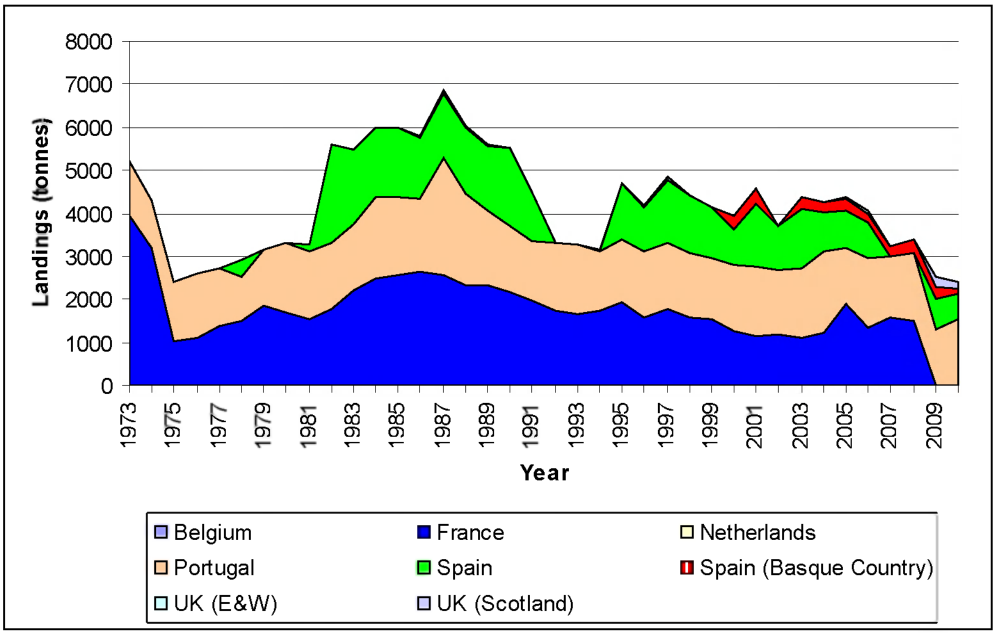


Figure 19.1. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of *Rajidae* spp in Subarea VIII and Division IXa. (landings data not available for Spain in 2007).

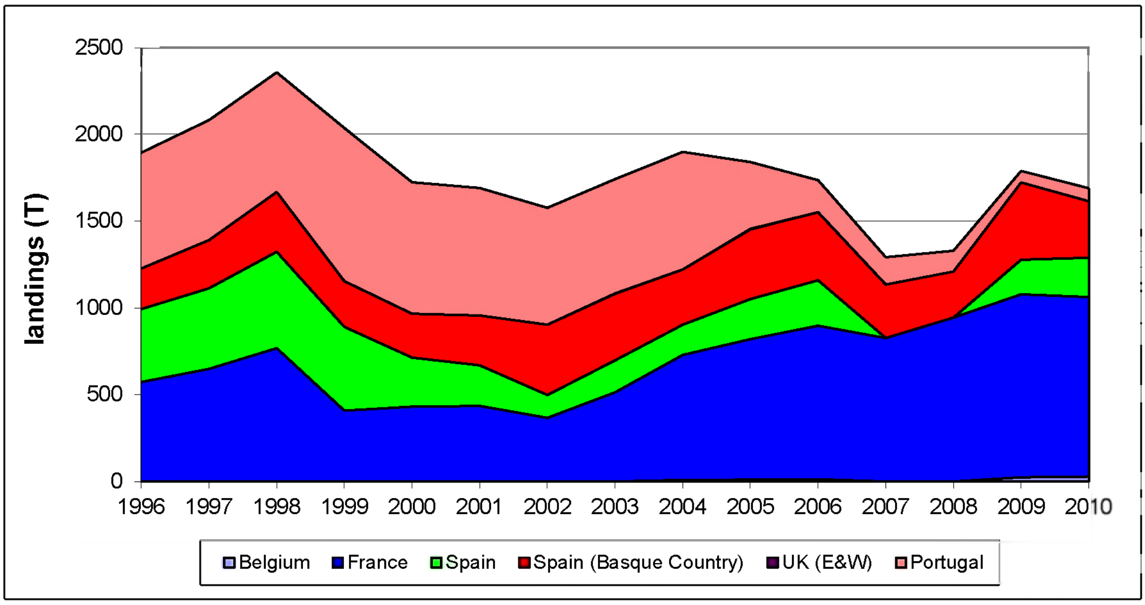
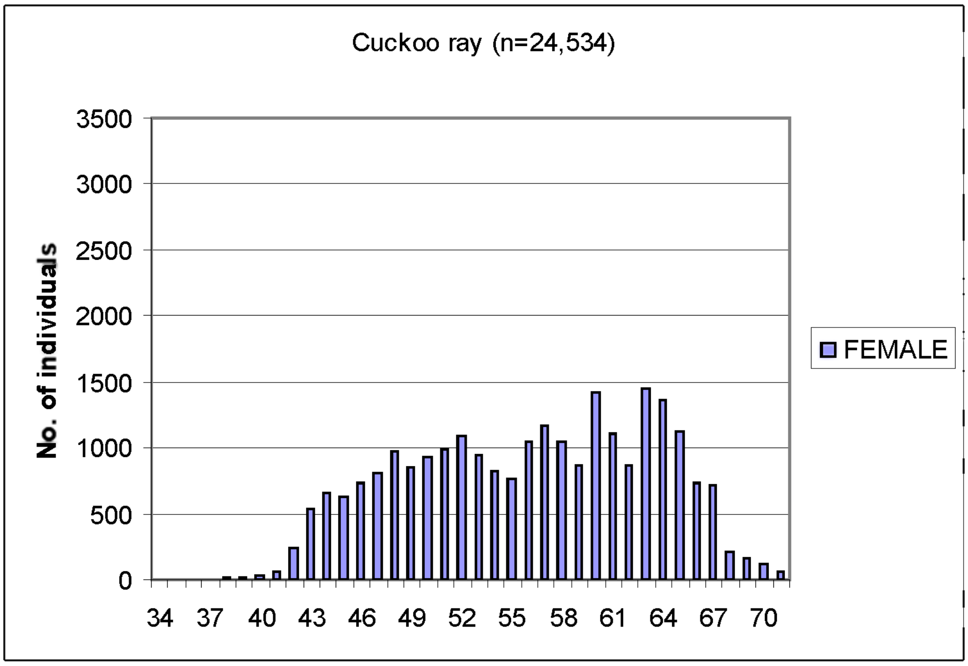


Figure 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of Lesser-spotted dogfish in Subarea VIII and Division IXa. (Spanish landings data not available for 2007).



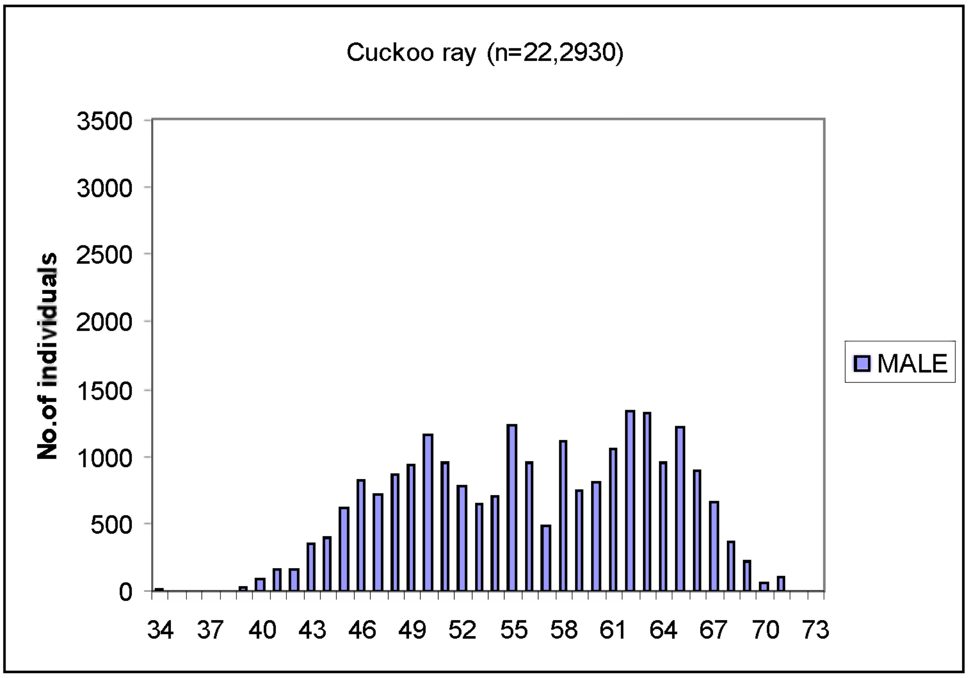
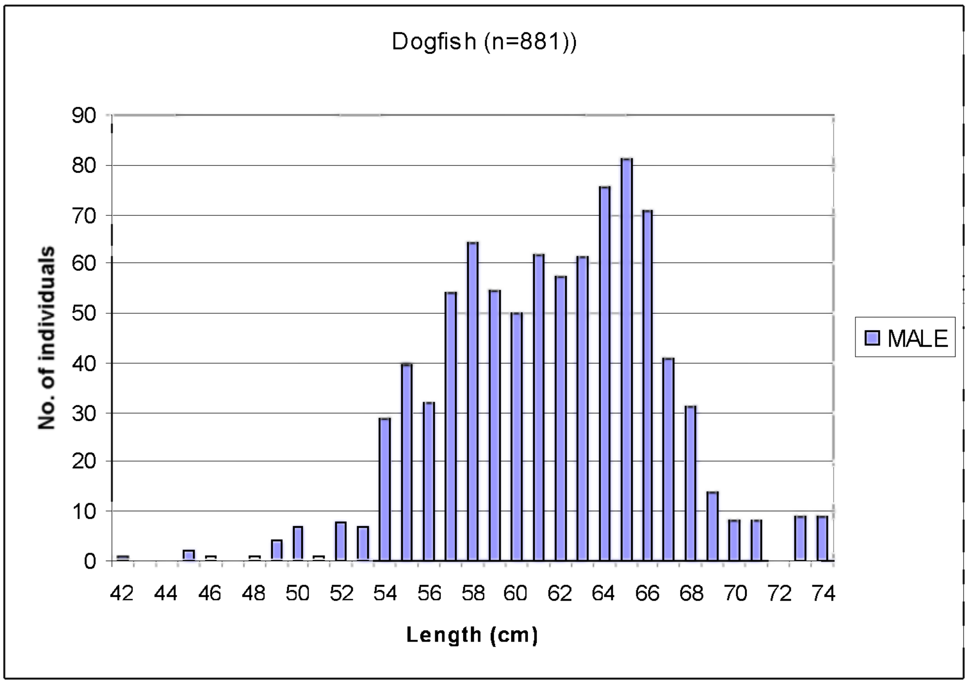


Figure 19.3a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies by sex of the Cuckoo ray (*L. naevus*) caught in Bay of Biscay in 2010 by the French fleets.



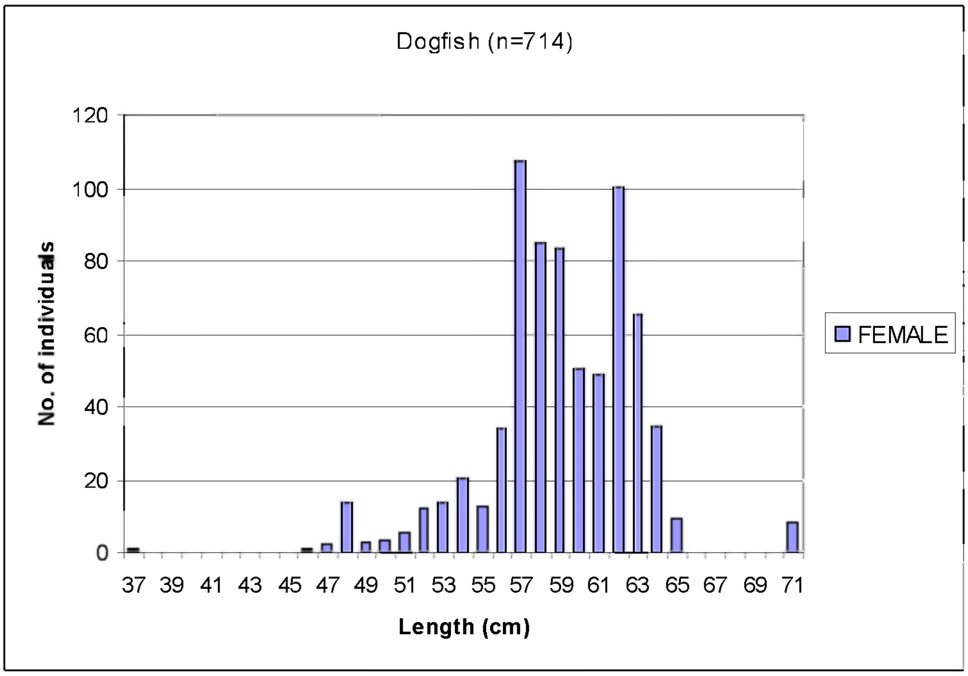


Figure 19.3b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies by sex of the lesser spotted dogfish (*S. canicula*) caught in Bay of Biscay in 2010 by the French fleets.

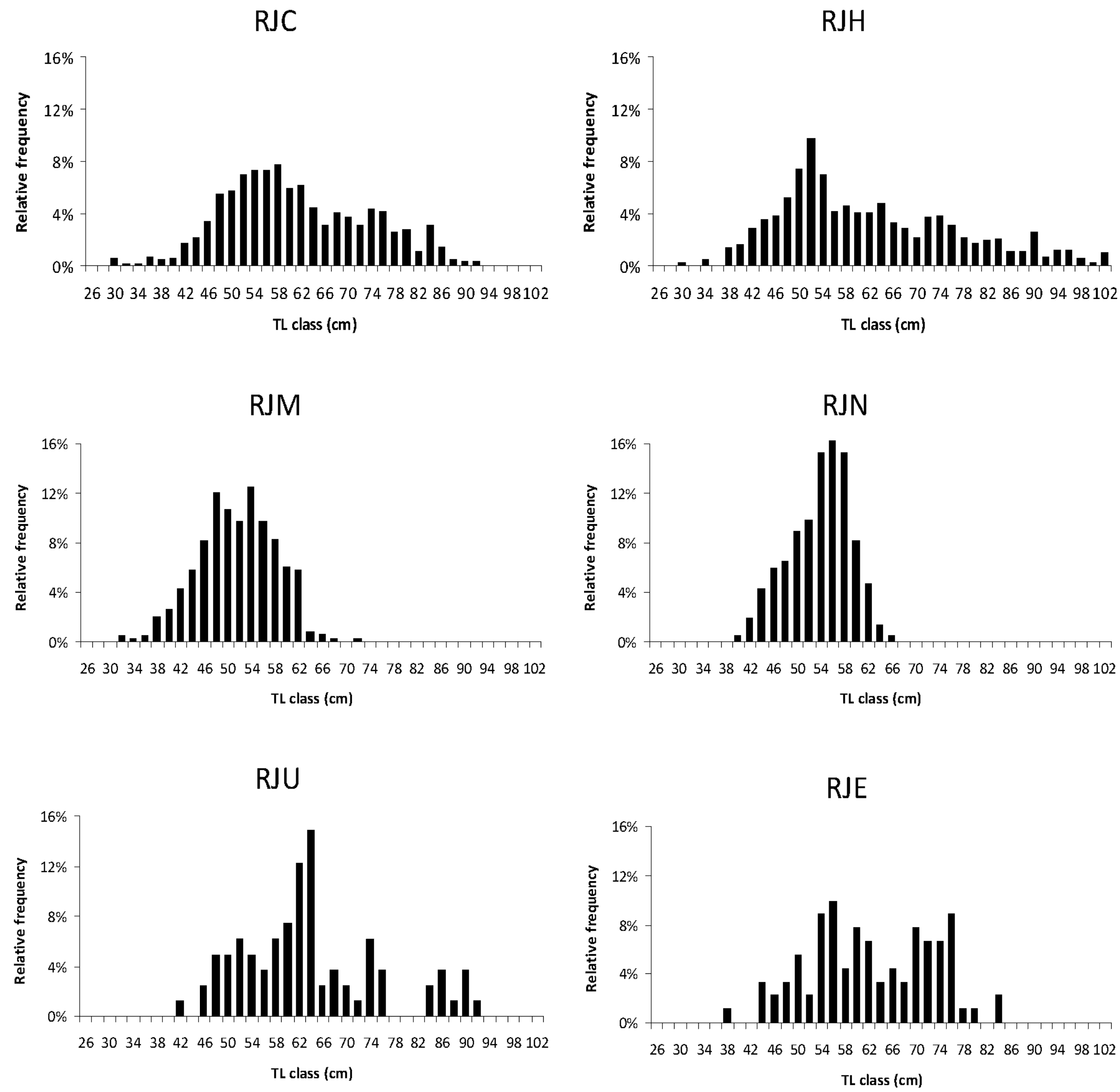


Figure 19.4. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters Length frequency distribution of *Raja clavata*, RJC; *Raja brachyura*, RJH; *Raja montagui*, RJM; *Leucoraja naevus*, RJN; *Raja undulata*, RJU; *Raja microocellata*, RJE in Peniche landing port (2 cm length class; number of sampled trips: 82).

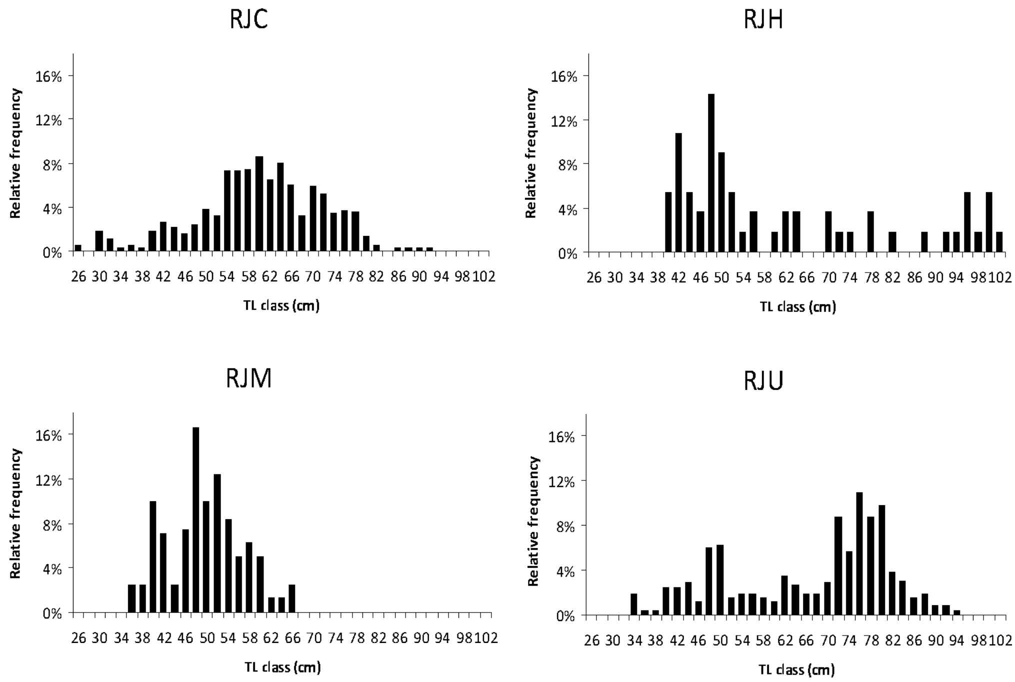


Figure 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters Length frequency distribution of *Raja clavata*, RJC; *Raja brachyura*, RJH; *Raja montagui*, RJM; *Raja undulata*, RJU) in Matosinhos (north of Portugal mainland) landing port (2 cm length class; number of sampled trips: 58).

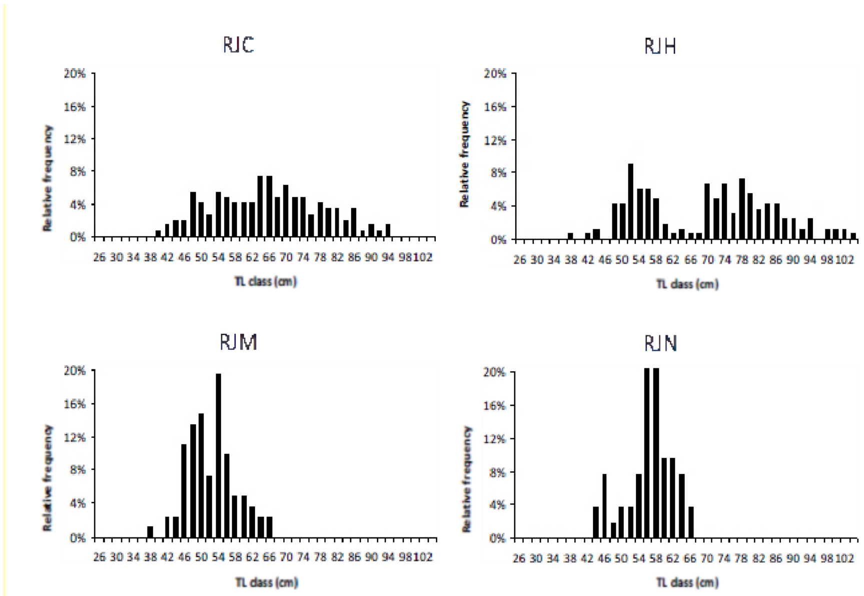


Figure 19.6. Length frequency distribution of *Raja clavata*, RJC; *Raja brachyura*, RJH; *Raja montagui*, RJM; *Leucoraja naevus*, RJN) in Sines (southwest of Portugal Mainland) landing port (2 cm length class; number of sampled trips: 48).

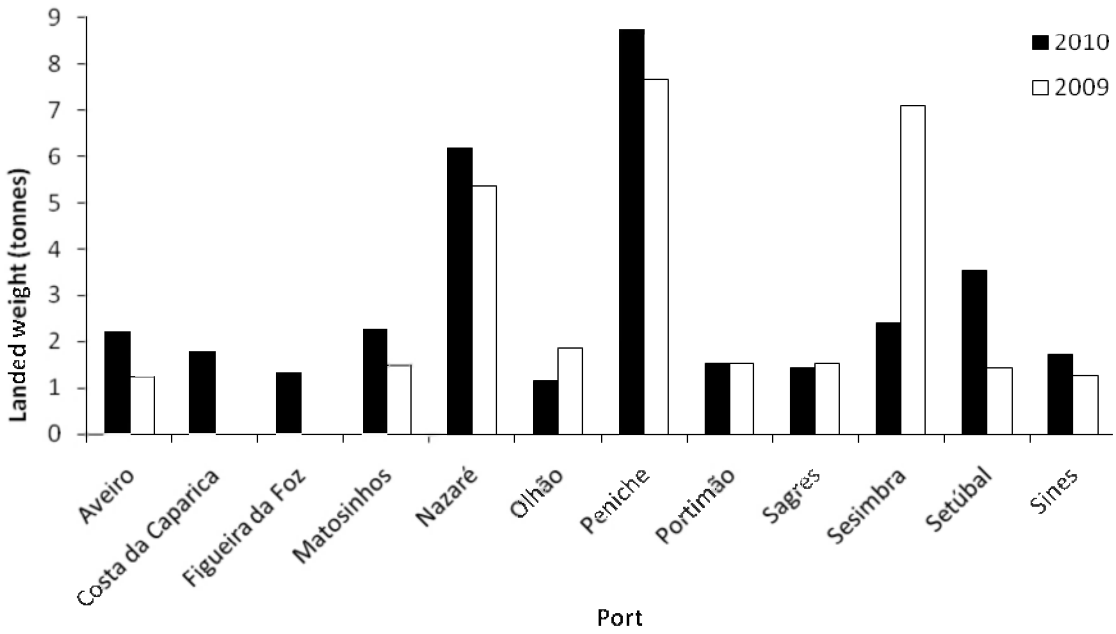


Figure 19.7. Landings assigned to the genus *Mustelus* by landing port (only landing ports with annual landings higher than 1 tonne were considered) in 2009 and 2010.

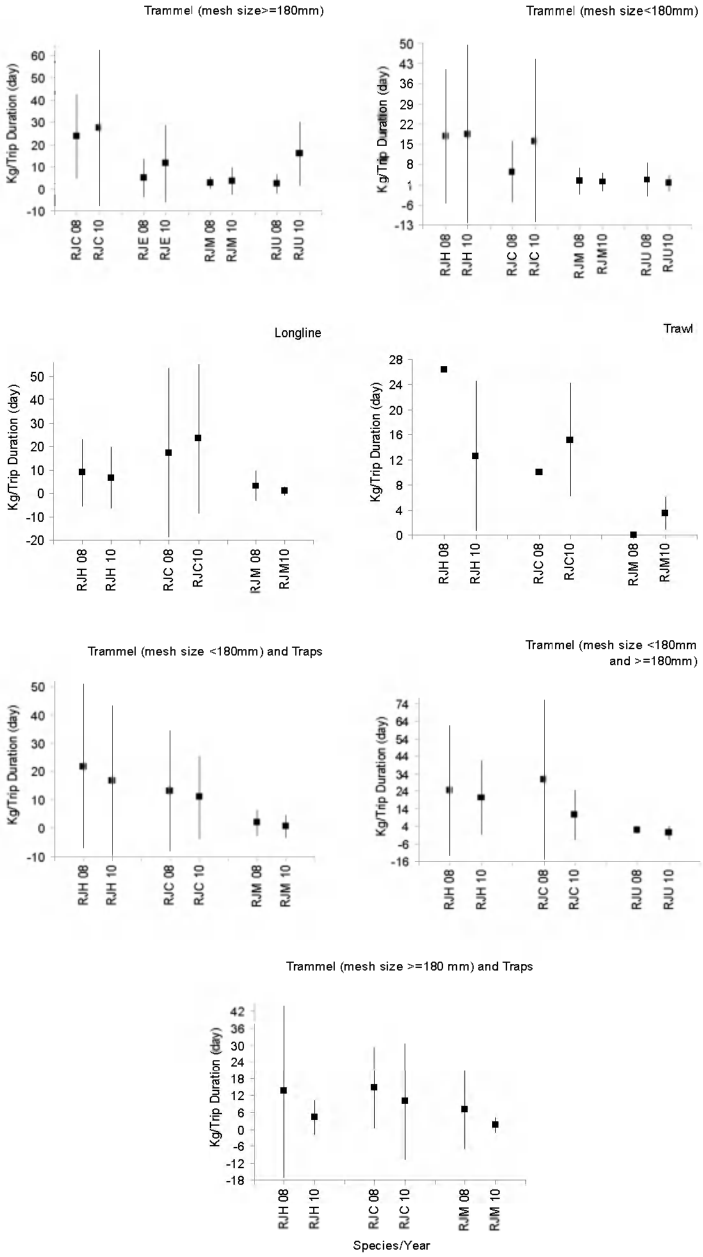


Figure 19.8. Lpue (kg/fishing day) by species and by fishing method for 2008 and 2010: *Raja clavata* (RJC), *Raja microocellata* (RJE), *Raja montagui* (RJM), *Raja undulata* (RJU) and *Raja brachyura* (RJH).

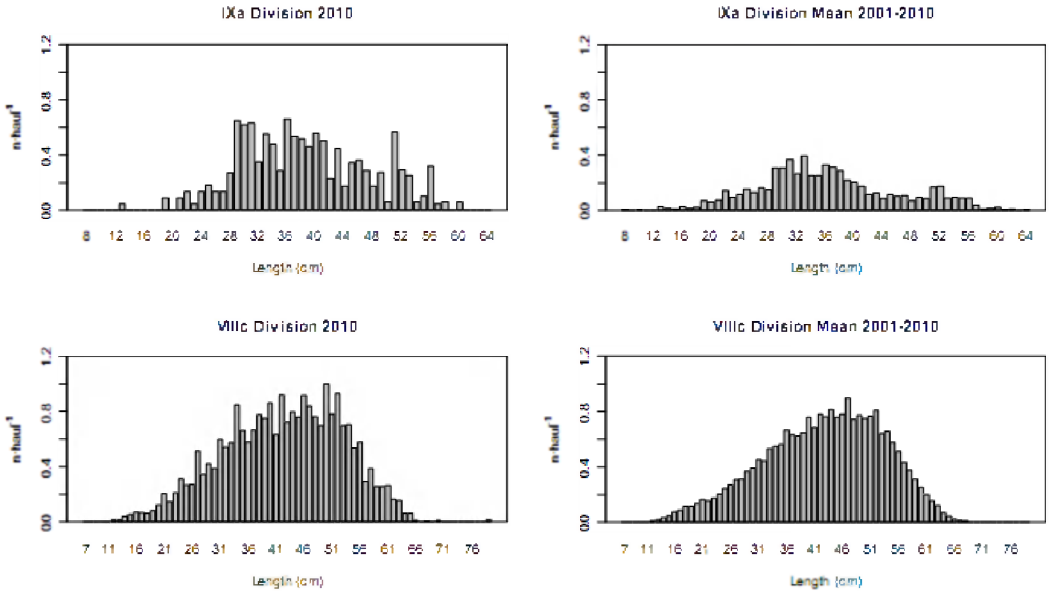


Figure 19.9a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *Scyliorhinus canicula* in 2010 in the two ICES divisions covered by the North Spanish Shelf bottom-trawl survey, and mean values for the last decade in both areas (2000–2010).

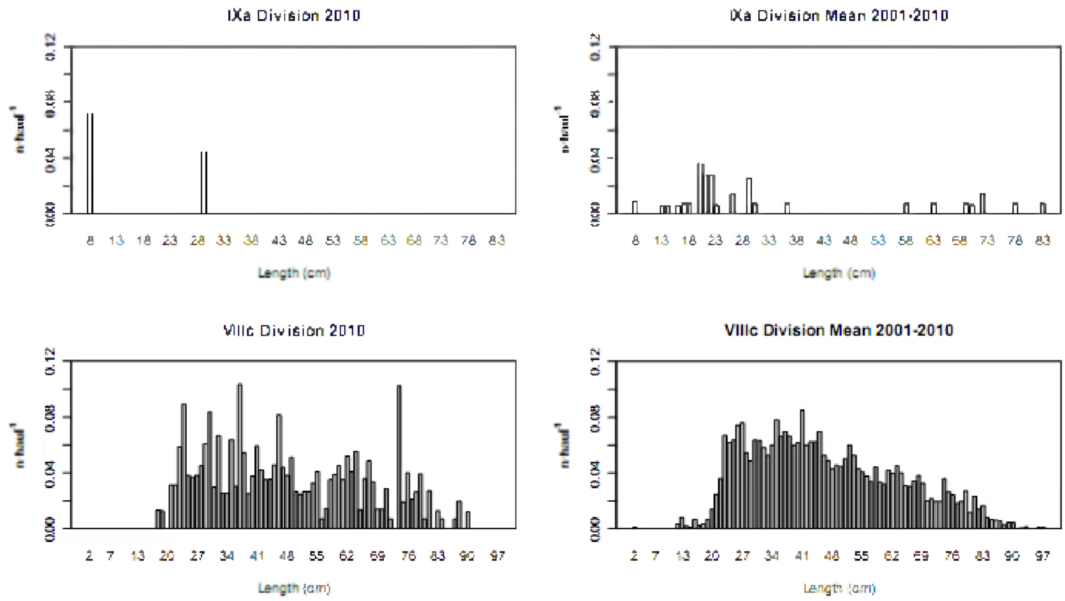


Figure 19.9b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distribution of thorny ray (*R. clavata*), in ICES Divisions IXa and VIIIc, during 2010 and mean values during the last decade (2000–2010).

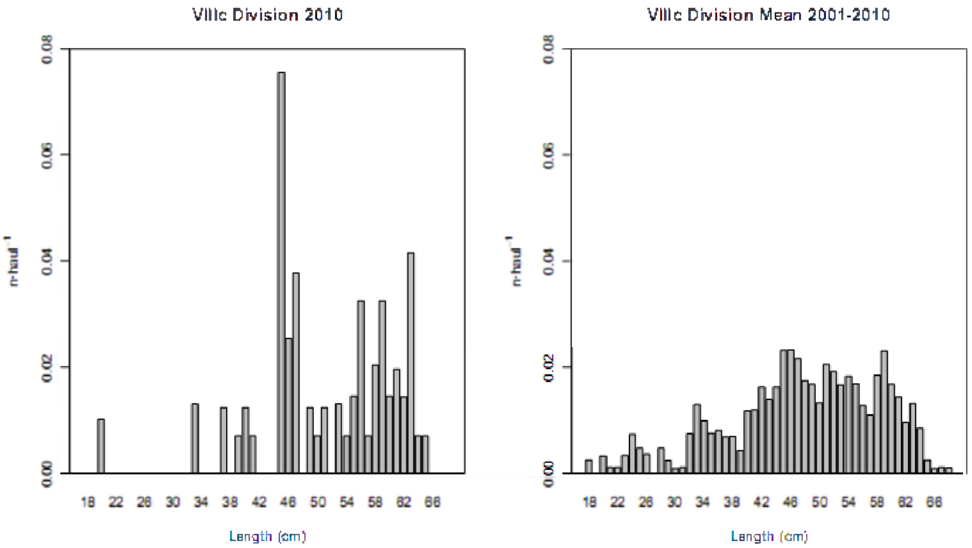


Figure 19.9c. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *Leucoraja naevus* in 2010 in VIIIc ICES Division covered by North Spanish shelf bottom-trawl survey, and mean values for the last decade (2000–2010).

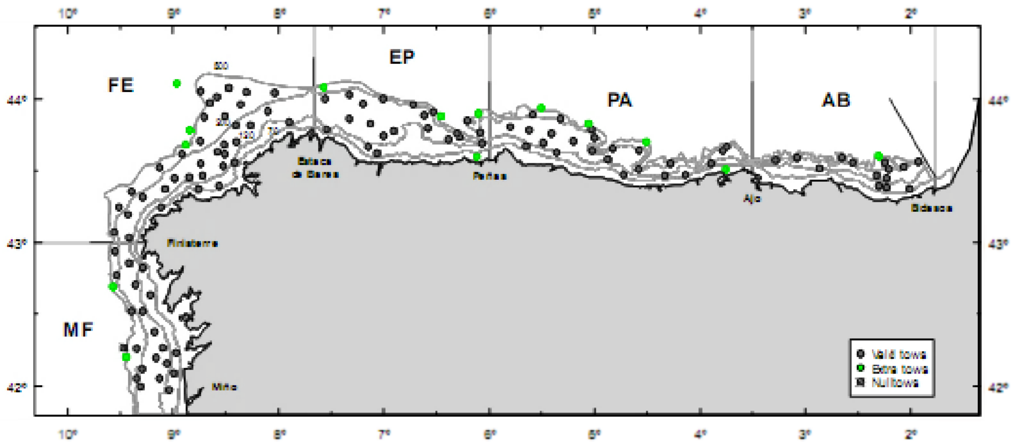


Figure 19.20. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratification design and hauls on the Northern Spanish Shelf Groundfish survey in 2010; depth strata are: A) 70–120 m, B) 121–200 m and C) 200–500 m. Geographic surveys are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-cabo Peñas, PA: Peñas-cabo Ajo, and AB: Ajo-Bidasoa.

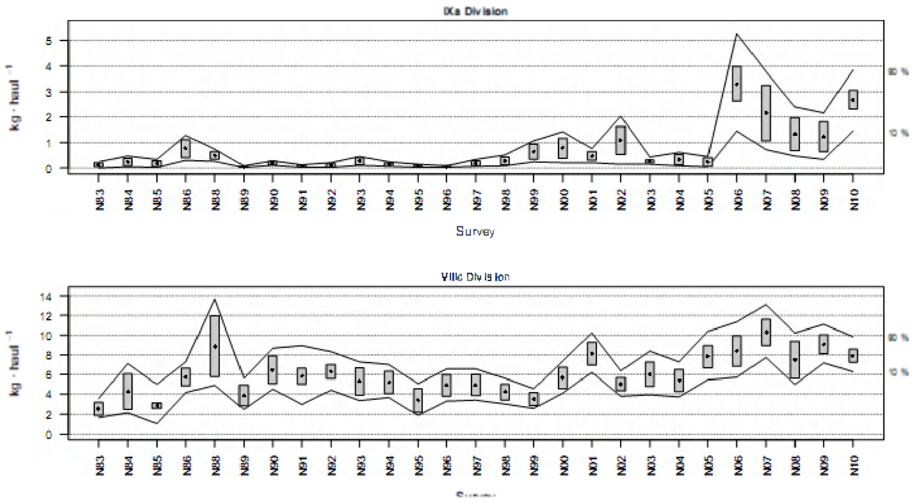


Figure 19.21. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Scyliorhinus canicula* biomass index during the North Spanish shelf bottom-trawl survey time-series (1983–2010 but in 1987) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

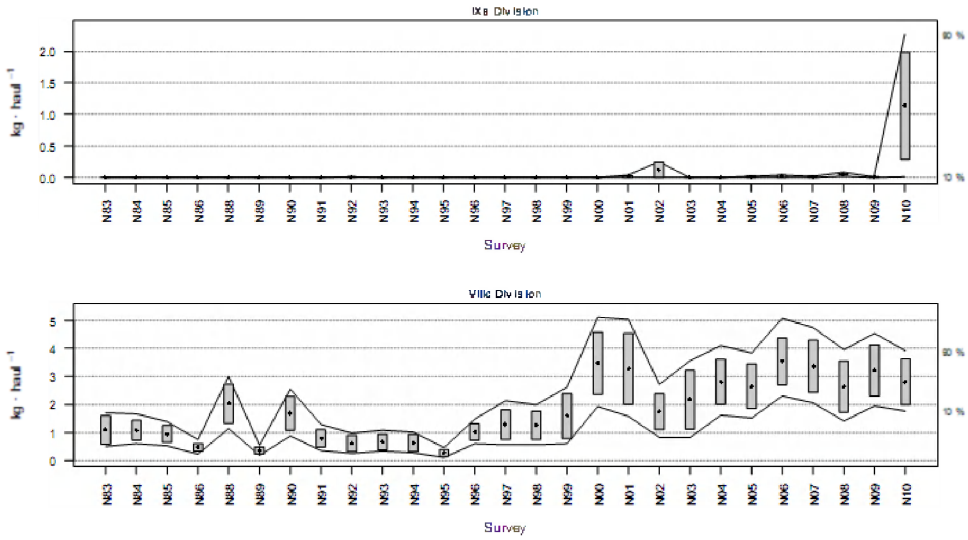


Figure 19.22. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in thorny ray (*Raja clavata*) biomass indices, in ICES Division IXa and VIIIc, during North Spanish Coast Survey time-series (1983–2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

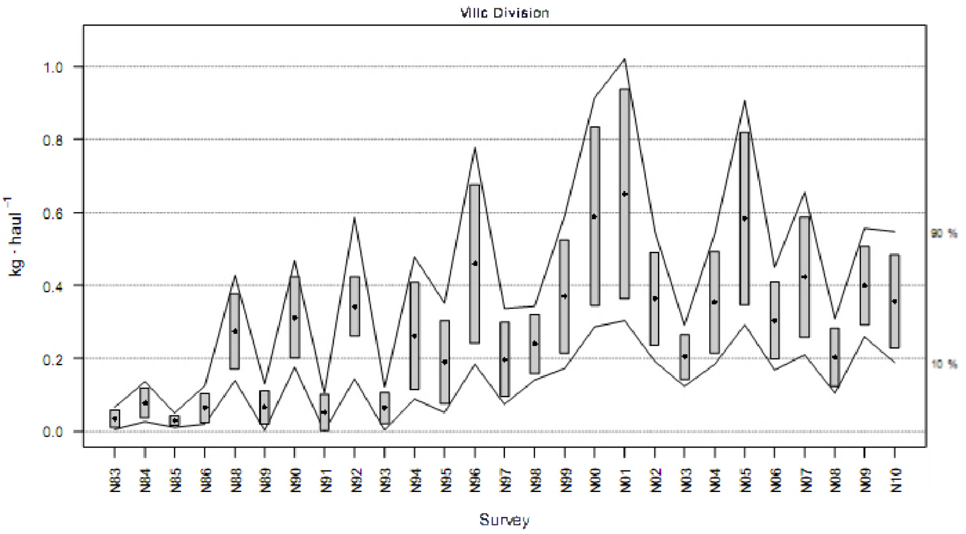


Figure 19.23. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Leucoraja naevus* biomass index during North Spanish shelf bottom-trawl survey time-series (1983–1986, 1988–2010) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

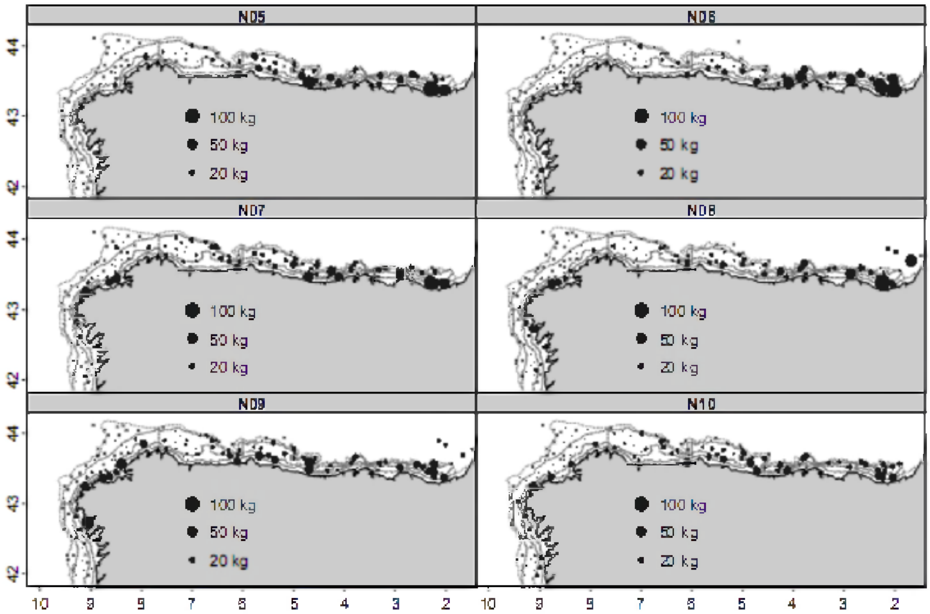


Figure 19.24a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of lesser-spotted dogfish (*S. canicula*), catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2010).

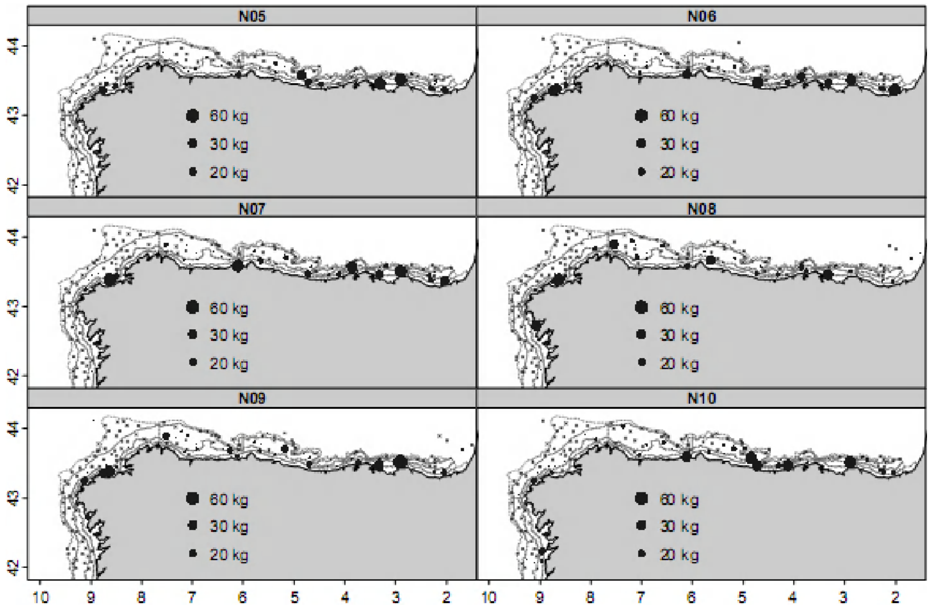


Figure 19.24b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of thornback ray (*R. clavata*) catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2010).

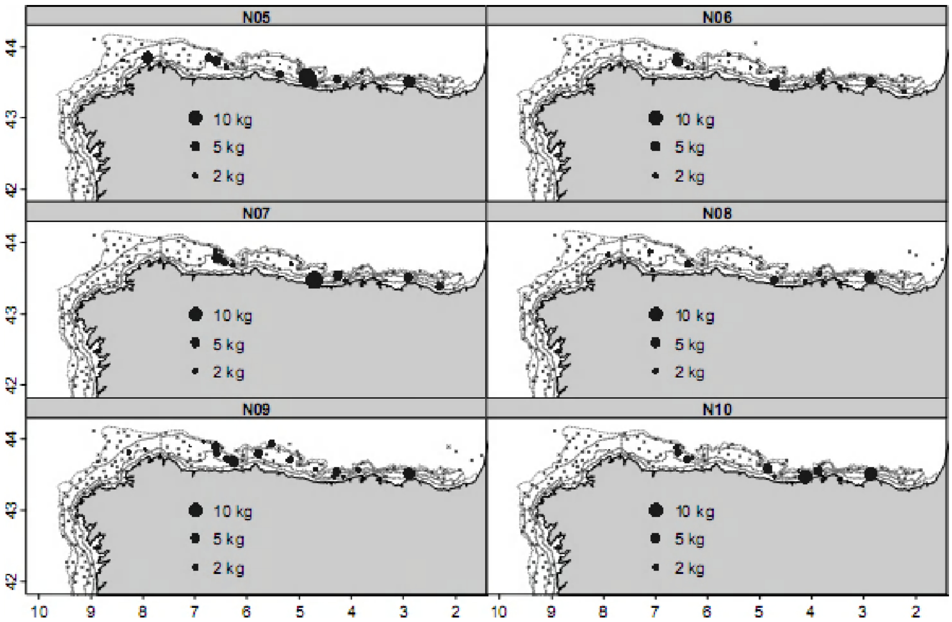


Figure 19.24c. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of cuckoo ray (*L. naevus*) catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2010).

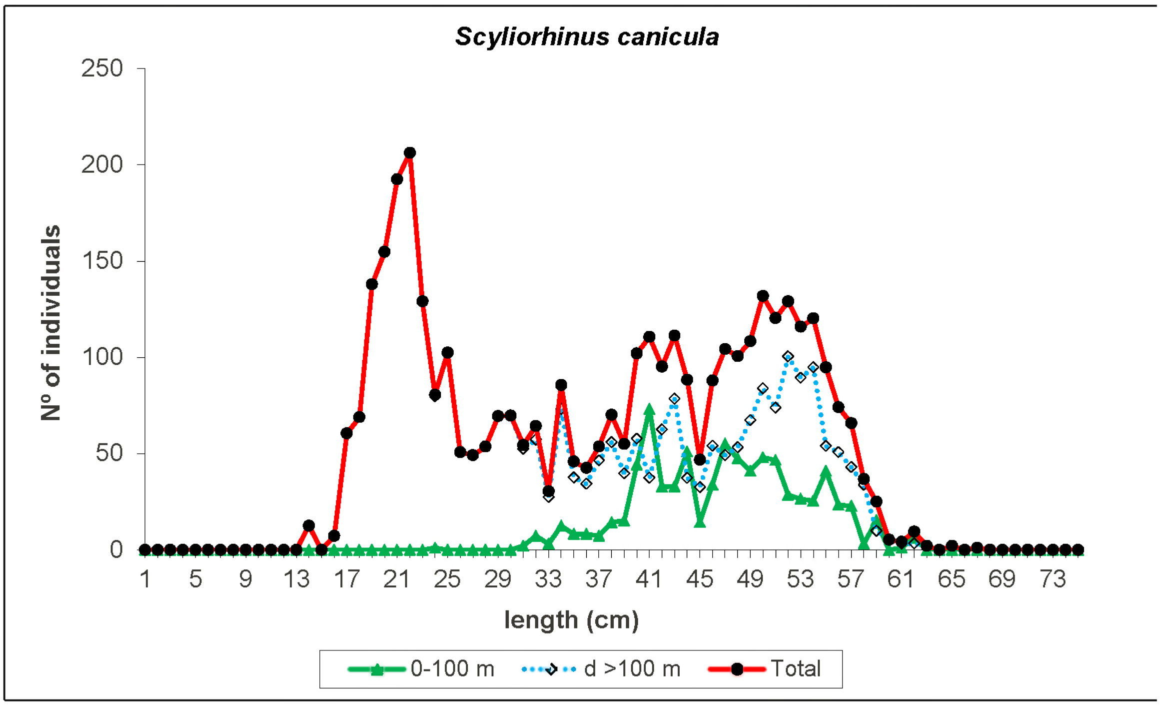


Figure 19.25. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters Length distribution of *S. canicula* by depth in the ITSASTEKA survey (Eastern VIIIc).

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.

For most species dealt with in this section the stock boundaries are not well known. The main species of demersal 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. Many of these may be discarded as a consequence of their low commercial value (ICES, 2005; (Pinho and Canha, 2011)). In the Azores area, kitefin shark *Dalatias licha* and tope *Galeorhinus galeus* are the most important commercial demersal elasmobranchs (see Sections 4 and 10 respectively).

Of the skates, the most abundant species in Subarea X is thornback ray *Raja clavata*. Other species also observed include *Dipturus batis, D. oxyrinchus, Leucoraja fullonica, Rajella bathyphila, Raja brachyura, Raja maderensis* and *Rostroraja alba* (Pinho, 2005; 2006, 2011). 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. These species are generally discarded if caught in commercial fisheries (Pinho and Canha, 2011). Some of the scarcer demersal elasmobranchs observed on MAR include *Bathyraja pallida* and *Bathyraja richardsoni* (ICES, 2005).

Stock boundaries are not known for the species in this area, neither are the potential movements of species that also occur on the continental shelf of mainland Europe. 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 where already described in ICES 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.

Demersal elasmobranchs are caught in the Azores EEZ by a multispecies demersal fishery, using handlines and bottom longlines, and by the black scabbardfish fishery using bottom longlines (ICES, 2005). The most commercially important elasmobranchs caught and landed from these fisheries are *Raja clavata* and *G. galeus* (Pinho, 2005; 2006; 2011; ICES, 2005).

20.2.2 The fishery in 2009 and 2010

During 2009 a Russian pelagic trawl targeting roundnose grenadier reported a by-catch of 0.6 t of mixed deep-water sharks from Subarea XIIc (WD Vinnichenko *et al*., 2010).

No significant changes were reported from the Azores fisheries where the landings of the demersal/deep-water sharks were very low due to the quota restrictions (WD Pinho, 2011). There are no target fisheries but discards of these species are expected to increase, particularly from the longliners, because quota and local area restrictions to fishing introduced on Subdivision Xa2 (Azores EEZ).

20.2.3 ICES advice applicable

ACOM has never provided advice for these stocks, but will in 2012.

20.2.4 Management applicable

NEAFC has been 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, entanglingnets 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 the islands 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).

Under the Common Fisheries Policy of the EU a box of 100 miles was created around the Azorean EEZ where almost only the Azorean fleets are permitted to 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 1539/2008).

20.3 Catch data

20.3.1 Catch data

The catches reported from each country and Subarea is given in Tables 20.1–20.3. Historical total landings of skates reported for Area 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

New information was presented this year on longline fishery bycatches and discards from Subdivision Xa2 (WD Pinho and Canha, 2011). Elasmobranch species were recorded from 60% of the sampled sets for the period 2005–2010. A total of 8153 elasmobranchs, of 12 different species, were caught on the sampled sets. About 89% of the total bycatch was discarded and only 11% was maintained on board. All the *Etmopterus spinax* caught was discarded representing 87% of the total discards from the longliners during this period. Other discarded species were *Deania hystricosa*, *Dipturus batis* and *Raja clavata*. Together these four species represent 98% of the observed elasmobranchs discards. The reason for discards is mainly the non commercial value of the species (98%) and in a very minor proportion (1.9%) the undersize aspect. Undersize is an important reason for *Raja clavata* discards representing about 37% of the total reason for this species.

20.3.3 Quality of catch data

Species-specific landings data are not currently available for skates landed in this region. For demersal sharks misidentification is known to occur.

20.4 Commercial catch composition

20.4.1 Species and size composition

In the Azores there is no systematic fishery/landing sampling programme for these species because they have very low priority on the port sampling programme. Landings statistics on rays and skates from Azorean fisheries are reported under generic categories. Since 2004, length samples of *Raja clavata* have been collected, however few individuals were sampled.

20.4.2 Quality of data

Only limited data are available.

20.5 Commercial catch-effort data

No new information.

20.6 Fishery-independent surveys

Since 1995 Department Oceanography and Fisheries (DOP) has carried out an annual spring demersal bottom longline survey 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; 2011 WD.

Raja clavata is one of demersal elasmobranch species most commonly reported from the Azorean spring bottom longline (ICES, 2006). Relevant biological information available from surveys on this species was updated. An annual abundance index for this species is presented in Figure 20.2. The length frequency of samples is illustrated in Figure 20.3, and the absence of records of the youngest size classes in this survey will be a gear effect. Relative abundance for other species is available from this survey. These figures will be examined in greater detail in 2012.

Information on elasmobranchs recorded on MAR is available from the literature (Hareide and Garnes, 2001) and was summarized in ICES, 2005. Some information on deep-water sharks was presented during the 2009 meeting (Vinnichenko and Fomin, 2009 WD), and this is detailed in Sections 3 and 5.

20.7 Life-history information

No new information.

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 allow the general status of the more frequent species to be evaluated in future.

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

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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Vinnichenko, V. I., Dolgov, A.V. and Yurko, A.S. 2010. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2009.

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		11	18
Total		99	117	109	125	121	77	91	73	51	63	82	91

ICES SUBAREA X			
Country	Species	2009	2010
Azores	Rajidae	60	68
France	Rajidae	.	.
Spain	Rajidae		
Azores	Bluntnose six-gill shark	.	0.6
Azores	Sharks	10	6.3
Total		71	75

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
UK	Rays and skates	
Norway	Rajidae	
Total		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
UK	Rays and skates	+
Norway	Rajidae	
Total		0.02

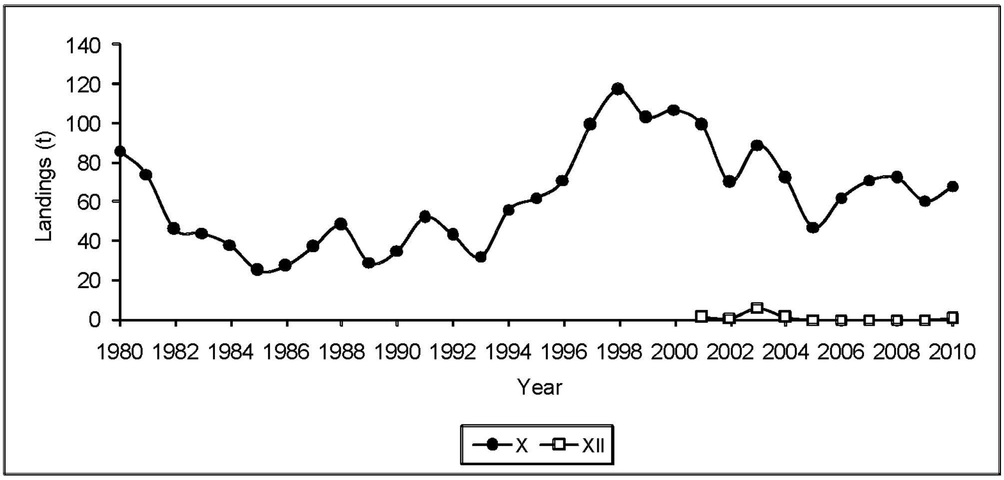

Figure 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Historical landings of rays from Azores (Ices Subarea X) and MAR (ICES Subarea XII).

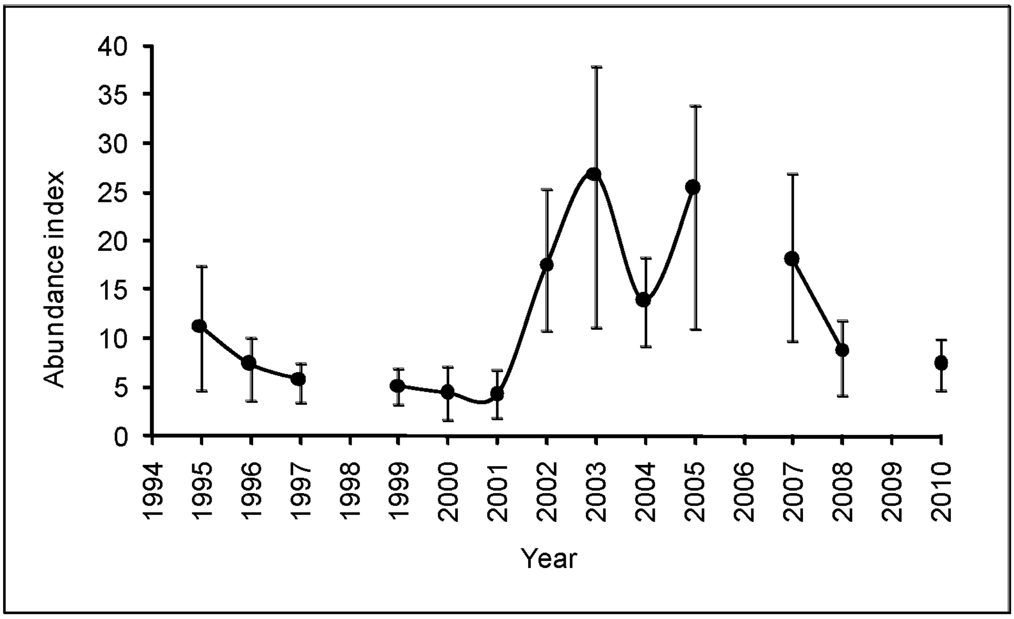

Figure 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Survey annual abundance, in number, of *Raja clavata* from the Azores (ICES X).

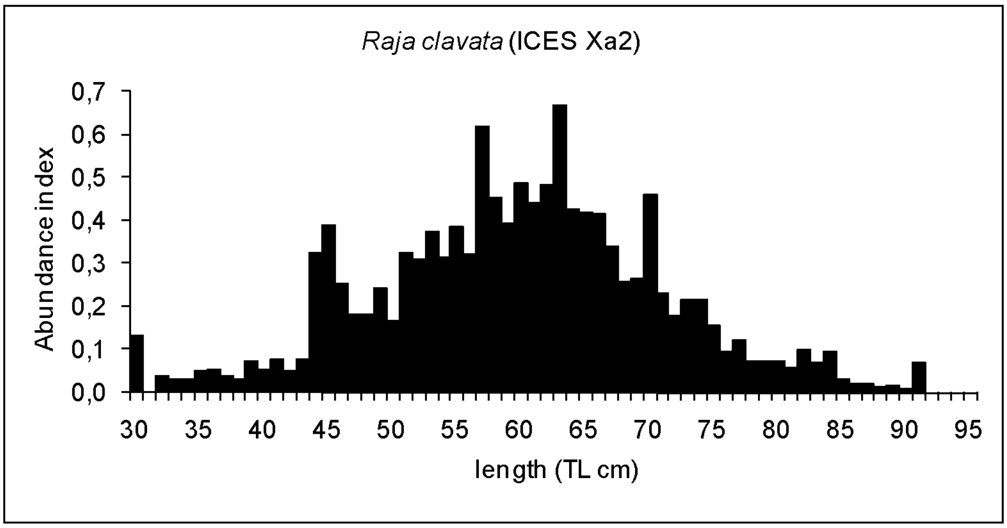

Figure 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* caught at the Azorean demersal spring bottom longline surveys during the period 1995–2010.

21 Other issues

This section of the reports addresses the generic terms of reference and other miscellaneous issues. The generic ToRs that WGEF were asked to address were:

i) Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (see http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF

j) Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status

k) Take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP) http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf

l) Provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes.

21.1 Elements of WGEF work that may help determine the status for MSFD descriptors and determining 'Good Environmental Status'

The European Marine Strategy Framework Directive (MSFD), adopted in June 2008, emphasizes that *"The marine environment is a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive"* (European Commission, 2008). The MSFD is also to support the EC position with regards the *"Convention on Biological Diversity, on halting biodiversity loss, ensuring the conservation and sustainable use of marine biodiversity…."*

The directive aims to achieve Good Environmental Status (GES) by 2020, which is to be based on eleven defined qualitative descriptors for determining GES. In terms of these descriptors, WGEF considered that the following three descriptors were of particular relevance to chondrichthyan fish:

(1) Biological diversity, and that *"The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions."*

(3) Commercial fish, and that *"Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock."*

(4) Foodwebs, and that *"All elements of the marine foodwebs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity"*.

There are limited and/or potential links between chondrichthyans and a further four Descriptors.

Descriptor 2 (non-indigenous species): There are cases of non-indigenous elasmobranchs, for example honeycomb stingray (*Himantura uarnak*) is a Lessepsian migrant that has entered the eastern Mediterranean basin from the Red Sea (via the Suez Canal). However, non-indigenous elasmobranchs are not considered an issue for the ICES area.

Descriptor 6 (sea-floor integrity) aims to ensure "that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected", and it is noted that many elasmobranchs are demersal, and so benthic habitats can be important feeding grounds and, for oviparous species, egg-laying sites.

Descriptor 7 (hydrographical conditions) aims to ensure that "*Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems*". The distributions of some elasmobranchs (species and/or particular aggregations) may be directly or indirectly influenced by the hydrography of the area.

Descriptor 9 highlights that contaminants in fish/seafood for human consumption "*do not exceed levels established by Community legislation or other relevant standards*", and given that elasmobranchs are top predators that can accumulate contaminants, then there is a rationale for considering that some species of elasmobranch be monitored for contaminants.

The four remaining descriptors (Descriptor 5: human-induced eutrophication; Descriptor 8: Concentrations of contaminants; Descriptor 10: Marine litter, and Descriptor 11: Introduction of energy including underwater noise) are not considered by WGEF to be of immediate relevance to chondrichthyans.

In terms of the work of WGEF, the status of several elasmobranch stocks are either assessed or evaluated, and these data may be useful for those species that are viewed as appropriate elements of Descriptors 1, 3 and 4.

Many of the species that WGEF address are commercial stocks (e.g. spurdog, skates), and as such these species should be considered within Descriptor 3. Some other elasmobranch stocks are of greater interest and relevance to nature conservation (e.g. angel shark), and so could be considered within Descriptor 1. As top predators, some species if not addressed within either of these could be considered within Descriptor 4.

In terms of those elasmobranch species that may be at the greatest risk of being lost from EC waters, which may include taxa such as *Rostroraja alba, Squatina squatina, Pristis* spp., *Rhinobatos* spp., these species are not taken, or are only taken very occasionally, in existing surveys and may have been extirpated from areas of former range. Hence, there is little potential for quantitative indicators to be developed for such species. If a localized population of such species did exist in the waters of a Member State (MS), then dedicated, non-lethal surveys would be required if it was decided that monitoring such species was an appropriate element of the MSFD.

In terms of commercial elasmobranchs, stock assessments have been undertaken and benchmarked for spurdog, which could enable assessment-based metrics to be considered. However, most other elasmobranch stocks are less well known, have fewer species-specific data, and full analytical assessments have not been conducted by ICES.

Given this, and that time-series of species-specific data are often only available from scientific surveys, the potential criteria suggested under Descriptor 1 (e.g. species distribution and range; trends in abundance and/or biomass, demographic characteristics) could be considered for MSFD monitoring of some of the data-poor commercial species that should be considered under Descriptor 3.

The monitoring requirements of the MSFD will be based primarily on existing surveys, at least in the short term, and so it would be most pragmatic to develop metrics for those elasmobranchs that are taken in sufficient numbers in existing surveys (or that could be appropriately sampled with slight modifications to existing surveys, depending on resource availability, and not compromising other aims of the survey).

Surveys data could be used to generate simple metrics (e.g. presence/absence; frequency of occurrence) for the less frequently caught species; with other metrics (e.g. spatial distribution, size distribution, length at 50% maturity and trends in cpue) derived for the more frequently sampled species.

Demersal elasmobranchs

Trawl survey information may be informative for some of the more frequently sampled skates (Rajidae). Species such as *Raja clavata* and *Leucoraja naevus* are widespread in the North Sea, Celtic Seas and Biscay–Iberian ecoregions, and the former is also taken in Azorean surveys. Hence survey-derived metrics could be generated for these species.

Other skate species can be locally common, and so survey information for the *Dipturus batis*-complex (VI), *Raja montagui* (VIa), *R. brachyura* (VIIa, VIIe), *R. microocellata* (VIIf) and *R. undulata* (VIIde) could be used in more regional assessments of GES.

Deep-water elasmobranchs

Although survey data are restricted to few parts of ICES area, regional surveys could be used to inform on species such as *Deania calcea, Centrophorus squamosus* and *Centroselachus crepidater.* WGNEACS would be able to provide further information on the kinds of metrics that could be developed for such species.

Pelagic elasmobranchs

Given that there are no fishery-independent surveys for large pelagic fish in the ICES area, then it will be difficult for this part of the ecosystem to be included within the MSFD at the present time. For example, blue shark *Prionace glauca* in the ICES area are part of a much wider North Atlantic stock, and their status should only be inferred from stock assessments (e.g. in conjunction with ICCAT) and regional metrics for such a species may not be informative. Porbeagle *Lamna nasus* is a data poor stock, and would require dedicated survey effort. Although some sightings data are available for basking shark *Cetorhinus maximus*, surface sightings may bias our perception of the stock distribution, and regional metrics may not be informative, given their migratory behaviour and that oceanographic features may result in important differences in spatial distribution. Tope *Galeorhinus galeus* is also semi-pelagic, and data from recreational fishers and basic information from trawl surveys may yield basic metrics that might inform on the stock status.

21.2 Comments on the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice

WGEF looked at the Workshop report (ICES, 2011). Critical habitats for elasmobranchs, which may include mating grounds, parturion/egg-laying grounds, nursery grounds and feeding grounds, may have a role in the management of their stocks. Species suggested for use as indicators under the Marine Strategy Framework Directive (see above), may also be used as population indicators in this case. Each of these species is found in sufficient regional abundance for existing surveys to detect changes in population.

WGEF were also asked to 'identify spatially resolved data'. This Term of Reference is addressed within each stock chapter.

21.3 References

European Commission. 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

European Commission. 2010. Commission decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters. 2010/477/EU Official Journal of the European Union L232: 14–24.

ICES. 2011. Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP). 1–4 November 2010, Lisbon, Portugal. ICES CM 2011/SSGHIE:01. 25 pp.

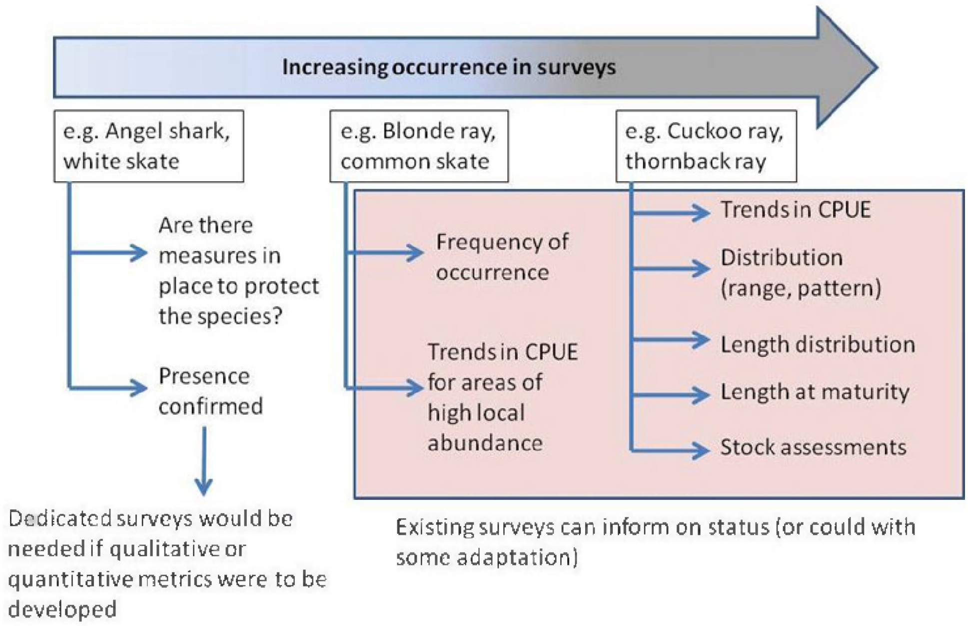

Figure 21.1. Illustrative account of how fish with increasing frequency and relative abundance in surveys could be used for more quantitative metrics for the MSFD.

Table 21.1. Potential role of elasmobranchs for inclusion within the MSFD for the Northeast Atlantic Ocean region. Spurdog, as a commercial species, is a useful candidate species, and is assessed as a single stock. Other species could be assessed at appropriate subdivisions as indicated below.

Subregion	Subdivision	Potential case-study species	Survey data
-	-	Spurdog*	
Greater North Sea, including the Kattegat, and the English Channel	Northern and central North Sea (IVa,b)	Cuckoo ray	IBTS-Q1 IBTS-Q3 BTS
	Southern North Sea and Eastern Channel (IVc, VIId)	Thornback ray	IBTS-Q1 IBTS-Q3
	English Channel (VIId,e)	Undulate ray Blonde ray	
Celtic Seas	NW Scotland (VIa,b)	Common skate complex Cuckoo ray	
	NW Scotland (VIa)	Thornback ray Spotted ray	
	Irish Sea (VIIa)	Thornback ray Blonde ray	
	Bristol Channel (VIIf)	Thornback ray Small-eyed ray	
	West of Ireland (VIIb,j)	Thornback ray Undulate ray	
	Celtic Sea and west of Ireland (VIIb,c,g–kj	Cuckoo ray Common skate-complex	
Bay of Biscay and the Iberian Coast	Bay of Biscay (VIIIa,b)	Thornback ray Cuckoo ray	
	Cantabrian Sea (VIIIc)	Thornback ray Cuckoo ray	
	Portuguese waters (IXa)	Thornback ray Cuckoo ray	
Macaronesia	Azores (X)	Thornback ray	

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Annex 2: Draft WGEF Terms of Reference 2012

2011/ACOM19 The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Graham Johnston, Ireland, will meet at Faro or Lisbon (TBC), Portugal 18–25 June 2012 to:

a) 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;

b) To underpin assessments of demersal elasmobranchs, WGEF will:

i) Examine species-specific survey information from the relevant survey time series, and commercial information from areas where survey data are not adequate;

ii) Collate length-based data and investigate relative methods for their assessment;

iii) Examine the time-series of species-specific landings of ray and skate species that is now available.

c) Evaluate the status of the stocks in the table below.

d) Examine the stock status of *Mustelus* spp.

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

f) Provide first draft of advice text for the stocks listed in the table below;

g) Finalise stock annexes for demersal elasmobranchs in the Celtic Seas, and demersal elasmobranchs in the North Sea and demersal elasmobranchs in the Biscay and Iberian region.

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 25 July 2011 for the attention of ACOM.

Fish Stock	Stock Name	Stock Coord.	Assess. Cood.	Perform assessment	Advice
skx-67-d	Demersal elasmobranchs in the Celtic Sea and West of Scotland			Y	Y
skx-347d	Demersal elasmobranchs in the North Sea, Skagerrak and eastern English Channel			Y	Y
skx-89a	Demersal elasmobranchs in the Bay of Biscay and Iberian waters			Y	Y
dgs-nea	Spurdog (*Squalus acanthias*) in the Northeast Atlantic			N	N
por-nea	Porbeagle (*Lamna nasus*) in the Northeast Atlantic			Y	Y
bsk-nea	Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic			Y	Y
	Portuguese dogfish (*Centroscymnus coelolepis*) in the Northeast Atlantic			Y	Y
	Leafscale gulper shark (*Centrophous squamosus*) in the Northeast Atlantic			Y	Y
sck-nea	Kitefin shark (*Dalatias licha*) in the Northeast Atlantic			Y	Y
skx-10	Demersal elasmobranchs in the waters of the Azores and mid Atlantic ridge			Y	Y

Annex 3: Recommendations

Recommendations received

PGCCDBS recommends that WGEF formulates a proposal for a small-scale study to:

a) improve logbook recordings by species ID keys and by revision of legal requirements, and

b) establish species ID methods by genetics, etc. in order to improve species ID for the Centrophoridae family, particularly those occurring in the NE Atlantic (e.g. *C. granulosus, C. lusitanicus*).

PGCCDBS recommends that WGEF formulates a proposal for a small-scale study on stock structure of deep-water sharks that should be considered in conjunction with the proposed workshop on age reading (WKARDS 2012, see Annex 15).

Species identity is a concern of WGEF. WGEF supports the need for genetic samples to better improve species identity and stock identity within the Centrophoridae family. However, access to these genetic samples is limited, as a consequence of the decline in the number of deep-water surveys. The stock structure of other species should also be considered from a genetic point of view.

WGEF therefore recommends that, initially, genetic samples are collected on each survey that takes place as part of the Northern component of WGNEACS. This should consist of one muscle sample (appropriate protocols to follow) from each individual caught of the following species:

- *Centrophorus squamosus*
- *Centrophorus granulosus*
- *Centrophorus lusitanicus*
- *Centrophorus uyato*
- *Centroscymnus coelolepis*
- *Deania* spp.

Additionally, a minimum of two adult males, two adult females and two juvenile individuals of each of the above specimens caught, should be frozen whole, as voucher samples, where possible.

Genetic samples from these species should also be collected on board the Scottish deep-water survey and on board other Central/Southern area surveys when they take place.

The stock structure of deep-water sharks can be considered using the genetic aspects proposed above. As there are few current samples, and as the WKARDS workshop is not going ahead, it is felt that now is not a suitable time to follow this recommendation, and that this should be revisited at a future time, when more samples become available.

Recommendations by WGEF

WGEF makes the following recommendations:

Recommendation	Adressed to
1. WGEF recommends that WGBEAM provide North Sea beam trawl data for analysis, particularly information that is not available from DATRAS. These data should include the numbers-at-length of the main elasmobranchs, by species, by haul, and by sex, along with haul positions, including zero-catch hauls.	WGBEAM
2. WGEF recommends that IBTSWG provide catch data for analysis, particularly information that is not available from DATRAS. These data should include the numbers-at-length of the main elasmobranchs, by species, by haul, and by sex (where available), along with haul positions, including zero-catch hauls.	IBTSWG

Annex 4: Stock annexes

4.1 Stock Annex: Other deep-water sharks and skates from the Northeast Atlantic (ICES Subareas IV–XIV)

Stock	Other deep-water sharks and skates from the North east Atlantic (ICES Subareas IV–XIV)
Working Group	WGEF
Date:	June 2011
Revised by	WGEF (Tom Blasdale)

A. General

A.1. Stock definition

The present section includes information about deep-water elasmobranch species other than Portuguese dogfish and leafscale gulper shark (see Section 3) and kitefin shark (see Section 4). Little information exists on the majority of the species presented here other than annual landings data for some species, which are probably incomplete. In addition, it is likely that the available data for some species may be unreliable due to problems with species identification. For example gulper shark may be sometimes confounded due to morphological similarity with other similar species such as *C. niaukang*, *C. lusitanicus* and *C. harrissoni* (Compagno *et al.*, 2005).

The species and generic landings categories for which landings data are presented are: Gulper shark (*Centrophorus granulosus*), birdbeak dogfish (*Deania calceus*), longnose velvet dogfish (*Centroselachus (Centroscymnus) crepidater*), black dogfish (*Centroscyllium fabricii*), velvet belly (*Etmopterus spinax*), blackmouth catshark (*Galeus melastomus*), Greenland shark (*Somniosus microcephalus*), lantern sharks *nei* (*Etmopterus* spp.), and 'aiguillat noir' (may include *C. fabricii, C. crepidater* and *Etmopterus* spp.).

14 species of skate (Rajidae) are known from deep water in this area: 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 (*Dipturus lintea*), Norwegian skate (*Dipturus nidarosiensis*) and blue pygmy skate (*Neoraja caerulea*). Most of these species are poorly known. Species such as *Dipturus batis* complex (see Section 21.1) and *Leucoraja fullonica* may occur in deep water, but their main areas of distribution extend to much shallower waters and they are not considered in this section.

A.2. Fishery

Divisions VIII, IX and X

Gulper shark *Centrophorus granulosus* was the main target of a directed longline fishery for deep-water sharks, which started in 1983 in northern Portugal (STECF, 2003), but has now finished. The species is occasionally captured by the Portuguese black scabbardfish longline fishery in Subarea IX.

Other deep-water species are captured by artisanal fisheries operating in ICES Subareas IX and X. The crustacean trawl fishery operating in Subarea IX captures species such as birdbeak dogfish, black mouth catshark and lantern sharks, but these are mainly discarded.

Subareas IV, V, VI, VII, XII and XIV

Several species of deep-water shark and skate are caught as bycatch in mixed deep-water trawl fisheries in Subareas VI, VII and XII. Many of the species considered here were formerly discarded by these fisheries; however, in more recent years species such as longnose velvet dogfish and black dogfish were increasingly retained and landed. Greenland shark is caught as bycatch mainly in Norwegian, Faroese and Icelandic longline fisheries for ling, tusk and Greenland halibut. In recent years, most reported landings are from Iceland. Norway conducted a directed fishery for this species between 1800 and 1960 (Moltu, 1932; Rabben, 1982). Until 1900, the fishery was conducted in fjords and coastal areas. After 1900 the fishery expanded to offshore grounds and in 1927 to distant waters in the Denmark Strait and East Greenland. Only the liver was landed by Norwegian vessels. The landings of liver after 1910 are shown in Figure 5.2. No conversion factor for liver weight to whole weight is established for this species.

In 2007, a Russian longliner started fishing deep-water sharks in the Faroese Fishing Zone (FFZ) and on the Reykjanes Ridge. The total catch of the elasmobranches in those and others NEA areas amounted to 483 t (Vinnichenko, 2008).

A.3. Ecosystem aspects

No data.

B. Data

B.1. Commercial catch

Landings data are available for 13 species and mixed categories. Landings tables are presented in the WGEF report for; Gulper shark (*Centrophorus granulosus),* Birdbeak dogfish (*Deania calceus),* Longnose velvet dogfish (*Centroselachus (Centroscymnus) crepidater*), Black dogfish (*Centroscyllium fabricii*), Velvet belly (*Etmopterus spinax*), Lantern sharks nei *Etmopterus* spp., Blackmouth dogfish (*Galeus melastomus*), "Aiguillat noir" and Greenland shark (*Somniosus microcephalus*).

Landings have are known to occur for the following species and categories but limited data are available.

Knifetooth shark Scymnodon ringens

Knifetooth shark is rarely reported as separate species as it is generally included in aggregated categories. UK (Scotland) reported 61 t in 2005 and 196 t in 2007; however, it is considered that species identification at that time may have been unreliable. Portugal reported 63.5 t in 2007 in Subarea X.

Angular rough shark Oxynotus centrina

The angular rough shark is caught irregularly by the Portuguese fisheries in Subarea IXa. The catch was 53 t in 2006, 90 t in 2007 and 50 t in 2008 No landings were reported for 2009. It is admitted that Portuguese landings are incorrectly classified and they correspond to *Balistes* spp.: This result from the fact that both *Oxytonus* and *Balistes* have the same Portuguese common name , in Portuguese "peixe-porco" (Serra-Pereira *et al*., 2011 WD).

Bluntnose sixgill shark Hexanchus griseus

Bluntnose sixgill shark is sporadically caught by UK, French and Portuguese fisheries in Subareas VII, VIIIa and X respectively. The catches vary from 1 to 4 t/year.

Deep-water catshark of the genus Apristurus

Several species of deep-water catshark of the genus *Apristurus* (*A. laurussoni, A. melanoasper, A. aphyoides, A. manis* and *A. microps*) are caught, sometimes in large amounts, since the development of deep-sea trawl fisheries on the NE Atlantic continental slopes in the 1990s. No country has so far reported catches of these deep-water catsharks as they are generally discarded because they have no commercial value (they are small-bodied and soft-bodied sharks).

Deep-water skates Rajidae

Little information is available on landings of deep-water skates. It is likely that some deep-water species are included in landings data under the generic category of "Raja rays *nei*".

Dipturus nidarosiensis accounted for 1% of skates recorded in biological sampling in Irish ports between 2001 and 2007. Iglesias *et al.* (2010) found that on French markets in 2005, 14.7% of landings described as common skate and 14.6% of those described as longnose skate were in fact misidentified *D. Nidarosiensis*.

Catches of several ray 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.

Discards

Little information is available on discards of other deep-water sharks and skates but discarding rates were thought to be high for many species. Some information on discarding of these species in French and Scottish fisheries in Subarea VI can be found in Allain *et al*., 2002; Blasdale and Newton, 1998 and Crozier, 2003 WD.

B.2. Biological

Velvet belly Etmopterus spinax

Coelho and Erzini, 2007 published the results of a study on the population of *Etmopterus pusillus* from southern Portugal. They provided different growth models with the following biological parameters: first maturity 38 cm TL and seven years for male, and 38 cm TL and nine years for female; maximum age 13 years for male and 17 years for female; ovarian fecundity varying from 2–18 oocytes.

Gulper shark Centrophorus granulosus

Bañón *et al.* (2008) studied the reproductive biology of *C. granulosus* along the continental slope of Galician waters and the Galician Bank. Specimens were captured between 741–1211 m depth. They ranged from 44 to 166 cm; with males between 73 and 127 cm (N=12) and females between 44 and 166 cm (N=256). The size at 50% maturity was 147 cm for females. From males, size at 50% maturity could not be determined due to the low number of males in the sampling (Bañón *et al.*, 2008). The smallest mature female measured 138 cm and the largest immature female 153 cm, whereas the smallest mature male measured 118 cm and the largest immature male 115 cm.

Guallart and Vicent (2001) studied also the reproduction of the species using specimens obtained from commercial catches made with bottom longlines and bottom gillnets in depths between 150 and 650 m depth in the Gulf of Valencia (western Mediterranean) during the period from 1992–1997. They concluded that the species reproduces through aplacental viviparity (Guallart and Vicent, 2001). Its fecundity is one of the lowest described, with only one embryo in a pregnancy lasting about two years (Guallart and Vicent, 2001). The gulper shark has a gestation period of about two years (Capapé, 1985; Guallart, 1998). At birth, each pup measures approximately 30–42 cm total length (Compagno *et al.*, 2005).

The differences found in size and reproductive parameters in Galician specimens could indicate a marked distinctiveness of Mediterranean and Atlantic populations. Banon *et al.* (2008) also refer that such difference can be due misidentification with *Centrophorus niaukang* Teng, 1959. *C. niaukang* has a maximum size to about 170 cm TL, 1–6 pups/litter, size at birth to 30–45 cm TL, males mature at 90–110 cm TL and females at 130–149 cm TL (Yano and Kugai, 1993; Fowler, 2003; Compagno *et al.*, 2005).

Table 1. Other deep-water sharks and skates from the Northeast Atlantic. Ecological and biological parameters of various deep-water sharks.

Vernacular names: English French Spanish	Scientific name	Depth range in m	Size TL in cm	Maturity size male	Maturity size female	Mode reproduction	Fecundity	Size at birth in cm	Length / Weight	Longevity	IUCN
Gulper shark Squale-chagrin commun Quelvacho	*Centrophorus granulosus*	50 1440	150	# 60–80	> 96	ovoviviparous		30–42			VU
Black dogfish Aiguillat noir Tollo negro merga	*Centroscyllium fabricii*	180 1600	107			ovoviviparous	14		a = 0.0009 b = 3.420		-
Longnose velvet dogfish Pailona à long nez Sapata negra	*Centroselachus crepidater*	230 1500	130	64–68	82	ovoviviparous	4–8	28–35	a = 0;0024 b =3.250	54	LC
Birdbeak dogfish Squale-savate Tollo pajarito	*Deania calcea*	60 1490	122	85	105	ovoviviparous	6–12	29–34	a = 0.0012 b = 3.260	female: 35 male: 32	LC
Velvet belly Requin-lanterne Negrito	*Etmopterus spinax*	70 2490	60	33–36		ovoviviparous	6–20		a = 0.0018 b = 3.240		-

Vernacular names: English French Spanish	Scientific name	Depth range in m	Size TL in cm	Maturity size male	Maturity size female	Mode reproduction	Fecundity	Size at birth in cm	Length / Weight	Longevity	IUCN
Blackmouth catshark Chien espagnol Pintarroja bocanegra	*Galeus melastomus*	55 1873	90			oviparous	13		a = 0.0025 b = 3.020		-
Bluntnose sixgill shark Requin griset Canabota gris	*Hexanchus griseus*	0 2500	482	315–400	400–482	ovoviviparous	22–108	60–75	a = 0.0135 b = 3.000		LR/nt
Angular roughshark Centrine commune Cerdo marino	*Oxynotus centrina*	60 777	150	50	50	ovoviviparous	7–8				-
Greenland shark Laimargue du Groenland Tollo de Groenlandia	*Somniosus microcephalus*	0 2200	730	244–427	244–427	ovoviviparous			a = 0.0114 b = 3.000		NT

a)

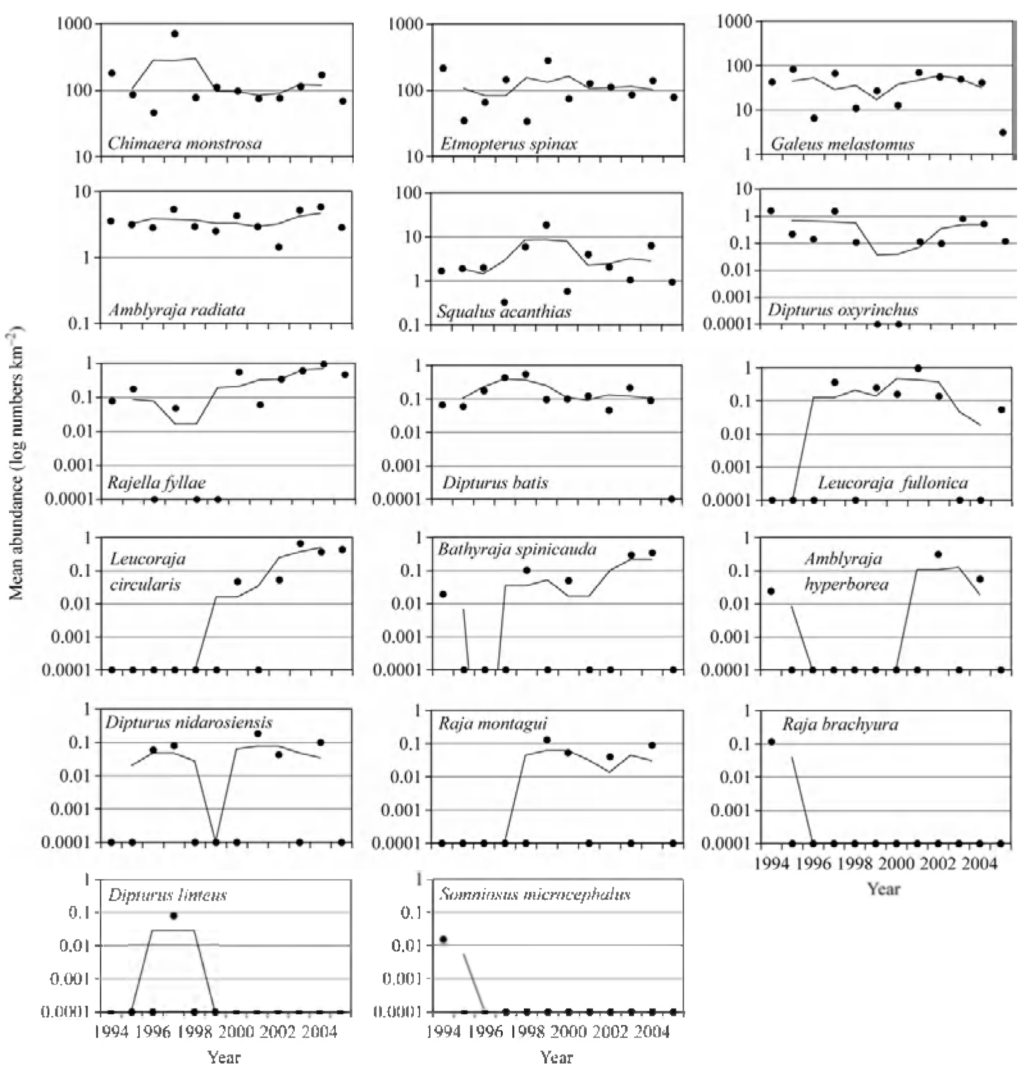

Figure 5.18. Other deep-water sharks and skates from the Northeast Atlantic. Mean abundance of all chondrichthyan species along the north coast of Norway from the coastal surveys of 1992–2005. Note that the abundance scales differ between panels (Williams *et al.*, 2008).

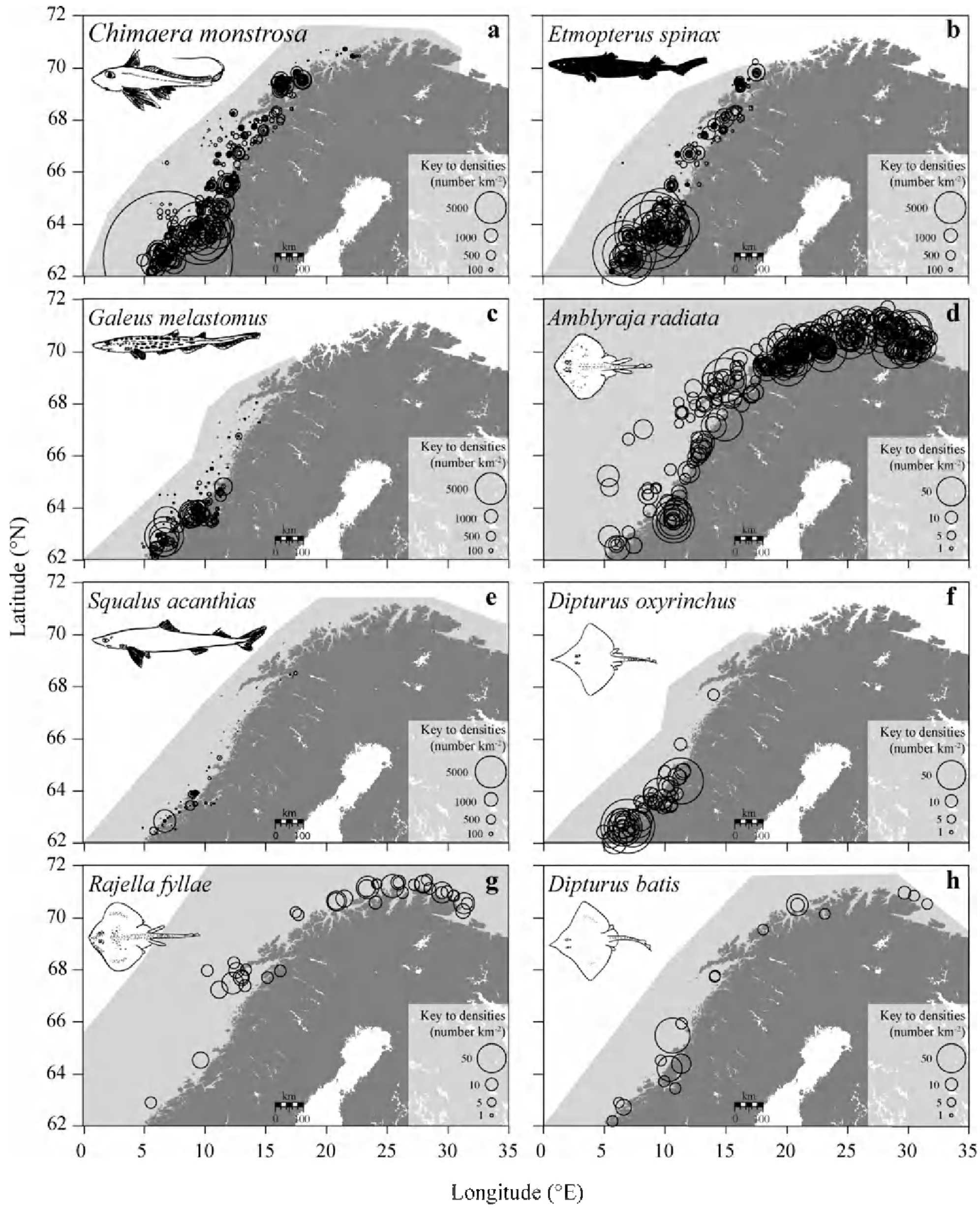

Figure 5.19. Other deep-water sharks and skates from the Northeast Atlantic. Distribution and abundance of (a) *Chimaera monstrosa*, (b) *Etmopterus spinax*, (c) *Galeus melastomus*, (d) *Amblyraja radiata*, (e) *Squalus acanthias*, (f) *Dipturus oxyrinchus*, (g) *Rajella fyllae*, and (h) *Dipturus batis* along the north coast of Norway from the coastal surveys of 1992–2005. Note that the abundance scales differ between panels (Williams *et al.*, 2008).

B.3. Surveys

Scottish deep-water trawl survey (SDS)

Marine Scotland Science (formerly FRS) has conducted deep-water surveys (depth range 300–1900 m) to the West of Scotland since 1996. Since 1998, these have been reasonably consistent about survey design, gear and area covered. *Chondricthyan* species diversity in the survey peaks between 1000–1500 m with eleven species of skates and six chimaera species.

The most abundant species (in terms of catch rates, kg.h^{-1}) are *C. crepidator* and *D. calceus*. A more detailed preliminary analysis of the catch rates of eight of the deep-water shark species is presented in Jones *et al.*, 2005. Spatial distribution of catches of eight deep-water shark species is presented in Figure 1.

Jones *et al.*, 2005 conducted a preliminary analysis of cpue of eight deep-water sharks caught in Scottish surveys between 1998 and 2004 (Figure 2). Cpue in the surveys was also compared with cpues from exploratory fishing by MAFF in the 1970s (Figure 3). These comparisons must be treated with caution as Scottish surveys over period have not been entirely standardized with respect to the depth range fished and the historical surveys used very different gear.

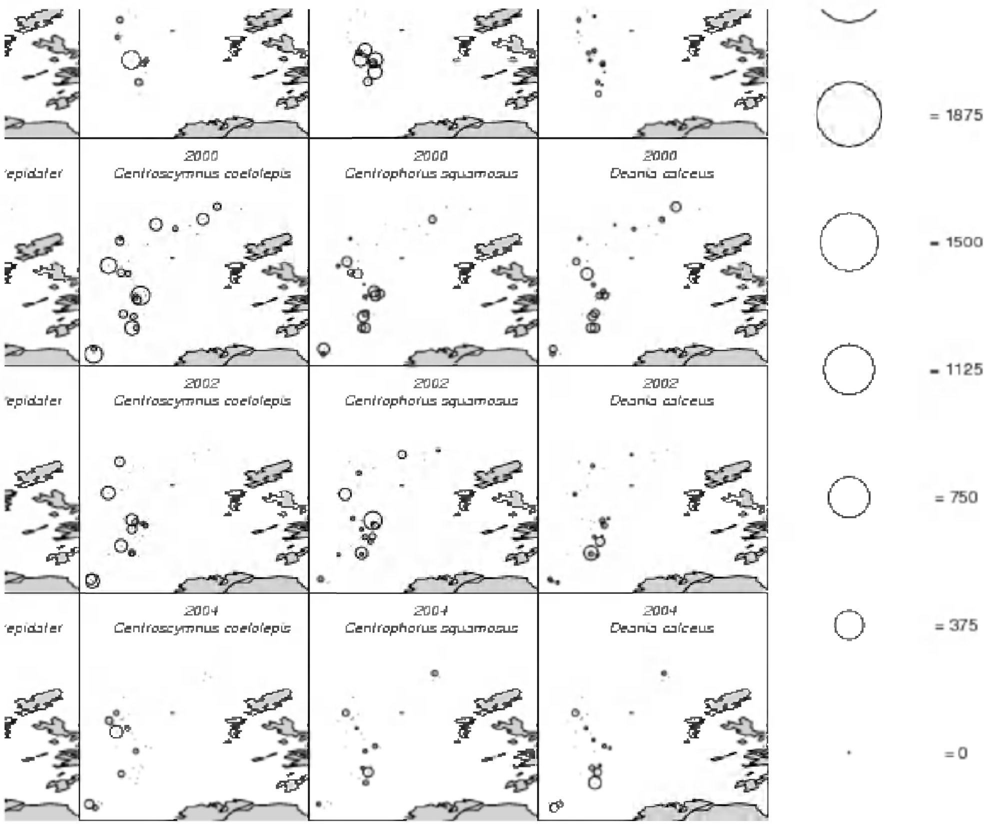

Figure 1. Spatial distribution and relative abundance (kg per hour) of four deep-water Squaliform species recorded during the FRS deep-water surveys, 1998–2004.

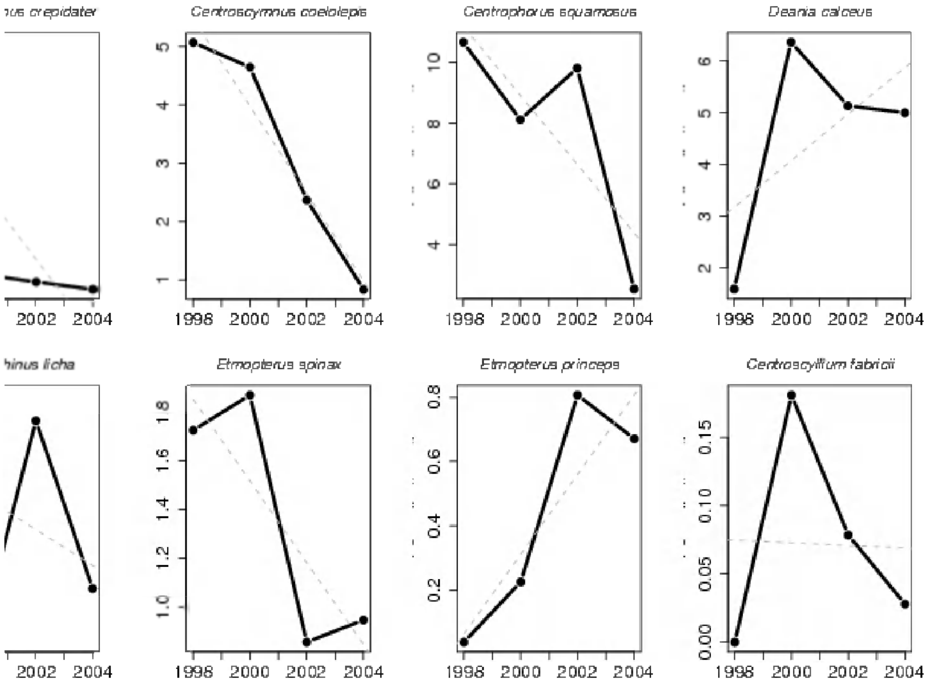

Figure 2. Change in cpue (kg per hour) in Scottish surveys in Division VIa between 1998 and 2004 for eight deep-water species.

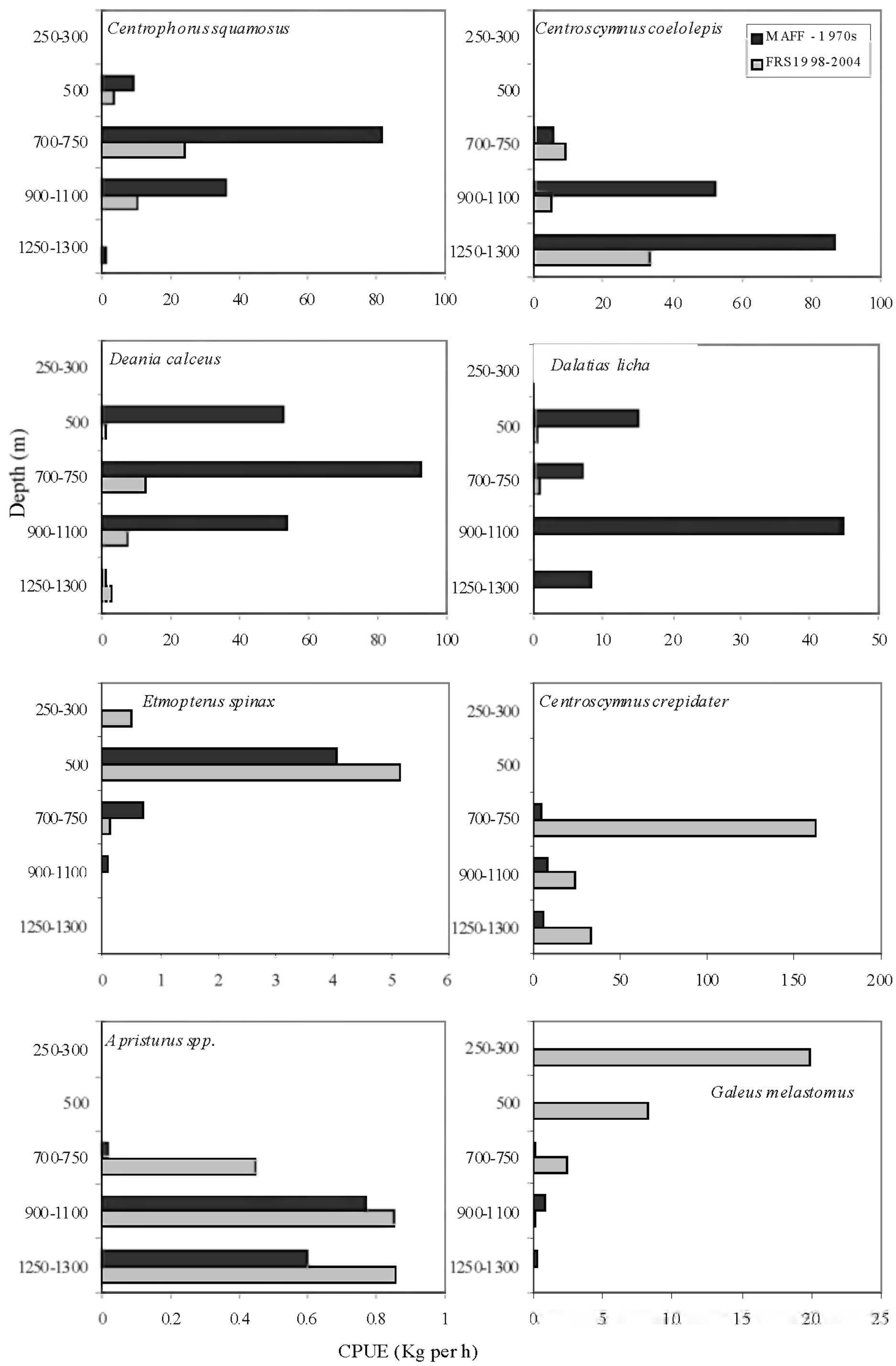

Figure 3. Comparison of catch rates (kgs per hour) for eight species of deep-water shark caught during MAFF and FRS deep-water surveys. Note: in this plot all the data from the FRS and MAFF surveys are pooled.

Spanish Porcupine groundfish survey(SpPGFS (WIBTS–Q4))

Spanish bottom-trawl surveys performed since 2001 to 2007 on the Porcupine Bank (Velasco and Blanco, 2008) demonstrated that the blackmouth dogfish represented 1.7% of the total fish biomass, with an increase from 2001 to 2005 (5.4 kg/haul in 2001 to 17.8 kg/haul in 2005), then a strong drop in 2006. Maximum abundance was observed between 400–800 m depth; the total length ranged from 8–79 cm with modes at 44–50 and 65 cm (Figures 4 and 5).

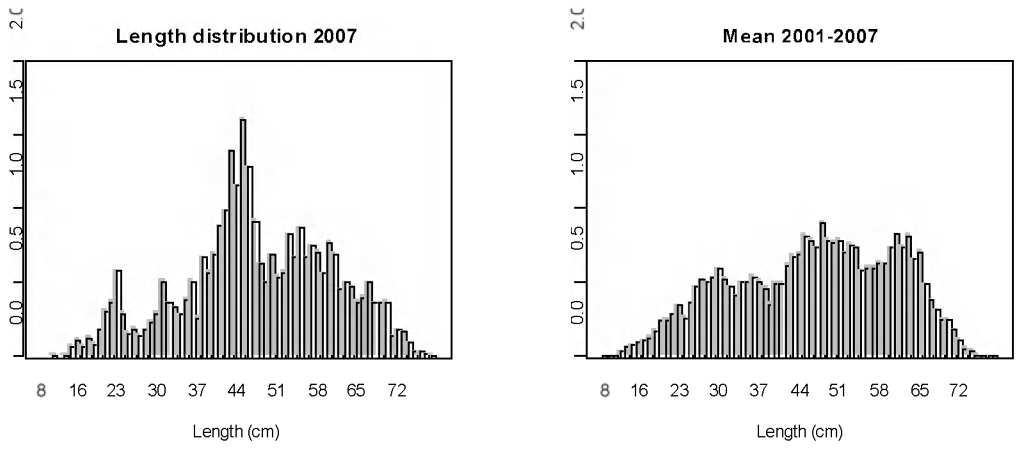

Figure 4 Other deep-water sharks and skates from the Northeast Atlantic. Stratified length distributions of blackmouth catshark (*G. melastomus*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).

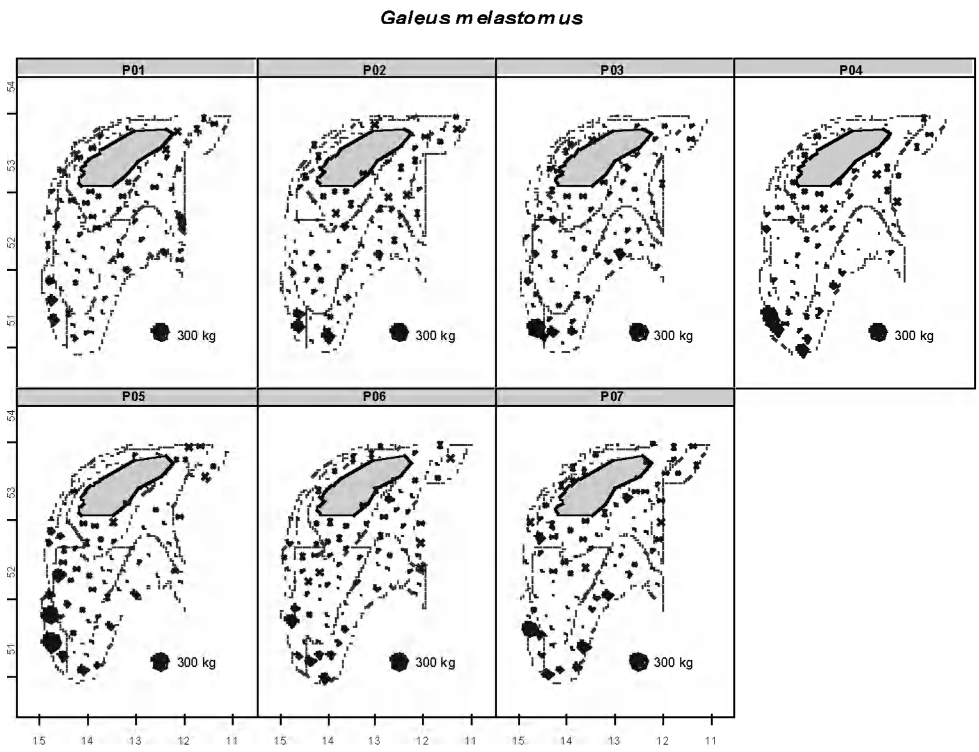

Figure 5. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of blackmouth catshark (*G. melastomus*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).

These surveys indicated that the abundance of the birdbeak dogfish was variable but represented 0.5% of the total fish biomass on average; the maximum abundance was observed between 750–800 m depth; the total length ranged from 18–118 cm with two modes at 70–72 cm and 85–99 cm. (Figures 6 and 7).

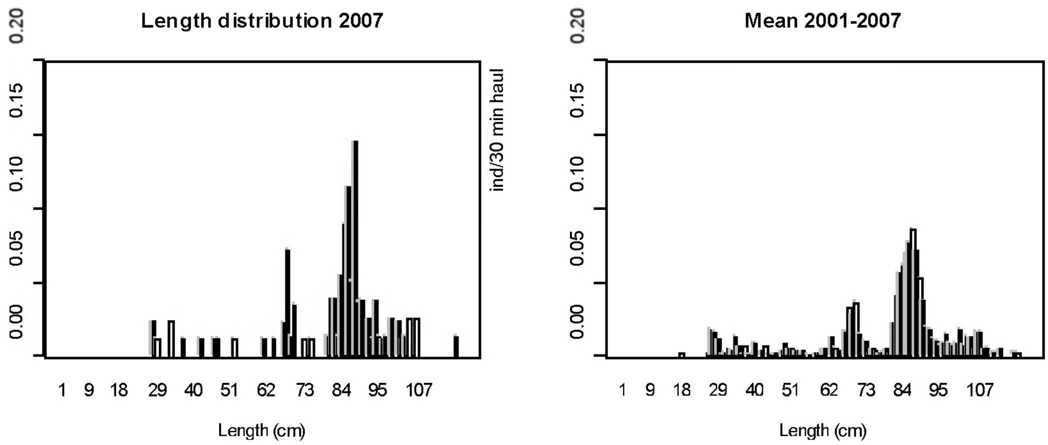

Figure 6. Other deep-water sharks and skates from the Northeast Atlantic Stratified length distributions of birdbeak dogfish (*D. calcea*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).

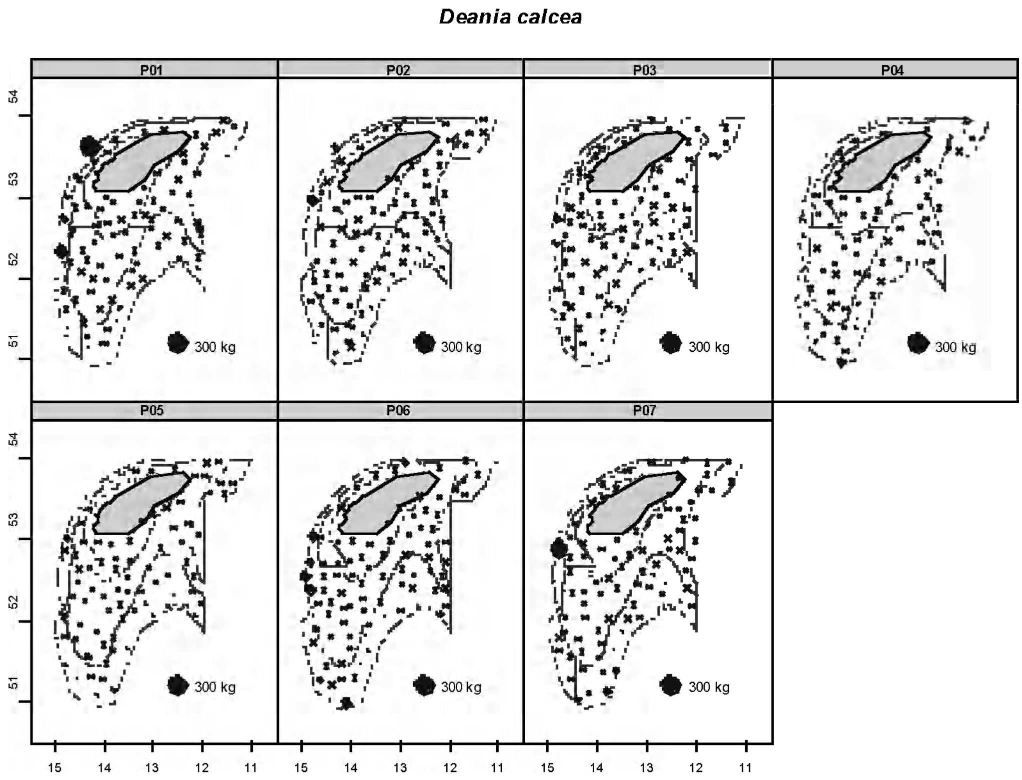

Figure 7. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of birdbeak dogfish (*D. calcea*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).

Velvet belly accounted for 0.3% of the total fish biomass with yields varying from 0.3–4.9 kg /haul; the maximum abundance was observed between 300–350 m depth; (Figures 8 and 9).

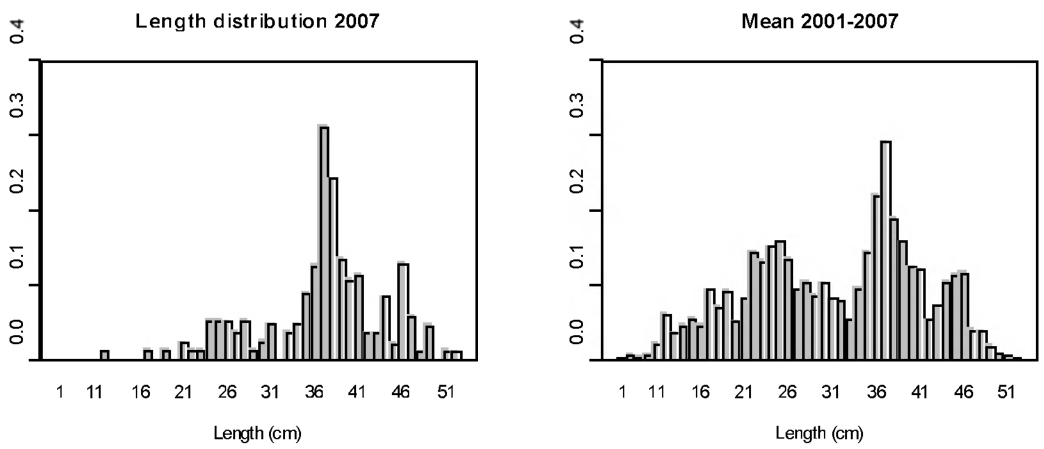

Figure 8. Stratified length distributions of velvet belly (*E. spinax*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).

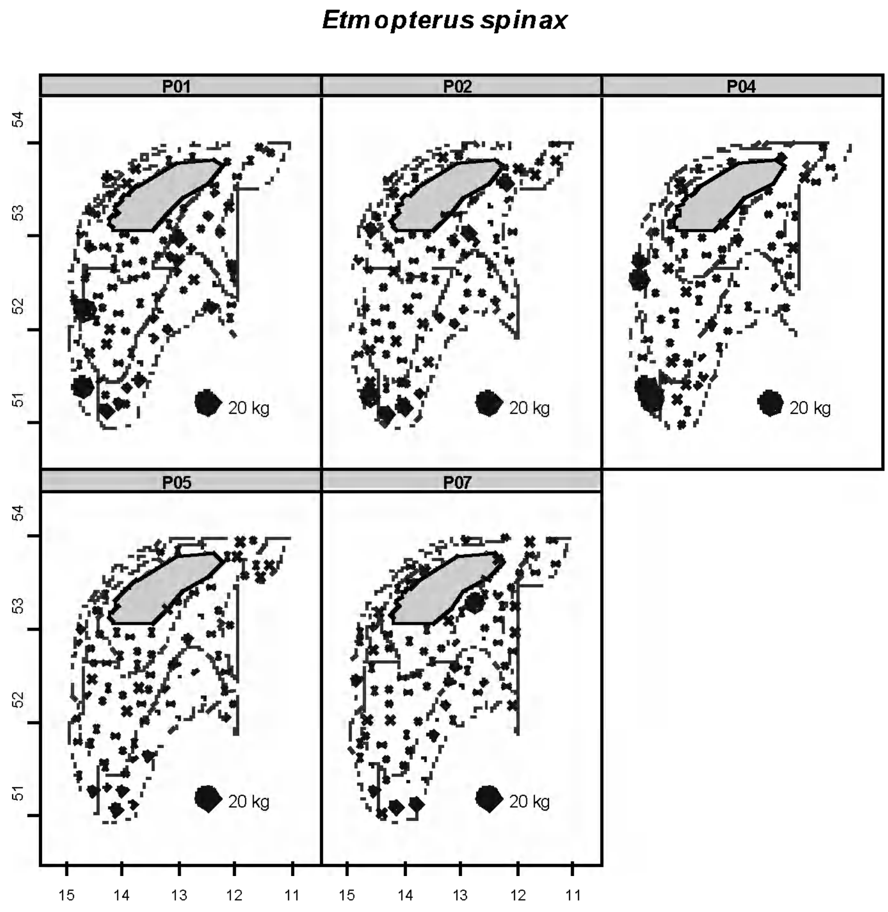

Figure 9. Geographic distribution of velvet belly (*E. spinax*) catches (kg/30 min haul) in years with high biomass abundance in Porcupine surveys time-series (2003 and 2006; from Velasco and Blanco, 2008).

Knifetooth shark represented 0.2% of the total fish biomass, with yields varying from 3.2 kg/haul in 2004 to 0.5 kg/haul in 2005. Maximum abundance was observed between 600–700 m depth, the total length frequency distribution demonstrated three modes at 40–41 cm, 72–74 cm and 104–107 cm (Figures 10 and 11).

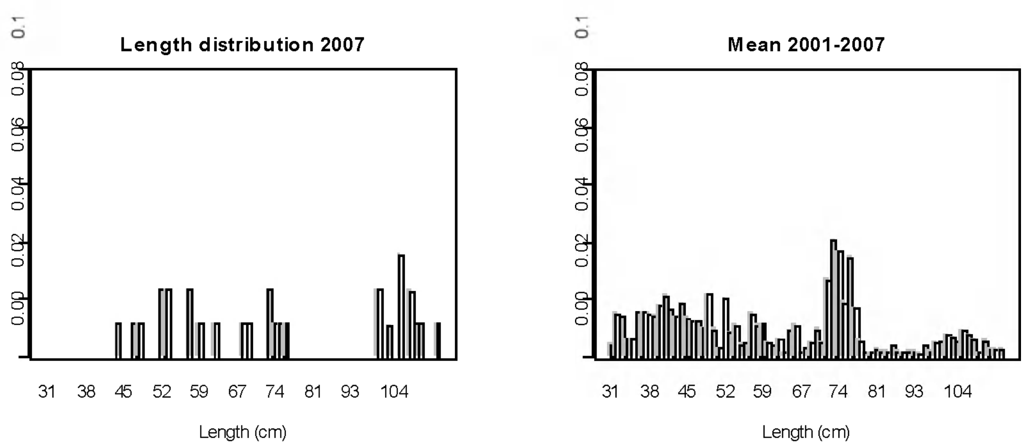

Figure 10. Stratified length distributions of knifetooth dogfish (*S. ringens*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).

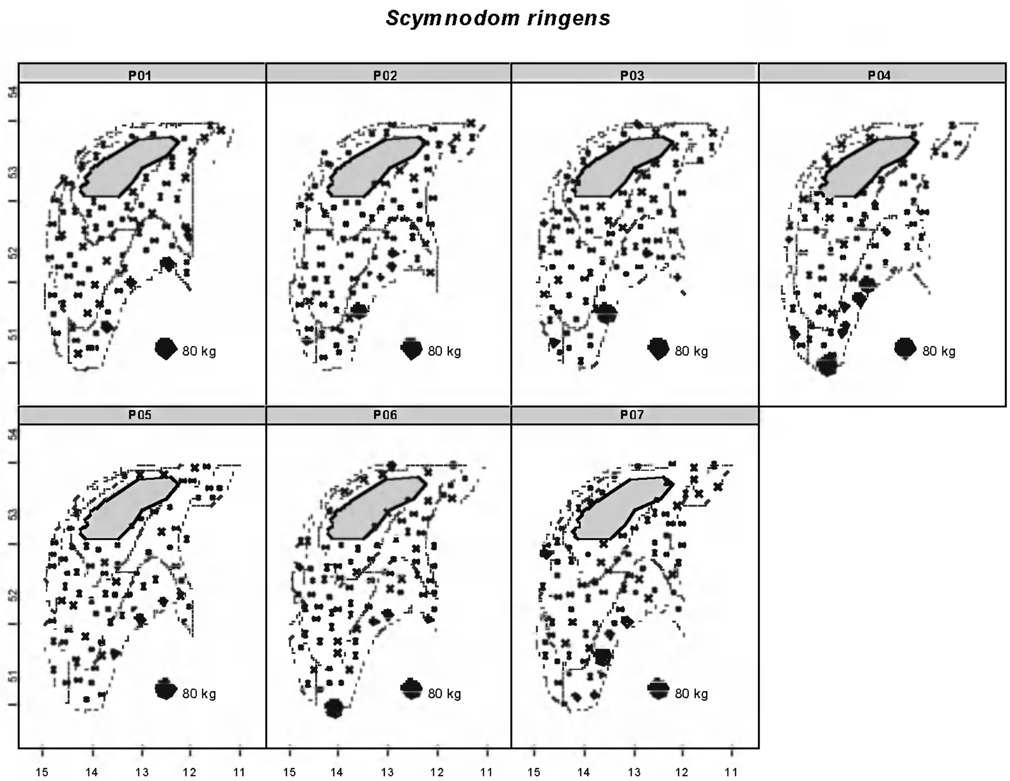

Figure 11. Geographic distribution of knifetooth dogfish (*S. ringens*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).

B.4. Commercial cpue

B.5. Other relevant data

C. Assessment: data and method

No assessment.

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	xxx t	Explain
Approach	F_{MSY}	Xxx	Explain
	B_{lim}	xxx t	Explain
Precautionary	B_{pa}	xxx t	Explain
Approach	F_{lim}	Xxx	Explain
	F_{pa}	Xxx	Explain

H. Other issues

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4.2 Stock Annex: Spurdog in the Northeast Atlantic

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. The relationships between the main NE Atlantic stock and populations in the Mediterranean are unclear.

In the ICES area, this species exhibits a complex migratory pattern. Norwegian and British tagging programmes conducted in the 1950s and 1960s focused on individuals captured in the northern North Sea. These were regularly recaptured off the coast of Norway, indicating a winter migration from Scotland, returning in summer (Aasen, 1960; 1962). Other tagging studies in the English Channel indicated summer movement into the southern North Sea (Holden, 1965). Few individuals tagged in this more southerly region were recaptured in the north and vice-versa and therefore at this time, distinct Scottish-Norwegian and Channel stocks were believed to exist. A tagging study initiated in the Irish and Celtic Seas in 1966 yielded recaptures over 20 years from all round the British Isles and suggests that a single NE Atlantic stock is more likely (Vince, 1991). Transatlantic migrations have occurred (e.g. Templeman, 1976), but only occasionally, and therefore it is assumed that there are two separate North Atlantic stocks.

No studies have been conducted using parasitic markers and only preliminary studies on population genetics, to identify spurdog stocks. Data on morphometrics/meristics are inadequate for stock identification. The conclusions drawn about stock identity are therefore based solely on the tagging studies described above.

The fishery

Historically, spurdog was a low-value species and in the 1800s was considered as a nuisance to pelagic herring fisheries, both as a predator and through damage to fishing nets. However, during the first half of the 20th century, this small shark became highly valued, both for liver oil and for human consumption, and NE Atlantic spurdog was increasingly targeted. By the 1950s, targeted spurdog fisheries were operating in the Norwegian Sea, North Sea and Celtic Seas. Landings peaked at a total of over 60 000 tonnes in the 1960s (See Figure 2.1; Table 2.1 in 2010 Report) and since then have declined, except for a brief period during the 1980s when targeted gillnet and longline fisheries along the west coasts of Ireland and in the Irish Sea developed.

In more recent years, an increasing proportion of the total spurdog landings are taken as bycatch in mixed demersal trawl fisheries. The larger, offshore longline vessels that targeted spurdog around the coasts of the British Isles have stopped, although there are landings from gillnet and longline fisheries, which are often undertaken in seasonal, inshore fisheries.

The main exploiters of spurdog have historically been France, Ireland, Norway and the UK (see Figure 2.2 and Table 2.21 in 2010 Report). 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) (see Figure 2.3 and Table 2.3 in 2010 Report). Outside these areas, landings have generally been low.

In the UK (E&W), more than 70% of spurdog landings were taken in line and gillnet fisheries in 2005, with most landings coming from Subarea VII and in particular the Irish Sea. Such fisheries are likely to be closer inshore and may be targeting aggregations of mature female spurdog. The introduction of a bycatch quota deterred such target fisheries in both Subareas IV and VII in 2008 and 2009.

Scottish landings of spurdog in 2009 mainly came from the mixed demersal trawl and seine fisheries in the North Sea and to the West of Scotland. Less than 1% of landings were taken by other gears , compared with more than 20% taken by longliners in 2007. It seems likely that this reduction has been due to the extension of the 5% bycatch regulation to the West of Scotland region in 2008 and potentially due to the implementation of limits on the maximum landings size (100 cm) in 2009 to deter target fisheries.

The Irish fishery for spurdog consists mainly of bottom otter trawlers and less than 30% of landings comes from longline and gillnet fisheries. Most landings are reported from Division VIa and Division VIIg. From April 2008 there has been no directed spurdog fishery in Irish waters.

Over 70% of Norwegian spurdog landings in 2009 were taken in gillnet fisheries operating in Subareas IIa, IIIa and IVa. In Subarea IIIa, a significant component of the landings (>40%) was taken as bycatch by shrimp trawlers. The remainder of the landings are taken in line fisheries and to a lesser extent, other trawl fisheries.

Catch data

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 the WGEF Report 2010.

A number of generic categories are used in the logbooks which may include some spurdog. The estimates of total landings made by the WG (and used in the Stock Assessment) are therefore based on expert judgement and the process for obtaining these estimates is described below:

> 1903–1960: Landings data from the *Bulletin Statistique* for the category "Dogfish, etc." have been assumed to be comprised entirely of spurdog. Landings of other dogfishes (e.g. tope and smooth hound) are assumed to be a negligible component of these catches, as these species are typically discarded in the stock area.

1961–1972: Landings data from the *Bulletin Statistique* for the categories "Picked dogfish" and "Dogfishes and hounds" have been used, and assumed to be comprised almost entirely of spurdog. Landings of other dogfishes (e.g. tope and smooth hound) are assumed to be a negligible component of these catches, as these species are typically discarded in the stock area. No country consistently reported both of these dogfish categories in proportions that would be consistent with the nature of the fisheries. Fisheries for deep-water sharks were not well established in the stock area in this period.

1973–present: Landings data from the ICES database were used, and these data included species-specific data for spurdog and some of the data from the appropriate generic categories (i.e. *Squalus* spp, Squalidae, Dogfishes and hounds, and Squalidae and Scyliorhinidae). National species-specific data for Iceland (1980–2002), Germany (1995–2002) and Ireland (1995–2002) were used to update data from the ICES database (ICES, 2003). The following assumptions were made regarding generic categories, based on the judgement of WG members.

Belgian landings of *Squalus* spp. were assumed to be spurdog.

Landings of Squalidae from ICES Subareas I–V and VII (except French landings) were assumed to be spurdog on the basis that fisheries for other squaloids (i.e. deep-water species) were not well developed in these areas over the period of reported landings. Landings of Squalidae from ICES Subarea VI were assumed to be spurdog for early period and for nations landings low quantities. The increase in French and German landings of Squalidae in this area after 1991 and 1995 respectively were assumed to be comprised of deep-water squaloid sharks. Similarly, French landings from ICES Divisions VIIb–c (all years), VIIg–k (1991 onwards) and VIII (all years) were assumed to be deep-water sharks. Landings of Squalidae from areas further south were excluded as they were out of the stock area and were likely comprised of deep-water species.

Landings of "dogfishes and hounds" from Areas VIIa and VIII were assumed to be spurdog. Landings of this category from other areas were generally low and excluded, with the assumption that spurdog contained in this category would be negligible.

French data were lacking from the ICES database and Bulletin Statistique for the years (1966–1967 and 1969–1977 inclusive), and these data were estimated from "Statistique des Peches Maritimes". As only aggregated shark landings were available for these years, spurdog landings were assumed to comprise 53% of the total shark landings, as spurdog comprised 50–57% of shark landings in subsequent years.

Discards

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

Some preliminary elasmobranch discard estimates from the Basque fleets operating in Subareas VI, VII and VIII were presented in Diez *et al*., (2006, WD). Initial studies found no discarding of spurdog by the Baka trawler fleets.

A recent study on the estimated short-term discard mortality of otter trawl captured spurdog in the NW Atlantic demonstrated that mortality 72 hours after capture was in some cases well below the currently estimated 50% for trawling (Mandelman and Farrington, 2006). When catch-weights exceeded 200 kg, there were increases in 72 hours mortality that more closely approached prior estimates, indicating that as tows become more heavily packed, there was a greater potential for fatal damage to be inflicted. It should be noted that tow duration in this study was only 45–60 minutes, and additional studies on the discard survivorship in various commercial gears are required, under various deployment times.

Discard survival from liners is unknown, and may depend on hook type, where the fish is hooked and also whether there is a bait stripper. Spurdog with broken jaws (i.e. possibly have gone through a bait stripper) have been observed (Ellis, pers. obs.) with healed wounds, although quantitative data are lacking.

Quality of 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 overreporting that has occurred. The introduction of UK and Irish legislation requiring registration of all fish buyers and sellers may mean that these misreporting problems have greatly declined since 2006.

It is not known whether the 5% bycatch ratio has lead to any misreporting or reporting under generic landings categories, although the buyers and sellers legislation should deter this and so the bycatch ratio may have resulted in more discarding.

Commercial catch composition

Length compositions

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. Scottish data are available for the North Sea and West of Scotland separately while the English data are all areas combined. The two sets of Scottish length frequency distributions (IV and VIa) are very similar and these have therefore been combined to give a 'total' Scottish length frequency distribution. Typically these 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. The length distributions of the male landings appear to be relatively similar. Figure 1 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.

Raw market sampling data were also provided by Scotland for the years 2005–2008. However, sampled numbers have been low in recent years (due to low landings) and use of these data was not pursued.

Discard length compositions

There are no international estimates of discard length frequencies.

Discard length frequencies have previously been provided by UK (E & W) for fisheries operating in the Celtic Seas (Subareas VI–VII) and North Sea (Subarea IV), as observed for the years 1999–2006 (Figure 2). The data for beam trawl, demersal trawl and drift/fixed net fisheries indicate that most spurdog are retained, although juveniles (e.g. individuals <45–50 cm) tend to be discarded, which agrees with data from market sampling. Data were limited for seine and longline fisheries.

Quality of data

Length frequency samples are only available for UK landings and these are aggregated into broader length categories and have been used in the previously presented assessments. No data were available from Norway, France or Ireland who are the other main exploiters of this stock. Over the past 20 years, UK landings have on average 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 less than 20% of the total. It is not known to what extent the available commercial length–frequency samples are representative of the catches by these other nations.

Commercial catch–effort data

No studies of commercial cpue data have been undertaken.

Fishery-independent information

Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. The following survey data are available to this group:

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 1977–2009.

UK (England & Wales) Q4 SWIBTS survey 2004–2009 in the Irish and Celtic Seas.

UK (NI) Q1 Irish Sea groundfish survey 1992–2009.

UK (NI) Q4 Irish Sea groundfish survey 1992–2009.

Scottish Q1 west coast groundfish survey: years 1990–2009.

Scottish Q4 west coast groundfish survey: years 1990–2009.

Scottish Q1 North Sea groundfish survey: years 1990–2009.

Scottish Q3 North Sea groundfish survey: years 1990–2009.

Irish Q3 Celtic Seas groundfish survey: years 2003–2009.

Both Ireland and UK (England and Wales) now participate in the fourth quarter westerly IBTS surveys, and further studies of these data will be undertaken in 2010.

Cpue

The overall trends in the various surveys examined in previous meetings have indicated a trend of decreasing occurrence and decreasing frequency of large catches (Figures 3 and 4), with catch rates also decreasing, although catch rates are highly variable (ICES, 2006).

Length distributions

Length distributions were analysed from survey data made available to the group in 2009. The UK (E&W) Q4 SWIBTS exhibits annual differences in length frequency distributions of spurdog caught. In 2005 the mean length frequency of females and males was higher than previous and preceding years. In 2008 relatively larger numbers of juveniles <55 cm were caught in the survey (Figure 5).

The length frequency distributions obtained from the UK(NI) Q4 GFS survey demonstrate a large proportion of larger fish (>85 cm) which are likely to be mature females (males are smaller) (Figure 6), although sex disaggregated data are only available since 2006 (Figure 7–8). A large haul of predominantly large females was caught in 2008 which has influenced the pattern of the length frequencies from this survey (Figure 8).

Length frequencies generated from the Irish Q3 GFS survey suggest spatial as well as temporal variation in the size distributions (Figure 9). Catches in the southern region of the survey area (VIIg) tended to consist of smaller individuals, while larger individuals were the dominant component in the remaining areas.

Presence of pups

Pups of spurdog (individuals ≤25 cm) are caught in many of the surveys, although generally in very small numbers. Although catches of pups tend to be low and may not be accurate indicators of recruitment, the location of catches may indicate possible pupping grounds or nursery areas. The location of survey hauls were spurdog pups (individuals ≤25 cm) were present was plotted for data from the North Sea (Figure 10).

Seasonal distributions of spurdog catches in VIIa(N) and VIA(S) by biomass and numbers have been plotted from survey data in the area (Figure 11).

Biological parameters

Life-history information

Although there have been several studies in the North Atlantic and elsewhere describing the age and growth of spurdog (Holden and Meadows, 1962; Sosinski, 1977; Hendersen *et al.*, 2001), routine ageing of individual from commercial catches or surveys is not carried out.

WGEF assumes the following sex-specific parameters in the length–weight relationship ($W=aL^b$) for NE Atlantic spurdog (Coull *et al.*, 1989):

	A	B
Female	0.00108	3.301
Male	0.00576	2.89

where length is measured in cm and weight in grammes.

The proportion mature-at-length was assumed to follow a logistic ogive with 50% maturity at 80 cm for females and 64 cm for males. Values of female length at 50% maturity from the literature include 74 cm (Fahy, 1989), 81 cm (Jones and Ugland, 2001) and 83 cm (Gauld, 1979).

The WG has assumed a linear relationship between fecundity (F) and total length (L):

$F = 0.344.L–23.876$ (Gauld, 1979).

More recent information on the fecundity length relationship of spurdog caught in the Irish Sea indicates:

$F = 0.428.L–31.87$ (n=179; Ellis and Keable, 2008).

Natural mortality

Not known, though estimates ranging from 0.1–0.3 have been described in the scientific literature (Aasen, 1964; Holden, 1968). WGEF has assumed a length-dependent natural mortality with a value of 0.1 for a large range of ages, but higher values for both very small (young) and large (old) fish.

Recruitment

Ellis and Keable, 2008, reported a maximum uterine fecundity of 21 pups, which was greater than previously reported for NE Atlantic spurdog. It is unclear as to whether this increase is a density-dependent effect or sampling artefact.

Exploratory assessment models

Previous studies

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).

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.

Data exploration and preliminary modelling

At the 2006 WG meeting, an analysis of Scottish survey data was presented which investigated methods of standardizing the survey catch rate to obtain an appropriate index of abundance. Following on from this, and the subsequent comments of the most recent Review Group, further analysis was conducted in 2009. The major concern was that given the large differences in size for this species, an index of abundance in Nhr^{-1} was less informative than an index of biomass catch rates. The analysis was updated at the WG in 2009 to address these concerns.

Data from four Scottish surveys listed above (1990–2009) 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, together with the associated information on gear type, haul time, depth, duration and location. Each survey dataset used in this analysis contains over 1000 hauls and the North Sea Q3 contains over 1500. 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 min.

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 explain the variation in catch-rate 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 analysis was conducted in stages: initially each survey was considered separately then the model fitted to all survey data combined. Because the aim was to obtain an index of temporal changes in the cpue, 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 and interactions terms were also investigated. Variables which explained greater than 5% of the deviance were retained in the model. All variables were included as categorical variables.

Stock assessment

Introduction

The exploratory assessment for spurdog presented in 2006 (ICES, 2006) has been extended 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). The statistical analysis of survey data provides a delta-lognormal GLM-standardised index of abundance (with associated CVs), based on Scottish groundfish surveys. The exploratory assessment assumes two "fleets", with landings data split to reflect a fleet with Scottish selectivity (non-target), and one with England & Wales selectivity (target). 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 exploratory assessment is based on an approach developed by Punt and Walker (1998) for school shark (*Galeorhinus galeus*) off southern Australia. The approach is essentially 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 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 (a new feature compared to ICES, 2006) 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 proportions-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 since 2011 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+) when fitting to survey proportions-by-length-category data for females and males separately.

The only estimable parameters considered are the total number of pregnant females in the virgin population ($N_0^{f,preg}$), Scottish survey selectivity-by-length-category (4 parameters), commercial selectivity-by-length-category for the two fleets (6 parameters, three reflecting non-target selectivity, and three target selectivity), extent of density-dependence in pup production (Q_{fec}), and constrained recruitment deviations (1960–2009). 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 invariant, as in the Punt and Walker (1998) approach, but growth variation could be included (Punt *et al.*, 2001).

Population dynamics model

The model is largely based on Punt and Walker (1998) and Punt *et al.* (2001).

Basic dynamics

The population dynamics for spurdog are assumed to be governed by:

$$N^s_{y+1,a} = \begin{cases} \Phi^s R_{y+1} & a=0 \\ (N^s_{y,a-1}e^{-M_{a-1}/2} - \sum_j C^s_{j,y,a-1})e^{-M_{a-1}/2} & 0<a\le A-1 \\ (N^s_{y,A-1}e^{-M_{A-1}/2} - \sum_j C^s_{j,y,A-1})e^{-M_{A-1}/2} + (N^s_{y,A}e^{-M_A/2} - \sum_j C^s_{j,y,A})e^{-M_A/2} & a=A \end{cases} \quad \text{1a}$$

where $s=f$ or m, Φ^s is the sex ratio (assumed to be 0.5), R_y the recruitment of pups to the population, $N^s_{y,a}$ the number of animals of sex *s* and age *a* at the start of year *y*, M_a the instantaneous rate of natural mortality-at-age *a*, $C^s_{j,y,a}$ the number of animals caught of sex *s* and age *a* in year *y* by fleet *j*, and *A* the plus group (60). Total biomass is then calculated as:

$$B_y = \sum_s \sum_a w^s_a N^s_{y,a} \quad \text{1b}$$

where w^s_a is the begin-year mean weight of animals of sex *s* and age *a*.

Recruitment

The number of pups born each year depends on the number of pregnant females in the population as follows:

$$N_{pup,y} = \sum_{a=1}^{A} P'_a P''_a N^f_{y,a} \quad \text{2a}$$

where P'_a is the number of pups per pregnant female of age *a*, and P''_a the proportion females of age *a* that become pregnant each year. Q_y, the density-dependence factor that multiplies the number of births in year *y*, is calculated as follows:

$$Q_y = 1 + (Q_{fec} - 1)(1 - N_{pup,y}/R_0) \quad \text{2b}$$

where Q_{fec} is the parameter that determines the extent of density-dependence, and R_0 the virgin recruitment level (see "Initial conditions" below). Recruitment in year *y* is the product of these two equations, and in order to allow for interannual variation in pup survival rate, "process error" is introduced to give the following:

$$R_y = Q_y N_{pup,y}\, e^{\varepsilon_{r,y}} \qquad 2c$$

where the recruitment residuals $\varepsilon_{r,y}$ are estimated (see equation 9a below).

Fecundity

Fecundity, expressed as number of pups per pregnant female of age *a*, is modelled as follows:

$$P'_a = \begin{cases} 0 & l^f_a < l^f_{mat00} \\ b_{fec}\left(l^f_a + \sqrt{(l^f_a + a_{fec}/b_{fec})^2 + \gamma^2} - \sqrt{(a_{fec}/b_{fec})^2 + \gamma^2}\right)/2 & l^f_a \geq l^f_{mat00} \end{cases} \qquad 3$$

where l^f_{mat00} is the female length-at-first maturity (Table 1), and γ is set at 0.001. The bent hyperbola formulation (Mesnil and Rochet, 2010) given in the bottom line of equation 2.3, is to ensure that if parameters a_{fec} and b_{fec} are estimated, P'_a remains non-negative and the function is differentiable for $l^f_a \geq l^f_{mat00}$.

Estimated fishing proportion and catch-at-age

Catches are assumed to be taken in a pulse in the middle of the year, with the fully selected fishing proportion $F_{j,y}$ being estimated from the observed annual catch (in weight) by fleet $C_{j,y}$ as follows:

$$F_{j,y} = \frac{C_{j,y}}{\sum_a e^{-M_a/2} \sum_s w^s_{a+\frac{1}{2}} S^s_{com,j,a} N^s_{y,a}} \qquad 4a$$

where $w^s_{a+\frac{1}{2}}$ is the mid-year mean weight of animals of sex *s* and age *a*, and $S^s_{com,j,a}$ the selectivity-at-age of animals of sex *s* and age *a* caught by fleet *j*. For the purposes of estimating a mean fishing proportion trajectory, the mean effective fishing proportion over ages 5–30 is calculated as follows:

$$F_{prop5-30,y} = \sum_j \frac{1}{26} \sum_{a=5}^{30} \left[\frac{\sum_s S^s_{com,j,a} N^s_{y,a} (F_{j,y} S^s_{com,j,a})}{\sum_s S^s_{com,j,a} N^s_{y,a}} \right] \qquad 4b$$

Catch-at-age (in numbers) is estimated as follows:

$$C^s_{j,y,a} = F_{j,y} S^s_{com,j,a} N^s_{y,a} e^{-M_a/2} \qquad 4c$$

Commercial selectivity

Commercial selectivity-at-age is calculated from commercial selectivity-by-length category parameters as follows:

$$S^{s*}_{com,j,a} = \begin{cases} S_{c2,j} & 16 \le l^s_a < 55 \\ S_{c3,j} & 55 \le l^s_a < 70 \\ S_{c4,j} & 70 \le l^s_a < 85 \\ 1 & l^s_a \ge 85 \end{cases} \qquad \text{5a}$$

so that:

$$S^{s}_{com,j,a} = S^{s*}_{com,j,a} / \max_j (S^{s*}_{com,j,a}) \qquad \text{5b}$$

where l^s_a is the length-at-age for animals of sex *s*. Selectivity-by-length category parameters $S_{c2,j}$, $S_{c3,j}$ and $S_{c4,j}$ (*j=non-tgt* or *tgt*) are estimated in the model.

Survey selectivity

Survey selectivity-at-age $S^s_{sur,a}$ for animals of sex *s* is calculated in the same manner as commercial selectivity, except that there is only one survey abundance-series (the index *j* is dropped from the above equations) and different length categories (the 16–54 cm category is split into 16–31 and 32–54, and the 70–84 and 85+ categories are combined into a single 70+ category), leading to four selectivity parameters to be estimated (S_{s1}, S_{s2}, S_{s3} and S_{s4}), the first three applying to the smallest length categories (16–31, 32–54 and 55–69), regardless of sex, and the fourth (S_{s4}) to the 70+ category for females only (assuming 1 for males in this length category).

Initial conditions

The model assumes virgin conditions in 1905, the earliest year for which continuous landings data are available, with the total number of pregnant females in the virgin population, $N_0^{f,preg}$, treated as an estimable parameter in the model. Taking the model back to 1905 ensures that the assumption of virgin conditions is more appropriate, although it also implies that exploitation patterns estimated for the most recent period (1980+) are taken back to the early 1900s. Taking the model back also allows early fecundity data to be fitted. Virgin conditions are estimated by assuming constant recruitment and taking the basic dynamics equations forward under the assumption of no commercial exploitation. Virgin recruitment (R_0) is then calculated as follows [note: $\sum_{i=0}^{-1}()$ is defined as 0]:

$$R_0 = \frac{N_0^{f,preg}}{\Phi^f \left[\sum_{a=0}^{A-1} P''_a e^{-\sum_{i=0}^{a-1} M_i} + P''_A \frac{e^{-\sum_{i=0}^{A-1} M_i}}{1-e^{-M_A}} \right]} \qquad \text{6}$$

Natural mortality for pups (M_{pup})

With the possibility of estimating the fecundity parameters a_{fec} and b_{fec} (equation 2.3), the natural mortality parameter M_{pup} (Table 1) needs to be calculated so that, in the absence of harvesting, the following balance equation is satisfied:

$$\frac{1}{\Phi^f} = \sum_{a=0}^{A-1} P'_a P''_a e^{-\sum_{i=0}^{a-1} M_i} + P'_A P''_A \frac{e^{-\sum_{i=0}^{A-1} M_i}}{1-e^{-M_A}} \qquad 7$$

Estimating MSY parameters

Two approaches were used to derive MSY parameters. In order to derive MSYR, the ratio of maximum sustainable yield, MSY, to the mature biomass (assumed to be the biomass of all animals $\geq l^f_{mat00}$) at which MSY is achieved (MSY/B_{MSY}) is calculated. This follows the same procedure for calculating MSYR as Punt and Walker (1998), and ensures that MSYR is comparable among different stocks/species, which would then allow MSYR estimates for other stocks/species to be used to inform on the likely range for spurdog. The selectivity for this first approach is therefore simply:

$$S^{s,mat}_{MSY,a} = \begin{cases} 0 & l^s_a < l^f_{mat00} \\ 1 & l^s_a \geq l^f_{mat00} \end{cases} \qquad 8a$$

However, an estimate of $F_{prop,MSY}$ is needed from the assessment, which should correspond to the selection patterns of the fleets currently exploiting spurdog. The second approach was therefore to use selection patterns estimated for the non-target and target fleets (average over most recent five years; equations 4a-b) to estimate $F_{prop,MSY}$. The selectivity for the second approach is therefore calculated as follows:

$$S^{s,cur}_{MSY,j,a} = \bar{f}_{rat,j} S^s_{com,j,a} \qquad 8b$$

where $S^s_{com,j,a}$ is from equation 2.5b, and $\bar{f}_{rat,j}$ is a five-year average as follows:

$$\bar{f}_{rat,j} = \frac{1}{5} \sum_{y=yend-4}^{yend} \frac{F_{j,y}}{\sum_j F_{j,y}} \qquad 8c$$

where $F_{j,y}$ is from equation 4a, and *yend* is the most recent year of data used in the assessment. In order to calculate MSY parameters, the first step is to express population dynamics on a per-recruit basis. Therefore, taking equations 1a and 4c, the equivalent per-recruit equations (dropping the *y* subscript) are given as:

$$N^s_{pr,a} = \begin{cases} \Phi^s & a=0 \\ \Phi^s \prod_{i=0}^{a-1} \left(1 - \sum_j F_{mult} S^s_{MSY,j,i}\right) e^{-M_i} & 0 < a \leq A-1 \\ \Phi^s \dfrac{\prod_{i=0}^{A-1} \left(1 - \sum_j F_{mult} S^s_{MSY,j,i}\right) e^{-M_i}}{\left(1 - \sum_j F_{mult} S^s_{MSY,j,A}\right)(1-e^{-M_A})} & a = A \end{cases} \qquad 8d$$

where s represents sex, F_{mult} replaces $F_{j,y}$ as the multiplier that is used to search for MSY, and the selection pattern $S^s_{MSY,j,a}$ reflects either the first approach (equation 8a, defined in terms of animals all animals $\geq l^f_{mat00}$ only, so subscript j and the summation over j is dropped) or the second approach (equation 8b, reflecting exploitation by current fleets, so subscript j and the summation over j is kept). Equation 2a therefore becomes:

$$N_{pup,pr} = \sum_{a=1}^{A} P'_a P''_a N^f_{pr,a} \qquad 8e$$

Recruitment can be expressed in terms of $N_{pup,pr}$ by re-arranging equations 2b–c (omitting the process error term) as follows:

$$R = \frac{R_0}{N_{pup,pr}}\left[1 - \frac{(1/N_{pup,pr} - 1)}{Q_{fec} - 1}\right] \qquad 8f$$

Yield can then be calculated as follows for the first (Y^{mat}) and second (Y^{cur}) approaches:

$$Y^{mat} = R\sum_{s}\sum_{a=0}^{A}\left(F_{mult}S^{s,mat}_{MSY,a}w^s_a N^s_{pr,a}\right) \qquad 8g$$

and

$$Y^{cur} = R\sum_{s}\sum_{a=0}^{A}\sum_{j}\left(F_{mult}S^{s,cur}_{MSY,j,a}w^s_{a+\frac{1}{2}}N^s_{pr,a}e^{-M_a/2}\right) \qquad 8h$$

MSY is found by solving for the F_{mult} value that maximises equation 8g or 8h, and the corresponding $F_{prop,MSY}$ is calculated using equation 4b (replacing $F_{j,y}$ with F_{mult}, $S^s_{com,j,a}$ with $S^s_{MSY,j,a}$, and $N^s_{y,a}$ with $N^s_{pr,a}$). Here, equation 8g has been used for the purposes of calculating MSYR, and equation 8h for estimating $F_{prop,MSY}$.

Likelihood function

Survey abundance index

The contribution of the Scottish survey abundance index to the negative log-likelihood function assumes that the index $I_{sur,y}$ is lognormally distributed about its expected value, and is calculated as follows:

$$-\ln L_{sur} = \tfrac{1}{2}\sum_{y}[\ln(2\pi\sigma^2_{sur,y}) + \varepsilon^2_{sur,y}] \qquad 9a$$

where $\sigma_{sur,y}$ is the CV of the untransformed data, q_{sur} the survey catchability (estimated by closed-form solution), and $\varepsilon_{sur,y}$ the normalised residual:

$$\varepsilon_{sur,y} = [\ln(I_{sur,y}) - \ln(q_{sur}N_{sur,y})]/\sigma_{sur,y} \qquad 9b$$

$N_{sur,y}$ is the "available" mid-year abundance corresponding to $I_{sur,y}$, and is calculated as follows:

$$N_{sur,y} = \sum_s \sum_a S^s_{sur,a} [N^s_{y,a} e^{-M_a/2} - \sum_j C^s_{j,y,a} / 2] \quad \text{9c}$$

Commercial proportion-by-length-category

The contribution of the commercial proportion-by-length-category data to the negative log-likelihood function assumes that these proportions $p_{j,y,L}$ for fleet j and length category L (combined sex) are multinomially distributed about their expected value, and is calculated as follows (Punt *et al.*, 2001):

$$-\ln L_{pcom,j} = k_{pcom,j} \sum_y \sum_L \varepsilon_{pcom,j,y,L} \quad \text{10a}$$

where $k_{pcom,j}$ is the effective sample size, and the multinomial residual $\varepsilon_{pcom,j,y,L}$ is:

$$\varepsilon_{pcom,j,y,L} = -\frac{n_{pcom,j,y}}{\bar{n}_{pcom,j}} p_{j,y,L} [\ln(\hat{p}_{j,y,L}) - \ln(p_{j,y,L})] \quad \text{10b}$$

with $n_{pcom,j,y}$ representing the number of samples on which estimates of proportions by length category are based, and $\bar{n}_{pcom,j}$ the corresponding average (over y). Because actual sample sizes were not available for the commercial data (only raised sample sizes), all model runs assumed $n_{pcom,j,y} = \bar{n}_{pcom,j}$, ICES (2010) concluded that model results were not sensitive to this assumption. Four length categories are considered for the commercial proportions-by-length (16–54 cm; 55–69 cm; 70–84 cm; and 70+ cm), and the model estimates $\hat{p}_{j,L,y}$ are obtained by summing the estimated numbers caught in the relevant length category L and dividing by the total across all the length categories. The effective sample size $k_{pcom,j}$ is assumed to be 20 for all j (but a sensitivity test explores alternative assumptions).

Survey proportion-by-length-category

The negative log-likelihood contributions ($-\ln L_{psur}$) for the Scottish survey proportions-by-length category are as for the commercial proportions, except that there is only one survey abundance-series (the j index is dropped in the above equations), and different length categories (the 16–54 cm category is split into 16–31 and 32–54, and the 70–84 and 85+ categories are combined into a single 70+ category). The effective sample size k_{psur} is assumed to be 10, and reflects the lower sample sizes for surveys relative to commercial catch data (Punt *et al.*, 2001).

Fecundity

The contribution of the fecundity data from two periods to the negative log-likelihood function assumes that the data are normally distributed about their expected value, and is calculated as follows:

$$-\ln L_{fec} = \tfrac{1}{2} \sum_{y=1960;2005} \sum_{k=1}^{K_y} [\ln(2\pi\sigma^2_{fec}) + \varepsilon^2_{fec,k,y}] \quad \text{11a}$$

where K_y represents the sample sizes for each of the periods (K_{1960}=783, K_{2005}=179), k the individual samples, and $\varepsilon_{fec,k,y}$ is:

$$\varepsilon_{fec,k,y} = [P'_{k,y} - \hat{P}'_{k,y}] / \sigma_{fec} \quad \text{11b}$$

where $P'_{k,y}$ represents the data and $\hat{P}'_{k,y}$ the corresponding model estimate calculated by multiplying equation 3 with Q_y in equation 2b and substituting the length of the sample in equation 3 (where the age subscript a is replaced by the sample subscript k). A closed-form solution for σ_{fec} exists as follows:

$$\sigma_{fec} = \sqrt{\frac{\sum_{y=1960;2005} \sum_{k=1}^{K_y} (P'_{k,y} - \hat{P}'_{k,y})^2}{(K_{1960} + K_{2005})}} \qquad \text{11c}$$

Recruitment

Recruitment (pups) is assumed to be lognormally distributed about its expected value, with the following contribution to the negative log-likelihood function:

$$-\ln L_r = \tfrac{1}{2} \sum_y [\ln(2\pi\sigma_r^2) + (\varepsilon_{r,y} / \sigma_r)^2] \qquad 12$$

where $\varepsilon_{r,y}$ are estimable parameters in the model, and σ_r is a fixed input (0.2 for the base case).

Total likelihood

The total negative log-likelihood is the sum of the individual components:

$$-\ln L_{tot} = -\ln L_{sur} - \sum_j \ln L_{pcom,j} - \ln L_{psur} - \ln L_{fec} - \ln L_r \qquad 13$$

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 1.

Quality of assessments

WGEF has attempted various analytic assessments of NE Atlantic spurdog using a number of different approaches (see Section 2.8 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.

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 landings length (100 cm);
- lack of discard information.

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.

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.

Exploratory assessment

As with any stock assessment model, the exploratory assessment relies heavily on the underlying assumptions, particularly with regard to life-history parameters (e.g. natural mortality and growth), and on the quality and appropriateness of input data. The inclusion of 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 likelihood surface does not have a well-defined optimum, and additional information, such as on appropriate values of MSYR for a species such as spurdog, would help with this problem. Further refinements of the model are possible, such as including variation in growth. Selectivity curves also cover a range of gears over the entire catch history, and more appropriate assumptions (depending on available data) could be considered.

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

- 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);
- Information on likely values of MSYR for a species such as spurdog.

Reference points

$F_{prop,MSY}$=0.028, as estimated by the current assessment, assuming average selection over the most recent five years of data (2006–2010 for this estimate).

Management considerations

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 a new TAC has been established for other areas, given that northern Scotland is an important area for spurdog, separate TACs for the waters of VIa and IVa 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.

Since 2009, there has been a maximum landing length (MLL) to deter targeting of mature females (see Section 2.10 of ICES, 2006 for simulations on MLL). Discard survival of such fish needs to be evaluated. 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.

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.

Although there is no EU minimum landing size for spurdog, there is some discarding of smaller fish, and it is likely that spurdog of <40 or 45 cm are discarded in most fisheries. The survivorship of discards of juvenile spurdog is not known.

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Table 1. 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

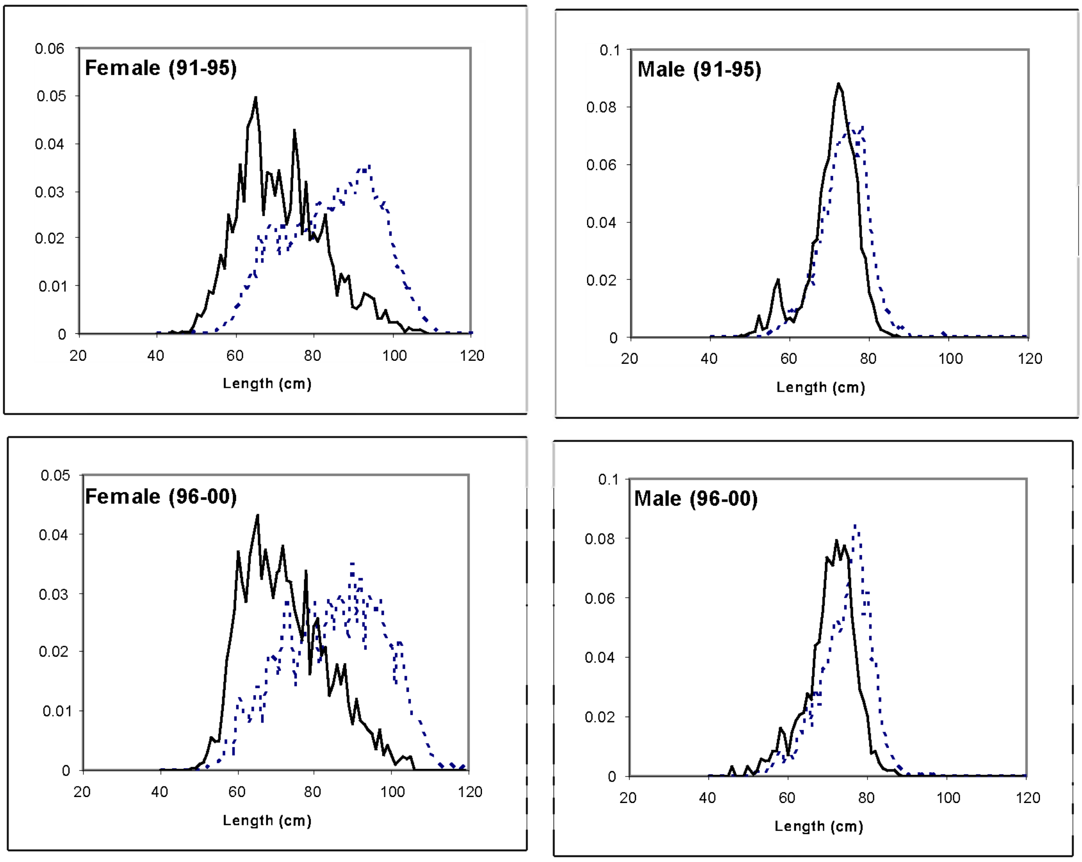


Figure 1. Northeast Atlantic spurdog. Comparison of length frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK (E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.

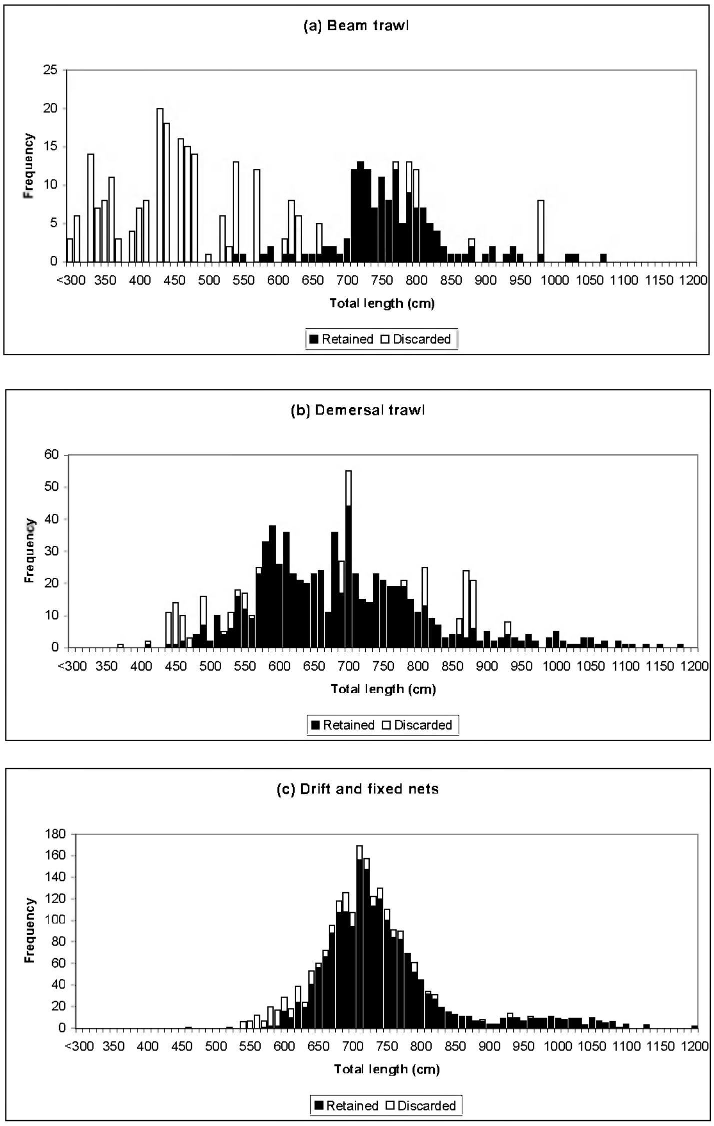
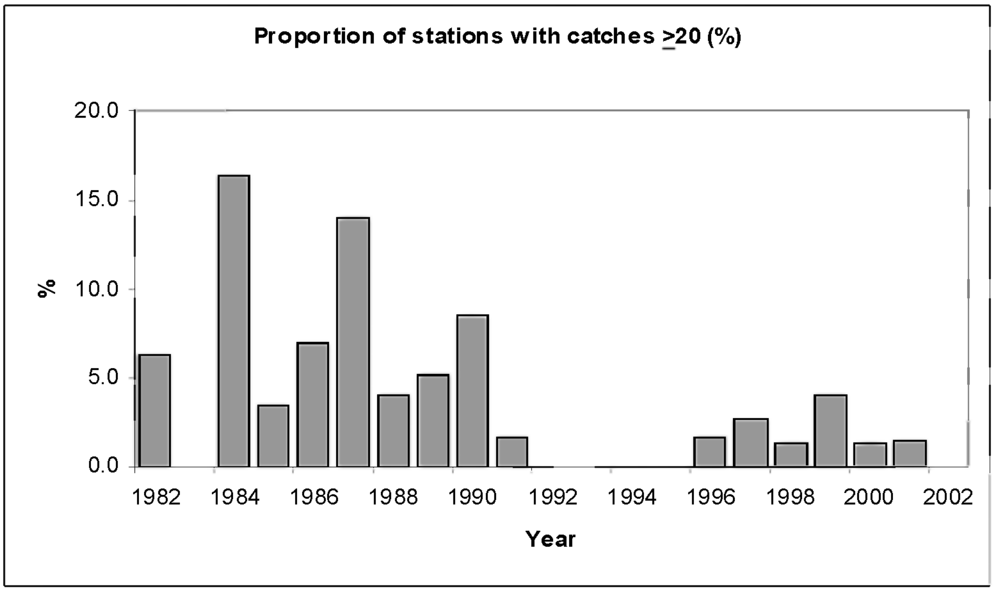


Figure 2. Northeast Atlantic spurdog. Length distribution of discarded and retained in fisheries in the North Sea and Celtic Seas ecoregions for (a) beam trawl, (b) demersal trawl and (c) drift and gillnets. These data (1999–2006) are aggregated across individual catch samples (Source: UK (E&W) Discards surveys).



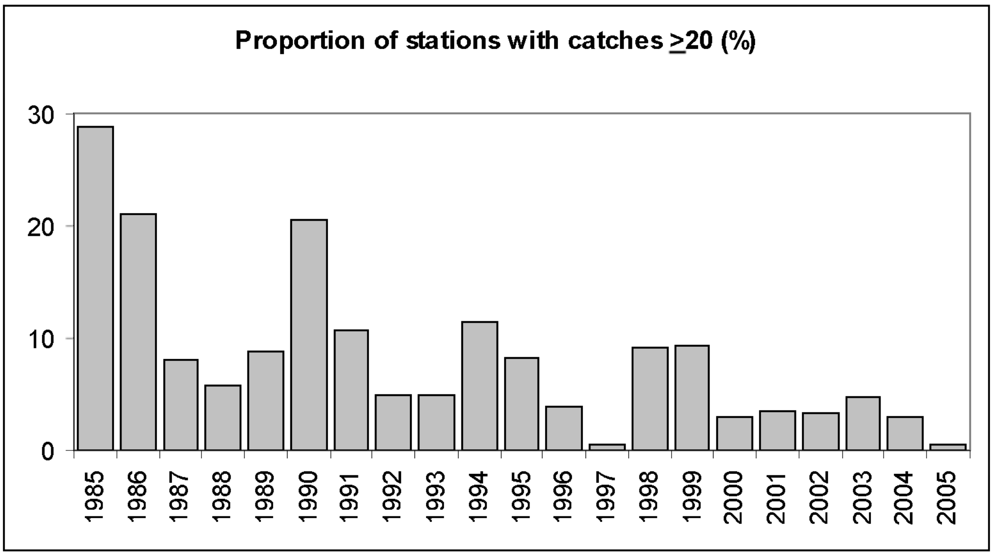
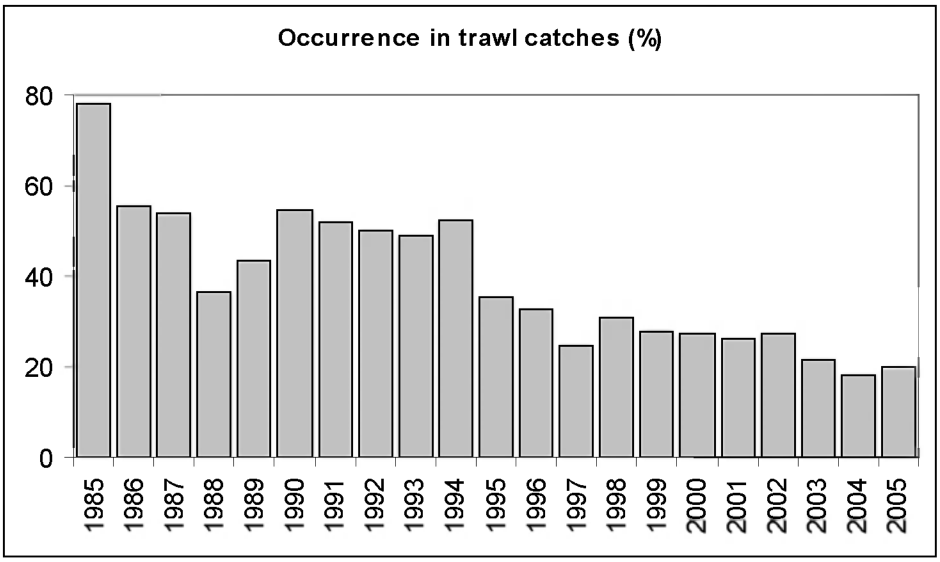


Figure 3. Northeast Atlantic spurdog. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h^{-1}. (Source: ICES, 2006).

a)



b)

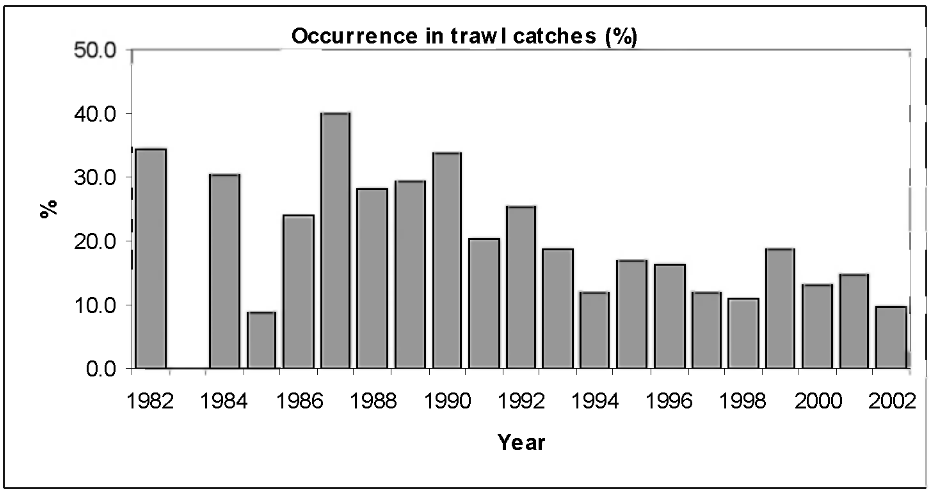
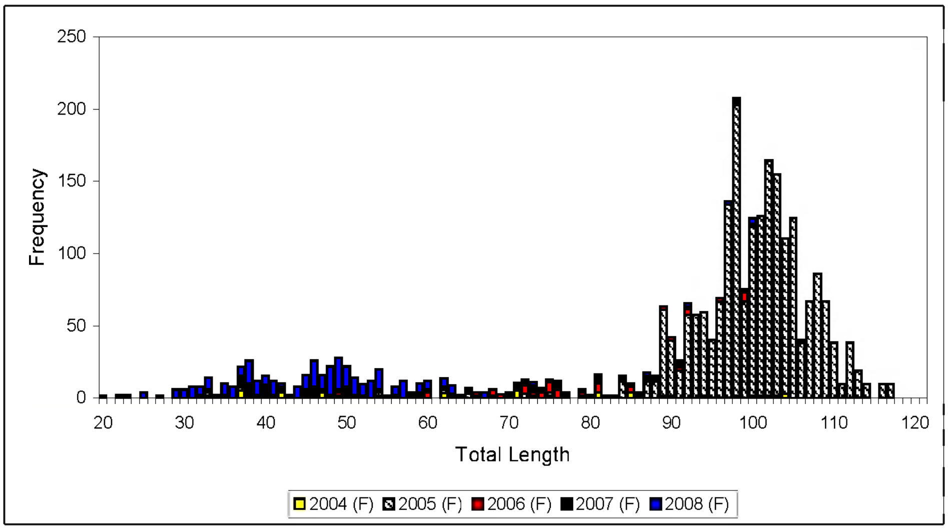


Figure 4. Northeast Atlantic spurdog. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).



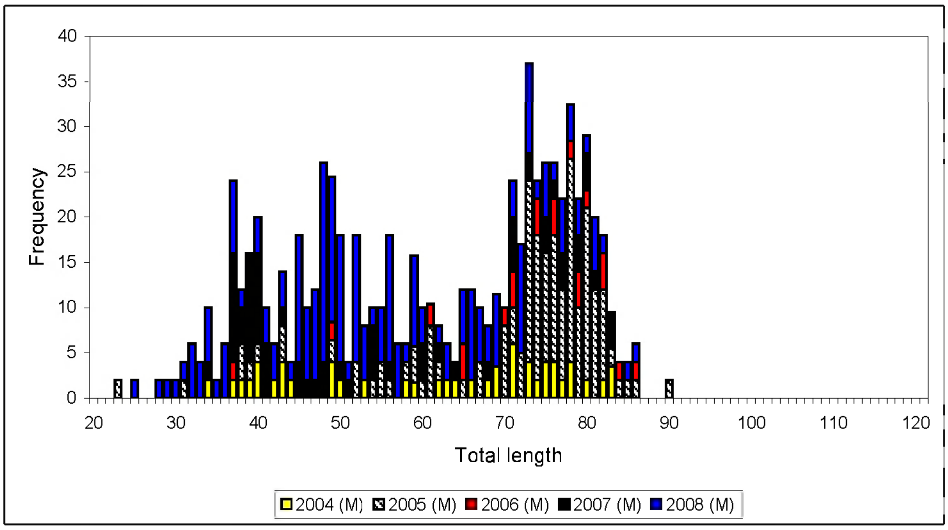


Figure 5. Northeast Atlantic spurdog. Temporal variations in length frequencies of female (top) and male (bottom) spurdog in UK (E&W) Q4 survey.

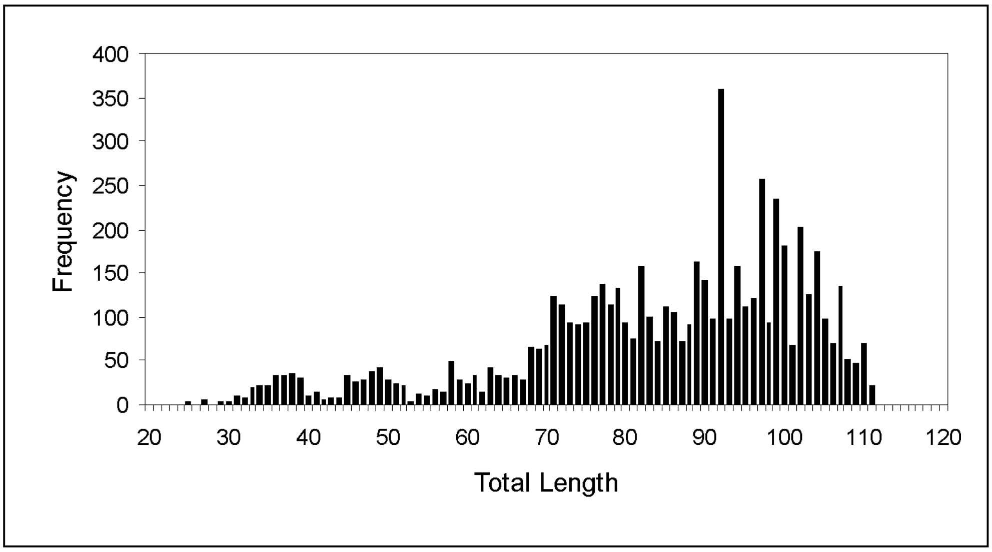


Figure 6. Northeast Atlantic spurdog. Length frequencies of spurdog in UK (NI) GFS Q4 survey 1992–2008.

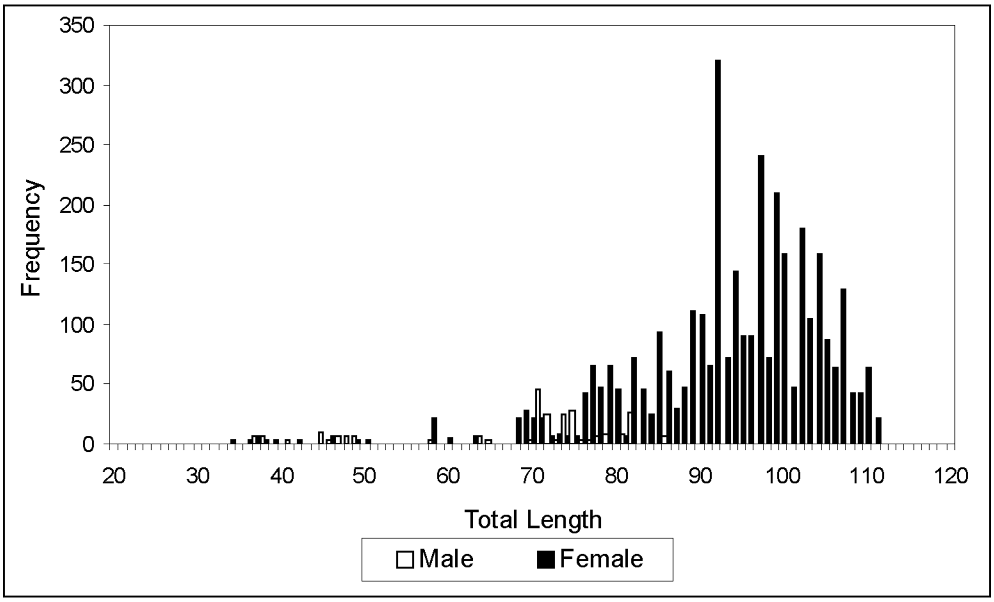


Figure 7. Northeast Atlantic spurdog Sex segregated length frequencies of spurdog in UK (NI) GFS Q4 survey 2006–2008.

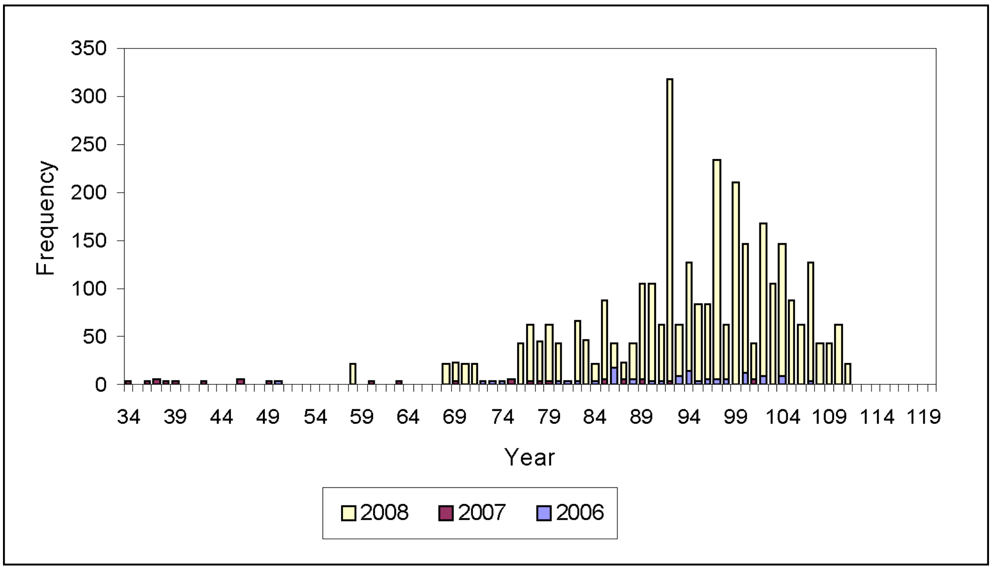


Figure 8. Northeast Atlantic spurdog. Length frequencies of female spurdog in UK (NI) GFS Q4 survey 2006–2008. Dominance of large females observed in 2008 influenced by single large haul.

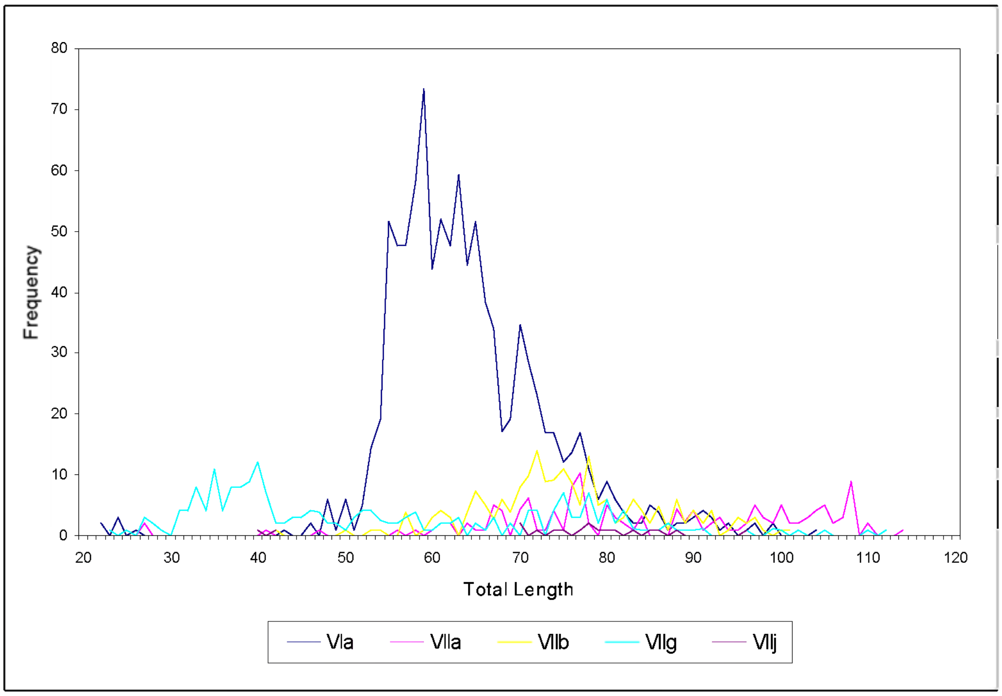


Figure 9. Northeast Atlantic spurdog. Variation in length frequencies of spurdog by region generated from MI GFS Q3 survey.

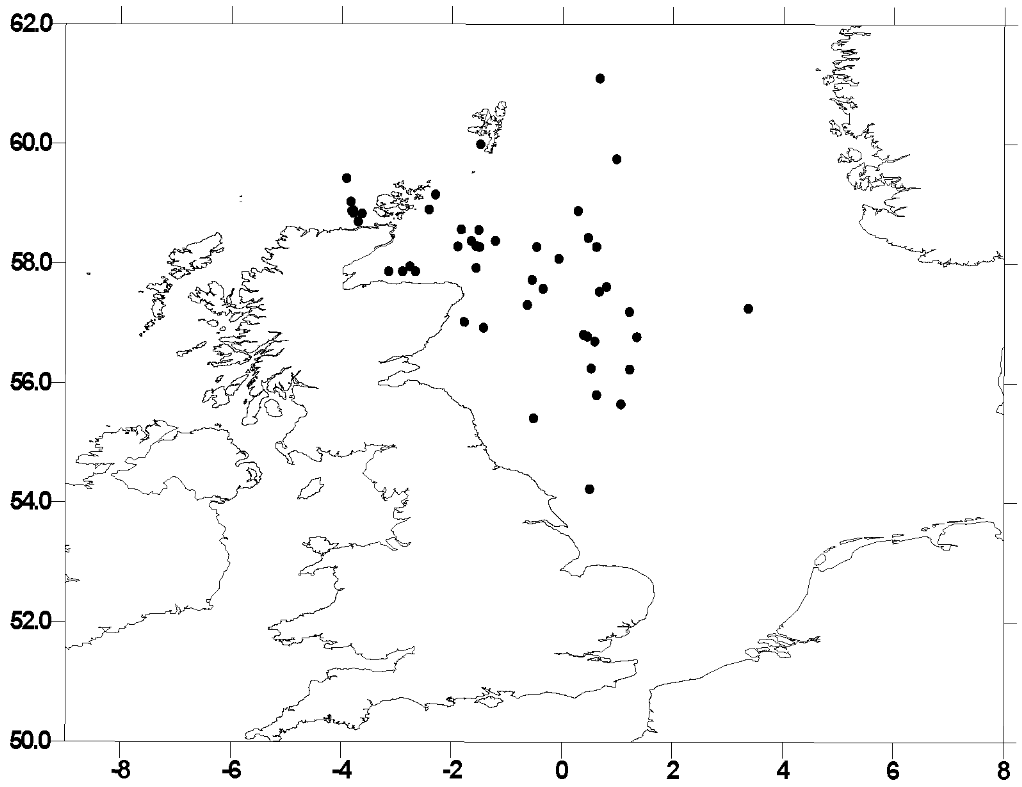


Figure 10. Northeast Atlantic spurdog. Occurrence of spurdog pups (ind. ≤250 mm) in North Sea (Source of data: DATRAS, downloaded 25 June 2009).

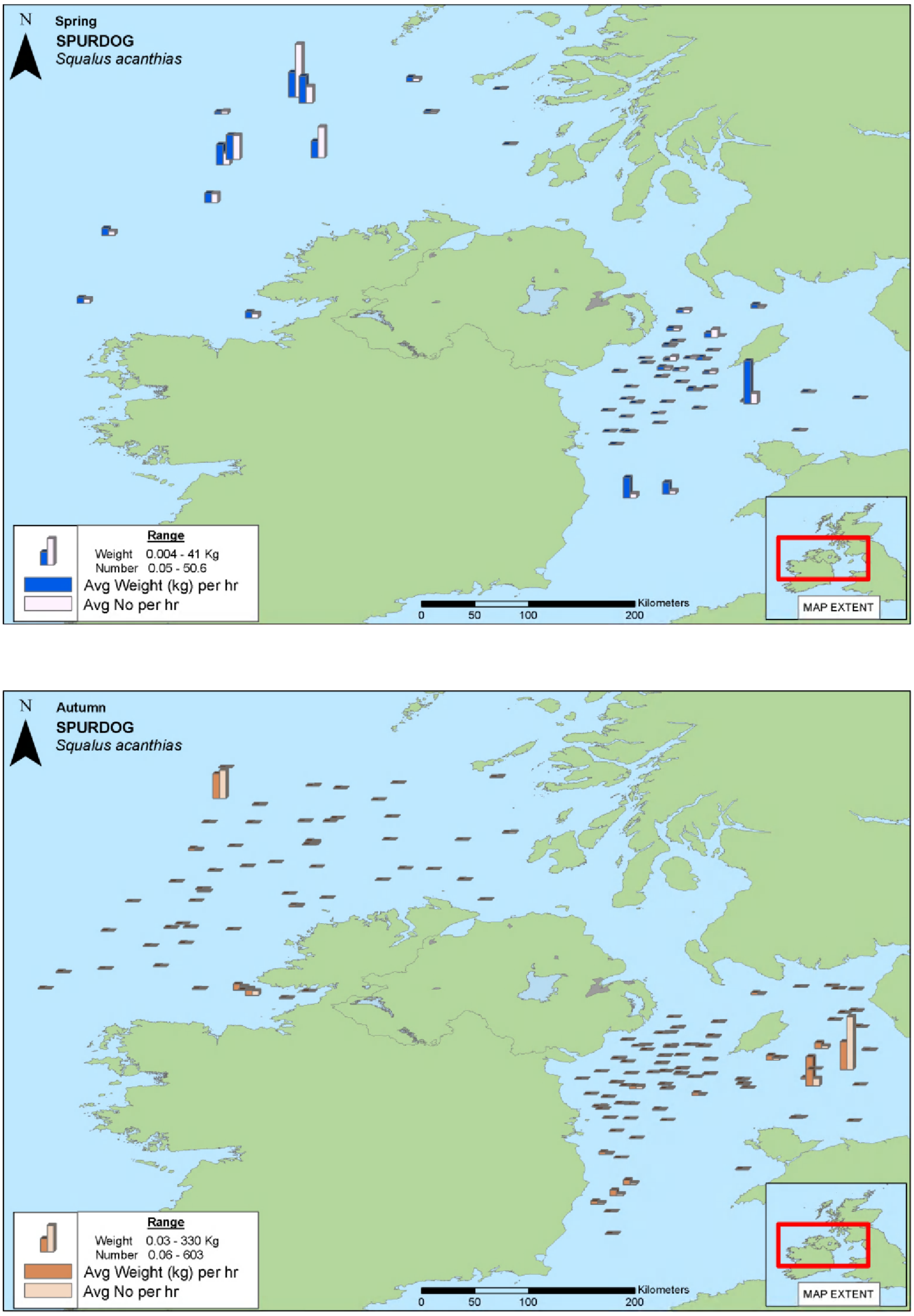


Figure 11. Northeast Atlantic spurdog. Seasonal distribution, average abundance (No. per hr.) and average weight (Kg per hr) of spurdog *Squalus acanthias* in VIIa(N) and VIa(S) as estimated from research surveys (see NIEA. 2008).

Annex 5: Stock data problems relevant to Data Collection

Stock	Data Problem	How to be addressed in	By who
Spurdog	Age and growth	The WGEF assessment method converts length-based information to age. There is uncertainty in the growth parameters of spurdog, and updated studies could usefully be undertaken	National laboratories
Spurdog	Migratory patterns (e.g. in relation to the environment, and how changes could affect survey indices)	Improved studies of earlier tagging information (that may be available in Norway and England), analyses of the spatial temporal dynamics of spurdog	National laboratories
Deep-water Sharks	No monitoring of the effectiveness of management measures (TAC = 0) of deep-water sharks	Implementation of deep-water longline surveys	National responsible of surveys
Demersal skates and rays (general issues)	Stock structure of various species	Various methods could be applied (e.g. genetics, internal parasites, tagging studies)	National laboratories; DCF surveys (e.g. IBTS and BTS) could be asked to tag and release selected species to better understand mixing.
Demersal skates and rays (general issues)	Reproductive biology	Need better information on fecundity, which could be done through oocyte counts of preserved ovaries, and through examination of egg-laying rates in captive-held specimens	If resource were available, ovaries could be collected under the DCF.
Demersal skates and rays (general issues)	Discard survival	Some elasmobranchs are very hardy and can survive capture and subsequent release. A better understanding of the factors that affect survival and how to mitigate this are required	Discard survival studies, potentially to be EU funded
Demersal elasmobranchs in the North Sea/eastern Channel	Blonde rays	Little known in the North Sea, but locally abundant	Collaborative initiatives between fisheries scientists and fishermen could help increase our knowledge of the stock

Stock	Data Problem	How to be addressed in	By who
Demersal elasmobranchs in the North Sea/eastern Channel	Skates on offshore fishing grounds	Consider an increase in survey effort on offshore banks etc. on existing surveys	DCF-funded surveys such as IBTS
Demersal elasmobranchs in the North Sea/eastern Channel	Thornback ray in the Wash	Consider a slight increase in survey effort on existing surveys to increase our knowledge of *Raja clavata* in The Wash area	DCF-funded surveys such as IBTS
Demersal elasmobranchs in the Celtic Seas	Studies on species with patchy distributions (blonde and undulate ray in the English Channel, angel shark in Cardigan Bay, blonde ray off SE Ireland)	Need some area-specific surveys with appropriate gears and local fisher knowledge to better understand the biology and small-scale distribution of skates species with patchy distributions (i.e. those where existing surveys are inappropriate for informing on stock status)	Collaborative initiatives between fisheries scientists and commercial fishermen could help increase our knowledge of he stock
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	No data available on maturity	Improve the biological collection of data. Countries involved in fishery provide data on maturity and natural mortality	National responsibility under the DCF
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	Species-specific identification of the landings (rays and smooth hounds)	Reinforce the samplers and observers training.	National responsible of sampling in ports and/or on board
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	few commercial length frequencies	Reinforce the samplers and observers effort in taking data. Countries involved in fishery provide data on length frequencies	National responsible of sampling in ports and/or on board
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	Scarce data on discards	Countries involved in fishery provide data on discards. Reinforce the observers on-board effort.	National responsibility under the DCF
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	No data on age composition	Reinforce the collection and analysis of otoliths. Countries involved in fishery provide data age	National responsibility under the DCF
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	Scarce commercial effort and cpue data	Countries involved in fishery provide data of standardized effort and cpue	National responsibility under the DCF
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	No surveys in deep-water fishing grounds. DW Fishing grounds not suitable for trawling	Implementation of deep-water longline surveys.	National responsible of surveys

Stock	Data Problem	How to be addressed in	By who
Demersal elasmobranchs in the Bay of Biscay and Iberian Waters	No data available on maturity	Improve the biological collection of data. Countries involved in fishery provide data on maturity and natural mortality	National responsibility under the DCF
Pelagic sharks	No fishery-independent sources of information for porbeagle, thresher, etc.	Funding for a fishery-independent longline survey is required. Such a survey could help inform on the status of the pelagic ecosystem, and although expensive could be undertaken every x years (i.e. such a survey does not need to be annual)	Joint survey by those countries with these fisheries. Should be DCF funded as impacts several EU members, and will also relate to MSFD.

Annex 6: NEAFC request on Northeast Atlantic elasmobranch species classification

Advice summary

A table illustrating the elasmobranch species found within the NEAFC area is outlined in Table 1 below. It was agreed with NEAFC that advice on basking shark, *Cetorhinus maximus*, and porbeagle, *Lamna nasus*, would be provided in 2012, as part of the Working Group on Elasmobranch Fishes assessment cycle.

Request

"A number of Northeast Atlantic elasmobranch species currently feature on the NEAFC list of deep-water species managed under deep-water demersal fish regulations. Others are highly migratory pelagic species and fisheries for these species are regulated by ICCAT. However, NEAFC is aware of species with North Atlantic distributions that fall into neither of these categories. ICES is requested to list Northeast Atlantic elasmobranch species and classify them as 1) Highly migratory and widely distributed, 2) Deep-water species, and 3) Elasmobranch species that have distributions within the NEAFC area and are not Category 1) or 2). ICES is further requested to provide advice on basking shark (*Cetorhinus maximus*) and porbeagle (*Lamna nasus*) within the NEAFC CA, with an evaluation of the need for management actions."

ICES Advice

As agreed intersessionally with NEAFC, advice on basking shark, *Cetorhinus maximus*, and porbeagle, *Lamna nasus*, will be provided in 2012, as part of the Working Group on Elasmobranch Fishes assessment cycle.

A table outlining the elasmobranch species found within the NEAFC area is provided below (Table 1).

Basis of advice

The list of species found in Table 1 is provided as the result of a literature review (See references below). References to frequency of occurrence is as a result of published information and results from grey literature, including survey reports and expert group opinion.

Methods

Classification into the categories requested by NEAFC was carried out in the following way:

Highly migratory and widely distributed

WGEF considers that this classification refers to pelagic shark species. Demersal elasmobranchs, such as the *Rajidae*, while they may be widely distributed, are not considered highly migratory, so are not placed in this classification.

Very few members of this group are well identified at a species level in landings, these are following: the basking shark (*Cetorhinus maximus* now in Appendix 2 of the Bern, Barcelona Convention and in CITES), blue shark (*Prionace glauc*a) and the porbeagle (*Lamna nasus*). Other sharks as shortfin mako shark (*Isurus oxyrinchus*), thresher shark (*Alopias vulpinus*) are caught regularly but not recorded separately in the landings. This also occurs for species taken by the coastal fisheries, such as tope (*Galeorhinus galeus*).

Deep-water species

Twelve–thirteen species of sharks are caught regularly in the deep-water fisheries of the Northeast Atlantic. Deep-water fisheries are here defined as those that take place in waters greater than 400 m in depth. The most commercially important species caught belong to the Squalidae family, e.g. the Portuguese dogfish (*Centroscymnus coelolepis*) and longnose velvet dogfish (*Centoscymnus crepidater*), Leafscale gulper shark (*Centrophorus squamosus*), gulper shark (*Centrophorus granulosus*), kitefin shark (*Dalatias licha*), birdbeak dogfish (*Deania calcea*), great lanternshark (*Etmopterus princeps*) and velvet belly (*Etmopterus spinax*). The blackmouth catshark (*Galeus melastomus* and probably *G. atlanticus*), which belongs to the family Scyliorhinidae, is also taken in catches by the deeper waters trawlers.

Table 1 shows the taxonomic list with some specifications about the categories, depth range and if the species is rare, very rare or common. This list was produced by referring to the Delass final report integrating it with information from FishBase.

Sources

Heessen H. J.L. Ed. 2003. Development of Elasmobranch Assessments DELASS DG Fish Study Contract 99/055 Final Report. 603 pp.

Froese, R. and Pauly, D. 2000. FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines. 344 pp.

CMS. 2006. Convention on Migratory Species: Appendix I and II of CMS. At: http://www.cms.int/documents/appendix/cms_app1_2.htm#appendix_I. Accessed 10 October 2006. The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 115 (as of 1 March 2011) Parties from Africa, Central and South America, Asia, Europe and Oceania.

Bern Convention. 1979. Bern Convention on the Conservation of European Wildlife and Natural Habitats (also known as the Bern Convention) CETS No.: 104. Treaty open for signature by the Member States, the Non-member States which have participated in its elaboration and by the European Union, and for accession by other Non-member States Opening for signature Entry into force Place: Bern, Date: 19/9/1979, came into force on June 1, 1982.

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora. From http://en.wikisource.org/w/index.php?title=Convention_on_International_Trade_in_Endangered_Species_of_Wild_Fauna_and_Flora&oldid=2796367. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (also known as Washington Convention) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington DC., United States of America, on 3 March 1973, and on 1 July 1975 CITES entered in force.

Barcelona Convention. 2006. Protecting the Mediterranean Sea. At: http://europa.eu/scadplus/leg/en/ lvb/l28084.htm. Accessed 12 September 2006. Convention for the Protection of the Mediterranean Sea Against Pollution Signed 16 February

1976, in force 12 February 1978 (revised in Barcelona, Spain, on 10 June 1995 as the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean).

Table 1. Elasmobranchs of the Northeast Atlantic.

Order	Family	Species name	Category	Occurrence	Habitat	General depth range (m)
		SHARKS				
HEXANCHIFORMES						
	Hexanchidae					
		1 *Heptranchias perlo* (Bonnaterre, 1788)	2	r	demersal	150-1000
		2 *Hexanchus griseus* (Bonnaterre, 1788)	2	f	demersal	150-2550
		3 *Hexanchus nakamurai* Teng, 1962 (formerly *H. vitulus* Springer & Waller, 1969)	2	r	demersal	100-600
	Chlamydoselachidae					
		4 *Chlamydoselachus anguineus* Garman, 1884	2	r	demersal	150-1280
ORECTOLOBIFORMES						
	Ginglymostomatidae					
		5 *Ginglymostoma cirratum* (Bonnaterre, 1788)	3	r	demersal	0-130
LAMNIFORMES						
	Odontaspididae					
		6 *Odontaspis ferox* (Risso, 1810)	3	r	demersal	10-200
	Mitsukurinidae					
		7 *Mitsukurina owstoni* Jordan, 1898 – or *M. nasuta* (Brag	2	vr	demersal	270-960
	Lamnidae					
		8 *Carcharodon carcharias* (Linnaeus, 1758)	1	r	pelagic	0-1280
		9 *Isurus oxyrinchus* Rafinesque, 1810	1	c	pelagic	0-740
		9 bis *Isurus paucus* GuitartManday, 1966	1	r	pelagic	0-200
		10 *Lamna nasus* (Bonnaterre, 1788)	1	f	pelagic	0-715
	Cetorhinidae					
		11 *Cetorhinus maximus* (Gunnerus, 1765)	1	f	Pelagic	0-2000
	Alopiidae					
		12 *Alopias superciliosus* (Lowe, 1839)	1	r	Pelagic	0-500
		13 *Alopias vulpinus* (Bonnaterre, 1788)	1	f	Pelagic	0-550
CARCHARHINIFORMES						
	Scyliorhinidae					
		14 *Apristurus aphyodes* Nakaya & Stehmann, 1998 ?	2	u	demersal	1000-1800
		15 *Apristurus laurussoni* (Saemundsson, 1922)	2	c	demersal	560-1462
		16a *Apristurus manis* (Springer, 1979)	2	u	demersal	600-1900
		16b *Apristurus melanoasper* Iglesias, Nakaya & Stehmann	2	u	demersal	512-1520
		16 *Apristurus microps* (Gilchrist, 1922)	2	u	demersal	1000-2200
		17a *Galeus atlanticus* Rafinesque, 1810	2	u	demersal	200-1200
		17 *Galeus melastomus* Rafinesque, 1810	2	c	demersal	55-1873
		18 *Galeus murinus* (Collett, 1904)	2	u	demersal	475-1200
		19 *Scyliorhinus canicula* (Linnaeus, 1758)	3	c	demersal	1-400
		20 *Scyliorhinus stellaris* (Linnaeus, 1758)	3	c	demersal	1-200
	Pseudotriakidae					
		21 *Pseudotriakis microdon* Capello, 1868	2	f	demersal	200-1500
	Triakidae					
		22 *Galeorhinus galeus* (Linnaeus, 1758)	1,3	c	demersal	0-1100
		23 *Mustelus asterias* Cloquet, 1821	3	c	demersal	0-350
		24 *Mustelus mustelus* (Linnaeus, 1758)	3	c	demersal	0-350
		25 *Mustelus punctulatus* Risso, 1826	3	c	demersal	0-350
	Carcharhinidae					
		26 *Carcharhinus brevipinna* (Muller & Henle, 1839)	1	r	coastal pelagic	0-70
		27 *Carcharhinus falciformis* (Müller & Henle, 1839)	1	r	pelagic	0-400
		28 *Carcharhinus limbatus* (Müller & Henle, 1839)	3	r	coastal pelagic	0-30
		29 *Carcharhinus longimanus* (Poey, 1861)	1	r	pelagic	0-230
		30 *Carcharhinus obscurus* (Leseur, 1818)	1,3	r	coastal pelagic	0-400
		31 *Carcharhinus plumbeus* (Nardo, 1827)	1,3	f	coastal pelagic	0-1800
		32 *Galeocerdo cuvier* (Peron & Leseur, 1822)	1,3	vr	coastal pelagic	0-370
		33 *Prionace glauca* (Linnaeus, 1758)	1	c	pelagic	0-400
	Sphyrnidae					
		34 *Sphyrna lewini* (Griffith & Smith, 1834)	1,3	r	pelagic	2-512
		35 *Sphyrna tudes* (Valenciennes, 1822)	1,3	r	pelagic	0-200
		36 *Sphyrna zygaena* (Linnaeus, 1758)	1,3	r	pelagic	0-200
SQUALIFORMES						
	Dalatiidae					
	Etmopterinae					
		37 *Etmopterus princeps* Collett, 1904	2	c	Demersal	200-2213
		38 *Etmopterus pusillus* (Lowe, 1839)	2	c	demersal	180-1070
		39 *Etmopterus spinax* (Linnaeus, 1758)	2	c	Demersal	200-2500
		40 *Centroscyllium fabricii* (Reinhardt, 1825)	2	c	Demersal	180-1600
	Somniosinae					
		41 *Somniosus microcephalus* (Bloch & Schneider, 1801)	2,3	f	Demersal	0-2200
		42 *Somniosus rostratus* (Risso, 1826)	2	r	Demersal	200-1000
		43 *Centroscymnus coelolepis* Bocage & Capello, 1864	2	c	Demersal	150-3700
		44 *Centroselachus crepidater* (Bocage & Capello, 1864)	2	c	Demersal	230-1500
		45 *Scymnodon ringens* Bocage & Capello, 1864	2	c	Demersal	200-1600
		45a *Zameus squamulosus* (Günther, 1877)	2	r	Demersal	400-2200
	Oxynotinae					
		46 *Oxynotus centrina* (Linnaeus, 1758)	2	u	Demersal	50-800
		47 *Oxynotus paradoxus* Frade, 1929	2	u	demersal	265-720
	Dalatiinae					
		48 *Squaliolus laticaudus* Smith & Radcliffe, 1912	2	u	Demersal	200-1200
		49 *Dalatias licha* (Bonaterre, 1788)	2	c	Demersal	50-1800
	Centrophoridae					
		50 *Centrophorus granulosus* (Bloch & Schneider, 1801)	2	c	demersal	50-1440
		51 *Centrophorus lusitanicus* Bocage & Capello, 1864	2	u	demersal	300-1400
		52 *Centrophorus squamosus* (Bonnaterre, 1788)	2	c	demersal	145-2400
		53 *Centrophorus uyato* (Rafinesque, 1810)	2	u	Demersal	
		54 *Deania calceus* (Lowe, 1839)	2	c	demersal	400-1000
		55 *Deania hystricosa* (Garman, 1906)	2	u	demersal	600-1000
		56 *Deania profundorum* (Smith & Radcliffe, 1912)	2	u	demersal	275-1785
	Squalidae					
		57 *Squalus acanthias* Linnaeus, 1758	3	c	demersal	0-1460
		58 *Squalus blainvillei* (Risso, 1826)	3	c	demersal	16-780
		58 bis *Squalus megalops* (Macleay, 1881)	3	vr	demersal	30-750
	Echinorhinidae					
		59 *Echinorhinus brucus* (Bonnaterre, 1788)	2	r	demersal	10-900
SQUATINIFORMES						
	Squatinidae					
		60 *Squatina squatina* (Linnaeus, 1758)	3	r	demersal	0-150

Order	Family	Species name	Category	Occurrence	Habitat	General depth range (m)
		BATOIDS				
PRISTIFORMES						
	Pristidae					
		61 *Pristis pectinata* Latham, 1794	3	vr	demersal	5-100
		62 *Pristis pristis* (Linnaeus, 1758)	3	vr	demersal	5-100
TORPEDINIFORMES						
	Torpedinidae					
		63 *Torpedo* (*Tetronarce*) *nobiliana* Bonaparte, 1835	3	c	demersal	10-350
		64 *Torpedo* (*Torpedo*) *marmorata* Risso, 1810	3	c	demersal	1-100
		65 *Torpedo* (*Torpedo*) *torpedo* (Linnaeus, 1758)	3	c	demersal	1-70
RAJIFORMES						
	Rhinobatidae					
		66 *Rhinobatos cemiculus* E. Geoffroy Saint-Hilaire, 1817	3	r	demersal	1-100
		67 *Rhinobatos rhinobatos* (Linnaeus, 1758)	3	r	demersal	1-100
	Rajidae					
		68 *Bathyraja pallida* (Forster, 1967)	2	vr	demersal	2400-2960
		69 *Bathyraja richardsoni* (Garrick, 1961)	2	r	demersal	1370-2500
		70 *Bathyraja spinicauda* (Jensen, 1914)	2	c	demersal	140-1463
		71 *Amblyraja hyperborea* (Collette, 1879)	2	c	demersal	140-2500
		72 *Amblyraja jenseni* (Bigelow & Schroeder, 1950) ?	2	r	demersal	366-2295
		73 *Amblyraja radiata* (Donovan, 1808)	2,3	c	demersal	20-1000
		74 *Dipturus batis* (Linnaeus, 1758)	2,3	f	demersal	50-600
		75 *Dipturus nidarosiensis* (Collett, 1880)	2	f	demersal	200-1000
		76 *Dipturus oxyrinchus* (Linnaeus, 1758)	2	f	demersal	150-900
		77 *Dipturus* sp. (yet undescribed, Stehmann)	?	u	demersal	
		78 *Leucoraja circularis* (Couch, 1838)	3	c	demersal	70-676
		79 *Leucoraja fullonica* (Linnaeus, 1758)	3	c	demersal	50-550
		80 *Leucoraja naevus* (Müller & Henle, 1841)	3	c	demersal	20-500
		81 *Malacoraja kreffti* (Stehmann, 1978)	2	vr	demersal	1200-1200
		82 *Malacoraja spinacidermis* (Barnard, 1923)	2	vr	demersal	450-1568
		83 *Neoraja caerulea* (Stehmann, 1976)	2	u	demersal	600-1262
		84 *Raja brachyura* Lafont, 1873	3	c	demersal	10-380
		85 *Raja clavata* Linnaeus, 1758	3	c	demersal	10-577
		86 *Raja microocellata* Montagu, 1818	3	c	demersal	0-100
		87 *Raja miraletus* Linnaeus, 1758	3	c	demersal	17-462
		88 *Raja montagui* Fowler, 1910	3	c	demersal	10-345
		89 *Raja undulata* Lacepede, 1802	3	c	demersal	10-200
		90 *Rajella bathyphila* (Holt & Byrne, 1908)	2	r	demersal	600-2172
		91 *Rajella bigelowi* (Stehmann, 1978)	2	c	demersal	650-4156
		92 *Rajella dissimilis* (Hulley, 1970) ?	2	r	demersal	719-1620
		93 *Rajella fyllae* (Lütken, 1888)	2	c	demersal	170-1050
		94 *Rajella kukujevi* (Dolganov, 1985) ?	2	u	demersal	750-800
		95 *Rostroraja alba* (Lacepède, 1803)	3	r	demersal	10-600
		96 *Dipturus linteus (Fries, 1838)*	2	r	demersal	150-1170
		97 *Breviraja* sp. (generic assignment and specific identity	2			
	Dasyatidae					
		98 *Dasyatis centroura* (Mitchill, 1815)	3	c	demersal	5-270
		99 *Dasyatis pastinaca* (Linnaeus, 1758)	3	c	demersal	5-200
		100 *Pleuroplatytrygon violacea* (Bonaparte, 1832)	1	c	pelagic	0-240
	Gymnuridae					
		101 *Gymnura altavela* (Linnaeus, 1758)	3	r	demersal	5-100
	Myliobatidae					
	Myliobatinae					
		102 *Myliobatis aquila* (Linnaeus, 1758)	3	c	demersal/pelagic	1-300
		103 *Pteromylaeus bovinus* (E. Geoffroy Saint-Hilaire, 1817	3	c	demersal/pelagic	10-150
	Rhinopterinae					
		104 *Rhinoptera marginata* (E. Geoffroy Saint-Hilaire, 1817	3	r	demersal/pelagic	0-
	Mobulinae					
		105 *Mobula mobular* (Bonnaterre, 1788) ???	1	c	pelagic	0-50

1) Highly migratory and widely distributed.
2) Deepwater species
3) Elasmobranch species that have distributions within the NEAFC area and are not Category 1) or 2).

r	rare
vr	very rare
c	common
u	unknown

Dubious species: Carcharhinus signatus

Annex 7: Technical minutes for the Review Group on Elasmobranch Fishes

- RGEF
- By correspondence, 13–15 September 2010
- Participants: Maurice Clarke (Chair), Kjell Nedreaas, Max Cardinale, Michala Ovens (ICES Secretariat), Graham Johnston (Chair of WG). ADG members: Helen Dobby, Tammo Bult, Doug Beare, Henrik Sparholt.
- Working Group: WGEF

General

The RG acknowledges the intense effort expended by the working group to produce the report.

The Review Group considered the following stocks:

- Spurdog in the NE Atlantic

And the following special requests:

- NEAFC request on classification of elasmobranchs

The remainder of the WGEF report was not considered by the RG in 2011. This is because these chapters were not relevant for the provision of advice for 2012.

Spurdog in the NE Atlantic (Section 2)

1) Assessment type: update;
2) Assessment: analytical;
3) Forecast: presented;
4) Assessment model: Age–length and sex-structured model (Punt and Walker, 2008);
5) Consistency: This can be considered a new assessment, and was benchmarked in 2011;
6) Stock status: B<< any candidate for MSY $B_{trigger}$. F < F_{MSY} Harvest Ratio. Recruitment at a historical low, stock at risk of recruitment impairment;
7) Man. Plan.: There is no agreed management plan for this stock.

General comments

This chapter is long and very detailed, containing a vast amount of work, which the WGEF is congratulated. WGEF answered the terms of reference assigned to it. Only two pieces of advice are scheduled for drafting in 2011, and RGEF concentrated on these.

The assessment and forecast were performed according to the stock annex.

Technical comments

The GLM model to derive the year effect from the Scottish survey should become a GAM because:

1) The year effect is continuous (since the SSB of the year before is correlated with the year after especially for a species with several age classes as spur-

dog) and thus it should be modelled with a smoother and not with a factor as currently done.

2) The month effect as it is built into the current model does not allow to specify that month 1 is much closer to month 12 than otherwise, instead this can be easily modelled with a cyclic smoother in a GAM.

3) There are a large number of surveys that can be used to derive an index for tuning. These should be combined in a single index through modelling and this would also allow to alleviate one of the main issue of the current survey index, i.e. its limited geographical coverage when compared to the stock distribution. Combining several surveys can be done using a swept area method or including a vessel effect in the model.

4) Indeed, considering the complexity of the species (male and female rather spatially separated, different growth rates between sexes, etc) and the need to include certain data as prior information, it could be useful for SS3 model (Bayesian Stock Synthesis) be tested in the future.

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 landings length (100 cm);
- lack of discard information.

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 effort. This was addressed by the model;
- annual survey length frequency distribution data (aggregated over all hauls) may be dominated by data from single large haul. This was also addressed by the model.

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.

Assessment

All the uncertainties and caveats that apply to the data should be borne in mind when interpreting the results of the assessment. Furthermore, the following should be noted:

- The model is assumption-rich, and only a limited number of parameters are estimated, implying that uncertainty is likely underestimated in the assessment;
- The model requires projections back in time to a period where only landings data are available (in order to estimate virgin conditions and take early fecundity data into account), which requires assumptions about the nature of fisheries on spurdog back then, but sensitivity tests (WGMG 2009) have shown model results to be fairly insensitive to alternative assumptions about selectivity;
- The fecundity parameters are highly correlated with each other and confounded to a certain extent with the parameter governing the amount of curvature in the stock–recruit relationship, and additional information on MSY rates for similar species may be useful in dealing with this problem.

Conclusions

The RGEF compliments WGEF on the extensive work that has been done. Notwithstanding the technical comments above, the assessment is very good and provides robust information on stock status. RGEF does not, however, accept the forecast as a basis for advice. This is because the assessment shows that the stock size is well below any possible candidate for $B_{MSY\ trigger}$. WGEF did not propose a trigger biomass either.

To avoid dispensatory effects at low stock size, in this instance, RGEF advocates that F should reach zero at a positive SSB, and not at the origin. This implies that the stock is currently at a level that requires F to be set at zero.

It is likely that this assessment will remain the standard operating procedure for spurdog for some years. This is appropriate as we would not expect a significant change in stock development in the next five years at least. Apart from the small adjustments suggested above, this method is considered a very good approach and may have utility for other shark species, both in ICES and elsewhere. RGEF advises that this stock does not require benchmarking for at least five years, and maybe even longer.

WGEF's efforts with spurdog should now concentrate on input data rather than assessment methodology. Areas for future work include collation and refinement of available fisheries-independent indices, discard estimation and improvement of knowledge of migrations and movements.

A rebuilding plan is required for this stock. This should include biomass targets, harvest rates and a clear decision rule that can be applied at low stock size.

NEAFC Special Request

The NEAFC special request was handled adequately by WGEF.