# ICES WGEF REPORT 2010

ICES ADVISORY COMMITTEE

ICES CM 2010/ACOM:19

# Report of the Working Group on Elasmobranch Fishes (WGEF)

22–29 June 2010

Horta, Portugal

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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## Executive Summary

The ICES Working Group on Elasmobranch Fishes, 2010 (Chair, Graham Johnston, Ireland) was held in Horta, Azores, Portugal from the 22–29 June 2010. 15 WG members attended, with seven 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.

The meeting's primary Terms of Reference required an update assessment of ten elasmobranch stocks or assemblages, as well as updates of the data available for several other stocks. Each of these was provided and are summarised below.

A special request from the European Commission was received in the week prior to the meeting. This required two additional stock assessments (for *Raja undulata* and *Dipturus batis*) as well as the assessment of the conservation status of three rare (within European waters) elasmobranch families. The stock assessments were carried out during the meeting, but the conservation status request was carried out afterwards by correspondence.

Following a benchmark assessment (WKDEEP 2010) in January this year, a decision was made to re-title Chapter 3, Deep-water siki sharks, to Portuguese dogfish and Leafscale Gulper Shark. This was seen as an attempt to move away from the non-scientific, occasionally confusing term 'siki' and to begin the separation process for these stocks. Two separate summary sheets for these species were provided for the first time.

Following two papers published in 2009, it was agreed that there has been misuse of the species name *Dipturus batis*, which in fact exists as two species – *Dipturus flossida* and *Dipturus intermedia*. *Dipturus batis* complex is the term used within this report when referring to these species. This is further elaborated on in Section 21.1.

19 Working Documents were presented to the Group, a much higher number than in previous years, emphasising the increasing importance of elasmobranch research, and the growing awareness of elasmobranch conservation issues, both within the marine field, and amongst the general public.

### Stock assessment results

- Spurdog (*Squalus acanthias*)

  A population dynamic model was used, with updated data since the last full assessment in 2008. This shows that the spurdog stock is at very low levels.

- Portuguese dogfish (*Centroscymnus coelolepis*)

  Due to the highly depleted level of this stock, there is no appropriate $F_{MSY}$ level that can be set. Issues remain with separating the landings out of this species out of the generic "siki" category.

- Leafscale Gulper Shark (*Centrophorus squamosus*)

  Due to the highly depleted level of this stock, there is no appropriate $F_{MSY}$ level that can be set. Issues remain with separating the landings out of this species out of the generic "siki" category.

- Kitefin Shark (*Dalatias licha*)

There is no information to change our perception of the stock, which is at a low level.

- Basking Shark (Cetorhinus maximus)

  Due to the presence of this species on several conservation lists, this species should remain on the Prohibited Species list

- Porbeagle (*Lamna nasus*):

  The 2009 joint assessment with ICCAT was used, along with updated landings and survey trends to assess this stock. These indicate that the north-eastern porbeagle stock is depleted.

- Demersal elasmobranchs in the North Sea

  In general, survey indicates that stocks of these species, particularly *Raja clavata, Raja montagui* and *Scyliorhinus canicula* are stable or increasing.

- Demersal elasmobranchs in the Celtic Seas

  In general, survey indicates that stocks of these species, particularly *Raja microocellata* and *Sciliorhinus canicula* are stable or increasing.

- Demersal Elasmobranchs in Biscay and Iberia

  In general, survey indicates that stocks of these species, particularly *Raja clavata, Leucoraja naevus* and *Sciliorhinus canicula* are stable or increasing.

In addition updated data was provide 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, Faeroese, and Iceland & East Greenland eco-regions).

# 1 Introduction

## 1.1 Terms of Reference

2009/2/ACOM19 The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Graham Johnston, Ireland, will meet in the Department of Oceanography and Fisheries (University of the Azores), Portugal 22–29 June 2010 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 ) Critically review 2008 and 2009 species-specific landings data for skates from ICES Subareas IV, VI–IX, and appraise their reliability through comparison with other data sources (e.g. market sampling and discard/ observer programmes);

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

d ) Set MSY reference points ($F_{MSY}$ and MSY $B_{trigger}$) according to the ICES MSY framework and following the guidelines developed by WKFRAME1 and WKFRAME2 for the stocks in the table below.

e ) Provide first draft of advice text for the stocks listed in the table below.

f ) Examine the potential benefits of size-based restrictions (minimum landings sizes and/or maximum landing lengths) for elasmobranchs;

g ) Undertake preliminary studies to identify important elasmobranch habitats, including nursery grounds;

h ) Finalise stock annexes for porbeagle, spurdog, kitefin shark and basking shark;

i ) To work intersessionally to finalize the elasmobranch CRR prior to the next meeting;

j ) To improve the availability of appropriate identification material for chondrichthyan fishes by (a) working intersessionally to collate and archive electronic copies of photographs; (b) further develop, circulate and test the utility of national photo-identification guides; and (c) develop a standardized user-friendly template.

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 24 July 2010 for the attention of ACOM.

The TORs are addressed in the sections identified in Table 1.1.

**Table 1.1. Specific terms of reference addressed in the Report.**

| 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 | Update |
| skx-347d | Demersal elasmobranchs in the North Sea, Skagerrak and eastern English Channel | | | y | Update |
| skx-89a | Demersal elasmobranchs in the Bay of Biscay and Iberian waters | | | y | Update |
| dgs-nea | Spurdog (Squalus acanthias) in the Northeast Atlantic | | | y | Update |
| por-nea | Porbeagle (Lamna nasus) in the Northeast Atlantic | | | y | Update |
| bsk-nea | Basking shark (Cetorhinus maximus) in the Northeast Atlantic | | | y | Update |
| cyo-nea | Portuguese dogfish (Centroscymnus coelolepis) and leafscale gulper shark (Centrophorus squamosus) in the Northeast Atlantic | | | y | Update |
| sck-nea | Kitefin shark (Dalatias licha) in the Northeast Atlantic | | | y | Update |

## 1.2 Special Requests

A special request from the EC was received prior to the meeting. These additional Terms of Reference are outlined below.

### Requests for specific advice

#### Undulate ray and common skate in the Celtic Sea and in the Bay of Biscay

##### Background

The advice issued by ICES regarding the conservation and management of elasmobranchs dates from 2008 and will be reviewed/updated this year on the basis of new information from research, survey results and data collection. In its 2008 advice, ICES indicated that the state of conservation of the undulate ray (*Raja undulata*) in the Celtic Seas is *uncertain but with cause for concern*. As for the common skate (*Dipturus batis*), it is assessed as *depleted*. ICES recommended avoiding targeted fishing for this species.

Regarding the Bay of Biscay and Iberian waters stocks, no specific advice on either of these species is provided in the 2008 advice. ICES issues a general advice whereby "… *a cautious approach to management should be considered, which could imply reducing landings compared to recent averages.*", and "… *since elasmobranch species are caught as a by-catch in demersal fisheries, they would benefit from a reduction in the overall demersal fishing effort*".

Both France (regarding stocks in the Celtic Seas) and Portugal (regarding stocks in the Bay of Biscay and Iberian waters) contest the grounds on which the fishing opportunities regulation (EU) nr 53/2010 stipulates a ban on landings for these two species and the concomitant obligation immediately to release back to sea any individuals taken as bycatches.

#### Terms of reference

The Commission requests ICES, when providing its advice on elasmobranch species in 2010, to examine and assess the following elements regarding management considerations:

To what extent current scientific information regarding of the state of these two stocks in the Celtic Seas and in the Bay of Biscay/Iberian waters supports the continuation of the measures provided for in the EU fishing opportunities regulation referred to above.

Where appropriate, ICES is invited to recommend any alternative measures it would consider as potentially more effective than those in force, taking into account the various fisheries taking place in each area and their impact on the stocks e.g. by métiers.

### Conservation of three species of rays

#### Background

The Commission's attention has been drawn to the status of three species of elasmobranchs in EU waters. According to the ONG Oceana, these three species count among eleven elasmobranch species that are endangered and that should receive protection under EU regulations. These are:

- Devilfish (*Mobula mobular*) – listed by IUCN as endangered. There seems to be no directed fishing for this species in EU waters. It is a bycatch in swordfish driftnets mainly in the Mediterranean.
- Sawfish (in particular *Pristis pristis; P. pectinata, P. perotteti* estimated extinct in EU waters) – listed by IUCN as critically endangered. Impacted by coastal artisanal fisheries and habitat modification.
- Guitarfish (in particular *Rhinobatos rhinobatos*, other species found in EU waters to be identified) – listed by IUCN as endangered.

These species are not specifically concerned by EU conservation measures. The driftnets ban, the Mediterranean technical measures and EU/national area-based measures to protect certain habitats/species may be affording some degree of protection. The Commission is interested in assessing the feasibility and appropriateness of specific conservation measures for the species concerned in the framework of the regulation of annual fishing opportunities.

The fishing opportunities regulation may restrict catches and fishing effort for these species, up to the establishment of a zero TAC. It would also be possible to include them among the species to which Article 6 of the regulation applies. Article 6 foresees that it shall be prohibited for EU vessels to fish for, to retain on board, to tranship and to land certain species considered as particularly in need of protection from fishing impacts.

#### Terms of reference

ICES is requested to provide advice on the fisheries or fishing activities that have an impact on the conservation of the species listed above that are found in EU waters. ICES is then requested to review, assess and summarise the best available scientific information concerning the state of the stocks of these species.

ICES is requested to distinguish between stocks in the Mediterranean and stocks in the Atlantic Ocean/North Sea, and to discuss possible differences in conservation status and in fishing impacts in each of these two broad areas.

ICES is requested to formulate management recommendations in the form of measures that would provide effective protection and promote the recovery of these species, including, but not limited to, the possibility of granting them status of prohibited species within the meaning of Article 6 of the fishing opportunities Council Regulation (EU) nr 53/2010.

These Special Requests are addressed in Annex 5.

## 1.3 Participants

The following WGEF members attended the meeting:

| | |
|---|---|
| Gerard Bias | France |
| Tom Blasdale | UK (Scotland) |
| Guzman Diez | Spain (Basque Country) |
| Helen Dobby | UK (Scotland) |
| Jim Ellis | UK (England and Wales) |
| Ivone Figueiredo | Portugal |
| Boris Frentzel-Beyme | Germany |
| Henk Heesen | The Netherlands |
| Graham Johnston (Chair) | Ireland |
| Sophy McCully | UK (England and Wales) |
| José De Oliveira | UK (England and Wales) |
| Mario 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) |
| Maurice Clarke | Ireland |
| Enric Cortes | USA |
| Kelle Moreau | Belgium |
| Harriet van Overzee | The Netherlands |
| Bernard Seret | France |
| Francisco Velasco | Spain |

## 1.4 Background

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 sub-contractors. Although 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 although 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 sub-group 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 & Iberian demersal elasmobranchs and for deep-water siki sharks. A three year assessment schedule was also agreed (see next section).

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 to three-yearly cycle. In order to facilitate the best assessments of each of the main species for which advice is sought, the Group will deal with different species in different years. Table 1.2 presents this plan.

**Table 1.2. Future planning of the work of the Group. Plan for assessment of the main species (1=update of relevant information, including exploratory assessments, 2 = Assessment).**

| Stocks | Does ICES provide advice | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Spurdog | Yes | 2 | 2 | 1 |
| Portuguese dogfish and Leafscale gulper shark | Yes | 1 | 1 | 1 |
| Kitefin shark | Yes | 1 | 1 | 1 |
| Other deep-water sharks | | 1 | 1 | 1 |
| Porbeagle | Yes | 2 | 1 | 1 |
| Basking shark | Yes | 1 | 1 | 1 |
| Blue shark in the North Atlantic | | 1 | 1 | 1 |
| Shortfin mako in the North Atlantic | | 1 | 1 | 1 |
| Tope in the NE Atlantic and Mediterranean | | 1 | 1 | 1 |
| Thresher shark in the NE Atlantic and Mediterranean | | 1 | 1 | 1 |
| Other Pelagic species | | 1 | 1 | 1 |
| Demersals in Barents Sea | | 1 | 1 | 1 |
| Demersals in Norwegian Sea | | 1 | 1 | 1 |
| Demersals in North Sea ecoregion (III, IV, VIId) | Yes | 1 | 2 | 1 |
| Demersals at Iceland and east Greenland | | 1 | 1 | 1 |
| Demersals at the Faroe Islands | | 1 | 1 | 1 |
| Demersals in the Celtic Seas | Yes | 1 | 2 | 1 |
| Demersals in Biscay and Iberian waters | Yes | 1 | 2 | 1 |
| Demersals in the Azores and Mid Atlantic Ridge | | 1 | 1 | 1 |

This plan will allow for preparation of datasets in the years between assessments and for exploratory assessments to be undertaken. In the years where an assessment is not planned, data preparation, screening and checking will take place and the absence of a scheduled assessment in any given year does not imply that the relevant participants would not attend. Rather it is planned to spend the time preparing for the next scheduled assessment. In 2011 special emphasis will be spent on gathering data on elasmobranchs in the Mid-Atlantic Ridge and the Faeroe Islands ecoregions, as there is little information currently available to the Working Group. It is hoped that data from these regions will be provided inter-sessionally.

It is further proposed that, as the advice cycle is provided on a biennial basis, that the meeting length can be adjusted to accommodate this. WGEF proposes 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.

## 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. While 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 versus 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 standardised 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 sub-optimal 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 fishes 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 recognised 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 to 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.

## 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 2010). 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.

In June 2010 WGEF received two recommendations from PGCCDBS (outlined below). These will be addressed inter-sessionally.

**Table 1.3. Recommmendations received by WGEF from PGCCDBS, June 2010.**

| AWG | Stock | Data problem | How to be addressed | PGCCDBS Comments |
|---|---|---|---|---|
| WKDEEP | Deep-water sharks | Improvement of species identification | Taxonomic problems on the identification of species include in the Centrophoridae family particularly those occurring at NE Atlantic (e.g. C. granulosus, C. lusitanicus). Recommendation: There is a need for a project to revise the using for example genetic approach. | PGCCDBS recommends that WGEF draw up proposal for small scale study which could include:<br>a) improvement of logbook recordings by species ID keys & revision of legal requirements;<br>b) establishment of species ID methods by genetics etc. |
| WKDEEP | Deep-water sharks | Stock structure | For both species C. squamosus and C. coelolepis it is assumed a unique stock for the whole NE Atlantic, although for the second species the structure into local populations might be admitted. In the future, genetic studies are encouraged possibly under dedicated scientific projects. | PGCCDBS recommends that WGEF draw up proposal for small scale study which should be considered in conjunction with proposed WK on age reading. |

### 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 on "Elasmobranch Fisheries: Developments in stock assessment, technical mitigation and management measures" will be held at the 2010 ICES Annual Science Conference in Nantes, France. This will be co-convened by members of WGEF and WGFTFB.

#### Study Group on the Bycatch of Endangered Species (SGBYC)

SGBYC has completed three years as a study group, and is expected to become a full Working Group in 2011. The Group is expanding 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.

### 1.12 Other fisheries meetings of relevance to WGEF

#### 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 colloborations continue to usefully assess and update knowledge on pelagic shark species.

### 1.13 Relevant biodiversity conservation issues

ICES' work on elasmobranch fishes 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.**

| Species | Multinational Environmental Agreement | | | |
|---|---|---|---|---|
| | OSPAR | CMS | CITES | Bern |
| Spurdog *Squalus acanthias* | ✓ | App II | Proposed, Rejected 2009 | |
| 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 2009 | 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 North-East 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

The ICES mixed fisheries advice for demersal fisheries in Division IIIa (Skagerrak–Kattegat) in Subarea IV (North Sea), and in Division VIId (Eastern Channel) in 2009 was that they should be managed according to the following rules, which should be applied simultaneously:

- should minimize bycatch or discards of cod;
- should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks;
- where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- **should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.**

ICES Advice for 2009 was that fisheries in the Celtic Seas should be managed according to the following rules, which should be applied simultaneously. In these fisheries, there should be:

- **no catch or discard of cod and whiting in Division VIa and in Division VIIa, of haddock in Division VIa and sole in Division VIIa, or of spurdog, white skate, and angel shark;**
- **minimal catch of common skate and undulate ray;**
- adherence to the recommended reduction in fishing mortality for cod in Divisions VIIe–k, whiting in Divisions VIIe–k, plaice in Divisions VIIfg, and plaice and sole in Division VIIe;
- development of rebuilding plans for herring in Divisions VIa (South) and VIIb, c and Celtic Sea herring (VIIg, j, VIIa south). Both stocks are in need of rebuilding and fishing should not proceed without rebuilding plans;

There was no update of these rules for 2010.

## 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 this year.

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).

At present WGEF considers that discard data should be brought to the meetings of the Group and collated there.

Only limited French landings data were available to the group in 2010. Landings data for 2009 as well as 2010 will need to be provided prior to the next meeting.

Russian commercial fishing data was provided in a Working Document (Vinnichenko *et al.*, 2010 WD). This showed fishing landings data not provided in official statistics. WGEF recommends that these data be provided in full, as well as the fishing effort associated with these fisheries.

### 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 ) Fishermen 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.

### Species-specific landings

ToR (b) asks WGEF to "Critically review 2008 and 2009 species-specific landings data for skates from ICES Subareas IV, VI–IX, and appraise their reliability through comparison with other data sources (e.g. market sampling and discard/observer programmes)".

In 2008 EC regulations stated that landings of the main species of rays and skates in ICES Division IIa and Subarea IV should be reported separately (Council Regulation (EC) No 40/2008 (16/01/2008).

For 2009 the requirements to provide species-specific landings were further extended to Divisions VIa–b and VIIa–c, e–k, Division VIId and Subareas VIII and IX.

In the chapters on demersal elasmobranchs for areas where species-specific landings data for rays and skates are required, details are provided on the percentage of skate landings for which species-specific information has been provided. Special attention is given to the reliability of this information.

### 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

Some nations are now providing data for larger sharks. The most commonly documented lengths for large sharks are total length ($L_T$) or fork length ($L_F$). However, even these lengths are not taken identically between samplers. A review of this can be found in Francis, 2006. The different length measurements that are discussed include:

- Flexed total length ($L_{T\ flex}$) – tip of snout to posterior tip of tail, with tail flexed down to midline.
- Natural total length ($L_{T\ nat}$) – as above but with tail in natural position and perpendicular drop down to midline.
- Calculated total length ($L_{T\ calc}$) – sum of the precaudal length and tail length.
- Fork length ($L_F$) – tip of the snout to fork in the tail.
- Precaudal length ($L_{PC}$) – tip of the snout to the origin of the upper lobe of the caudal fin.

Despite these defined measurements criteria sources of differentiation and error include:

1) Whether the measurement is made along a board, under the body or over the body (in which case the length will be larger as a result of body curvature).
2) Whether the animal is laid on the board/surface on its belly or side.
3) Whether the tail is depressed down onto a board-this in itself can create discrepancies, as the body depth of each animal will vary, and the tail may be depressed down farther than the midline if lying on its belly.
4) Where the measurement is made perpendicular to the board by eye; this can result in human error in judgement unless a rule in used to make that perpendicular line to the board.
5) Whether the tail is actually measured at all; i.e. fork or precaudal length, and whether the tail section is calculated rather than the actual observed measurement.

WGEF recommend that PGCCDBS ensures that all nations providing length data for sharks, state clearly which measurements have been collected.

WGEF is working with ICES member states to standardise measurement protocols, particularly regarding flexed and natural length.

#### Other issues – *Dipturus* complex

Two recent papers (Iglesias *et al*., 2010; Griffiths *et al*., 2010), showed 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.

This issue is further discussed in Section 21.1.

### 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 2010 WGEF updated and refined the model last used for the spurdog assessment in 2008. Further information can be found in Section 2.

### 1.17 ICES cooperative research report

The production of an ICES Cooperative Research report has been a Term of Reference for the Group since 2008. However, it was decided, after much discussion, that, regretably, this is not currently an achievable ambition. Increasing workload demands within national programmes means that the time required is not available. It is intended instead that the continued production of stock annexes will supplement the Group’s annual report.

## 1.18 Working documents presented

The following Working Documents were provided:

Abella, A. J., Baino, R. and F. Serena. 2010. Some information on Fisheries, conservation and research on elasmobranchs in the Mediterranean Sea. Working Document to WGEF WD2010-05.

Abello, A.J., Baino, R.T. and F. Serena. 2010. Some information on Fisheries, conservation and research on elasmobranchs in the Mediterranean Sea. Working Document to WGEF WD2010-13.

Berrow, S and Johnson. E. 2010. Basking Shark satellite telemetry and tracking in Ireland. Working Document to WGEF WD2010-03.

Diez, G., Ruiz, J., Zarautz, L. and E. Mugerza. 2010. Lesser Spotted Dogfish CPUEs And Discards Of The Basque Trawlers In The Period 2003—2009. Working Document to WGEF WD2010-08.

Ellis, J. R. 2010. An overview of the demersal elasmobranchs in the Irish Sea and Bristol Channel (ICES Divisions VIIa,f). Working Document to WGEF WD2010-15.

Ellis, J. R. 2010. An overview of the demersal elasmobranchs in the eastern English Channel (ICES Division VIId). Working Document to WGEF WD2010-16.

Ellis, J. 2010. An overview of the biology and status of undulate ray (*Raja undulata*). Working Document to WGEF WD2010-07.

Fernandes, A. C., Prista, N., Silva, D., Henriques, E., Ferreira, A., Abreu, P. and Fernandes, P. 2010. Deepwater Sharks caught by the Portuguese longline fleet: results from the onboard sampling programme. Working Document to WGEF WD2010-17.

Figueiredo, I., Moura, T. and N. Veiga. 2010. Revision and update of landing per unit effort data of deepwater sharks – Portuguese dogfish and leafscale gulper shark - in Portuguese longline fishery (1995–2009). Working Document to WGEF WD2010-18.

Pino, M.R. 2010. Update landings of elasmobranches from the azores (ICES Area X). Working Document to WGEF WD2010-19.

Santos J., Araújo, H., Salinas, I. and N. Pérez. 2010. Elasmobranches Results from Spanish Discard Sampling Programme. Working Document to WGEF WD2010-11.

Saunders R.A., Royer F., and M.W, Clarke. 2010. Winter Migration and diving behaviour of porbeagle shark. Working Document to WGEF WD2010-02.

Seret, B. 2010. French data related to the undulate ray (*Raja undulata*). Working Document to WGEF WD2010-04.

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Verissimo, A. 2010. Population structure of the spurdog *Squalus acanthias* in North Atlantic waters. Working Document to WGEF WD2010-01.

Verissimo, A. 2010. Population structure of the Portuguese dogfish *Centroscymnus coelolepis* within the eastern Atlantic. Working Document to WGEF WD2010-12.

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

Vollen, T. 2010. The Norwegian Reference Fleet 2007–2009: Catch and discard of elasmobranchs. Working Document to WGEF WD2010-06.

## 1.19 References


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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.

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

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

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.

WD2010-01 which uses microsatellite data analysis found genetic homogeneity between east and west Atlantic spurdog, but suggests this could be accomplished by transatlantic migration 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) (Figure 2.3 and Table 2.3). Outside these areas, landings have generally been low. Further details of the historical development of the fishery can be found in the Stock Annex.

### 2.2.1 The fishery in 2009

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 coming 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.

No information was available for French fisheries for spurdog.

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

### 2.2.2 ICES advice applicable

In 2008, ICES provided the following advice for spurdog which was unchanged in 2009:

'The only new information available for spurdog (*Squalus acanthias*) is landings data which does not offer any reason to change the advice from 2006. The advice for **2009 and 2010** is therefore the same as the advice given in 2006: *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 (...).*'

### 2.2.3 Management applicable

The following table summarizes ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2010:

| 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 | - | - | - | 12 5471) |
| 2002 | No advice | - | 7100 | - | - | - | 9050 |
| 2003 | No advice | - | 5640 | - | - | - | 10132 |
| 2004 | No advice | - | 4472 | - | - | - | 8044 |
| 2005 | No advice | - | 1136 | - | - | - | 6592 |
| 2006 | F=0 | Stock depleted and in danger of collapse | 1051 | - | - | - | 3771 |
| 2007 | F=0 | Stock depleted and in danger of collapse | 841(2) | 2828 | - | - | 2575 |
| 2008 | No new advice | No new advice | 631(2,3) | - | - | 2004 (2) | 1583 |
| 2009 | F=0 | Stock depleted and in danger of collapse | 316(3,4) | - | 104(4) | 1002(4) | |
| 2010 | F=0 | Stock depleted and in danger of collapse | 0(5) | | 0(5) | 0(5) | |

**(1) The WG estimate of landings in 2001 may include some misreported deep-sea sharks or other species;**

**(2) Bycatch quota. These species shall not comprise more than 5% by live weight of the catch retained on board.**

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

**(4) A maximum landing size of 100 cm (total length) shall be respected.**

**(5)Bycatches are permitted up to 10% of the 2009 quotas established in Annex Ia to Regulation (EC) No. 43/2009 under the following conditions:**

**catches taken with longlines of tope shark (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calceus*), leafscale gulper shark (*Centrophorus squamosus*), greater lantern shark (*Etmopterus princeps*), smooth lantern shark (*Etmopterus pusillus*) and Portuguese dogfish (*Centroscymnus coelolepis*) and spurdog (*Squalus acanthias*) are included (Does not apply to IIIa);**

**a maximum landing size of 100 cm (total length) is respected;**

**the bycatches comprise less than 10% of the total weight of marine organisms on board the fishing vessel;**

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

In all regulated areas, the TAC for spurdog has been reduced to zero for 2010. Landings are permitted under a bycatch TAC (equal to 10% of the 2009 quotas) provided certain conditions are 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. However, vessels less than 15 m in length are allowed to fish for spurdog with traditional gear in inshore (within 4 nm) territorial waters. Spurdog caught as bycatch in other fisheries have to be landed and the Directorate of Fisheries in Norway are allowed to stop the fishery when catches reach the 2007 level. Norway has a 70 cm minimum landing size.

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 2009 were 1552 t, although this figure does not include French or Faroese landings and it is anticipated this value will be revised upwards next year. Some updates have been made to the WG estimates of pre-2009 total landings. In recent years Norway has taken the greatest proportion of the total landings, followed by France and Scotland. For some nations, landings increased in 2009 (despite a reduction in TAC) which may be due to the removal of the strict bycatch restrictions which were in place in 2007 and 2008.

### 2.2.5 Discards

Estimates of total amount of spurdog discarded are not routinely provided although some discard sampling does take place. The only new information comes from WD2010-06 on the composition of Norwegian elasmobranch catches which suggests significant numbers of spurdog are being discarded. No other new data were available for 2010.

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 landings length (in 2009) has lead to misreporting (although the buyers and sellers legislation should deter this) or increased discarding.

## 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 2.4 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 may mean that the latter length frequencies are not representative of total removals.

Raw market sampling data were also provided by Scotland for the years 2005–2009. 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 previously provided by UK (E&W) for a limited number of fleets but these have not been updated in recent years 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 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 15% of the total. In 2009 UK landings are around 35% of the total, but this total does not yet include French landings. 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 no length frequency data from recent years.

## 2.4 Commercial catch-effort data

No commercial cpue data were available to the WG.

## 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 1990–2009.
- 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.
- Scottish Rockall haddock survey: years 1990–2009.
- Irish Q3 Celtic Seas groundfish survey: years 2003–2009.
- North Sea IBTS (NS-IBTS) survey: years 1977–2009

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 quarter 1 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 $Nhr^{-1}$ 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.

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 Exploratory assessment

### 2.8.1 Introduction

The exploratory assessment for spurdog presented in 2006 (ICES, 2006) has been extended to account for a further four 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 data sets 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, and one with England & Wales selectivity. The Scottish and England & Wales selectivities were estimated by fitting to proportions-by-length-category data derived from Scottish and England & Wales commercial landings data bases.

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.

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 Scottish selectivity, and three England & Wales 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).

## 2.8.2 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:

$$N_{y+1,a}^{s} = \begin{cases} \Phi^{s} R_{y+1} & a = 0 \\ (N_{y,a-1}^{s} e^{-M_{a-1}/2} - \sum_{j} C_{j,y,a-1}^{s}) e^{-M_{a-1}/2} & 0 < a \le A-1 \\ (N_{y,A-1}^{s} e^{-M_{A-1}/2} - \sum_{j} C_{j,y,A-1}^{s}) e^{-M_{A-1}/2} + (N_{y,A}^{s} e^{-M_{A}/2} - \sum_{j} C_{j,y,A}^{s}) e^{-M_{A}/2} & a = A \end{cases} \qquad 2.1a$$

where $s$=$f$ or $m$, $\Phi^s$ 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:

$$B_y = \sum_s \sum_a w^s_a N^s_{y,a} \qquad 2.1b$$

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:

$$N_{pup,y} = \sum_{a=1}^{A} P'_a P''_a N^f_{y,a} \qquad 2.2a$$

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:

$$Q_y = 1 + (Q_{fec} - 1)(1 - N_{pup,y} / R_0) \qquad 2.2b$$

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:

$$R_y = Q_y N_{pup,y}\, e^{\varepsilon_{r,y}} \qquad 2.2c$$

where the recruitment variability parameter $\sigma_r$ is assumed known (0.2 for the base case), and recruitment residuals $\varepsilon_{r,y}$ are estimated.

#### Fecundity

Fecundity, expressed as number of pups per pregnant female of age $a$, is modelled as follows:

$$P'_a = \begin{cases} 0 & l^f_a < l^f_{mat00} \\ b_{fec}\left(l^f_a + \sqrt{(l^f_a + a_{fec}/b_{fec})^2 + \gamma^2} - \sqrt{(a_{fec}/b_{fec})^2 + \gamma^2}\right)/2 & l^f_a \geq l^f_{mat00} \end{cases} \qquad 2.3$$

where $l^f_{mat00}$ is the female length-at-first maturity (Table 2.5), and $\gamma$ 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:

$$F_{j,y} = \frac{C_{j,y}}{\sum_a e^{-M_a/2} \sum_s w^s_{a+\frac{1}{2}} S^s_{com,j,a} N^s_{y,a}} \qquad 2.4a$$

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:

$$F_{prop5-30,y} = \sum_j \frac{1}{26} \sum_{a=5}^{30} \left[ \frac{\sum_s S^s_{com,j,a} N^s_{y,a} (F_{j,y} S^s_{com,j,a})}{\sum_s S^s_{com,j,a} N^s_{y,a}} \right] \qquad 2.4b$$

Catch-at-age (in numbers) is estimated as follows:

$$C^s_{j,y,a} = F_{j,y} S^s_{com,j,a} N^s_{y,a} e^{-M_a/2} \qquad 2.4c$$

#### Commercial selectivity

Commercial selectivity-at-age is calculated from commercial selectivity-by-length category parameters as follows:

$$S^{s*}_{com,j,a} = \begin{cases} S_{c2,j} & 16 \le l^s_a < 55 \\ S_{c3,j} & 55 \le l^s_a < 70 \\ S_{c4,j} & 70 \le l^s_a < 85 \\ 1 & l^s_a \ge 85 \end{cases} \qquad 2.5a$$

so that:

$$S^s_{com,j,a} = S^{s*}_{com,j,a} / \max_j (S^{s*}_{com,j,a}) \qquad 2.5b$$

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 $S_{c4,j}$ ($j$=*sco* or *e&w*) 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 one additional length category (the 16–54 cm category is split into 16–31 and 32–54), leading to 4 selectivity parameters to be estimated ($S_{s1}$, $S_{s2}$, $S_{s3}$ and $S_{s4}$).

#### 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]:

$$R_0 = \frac{N_0^{f,preg}}{\Phi^f \left[ \sum_{a=0}^{A-1} P''_a e^{-\sum_{i=0}^{a-1} M_i} + P''_A \frac{e^{-\sum_{i=0}^{A-1} M_i}}{1-e^{-M_A}} \right]} \qquad 2.6$$

**Natural mortality for pups (Mpup)**

With the possibility of estimating the fecundity parameters $a_{fec}$ and $b_{fec}$ (equation 2.3), the natural mortality parameter $M_{pup}$ (Table 2.5) needs to be calculated so that, in the absence of harvesting, the following balance equation is satisfied:

$$\frac{1}{\Phi^f} = \sum_{a=0}^{A-1} P'_a P''_a e^{-\sum_{i=0}^{a-1} M_i} + P'_A P''_A \frac{e^{-\sum_{i=0}^{A-1} M_i}}{1-e^{-M_A}} \qquad 2.7$$

### 2.8.3 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:

$$S^{s,mat}_{MSY,a} = \begin{cases} 0 & l^s_a < l^f_{mat00} \\ 1 & l^s_a \geq l^f_{mat00} \end{cases} \qquad 2.8a$$

However, an estimate of $F_{MSY}$ 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 Scottish and England & Wales fleets (average over most recent five years; equations 2.4a–b) to estimate $F_{MSY}$. The selectivity for the second approach is therefore calculated as follows:

$$S^{s,cur}_{MSY,j,a} = \bar{f}_{rat,j} \, S^s_{com,j,a} \qquad 2.8b$$

where $S^s_{com,j,a}$ is from equation 2.5b, and $\bar{f}_{rat,j}$ is a 5-year average as follows:

$$\bar{f}_{rat,j} = \frac{1}{5}\sum_{y=2005}^{2009}\frac{F_{j,y}}{\sum_j F_{j,y}} \tag{2.8c}$$

where $F_{j,y}$ is from equation 2.4a. In order to calculate MSY parameters, the first step is to express population dynamics on a per-recruit basis. Therefore, taking equations 2.1a and 2.4c, the equivalent per-recruit equations (dropping the $y$ subscript) are given as:

$$N^s_{pr,a} = \begin{cases} \Phi^s & a = 0 \\ \Phi^s \prod_{i=0}^{a-1}\left(1 - \sum_j F_{mult} S^s_{MSY,j,i}\right) e^{-M_i} & 0 < a \le A-1 \\ \Phi^s \dfrac{\prod_{i=0}^{A-1}\left(1 - \sum_j F_{mult} S^s_{MSY,j,i}\right) e^{-M_i}}{\left(1 - \sum_j F_{mult} S^s_{MSY,j,A}\right)(1 - e^{-M_A})} & a = A \end{cases} \tag{2.8d}$$

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 2.8a, defined in terms of animals all animals $\ge l^f_{mat00}$ only, so subscript $j$ and the summation over $j$ is dropped) or the second approach (equation 2.8b, reflecting exploitation by current fleets, so subscript $j$ and the summation over $j$ is kept). Equation 2.2a therefore becomes:

$$N_{pup,pr} = \sum_{a=1}^{A} P'_a P''_a N^f_{pr,a} \tag{2.8e}$$

Recruitment can be expressed in terms of $N_{pup,pr}$ by re-arranging equations 2.2b–c (omitting the process error term) as follows:

$$R = \frac{R_0}{N_{pup,pr}}\left[1 - \frac{(1/N_{pup,pr} - 1)}{Q_{fec} - 1}\right] \tag{2.8f}$$

Yield can then be calculated as follows for the first ($Y^{mat}$) and second ($Y^{cur}$) approaches:

$$Y^{mat} = R\sum_s \sum_{a=0}^{A}\left(F_{mult} S^{s,mat}_{MSY,a} w^s_a N^s_{pr,a}\right) \tag{2.8g}$$

and

$$Y^{cur} = R\sum_s \sum_{a=0}^{A}\sum_j\left(F_{mult} S^{s,cur}_{MSY,j,a} w^s_{a+\frac{1}{2}} N^s_{pr,a} e^{-M_a/2}\right) \tag{2.8h}$$

MSY is found by solving for the $F_{mult}$ value that maximises equation 2.8g or 2.8h, and the corresponding $F_{MSY}$ is calculated using equation 2.4b (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 2.8g has been used for the purposes of calculating MSYR, and equation 2.8h for estimating $F_{MSY}$.

### 2.8.4 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:

$$-\ln L_{sur} = \tfrac{1}{2}\sum_{y}[\ln(2\pi\sigma^{2}_{sur,y}) + \varepsilon^{2}_{sur,y}] \qquad 2.9a$$

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:

$$\varepsilon_{sur,y} = [\ln(I_{sur,y}) - \ln(q_{sur}N_{sur,y})]/\sigma_{sur,y} \qquad 2.9b$$

$N_{sur,y}$ is the "available" mid-year abundance corresponding to $I_{sur,y}$, and is calculated as follows:

$$N_{sur,y} = \sum_{s}\sum_{a} S^{s}_{sur,a}[N^{s}_{y,a}e^{-M_a/2} - \sum_{j} C^{s}_{j,y,a}/2] \qquad 2.9c$$

#### 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):

$$-\ln L_{pcom,j} = k_{pcom,j}\sum_{y}\sum_{L}\varepsilon_{pcom,j,y,L} \qquad 2.10a$$

where $k_{pcom,j}$ is the effective sample size, and the multinomial residual $\varepsilon_{pcom,j,y,L}$ is:

$$\varepsilon_{pcom,j,y,L} = -\frac{n_{pcom,j,y}}{\overline{n}_{pcom,j}} p_{j,y,L}[\ln(\hat{p}_{j,y,L}) - \ln(p_{j,y,L})] \qquad 2.10b$$

with $n_{pcom,j,y}$ representing the number of samples on which estimates of proportions-by-length category are based, and $\overline{n}_{pcom,j}$ the corresponding average (over $y$). Because actual sample sizes were not available for the commercial data (only raised sample sizes), all model runs assumed $n_{pcom,j,y} = \overline{n}_{pcom,j}$, but a sensitivity test is included which considers the raised sample sizes for the commercial data. 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 one additional length category (the 16–54 cm category is split into 16–31 and 32–54). 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:

$$-\ln L_{fec} = \tfrac{1}{2} \sum_{y=1960;2005} \sum_{k=1}^{K_y} [\ln(2\pi\sigma_{fec}^2) + \varepsilon_{fec,k,y}^2] \qquad 2.11a$$

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:

$$\varepsilon_{fec,k,y} = [P'_{k,y} - \hat{P}'_{k,y}] / \sigma_{fec} \qquad 2.11b$$

where $P'_{k,y}$ represents the data and $\hat{P}'_{k,y}$ the corresponding model estimate calculated by multiplying equation 2.3 with $Q_y$ in equation 2.2b and substituting the length of the sample in equation 2.3 (where the age subscript *a* is replaced by the sample subscript *k*). A closed-form solution for $\sigma_{fec}$ exists as follows:

$$\sigma_{fec} = \sqrt{\frac{\sum_{y=1960;2005} \sum_{k=1}^{K_y} (P'_{k,y} - \hat{P}'_{k,y})^2}{(K_{1960} + K_{2005})}} \qquad 2.11c$$

#### Recruitment

Recruitment (pups) is assumed to be lognormally distributed about its expected value, with the following contribution to the negative log-likelihood function:

$$-\ln L_r = \tfrac{1}{2} \sum_{y} [\ln(2\pi\sigma_r^2) + (\varepsilon_{r,y} / \sigma_r)^2] \qquad 2.12$$

where $\varepsilon_{r,y}$ are estimable parameters in the model, and $\sigma_r$ is a fixed input (0.2 for the base case).

#### Total likelihood

The total negative log-likelihood is the sum of the individual components:

$$-\ln L_{tot} = -\ln L_{sur} - \sum_{j} \ln L_{pcom,j} - \ln L_{psur} - \ln L_{fec} - \ln L_r \qquad 2.13$$

### 2.8.5 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 Scottish fleet and an England & Wales fleet, were therefore defined, accounting for around 40–60% of landings of spurdog during the period 1985–2005 (although these percentages have come down somewhat after 2005). 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.

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 1990–2009, 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.

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 2.10b), but a sensitivity test is included that takes these raised sample sizes into account.

The fecundity data, given as pairs of values reflecting length of pregnant female and corresponding number of pups, is listed in Tables 2.10a and b for the two periods (1960 and 2005).

### 2.8.6 Summary of model runs

| Category | Description | Figures | Tables |
|---|---|---|---|
| •Base case run | | 2.17–25 | 2.11–13 |
| •Retrospective | A 5-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 | |
| Pre-1980 selection | A comparison of alternative assumptions about pre-1980 fleet selectivity, reflecting exploitation of older or younger animals | 2.28 | 2.12 |
| Recruitment | A comparison of alternative assumptions for recruitment variability, and for the starting year for which recruitment deviations estimated | 2.29 | |
| Data weighting | A comparison of alternative data weightings for effective sample sizes, and for using raised sample sizes instead of assuming $n_{pcom,j,y} = \overline{n}_{pcom,j}$ for commercial proportion by length category data | 2.30 | |

### 2.8.7 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 $\geq l^{f}_{mat00}$), 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 (1.94) 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. 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, and there are indications of change around 2000, with the larger length categories associated with predominantly negative residuals, and the smaller ones with predominantly positive residuals; this change is as yet unexplained.

Figure 2.20 compares the deterministic and stochastic versions of recruitment, and plots the estimated recruitment residuals normalised by $\sigma_r$. 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 (2010) total biomass levels relative to 1905 and 1955 ($B_{depl05}$ and $B_{depl55}$), are shown in Table 2.11 ("Base case") together with estimates of precision. 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 survey selectivity parameters, 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).

A plot of recruitment vs the number of pregnant females in the population, effectively a stock–recruit plot, is given in Figure 2.23 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.

#### 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 18% of pre-exploitation levels, Table 2.11), 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.

### 2.8.8 Retrospective analysis

A 5-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.

### 2.8.9 Sensitivity analyses

Four 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 ($Q_{fec}$=1.94; 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 ($Q_{fec}$=2.31) and upper bound ($Q_{fec}$=3.98). 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) Pre-1980 selection

Alternatives to assuming that the selection patterns prior to 1980 are the same as those post-1980 are explored in this set of sensitivity analyses. The alternatives are shown in Figure 2.28a(ii) and are derived by applying the multipliers shown in Figure 2.28a(iii) to the base case selection in Figure 2.28a(i). These reflect selection towards older ("oldsel") or younger animals ("youngsel"). Results are shown in Figure 2.28b and Table 2.11, and reveal that current estimates are the same, and although there is some sensitivity towards the beginning of the population trajectories (total biomass and recruitment), the estimates of depletion levels are relatively insensitive to these assumptions, ranging from 16–19% for $B_{depl05}$, and 20–24% for $B_{depl55}$.

c) Recruitment

This set explores sensitivity to some of the assumptions about recruitment, namely the input value for recruitment variability, $\sigma_r$ (base case=0.2), and the starting year for which recruitment deviations are estimated (base case=1960). Alternative values considered for the former were 0.1 and 0.3, and for the latter, 1950 and 1970. Results in Figure 2.29 show relative insensitivity to these assumptions.

d) Data weighting

Alternative weighting of the different sources of data can lead to markedly different model results, so this set of sensitivity tests explores the problem for instances where assumptions about weighting have had to be made, namely regarding the effective sample size for the proportion-by-length-category data, and for the within-series weighting of the commercial proportions-by-length-category data. For the former, a series of alternative weights are explored, as reflected in the left-hand-side legend to Figure 2.30 (see caption for details), and for the latter, the base case assumption of equal weighting for the commercial proportion data (as implied by assuming $n_{pcom,j,y} = \overline{n}_{pcom,j}$ in equation 2.10b) is contrasted with the annually-differing weights when the raised sample sizes given in Table 2.9 are used. The model is more sensitive to the former (alternative effective sample sizes) than to the latter (annually differing weights), but even in that case, the sensitivity is relatively low, with overall trends remaining similar.

### 2.8.10 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 2004–2008 (0, 0.25, 0.5, 0.75 and 1), a proportion of the TAC in 2009 (0.1 and 1), and on $F_{MSY}$ (=0.024), assuming that the catch in 2010 will be 142.2 tons. Results are given in Table 2.13, expressed as total biomass in future relative to the total biomass in 2010, and are illustrated in Figure 2.31a for the average catch options, and in Figure 2.31b for the 2009 TAC and $F_{MSY}$ options.

### 2.8.11 Conclusion

The base case model shows almost no retrospective bias and provides reasonable fits to most of the available data (the exception being the Scottish survey proportion-by-length-category data, which revealed an unexplained change in selection around 2000). 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 ($Q_{fec}$=1.94). The model also shows sensitivity to the assumptions about selection patterns prior to 1980, but current estimates are the same and depletion levels relatively insensitive. Further sensitivity tests show the model to be relatively insensitive to assumptions about recruitment and alternative data weighting scenarios. The model therefore has potential as an assessment model for spurdog, and a summary plot of the base case run, showing landings and estimates of recruitment, mean fishing proportion (with $F_{MSY}$=0.024) and total biomass, together with estimates of precision, is given in Figure 2.32.

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.

## 2.9 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.

### 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 landings 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 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 data set 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.

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.

## 2.10 MSY considerations

Exploitation status is below $F_{MSY}$, 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 2011. Projections assuming a total catch of 142 t (the bycatch quota in 2010) suggest that the stock will rebuild by 10–17% of its current (2010) level by 2015 (Table 2.13).

## 2.11 Reference points

$F_{MSY}$=0.024, as estimated by the current assessment, assuming average selection over the last five years.

## 2.12 Conservation considerations

In 2006 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.

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.

## 2.14 References

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**Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2009).**

| Year | Landings (tonnes) | Year | Landings (tonnes) | Year | Landings (tonnes) |
|---|---|---|---|---|---|
| 1947 | 16 893 | 1968 | 56 043 | 1989 | 30 275 |
| 1948 | 19 491 | 1969 | 52 074 | 1990 | 29 930 |
| 1949 | 23 010 | 1970 | 47 557 | 1991 | 29 700 |
| 1950 | 24 750 | 1971 | 45 653 | 1992 | 29 234 |
| 1951 | 35 301 | 1972 | 50 416 | 1993 | 25 684 |
| 1952 | 40 550 | 1973 | 49 412 | 1994 | 21 011 |
| 1953 | 38 206 | 1974 | 45 684 | 1995 | 21 534 |
| 1954 | 40 570 | 1975 | 44 119 | 1996 | 17 298 |
| 1955 | 43 127 | 1976 | 44 064 | 1997 | 15 391 |
| 1956 | 46 951 | 1977 | 42 252 | 1998 | 13 879 |
| 1957 | 45 570 | 1978 | 47 235 | 1999 | 12 244 |
| 1958 | 50 394 | 1979 | 38 201 | 2000 | 15 854 |
| 1959 | 47 394 | 1980 | 40 681 | 2001 | 16 630 |
| 1960 | 53 997 | 1981 | 39 278 | 2002 | 11 020 |
| 1961 | 57 721 | 1982 | 31 305 | 2003 | 12 246 |
| 1962 | 57 256 | 1983 | 37 041 | 2004 | 9365 |
| 1963 | 62 288 | 1984 | 35 190 | 2005 | 8354 |
| 1964 | 60 146 | 1985 | 38 670 | 2006 | 4054 |
| 1965 | 49 336 | 1986 | 30 912 | 2007 | 2827 |
| 1966 | 42 713 | 1987 | 42 334 | 2008 | 1737 |
| 1967 | 44 116 | 1988 | 35 529 | 2009 | 1522 |

**Table 2.2. Spurdog in the NE Atlantic. WG estimates of total landings by nation (1980–2009).**

| | 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 | 1 | 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) | 8942 | 8659 | 6927 | 6789 | 8043 | 7836 | 7042 | 7662 | 6911 | 5370 | 5414 | 3767 | 4201 | 3490 | 3461 |
| UK (Sc) | 4994 | 3970 | 3654 | 4371 | 4957 | 6749 | 6267 | 8043 | 8075 | 8024 | 7768 | 8531 | 9677 | 6614 | 4676 |
| Total | 40 681 | 39 278 | 31 305 | 37 041 | 35 191 | 38 669 | 30 905 | 42 333 | 35 528 | 30 277 | 29 906 | 29 559 | 29 040 | 25 632 | 20 850 |

| Country | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 391 | 430 | 443 | 382 | 354 | 400 | 410 | 23 | 11 | 13 | 20 | 17 | 0 | 0 | 7 |
| Denmark | 146 | 142 | 196 | 126 | 131 | 146 | 156 | 107 | 232 | 219 | 82 | 68 | 0 | 0 | 0 |
| Faroe Islands | 310 | 51 | 218 | 362 | 486 | 368 | 613 | 340 | 224 | 295 | 225 | 271 | 241 | 122 | na |
| France | 1978 | 1607 | 1555 | 1286 | 998 | 4342 | 4304 | 2569 | 1705 | 1062 | 2426 | 715 | 453 | 366 | na |
| Germany | 48 | 19 | 11 | 17 | 49 | 194 | 304 | 121 | 98 | 138 | 140 | 6 | 0 | 0 | 1 |
| Iceland | 166 | 156 | 106 | 80 | 57 | 107 | 199 | 276 | 200 | 142 | 71 | 75 | 36 | 52 | 102 |
| Ireland | 3056 | 2305 | 2214 | 1164 | 904 | 905 | 1227 | 1214 | 1416 | 1076 | 940 | 614 | 558 | 163 | 214 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 28 | 39 | 27 | 10 | 25 | 41 | 34 | 28 | 26 | 5 |
| Norway | 3940 | 2748 | 1567 | 1293 | 1461 | 1643 | 1424 | 1091 | 1119 | 1054 | 1010 | 790 | 616 | 711 | 543 |
| Poland | 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 |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 11 | 0 | 0 | 27 | 94 | 372 | 395 | 306 | 135 | 17 | 71 | 106 | 30 | 15 | 29 |
| Sweden | 104 | 154 | 196 | 140 | 114 | 123 | 238 | 0 | 275 | 244 | 170 | 148 | 95 | 9 | 80 |
| UK (E&W) | 2353 | 2575 | 3048 | 4478 | 4430 | 3631 | 4516 | 2823 | 3109 | 1729 | 1887 | 434 | 386 | 91 | 194 |
| UK (Sc) | 8517 | 6873 | 5665 | 4501 | 3248 | 3606 | 2897 | 2120 | 3708 | 3342 | 1263 | 766 | 415 | 178 | 345 |
| Total | 21 276 | 17 180 | 15 319 | 13 902 | 12 347 | 15 867 | 16 725 | 11 020 | 12 246 | 9365 | 8352 | 4054 | 2867 | 1737 | 1522 |

**Table 2.3. Spurdog in the NE Atlantic. WG estimates of landings by ICES Subarea (1980–2009).**

| 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 |
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltic | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 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 |
| III and IV | 7347 | 5299 | 4977 | 3895 | 2705 | 2475 | 2516 | 1904 | 2395 | 2163 | 1019 | 742 | 550 | 490 | 553 |
| V | 484 | 217 | 320 | 442 | 545 | 879 | 1406 | 808 | 583 | 677 | 473 | 457 | 352 | 189 | 102 |
| VI | 5164 | 4168 | 3412 | 2831 | 2715 | 5977 | 5624 | 3169 | 3398 | 2630 | 2838 | 851 | 502 | 165 | 217 |
| VIIA | 1177 | 1555 | 1516 | 1704 | 2010 | 1562 | 1878 | 1529 | 2021 | 938 | 605 | 411 | 280 | 74 | 114 |
| VIIB,C | 1004 | 603 | 450 | 854 | 1037 | 1028 | 816 | 527 | 588 | 432 | 358 | 270 | 262 | 56 | 81 |
| VIID,E, F | 760 | 852 | 646 | 443 | 411 | 438 | 555 | 295 | 268 | 278 | 290 | 174 | 197 | 162 | 91 |
| VIIG-K | 2258 | 2328 | 3046 | 2683 | 1824 | 2161 | 2846 | 2130 | 2339 | 1739 | 1973 | 531 | 313 | 196 | 128 |
| VIII | 602 | 408 | 418 | 308 | 171 | 405 | 469 | 269 | 134 | 56 | 97 | 85 | 50 | 64 | 4 |
| IX | 5 | 2 | 2 | 2 | 3 | 19 | 8 | 11 | 5 | 14 | 7 | 35 | 9 | 4 | 2 |
| X | 0 | 0 | 0 | 0 | 18 | 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 |
| Other | 5 | 12 | 10 | 6 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Total | 21 534 | 17 298 | 15 391 | 13 879 | 12 244 | 15 854 | 16 630 | 11 020 | 12 246 | 9365 | 8354 | 4054 | 2827 | 1737 | 1522 |

**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 | % Dev | P-value |
|---|---|---|---|---|---|---|
| | | | 5274 | 6005.3 | | |
| as.factor(year) | 19 | 74.1 | 5255 | 5931.2 | 5% | 3.21E-05 |
| as.factor(month) | 10 | 1015.4 | 5245 | 4915.8 | 70% | 8.84E-212 |
| as.factor(roundarea) | 19 | 369 | 5226 | 4546.8 | 25% | 1.19E-66 |

| Lognormal model | Df | Deviance | Resid Df | Resid. Dev | % Dev | P-value |
|---|---|---|---|---|---|---|
| | | | 1342 | 3518.7 | | |
| as.factor(year) | 19 | 196.2 | 1323 | 3322.5 | 29% | 7.81E-11 |
| as.factor(month) | 3 | 325.5 | 1320 | 2997.1 | 47% | 2.20E-16 |
| as.factor(roundarea) | 17 | 166.2 | 1303 | 2830.9 | 24% | 3.21E-09 |

**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 $l_a^s = L_\infty^s (1 - e^{-\kappa^s (a - t_0^s)})$ | |
| $L_\infty^f$, $L_\infty^m$ | 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 $P''_a = \dfrac{P''_{\max}}{1 + \exp\left[-\ln(19) \dfrac{l_a^f - l_{mat50}^f}{l_{mat95}^f - l_{mat50}^f}\right]}$ where $P''_{\max}$ is the proportion very large females pregnant each year, and $l_{matx}^f$ the length at which x% of the maximum proportion of females are pregnant each year | |
| $P''_{\max}$ | 0.5 | average from literature |
| $l_{mat50}^f$, $l_{mat95}^f$ | 80 cm, 87 cm | average from literature |

**Table 2.6. Northeast Atlantic spurdog. Landings used in the assessment. Allocations to the Scottish and England & Wales fleet (for the purposes of the assessment model only) are done on the basis of relative proportions [e.g. Sco/(Sco+E&W)] from 1980 onwards, and using the average proportion for 1980–1984 for the period prior to 1980.**

| | Sco | E&W | Total | | Sco | E&W | Total | | Sco | E&W | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1905 | 4733 | 2515 | 7248 | 1940 | 6157 | 3271 | 9428 | 1975 | 28810 | 15309 | 44119 |
| 1906 | 1436 | 763 | 2199 | 1941 | 5707 | 3033 | 8740 | 1976 | 28774 | 15290 | 44064 |
| 1907 | 933 | 496 | 1429 | 1942 | 6938 | 3687 | 10625 | 1977 | 27591 | 14661 | 42252 |
| 1908 | 920 | 489 | 1409 | 1943 | 5342 | 2839 | 8181 | 1978 | 30845 | 16390 | 47235 |
| 1909 | 1321 | 702 | 2023 | 1944 | 5323 | 2828 | 8151 | 1979 | 24946 | 13255 | 38201 |
| 1910 | 1021 | 542 | 1563 | 1945 | 4425 | 2351 | 6776 | 1980 | 26397 | 14284 | 40681 |
| 1911 | 1278 | 679 | 1957 | 1946 | 7115 | 3780 | 10895 | 1981 | 27565 | 11714 | 39279 |
| 1912 | 2089 | 1110 | 3199 | 1947 | 11031 | 5862 | 16893 | 1982 | 21510 | 9795 | 31305 |
| 1913 | 2644 | 1405 | 4049 | 1948 | 12728 | 6763 | 19491 | 1983 | 22540 | 14501 | 37041 |
| 1914 | 1725 | 916 | 2641 | 1949 | 15026 | 7984 | 23010 | 1984 | 21775 | 13415 | 35190 |
| 1915 | 1699 | 903 | 2602 | 1950 | 16162 | 8588 | 24750 | 1985 | 20782 | 17888 | 38670 |
| 1916 | 349 | 185 | 534 | 1951 | 23052 | 12249 | 35301 | 1986 | 16361 | 14550 | 30911 |
| 1917 | 221 | 118 | 339 | 1952 | 26480 | 14070 | 40550 | 1987 | 20684 | 21650 | 42334 |
| 1918 | 295 | 156 | 451 | 1953 | 24949 | 13257 | 38206 | 1988 | 16437 | 19092 | 35529 |
| 1919 | 1736 | 923 | 2659 | 1954 | 26493 | 14077 | 40570 | 1989 | 12139 | 18135 | 30274 |
| 1920 | 2871 | 1525 | 4396 | 1955 | 28162 | 14965 | 43127 | 1990 | 12293 | 17637 | 29930 |
| 1921 | 3475 | 1846 | 5321 | 1956 | 30659 | 16292 | 46951 | 1991 | 9102 | 20598 | 29700 |
| 1922 | 3527 | 1874 | 5401 | 1957 | 29758 | 15812 | 45570 | 1992 | 8858 | 20376 | 29234 |
| 1923 | 3693 | 1962 | 5655 | 1958 | 32908 | 17486 | 50394 | 1993 | 8878 | 16806 | 25684 |
| 1924 | 4150 | 2205 | 6355 | 1959 | 30949 | 16445 | 47394 | 1994 | 8938 | 12073 | 21011 |
| 1925 | 4388 | 2331 | 6719 | 1960 | 35261 | 18736 | 53997 | 1995 | 4663 | 16871 | 21534 |
| 1926 | 4752 | 2525 | 7277 | 1961 | 37692 | 20029 | 57721 | 1996 | 4840 | 12458 | 17298 |
| 1927 | 5482 | 2913 | 8395 | 1962 | 37389 | 19867 | 57256 | 1997 | 5405 | 9986 | 15391 |
| 1928 | 6218 | 3304 | 9522 | 1963 | 40675 | 21613 | 62288 | 1998 | 6924 | 6956 | 13880 |
| 1929 | 6086 | 3234 | 9320 | 1964 | 39276 | 20870 | 60146 | 1999 | 7085 | 5159 | 12244 |
| 1930 | 7780 | 4134 | 11914 | 1965 | 32217 | 17119 | 49336 | 2000 | 7979 | 7875 | 15854 |
| 1931 | 7730 | 4108 | 11838 | 1966 | 27892 | 14821 | 42713 | 2001 | 10131 | 6499 | 16630 |
| 1932 | 10922 | 5804 | 16726 | 1967 | 28808 | 15308 | 44116 | 2002 | 6294 | 4726 | 11020 |
| 1933 | 13220 | 7024 | 20244 | 1968 | 36597 | 19446 | 56043 | 2003 | 5585 | 6661 | 12246 |
| 1934 | 13307 | 7071 | 20378 | 1969 | 34005 | 18069 | 52074 | 2004 | 3193 | 6172 | 9365 |
| 1935 | 14540 | 7726 | 22266 | 1970 | 31055 | 16502 | 47557 | 2005 | 5004 | 3349 | 8353 |
| 1936 | 13664 | 7261 | 20925 | 1971 | 29812 | 15841 | 45653 | 2006 | 1466 | 2589 | 4055 |
| 1937 | 15627 | 8303 | 23930 | 1972 | 32922 | 17494 | 50416 | 2007 | 1362 | 1466 | 2828 |
| 1938 | 11882 | 6314 | 18196 | 1973 | 32266 | 17146 | 49412 | 2008 | 590 | 1147 | 1737 |
| 1939 | 13138 | 6981 | 20119 | 1974 | 29832 | 15852 | 45684 | 2009 | 548 | 974 | 1522 |

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

| | Index | CV |
|---|---|---|
| 1990 | 169.5 | 0.33 |
| 1991 | 99.3 | 0.32 |
| 1992 | 83.7 | 0.32 |
| 1993 | 159.8 | 0.32 |
| 1994 | 144.6 | 0.35 |
| 1995 | 53.8 | 0.45 |
| 1996 | 89.1 | 0.35 |
| 1997 | 56.6 | 0.35 |
| 1998 | 85.6 | 0.35 |
| 1999 | 184.6 | 0.34 |
| 2000 | 76.0 | 0.36 |
| 2001 | 99.4 | 0.34 |
| 2002 | 100.5 | 0.33 |
| 2003 | 87.1 | 0.34 |
| 2004 | 64.2 | 0.37 |
| 2005 | 87.5 | 0.36 |
| 2006 | 71.8 | 0.35 |
| 2007 | 98.0 | 0.32 |
| 2008 | 83.6 | 0.35 |
| 2009 | 69.7 | 0.36 |

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

| | $n_{psur,y}$ | 16-31 | 32-54 | 55-69 | 70-84 | 85+ |
|---|---|---|---|---|---|---|
| 1990 | 1586 | 0.0691 | 0.4300 | 0.2188 | 0.2733 | 0.0088 |
| 1991 | 2418 | 0.2365 | 0.3968 | 0.2103 | 0.1540 | 0.0025 |
| 1992 | 275 | 0.4237 | 0.2799 | 0.1117 | 0.1846 | 0.0000 |
| 1993 | 1049 | 0.1186 | 0.2979 | 0.2697 | 0.3047 | 0.0089 |
| 1994 | 4132 | 0.0330 | 0.8953 | 0.0370 | 0.0336 | 0.0012 |
| 1995 | 4203 | 0.3606 | 0.6233 | 0.0080 | 0.0078 | 0.0005 |
| 1996 | 689 | 0.1016 | 0.4045 | 0.2258 | 0.2534 | 0.0147 |
| 1997 | 444 | 0.1034 | 0.4470 | 0.1401 | 0.2875 | 0.0219 |
| 1998 | 883 | 0.1086 | 0.4621 | 0.2718 | 0.1318 | 0.0256 |
| 1999 | 655 | 0.1532 | 0.3707 | 0.1250 | 0.3451 | 0.0060 |
| 2000 | 4041 | 0.0027 | 0.9086 | 0.0633 | 0.0235 | 0.0017 |
| 2001 | 340 | 0.0281 | 0.3729 | 0.1879 | 0.3876 | 0.0235 |
| 2002 | 417 | 0.0401 | 0.1992 | 0.3845 | 0.3528 | 0.0232 |
| 2003 | 617 | 0.0436 | 0.5065 | 0.1942 | 0.2411 | 0.0146 |
| 2004 | 253 | 0.0393 | 0.1847 | 0.2634 | 0.5009 | 0.0117 |
| 2005 | 346 | 0.0450 | 0.1683 | 0.3600 | 0.4122 | 0.0145 |
| 2006 | 286 | 0.0665 | 0.2435 | 0.3469 | 0.3264 | 0.0167 |
| 2007 | 411 | 0.0542 | 0.3274 | 0.2564 | 0.3315 | 0.0305 |
| 2008 | 628 | 0.1533 | 0.5028 | 0.1104 | 0.2208 | 0.0127 |
| 2009 | 653 | 0.1025 | 0.4878 | 0.1135 | 0.2730 | 0.0232 |

**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 2.11. 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.**

| | $N_0^{f,preg}$ | Qfec | qsur | Bdepl05 | Bdepl55 |
|---|---|---|---|---|---|
| Base case | 98 528 | 1.94 | 0.000923 | 18% | 22% |
| | [2.3%] | [2.4%] | [27%] | [31%] | [30%] |
| Old sel | 89 361 | 1.94 | 0.000923 | 19% | 24% |
| | [2.6%] | [2.5%] | [26%] | [29%] | [28%] |
| Young sel | 109 450 | 1.94 | 0.000917 | 16% | 20% |
| | [2.3%] | [2.4%] | [30%] | [34%] | [34%] |

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

| | $N_0^{f,preg}$ | Sc2,sco | Sc2,e&w | Sc3,sco | Sc3,e&w | Sc4,sco | Sc4,e&w | Ss1 | Ss2 | Ss3 | Ss4 | Qfec | □r,05 | □r,06 | □r,07 | □r,08 | □r,09 | qsur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $N_0^{f,preg}$ | 1 | | | | | | | | | | | | | | | | | |
| Sc2,sco | -0.10 | 1 | | | | | | | | | | | | | | | | |
| Sc2,e&w | 0.00 | 0.00 | 1 | | | | | | | | | | | | | | | |
| Sc3,sco | -0.17 | 0.40 | 0.01 | 1 | | | | | | | | | | | | | | |
| Sc3,e&w | 0.05 | 0.02 | 0.08 | 0.08 | 1 | | | | | | | | | | | | | |
| Sc4,sco | -0.23 | 0.42 | 0.01 | 0.88 | 0.11 | 1 | | | | | | | | | | | | |
| Sc4,e&w | -0.03 | 0.07 | 0.10 | 0.21 | 0.56 | 0.26 | 1 | | | | | | | | | | | |
| Ss1 | 0.02 | 0.01 | 0.00 | 0.02 | 0.02 | 0.01 | 0.02 | 1 | | | | | | | | | | |
| Ss2 | 0.03 | 0.01 | 0.00 | 0.02 | 0.03 | 0.02 | 0.03 | 0.97 | 1 | | | | | | | | | |
| Ss3 | 0.05 | 0.01 | 0.00 | 0.03 | 0.04 | 0.03 | 0.04 | 0.95 | 0.97 | 1 | | | | | | | | |
| Ss4 | 0.04 | 0.01 | 0.01 | 0.05 | 0.05 | 0.05 | 0.07 | 0.95 | 0.97 | 0.95 | 1 | | | | | | | |
| Qfec | 0.15 | 0.08 | 0.00 | 0.28 | 0.21 | 0.31 | 0.29 | 0.03 | 0.05 | 0.08 | 0.08 | 1 | | | | | | |
| □r,05 | -0.02 | 0.00 | 0.00 | -0.01 | -0.01 | -0.02 | -0.02 | 0.00 | -0.01 | 0.00 | 0.00 | -0.04 | 1 | | | | | |
| □r,06 | -0.02 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | -0.01 | 0.00 | 0.00 | -0.03 | 0.00 | 1 | | | | |
| □r,07 | -0.01 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | -0.01 | 0.00 | 0.00 | -0.02 | 0.00 | 0.00 | 1 | | | |
| □r,08 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 1 | | |
| □r,09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 1 | |
| qsur | -0.37 | -0.04 | -0.01 | -0.23 | -0.24 | -0.25 | -0.31 | 0.10 | 0.11 | 0.01 | -0.02 | -0.75 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 1 |

**Table 2.13. Northeast Atlantic spurdog. Assessment projections under different future catch options. Estimates of total biomass relative to the total biomass in 2010 are shown, assuming that the catch in 2010 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.**

| | Catch Options | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | zero | Cav 04-08 | 0.75Cav | 0.50Cav | 0.25Cav | TAC09 | 0.1TAC09 | $F_{MSY}$* |
| Catch | 0 | 5268 | 3951 | 2634 | 1317 | 1422 | 142.2 | *5695* |
| **Point estimates** | | | | | | | | |
| 2011 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| 2012 | 1.05 | 1.03 | 1.04 | 1.04 | 1.05 | 1.05 | 1.05 | 1.03 |
| 2013 | 1.08 | 1.04 | 1.05 | 1.06 | 1.07 | 1.07 | 1.08 | 1.04 |
| 2014 | 1.11 | 1.05 | 1.07 | 1.08 | 1.09 | 1.09 | 1.11 | 1.05 |
| 2015 | 1.14 | 1.07 | 1.08 | 1.10 | 1.12 | 1.12 | 1.13 | 1.06 |
| 2016 | 1.17 | 1.08 | 1.10 | 1.12 | 1.14 | 1.14 | 1.16 | 1.07 |
| 2017 | 1.20 | 1.09 | 1.12 | 1.14 | 1.17 | 1.17 | 1.19 | 1.08 |
| 2018 | 1.23 | 1.10 | 1.13 | 1.17 | 1.20 | 1.19 | 1.23 | 1.09 |
| 2019 | 1.26 | 1.12 | 1.15 | 1.19 | 1.22 | 1.22 | 1.26 | 1.11 |
| 2020 | 1.29 | 1.13 | 1.17 | 1.21 | 1.25 | 1.25 | 1.29 | 1.12 |
| **Point estimates - 2 standard deviations** | | | | | | | | |
| 2011 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 2012 | 1.04 | 1.01 | 1.02 | 1.03 | 1.03 | 1.03 | 1.03 | 1.02 |
| 2013 | 1.06 | 1.01 | 1.02 | 1.04 | 1.05 | 1.05 | 1.06 | 1.02 |
| 2014 | 1.08 | 1.01 | 1.03 | 1.05 | 1.06 | 1.06 | 1.08 | 1.02 |
| 2015 | 1.10 | 1.01 | 1.03 | 1.06 | 1.08 | 1.08 | 1.10 | 1.03 |
| 2016 | 1.12 | 1.01 | 1.04 | 1.07 | 1.10 | 1.10 | 1.12 | 1.03 |
| 2017 | 1.15 | 1.01 | 1.05 | 1.08 | 1.12 | 1.12 | 1.15 | 1.03 |
| 2018 | 1.17 | 1.01 | 1.05 | 1.10 | 1.14 | 1.14 | 1.17 | 1.04 |
| 2019 | 1.20 | 1.01 | 1.06 | 1.11 | 1.16 | 1.16 | 1.19 | 1.05 |
| 2020 | 1.22 | 1.01 | 1.07 | 1.13 | 1.18 | 1.18 | 1.22 | 1.05 |
| **Point estimates + 2 standard deviations** | | | | | | | | |
| 2011 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 |
| 2012 | 1.07 | 1.05 | 1.06 | 1.06 | 1.07 | 1.06 | 1.07 | 1.05 |
| 2013 | 1.10 | 1.08 | 1.08 | 1.09 | 1.09 | 1.09 | 1.10 | 1.06 |
| 2014 | 1.14 | 1.10 | 1.11 | 1.11 | 1.12 | 1.12 | 1.14 | 1.08 |
| 2015 | 1.17 | 1.12 | 1.13 | 1.14 | 1.16 | 1.15 | 1.17 | 1.10 |
| 2016 | 1.21 | 1.15 | 1.16 | 1.17 | 1.19 | 1.19 | 1.21 | 1.11 |
| 2017 | 1.25 | 1.17 | 1.19 | 1.20 | 1.22 | 1.22 | 1.24 | 1.13 |
| 2018 | 1.28 | 1.20 | 1.21 | 1.23 | 1.26 | 1.25 | 1.28 | 1.15 |
| 2019 | 1.32 | 1.22 | 1.24 | 1.26 | 1.29 | 1.29 | 1.32 | 1.16 |
| 2020 | 1.36 | 1.25 | 1.27 | 1.29 | 1.32 | 1.32 | 1.36 | 1.18 |

*For the $F_{MSY}$ option, the "catch" is the average for 2011-2020

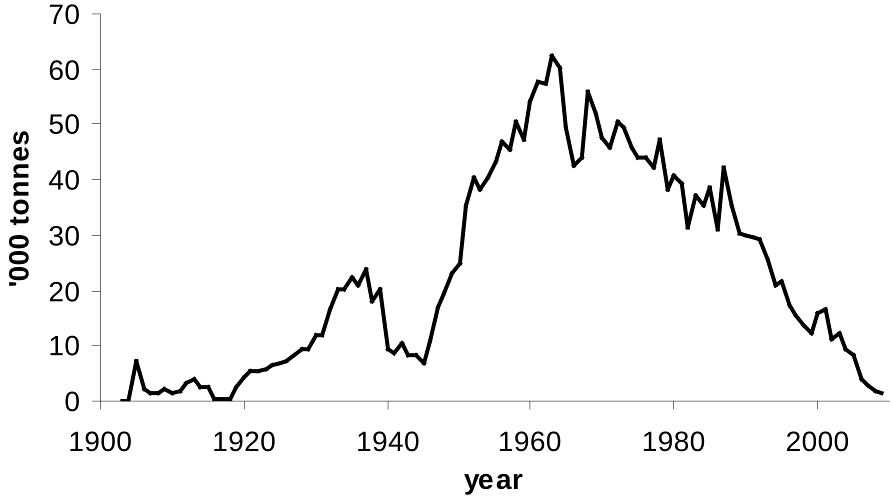



**Figure 2.1. Spurdog in the NE Atlantic. WG estimates of total international landings of NE Atlantic spurdog (1905–2009).**

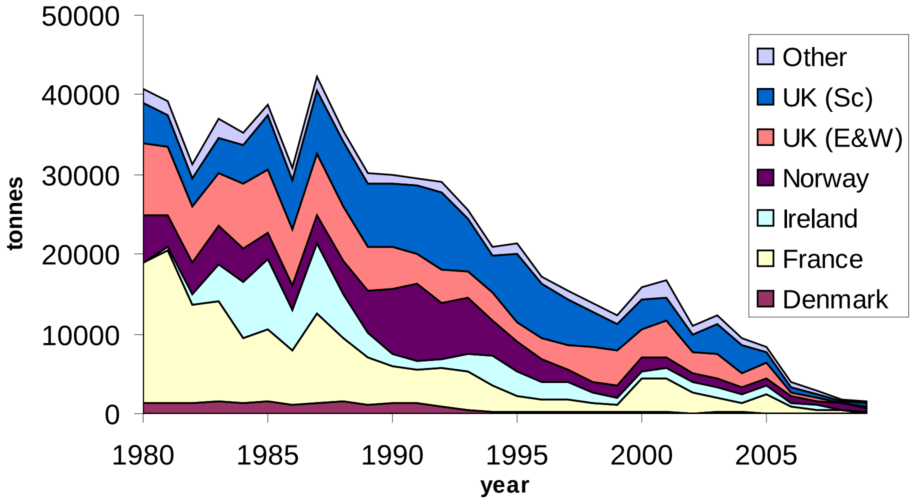



**Figure 2.2. Spurdog in the NE Atlantic. WG estimates of landings by nation (1980–2009).**

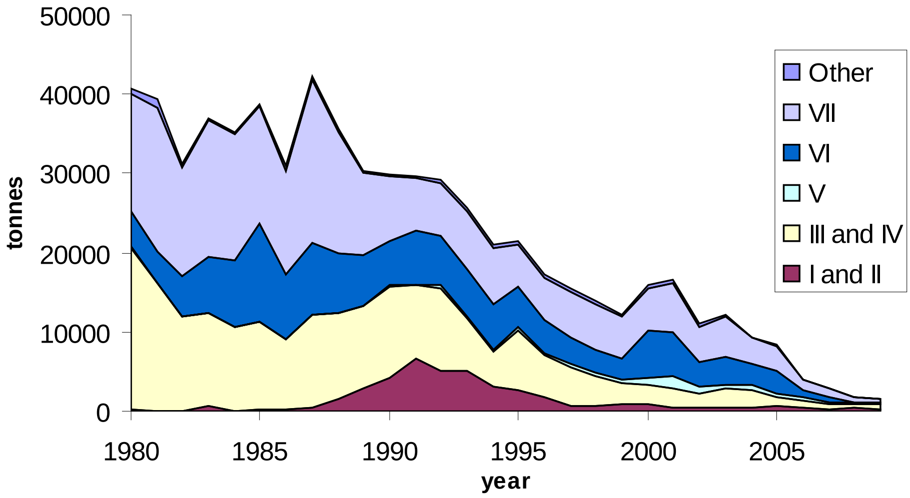



**Figure 2.3. Spurdog in the NE Atlantic. WG estimates of landings by ICES Subarea (1980–2009).**

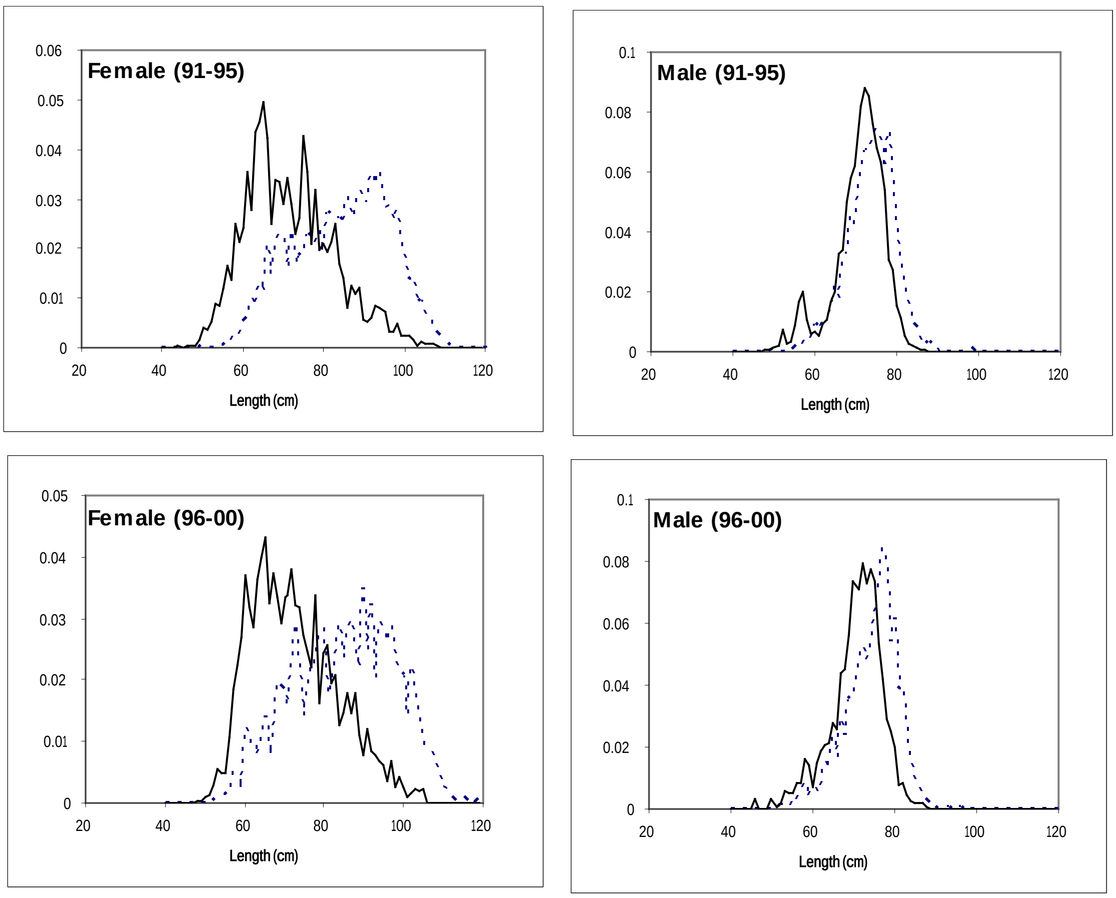



**Figure 2.4. Spurdog in the NE Atlantic. Comparison of length frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK (E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.**

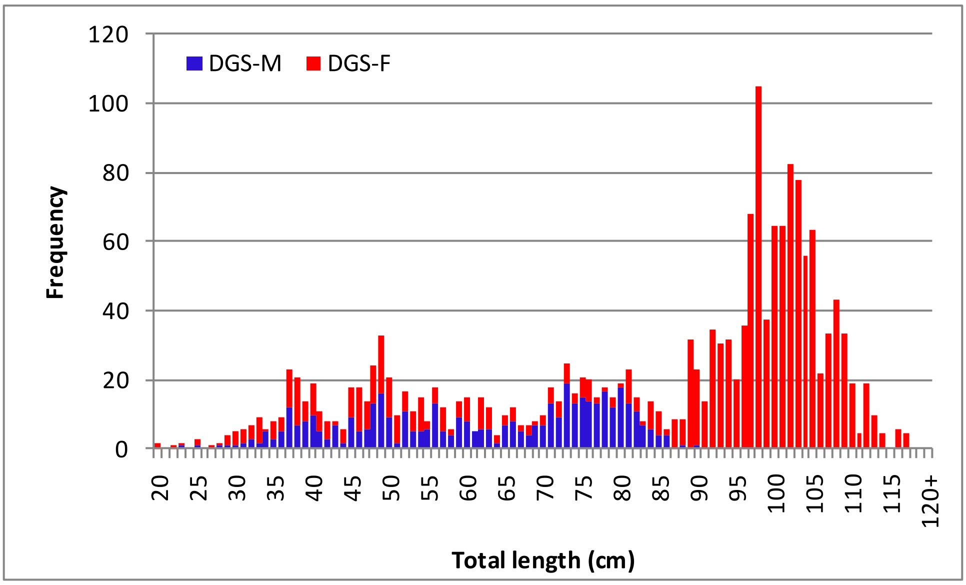



**Figure 2.5. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid and additional tows). Length distribution highly influenced by a single haul of large females.**

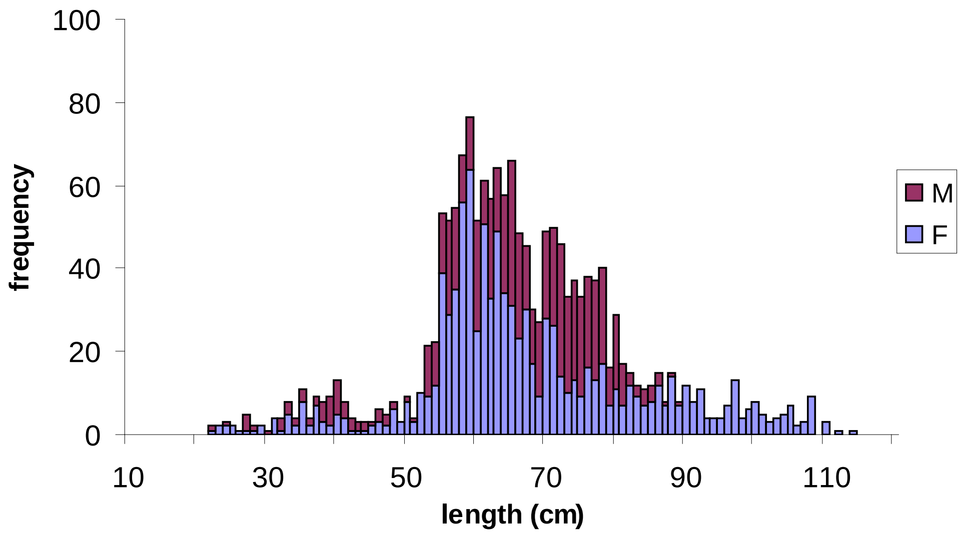
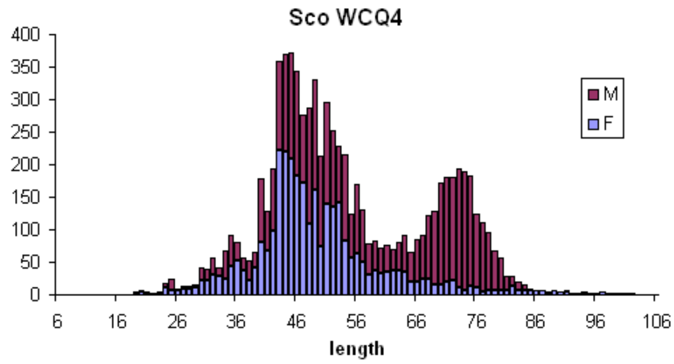



**Figure 2.6. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Irish Q3 Celtic Seas groundfish survey (2003–2009).**



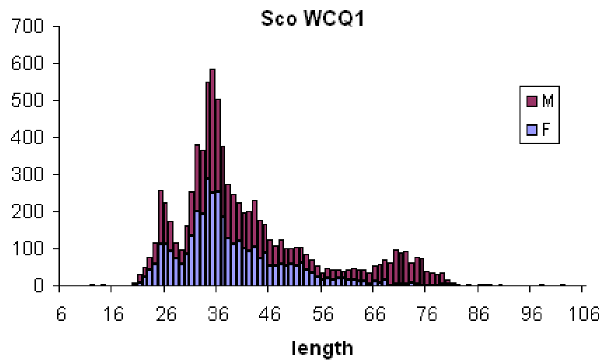




**Figure 2.7. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Scottish Q1 and Q4 groundfish surveys (1990–2009). Length frequency distributions highly influenced by a small number of hauls containing many small individuals.**

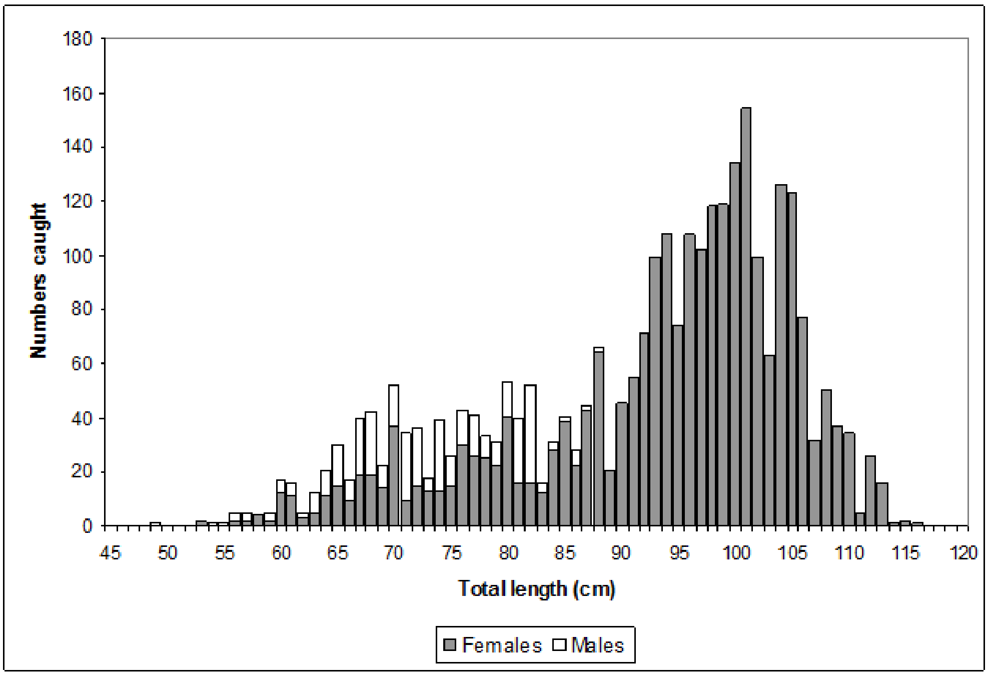



**Figure 2.8. Spurdog in the NE Atlantic. Total length frequency of male and female spurdog taken during the UK (E&E) FSP survey, raised for those catches that were sub-sampled (n = 2517 females and 356 males).**

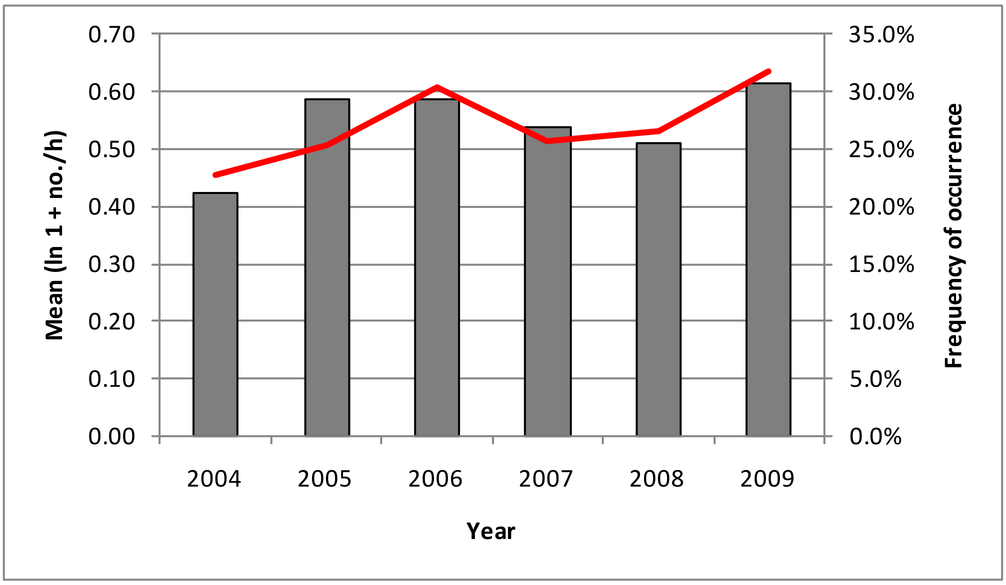



**Figure 2.9. Spurdog in the NE Atlantic. Catch rate in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid tows), giving the mean (ln 1 + no.h-1, grey columns) and frequency of occurrence (red line).**

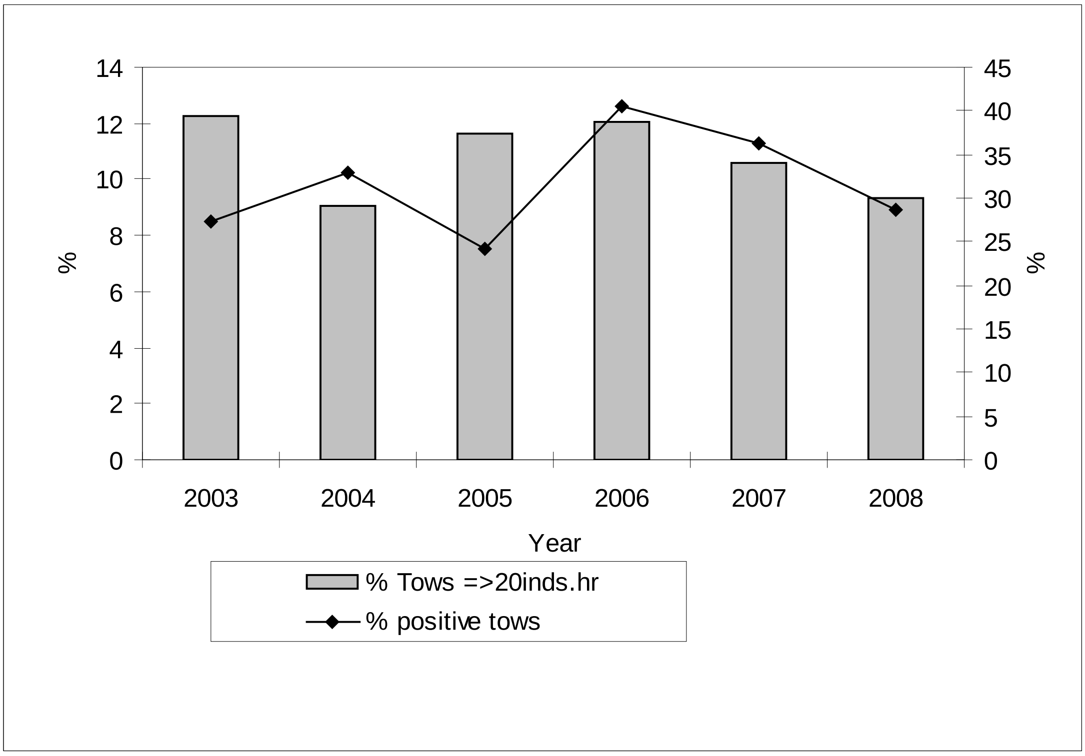



**Figure 2.10. Northeast Atlantic Spurdog. Proportion of survey hauls in Irish Q3 groundfish survey 2003–2008, ICES Area VII, in which nominal cpue was ≥ 20 per 1-hour tow, and percentage of tows in which spurdog occurred.**

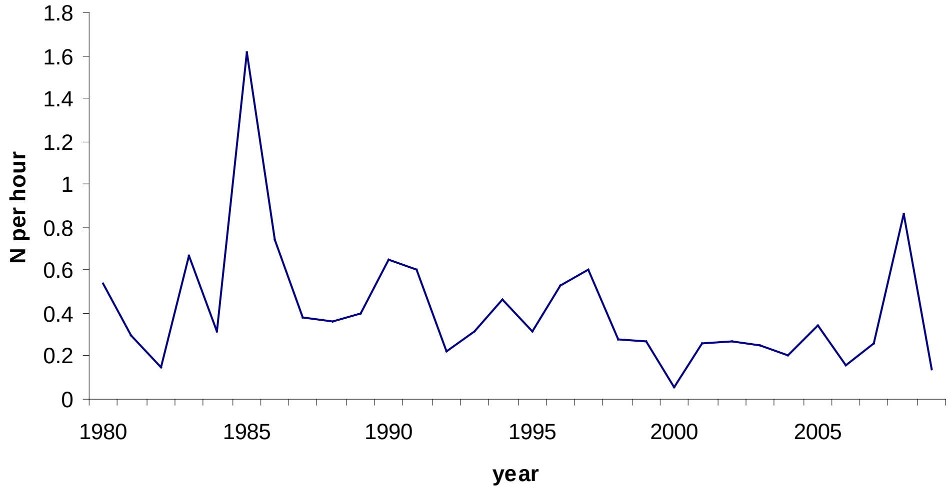
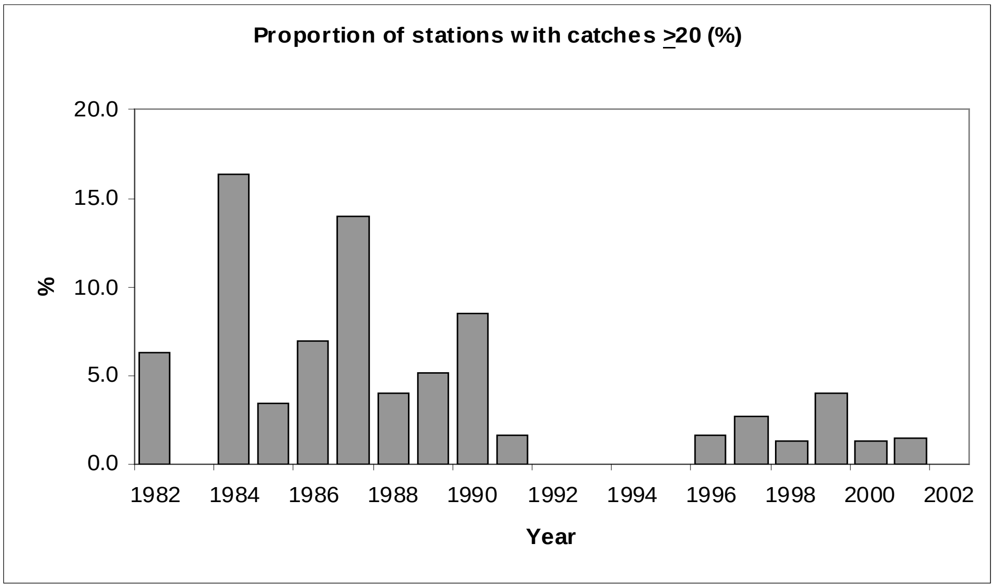



**Figure 2.11. Spurdog in the NE Atlantic. Average catch rate in numbers per hour from the North Sea IBTS.**



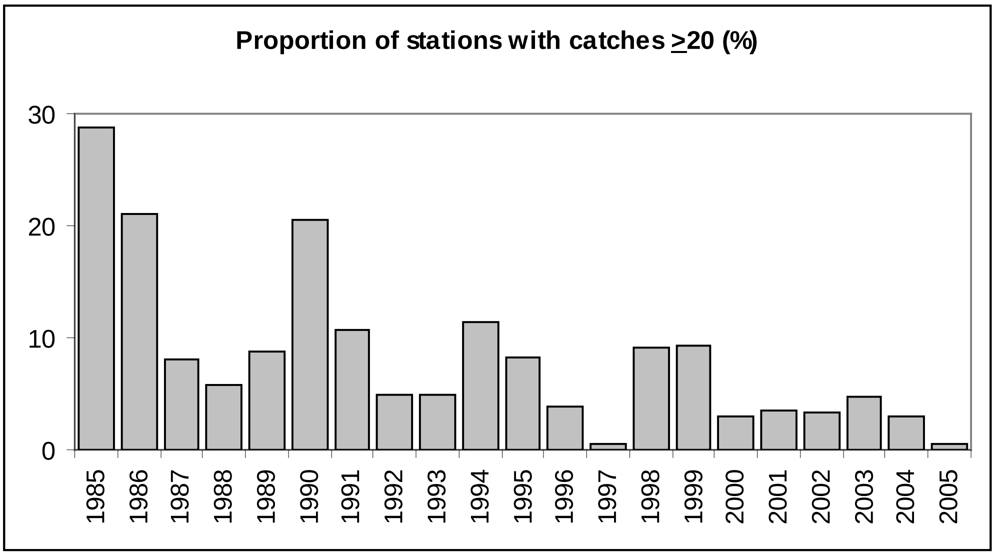
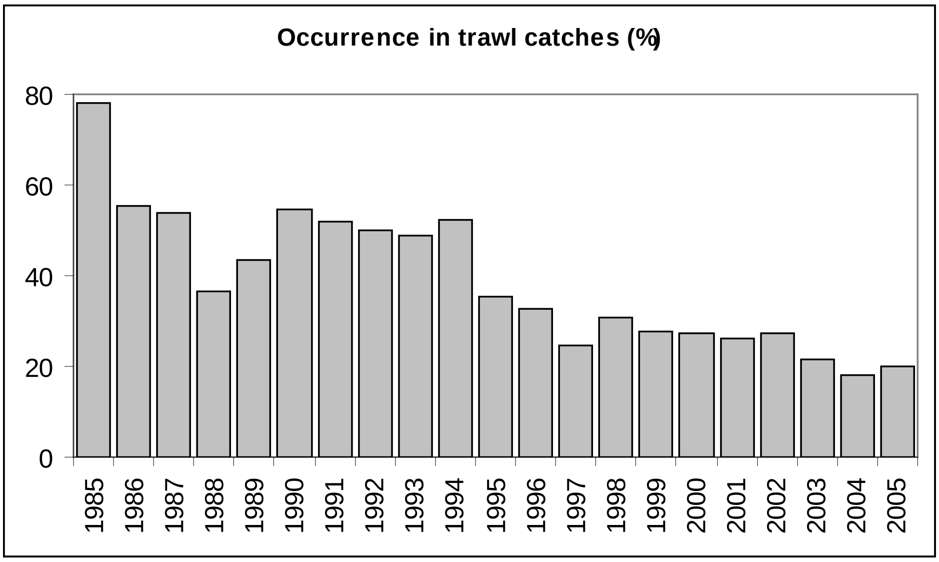




**Figure 2.12. Spurdog in the NE Atlantic. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h–1. (Source: ICES, 2006).**

a)




b)

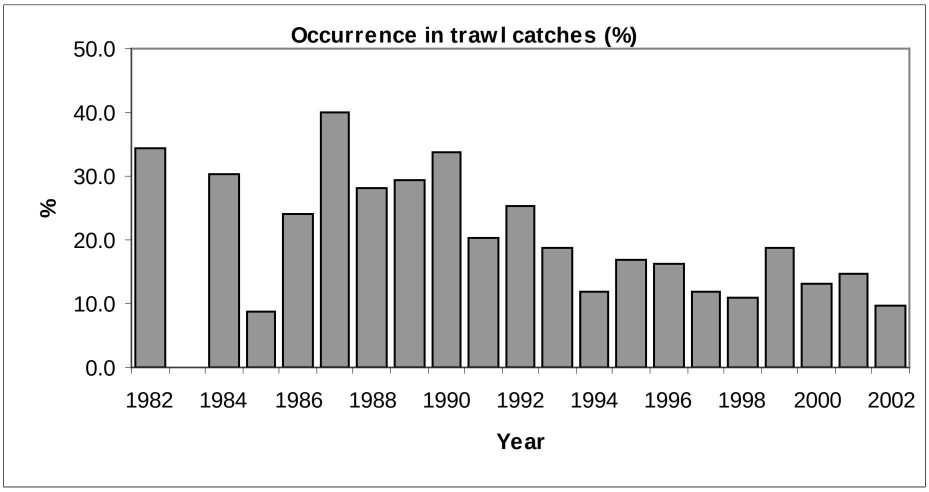



**Figure 2.13. Spurdog in the NE Atlantic. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).**

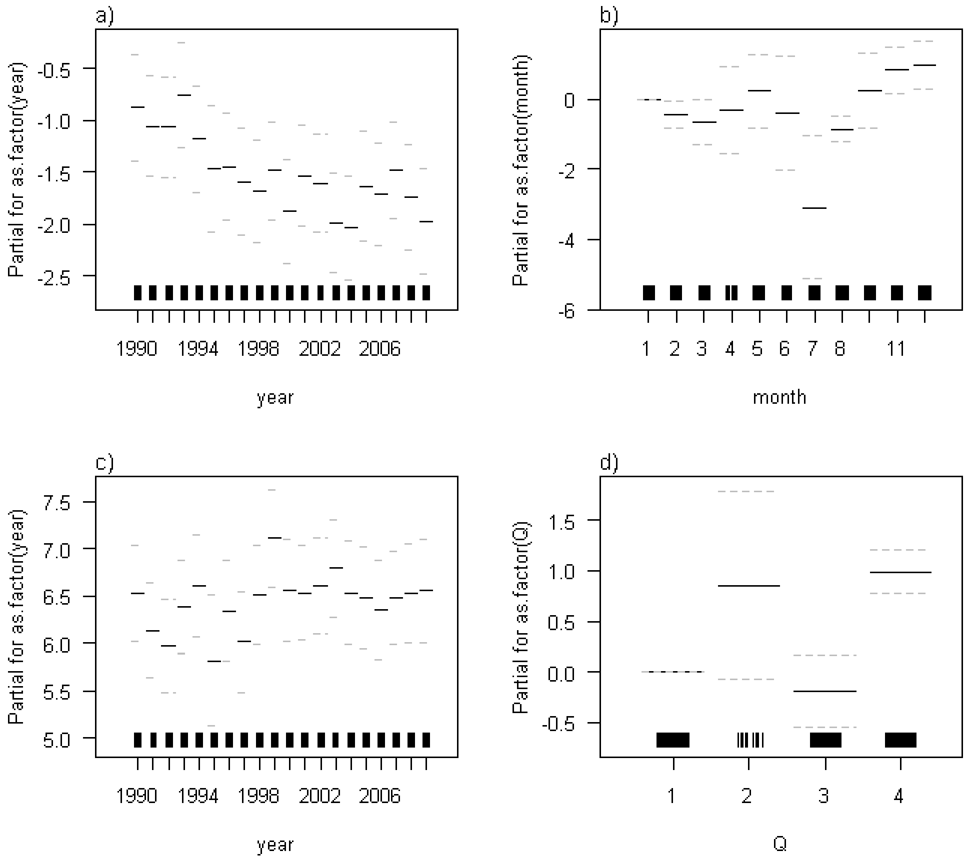



**Figure 2.14. Northeast Atlantic spurdog. Estimated year and quarter effects (± 1 s.e.) from the delta-lognormal GLM: binomial model shown in a) and b), and lognormal results in c) and d) (log scale).**

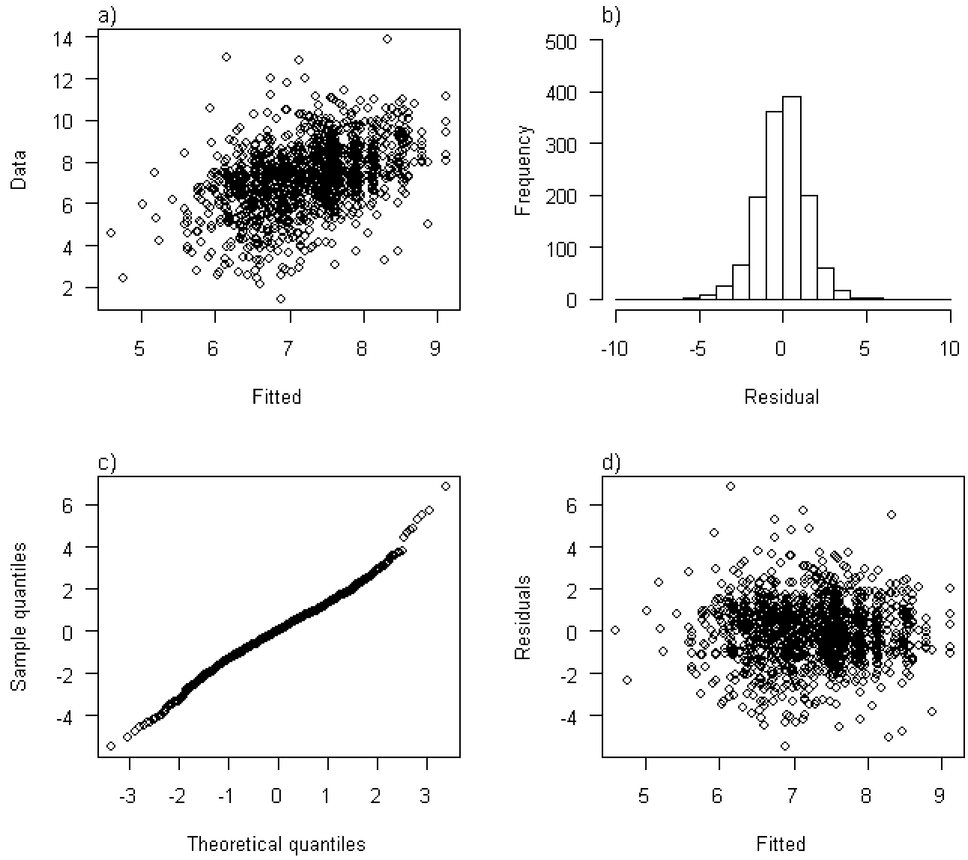



**Figure 2.15. Northeast Atlantic spurdog. Analysis of Scottish survey data. Residual plot of final lognormal model fit: a) observed vs. fitted values, b) histogram of residuals, c) normal Q-Q plot and d) residuals vs. fitted values.**

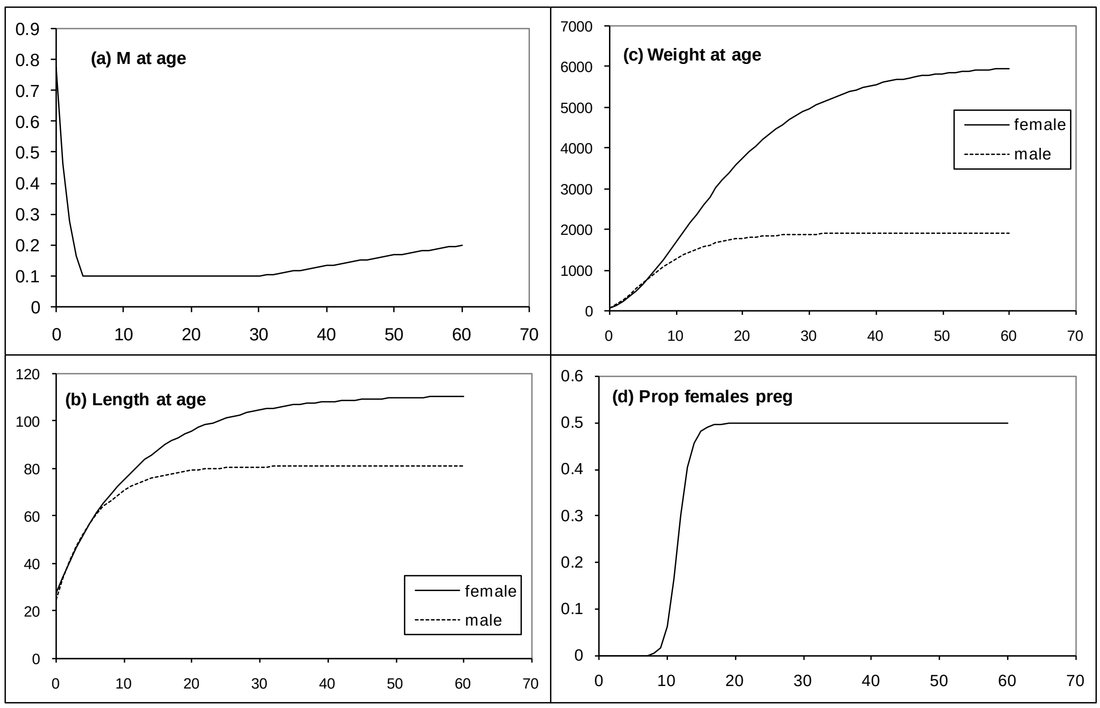



**Figure 2.16. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.5.**

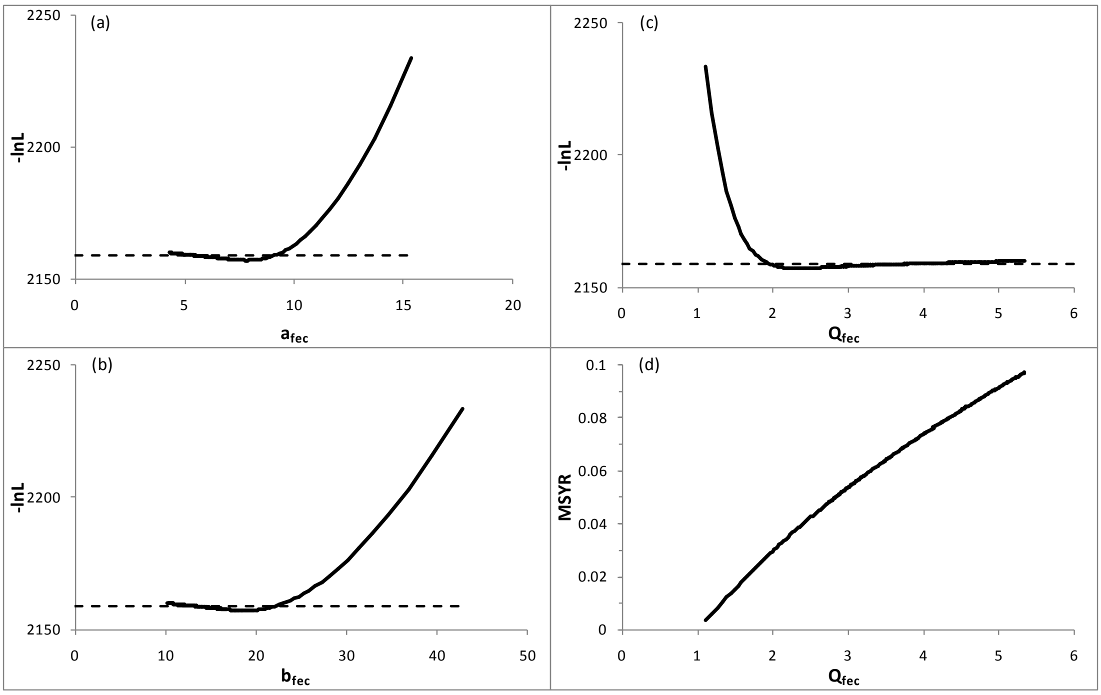



**Figure 2.17. Northeast Atlantic spurdog. Negative log-likelihood (-ln*L*) for a range of (a) $a_{fec}$ and (b) $b_{fec}$ values, with (c) corresponding $Q_{fec}$. Plot (d) shows MSYR (MSY/$B_{MSY}$) vs. $Q_{fec}$. Using the likelihood ratio criterion, the hashed line in plots (a)-(c) indicate the minimum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

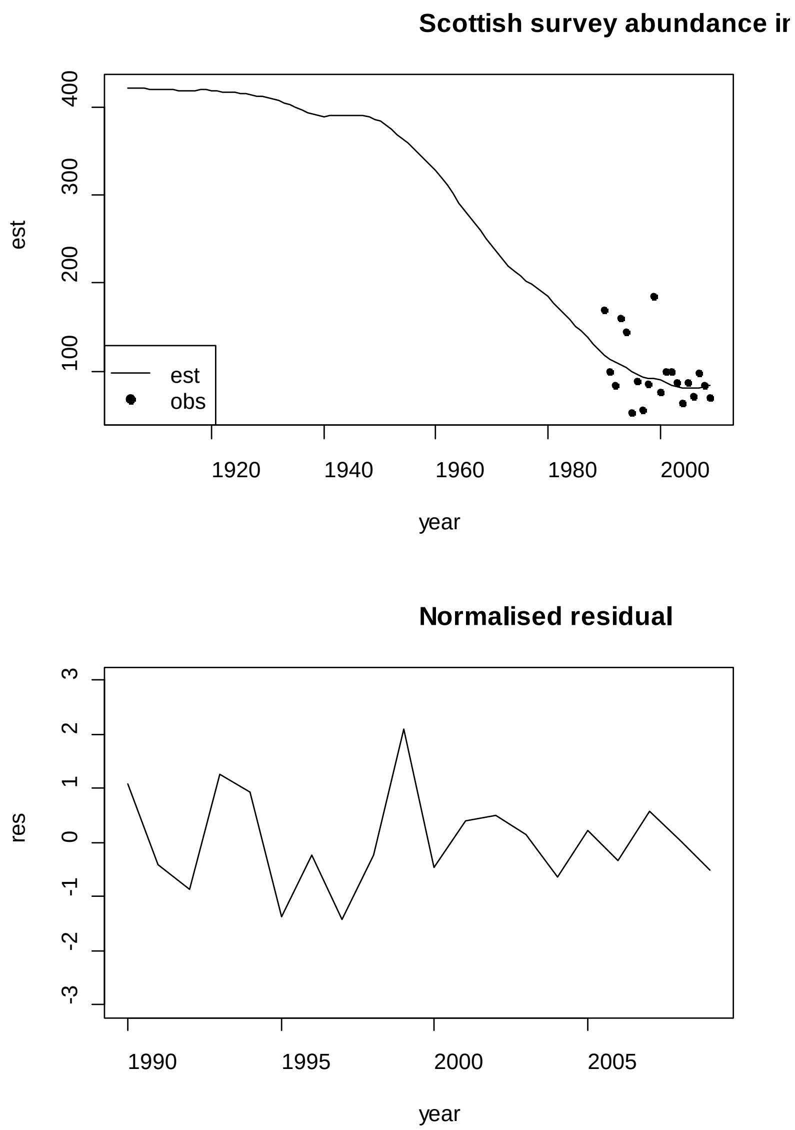



**Figure 2.18. Northeast Atlantic spurdog. A Model fit to the Scottish surveys abundance index (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in equation 2.9b) (bottom).**

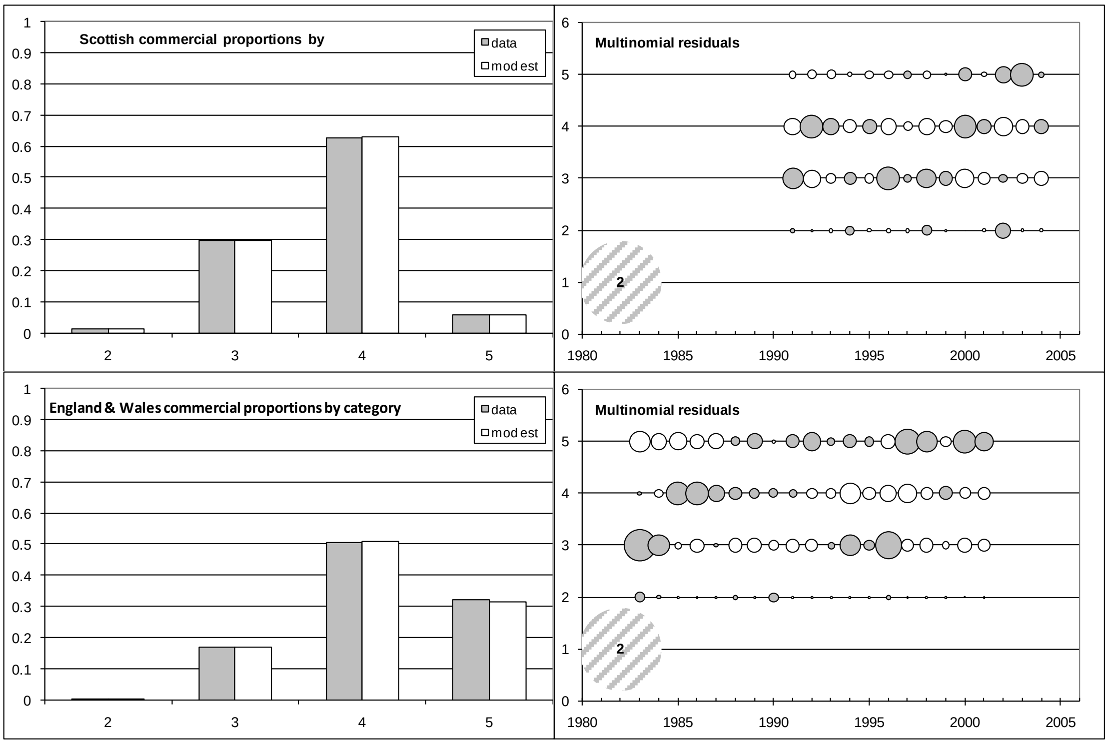



**Figure 2.19a. Northeast Atlantic spurdog. Model fits to the Scottish (top row) and England & Wales (bottom row) commercial proportions-by-length category data for the base-case run. The left-hand side plots show proportions by length category averaged over the time period for which data are available, 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.**

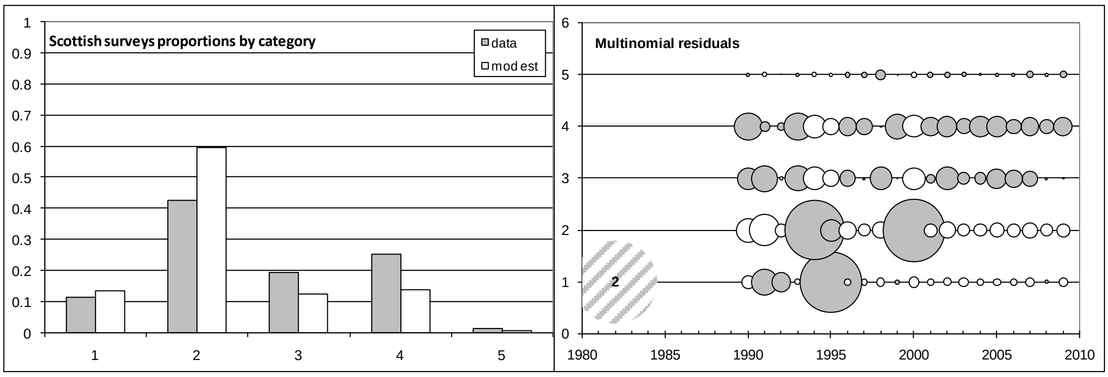



**Figure 2.19b. Northeast Atlantic spurdog. Model fits to the Scottish survey proportions-by-length category data for the base-case run. A further description of these plots can be found in the caption to Figure 2.19a. Length categories considered are 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70–84 cm; 5: 85+ cm.**

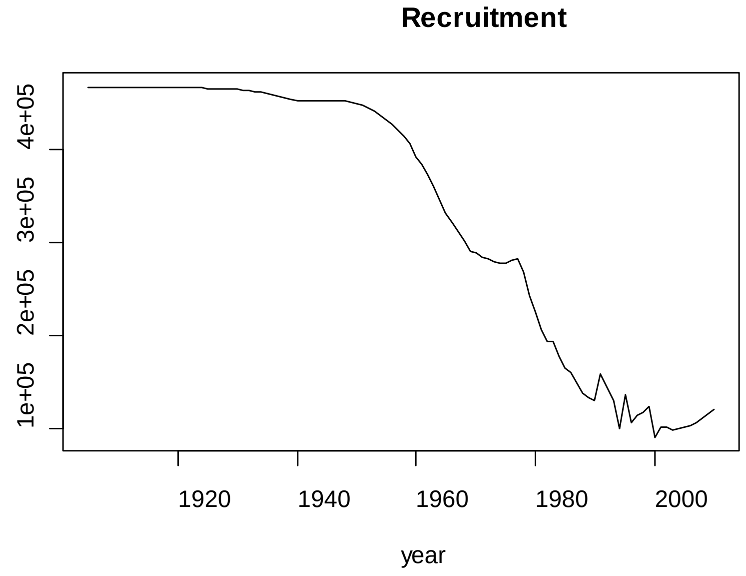



**Figure 2.20. Northeast Atlantic spurdog. A comparison of the deterministic ($N_{pup}$) and stochastic ($R$) versions of recruitment (equations 2.2a–c) (top panel) with normalised residuals ($\varepsilon_{r,y}/\sigma_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model) (bottom).**

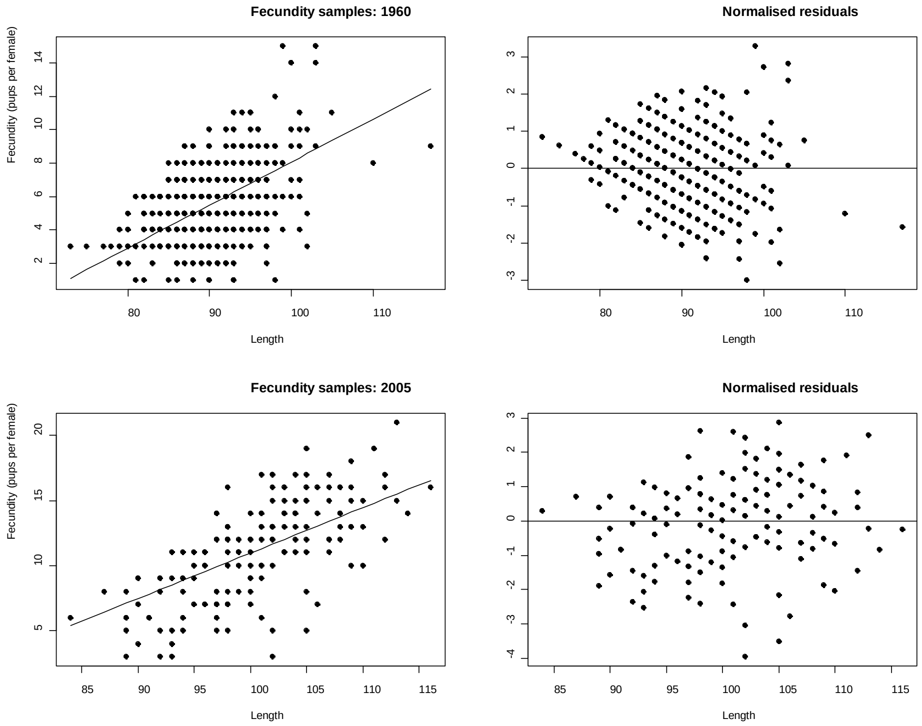



**Figure 2.21a. Northeast Atlantic spurdog. Fecundity data from two periods: top–1960 and bottom–2005, with fits shown on the left, and normalised residuals ($\varepsilon_{fec,k,y}$ in equation 2.11b) on the right.**

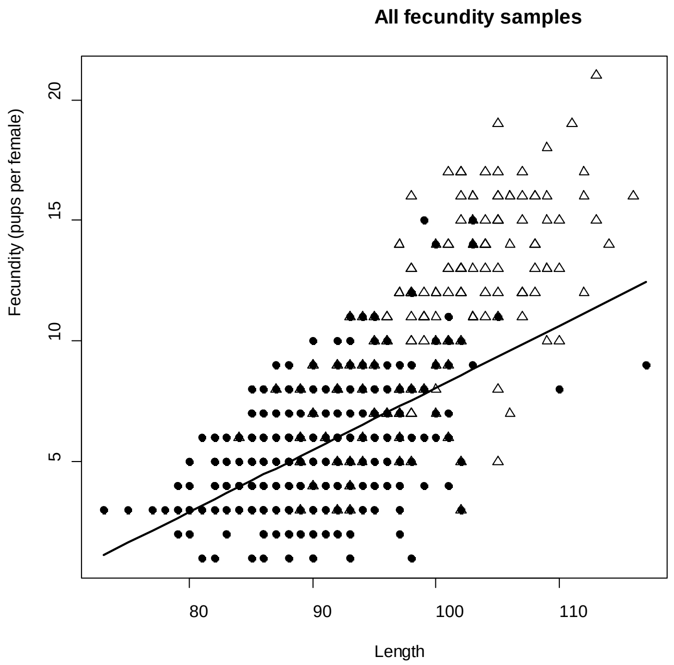



**Figure 2.21b. Northeast Atlantic spurdog. Plotting all the fecundity data together, with the fitted curves (open triangles=1960, solid circles=2005).**

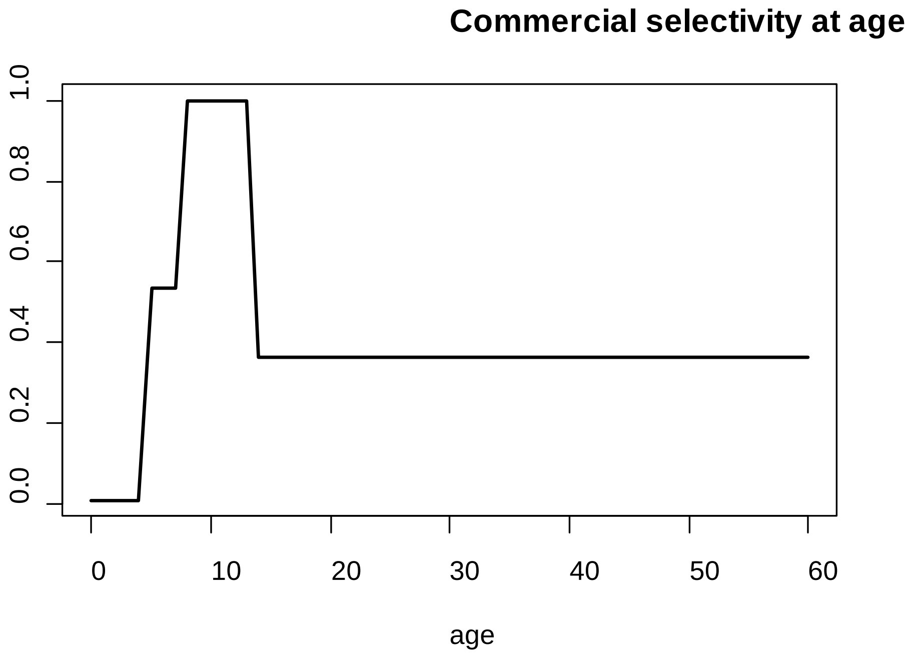



**Figure 2.22. Northeast Atlantic spurdog. Estimated commercial (top panel) and survey (bottom) selectivity-at-age curves for the base-case run. The two commercial fleets considered have Scottish (Sco) and England & Wales (E&W) selectivity, which differ by sex because of the life-history parameters for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

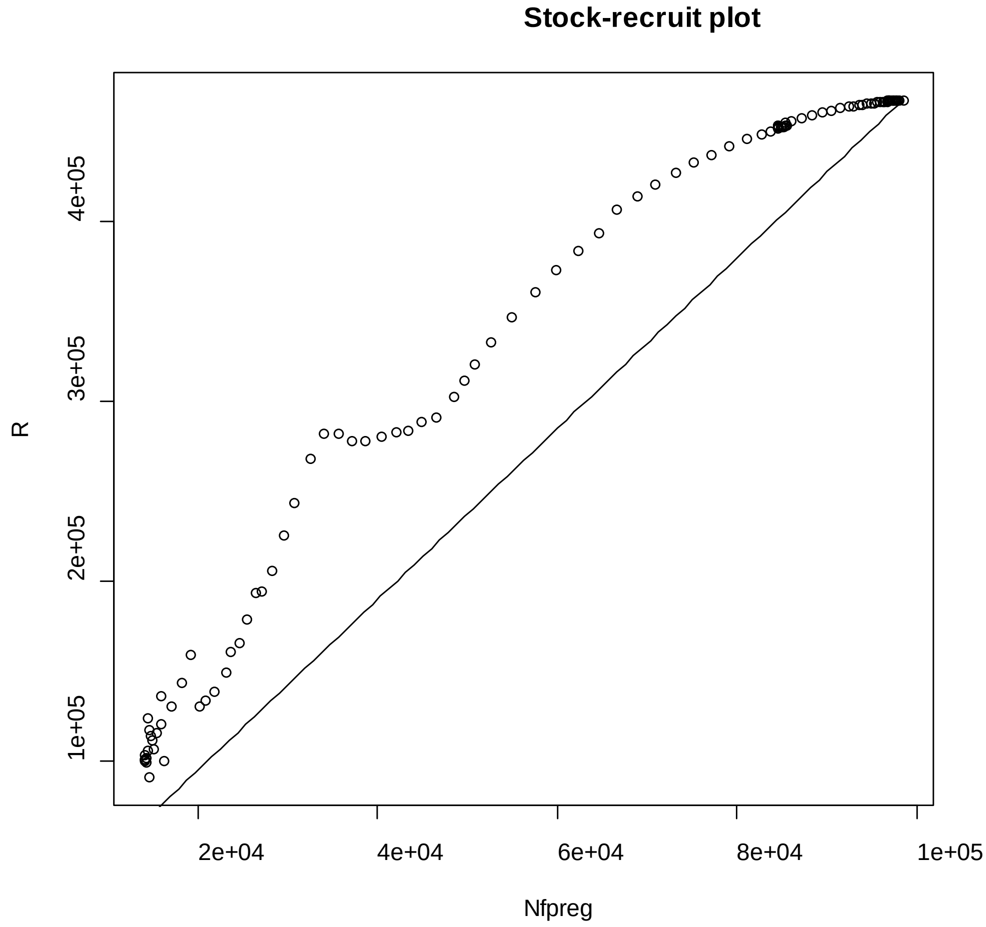



**Figure 2.23. Northeast Atlantic spurdog. A plot of recruitment (*R*) vs. number of pregnant females (open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).**

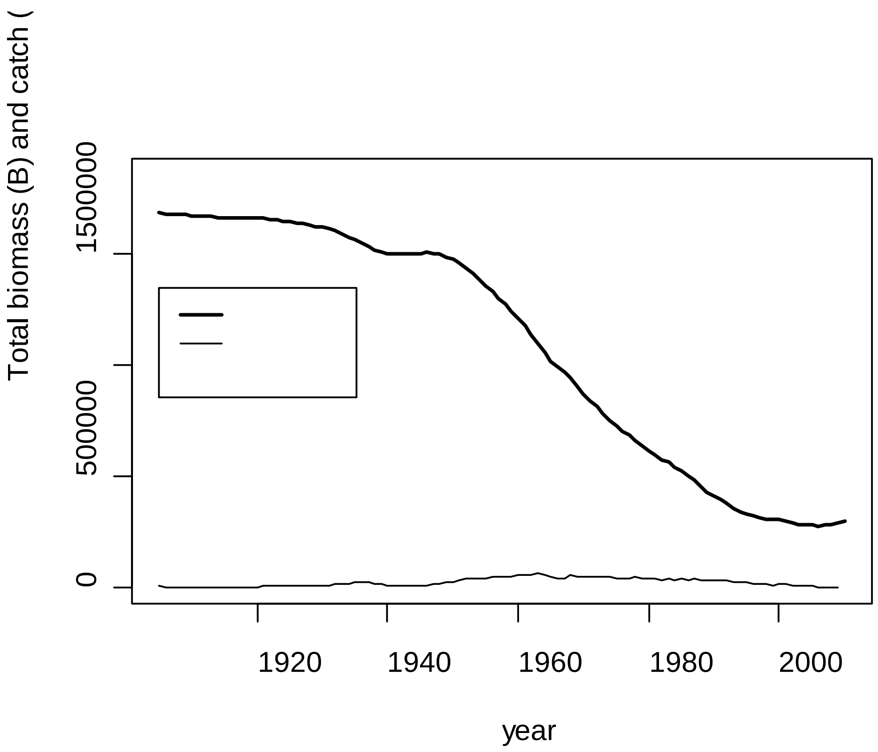



**Figure 2.24. Northeast Atlantic spurdog. Estimates of total biomass (*B*) and mean fishing proportion ($F_{prop5\text{-}30}$) are shown in the top panel together with observed total annual catch (*C*), with the bottom panel repeating the information, but without the total biomass to show more detail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

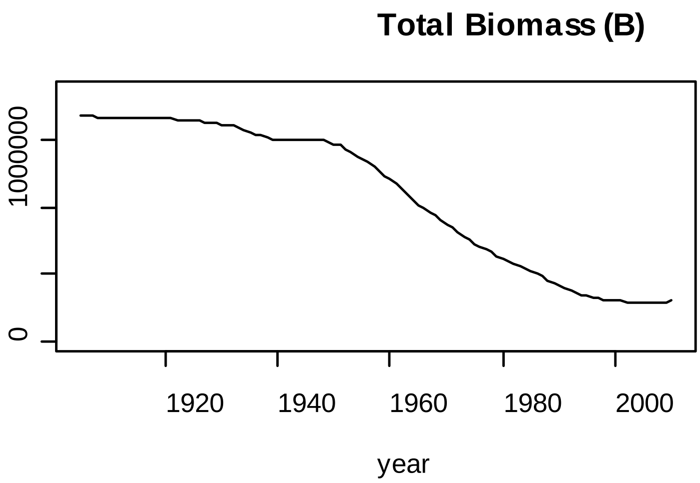



**Figure 2.26. Northeast Atlantic spurdog. A repeat of Figure 2.25 (omitting probability intervals for clarity), giving a 5-year retrospective comparison (the model was re-run, each time omitting a further year in the data).**

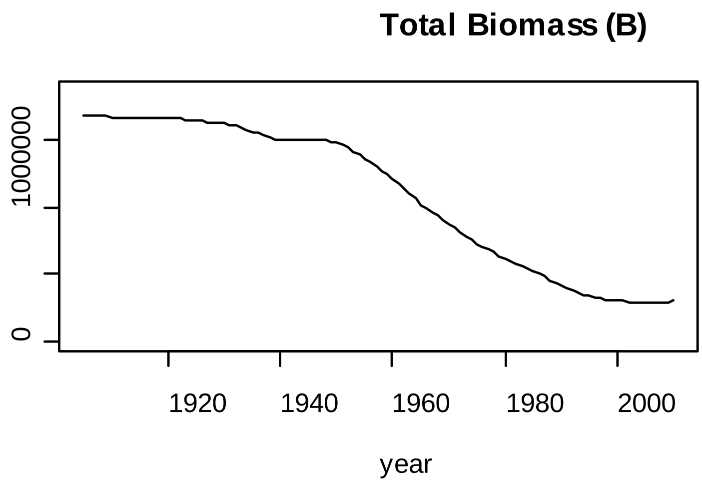



**Figure 2.27a. Northeast Atlantic spurdog. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production ($Q_{fec}$). Three alternative values are considered, related to the smallest, optimum (in terms of lowest –ln*L*) and largest value of $Q_{fec}$ below the hashed line in Figure 2.17c (respectively 1.94 [base case], 2.31 and 3.98).**

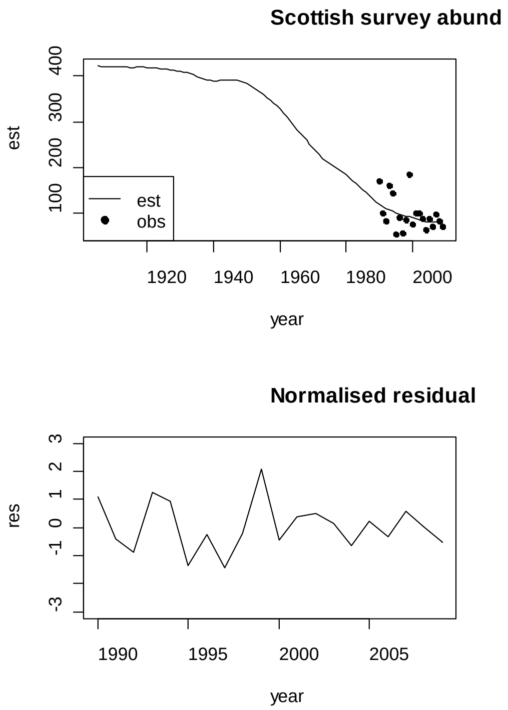



**Figure 2.27b. Northeast Atlantic spurdog. A demonstration of the deterioration of the model fit to the Scottish survey data as $Q_{fec}$ increases. Left-hand side: $Q_{fec}$=1.94; right-hand side: $Q_{fec}$=3.98.**

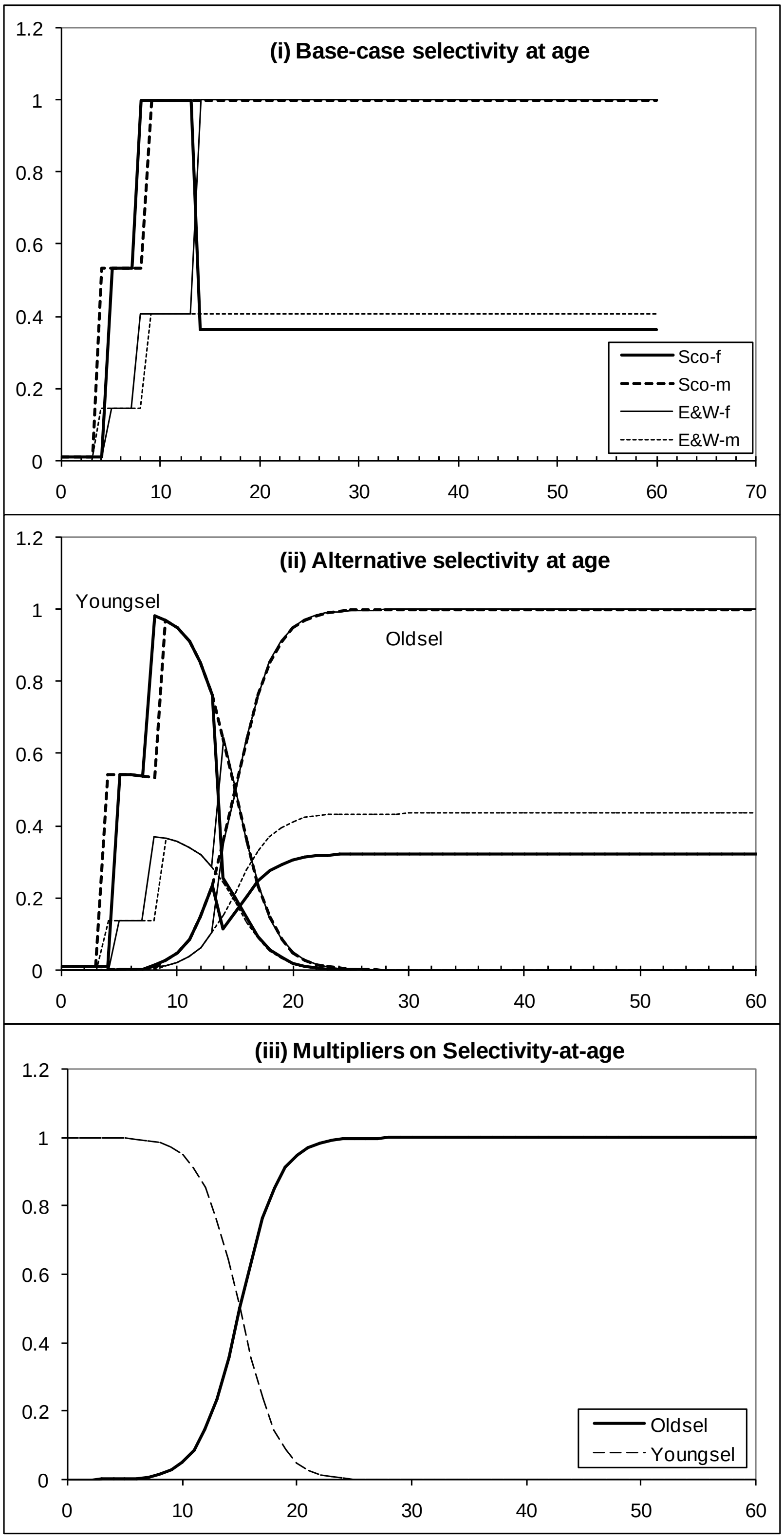



**Figure 2.28a. Northeast Atlantic spurdog. Alternative assumptions for selection-at-age for the period prior to 1980, with (i) showing the base-case option, (ii) the two alternative scenarios reflecting selection of younger ("youngsel") and older ("oldsel") animals, and (iii) the multipliers on the base-case selection used to obtain the selection patterns in (ii).**

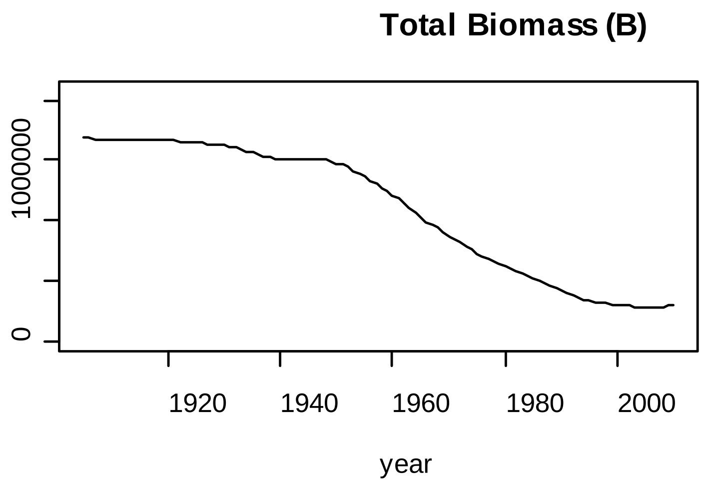



**Figure 2.28b. Northeast Atlantic spurdog. A comparison of the alternative assumptions for selection-at-age prior to 1980, corresponding to the selection patterns shown in Figure 2.28a(i) and (ii).**

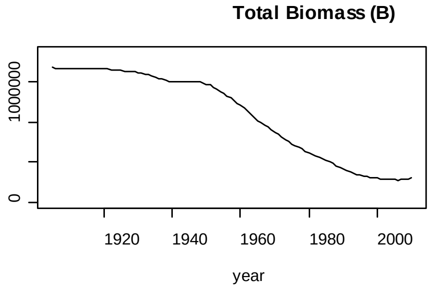



**Figure 2.29. Northeast Atlantic spurdog. A sensitivity analysis of recruitment assumptions. Left-hand side: sensitivity to recruitment variability ($\sigma_r$), with three alternative values are considered: $\sigma_r$ = 0.1, 0.2 (the base-case option) and 0.3. Right-hand side: sensitivity analysis of the starting year for estimating recruitment deviations, with three alternative starting years are considered: 1950, 1960 (the base-case option) and 1970.**

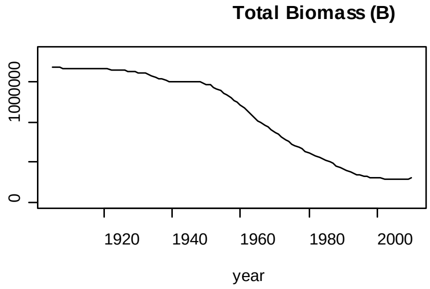



**Figure 2.30. Northeast Atlantic spurdog. A sensitivity analysis of the weighting of the proportion-by-length category data. Left-hand side: alternative effective sample sizes, shown in the legend in order of fleet/survey (Scottish commercial, England & Wales commercial, and Scottish survey; base-case=20, 20, 10). Right-hand side: alternative within-series weighting for the commercial fleets, reflecting equal weighting (base-case, where $n_{pcom,j,y} = \bar{n}_{pcom,j}$ is assumed) or annual weighting depending on raised number of samples.**

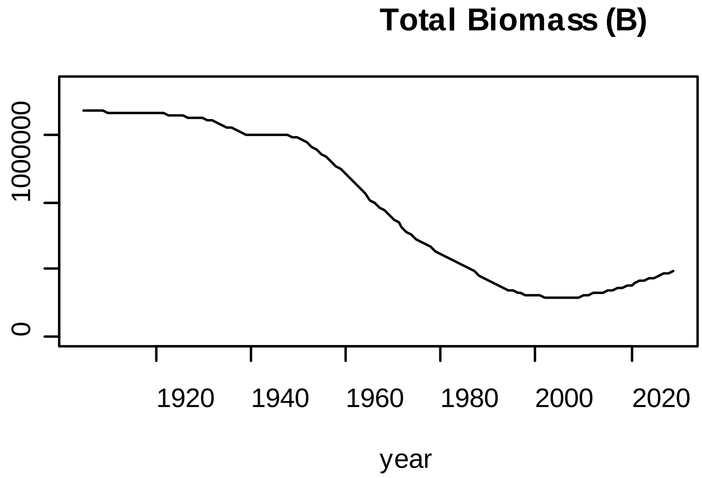



**Figure 2.31a. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the average catch for 2004–2008 (Cav=5268 tons).**

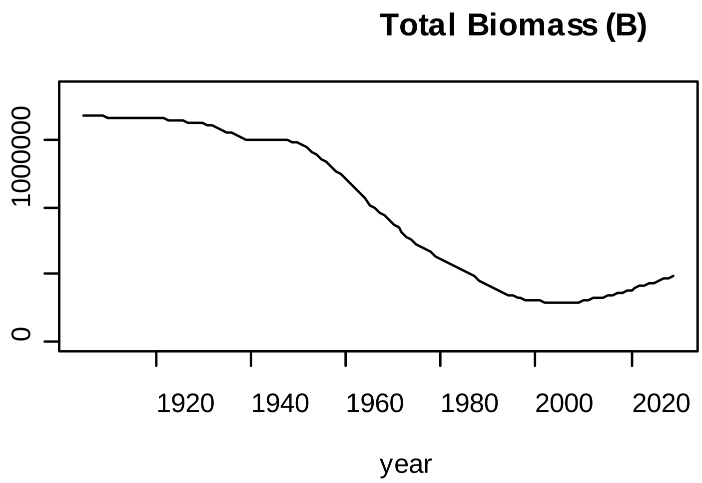



**Figure 2.31b. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the 2009 TAC (TAC09=1422 tons). These are shown together with exploitation at $F_{MSY}$.**

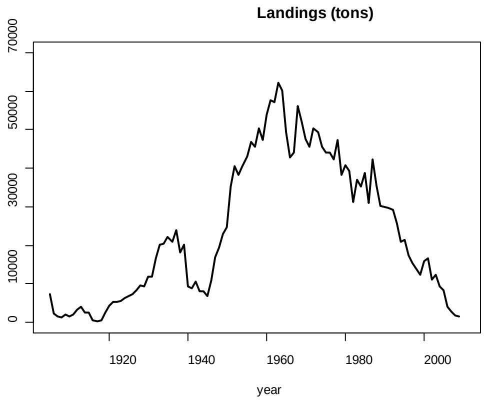



**Figure 2.32. Northeast Atlantic spurdog. Summary four-plot for the base-case, showing long-term trends in landings (tons), recruitment (number of pups), mean fishing proportion (average ages 5–30, dotted horizontal line=$F_{MSY}$=0.024) and total biomass (tons). Hashed lines reflect estimates of precision (±2 standard deviations).**

# 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. The mtDNA is not very adequate for analyzing the population structure of elasmobranchs. Although the microsatellites are considered a more 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.

STECF, 2006 presented a review of available information on deep-water shark gillnet fisheries. After the ban on gillnet fisheries in the northern area, gillnet and longline fisheries developed in Subarea VIII and Division IXb in 2006.

Leafscale gulper shark and Portuguese dogfish are both taken in several mixed trawl fisheries and mixed longline fisheries. They are taken as a bycatch in other fisheries, for example the anglerfish gillnet fishery. There was a directed Spanish (Basque country) longline fishery in Subarea VIII from 1995–2005, this stopped in 2006 (although bycatch was still taken), re-started in 2007 and ceased in 2009.

Information on the French fishery from industry–science partnerships refers that since 2000 new areas have been fished in this period (Biseau, 2008b WD) and there is a slight tendency for recent catches of deep-water sharks be derived from shallower depths (Biseau, 2008a WD), possible reflecting a change in fishing pattern.

The analysis of French trawler information on number or vessel, nominal fishing effort that the fishery for deep-water species and in particularly for deep-water sharks, indicates that the fishing activity on deep-water species been greatly reduced (Tables 3.1. and 3.2).

### 3.2.2 The fishery in 2009

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 (Subdivision 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 7 days at depths between of 450–850 m (a total of 50 000 hooks were set).

### 3.2.3 ICES advice applicable

No advice was provided in 2009. The 2008 advice was valid for 2009 and 2010.

In 2008, given the very poor state of Portuguese dogfish and leafscale gulper shark, ICES recommended a zero catch. This recommendation was based on cpue information available. Portuguese dogfish and leafscale gulper shark were considered depleted despite the fact that the rates of exploitation and stock sizes of deep-water sharks could not be quantified.

In 2006, ICES noted substantial declines in cpue series for both *C. coelolepis* and *C.*

*squamosus* in Subareas VI, VII and XII, suggesting that the stocks of both species were depleted. Cpue for both species in the northern area (VI, VII and XII) had displayed strong downward trends leading to the conclusion that the stocks were being exploited at unsustainable levels. In Division IXa, cpue series, although short, appeared to be stable.

In 2006, ICES advised that no target fisheries should be permitted unless there were reliable estimates of current exploitation rates and stock productivity. ICES advised that the TAC should set at zero for the entire distribution area of the stocks and additional measures should be taken to prevent by catch of Portuguese dogfish and leafscale gulper shark in fisheries targeting other species.

### 3.2.4 Management applicable

The TAC 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: Portuguese dogfish, leafscale gulper shark, birdbeak dogfish (*Deania calceus*), kitefin shark (*Dalatias licha*), greater lantern shark (*Etmopterus princeps*), velvet belly (*Etmopterus spinax*), black dogfish (*Centroscyllium fabricii*), gulper shark (*Centrophorus granulosus*), blackmouth dogfish (*Galeus melastomus*), mouse catshark (*Galeus murinus*), and Iceland catshark (*Apristurus* spp).

| 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) |

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

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

A number of effort regulations also apply to these deep-water shark species. Council of the EU Regulation (EC) No 2347/2002 sets maximum capacity and power (kW) ceilings on individual member states' fleets fishing for deep-water species.

Council Regulation (EC) No 27/2005 sets a limit of effort (kilowatt*days) at 90% the 2003 level for 2005, and in at 80% for 2006.

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.

Council Regulation (EC) No 881/2008 prohibited fishing for deep-sea sharks in Community waters and waters not under the sovereignty or jurisdiction of third countries of V, VI, VII, VIII and IX by vessels flying the flag of Portugal.

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 3.3–3.4.

In 2006, WGEF produced estimates of landings of each of these species (ICES, 2006). This has not been updated since. In 2008 France presented a split of French landings, by species (Biseau, WD 2008a), but the ratios were not used by WGEF because they were derived from 1990s data on species abundance-by-depth which is no longer valid, as a consequence of the declining relative abundance of Portuguese dogfish.

It can be seen that 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.

Although some countries did not report the 2009 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 deterrent the commercial exploitation of deep-water shark but is also likely that misreporting problems have increased.

Information on deep-water shark catches made by Russian vessels operating in 2009 in various areas is summarized in Table 3.5.

### 3.3.2 Discarding

New discard data was made available from Portuguese longliners. The onboard sampling programme of the Portuguese deep-water longliners started in mid-2005 and is included in the EU DCR/NP. IPIMAR is responsible for the sampling programme which is programmed to take place once a month on randomly selected vessels belonging to that fleet component. The sampling is made difficult by the small number of vessels and their overall small size which put considerable logistical and safety constraints to the sampling programme. . In 2009, six fishing trips were sampled. Setting operations lasted about two hours, while the retrieving operations took between 10 and 17 hours. The number of hooks used varied between 9000 and 10 800 hooks per trip and sardine was the main bait used. The setting depth of the gear averaged 1097 meters and soaking time ranged 29 to 38.5 hours. Black scabbardfish predominated in the catches (93% of catches in number) followed by Leafscale Gulper shark and *Etmopterus pusillus*. The 2009 results are in agreement with the observed in previous years (Fernandes and Ferreira, 2006; Fernandes *et al*., 2008; Fernandes *et al*., 2009). Results show that both landings and discards (in numbers) of Portuguese dogfish or Leafscale gulper shark are reduced (Table 3.6).

Despite the lack of information on quantities discarded for the remaining deep-water fisheries it is expected that discarding has increased, as a consequence of management regulations (e.g. bycatch limits; quota may be limited for some fleets).

### 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. In recent years other MS have increased species-specific reporting of landings but some of these data may contain misidentifications.

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.

Nevertheless it is admitted 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. Since the introduction of quotas on deep-water sharks in 2005, it is likely that some underreporting has occurred.

Better estimates of discards are required for all deep-water fisheries. The actual sampling levels required by DCF are considered inadequate for these stocks.

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

## 3.4 Commercial catch composition

### 3.4.1 Species composition

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

In 2006 WGEF siki landings were split by species using data available of species proportion by MS, fishery and ICES subarea. When such data were not available for a particular MS the proportion estimated to a similar fishery/subarea was adopted. Although many assumptions were made in order to reconstruct landings, the WGEF considered that they represented the best estimates of recent and historical catches of these species that can be produced.

Information recently received from France refers that between 1990s and 2001 all the French trawlers reported all catch of deep-water sharks as siki. It is also mentioned that in the 1990s only the larger deep-water sharks, Portuguese dogfish and leafscale gulper shark, were landed. After 2001 some vessels began to sort the catches by species. It is considered that for the period 2002–2008, the leafscale gulper shark was properly identified However Portuguese dogfish and longnose velvet dogfish were both landed together and not distinguished by the industry. It is further referred that those two species are the only ones landed together (Table 3.7 item CYO+CYP) because the other deep-water shark with commercial value, *Centrocyllium fabricii*, is sold and recorded separately as black dogfish.

### 3.4.2 Length composition

Length frequency information for Leafscale gulper (Figure 3.3) and for Portuguese dogfish (Figure 3.4) was provided for 2009 from the Portuguese longline fishery operating in ICES Division IXa (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, standardized lpue from Portuguese longliners data were presented for each species in separate (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 of previous analyses was that to analyse commercial catch rate data of each deep-water shark species it is necessary to have information on the fishing locations. Furthermore the efforts done to circumvent the inexistence of VMS data for the period other than 2000–2004 by considering other factors, 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).

Individual daily landings of Portuguese dogfish (CYO) and of Leafscale gulper shark (GUQ) and per fishing vessel were reanalysed for the period 1995–2006. After 2007 despite daily landings were available they were considered not reliable. For both species, data used were restricted to daily landings with more than 10% of the total landing of the species in analysis. A generalized linear model (GLM) was fitted to daily landing data available for each species. The GLM considered the factors VESSEL, YEAR*BSF/TOTAL CATCH, MONTH, and the relations between GUQ/TOTAL CATCH and CYO/TOTAL CATCH for the Portuguese dogfish and leafscale gulper shark, respectively. A lognormal distribution with an identity link function was adopted. The results reinforced the importance of spatial effects on the abundance index estimates of these species. For 2007 onwards only two observations obeyed to the 10% criterion and for both of them the predicted values (obtained using the selected GLM models) were much higher than the observed (Figueiredo *et al.*, 2010).

New French standardised landings per unit of 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. A Generalised Additive Models was adjusted using depth, vessel, statistical rectangle, area and year as explanatory variables (method described in Lorance *et al.*, 2010). Following, the results obtained with EC-logbook data (Biseau, 2006WD), lpues were estimated in five small areas (Figure 3.5). 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 (Figure 3.6). Abundance indices could not be derived for all five small areas probably owing to 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 where more than one vessel has operated the standardised cpue biomass index indicates a decrease over time, where the abundance in recent years is between one half and one third of the abundance in 1993–1996 (Figure 3.7). 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. However since 2000 the survey has been reasonably consistent in survey design, gear deployed and area covered (Jones *et al.*, 2005). The survey uses a large commercial trawl (made by Jackson) and is towed for a period of 1.5–2 hours at speeds of 3–3.5 knots. Initially, the survey was carried out on a biennial basis, but since 2004 has been carried out annually. Distributions of positions fished in this survey are shown in Figures 3.8 and 3.9 and number of hauls per year and depth category in Table 3.8.

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. Parallel tows are carried out in the northernmost area with Scotland for inter-calibration purposes. The survey took place in September from 2006–2008 and in December 2009. After this the survey will become biennial, beginning in 2011.

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 (PGNEACS).

## 3.7 Life-history information

No new information since 2006.

## 3.8 Assessments

### 3.8.1 Exploratory assessment

#### 3.8.1.1 Portuguese dogfish

During WKDEEP 2010 an exploratory model was presented. Due to uncertainties on data from others ICES subareas namely VI and VII was applied to only one portion of the region adopted by ICES as assessment unit. The demographic model proposed is a state-space model that divides the population system dynamics into two processes running in parallel: an unobserved process that describes the female population abundance in number, and an observational model, annual catches, that allows establishing the connection between the unknown states. As outputs of the model are estimates of the population abundance in number along the time range, as well as the posterior estimates of some vital parameters of the species and of the fishery. In the approach made during the Benchmark only the females' population abundance was considered.

According to the model the state of the population at each successive time-steps, {nt, t=0,1, …, T} is described by unobserved vectors denoting the annual female population abundance in number in January of year t. The state vectors are constituted by four components, two of those representing the females that have survived to fishing, further subdivided into two Length groups-juveniles (length <101.2 cm) and adults (length 101.2 cm).

For further details on the methodology see ICES WKDEEP Report 2010 Section 5.

WKDEEP recommended running the model for the dataset presented for the fisheries taken in the northern areas as an exploratory assessment. It was further recommended to adapt the model in order to accommodate the male population in the state vectors for the next WGEF meeting.

### 3.8.2 Assessment

In two last years the assessment of both Portuguese dogfish and Leafscale gulper shark for more recent years only relied on fishery independent data: Scottish and Irish surveys.

The total fishing effort of Scottish survey by latitude and depth is presented in Figure 3.9. Both the surveyed area and sampling effort have changed over years. In particular, in 2005 the southern areas were not surveyed. Furthermore in 2009 fishing haul duration has been reduced from 2 h to 1 h.

The new fishery-dependent data present on French trawlers and Portuguese longliners were considered not adequate for assessing both Portuguese dogfish and Leafscale gulper shark.

Irish survey covers a small time-series (Figure 3.14, 3.15–Portuguese dogfish, 3.16–Leafscale gulper shark) and WGEF considers that a longer time-series are required so that trends can be determined.

#### 3.8.2.1 Portuguese dogfish

Trends on cpue over years are different for different depth strata (Figure 3.12). The largest reduction on cpue was observed in two shallower strata.

At the deepest depth stratum changes either on the frequency of occurrence and on cpue have been low over the entire range of years.

#### 3.8.2.2 Leafscale gulper shark

The deepest stratum (>1550 m) show the highest cpue values in all the years (Figure 3.13). At this stratum both frequency of occurrence and cpue do not show great change along years.

At the two remaining strata (500–999; 1000–1499) the declines on the frequency of occurrence were quite marked.

## 3.9 Quality of assessments

The use of fishery-dependent data on Portuguese dogfish or Leafscale scale gulper for assessment purposes is not expected to continue to be used in the future due restrictive quotas for either Portuguese dogfish and Leafscale gulper shark.

Furthermore fishery-independent data are just derived from surveys take place in a restricted area of the whole distribution areas considered for each of the two stocks.

These surveys were also not specifically designed to estimate abundance indices of either Portuguese dogfish or Leafscale gulper shark.

WGEF considers that the information available is insufficient to monitor the stocks of the two species, as well as, to evaluate the evolution of their status in the future. To provide fisheries data for future assessments it may desired to establish small-scale sentinel fishery, particularly in the southern areas.

The analysis on survey data on both occurrence and cpue reinforce the recommendation for species not to be assessed together.

## 3.10 Reference points

Precautionary reference points of $U_{lim}$ = 0.2* virgin biomass and $U_{pa}$ = 0.5* virgin biomass were proposed by the SGDEEP in 1998 (ICES, 1998) in common with some other deep-water stocks. However, abundance indices may not correspond to the start of the fishery and so virgin levels are not known.

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.

## 3.11 Management considerations

On the basis of their life-history parameters, being slow-growing and late maturing, these two species are considered highly vulnerable to exploitation.

There is no new information since 2008, to alter our perception of the status of these stocks "Due to its very low productivity, Portuguese dogfish and leafscale gulper shark can only sustain very low rates of exploitation. The rates of exploitation and stock sizes of deep-water sharks cannot be quantified. However, based on the cpue information, Portuguese dogfish and Leafscale gulper shark are considered to be depleted. Given their very poor state, ICES recommends a zero catch of Portuguese dogfish and Leafscale gulper shark".

The ban on gillnetting has led to some diversion of effort to West Africa.

IUU fishing is known to take place in international waters, and this may be continuing.

Further studies of biology and stock discrimination are still required.

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**Table 3.1. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French fleet of fresh fish trawlers, vessels having landed more than 5 tonnes of deep-water sharks, number of vessels, total power (kw), number of days at sea and days fishing, fishing effort (fishing days* 1000 kw).**

| Year | Number of vessels | Total power (kw) | Days at sea | Fishing days | Fishing effort |
|---|---|---|---|---|---|
| 1989 | - | - | - | - | - |
| 1990 | 6 | 8935 | 545 | 545 | 811 |
| 1991 | 10 | 14 911 | 1091 | 1091 | 1623 |
| 1992 | 40 | 46 034 | 5285 | 5285 | 6070 |
| 1993 | 44 | 46 002 | 6253 | 6253 | 6332 |
| 1994 | 48 | 46 957 | 6143 | 6143 | 5899 |
| 1995 | 49 | 48 361 | 6008 | 6008 | 5398 |
| 1996 | 44 | 43 063 | 6460 | 6460 | 6051 |
| 1997 | 40 | 38 059 | 5977 | 5977 | 5617 |
| 1998 | 36 | 31 759 | 5907 | 5907 | 5295 |
| 1999 | 41 | 34 225 | 6252 | 5583 | 4887 |
| 2000 | 45 | 38 617 | 7602 | 6428 | 5825 |
| 2001 | 47 | 46 374 | 7358 | 6121 | 6362 |
| 2002 | 38 | 39 019 | 5920 | 4600 | 4911 |
| 2003 | 29 | 29 744 | 4843 | 3834 | 4112 |
| 2004 | 27 | 28 944 | 5099 | 4068 | 4408 |
| 2005 | 23 | 26 813 | 4045 | 3015 | 3430 |
| 2006 | 24 | 23 362 | 4024 | 3119 | 3129 |
| 2007 | 18 | 18 110 | 2999 | 2368 | 2484 |
| 2008 | 16 | 17 025 | 3197 | 2485 | 2680 |

**Table 3.2. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French fleet of fresh fish trawlers, vessels having landed more than 100 tonnes of deep-water sharks per year, number of vessels, total power (kw), number of days at sea and days fishing, fishing effort (fishing days* 1000 kw).**

| Year | Number of vessels | Total power (kw) | Days at sea | Fishing days | Fishing effort |
|---|---|---|---|---|---|
| 1989 | - | - | - | - | - |
| 1990 | - | - | - | - | - |
| 1991 | 6 | 8935 | 561 | 561 | 835 |
| 1992 | 8 | 11 879 | 889 | 889 | 1319 |
| 1993 | 14 | 20 356 | 1727 | 1727 | 2489 |
| 1994 | 9 | 13 439 | 1010 | 1010 | 1509 |
| 1995 | 11 | 15 794 | 1457 | 1457 | 2056 |
| 1996 | 13 | 18 738 | 1754 | 1754 | 2505 |
| 1997 | 7 | 9906 | 1023 | 1023 | 1426 |
| 1998 | 5 | 6771 | 936 | 936 | 1266 |
| 1999 | 9 | 8832 | 1959 | 1615 | 1615 |
| 2000 | 12 | 13 248 | 2986 | 2321 | 2573 |
| 2001 | 12 | 17 855 | 2745 | 2055 | 3053 |
| 2002 | 5 | 6918 | 1145 | 810 | 1116 |
| 2003 | 3 | 4794 | 610 | 431 | 677 |
| 2004 | 2 | 3322 | 420 | 359 | 589 |
| 2005 | 1 | 1850 | 265 | 165 | 305 |
| 2006 | 2 | 3700 | 464 | 307 | 568 |
| 2007 | 2 | 3700 | 424 | 312 | 577 |
| 2008 | 3 | 5172 | 560 | 388 | 681 |

**Table 3.3. 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 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IVa | 0 | 12 | 8 | 10 | 140 | 63 | 98 | 78 | 298 | 227 | 81 | 55 | 1 | 3 | 10 |
| Va | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 0 |
| Vb | 0 | 0 | 140 | 75 | 123 | 97 | 198 | 272 | 391 | 328 | 552 | 469 | 410 | 475 | 215 |
| VI | 0 | 8 | 6 | 1013 | 2013 | 2781 | 2872 | 2824 | 3639 | 4135 | 4133 | 3471 | 3455 | 4459 | 3086 |
| VII | 0 | 0 | 0 | 265 | 1171 | 1232 | 2087 | 1800 | 1168 | 1637 | 1038 | 895 | 892 | 2685 | 1487 |
| VIII | 0 | 0 | 6 | 70 | 62 | 25 | 36 | 45 | 336 | 503 | 605 | 531 | 361 | 634 | 669 |
| IX | 560 | 507 | 475 | 1075 | 1114 | 946 | 1155 | 1354 | 1189 | 1311 | 1220 | 972 | 1049 | 1130 | 1198 |
| X | 0 | 0 | 0 | 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 | 890 | 719 | 1416 |
| XIV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 15 | 0 | 0 | 0 | 12 |
| Unknown Area | | | | | | | | | | | | | | | |
| | 560 | 527 | 635 | 2509 | 4626 | 5152 | 6455 | 6512 | 7168 | 8182 | 7705 | 6484 | 7059 | 10 105 | 8093 |

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| IVa | 16 | 5 | 4 | 4 | 3 | 1 | 0 |
| Va | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vb | 300 | 229 | 239 | 195 | 590 | 171 | 0 |
| VI | 3855 | 2754 | 1102 | 638 | 737 | 621 | 14 |
| VII | 3926 | 3477 | 842 | 323 | 94 | 111 | 1 |
| VIII | 746 | 674 | 376 | 208 | 23 | 27 | 84 |
| IX | 1180 | 1125 | 1033 | 1325 | 517 | 463 | 42 |
| X | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| XII | 849 | 767 | 134 | 0 | 1 | 0 | 0 |
| XIV | 4 | 0 | 0 | 0 | 61 | 0 | 0 |
| Unknown Area | | | 1323 | 34 | 0 | 0 | 0 |
| | 10 876 | 9031 | 5054 | 2727 | 2025 | 1393 | 141 |

**Table 3.4. 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 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 0 | 0 | 140 | 1288 | 3104 | 3468 | 3812 | 3186 | 3630 | 3095 | 3177 | 3079 | 3519 | 3684 | 2103 |
| UK (Scotland) | 0 | 20 | 14 | 24 | 165 | 469 | 743 | 801 | 576 | 766 | 1007 | 625 | 623 | 2429 | 1184 |
| UK (England and Wales) | 0 | 0 | 0 | 104 | 80 | 174 | 387 | 986 | 1036 | 2202 | 1494 | 1019 | 413 | 320 | 335 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 5 | 0 | 3 | 2 | 138 | 454 | 577 |
| Iceland | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| Spain (Basque C) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 286 | 473 | 561 | 450 | 280 | 608 | 621 |
| Portugal | 560 | 507 | 481 | 1093 | 1128 | 946 | 1155 | 1354 | 1189 | 1314 | 1260 | 1036 | 1108 | 1151 | 1198 |
| Germany | 0 | 0 | 0 | 0 | 148 | 91 | 358 | 92 | 164 | 106 | 40 | 214 | 265 | 431 | 518 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 |
| Latvia | 0 | 0 | 0 | 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 | 0 | 14 | 40 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Russia | | | | | | | | | | | | | | | |
| Spain (Galicia) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 572 | 615 | 1381 |
| Faeroe Island | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 60 | 282 | 226 | 158 | 54 | 23 | 0 | 0 |
| Norway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 118 | 399 | 75 |
| Total | 560 | 527 | 635 | 2509 | 4626 | 5152 | 6455 | 6512 | 7168 | 8182 | 7705 | 6484 | 7059 | 10 105 | 8093 |

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| France | 1454 | 1189 | 866 | 744 | 855 | 802 | 0 |
| UK (Scotland) | 1594 | 1135 | 802 | 184 | 86 | 49 | 15 |
| UK (England and Wales) | 4027 | 3610 | 1533 | 537 | 23 | 7 | 0 |
| Ireland | 493 | 764 | 381 | 113 | 36 | 8 | 0 |
| Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain (Basque C) | 719 | 563 | 359 | 78 | 0 | 0 | 84 |
| Portugal | 1180 | 1125 | 1033 | 1072 | 522 | 463 | 42 |
| Germany | 640 | 0 | 79 | 0 | 0 | 0 | 0 |
| Estonia | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 28 | 0 | 0 | 0 | 1 | 62 | 0 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Russia | | | | 0 | 500 | 0 | 0 |
| Spain (Galicia) | 737 | 626 | 0 | 0 | 0 | 0 | 0 |
| Faeroe Island | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Norway | 0 | 19 | 0 | 0 | 0 | 0 | 0 |
| Total | 10876 | 9031.4 | 5053 | 2727 | 2023 | 1393 | 141 |

**Table 3.5. 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 3.6. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). 2009 Portuguese longliner (ICES Division IXa) - Mean percentage, in numbers, by especies in catch and in the discard.**

| | Landings | | | | Discards | | | |
|---|---|---|---|---|---|---|---|---|
| **Species** | **min** | **Mean** | **Max** | **sd** | **min** | **Mean** | **Max** | **sd** |
| Centroscymnus coelolepis | 0.0 | **0.5** | 1.4 | 0.52 | 0.0 | **0.1** | 0.3 | 0.12 |
| Centroscymnus crepidater | 0.0 | 0.0 | 0.1 | 0.05 | 0.0 | **0.1** | 0.3 | 0.12 |
| Centrophorus granulosus | 0.0 | **0.1** | 0.4 | 0.16 | 0.0 | 0.0 | 0.0 | 0.00 |
| Centrophorus squamosus | 0.3 | **1.4** | 4.6 | 1.66 | 0.0 | 0.0 | 0.0 | 0.00 |
| Deania calcea | 0.1 | **0.9** | 2.0 | 0.69 | 0.0 | 0.0 | 0.2 | 0.08 |
| Etmopterus pusillus | 0.0 | 0.0 | 0.0 | 0.00 | 0.8 | **1.9** | 2.3 | 0.56 |
| Galeus melastomus | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | **0.1** | 0.4 | 0.16 |
| Prionace glauca | 0.0 | **0.1** | 0.3 | 0.12 | 0.0 | **0.1** | 0.3 | 0.12 |
| Scymnodon ringens | 0.0 | **0.3** | 0.9 | 0.35 | 0.0 | 0.0 | 0.0 | 0.00 |

**Table 3.7. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French deep-water trawlers. Landings of fraction of trawlers that after 2002 began separate landings by species (columns two to five) and of trawlers that have never separated by species (columns six to eight). Siki is a generic category Siki that includes several deep-water shark species, GUQ corresponds to Leafscale gulper shark and CYO+CYO corresponds to Portguese dogfish plus Longnose velvet dogfish 2009 Portuguese longliner (ICES Division IXa) - Mean percentage, in numbers, by especies in catch and in the discard. Estimates of CUQ for all other vessels are presented at last column.**

| | Vessels separating the species reliably | | | All other vessels | | | Estimate of CUQ landings |
|---|---|---|---|---|---|---|---|
| | Siki | GUQ | CYO+CYP | siki | GUQ | CYO | |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1993 | 0 | 0 | 0 | 8 | 0 | 0 | |
| 1994 | 635 | 0 | 0 | 384 | 0 | 0 | |
| 1995 | 1088 | 0 | 0 | 1572 | 0 | 0 | |
| 1996 | 920 | 0 | 0 | 2277 | 0 | 0 | |
| 1997 | 933 | 0 | 0 | 1820 | 0 | 0 | |
| 1998 | 39 | 0 | 0 | 1793 | 0 | 0 | |
| 1999 | 805 | 0 | 0 | 1728 | 0 | 0 | |
| 2000 | 1047 | 0 | 0 | 1974 | 0 | 0 | |
| 2001 | 1334 | 0 | 0 | 1815 | 0 | 0 | |
| 2002 | 154 | 42 | 388 | 1381 | 0 | 0 | 192 |
| 2003 | 0 | 60 | 560 | 663 | 0 | 0 | 124 |
| 2004 | 0 | 64 | 489 | 618 | 0 | 0 | 136 |
| 2005 | 15 | 52 | 328 | 480 | 2 | 0 | 120 |
| 2006 | 31 | 57 | 230 | 446 | 2 | 0 | 152 |
| 2007 | 41 | 41 | 191 | 542 | 33 | 0 | 150 |
| 2008 | 0 | 77 | 231 | 489 | | | 199 |

**Table 3.8. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Number of hauls >500 m per year on Scottish deep-water surveys.**

| Depth | 500–999 | 1000–1499 | >1500 | Total |
|---|---|---|---|---|
| 2000 | 13 | 10 | 5 | 28 |
| 2002 | 11 | 9 | 7 | 27 |
| 2004 | 11 | 5 | 6 | 22 |
| 2005 | 7 | 6 | 6 | 19 |
| 2006 | 15 | 10 | 8 | 33 |
| 2007 | 9 | 6 | 7 | 22 |
| 2008 | 11 | 9 | 11 | 31 |
| 2009 | 12 | 15 | 11 | 38 |

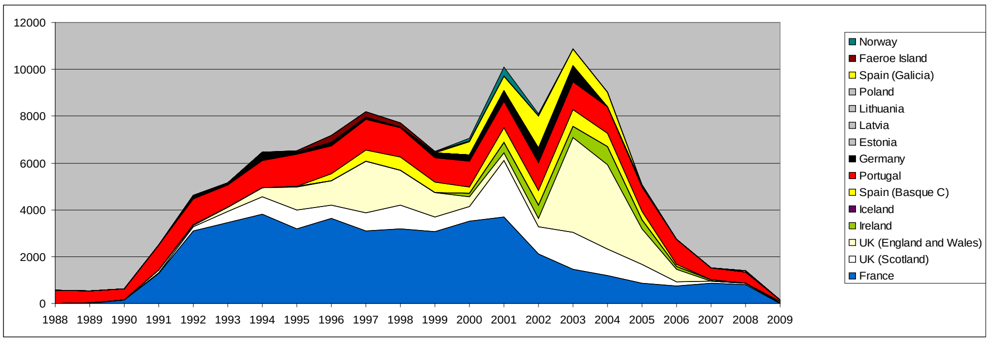



**Figure 3.1. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by country.**

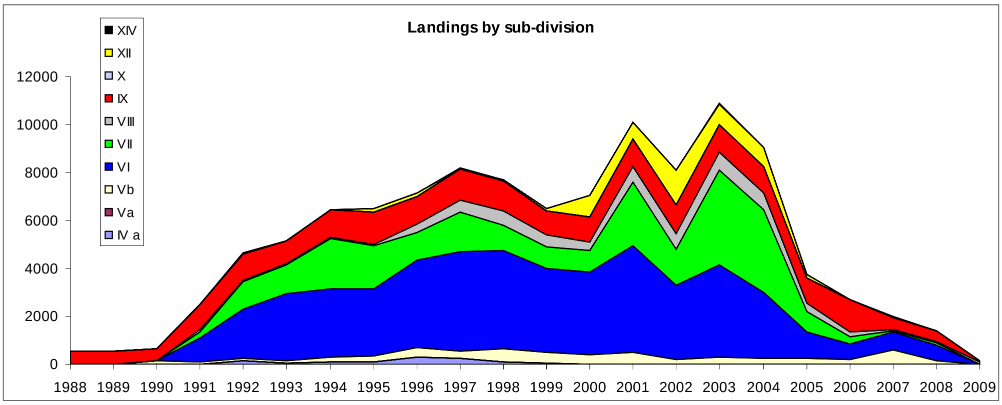



**Figure 3.2. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by ICES Subarea.**

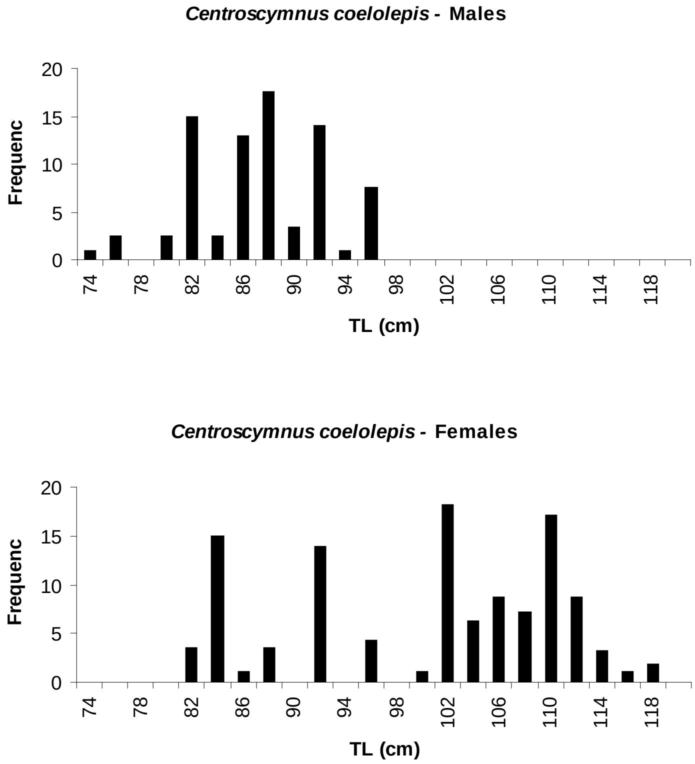
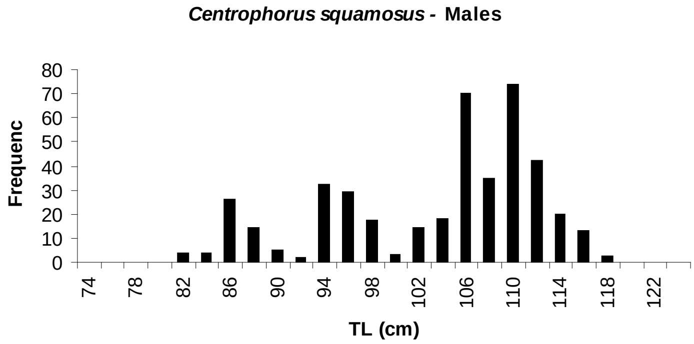



**Figure 3.3. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). (ICES Division IXa). Length frequency distribution by sex (2 cm length class; number of sampled trips: 17).**



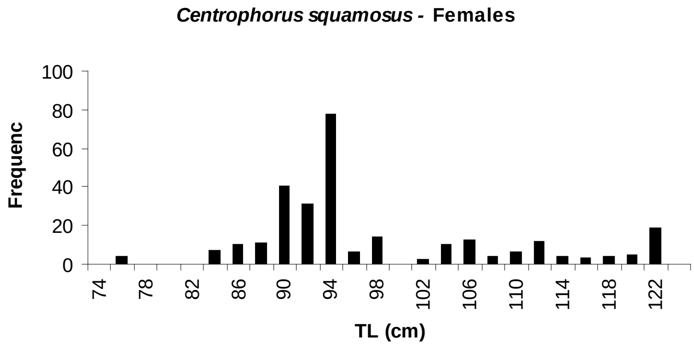




**Figure 3.4. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). (ICES Division IXa). Length frequency distribution by sex (2 cm length class; number of sampled trips: 17).**

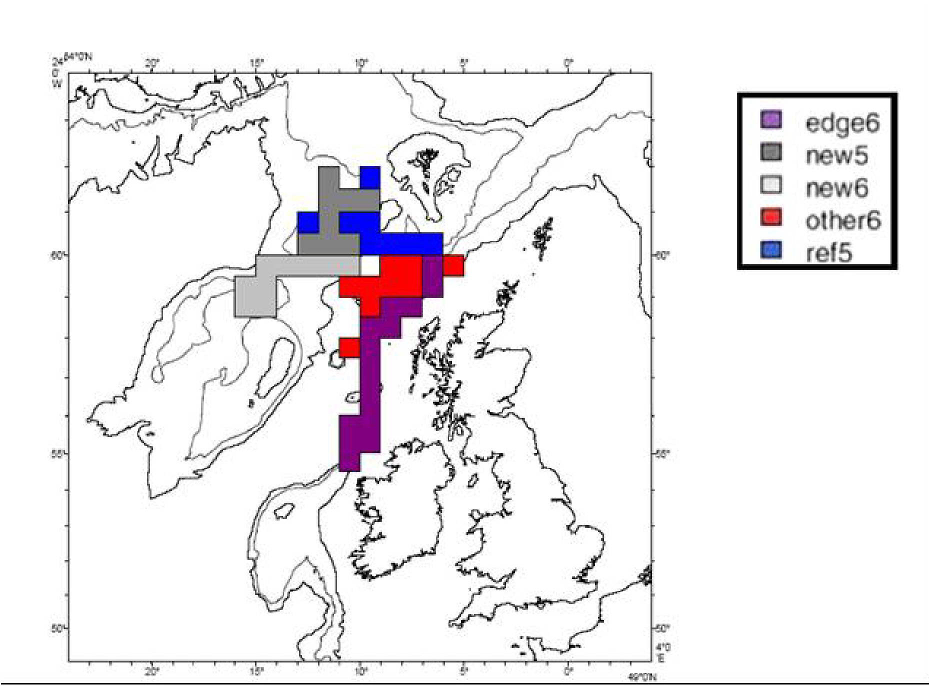



**Figure 3.5. Portuguese Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French trawlers. Small areas defined for the estimation of lpue from French tallybook. Purple: edge6; red: other6; dark grey:new6; light grey new5; blue: ref5.**

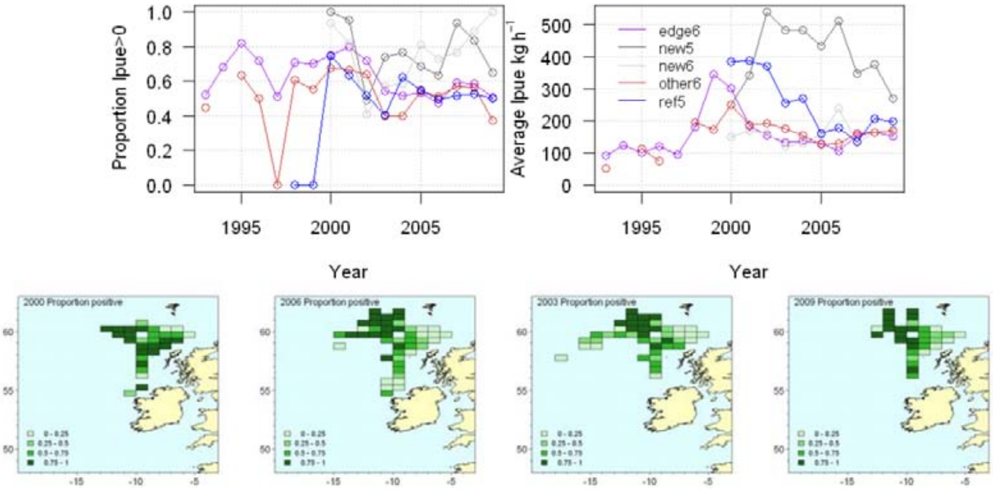



**Figure 3.6. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). French trawlers Occurrence (proportion of haul with lpue>0) and average lpue for the positive (with catch of siki) haul of siki sharks in tallybook hauls per area (top panels) and spatial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

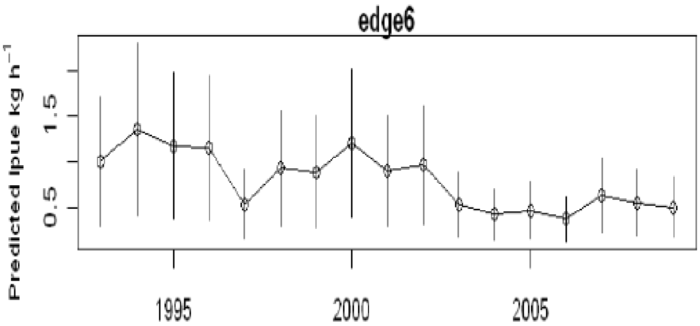



**Figure 3.7. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Standardised cpue for area edge6 for the period 1993–2009. Vertical bars are 95% confidence intervals.**

**Figure 3.8. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Positions fished in Scottish deep-water survey 2000–2009.**

**Figure 3.9. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Depth and latitude distribution of fishing effort (hours fishing) on Scottish surveys 2000–2009.**

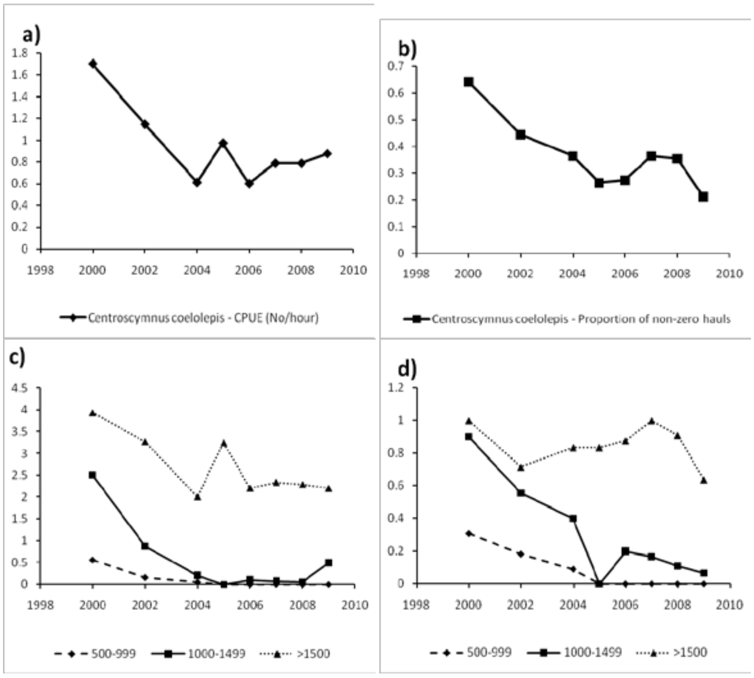



**Figure 3.10. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). a) cpue (numbers/hour) and b) proportion of non-zero hauls for *C. coelolepis* in Scottish deep-water surveys, all depths combined. c) cpue (numbers/hour) by depth category; d) proportion non-zero hauls by depth category.**

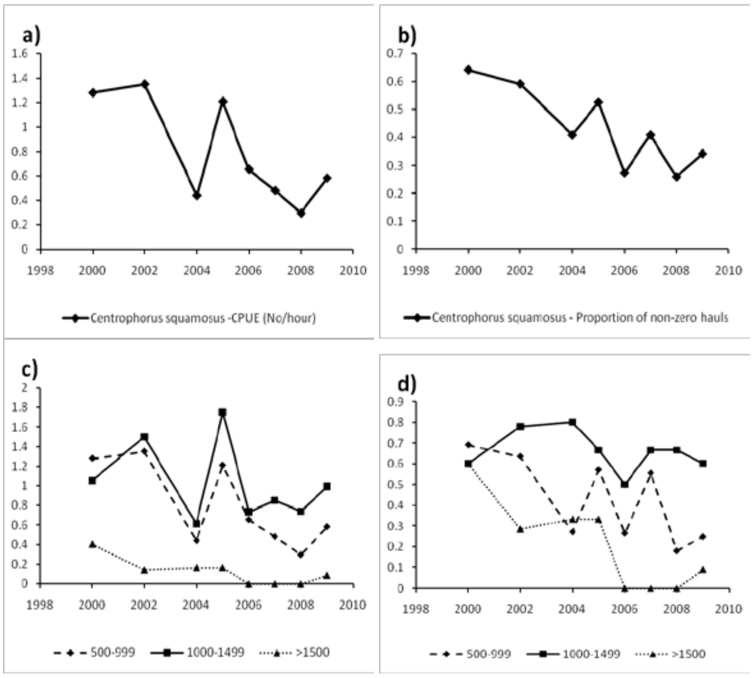



**Figure 3.11. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). a) cpue (numbers/hour) and b) proportion of non-zero hauls for *C. squamosus* in Scottish deep-water surveys, all depths combined. c) cpue (numbers/hour) by depth category; d) proportion non-zero hauls by depth category.**

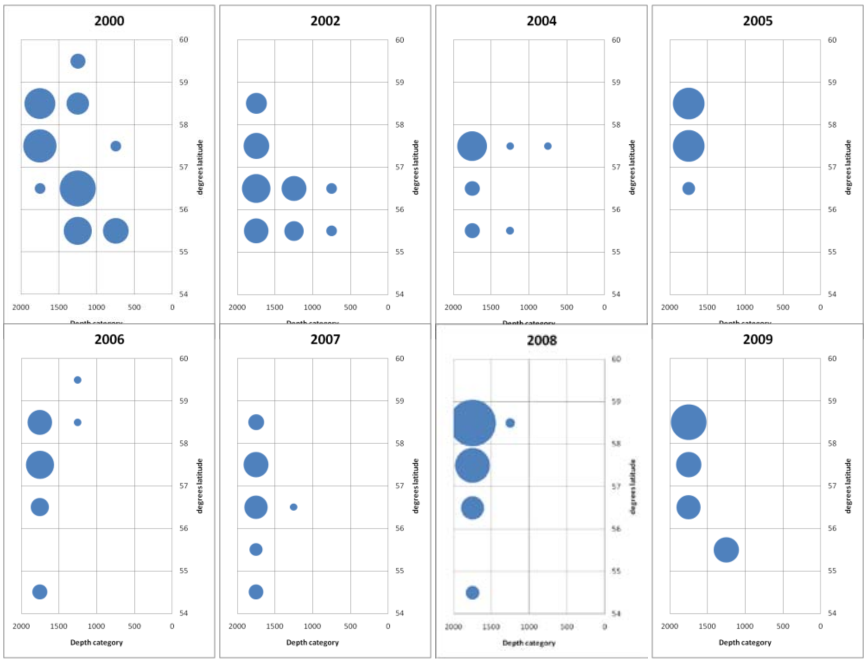



**Figure 3.12. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). *Centroscymnus coelolepis*. Cpue (numbers /hour) in Scottish surveys by 500 m depth category and latitude.**

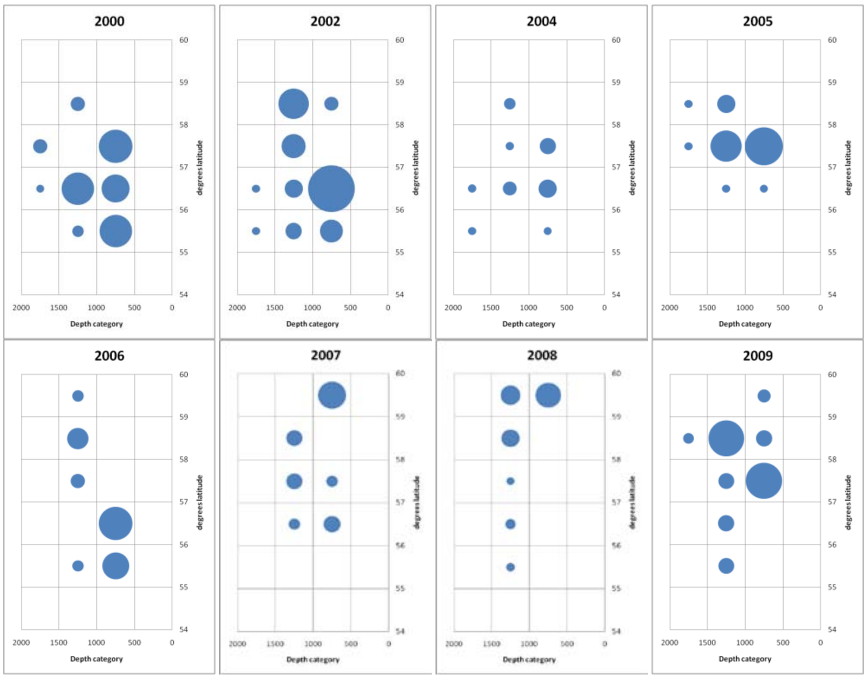



**Figure 3.13. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). *Centrophorus squamosus*. Cpue (numbers /hour) in Scottish surveys by 500 m depth category and latitude.**

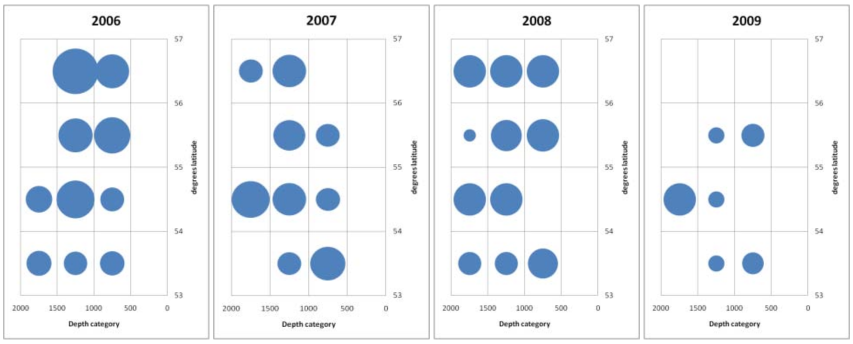



**Figure 3.14. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Depth and latitude distribution of fishing effort (hours fishing) on Irish surveys 2000–2009.**

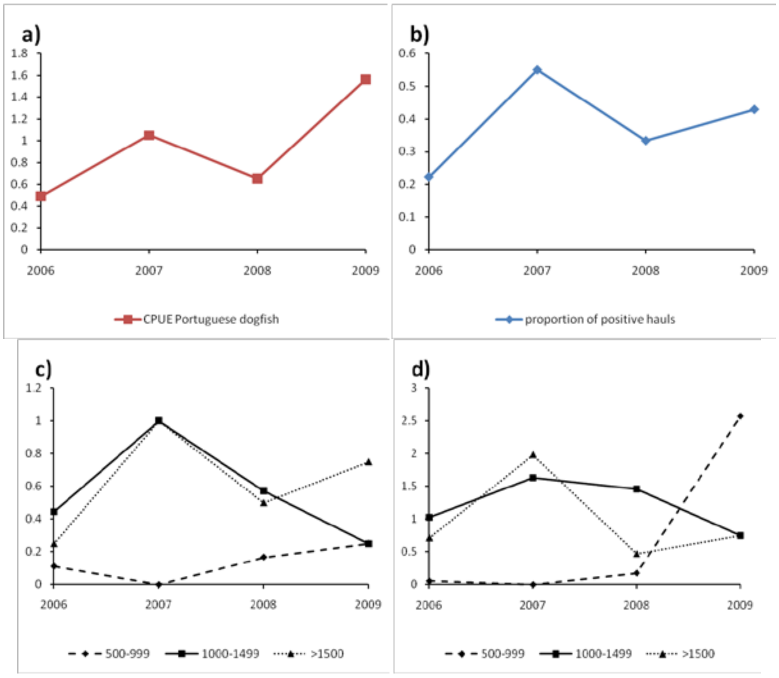



**Figure 3.15. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). a) cpue (numbers/hour) and b) proportion of non-zero hauls for *C. coelolepis* in Irish deep-water surveys, all depths combined. c) cpue (numbers/hour) by depth category; d) proportion non-zero hauls by depth category.**

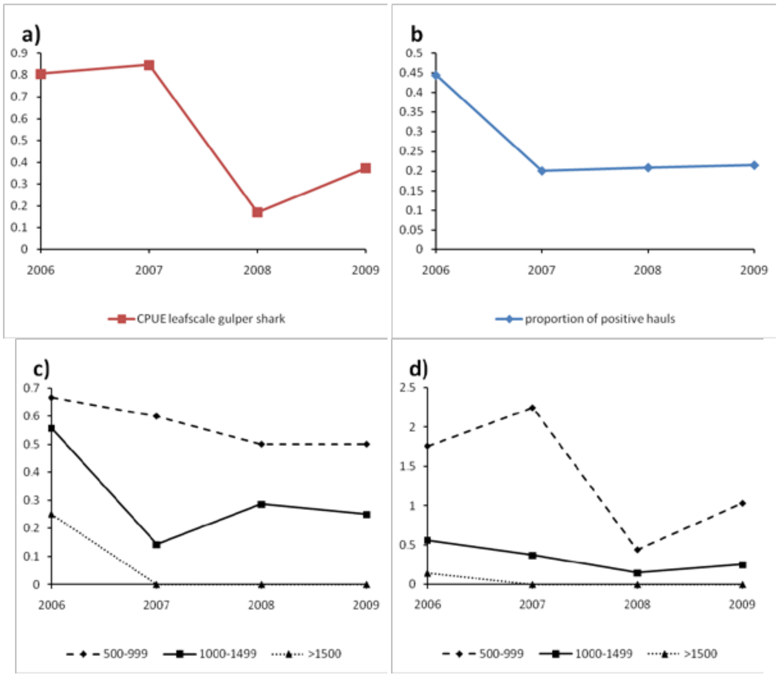



**Figure 3.16. Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). a) cpue (numbers/hour) and b) proportion of non-zero hauls for *C. squamosus* in Irish deep-water surveys, all depths combined. c) cpue (numbers/hour) by depth category; d) proportion non-zero hauls by depth category.**

# 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 2008 and 2009

Kitefin from the Azores is now a bycatch from different demersal/deep-water mixed hook and line fisheries, with landings in the period 2004–2009 usually 10 t or less.

### 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".

### 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 1988–2009 are given in Table 4.1 and total historical landings 1972–2009 in Figure 4.1.

### 4.3.2 Discards

Discards are suspected to occur on the Azorean longliners because the distribution of the stock matches with the fishing area and effort distribution of deep-water fisheries (Pinho, 2005). Data from logbooks and observers are available for the period 2007–2009 but were not ready on time for this meeting.

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).

### 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. Data from observers or fishing logbooks are not available. 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

There is no new information available. Existing surveys (the Azorean longline survey) rarely catch kitefin shark (only 25 individuals were caught during the last ten years), because the survey is not designed for the species, and will not provide reliable indices of relative abundance (Pinho, 2005 WD). There was no survey during 2009.

## 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 years 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.

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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 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 6 |
| Total | | 45 | 313 | 189 | 40 | 144 | 9 | 47 | 21 | 14 | 11 | 6 |

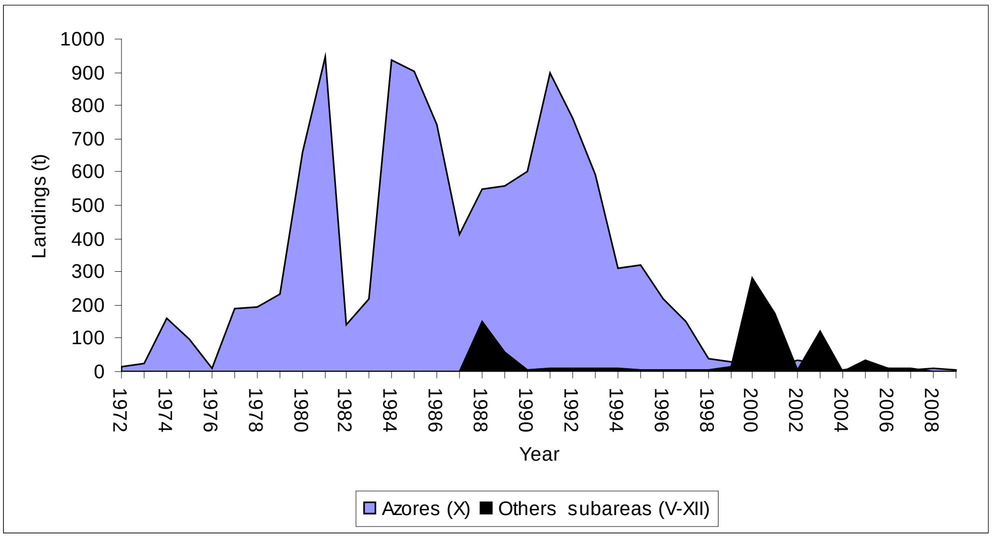


**Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin by ICES statistical areas.**

# 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). In general, these species have lower commercial interest than the species dealt with in the previous section. 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, considered to be distributed worldwide, 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 (S*omniosus 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. These fisheries were described in some detail in Section 3 of ICES, 2005 and in the Report of WGDEEP (ICES 2010).

#### 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 (Figure 5.1). 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).

### 5.2.2 The fishery in 2009

In 2009 EU TACs for deep-water sharks were reduced to very low levels and in 2010, to zero (see Section 5.2.4 below). Consequently, landings of the species covered in this chapter were very much reduced in 2009. As most of these species are taken as by-catch in mixed fisheries, it is likely that discarding has increased.

Reported catches in the directed Portuguese longline fishery for gulper sharks reduced to very low levels in 2009 but it is possible that the fishery has continued with catches being misreported as *C. lusitanicus* to which TACs do not apply.

Directed Russian longline fisheries for deep-water sharks occurred in the Faroese Fishing Zone, Reykjanes Ridge, Rockall Bank, Hatton Banks and the Barents Sea. Catches included birdbeak dogfish, longnose velvet dogfish, black dogfish, greater lanternshark and velvet belly. Little information on these fisheries is available to WGEF but biological information on the catches was described in Vinnichenko *et al.*, (2010 WD).

### 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 dogfish (*Deania profundorum*) are also included on the list.

In 2009, the EU TAC for deep-water sharks in Subareas V, VI, VII, VIII and IX was 824 t (a decrease of 67% from 2008). In Subarea X, the 2009 TAC was set at 10 t, in Subarea XII, 25 t. In 2010, TACs in all areas were reduced to zero with an allowance for bycatch of 10% of 2009 TACs.

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

## 5.3 Catch data

### 5.3.1 Landings

#### 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 landings may have been misidentified as other morphologically very similar species such as *C. lusitanicus*. In 2009 Portugal reported 211 tonnes of *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 considered to be misidentified leafscale gulper sharks. These data have been included in Working Group estimates of "siki sharks".

#### Birdbeak dogfish *Deania calceus*

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 genus, 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 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.

#### 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 near 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 were no reported landings in 2009.

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

#### 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&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 2005 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 and VII.

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 species and further investigations are required. 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. In recent years, French landings of *Etmopterus princeps* have been included in siki sharks.

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 Alboran Sea, *G. melastomus* coexists with its congener *G. atlanticus* (Rey *et al.*, in press, 2009) throughout their whole bathymetic ranges. *G. atlanticus* is somewhat smaller than *G. melastomus*, but no size–depth trends were observed.

#### "*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 and Figure 5.1.

#### 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 196t 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. (Table 5.10).

#### 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 (Table 5.10). No landings were reported for 2009.

#### 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.

### 5.3.2 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.

### 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 sharks (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 leafscale gulper shark.

## 5.4 Commercial catch composition

### 5.4.1 Species and size compositions

Length distributions of catches of other deep-water sharks in Russian longline fisheries in the Faroes Fishing Zone, Hatton Bank and the Reykjanes Ridge are presented in Figures 5.1 to 5.3 (Vinnichenko, 2010 WD).

## 5.5 Commercial catch-effort data

No new information is available.

## 5.6 Fishery-independent surveys

### 5.6.1 Scottish deep-water surveys in Division VIa

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 5.7.

Jones *et al.*, 2005 conducted a preliminary analysis of cpue of eight deep-water sharks caught in Scottish surveys between 1998 and 2004 (Figure 5.8). Cpue in the surveys was also compared with cpues from exploratory fishing by MAFF in the 1970s (Figure 5.9). 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.

### 5.6.2 Porcupine bank surveys

Spanish bottom-trawl surveys performed between 2001 and 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 5.10–5.11).

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 5.12–5.13).

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 5.14–5.15).

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 5.16–5.17).

### 5.6.3 Norwegian surveys

A recent study (Williams *et al*., 2008) on the distribution and abundance of chondrichthyans along the north coast of Norway revealed that the abundance did not change significantly although average water temperature rise during the study (1992–2005) and that the current fishery levels do not appear to be impacting the population of the more commonly occurring chondrichthyans, including *Etmopterus spinax, Galeus melastomus* and the chimaeras (Figures 5.18 and 5.19).

### 5.6.4 Future coordination of deep-water surveys

Future, internationally coordinated surveys along the continental slope will provide information on these elasmobranchs.

## 5.7 Life-history information

Maturity stages of other deep-water sharks sampled in Russian longliners fishing in the Faroes Fishing Zone, Hatton Bank and the Reykjanes Ridge are presented in Figures 5.4 to 5.6 (Vinnichenko 2010 WD).

#### 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 7 years for male, and 38 cm TL and 9 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 2 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 matures at 90–110 cm TL and females at 130–149 cm TL (Yano and Kugai, 1993; Fowler, 2003; Compagno *et al.*, 2005).

## 5.8 Exploratory assessment models

No assessments studies were conducted so far for the lesser-known deep-water sharks.

## 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

In the continental slopes of Europe these species should be managed in a multispecies context with particular attention to the management of leafscale gulper shark and Portuguese dogfish (Section 3) and kitefin shark (Section 4).

The apparent decline in landings of Greenland shark is a concern. This may simply represent a decline in the marketability of this species, or it may be a decline in the stock. More data should be collated for this species and further studies undertaken.

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**Table 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of gulper shark. Figures in grey are of uncertain origin and may be unreliable.**

| Country | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UK (England and Wales) | | | | | | 2 | n.a. | + | 83 | . | | |
| UK (Scotland) | | | | | | 23 | 17 | + | 0 | | 2 | |
| Ireland | | | | | | 2 | n.a. | n.a. | | | | |
| Portugal | 187 | 95 | 54 | 96 | 159 | 203 | 89 | 62 | 104 | 129 | 93 | 15 |
| Spain | | | | | 8 | | n.a. | n.a. | 0 | . | | |
| Total | 187 | 95 | 54 | 96 | 167 | 230 | 106 | 62 | 187 | 129 | 95 | 15 |

**Table 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of birdbeak dogfish. Figures in grey are of uncertain origin and may be unreliable.**

| Country | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Russia | | | | | | | | | | 7 | | |
| Spain | | | | | 5 | n.a. | n.a. | n.a | 0 | | | |
| UK (England and Wales) | | | | | | | | 47 | 20 | | | |
| UK(Scotland) | | | | 1 | + | 3 | 38 | 2 | 0 | | | |
| Portugal | | | 13 | 37 | 67 | 72 | 157 | 145 | 74 | 43 | 61 | 17 |
| Total | | | 13 | 38 | 72 | 75 | 195 | 194 | 94 | 50 | 61 | 17 |

**Table 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of longnose velvet dogfish. Figures in grey are of uncertain origin and may be unreliable.**

| Country | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | | | 382 | 395 | 47 | 90 | 49 | | 35.1 | 1.2 | 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 | 1.2 | 137 | |

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

| Country | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 359 | 128 | 25 | 52 | | | | | | | | |
| UK (England and Wales) | | | | | | | | 8 | | | | |
| Scotland | | | | | | | | | | 8 | | |
| Spain | | | | | 85 | n.a. | n.a. | | | | | |
| Total | 359 | 128 | 25 | 52 | 85 | n.a. | n.a. | 8 | 0 | 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 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 846 | 2388 | 2888 | 2150 | 2043 | + | + | + | + | + | + | | | | | |
| Spain | | | | | | | 38 | 338 | 99 | n.a. | n.a. | | | | | |
| Portugal | + | + | + | + | | | + | | | | + | + | 0.02 | | | |
| Total | 846 | 2388 | 2888 | 2150 | 2043 | + | 38 | 338 | 99 | + | + | + | 0 | 0 | | |

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

| Country | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | | | | | | | | + | 1 | | | | 2 | |
| Spain (Basque c.) | | | + | | + | | | | + | | 4 | | | 4 |
| Spain | 4 | 3 | 6 | 2 | 4 | 1 | 35 | 1 | | 4 | | | | |
| Portugal | 35 | 29 | 22 | 23 | 39 | 36 | 52 | 29 | 57 | 38 | 29 | 26 | 15 | 12 |
| Total | 39 | 32 | 28 | 25 | 43 | 37 | 87 | 30 | 58 | 41 | 32 | 26 | 17 | 16 |

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

| Country | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iceland | 61 | 73 | 87 | 51 | 45 | 57 | 56 | 55 | 58 | 54 | 24 | 3 | 34 | 26 |
| Total | 61 | 73 | 87 | 51 | 45 | 57 | 56 | 55 | 58 | 54 | 24 | 3 | 34 | 26 |

**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 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gulper Shark | 1056 | 801 | 958 | 886 | 344 | 423 | 242 | 291 | 187 | 95 | 54 | 96 | 167 | 230 | 106 | 62.2 | 187 | 129 | 95 | 15 |
| Birdbeak Dogfish | | | | | | | | | | | 13 | 38 | 72 | 75 | 195 | 194 | 96 | 43 | 66 | 17 |
| Black Dogfish | | | | | | | | | | | 467 | 486 | 47 | 90 | 49 | 5 | 36 | 2 | 137 | 0 |
| Longnose Velvet Dogfish | | | | | | | | | | | 86 | 71 | 17 | 33 | 15 | 216 | 409 | 22 | 2 | 20 |
| Velvet Belly | | | | 27 | + | 10 | 8 | 32 | 359 | 128 | 25 | 52 | 85 | n.a. | n.a. | 8 | 0 | 8 | 0 | 0 |
| Blackmouth Dogfish | 17 | 17 | 16 | 20 | 37 | 29 | 39 | 32 | 28 | 25 | 43 | 37 | 87 | 30 | 58 | 41 | 4 | 0 | 28 | 4 |
| Lantern Shark NEI | | | | | 846 | 2388 | 2888 | 2150 | 2043 | + | 38 | 338 | 99 | + | + | + | 0 | 0 | 0 | 0 |
| Aiguillat noir | | | | | | | | | | | 123 | 165 | 11 | 37 | 21 | 5 | 0 | 0 | 0 | 0 |
| Greenland Shark | 54 | 58 | 68 | 41 | 42 | 43 | 61 | 73 | 87 | 51 | 45 | 57 | 57 | 61 | 66 | 0 | 24 | 3 | 34 | 26 |
| Angular Roughshark | | | | | | | | | | | | | | | 75 | 98 | 52 | 0 | 0 | 54 |
| Knifetooth dogfish | | | | | | | | | | | 894 | 1340 | 642 | 556 | 585 | 630 | 807 | 206 | 361 | 137 |
| Total | 1127 | 876 | 1042 | 974 | 1269 | 2893 | 3238 | 2578 | 2704 | 299 | 54 | 96 | 167 | 230 | 106 | 62.2 | 187 | 129 | 95 | 15 |

**Table 5.11. 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<br>Squale-chagrin commun<br>Quelvacho | *Centrophorus granulosus* | 50<br>1440 | 150 | # 60–80 | > 96 | ovoviviparous | | 30–42 | | | VU |
| Black dogfish<br>Aiguillat noir<br>Tollo negro merga | *Centroscyllium fabricii* | 180<br>1600 | 107 | | | ovoviviparous | 14 | | a = 0.0009<br>b = 3.420 | | - |
| Longnose velvet dogfish<br>Pailona à long nez<br>Sapata negra | *Centroselachus crepidater* | 230<br>1500 | 130 | 64–68 | 82 | ovoviviparous | 4–8 | 28–35 | a = 0;0024<br>b =3.250 | 54 | LC |
| Birdbeak dogfish<br>Squale-savate<br>Tollo pajarito | *Deania calcea* | 60<br>1490 | 122 | 85 | 105 | ovoviviparous | 6–12 | 29–34 | a = 0.0012<br>b = 3.260 | female: 35<br>male: 32 | LC |
| Velvet belly<br>Requin-lanterne<br>Negrito | *Etmopterus spinax* | 70<br>2490 | 60 | 33–36 | | ovoviviparous | 6–20 | | a = 0.0018<br>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<br>Chien espagnol<br>Pintarroja bocanegra | *Galeus melastomus* | 55<br>1873 | 90 | | | oviparous | 13 | | a = 0.0025<br>b = 3.020 | | - |
| Bluntnose sixgill shark<br>Requin griset<br>Canabota gris | *Hexanchus griseus* | 0<br>2500 | 482 | 315–400 | 400–482 | ovoviviparous | 22–108 | 60–75 | a = 0.0135<br>b = 3.000 | | LR/nt |
| Angular roughshark<br>Centrine commune<br>Cerdo marino | *Oxynotus centrina* | 60<br>777 | 150 | 50 | 50 | ovoviviparous | 7–8 | | | | - |
| Greenland shark<br>Laimargue du Groenland<br>Tollo de Groenlandia | *Somniosus microcephalus* | 0<br>2200 | 730 | 244–427 | 244–427 | ovoviviparous | | | a = 0.0114<br>b = 3.000 | | NT |

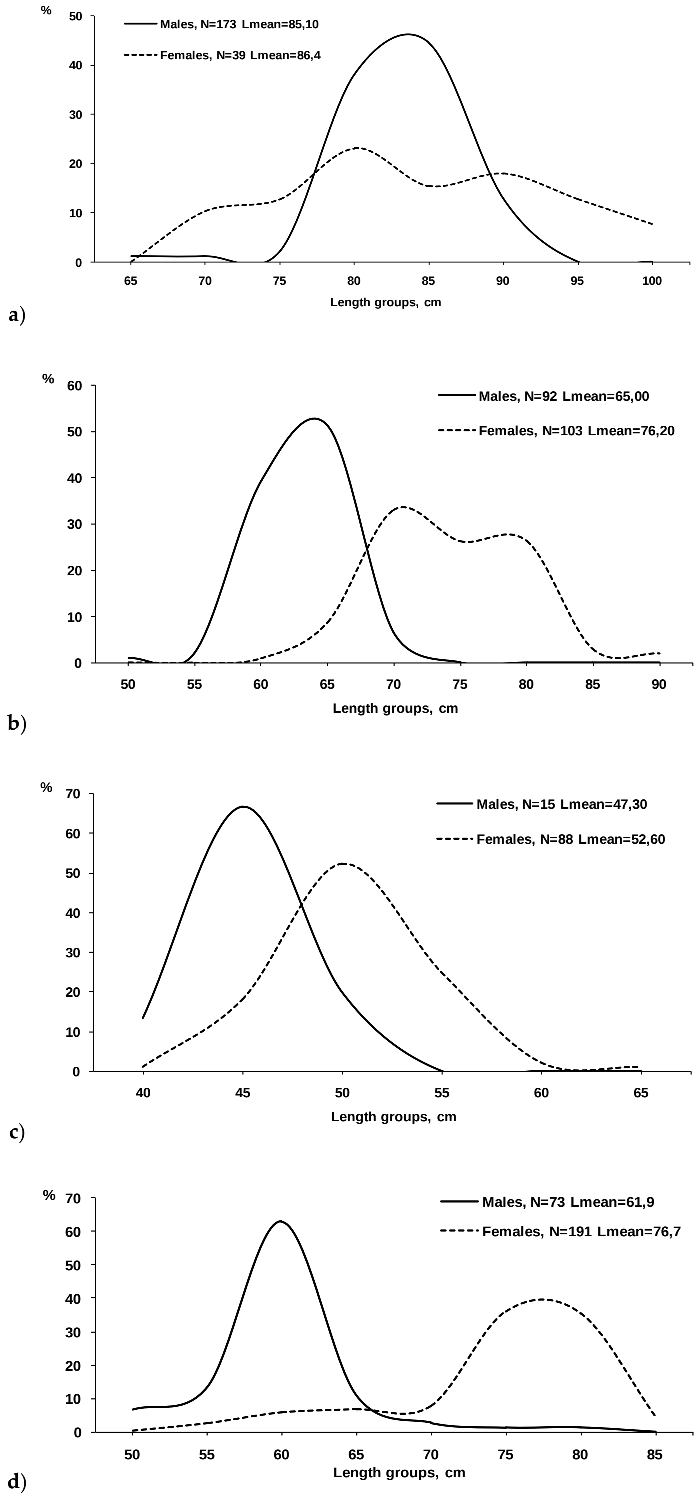
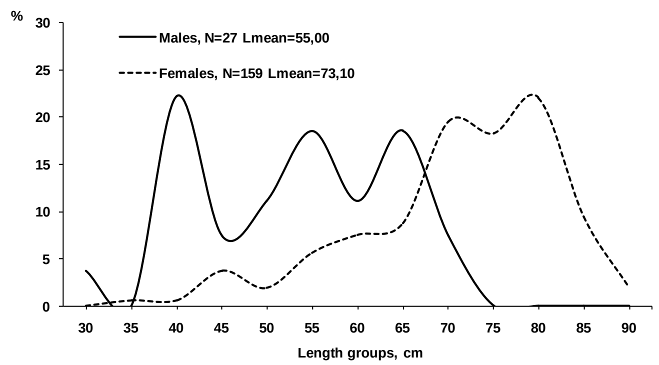
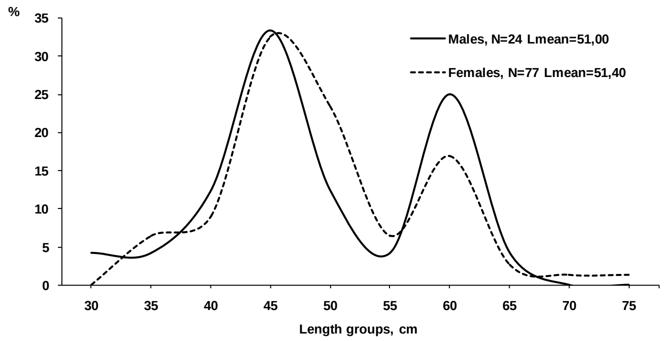



**Figure 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Length composition of in Russian longline catches in the Faroes Fishing Zone (Division Vb) in 2009. From Vinnichenko, 2010 WD. a) Birdbeak dogfish b) Black dogfish, c) Velvet Belly, d) Longnose velvet dogfish.**




a)




b)

**Figure 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Length composition in Russian longline catches on the Hatton Bank (Division XIIb) in July 2009. From Vinnichenko, 2010 WD b) Greater lanternshark a) Black dogfish.**

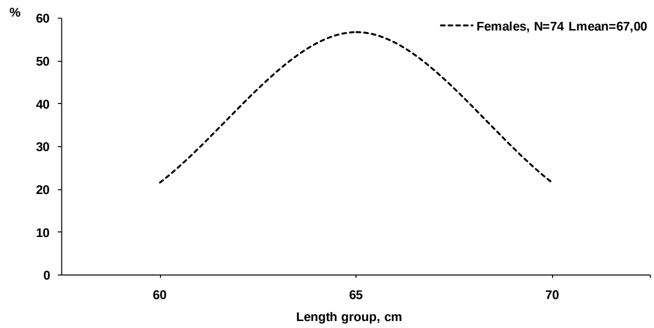
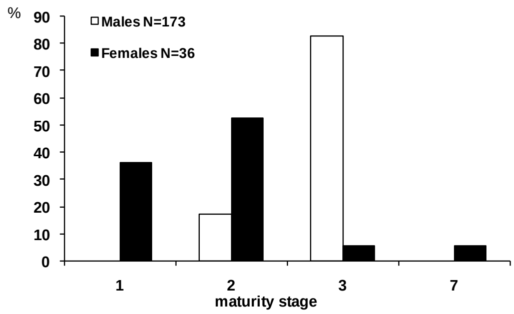
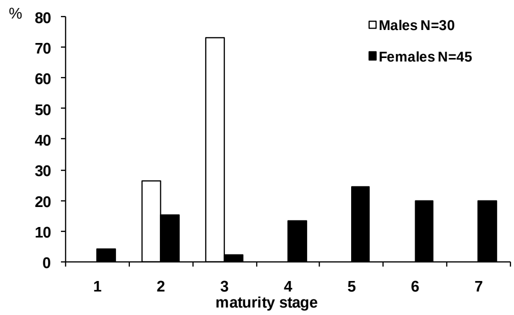


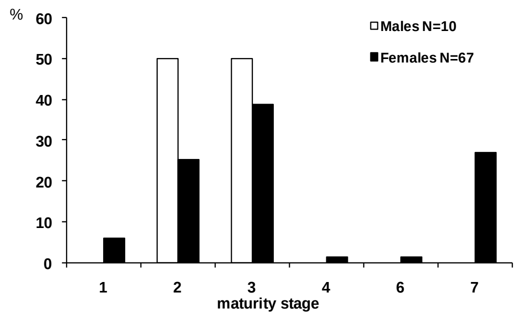

**Figure 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Length composition of a) Greater lantern shark in long-line catches on Reykjanes Ridge in July-August 2009.**



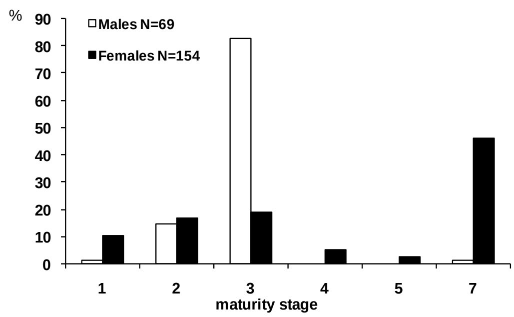

a)




b)

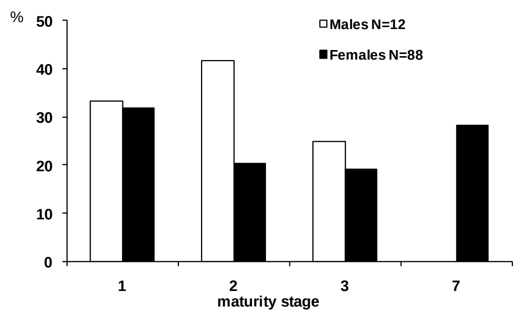



c)




d)

**Figure 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Maturity of a) Bird-beak dogfish b) Black dogfish c) velvet belly and d) longnose velvet dogfish in Russian longline catches within the Faroese Fishing Zone (Division Vb) in June-August 2009. From Vinnichenko, 2010. WD.**



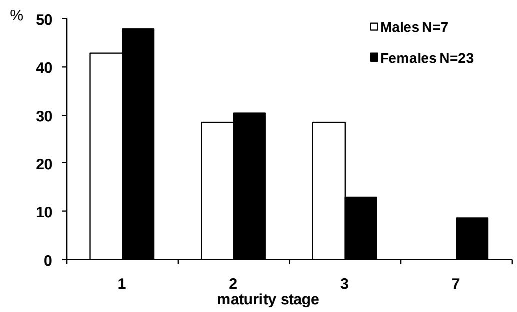




**Figure 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Maturity of a) Black dogfish and b) greater lanternshark in long-line catches on the Hatton Bank (Division XIIb) in July 2009. From Vinnichenko, 2010. WD.**

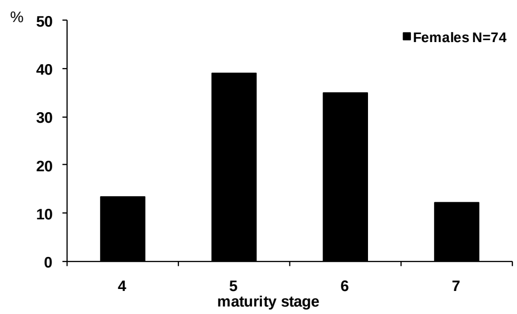



**Figure 5.6. Other deep-water sharks and skates from the Northeast Atlantic. Maturity of Greater lantern shark in Russian longline catches on Reykjanes Ridge in July–August 2009.**

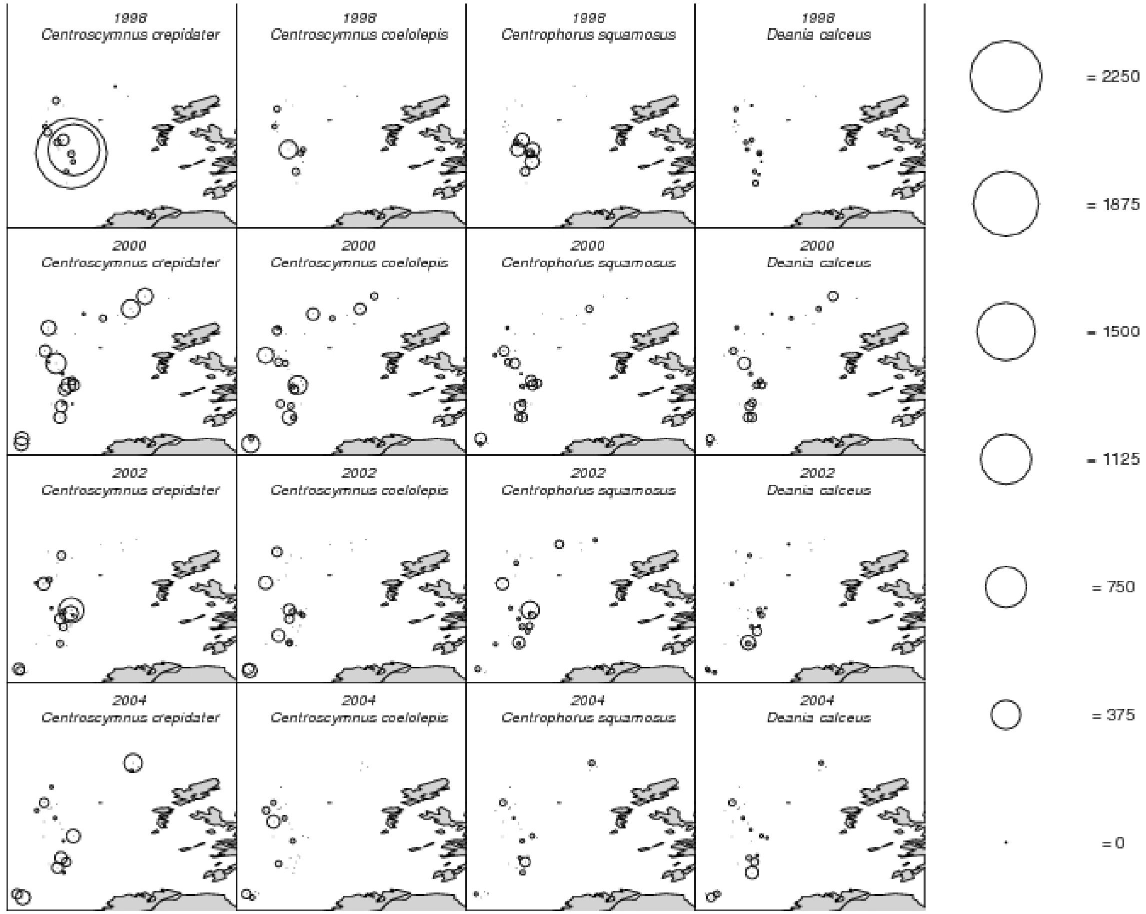



**Figure 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Spatial distribution and relative abundance (kg per hour) of four deep-water Squaliform species recorded during the FRS deep-water surveys, 1998–2004.**

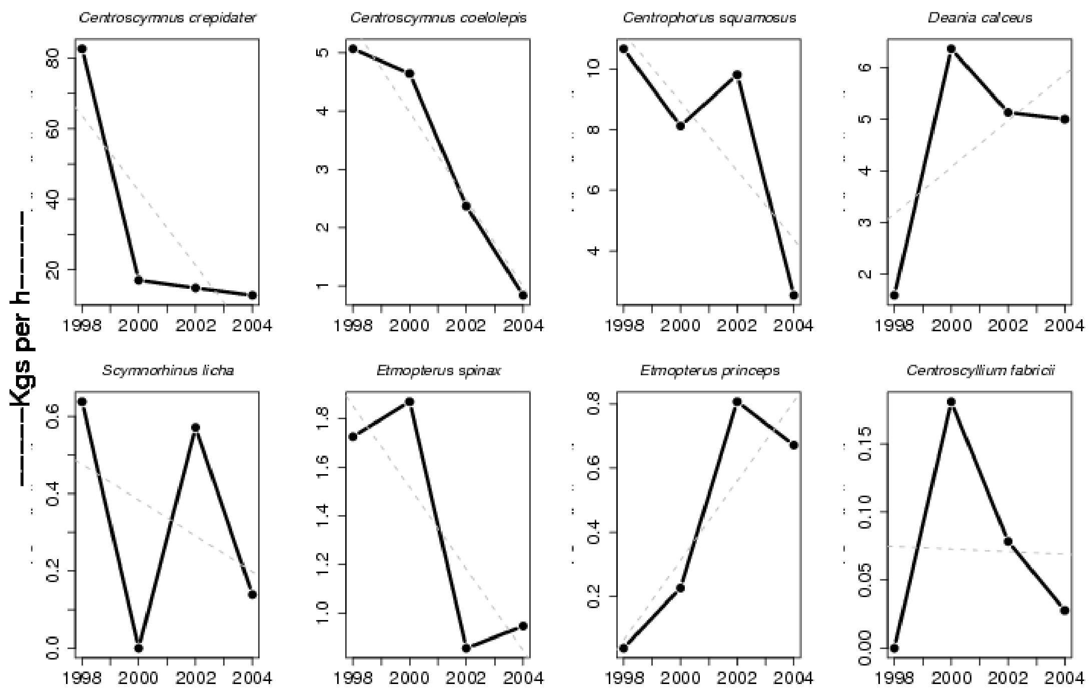



**Figure 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Change in cpue (kg per hour) in Scottish surveys in Division VIa between 1998 and 2004 for eight deep-water species.**

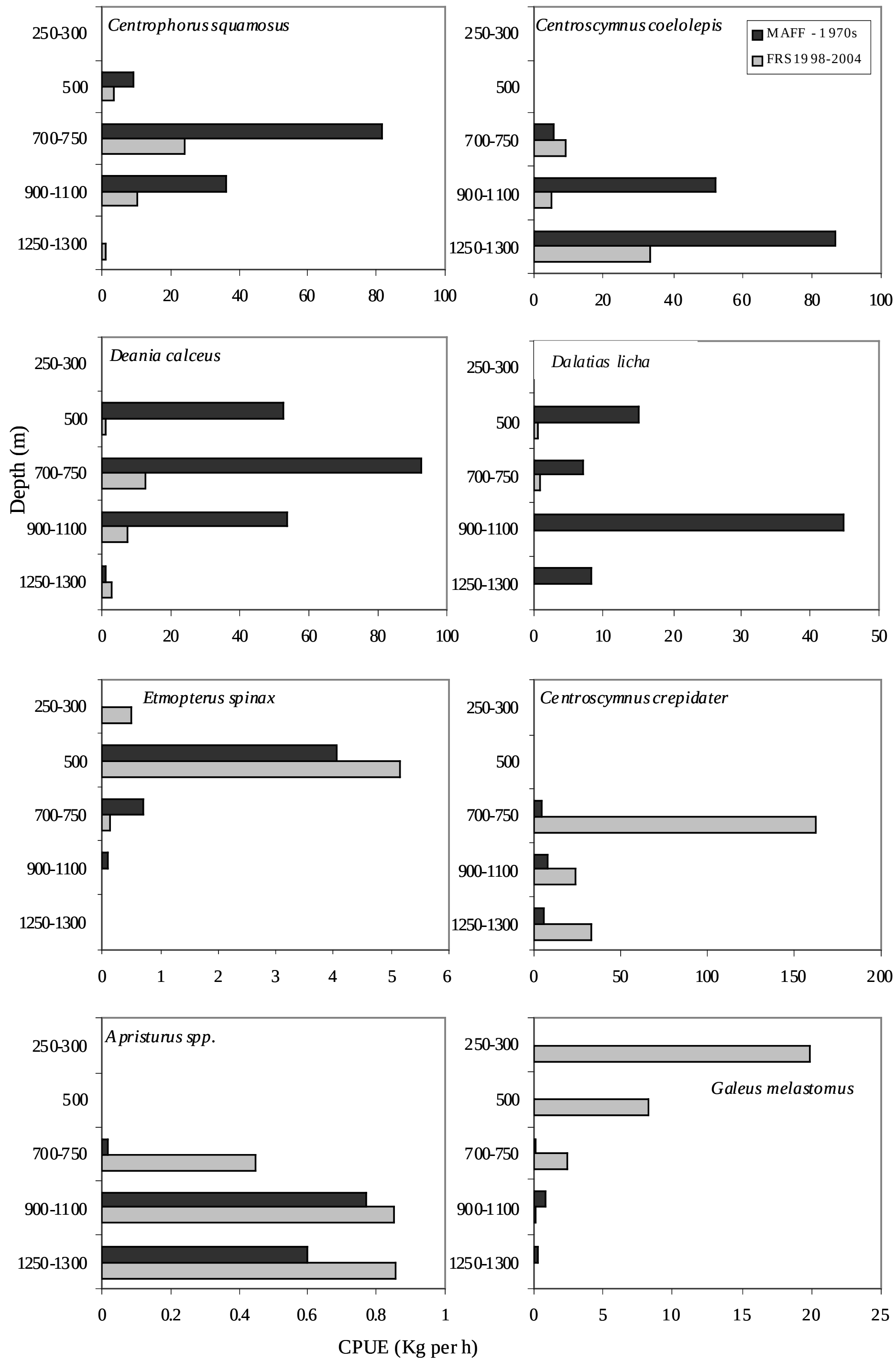



**Figure 5.9. Other deep-water sharks and skates from the Northeast Atlantic. Comparison of catch rates (kgs per hour) for eight species of deep-water shark caught during MAFF and FRS deep-water surveys. Note: in this plot all the data from the FRS and MAFF surveys are pooled.**

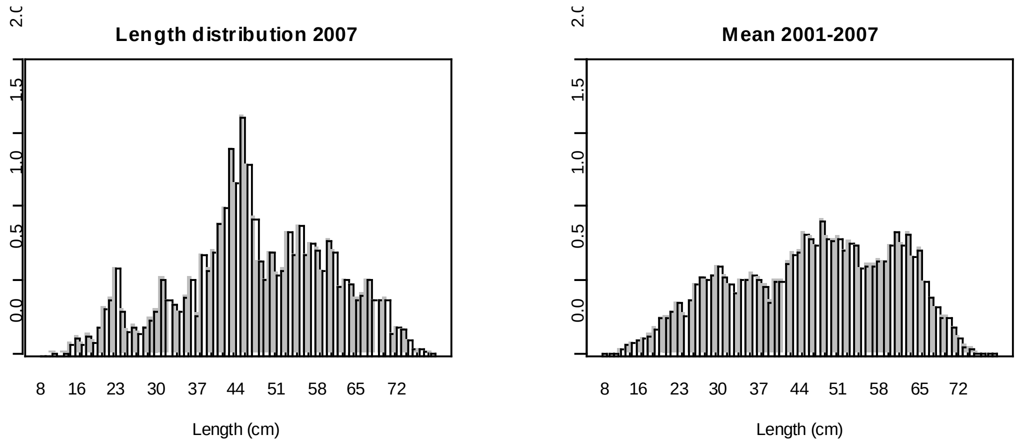



**Figure 5.10. Other deep-water sharks and skates from the Northeast Atlantic. Stratified length distributions of blackmouth catshark (*G. melastomus*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).**

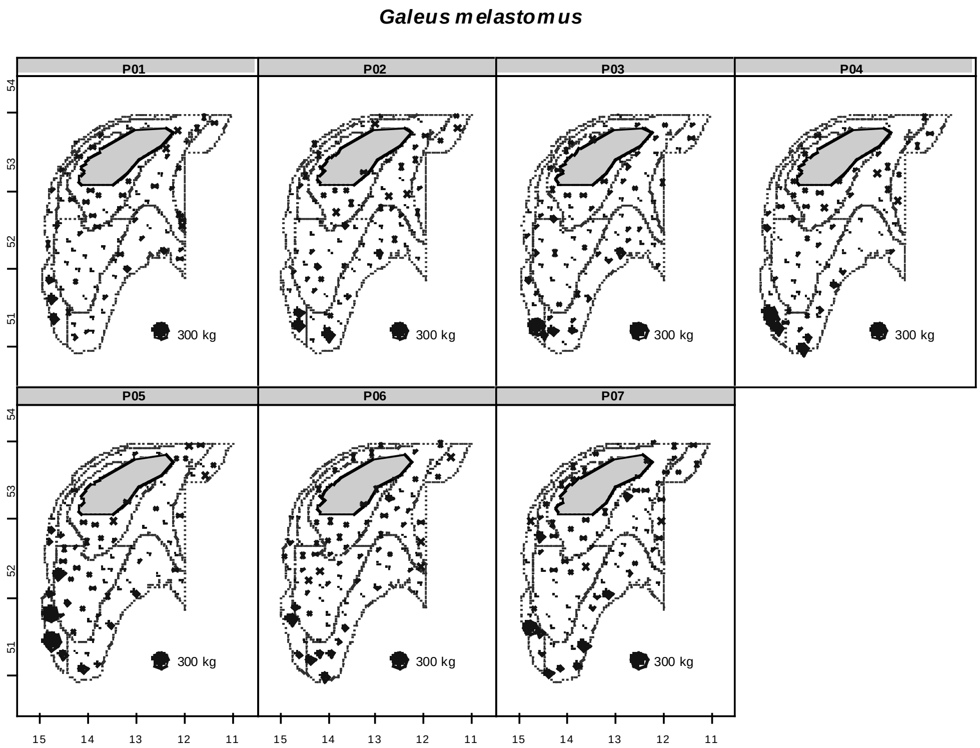



**Figure 5.11. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of blackmouth catshark (*G. melastomus*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).**

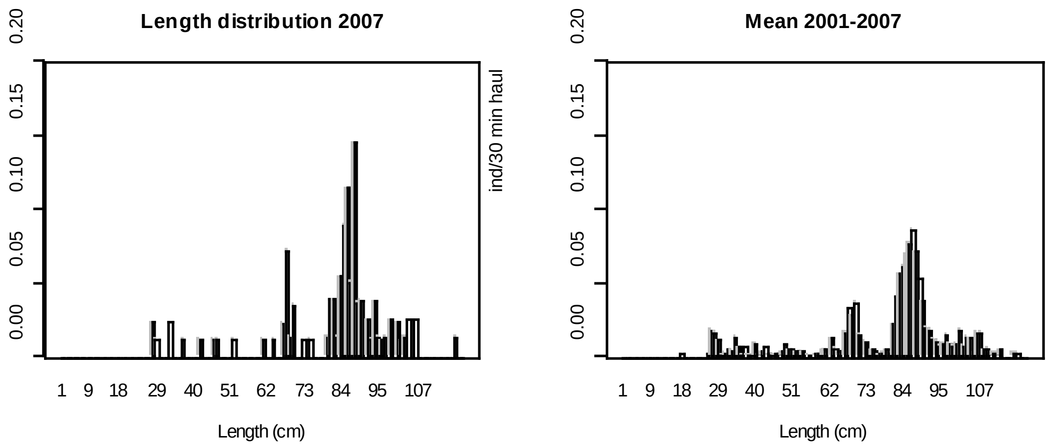



**Figure 5.12. Other deep-water sharks and skates from the Northeast Atlantic Stratified length distributions of birdbeak dogfish (*D. calcea*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).**

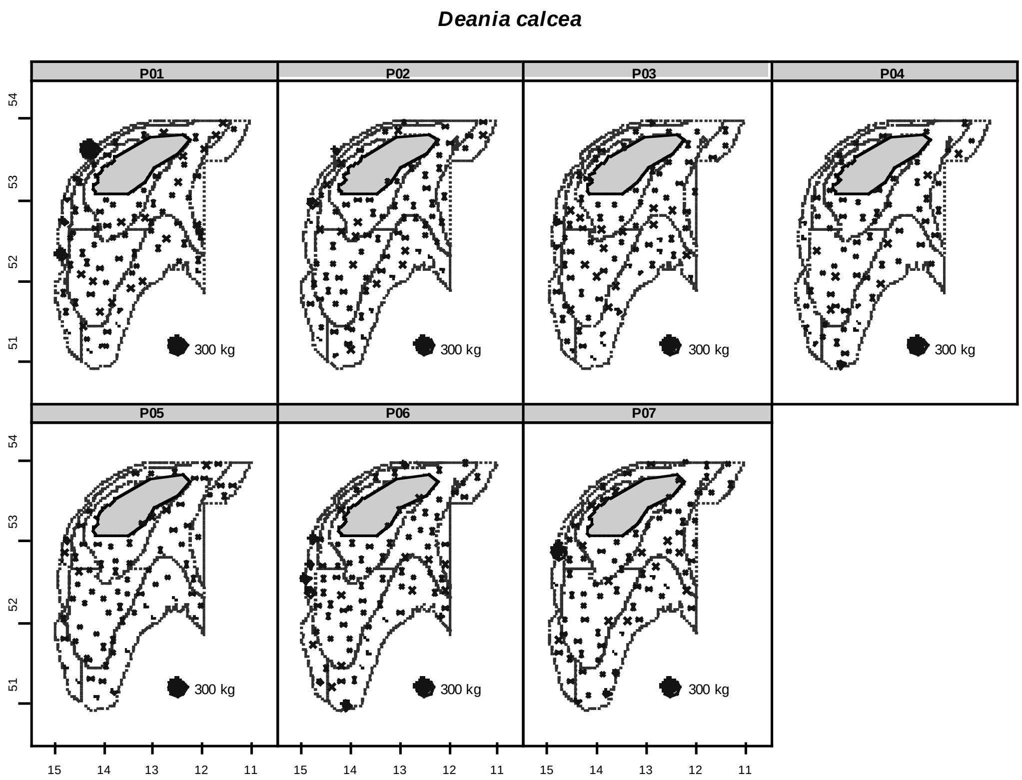



**Figure 5.13. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of birdbeak dogfish (*D. calcea*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).**

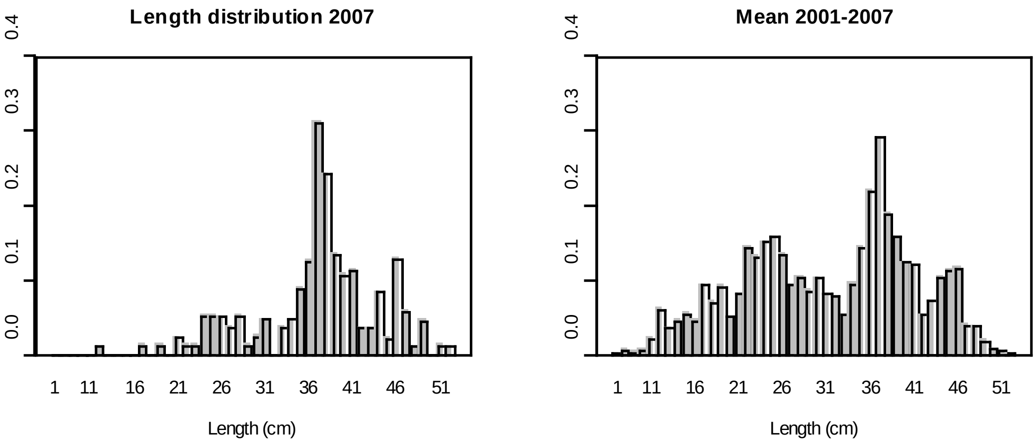



**Figure 5.14. Other deep-water sharks and skates from the Northeast Atlantic Stratified length distributions of velvet belly (*E. spinax*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).**

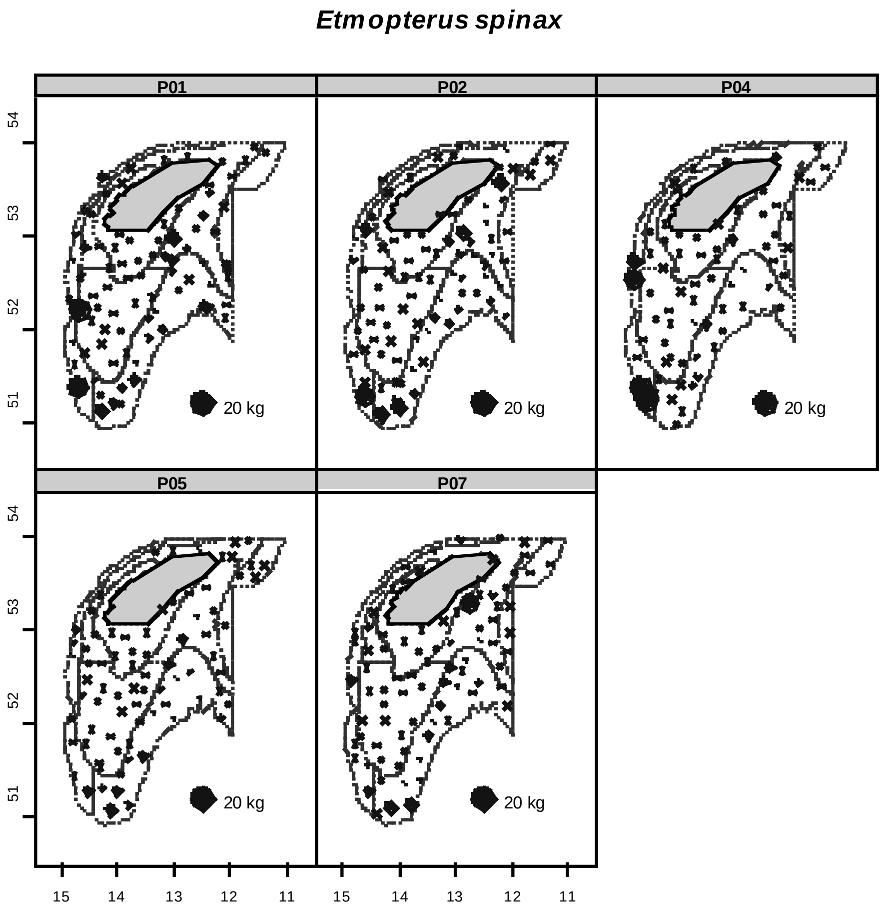



**Figure 5.15. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of velvet belly (*E. spinax*) catches (kg/30 min haul) in years with high biomass abundance in Porcupine surveys time-series (2003 and 2006; from Velasco and Blanco, 2008).**

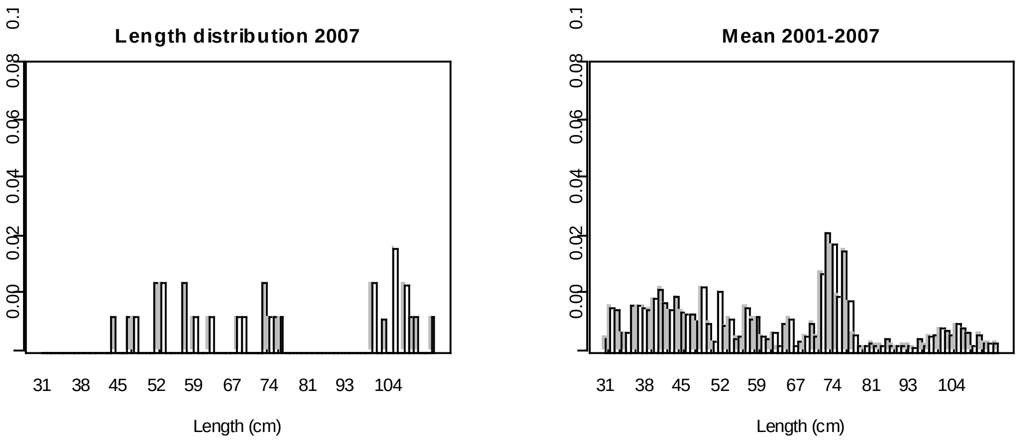



**Figure 5.16. Other deep-water sharks and skates from the Northeast Atlantic Stratified length distributions of knifetooth dogfish (*S. ringens*) in 2007 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2007; from Velasco and Blanco, 2008).**

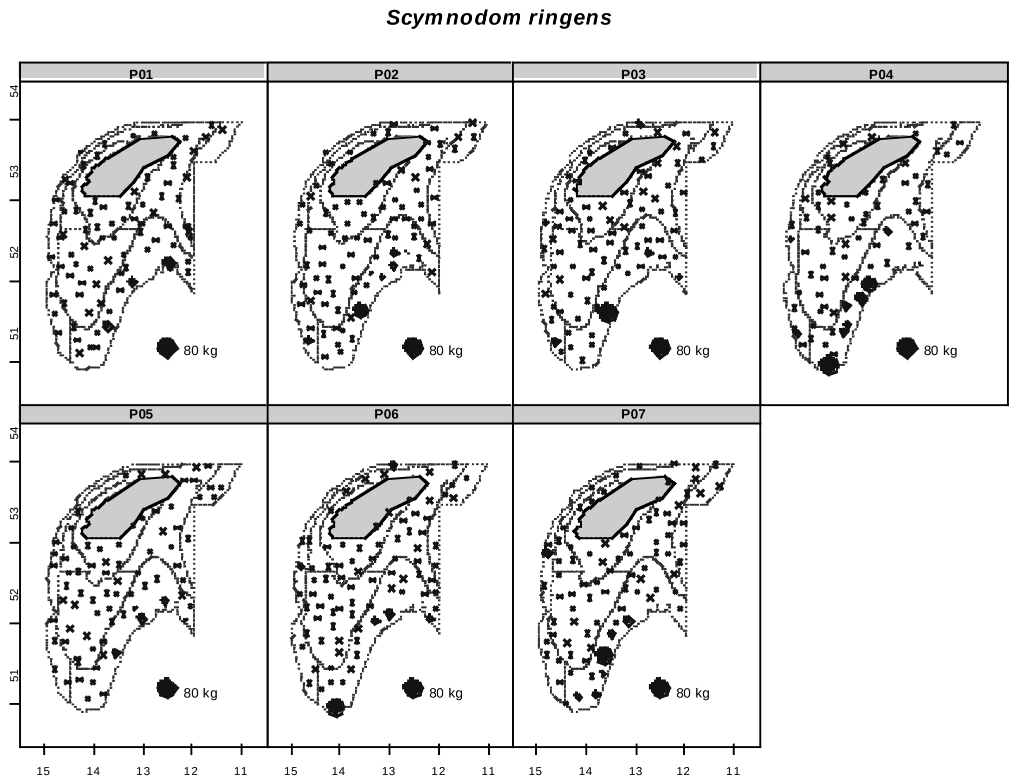



**Figure 5.17. Other deep-water sharks and skates from the Northeast Atlantic Geographic distribution of knifetooth dogfish (*S. ringens*) catches (kg/30 min haul) during Porcupine surveys time-series (2001–2007; from Velasco and Blanco, 2008).**

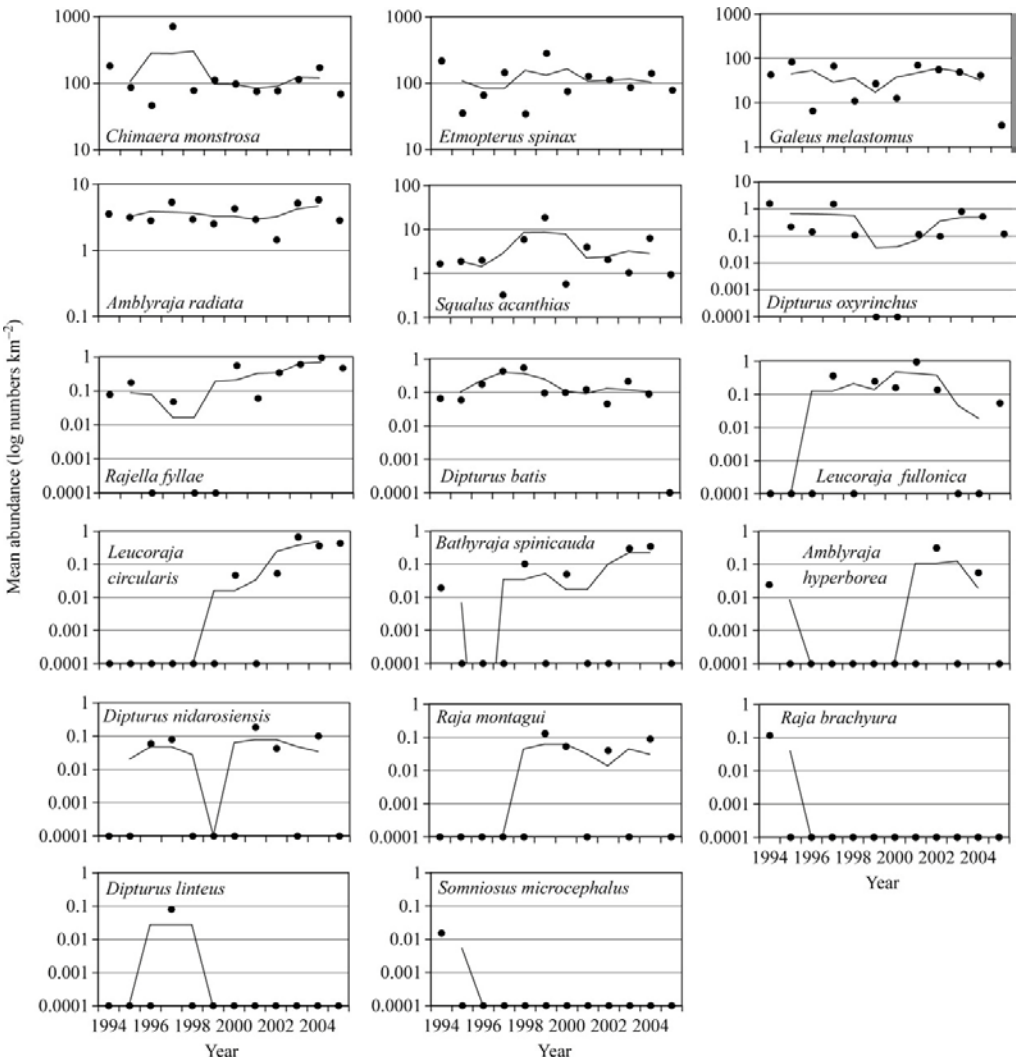



**Figure 5.18. Other deep-water sharks and skates from the Northeast Atlantic. Mean abundance of all chondrichthyan species along the north coast of Norway from the coastal surveys of 1992–2005. Note that the abundance scales differ between panels (Williams *et al.,* 2008).**

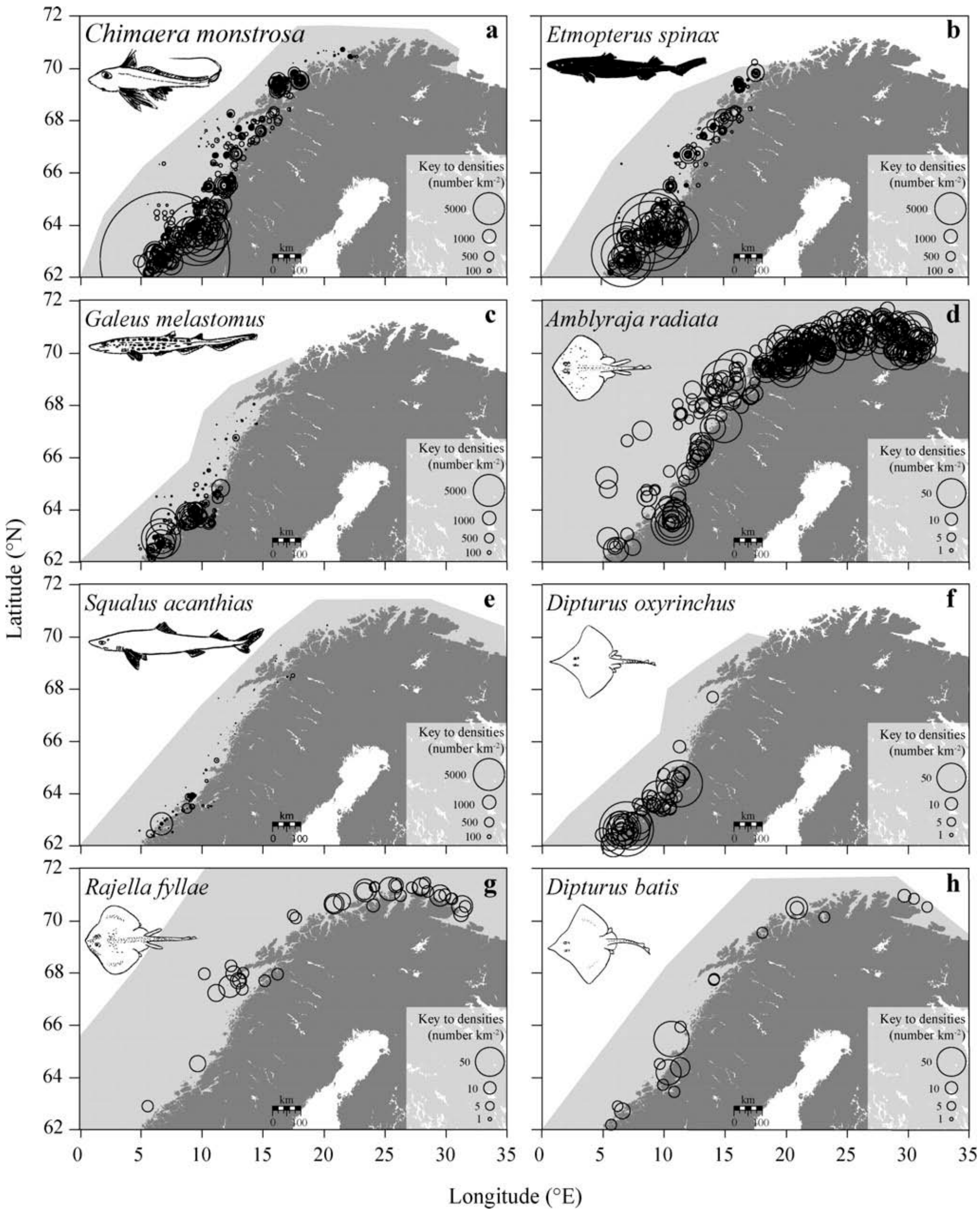



**Figure 5.19. Other deep-water sharks and skates from the Northeast Atlantic. Distribution and abundance of (a) *Chimaera monstrosa*, (b) *Etmopterus spinax*, (c) *Galeus melastomus*, (d) *Amblyraja radiata*, (e) *Squalus acanthias*, (f) *Dipturus oxyrinchus*, (g) *Rajella fyllae*, and (h) *Dipturus 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).**

# 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 are France and, to a lesser extent, Spain, UK and Norway in recent years. The only regular, directed target fishery that still exists is 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 2009

There were no major changes to the fishery noted in 2009.

### 6.2.3 ICES advice applicable

The advice is biennial and consequently the 2009 advice remains valid for 2010 and is cited below:

'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.

Porbeagles are particularly vulnerable to fishing mortality, because the population productivity is low (long-lived, slow-growing, high age-at-maturity, low fecundity, and a protracted gestation period) and they have an aggregating behaviour. Therefore, risk of depletion of reproductive potential is high. It is recommended that exploitation of this species should only be allowed when indicators and reference points for stock status and future harvest have been identified and a management strategy, including appropriate monitoring requirements has been decided upon and is implemented.'

In addition, ICES added the following management considerations: "there may be potential benefits to the stock by protecting mature females… If a non-zero TAC is set, ICES recommends the introduction of a maximum landing length (MLL). This is expected to deter fisheries targeting areas where large females occur. Although there are no studies to define an MLL that would be most beneficial to the stock, the length at first maturity of females may serve as a preliminary MLL which would be at ~210 cm fork length".

### 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 has been 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.

## 6.3 Catch data

### 6.3.1 Landings

Tables 6.1a, b and Figures 6.2–6.3 demonstrate the historical landings of porbeagle in the Northeast Atlantic. In 2009, France remains the major contributor as in preceding years.

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 very limited.

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 UE adoption of a maximum landing size, some large fish have been 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).

## 6.4 Commercial catch composition

Only limited length frequency data are available for porbeagle. However, length distributions by sex are available in 2008 and 2009 (Hennache and Jung, 2010) for the French target fishery (Figure 6.4). 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 shows 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 the 2009 sampling.

## 6.5 Commercial catch-effort data

A new cpue series were 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 date 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 show higher values occurring at the end of the 1970s (Figure 6.5). Since then, cpue has varied between 400–900 kg per day without displaying any trend.

Spanish data were more variable (Figure 6.6), 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 completed in 2010 by information on migration provided by a limited number of pop-up satellite tags which were attached on porbeagle in North West coast of Ireland (Saunders *et al.*, 2010). Some information have also been added on sex-ratio segregations, on the likelihood of a nursery ground in the Saint Georges Channel, on the diet and on life history parameter according to the recent work made by the NGO APECS (Hennache and Jung, 2010).

## 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 cannot be updated by the 2010 WGEF because the lack of available cpue in 2009. The models used during the 2009 assessment should be made available at any future benchmark assessment for these species.

*** BSP model**

The BSP model uses catch and standardized cpue data (see Section 6.5.2 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 showed 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 with 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 historical 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 (F2008 /FMSY) between 2.54 and 3.32.

The conclusions of these assessments were that the exploratory assessments indicate that current biomass is below BMSY and that recent fishing mortality is near or possibly above FMSY. 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 BMSY 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 effect of different selection patterns on the NE Atlantic porbeagle stock was evaluated: flat-topped and dome-shaped curves and with maximum selectivity at either age 5 or13 (age 13 corresponds to age at maturity of females and to the current maximum landing length of 210 cm fork length).

The analysis shows 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 presented in this report must be considered exploratory assessments, using several assumptions (carrying capacity for the SSB model, F in the historical 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 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.

Stock projections based on the BSP model shows 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) has been adopted by EC. It constitutes a 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. inter-dorsal 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 (1971–2009). 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, Nl) | | 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 |
| rance | 196 | 208 | 233 | 341 | 327 | 546 | 306 | 466 | 642 | 824 | 644 | 450 | 495 | 435 |
| ermany | . | . | . | . | . | . | . | . | 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 & Nl) | 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 (1971–2009). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 107 | 73 | 76 | 42 | 21 | 20 | 4 | 3 | 2 | 2 | 4 |
| Faroe Is | 10 | 13 | 8 | 10 | 14 | 5 | 19 | 21 | 13 | 0 | 4 |
| France | 273 | 361 | 339 | 439 | 394 | 374 | 246 | 185 | 347 | 221 | 256 |
| Germany | 0 | 17 | 1 | 3 | 5 | 6 | 5 | 0 | | 0 | 0 |
| Iceland | 3 | 2 | 4 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| Ireland | 8 | 2 | 6 | 3 | 11 | 18 | 3 | 4 | 8 | 7 | 0 |
| Netherlands | . | 0 | | | 0 | | 0 | | 0 | 0 | 0 |
| Norway | 34 | 23 | 17 | 14 | 19 | 24 | 11 | 27 | 10 | 12 | 9 |
| Portugal | 0 | 15 | 4 | 11 | 4 | 57 | 10 | 6 | 2 | 1 | 0 |
| Spain | 15 | 11 | 23 | 49 | 22 | 9 | 10 | 26 | 6 | 32 | 0 |
| Sweden | 1 | 1 | 1 | . | . | 5 | 0 | . | 1 | 0 | 0 |
| Spain (Basque Country) | 41 | 38 | 45 | 16 | 22 | 10 | 11 | 5 | 16 | 13 | 3 |
| UK (Eng,Wal & NI) | 6 | 7 | 10 | 7 | 25 | 24 | 24 | 11 | 26 | 12 | 10 |
| UK (Scot) | . | . | 1 | . | . | . | . | . | . | 1 | 0 |
| Japan | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| TOTAL | 498 | 563 | 535 | 596 | 537 | 553 | 343 | 289 | 431 | 313 | 288 |

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

| | % Weight of in the catches of porbeagle | |
|---|---|---|
| Year | < 50 kg | >50 kg |
| 1992 | 26.0 | 74.0 |
| 1993 | 29.7 | 70.3 |
| 1994 | 33.1 | 66.9 |
| 1995 | 49.9 | 53.1 |
| 1996 | 31.9 | 68.1 |
| 1997 | 39.2 | 60.8 |
| 1998 | Data not available by weight category | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 53.7 | 46.3 |
| 2004 | 44.0 | 56.0 |
| 2005 | 40.0 | 60.0 |
| 2006 | 44.3 | 55.7 |
| 2007 | 44.9 | 55.1 |
| 2008 | 45.9 | 54.1 |
| 2009 | 51.8 | 48.2 |

**Table 6.3. Porbeagle in the NE Atlantic. Length–weight relationships of porbeagle from scientific studies.**

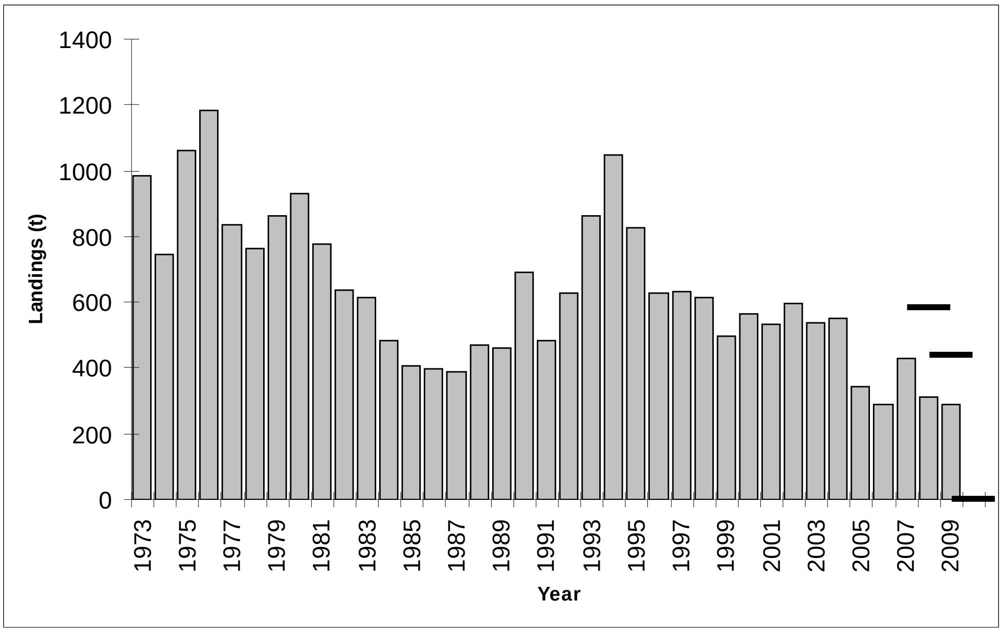
| Stock | L-W relationship | Sex | n | Length range | Source |
|---|---|---|---|---|---|
| NW Atlantic | W = (1.4823 x 10–5) LF 2.9641 | C | 15 | 106–227 cm | Kohler *et al.*, 1995 |
| NE Atlantic (Bristol Channel) | W = (1.292 x 10–4) LT 2.4644 | C | 71 | 114–187 cm | Ellis and Shackley, 1995 |
| NE 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% |



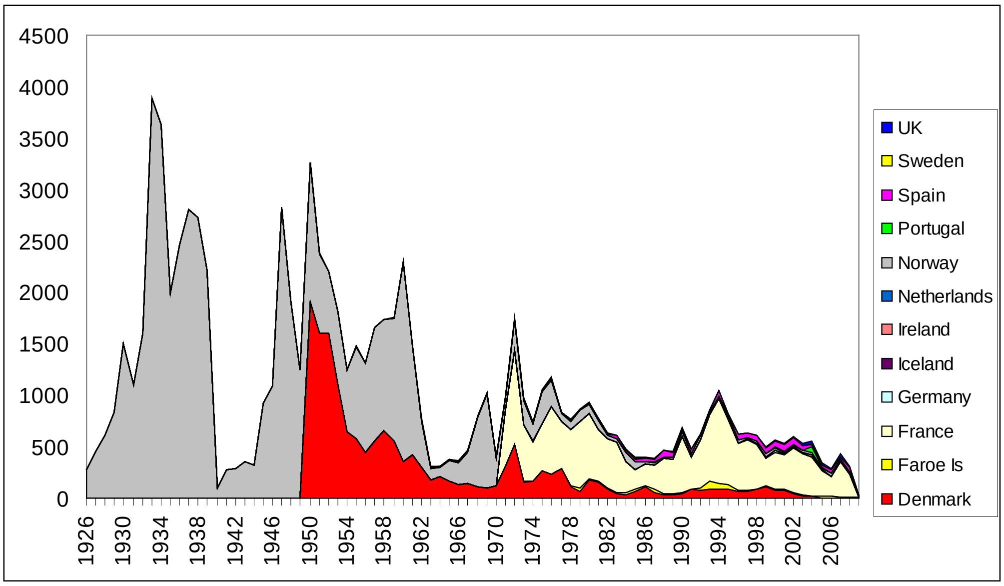




**Figure 6.1. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2009 (top, black lines indicates 2008–2010 TAC) and longer-term trend in landings (1926–1970) for those fleets reporting catches.**

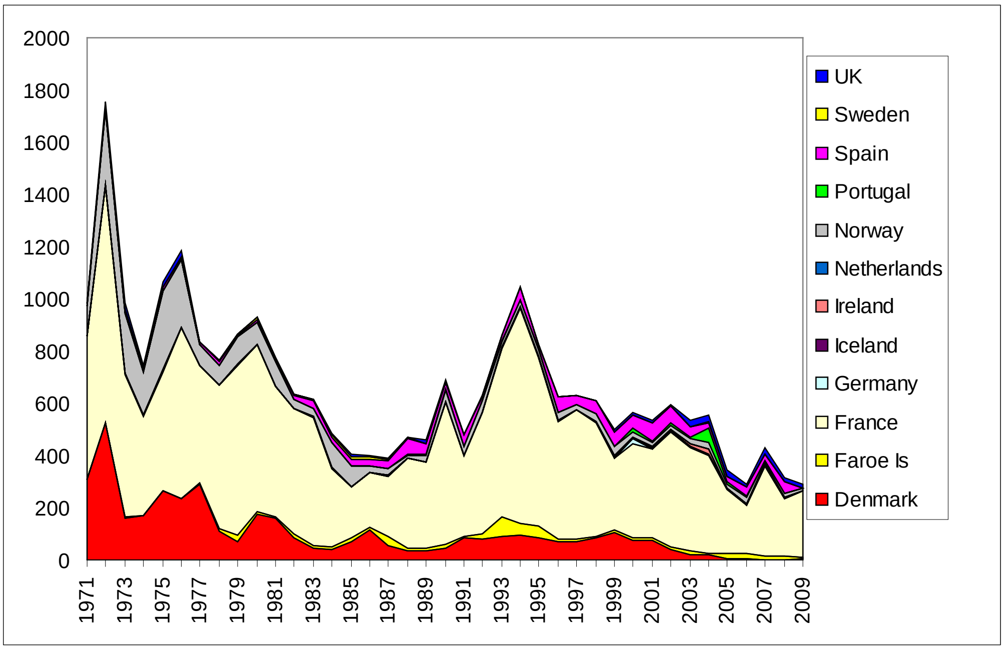



**Figure 6.3. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2009 by country.**

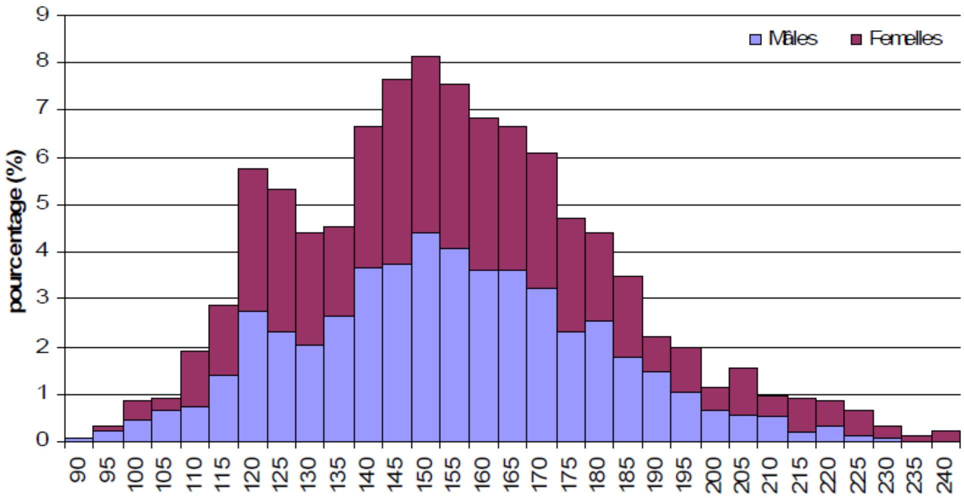



**Figure 6.4. Porbeagle in the NE Atlantic. Length frequency distribution of the landings of the Yeu porbeagle targeted fishery in 2008–2009 (n =1769). Source: Hennache and Jung, 2010.**

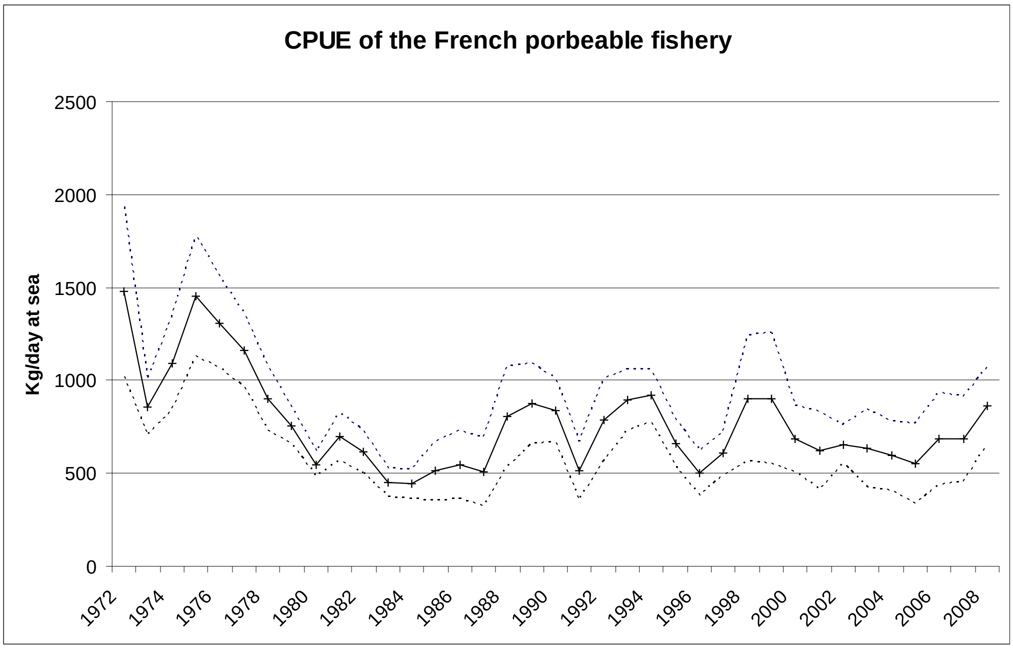



**Figure 6.5. Porbeagle in the NE Atlantic. Nominal cpue (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (± 2 SE of ratio estimate). From Biais and Vollette, 2009.**

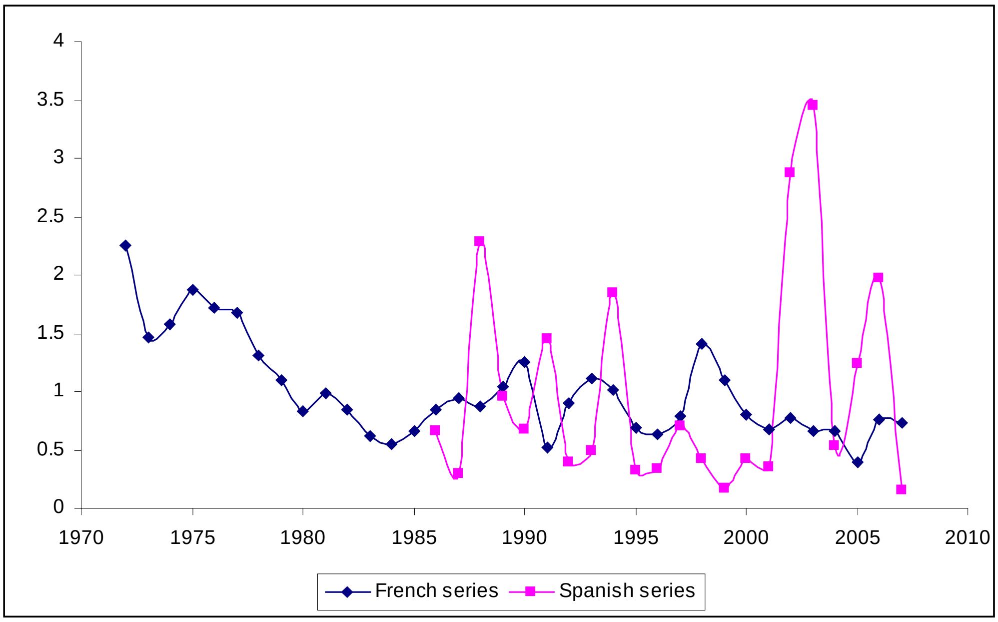



**Figure 6.6. Porbeagle in the NE Atlantic. Temporal trends in standardized cpue for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the NE Atlantic (1986–2007).**

# 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) indicicates panmixia, whereas Noble *et al.* (2006) suggested little gene flow between populations in the northern and southern hemispheres. A rough estimates 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 Norweigan 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. A total of ~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 2010.

### 7.2.2 The fishery in 2009

There was no directed fishery for basking sharks in Norway, UK or Ireland in 2009.

The only bycatch of basking shark reported in 2009 was one individual landed in UK (Gue.). There were no Norwegian bycatch of basking shark.

### 7.2.3 ICES advice applicable

The 2009 advice was the same as the advice given since 2006: "No targeted fishing for basking shark should be permitted and additional measures should be taken to prevent bycatch of basking shark in fisheries targeting other species. A TAC should cover all areas where basking sharks are caught in the Northeast Atlantic. This TAC should be set at zero."

### 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 2007–2009. Live specimens caught as bycatch have to be released immediately, although dead or dying specimens have to 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 1977–2009 are presented in Table 7.1, and Figure 7.2. The Table and Figure include landings data from UK (Gue.) (1984 and 2009), Portugal (1991–2009), France (1990–2009) and Norway (1977–2009). 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.

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 2010.

### 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.

Some reports of basking shark discard exist. A summary of these can be found in the Stock Annex 2010.

Some reports of basking shark discard exist. Berrow (1994) estimated 77–120 sharks were caught annually in the gillnet fishery in the Celtic Sea (Berrow, 1994). Berrow and Heardman (1994) recieved 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 deepwater 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 entanglement nets 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.

During 2007–2009, five specimens of basking shark were caught and discarded by the Norwegian Coastal Reference Fleet (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.

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. 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 2010.

## 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 2010.

## 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 2010.

## 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-histoy information

A summary of the knowledge on 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 the 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, showing 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 showed 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 hypotesized 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 months 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

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 "Vunerable".

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 North-East 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 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 1977–2008.**

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

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I & II | 96 | 593 | 781 | 533 | 1613 | 1374 | 920 | 604 | 792 | 425 | 55 |
| III & IV | 10 | | 116 | 220 | 84 | | 157 | 23 | | 43 | |
| Va | | | | | | | | | | | |
| Vb | | | | | | | | | | | |
| VI | | | | | | | | | | | |
| VII | | | | | | | | | | | |
| VIII | | | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 |
| IX | | | | | | | | | 1 | 1 | |
| X | | | | | | | | | | | |
| XII | | | | | | | | | | | |
| XIV | | | | | | | | | | | |
| TOTAL | 106 | 593 | 897 | 753 | 1697 | 1374 | 1077 | 628 | 793 | 471 | 56 |

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I & II | 31 | 117 | 80 | 54 | 128 | 72 | 87 | 6 | 26 | 4 | 0 |
| III & IV | | | | | 0 | | | | | | |
| Va | | | | | | | | | | | |
| Vb | | | | | | | | | | | |
| VI | | | | | | | | | | | |
| VII | | | | | | | 1 | 0 | 0 | + | + |
| VIII | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | |
| IX | | | | | 1 | + | 2 | 0 | 0 | | |
| X | | | 1 | | | | | | | | |
| XII | | | | | | | | | | | |
| XIV | | | | | | | | | | | |
| TOTAL | 32 | 118 | 81 | 54 | 129 | 72 | 90 | 6 | 26 | 5 | + |

**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 (1 individual) and 7132 kg (2 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 1990–2009.**

| Year | Area IIa | | | | | | | Area IVa | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Harpoon | Gillnets | Driftnets* | Undefined nets | Bottom trawl | Danish seine | Hooks and line | Harpoon | Gillnets | % |
| 1990 | 84,0 | 0,0 | 3,1 | 0,0 | 0,0 | 0,0 | 0,0 | 12,9 | 0,0 | 100 |
| 1991 | 69,7 | 0,0 | 1,0 | 0,0 | 0,0 | 0,0 | 0,0 | 29,3 | 0,0 | 100 |
| 1992 | 83,1 | 0,0 | 6,0 | 0,0 | 5,6 | 0,0 | 0,4 | 4,9 | 0,0 | 100 |
| 1993 | 99,1 | 0,8 | 0,0 | 0,0 | 0,1 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 1994 | 85,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 14,6 | 0,0 | 100 |
| 1995 | 89,8 | 6,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 3,7 | 100 |
| 1996 | 89,1 | 10,3 | 0,0 | 0,2 | 0,0 | 0,4 | 0,1 | 0,0 | 0,0 | 100 |
| 1997 | 66,7 | 23,7 | 0,0 | 0,0 | 0,0 | 0,0 | 0,5 | 9,1 | 0,0 | 100 |
| 1998 | 67,2 | 28,5 | 0,0 | 0,0 | 0,0 | 0,0 | 4,4 | 0,0 | 0,0 | 100 |
| 1999 | 9,1 | 81,8 | 0,0 | 7,8 | 1,3 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2000 | 33,4 | 58,7 | 0,0 | 0,0 | 7,8 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2001 | 0,0 | 96,0 | 0,0 | 0,0 | 4,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2002 | 16,3 | 78,5 | 0,0 | 0,0 | 5,2 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2003 | 3,4 | 89,7 | 0,0 | 0,0 | 7,2 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2004 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2005 | 54,1 | 44,5 | 0,0 | 0,5 | 1,4 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2006 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2007 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2008 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2009** | - | - | - | - | - | - | - | - | - | - |

*** These driftnets for salmon were banned after 1992.**

**** No catch in 2009.**

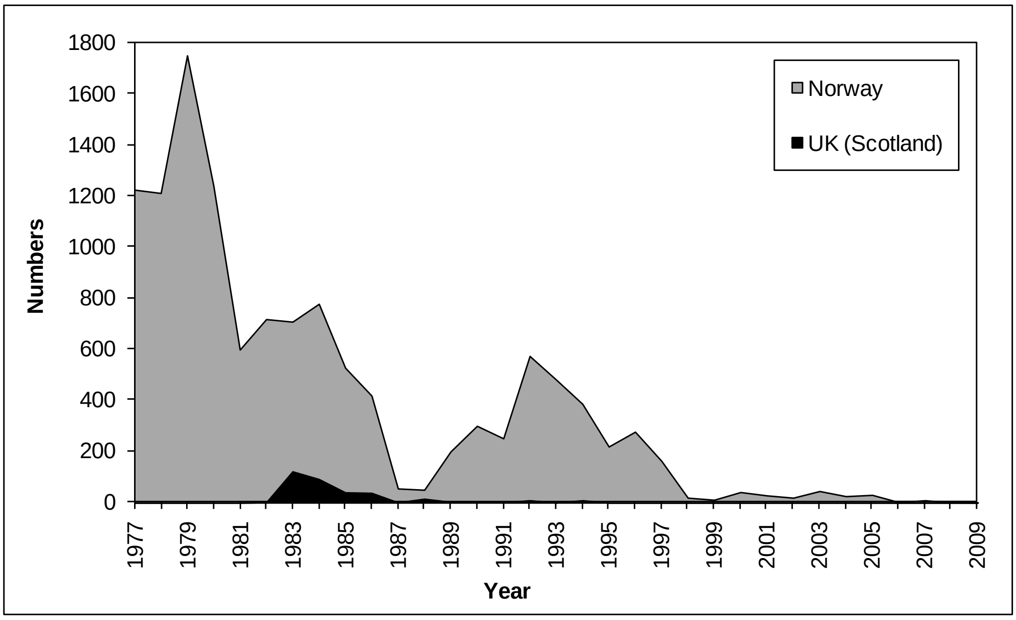


**Figure 7.1. Basking sharks in the Northeast Atlantic. Numbers of basking sharks caught by Norway and Scotland from 1977–2007 in ICES Areas I–XIV from 1977–2009.**

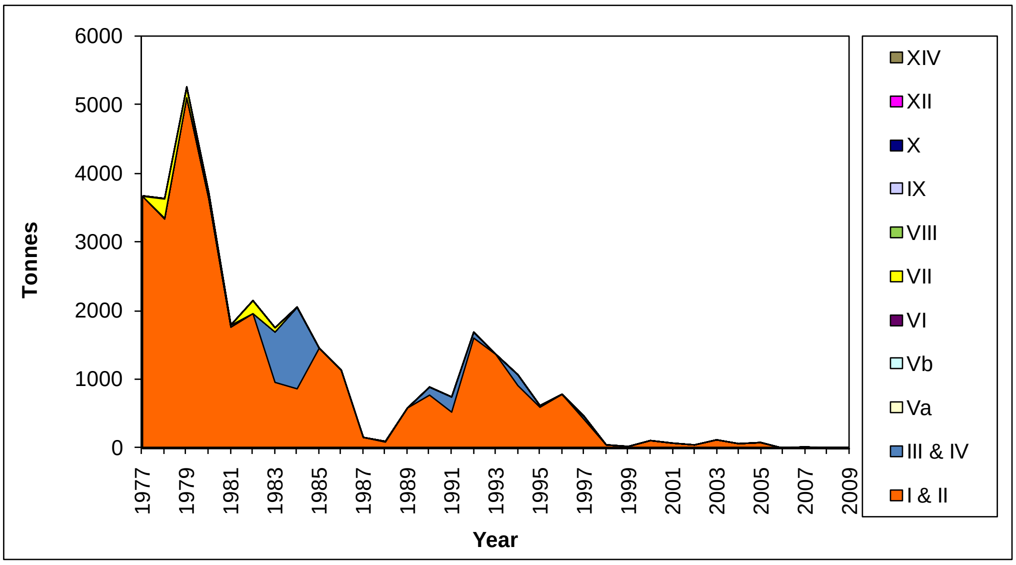


**Figure 7.2. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2009.**

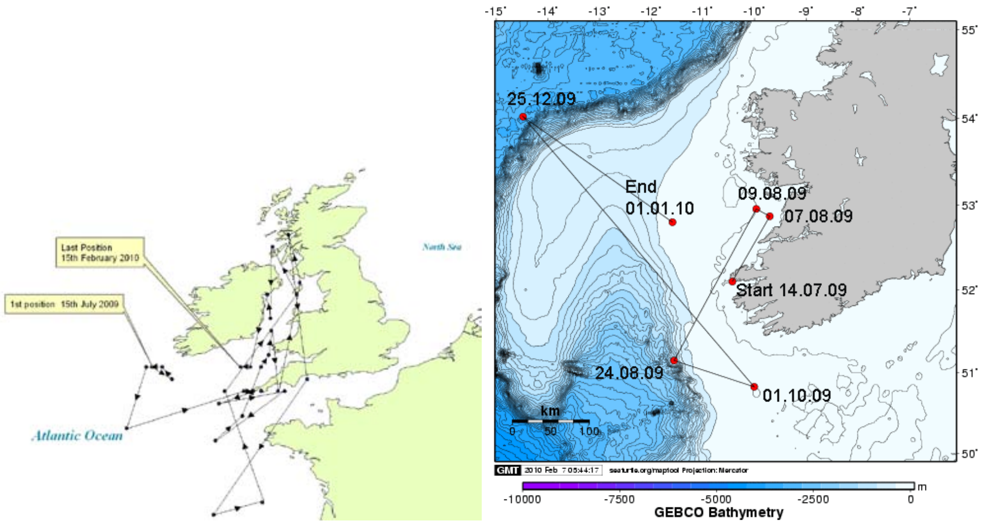


**Figure 7.3 Geo-locations from basking shark A (left, sex=male) and B (right, sex=unknown). Source Berrow and Jackson, 2010.**

# 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 2009

No new information.

Reported catches in 2009 by ICES member nations were minimal to zero and are therefore not included in the catch table.

### 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) showed 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.*, in press). 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:

WR = 0.4 + 1.22 WD
WD = 0.2 + 0.81 WR

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 showed 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 Fish-stat: 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 | - | - | - | - | - | - | - | - | - | - | - |
| 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 | - | - | - | - | - | - | - | - | 10 483 | 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 |
| 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 |
| 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 |
|---|---|---|---|---|---|
| Benin | Atlantic, Eastern Central | 6 | 6 | 5 | . |
| China | Atlantic, Eastern Central | . | . | 472 | 111 |
| Ghana | Atlantic, Eastern Central | . | . | . | 21 |
| Liberia | Atlantic, Eastern Central | . | . | . | . |
| Panama | Atlantic, Eastern Central | - | 254 | 891 | 806 |
| Portugal | Atlantic, Eastern Central | 1440 | 1754 | 2212 | 3169 |
| Russian Federation | Atlantic, Eastern Central | 1 | - | - | - |
| Senegal | Atlantic, Eastern Central | . | . | 43 | 134 |
| Spain | Atlantic, Eastern Central | 7138 | 6036 | 4320 | 4625 |
| United Kingdom | Atlantic, Eastern Central | . | . | - | 62 |
| Channel Islands | Atlantic, Northeast | - | - | - | 1 |
| Denmark | Atlantic, Northeast | <0.5 | 1 | 1 | - |
| France | Atlantic, Northeast | 120 | 134 | 167 | 109 |
| Ireland | Atlantic, Northeast | <0.5 | - | <0.5 | <0.5 |
| Netherlands | Atlantic, Northeast | - | - | 1 | - |
| Portugal | Atlantic, Northeast | 1990 | 2627 | 3283 | 3026 |
| Spain | Atlantic, Northeast | 5408 | 6069 | 10 684 | 13107 |
| United Kingdom | Atlantic, Northeast | 5 | 3 | 6 | 5 |
| Canada | Atlantic, Northwest | 1134 | 977 | 843 | - |
| Portugal | Atlantic, Northwest | - | 11 | 71 | 70 |
| Spain | Atlantic, Northwest | 1150 | 1387 | - | 2214 |
| China | Atlantic, Western Central | - | - | - | 1 |
| Portugal | Atlantic, Western Central | 3 | 1 | 2 | 32 |
| Spain | Atlantic, Western Central | 1310 | 1972 | 2034 | 842 |
| Trinidad and Tobago | Atlantic, Western Central | 1 | 1 | <0.5 | 2 |
| Venezuela, Boliv Rep of | Atlantic, Western Central | 26 | 10 | 18 | 7 |
| | **Total** | **19 732** | **21 243** | **25 053** | **28 344** |

**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. ($L_\infty$ 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 |

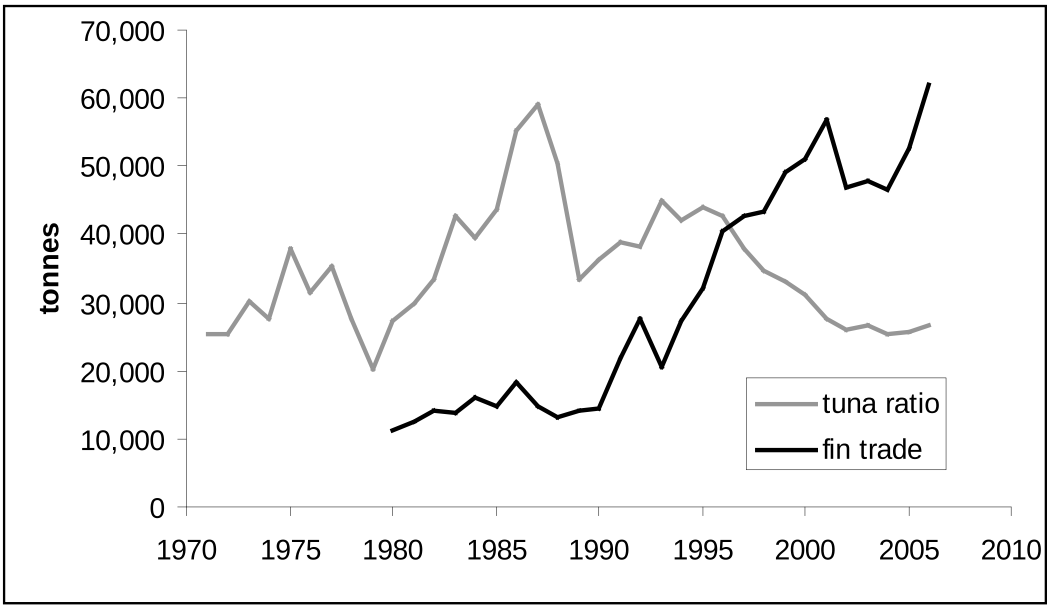


**Figure 8.1. Blue Shark in the North Atlantic. Two estimates of catch, as presented by ICCAT 2008. Tuna ratio: resulting from application of the method of estimating catches using the ICCAT reported data and the ratio of tunas to shark catch; fin trade: based on the medians scaled to effort partitioned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

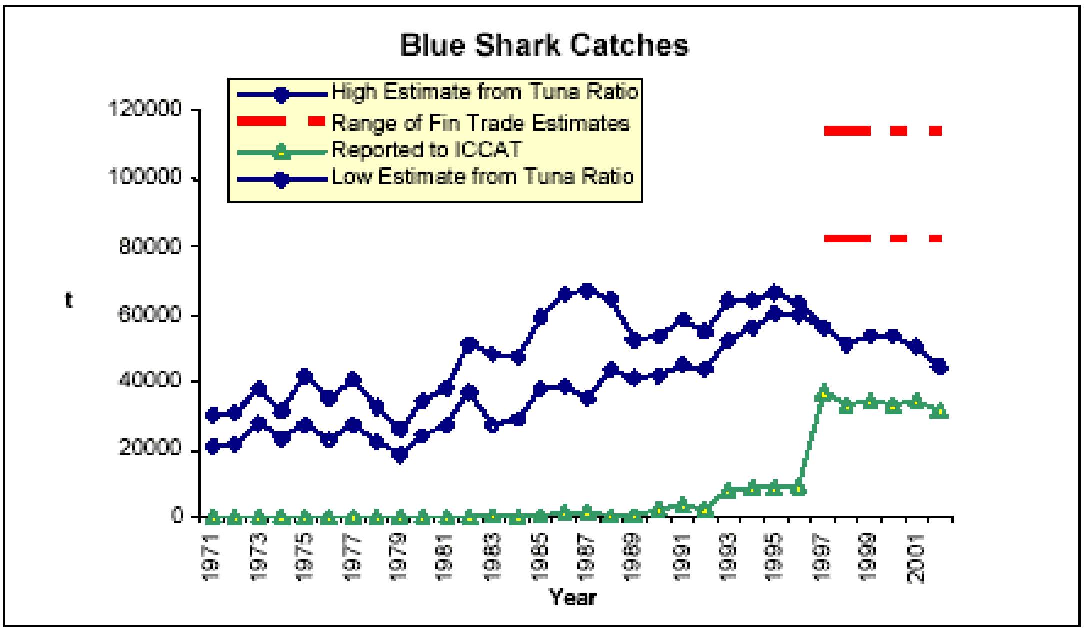


**Figure 8.2. Blue shark in the Atlantic. Comparison of shark catch reported to ICCAT with estimates resulting from tuna to shark ratios and from fin trade data for blue sharks in the Atlantic. Source: ICCAT.**

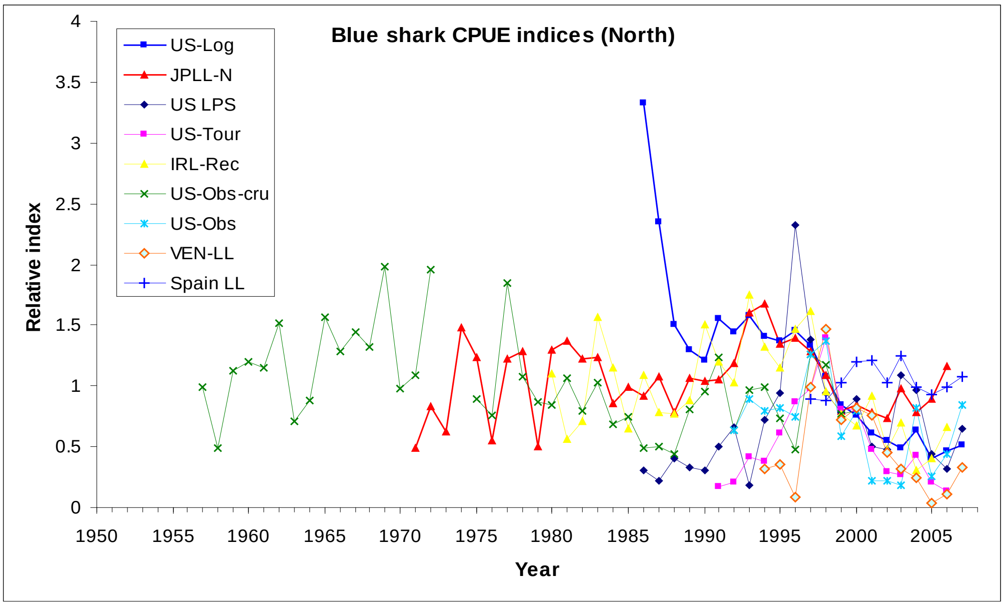


**Figure 8.3. Blue Shark in the North Atlantic. Cpue indices used in ICCAT assessment in 2008. Indices presented on a relative scale.**

# 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 | t0 | 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. $L_\infty$ 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 (LT) | 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 (TL) | 195 cm | | | Stevens, 1983 |
| Male length-at-maturity (TL) | 197–202 cm (median) | 215 | New Zealand | Francis and Duffy, 2005 |
| | 180 cm (LF) | | NE Atlantic (Portugal) | Maia *et al*., 2007 |
| | 200–220 | | Worldwide | Pratt and Casey, 1983; Mollet *et al*., 2000 |
| Female length-at-first maturity (TL) | 265–280 cm | | | Cliff *et al*., 1990 |
| Female length-at-maturity (TL) | 301–312 (median) | 88 | New Zealand | Francis and Duffy, 2005 |
| | 270–300 cm (LT) | | 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 (TL) | 296 cm | | | Compagno, 2001 |
| Female maximum length (TL) | 396 cm<br>408 cm (estimated) | | | Compagno, 2001 |
| Life span (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<br>40.6 cm year–1 second year<br>5.0 cm month–1 in summer<br>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 TD (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 |

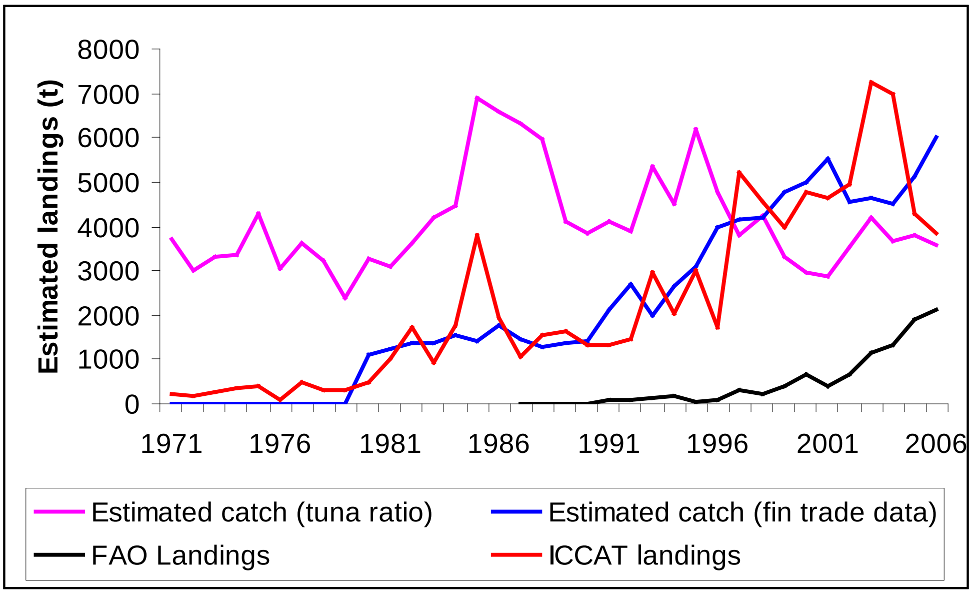


**Figure 9.1. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Available landings (tonnes) from North Atlantic by FAO Areas 27, 21 and 34. Reporting was minimal for the years 2005 and 2006. (Source: ICCAT).**

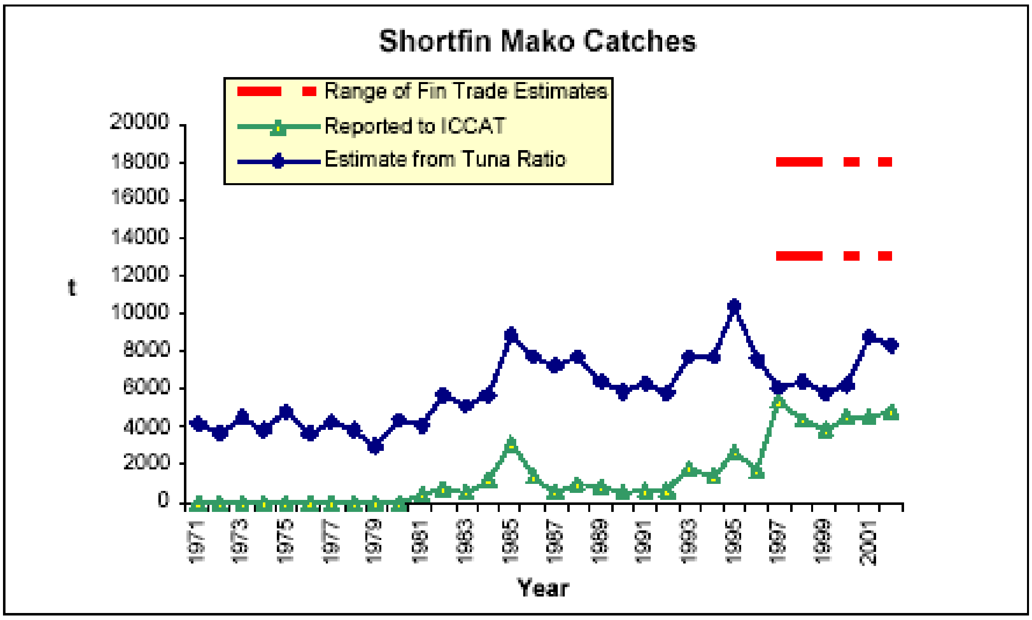


**Figure 9.2. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Comparison of landed weights from data reported to ICCAT, from data raised to catches of tunas and from fin trade estimates (ICCAT 2005).**

# 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 2009

There were no major changes to the fishery noted in 2009.

### 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 has 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 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 North-west Africa are available. The degree of possible misreporting or underreporting is not known. Overall available landings appear relatively stable in recent years, at about 500 t.y$^{-1}$. 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

New 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

ICES. 2008. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 31 March–4 April 2008, Vigo, Spain. ICES CM 2008 RMC:02; 228 pp.

Punt, A. E., Pribac, F., Walker, T. I., Taylor, B. L. and Prince, J. D. 2000. Stock assessment of school shark *Galeorhinus galeus* based on a spatially-explicit population dynamics model. *Marine and Freshwater Research*, 51: 205–220.

Punt, A. E., and Walker, T. I. 1998. Stock assessment and risk analysis for the school shark (*Galeorhinus galeus*) off southern Australia. *Marine and Freshwater Research*, 49: 719–731.

Xiao, Y. and Walker, T. I. 2000. Demographic analysis of gummy shark (*Mustelus antarcticus*) and school shark (*Galeorhinus galeus*) off southern Australia by applying a generalized Lotka equation and its dual equation. *Canadian Journal of Fisheries and Aquatic Sciences*, 57: 214–222.

**Table 10.1. Tope in the North East Atlantic and Mediterranean. Reported species-specific landings (Tonnes) for the period 1978–2008. 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 | 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 | na | na | na | na | 63 | 51 | 28 | 23 | 21 | 21 | 21 | 55 | 45 |
| 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 | + | + | + | + | + | + | + | + | 1 | | | | |
| 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 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 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 North East Atlantic and Mediterranean. Reported species-specific landings (Tonnes) for the period 1978–2008. 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 North-west African waters.**

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

**Table 10.1. (continued). Tope in the North East Atlantic and Mediterranean. Reported species-specific landings (nearest Tonne) for the period 1978–2009. 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 North-west African waters.**

| ICES Division IIIa–IV | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 8 | 4 | 5 | 5 | 5 | 8 | 6 | 3 | 4 | 3 |
| France | 11 | 11 | 6 | 6 | 3 | 3 | 6 | 6 | 6 | na |
| Sweden | - | - | - | - | - | + | 0 | 0 | 0 | 0 |
| UK | 13 | 10 | 13 | 11 | 8 | 10 | 13 | 5 | 2 | 1 |
| UK (Scotland | - | - | - | - | - | - | - | 0 | 0 | 0 |
| Total (IIIa–IV) | 32 | 25 | 24 | 22 | 16 | 21 | 25 | 14 | 12 | 4 |
| ICES Division V–VII | | | | | | | | | | |
| France | 368 | 394 | 324 | 284 | 209 | 181 | 293 | 155 | 187 | na |
| Ireland | na | 4 | 1 | 6 | 4 | na | 7 | 3 | 4 | 3 |
| Spain | na | + | 242 | 3 | na | na | na | na | 60 | 69 |
| Spain (Basque country) | - | + | + | 3 | 15 | 10 | . | . | . | 0 |
| UK | 98 | 72 | 60 | 55 | 65 | 65 | 74 | 44 | 33 | 22 |
| Total (VI–VII) | 466 | 470 | 627 | 351 | 293 | 256 | 374 | 202 | 284 | 93 |
| ICES Division VIII | | | | | | | | | | |
| France | 71 | 58 | 49 | 60 | 16 | 29 | 40 | 28 | 35 | na |
| Spain | na | 9 | 13 | 10 | na | na | na | na | 21 | 33 |
| Spain (Basque country) | - | 9 | 6 | 10 | 10 | 14 | 12 | 1 | 12 | 14 |
| UK | | 1 | | 3 | 8 | 6 | 5 | 0 | 0 | 0 |
| Total (VIII) | 71 | 77 | 68 | 83 | 34 | 49 | 57 | 29 | 69 | 47 |
| ICES Division IX | | | | | | | | | | |
| Spain | na | na | na | na | 76 | na | na | na | 96 | 85 |
| Total (IX) | | | | | 76 | | | | 96 | 85 |
| ICES Division X | | | | | | | | | | |
| Portugal | 142 | 82 | 77 | 69 | 51 | 45 | 45 | na | 47 | 34 |
| Total (X) | 142 | 82 | 77 | 69 | 51 | 45 | 45 | 0 | 47 | 34 |
| Other | | | | | | | | | | |
| France | - | 2 | - | - | - | - | - | - | - | |
| UK | - | - | - | - | - | - | - | - | - | |
| CECAF area | | | | | | | | | | |
| Portugal | 2 | 1 | 2 | 98 | na | na | na | na | na | |
| **Total landings** | **713** | **656** | **798** | **622** | **470** | **371** | **502** | **245** | **412** | **179** |

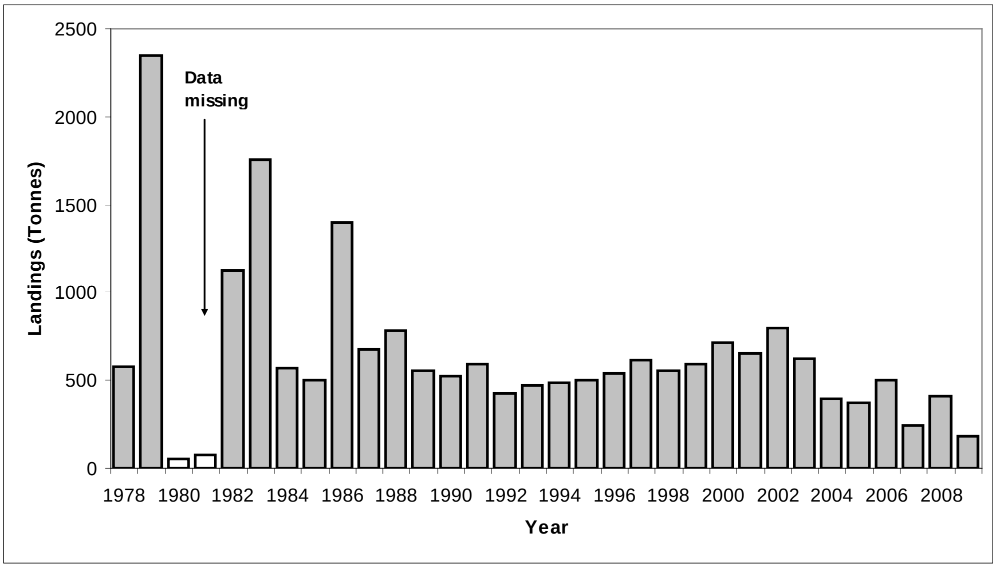


**Figure 10.1. Tope in the North East Atlantic and Mediterranean. Annual landings of tope. These data are considered underestimates as some tope are landed under generic landings categories, and no species-specific landings data are available for the Mediterranean Sea and North-west African waters. Not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

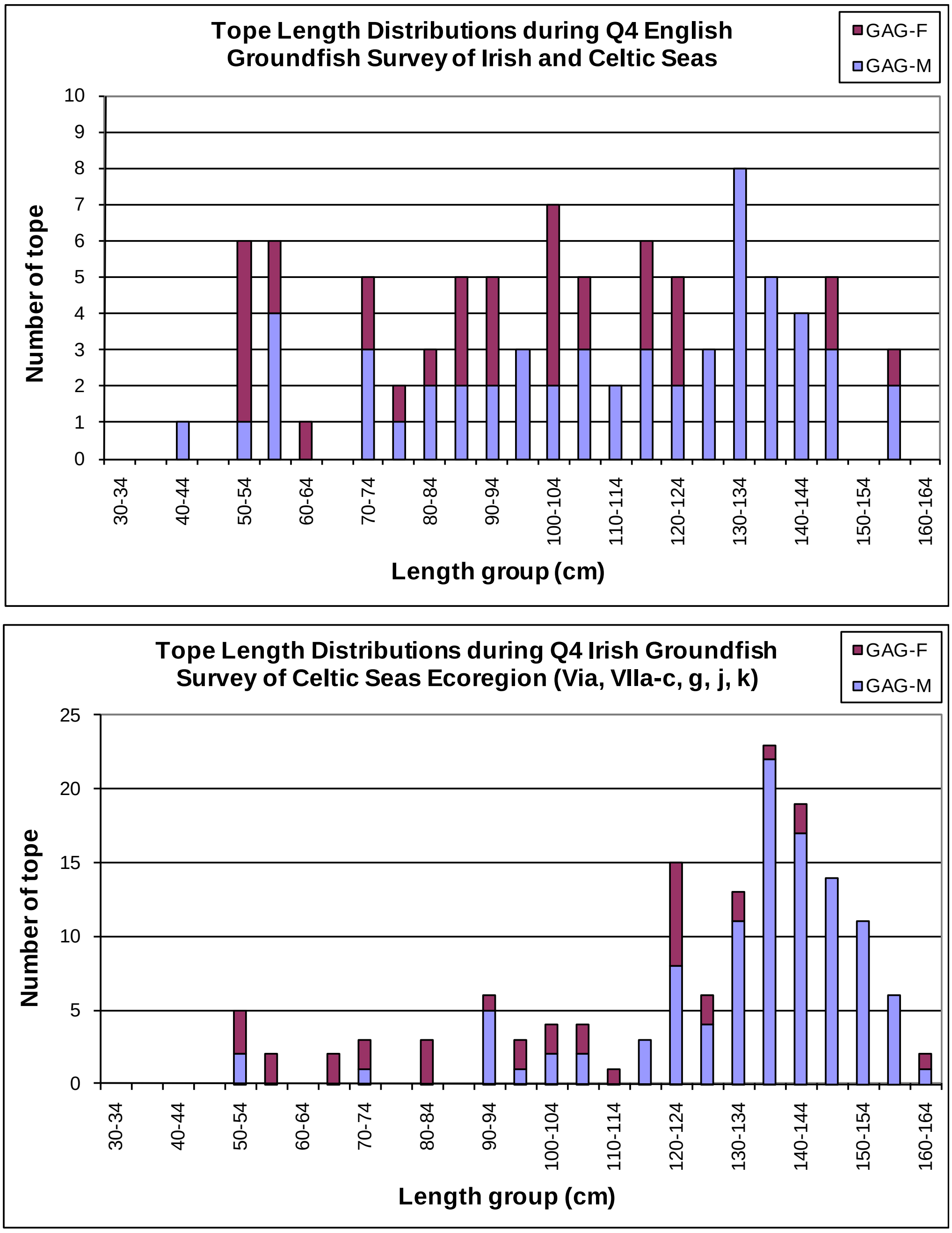


**Figure 10.2. Tope length distributions from a) English Groundfish Survey data, years 2004–2009, conducted in Q4 in Celtic and Irish Seas, and b) Irish Groundfish Survey data, years 2003–2009, conducted in Q4 in the Celtic Seas Ecoregion (ICES Divisions VIa, VIIa-c, g, j, k).**

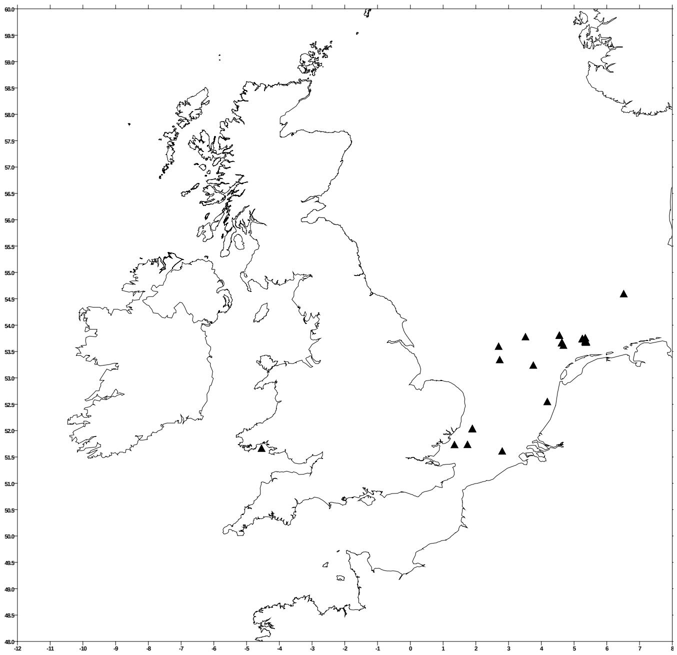

**Figure 10.3. Tope in the North East Atlantic and Mediterranean. Sites where tope pups (24–45 cm total length) have been reported during UK surveys.**

# 11 Thresher sharks in the North East 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 tunas 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 2009

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 38–248 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 (1 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. However, the French landings reported to ICCAT are larger, at between 9–30 t since 2002. Landings data for 2009 were incomplete for France; these data (Table 11.2) will be updated next year. 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, however, for the same year, just eight tonnes were reported to ICCAT by Portugal. No national landings have been reported to WGEF since, yet catches of 107, 153 and 56 t were reported to ICCAT by Portugal in 2006, 2007 and 2008 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. Similarly, like Portugal, landings of 44 t in 2007 and 81 t in 2008, 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 248 t in 2001, and the lowest level of 38 t in 2005. Better harmonisations 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) program 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 program (Alop project) in the Mediteranean Sea, in close collaboration with the fishing industry.

The aims of the 'Alop' project are (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 fishermen to release the individuals alive at sea after tagging.

Therefore, in WGEF 2011, we hope to present preliminary findings of this study.

## 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 the summer of 1996. They showed 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 fishes, 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 onboard, transshipping, 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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Camhi, M.D., Valenti, S.V., Fordham, S.V., Fowler, S.L. and Gibson, C. 2009. The Conservation Status of Pelagic Sharks and Rays: Report of the IUCN Shark Specialist Group Pelagic Shark Red List Workshop. IUCN Species Survival Commission Shark Specialist Group. Newbury, UK. x + 78p.

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Moreno J. and Moron J. 1992. Reproductive biology of the bigeye thresher shark, *Alopias superciliosus* (Lowe, 1839). *Australian Journal of Marine and Freshwater Research*, 43(1): 77–86.

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Sebastian H., Haye P. A. and Shivji M. S. 2008. Characterization of the pelagic shark-fin trade in north-central Chile by genetic identification and trader surveys. *Journal of Fish Biology* 73: 2293–2304.

**Table 11.1. Thresher sharks in the North East 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 | 138 | 25 | 193 | | | | 13 | | | | 206 |
| 1998 | 44 | 104 | 27 | 175 | | | | 7 | | | | 182 |
| 1999 (1) | 15 | 44 | (57) | 59 | 1 | | 1 | 35 | | | | 96 |
| 2000 | 8 | 21 | 23 | 52 | | 2 | 2 | 128 | | | | 182 |
| 2001 | 21 | 35 | 61 | 117 | | 2 | 2 | 129 | | | | 248 |
| 2002 | 11 | 38 | 25 | 74 | 21 | | 21 | 24 | | | | 119 |
| 2003 | 7 | 18 | 1 | 26 | 17 | | 17 | 28 | | + | + | 71 |
| 2004 | 17 | 37 | 11 | 65(2) | 22 | + | 21 | 23 | | + | | 109 |
| 2005 | na | na | na | ?(2) | 8 | | 8 | 30 | + | | | 38 |
| 2006 | na | na | na | na | 107 | | 107 (3) | 12 | + | | | 119 |
| 2007 | 12 | 32 | na | 44 | 153 | 3 | 156 (3) | 9 | 1 | | | 210 |
| 2008 | na | na | 81 | 81 | 53 | 3 | 55 | 10 | 1 | + | | 147 |

**(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 North East 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Azores | | | | | | | | | | | | | | 0 | 0 |
| Denmark | IV | | | | | | . | . | + | . | | | | | |
| France | VI,VII, IX | 17 | 22 | 18 | 13 | 107 | 112 | 4 | 3 | 1 | 2 | 1 | 2 | 3 | na |
| France | VIII | | | | | | | | | 2 | 7 | 11 | 10 | 4 | na |
| 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 |
| Spain | VII - IX | | 53 | 54 | 36 | 1 | | | 3 | 84 | 54 | | | | |
| UK(E&W) | IV | | | | | | | | | | | 0 | | 0 | 0 |
| UK(E&W) | VII | | | | | | | | | | | | 1 | 1 | 1 |
| Total | | 30 | 113 | 98 | 61 | 123 | 137 | 25 | 23 | 120 | 143 | 12 | 13 | 8 | 2 |

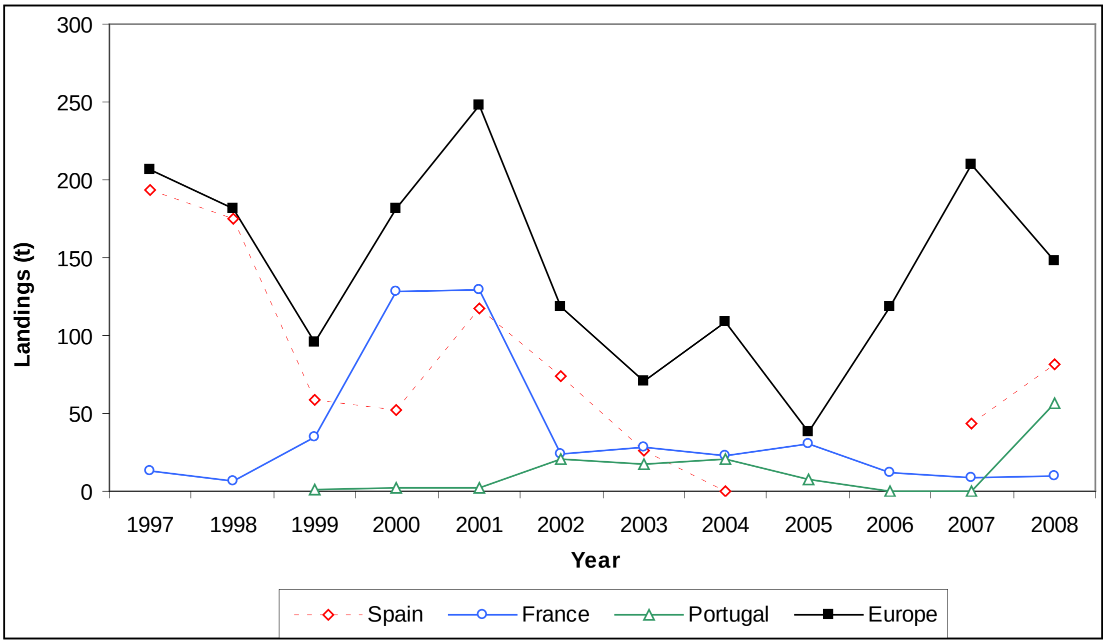


**Figure 11.1. Thresher sharks in the North East Atlantic and the Mediterranean Sea. Reported landings of thresher sharks by Spain, Portugal and France (1997–2008, ICCAT and national data). Spanish data (2005–2006) are lacking, and recent Portuguese landings need verification.**

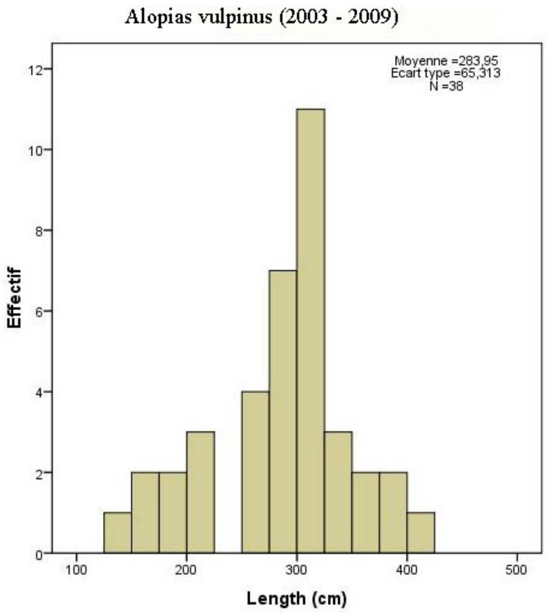


**Figure 11.2. Length frequency distributions for *Alopias vulpinus* sampled in the Divisions VII-Iabcd in the framework of the Data Collection Regulation program by observers on board French vessels between 2003 and 2009 (Lengths are fork length over the body).**

# 12 Other pelagic sharks in the North East 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 2009

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. In the ICCAT database, these records are very few; Spain reported 326 t of pelagic sharks in 2000. 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 562 t of hammerhead sharks in 2005. Data on requiem shark species are scare and variable. Total landings of requiem sharks varied from 5–158 t for the period 1997–2007. Landings for *Carcharhinus falciformis* and *C. longimanus* are sporadically reported by Spain (Table 12.1). Some landings of longfin mako are reported by Spain, varying from 3–28 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 1–10 t of tiger and silky sharks.

Studies by Castro *et al*., 2000 and Mejuto *et al*., 2002 demonstrate that 99% of the by-catch 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 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.*, in press 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.

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**Table 12.1. Other pelagic sharks in the North East 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. Value in brackets has not been validated by ICCAT in 2008. OCS: *Carcharhinus longimanus*-FAL: *Carcharhinus falciformis* LMA: *Isurus paucus*-SPK: *Sphyrna mokarran*-SPL: *Sphyrna lewini*-SPN: *Sphyrna* spp-SPZ: *Sphyrna zygaena*.**

| ICCAT | Spain | | | | | | | | | | | Portugal | | France | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NE Atlantic | SPN | SPL | SPK | SPZ | Total *Sphyna* | FAL | OCS | RSK | Total Requiem | LMA | Total Spain | SPZ | RSK | RSK | |
| 1997 | (353) | | | 220 | 573 | | | | | 26.6 | 599.6 | | | | 599.6 |
| 1998 | (343) | (3) | (1) | 103 | 450 | | | (158) | 158 | 8.2 | 616.2 | | | | 616.2 |
| 1999 | | | | | | | | (60) | 60 | 0 | 60 | | | | 60 |
| 2000 | (312) | | | (1) | 313 | | 2.5 | | 2.5 | 19.7 | 335.2 | 14 | | | 349.2 |
| 2001 | (249) | | | (4) | 253 | | 6.7 | (100) | 106.7 | 51.3 | 411 | 6 | | | 417 |
| 2002 | (263) | | | (9) | 272 | | 0.6 | (80) | 80.6 | 64.5 | 417.1 | 16.3 | | | 433.4 |
| 2003 | (231) | 290 | | 88 | 609 | 31 | 1.1 | (86) | 118.1 | 61.9 | 789 | 11.5 | (155) | | 955.5 |
| 2004 | (364) | 139 | | 146.4 | 649 | 4 | | (97) | 101 | 51.2 | 801.2 | 7 | | | 808.2 |
| 2005 | | 317.3 | | 217.5 | 534.8 | 15.9 | | | 15.9 | | 550.7 | 12 | | | 562.7 |
| 2006 | | 147.8 | | | 147.8 | 27.3 | | | 27.3 | | 165.1 | | | | 165.1 |
| 2007 | 103 | | | 2 | 105 | | | | | | | 29 | 5 | | 239 |
| 2008 | | | | | | | | | | | | | | 527 | 527 |

**Table 12.3. Other pelagic sharks in the North East 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 North East 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Devil fish | Spain | - | - | - | - | - | - | 1 | 3 | 3 | 2 | 1 |
| Smooth hammerhead | Portugal | . | 8 | 8 | 4 | 5 | 7 | 20 | 3 | 13 | 9 | 7 |
| Smooth hammerhead | Spain | - | - | - | - | - | - | 5 | 10 | <0.5 | 3 | 2 |
| Oceanic whitetip shark | Portugal | - | - | - | - | - | - | - | - | - | - | 1 |
| Stingrays nei | France | 5 | 6 | 10 | 7 | 10 | 11 | 14 | 20 | 13 | 8 | 1 |
| Tiger shark | Spain | - | - | - | - | - | - | 2 | 4 | 5 | 3 | 2 |

**Table 12.5. Other pelagic sharks in the North East 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) | Life span 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<br>K= 0.065<br>T0 = –4.40 | 4.42–4.53 |
| Longfin mako *Isurus paucus* | Cosmopolitan | 417 | Ovoviviparous | | | | 2 | | | | 4.5 |
| Silky shark *Carcharhinus falciformis* | Circumtropical 0–500 m | 350 | Viviparous | 210–220 M<br>225 F | 6–7<br>7–9 | 12 | 2–15 | 57–87 | 25 | L∞ = 291/315<br>K= 0.153 / 0.1<br>T0 = –2.2 / –3.1 | 4.4–4.52 |
| Spinner shark *Carcharhinus brevipinna* | Circumtropical 0–100 m | 300 | Viviparous | 176–212 | | | Up to 20 | 60–80 | | L∞ = 214 FL<br>K= 0.210<br>T0 = –1 .94 | 4.2–4.5 |
| Oceanic whitetip *Carcharhinus longimanus* | Cosmopolitan 0–180 m | 396 | Viviparous | 175–189 | 4–7 | | 1–15 | 60–65 | 22 | L∞ = 245 / 285<br>K= 0.103 / 0.1<br>T0 = 2.7 / – 3.39 | 4.16–4.39 |
| Dusky shark *Carcharhinus obscurus* | Circumglobal | 420 | Viviaparous | 220–280 | 14–18 | | 3–14 | 70–100 | 40 | L∞ = 349 / 373<br>K= 0.039/ 0.038<br>T0 = –7.04/ –6.28 | 4.42–4.61 |
| Sandbar shark *Carcharhinus plumbeus* | Circumglobal 0–1800 m | 250 | Viviparous | 130–183 | 13–16 | | 1–14 | 56–75 | 32 | L∞ = 186 FL<br>K= 0.046<br>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) | Life span years | Growth | Trophic level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Night shark *Carcharhinus signatus* | Atlantic 0–600 m | 280 | Viviparous | 185–200 | | | 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 | | | 13–42 | 60–70 | | | 4.23–4.43 |
| Smooth hammerhead *Sphyrna zygaena* | Circumglobal 0–200 m | 500 | Viviparous | 210–265 | | | 20–50 | 50–60 | | | 4.32–4.5 |
| Pelagic stingray *Pteroplatytrygon violacea* | Cosmopolitan 37–238 | 160 | Ovoviviparous | 35–40 DW | | | 4–9 | 15–25 DW | | L∞ = 116 DW K= 0.0180 | 4.36 |
| Devil ray *Mobula mobular* | NE Atl. + Med. epipelagic | 520 | Ovoviviparous | | | | | | | | 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 (see Section 21.1), 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 Arctic and *R. fyllae* (3% and 2% by number, respectively), and the remaining species are scarce (Dolgov *et al.*, 2004b; Drevetnyak *et al.*, 2005).

All 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* and spurdog *Squalus acanthias* is present in the coastal areas (see Section 2).

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 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 2009

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 2009

There are no TACs or other management measures 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 fishes, in the Norwegian Economic Zone. However, discarding of skates was still done in 2009 (pers.comm. Norwegian Directorate of Fisheries), although the precise quantity is unknown.

## 13.3 Catch data

### 13.3.1 Landings

Landings data are limited and only available for ICES Subdivision I for all skate species combined (Figure 13.1 and Table 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 with 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 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 to corresponding numbers from the official Norwegian landings statistics. Future analysis of these data should include quantities and proportions of elasmobranchs in relation to commercial teleosts such as cod and haddock.

According to personal communication, there may be some unreported pole and line catches of the Greenland sharks (*Somniosus microcephalus*) in the Russian coastal areas (Vinnichenko *et al.*, 20010 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 Referance 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).

Vinnichencho *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 surveys

For the offshore areas, data from October–December survey cruises 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.

Vinnichencho *et al.* (2010 WD) reported on catches of *A. radiata* from the 2009 survey cruise. 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.

Vinnichencho *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/Norweian surveys. These are presented in Section 13.6.4.

### 13.6.2 Norwegian coastal survey

The distribution and diversity of elasmobranch species in North-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 analyzed, and presented to the WGEF, as some of the issues regarding species misidentification have been solved.

### 13.6.3 Norwegian deep-water survey

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, 2008, in the Norwegian Sea Ecoregion (Section 14).

### 13.6.4 Joint Russian/Norwegian surveys

Two joint Russian/Norwegian surveys are conducted in the Barents Sea. The cruises run in February, in the southern Barents Sea northwards to the latitude of Bear Island, and August–September, 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. Due to 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 Vinnichenco *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 registered (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.

Vinnichencho *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

There are concerns regarding the accuracy of skate species identification with regard to Norwegian Survey data. This is particularly relevant to confusion between *A. radiata* and *R. clavata*, and possibly other species. 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.

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.

## 13.7 Life-history information

Length data are available for *A. radiata, A. hyperborea, R. fyllae, D. batis* (complex) and *B. spinicauda* (see ICES, 2007). 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 on the International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species:

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

"Near threatened": *B. spinicauda*, *D. oxyrinchus*, *L. fullonica*, and *R. Clavata*;

"Least concern": *A. radiata* (Northeast Atlantic subpopulation), *A. hyperborea, R. fyllae,* and *D. Linteus*;

*B. spinicauda, D. batis* (complex), *A. hyperborea* and *L. fullonica* are listed as Data Deficient in the Norwegian Red List, 2006;

In the Norwegian Red List (2006) Species listed as "data deficient" are: *D. ba-*

*tis* (complex), *B. spinicauda, D. oxyrinchus, L. fullonica, A. hyperborea,* and *D. linteus.*

## 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 mis-identification of some species during surveys needs to be resolved before sound and reliable advice can be given for elasmobranchs in the Barents Sea ecoregion.

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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, 1973–2008. Total landings (tonnes).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | 1 | . | . | . | . | . | . | . | . | . |
| France | . | . | . | 81 | 49 | 44 | . | . | . | . | . | . | . |
| Germany | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | . | . | . | 1 | 3 | 4 | 8 | 2 | 2 | 2 | 1 | 10 | 11 |
| Portugal | . | . | 100 | 11 | 1 | . | . | . | . | . | . | . | . |
| USSR/Russian Fed. | . | . | . | . | . | 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 | n.a. | n.a. | n.a. | n.a. | n.a. | . | . | . | 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 | . | . | 399 | 790 |
| Spain | . | . | . | . | . | . | . | . | . | 7 | . | . | . |
| UK - E & W | | 2 | . | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | n.a. | n.a. | n.a. | | | | 0 | 0 |
| France | . | . | . | . | . | . | . | | | 0 | |
| Germany | . | . | . | n.a. | n.a. | n.a. | | | | 0 | 0 |
| Iceland | . | 4 | . | n.a. | n.a. | n.a. | | | | n.a. | 0 |
| Norway | 21 | 12 | 30 | 26 | 2 | 1 | 4 | 13 | 4 | 72 | 15 |
| Portugal | . | . | . | n.a. | n.a. | n.a. | . | | | 0 | 0 |
| USSR/Russian Fed. | 568 | 502 | 218 | 173 | 38 | 69 | 37 | 48 | 24 | 6 | 2 |
| Spain | . | . | . | n.a. | n.a. | n.a. | . | | | 0 | 0 |
| UK - E & W | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | . | | | 0 | 0 |
| UK – Scotland | . | . | . | n.a. | n.a. | n.a. | . | | 0 | 0 | 0 |
| Total | 589 | 518 | 248 | 199 | 40 | 1 | 4 | 13 | 28 | 72 | 17 |

**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 | |

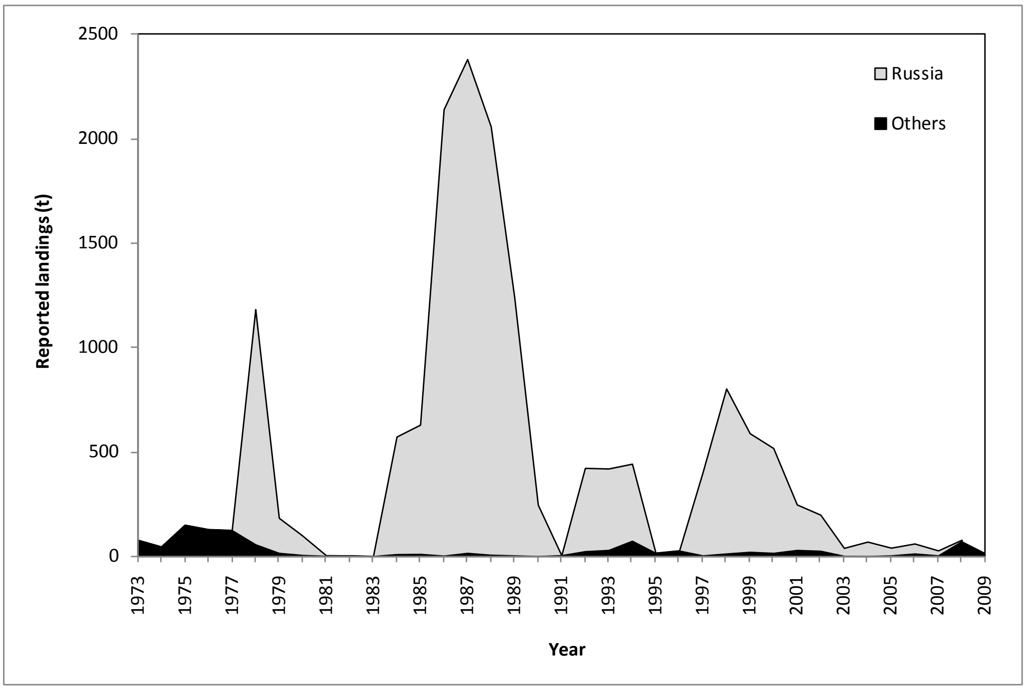


**Figure 13.1. Demersal elasmobranchs in the Barents Sea. Skates and rays from ICES Area 27, Subdivision 1, 1973–2009. Total landings (tonnes).**

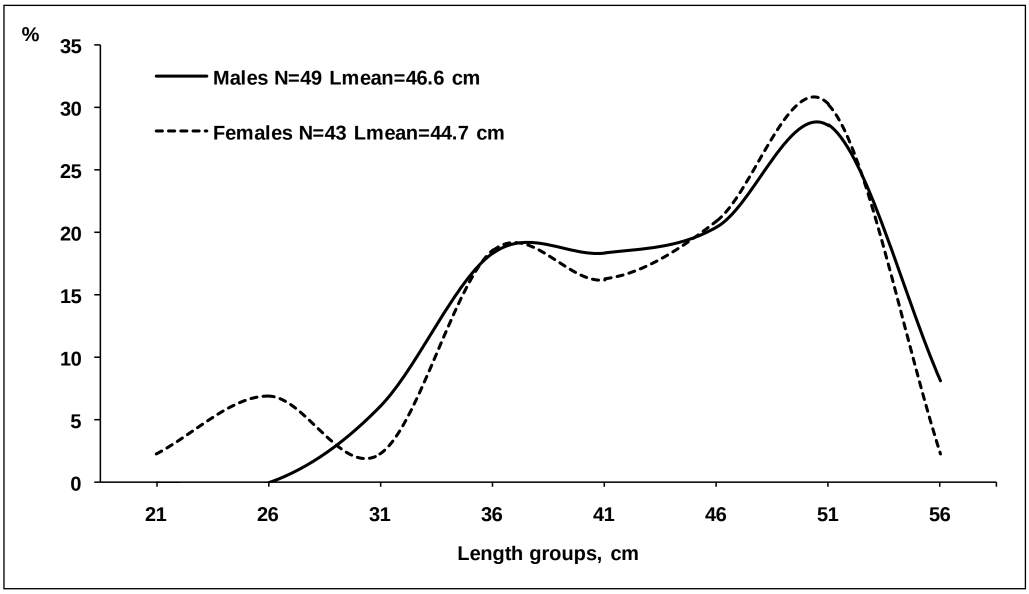


**Figure 13.2. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* from commercial bottom trawl catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).**

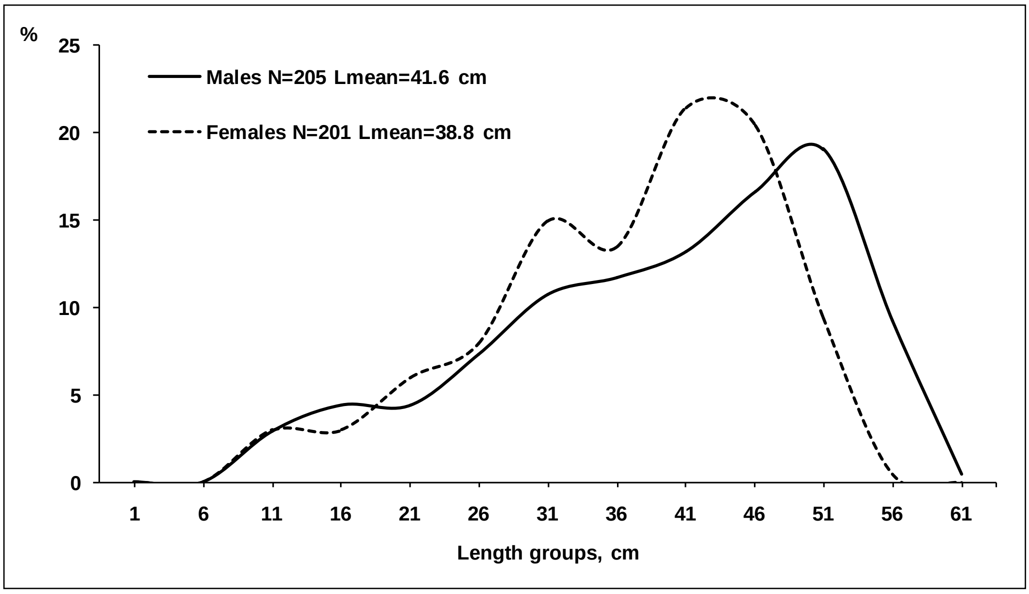


**Figure 13.3. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

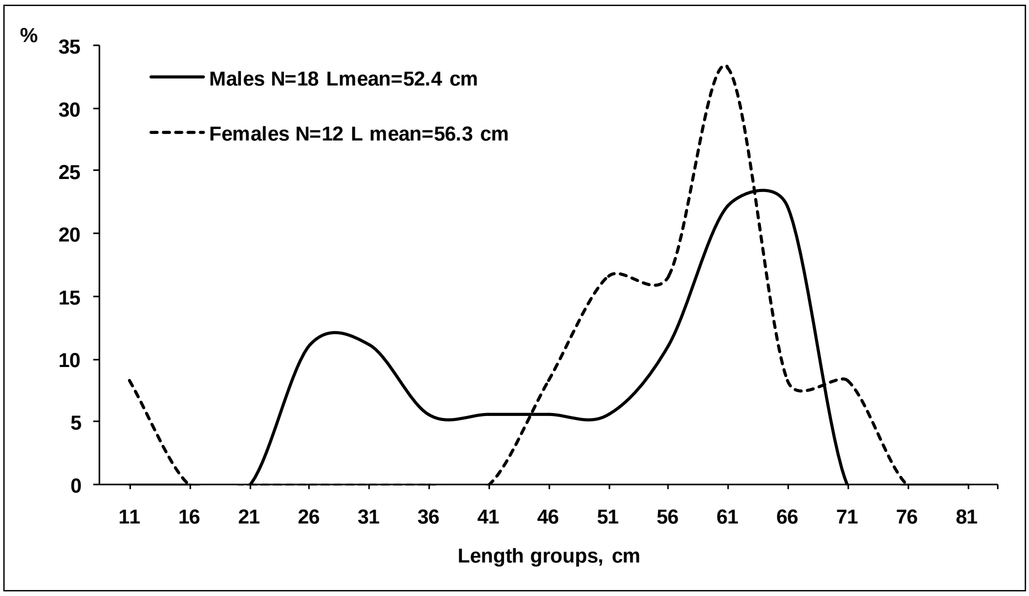


**Figure 13.4. Demersal elasmobranchs in the Barents Sea. Length composition of *A. hyperborea* in the Barents Sea (Area I) based on data of the joint Russian/Norwegian ecosystem survey (August–.September 2009). (Source: Vinnichenko *et al.*, 2010 WD)**

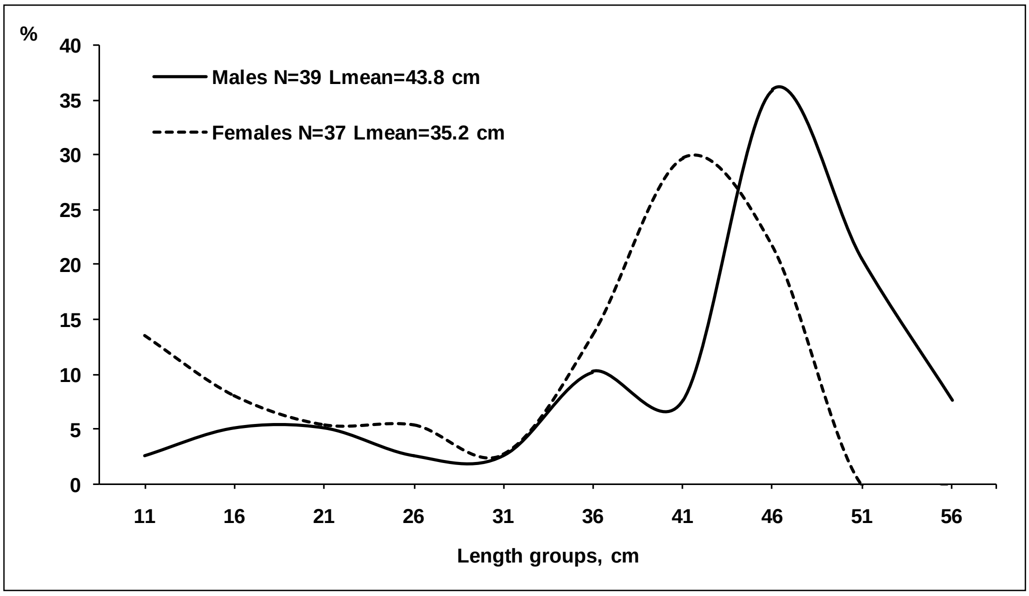


**Figure 13.5. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the joint Russian/Norwegian winter survey (February 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

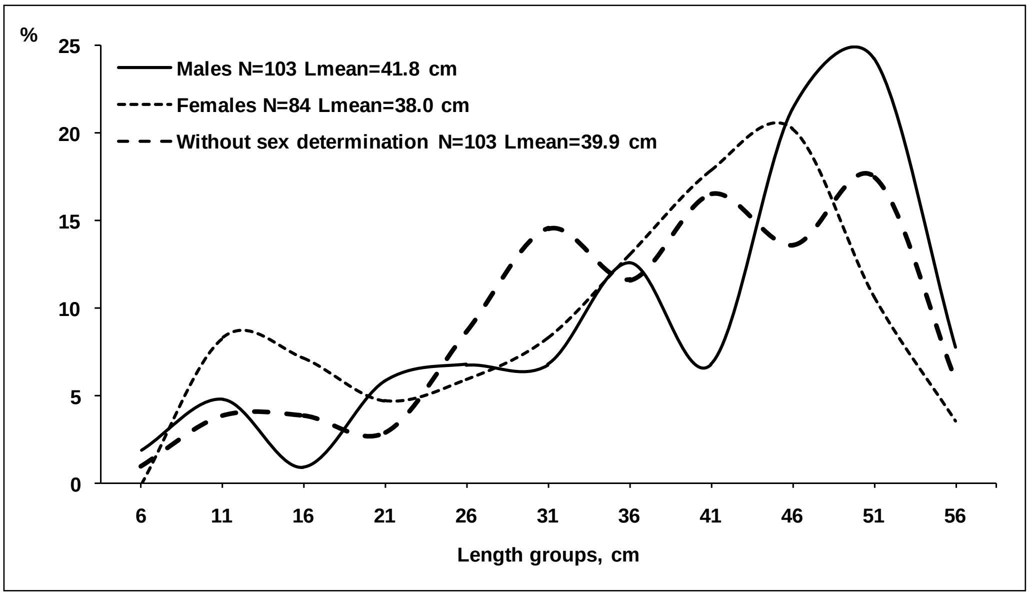


**Figure 13.6. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Subarea I) based on data of the joint Russian/Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

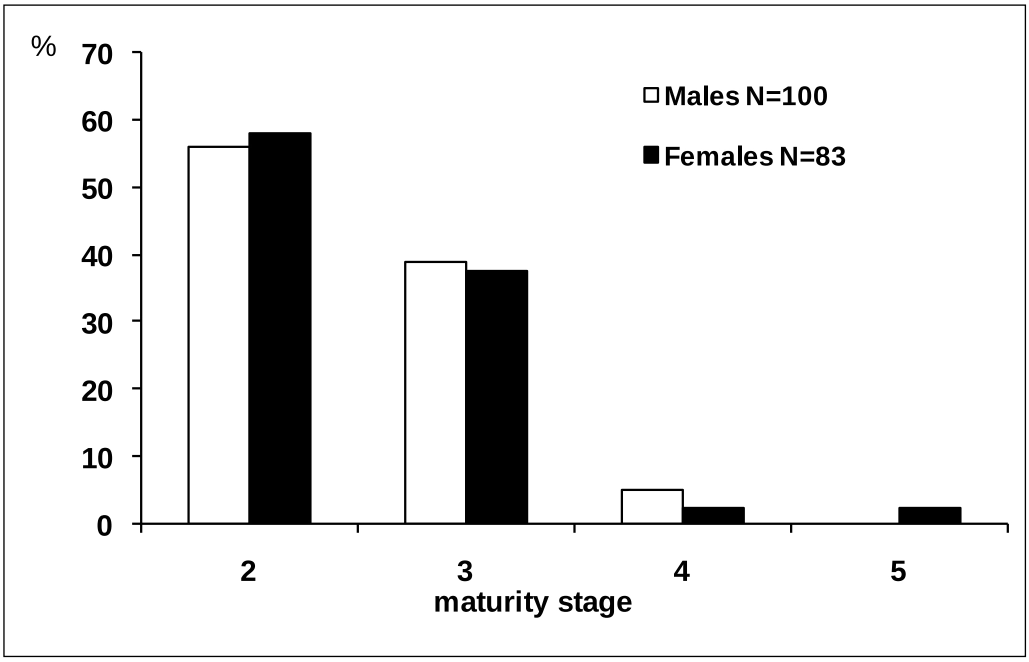


**Figure 13.7. Demersal elasmobranchs in the Barents Sea. Maturity of *A. radiata* in bottom trawls catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).**

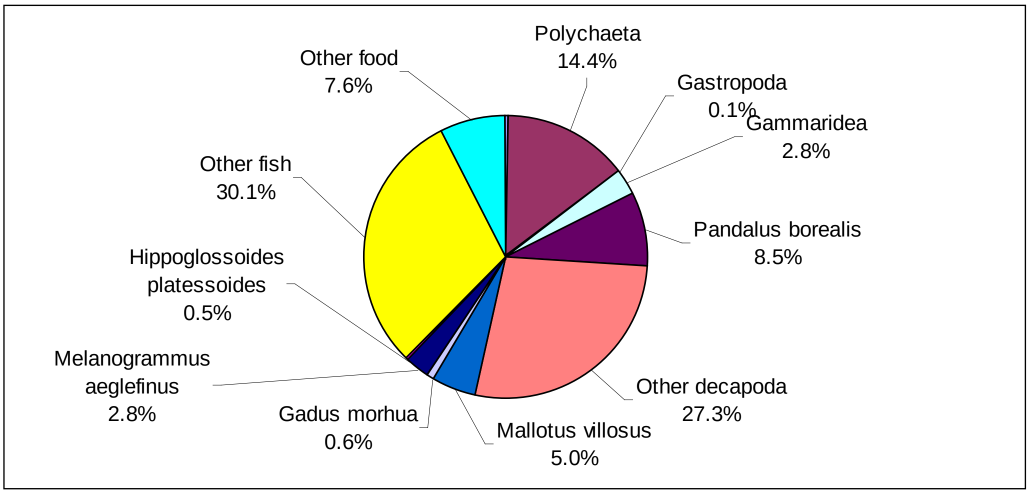


**Figure 13.8. Demersal elasmobranchs in the Barents Sea. Food composition of *A. radiata* in the Barents Sea (Area I) in 2009, % by weight (N=169, 27 % empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).**

# 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) (Table 14.1). 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 *R. montagui,* blonde ray *R. brachyura,* common skate *D. batis* (complex) (see Section 21.1), sailray *D. linteus,* Norwegian skate *D. nidarosiensis,* sandy ray *Leucoraja circularis*, shagreen ray *L. fullonica* round skate *Rajella fyllae*, arctic skate *Amblyraja hyperborea,* and spinytail skate *Bathyraja spinicauda* (see also Stehmann and Bürkel, 1984). Longnose 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 small-spotted catshark *Scyliorhinus canicula*, porbeagle L*amna 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 14.2 and Figure 14.2 for the years 1973–2009.

### 14.2.2 The fishery in 2009

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 or other management measures 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 fishes, in the Norwegian Economic Zone. However, discarding of skates was still done in 2009 (pers.comm. Norwegian Directorate of Fisheries), although the precise quantity is unknown.

## 14.3 Catch data

### 14.3.1 Landings

Data are very limited and only available for ICES Subdivision II for all skate landings combined (Figure 14.1 and Table 14.2). 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.

Landings data (not resolved to species level) have been provided by Norway, France, and Scotland in recent years. Russian landings were provided for 2009 (Vinnichencho *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 (Figure 14.2). The catches primarily comprised males as long as 41–55 cm and females with the length of 36–50 cm. 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.

Vinnichencho *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/Norweian 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, by-catch 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 showed 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

*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.

Vinnichencho *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/Norweian surveys. These are presented in Section 14.6.4.

### 14.6.2 Norwegian coastal survey

The distribution and diversity of elasmobranchs in North 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. 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 Norwegian deep-water survey

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

Two joint Russian/Norwegian surveys are conducted in the Barents Sea. The cruises run in February, in the southern Barents Sea northwards to the latitude of Bear Island, and August–September, 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. Due to 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 Vinnichenco *et al.* (2010 WD).

*A. radiata* was the dominating species in the August–September cruise. Individuals with 5–61 cm length occurred (Figure 14.5). The average length was 33–37 cm (Vinnichencho *et al.*, 2010 WD).

Vinnichencho *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/Norweian 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.

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.

## 14.7 Life-history information

No new information.

### 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 on the International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species:

> "Critically endangered": *D. batis* (complex);
>
> "Near threatened": *B. spinicauda*, *D. oxyrinchus*, *L. fullonica*, *R. clavata*, *R. brachyura*, *D. nidarosiensis*, and *S. Microcephalus;*
>
> "Least concern": *A. radiata* (Northeast Atlantic subpopulation), *A. hyperborea*, *R. fyllae*, *D. linteus*, *R. montagui*, *E. spinax*, *G. melastomus*, and *S. Canicula;*
>
> In the Norwegian Red List (2006) several species are listed as "data deficient": *D. batis* (complex), *B. spinicauda*, *D. oxyrinchus*, *L. fullonica*, *D. nidarosiensis*, *A. hyperborea*, *D. linteus*, and *R. montagui*.

## 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.

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**Table 14.1. 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 14.2. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Area 27 Subdivisions II, IIa and IIb from 1973–2009.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | 1 | | | | | | | | | | |
| Estonia | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 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 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 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 | | 181 | 112 | 257 | | | 77 | 139 |
| Spain | 5 | | 9 | | | | | | | 3 | | 3 | 15 |
| UK - E, W & NI | 2 | 4 | | 2 | 1 | | 1 | | | 1 | 4 | | |
| UK - Scotland | | 2 | 1 | | | | | | | | | | |
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | n.a. | n.a. | n.a. | 0 | | | 0 | 0 |
| Estonia | n.a. | n.a. | n.a. | 5 | n.a. | n.a. | | | | n.a. | n.a |
| Faroe Islands | | n.a. | | n.a. | 2 | n.a. | | | | 0 | 0 |
| France | n.a. | 5 | 4 | 7 | 2 | 7 | 8 | | 4 | 2 | n.a |
| Germany | | 2 | | 2 | 2 | 7 | 0 | | | 0 | 0 |
| Iceland | | | 4 | | n.a. | n.a. | | | | n.a. | 0 |
| Netherlands | | | | n.a. | n.a. | n.a. | | | | 0 | 0 |
| Norway | 239 | 244 | 233 | 118 | 111 | 135 | 133 | 146 | 189 | 259 | 236 |
| Portugal | 10 | 6 | 3 | n.a. | 8 | n.a. | . | | | 0 | 0 |
| USSR/Russian Fed. | 247 | 400 | 113 | 38 | 6 | n.a. | | | | n.a. | 8 |
| Spain | 6 | | 7 | 11 | 32 | n.a. | . | | | 0 | 0 |
| UK - E, W & NI | 1 | | | n.a. | n.a. | n.a. | . | 0 | 0 | 0 | 0 |
| UK - Scotland | 1 | 1 | 1 | 3 | 3 | n.a. | . | 4 | 1 | 1 | 0 |
| Total | 504 | 658 | 365 | 184 | 166 | 149 | 141 | 150 | 194 | 217 | 244 |

**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 elasmobrancs 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 |

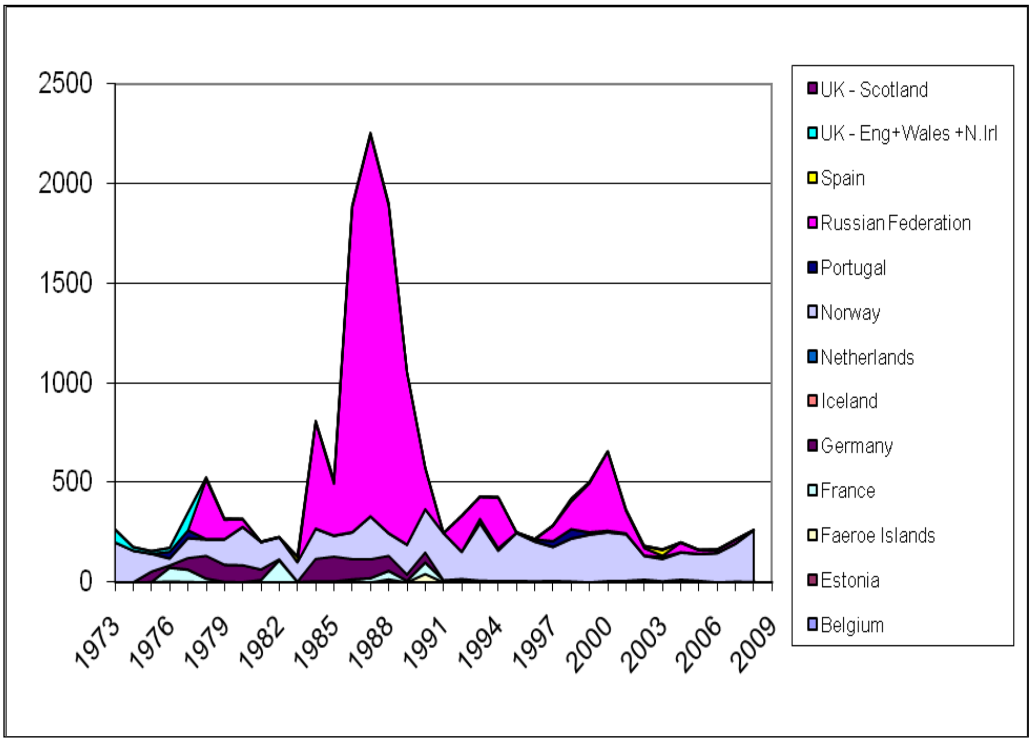


**Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Area 27 Subdivisions II, IIa and IIb from 1973–2008.**

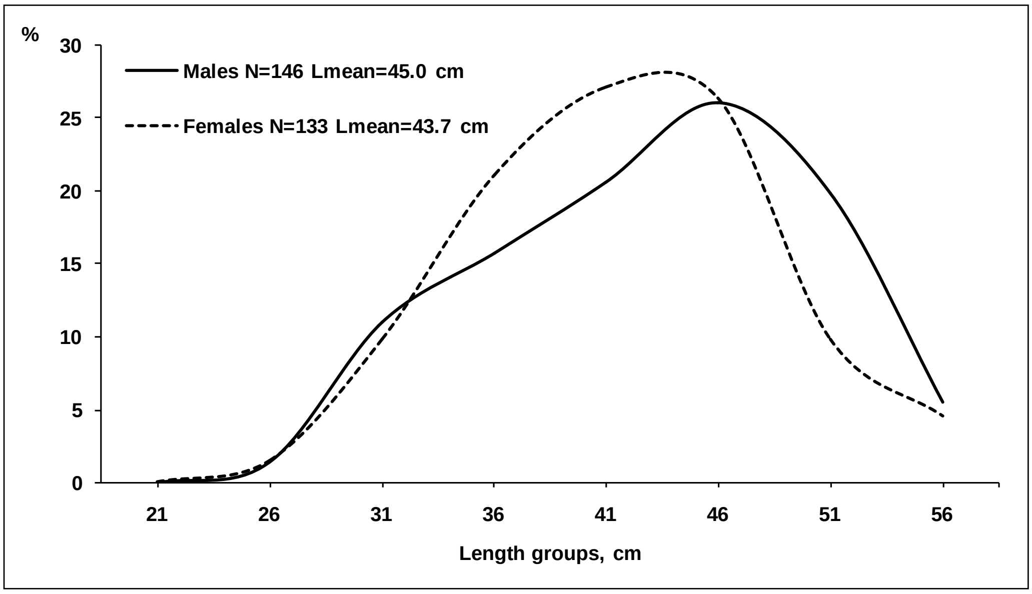


**Figure 14.2. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* from commercial bottom trawl catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).**

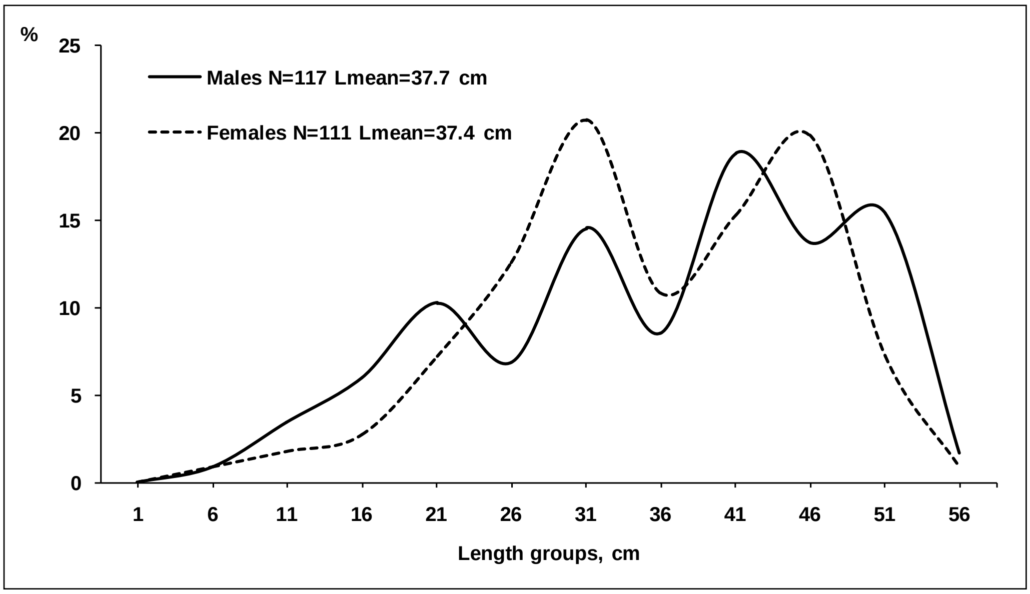


**Figure 14.3. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

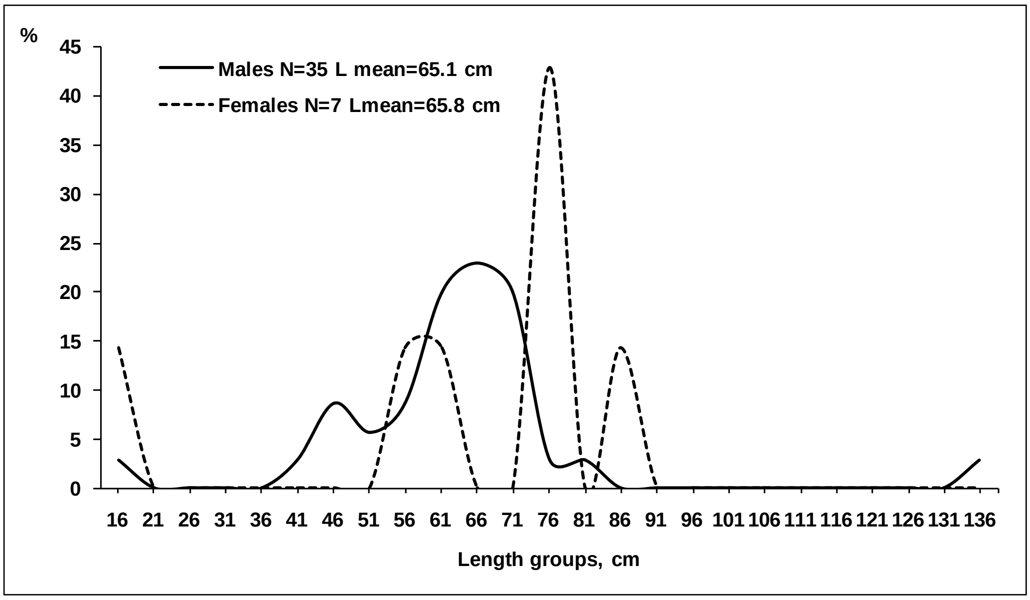


**Figure 14.4. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. hyperborea* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

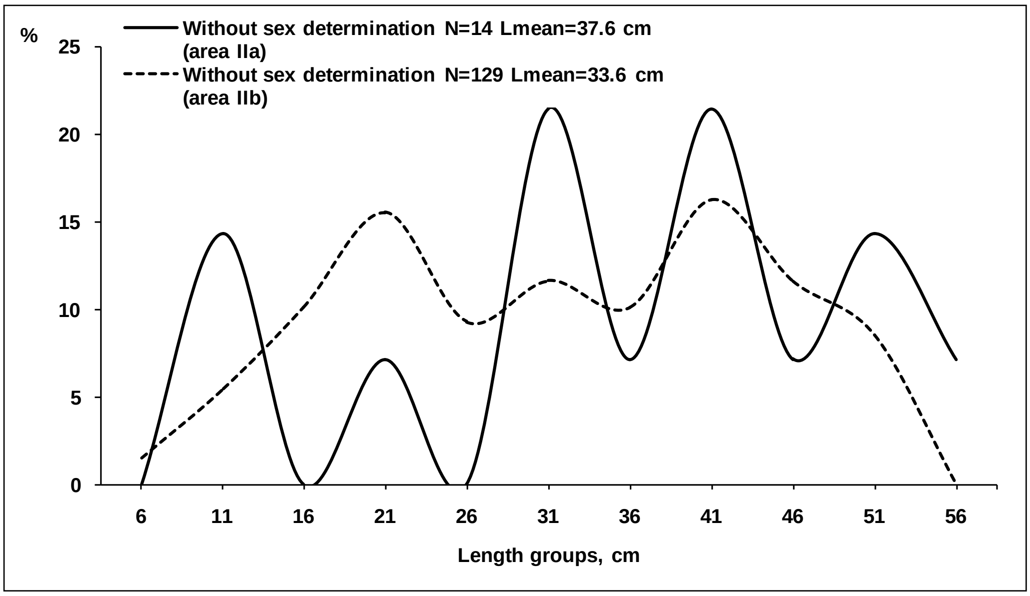


**Figure 14.5. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Area IIa and IIb) based on data of the joint Russian/Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.*, 2010 WD).**

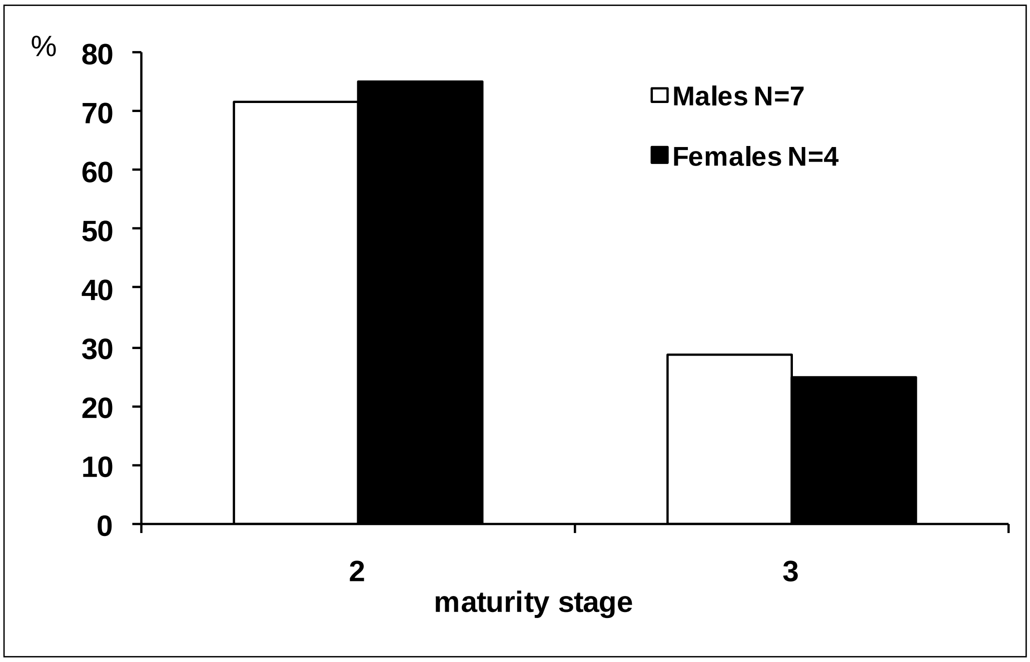


**Figure 14.6. Demersal elasmobranchs in the Norwegian Sea. Maturity of *A. radiata* in bottom trawls catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).**

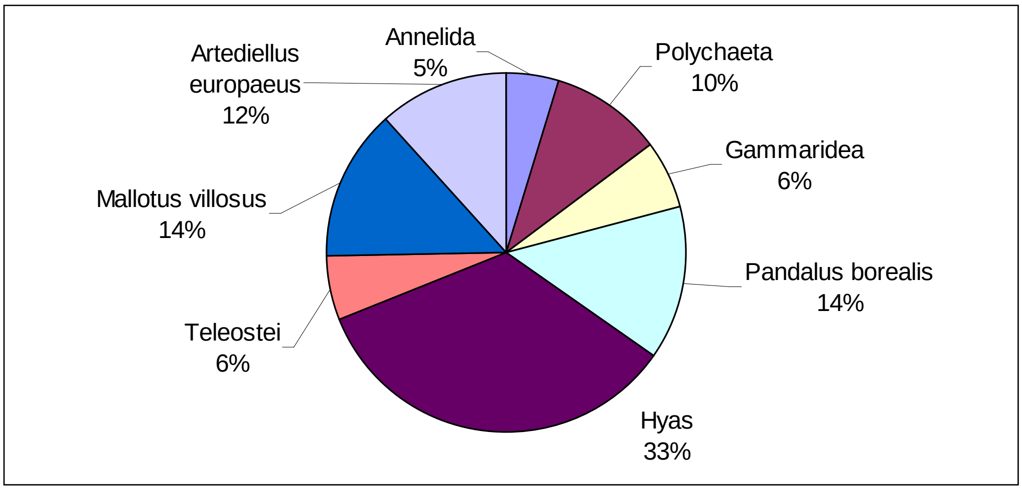


**Figure 14.7. Demersal elasmobranchs in the Norwegian Sea. Food composition of *A. radiata* in the Norwegian Sea in November 2009 (% by weight) (N=11 stomachs, 9.0 % empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).**

# 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 has likely resulted in misreporting since 2007, both of area and species composition.

### 15.2.2 The fishery in 2009

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.

#### 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 has not changed compared to 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 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* – uncertain. 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, 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". In 2006 the EC TAC for skates and rays for Areas IIa (EC waters) and IV (EC waters) was set at 2737 t, which was 15% less than the TAC for 2005. The TAC for 2007 was 20% less than that for 2006 (on no particular scientific ground). This TAC was indicated to comprise of "bycatch quota" and it is specifically mentioned that "These species shall not comprise more than 25% by live weight of the catch retained on board".

The TAC for 2008 was set at 1643 t, a 25% reduction on the 2007 TAC. 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 2009 was set at 2755 t, which 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. The TAC does not apply for *S. squatina*, *D. batis*, and *R. undulata* in Area VIId. "Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable". For Areas IIa and IV the TAC was indicated to contain a "bycatch quota" for vessels over 15 m length overall and "these species shall not comprise more than 25% by live weight of the catch retained on board".

The TAC for skates and rays for 2010 for the different parts of the area was 15% less than the 2009 TAC: 1397 t for IIa and IV, 887 t for VIId and 58 t for IIIa.

Within the North Sea Area, the Kent and Essex Sea Fisheries Committee (England) has a minimum landings size of 40 cm disc width for skates and rays.

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.

## 15.3 Catch data

### 15.3.1 Landings

The landings tables for all skates and rays combined (Table 15.1–15.4) were updated. Belgium did not provide data for 2007; France did not provide data by area for 2009. 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 programme of the Dutch beam trawl fleet for the period 2002–2009 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.

Length frequency distributions of discarded and retained elasmobranchs, covering the period from 1998–2006, were provided by UK (England) and illustrated in ICES, 2006.

### 15.3.3 Quality of the catch data

In 2008 the EC asked its Member States to start reporting their landings of rays by (major) species. Official species-specific landings are therefore available for two years now. 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 and the Netherlands demonstrate a consistent high level of species-specific declaration for the different ICES areas. In 2009 for Areas IV and VIId 73% and 67% of Belgian landings and 100% and 82% of Dutch landings were declared up to species level respectively. For UK (E, W & NI) and Norway the percentage of species-specific declaration differs by area. Norway declared 0% and 23% of its landings to species level for Areas IIIa and IV respectively and UK (E, W & NI) declared 81% and 73% of its landings to species level for Areas IV and VIId respectively. UK (Scotland) mainly landed rays and skates from Area IV for which only 7% was reported down to species level. France provided landings by species, but no information by area was given.

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 catch 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 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.

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.

For 2008 and 2009 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. For example, landings data (Table 15.6) suggest that *R. clavata* is the most common species. This in contrast to the market sampling of the Dutch beam trawl fishery which demonstrates that *R. montagui* is generally the most common species landed followed by *R. clavata* and *R. brachyura* (Table 15.10). The percentage of *R. brachyura* has considerably decreased in the landings in 2008 and 2009, compared to the years 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 *Amblyraja hyperborea* as reported by the UK (E, W and NI) are likely the result of misidentification. Landings of *Raja alba* reported by UK (Scotland) are also very unlikely, and should 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 Availability of survey data

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).

Time-series of the most relevant species, based on North Sea IBTS surveys for the years 1977–2009, are shown in Figure 15.4.

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.

### 15.6.2 Eastern English Channel and southern North Sea

Martin *et al.*, 2005 analysed data from the Channel Ground Fish Survey (IFREMER) and the Eastern Channel Beam Trawl Survey (Cefas) 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 Cefas beam trawl survey in the eastern Channel 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 15.5). 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.

### 15.6.3 Changes in abundance and spatial variation

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 15.6.3.1 and 15.6.3.2. A further detailed explanation on these analyses can be found in ICES, 2007a.

#### 15.6.3.1 GAM analyses of survey trends

The GAM analysis focused on the most abundant species caught in the Q1 IBTS across this ecoregion: *R. clavata*, *L. naevus*, *A. radiata* and lesser-spotted dogfish. Only 'filtered' Q1 IBTS 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 15.6). 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. 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.

##### 15.6.3.2 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 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 (e.g. Figure 15.7: *R. clavata*). The area occupied (AO) changes over time (Figure 15.8). 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.

## 15.7 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.

### 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, and WGBEAM should be asked to consider this.

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

### 15.8.1 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 six nm of the coast).

## 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 south-western 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 (Table 15.12 and 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 and 2010 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 eco-region are demonstrated in Table 15.13.

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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.**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | . | . | . | | 0 | 0 | | 0 | |
| Denmark | 7 | 11 | 41 | 56 | 22 | 36 | 129 | 65 | 26 | 8 | 5 | 12 |
| Germany | + | . | . | . | + | | | . | 1 | | | |
| Iceland | . | . | . | . | | . | | | | | | |
| Netherlands | . | . | . | . | . | | | 0 | 0 | 0 | 0 | 0 |
| Norway | 134 | 208 | 123 | 154 | 159 | 163 | 85 | 94 | 51 | 13 | 23 | 33 |
| Sweden | 1 | 2 | 2 | 12 | 13 | 9 | | 10 | 18 | 11 | 6 | 2 |
| UK (E, W_& NI) | . | . | . | . | . | . | . | 0 | 0 | 0 | 0 | |
| UK (Scotland) | . | . | . | . | . | . | . | 0 | | 0 | 0 | |
| Total of submitted data | 142 | 221 | 166 | 222 | 194 | 208 | 214 | 169 | 95 | 32 | 34 | 47 |

**Table 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea IV.**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 373 | 336 | 332 | 370 | 436 | 323 | 276 | 327 | 350 | n.s. | 371 | 299 |
| Denmark | 20 | 45 | 93 | 65 | 34 | 33 | 25 | 23 | 26 | 27 | 23 | 29 |
| Faroe Islands | . | . | n.s. | n.s. | | | | | | | | |
| France | 47 | n.s. | 31 | 61 | 62 | 36 | 37 | 34 | 15 | 56 | 69 | n.s. |
| Germany | 9 | 16 | 23 | 11 | 22 | 21 | 17 | 29 | 16 | | | 0 |
| Iceland | . | . | . | . | | . | | | 0 | | | |
| Ireland | . | . | . | . | | . | | 0 | 0 | 119 | 0 | |
| Netherlands | 609 | 515 | 693 | 834 | 805 | 686 | 561 | 680 | 603 | 721 | 564 | 379 |
| Norway | 180 | 152 | 161 | 173 | 83 | 113 | 77 | 87 | 96 | 71 | 97 | 133 |
| Poland | . | . | . | . | | | | | | | | |
| Sweden | + | + | + | + | + | + | 20 | 0 | 0 | 0 | 0 | 0 |
| UK (E, W_& NI) | 794 | 618 | 516 | 476 | 500 | 537 | 550 | 434 | 348 | 329 | 392 | 348 |
| UK (Scotland) | 1381 | 965 | 860 | 822 | 853 | 741 | 512 | 404 | 374 | 331 | 343 | 311 |
| Total of submitted data | 3413 | 2647 | 2709 | 2812 | 2794 | 2490 | 2075 | 2018 | 1801 | 1569 | 1859 | 1499 |

**Table 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division VIId.**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 66 | 93 | 69 | 79 | 113 | 153 | 96 | 94 | 109 | n.s. | 174 | 125 |
| France | 738 | 558 | 693 | 729 | 725 | 796 | 695 | 602 | 687 | 792 | 710 | n.s. |
| Germany | . | . | + | . | . | . | 0 | . | 0 | | | |
| Ireland | . | . | . | . | . | 2 | 0 | 0 | 0 | 0 | 0 | |
| Netherlands | . | . | . | . | . | . | . | | 13 | 21 | 13 | 10 |
| Spain | na | na | na | na | na | na | + | 0 | | | | |
| UK (E, W_& NI) | 246 | 437 | 355 | 169 | 140 | 186 | 157 | 147 | 139 | 188 | 199 | 152 |
| UK (Scotland) | + | . | . | . | . | . | . | 0 | 2 | 2 | 6 | 8 |
| Total of submitted data | 1050 | 1088 | 1117 | 977 | 978 | 1137 | 948 | 843 | 948 | 1001 | 1102 | 295 |

**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).**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 439 | 429 | 401 | 449 | 548 | 476 | 372 | 422 | 459 | n.s. | 545 | 424 |
| Denmark | 27 | 56 | 134 | 121 | 56 | 69 | 154 | 88 | 52 | 35 | 28 | 41 |
| Faroe Islands | . | . | n.s. | n.s. | . | . | . | 0 | 0 | 0 | 0 | 0 |
| France | 785 | 599 | 724 | 790 | 725 | 796 | 732 | 636 | 701 | 848 | 779 | n.s. |
| Germany | 9 | 16 | 23 | 11 | 22 | 21 | 17 | 29 | 17 | 0 | 0 | 0 |
| Iceland | . | . | . | . | . | . | . | 0 | 0 | 0 | 0 | 0 |
| Ireland | . | . | . | . | . | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 609 | 515 | 693 | 834 | 805 | 686 | 561 | 680 | 615 | 742 | 577 | 389 |
| Norway | 314 | 360 | 284 | 327 | 242 | 276 | 162 | 181 | 120 | 84 | 120 | 166 |
| Poland | . | . | . | . | . | . | . | 0 | 0 | 0 | 0 | 0 |
| Spain | na | na | na | na | na | na | + | 0 | 0 | 0 | 0 | 0 |
| Sweden | 1 | 2 | 2 | 12 | 8 | 9 | 20 | 10 | 18 | 11 | 6 | 2 |
| UK (E&W and NI) | 1040 | 1055 | 871 | 645 | 640 | 723 | 707 | 580 | 487 | 517 | 591 | 500 |
| UK (Scotland) | 1381 | 965 | 860 | 822 | 853 | 741 | 512 | 404 | 375 | 331 | 349 | 320 |
| Total of submitted data | 4606 | 3997 | 3992 | 4011 | 3899 | 3799 | 3237 | 3030 | 2845 | 2688 | 2995 | 1841 |

**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 2009.**

| Area IIIa | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| DENMARK | Skates and rays | 12 | | |
| | Total: | 12 | | |
| Percent of catch as species-specific landings: | | | 0% | |
| NORWAY | Skates and rays | 33 | | |
| | Total: | 33 | | |
| Percent of catch as species-specific landings: | | | 0% | |
| SWEDEN | Skates and rays | 1.8 | | |
| | Total: | 1.8 | | |
| 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 2009.**

| Area IV | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| BELGIUM | *Raja brachyura* | 82.5 | 27.6% | 37.9% |
| | *Raja clavata* | 99.8 | 33.3% | 45.8% |
| | *Raja montagui* | 33.6 | 11.2% | 15.4% |
| | *Leucoraja naevus* | 1.9 | 0.6% | 0.9% |
| | Skates and rays | 81.6 | 27.2% | |
| | Total: | 299.3 | 100.0% | |
| Percent of catch as species-specific landings: | | | 72.8% | |
| NETHERLANDS | *Raja brachyura* | 7.2 | 1.9% | 1.9% |
| | *Raja clavata* | 171.2 | 45.2% | 45.3% |
| | *Raja montagui* | 199.5 | 52.7% | 52.7% |
| | *Leucoraja naevus* | 0.4 | 0.1% | 0.1% |
| | Skates and rays | 0.3 | 0.1% | |
| | Total: | 378.5 | 100.0% | |
| Percent of catch as species-specific landings: | | | 99.9% | |
| NORWAY | *Dipturus batis* | 31 | 23.3% | 100% |
| | Skates and rays | 102 | 76.7% | |
| | Total: | 133 | 100.0% | |
| Percent of catch as species-specific landings: | | | 23.3% | |
| UK (E, W & NI) | *Amblyraja hyperborea* | 0.6 | 0.2% | 0.2% |
| | *Amblyraja radiata* | 0.1 | 0.0% | 0.0% |
| | *Leucoraja naevus* | 2.0 | 0.6% | 0.7% |
| | *Raja brachyura* | 8.6 | 2.5% | 3.1% |
| | *Raja clavata* | 246.7 | 70.9% | 87.6% |
| | *Raja microocellata* | 0.4 | 0.1% | 0.1% |
| | *Raja montagui* | 23.2 | 6.7% | 8.2% |
| | Skates and rays | 66.4 | 19.1% | |
| | Total: | 348.0 | 100.0% | |
| Percent of catch as species-specific landings: | | | 80.9% | |
| UK (ScotlandI) | *Raja alba* | 6.7 | 1.9% | 25.4% |
| | *Dipturus batis* | 5.2 | 1.5% | 19.7% |
| | *Raja clavata* | 6.2 | 1.8% | 23.5% |
| | *Raja brachyura* | 3.3 | 0.9% | 12.5% |
| | *Leucoraja naevus* | 2.5 | 0.7% | 9.5% |
| | *Dipturus oxyrinchus* | 1.2 | 0.3% | 4.5% |
| | *Raja circularis* | 0.6 | 0.2% | 2.3% |
| | *Raja montagui* | 0.7 | 0.2% | 2.7% |
| | Skates and rays | 275.3 | 79.1% | |
| | Total: | 301.7 | 86.7% | |
| Percent of catch as species-specific landings: | | | 7.6% | |

**Table 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Division VIId in 2009.**

| Area VIId | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| BELGIUM | *Raja brachyura* | 22.1 | 17.7% | 26.7% |
| | *Raja clavata* | 56.8 | 45.6% | 68.6% |
| | *Raja montagui* | 3.3 | 2.6% | 4.0% |
| | *Leucoraja naevus* | 0.6 | 0.5% | 0.7% |
| | Skates and rays | 41.8 | 33.5% | |
| | Total: | 124.6 | 100.0% | |
| Percent of catch as species-specific landings: | | | 66.5% | |
| NETHERLANDS | *Raja brachyura* | 1.0 | 10.0% | 12.1% |
| | *Raja clavata* | 7.0 | 69.7% | 85.0% |
| | *Raja montagui* | 0.2 | 2.0% | 2.4% |
| | *Amblyraja radiata* | 0.0 | 0.4% | 0.5% |
| | Skates and rays | 1.8 | 18.0% | |
| | Total: | 10.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 82.0% | |
| UK (E, W & NI) | *Leucoraja naevus* | 0.2 | 0.1% | 0.2% |
| | *Raja brachyura* | 29.7 | 19.6% | 26.8% |
| | *Raja clavata* | 73.5 | 48.5% | 66.4% |
| | *Raja microocellata* | 2.8 | 1.8% | 2.5% |
| | *Raja montagui* | 4.1 | 2.7% | 3.7% |
| | *Raja undulata* | 0.4 | 0.3% | 0.4% |
| | Skates and rays | 41.0 | 27.0% | |
| | Total: | 151.7 | 100.0% | |
| Percent of catch as species-specific landings: | | | 73.0% | |

**Table 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings of *Scyliorhinus canicula* in IIIa, IV and VIId.**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | NA | NA | NA | NA | 226 | 238 | 265 | n.s. | 338 | 313 |
| France | 1633 | 1811 | 1899 | 1777 | 1472 | 1614 | 1492 | 1459 | 1406 | n.s. |
| Netherlands | NA | NA | NA | NA | NA | NA | NA | NA | NA | 37 |
| UK (E,W&NI) | NA | NA | NA | 13 | 57 | 92 | 118 | 94 | 102 | 116 |
| UK (Scotland) | . | . | 1 | 5 | 3 | 22 | 6 | 3 [1)] | 2 [1)] | 3 [1)] |
| | 1633 | 1811 | 1900 | 1795 | 1758 | 1966 | 1881 | 1556 | 1848 | 469 |

**[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.**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | 12 | 13 | 10 | n.s. | 12 | 8 |
| France | 146 | 261 | 478 | 459 | 587 | 630 | 722 | 787 | 668 | n.s. |
| Netherlands | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1 |
| UK (E,W&NI) | | | | | | 169 | | 123 | 114 | 131 |
| | 146 | 261 | 478 | 459 | 598 | 811 | 731 | 910 | 794 | 140 |

**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: TAC (tonnes) for North Sea rays and skates, and EC landings.**

| 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)] | 1841 [4)] |
| 2010 | 2342 [5)] | |

**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.**

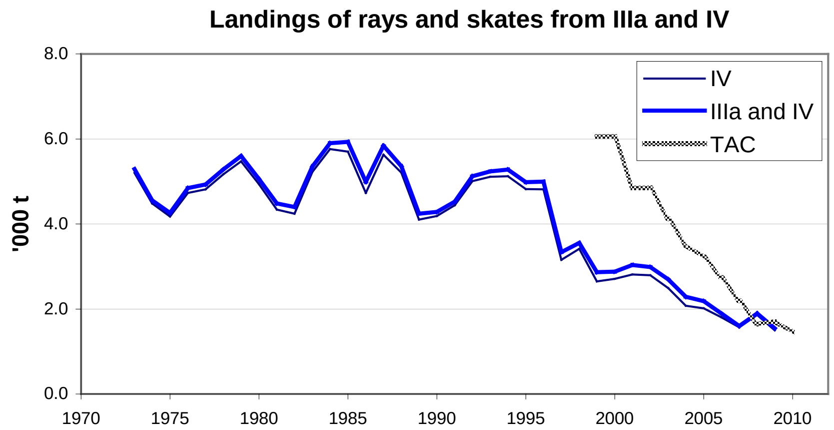
**3) This includes a shared TAC of 1643 t for Areas IIa and IV; a TAC of 1044 t for VIId and a TAC of 68 t for IIIa.**

**4) French landings in 2009 are missing from this figure.**

**5) 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.**

**Table 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Technical interactions.**

| | | Cod 347d | Cod katt. | Had 34 | Whg 47d | Sai 346 | Ang 346 | Ple 4 | Ple 7d | Ple 3a | Sol 3a | Sol 4 | Sol 7d | San 4 | Nop 4 | Nep stocks | Pan stocks | DemRays 347 | DemSharks 347 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Main gears | Cod 347d | | L | H | H | M | ?? | M | M | M | M | M | M | L | L | H | ?? | L | L |
| | Cod kattegat | BT, OT | | L | 0 | 0 | ?? | 0 | 0 | M | M | 0 | 0 | 0 | 0 | H | ?? | L | L |
| | Had 34 | OT | | | H | M | ?? | L | 0 | L | L | L | 0 | L | L | H | ?? | L | L |
| | Whg 47d | OT | | | | M | ?? | M | M | 0 | 0 | M | M | L | L | H | ?? | L | L |
| | Sai 346 | OT | | | | | ?? | L | 0 | L | L | L | 0 | L | L | L | ?? | L | L |
| | Ang 346 | | | | | | | | | | | | | | | | | L | L |
| | Ple 4 | BT | | OT | BT | OT | ?? | | 0 | 0 | 0 | H | 0 | L | L | L | ?? | H | H |
| | Ple 7d | BT | | | BT, OT | | ?? | | | 0 | 0 | 0 | H | L | L | L | ?? | H | H |
| | Ple 3a | BT, OT | BT, OT | OT | | | ?? | | | | H | 0 | 0 | 0 | 0 | L | ?? | L | L |
| | Sol 3a | BT,OT,GN | BT,OT,GN | OT | BT, OT | | | | | BT | | 0 | 0 | 0 | 0 | L | ?? | L | L |
| | Sol 4 | BT | | OT | BT | OT | | BT | | | | | 0 | 0 | 0 | L | ?? | H | H |
| | Sol 7d | BT | | | BT | | | | BT | | | | | 0 | 0 | L | ?? | H | H |
| | San 4 | Ind | | Ind | Ind | Ind | | | | | | | | | M | 0 | 0 | L | L |
| | Nop 4 | Ind | | Ind | Ind | Ind | | | | | | | | Ind | | 0 | 0 | L | L |
| | *Nep* stocks | | | | | | | | | | | | | | | | H? | L | L |
| | *Pan stocks* | | | | | | | | | | | | | | | | | L | L |
| | DemRays 347 | | | | | | | BT | BT | | | BT | BT | | | | | | H |
| | DemShar 347 | | | | | | | | | | | | | | | | | | |



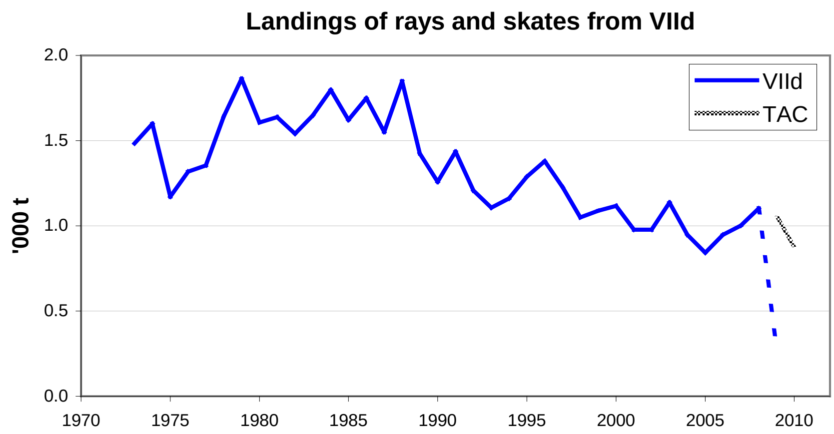




**Figure 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates in IIIa and IV, and in VIId since 1973, based on WG estimates. TAC for both areas is added. The exceptional high value reported by France for 1991 has been omitted from these graphs. Data for 2009 are incomplete, especially in VIId.**

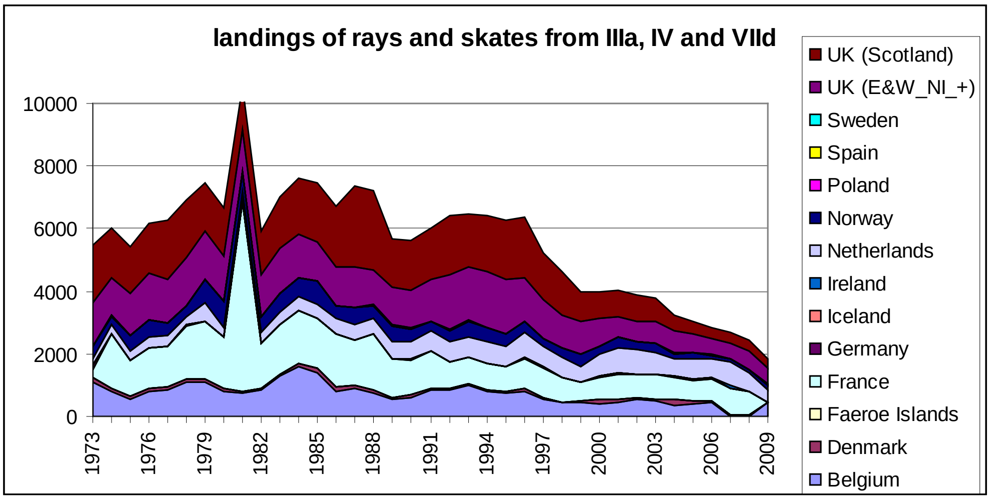



**Figure 15.2. Landings (t) of rays and skates from Skagerrak (IIIa), the North Sea (IV) and the eastern Channel (VIId).**

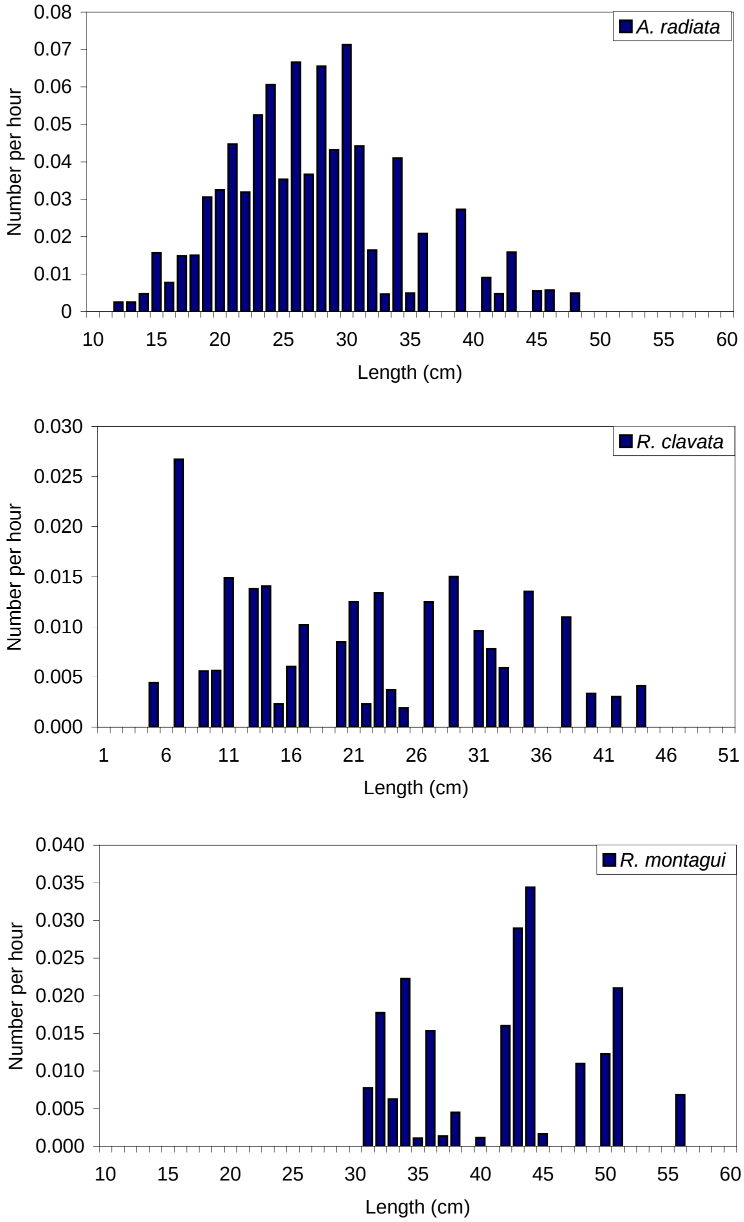



**Figure 15.3. Length frequency distribution of the average number of *A. radiata, R. clavata* and *R. montagui* discarded per hour by Dutch beam trawl vessels for the period 2002–2009.**

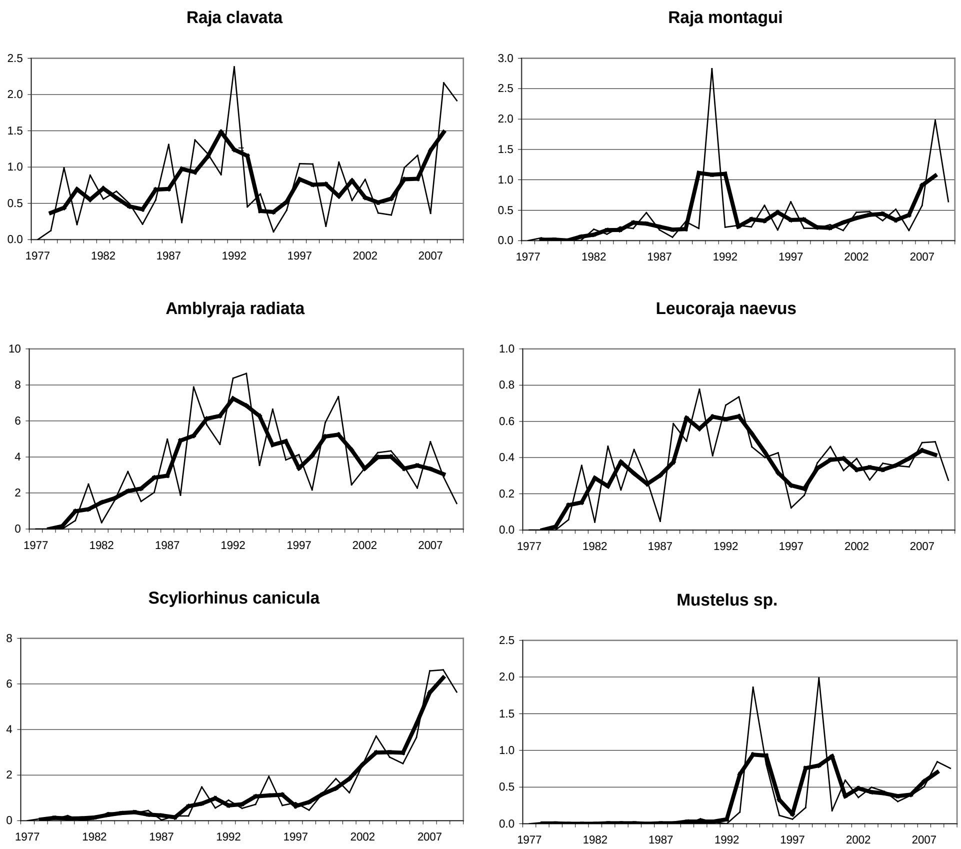



**Figure 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) during the quarter 1 North Sea IBTS in the years 1977–2009 in roundfish Areas 1–7.**

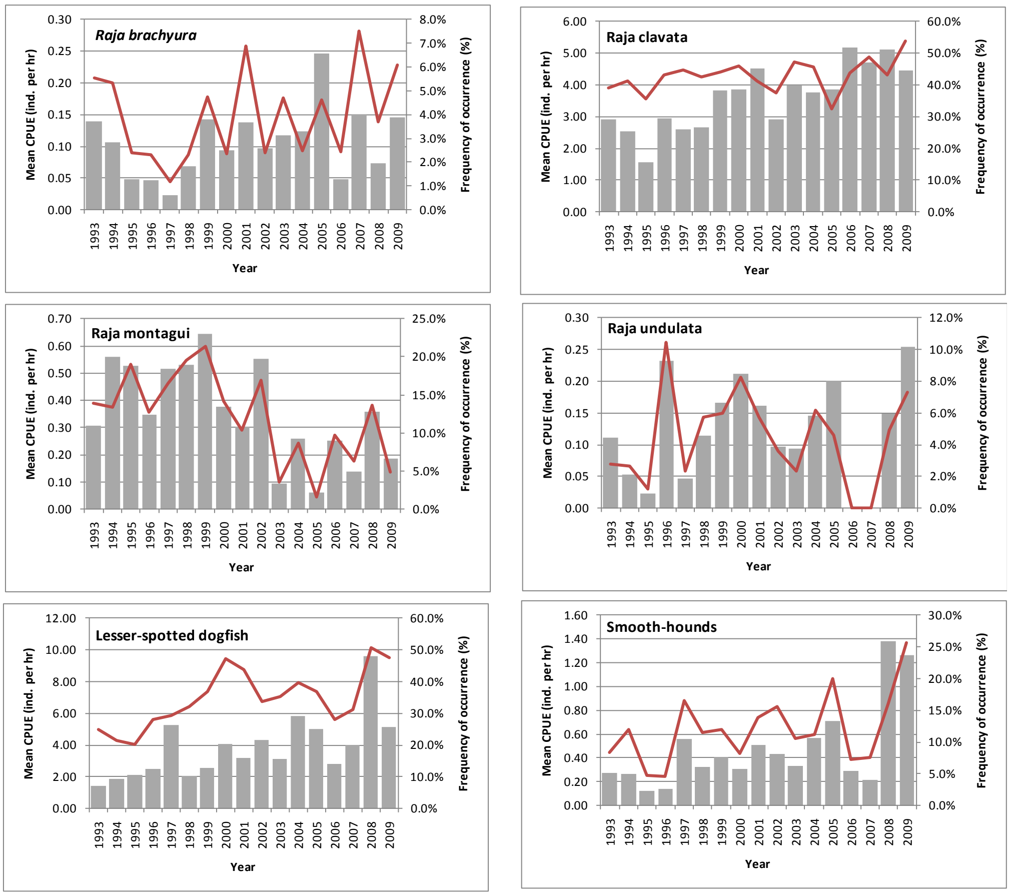



**Figure 15.5. Catch rates of the Cefas beam trawl survey in the eastern Channel 1993–2009 for *R. brachyura*, *R. montagui*, *R. clavata*, *R. undulata*, *S. canicula* and *Mustelus* spp.**

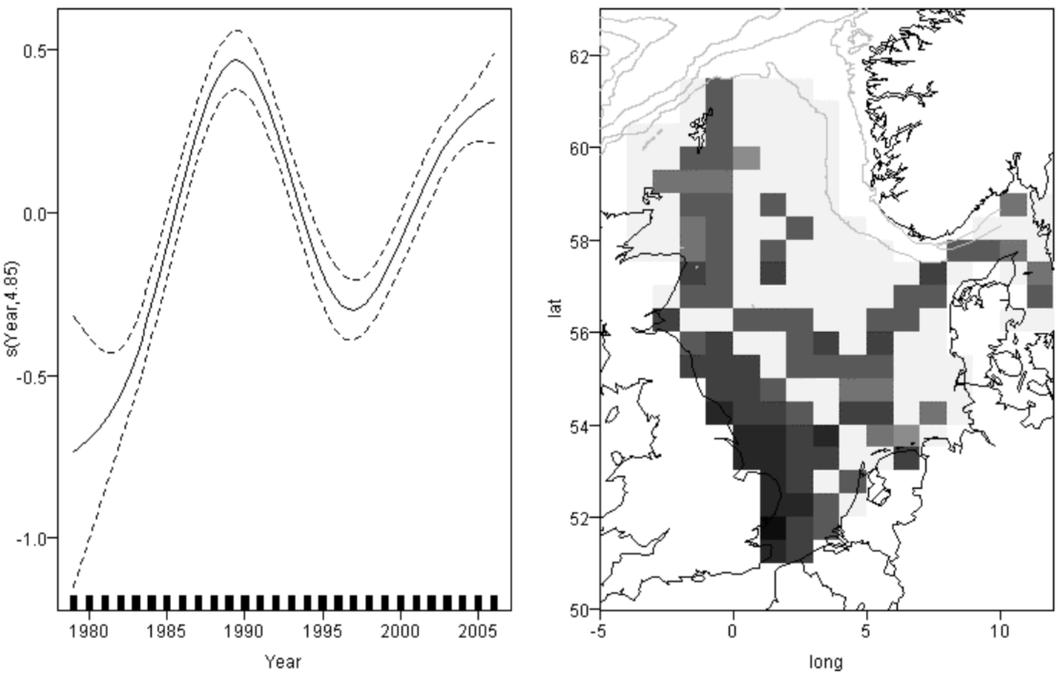



**Figure 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Thornback ray in the North Sea. Results of GAM analysis of the 'filtered' Q1 IBTS data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007a).**

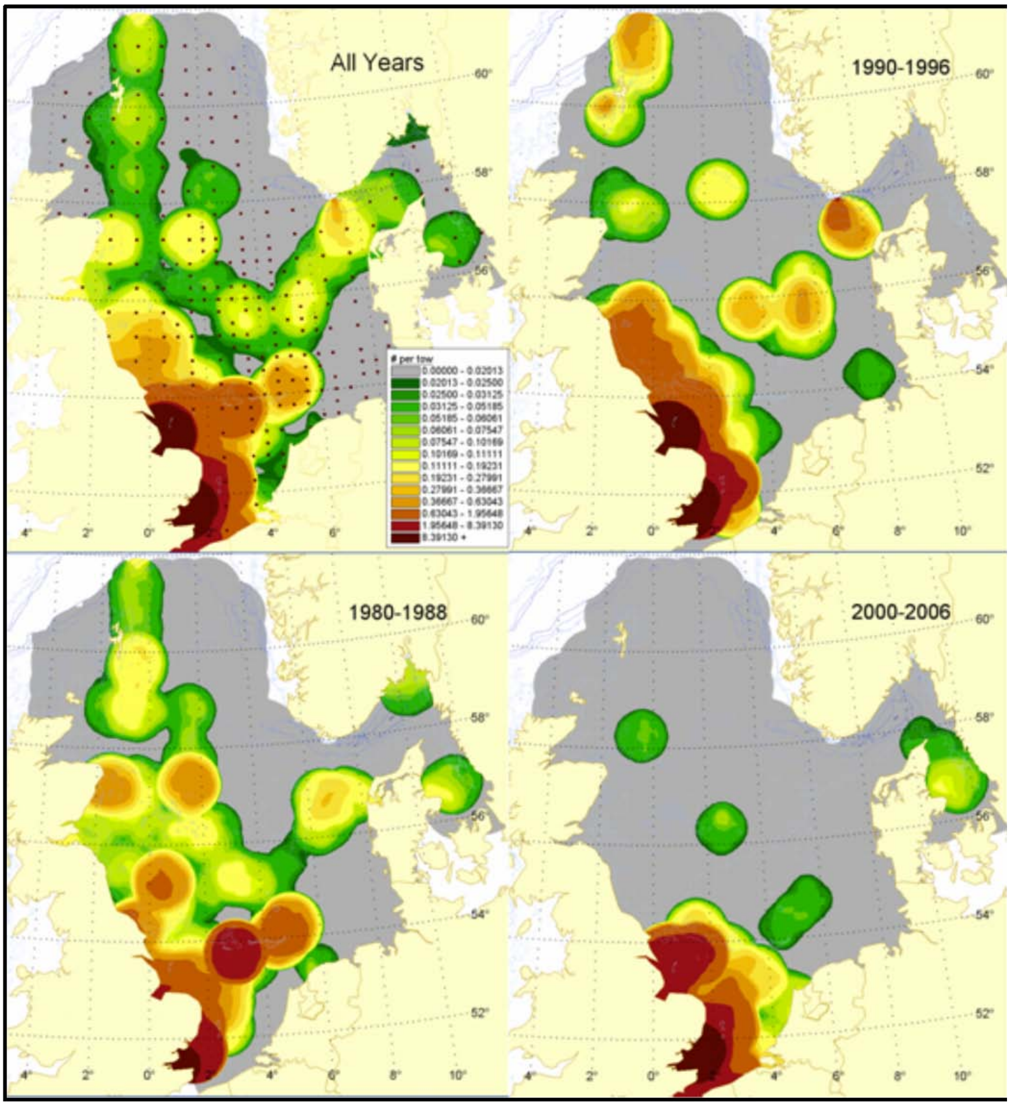



**Figure 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja clavata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007a).**

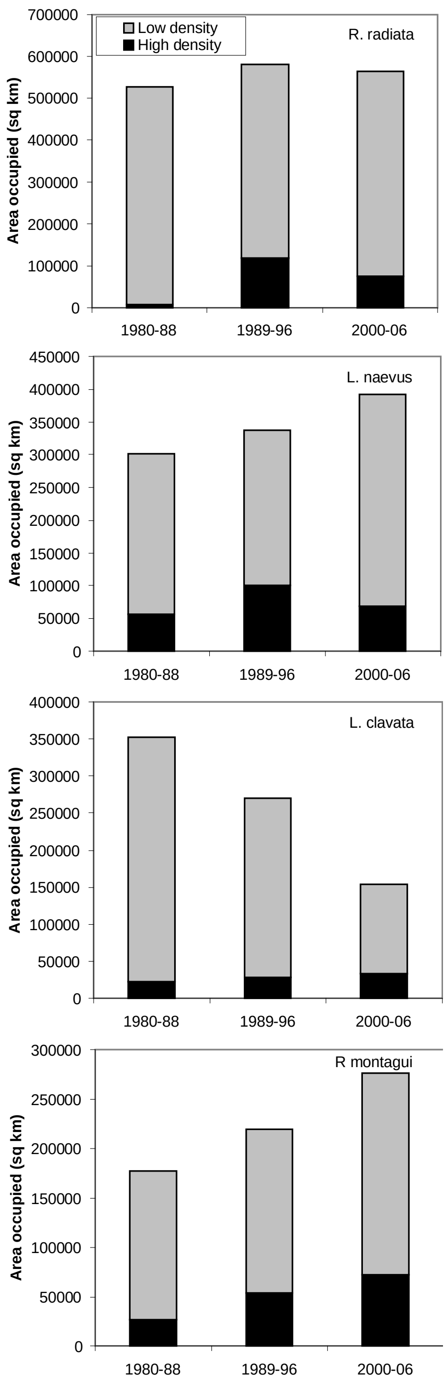



**Figure 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Area occupied during three periods illustrated in the distribution maps for *Amblyraja radiata, Leucoraja naevus, Raja clavata* and *R. montagui* (Source: ICES, 2007a).**

# 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) *A. 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 *D. 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 while the skate is always boiled.

Starry ray 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 2009

No new information.

### 16.2.3 ICES advice applicable

ACOM has not provided 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

This section deals only with the demersal skates not detailed elsewhere in the Report (see above). 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 (1906–2009), starry ray *A. radiata* (1973–2009), sailray *D. linteus* (2000–2009) and shagreen ray L. *fullonica* (1993–2009) were made available to the Group in 2010. Table 16.1 contains data from the ICES database between 1973 and 2009, except for common skate and starry ray, which combined sums up to the reported '*Raja* rays *nei*' in those years.

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. spinicaud*a have been reported. Fishermen 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 1973–2008, 13 countries (Belgium, Faroe Islands, France, Germany, Greenland, Iceland, Norway, Portugal, 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, Figure 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 2009.

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 data

The major nation fishing skates 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 have covered the area between 61º45'–67º N 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). Many of the landings are reported to species (with ca. 21% of the catch not 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 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.

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Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 424 pp.

Jørgensen, O. A. 2006. Elasmobranchs at East Greenland, ICES Division 14B. Working paper ICES Elasmobranch WG. June 2006.

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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, which contains Icelandic national data.**

| 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 | | 63 | 4 | 2 | 3 | 2 | 3 | 6 | 1 | 10 | 3 | 5 |
| | UK - England & Wales | 385 | 187 | 195 | 106 | 5 | | | | | | | | |
| | UK - Scotland | 5 | 8 | 14 | 8 | | | | | | | | | |
| 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 | | | | | | | | 2 | 12 | 24 | 19 | 16 | 12 |
| *Raja rays nei* | Belgium | 18 | 22 | 20 | 22 | 6 | 9 | 6 | 3 | | | | | |
| | Faroe Islands | | 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 | | | | | | | 25 | 8 | 8 | 7 | 10 | 2 | 19 |
| | Portugal | | | | | | | | | | | | 1 | |
| | UK - Eng+Wales+N.Irl. | | | | | | | 1 | 2 | | 4 | | | 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 |
| *Dipturus batis* | Iceland | 80 | 94 | 82 | 59 | 120 | 145 | 167 | 137 | 117 | 127 | 128 |
| | Norway | | 3 | | | | | | | | | |
| *Amblyraja radiata* | Iceland | 996 | 1076 | 1211 | 1781 | 1491 | 1013 | 657 | 530 | 473 | 636 | 868 |
| *Dipturus linteus* | Iceland | | | | | 10 | 8 | 20 | | | | 8 |
| *Leucoraja fullonica* | Iceland | 21 | 27 | 37 | 32 | 17 | 23 | 16 | 16 | 25 | 4 | 33 |
| *Raja rays nei* | Faroe Islands | 5 | | 2 | 2 | | 8 | 9 | 16 | 7 | 11 | |
| | Germany* | | 7 | | | | | | | | | |
| | Iceland | | | | | | | | 8 | | 10 | |
| | Norway | 8 | 3 | 6 | 5 | 1 | | | 7 | | 1 | |
| | Portugal | | | 1 | | | | | | | | |
| | Russian Federation | | | | | | 2 | 6 | 3 | | | |
| | Spain | | | | | 15 | | | | | | |
| | UK - Eng+Wales+N.Irl. | 2 | | 1 | | | 1 | | 1 | | | |
| | UK - Scotland | | | | | 1 | | | | | | |
| Total | | 1112 | 1210 | 1340 | 1879 | 1655 | 1200 | 875 | 718 | 622 | 789 | 1037 |

**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 |

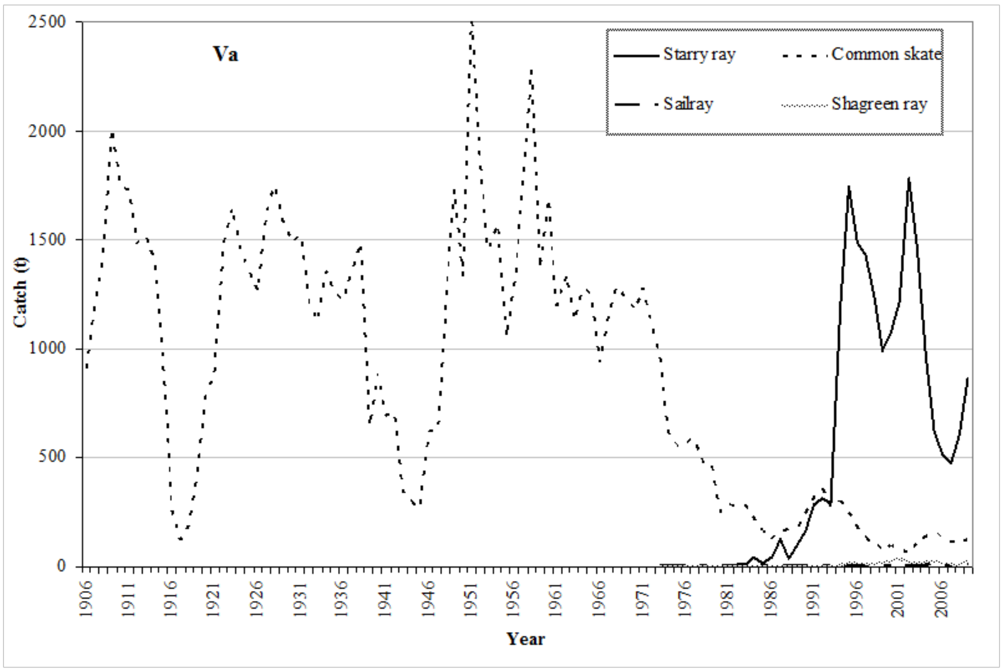


**Figure 16.1. Demersal Elasmobranchs at Iceland. WG estimates of the most commonly reported rays in Va, 1906–2009.**

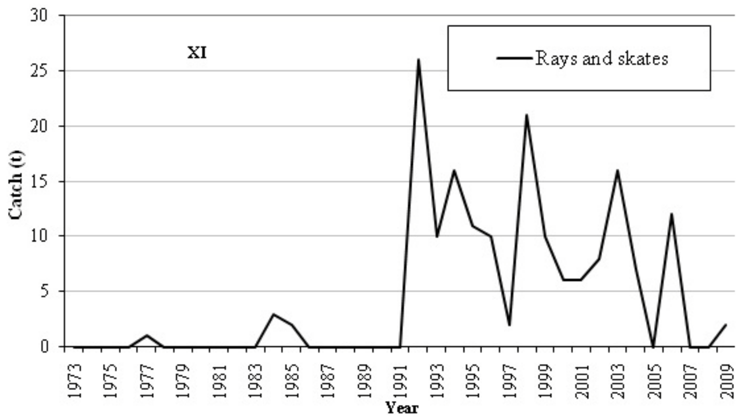


**Figure 16.2. Demersal Elasmobranchs at east Greenland. WG estimates of the most commonly reported rays and skates in XIV, 1973–2009.**

# 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 *D. linteus*, long-nosed skate *D. oxyrinchus*, sandy ray *Leucoraja circularis*, shagreen ray *L. fullonica*, cuckoo ray *L. naevus*, spotted ray *Raja montagui*, thornback ray *R. clavata*, round skate *Rajella fyllae*, Arctic skate *Amblyraja hyperborea*, starry ray (thorny skate) *A. radiata*, white skate *Rostroraja alba* and common stingray *Dasyatis pastinaca*. Demersal sharks include several deep-water species (Leafscale gulper shark *Centrophorus squamosus*, black dogfish *Centroscyllium fabricii*, birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*, Greenland shark *Somniosus microcephalus*, mouse catshark *Galeus murinus* and blackmouth catshark *Galeus melastomus;* see Section 5) and spurdog (Section 2). Chimareas also occur in the area: rabbitfish *Chimarea 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, nine countries (Denmark, Faroe Islands, France, Germany, Netherlands, Norway, Poland, UK and Russia) have reported landings of demersal elasmobranchs 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 elasmobranches in those and other NEA areas amounted to 483 t (Vinnichenko, 2008).

### 17.2.2 The fishery in 2009

In 2009, the elasmobranchs were caught both during the target fishery in the FFZ and as bycatch in the other NEA areas by Russian boats.

In June–August, on the slopes of the Lousy, Bill-Baileys and Føre Banks (700–1150 m depths), 1 longliner carried out the target fishery of deep-water sharks. On the whole, in the area, the total number of fishing days was 22; 389 000 hooks were set; the catch was 187.6 t including 98.5 t deep-water sharks. The average shark catch rate was 253.2 kg per a 1000 hooks and 4.5 t per a fishing day. According to the data from the observer aboard longliner the leafscale gulper shark *C. squamosus* prevailed (57%) in the catches. Other shark species were also caught in the area: birdbeak dogfish *D. calcea*, the black mouthed dogfish *G. melastomus*, mouse catshark *G. murinus*, the black dogfish *C. fabricii*, the velvet belly *Etmopterus spinax*, as well as sandy ray *L. circularis*, thorny and Arctic skates.

### 17.2.3 ICES advice applicable

ACOM has not provided advice on these stocks.

### 17.2.4 ICES advice applicable 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 are shown in Figure 17.1.

WGEF notes the large decline in the Faroese landings in 2009.

### 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 length composition

All skates in Division Vb, with the exception of French landings (1896, 1987 and1996–2008) and Norwegian landings (2009) of the *D. batis* species-complex and Scottish landings of *R. clavata* (2009), were reported as '*Raja rays nei*'. 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 References

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.

Vinnichenko V.I. *et al*. 2010. Russian research and fisheries of sharks and skates in the North-east Atlantic in 2009. Working Document for the Working Group on Elasmobranch Fishes, ICES, 29 pp.

**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 | | | 1 | 1 | | | | | | | | | |
| | Norway | 29 | 27 | 37 | 42 | 46 | 64 | 37 | 18 | 21 | 13 | 32 | 35 | 14 |
| | UK - Eng+Wales+N.Irl. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - England & Wales | 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 | | | | | | | 1 | | | | | | |
| *Raja clavata* | France | | | | | | | 10 | | | 1 | 6 | 23 | 38 |
| | Total | 610 | 393 | 461 | 527 | 566 | 436 | 375 | 291 | 172 | 272 | 272 | 343 | 331 |

WG Estimates of Landings (t) of Rays in ICES Area Vb

| Species | Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Raja rays nei* | Denmark | | 1 | | | | | | | | | | | |
| | 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 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | 3 | 3 | 0 | 6 | 0 |
| | UK - England & Wales | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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 | | 2 | 2 | | | | | | | | 0 | 0 | 0 |
| *Dipturus oxyrinchus* | France | | | | | | | | | | | 0 | 0 | 0 |
| *Raja clavata* | France | | | | | | | | | | | 0 | 0 | 0 |
| *Raja montagui* | France | | | | | | | | | | | 0 | 0 | 0 |
| *Dasyatis pastinaca* | France | | | | | | | | | | | 0 | 0 | 0 |
| *Leucoraja circularis* | France | | | | | | | | | | | 0 | 0 | 0 |
| *Leucoraja fullonica* | France | | | | | | | | | | | 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 |
| *Raja rays nei* | Faroe Islands | 175 | 0 | 76 | 25 | 98 | 272 | 274 | 238 | 185 | 178 | 18 |
| | France | 2 | 0 | 0 | 1 | 5 | 8 | 6 | 20 | 8 | 6 | |
| | Germany | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | |
| | Norway | 45 | 50 | 21 | 15 | 5 | 0 | 11 | 10 | 16 | 5 | 0 |
| | UK - Eng+Wales+N.Irl. | 0 | 23 | 2 | 0 | 2 | 15 | 5 | 0 | 0 | 0 | |
| | UK - England & Wales | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | UK - Scotland | 6 | 12 | 25 | 12 | 6 | 5 | 25 | 2 | 2 | 2 | 4 |
| *Dipturus batis* | Norway | | | | | | | | | | 4 | 0 |
| | France | 4 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 0 | |
| *Leucoraja naevus* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Dipturus oxyrinchus* | France | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Raja clavata* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | UK - Scotland | | | | | | | | | | | 1 |
| *Raja montagui* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Dasyatis pastinaca* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Leucoraja circularis* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Leucoraja fullonica* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Rostroraja alba* | UK - Scotland | | | | | | | | | | | 1 |
| | Total | 233 | 89 | 129 | 55 | 122 | 304 | 323 | 272 | 213 | 196 | 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* | * | * | ** | *** | *** | *** | ** |

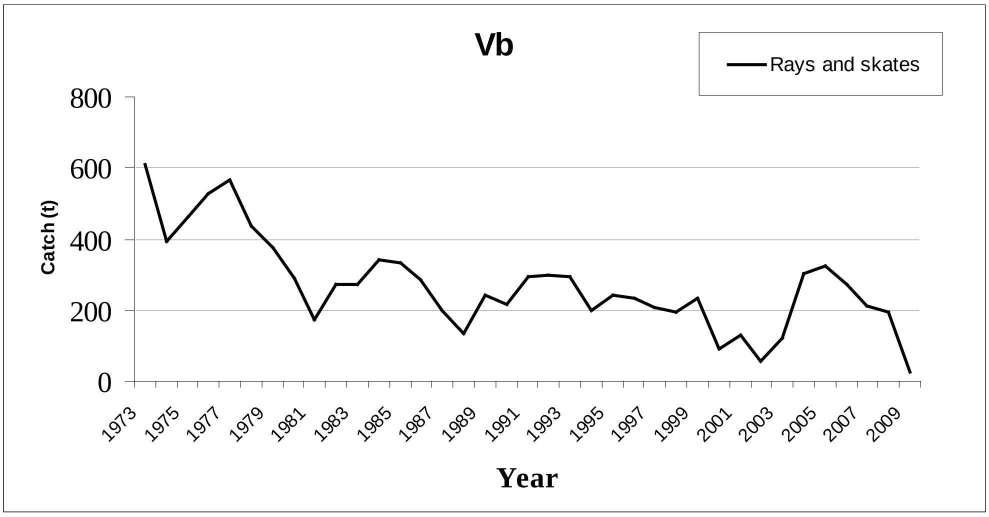


**Figure 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates and rays from Division Vb based on ICES FISHSTAT and data from France.**

# 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 North-western waters RAC. The south-western sector of ICES Division VIIk is contained in the oceanic northeast Atlantic ecoregion.

The following provides a general overview of the different areas within the Celtic Seas ecoregion. Whereas some demersal elasmobranchs, such as spurdog, tope and lesser-spotted dogfish, are widespread throughout this region, there are some important regional differences in the distributions of other species, which are described below.

Other than spurdog *Squalus acanthias* (see Section 2) and tope *Galeorhinus galeus* (Section 10), the main species of demersal shark taken in fisheries in this ecoregion are lesser-spotted dogfish *Scyliorhinus canicula*, smooth-hounds *Mustelus* spp. and greater-spotted dogfish *Scyliorhinus stellaris*. Angel shark *Squatina squatina* is now very rare in the area. Black-mouth dogfish *Galeus melastomus* occurs on the outer continental shelf and upper continental slope, but the distribution of this species also extends into deeper waters.

At least sixteen species of skate and ray are recorded in the area. The most commonly occurring skates (Rajidae) on the continental shelf of this ecoregion are thornback ray *Raja clavata*, cuckoo ray *Leucoraja naevus*, blonde ray *R. brachyura* and spotted ray *R. montagui*. Undulate ray *R. undulata* and small-eyed ray *R. microocellata* may be locally abundant in the inshore waters of the southern parts of this ecoregion. Shagreen ray *L. fullonica* and sandy ray *L. fullonica* appear to be more common on the outer continental shelf and upper continental slope, and other skates (e.g. long-nosed skate *Dipturus oxyrinchus*) will also occur in deeper waters. The common skate complex (see Section 21.1) is also distributed over the ecoregion. There are very few recent records of white skate *Rostroraja alba* in the area. There are some important regional differences in the distributions of the skates, which are described below.

Other batoids (stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana*) may be observed in this ecoregion, although they are more common in more southerly waters. These are generally discarded if caught in commercial fisheries and are not considered in this report.

**West of Scotland (VIa):** The main demersal elasmobranchs occurring in the shelf waters west of Scotland include lesser-spotted dogfish, *R. clavata*, *L. naevus* and '*Dipturus batis*'. Offshore species, such as black-mouth dogfish *L. fullonica* and sandy ray *L. circularis* are distributed mainly towards the edge of the continental shelf. A recent tagging study showed that '*D. batis*' move into shallow water in summer and autumn (Thorborn, 2008).

**Rockall (VIb):** Though this division contains extensive deep-water areas (see Sections 3 and 5), many of the species occurring on the continental shelf off mainland Scotland also occur on the Rockall Plateau. It is possible that the shallow water skates on the Rockall Plateau form separate populations. There are limited fisheries-independent data available from this area. *Raja clavata, R. brachyura, R. montagui,* round skate *Ra-*

*jella fyllae, 'D. batis', D. oxyrinchus, L. circularis, L. fullonica* and black-mouth dogfish have been recorded in Scottish surveys in this area.

**Irish Sea (VIIa):** The more common demersal elasmobranchs in the Irish Sea include spurdog, lesser-spotted dogfish, *R. clavata* and *R. montagui,* and *L. naevus* is common on offshore fishing grounds in this division. *R. brachyura* is locally abundant in some areas. Occasional individuals of *R. microocellata* also occur, but the main stock area for this species is VIIf. Starry smooth-hound and greater-spotted dogfish also occur in this area, especially along the west coast of Wales. Angel shark was formerly common in Cardigan Bay and this area may be one of the remaining habitats for this species around the United Kingdom.

**Bristol Channel (VIIf):** The most abundant demersal elasmobranchs in the Bristol Channel include lesser-spotted dogfish, *R. clavata, R. montagui,* and *R. microocellata,* which is locally abundant in this area. Although *L. naevus* is one of the dominant skate species in the Celtic Sea, it is rarely observed in the shallower parts of the Bristol Channel and only occurs in the western parts of VIIf. Once again, tope, smooth-hounds and greater-spotted dogfish all occur regularly in this area.

**Western English Channel, Celtic Sea and west of Ireland (VIIb,c,e,g–k):** The most abundant demersal elasmobranchs in the Celtic Sea include lesser-spotted dogfish, *R. clavata, R. montagui* and *L. naevus*. Tope and smooth-hounds also occur in the area, with juveniles more common inshore and larger individuals also occurring around the offshore sand banks in the Celtic Sea. Greater-spotted dogfish also occur regularly in this area, although is typically restricted to inshore, rocky grounds. *Raja undulata* is found in localised populations on the south-west coast of Ireland, and also in the English Channel, where it is most abundant in the Normano-Breton Gulf. *R. brachyura* can be locally abundant in parts of the area. Several other species occur on the offshore grounds of the Celtic Sea and along the edge of the continental shelf, including '*D. batis', L. fullonica, L. circularis* and black-mouth dogfish.

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.

Tagging studies by the Irish Central Fisheries Board indicate that *R. clavata* recaptures occur all along the Irish coast, while *R. undulata* seem to form a discrete population in Tralee Bay (Green, 2007 WD). Recent tagging studies of undulate ray off Jersey would also indicate high site fidelity (Cefas, unpublished data).

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 localised, inshore fisheries targeting skates (e.g. *R. clavata*) using longline and tanglenets. There is a small fishery off southeast Ireland targeting various skate species in the southern Irish Sea (Area VIIa), using rockhopper otter trawls and beam trawls. UK trawlers target skates in the Bristol Channel (VIIf) at some times of year.

Most coastal dogfishes (e.g. tope, smooth-hounds and catsharks) are taken as a by-catch in various trawl and gillnet fisheries. Due to the low market value of these species, they tend to be discarded by some nations, though some of marketable size are sometimes retained. A largely unknown quantity is retained for use as bait in the Irish Sea and Bristol Channel pot fishery for whelk *Buccinum undatum* and the northwest Ireland crab fishery. The extent to which these landings are declared is unclear.

There are *Nephrops* fisheries in the Irish Sea (VIIa), Celtic Sea (VIIg), Porcupine Seabight (VIIj) and at the Aran Islands, (VIIb) which may catch various elasmobranchs as a bycatch. In the deep waters of Area VI and VII there is a skate bycatch in fisheries for anglerfish, megrim, and hake, and these species include *L. fullonica, L. circularis* and *Dipturus* spp.

There is also a large recreational fishery for skates, rays and dogfishes, 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 2008

There is no new information relating specifically to elasmobranchs. Changes in fishing patterns in these areas are summarised by the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and Working Group for the Celtic Seas Ecoregion (WGCSE), although the 2010 Reports of these Expert Groups were not available.

Landings tables for the relevant species are provided in Tables 18.1–18.6.

### 18.2.3 ICES advice applicable

ICES provided advice for stocks in this region for the first time in 2008. The advice was divided into the following sections:

***No fisheries: Species where indicators show extirpation***

- White skate - has a localized and patchy distribution, and is extirpated from most parts of the Celtic Seas ecoregion. It should receive the highest possible protection. Any incidental bycatch should not be landed, but returned, to the sea, as they are likely to have a high survival rate.
- Angel shark - has a localized and patchy distribution, and is extirpated from parts of its former range. It should receive the highest possible protection. Any incidental bycatch should not be landed, but returned, to the sea, as they are likely to have a high survival rate.

*No target fisheries: Species where indicators show depletion (or may be susceptible to local depletion)*

- Common skate - has declined in many inshore areas of England and Wales, although is still present in the inshore areas of Scotland and Ireland. Target fisheries for this species should not be permitted and measures should be taken to minimize bycatch.
- Undulate ray - Has a patchy distribution, with some of these areas showing signs of depletion. As a precautionary measure, target fisheries for this species should not be permitted unless exploitation rates are shown to be sustainable.

*Status quo catch: Species where indicators show recent stability or increase*

- Thornback ray, spotted ray in VIa and VIIa,f,g. and cuckoo ray in VIa.
- Small-eyed ray in VIIf has a restricted distribution and is locally abundant in the Bristol Channel, this stock should be monitored to ensure that it does not decline.
- Lesser-spotted dogfish - the current exploitation rates appear to be sustainable. As there are no apparent detrimental impacts on the stock from current commercial fisheries, no management actions are required for this species at this time.
- Greater-spotted dogfish - Has a restricted distribution and is locally abundant in parts of the Celtic Seas ecoregion, and should be monitored appropriately.
- Smooth-hounds have a relatively higher productivity than similar elasmobranchs and can probably sustain fisheries. Management measures should prevent overexploitation. Fisheries should only expand when accompanying measures lead to improved data collection and biological studies to ensure its sustainable harvest.

*No advice: Species where indicators are unknown*

- Cuckoo ray in VII - Further studies to better understand stock structure are required, although this species is one of the more abundant skates in the Celtic Seas ecoregion.
- Blonde ray - is widely distributed in the Celtic Seas ecoregion, but it has a tendency to form local aggregations and so may be prone to localized depletions.
- Sandy ray - most abundant on the outer continental shelf and upper continental slope, it is not well sampled in most existing groundfish surveys.
- Shagreen ray - most abundant on the outer continental shelf and upper continental slope, it is not well sampled in most existing groundfish surveys.

### 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. Within this, catches of *L. naevus, R. clavata, R. brachyura, R. montagui, R. microocellata, L. circularis* and *L. fullonica* should be reported separately. This did not apply to undulate ray (*R. undulata*), common skate (*D. batis*), Norwegian skate (*D. nidarosiensis*) and white skate (*Rostroraja alba*). These species were to be immediately released unharmed where applicable, and fishers encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. It was also forbidden to retain angel shark.

For 2010, the TAC for skates and rays was reduced by ca. 15% to 13 387 t, and the regulations kept the same caveats regarding species-specific landings for the main species and for non-retention of selected species. Angel shark, *R. undulata* and *'D. batis'* were also to the Prohibited species list (see Annex 5, Special requests). It was also indicated that up to 5% of the national quotas may be fished in the EU waters of VIId.

Under current EU legislation, where a directed fishery for skates takes place, a mesh size in the codend of no less than 280 mm is required and not less than 220 mm in the rest of the trawl.

Under Regulation 850/1998 a minimum mesh size of 220 mm is required for gillnets targeting skates and rays (those catching <70% skates and rays) in Subareas VI and VII.

The European Commission published an action plan for the conservation and management of sharks in February, 2009. This intends, amongst other aims, to ensure that directed fisheries for sharks are sustainable and that the bycatch of sharks resulting from other fisheries is sustainable (EC 2009). This will affect how fisheries in this ecoregion operate in the future.

Within UK waters, the South Wales Sea Fisheries Committee (SFC) had a bylaw stipulating a minimum landing size for skates and rays. On 1st April 2010 the South Wales SFC became amalgamated with the Welsh Assembly Government (WAG), and it is unclear as to whether this regulation will be introduced in all Welsh waters.

The Cumbria SFC also has a bylaw stipulating a minimum landing size for skates and rays. The North Devon Fishery has also recently introduced a voluntary minimum landing size of 38 cm (wingtip to wingtip) for skates. Within the Bristol Channel, Belgian beam trawlers are also observing the minimum landing size on a voluntary basis (Anon., 2009).

Tralee Bay (Area VIIj) is voluntarily closed to commercial fishing to protect regionally important elasmobranchs such as *R. undulata* and angel shark, which are only found in localized populations on the Irish West coast. There are no other known specific closed areas for the protection of elasmobranchs.

*'Dipturus batis'* and *Squatina squatina* were removed from the Irish Specimen Fish List in 1975 and 2005 respectively, to prevent targeted fishing by recreational fishers.

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 six nm of the coast).

## 18.3 Catch data

### 18.3.1 Landings

Landings data are incomplete for 2009 as not all nations were able to provide national data by the time of the meeting. All data must be treated as provisional, even for those countries that provided data.

#### 18.3.1.1 Skates

Landings tables for skates (Rajidae) by country are provided in Tables 18.1a–h. Landings for the entire data series available are shown in Figure 18.1(a–c). Landings by area within the ecoregion are illustrated in Figures 18.2. 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 (although not all data were available for this time period).

***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 for the past two 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, mainly catching deep-water species, including sharks, but also catching seven tonnes 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. Once again, recent landings (although some data were not available) 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 and the UK.

***Bristol Channel (VIIf)***

Following an increase in reported skate landings in the mid-1970s, skate landings in VIIf ranged from 1000–1600 t. Landings have decreased since 2002. 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), at ca. 8000 t per year from 1973–2000. Landings have since declined each year and are now also at the lowest level in the time-series (although not all data were available for the recent year).

#### 18.3.1.2 Skate landing categories

Traditionally, most skate landings have been reported under a generic landing category, although some nations (e.g. France) have reported some species-specific landings. Such species-specific data are shown in Tables 18.2–18.6. These data suggest that the four major commercial species in French fisheries (Table 18.4) in Subarea VI are *R. clavata, L. naevus, 'D. batis'* and *D. oxyrinchus*, with *L. naevus, R. montagui, R. clavata* and *'D. batis'* the major species in Subarea VII. WGEF consider that French landings of *R. montagui* also include quantities of *R. brachyura* (See Section 18.3.3). The importance of *R. clavata* and *L. naevus* is also apparent in Spanish (Basque country) and Belgian landings data (Tables 18.5–18.6).

Since 2009 there has been a requirement for species-specific reporting, and these data are discussed in greater detail in Section 18.4.2.

#### 18.3.1.3 Dogfishes

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. Landings data for *Mustelus* spp. are provided in Table 18.7 and Figure 18.3.

Landings tables for lesser-spotted dogfish have not been provided, as it was not possible to disaggregate this species from the many categories under which it is 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 identify 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 a peak in UK landings in 1997 from VIIj–k were 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 by Borges *et al.*, 2005 and ICES, 2007. These studies indicated that skates below a certain size (ca. 47 cm) were generally discarded, regardless of species, although *R. clavata* would sometimes be retained at a smaller size.

Discard sampling in VIIg highlights the prevalence of juvenile (<25 cm) *Scyliorhinus* spp. compared with the other areas suggesting that this area may be an important nursery ground for lesser-spotted dogfish, as also indicated from groundfish surveys (Ellis *et al*., 2005).

#### 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 on-going studies in UK waters have been examining the discard survival of various skates in case study fisheries. It was observed that, in the Bristol Channel otter trawl fishery, short-term survival was ca. 55% (Enever *et al.*, 2009), and there was a correlation between catch weight and survival of discarded skates, with larger catches presumably resulting in increased compression and abrasion in the codend, and higher mortality.

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 high discard survival from such fisheries.

Further studies to examine discard survival for other gears (e.g. gillnets and beam trawlers) and other species are on-going.

### 18.3.3 Quality of catch data

Until 2009, there was no quota for "skates and rays" in this region. This meant that there was a rationale for fishers to log quota species as "skates and rays", possibly leading to an overestimation of catch quantities. Misreporting of quota species as elasmobranchs is known to have occurred, such as where anglerfish and hake are reported as "skates and rays" or under generic landings categories for dogfishes, although the extent of this problem is unknown. The introduction of quota, and the introduction of buyers and sellers legislation in the UK and Ireland in 2006, should have reduced misreporting.

Since 1995 EU regulations require skippers to record all landings in the logbook, regardless of species. It is not clear what effect this had on the landings data for "skates and rays", as it is not known if they were completely reported prior to this.

Vessels less than 10 m have not always been required to carry a logbook, so inshore catches of skates may be under-represented in official landing statistics. This may be important in areas where there may be locally abundant species that are otherwise rare.

## 18.4 Commercial catch composition

### 18.4.1 Species composition

Skates have traditionally been landed by grade (size), which often comprises a mixture of species. Only since the DELASS project had some recent information on species composition became available for various countries (Heessen, 2003). Some countries have continued to provide landings by species but most were supplied as mixed species information. Species breakdown per country (where available) is supplied in Tables 18.3–18.6. Information on species composition of landings provided by Belgium and Ireland was discussed in ICES, 2007. Some historical information is available in the scientific literature (Du Buit, 1966, 1968, 1970, 1972; Fahy, 1988, 1989a, 1989c, 1991; Fahy and O'Reilly, 1990; Gallagher *et al.*, 2005a).

### 18.4.2 Species-specific landings

Landings by each country have been analysed to determine the percentage landings of each country that are declared in species-specific categories (Table 18.2). From these figures it can be seen that there are large variations in species-specific landings, both within countries and between countries.

In 2009, Belgium, UK (Scotland) and UK (E, W&NI) reported ca. 57%, 39% and 81% respectively of their total skate landings from the Celtic Seas ecoregion to species level. Although Ireland only managed 5% in 2009, steps are being taken to improve compliance with the regulation to report skates to species level.

The species composition as reported by Belgian fisheries included only four species (Table 18.3). Catches in the Irish Sea were dominated by *R. clavata* and *R. brachyura*, with *L. naevus* and *R, montagui* reported as a lower proportion. These are the four main skate species in this area, although there may be some confusion between *R. brachyura* and *R. montagui*. Belgian catches in VIIf,g were also dominated by *R. clavata.* However, the absence of *R. microocellata* in Belgian landings is conspicuous, and it is unclear as whether this locally abundant species is reported under the generic landing category or is being reported as another species. *L. naevus*, which is abundant in VIIg, is not a major component of the skate fauna over much of VIIf, and so the high proportion of *L. naevus* in VIIf required further investigation.

The species composition in VIa,b as reported by UK (Scotland) comprised nine species, with *L. naevus, R. brachyura, R. clavata* and *R. montagui* all important species (Table 18.3). UK (Scotland) also reported quantities of various offshore species from VIb, including *D. oxyrinchus, L. circularis* and *L. fullonica*. The records of *R. alba* seem quite strange and are possibly erroneous. Further studies to investigate these reports are required and such data verified if correct.

UK (England, Wales and Northern Ireland) reported twelve species of skate from landings from this area. The records of *A. radiata* may be erroneous, although these involved low quantities of fish. There were records of *D. nidarosiensis* and *D. oxyrinchus*, and improved monitoring of landings of this genus could usefully be undertaken.

Landings in VIIa were dominated by *R. clavata*, and there were no unusual species records in this Division. Landings from VIIe were diverse (ten species were recorded, although the presence of *A. radiata* is questionable). The records of *L. circularis* and *L. fullonica* in VIIf are questionable, but could be due to skate catches being allocated across the rectangles fished in any one trip. However, *R. microocellata* is known locally as ‘sandy ray’ in this area, which could also explain the apparent presence of *L. circularis* in this division.

The declaration of skates to species level, which has already begun, should increase and could usefully be applied to other elasmobranch species. Categories such as “Sharks” and “dogfishes and hounds” are still used by several countries, and it is difficult to separate these into constituent species or species-complexes.

Although France has historically declared a large proportion of its catches to species level, close examination of the data indicates another problem, in that there are no declarations of blonde ray, *Raja brachyura*. This species is known to be relatively common in this area, and should appear in the catch records. Hence it is most likely that *R. brachyura* and *R. montagui* are landed together. This will probably occur in other fleets as well.

The difficulty in species identification has been well documented (ICES, 2007), as has the problem of declaring landed elasmobranch species in generic categories (Johnston *et al.*, 2005). Improved information on the species composition caught by various métiers in space and time (e.g. from observer and market sampling programmes) will be increasingly important.

### 18.4.3 Size composition

Market sampling data are available for these species for recent years. 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.

Figure 18.4a presents the length frequencies series from 1985 to 2009 (two first quarters of the year for 2009) by sex of *Leucoraja naevus* caught in Divisions VIIh and VIIIa by the French demersal trawl fisheries. It demonstrates a negatively skewed distribution during the most recent period (2004–2009) for both sexes. The positions of these catches, by gear, are illustrated in Figure 18.4b.

The Data Collection Framework (DCF) now requires concurrent sampling to take place within defined métiers. It is expected that this will lead to an increase in market sampling of elasmobranchs.

In the framework of the DCF, the National "Observer programme at sea“; ObsMER Programme started to sample sharks and rays bycatch caught by the domestic fisheries since 2003. Length frequency distributions for lesser-spotted dogfish and for cuckoo ray *Leucoraja naevus* sampled in Divisions VIIg,hj are presented in Figure 18.5.

### 18.4.4 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.

Some Working Group members provide national data that differs from that provided by Fishstat. These data are considered more reliable. The use of sale slip data is used by some other working groups to better quantify landings from some countries. It is recommended that this method of assessing landings figures be looked at for possible future use by WGEF.

## 18.5 Catch per unit of effort

### 18.5.1 Commercial cpue

There were no new commercial cpue data available. A decline in landings per unit of effort (lpue) by the French fleet in VIIg–j for *Leucoraja naevus* was noted by ICES, 2008 (see Figure 18.6).

Preliminary analyses of skate cpue from the Irish otter trawl fishery in VIIa were examined by the WGEF in 2008. However, these data were not considered to be indicative of stock trends. Changes in species reporting and fleet behaviour since the introduction of the Cod Recovery Plan in the Irish Sea need to be investigated before such data can be used for further analyses (ICES, 2008).

Discards per unit of effort (dpue) of lesser spotted dogfish in VII have decreased slightly since 1999; although surveys indicate an increase in abundance of this species (see ICES, 2007).

### 18.5.2 Recreational cpue

The Irish Central Fisheries Board began an effort recording programme in 1981 in Tralee Bay, southwest Ireland. Two charter-angling vessels record all their catch each year. These data (Figure 18.7) demonstrate that catches of *R. undulata*, a species that forms a discrete population in Tralee Bay, declined from a high of 80–100 fish per year when recording began to 20–30 fish per year in the mid 1990s, before increasing to 40–60 per year at the beginning of this century and now appears to be declining again, although catches fluctuate each year.

Catches of *Squatina squatina* have also declined since this programme began, from over 100 per year in 1981, to 20 in 1984, before increasing to 100 again in the late 1980s. These catches declined to very low levels in the 1990s and there have been no catches at all in the most recent years.

## 18.6 Fishery-independent surveys

Several fishery-independent surveys operate in the Celtic Seas ecoregion, as discussed below. Groundfish surveys can provide some spatial and temporal patterns in the species composition of the various skates (e.g. Quéro and Guéguen, 1981) as well as trends in relative abundance of selected demersal elasmobranchs.

### 18.6.1 Southern and Western International Bottom Trawl Survey in Q4 (SWIBTS)

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 Q4 IBTS surveys for southern and western waters (see Figure 18.8).

The trawls used in all these surveys are not standardized (see Table 18.9), although individual surveys should be able to provide regional data on the distribution, relative abundance, species composition, size composition and abundance trends for a variety of demersal elasmobranchs.

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 survey of the Celtic Sea and Bay of Biscay

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. Although no updated analyses were undertaken for this survey-series, this survey-series has previously been examined by Mahé and Poulard (2005), who 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)

Preliminary analyses of these data were presented this year. Due to the short time period of the survey, temporal trends in relative abundance should only be examined when there is a longer time-series.

Approximately 16 demersal elasmobranch species were recorded over the period 2003–2009 (Table 18.10). Records of *Amblyraja radiata* and *Rostroraja alba* are considered questionable. Some of the skates (e.g. *Dipturus oxyrinchus, R. undulata, L. fullonica*) were only recorded occasionally. Species that are captured in most or all years, albeit in low numbers included *Raja brachyura, R. microocellata, 'D. batis'*, and tope. Other species (including lesser-spotted dogfish, spurdog and the skates *L. naevus, R. clavata* and *R. montagui*) are captured in this survey relatively frequently.

The length frequency distributions of the main elasmobranchs captured in this survey are summarised in Figure 18.9.

#### 18.6.1.3 Spanish Porcupine bottom-trawl survey

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 3 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 (Velasco *et al*., 2010 WD). This Working Document presented the results on nine of the most commonly reported elasmobranchs taken in the survey series (2001–2009), including black-mouth dogfish (Figure 18.10), lesser-spotted dogfish (Figure 18.11), *L. circularis* (Figure 18.12), *L. naevus* (Figure 18.13) and *D. batis* (Figure 18.14). 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

The UK (England and Wales) survey has only used standardized gears since 2004, and preliminary analyses of these data were presented this year. Due to the short time period of the survey, temporal trends in relative abundance should only be examined when there is a longer time-series.

A total of 15 demersal elasmobranch species were recorded over the period 2004–2009 (Table 18.11; data including all valid and additional tows). Five species (*'Dipturus batis', L. fullonica, Torpedo nobiliana, Dasyatis pastinaca* and black-mouth dogfish) were only recorded occasionally. A further four species (*L. naevus, R. brachyura*, greater-spotted dogfish and tope) have been recorded every year, but in low numbers (<100 individuals in each year). The remaining six species (lesser-spotted dogfish, starry smooth-hound, spurdog and the skates *R. clavata, R. montagui* and *R. microocellata*) are captured in this survey relatively frequently.

The length frequency distributions of the main elasmobranchs captured in this survey are summarised in Figure 18.15.

#### 18.6.1.5 UK (Northern Ireland) Irish Sea groundfish survey

UK (Northern Ireland) has undertaken annual Q1 and Q4 trawl survey of the Irish Sea since 1992. The gear deployed is a commercial rockhopper trawl fitted with a 20 mm liner in the codend and is towed for a set time period, (either 20 minutes or 1 hour) to allow comparison between tows and years. As the survey was originally targeted at juvenile gadoids, it 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 sub-stratum. 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.

Although no new analyses of this survey were conducted, AFBI (NI) analysed available survey data from the VIIa (N) region in 2008 and produced a series of distribution maps for the most abundant species of elasmobranch (Figure 18.16). The survey time-series highlighted seasonal variations in abundance of a number of species in the region, in particular the demersal shark species (Figure 18.17), which demonstrated marked increases in catch rates in Q4 compared with Q1. This effect was not as pronounced for skates (Figure 18.18). To investigate the location of potential nursery grounds in the area an index based on the ratio of average weight (Kg)/average abundance (No./hr) was also plotted (Figure 18.19). For further information on these analyses, see NIEA (2008).

#### 18.6.1.6 UK (Scotland) western groundfish survey

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 Section 18.6.3.1).

The survey uses a GOV with heavy ground gear 'C'. In 1998, a change of research vessel took place and at the same time haul duration was reduced from 1 hour to 30 minutes. A comparative fishing trial was conducted and subsequent analysis revealed no significant differences in catch rate for a number of commercial teleost species (Zuur *et al*., 2001).

The most frequently occurring demersal elasmobranchs in the Scottish VIa surveys are *L. naevus, R. clavata, R. montagui, 'D. batis'* and lesser-spotted dogfish (Figure 18.20). Some other skates (e.g. *R. brachyura, A. radiata*), tope and *Mustelus* spp. are caught in much lower numbers, and there are only occasional records of other species.

### 18.6.2 Beam trawl surveys

#### 18.6.2.1 UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey

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 relatively shallow 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 sub-adults of the larger species (Figure 18.21). Smooth-hounds caught by the gear also tend to be juveniles.

Catch rates (n.h$^{-1}$) for this survey have been summarized (Figures 18.22–18.23), with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least twelve times during the 17 year time-series (1993–2009).

#### 18.6.2.2 UK beam trawl surveys in the western English Channel (VIIe)

There are also beam trawl surveys in the western English Channel, one conducted in and around the Great West Bay (between Start Point and Portland) during October, and a recent springtime survey covering the wider western English Channel. Although data on undulate ray from the latter survey were examined (Annex 5), further analyses of both these data sets are required.

### 18.6.3 Other sources of survey data

#### 18.6.3.1 Additional UK (Scottish) surveys

UK (Scotland) also undertakes a Q1 west coast survey covering a similar area to the Q4 survey (see Section 18.6.1.6), and results from this survey are presented (Figure 18.20).

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.

Both these surveys also report results to the IBTSWG.

#### 18.6.3.2 UK Western groundfish survey with Portuguese high headline trawl

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.

Since 2004, the basis of the field programme changed to collecting additional biological data for commercial species, and so is not a standardized survey in line with previous years. This data collection survey will not be undertaken in 2011.

#### 18.6.3.3 Additional Irish surveys

An annual survey to collect maturity data on commercially important species took place during the spring spawning season. This survey began in 2004 and ended in 2009. Different areas were surveyed each year, so annual trends cannot be derived. An annual deep-water trawl survey to the west of Ireland began in 2006, covering 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

Several surveys take place in this area, including UK, Irish, French and Spanish groundfish surveys. It must be noted that catch rates for annual surveys tend to be low for many species and quite variable, with many zero catches. Analyses of more specific areas within the overall survey areas may be more appropriate for some species. Hence, these trends should be viewed with some caution.

#### 18.6.4.1 *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, as observed in the UK beam trawl survey, are low and variable (Figure 18.22), and more detailed analyses of these data are required.

#### 18.6.4.2 *Raja clavata*

The French EVHOE surveys indicated stable catch rates, but with a very large peak in abundance in 2001 (Mahé and Poulard, 2005). This was attributed to very large catches of juvenile *R. clavata* on this survey The UK PHHT survey indicated a slight decreasing trend, although the sampling grid for this survey is considered to be mostly outside 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 18.22).

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 ground gear 'A' is used (Table 18.11).

The UK (Northern Ireland) survey of the Irish Sea would indicate low but stable catches (Figure 18.18), although this survey uses a rockhopper trawl, and so the catchability may be low.

The UK (Scotland) survey of VIa would also suggest stable/increasing catch trends (Figure 18.20b), although once again it should be noted that this survey uses a trawl with bobbins, and such a ground gear (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 *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 localised 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 18.22). The smallest size class is not often taken in the survey (Figure 18.21), 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 reported at these sites (Table 18.11).

Further studies of this species in VIIe (from UK beam trawl surveys) and from the Irish Groundfish Survey are required.

#### 18.6.4.4 *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 (Figure 18.22).

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. montagui,* especially on those tows where ground gear 'A' is used.

The UK (Northern Ireland) survey of the Irish Sea would indicate stable/increasing catches (Figure 18.18) although this survey uses a rockhopper trawl, and the catchability may be low.

The UK (Scotland) survey of VIa would also suggest stable/increasing catch trends (Figure 18.20c), although once again it should be noted that this survey uses a trawl with bobbins, and such a ground gear may not sample skates effectively.

#### 18.6.4.5 *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 demonstrates that there is a decreasing trend in mean length of this species in the Bay of Biscay, but this is not demonstrated in catches from the Celtic Seas.

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 demonstrates an increased relative abundance in 2003 (Figure 18.13a) followed by a gradual decline, although catch rates in the last two years are comparable to those observed at the start of the time-series.

The UK (Scotland) survey of VIa would also suggest stable/increasing catch trends (Figure 18.20a).

The UK (England and Wales) beam trawl survey in VIIa catches reasonable numbers of *L. naevus*, mostly on the offshore stations on coarse grounds. Although there is the indication of a slight decline from the start of the time-series, this survey would indicate stable catches in recent years (Figure 18.22). *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 *Leucoraja circularis* and *Leucoraja 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 18.12a–c). Peak catches were in 2003. Overall, the limited time-series would suggest low but stable catches. This species is taken only infrequently in other surveys, and 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 (Tables 18.10–18.11), which may reflect insufficient sampling of the main habitat, and possibly a gear effect.

#### 18.6.4.7 Lesser-spotted and greater-spotted dogfish

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 18.23).

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 18.11).

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 (Figure 18.17) and the UK (Scotland) survey of VIa (Figure 18.20e) would also both suggest 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 includes 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 18.23).

The UK (England and Wales) westerly IBTS survey also has stations along the western coast of Wales. Although they are captured regularly in this survey, catches comprise few individuals (Table 18.11).

Both these UK surveys have tagged and released a number of greater-spotted dogfish in recent years, which will hopefully provide information to aid stock identification.

#### 18.6.4.8Starry smooth-hound

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, and though 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 18.23). The smooth-hounds taken in this survey are generally juveniles, and the low proportion of mature fish is due to a low catchability.

The UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea also indicates an increase in mean catch rates (Figure 18.17). The UK (England and Wales) and Irish groundfish survey also catch reasonable numbers of smooth-hound (Tables 18.10–18.11), 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 UK (England and Wales) western IBTS 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 declining catch rates (Figure 18.4) of '*D. batis*'. A preliminary examination of Scottish data (Figure 18.20d) indicates some increase in the proportion of hauls in which they were observed, although it should be recognised 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).

It is also recommended that surveys coordinated by IBTSWG, PGNEACS and WGBEAM report catch data on the common skate complex using the updated species names for the two species (see Section 21.1 for further information for some of the morphological characteristics used to distinguish these species).

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 18.10b–18.14b), Irish surveys (Figure 18.9) and surveys from UK (England and Wales) (Figure 18.15, 18.21) and UK (Scotland) (Figure 18.20).

Preliminary analyses of the size distributions of some of the demersal elasmobranchs taken in some of the relatively new western IBTS surveys were undertaken. This is primarily to illustrate the life-history stages that may be represented in these surveys, and so as to gauge whether the surveys are likely to be appropriate to examining the pups/juveniles and/or adults of the various species.

The various western IBTS groundfish surveys and ongoing UK Q3 beam trawl surveys in the Celtic Seas could be used to inform on annual changes in size distributions. Analyses of these data may be able to inform on recruitment events for some species.

Data for some of the species, such as *R. microocellata* (Figure 18.21) demonstrate several modes in the size range. As age data are not available for these species, these modes may possibly be used to estimate relative abundances for younger age classes.

### 18.6.6 Localised populations

Several species of demersal elasmobranch that, although occurring sporadically throughout much of the Celtic Seas region, have certain areas where they are locally abundant. Localised 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 at a more local 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 western English Channel (VIIe);
- *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 to the resurrected species names (see Section 21.1).

#### 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 for informing on larger skates.

The western IBTS surveys use a variety of trawl gears deemed appropriate for the grounds on which they fish, and so include trawls with rockhopper discs or bobbins, as well as standard ground gears on fine ground. There is insufficient knowledge of the catchability of demersal elasmobranchs in these various gears.

#### 18.6.7.3 'Health warning' in relation to gear performance during the 2008 Spanish Porcupine survey

In spite of using the same gear design as in previous years, there were differences in the mean vertical opening and door spread of the gear during the survey in 2008. Vertical opening decreased from 2.96 m to 2.50 ± 0.07 m, and the door spread increased from 131.7 m to 147.2 ± 4.7 m. The differences with previous years were not solved despite two gear changes and modifications in the rigging of the trawl doors. These changes occurred together with a longer mean time to make ground contact, produced a decrease in the abundance indices of several species. It has not been possible to evaluate the effects of the gear behaviour for all species, although it did not affect significantly the number of fish species caught: 103 fish species in 2008 compared with 97.4 fish species as a mean in the last five years. Data from this survey has been used to examine the status of *L. naevus* and *L. circularis* in this ecoregion.

## 18.7 Life-history information

Various published biological studies provide maturity and age data for skates in the Celtic Seas (e.g. Fahy, 1989b; Gallagher, 2000; Gallagher *et al.*, 2005b). 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. Updated information on the length-at-maturity (Table 18.12), and the length–weight relationships (Table 18.13) for a variety of skates were provided from UK surveys (all surveys combined).

### 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.

Trawl surveys could usefully provide information on catches of viable (i.e. containing yolk or embryos) skate egg-cases, and it is recommended that IBTSWG and WGBEAM be asked to record the numbers of viable skate egg cases (by species where possible) in future trawl surveys.

Surveys may be able to provide information on the locations of nursery grounds (e.g. Figure 18.19) 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 (10–20 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 are illustrated in Figures 18.24–18.25, but the complete results and a description of the methods used see are provided in ICES (2007).

#### *Division VIa*

*Raja clavata:* Figure 18.24a shows the estimated effects from the fitted GAM. The survey catch rates in terms of no.$h^{-1}$ were estimated to have been higher in recent years than in the mid 1990s. Highest catches were estimated to occur in the statistical rectangles around St Kilda and in waters less than 250 m deep. The seasonal pattern was rather uncertain, probably because most data were obtained in either the 1st or 4th quarters of the year.

*Leucoraja naevus:* The results of the fitted GAMs are shown in Figure 18.24b. The year effect estimated by the model demonstrated some fluctuations over the 20-year time period, although recent catch rates were estimated to be the highest in the time-series. The estimated spatial distribution indicated lower catch rates in the Minches and Clyde with higher catch rates in the more offshore areas of the shelf. Catch rates were estimated to be highest in shelf seas. However, it should be highlighted that there is likely to be some confounding of spatial and depth effects and additionally the estimated form of the relationship between depth and catch rate may be too smooth.

*Raja montagui:* The estimated year effects for spotted ray in Division VIa demonstrated an increasing trend over time (Figure 18.24c). The highest catch rates were estimated to come from statistical rectangles to the south and north of the Hebrides.

*Scyliorhinus canicula:* Figure 18.24d shows the results of the fitted GAM. The estimated temporal trend in catch rate demonstrated a significant increase between 1990 and 2003 and has stabilized since then. Highest catch rates were estimated to occur in the offshore regions of the shelf, particularly to the northwest of Ireland.

#### *Division VIb*

The survey conducted at Rockall has very low catch rates of all elasmobranch species and is therefore only useful as an indicator of whether a species is present in this part of Division VIb. There is little useful survey information from the deeper water of Division VIb.

#### *Division VIIa/VIIf*

The analyses for the Irish Sea and Bristol Channel make use of the UK (E&W) beam trawl survey. This survey has been carried out at the same time each year and therefore no seasonal trends were included in the statistical model.

*Raja clavata:* Figure 18.25a shows the estimated effects from the fitted statistical models. The model estimated that there had been a significant increase in catch rate (N.$h^{-1}$) over the period for which data were used (1993–2006). The highest catch rates came from Cardigan Bay and the other statistical rectangles around the coast of Wales, with lower catch rates apparent in more southerly and northwesterly regions.

*Leucoraja naevus:* The results of the analysis for cuckoo ray in VIIa/VIIf are shown in Figure 18.25b. The statistical model estimated a small (but marginally significant) decline in catch rate over the 14 years of survey data. The estimated spatial distribution of survey catch rates demonstrated that the highest rates came from the statistical rectangles in the central Irish Sea, with lower catch rates occurring around the coastline of England and Wales.

*Raja montagui:* Figure 18.25c shows the results of the fitted GAM for spotted ray in the Irish Sea and Bristol Channel. The model estimated a significant increase in catch rate over the time-series of available data. Catch rates were estimated to be highest in the statistical rectangles in the central Irish Sea.

*Scyliorhinus canicula:* The results of the analysis for lesser-spotted dogfish in VIIa/VIIf are shown in Figure 18.25d. The statistical model estimated a significant increase in catch rate over the 14 years of survey data. The estimated spatial distribution of survey catch rates demonstrated that the highest rates come from the statistical rectangles in the central Irish Sea, with lower catch rates occurring around the coastline of England and Wales.

### 18.8.2 Stock status

In the absence of formal stock assessments for the species and stocks in this ecoregion, the following provides a qualitative evaluation of stock status of the major species.

#### *West of Scotland (VIa)*

*'Dipturus batis'*: Local populations still exist, and both species within this complex (blue skate *Dipturus* cf. *flossada*) and flapper skate *D.* cf. *intermedia*) occur in this division.

*Dipturus oxyrinchus:* Status uncertain. Infrequent in surveys.

*Leucoraja circularis:* Status uncertain. Infrequent in surveys.

*Leucoraja fullonica:* Status uncertain. Infrequent in surveys.

*Leucoraja naevus:* Uncertain, with the different surveys giving contrasting signals. Catches seem to have increased in VIa. Better delineation of the stock structure is required to aid in the interpretation of these survey indices.

*Raja brachyura:* Status uncertain.

*Raja clavata:* Status uncertain, although catch rates seem to be stable/increasing in surveys.

*Raja montagui*: Survey catches are stable/increasing.

*Scyliorhinus canicula:* Survey catches are stable/increasing.

*Scyliorhinus stellaris*: No information.

*Mustelus* spp. No information.

*Raja microocellata* is only a vagrant in this area.

#### *Rockall (VIb)*

There is not enough information to assess the status of any demersal elasmobranchs in this area.

#### *Irish Sea (VIIa)*

*'Dipturus batis'*: Although this has been described as extirpated (Brander, 1981), occasional individuals have been reported from the north-western Irish Sea (e.g. discard sampling in the North Channel and from recreational angling in deep waters outside Belfast Lough), and WGEF consider this species to be 'near-extirpated' in VIIa.

*Leucoraja fullonica:* Very infrequent in this division, as it outside the main distribution range.

*Leucoraja naevus:* Uncertain, with the different surveys giving contrasting signals. There is some indication of stable catch rates, although a better delineation of the stock structure is required to aid in the interpretation of survey indices.

*Raja brachyura*: Uncertain. No trends are apparent from surveys, with mean catch rates low and variable, possibly due to the patchy distribution of this species. There has been an increase in their occurrence in catches in the UK (Northern Ireland) groundfish survey in the latter part of survey (1999 onwards). Most survey catches are from the eastern Irish Sea. There are misidentification issues with this species.

*Raja clavata:* Uncertain, although Catch rates seem to be stable/increasing in the surveys that cover the main part of their range.

*Raja microocellata:* Occasional vagrants, presumably from the VIIf,g stock.

*Raja montagui*: Survey catches are stable/increasing. There are misidentification issues with this species in the commercial catch.

*Raja undulata:* Occasional vagrant to the southern part of the division.

*Scyliorhinus canicula:* Survey catches are stable/increasing.

*Scyliorhinus stellaris*: Uncertain. Survey catches are stable/increasing, but only reported from coarse ground stations in small numbers. This species may be more abundant on rocky, inshore grounds.

*Mustelus* spp.: Uncertain. Survey catches of *Mustelus asterias* are low in this ICES Division, but appear to be stable/increasing. The NI GFS catches demonstrate increasing trend in most recent years. The problems of species identification within this genus, makes species-specific assessments very difficult.

#### *Bristol Channel (VIIf)*

*'Dipturus batis':* Unknown, but numbers are likely to be low.

*Leucoraja fullonica:* Very occasional vagrant in this area.

*Leucoraja naevus:* Very small numbers taken in the outer Bristol Channel. More common in VIIe,g,h.

*Raja brachyura:* Uncertain. No trends are apparent from surveys. There are likely to be misidentification issues with this species in commercial catches.

*Raja clavata:* Uncertain, although catch rates seem to be stable/increasing in surveys.

*Raja microocellata:* Uncertain, although catch rates seem to be stable in surveys. This is one of the main stock areas for this species.

*Raja montagui*: Survey catches seem to be stable/increasing. There are likely to be misidentification issues with this species in commercial catches.

*Raja undulata:* Occasional vagrant to the southern part of the division.

*Scyliorhinus canicula:* Survey catches are stable/increasing.

*Scyliorhinus stellaris:* Uncertain, only taken occasionally in survey hauls.

*Mustelus* spp.: Survey catches appear to be stable/increasing in this ICES division.

#### *Western English Channel, Celtic Sea and west of Ireland (VIIb,c,e,g–k)*

*'Dipturus batis':* Regularly encountered in further offshore areas, but survey data are limited.

*Leucoraja circularis*: Uncertain. Survey catches (in VIIc) appear stable, but only a short time-series is available.

*Leucoraja fullonica:* Uncertain. There is a poor signal from surveys.

*Leucoraja naevus:* Uncertain, with the different surveys giving contrasting signals. The Spanish survey demonstrates an increase in catches to the west of Ireland. Better delineation of the stock structure is required to aid in the interpretation of these survey indices.

*Raja brachyura:* Status uncertain.

*Raja clavata:* Uncertain, although catch rates seem to be stable/increasing in surveys.

*Raja microocellata:* Patchy distribution. May be locally abundant in parts of VIIe. Larger individuals occur in the deeper waters of VIIg and VIIh. Degree of mixing between VIIe and VIIf unknown.

*Raja montagui*: Status uncertain.

*Raja undulata:* Patchy distribution. More frequently encountered in the southern part of VIIe and in the inshore waters of VIIj.

*Scyliorhinus canicula:* Survey catches are stable/increasing.

*Scyliorhinus stellaris:* Occurs in shallow, rocky waters and are only infrequently encountered in surveys.

*Mustelus* spp.: Uncertain. Survey catches in the PHHT (1988–2005) appeared to increase, although this survey no longer operates. IBTS Q4 surveys may be able to detect more recent changes in relative abundance.

## 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 localised, 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 18.14.

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.

There was no new information to alter our perception of the state of the stocks (summarised in Section 18.8.2).

### 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 countries. The French fisheries Ministry has asked for explanations regarding the implementation of this measure, particularly with regards *Raja undulata* (see Annex 5 for further discussion).

#### 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.

Localised 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 References


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**Table 18.1. Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1a | Total landings (t) of Rajidae in Area 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 | . | + | . | + |
| Faeroe 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 |

| Table 18.1a Cont. | Total landings (t) of Rajidae in Area VIa | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Belgium | . | 1 | 2 | 7 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 8 | 9 | 4 | 4 | 0 | . | |
| Denmark | + | + | + | + | + | . | + | + | . | . | . | . | . | 0 | | . | . | . |
| Faeroe Islands | . | . | . | . | . | . | . | . | . | . | . | . | . | na | . | . | 0 | . |
| France | 603 | 606 | 437 | 553 | 526 | 384 | 333 | 0 | 321 | 278 | 212 | 183 | 149 | 181 | 174 | 194 | 245 | |
| 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 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | |
| Norway | 82 | 56 | 9 | 74 | 29 | 20 | 50 | 29 | 49 | 20 | 25 | 2 | 2 | 10 | 4 | 5 | 11 | 4 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | |
| Spain | . | . | . | . | 47 | 58 | 69 | 34 | 2 | . | 9 | 27 | 14 | 14 | 0 | 0 | 4 | |
| Spain (Basque Country) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| UK - (E,W&N.I.) | 72 | 70 | 101 | 138 | 101 | 69 | 157 | 67 | 108 | 65 | 114 | 159 | 66 | 26 | 18 | 5 | 1 | 4 |
| UK – Scotland | 1605 | 1419 | 1429 | 1980 | 2606 | 1879 | 1460 | 1324 | 1316 | 1263 | 1136 | 1307 | 1012 | 623 | 369 | 426 | 297 | 240 |
| Total | 2712 | 2483 | 2245 | 3256 | 3992 | 3012 | 2575 | 1853 | 2073 | 1869 | 1809 | 2053 | 1488 | 1043 | 744 | 750 | 667 | 330 |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1b | Total Landings (t) of Rajidae in Area VIb | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| Estonia | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faeroe 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 Fed. | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 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 |

| Table 18.1b Cont. | Total Landings (t) of Rajidae in Area VIb | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Estonia | . | . | . | . | . | . | . | . | . | 56 | 1 | . | . | . | . | . | . | . |
| Faeroe Islands | . | . | . | . | . | . | . | . | . | . | . | . | na | na | . | . | 3 | |
| France | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 5 | 2 | 6 | 15 | 0 | 17 | 17 | |
| Germany | . | 6 | 25 | 17 | 49 | 26 | 36 | 67 | 76 | 8 | 1 | 6 | 22.3 | 22 | 6 | 0 | | |
| Ireland | . | 24 | 23 | 60 | 68 | 23 | 15 | 28 | 20 | 10 | 1 | 18 | 7.28 | 9 | 24 | 14 | 15 | 4 |
| Norway | 234 | 170 | 272 | 176 | 95 | 101 | 98 | 59 | 120 | 80 | 44 | 61 | 45.95 | 39 | 82 | 81 | 66 | 112 |
| Portugal | . | . | . | 56 | . | 25 | 26 | 24 | 29 | 17 | 31 | 18 | na | 0 | 0 | | | |
| Russian Fed. | . | . | . | . | . | . | . | . | 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 | 47.8 | 20 | 20 | 9 | 0 | 0 |
| UK – Scotland | 57 | 70 | 98 | 97 | 83 | 91 | 101 | 123 | 204 | 97 | 79 | 146 | 164 | 59 | 51 | 30 | 26 | 35 |
| Total | 303 | 295 | 446 | 479 | 798 | 781 | 893 | 770 | 964 | 559 | 290 | 344 | 294 | 164 | 183 | 151 | 127 | 152 |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1c | Total landings (t) of Rajidae in area 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 |
| **Table 18.1c Cont.** | **Total landings (t) of Rajidae in area VIIa** | | | | | | | | | | | | | | | | | | |
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | |
| Belgium | 230 | 107 | 224 | 218 | 265 | 298 | 398 | 542 | 504 | 724 | 997 | 830 | 860 | 860 | 593 | 680 | 295 | 250 | |
| France | 642 | 550 | 330 | 293 | 282 | 151 | 285 | n.s. | 163 | 343 | 349 | 322 | 183 | 192 | 114 | 51 | 14 | | |
| Ireland | 1301 | 679 | 514 | 438 | 438 | 593 | 692 | 827 | 759 | 807 | 1032 | 1086 | 825 | 786 | 645 | 721 | 515 | 370 | |
| 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 | |
| UK (Scotland) | 107 | 96 | 86 | 42 | 55 | 80 | 52 | 33 | 86 | 80 | 68 | 67 | 38 | 30 | 65 | 13 | 1 | 2 | |
| Total | 3430 | 2435 | 1902 | 1597 | 1829 | 1946 | 2440 | 2342 | 2189 | 2937 | 3309 | 3489 | 2256 | 3120 | 1689 | 1724 | 1071 | 837 | |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1d | Total landings (t) of Rajidae in area 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 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain (b) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - (E,W&N.I.) | 504 | 401 | 468 | 437 | 452 | 436 | 444 | 494 | 508 | 529 | 480 | 558 | 648 | 697 | 784 | 761 | 710 | 666 | 627 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Total | 686 | 916 | 1174 | 1190 | 1278 | 1191 | 1444 | 1579 | 1531 | 1496 | 1267 | 1033 | 1131 | 1236 | 1160 | 1397 | 1344 | 1127 | 1389 |

| Table 18.1d Cont. | Total landings (t) of Rajidae in area VIIf | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Belgium | 128 | 96 | 117 | 108 | 89 | 116 | 121 | 103 | 90 | 91 | 117 | 134 | 210 | 208 | 138 | 206 | 184 | 193 |
| Denmark | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | | | | |
| France | 663 | 565 | 468 | 394 | 432 | 485 | 464 | 453 | 538 | 642 | 526 | 536 | 478 | 429 | 305 | 424 | 399 | |
| Germany | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | |
| Ireland | . | . | . | . | . | . | 1 | . | . | . | 1 | 1 | 15 | 8 | 6 | 2 | 4 | 3 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | |
| Norway | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | 0 | 0 | |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | | | |
| 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 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | | 0 | |
| Total | 1497 | 1299 | 1215 | 1091 | 1205 | 1275 | 1222 | 1117 | 1241 | 1427 | 1564 | 1437 | 1312 | 1276 | 1101 | 1252 | 1226 | 741 |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1e | Total landings (t) of Rajidae in area 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 |

| Table 18.1e Cont. | Total landings (t) of Rajidae in area VIIegh | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Belgium | 183 | 209 | 172 | 203 | 177 | 293 | 260 | 240 | 223 | 248 | 347 | 576 | 407 | 432 | 582 | 569 | 636 | 506 |
| Denmark | 1 | + | 0 | + | . | . | . | . | . | . | . | . | . | . | | | | |
| France | 6477 | 5873 | 5836 | 6029 | 6425 | 7093 | 6114 | 6098 | 5710 | 5603 | 5273 | 5588 | 4261 | 4517 | 3740 | 3741 | 3302 | |
| Germany | . | . | . | . | . | . | . | . | . | . | + | . | 3 | . | | | | |
| Ireland | . | 120 | 106 | 162 | 349 | 479 | 446 | 408 | 203 | 481 | 729 | 838 | 844 | 334 | 315 | 285 | 214 | 198 |
| Netherlands | na | na | na | na | na | na | 9 | na | 7 | 7 | 11 | . | . | . | 1 | | | 0.561 |
| 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 |
| UK - (E,W&N.I.) | 751 | 735 | 869 | 997 | 953 | 1098 | 1167 | 796 | 932 | 880 | 775 | 804 | 811 | 1024 | 727 | 730 | 667 | 650 |
| UK (Scotland) | . | 1 | . | . | . | 2 | . | 2 | . | 2 | . | . | 149 | 3 | 1 | | 3 | 3 |
| Total | 7412 | 6938 | 6983 | 7391 | 8216 | 9897 | 9173 | 10191 | 8781 | 8374 | 7788 | 7837 | 6490 | 6318 | 5366 | 5326 | 4826 | 1364 |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1f | Total landings (t) of Rajidae in area 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 |
| 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 |

| Table 18.1f Cont | Total landings (t) of Rajidae in area VIIbcjk | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 5 | 0 | 5 | 1 | na | 0 | 0 | 0 | | |
| France | 546 | 298 | 224 | 297 | 375 | 599 | 500 | ns | 568 | 362 | 272 | 192 | 101 | 257 | 255 | 391 | 421 | |
| 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 |
| 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 | |
| UK - (E,W&N.I.) | 71 | 88 | 201 | 361 | 469 | 468 | 376 | 352 | 597 | 545 | 373 | 350 | 364 | 269 | 176 | 172 | 83 | 90 |
| UK (Scotland) | 10 | 34 | 43 | 73 | 58 | 36 | 67 | 121 | 189 | 162 | 124 | 226 | 70 | 58 | 77 | 0 | 66 | 39 |
| Total | 1246 | 1029 | 1111 | 1469 | 3004 | 3599 | 3679 | 3642 | 4601 | 2664 | 4062 | 2487 | 968 | 1081 | 1016 | 995 | 954 | 491 |

| Table 18.1g | Total landings (t) of Rajidae in area VII (unspecified) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Spain | | | | | | | | | | | | | | | | | | 643 | 693 |
| Spain (Basque Country) | | | | | | | | | | | | | | | | | | | 0.8 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 643 | 693 |

**Table 18.1. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion.**

| Table 18.1h | Total landings (t) of Rajidae the Celtic Seas | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faeroe Islands | 109 | 95 | 43 | 43 | 24 | 15 | 61 | 44 | . | 23 | 22 | 18 | 3 | 6 | . | . | . | . | . |
| France | 9013 | 6818 | 8772 | 9104 | 8638 | 8820 | 8871 | 9208 | 13930 | 9171 | 9475 | 8885 | 9736 | 10674 | 10442 | 10689 | 9724 | 10267 | 9749 |
| 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 |

| Table 18.1h Cont | Total landings (t) of Rajidae in the Celtic Seas | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Belgium | 541 | 413 | 515 | 536 | 532 | 709 | 781 | 913 | 824 | 1067 | 1467 | 1549 | 1485 | 1503 | 1316 | 1455 | 1115 | 949 |
| Denmark | 2 | + | . | + | . | . | . | . | . | . | . | . | . | 0 | . | . | . | . |
| Estonia | . | . | . | . | . | . | . | . | . | 56 | 1 | . | . | . | . | . | . | . |
| Faeroe Islands | . | . | . | . | . | . | . | . | . | . | . | . | . | na | . | . | 4 | . |
| France | 8931 | 7896 | 7295 | 7566 | 8040 | 8712 | 7696 | 6551 | 7307 | 7233 | 6637 | 6823 | 5178 | 5591 | 4587 | 4818 | 4398 | . |
| 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 | ##### | ##### | 1018 |
| Netherlands | na | na | na | na | na | na | 13 | 4 | 13 | 7 | 11 | na | na | 0 | 1 | . | . | 1 |
| Norway | 316 | 226 | 281 | 250 | 124 | 121 | 148 | 88 | 169 | 111 | 69 | 63 | 48 | 49 | 101 | 90 | 77 | 116 |
| 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 |
| UK - (E,W&N.I.) | 2761 | 2555 | 2577 | 2764 | 3163 | 3228 | 3467 | 2858 | 3077 | 3283 | 3137 | 3310 | 2431 | 3222 | 1865 | 1796 | 1633 | 1504 |
| UK – Scotland | 1779 | 1620 | 1656 | 2192 | 2802 | 2088 | 1680 | 1603 | 1795 | 1604 | 1407 | 1746 | 1433 | 773 | 562 | 469 | 393 | 319 |
| Total | 1 6600 | 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 | 4606 |

**Table 18.2. Demersal elasmobranchs in the Celtic Seas. Analyses of species species-specific landings data indicating the proportion of skate landings being reported to species level by nation and ICES division. Data for France were not available.**

| Nation | Division | Total reported skate landings (t) | Skates reported under generic landings (t) | Skates reported to species level (t) | Skates reported to species (%) |
|---|---|---|---|---|---|
| Belgium | VIIa | 250.1 | 67.8 | 182.3 | 72.9% |
| | VIIe | 15.1 | 4.3 | 10.9 | 71.7% |
| | VIIf | 190.7 | 106.6 | 84.1 | 44.1% |
| | VIIg | 487.3 | 229.6 | 257.7 | 52.9% |
| Ireland | VIa | 81.5 | 72.2 | 9.3 | 11.5% |
| | VIb | 4.2 | 4.2 | 0.0 | 0.0% |
| | VIIa | 370.1 | 366.8 | 3.4 | 0.9% |
| | VIIb | 211.4 | 192.3 | 19.1 | 9.0% |
| | VIIc | 9.3 | 8.2 | 1.0 | 11.0% |
| | VIIf | 2.7 | 2.7 | 0.0 | 0.0% |
| | VIIg | 197.2 | 189.3 | 7.9 | 4.0% |
| | VIIh | 0.3 | 0.3 | 0.1 | 16.0% |
| | VIIj | 140.6 | 130.8 | 9.8 | 7.0% |
| | VIIk | 0.4 | 0.1 | 0.2 | 63.9% |
| Netherlands | VIIe | 0.6 | 0.4 | 0.2 | 30.5% |
| UK (Scot.) | VIa | 235.5 | 145.7 | 89.8 | 38.1% |
| | VIb | 26.8 | 15.3 | 11.5 | 42.8% |
| | VIIa | 2.2 | 0.5 | 1.6 | 75.0% |
| | VIIc | 0.3 | | 0.3 | 100.0% |
| | VIIk | 0.1 | | 0.1 | 100.0% |
| UK(E,W,NI) | VIA | 3.5 | 1.4 | 2.1 | 60.9% |
| | VIIA | 214.0 | 59.8 | 154.2 | 72.1% |
| | VIIB | 14.2 | 0.0 | 14.2 | 99.7% |
| | VIIC | 0.7 | | 0.7 | 100.0% |
| | VIIE | 406.4 | 86.6 | 319.9 | 78.7% |
| | VIIF | 545.8 | 123.6 | 422.2 | 77.4% |
| | VIIG | 81.2 | 9.6 | 71.6 | 88.2% |
| | VIIH | 162.1 | 2.9 | 159.2 | 98.2% |
| | VIIJ | 75.4 | 0.4 | 75.1 | 99.5% |

**Table 18.3. Demersal elasmobranchs in the Celtic Seas. Analyses of species-specific landings data indicating the species composition of skates taken by ICES division for (a) Belgium; (b) UK (Scotland); and (c) UK (England, Wales and Northern Ireland).**

a ) Species composition in Belgian skate landings

| Division | *R. brachyura* | *R. clavata* | *R. montagui* | *L. naevus* |
|---|---|---|---|---|
| VIIA | 38.1% | 42.2% | 7.4% | 12.2% |
| VIIe | 58.3% | 15.4% | 17.5% | 8.8% |
| VIIf | 18.8% | 43.1% | 17.9% | 20.1% |
| VIIg | 33.7% | 42.7% | 13.1% | 10.5% |

b ) Species composition in UK (Scotland) skate landings

| Division | *R. brachyura* | *R. clavata* | *R. montagui* | *L. circularis* | *L. fullonica* | *L. naevus* | *D. batis* | *D. oxyrinchus* | *R. alba* |
|---|---|---|---|---|---|---|---|---|---|
| VIa | 0.9% | 44.1% | 15.7% | | | 29.9% | 4.0% | | 5.5% |
| VIb | 10.3% | 62.4% | 6.8% | 5.9% | 1.5% | 5.3% | | 0.5% | 7.3% |

c ) Species composition in UK (England, Wales and Northern Ireland) skate landings

| Division | *R. brachyura* | *R. clavata* | *R.microocellata* | *R. montagui* | *R.undulata* | *L. circularis* | *L. fullonica* | *L. naevus* | *D.batis* | *A.radiata* | *D.oxyrinchus* | *D.nidarosiensis* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI a | | 100.0% | | | | | | | | | | |
| VII a | 1.9% | 96.8% | | 0.7% | | | | 0.2% | 0.4% | | | |
| VII b | 3.1% | 31.7% | | | | | 2.0% | 61.3% | | | | 1.9% |
| VII c | 38.0% | 62.0% | | | | | | | | | | |
| VII e | 49.2% | 24.2% | 4.6% | 4.8% | 0.4% | 0.1% | 0.2% | 16.5% | 0.1% | | | |
| VII f | 28.4% | 28.8% | 30.8% | 4.7% | | 2.0% | 1.3% | 3.9% | | | | |
| VII g | 16.4% | 34.1% | 18.0% | 2.0% | | 6.0% | 4.6% | 17.1% | | | 0.4% | 1.2% |
| VII h | 3.1% | 1.2% | 3.6% | 0.3% | | | 9.9% | 78.0% | 0.4% | 0.5% | 3.1% | |
| VII j | 0.9% | 12.4% | 0.2% | 0.3% | | | 10.2% | 66.4% | | | 4.7% | 4.9% |

**Table 18.4a. Demersal elasmobranchs in the Celtic Seas. Species-Specific French batoid landings, all areas combined (1995–2001).**

| Species | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|
| *T. marmorata* | 15 | 16 | 27 | 33 | 24 | 7 | 1 |
| *D. batis* | 296 | 331 | 344 | 278 | 130 | 468 | 537 |
| *D. oxyrhinchus* | 366 | 330 | 315 | 356 | 20 | 96 | 47 |
| *L. circularis* | 529 | 519 | 537 | 454 | 82 | 327 | 275 |
| *L. fullonica* | 56 | 50 | 43 | 40 | 21 | 21 | 36 |
| *L. naevus* | 3741 | 4043 | 4722 | 3848 | 1021 | 2541 | 2236 |
| *R. clavata* | 1739 | 1652 | 1535 | 931 | 478 | 865 | 618 |
| * *R. montagui* | 882 | 973 | 1176 | 981 | 551 | 1062 | 1071 |
| *R. undulata* | 12 | 6 | 10 | 2 | 1 | 0 | 0 |
| *D. pastinaca* | 1 | 1 | 4 | | 2 | 10 | 3 |
| *M. aquila* | 3 | 2 | 2 | 1 | 2 | 1 | 0 |
| Various | 2066 | 2507 | 2830 | 1111 | 6657 | 3558 | 2680 |
| Total | 9706 | 10 430 | 11 544 | 8035 | 8989 | 8956 | 7504 |

*** WGEF consider that records *of R. montagui* also include landings of *R. brachyura*.**

**Table 18.4b. Demersal elasmobranchs in the Celtic Seas. Species-Specific French batoid landings for Subareas VI and VII (1999–2002).**

| Year | 1999 | 2000 | 2001 | 2002 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|
| Area | VI | VI | VI | VI | VII | VII | VII | VII |
| *T. marmorata* | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.2 |
| *D. batis* | 8.8 | 73.3 | 69.9 | 5.0 | 118.3 | 384.6 | 471.0 | 263.2 |
| *D. oxyrinchus* | 5.4 | 39.6 | 18.3 | 42.8 | 15.7 | 53.4 | 30.9 | 73.7 |
| *L. circularis* | 0.3 | 8.5 | 7.2 | 2.4 | 66.2 | 264.0 | 236.4 | 157.3 |
| *L. fullonica* | 0.0 | 0.4 | 0.1 | 0.3 | 22.5 | 45.0 | 47.3 | 65.1 |
| *L. naevus* | 5.6 | 57.0 | 61.1 | 43.3 | 706.8 | 1728.4 | 1660.2 | 1159.1 |
| *R. clavata* | 10.9 | 60.8 | 50.4 | 49.8 | 450.2 | 710.8 | 548.5 | 506.1 |
| *R. microocellata* | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | 0.5 | 0.9 | 0.0 |
| *R. montagui** | 0.1 | 0.5 | 0.7 | 0.8 | 533.9 | 1004.7 | 1065.8 | 886.2 |
| *R. undulata* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Large rays # | 0.0 | 3.5 | 0.0 | 0.0 | 12.0 | 29.9 | 12.1 | 1.5 |
| *D. pastinaca* | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 8.6 | 2.8 | 4.8 |
| *M. aquila* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Total | 31.1 | 243.6 | 207.6 | 144.5 | 1935.2 | 4229.9 | 4076.0 | 3117.3 |

*** WGEF consider that records of *R. montagui* also include landings of *R. brachyuran*.**

**# Including *D. batis, R. alba, D. oxyrinchus, D. nidarosiensis*.**

**Table 18.5. Demersal elasmobranchs in the Celtic Seas. Species-specific landings from Spain (Basque Country), in Subareas VI, VII and VIII (2000–2003).**

| Year | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| D. batis | 8.3 | 9.6 | 0.0 | 0.0 |
| D. oxyrhinchus | 0.0 | 0.2 | 0.0 | 0.0 |
| L. fullonica | 5.3 | 33.5 | 0.0 | 1.5 |
| L. naevus | 330.3 | 290.9 | 290.0 | 287.0 |
| * R. asterias | 0.0 | 0.1 | 0.0 | 0.0 |
| R. clavata | 51.7 | 107.9 | 65.1 | 47.1 |
| R. montagui | 2.7 | 6.2 | 20.9 | 5.1 |
| R. undulata | 0.5 | 0.0 | 0.0 | 0.1 |
| Total | 398.8 | 448.4 | 376.0 | 340.9 |

**No data available for 2004.**

*** This species does not occur in the Celtic Seas ecoregion.**

**Table 18.6. Demersal elasmobranchs in the Celtic Seas. Belgian Species-Specific Landings by division for the years 2001 and 2002.**

| | 2001 | 2002 | 2001 | 2002 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Area | VIIa | VIIa | VIId | VIId | VIIf,g | VIIf,g |
| *L. circularis** | 9.3 | 22.7 | 6.0 | 3.2 | 104.7 | 86.5 |
| *L. naevus* | 77.6 | 137.3 | 0.0 | 0.2 | 27.9 | 44.3 |
| *R. brachyura* | 137.8 | 228.0 | 9.8 | 11.3 | 27.4 | 80.0 |
| *R.clavata* | 382.8 | 449.7 | 58.5 | 68.9 | 116.1 | 108.2 |
| *R. montagui* | 99.6 | 158.9 | 15.8 | 31.5 | 65.1 | 133.7 |
| Total | 707.0 | 996.6 | 90.1 | 115.2 | 341.2 | 452.8 |

*** These records are considered by WGEF to be misidentified *R. microocellata*.**

**Table 18.7. 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).**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 8 | 8.4 | 3 |
| France | 824 | 513 | 623 | 654 | 827 | 1401 | 1635 | 1538 |
| Ireland | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 2 | 35 | na. |
| Spain (Basque country) | 4 | 6 | 20 | 24 | 36 | 17 | 9 | . |
| UK ( Eng+Wales+N.Irl). | 0 | 12 | 74 | 54 | 67 | 56 | 171 | 103 |
| Total | 828 | 531 | 717 | 732 | 930 | 977 | 1858 | 1644 |

**Table 18.8. 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.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France (Bulletin) | 8 | 3 | 32 | 26 | 29 | 0 | 0 | 18.7 | 19.5 | 0 | 0 | 9 |
| France (ICES) | 0 | 0 | 0 | 0 | 0 | 24 | 19 | 0 | 0 | 18 | 13 | 9 |
| UK(E,W &N.I.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 8 | 3 | 32 | 26 | 29 | 24 | 19 | 18.7 | 19.5 | 18 | 13 | 18 |
| | | | | | | | | | | | | |
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France (Bulletin) | 11.5 | 0 | 8 | 13 | 9 | 5 | 4 | 2 | 2 | 2 | 2 | 2 |
| France (ICES) | 13 | 14 | 12 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| UK(E,W &N.I.) | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 24.5 | 14 | 20 | 15 | 13 | 8 | 6 | 3 | 3 | 3 | 4 | 3 |
| | | | | | | | | | | | | |
| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | . | na | |
| France (Bulletin) | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.125 | na | |
| France (ICES) | 0 | 0 | 1 | + | + | + | 0 | + | + | . | 0.501 | 0.227 |
| UK(E,W &N.I.) | (47) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.042 | 0.0009 | 0 |
| Total | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.167 | 0.5019 | 0.227 |

**Table 18.9. Demersal elasmobranchs in the Celtic Seas. Summary details of SWIBTS and beam trawl surveys in the Celtic Seas ecoregion. Adapted from ICES (2009, 2010b).**

| COUNTRY | IRELAND | UK (SCOT) | UK (ni) | uk (END/WAL) | FRANCE | spain | UK (ENG/WAL) | UK (ENG/WAL) |
|---|---|---|---|---|---|---|---|---|
| LABORATORY | MI | MLA | AFBI | CEFAS | IFREMER | IEO | CEFAS | CEFAS |
| RESEARCH VESSEL | Celtic Explorer | Scotia | Corystes | Endeavour | Thalassa | Vizconde de Eza | Endeavour [1] | Endeavour [1] |
| GEAR TYPE | 36/47 GOV | 36/47 GOV | ROCKHOPPER OTTER TRAWL | 36/47 GOV [34/45 GOV] | 36/47 GOV | BACA 40/52 | 4 m BT | 4 m BT |
| DEPTH RANGE | 20–600 | 20–400 | 20–120 | 20–150 | 30–400 | 150–800 | 10-135 | |
| TRAWL SPEED (KNOTS) | 4 | 4 | 3 | 4 | 4 | 3.5 | 4 | 4 |
| GROUNDROPE | Rubber discs | Bobbins | Rubber discs | Groundgear A [Groundgear D] | Groundgear A | Synthetic wrapped wire core (double coat) | - | - |
| SURVEY AREA | VIA, VII | VI | VIIA | VIIA,E-H | VIIF-J, VIII | VIIC | VIIAF | VIIE |
| STATION GRID | Semi-random depth stratified | Semi-random, 1-2 tows per rectangle | Fixed stations in strata | Fixed stations in strata | Stratified random | Random stratified across 5 strata | Fixed | Fixed |
| QUARTER | 4 | 4 | 1,4 | 4 | 4 | 3-4 | 3 | 3 |
| INITIATED (FOR QUARTER) | 2003 | 1992 | 1992 | 2003 | 1997 | 2001 | 1988 [2] | 1988 |
| COORDINATION | IBTSWG | IBTSWG | IBTSWG | IBTSWG | IBTSWG | IBTSWG | WGBEAM | WGBEAM |

**Notes**

**[1] Endeavour used in recent years only. RV Corystes used previously.**

**[2] Grid standardised since 1993**

**Table 18.10. Demersal elasmobranchs in the Celtic Seas. Taxonomic list of elasmobranchs taken in the Irish IBTS in VIa, VIIa–c,g,j,k, giving the numbers of each species caught by year, the total number of males and females, the overall sex ratio and length range. *Identification of *R. alba* is considered to be potentially misidentified.**

| Species | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Males | Females | Unsexed | Sex ratio (M:F) | L min (cm) | L max (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Squalus acanthias* | 268 | 134 | 724.2 | 183 | 142 | 117 | 92 | 649.6 | 1010.6 | | 1:1.6 | 22 | 114 |
| *Galeus melastomus* | 26 | 15 | 65 | 80 | 116 | 37 | 68 | 189 | 215 | 3 | 1:1.1 | 13 | 72 |
| *Scyliorhinus canicula* | 3732.7 | 7465.1 | 3145 | 4456.9 | 5851.9 | 6039.5 | 7533.1 | 21291 | 16601 | 332.3 | 1:0.8 | 9 | 77 |
| *Scyliorhinus stellaris* | 23 | 40 | | 1 | | 3 | 3 | 33 | 37 | | 1:1.1 | 23 | 113 |
| *Galeorhinus galeus* | 19 | 14 | 2 | 69.004 | 9 | 19 | 13 | 110.004 | 35 | | 1:0.3 | 50 | 163 |
| *Mustelus* spp. | 81 | 116 | 2 | 13 | 25 | 26 | 22 | 175 | 109 | 1 | 1:0.6 | 32 | 120 |
| *Amblyraja radiata* | | 2 | | | | | | 1 | 1 | | 1:1 | 65 | 74 |
| *'Dipturus batis'* | 20 | 42 | 30 | 16 | 42 | 52 | 110 | 148 | 158 | 6 | 1:1.1 | 26 | 210 |
| *Dipturus oxyrinchus* | 2 | 8 | | | | 2 | | 6 | 6 | | 1:1 | 33 | 73 |
| *Leucoraja fullonica* | 1 | | 1 | 1 | 1 | 1 | 6 | 3 | 7 | 1 | 1:2.3 | 50 | 74 |
| *Leucoraja naevus* | 67 | 212.5 | 148.8 | 117 | 197 | 121 | 213 | 639.7 | 552.6 | | 1:0.9 | 12 | 73 |
| *Raja brachyura* | 34 | 46 | 13 | 12 | 29 | 32 | 11 | 109 | 118 | | 1:1.1 | 32 | 99 |
| *Raja clavata* | 173 | 291 | 81 | 215 | 207 | 220 | 273 | 714 | 904 | | 1:1.3 | 12 | 95 |
| *Raja microocellata* | 1 | 6 | | 10 | 44 | 23 | 1 | 45 | 40 | | 1:0.9 | 35 | 86 |
| *Raja montagui* | 188 | 415 | 276.4 | 304 | 376 | 248 | 480 | 1231.4 | 1418 | | 1:1.2 | 10 | 73 |
| *Raja undulata* | 3 | 2 | | | | | | 4 | 1 | | 1:0.3 | 17 | 71 |
| ** Rostroraja alba* | | | 6 | 2 | | | | 4 | 4 | | 1:1 | 49 | 54 |
| *Torpedo nobiliana* | 1 | 2 | | | 3 | | | 3 | 2 | 1 | 1:0.6 | 75 | 125 |
| *Dasyatis pastinaca* | | | 2 | 5 | 1 | | | 1 | 7 | | 1:7 | 49 | 116 |

**Table 18.11. Demersal elasmobranchs in the Celtic Seas. Taxonomic list of elasmobranchs taken in the UK (English and Welsh) IBTS in the Irish Sea and Celtic Sea, giving the numbers of each species caught by year, the total number of males and females, the overall sex ratio and length range.**

| Species | Species | Raised no. caught | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Males | Females | Sex ratio | L min (cm) | L max (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Squalus acanthias* | DGS | 1834.7 | 89 | 1136.7 | 65 | 116 | 324 | 104 | 452 | 1382.7 | 1:3.06 | 20 | 117 |
| *Galeus melastomus* | DBM | 2 | - | - | - | 1 | - | 1 | 1 | 1 | - | 22 | 62 |
| *Scyliorhinus canicula* | LSD | 20786.9 | 3745 | 2653 | 3672.3 | 4008.5 | 3325 | 3383.1 | 11915.2 | 8871.7 | 1:0.74 | 9 | 75 |
| *Scyliorhinus stellaris* | DGN | 164 | 30 | 22 | 43 | 29 | 16 | 24 | 82 | 82 | 1:1 | 28 | 117 |
| *Galeorhinus galeus* | GAG | 90 | 9 | 20 | 9 | 20 | 16 | 16 | 56 | 34 | 1:0.61 | 43 | 155 |
| *Mustelus* spp. | SDS | 682 | 101 | 69 | 137 | 216 | 54 | 105 | 406 | 276 | 1:0.68 | 27 | 107 |
| *'Dipturus batis'* | SKT | 10 | 2 | - | - | 4 | 3 | 1 | 4 | 6 | - | 27 | 135 |
| *Leucoraja fullonica* | SHR | 3 | - | - | - | 2 | 1 | - | 1 | 2 | - | 44 | 58 |
| *Leucoraja naevus* | CUR | 233 | 24 | 10 | 46 | 77 | 42 | 34 | 117 | 116 | 1:0.99 | 14 | 69 |
| *Raja brachyura* | BLR | 118 | 31 | 8 | 27 | 8 | 15 | 29 | 63 | 55 | 1:0.87 | 18 | 90 |
| *Raja clavata* | THR | 1055 | 109 | 250 | 163 | 91 | 226 | 216 | 484 | 571 | 1:1.18 | 10 | 98 |
| *Raja microocellata* | PTR | 513 | 55 | 120 | 93 | 36 | 105 | 104 | 250 | 263 | 1:1.05 | 13 | 85 |
| *Raja montagui* | SDR | 548 | 87 | 71 | 69 | 74 | 101 | 146 | 267 | 281 | 1:1.05 | 12 | 74 |
| *Torpedo nobiliana* | ECR | 2 | - | - | 1 | 1 | - | - | - | 2 | - | 99 | 105 |
| *Dasyatis pastinaca* | SGR | 1 | 1 | - | - | - | - | - | - | 1 | - | 88 | |

**Table 18.12. Demersal elasmobranchs in the Celtic Seas. Summary of maturity information collected from UK (England & Wales) surveys (including both coordinated surveys, and dedicated surveys of various skates) around the British Isles. Data provided include the sample size (N), length range of fish observed, length at first maturity, length of largest immature fish and 50% maturity.**

| | | Females | | | | | Males | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Region | N | Length range | First maturity | Largest immature | 50% | N | Length range | First maturity | Largest immature | 50% |
| *Amblyraja radiata* | North Sea | 448 | 8–49 | 32 | 46 | 38.2 | 428 | 8–49 | 30 | 44 | 36.2 |
| *Leucoraja naevus* | Combined | 986 | 10–69 | 50 | 65 | 59.4 | 988 | 11–72 | 48 | 64 | 56.3 |
| | Celtic Seas | 827 | 10–69 | 51 | 65 | - | 841 | 11–72 | 49 | 64 | - |
| | North Sea | 129 | 15–62 | 50 | 58 | - | 109 | 17–63 | 48 | 57 | - |
| *Raja brachyura* | Combined | 395 | 11–108 | 60 | 93 | 85.6 | 360 | 13–100 | 55 | 91 | 78.2 |
| *Raja clavata* | Combined | 3330 | 10–98 | 47 | 90 | 75.1 | 6002 | 10–94 | 47 | 88 | 66.5 |
| | Celtic Seas | 2394 | 10–98 | 47 | 90 | - | 2448 | 10–89 | 56 | 76 | - |
| | North Sea | 885 | 12–94 | 67 | 82 | - | 3503 | 11–94 | 47 | 88 | - |
| *Raja microcellata* | Combined | 739 | 12–85 | 73 | 83 | 77.1 | 709 | 13–80 | 66 | 74 | 69 |
| *Raja undulata* | Combined | 45 | 17–95 | 79 | 83 | - | 85 | 22–97 | 80 | 88 | 83 |
| *Raja montagui* | Combined | 1811 | 10–76 | 49 | 70 | 64 | 1947 | 10–67 | 40 | 66 | 50.3 |
| | Celtic Seas | 1677 | 10–74 | 49 | 69 | - | 1761 | 10–67 | 40 | 66 | - |
| | North Sea | 121 | 17–76 | 53 | 70 | - | 178 | 14–67 | 47 | 60 | - |

**Table 18.13. Demersal elasmobranchs in the Celtic Seas. Summary of length-weight relationships for skates, as recorded from UK (England & Wales) surveys around the British Isles.**

| | | Females | | | Males | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Ecoregion** | n | Relationship | r2 | n | Relationship | r2 |
| *Amblyraja radiata* | North Sea | 448 | y = 0.0114x2.9142 | 0.95 | 428 | y = 0.0083x3.0051 | 0.96 |
| *Raja brachyura* | Combined | 395 | y = 0.0026x3.2742 | 0.99 | 360 | y = 0.0027x3.2563 | 0.99 |
| *Leucoraja naevus* | Combined | 986 | y = 0.0037x3.1309 | 0.98 | 988 | y = 0.0043x3.0866 | 0.96 |
| | Celtic Seas | 827 | y = 0.0036x3.1450 | 0.99 | 841 | y = 0.0041x3.1052 | 0.99 |
| | North Sea | 129 | y = 0.003x3.1833 | 0.98 | 109 | y = 0.0032x3.1610 | 0.99 |
| *Raja microcellata* | Combined | 739 | y = 0.0028x3.2472 | 0.99 | 709 | y = 0.0032x3.1949 | 0.99 |
| *Raja montagui* | Combined | 1811 | y = 0.0032x3.1928 | 0.99 | 1947 | y = 0.0042x3.1055 | 0.99 |
| | Celtic Seas | 1677 | y = 0.0032x3.1859 | 0.99 | 1761 | y = 0.0043x3.0942 | 0.99 |
| | North Sea | 121 | y = 0.0028x3.2299 | 0.99 | 178 | y = 0.0034x3.1645 | 0.99 |
| *Raja undulate* | Combined | 45 | y = 0.0034x3.1784 | 0.99 | 85 | y = 0.0035x3.1615 | 0.99 |
| *Raja clavata* | Combined | 3330 | y = 0.0038x3.1459 | 0.99 | 6002 | y = 0.0046x3.0821 | 0.99 |
| | Celtic Seas | 2394 | y = 0.0036x3.1607 | 0.99 | 2448 | y = 0.0042x3.1059 | 0.99 |
| | North Sea | 885 | y = 0.0046x3.0896 | 0.99 | 3503 | y = 0.0061x3.0017 | 0.99 |

**Table 18.14. 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 1903–2009 (Source: ICES).**

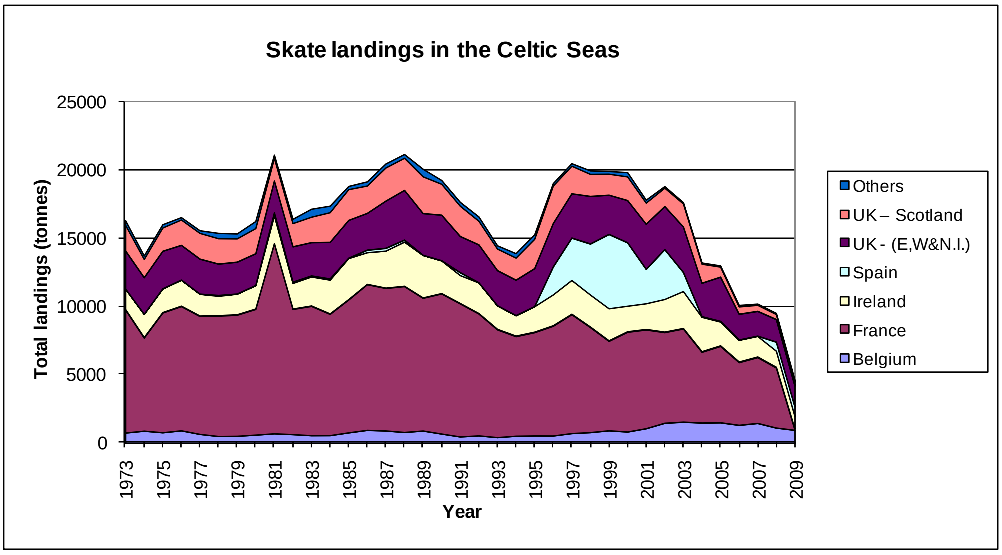



**Figure 18.1b. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2009 (Source: ICES).**

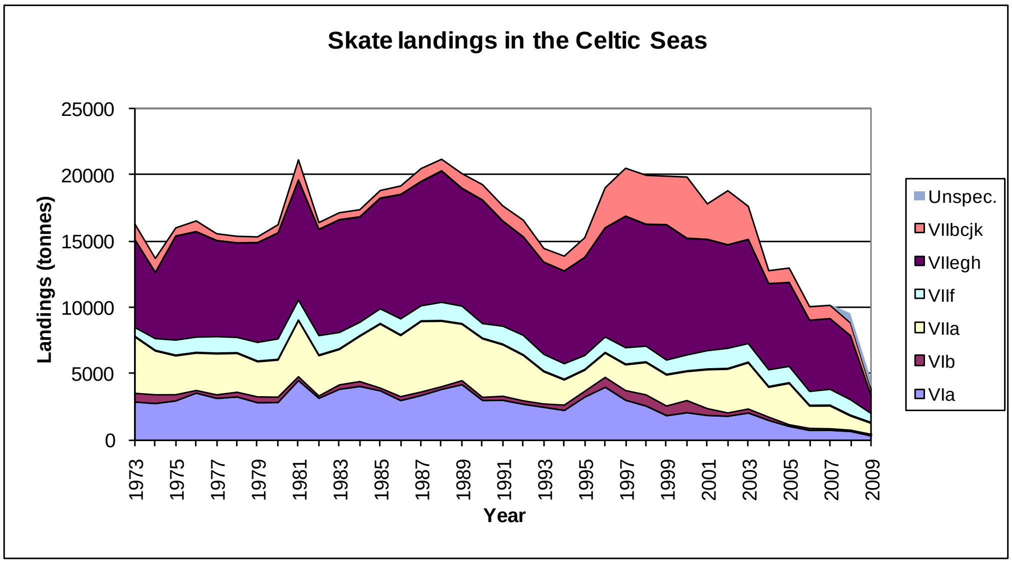



**Figure 18.1c. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by ICES Division in the Celtic Seas from 1973–2009 (Source: ICES).**

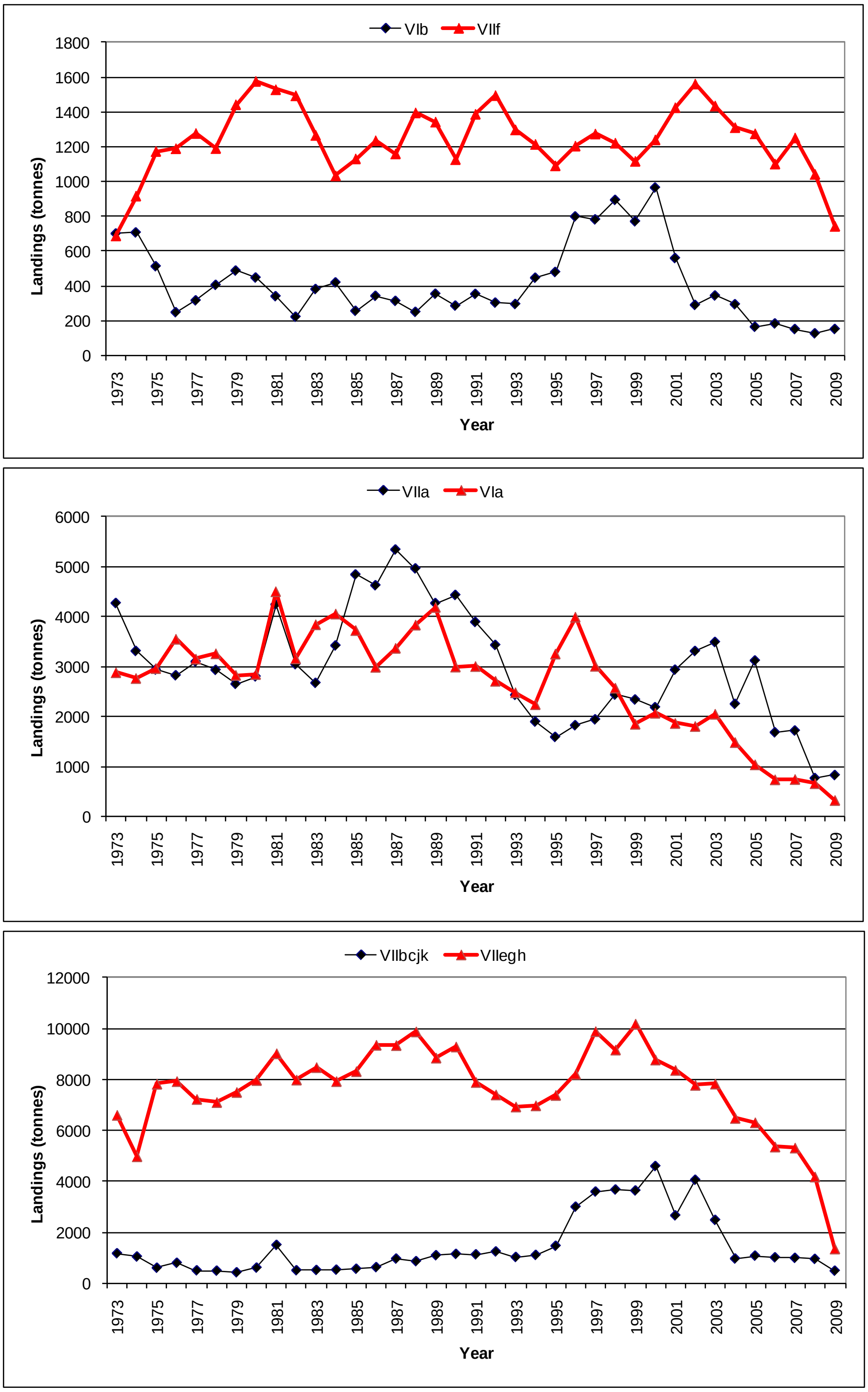
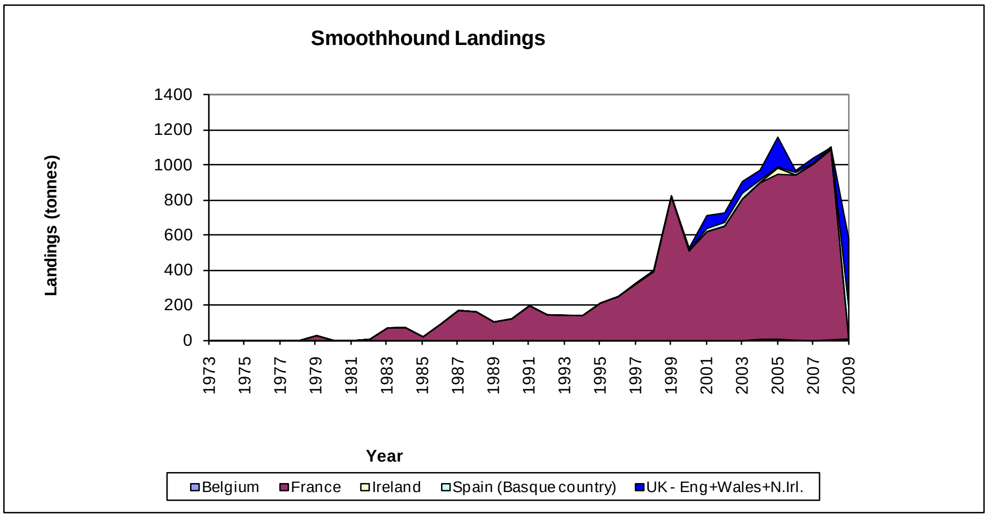



**Figure 18.2. Demersal elasmobranchs in the Celtic Seas. Landings (tonnes) of skates (Rajidae) by ICES Division in the Celtic Seas from 1973–2009 (Source: ICES).**



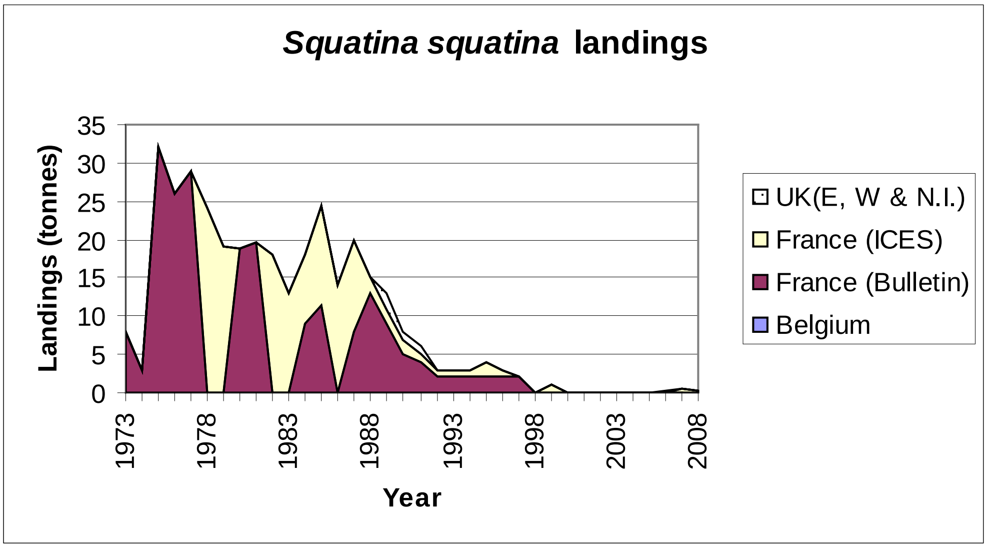




**Figure 18.3. Demersal elasmobranchs in the Celtic Seas. Total landings of *Mustelus* spp. (1973–2009, top) and *Squatina squatina* (1973–2008, bottom). It should be noted that landings of smooth-hounds at the start of the time-series may under represent true catches, as an unknown quantity may have been landed under generic dogfish landing categories. French data are lacking for 2009. Angel shark is now on a prohibited species list and no data were available for 2009. (Source: ICES and Bulletin de Statistiques des Peches Maritimes).**

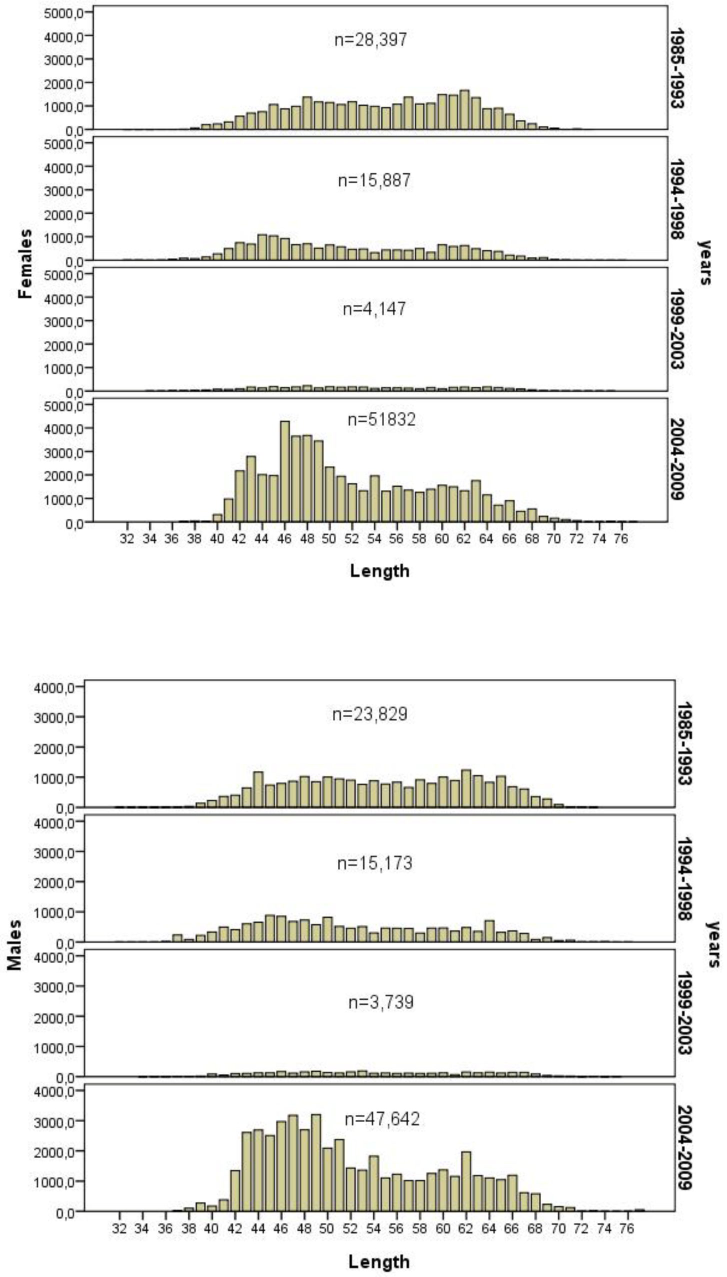



**Figure 18.4a. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of cuckoo ray *Leucoraja naevus* caught in Divisions VIIh and VIIIa by the French demersal trawl fisheries between 1985 and 2009 (two first quarters of the year).**

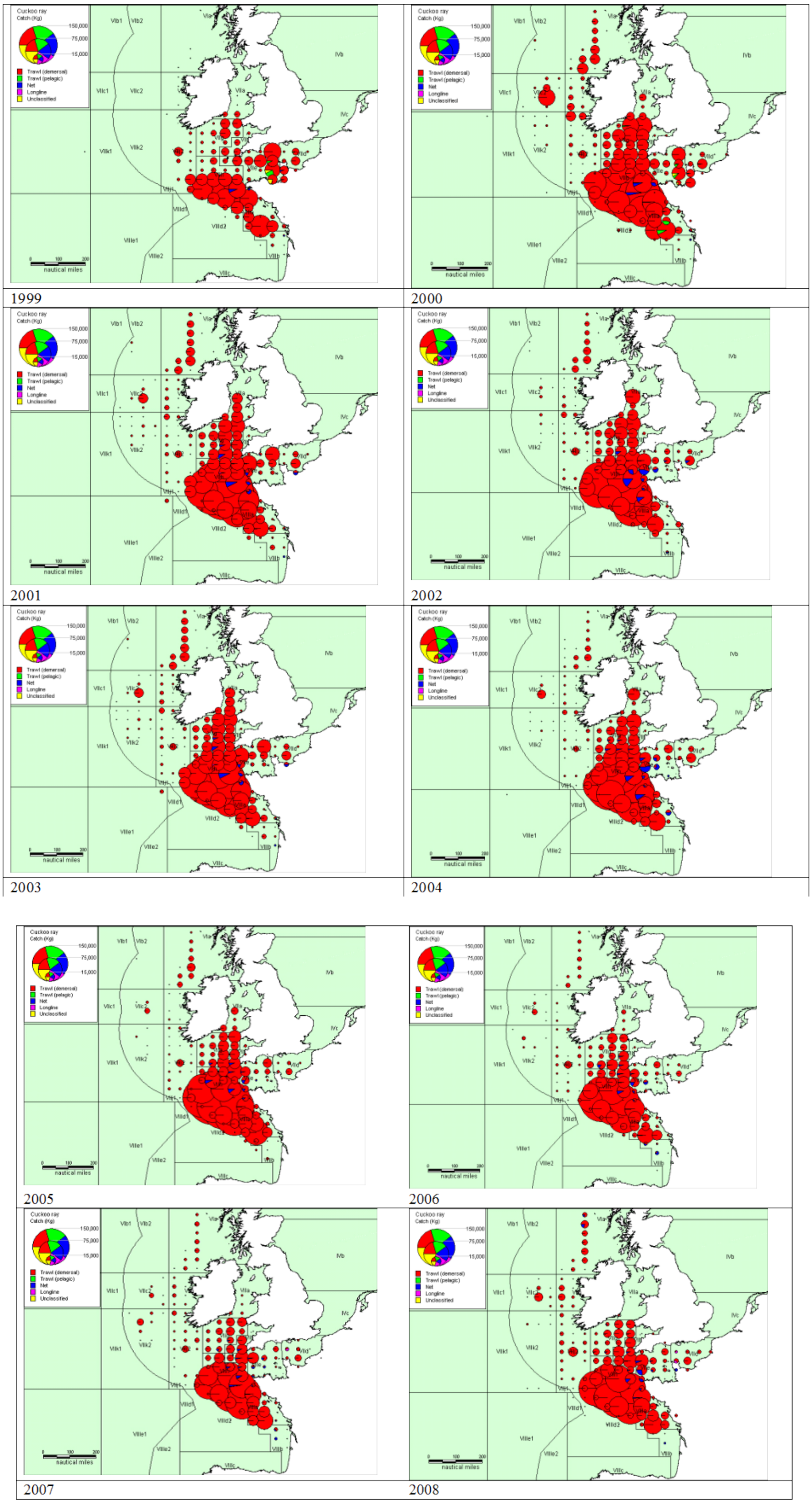
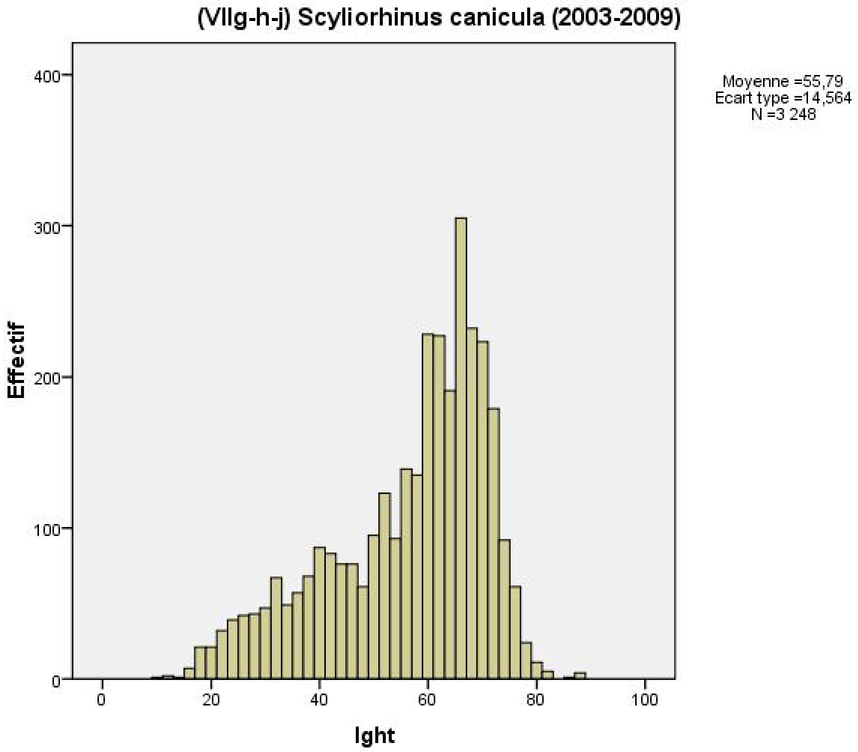



**Figure18.4b. Demersal Elasmobranchs in the Celtic Seas. *Leucoraja naevus* catches per year and per gear for the French fisheries from 1999 to 2008. Source: IFREMER.**



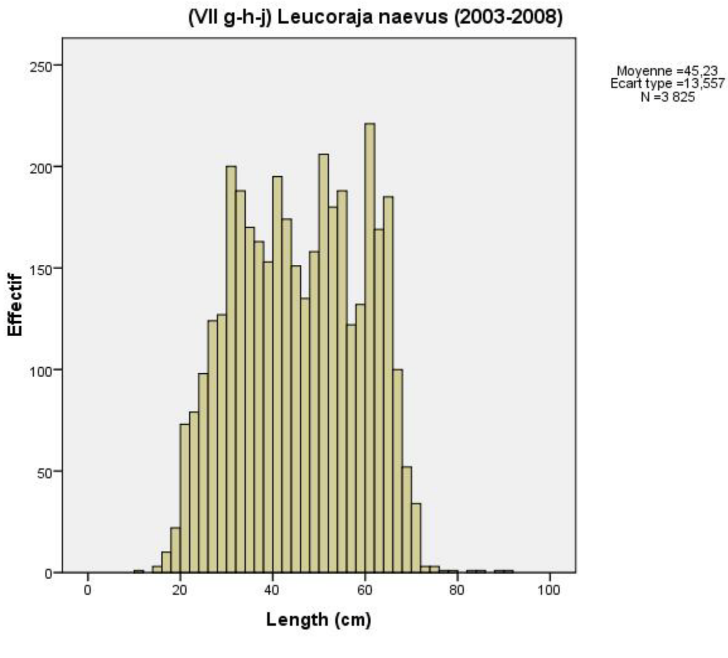




**Figure 18.5. Demersal elasmobranchs in the Celtic Seas. Length frequency of *Scyliorhinus canicula* (above) and *Leucoraja naevus* (below) sampled by the French observer at sea programme, demersal trawl fishery, 2003–2009, in Area VIIg,h,j. (Source: IFREMER).**

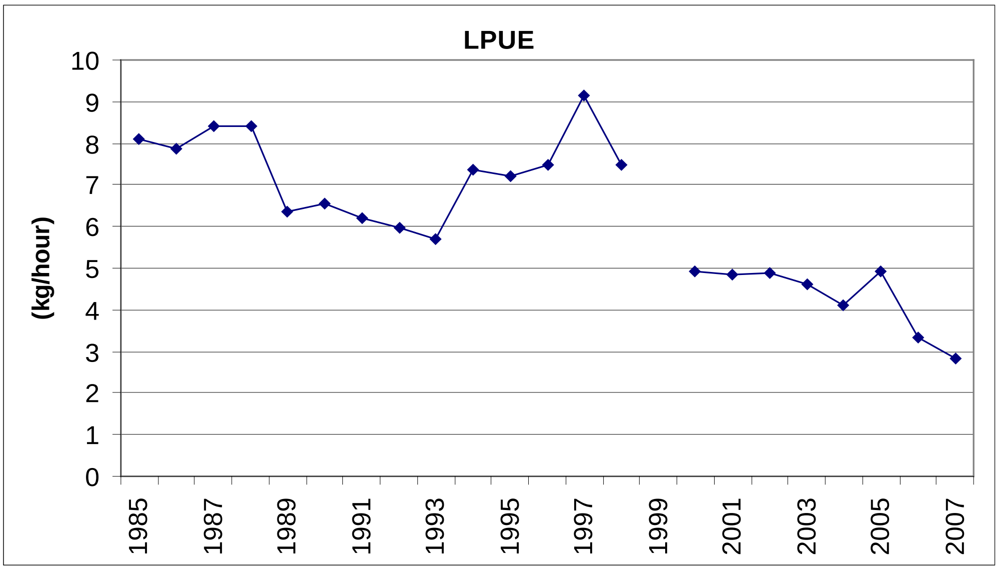



**Figure 18.6. Demersal elasmobranchs in the Celtic Seas. Lpue of *Leucoraja naevus* in the Celtic Sea, from French trawlers targeting benthic species (anglerfish, megrim and rays). Data from 2000 onwards are from logbooks only.**

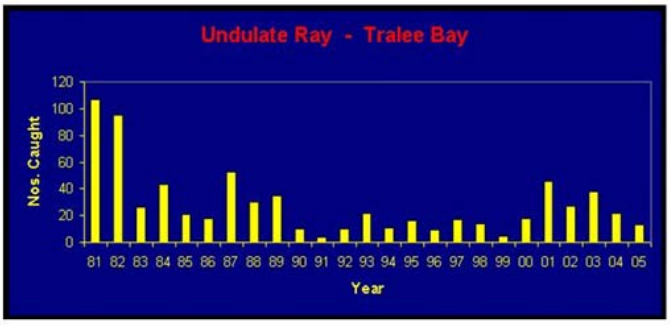




**Figure 18.7. Demersal Elasmobranchs in the Celtic Seas. Angling effort of two charter boats in Tralee Bay 1981–2005 of monkfish (angel shark *Squatina squatina)* and undulate ray *R. undulata*. Source: Irish Central Fisheries Board.**

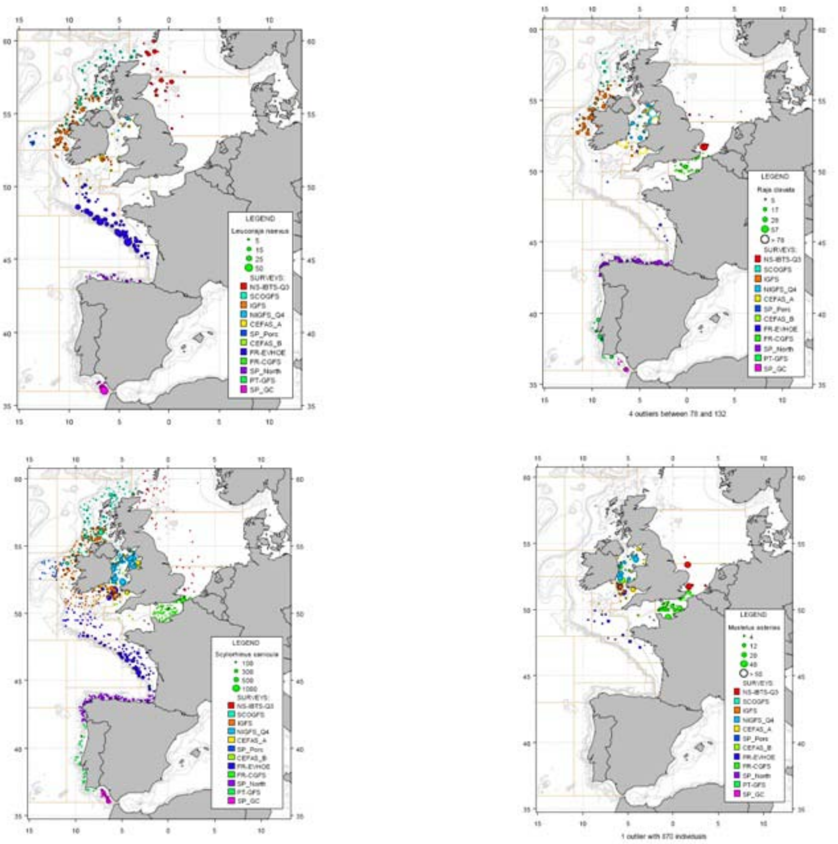


**Figure 18.8. Demersal elasmobranchs in the Celtic Seas. Catches, in numbers per hour, of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, lesser-spotted dogfish *Scyliorhinus canicula* and starry smooth hound *Mustelus asterias* in Q4 IBTS surveys in the Southern and Western Areas in 2009. 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, 2010a).**

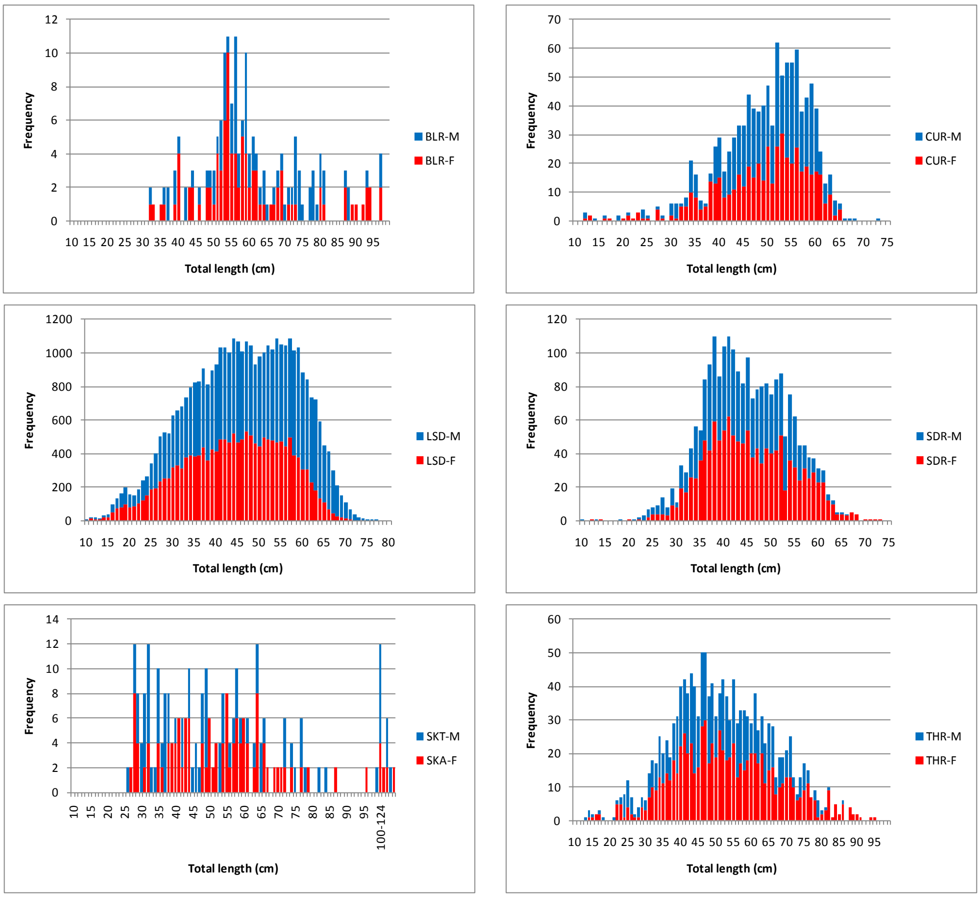



**Figure 18.9. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *R. brachyura* (BLR), *L. naevus* (CUR), lesser-spotted dogfish (LSD), *R.montagui* (SDR), '*D. batis*' (SKT) and *R. clavata* (THR) in the Irish Groundfish Survey (2003–2009).**

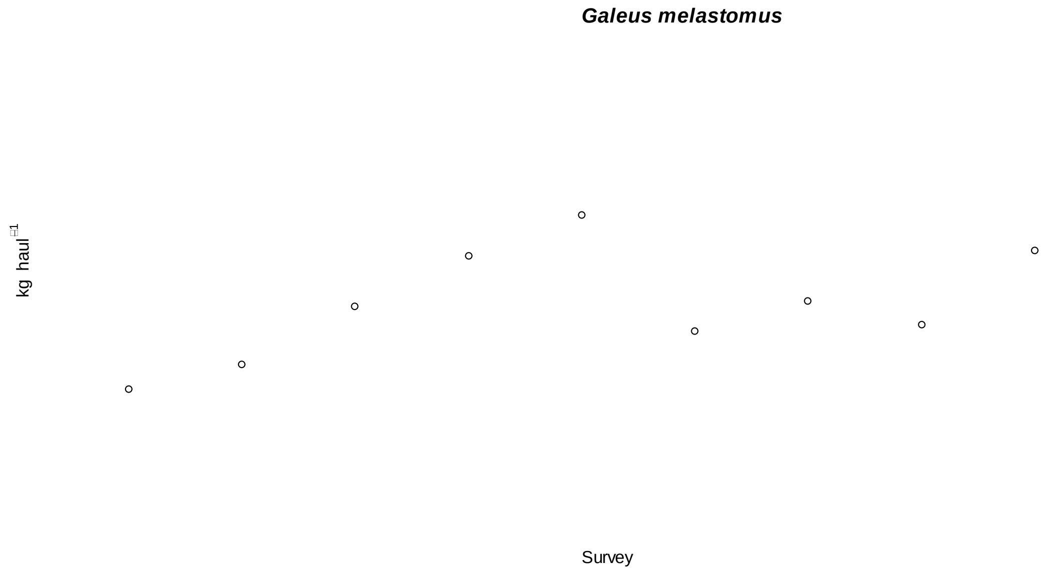



**Figure 18.10a. Demersal elasmobranchs in the Celtic Seas. Changes in black-mouth dogfish (*Galeus melastomus*) biomass index during Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)**

**Figure 18.10b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of black-mouth dogfish (*G. melastomus*) in 2009 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2009).**

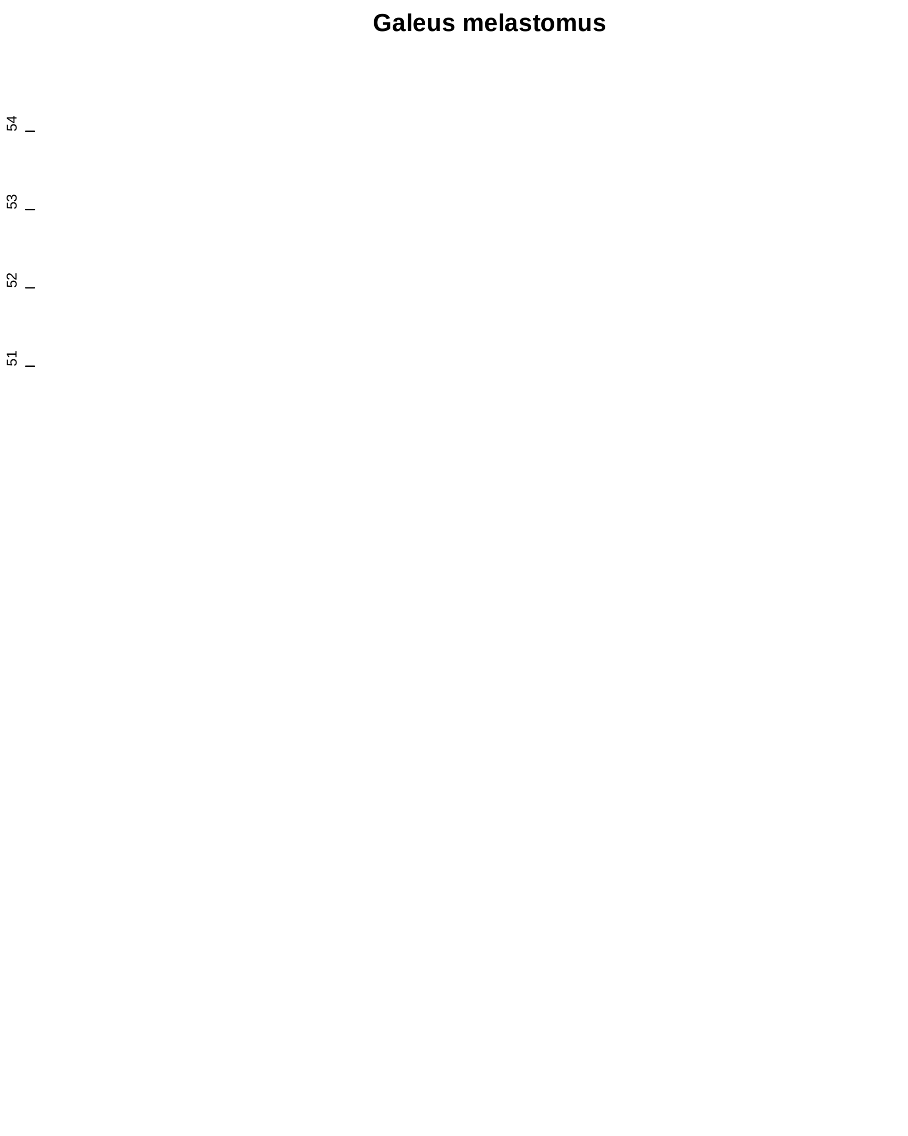



**Figure 18.10c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of black-mouth dogfish (*G. melastomus*) catches (kg·haul$^{-1}$) during Porcupine surveys time-series (2001–2009).**

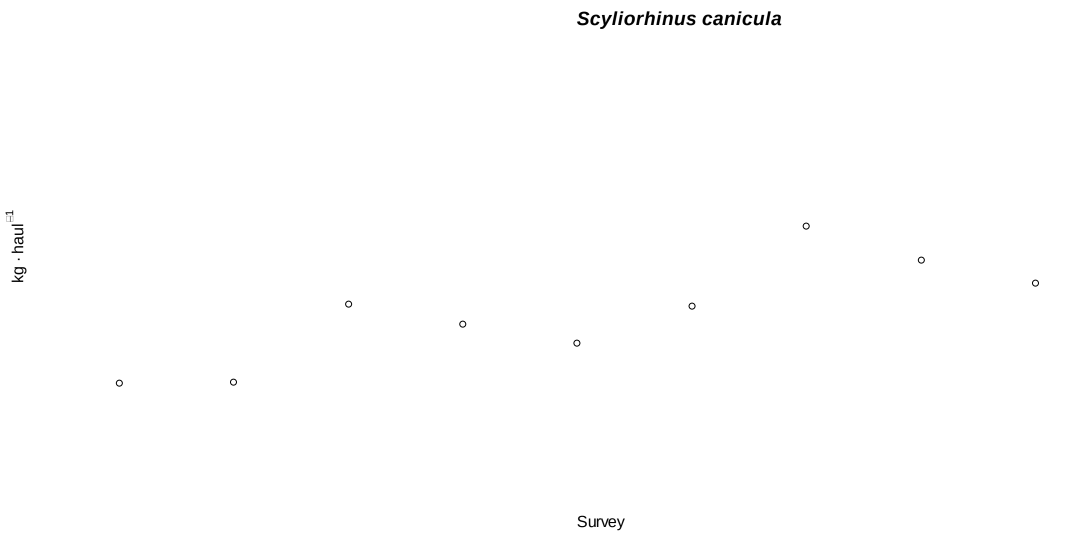



**Figure 18.11a. Demersal elasmobranchs in the Celtic Seas. Changes in lesser-spotted dogfish (*Scyliorhinus canicula*) biomass index (kg·haul$^{-1}$) during Porcupine Survey time-series (2001–2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).**

**Figure 18.11b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of lesser spotted dogfish (*S. canicula*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2009).**

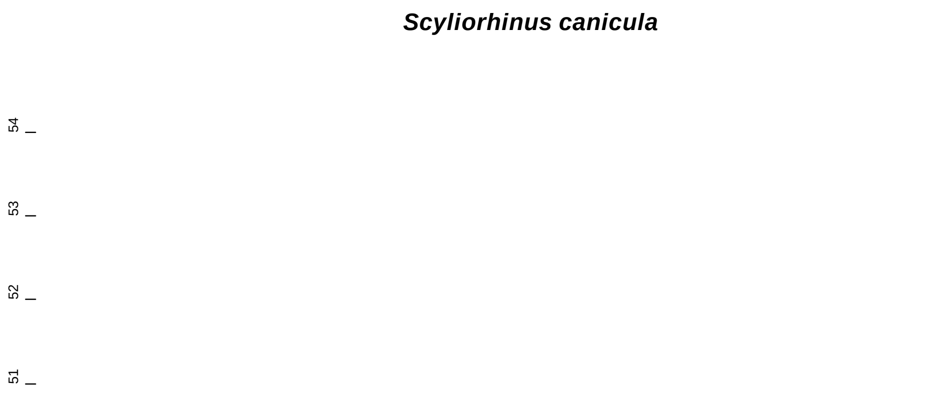



**Figure 18.11c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of lesser spotted dogfish (*S. canicula*) catches (kg·haul$^{-1}$) in Porcupine surveys (2001–2009).**

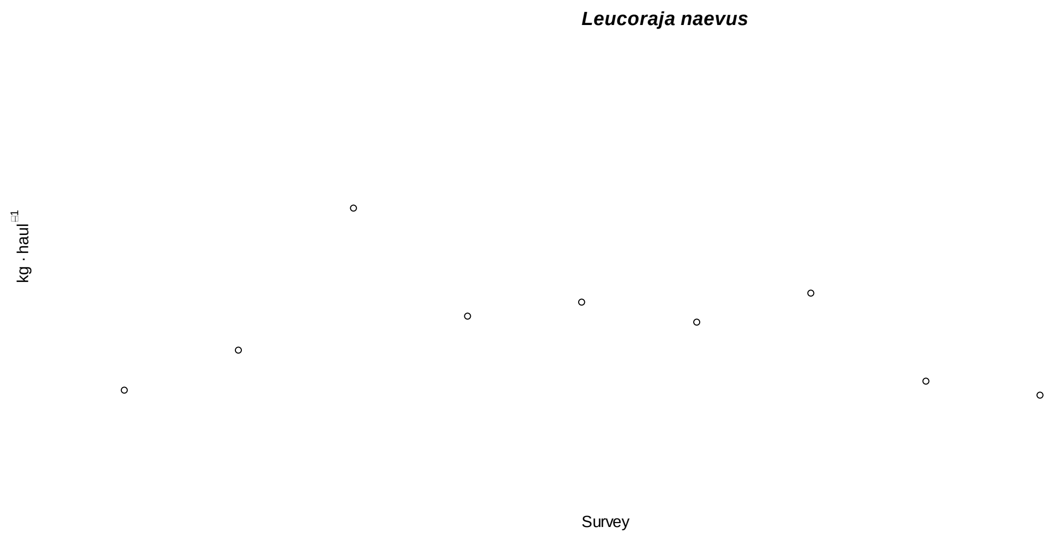



**Figure 18.12a. Demersal elasmobranchs in the Celtic Seas. Changes in *Leucoraja naevus* biomass index (kg·haul$^{-1}$) during Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).**

**Figure 18.12b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of cuckoo ray (*L. naevus*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2009).**

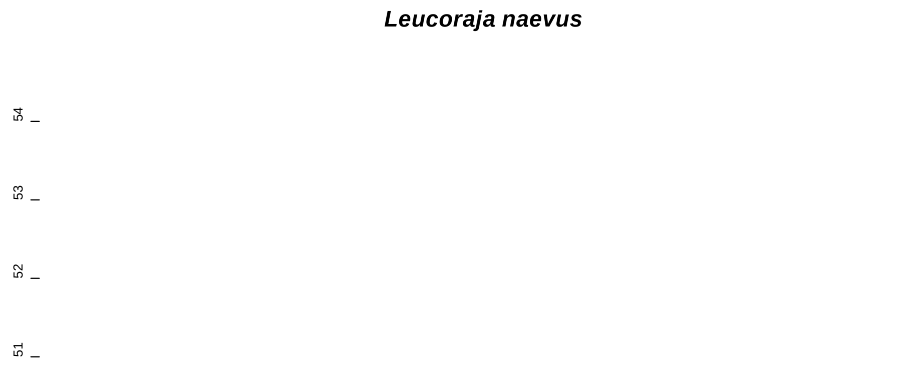



**Figure 18.12c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of *Leucoraja naevus* catches (ind haul$^{-1}$) during Porcupine surveys time-series (2001–2009).**

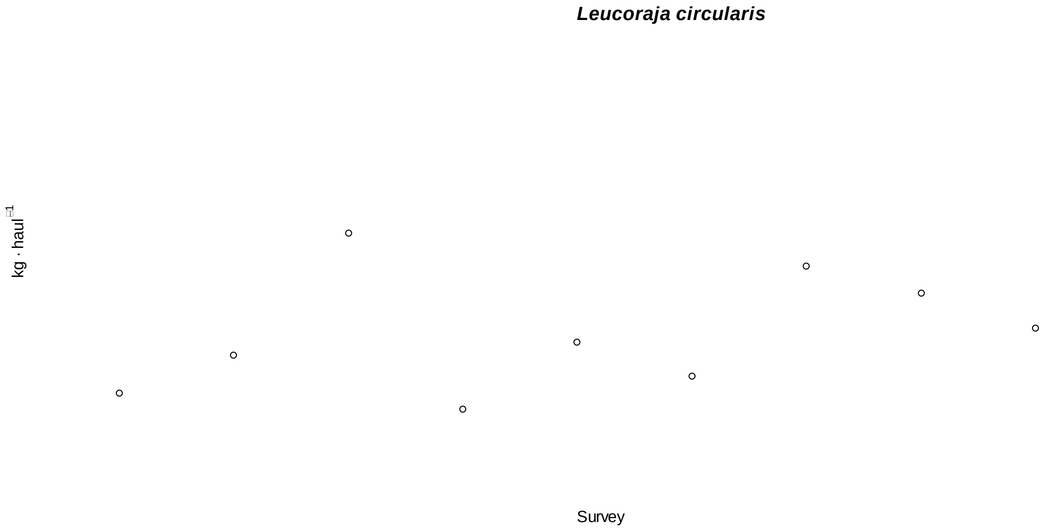



**Figure 18.13a. Demersal elasmobranchs in the Celtic Seas. Changes in sandy ray (*Leucoraja circularis*) biomass index (kg·haul$^{-1}$) during Porcupine Survey time-series (2001–2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).**

**Figure 18.13b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of sandy ray (*L. circularis*) in 2009 in Porcupine survey, and mean values during Porcupine Survey time-series (2001–2009).**

***Leucoraja circularis***


**Figure 18.13c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of sandy ray (*L. circularis*) catches (kg·haul$^{-1}$) in Porcupine surveys (2001–2009).**

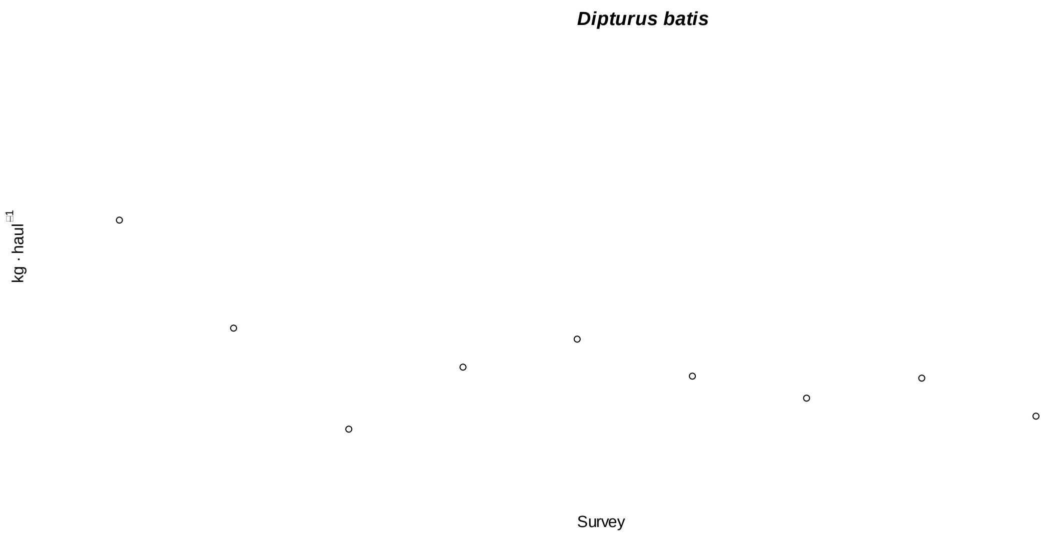



**Figure 18.14a. Demersal elasmobranchs in the Celtic Seas. Changes in common skate complex ('*Dipturus batis*') biomass index (kg.haul$^{-1}$) during Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).**

**Figure 18.14b. Demersal elasmobranchs in the Celtic Seas. Stratified length distributions of common skate complex ('*D. batis*') in 2009 in Porcupine survey, and Mean values during Porcupine Survey time-series (2001–2009).**

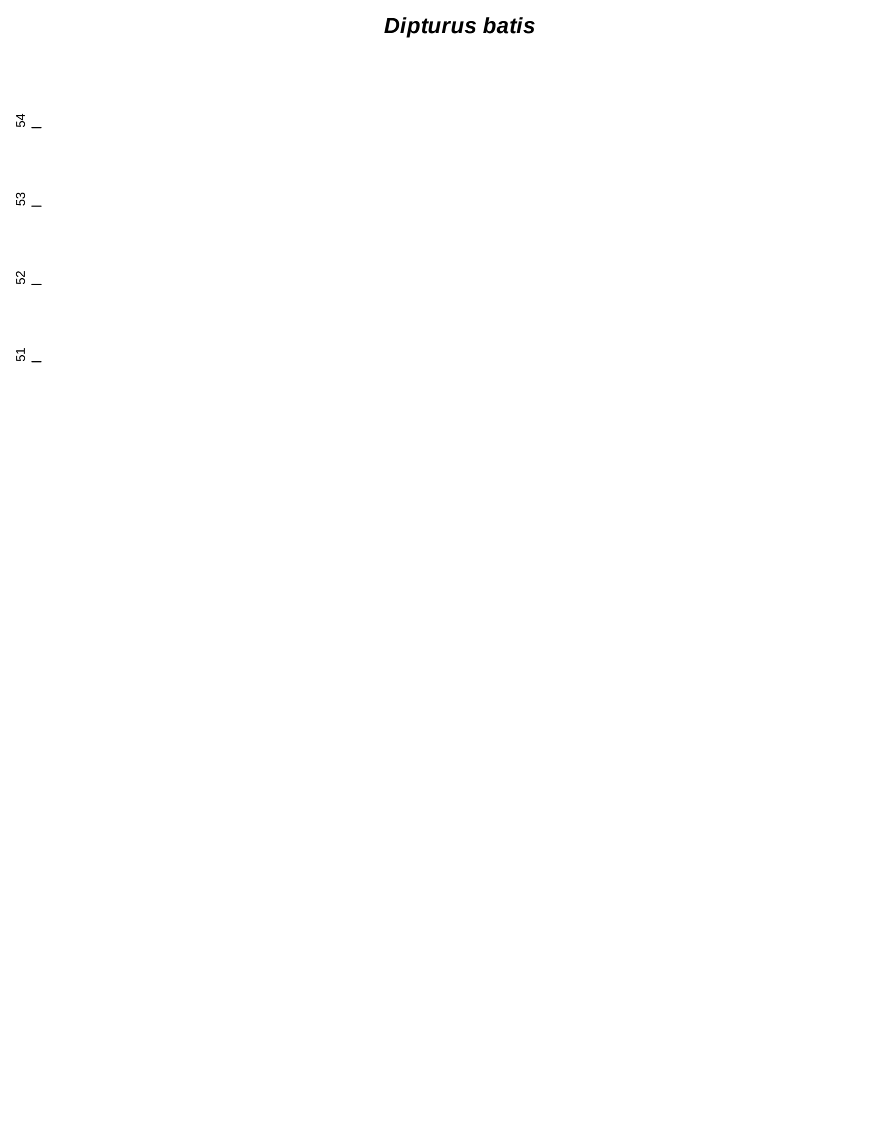



**Figure 18.14c. Demersal elasmobranchs in the Celtic Seas. Geographic distribution of common skate complex ('*D. batis*') catches (ind. haul$^{-1}$) in Porcupine surveys (2001–2009).**

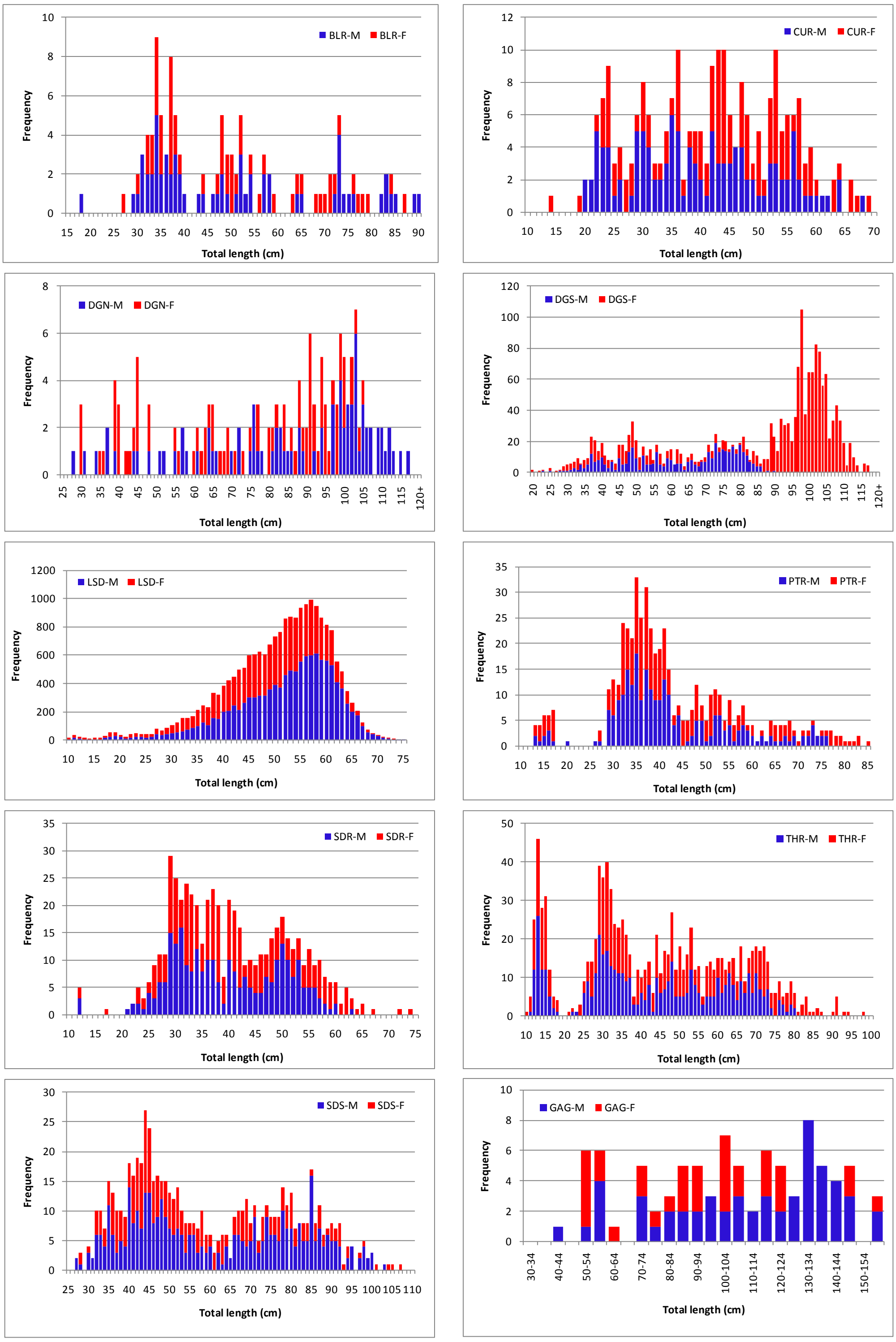
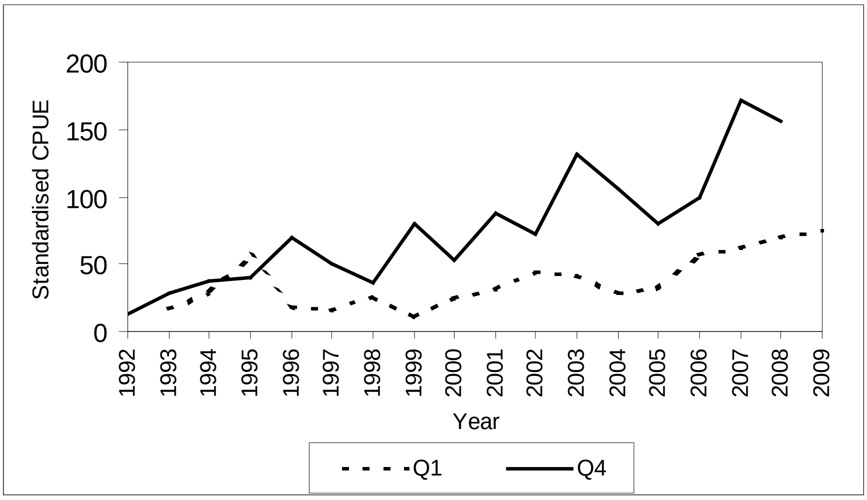
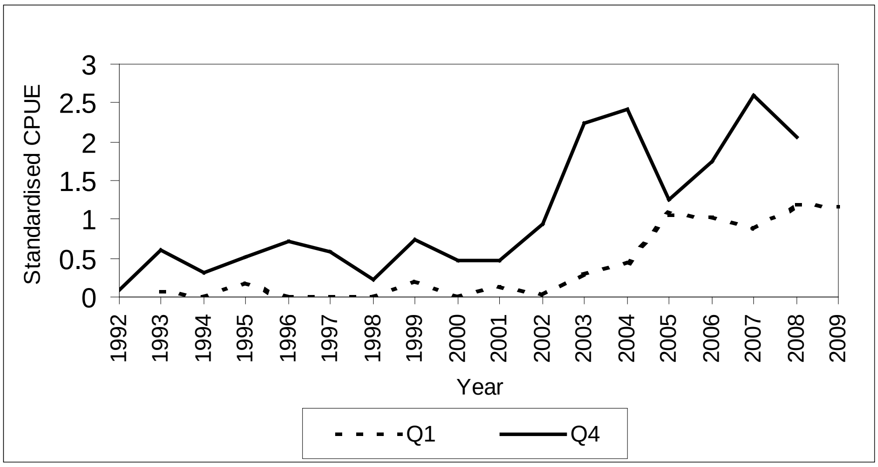



**Figure 18.15. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of elasmobranchs taken in the UK (English & Welsh) westerly IBTS (For species codes see Table 18.11).**


**Figure 18.16. Demersal elasmobranchs in the Celtic Seas. Catches of cuckoo ray *Leucoraja naevus*, blonde ray *Raja brachyura*, thornback ray *Raja clavata*, small-eyed ray *Raja microcellata*, spotted ray *Raja montagui* and undulate ray *Raja undulata*, mean weight per hour, from combined autumn surveys in the Celtic seas. Source: NIEA 2008.**



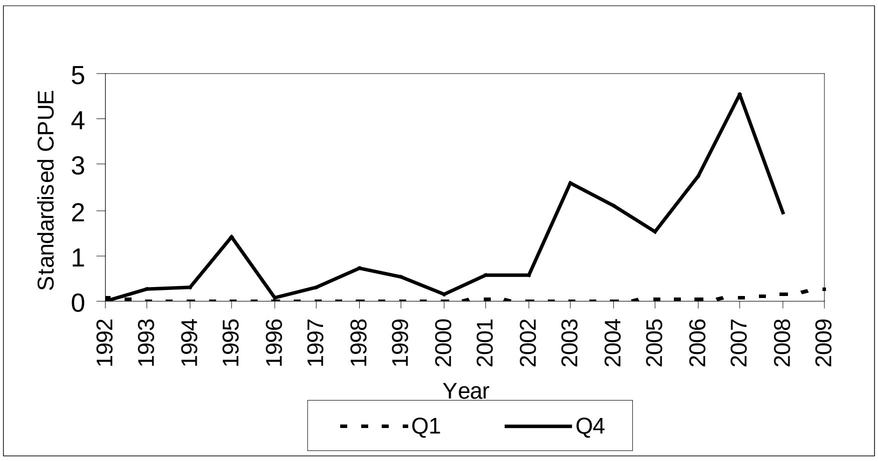




**Figure 18.17. Demersal elasmobranchs in the Celtic Seas. Mean catch rates of *Scyliorhinus canicula, Scyliorhinus stellaris* and *Mustelus spp*. from the Q1 (1992–2009) and Q4 (1992–2008) UK (NI) survey in Area VIIa (N).**

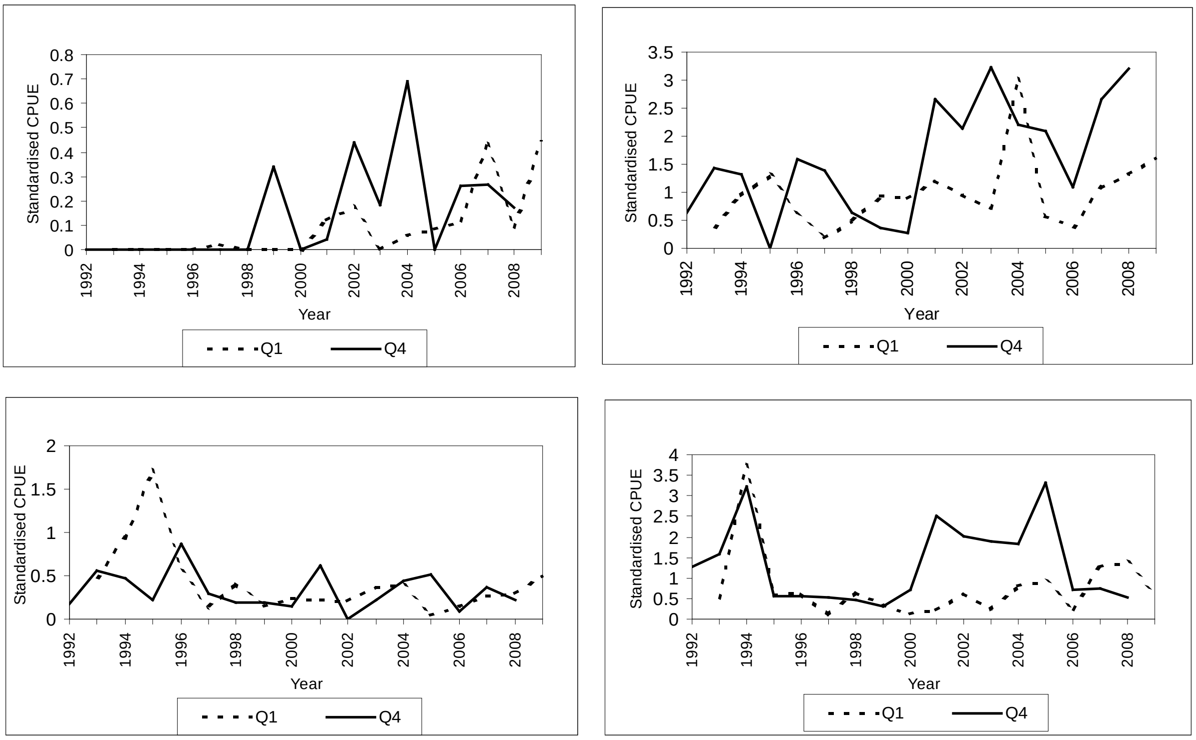



**Figure 18.18. Demersal elasmobranchs in the Celtic Seas. Mean catch rates of *Raja brachyura* and *Raja montagu*i, *Leucoraja naevus* and *Raja clavata* from the Q1 (1992–2009) and Q4 (1992–2008) UK (NI) survey in the Irish Sea (VIIa).**

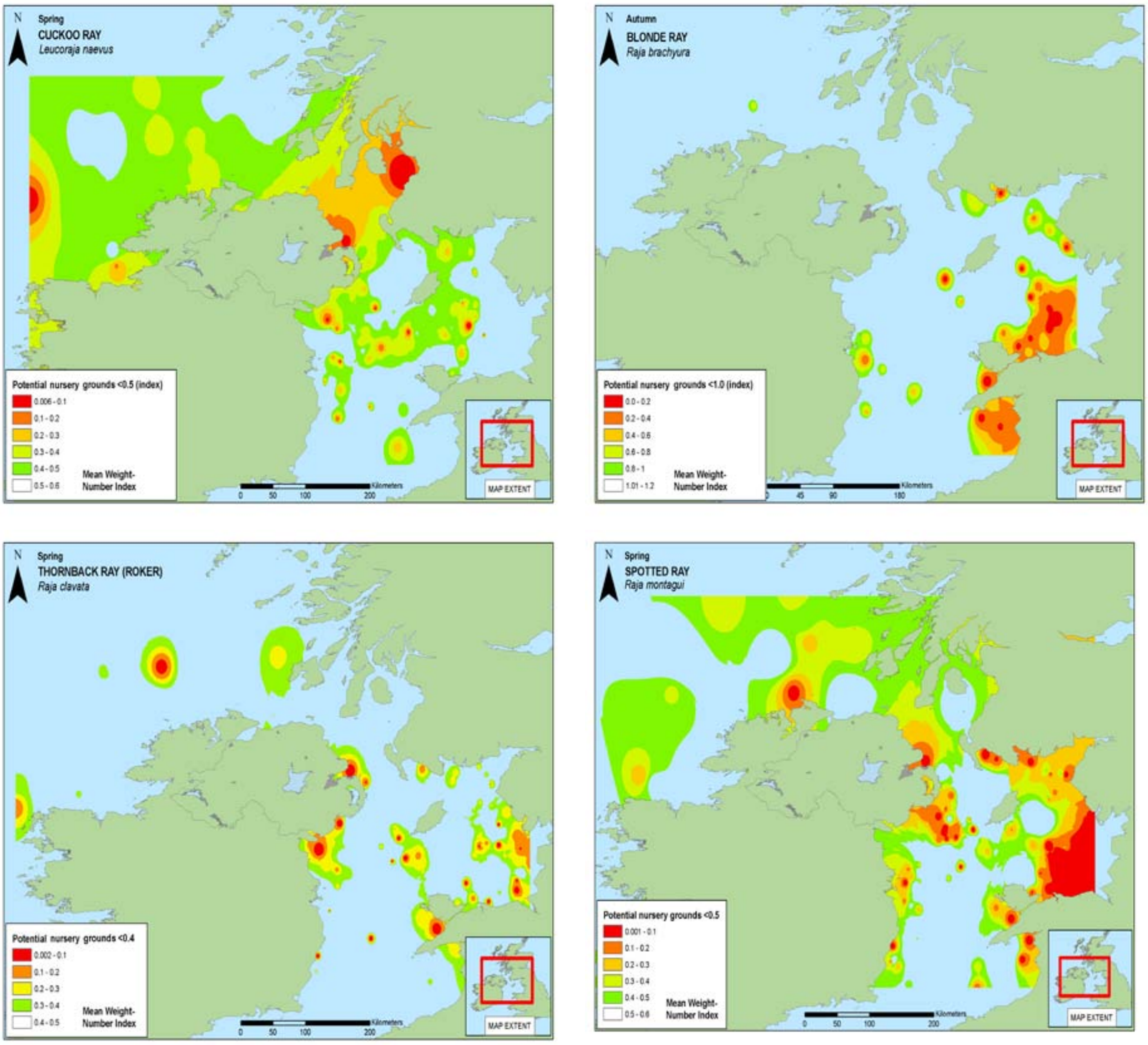



**Figure 18.19. Demersal elasmobranchs in the Celtic Seas. Potential nursery areas for cuckoo ray *Leucoraja naevus*, blonde ray, *Raya brachyura,* thornback ray, *Raja clavata* and spotted ray, *Raja montagui,* in study area as estimated from research survey data (average weight (Kg)/average abundance (No./hr). The lower the index value, the larger proportion of smaller individuals in sample catch. (NIEA, 2008).**

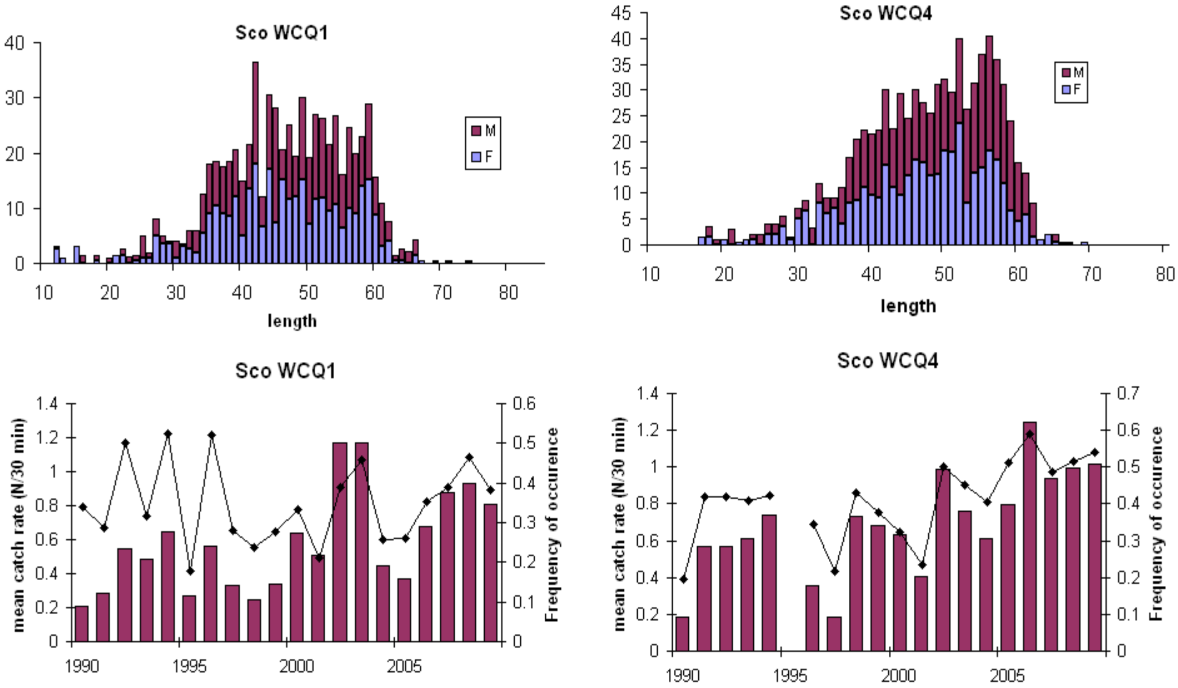



**Figure 18.20a. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *L. naevus* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min⁻¹.**

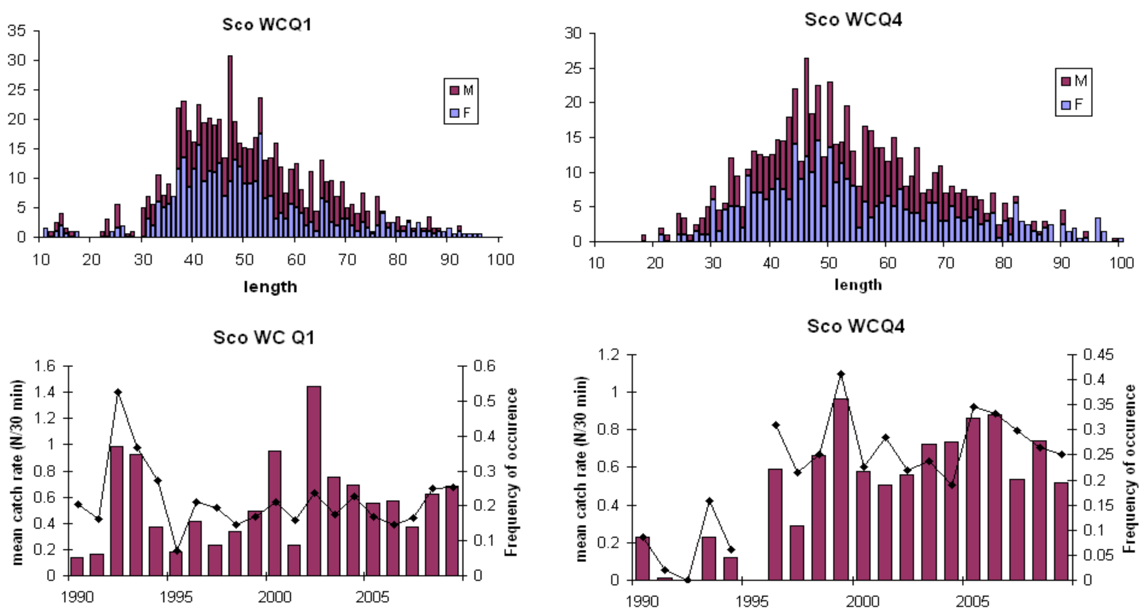



**Figure 18.20b. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *R. clavata* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min⁻¹.**

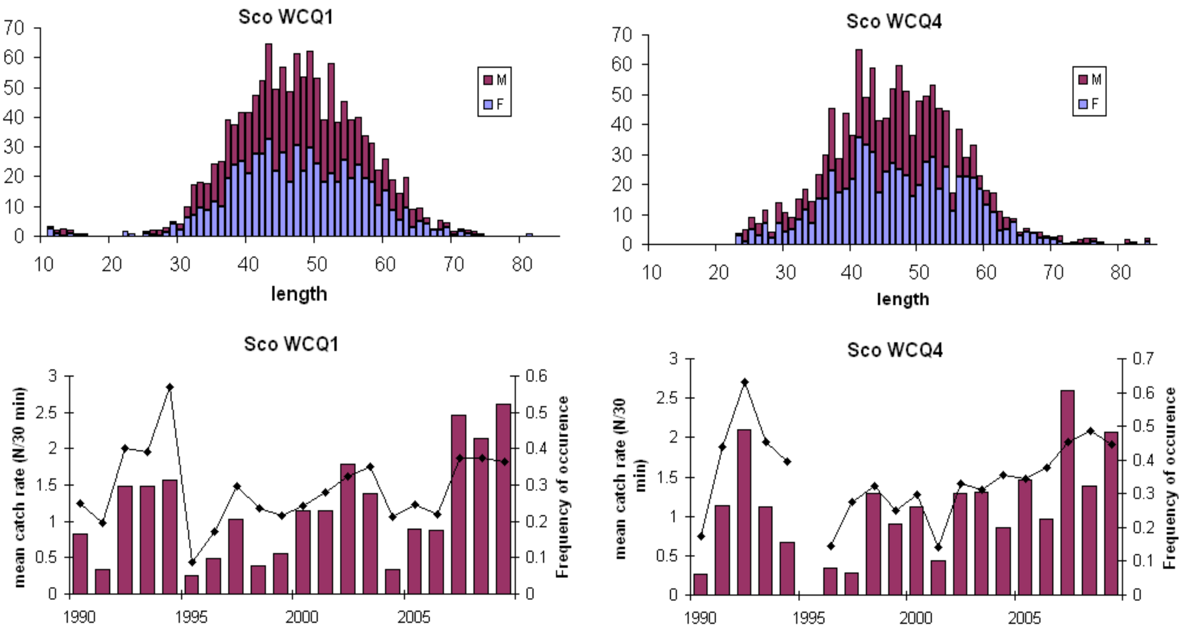



**Figure 18.20c. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of *R. montagui* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

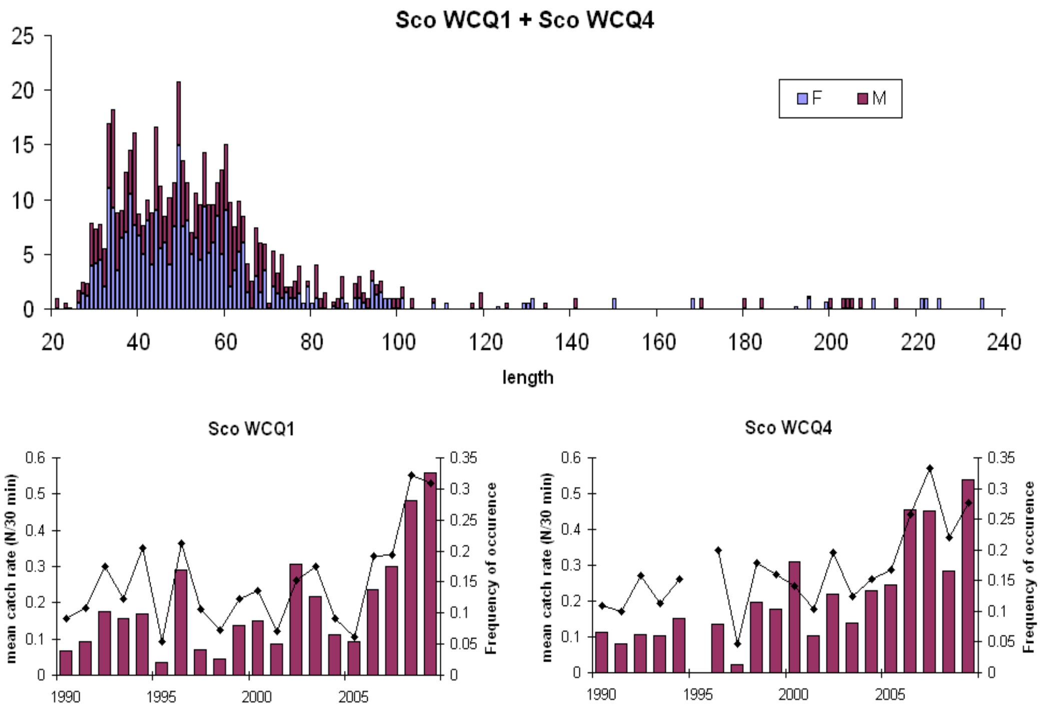



**Figure 18.20d. Demersal elasmobranchs in the Celtic Seas. Combined length frequency distributions of '*D.* batis' from the Scottish west coast surveys in Q1 and Q4 (upper plot). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

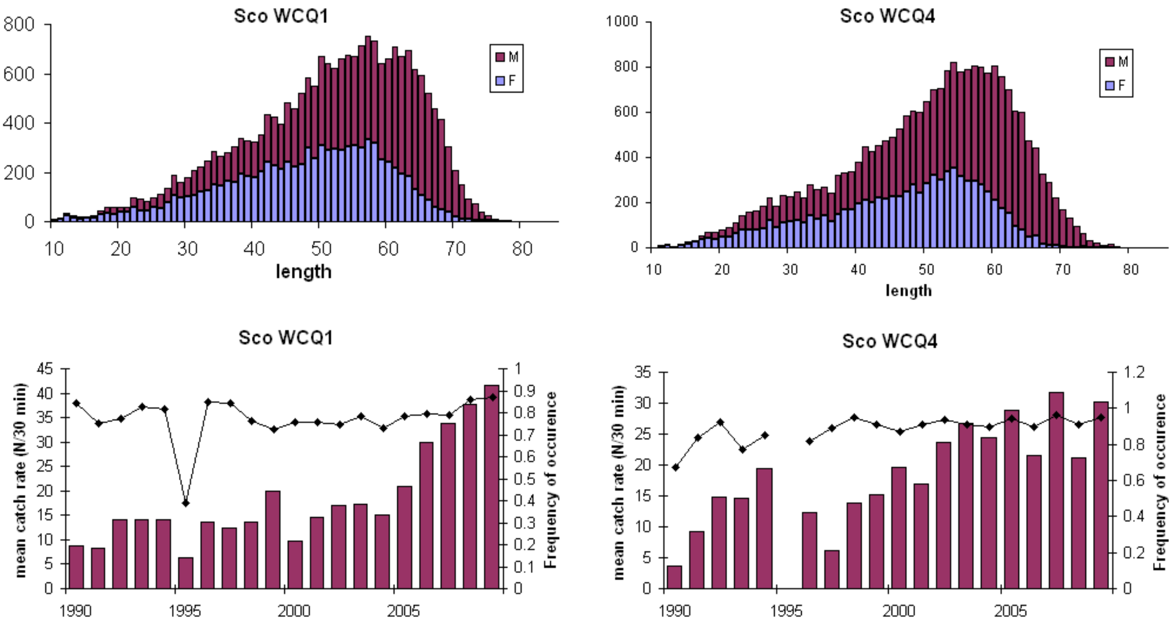



Figure 18.20e. Demersal elasmobranchs in the Celtic Seas. Length frequency distributions of lesser-spotted dogfish from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 $min^{-1}$.

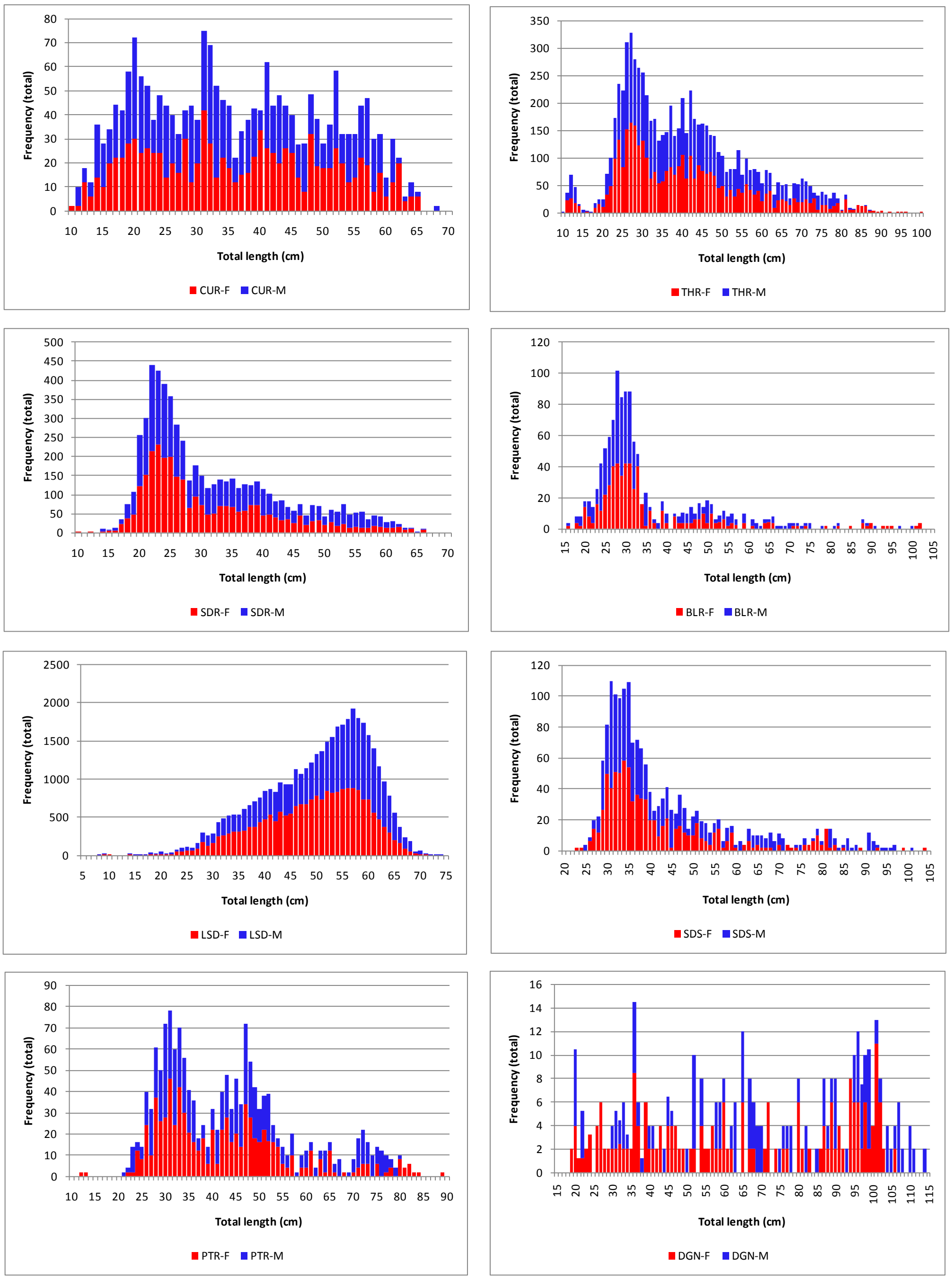



**Figure 18.21. Demersal elasmobranchs in the Celtic Seas. Length-frequency of *L. naevus* (CUR), *R. montagui* (SDR), lesser-spotted dogfish (LSD), *R. microocellata* (PTR), *R. clavata*(THR), *R. brachyura* (BLR), smooth-hounds (SDS) and greater-spotted dogfish (DGN) taken during the UK beam trawl survey in the Irish Sea and Bristol Channel (all valid tows, 1993–2009).**

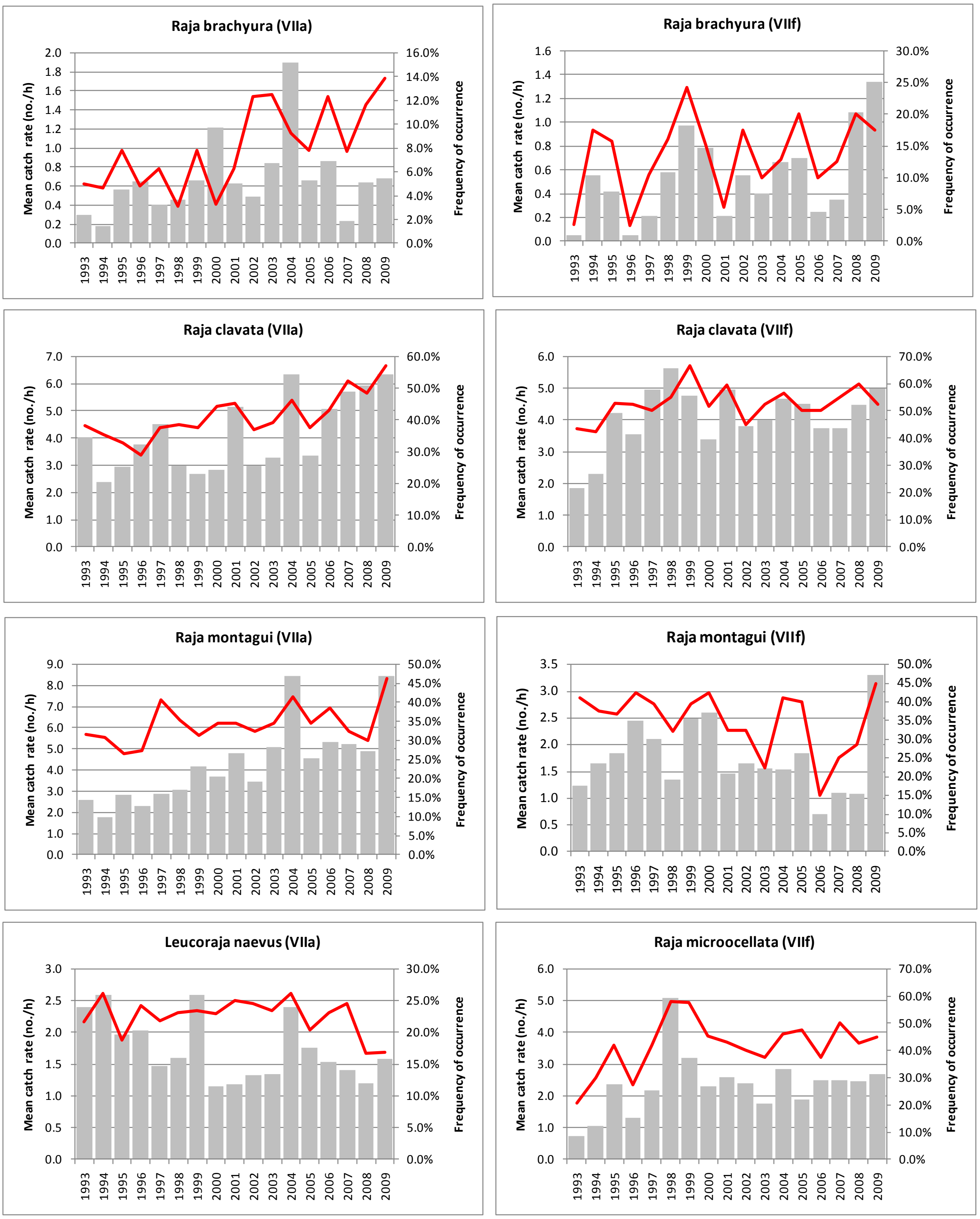



**Figure 18.22. Demersal elasmobranchs in the Celtic Seas. Mean catch rates (no.h$^{-1}$, columns) and frequency of occurrence (red line) of *R. brachyura, R. clavata* and *R. montagui* in the Irish Sea (VIIa, left panel) and Bristol Channel (VIIf, right panel), and *R. microocellata* in VIIf and *L. naevus* in VIIa. Data from the UK 4 m-beam trawl survey in the Irish Sea and Bristol Channel (1993–2009).**

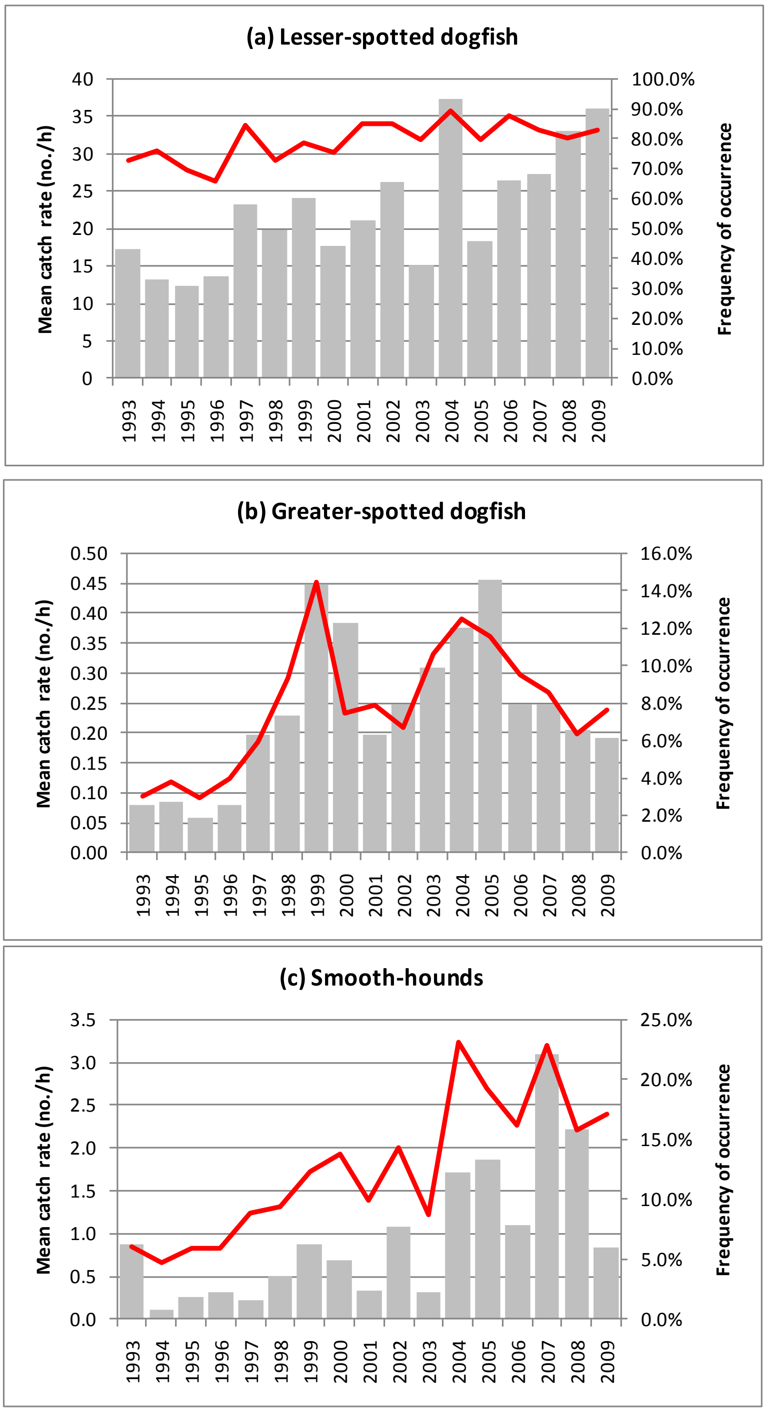



**Figure 18.23. Demersal elasmobranchs in the Celtic Seas. Mean catch rates (ind.$h^{-1}$, columns) and frequency of occurrence (red line) of (a) lesser-spotted dogfish, (b) greater-spotted dogfish and (c) smooth-hounds from the UK 4 m beam trawl survey in the Irish Sea and Bristol Channel (1993–2009).**

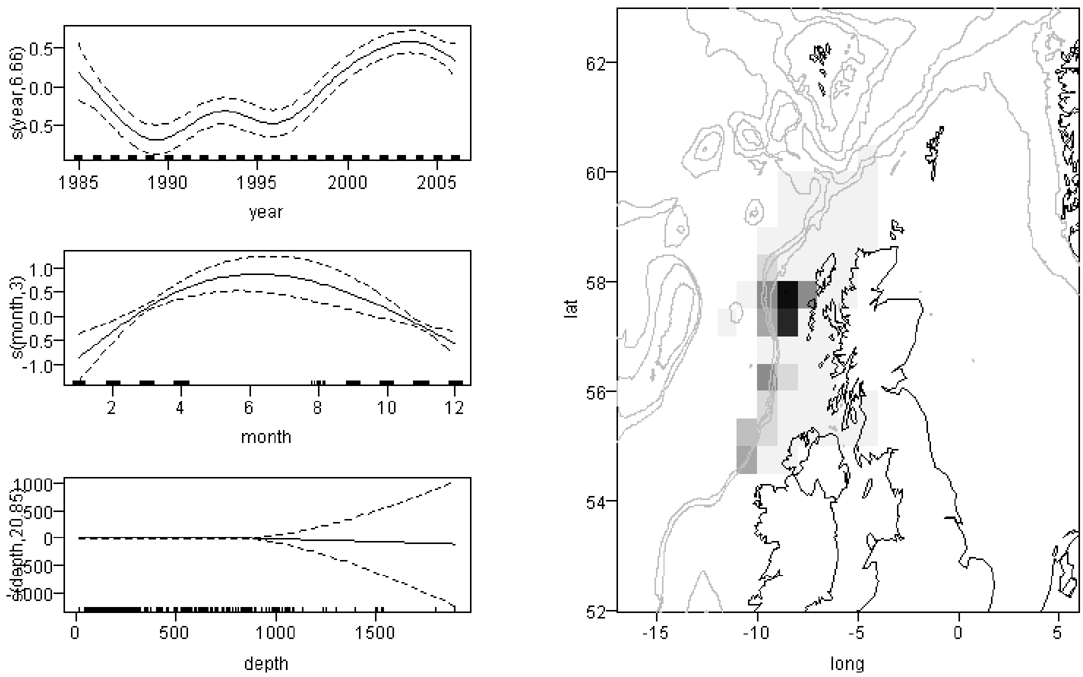



**Figure 18.24a. Demersal Elasmobranchs in the Celtic Seas. Thornback ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey catch rate data (log scale). Models are for N/hr.**

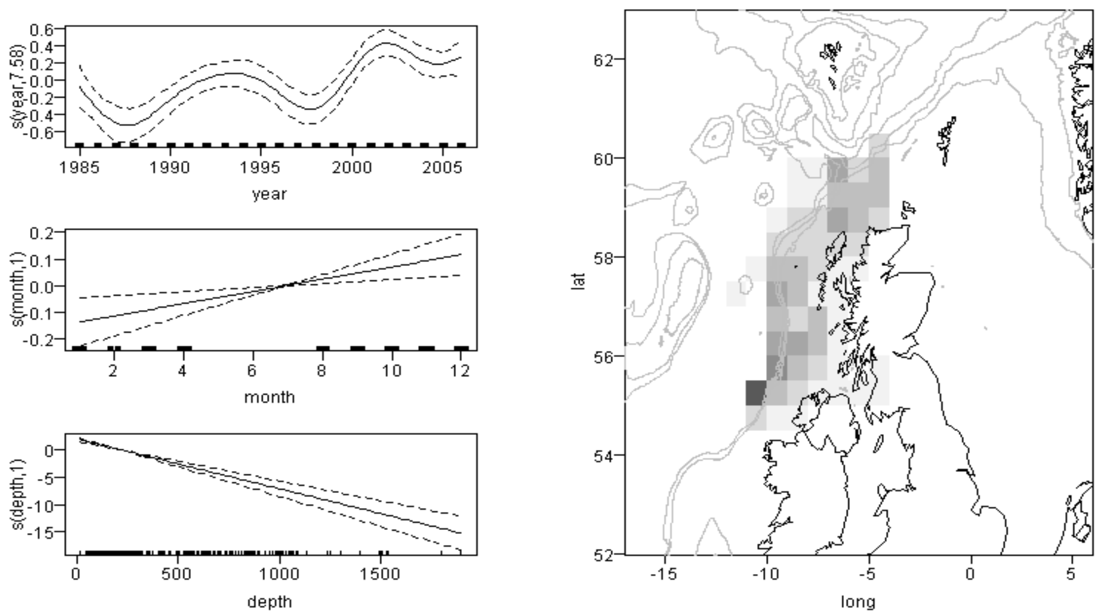



**Figure 18.24b. Demersal Elasmobranchs in the Celtic Seas. Cuckoo ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data (log scale). Models are of N/hr.**

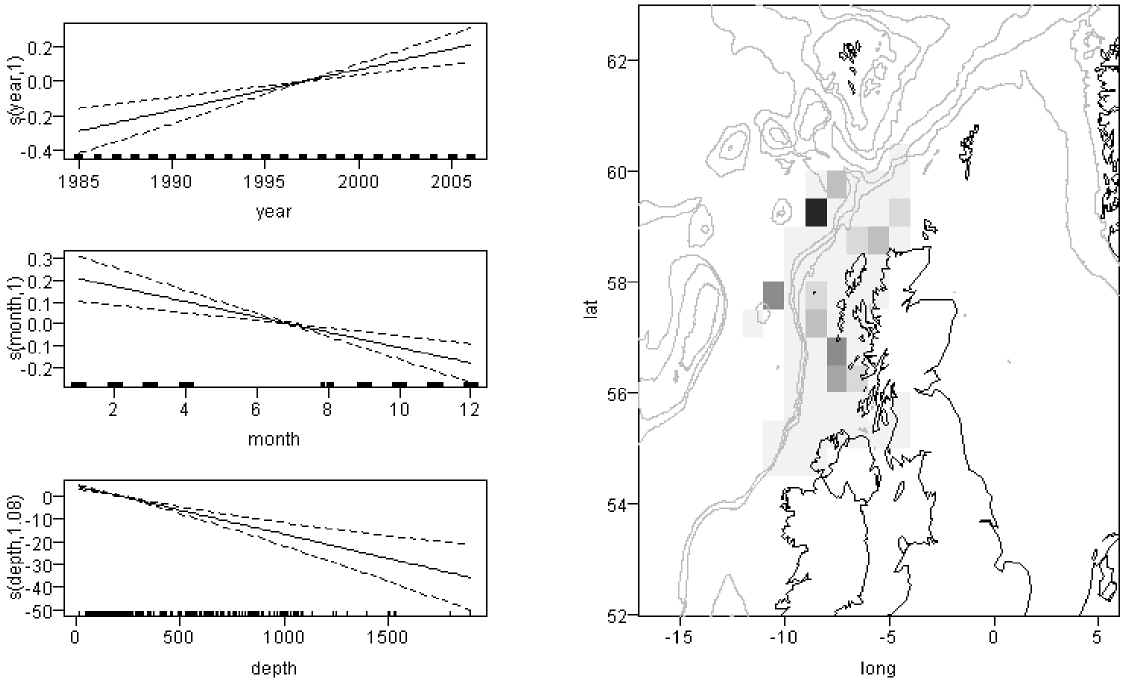



**Figure 18.24c. Demersal Elasmobranchs in the Celtic Seas. Spotted ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data (log scale). Models are for N/hr.**

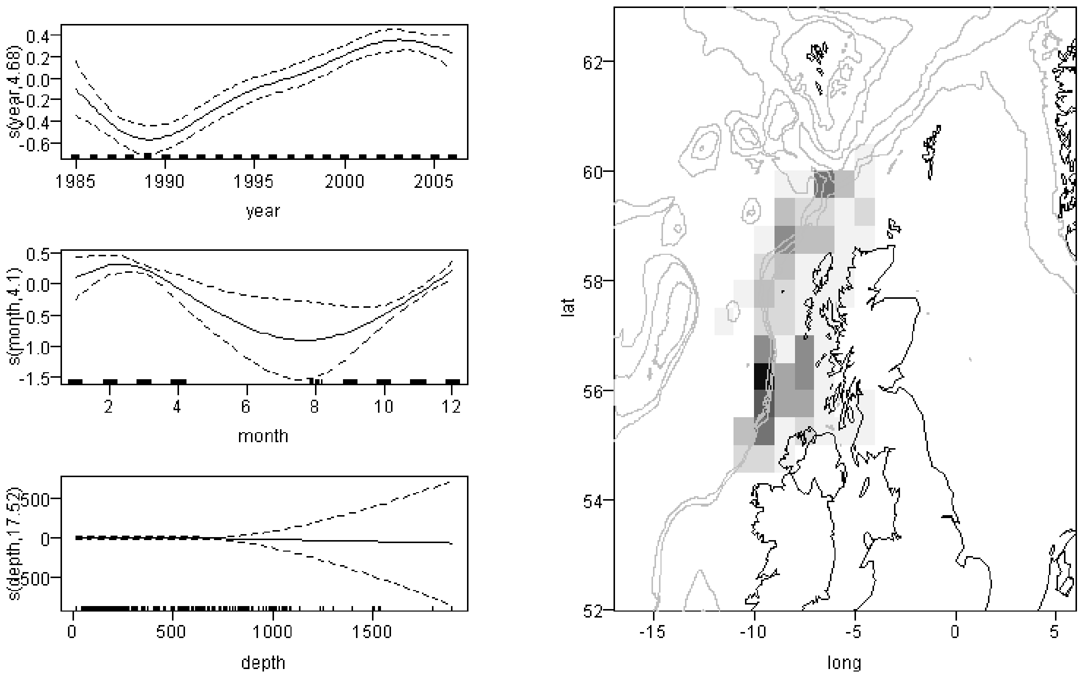



**Figure 18.24d. Demersal Elasmobranchs in the Celtic Seas. Lesser spotted dogfish in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data. (N/hr).**

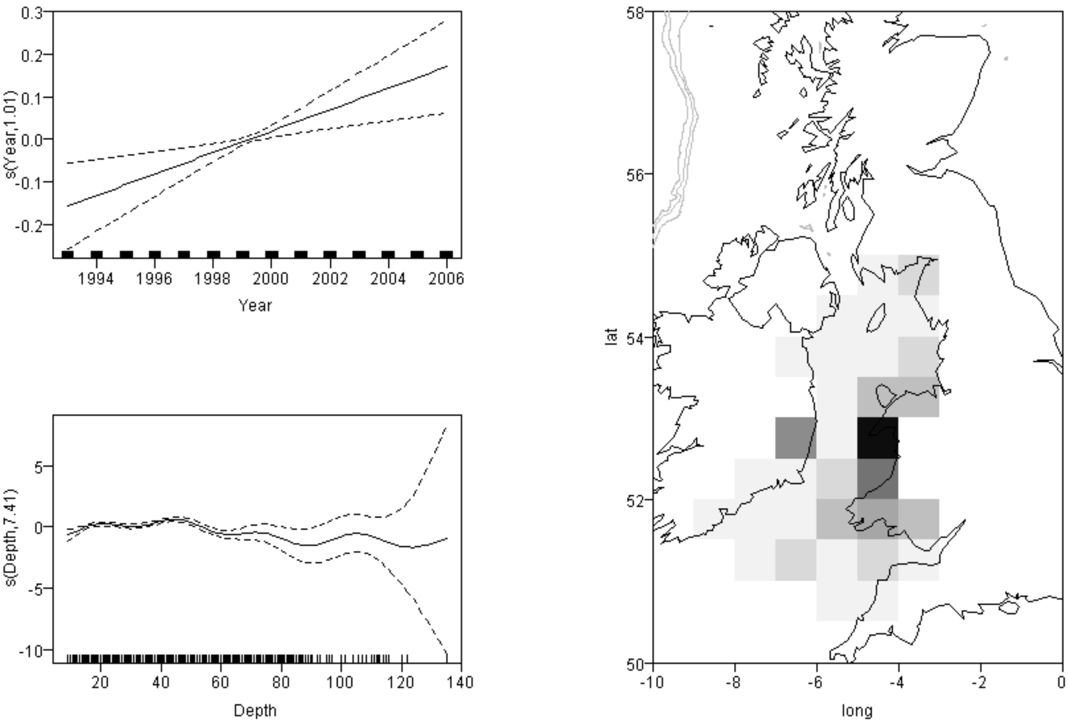



**Figure 18.25a. Demersal Elasmobranchs in the Celtic Seas. Thornback ray in Divisions VIIa and VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.**

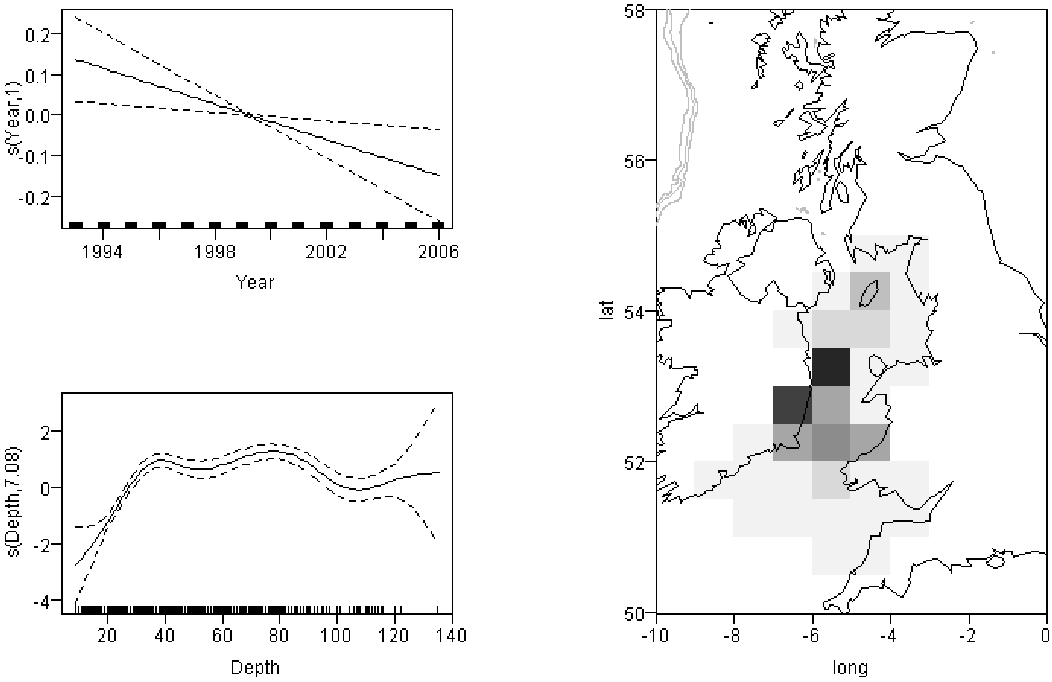



**Figure 18.25b. Demersal Elasmobranchs in the Celtic Seas. Cuckoo ray in Division VIIa and VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.**

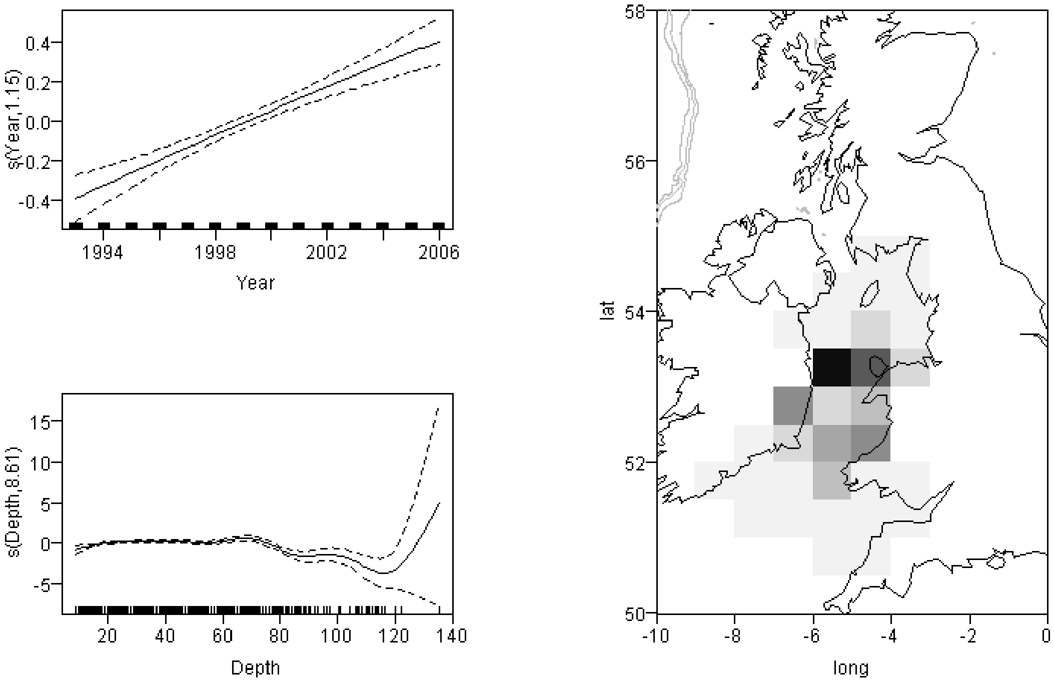



**Figure 18.25c. Demersal Elasmobranchs in the Celtic Seas. Spotted ray in Division VIIa and VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.**

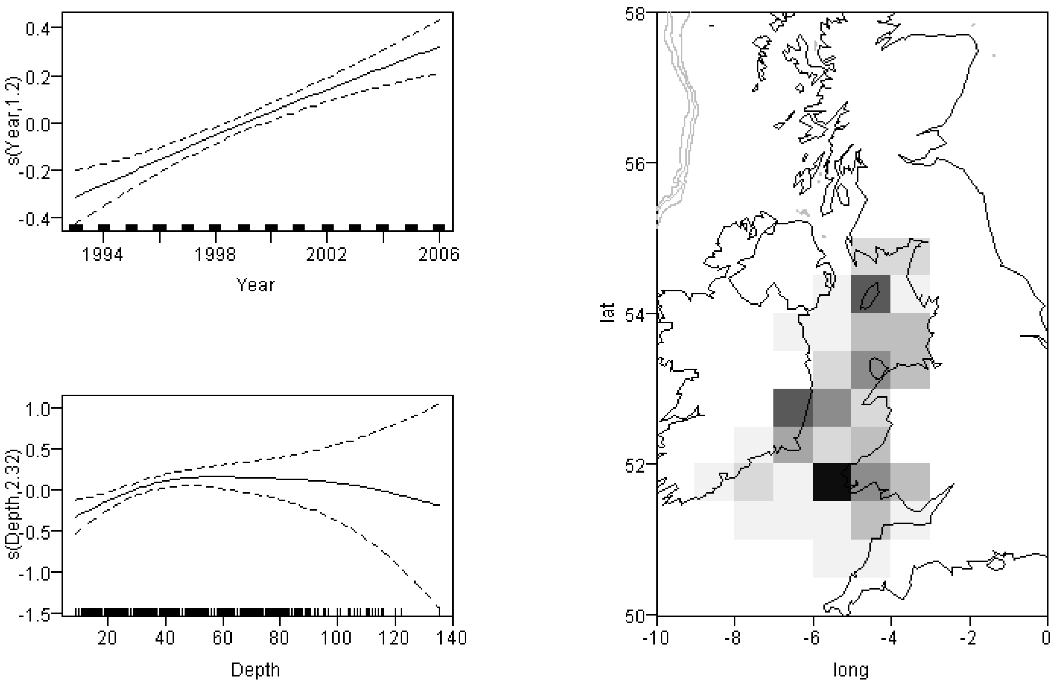



**Figure 18.25d. Demersal Elasmobranchs in the Celtic Seas. Lesser spotted dogfish in Division VIIa and VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.**

# 19 Demersal elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa)

## 19.1 Eco-region 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.). In Portugal, the trawler fleet operates along the Portuguese continental coast (Division IXa), targeting a wide number of teleosts and crustaceans. Associated with these, several species of skate are also landed, mainly in the ports of Matosinhos, Peniche and Portimão.

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 three species considered as the more valuable to assess are:

#### Skates and rays

Thornback ray (*Raja clavata*): As biological and fisheries data are most accurate and comprehensive for the Celtic Sea (VIIe–k), 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.

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,* long-nose skated *D. oxyrinchus* and white skate *Rostroraja alba.* Some of these species have patchy distributions.

#### Dogfishes

The 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.

In terms of demersal sharks, spurdog (Section 2) and tope (Section 10), blackmouth catshark *Galeus melastomus,* smooth hounds (*Mustelus asterias* and *M. mustelus*), guitarfish (*Rhinobatis spp.*), and angel shark *Squatina squatina* also occur. The biology and stock structure for many of these species is less well known.

## 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. 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

Skates are a traditionally food resource in France, and France has had directed fisheries for skates since the 1800s. Since the 1960s, skates 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 skates are also landed include sandy ray *Leucoraja circularis*, *L. fullonica*, smalleyed ray *Raja microocellata*, *D. batis* and *D. oxyrinchus*. *Rostroraja alba* is now rarely caught.

### 19.2.2 The fishery in 2009

No new information.

### 19.2.3 ICES advice applicable

ICES first provided advice for the demersal elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa) in 2008, primarily regarding *S. canicula* and *R. clavata* and *L. naevus.* ICES recommended for these two groups of species the landings in 2009 not to exceed recent average for the period 2002–2006 (3900 t for skates and rays and 1800 t for *S. canicula*).

No new advice was provided by ICES in 2009.

### 19.2.4 Management applicable

The Council Regulation (EC) No 43/2009 established a TAC of 6243 t in 2009 for Rajidae of Divisions VIII and IX.

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*) 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.

This is until now the only measures adopted for the Council of the EU to promote the management of skates in this ecoregion.

### 19.2.5 Landings

#### Skates and rays

Landings for the period 1996–2009 are given in Table 19.1a–e. Historically the main countries reporting international landings since 1973 in Subarea VIII are France, Spain and Portugal. French landings in 2009 are not available 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, 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 but from 1996–2006 the annual landings seem to have stabilized at 3700–5000 t (Figure 19.1). The mis-reporting of Spanish and French landings in 2007 and 2009 does not allow making any interpretation of trend in the last three 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 were since 1998 between 250 and 350 $t.y^{-1}$.

New species-specific landings of skates for Subarea VIII and Division IXa have been provided in 2009. According to these data (Table 19.5) the most important species landed in last years in decreasing order are *L. naevus, R. clavata, R. brachyura, R. undulata, R. montagui, R. microcellata* and *L. circularis*.

#### 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 (Basque Country) landed 415 t of lesser-spotted dogfish in 2009 (Table 19.2c). In Division VIIIc only Spanish and Basque Country landings are important although since 1999 they have been reduced strongly. The other hand and due to the effort of trawler fleet is much more reduced 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. 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 66 t were reported by Portugal in 2009.

The total historical landings of lesser-spotted dogfish in Biscay and Iberian waters since the peak of 1998 have been stabilised around 1800 $t.y^{-1}$, (Table 19.2; Figure 19.2), but like in the case of rays the misreporting of the landings of Spain and France in 2007 and 2009 respectively does not allow making any interpretation of trend in last three years.

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 (Tables 19.3a, b) and especially in 2008. The increase in 2008 and 2009 is also important in the Spanish (Basque) fleets that landed 82 t and 166 t respectively.

In Division IXa the landings of smooth hounds come only from the Portuguese vessels, the historical trend show a saw tooth profile with the lowest record of 11 t in 2006.

#### Other demersal sharks

Angel shark landings in Subarea VIII have always been very low, and after the revision of French data in the historical series, only 1,7 t of this species have reported in landings since 1996 (Table 19.4a).

### 19.2.6 Discards

Information on the methodology and results of the Spanish discard sampling program of main elasmobranch species in VIIIc and IXa have been presented in a Working Documents (Santos *et al.*, 2010). The results of the Spanish programme show that *S. canicula, G. melastomus*, *L. naevus*, *R. brachyura, R. clavata, C. squamosus* and *D. calceus* are the species most important in the discarded catch since 2003 in these two divisions.

An historical overview of lesser spotted dogfish discards by the Basque trawler fleet has been also presented in a Working Document (Diez *et al.*, 2010) The results involve the geographical distribution by statistical rectangle of discards (in Divisions VI, VII and VIII) and information of the length frequencies of discarded versus retained in last two years.

The onboard sampling programme on the Portuguese artisanal commercial fleet operating with gillnets/trammel nets started in the last quarter of 2009, as part of EU DCR/NP. In 2009 four trammelnet trips, on three different vessels, were sampled.

Skates species were observed present in only two trips (11.5 kg and 11.0 kg) with 2% and 8% of discards in weight in relation to total catch of skates.

The information of historical series of discards of main demersal elasmobranch of the Basque OTB and PTB fleets in Divisions VIIIa, b, c, d since 2003 were also updated in this section (Table 19.6).

#### OTB Basque fleet

Skates and rays: Smaller skates (mainly juveniles of *L. naevus* and *R. clavata*) are usually discarded, and the trend of discards of these species shows a decrease since 2004 (Table 19.6). In 2009 the sampling methodology was improved on board with the aim of distinguishing the specific composition of discards. The data collected this year confirm that only small individuals of *L. naevus* are usually discarded in significant quantities by this fleet.

Lesser-spotted dogfish: Even though 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 and 2008, but although in 2009 the level of the landings were similar to other years, discards increased significantly to 1092 t.

Blackmouth catshark is landed and discarded in insignificant amounts except in 2004 in which 226 t were estimated as discards. This important discard recorded in this year might be due probably to an overestimation of the estimates in the subsamples because this species is very scarce in the catches.

#### PTB Basque fleet

The elasmobranch catches and landings of PTB fleet operating in Division VIIIc are historically scarce. The only elasmobranch species discarded is lesser-spotted dogfish. As in the case of OTB fleet, due to its low value only larger specimens are retained (Table 19.6).

### 19.2.7 Quality of the catch data

France, historically one of the most important countries in landings of elasmobranch in Subarea VIII did not report 2009 landings to the Working Group. Non-reported data in 2007 are still not resolved for some countries.

## 19.3 Commercial catch compositions

### 19.3.1 Species and size composition

Length frequencies of *L. naevus* and *S. canicul*a in 2009 are provided from the French demersal trawl fleet landings catches in Bay of Biscay. (Figures 19.3a and 19.3b). In the framework of the French DCR program, the National "Observer program at sea“; ObsMER started to sample shark and skate bycatches caught by the domestic fisheries since 2003.

The length frequency distribution of six ray species under the Portuguese DCR sampling program in the three main landing ports: Peniche, Matosinhos and Sines were available for the WG. Frequencies in number were extrapolated for the total weight landed by each sampled fishing vessel (Figure 19.3c).

There is a figure of a two year series of *S. canicula* length frequencies (retained vs discarded) of the Basque trawler fleet in VIIIabd, in the Working Document of Diez *et al.*

(2010). Length frequencies of Spanish commercial landings were not available for this Working Group. It is expected to be information of length frequencies on the main elasmobranch species landed in the Basque Country ready for next WGEF.

### 19.3.2 Quality of the catch data

Although in some years of the historical series a significant proportion of annual skate landings is still reported as *Rajidae* spp, in recent years, most of the countries involved in the fisheries in Divisions IXa and Subarea VIII have provided the specific composition of landings (Table 19.5). In order to register possible changes that might occur in the specific composition of landings of these species, in the case of Basque Country (Spain) and Portugal the sampling methodology have been improved with a more effective sampling in ports allowing to obtain in 2009 direct estimates of the species-specific composition of landings of Rays. However the specific identification of landings of less common rays as well as smooth hounds it is a problem that still remains for these species. On the other hand it is still necessary to update the historical series of effort and lpue by species of the trawler fleets but also the artisanal fleet fishing coastal skates, as well as biological studies for the correct determination of biological cycle and reproduction aspects of rays in Iberian waters.

## 19.4 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 19.7).

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.

Effort for each fleet was obtained from the information provided yearly by the logbooks filled out by the skippers of most of the ships landing in Basque ports. Effective fishing effort for each fleet was calculated using the following formula:

Effort = fishing days = trips * (mean days/trip)

In OTB, since 1994 landings of lesser-spotted dogfish have been on average 298 $t.y^{-1}$, The lpue of this species show a continuous increase since the first year of the series whit a minimum in 1994 (191 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. Landings of spurdog in VIII have been historically very scarce, that is why the lpue of this species are very low. In 2009 only 0.25 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 last two years the lpue increased strongly, reaching 24 kg/day in 2008 and 68 kg/day in 2009.

Elasmobranch landings and lpue in PTB have been historically much lower than in OTB. The historical trend of lpue of rajidae shows a decrease since 2001, on the contrary lesser-spotted dogfish although lpue shows peaks and troughs the overall trend show increase along the historical series. Lpue of spurdog and smooth hounds in VIII have been even lower than obtained by OTB and barely reached 2.2 kg/day in 1998 and 18 kg/day in 2000 respectively.

## 19.5 Fishery-independent surveys

An update of the results on four of the most important elasmobranch species sampled in the Spanish bottom trawl surveys on the Northern Iberian shelf is presented in a Working Document (Velasco *et al.*, 2010). Also this section includes information of the Portuguese IBTS survey (2009) related to the main elasmobranchs studied in the survey.

### 19.5.1 Surveys of the Cantabrian Sea

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 19.3d, 19.3e, and 19.3f) for the main commercial species and elasmobranch. Survey design (Figure 19.4) is random stratified with number of hauls allocated proportionally to strata area, and it includes five geographical sectors and three depth strata which were changed in 1997 after studies of fish community distributions. It covers depths of 70–500 m, with special hauls in shallower and deeper grounds. The gear used is a "baca" trawl 44/60 (ICES, 2002b) with an inner 20 mm liner covering the codend, 2 m vertical opening, ca. 19 m horizontal opening and ca. 105 m door spread.

The result of survey shows relatively high abundances of *S. canicula*, *R. clavata* and *L. naevus* in the VIIIc Division since 2000–2001. In Division IXa only *S. canicula* is relatively abundant, being present in all the years of the series, while Cuckoo ray does not appear in this area and thorny ray is scarce and has appeared mainly since 2001. Their length distributions do not present remarkable changes in neither of both ICES divisions covered in the survey.

#### Lesser-spotted dogfish

The historical series of results of the survey shows that the biomass index for this species in Division VIIIc is always higher than in IXa. In the Division VIIIc a clear trend cannot be observed until 1999, since 2000 the index shows continuous saw tooth but the trend indicates a slight increase in abundance until 2009. In Division IXa until 2005 the abundance index was below 1 kg per haul but increases to more than 3 kg per haul in 2006 to descend in the following years (Figure 19.5).

#### Skates and rays

Like in the case of lesser spotted dogfish, the series show that *R. clavata* is more abundant in Division VIIIc than in IXa. In VIIIc an increasing trend can be observed since 1995, with peaks in 2000 and 2001 and levels from 2006 to 2009 remain among the highest in the series (Figure 19.6). Although the abundance of *L. naevus* shows periodic saw tooths in Division VIIIc, an increasing trend is observed from 1983 to 2001 and from 2003 to 2005, to recover again a series of sucessive peaks and troughs since 2006 (Figure 19.7).

The most remarkable result is the peak in abundance of blackmouth catshark that in 2009 has been 3.7 times more abundant than in 2008, and 3.4 times than of the mean of the previous ten years. This peak is related to a big catch in one haul in the central part of the Cantabrian Sea, but is also accompanied by high catches in all the special hauls carried out in grounds deeper than 500 m. The rest of the elasmobranch species in the area remain in levels similar to those of previous years.

The geographic distribution of *S. canicula*, *R. clavata* and *L. naevus* along the Cantabrian Sea (Division VIIIc) is shown in Figures 19.8a, 19.8b, and 19.8c.

### 19.5.2 Portuguese Surveys in Subarea IX

In general, the catchability of the different gears used in the Northeast Atlantic surveys is not constant; and specially the trawling gear use in the Portuguese Winter Groundfish Survey is quite different due to the smaller doors spread. Besides the methodology of this survey is not designed for elasmobranch sampling, therefore abundance of the elasmobranch species of this survey is not proportional to the abundace found in other areas (ICES 2010a; ICES IBTSWG 2010).

Of the 10 elasmobranch species considered in the IBTS trawling surveys only *S. canicula* and *R. clavata* were found in 2009 in significant amounts along the Portuguese waters (IXa) (Figures 19.9a and 9b). *R montagu*i and *R. undulata* were found only in occasional hauls, while the rest of skates and sharks species did not appeared in any of the hauls (ICES IBTSWG 2010).

## 19.6 Life-history information

No new information is available to WGEF 2010.

The tagging programme carried out since 1993 by the IEO in the Cantabrian Sea is still active.

### 19.6.1 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 Exploratory assessment models

The general status has been evaluated in the three main elasmobranch species landed from the Divisions included in the ecoregion. The analysis has been performed based on fragmented information of the three sources available: commercial lpue, IBTS surveys and national landings. Unfortunately none of these three sources cover the whole area of Bay of Biscay and Iberian waters; not in geographical terms nor in time scale (in this last case due to important misreporting in the last years). In order to make a more clear the interpretation, the analysis has been split in three groups of divisions according to the homogenity of information available in each case (Divisons VIIIa,b,d, VIIIc, and IXa). Therefore the management considerations presented in this section should be interpreted taking into account these restrictions.

### 19.7.1 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 d is increasing since 1994. Updated information of lpue trawler fleet indicates that the lpue for *S. canicula* in Subarea VIII have been increasing from 1994 to 2009. The increase of discard in 2009 could also indicate a more abundance of small individuals in Subarea VIII. The punctual misreporting in last years of some countries that historically have contributed significantly to the landings did not allow making an appropriate analysis of the trend of the landings of this species.

#### *Rajidae*

The stocks of rays (mainly *L. naevus* and *R. clavata*) show a sligth increase of lpue since 2005 after an important fall from 1999 to 2004. In Subarea VIIIa,b,d the commercial lpue of skates decreased strongly from 1998 to 2003 although a slight recovery can be observed since 2004. Due to misreporting of Spanish and French data in the last three years, the state of these stocks is difficult to interpret from the commercial landings; however results obtained from surveys carried out in this Subarea indicate an increase of *R. clavata* biomass since 1996. Less clear is the situation of *L. naevus*, demonstrating a series of sucessive peaks in the biomass index since 1988, although an overall view of historical series seems to indicate a continuous, but slight, increase of abundance.

#### *Other elasmobranchs*

The landings of smooth hounds (*Mustelus* spp.) clearly demonstrated that landings in Subarea VIIIabd have increased by five times from 1996 to 2008. The commercial lpues show the same trend but it is more noticeable in the last two years. The specific identification of landings is a problem that still remains for this species. Since 1996 landings of less frequent elasmobranch species as *Squatina squatina* are negligible; in these divisions only France reported landings of 1.7 t in the last 14 years.

### DivisionVIIIc

#### *Lesser spotted dogfish*

Landings of this species are stabilized since 2000 at around 170 t per year after two peaks in 1997 and 1999. On the other hand, the IBTS survey in this division indicates that after an important peak in 2006, lesser spotted dogfish shows the best abundance index of the series since this year.

#### *Rajidae*

Excluding the years 2007 and 2009 in which significant mis-reportings happened, landings of rays since 2004 show a decrease after two peaks in 2001 and 2003. The historical series of abundance index of surveys in VIIIc show an irregular increase of the abundance of *R. clavata* since 1996. The biomass index of *L. naevus* shows continuous sawtooths in the historical series, however despite of these fluctuations the trend of series indicates an increasing 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 on landings registered during the last years could be related to changes in the effort distribution targeting different species, and to better discrimination of the species at Portuguese landing ports. According to the IBTS survey in Northern

IXa there is an increase of abundance index since 2006, and 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 in this division are quite stable since 20 years ago, and have been always above 1500 $t.y^{-1}$, except in 2007 when 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 don't show any clear trend in this area in which only national landings of Portugal are available. Landings since 1999 fluctuate from 11 to 72 t $year^{-1}$.

## 19.8 Quality of assessments

No stock assessments have been conducted.

Current existing commercial data (effort, lpue, landings) are not appropiate. Effort and lpues don't cover the whole area of the ecoregion and are only available for some divisions (VIIIa,b d). National landings show problems of misreporting in some of the last years, and there is still misidentification of species included in the category of "other elasmobranch" and in less common species and coastal skates (i.e. *R. undulata*). In this sense the trends of Portuguese, French and Spanish landing of smooth hounds should are not considered reliable because the common name of smooth hounds is often applied to several species (*M. mustelus, M. asterias, G. galeus and others).*

Although there is valuable information 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 for the sampling of elasmobranchs, especially for species with patchy distribution. The effort of surveys in coastal areas is besides very scarce and do not cover a wide range of depths.

The tables of national landings should be modified for next WG in order to include a species-specific detail of landings of the main rajidae species.

Effort and lpue from commercial fleets should be provided for all countries involved in the landings of the ecoregion.

Catches of certain skate species, such as *R. alba*, in both commercial landings and in surveys, are too low to provide meaningful abundance estimates.

## 19.9 Reference points

No reference points have been proposed for the stocks in this ecoregion.

## 19.10 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. In this sense, the French Fisheries Ministry has asked for explanations regarding the implementation of this measure, with regards to undulate ray. 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). This special request is considered in Section 22.1.

Also, Spanish artisanal fishermen operating in coastal waters of IXa and VIIIc expressed initial surprise at this measure, as there is not enough information or evidence of declines in the populations of *R. undulata*. In this sense, due to the coastal and shallow distribution of this species, there is not enough information on catches and landings obtained from the surveys or from the Spanish trawler fleets, which historically land most of skates in Cantabrian Sea and Bay of Biscay waters, but do not fish *R. undulata*, since 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. The "*modus operandi*" of these fleets make very difficult to get reliable information about the landings of these species and therefore to obtain any scientifically valid information on the status of these populations. However a recent work confirmed the importance of undulate ray for the artisanal fleets in the coastal waters of Galicia (IXa) in the area and did not find evidence to establish any decreasing trend in its abundance in the study area (Bañon *et al.*, 2008).

ICES provided advice for undulate ray in the Celtic Seas ecoregion, where there was concern over this species in certain areas. The Celtic Seas is the northern limit of the biogeographical distribution of this species. ICES did not comment on the status of this species in the Biscay–Iberian ecoregion, which is the main part of its biogeographical range.

## 19.11 Management considerations

The Council Regulation (EC) No 43/2009 established a TAC of 6243 t in 2009 for Rajidae in Diviisons VIII and IX. Quotas in 2009 have not been reached for any of the countries that have reported national landings. In 2010 Council Regulation reduced the TAC to 5459 t (13%).

| RAJIDAE | TAC | TAC | LANDINGS |
|---|---|---|---|
| Divisions VIII & IX | 2009 | 2010 | 2009* |
| Belgium | 13 | 11 | 11 |
| France | 2 435 | 2 070 | N.A. |
| Portugal | 1 974 | 1 678 | 1 314 |
| Spain | 1 986 | 1 688 | 1 094 |
| UK | 14 | 12 | 0.6 |
| UE | 6 243 | 5 459 | 2 419 |

***provisional.**

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.

## 19.12 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** |
| Belgium | 12 | 6 | 11 | 11 | 6 | 11 | 14 | 11 | 8 | 12 | 14 | | | 11 |
| France | 1535 | 1733 | 1503 | 1479 | 1206 | 1091 | 1106 | 1037 | 1170 | 1797 | 1296 | 1505 | 1395 | |
| Netherlands | | | | | | 1 | | | | | | 0 | 0 | 0 |
| Spain | 872 | 906 | 724 | 677 | 146 | 76 | 323 | 27 | 20 | 9 | 12 | | 17 | 16 |
| Spain (Basque Country) | * | * | * | * | 296,9 | 336,84 | * | 252 | 242 | 278 | 218 | 199 | 283 | 224 |
| UK (E&W) | 22 | 76 | 13 | 7 | 2 | 3 | 4 | 4 | | 8 | 40 | 0 | 0 | 0 |
| UK (Scotland) | | | | | | | | | | 1 | | 3 | 2 | 0 |
| Total | 2442 | 2721 | 2251 | 2174 | 1657 | 1518 | 1447 | 1331 | 1440 | 2106 | 1581 | 1707 | 1697 | 252 |

* Included in Spanish Landings.

** provisional data

| 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*** |
| Belgium | | | | | | | | | | | | | | |
| France | 46 | 50 | 60 | 52 | 43 | 66 | 64 | 73 | 63 | 97 | 61 | 58 | 89 | |
| Spain | 89 | 92 | 74 | 2 | 1 | 1 | 9 | 5 | 40 | ** | ** | | | |
| Spain (Basque Country) | * | * | * | * | 0 | 2 | * | 0 | 1 | 0 | 1 | 2 | 0 | 0 |
| UK (E&W) | | | | | | | | | | | 3 | 0 | 0 | 0 |
| UK (Scotland) | | | | | | | | | | | | 1 | 0 | 0 |
| Total | 135 | 143 | 134 | 54 | 44 | 69 | 73 | 78 | 104 | 97 | 64 | 61 | 89 | 0 |

* Included in Spanish Landings.

** Included in area VIIIab.

*** provisional data

| 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** |
| Belgium | | | | | | | | | | | | | | |
| France | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| Netherlands | | | | | | | | | | | | 0 | 0 | |
| Portugal | 11 | 7 | 10 | 4 | 4 | 5 | | | 264 | 0 | | 0 | 0 | |
| Spain | 0 | 321 | 345 | 226 | 424 | 978 | 352 | 1004 | 511 | 546 | 430 | | 486 | 489 |
| Spain (Basque Country) | * | * | * | * | 5 | 16 | * | 21 | 21 | 20 | 14 | 9 | 23 | 22 |
| UK (E&W) | | | | | | | | | | | | 0 | 0 | |
| UK (Scotland) | | | | | | | | | | | | 0 | 0 | |
| Total | 11 | 328 | 356 | 231 | 434 | 999 | 352 | 1025 | 796 | 567 | 444 | 10 | 509 | 511 |

* Included in Spanish Landings.

** provisional data

| 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* |
| France | n.a. | n.a. | n.a. | n.a. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Portugal | 1534 | 1512 | 1485 | 1420 | 1528 | 1591 | 1521 | 1598 | 1614 | 1303 | 1544 | 1555 | 1580 | 1314 |
| Spain | 58 | 143 | 197 | 276 | 285 | 416 | 339 | 342 | 325 | 300 | 364 | | 345 | 342 |
| Total | 1592 | 1655 | 1682 | 1696 | 1813 | 2007 | 1860 | 1940 | 1939 | 1602 | 1908 | 1555 | 1925 | 1656 |

| 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* |
| Belgium | 12 | 6 | 11 | 11 | 6 | 11 | 14 | 11 | 8 | 12 | 14 | 0 | 0 | 11 |
| France | 1581 | 1784 | 1564 | 1532 | 1250 | 1157 | 1170 | 1110 | 1233 | 1894 | 1357 | 1564 | 1484 | 0 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 1545 | 1519 | 1495 | 1424 | 1532 | 1596 | 1521 | 1598 | 1878 | 1303 | 1602 | 1555 | 1580 | 1314 |
| Spain | 1019 | 1462 | 1340 | 1181 | 855 | 1471 | 1022 | 1378 | 895 | 855 | 806 | na | 849 | 848 |
| Spain (Basque Country) | * | * | * | * | 302 | 354 | * | 273 | 264 | 298 | 233 | 210 | 306 | 246 |
| UK (E&W) | 22 | 76 | 13 | 7 | 2 | 3 | 4 | 4 | 0 | 8 | 43 | 0 | 0 | 0 |
| UK (Scotland) | | | | | | | | | | 1 | | 4 | 2 | 0 |
| Total | 4179 | 4846 | 4423 | 4155 | 3947 | 4593 | 3732 | 4374 | 4279 | 4372 | 4055 | 3333 | 4221 | 2419 |

* provisional data

**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** |
| Belgium | . | . | . | . | . | . | . | . | 9 | 10 | 13 | . | . | 24 |
| France | 568 | 645 | 762 | 405 | 426 | 426 | 360 | 503 | 708 | 798 | 879 | 821 | 932 | |
| Spain | 0 | 0 | 63 | 0 | 7 | 7 | 28 | 1 | 0 | 0 | 2 | N.A. | 1 | 0 |
| Spain (Basque Country) | 223 | 270 | 336 | 254 | 247 | 277 | 353 | 318 | 254 | 335 | 318 | 247 | 218 | 415 |
| UK (E&W) | | | | | | | | 2 | | 3 | 0 | | 0 | |
| Total | 791 | 915 | 1161 | 660 | 681 | 711 | 741 | 824 | 971 | 1147 | 1211 | 1068 | 1151 | 439 |

| 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** |
| France | 5 | 4 | 5 | 2 | 4 | 5 | 3 | 7 | 7 | 10 | 5 | 4 | 10 | |
| Spain | 0 | 0 | 97 | 0 | 78 | 0 | 0 | 0 | 0 | * | * | N.A. | 0 | 0 |
| Spain (Basque Country) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 |
| Total | 5 | 4 | 103 | 2 | 83 | 5 | 4 | 7 | 7 | 10 | 7 | 6 | 10 | 0 |

* Included in area VIIIab.

** provisional data

| 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* |
| France | 0 | 0 | 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 |
| Spain (Basque Country) | 11 | 8 | 8 | 9 | 5 | 10 | 52 | 65 | 63 | 66 | 73 | 59 | 47 | 30 |
| Total | 428 | 466 | 385 | 458 | 173 | 201 | 120 | 183 | 157 | 211 | 241 | 60 | 198 | 161 |

* provisional data

| 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 |
| Spain | 3 | 6 | 19 | 34 | 30 | 39 | 39 | 69 | 86 | 88 | 92 | N.A. | 76 | 67 |
| Portugal | 667 | 691 | 689 | 882 | 757 | 734 | 673 | 658 | 677 | 385 | 185 | 157 | 120 | 66 |
| Total | 670 | 697 | 708 | 916 | 787 | 773 | 712 | 727 | 763 | 472 | 276 | 157 | 196 | 134 |

| 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* |
| Belgium | . | . | . | . | . | . | . | . | 9 | 10 | 13 | . | . | 24 |
| France | 573 | 648 | 768 | 408 | 431 | 435 | 366 | 513 | 720 | 809 | 884 | 826 | 944 | 0 |
| Spain | 420 | 464 | 555 | 482 | 283 | 234 | 132 | 184 | 174 | 231 | 262 | N.A. | 226 | 199 |
| Spain (Basque Country) | 234 | 278 | 344 | 263 | 253 | 287 | 405 | 384 | 318 | 401 | 392 | 308 | 265 | 445 |
| UK (E&W) | . | . | . | . | . | . | . | 2 | . | 3 | | | 0 | 0 |
| Portugal | 667 | 691 | 689 | 882 | 757 | 734 | 673 | 658 | 677 | 385 | 185 | 157 | 120 | 66 |
| Total | 1894 | 2081 | 2356 | 2036 | 1723 | 1690 | 1576 | 1741 | 1898 | 1839 | 1735 | 1291 | 1555 | 734 |

* provisional data

**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* |
| Belgium | . | . | . | . | . | . | . | . | + | 0,1 | 0,1 | . | . | 0 |
| France | 97 | 115 | 158 | 48 | 142 | 149 | 188 | 321 | 407 | 394 | 437 | 354 | 665 | |
| Portugal | . | . | . | . | + | . | . | . | 1 | 0 | 0 | 0 | 0 | |
| Spain (Basque Country) | 53 | 56 | 57 | 46 | 61 | 58 | 85 | 58 | 56 | 54 | 62 | 45 | 82 | 166 |
| Total | 150 | 170 | 214 | 94 | 202 | 207 | 273 | 379 | 464 | 448 | 500 | 399 | 748 | 166 |

* provisional data

| TABLE 19.3B | SMOOTH HOUND (*MUSTELUS MUSTELUS*)-ICES DIVISION IXA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Portugal | 72 | 39 | 41 | 43 | 50 | 35 | 24 | 11 | 57 | 42 | 34 |
| Total | 72 | 39 | 41 | 43 | 50 | 34 | 24 | 11 | 57 | 42 | 34 |

**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* |
| France | 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 | |
| UK (E&W) | . | . | . | . | . | . | . | . | . | . | 0 | 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 | |

* provisional data

**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.**

| Country | Year | Area | 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 | Raja miraletus | Rostroraja alba | Miscellaneous | 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 |
| Belgium | 2002 | VIIIa,b | | | | | | 15 | 6 | | 0 | | | | | | | | | |
| Belgium | 2002 | VIIIa,b | | | | | | 7 | 2 | | 0 | | | | | 0 | | | 2 | |
| 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 | | | | | |
| 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 | | | | | |

| Country | Year | Area | 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 | Raja miraletus | Rostroraja alba | Miscellaneous | Raja spp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain (Basque Country)* | 2008 | VIII | | 4 | 0 | | 8 | 236 | 52 | | 7 | 0 | | | 0 | | | | | |
| Spain (Basque Country) | 2009 | VIII | | | | | 0 | 155 | 42 | | | | | | | | | | | 50 |
| 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 |
| UK (E & W) | 2009 | VIII | | | | | 0.0 | | 0.3 | | 0.1 | | | | | 0.0 | | | | 0.0 |
| UK (Scotland) | 2009 | VIII | | | | | | | | | 0.3 | | | | | | | | | |

landings based on the average species proportion from 2000 to 2003.

** Landings 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) and PTB (Bottom Pair Trawl) fleets in Subarea VIII.**

| OTB (Bottom otter trawl) | | | | | | |
|---|---|---|---|---|---|---|
| | *Scyliorhinus canicula* | | *Galeus melastomus* | | *Rajidae* spp. | |
| | landings (t) | estimated discard (t) | landings (t) | estimated discard (t) | landings (t) | estimated 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 | 154 | 6 |

*** Landings and discards of rajidae belongs to the species *L. Naevus*.**

| PTB (Bottom Pair Trawl) | | |
|---|---|---|
| | **Scyliorhinus canicula** | |
| | landings (t) | estimated discard (t) |
| 2003 | 9 | 3 |
| 2004 | 14 | 2 |
| 2005 | 4 | 7 |
| 2006 | 7 | 0 |
| 2007 | 15 | 5 |
| 2008 | 8 | 3 |
| 2009 | 10 | 0 |

**Table 19.7. 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 elasmobranches catched by the Basque Country OTB (Bottom otter trawl) and PTB (Bottom Pair 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 |

| 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 |

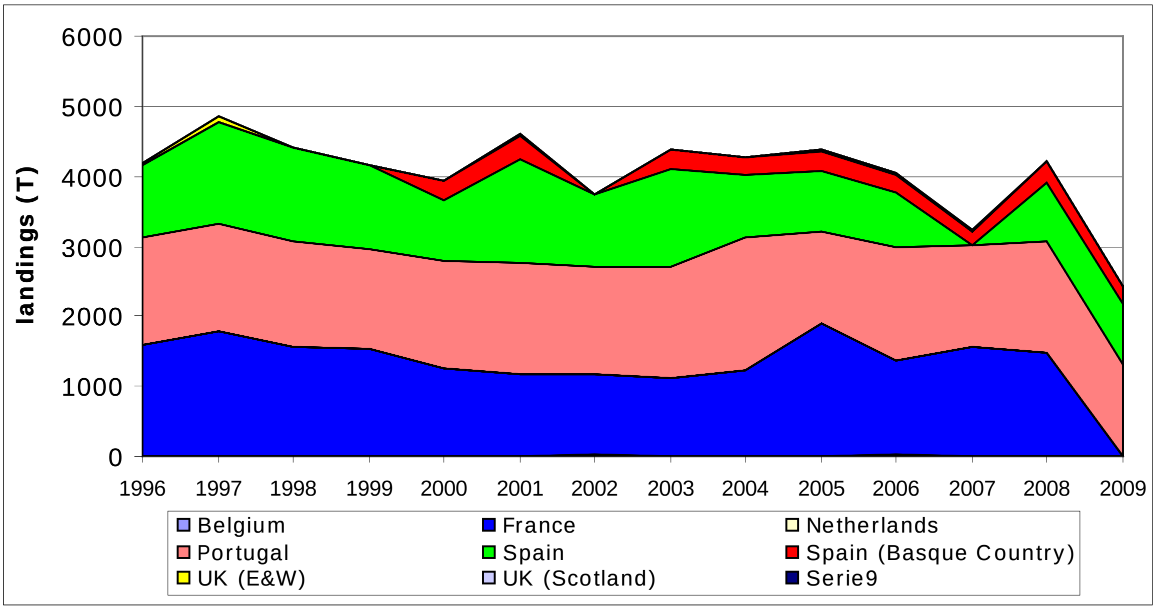



**Figure 19.1. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of *Rajidae* spp in Suabarea VIII and Division IXa. (landings data not available for Spain in 2007 and France in 2009).**

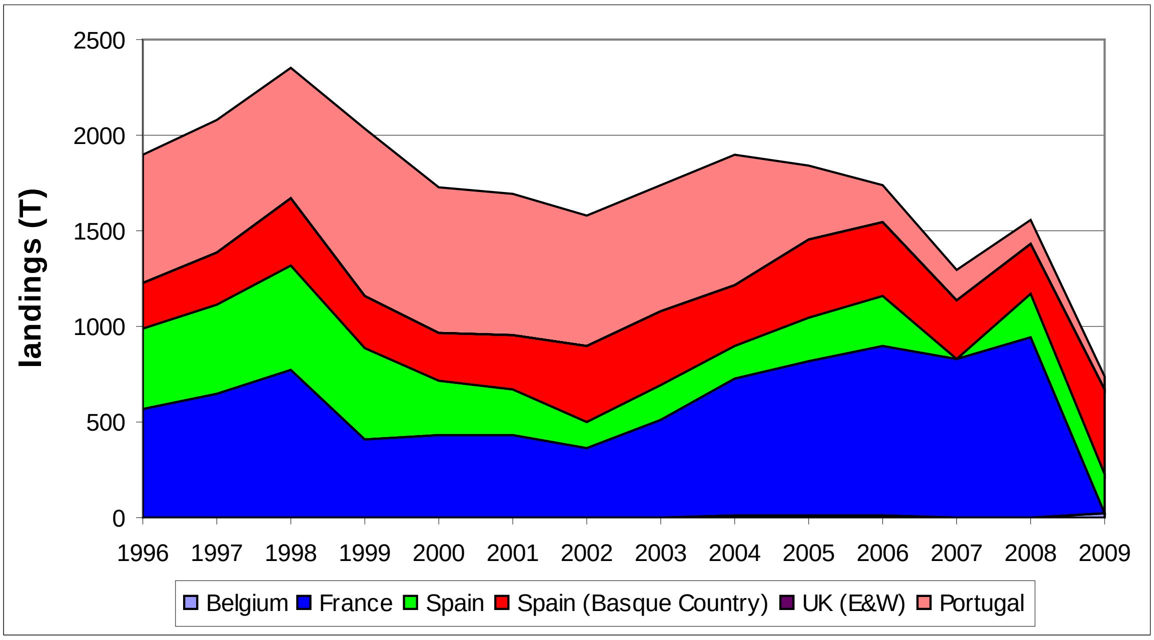



**Figure 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of Lesser-spotted dogfish in Suabarea VIII and Division IXa. (Spanish landings data not available for 2007).**

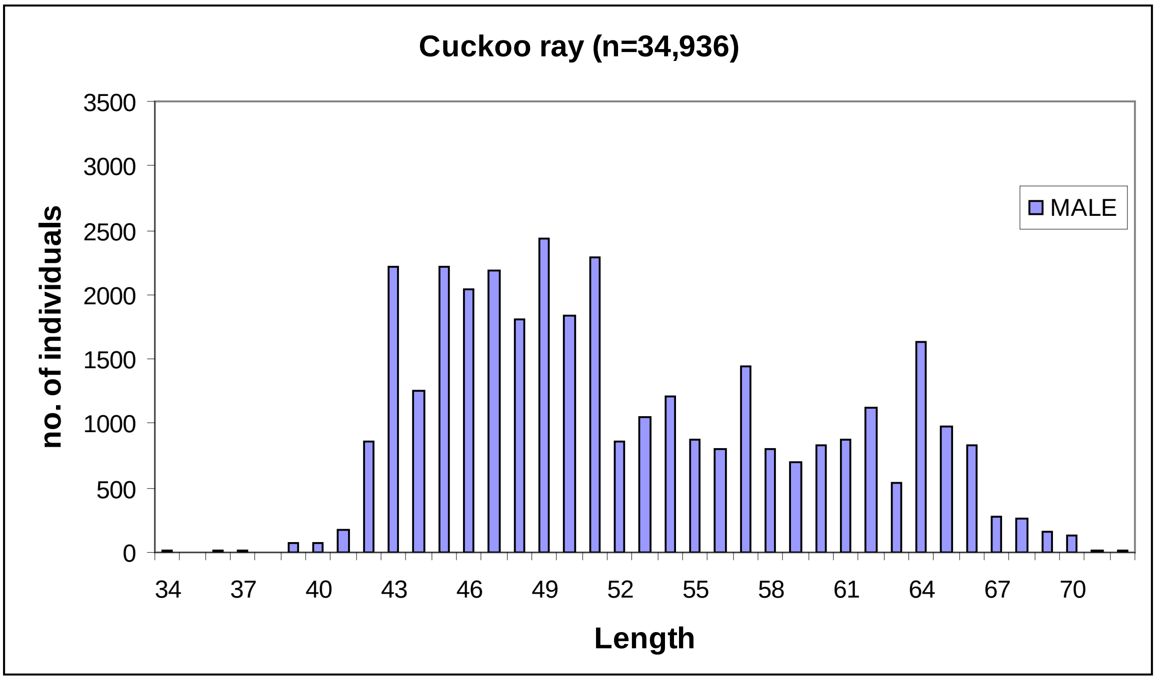
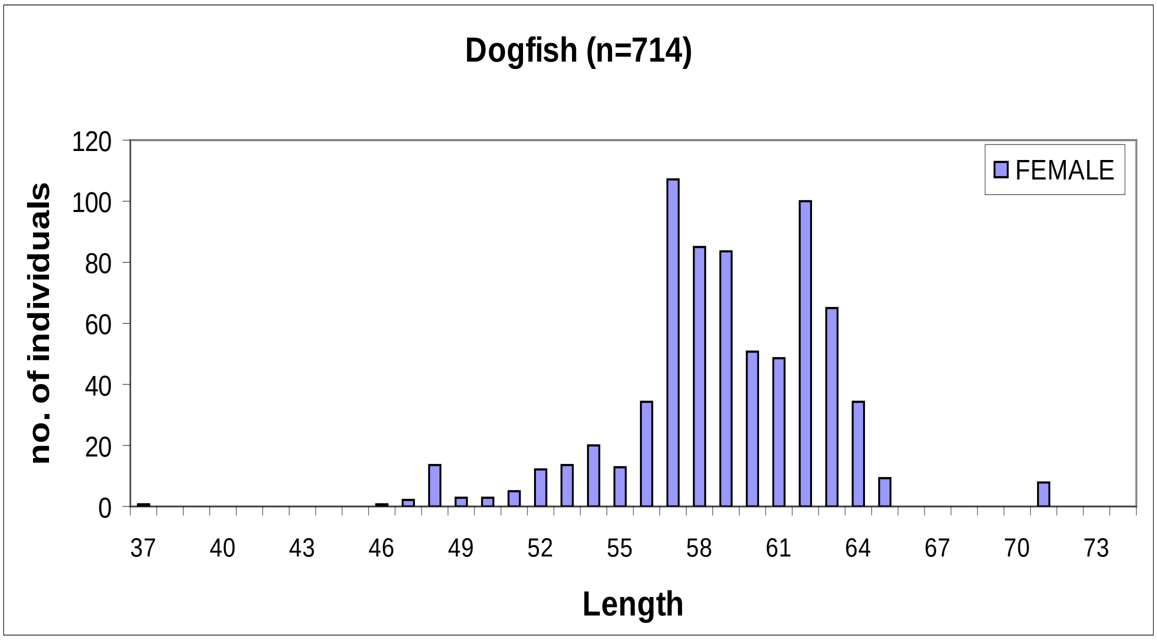



**Figure 19.3a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies by sex of the Cuckoo ray (*L. naevus*) caught in Bay of Biscay in 2009.**



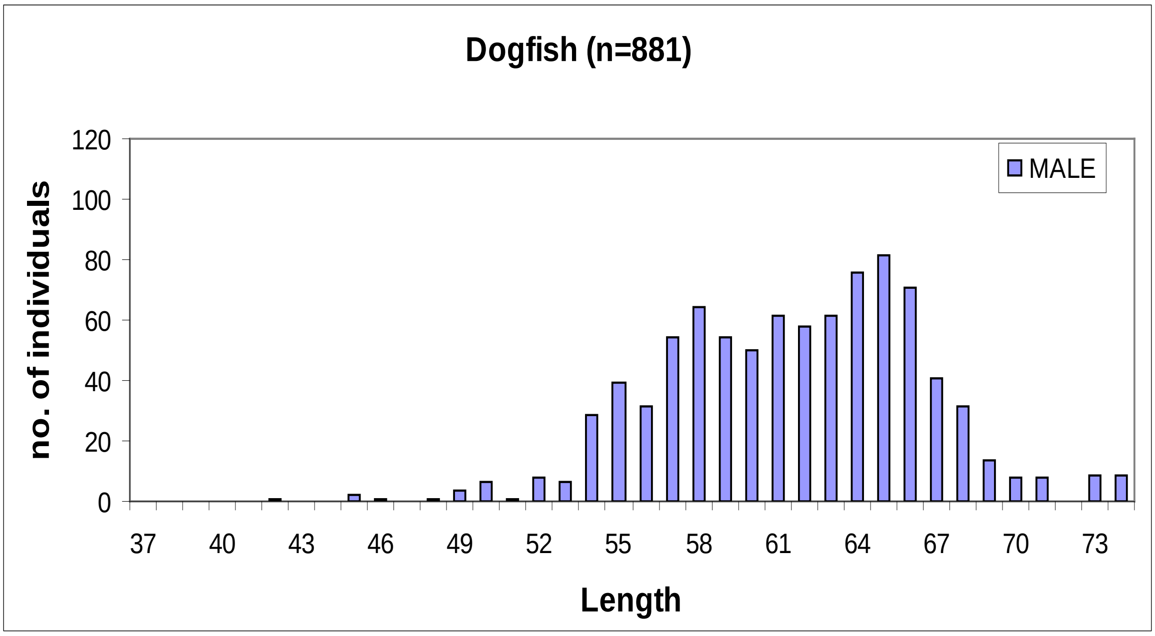




**Figure 19.3b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies by sex of the lesser spotted dogfish (*S. canicula*) caught in Bay of Biscay in 2009.**

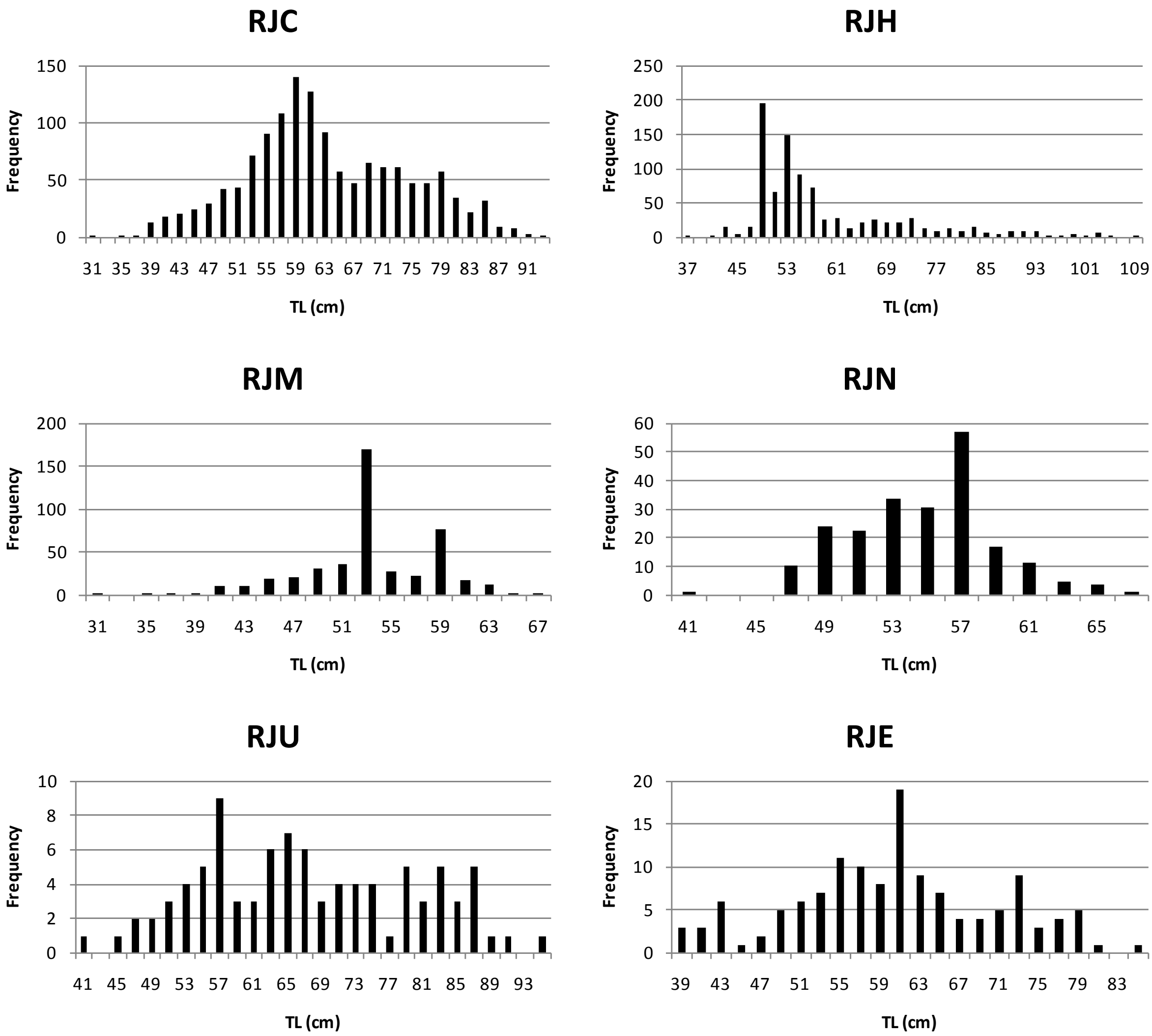



**Figure 19.3c. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequency distribution of skates (*Raja clavata*, RJC; *Raja brachyura*, RJH; *Raja montagui*, RJM; *Leucoraja naevus*, RJN; *Raja undulata*, RJU; *Raja microocellata*, RJE) in Peniche (centre) landing port (2 cm length class; number of sampled trips: 77).**

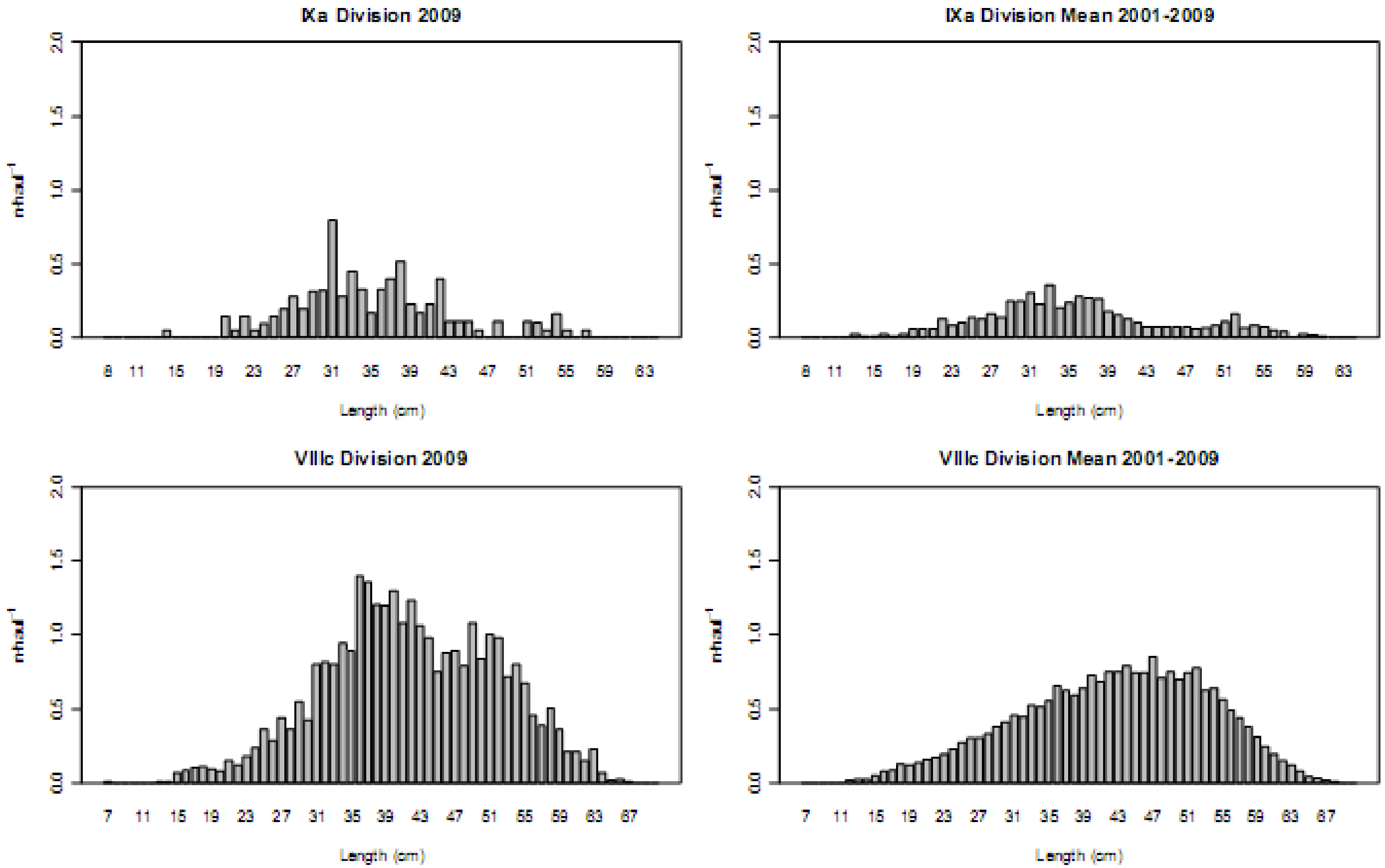



**Figure 19.3d. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *Scyliorhinus canicula* in 2009 in the two ICES divisions covered by the North Spanish Shelf bottom trawl survey, and Mean values for the last decade in both areas (2000–2009).**

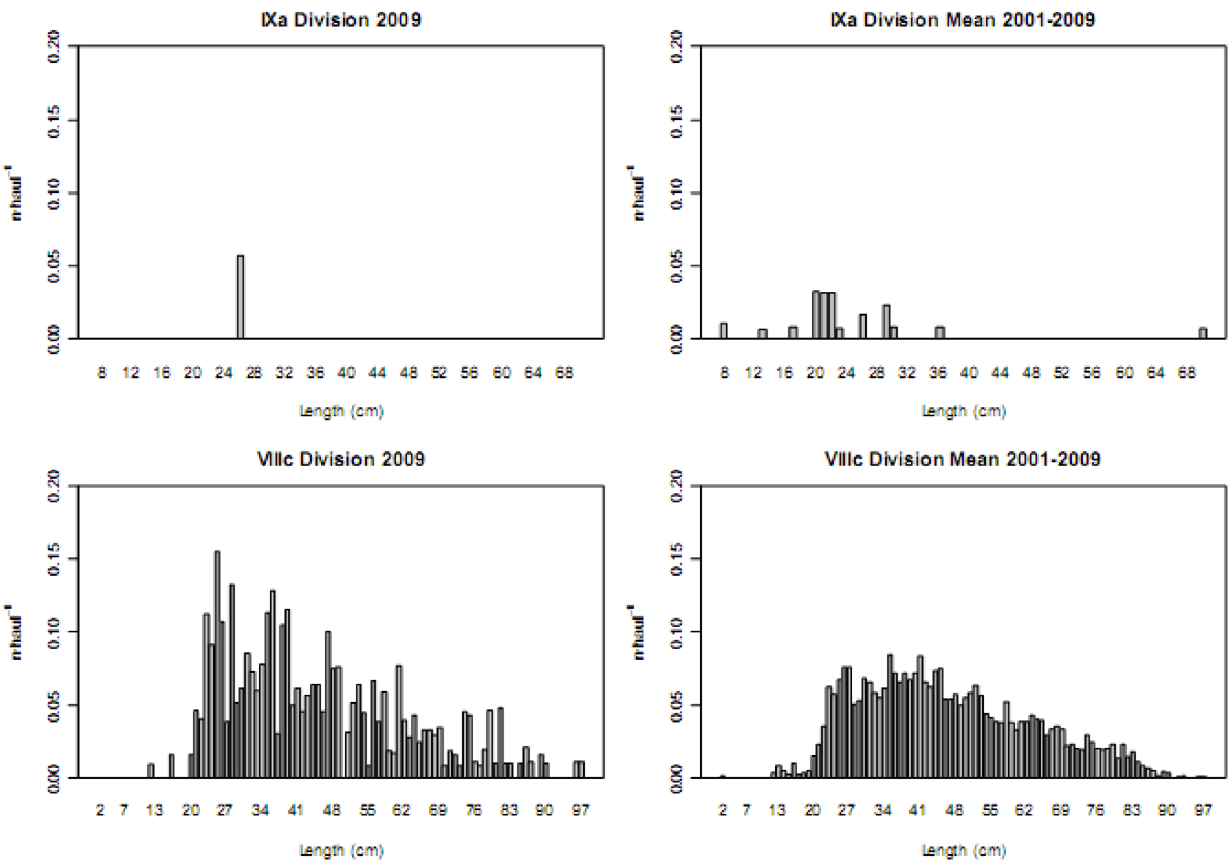



**Figure 19.3e. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distribution of thorny ray (*R. clavata*), in ICES Divisions IXa and VIIIc, during 2009 and mean values during the last decade (2000–2009).**

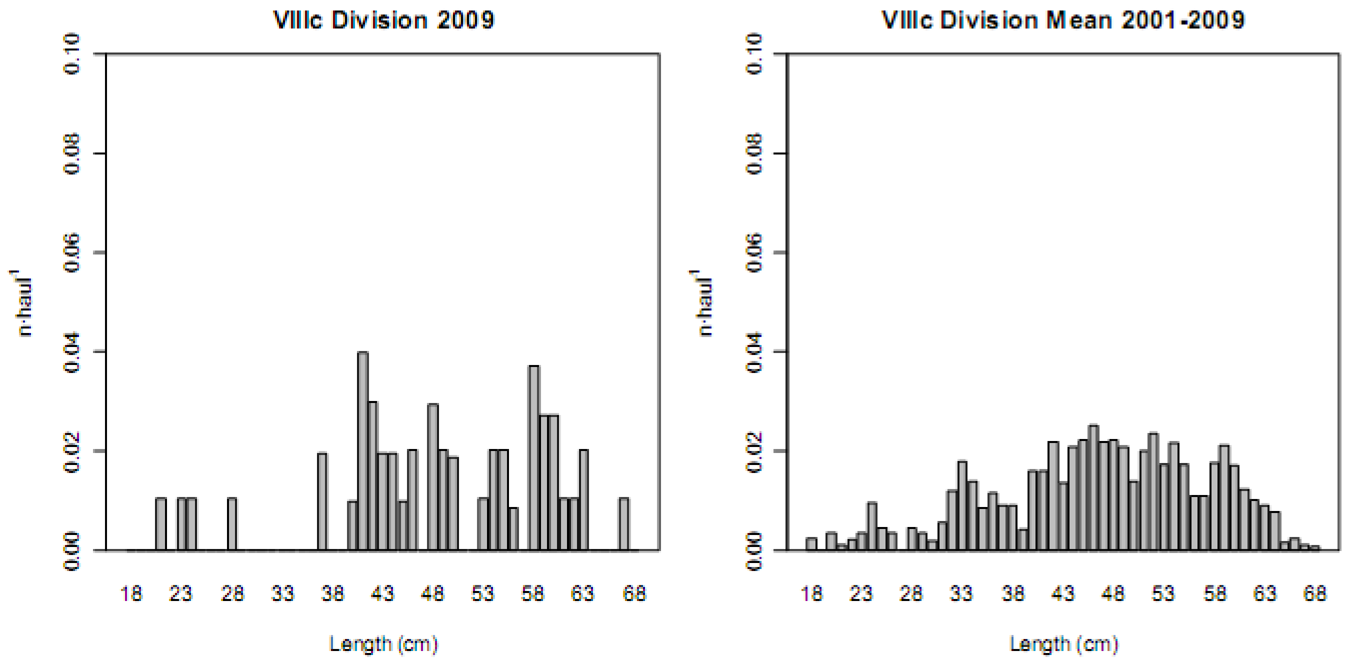



**Figure 19.3f. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *Leucoraja naevus* in 2009 in VIIIc ICES division covered by North Spanish shelf bottom trawl survey, and Mean values for the last decade (2000–2009).**

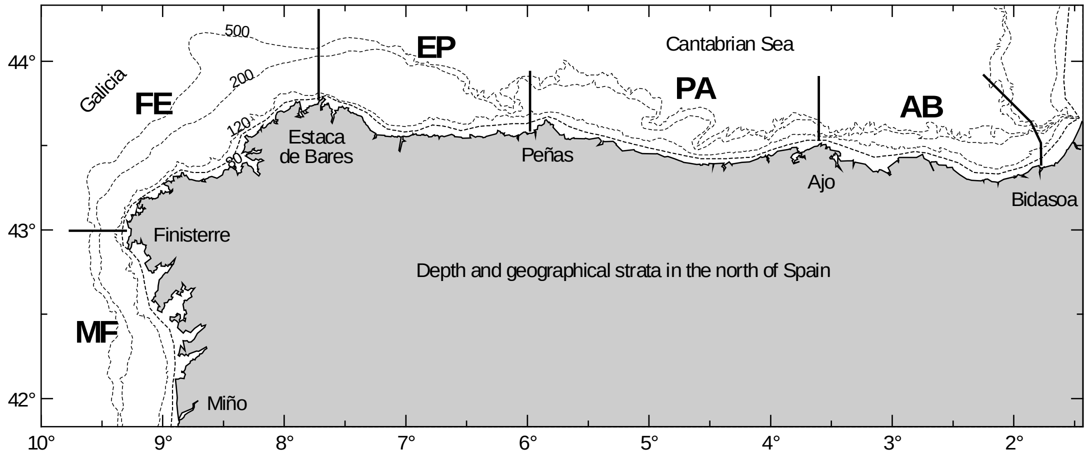



**Figure 19.4. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Design of the IBTS North of Spanish Shelf groundfish survey showing geographical sectors and depth stratification.**

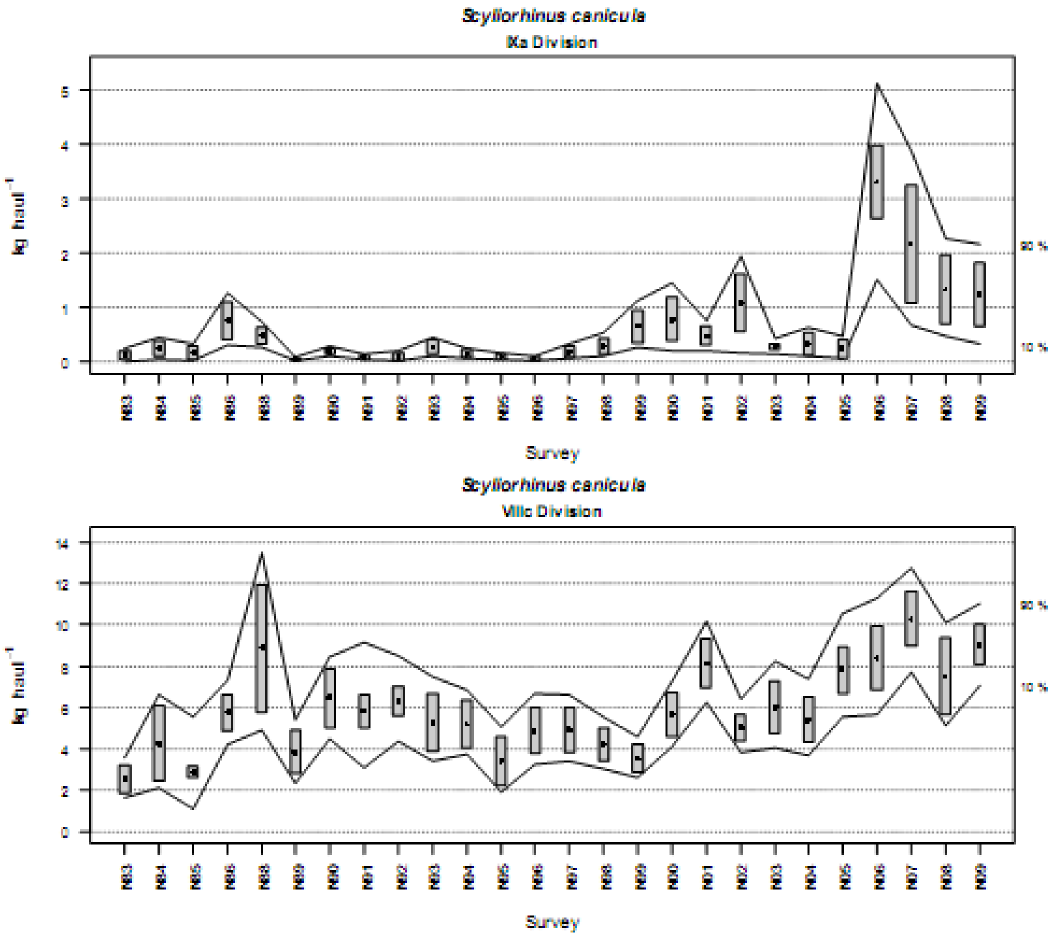



**Figure 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Scyliorhinus canicula*. biomass index during the North Spanish shelf bottom trawl survey time-series (1983–2009 but in 1987) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**

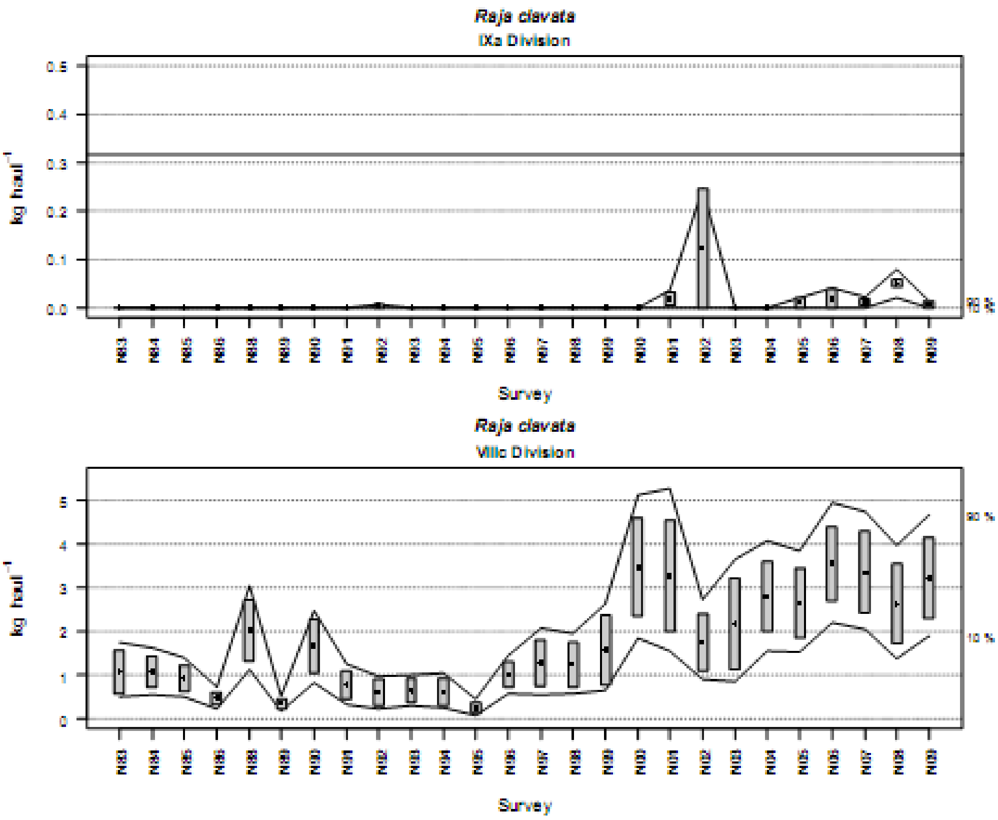



**Figure 19.6. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in thorny ray (*Raja clavata*) biomass indices, in ICES Division IXa and VIIIc, during North Spanish Coast Survey time-series (1983–2009). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**

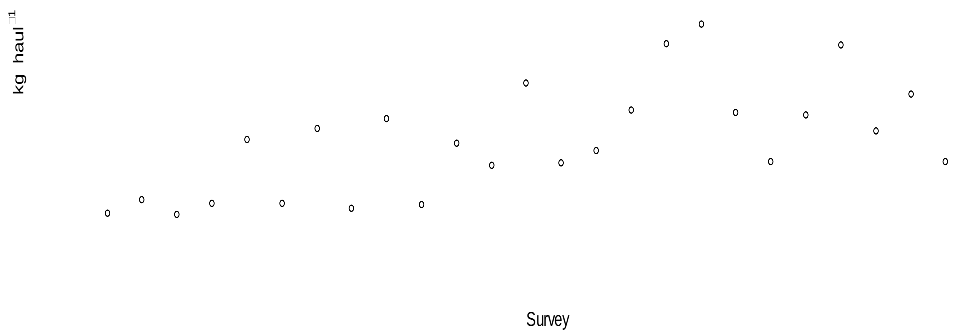
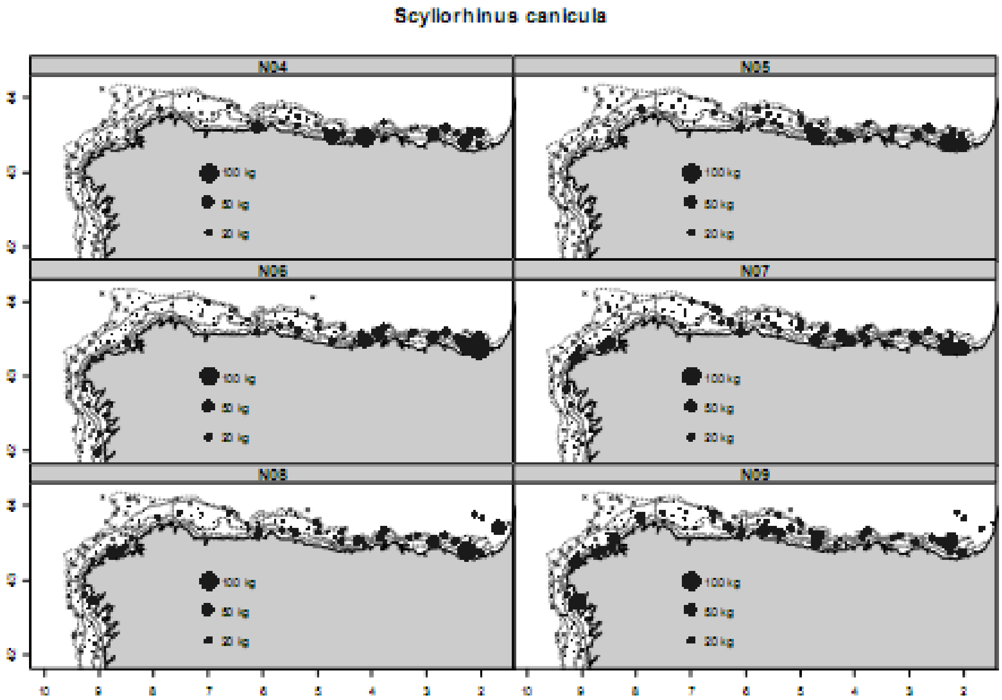
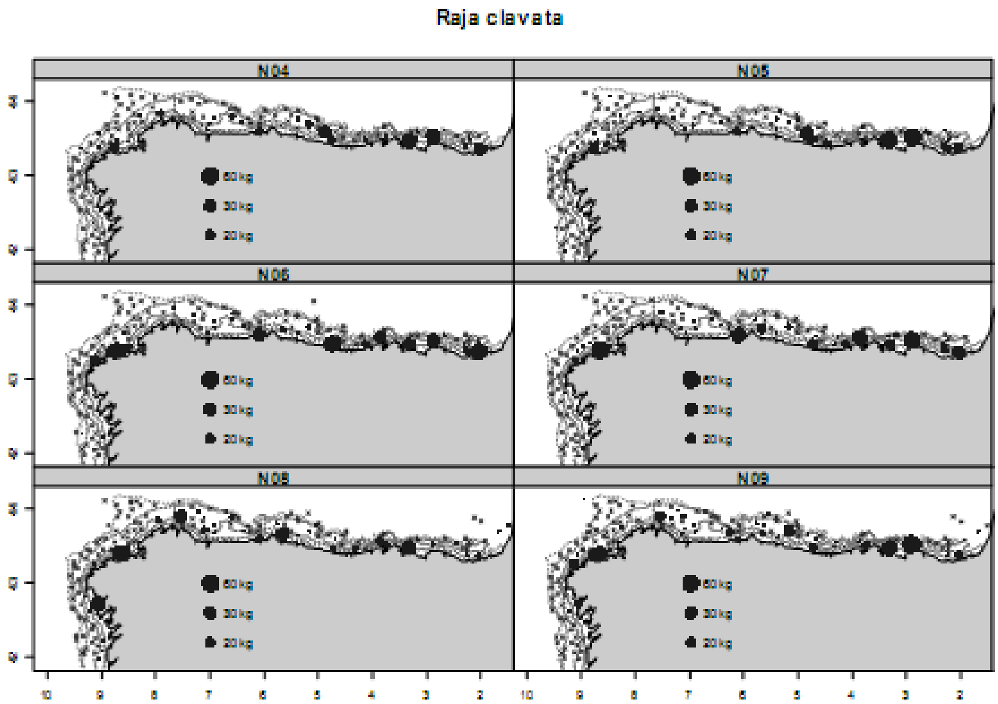


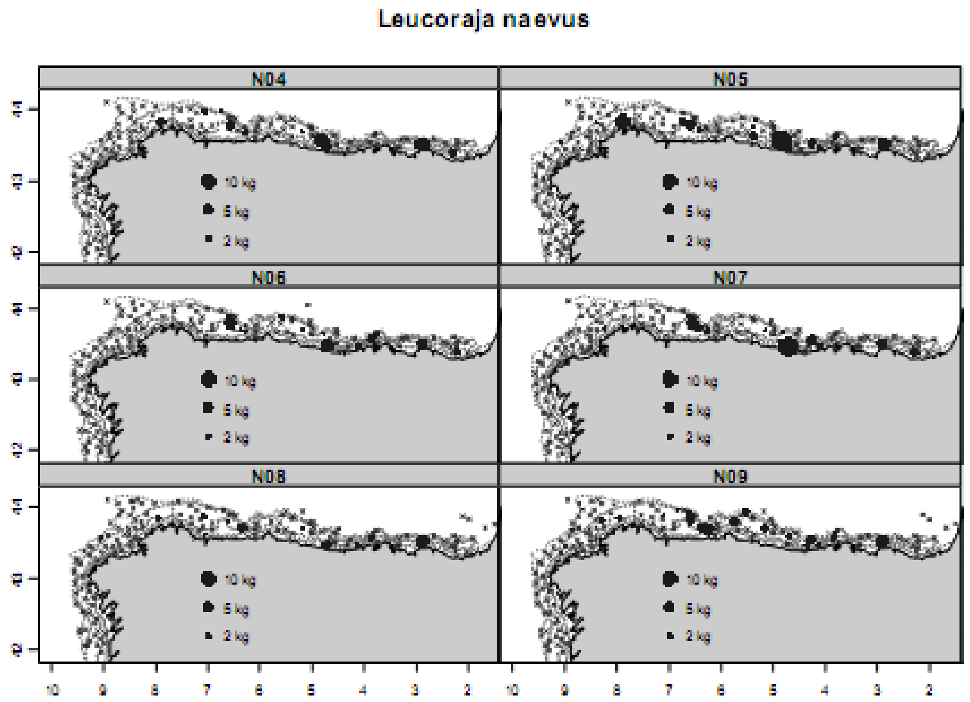

**Figure 19.7. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Leucoraja naevus* biomass index during North Spanish shelf bottom trawl Survey time-series (1983–1986, 1988–2009) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**


Scyliorhinus canicula
N04
N05
N06
N07
N08
N09
100 kg
50 kg
20 kg

a)


Raja clavata
N04
N05
N06
N07
N08
N09
60 kg
30 kg
20 kg

b)




c)

**Figure 19.8a, b and c.** Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. **Geographic distribution of lesser-spotted dogfish (*S. canicula*), thornback ray (*R. clavata*) and cuckoo ray (*L. naevus*) catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2009).**

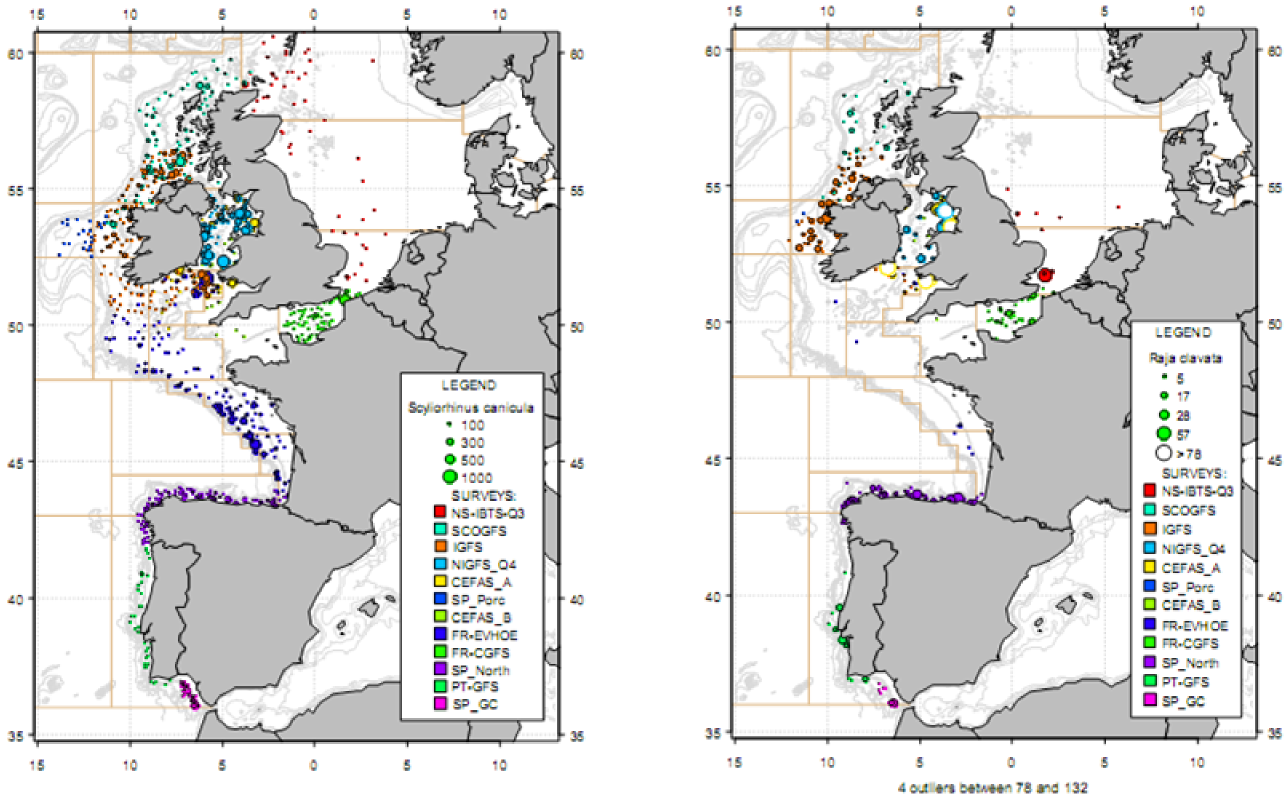



**Figure 19.9a and 19.9b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Catches in numbers per hour of *S.canicula* and *R. clavata* in autumn/winter 2009 IBTS surveys.**

# 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). 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). 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. 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; ICES, 2005).

### 20.2.2 The fishery in 2008 and 2009

During 2009 a Russian pelagic trawl targeting roundnose grenadier reported a by-catch of 0.6t 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, 2010). 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.

### 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). These recommendations include:

- Recommendation III (2006): Since 2006 NEAFC has prohibited fisheries with gillnets, entangling nets and trammelnets in depths below 200 m and introduced measures to remove and dispose of unmarked or illegal fixed gear and retrieve lost gear to minimize ghost fishing;
- Recommendation VII (2009): 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 XVI (2008): The access to the new bottom fishing areas (considered as other areas not mapped as actual existing bottom fishing areas) was limited;
- 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 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.

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 (Reg 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

No new information.

### 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 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.

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.

Following the completion of the Mareco project (http://www.mar-eco.no/) the intention is to fully examine the elasmobranch data from these surveys in WGEF 20011.

## 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

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**Table 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea X.**

| ICES SUBAREA X | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1996 |
| Azores | Rajidae | 48 | 29 | 35 | 52 | 43 | 32 | 55 | 62 | 71 | 99 | 117 | 71 |
| France | Rajidae | | | | | | | 1 | | | | | |
| Spain | Rajidae | | | | | | | . | | | | | |
| Azores | Bluntnose six-gill shark | + | 1 | 1 | 1 | + | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Azores | Sharks | + | + | 4 | 12 | + | n.a. | 138 | 256 | 328 | n.a. | n.a. | 328 |
| Total | | 48 | 30 | 40 | 65 | 43 | 32 | 194 | 318 | 399 | 99 | 117 | 399 |

| ICES SUBAREA X | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Azores | Rajidae | 99 | 117 | 103 | 83 | 68 | 70 | 89 | 72 | 47 | 62 | 71 | 72 | 60 |
| France | Rajidae | | | | | 2 | . | . | . | . | | | 0 | 0 |
| 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 | 0 | 0 |
| Azores | Sharks | n.a. | n.a. | 6 | 18 | 22 | n.a. | n.a. | n.a. | 3 | | 11 | 18 | 10 |
| Total | | 99 | 117 | 109 | 125 | 121 | 77 | 91 | 73 | 51 | 63 | 82 | 91 | 71 |

**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 |

**Table 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XIV.**

| ICES SUBAREA XII | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

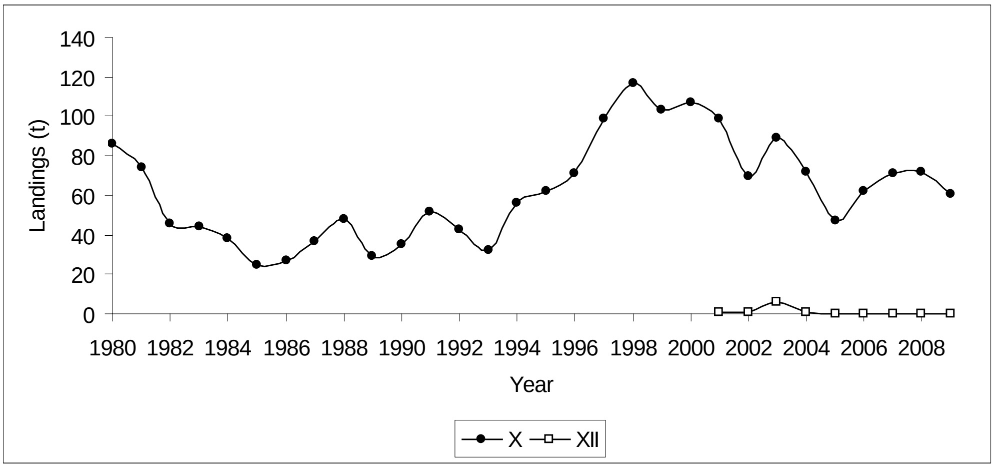


**Figure 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Historical landings of rays from Azores (Ices Subarea X) and MAR (ICES Subarea XII).**

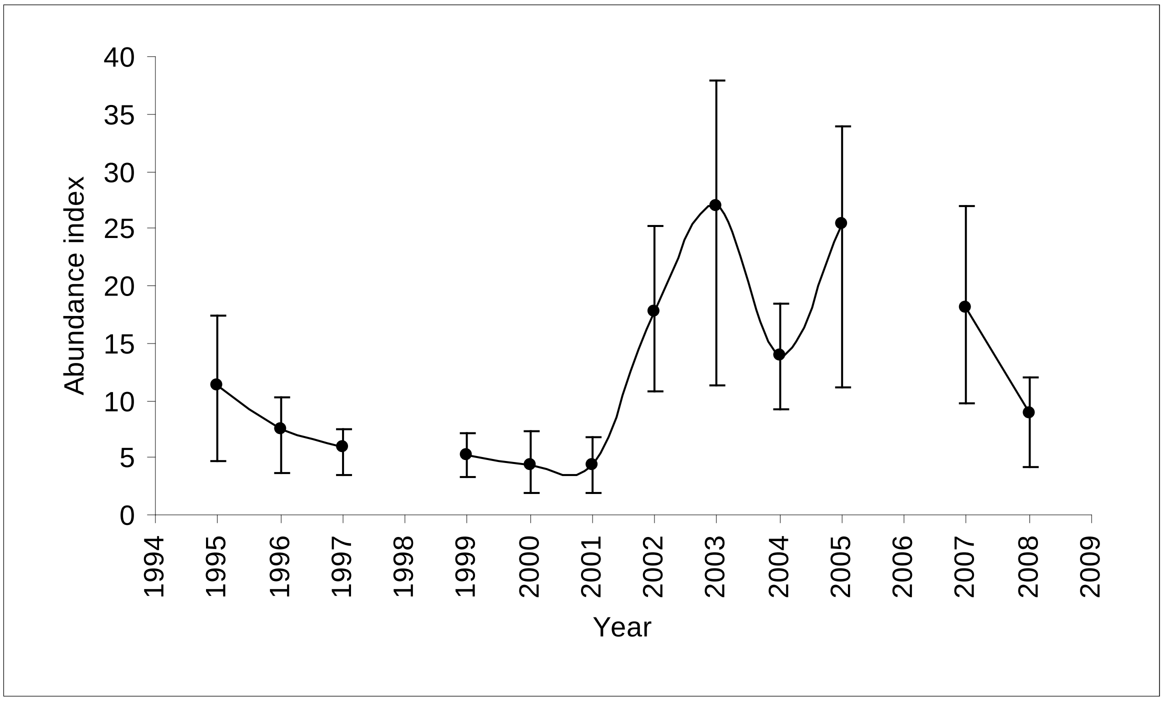


**Figure 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Survey annual abundance,, in number, of *Raja clavata* from the Azores (ICES X).**

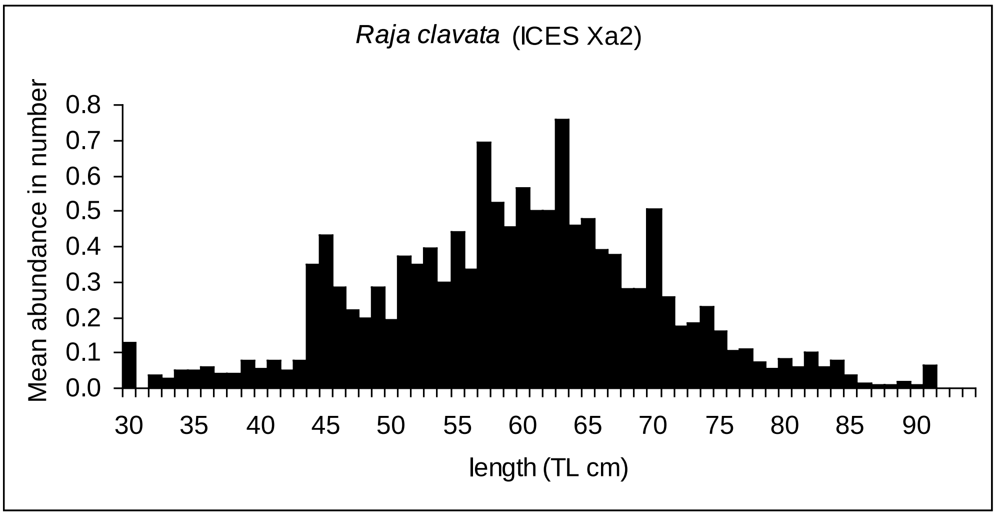


**Figure 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* caught at the Azorean demersal spring bottom longline surveys during the period 1995–2008.**

# 21 Other issues

## 21.1 Changes to the taxonomy of "common skate"

Early ichthyologists had differentiated between the blue or common skate and the flapper skate, although a taxonomic revision of the European skates in the 1920s combined these species as common skate *Raja batis.* Subsequent taxonomic work differentiated the rajids into various genera, with common skate then re-named *Dipturus batis.*

French scientists examining the molecular genetics of skates then detected differences in specimens of "*Dipturus batis*", and subsequently listed distinguishing characteristics for the two species (Iglésias *et al.*, 2010). A subsequent study confirmed these genetic differences (Griffiths *et al.*, 2010).

The nomenclature of the 'common skate complex' is currently being updated, and so the scientific name *Dipturus batis'* will soon be an invalid synonym. Taxonomists working on the problem have proposed that former scientific names should be resurrected for these two species: *Dipturus flossada* and *D. intermedia*, but this proposed change needs to be validated by the International Commission on Zoological Nomenclature (Iglésias *et al*., 2010).

Iglésias *et al.* (2010) also provided some of the morphological and life-history characteristics that may help differentiate the two species (Table 21.1). Although the geographical distributions of the two species are unclear, Griffiths *et al.* (2010) observed that samples from VIa were generally genetically distinct from samples collected in the Celtic Sea, with flapper skate *Dipturus intermedia* and occasional blue skate *D. flossada* and taken in VIa, and *D. flossada* taken on the Rockall Bank and in the Celtic Sea.

**Table 21.1. Preliminary differences between *Dipturus flossada* and *D. intermedia*. Adapted from Iglésias *et al.* (2010).**

| Common name | Blue skate | Flapper skate |
|---|---|---|
| Scientific name | *Dipturus flossada* | *Dipturus intermedia* |
| Eye | Pale yellow iris | Olive-green iris |
| 'Eye spots' on wing | Dark ocellus surrounded by a pale ring | Blotch of pale sports in a group |
| Lateral thorns on the tail | Lateral thorns perpendicular to tail (see Figure 21.1) | Lateral thorns angled |
| Inter-dorsal space | Short | Long |
| Teeth | Base of teeth narrower | Base of teeth broader |
| Length at 50% maturity | 115 cm (male); ca. 123 cm (female) | 185.5 cm (male); 197.5 cm (female) |

**Figure 21.1. Lateral thorns on a "common skate" from the Celtic Sea, in which the thorns are perpendicular to the tail, confirming the presence of *Dipturus flossada* in this area.**

## 21.2 References


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## Annex 2: Suggested WGEF ToRs for 2011

2010/x/ACOMxx The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Graham Johnston, Ireland, will meet at ICES Headquarters, Copenhagen, 22–28 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 FMSY 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 ) Finalise stock annexes for demersal elasmobranchs in the Celtic Seas, and demersal elasmobranchs in the North Sea; and blue shark in the North East 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.

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 24 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 | Update |
| skx-347d | Demersal elasmobranchs in the North Sea, Skagerrak and eastern English Channel | | | y | Update |
| skx-89a | Demersal elasmobranchs in the Bay of Biscay and Iberian waters | | | y | Update |
| dgs-nea | Spurdog (*Squalus acanthias*) in the Northeast Atlantic | | | y | Update |
| por-nea | Porbeagle (*Lamna nasus*) in the Northeast Atlantic | | | y | Update |
| bsk-nea | Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic | | | y | Update |
| cyo-nea | Portuguese dogfish (*Centroscymnus coelolepis*) and leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic | | | y | Update |
| sck-nea | Kitefin shark (*Dalatias licha*) in the Northeast Atlantic | | | y | Update |

## Annex 3: WGEF Recommendations 2010

In the absence of any alternative fisheries-independent data, WGEF recommends that PGCCDBS examine the possibility of a long long-line survey for large pelagic sharks.

It is also recommended that surveys coordinated by IBTSWG, PGNEACS and WGBEAM report catch data on the common skate complex using the updated species names for the two species (see Section 21.1 for further information for some of the morphological characteristics used to distinguish these species).

WGEF recommends to IBTSWG that *Dipturus* species be sampled by species. WGEF will provide sampling protocols/guides.

Trawl surveys could usefully provide information on catches of viable (i.e. containing yolk or embryos) skate egg-cases, and it is recommended that IBTSWG and WGBEAM be asked to record the numbers of viable skate egg cases (by species where possible) in future trawl surveys.

WGEF is to liaise with Russian delegate to obtain historical Russian deep-water survey and landings data.

WGEF has, for several years, used North Sea Q1 IBTS indices of abundance for several elasmobranch species. WGEF recommends that these indices be provided by the ICES Secretariat annually. Ideally the information should consist of:

- an overall index of abundance (all length classes combined) per roundfish area;
- the length distribution by roundfish area;
- N-at-length per ICES rectangle.

These indices should be calculated as other IBTS indices: 1) average per ICES rectangle, 2) then average per roundfish area, 3) then average over total North Sea.

WGEF recommends a Workshop to establish splitting ratios for deep-water sharks. This should involve members of the Fishing Industry and statistical experts to discuss how to deal with these historical data.

# Annex 4: Stock Annexes

## Kitefin in the North East Atlantic and Mediterranean

### Stock distribution

Kitefin (*Dalatias licha*) is widely distributed. It is a warm temperate and tropical cosmopolitan species found between 60º N and 48º S. It is an epibenthic species, but often ranges well-off the bottom, living at depth ranging from 40 to 1800 m (Compagno, 1984). In the Eastern Atlantic it is found from Iceland to Cameroon (Iceland, Scotland, and Irish Atlantic slope to Morocco, western Mediterranean, Azores, Canaries and from Madeira to Cameroon) (Compagno, 1984; Krefet and Tortonese, 1973).

It is also found in the Western Atlantic (Georges Bank and northern Gulf of Mexico), Western Indian Ocean (Mozambique and South Africa), Western Pacific (Japan, Autralia, and New Zealand) and in the Central Pacific (Hawaii).

WGEF considers there to be a single-stock of kitefin (*Dalatias licha*) in the ICES area. The stock area covers ICES Subareas V–X. 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. For assessment purposes the Azorean stock (ICES Subarea X) is considered as a management unit.

### The fishery

Historically an important target fishery was in place in the Azores from the seventies to the end of the nineties. A detailed description of the fisheries can be found in Heessen, 2003; ICES, 2003 and Machado *et al*., 2004.

Currently there are no targeted commercial fisheries for kitefin in the northeastern Atlantic, though they are taken as a bycatch in trawl and hook and line fisheries. Most of the landings nowadays are a residual bycatch from the Azorean demersal mixed hook and lines fisheries (Subarea X) (ICES, 2008).

As for almost all deep-water sharks around the Azores species misidentification may occur on the catch and landing statistics (Pinho, 2005).

### Catch data

#### Landings

Landings by country and subarea have been reported to ICES (Table 1). For most countries *Dalatias licha* may be reported under a mixed deep-water sharks' category or when species-specific landings are reported misidentification may occur. The degree of possible misreporting or underreporting is however not known.

#### Discards

Discards are suspected to occur on the Azorean longliners because the distribution of the stock matches with the fishing area and effort distribution of deep-water fisheries (Pinho, 2005).

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).

#### Quality of catch data

Landings data in the Azores is collected on the auctions and kitefin data may be considered of reasonable quality. However, 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 in general. The Azorean landings data reported to ICES come exclusively from the commercial first sale of fresh fish on the auctions. Therefore, data reported may be an underestimate of total landings (Pinho, 2005).

Biological data is not collected on the port sampling program under the Data Collection Regulations. Some generic biological data are available (Silva, 1988).

#### Commercial catch composition

Data is collected by species on the Azores auctions. However, for deep-water sharks misidentification is a problem.

### Commercial catch-effort data

There are very limited cpue data available for the ICES area and corresponds to the historical Azorean fishery (see Heessen, 2003 and ICES, 2003).

### Fishery-independent information

Survey data is very limited because the existing surveys on the North East Atlantic rarely catch kitefin shark. In the Azores only 25 individuals were caught during the last ten years from the annual Spring Demersal Longline Survey (Pinho, 2005 WD; Menezes *et al*., 2006). The species was also not frequent on other punctual surveys using different gear configuration (Menezes *et al*., 2009).

#### Cpue

There are very limited cpue data available for the ICES area and corresponds to the historical Azorean fishery (see Heessen, 2003 and ICES, 2003).

#### Length distributions

Length data in the Azores region (ICES Area X) was not collected in a systematic way along time. Length data available from the fishery was punctually collected from 1982 to 1987 and was reported by Silva (1988). Males length frequency range from 98 cm (age 5) to 132 cm (age 13), with a mode on 115 cm (age 9), and females from 119 cm (age 6) to 162 cm (age 25), with a mode on 142 cm (age 11).

### Life-history information

There is very limited biological information reported for this species and there is no routine monitoring of length, weight and maturity-at-age for either survey or commercial catches. The biology of the species is poorly known. The available biological information on Growth and reproduction was reported by Silva (1988).

Kitefin is a viviparous, non-placental species, without uterine compartments and continuous reproduction. In the Azore area copula might occur during August and September and embryonic development is estimated to take about two years which corresponds to a length at birth of 42cm (t=0, Lt=42cm). Males length frequency range from 98 cm (age 5) to 132 cm (age 13), with a mode on 115 cm (age 9), and females from 119 cm (age 6) to 162 cm (age 25), with a mode on 142 cm (age 11).

## Exploratory assessment models

### Previous studies

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 bottomnets 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 $B_{MSY}$.

### Data exploration and preliminary modelling

### Stock assessment

No new assessment of the species status was undertaken in 2010, because no new data were available.

## Quality of assessments

No new assessment of the species status was undertaken in 2010, because no new data were available.

## 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).

## Management considerations

Kitefin is considered highly vulnerable to overexploitation, as they have a low population productivity, relatively low fecundity and protracted reproductive cycle.

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**Table 1. Landings of Kitefin in the North East Atlantic (Tonnes) for the period 1988–2009.**

| Country | Sub-area | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | VII, VIII | . | . | . | . | . | . | . | . | . | . | . |
| UK Scotland | Vb, VI | . | . | . | . | . | . | . | . | . | . | . |
| UK (E&W) | VI, VII,VIII | . | . | . | . | . | . | . | . | . | . | . |
| Ireland | X | | . | . | . | . | . | . | . | . | . | . |
| 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 1. (continued). Landings of Kitefin in the North East Atlantic (Tonnes) for the period 1988–2009.**

| Country | Sub-area | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 6 |
| Total | | 45 | 313 | 189 | 40 | 144 | 9 | 47 | 21 | 14 | 11 | 6 |

## Basking shark in the Northeast Atlantic (ICES Areas I–XIV)

### Stock distribution

In the eastern Atlantic, *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) indicicates panmixia; whereas Noble *et al*. (2006) suggested little gene flow between populations in the northern and southern hemispheres. A rough estimates the population size was given by Hoelzel *et al*. (2006). Migration and mixing levels have yet to be fully determined.

### The fishery

#### History of the fishery

Norwegian fishers have always been the major catchers of basking sharks in the Northeast Atlantic. The fishery started off Namdalen and Hitra in 1760 (Moltu, 1932) and spread south to Møre and Romsdal. Strøm, 1762 also describes this fishery and claims it started before 1750 in northern Norway and spread southerly to Møre (western Norway). The fishery started close to shore but after a while the landings decreased and the fishery moved further from shore. According to Moltu, 1932 the fishery peaked in 1808 and the best fishing areas were between Romsdal and Storegga. After some years the fishery ceased, and in 1860 it ended. The fishery generally started around April and May, occasionally as early as March, peaking in June and finished by August or, less commonly, September (Myklevoll, 1968). Basking sharks were caught using hand-held harpoons from open boats. The fleet was composed of small wooden vessels 15–25 feet in length, which were sometimes used for hunting small whales as well as basking sharks (Kunzlik, 1988).

In 1920 the fishery resumed and the fishery employed more modern fishing gear and vessels. Basking sharks were harpooned by cannons mounted on steam vessels or smacks (Rabben, 1982–1983). This technology was developed for whaling and remained in use for basking sharks until the fishery was closed in 2006.

The Norwegian fleet conducted local fisheries from the Barents Sea to the Kattegat, as well as more distant fisheries ranging across the North Sea and south and west of Ireland, Iceland and Faroes. Norwegian fishers were fishing for porbeagle off the Scottish coast as early as 1934, and they started fishing for basking sharks in the immediate post-war years following the establishment of several native Scottish fisheries. Similarly, Norwegian vessels took basking sharks in Irish waters after the Second World War. The landings increased during the 1930s as the fishery gradually expanded to offshore waters. The main reason was that new markets were developed and thereby the demand for basking shark oil increased. 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).

McNally, 1976 and Parker and Stott, 1965 described two basking shark fisheries off the Irish west coast. Large numbers of basking sharks were taken by small boats on the 'Sunfish Bank' for several decades between 1770 and 1830. The season only lasted for a few weeks in April and May, but at least 1000 individuals may have been taken each year at the height of the fishery. In the early 1830s, sharks became very scarce. Despite continued high prices for 'sunfish' (basking shark) oil, the fishery collapsed in the second half of the 19th century. Basking sharks were next recorded in abundance around Achill Island in 1941 and a new fishery started 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, the last year in which shark catchers were employed. From 1957 onwards, continued declining sightings and catches made the fishery less profitable for the free-lance fishers who took over from them. 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.

Fairfax, 1998 summarized the limited information available on the earlier 18th and 19th century fisheries in Scotland. These appear, like the Irish fishery, to have ceased by the mid-1830s with large numbers of sharks not being reported again until the 1930s. Fairfax, 1998 and Kunzlik, 1988 describe the 20th century Scottish basking shark fisheries, which concentrated on the Firth of Clyde and West coast. Several small fisheries started up in the 1940s, some targeted basking shark full-time during summer, and others were more opportunistic. These took in all ~970 sharks between 1946 and 1953 (during a period when Norwegian vessels were also catching basking sharks in these waters).

Oil prices rose again in the mid-1970s. About 500 sharks were taken off eastern Ireland in 1974–1975, Norwegian catchers took several hundred sharks in 1975, some Clyde basking shark bycatch was processed in the late 1970s, and a small target harpoon fishery started again in the Clyde in 1982. Initial yields from the latter were good, but these were extremely short-lived and the fishery ceased at the end of 1994 after several years of poor catches and taking in all 333 sharks (Fairfax, 1998).

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).

More recent data on the price changes for basking shark fins are from the Norwegian Directorate of Fisheries, and cover the period from 1979 to 2008. This reveals that the nominal value of fins increased dramatically from 12 NOK per kg in 1979 to 165 NOK per kg in 1992, varied between 108 NOK and 203 NOK per kg during 1993–2005, and has decreased after 2005 (Figure 7.2). The inflation adjusted value of fins varied from 18 NOK per kg to 253 NOK per kg during 1990–2007, but has decreased considerably after 2005.

## Catch data

### Landings

Landings data within ICES Areas I–XIV from 1977–2009 are presented in Table 7.1, and Figure 7.3. The Table and Figure include landings data from UK (Gue.) (1984 and 2009), Portugal (1991–2009), France (1990–2009) and Norway (1977–2009). 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.

Table 7.2 demonstrates the Norwegian landings of liver and fins, official landings in live weight, revised landings in live weight (ICES WGEF 2008), and estimated numbers of landed individuals based on landings of liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins of basking shark from 1977–2007.

Table 7.3 demonstrates the proportions (%) of basking sharks caught by various gears as reported to the Directorate of Fisheries in Norway from 1990–2008. 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.

#### 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 extrapolated from very limited observer data to suggest that 77–120 sharks may be taken annually in the bottom-set gillnet fishery in the Celtic Sea (south of Ireland), though the reliability of this estimate has been questioned. Berrow and Heardman, 1994 received 28 records from fishers of sharks entangled in fishing gear (mostly surface gillnets) around the Irish coast during 1993, representing nearly 20% of all records of the species that year. At least 22% of basking shark bycatch in fishing nets died.

Bycatch in the Isle of Man herring fishery has amounted to 10–15 sharks annually, and a further bycatch source here is entanglement in pot fishers' ropes, amounting to some 4–5 sharks annually. Fairfax, 1998 reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter. Valeiras *et al.*, 2001 reported that of twelve reported basking sharks that were incidentally caught in fixed entanglement nets 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. In contrast to the coastal bycatches, extrapolation of observer data from oceanic gillnet fleets suggests that bycatch in these fisheries is very small; only about 50 basking sharks were among the several million sharks taken annually offshore in the Pacific Ocean (Bonfil, 1994).

During 2007–2009, five specimens of basking shark were caught and discarded by the Norwegian Coastal Reference Fleet (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.

#### Quality of catch data

The official Norwegian conversion factors used to convert from liver weight and fin weight to live fish weight were 10.0 for liver and 100.0 for fins, respectively up to 2007. These conversion factors were too high, and in 2008 the Norwegian conversion factors were revised by the Norwegian Directorate of Fisheries, and they are now 4.64 for liver and 40.0 for fins. Hence, the official Norwegian live weights reported from 1977 to 2007 were overestimated. Landed liver weights constituted the basis for the official catch statistics from 1977 to 1995, and from 1996 landings of fins have constituted the basis for the official catch statistics. A revised Norwegian catch statistics for basking shark is given based on landings of liver from 1977 to 1992 and landings of fins from 1993 to 2008 applying the revised conversion factors 4.64 for liver and 40.0 for fins (Table 7.2) The official Norwegian catch statistics will not be changed between 1977 and 1999, but from 2000–2008 the revised catch figures are applied.

### Commercial catch composition

The median weights of liver and fins of 56 probable individual basking sharks caught in Norway during 1992–1997 were 648.5 kg and 71.5 kg, respectively (Figure 7.4). Minimum and maximum weights for liver and fins were 45.0 kg and 974.0 kg and 6.0 kg and 110.0 kg, respectively.

The median estimated live weights of the same individuals were 3009 kg and 2860 kg from liver and fins weights, respectively (Figure 7.5). Minimum and maximum estimated weights were 209 kg and 4519 kg based on liver weights, respectively, and 240 kg and 4400 kg based on fin weights, respectively. This indicates that individuals >2500 kg dominated the catches taken by Norwegian fishers during 1992–1997.

### Commercial catch-effort data

There are no effort or cpue data available for the latest years, as there has been no targeted fishery. Hareid (2006 WD) estimated the numbers of Norwegian vessels involved in this fishery and the landings for 13 of the years between 1965 and 1985. These were used to calculate a simple estimate of effort. The largest number of vessels participating in this fishery was 70 vessels in 1978. Based on total landings and number of vessels participating in the fishery an estimate of cpue was generated for the years 1965–1985 (Table 7.4). For this period there was a significant decrease in cpue. This cpue series can be considered an underestimation of the decline in the abundance because the area fished expanded during this period.

### Fishery-independent surveys

Several countries, e.g. Norway and Denmark, 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.

### Life-history information

Most of the information in this Section is summarized from the review on basking shark by Sims *et al*. (2008).

#### Habitat

In the eastern Atlantic, *C. 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).

Basking sharks have a strong tendency to aggregate in coastal areas of continental shelves dominated by transitional waters between stratified and mixed water columns (Sims *et al*., 2005b). It has been argued that basking shark hibernate during the winter in a non-feeding state (Matthews, 1962; Parker and Boeseman, 1954), but this has been disputed by recent data from studies using satellite tags (Sims *et al*., 2003b;

Sims *et al*., 2005b; Skomal *et al*., 2004; Gore *et al*., 2008). All tagged sharks remained on the continental shelf and in shelf-edge habitats during the periods they were tracked, except for one animal crossing the Atlantic to Newfoundland, Canada (Gore *et al*., 2008). There were also indications of seasonal movements, northerly in early summer and southerly in late summer and autumn, in the North Atlantic (Sims *et al*., 2003b; Skomal *et al*., 2004).

In 1993 a sighting scheme was established to determine distribution and abundance of basking shark in Irish coastal areas. The concentrations given by Berrow and Heardman, 1994 are based mainly on sightings made in 1993 correspond to historical accounts from the same area.

Since 2003, the French Association Pour l'Etude et la Conservation des Sélaciens (APECS) has surveyed the migrating basking sharks off the Atlantic coast of France, by recording sightings and using satellite tags.

Doyle *et al*., 2005 presented the results of a public sightings record scheme for basking sharks, primarily in UK waters. The lack of effort information for the great majority of these records limited the application of these data. Other fishery-independent information currently being collected includes the photo-identification of individual sharks and the use of archival tags to track basking shark movements (e.g. Sims *et al*., 2005a; Southall *et al*., 2005).

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 the winter to the west coast of France (Figure 7.6). 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 7.6) The greatest depths recorded were 144 m and 136 m, respectively, showing 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 showed 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*., 2003b). It is hypotesized 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 months to find sufficient food.

There is no clear evidence to indicate differential distribution in the basking shark (Sims *et al*., 2008). Juvenile (2–3 m total length, LT) and putative sub-adult (3–5 m LT) sharks have been frequently observed in the same areas and summer-feeding aggregations as adults (Berrow and Heardman, 1994; Sims *et al*., 1997). Similarly, whether sexual segregation of the population occurs has not been shown unambiguously.

Males and females have been observed in the same areas during summer (Matthews and Parker, 1950; Maxwell, 1952; O'Connor, 1953; Sims *et al*., 2000a; Watkins, 1958), although more females than males have been caught in directed fisheries (Kunzlik, 1988) suggesting females may segregate from males, at least when they occur at the surface. Pregnant females are virtually unknown from these same locations so differential habitat utilisation by mature males and females at certain times in the reproductive cycle may well occur.

Importantly in relation to conservation surveys, recent data on vertical movements of basking shark indicate that the probability of sighting them at the surface is dependent on habitat type and prey behaviour and may differ by several orders of magnitude (Sims *et al*., 2005b). The chances of sighting a basking shark in frontal zones are some 60 times higher than in thermally well-stratified areas. These habitat-specific differences in surface occurrence may impact public sightings and research surveys aimed at monitoring numbers in different areas (Sims *et al*., 2008).

#### Reproduction

The basking shark is thought to be ovoviviparous (Matthews, 1950), and foetuses are suggested to be oophagous (Sims *et al*., 2008). Fertilisation is internal, as in all other sharks. From anatomical examinations of fishery-caught individuals, it is hypothesized that in the northeast Atlantic in U.K. waters, mating occurs during summer months (Matthews, 1950). The gestation period is not known with any certainty, but estimates as high as 3.5 years have been proposed (Parker and Stott, 1965). Only one published record of a pregnant female exists, from the western coast of Norway in August 1936. During towing she gave birth to six pups of 1.5 to 2.0 m, of which one was stillborn. If this number of pups is representative, it has a low fecundity even when compared to other relatively large-bodied ovoviviparous sharks (Compagno, 1984; Sims, 2005a). Little is known about embryo development and parturition (Sims *et al*., 2008).

#### Growth and maturity

Length-at-maturity for males is thought to be between 5 and 7 m, and 12 and 16 years, whereas females mature at 8.1–9.8 m and possibly 16–20 years (Compagno, 1984). Maximum length is unknown, but thought to be 10–12 m (Sims *et al*., 2008). The growth rate have been estimated to be 0.4 m per year and longevity to be about 40–50 years (Pauly, 1978; 2002), but new data suggests these estimates should be reassessed (Sims *et al*., 2003b). Aging using growth rings in vertebrae has proved difficult (Parker and Stott, 1965).

Available, reliable published and unpublished data on lengths and weights of 25 individual basking sharks from the Northeast Atlantic have been compiled, and are demonstrated together with a regression equation in Figure 7.7. E.g. the weight of an individual with a length of 800 cm is estimated at 2583 kg (Blom, 2008 WD).

#### Food and feeding

The basking shark feeds upon zooplankton prey by swimming with an open mouth so that a passive water flow passes across the gill-raker apparatus, but exactly how the particulate prey is filtered remains unresolved (Sims *et al*., 2008). Prey found in the stomach includes calanoid copepods, fish eggs, cirriped and decapods larvae, as well as Mysid larvae, decapod larvae, chaetognaths, larvaceans, polychaetes, cladocerans, fish larvae and post-larvae, fish eggs, and pelagic shrimp (Matthews and Parker, 1950; Mutoh and Omori, 1978; Sims and Merrett, 1997; Watkins, 1958). Based on filtration rates from the literature, Sims *et al*. (2008) approximated that at 5–7 m long, feeding constantly in food patches, may consume about 30.7 kg zooplankton per day.

#### Behaviour

Basking sharks observed at the surface in summer feed almost continuously, and frequently occur in large aggregations. In the Western English Channel, groups numbering between three and twelve individuals have been closely tracked (Sims and Quayle, 1998; Sims *et al*., 1997). Aggregations of apparently up to 200–400 individuals have been reported from U.K. regions such as southwest England and northwest Scotland (Doyle *et al*., 2005). Basking sharks are primarily solitary, but their propensity to exhibit prolonged feeding behaviour in specific areas probably results in the formation of feeding aggregations. These have been shown to occur most often near oceanographic or topographic features (Sims and Quayle, 1998). Recent behavioural studies have demonstrated the significant role of fronts as important habitat used for foraging by basking sharks. Basking sharks were thought to be indiscriminate planktivores (Matthews and Parker, 1950), but Sims and Quayle (1998) showed they were selective filter-feeders that chose the richest, most profitable plankton patches. Future surveys for basking shark, where identifying large numbers of individuals becomes important (perhaps using photographic identification; Sims *et al*., 2000b) for estimating population sizes, would benefit from efforts concentrated in front areas (Sims *et al*., 2008). The amount of time individual basking sharks spend on the surface is proportional to the quantity of zooplankton present in surface waters (Sims *et al*., 2003a). Future sightings schemes for basking sharks should therefore take into account zooplankton abundance in specific search areas.

It seems likely that courtship occurs as a consequence of individuals aggregating to forage in rich prey patches whereupon courtship can be initiated. In that way, locating the richest prey patches along fronts may be important for basking sharks to find mates as well as food in the pelagic ecosystem (Sims *et al*., 2008). As courtship-like behaviours occur annually off southwest England, this region may represent an annual breeding area for this protected species, although mating itself probably usually takes place at depth as it has yet to be observed at the surface (Sims *et al*., 2000a).

### Exploratory assessment models

No assessments have been undertaken.

### Quality of assessments

No assessments have been undertaken.

### Reference points

No reference points have been proposed for this stock.

### Conservation considerations

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”.

Basking shark was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002. Norway and Iceland have made a reservation on this listing and are therefore treated as ‘States not Party to the Convention’ with respect to trade in the species. For other States, this listing only affects international trade in basking shark products (including scientific samples). Export, re-export or introduction from the high seas requires a CITES permit from the relevant national authorities. Such a permit can only be granted if the exporting State's Scientific Authority has advised that this export will not be detrimental to the survival of the species (for example, because it comes from a sustainable managed stock), and the Management Authority is satisfied that it was not captured illegally. Imports require that an appropriate export or re-export permit be presented and approved by the importing State's CITES Management Authority. Trade inside the EU is controlled under the provisions of EC Regulations Nos. 338/97 and 1808/2001.

Basking shark was listed in 2005 on Appendices I and II of the Convention on the Conservation of Migratory Species (CMS). CMS Parties should strive toward 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 Convention encourages the Range States of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international cooperation) to conclude global or regional Agreements for their conservation and management. These Agreements are open to accession by all Range States, not just to the CMS Parties. Some Parties, from the ICES area and elsewhere, intimated that they might take out reservations on this listing, in some cases until they had the necessary legislation in place to implement strict protection measures. Reservations are not yet published.

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

The 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.

### Management considerations

At present there is no directed fishery for this species. The 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.

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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 1977–2008.**

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I & II | 3680 | 3349 | 5120 | 3642 | 1772 | 1970 | 967 | 873 | 1465 | 1144 | 164 |
| III & IV | | | | | | | 734 | 1188 | | | |
| Va | | | | | | | | | | | |
| Vb | | 14 | | 83 | 28 | | | | | | |
| VI | | | | | | | | | | | |
| VII | | 278 | 139 | | | 186 | 60 | 1 | | | |
| VIII | | | 7 | | | | | | | | |
| IX | | | | | | | | | | | |
| X | | | | | | | | | | | |
| XII | | | | | | | | | | | |
| XIV | | | | | | | | | | | |
| TOTAL | 3680 | 3641 | 5266 | 3725 | 1800 | 2156 | 1761 | 2062 | 1465 | 1144 | 164 |
| | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** |
| I & II | 96 | 593 | 781 | 533 | 1613 | 1374 | 920 | 604 | 792 | 425 | 55 |
| III & IV | 10 | | 116 | 220 | 84 | | 157 | 23 | | 43 | |
| Va | | | | | | | | | | | |
| Vb | | | | | | | | | | | |
| VI | | | | | | | | | | | |
| VII | | | | | | | | | | | |
| VIII | | | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 |
| IX | | | | | | | | | 1 | 1 | |
| X | | | | | | | | | | | |
| XII | | | | | | | | | | | |
| XIV | | | | | | | | | | | |
| TOTAL | 106 | 593 | 897 | 753 | 1697 | 1374 | 1077 | 628 | 793 | 471 | 56 |
| | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| I & II | 31 | 117 | 80 | 54 | 128 | 72 | 87 | 6 | 26 | 4 | 0 |
| III & IV | | | | | 0 | | | | | | |
| Va | | | | | | | | | | | |
| Vb | | | | | | | | | | | |
| VI | | | | | | | | | | | |
| VII | | | | | | | 1 | 0 | 0 | + | + |
| VIII | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | |
| IX | | | | | 1 | + | 2 | 0 | 0 | | |
| X | | | 1 | | | | | | | | |
| XII | | | | | | | | | | | |
| XIV | | | | | | | | | | | |
| TOTAL | 32 | 118 | 81 | 54 | 129 | 72 | 90 | 6 | 26 | 5 | + |

**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 (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 (1 individual) and 7132 kg (2 individuals), respectively, were reported. These weights are included in the official and revised landings and in the estimation of landed numbers. (Source: Blom, 2008 WD).**

| 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 1990–2009.**

| Year | Area IIa | | | | | | | Area IVa | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Harpoon | Gillnets | Driftnets* | Undefined nets | Bottom trawl | Danish seine | Hooks and line | Harpoon | Gillnets | % |
| 1990 | 84,0 | 0,0 | 3,1 | 0,0 | 0,0 | 0,0 | 0,0 | 12,9 | 0,0 | 100 |
| 1991 | 69,7 | 0,0 | 1,0 | 0,0 | 0,0 | 0,0 | 0,0 | 29,3 | 0,0 | 100 |
| 1992 | 83,1 | 0,0 | 6,0 | 0,0 | 5,6 | 0,0 | 0,4 | 4,9 | 0,0 | 100 |
| 1993 | 99,1 | 0,8 | 0,0 | 0,0 | 0,1 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 1994 | 85,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 14,6 | 0,0 | 100 |
| 1995 | 89,8 | 6,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 3,7 | 100 |
| 1996 | 89,1 | 10,3 | 0,0 | 0,2 | 0,0 | 0,4 | 0,1 | 0,0 | 0,0 | 100 |
| 1997 | 66,7 | 23,7 | 0,0 | 0,0 | 0,0 | 0,0 | 0,5 | 9,1 | 0,0 | 100 |
| 1998 | 67,2 | 28,5 | 0,0 | 0,0 | 0,0 | 0,0 | 4,4 | 0,0 | 0,0 | 100 |
| 1999 | 9,1 | 81,8 | 0,0 | 7,8 | 1,3 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2000 | 33,4 | 58,7 | 0,0 | 0,0 | 7,8 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2001 | 0,0 | 96,0 | 0,0 | 0,0 | 4,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2002 | 16,3 | 78,5 | 0,0 | 0,0 | 5,2 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2003 | 3,4 | 89,7 | 0,0 | 0,0 | 7,2 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2004 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2005 | 54,1 | 44,5 | 0,0 | 0,5 | 1,4 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2006 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2007 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2008 | 0,0 | 100,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 100 |
| 2009** | - | - | - | - | - | - | - | - | - | - |

*** These driftnets for salmon were banned after 1992.**

**** No catch in 2009**

**Table 7.4. Basking sharks in the Northeast Atlantic. Norwegian landings of liver (t), number of vessels participating in the fishery and estimate of cpue. (Source: Hareide, 2006 WD).**

| Year | Tonnes liver | Number of vessels | cpue |
|---|---|---|---|
| 1965 | 652 | 31 | 210 |
| 1966 | 911 | 30 | 304 |
| 1967 | 2090 | 53 | 394 |
| 1968 | 1580 | 70 | 226 |
| 1970 | 1887 | 57 | 331 |
| 1976 | 751 | 26 | 289 |
| 1977 | 793 | 32 | 248 |
| 1979 | 1133 | 30 | 378 |
| 1981 | 388 | 28 | 139 |
| 1982 | 465 | 25 | 186 |
| 1983 | 379 | 24 | 158 |
| 1984 | 444 | 26 | 171 |
| 1985 | 315 | 23 | 137 |

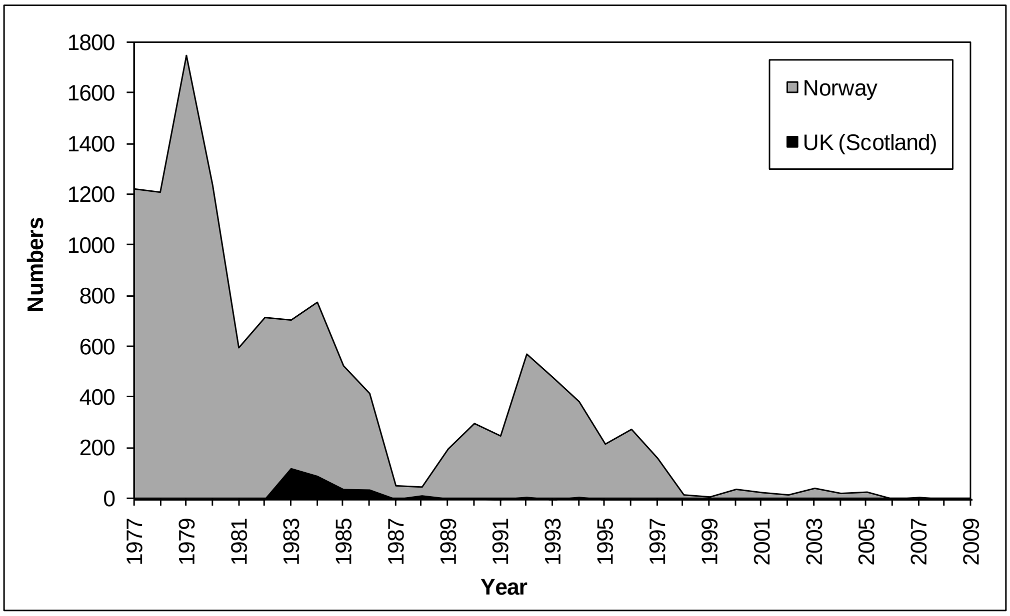


**Figure 7.1. Basking sharks in the Northeast Atlantic. Numbers of basking sharks caught by Norway and Scotland from 1977–2007 in ICES Areas I–XIV from 1977–2009.**

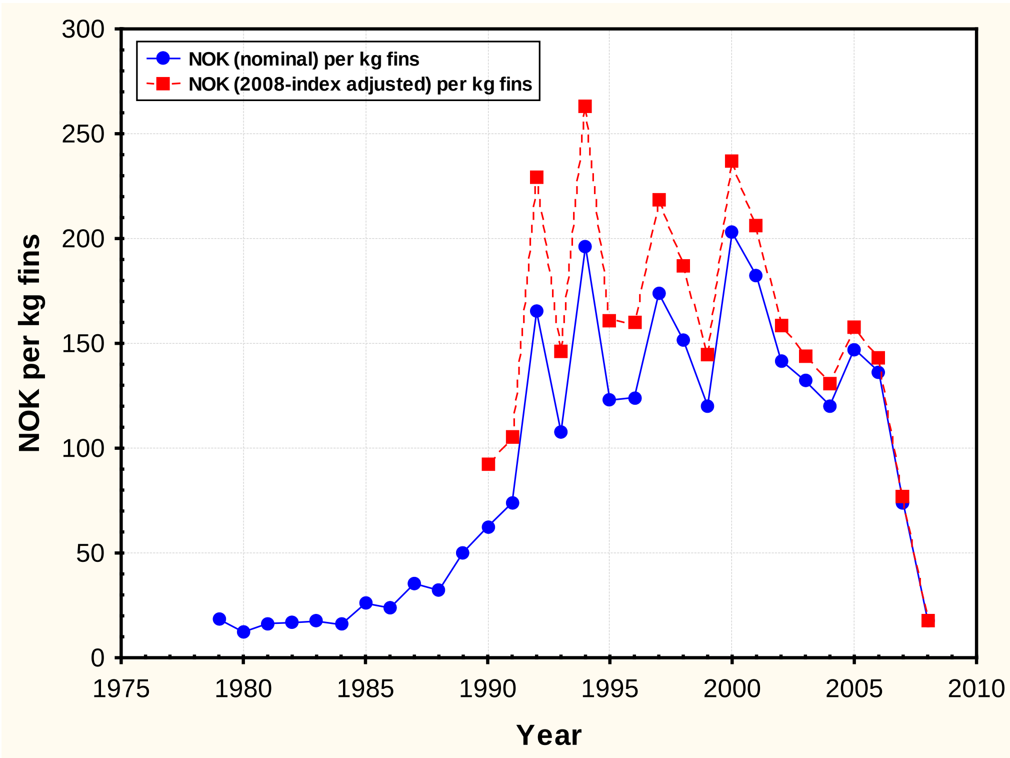


**Figure 7.2. Development in nominal and inflation adjusted prices (NOK per kg) paid to fishermen for fins of basking shark during 1979–2008. The data were provided by the Norwegian Directorate of Fisheries. (Source: Blom, 2008 WD).**

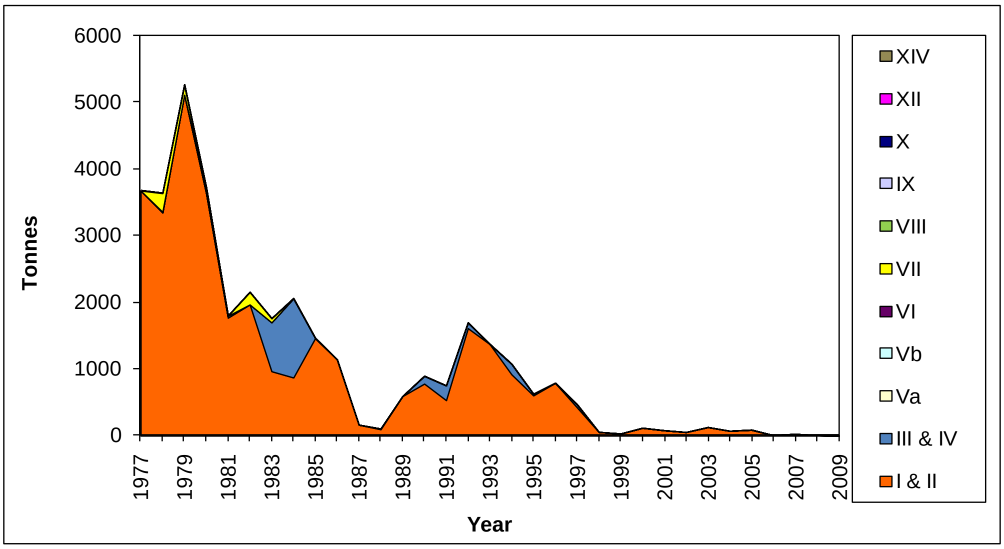


**Figure 7.3. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2009.**

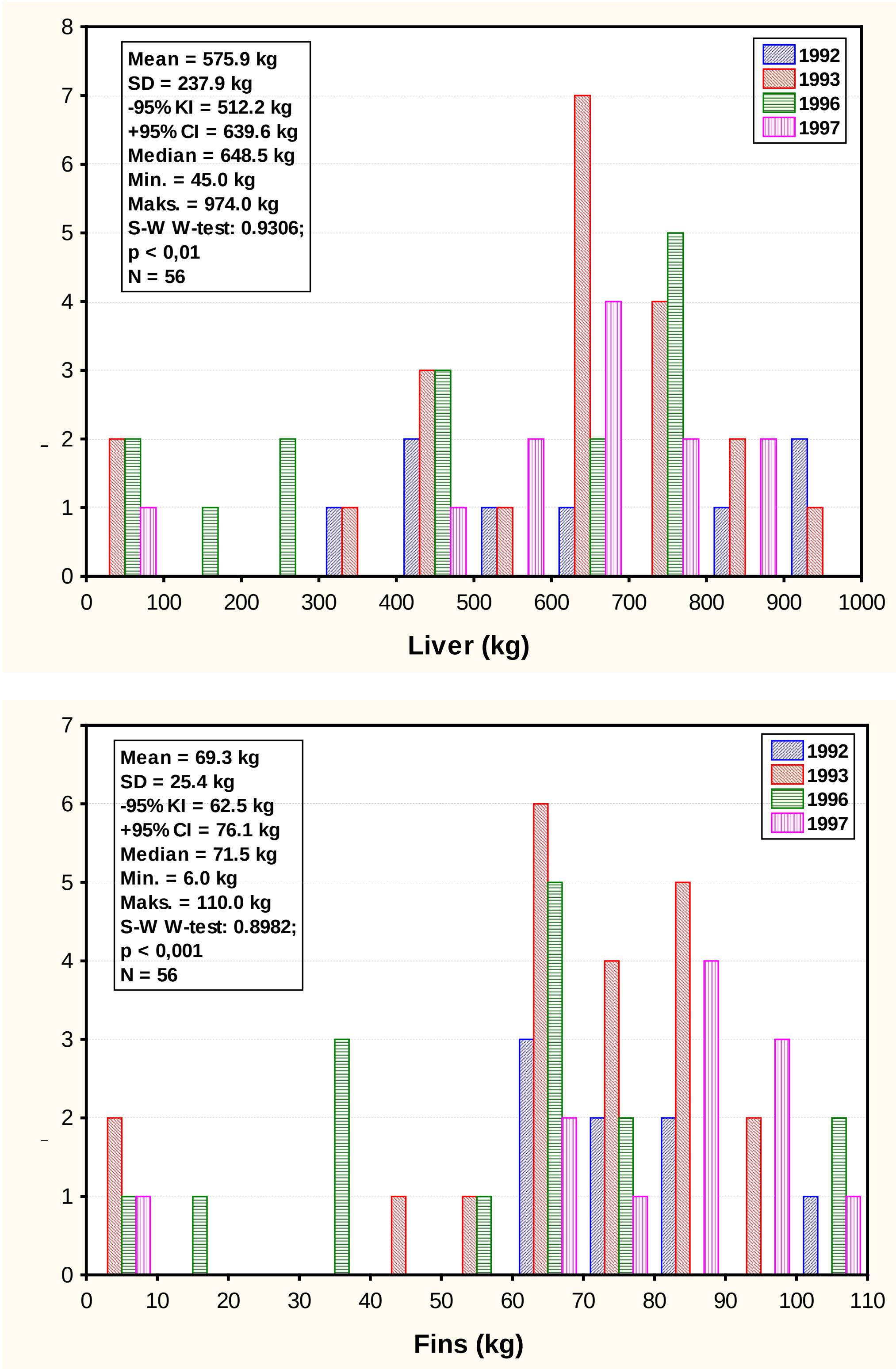


**Figure 7.4. Liver (A) and fin weights (B) (kg) of 56 probable individual basking sharks landed in 1992, 1993, 1996 and 1997. The distributions of liver and fin weights were different from a normal distribution (Shapiro-Wilk's W-test; p <0.004). (Source: Blom, 2008 WD).**

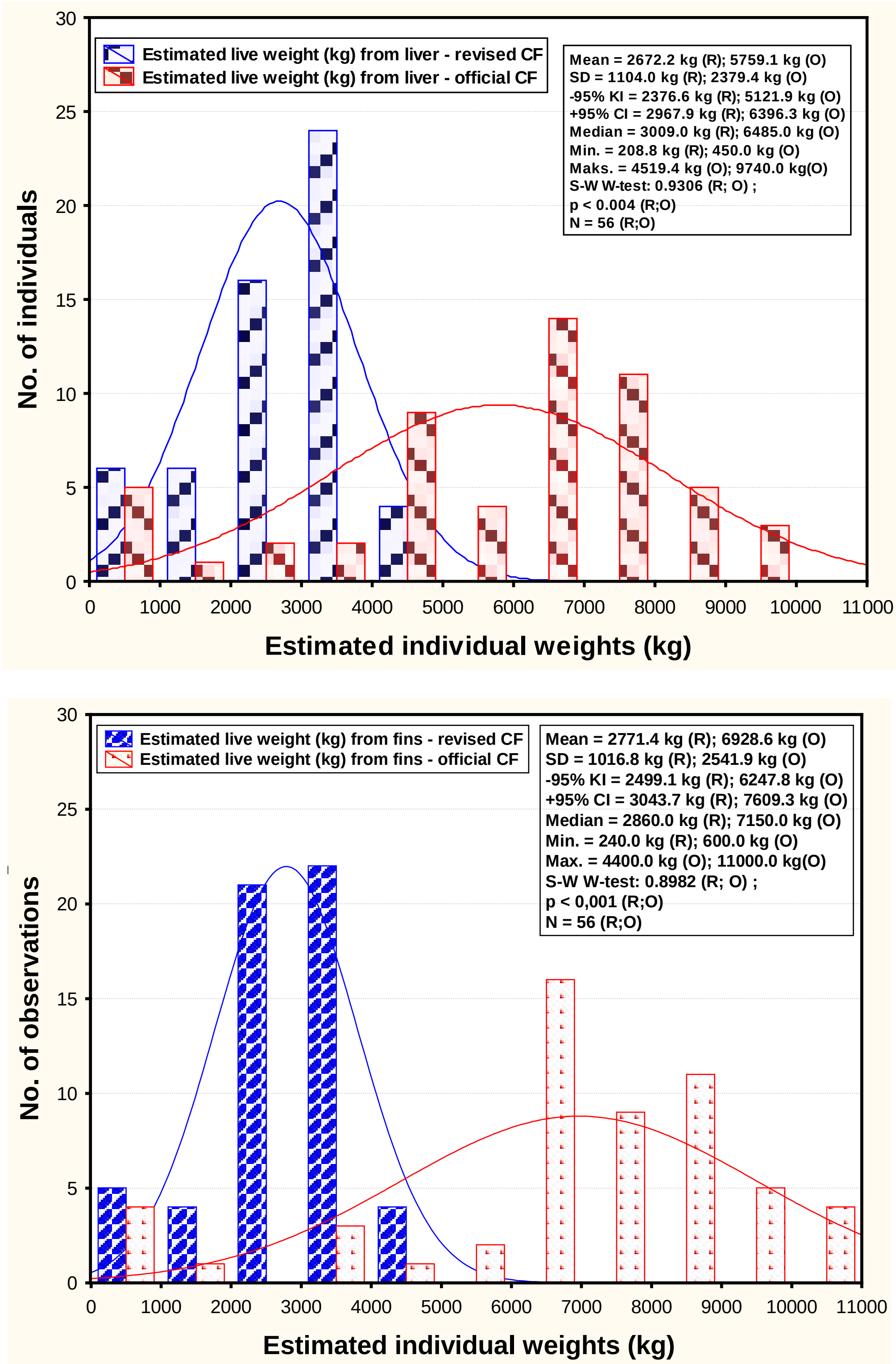


**Figure 7.5. Comparison of estimated weight (kg) of 56 probable individual basking sharks landed in Norway in 1992, 1993, 1996 and 1997 applying A. the revised (4.64) and old (10.0) conversion factors for liver, and B. revised (40.0) and old (100.0) conversion factors for fins. The distributions of weights differed from a normal distribution (Shapiro-Wilk's W-test; p <0.004). (Source: Blom, 2008 WD).**

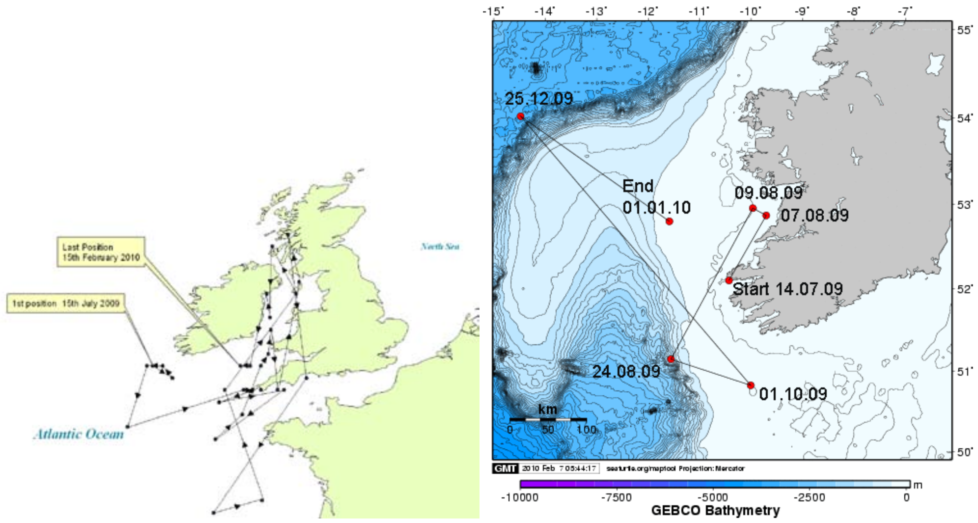


**Figure 7.6 Geo-locations from basking shark A (left, sex=male) and B (right, sex=unknown). (Source: Berrotw and Jackson, 2010 WD).**

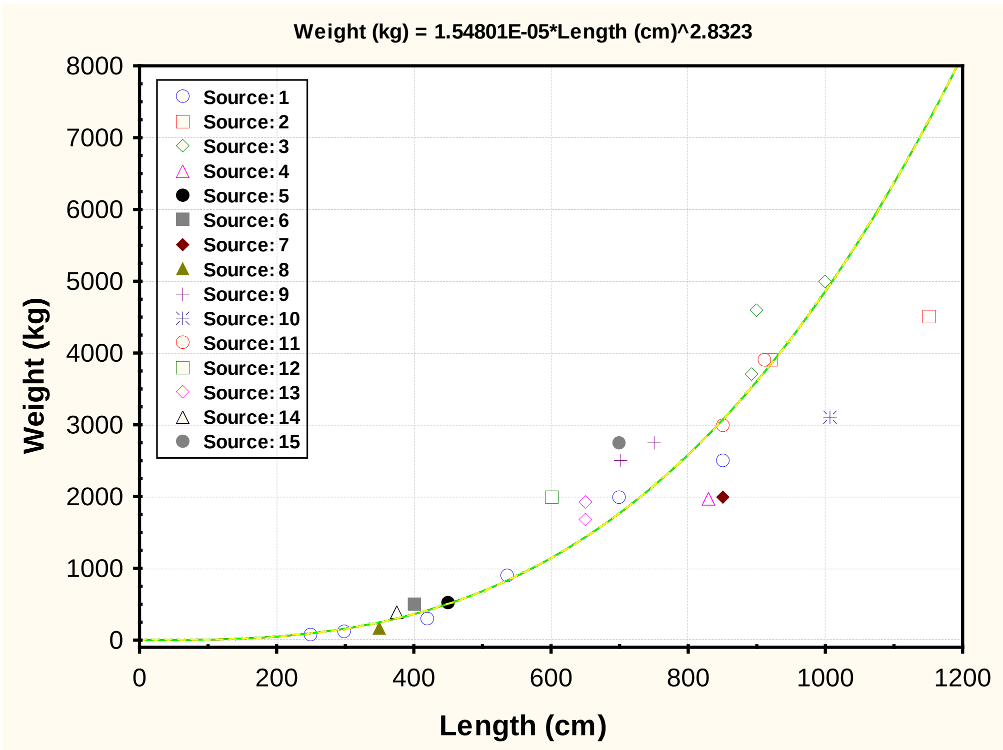


**Figure 7.7. Length–weight regression of basking shark based on various published and unpublished (websites on basking shark and information from newspapers) data on measured lengths and weights. The original log length-log weight regression equation was given as: log Weight = -11.075953 + 2.8323*log Length; $R^2$ = 0.939; N = 26. (Source: Blom, 2008 WD).**

## Porbeagle

### 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.

Buencuerpo *et al.,* 1998 reported that porbeagle made up 4% of the total catches in longline and gillnet fisheries off the northwest African coast, Iberian Peninsula and Straits of Gibraltar and more information on the distribution and frequency of porbeagle in the CECAF area is needed. Some records of porbeagle south of the ICES area may be misidentified shortfin mako.

The stock is considered separate from that in the NW Atlantic (Campana *et al.,* 1999; 2001; 2003). Tagging studies from Norway, the USA and Canada, resulted in 542, 1034 and 256 porbeagles being tagged respectively. In all 197 recaptures were made (53 from Norwegian, 119 for USA and 25 from Canadian studies). Initial studies did not report any transatlantic migrations (Campana *et al.,* 2003), although a single transatlantic migration has been reported (e.g. Green, 2007 WD; Figure 6.1). Canadian tagging studies have not reported any recaptures east of 42°W.

Genetic evidence suggests some gene flow across the Atlantic, within the northern hemisphere, as dominant haplotypes from the NE were also present in samples from NW Atlantic population (Pade *et al.,* 2006). The same study also found marked differences in haplotype frequencies between northern and southern hemisphere populations, indicating little or no gene flow between them.

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

### The fishery

Porbeagle has been exploited commercially since the early 1800s, principally by Scandinavian fishers; however, the “boom” period for this fishery in the NE Atlantic began in the 1930s. The target fishery for porbeagles before the Second World War and was mainly a Norwegian longline fishery in the North Sea, starting in 1926 and landing around 500 t annually in the first years. After a peak in 1933 (ca. 3800 t) the fishery declined. After the war, the target fishery resumed with Norwegian, Faroese and Danish vessels involved. Norway took about 2800 t in 1947. By the 1950s this fishery had extended to the Orkney-Shetland area and the Faroes then to the waters off Ireland and offshore banks. After this, the catches began to decline to below 2000 t annually, and in 1961 a fleet of Norwegian longliners extended their fishing for porbeagle to Northwest Atlantic waters.

In the early 1950s, landings for the Danish porbeagle fishery were greater than 1000 t, but by the mid to late 1950S average landings were 500–600 t per year; however, this declined to under 50 t by 1983. During the 1970s several countries including The Faroes, France, England, Iceland, Germany and Sweden started to report landings of porbeagle. French landings are largely from the Bay of Biscay and Celtic Sea. They are mainly provided by a longliner targeted fishery (Table 6.1) which landed relatively large quantities from the early 1970s, with a decline in the mid-1980s where landings decreased to around 200 t, with the number of boats in the targeted fishery also declining at this time. After this, catches fluctuated between ca. 200–500 t, with a peak of 640–840 t between 1993 and 1995.

Porbeagle fisheries have generally been seasonal, and many operations landed porbeagle opportunistically and sporadically rather than through directed fisheries. For instance, local fisheries in the Bristol Channel occasionally deploy longlines for porbeagle (Ellis and Shackley, 1995). The landings from Spain are thought to be taken mainly in fisheries using longlines, targeting swordfish and tuna and tend to be greater during spring and autumn, with a drop in summer, despite being erratic in nature (Mejuto, 1985; Lallemand-Lemoine, 1991). The Norwegian fishery was also mainly run between July–October in the eastern North Sea.

Porbeagle are currently landed by several European countries, principally France and, to a lesser extent, UK, Faeroes, Norway and Spain (although Spanish landings data are from the pelagic fleet, and further details of captures in demersal fleets are required).

The only regular, directed target fishery that still exists is the French fishery (although there have been occasional targeted fisheries in the UK). Catches are primarily made on the continental slope in Division VIIId (32%) and on the continental shelf in Divisions VIIj (23%) and VIIg (20%) (Poisson and Séret, 2008). Maps in Figure 6.2 show the distribution of the French catch by statistical rectangle by year and by gear type for the period 1999–2008. An example of the seasonal variation in catches (for 2000) is illustrated in Figure 6.3. Fishing trips generally last 10–18 days, with an average of 14 days. Porbeagle are targeted with drifting longlines set from near to the surface (e.g. in the outer Bristol Channel) or down to 220–230 m depth in deeper waters in the Bay of Biscay fishing grounds. Each longline is 1500 m long with 84 hooks ballasted with 1 kg of lead every 14th hook. Each vessel has ten such lines. The fishing activity occurs during the day, a first set in the early morning with 3–4 longlines soaking for 3.5–4 hours, and a second set in the afternoon functioning for 4.5–5 hours with all ten longlines deployed in the second set. The location of the second set depends on the catch rates in the first set. Frozen mackerel (*Scomber scombrus*) is used as bait, one third of a fish per hook. Most of the landings take place from March to August.

The number of French vessels landing more than 5 t has been below ten since 1990, fluctuating between three and five vessels (Biais and Vollette, 2009). Average prices, as observed in the Sables d'Olonne and Guilvinec market auctions in 2008, have varied around 3.5 Euros.kg$^{-1}$ of dressed porbeagle. Between 2002 and 2007, the income realized by the porbeagle targeted fishery varies between 26–42% of the annual turnover of the boats (Jung, 2008).

High seas tuna fisheries also take porbeagle but there is little available knowledge of the catches of this fishery (Only Japan reported catches in 1996–1997).

## Catch data

### Landings

The major landings have been made by Denmark, Norway and France throughout the time-series. Norway and Denmark landings are dominating up to the beginning of the seventies, thereafter France is the major contributor to the international landings.

Most of the Spanish catches are from pelagic fisheries for tuna and tuna-like species, with porbeagle catches mostly from ICES Subareas VII–IX but porbeagle is also caught by the Spanish mixed demersal fisheries.

Portuguese landings data were updated during the joint meeting with ICCAT in 2009.

Japanese landings for the NE Atlantic were reported to ICCAT in 1996 and 1997.

#### Discards

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

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

#### Quality of catch data

For some nations, porbeagle will have been reported within "sharks *nei*".

The confusion with shortfin mako (*Isurus oxyrinchus*) is suspected for some historical Spanish catches that are thought to refer to shortfin mako. Some reported landings of shortfin mako by UK-registered vessels fishing in Subareas IV and VI and Divisions VIId–e are also likely to represent misidentified porbeagle. To avoid this problem, some diagnostic characteristics can be used to distinguish porbeagle and shortfin mako (Table 6.2).

French targeted fishery landings are thought to be correctly documented from 1984 onwards. Prior to this period, there are discrepancies between the national data supplied to WGEF and data on the ICES catch statistics, especially in the 1970s. Further studies to check, confirm and harmonize datasets are needed.

Landings data from Spain (Basque Country) indicate that lamnids are taken in other mixed demersal fisheries (Table 6.3), and better estimates of porbeagle catches by Spanish demersal fisheries are required.

Landings data from non-ICES countries fishing in the NE Atlantic appear incomplete. Data are available for Japan only in two years and, furthermore, Republic of Korea and Taiwan (Province of China) are also expected to take porbeagle as a bycatch in tuna fisheries in the NE.

Further examination of national data suggests that there can be occasional confusion between catch numbers and catch weight, with some individual landings (presumably of one fish) reported as 1 kg. The extent of this problem still needs to be evaluated.

### Commercial catch composition

Measurement of the length of porbeagle shark catches is an important parameter for assessing population structure, size composition and growth of the stock. It is therefore important that there is a standardized approach to reporting size measurements. This is not easily achieved with larger elasmobranchs, and inaccuracies/inconsistencies are common between datasets. Therefore, care needs to be taken when comparing length data from different sources, and where appropriate conversion factors are required.

The most commonly documented lengths are total length ($L_T$) and fork length ($L_F$), and conversion factors between the two have been calculated. However, even these lengths are not taken identically between samplers. A review of this can be found in Francis, 2006.

The length compositions of porbeagle taken in the French fishery have been provided to WGEF in 2009 (see below). However, these data have been collected only sporadically (e.g. Ellis and Shackley, 1995; Gauld, 1989; Mejuto, 1985).

Launched by the National Fishing Industry Organization Committee (CNPMEM), the French NGO Association Pour l'étude et la Conservation des Sélaciens (APECS, the French representative of the European Elasmobranch Association, EEA) implemented an observer programme in 2008–2009 aiming at gathering information on the main biological parameters of porbeagle. This programme named EPPARTIY (Etude de la Pêcherie Palangrière au Requin Taupe de l'Ile d'Yeu) received the collaboration of the fishing industry of l'Ile d'Yeu, the main French porbeagle fishery for the observers.

The length distribution (Fork length over the body) by sex of porbeagle measured during the EPPARTIY programme between April and July 2008 were presented at the 2009 WGEF (Jung, 2008; Figure 6.4). Mean average length of porbeagle landed by month and sex are presented Figure 6.5. Mean length increased from April to June for both sexes and decreased in August, especially for males caught in the Celtic Sea, south of St George's Channel (Divisions VIIg and VIIh).

### Commercial catch-effort data

Preliminary analyses of data from the French fishery were undertaken in 2006 (see Section 6 of ICES, 2006, 2008), based on data supplied in Biseau, 2006, WD. These data provided some indication of effort in an otherwise data poor fishery; however, the rate of kg/vessel needs to be treated with some caution, and if possible re-parameterizing to account for true effort, in terms of taking days at sea, size of vessel, changes in fishing area, etc. into account.

More detailed data were presented in 2008 (Jung, 2008). Effort from the French targeted fishery were presented in annual number of hooks (Figure 6.8) taking into account the average day of fishing activity multiplied by the average daily number of fishing operation. Effort reached a maximum of 725 760 hooks in 1994 and decreased to 323 576 hooks deployed in 2007. A nominal cpue index was calculated from the individual vessel landings for the top twelve vessels presented in Table 6.4 (1993–2007). Annual variation ranged from 1 kg/hook (1994) to 0.73 kg/hook (2007) across the time-series, with a peak cpue of around 1.5 kg/hook in 1999, and a low of 0.54 kg/hook in 2005, however there is much variance. Further studies were requested to clarify this trend. Consequently, a longer time-series of logbook data was presented to the 2009 WG to allow a better interpretation of cpue trends (Figure 6.9).

Mejuto and Garcés, 1984 reported that the NW and N Spanish longline fleets had a cpue of 2.07 kg/1000 hooks for porbeagle shark. However, the cpue demonstrated a seasonal trend, with the highest catches being made in the last four months of the year, where the cpue was three to four times higher than in February or March although the effort was of a similar level.

### Life-history information

The biology of porbeagle is well described for the NW Atlantic stock (e.g. Jensen *et al.*, 2002; Natanson *et al.*, 2002; Cassoff *et al.*, 2007; Francis *et al.*, 2008), although less information is available for the NE Atlantic stock.

### Habitat

Porbeagle shark is a wide-ranging coastal and oceanic species found in temperate and cold-temperate waters worldwide (1–18°C, 0–370 m), and is more common on continental shelves (Stevens *et al.*, 2006a). Campana and Joyce, 2004 reported that more than half of the porbeagle caught were at temperatures of 5–10°C (at the depth of the hook). They suggest that as porbeagle are among the most cold tolerant of pelagic shark species, they could have evolved to take advantage of their thermoregulatory capability to feed on abundant cold-water prey in the absence of non-thermoregulating competitors.

In the North Atlantic, porbeagle abundance varies seasonally and spatially (Aasen, 1961; 1963; Templeman, 1963; Mejuto and Garcés, 1984; Mejuto, 1985; Gauld, 1989). In the NE Atlantic, the limited studies conducted on this population, and historical catch records indicate that porbeagle segregate by sex and size. Mejuto, 1985 found twice as many males were caught off Spain, whereas Gauld, 1989 found 30% more females were caught off Scotland, and Ellis and Shackley, 1995 found the males predominated in catches in the Bristol Channel. These observations have also been made by Hennache and Jung, 2010. On the shelf edge in the south of Ireland, the male/female ratio was 0.7 but 1.2 in the Bristol Channel and in the North of the Bay of Biscay.

Their movements reveal seasonal patterns; however, this knowledge is incomplete for a large part of the year. French catches indicates that porbeagle are mainly present in spring and in summer along the shelf edge (along the 200 m depth line) of the Celtic Sea and of the Bay of Biscay, and in the Saint Georges Channel and in the entrance of the Bristol Channel (Figure 6.3). Two recent studies have been carried out using a limited number of archival satellite tags. In the first one, four porbeagles were tagged caught off the SW England (Pade *et al.*, 2009). During July and August the sharks move erratically within the Celtic Sea. One individual was tracked during autumn, and this shark moved to deeper waters off the continental shelf before moving northwards. Sharks occupied a bathymetric range of 0–552 m and water temperatures of 9–19°C. In the second, archival tags were attached on three porbeagles in Northwest Ireland in September 2008. The tags were programmed to pop after 122 days. All three tagged porbeagles migrated south along the shelf edge (Saunders *et al.*, 2010).

### Nursery and pupping grounds

The nurseries are probably in continental waters, but there are few published data (Castro *et al.*, 1999). However, according to French catch length distribution (Hennache and Jung, 2010), the Saint Georges Channel is likely a nursery area (porbeagle length below 170 cm for 90% of the catches and below 125 cm for 25%).

Four gravid females were caught in the South of Ireland (Statistical rectangle 25D8) with full-term pups (embryo total lengths being 80–81 cm) within a few days in May 2008 (Hennache and Jung, 2010), possibly indicating a pupping ground. This limited knowledge would probably benefit from further satellite archival tagging to examine the movements of gravid females to infer where pupping grounds may be. Comparable studies have recently been undertaken in the NW Atlantic; and this study suggested that pupping grounds may occur in warmer waters south of the main stock area (Campana *et al.*, 2010).

### Diet

Porbeagles are opportunistic piscivores (Campana *et al.*, 2003). Stomachs of 1022 porbeagles from the Canadian fishery were examined by Joyce *et al*., 2002. Teleosts made up 91% of the diet by weight, with cephalopods being the second most important prey item and were found in 12% of stomachs. Pelagic fish and cephalopods constituted the largest proportion of the diet in spring, whereas groundfish dominated in the fall. This seasonal change follows a migration from deep to shallow water. No diet differences were found between the sexes.

The diet of porbeagle was also analysed by Cherel (unpublished, cited by Hennache and Jung, 2010) who looked at 168 stomachs from French catches. The results are similar to the NW Atlantic study: 90% of the diet is constituted in fish and the remaining part is cephalopods. The main prey species are whiting, blue whiting and horse mackerel.

#### Life-history parameters

Biological data of the NE Atlantic porbeagle shark are very scarce; with very few published studies (e.g. Mejuto and Garcés, 1984; Gauld, 1989; Stevens, 1990; Pade *et al*., 2006; Green, 2007). The majority of other biological parameters are available from studies conducted elsewhere in the world, mainly in the NW Atlantic, but also in the Pacific to a limited extent (see Table 6.5).

However, recent information has been collected by Hennache and Jung in 2008–2009 by sampling the catches of the French targeted fishery (sex ratio, length–weight relationship). The age have been determined on a sample of vertebrae (n=120). This study indicated that NE Atlantic porbeagle are slower growing than NW Atlantic porbeagle. However, further age and growth studies are needed to provide growth parameters for the NE Atlantic porbeagle stock.

The maturity estimates provided by Jensen *et al.* (2002) for NW Atlantic porbeagle (see Table 6.5) have been used in assessments for NE Atlantic in the absence of appropriate, recent data for NE Atlantic porbeagle.

Estimates of natural mortality include 0.18 (Aasen, 1963), 0.1–0.2 for immature and mature fish (Campana *et* al., 2001) and 0.114 (E. Cortes, unpublished).

### Exploratory assessment models

#### 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).

#### Stock assessment

The 2009 assessments cannot be updated by the 2010 WGEF because the lack of available cpue in 2009. The models used during the 2009 assessment should be made available at any future benchmark assessment for these species.

**** BSP model***

The BSP model uses catch and standardized cpue data (see Section 6.5.2 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 showed 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 with 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 historical 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 (F2008 /FMSY) between 2.54 and 3.32.

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

### Quality of assessments

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

### 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.

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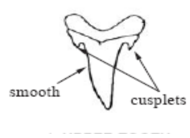
**Table 6.1. Porbeagle in the NE Atlantic. French landings (%) of porbeagle by broad categories of gear type, 1999–2007.**

| Gear Type | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| Longline | 77.5% | 60.9% | 81.0% | 78.8% | 82.1% | 72.3% | 74.9% | 67.9% | 89.0% |
| Net | 12.1% | 28.6% | 8.1% | 10.6% | 10.9% | 15.9% | 11.4% | 18.2% | 5.0% |
| Trawl (demersal) | 5.8% | 6.0% | 7.5% | 3.5% | 4.0% | 6.3% | 6.2% | 8.2% | 4.8% |
| Trawl (pelagic) | 4.6% | 4.2% | 2.6% | 5.6% | 2.8% | 4.8% | 7.3% | 3.8% | 0.8% |
| Unclassified | 0.1% | 0.2% | 0.7% | 1.6% | 0.2% | 0.8% | 0.1% | 1.9% | 0.4% |

**Table 6.2. Porbeagle in the NE Atlantic. Characteristics for the identification of porbeagle and shortfin mako (adapted from Compagno, 1984).**

| | Porbeagle | Mako |
|---|---|---|
| Teeth | Lateral cusps present on teeth* | No cusplets on teeth |
| |   |  |
| Origin of first dorsal fin | Over or anterior to posterior margins of pectoral fins | Over or behind posterior margin of the pectoral fins |
| Origin of second dorsal fin | Over origin of anal fin | In front of the origin of the anal fin |
| Caudal fin | Secondary keel present below main keel on caudal fin | No secondary keel |

*** However, sometimes these cusplets appear to be absent in young porbeagle, as they may be covered by some skin, which can lead to misidentification.**

**Table 6.3. Porbeagle in the NE Atlantic. Landings of Porbeagle and Shortfin mako (*Lamnidae*) from Spain (Basque Country).**

| Year | VI | VII | VIII | Total |
|---|---|---|---|---|
| 1996 | | | 20 | 20 |
| 1997 | 0 | 0 | 12 | 12 |
| 1998 | 1 | 2 | 24 | 27 |
| 1999 | 0 | 8 | 33 | 41 |
| 2000 | 0 | 3 | 35 | 38 |
| 2001 | | 7 | 39 | 45 |
| 2002 | 0 | 1 | 15 | 16 |
| 2003 | | 1 | 21 | 22 |
| 2004 | | 0 | 10 | 10 |
| 2005 | 0 | 1 | 10 | 11 |
| 2006 | | | 5 | 5 |
| 2007 | | 0 | 15 | 16 |
| 2008 | | | 13 | 13 |
| 2009 | | | 3* | 3 |

*** porbeagle alone**

**Table 6.4. Porbeagle in the NE Atlantic. Number of fishing trip per year for vessels involved in the targeted porbeagle fishery 1993 to 2007 (Jung, 2008).**

| Vessel | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | 10 | 9 | 5 | 5 | 6 | 2 | 3 | 2 | 9 | 9 | 9 | 7 | 8 | 7 |
| 2 | 4 | 12 | 6 | 9 | 5 | 7 | 4 | 4 | 6 | 4 | 5 | 7 | 2 | 3 | 3 |
| 3 | 1 | 5 | 6 | 1 | 5 | 5 | 3 | 6 | 5 | 5 | 7 | 6 | | | |
| 4 | 10 | 7 | 6 | 5 | 8 | 3 | 3 | 3 | 1 | 6 | 2 | | | | |
| 5 | 6 | 9 | 6 | 4 | 4 | 5 | 4 | 3 | 6 | 2 | | | | | |
| 6 | 3 | 9 | 9 | 10 | 8 | 7 | 8 | 8 | 5 | | | | | | |
| 7 | 4 | 2 | 4 | 4 | 2 | | | | | | | | | | |
| 8 | | | | | | | | | 5 | 6 | 5 | 7 | 3 | | 5 |
| 9 | | | | 1 | 1 | 2 | 3 | 2 | 2 | | | | | | |
| 10 | | | | | | | | | | | 5 | 2 | | | 3 |
| 11 | | | | | 5 | | | | | | | | 5 | 3 | 5 |
| 12 | 7 | 6 | 7 | 5 | | | | | | | | | | | |
| 13 | | | | | 3 | 3 | 2 | 3 | | | | | | | |
| 14 | | | 6 | 5 | 6 | | | | | | | | | | |
| 15 | 11 | 12 | | | | | | | | | | | | | |
| 16 | | | | 3 | | | | | | | | | | | |
| 17 | 4 | | | | | | | | | | | | | | |
| 18 | 10 | | | | | | | | | | | | | | |

**Table 6.5. Porbeagle in the NE Atlantic. Life-history parameters for porbeagle from the scientific literature.**

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Reproduction | Ovoviviparous with oophagy | | | Campana *et al*., 2003 |
| Gestation period | 8–9 months | | | Aasen, 1963; Francis and Stevens, 2000; Jensen *et al*., 2002 |
| Litter size | 4<br>(3.7–4 per year) | | Scotland and NW Atlantic | Gauld, 1989; Francis and Stevens, 2000; Jensen *et al*., 2002 |
| Size at birth | 60–75 cm | | NW Atlantic | Aasen, 1963; Compagno, 1984 |
| | 58–67 (LF) | | SW Pacific | Francis and Stevens, 2000 |
| Sex Ratio<br>(males : females) | 1:1.3 | 1368<br>(1954–1987- year-round samples) | Scotland | Gauld, 1989<br>(data from 1954–1987) |
| | 1:1 | 1228<br>(year-round samples) | NW Atlantic | Kohler *et al*., 2002 |
| | 1:0.25 | 65<br>(year-round samples) | NE Atlantic | Kohler *et al*., 2002 |
| | 1:0.5 | | NE Atlantic (Spain and Azores) | Mejuto, 1985 |
| | 1:0.6 | | N and NW Spain | Mejuto and Garcés, 1984 |
| | 1:0.84 | | Saint Georges Channel | Hennache and Jung, 2010 |
| | 1:0.85 | | North of Bay of Biscay | Hennache and Jung, 2010 |
| | 1:1.35 | | South Ireland | Hennache and Jung, 2010 |
| Embryonic sex ratio | 1:1 | | | Francis and Stevens, 2000; Jensen *et al*., 2002 |
| Male age at 50% maturity (years) | ~ 8 | | NW Atlantic | Natanson *et al*., 2002 |
| Female age at 50% maturity (years) | ~ 13 | | NW Atlantic | Natanson *et al*., 2002 |
| Male length at maturity (LF) | 150–200 cm<br>166–184 cm<br>(L50 ~ 174 cm) | | | Aasen 1961<br>Jensen *et al*., 2002 |
| Male mean length (LF) | 116 cm | | NW Atlantic | Kohler *et al*., 2002 |

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| | 147 cm | | NE Atlantic | Kohler *et al.*, 2002 |
| Female length at maturity (LF) | 210–230 cm<br>(L50 ~ 218 cm)<br>200–250 | | | Jensen *et al.*, 2002<br><br>Aasen, 1961 |
| Female mean length (LF) | 108 cm | | NW Atlantic | Kohler *et al.*, 2002 |
| | 154 cm | | NE Atlantic | Kohler *et al.*, 2002 |
| Maximum length (LF) | 250 cm (male)<br>302 cm (female) | | NW Atlantic | Campana (unpublished data*) |
| | 253 cm (male)<br>278 cm (female) | | NE Atlantic | Gauld, 1989 |
| Average growth rate | 25.2 cm y–1 | 3 | NE Atlantic | Stevens 1990 |
| Life span (years) Maximum age | 29–45 | | NW Atlantic | Campana *et al.*, 1999 |
| | 40+ (unfished popn. based on natural mortality estimates)<br>25 (fished, maximum observed) | | | Campana *et al.*, 2001 |
| | males: 25<br>females: 24<br>(vertebral counts)<br>Longevity calcs. indicate 45–46 in unfished popn. | | | Natanson *et al.*, 2002 |
| Length-weight relationship | W = (1.4823 x 10–5)<br>LF 2.9641 | | | Kohler *et al.*, 1995 |
| | W = ('4 x 10–5)<br>LF 2.7767 | 1022 | Bay of Biscay and Celtic Sea | Hennache and Jung, 2010 |
| | W = ('4 x 10–5)<br>LF 2.7316 | 564 | Bay of Biscay and Celtic Sea | Hennache and Jung, 2010 |
| | W = ('4 x 10–5)<br>LF 2.8226 | 456 | Bay of Biscay and Celtic Sea | Hennache and Jung, 2010 |
| Fork length-total length relationship | LF = 0.8971LT + 1.7939 | | | Kohler *et al.*, 1995 |
| Male growth parameters | $l_{\infty}$ = 257.7<br>k = 0.080<br>t0 = -5.78 | | NW Atlantic | Harley, 2002 |
| Female growth parameters | $l_{\infty}$ = 309.8<br>k = 0.061<br>t0 = -5.90 | | NW Atlantic | Harley, 2002 |

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Combined sex growth parameters | l□= 289.4<br>k = 0.066<br>t0 = -6.06 | | NW Atlantic | Harley, 2002; Natanson *et al.*, 2002 |
| | l□= 267.6 ± 9.3<br>k = 0.084 ± 0.009<br>t0 = -5.39 ± 0.47 | 577 | NW Atlantic | Cassoff *et al.*, 2007 (1993–2004 data) |
| Population growth rate | ~ 2.5% per year<br>max ~ 5% per year in unfished popn. | | | Campana *et al.*, 2003 |
| Generation time (years) | ~ 18<br>~ 11 | | NW Atlantic<br>Atlantic | Campana *et al.*, 2003<br>Cortés, 2000 |
| Intrinsic rate of increase | 0.05–0.07 | | NW Atlantic | Campana *et al.*, 2001 |
| Potential rate of increase per year | 0.8% | | Atlantic | Cortés, 2000 |
| Trophic level | 4.2 | 115 (stomachs) | various (4 studies) | Cortes, 1999 |
| Total mortality coefficient | 0.18 | | NW Atlantic | Aasen, 1963 |

*** Cited in Francis *et al.*, 2008**

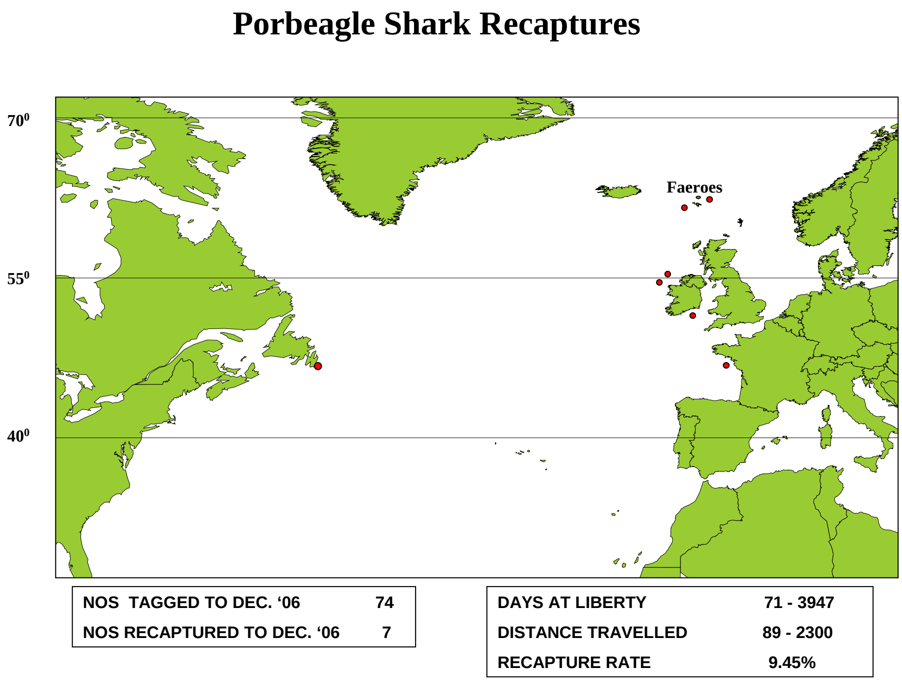
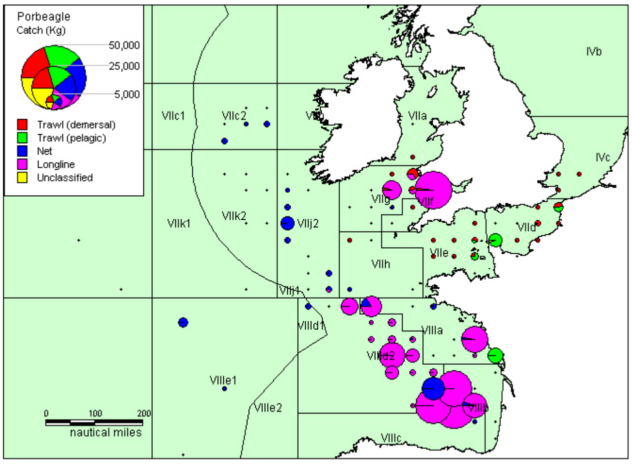
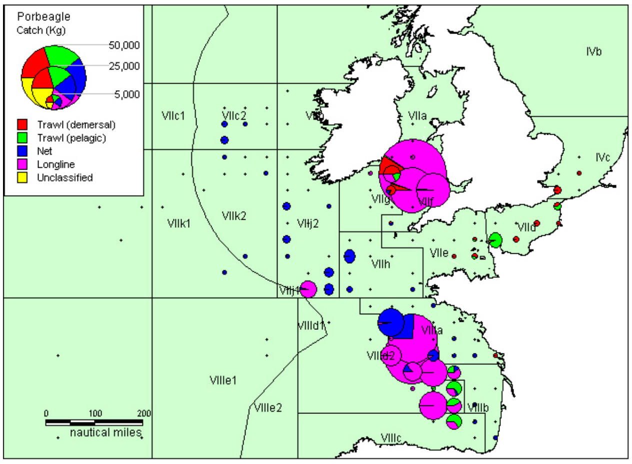


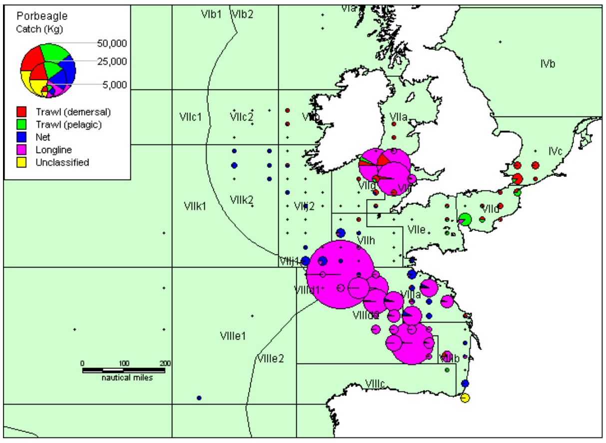

**Figure 6.1. Porbeagle in the NE Atlantic. Recapture locations of porbeagle sharks, from Irish Central Fisheries Board tagging programme (Green, 2007 WD).**



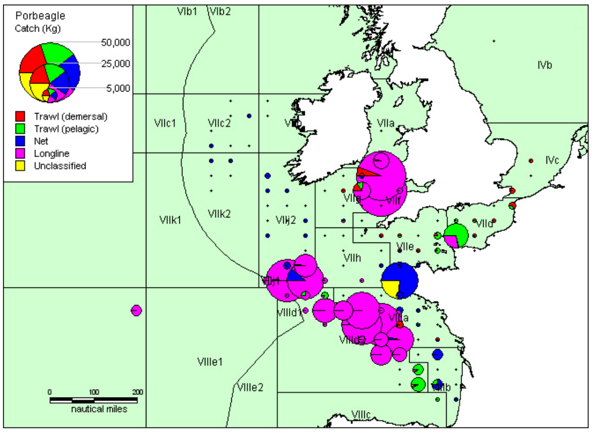

1999



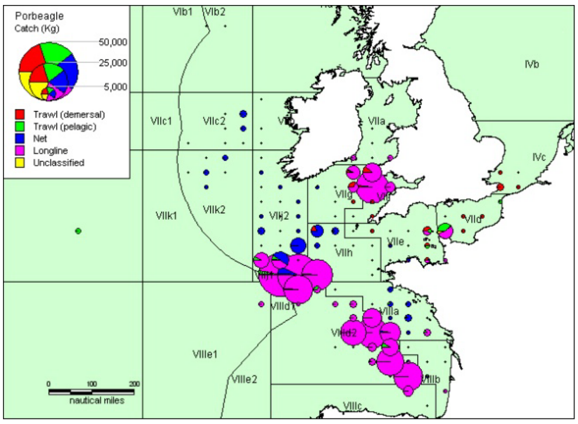

2000



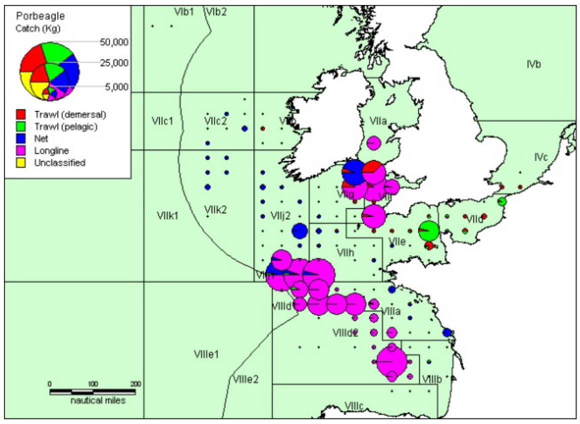

2001




2002




2003




2004

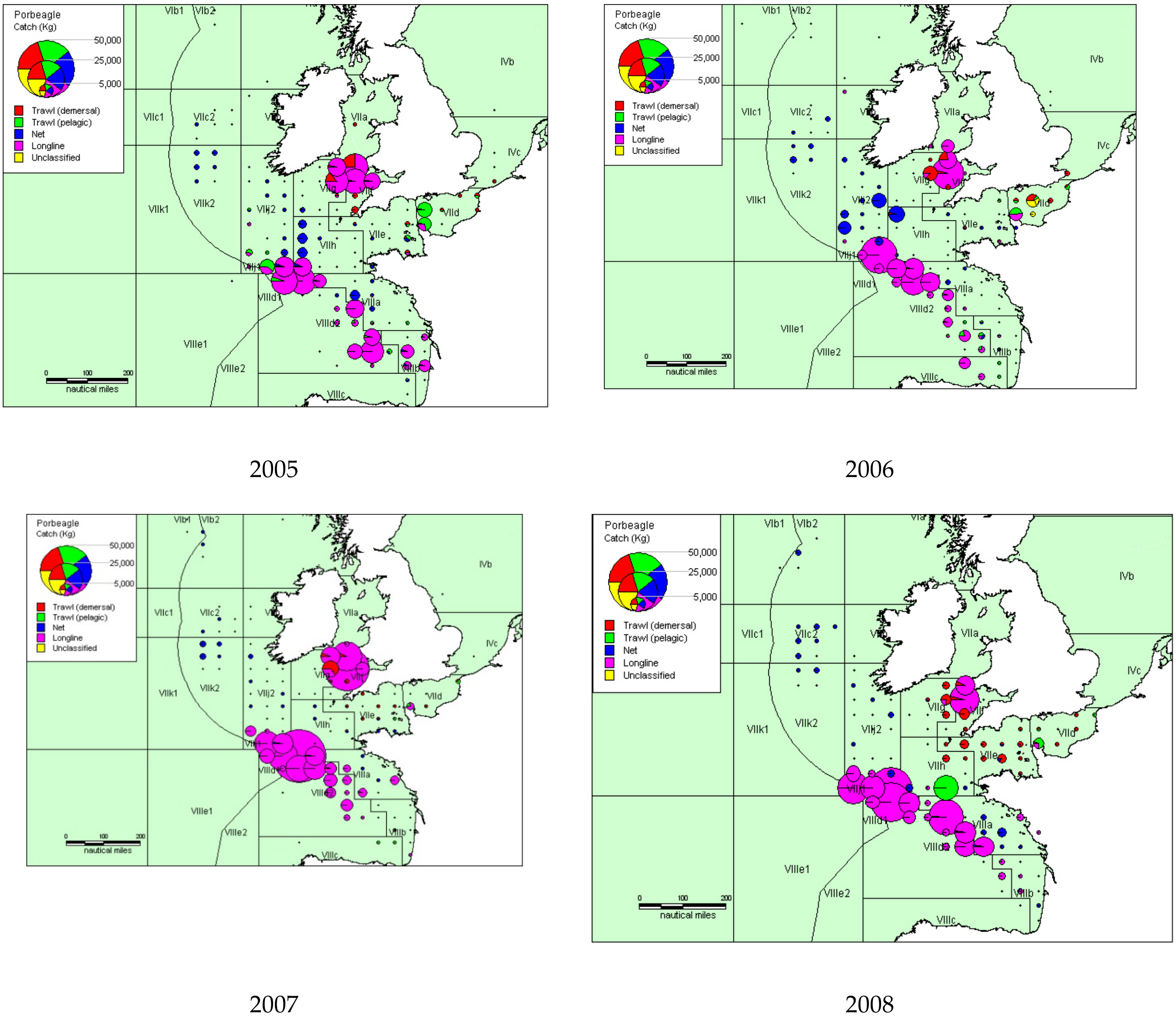
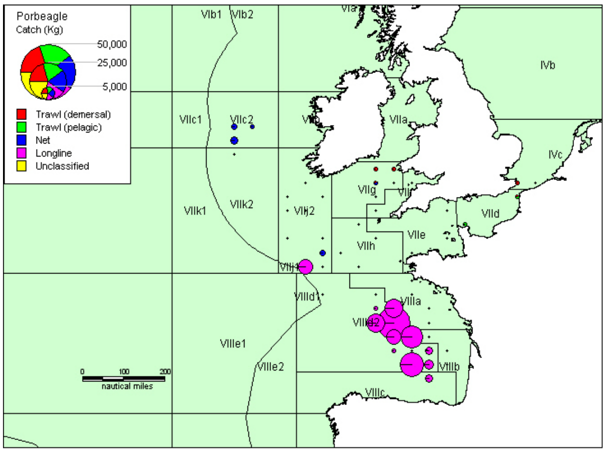
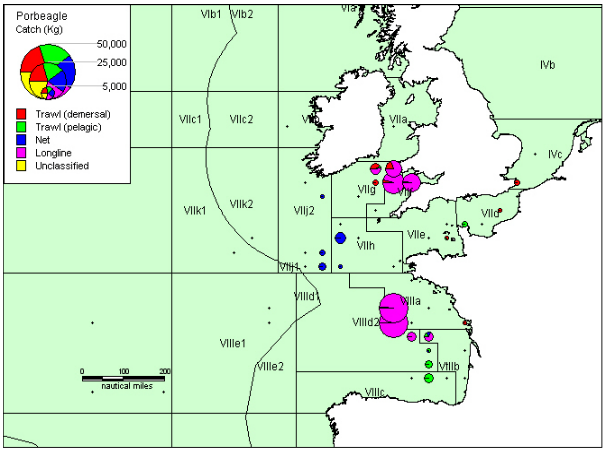


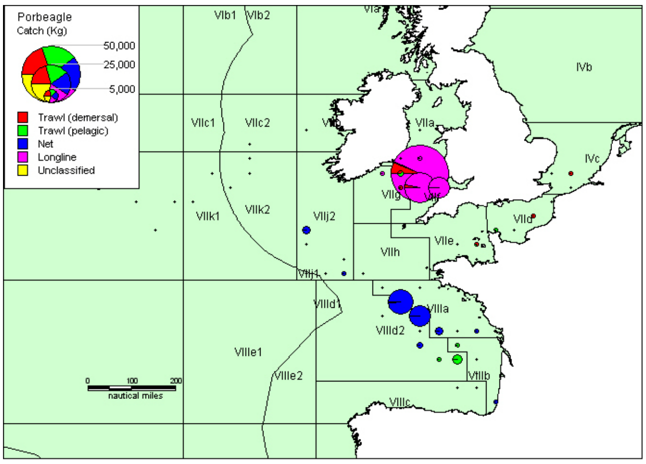

**Figure 6.2. Porbeagle in the NE Atlantic. Annual distribution of Porbeagle (*Lamna nasus*) catch by gear and ICES statistical rectangles, 1999–2008.**




April–May 2000




June–July 2000




August–September 2000

**Figure 6.3. Porbeagle in the NE Atlantic. Seasonal distribution of Porbeagle (*Lamna nasus*) catch by gear and ICES statistical rectangles (2000).**

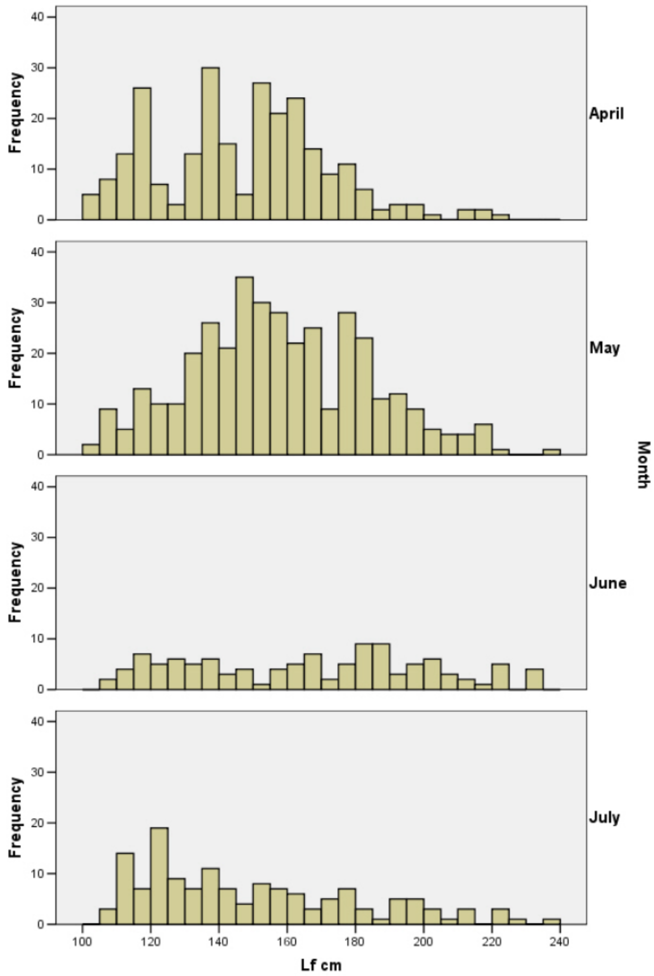



**Figure 6.4. Porbeagle in the NE Atlantic. Length–frequency distribution of the landings of the Yeu porbeagle targeted fishery by month in 2008 (April, n = 164; May, n = 350; June, n = 113; July, n = 142) 2008. Source: Jung, 2008.**

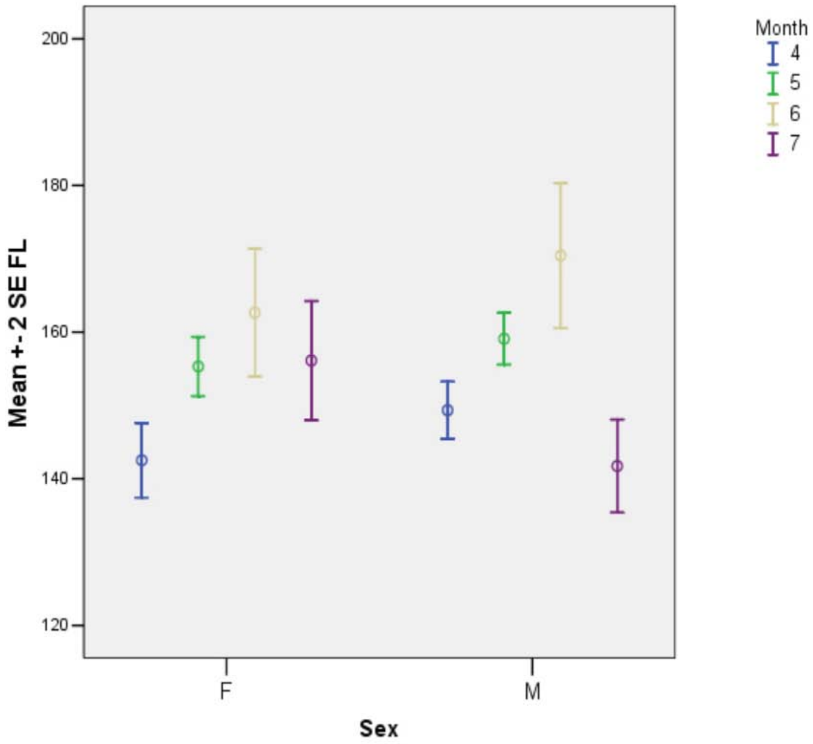



**Figure 6.5. Porbeagle in the NE Atlantic. Mean average length of the porbeagle landed in the French targeted fishery by sex for April (blue), May (green), June (yellow) and July (purple). Source: Jung, 2008.**

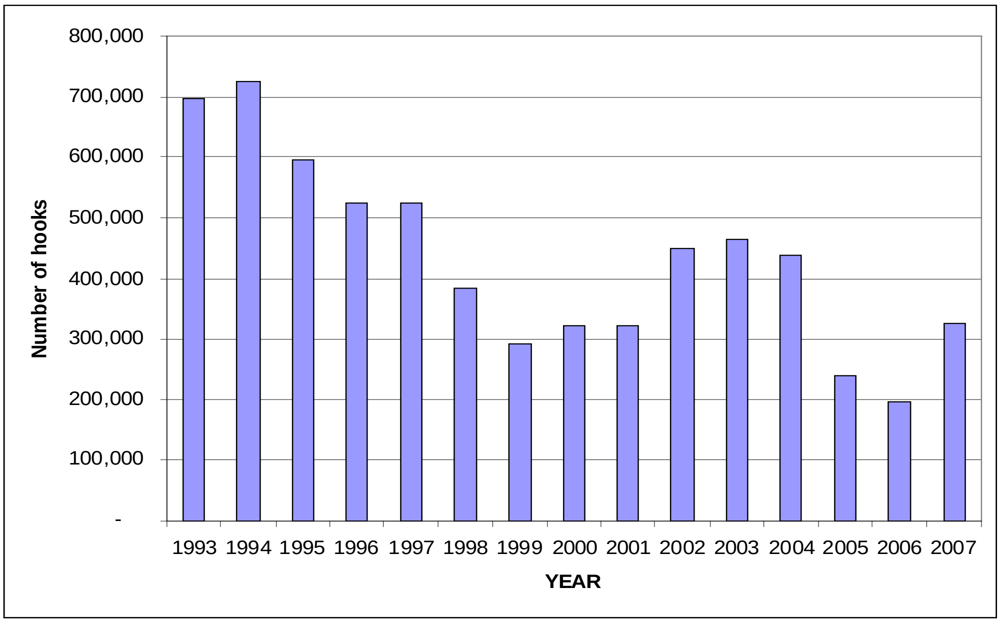



**Figure 6.8. Porbeagle in the NE Atlantic. Temporal trend in estimated effort (number of hooks per year) in the French porbeagle fishery, 1993–2007.**

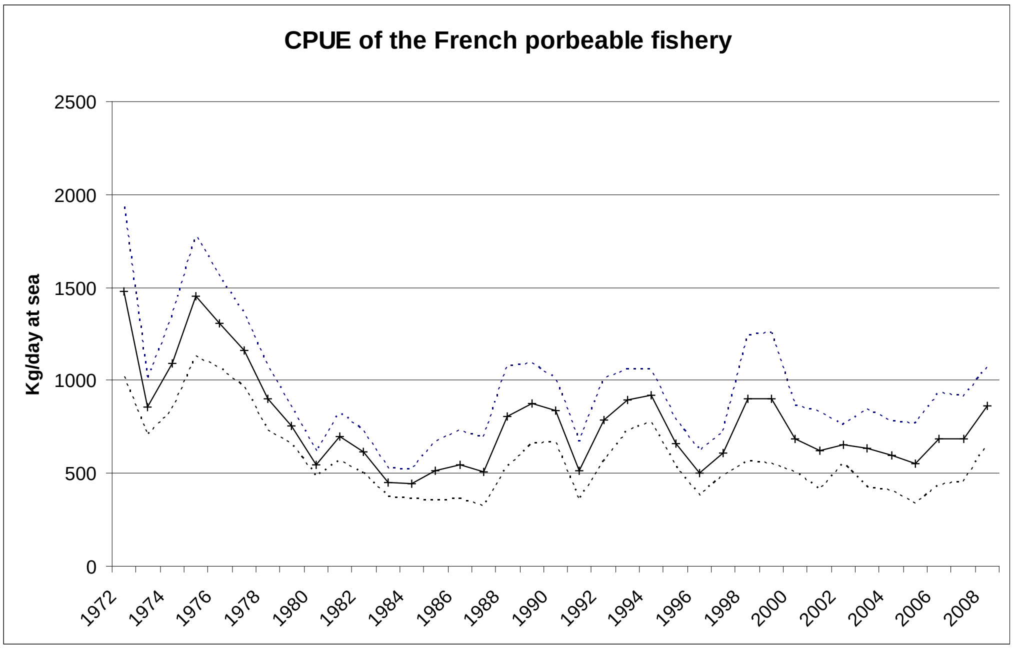



**Figure 6.9. Porbeagle in the NE Atlantic. Nominal cpue (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (± 2 SE of ratio estimate). From Biais and Vollette, 2009, WD.**

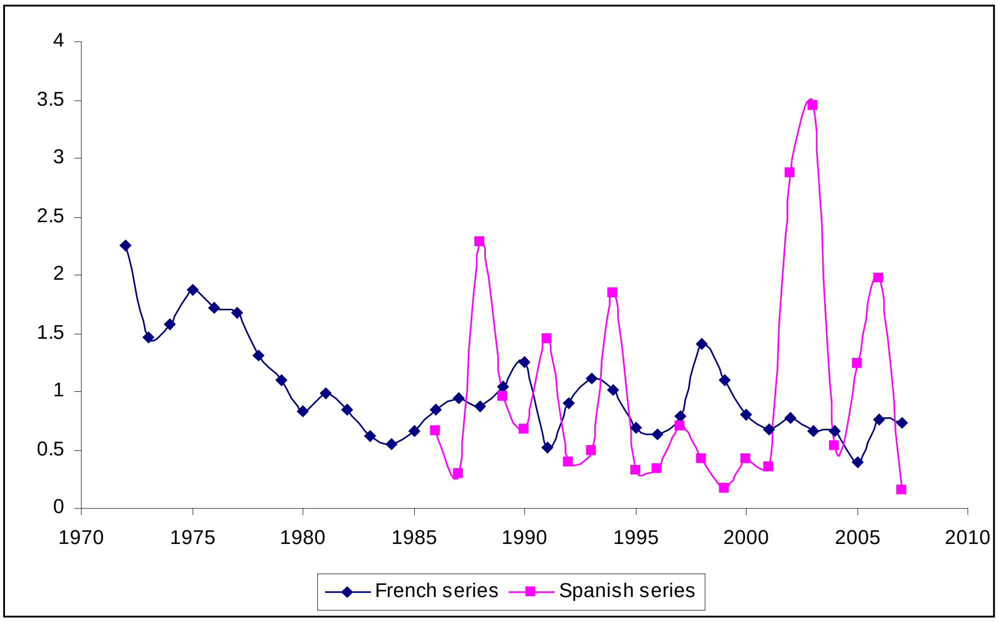



**Figure 6.10. Porbeagle in the NE Atlantic. Temporal trends in standardized cpue for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the NE Atlantic (1986–2007).**

## Portuguese dogfish (*Centroscymnus coeloepis*)

| | |
|---|---|
| Stock | Portuguese dogfish (*Centroscymnus coelolepis*) |
| Working Group | WKDEEP |
| Date | 17.02.2010–24.02.2010 |
| Revised by | Ivone Figueiredo and Tom Blasdale |

## A. General

**Portuguese dogfish** (*Centroscymnus coelolepis*) is widely distributed in the Northeast Atlantic. Specimens below 70 cm have been very rarely recorded 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.

### A.1. Stock definition

There is insufficient information to differentiate stocks in the Northeast Atlantic and consequently ICES has adopted the assumption of single stocks for each of these species in the ICES area.

### A.2. Fishery

Several species of deep-water sharks have been commercially exploited in the ICES area, however the most important are *C. squamosus* and *C. coelolepis*. These two species are both mainly taken in several mixed trawl fisheries in the Northeast Atlantic and in mixed and directed longline fisheries. Directed gillnet fisheries formerly operated in some areas.

Country by country accounts are presented as follows:

**Norway**–Norwegian longliners target blue ling (*Molva dypterigia*), Mora (*Mora moro*) and leafscale gulper shark (*Centrophorus squamosus*) on the continental slope between 800 and 1100 metres. In 2000 and 2001, a longline fishery for Greenland Halibut with a bycatch of Portuguese dogfish operated on Hatton Bank between 1300 and 1600 metres.

**Faroes**–A directed longline fishery on deep-water sharks was carried out in the southern and western slopes of Faroes Island from 1995 to 1999. No detailed information on this fishery is available although anecdotal information suggests that fishing was developed at depths between 800 and 1200 meters in the slopes west of the Wyville Thompson Ridge and south of the Faroe Bank Plateau.

**Germany**–At the early 2000s Two German vessels conducted a deep-water gillnet fishery (Hareide *et al.*, 2004). The main fishing area were Southern part of area VII (Porcupine Seabight and around Rockall. (Area VI and XII). The deep-water sharks were landed in Spain as 'various sharks'. This fishery ceased in 2006 as result of the EU ban on fishing with gillnets in depths greater than 600 m.

**France**–C. *squamosus* and *C. coelolepis* and lately, *Centroscyllium fabricii*, are caught by the French trawl fishery for mixed deep-water species. Initially this fishery was conducted in ICES Subareas VIa, VIIc,k but in 2001 when the Irish deep-water trawl fishery started to operate in Subarea VII most of the French fishing fleet moved to

Subarea VIa).

In Subarea XII there have been some French landings of deep-water sharks, but it is not possible to detect any trends from the available data.

**Ireland**–An Irish longline fishery targeting ling and tusk in the upper slope and deep-water sharks started in 2000 and ceased in 2003. Mainly two species of deep-water sharks, *C. coelolepis* and *C. squamosus* were marketed but there were some landings of birdbeak dogfish and longnose velvet dogfish.

Several large newer trawlers have targeted deep-water species in Subareas VI and VII. There is a directed fishery for orange roughy in Subarea VII, with a low a bycatch which includes *C. coelolepis* and *C. squamosus* as well as a more extensive fishery on the continental slopes of Sub-areas VI and VII for mixed deep-water species including *C. coelolepis* and *C. squamosus*.

**UK**–Between the mid 1980s and 2006, UK registered longliners and gillnetters operated a directed fishery for deep-water sharks in Subareas VI, VII and XII. The fleet was mostly composed of vessels based in Spain but registered in the UK, Germany and other countries outside the EU such as Panama.

*C. squamosus* and *C. coelolepis* are caught by a Scottish deep-water mixed-species trawl fishery operating mainly in Subarea VI. Since the introduction of TACs for a number of deep-water species in 2003, effort in this fishery has been at low level.

**Spain**–A fleet of around 24 large freezer trawlers conducts a mixed deep-water fishery in international waters of the Hatton Bank, mainly in ICES Subarea XII and partially in Division VIb, however, few of these vessels worked full-time in this fishery (two in 2000 and four in 2001). The main commercial fish species are smoothheads, roundnose grenadier, blue ling and *C. coelolepis*.

The Basque "baka" trawl fishery operates in Subareas VI and VII and Divisions VIIa,b,d but deep-water species including sharks are only important in Subarea VI. In the period 1997–2002, a small longline fishery targeting deep-water sharks landed annually in Basque ports about 150 t in "trunk" weight (i.e. gutted and without head, skin and fins) of deep-water sharks (Lucio *et al*., 2004).

**Portugal**–At Sesimbra (Division IXa), the longline fishery targeting black scabbardfish *Aphanopus carbo* takes a bycatch of deep-water sharks. The most important shark species caught by this fishery are the Portuguese dogfish and leafscale gulper sharks. Deep-water sharks are also caught by the Portuguese deep-water bottom-trawl fishery that targets the rose shrimp *Parapenaeus longirostris* and *Nephrops* mainly south and southwest of the Portuguese mainland. Deep-water shark species caught in this fishery are: birdbeak dogfish, blackmouth catshark, gulper shark, kitefin shark, leafscale gulper shark, smooth lanternshark *Etmopterus pusillus* and velvet belly.

From 1983 till 2001 there was directed longline fishery for deep-water sharks, based at Viana do Castelo in northern Portugal. Landings from this fishery predominantly consisted of gulper shark. However, other deep-water species are caught in relatively small quantities. These include the leafscale gulper shark, Portuguese dogfish, blackspot sea bream (*Pagellus bogaraveo*), greater fork-beard (*Phycis blennoides*), European conger (*Conger conger*) and the black scabbardfish. In the early years of the fishery only the livers of the sharks were of commercial value.

### A.3. Ecosystem aspects

***Centroscymnus coelolepis***

*C. coelolepis* is found in the Northwest Atlantic (from the Grand Banks to off Delaware Bay, and Cuba), Northeast Atlantic (Iceland to Sierra Leone, including the western Mediterranean, Azores and Madeira), South-East Atlantic (Namibia and South Africa) and western Pacific (Japan, New Zealand and Australia, and possibly in the South China Sea) (Compagno, 2004). Based on commercial landings and research vessel surveys, *C. coelolepis* is widely distributed in the ICES area, including off Norway (ICES Divisions IIIa and IVa), Faroes Islands (Vb), Iceland (Va), west of the British Isles (VI, VIIb–c, j–k), Bay of Biscay and Cantabrian Sea (VIII), Portugal (IX), Azores (X) and off Madeira.

*C. coelolepis* lives near the bottom from 270–3675 m depth (Compagno, 2004). In the Northeast Atlantic it is known from 1400–1900 m on the Reykjanes Ridge (Hareide and Garnes 2000), 1169 m off Iceland (Magnússon *et al.*, 2000); on the Hatton Bank 600–1200 m (Duran Muñoz *et al.*, 2000) and down to 1950 m (Hareide and Garnes, Appendix 8); 667–1750 m in the Rockall Trough (Gordon, 1999a), 750–2050 m in the Porcupine Seabight (Merret *et al.*, 1991) and 800–1500 m off Portugal (Veríssimo *et al.*, 2003).

## B. Data

### B.1. Commercial catch

In Portuguese and some Spanish fisheries, deep-water shark species have always been recorded separately in landings data. However, in other fisheries, it has been common practice until recently to record landings of all species collectively under generalized categories such as "various sharks not elsewhere identified", "siki sharks", "dogfish sharks not elsewhere identified," etc. This has made it very difficult to quantify landings of deep-water sharks, particularly as the same categories are often used to report other species such as pelagic sharks or spurdog.

Historical catches have been reconstructed according to a two stage procedure. First, landings data recorded under the various grouped categories were examined using expert knowledge of the fisheries operating in particular areas and time periods to determine which were likely to be deep-water sharks. These were included in the Working Group's estimate of "siki shark", i.e. mixed deep-water species comprising mainly *C. squamosus* and *C, coelolepis.* The data which were identified by WGDEEP 2005 as referring to deep-water shark species (included in the "siki sharks" data table) are listed in Table 1. All other records under mixed categories are believed to be other species.

In the second stage, the landings data in the "siki sharks" data table were split according to the proportions observed in various sampling schemes and surveys, etc to give estimates of species-specific landings. The data sources used in this splitting are listed in Table 2. A considerable number of assumptions have been made in order to split catches from areas, years and fisheries from which no data were available. For instance, data from trawl fisheries were used to split landings from UK gillnetters. This will be improved should better data become available in future e.g. it is expected that species-specific landings for UK gillnetters will be provided by the RACs.

**Table 1 Landings recorded in combined categories considered by WGEF to be "siki" sharks; i.e. mixed deep-water species comprising mainly *C. squamosus* and *C, coelolepis*.**

| Landing Category | country | ICES Subareas/Divisions | Years |
|---|---|---|---|
| cartilaginous fish NEI data | No landing in this category were considered to be deep-water sharks | | |
| various sharks NEI | UK-England and Wales | V, VI and VIIc, | 1990 to 2002 |
| | UK-Scotland | All | 1989 to 2001 |
| | Portugal | VIIIc | 1990 to 2000 |
| | Poland | VIb | 2002 and 2003 |
| | Estonia | VIb | 2002 and 2003 |
| | Lithuania | XII | 2001 and 2003 |
| dogfish sharks NEI | France* | VI, VII, XII | 1989 to 2003 |
| | Germany | V, VI, VII, XII | 1995 to 2003 |
| Landing identified by species but identification considered unreliable | Faroes | All | All |
| | France* | All | All |
| | Ireland (records of Portuguese dogfish probably contain unknown quantities of leafscale gulper shark) | VII | 2001-2006 |
| | Scotland (Portuguese dogfish probably contain unknown quantities of leafscale gulper shark. Records of Leafscale gulper shark are considered to be correct) | VI | 1997–2005 |
| | Lithuania (*C. coelolepis* landings probably contain *C. squamosus*) | All | All |
| Data supplied to WGEF but identification considered unreliable | UK-England and Wales** | All | 2001–2004 |
| | UK-Scotland | All | 2001–2004 |

*** all data in FISHSTAT was replaced by more reliable data provided to WGDEEP 2002**

**** Data from 2003 and 2004 replaced with data from Cefas**

**Table 2 Data sources to split "siki sharks".**

| Source | ICES area | Years | Gear | Type | Available information |
|---|---|---|---|---|---|
| French Landing | VIa | 1999–2001 | Trawl | Fishery Landing sampling | Ratios not by depth Note: 12 boats/year |
| French Landing | VIa | 2002–2008 | Trawl | Fishery | French landings statistics; vessels from one fish owning company reported the species separately using an appropriate protocol to identify species<br>Note: Represent 50% of landings |
| French trawler(auction market) | VIa | 2009 | Trawl | Fishery | Proportion of the two species by depth |
| SAMS | VIa | 2000–2009 | Trawl | Survey | Data by species in weight and number at fishing haul<br>Note: very small numbers caught |
| IRISH s | VIa &VIIc | 2006–2009 | Trawl | Survey | Data by species in weight and number at fishing haul Note: depth strata are not the same between surveys |
| DEEPNET Report | VI & VII | | Gillnet | Fishery | Ratios in weight Note: data from 1 recovered net |
| Cefas | Va,Vb<br><br>VIIj,k | 2004<br><br>2005 | Gillnet | Fishery | Observer data |
| Cefas | VIa | 2005; 2006 | Longline | Fishery | Observer data |
| Spanish fishery | VIb and XII Hatton Bank | 2005–2008 | Trawl | Fishery | Observer data<br>Ratios per depth and by ICES subarea |
| IEO | VIIb,k | 2001–2009 | Trawl | Survey | Information by haul |

Any future method developed to split the historical UK (E+W) landings data by species is not to be used for advice until it is benchmarked.

## B.2. Biological

***Centroscymnus coelolepis***

Some data on size-at-maturity, fecundity and gestation are available from Icelandic waters (Magnússon *et al.*, 2000), west of the British Isles (Gordon, 1999a; Clarke *et al.*, 2002; Girard, 2000) and Portuguese mainland (Veríssimo *et al.*, 2003; Figueiredo *et al.*, 2008). The size-at-maturity for females has been estimated as 93–94 cm off Iceland (Magnússon, 1999), 102 cm west of the British Isles (Clarke *et al.*, 2002; Girard, 2000), and 100 cm off Portugal (Veríssimo *et al.*, 2003). Males mature at a smaller size (85–86 cm) (Clarke *et al.*, 2002; Girard, 2000; Figueiredo *et al.*, 2008).

Estimates of ovarian (number of oocytes in the ovary) and uterine (number of embryos developing) fecundities are available for two areas. West of the British Isles, both ovarian and uterine fecundity are 13 (Clarke *et al.*, 2002), whereas off Portugal, ovarian and uterine fecundity were 13 and 10–11 respectively (Veríssimo *et al.*, 2003; (Figueiredo *et al.*, 2008). No clear trend between the number of developed follicles and embryos, and the total length was observed (Figueiredo *et al.*, 2008).The gestation period is still unknown in this species, although it is expected to last more than one year (Figueiredo *et al.*, 2008). Estimates of the size at birth range from 26.8 cm (Veríssimo *et al.*, 2003) to 30.7 cm (Clarke *et al.*, 2002).

Analysis of reproductive data demonstrated the existence of two periods during which ovulation is maximal. Late mature females, with high levels of gonad index and maximal values of oviducal gland index occurred in March and April and in October and November. The high variability of reproductive indices from females in these two periods suggested that individuals in different stages of the maturation process coexist and this stage might have a long duration (Figueiredo *et al.*, 2008).

### B.3. Surveys

FRS has conducted deep-water surveys (depth range 300–1900 m) in Division VIa since 1996. Since 1998 the survey has been reasonably consistent about survey design, gear deployed and area covered (Jones *et al.*, 2005). The survey uses a large commercial trawl (made by Jackson) and is towed for a period of 1.5–2 hours at speeds of 3–3.5 knots. Initially, the survey was carried out on a biennial basis, but since 2004 has been carried out annually.

### B.4. Commercial cpue

#### Portuguese longline fisheries

In the 2008 meeting of WGEF, standardized lpue from Portuguese longliners data were presented (Figueriedo *et al.*, 2008WD). This working document presented the results of an exploratory analysis of daily landings data from Portuguese vessels with deep-water licences to operate in the Portuguese continental slope. These vessels target black scabbardfish but have bycatch of Portuguese dogfish and leafscale gulper shark.

The underlying assumption "*at small spatial scales, catch is proportional to the fishing effort and density*" followed when evaluating catch rates as an index of abundance, may be not adequate for deep-water sharks due to the mixed nature of this fishery that catches them.

***Data used***

- Individual daily landings per species and per fishing vessel were available for the period 1995–2006.
- For the period 2000–2004, VMS records exhibited time intervals of 10 min which allows the identification of fishing locations. Afterwards and with cross analysis with the daily landings data it was possible to infer the catch data, because in this fishery discards are almost null (WD).
- Following point 2 of article 8 from EC Regulation no. 2244/2003 of 18 December and due to operational constraints associated with data handling in Portuguese VMS monitoring centre, requests of this type of data from 2005

onwards have been provided with a polling frequency of 2 hours, which make their use for the fishing location purpose not viable.

In the analysis of the longer dataseries, several attempts were made to incorporate into the hurdle model factors other than fishing locations as a way to circumvent the lack of that information for the remaining time period. Due to the low level of adjustment, particularly for Portuguese dogfish, the analysis proceeded by estimating the mean landed weight by daily landing per year as well as its variance. To avoid the use of almost null catches of each deep-water shark landings it was decided not to consider landings in which the weight of each of these species represented less than 10% of landed weight of black scabbardfish.

### Lpue from French fisheries in Subarea Vb, VI and VII

Time-series for lpue has been available in past years for a number of species exploited by French deep-water fisheries including deep-water sharks. Because sharks are not separated by species in landings data, this series is for combined species "siki" sharks. Lpues were calculated for a reference fleet of similar size vessels belonging to one French port and divided into six areas to account for changes in distribution of fishing effort (Figure 1). It is now impossible to further extend this time-series as all but one of the reference fleet has been decommissioned.

In one French port, landings of deep-water sharks are split by species. It is believed that vessels from this port are typical of the fishery as a whole so ratios derived from these landings can be used to split French landings of "siki" and thus calculate an unstandardized commercial lpue series for Portuguese dogfish and leafscale gulper shark individually. These series, when it is available, will be used in preference to the combined "sikis" lpue in assessments. Until then, the combined index will be used for historical trends but must be interpreted to take account of the different life histories of the two species and possible implications for sensitivity to fishing.

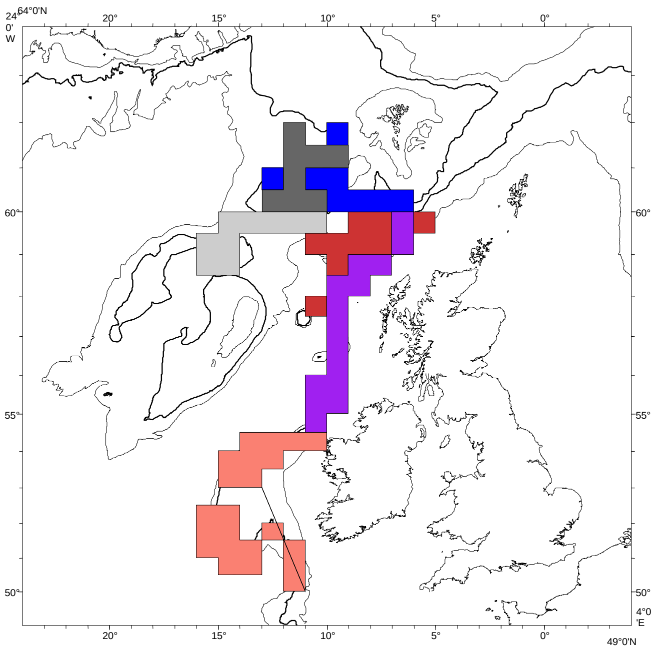



**Figure 1. Areas used to compute lpue of French vessels (black: New grounds in V; blue, Reference area in V; Grey: new grounds in VI; Purple reference area in VI-edge; Red: Reference area in the VI - other; pink reference area in VII.**

#### Industry data

An observer from the Long Distance Fleet Regional Advisory Council (LDRAC) attended the Benchmark meeting. The observer contacted the LDRAC headquarters to investigate the possibility of having UK gillnetter and longliner fisheries data available long before the next WGEF that will be held in June 2010.

### B.5. Other relevant data

***Centroscymnus coelolepis***

Biological studies on the species held in the NE Atlantic and in the Pacific oceans, gave evidences for the species spatial segregation by sex and by maturity stage (Girard and Du Buit, 1999; Clarke *et al*., 2001; Yano and Tanaka, 1988). In the NE Atlantic females of Portuguese dogfish in all maturity stages can be caught in all different commercially exploited areas. Such distribution pattern may suggest the existence of small-scale populations of Portuguese dogfish in those different areas within which individuals are able to complete the entire life cycle (Verissimo *et al*., 2003), fact that was already pointed by ICES (2007).

## C. Historical stock development

The first preliminary assessment on *C. coelolepis* and *C. squamosus* combined was attempted by SGDEEP (ICES, 2000) using the available series of catch and effort from French reference fleet trawlers as inputs. The series of cpue data presented in WGDEEP (ICES 2002b, Table 17.2) formed the basis of attempted assessments. In all cases, however, these assessments were considered to be too unreliable to be included in the Report of that Working Group.

Further analyses of stock status were presented in Basson *et al.* (2002) describes the results from the SGDEEP assessments of deep-water sharks using Schaefer and Delury analyses and from presence/absence analyses of long-term RV time-series data. This study demonstrated that it is evident that the relative importance of larger size females increased in recent years. In addition the percentages of non-zero hauls in Scottish research trawl surveys demonstrate a decline in percentage of hauls with *C. coelolepis* declined between 1975 and 2000.

A second attempt was made during DELASS. The French cpue data for Subareas V, VI and VII for *C. coelolepis* and *C.squamosus* together were used as inputs. The combined cpue for these Subareas was calculated from the total catch and effort data presented in the WGDEEP Report (ICES, 2002b). These data did not display as marked an upward trend as demonstrated in the WGDEEP Report (ICES, 2002b). Both cpue datasets were used as inputs. The time-series for Subarea VI, where most effort took place, both displayed downward trends until 1998. The WGDEEP 2002 series did not display the high peak in the SGDEEP 2000 series for 1991. However, the value for 2001 is the highest since 1994. There is no similar upward trend for the other subareas, and it is unclear what the reasons for this trend are. The series for the Subareas combined displayed the same trend, indicating the importance of effort in Subarea VI on these sharks. However, there is no anecdotal evidence from the fishery to suggest that there is an upward trend in abundance in 2000 or 2001.In addition, Norway (autoline) and Ireland (autoline and trawl) survey abundance indices in Subarea VI did not mirror the upward trend in cpue from the French commercial fishery. Furthermore, the pooled species data, from autoline surveys displayed a downward trend from 1997 to 2000. In Subareas VII and XII there is some evidence of a decline in survey cpue throughout the 1990s.

In the second attempt the cpue data for siki representing non-directed effort as input to Schaeffer Production Model, using the CEDA package (Holden *et al.*, 1995). This model and package were chosen to allow for comparisons to be made with the previous assessment attempted for these stocks. A sensitivity analysis was used to evaluate the effect of error models and ratio of initial to virgin biomass. A time-lag of zero was used because that the time-series of catch and cpue were too short to explore the effect of recruitment over range of years. It was assumed, therefore, that growth rather than recruitment was the main contributor to biomass production. The available time-series data of cpue data demonstrate a gradual decline across most of the time period. Given this sort of pattern, caution is needed because of the one-way trip. (Hilborn and Walters, 1992) resulting in highly unreliable estimates of the parameters of this model. A value of the ratio of initial stock to virgin stock was chosen as 0.7, based on sensitivity analysis. The fit of the Schaeffer production model was very poor when all years were included. It was considered reasonable to exclude years 1991 and 1993 because the 42|ICES WGEF Report 2005 fishery was not fully developed then. The directed cpue series (ICES, 2000) displayed a peak in 1991. However non-directed cpue did not display a first peak until 1993, which probably reflected the targeting of the orange roughy fishery in Subarea VI at that time. The years 2000 and 2001 were excluded because there was no supporting evidence of an upward trend in stock abundance in these years. Subsequent runs of the Schaeffer model gave a better model fit than when all years were included. Two additional scenarios were considered, using the WGDEEP 2002 cpue and the cpue recalculated in DELASS from the raw catch and effort data. The model was considered to fit the downward trend on abundance quite well, for the years considered.

Many of the output parameters from the Schaeffer production model are poorly estimated (Intrinsic rate of population increase (r) and maximum sustainable yield) and should not be used to assess the developments in these stocks. Carrying capacity and catchability seemed to be estimated with narrower confidence intervals. It was emphasized that because the estimates of carrying capacity are sensitive to the catch data used, the absence of species-specific data are a cause for concern. Given that Portuguese dogfish has a deeper bathymetric distribution than the leafscale gulper shark, the combined series may mask important trends in their respective abundance. Further refinement of species-specific catch and effort data, perhaps considering other reference fleets should be carried out. Such work would be particularly valuable for the fisheries that have taken place for the longest duration (French trawl and Portuguese longline fisheries). The stock of Portuguese dogfish certainly has not stabilized during the 1990s. Estimates of maximum sustainable yield (MSY) and intrinsic population growth rate (r) derived from stock production models cannot be usefully applied with the current model fits.

Advice given for these stocks in 2008 was based on trends in cpue and landings for the two species combined in French trawl fisheries and for separate species in Portuguese longline fisheries.

#### Benchmarked assessment methodology

Portuguese dogfish is assessed using trends in;

- Standardised cpue indices from Portuguese commercial fisheries;
- Presence/absence in Scottish and Irish surveys disaggregated by depth;

- French lpue indices; species-specific indices will be used when they become available. Until then, the combined "sikis" index may be used with caution to provide historical trends in combined lpue.

## G. Biological reference points

No appropriate biological reference points have been identified for these stocks.

## H. Other issues

None.

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## Leafscale gulper shark (*Centrophorus squamosus*)

| | |
|---|---|
| Stock | Leafscale gulper shark (*Centrophorus squamosus*) |
| Working Group | WKDEEP |
| Date: | 17.02.2010–24.02.2010 |
| Revised by | Ivone Figueiredo and Tom Blasdale |

# A. General

**Leafscale gulper shark** (*Centrophorus squamosus*) has a wide distribution in the North East Atlantic from Iceland and Atlantic slope south to Senegal, Madeira and the Canary Islands and the mid-Atlantic slope as far south as the Azores. On the Mid-Atlantic Ridge it is distributed from Iceland to Azores (Hareide and Garnes, 2001) The species can live as a demersal shark on the continental slopes (depths between 230 and 2400 m) or present 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). Available information demonstrates that pregnant females and pups are found in Portugal, both the mainland (Moura *et al.*, 2006) and Madeira, while only pre-pregnant and spent females are found in the northern areas (Garnes, Pers. Comm.).

### A.1. Stock definition

There is insufficient information to differentiate stocks of in the Northeast Atlantic and consequently ICES has adopted the assumption of single stocks for each of these species in the ICES area.

### A.2. Fishery

Several species of deep-water sharks have been commercially exploited in the ICES area, however the most important are *C. squamosus* and *C. coelolepis*. These two species are both mainly taken in several mixed trawl fisheries in the Northeast Atlantic and in mixed and directed longline fisheries. Directed gillnet fisheries formerly operated in some areas.

Country by country accounts are presented as follows:

**Norway**–Norwegian longliners target blue ling (*Molva dypterigia*), Mora (*Mora moro*) and leafscale gulper shark (*Centrophorus squamosus*) on the continental slope between 800 and 1100 metres. In 2000 and 2001, a longline fishery for Greenland Halibut with a bycatch of Portuguese dogfish operated on Hatton Bank between 1300 and 1600 metres.

**Faroes**–A directed longline fishery on deep-water sharks was carried out in the southern and western slopes of Faroes Island from 1995 to 1999. No detailed information on this fishery is available although anecdotal information suggests that fishing was developed at depths between 800 and 1200 meters in the slopes west of the Wyville Thompson Ridge and south of the Faroe Bank Plateau.

**Germany**–In the early 2000s two German vessels conducted a deep-water gillnet fishery (Hareide *et al.*, 2004). The main fishing area was the southern part of Area VII (Porcupine Seabight and around Rockall. (Area VI and XII). The deep-water sharks were landed in Spain as 'various sharks'. This fishery ceased in 2006 as a result of the

EU ban on fishing with gillnets in depths greater than 600 m.

**France**–C. *squamosus* and *C. coelolepis* and lately, *Centroscyllium fabricii*, are caught by the French trawl fishery for mixed deep-water species. Initially this fishery was conducted in ICES Subareas VIa, VIIc,k but in 2001 when the Irish deep-water trawl fishery started to operate in Subarea VII most of the French fishing fleet moved to Subarea VIa).

In Subarea XII there have been some French landings of deep-water sharks, but it is not possible to detect any trends from the available data.

**Ireland**–An Irish longline fishery targeting ling and tusk in the upper slope and deep-water sharks started in 2000 and ceased in 2003. Mainly two species of deep-water sharks, *C. coelolepis* and *C. squamosus* were marketed but there were some landings of birdbeak dogfish and longnose velvet dogfish.

Several large newer trawlers have targeted deep-water species in Subareas VI and VII. There is a directed fishery for orange roughy in Subarea VII, with a low a bycatch which includes *C. coelolepis* and *C. squamosus* as well as a more extensive fishery on the continental slopes of Sub-areas VI and VII for mixed deep-water species including *C. coelolepis* and *C. squamosus*.

**UK**–Between the mid 1980s and 2006, UK registered longliners and gillnetters operating a directed fishery for deep-water sharks in Subareas VI, VII and XII. The fleet was mostly composed of vessels based in Spain but registered in the UK, Germany and other countries outside the EU such as Panama.

*C. squamosus* and *C. coelolepis* are caught by a Scottish deep-water mixed-species trawl fishery operating mainly in Subarea VI. Since the introduction of TACs for a number of deep-water species in 2003, effort in this fishery has been at low level.

**Spain**–A fleet of around 24 large freezer trawlers conducts a mixed deep-water fishery in international waters of the Hatton Bank, mainly in ICES Subarea XII and partially in Division VIb, however, few of these vessels worked full-time in this fishery (two in 2000 and four in 2001). The main commercial fish species are smoothheads, roundnose grenadier, blue ling and *C. coelolepis*.

The Basque "baka" trawl fishery operates in Subareas VI and VII and Divisions VIIa,b,d but deep-water species including sharks are only important in Subarea VI. In the period 1997–2002, a small longline fishery targeting deep-water sharks landed annually in Basque ports about 150 t in "trunk" weight (i.e. gutted and without head, skin and fins) of deep-water sharks (Lucio *et al*., 2004).

**Portugal**–At Sesimbra (Division IXa), the longline fishery targeting black scabbardfish *Aphanopus carbo* takes a bycatch of deep-water sharks. The most important shark species caught by this fishery are the Portuguese dogfish and leafscale gulper sharks. Deep-water sharks are also caught by the Portuguese deep-water bottom-trawl fishery that targets the rose shrimp *Parapenaeus longirostris* and *Nephrops* mainly south and southwest of the Portuguese mainland. Deep-water shark species caught in this fishery are: birdbeak dogfish, blackmouth catshark, gulper shark, kitefin shark, leafscale gulper shark, smooth lanternshark *Etmopterus pusillus* and velvet belly.

From 1983 till 2001 there was directed longline fishery for deep-water sharks, based at Viana do Castelo in northern Portugal. Landings from this fishery predominantly consisted of gulper shark. However, other deep-water species are caught in relatively small quantities. These include the leafscale gulper shark, Portuguese dogfish, blackspot sea bream (*Pagellus bogaraveo*), greater fork-beard (*Phycis blennoides*), European conger (*Conger conger*) and the black scabbardfish. In the early years of the fishery only the livers of the sharks were of commercial value.

### A.3. Ecosystem aspects

***Centrophorus squamosus***

*C. squamosus* is found in the eastern Atlantic (from Iceland to Senegal and off Namibia and South Africa), western Indian Ocean (off South Africa and Madagascar) and western Pacific (Japan, Philippines, southeastern Australia and New Zealand) (Compagno, 2004). In the ICES area, *C. squamosus* is widely distributed in deeper waters off Iceland (ICES Divisions Va–b) the western British Isles (VIa–b, VIIb–c, j–k), Bay of Biscay and Cantabrian Sea (VIII), off Portugal (IX) and the Azores (X).

This species lives near the bottom of the continental slope from 230–2400 m depth (Compagno *et al.*, 2004). Recorded depth ranges in the Northeast Atlantic are 933 m off Iceland (Magnússon *et al.*, 2000); 1400–1900 m along the Reykjanes Ridge, west of Norway (Hareide and Garnes, 2000); on the Hatton Bank 600–1200 m (Duran Muñoz *et al.*, 2000) and down to 1950 m; 458–1019 m in the Rockall Trough (Gordon, 1999); 600–1400 m west of Ireland (Girard, 2000); 750–1500 m in the Porcupine Seabight (Merret *et al.*, 1991) and 800–1500 m off Portugal (Veríssimo *et al.*, *2003*).

## B. Data

### B.1. Commercial catch

In Portuguese and some Spanish fisheries, deep-water shark species have always been recorded separately in landings data. However, in other fisheries, it has been common practice until recently to record landings of all species collectively under generalized categories such as "various sharks not elsewhere identified", "siki sharks", "dogfish sharks not elsewhere identified," etc. This has made it very difficult to quantify landings of deep-water sharks, particularly as the same categories are often used to report other species such as pelagic sharks or spurdog.

Historical catches have been reconstructed according to a two stage procedure. First, landings data recorded under the various grouped categories were examined using expert knowledge of the fisheries operating in particular areas and time periods to determine which were likely to be deep-water sharks. These were included in the Working Group's estimates of "siki shark", i.e. mixed deep-water species comprising mainly *C. squamosus* and *C, coelolepis.* The data which were identified by WGDEEP 2005 as referring to deep-water shark species (included in the "siki sharks" data table) are listed in Table 1. All other records under mixed categories are believed to be other species.

In the second stage, the landings data in the "siki sharks" data table were split according to the proportions observed in various sampling schemes and surveys, etc to give estimates of species-specific landings. The data sources used in this splitting are listed in Table 2. A considerable number of assumptions have been made in order to split catches from areas, years and fisheries from which no data were available. For instance, data from trawl fisheries were used to split landings from UK gillnetters. This will be improved should better data become available in future e.g. it is expected that species-specific landings for UK gillnetters will be provided by the RACs.

**Table 1. Landings recorded in combined categories considered by WGEF to be "siki" sharks; i.e. mixed deep-water species comprising mainly *C. squamosus* and *C, coelolepis*.**

| Landing Category | Country | ICES Subareas/Divisions | Years |
|---|---|---|---|
| cartilaginous fish *NEI* data | No landing in this category were considered to be deep-water sharks | | |
| various sharks NEI | UK-England and Wales | V, VI and VIIc, | 1990 to 2002 |
| | UK-Scotland | All | 1989 to 2001 |
| | Portugal | VIIIc | 1990 to 2000 |
| | Poland | VIb | 2002 and 2003 |
| | Estonia | VIb | 2002 and 2003 |
| | Lithuania | XII | 2001 and 2003 |
| dogfish sharks *NEI* | France* | VI, VII, XII | 1989 to 2003 |
| | Germany | V, VI, VII, XII | 1995 to 2003 |
| Landing identified by species but identification considered unreliable | Faroes | All | All |
| | France* | All | All |
| | Ireland (records of Portuguese dogfish probably contain unknown quantities of leafscale gulper shark) | VII | 2001–2006 |
| | Scotland (Portuguese dogfish probably contain unknown quantities of leafscale gulper shark. Records of Leafscale gulper shark are considered to be correct) | VI | 1997–2005 |
| | Lithuania (*C. coelolepis* landings probably contain *C. squamosus*) | All | All |
| Data supplied to WGEF but identification considered unreliable | UK-England and Wales** | All | 2001–2004 |
| | UK-Scotland | All | 2001–2004 |

*** all data in FISHSTAT was replaced by more reliable data provided to WGDEEP 2002.**

**** Data from 2003 and 2004 replaced with data from Cefas.**

**Table 2.**

| Source | ICES area | Years | Gear | Type | Available information |
|---|---|---|---|---|---|
| French Landing | VIa | 1999–2001 | Trawl | Fishery Landing sampling | Ratios not by depth Note: 12 boats/year |
| French Landing | VIa | 2002–2008 | Trawl | Fishery | French landings statistics; vessels from one fish owning company reported the species separately using an appropriate protocol to identify species<br>Note: Represent 50% of landings |
| French trawler(auction market) | VIa | 2009 | Trawl | Fishery | Proportion of the two species by depth |
| SAMS | VIa | 2000–2009 | Trawl | Survey | Data by species in weight and number at fishing haul<br>Note: very small numbers caught |
| IRISH s | VIa &VIIc | 2006–2009 | Trawl | Survey | Data by species in weight and number at fishing haul Note: depth strata are not the same between surveys |
| DEEPNET Report | VI & VII | | Gillnet | Fishery | Ratios in weight Note: data from 1 recovered net |
| Cefas | Va,Vb<br><br>VIIj,k | 2004<br><br>2005 | Gillnet | Fishery | Observer data |
| Cefas | VIa | 2005; 2006 | Longline | Fishery | Observer data |
| Spanish fishery | VIb and XII Hatton Bank | 2005–2008 | Trawl | Fishery | Observer data<br>Ratios per depth and by ICES subarea |
| IEO | VIIb,k | 2001–2009 | Trawl | Survey | Information by haul |

Any future method developed to split the historical UK (E+W) landings data by species cannot be used for advice until it is benchmarked.

## B.2. Biological

### *Centrophorus squamosus*

There is little information regarding reproductive biology in this species, although there are some data on the size-at-maturity and fecundity for fish caught west of the British Isles (Gordon, 1999; Girard, 2000) and Portugal (Figueiredo *et al*., 2008). The size at first sexual maturity for fish caught off the western British Isles has been recorded as 98 and 106 cm for males and females respectively (Girard and Du Buit, 1999). Clarke *et al*. (2002) estimated that males and females matured at lengths of 102 and 128 cm respectively. In Portugal mainland, males and females mature at 99.1 and

126.3 cm, respectively, and median length at pregnancy was estimated as 123.8 cm (Figueiredo *et al*., 2008) Females from the western British Isles produce 7–11 oocytes, and a mean of five oocytes per ovary (Girard and Du Buit, 1999). However, it was recently suggested that ovarian fecundity is correlated with the female total length in this species (Figueiredo *et al*., 2008).

Available information reveals that pregnant females and pups are found in Portugal, mainly in Madeira and with sporadic occurrences in the mainland (Moura *et al*., 2006 WD) whereas only pre-pregnant and spent females are found in the northern areas (Garnes, pers. comm.).

In Portugal mainland and despite the scarcity of mature females, the gonad index increased in the second quarter and the greatest values of mean follicle diameter and of oviducal gland width (which are supposed to occur prior to ovulation) were also found in the second quarter of the year. These facts, although not conclusive, may lead to the hypothesis of the existence of a reproductive season (Figueiredo *et al*., 2008).

Clarke *et al*. (2002) estimated ages of 21–70 years for *C. squamosus* caught off the western British Isles, although the absence of smaller specimens in the study area restricted the fitting of growth models with meaningful confidence limits.

### B.3. Surveys

FRS has conducted deep-water surveys (depth range 300–1900 m) in Division VIa since 1996. Since 1998 the survey has been reasonably consistent about survey design, gear deployed and area covered (Jones *et al*., 2005). The survey uses a large commercial trawl (made by Jackson) and is towed for a period of 1.5–2 hours at speeds of 3–3.5 knots. Initially, the survey was carried out on a biennial basis, but since 2004 has been carried out annually.

### B.4. Commercial cpue

#### Portuguese longline fisheries

In the 2008 meeting of WGEF, standardized lpue from Portuguese longliners data were presented (Figueriedo *et al*., 2008WD). This Working Document presented the results of an exploratory analysis of daily landings data from Portuguese vessels with deep-water licences to operate in the Portuguese continental slope. These vessels target black scabbardfish but have bycatch of Portuguese dogfish and leafscale gulper shark.

The underlying assumption "*at small spatial scales, catch is proportional to the fishing effort and density*" followed when evaluating catch rates as an index of abundance, may be not adequate for deep-water sharks due to the mixed nature of this fishery that catches them.

##### *Data used*

- Individual daily landings per species and per fishing vessel were available for the period 1995–2006;
- For the period 2000–2004, VMS records exhibited time intervals of 10 minutes which allows the identification of fishing locations. Afterwards and with cross analysis with the daily landings data it was possible to infer the catch data, because in this fishery discards are almost null (WD);

- Following point 2 of article 8 from EC Regulation no. 2244/2003 of 18 December and due to operational constraints associated with data handling in Portuguese VMS monitoring centre, requests of this type of data from 2005 onwards have been provided with a polling frequency of 2 hours, which make their use for the fishing location purpose not viable.

In the analysis of the longer dataseries, several attempts were made to incorporate into the hurdle model factors other than fishing locations as a way to circumvent the lack of that information for the remaining time period. Due to the low level of adjustment, particularly for Portuguese dogfish, the analysis proceeded by estimating the mean landed weight by daily landing per year as well as its variance. To avoid the use of almost null catches of each deep-water shark landings it was decided not to consider landings in which the weight of each of these species represented less than 10% of landed weight of black scabbardfish.

#### Lpue from French fisheries in Subarea Vb, VI and VII

Time-series for lpue has been available in past years for a number of species exploited by French deep-water fisheries including deep-water sharks. Because sharks are not separated by species in landings data, this series is for combined species “siki” sharks. Lpues were calculated for a reference fleet of similar size vessels belonging to one French port and divided into six areas to account for changes in distribution of fishing effort (Figure 1). It is now impossible to further extend this time-series as all but one of the reference fleet has been decommissioned.

In one French port, landings of deep-water sharks are split by species. It is believed that vessels from this port are typical of the fishery as a whole so ratios derived from these landings can be used to split French landings of “siki” and thus calculate an unstandardized commercial lpue series for Portuguese dogfish and leafscale gulper shark individually. These series, when it is available, will be used in preference to the combined “sikis” lpue in assessments. Until then, the combined index will be used for historical trends but must be interpreted to take account of the different life histories of the two species and possible implications for sensitivity to fishing.

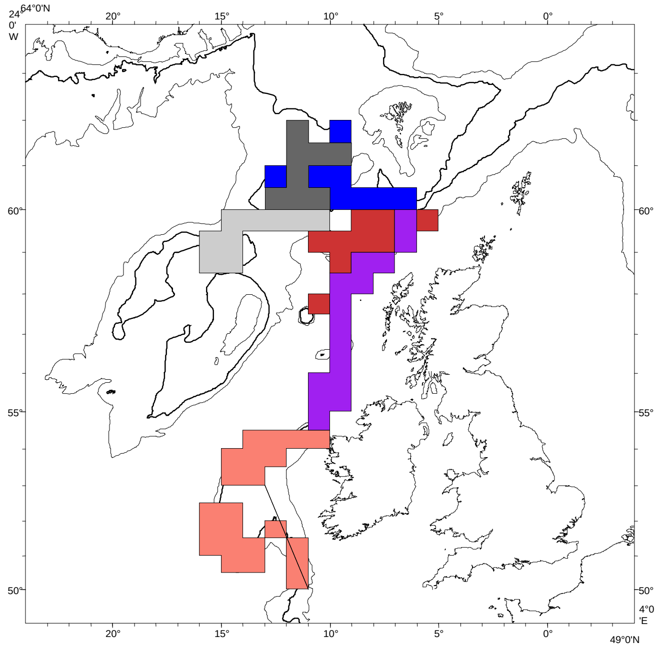


**Figure 1. Areas used to compute lpue of French vessels (black: New grounds in V; blue, Reference area in V; Grey: new grounds in VI; Purple reference area in VI-edge; Red: Reference area in the VI - other; pink reference area in VII.**

#### Industry data

An observer from the Long Distance Fleet Regional Advisory Council (LDRAC) attended the Benchmark meeting. The observer contacted the LDRAC Headquarters to investigate the possibility of having UK gillnetter and longliner fisheries data available long before the next WGEF that will be held in June 2010.

### B.5. Other relevant data

## C. Historical stock development

The first preliminary assessment on *C. coelolepis* and *C. squamosus* combined was attempted by SGDEEP (ICES, 2000) using the available series of catch and effort from French reference fleet trawlers as inputs. The series of cpue data presented in WGDEEP (ICES 2002b, Table 17.2) formed the basis of attempted assessments. In all cases, however, these assessments were considered to be too unreliable to be included in the Report of that Working Group.

Further analyses of stock status were presented in Basson *et al.* (2002) describes the results from the SGDEEP assessments of deep-water sharks using Schaefer and Delury analyses and from presence/absence analyses of long-term RV time-series data. This study demonstrated that it is evident that the relative importance of larger size females increased in recent years. In addition the percentages of non-zero hauls in Scottish research trawl surveys demonstrate a decline in percentage of hauls with *C. coelolepis* declined between 1975 and 2000.

A second attempt was made during DELASS. The French cpue data for Subareas V, VI and VII for *C. coelolepis* and *C.squamosus* together were used as inputs. The combined cpue for these Subareas was calculated from the total catch and effort data presented in the WGDEEP Report (ICES, 2002b). These data did not display as marked an upward trend as demonstrated in the WGDEEP Report (ICES, 2002b). Both cpue datasets were used as inputs. The time-series for Subarea VI, where most effort took place, both displayed downward trends until 1998. The WGDEEP 2002 series did not display the high peak in the SGDEEP 2000 series for 1991. However, the value for 2001 is the highest since 1994. There is no similar upward trend for the other subareas, and it is unclear what the reasons for this trend are. The series for the Subareas combined displayed the same trend, indicating the importance of effort in Subarea VI on these sharks. However, there is no anecdotal evidence from the fishery to suggest that there is an upward trend in abundance in 2000 or 2001.In addition, Norway (autoline) and Ireland (autoline and trawl) survey abundance indices in Subarea VI did not mirror the upward trend in cpue from the French commercial fishery. Furthermore, the pooled species data, from autoline surveys displayed a downward trend from 1997 to 2000. In Subareas VII and XII there is some evidence of a decline in survey cpue throughout the 1990s.

In the second attempt the cpue data for siki representing non-directed effort as input to Schaeffer Production Model, using the CEDA package (Holden *et al.*, 1995). This model and package were chosen to allow for comparisons to be made with the previous assessment attempted for these stocks. A sensitivity analysis was used to evaluate the effect of error models and ratio of initial to virgin biomass. A time-lag of zero was used because that the time-series of catch and cpue were too short to explore the effect of recruitment over range of years. It was assumed, therefore, that growth rather than recruitment was the main contributor to biomass production. The available time-series data of cpue data demonstrate a gradual decline across most of the time period. Given this sort of pattern, caution is needed because of the one-way trip. (Hilborn and Walters, 1992) resulting in highly unreliable estimates of the parameters of this model. A value of the ratio of initial stock to virgin stock was chosen as 0.7, based on sensitivity analysis. The fit of the Schaeffer production model was very poor when all years were included. It was considered reasonable to exclude years 1991 and 1993 because the 42|ICES WGEF Report 2005 fishery was not fully developed then. The directed cpue series (ICES, 2000) displayed a peak in 1991. However non-directed cpue did not display a first peak until 1993, which probably reflected the targeting of the orange roughy fishery in Subarea VI at that time. The years 2000 and 2001 were excluded because there was no supporting evidence of an upward trend in stock abundance in these years. Subsequent runs of the Schaeffer model gave a better model fit than when all years were included. Two additional scenarios were considered, using the WGDEEP 2002 cpue and the cpue recalculated in DELASS from the raw catch and effort data. The model was considered to fit the downward trend on abundance quite well, for the years considered.

Many of the output parameters from the Schaeffer production model are poorly estimated (Intrinsic rate of population increase (r) and maximum sustainable yield) and should not be used to assess the developments in these stocks. Carrying capacity and catchability seemed to be estimated with narrower confidence intervals. It was emphasized that because the estimates of carrying capacity are sensitive to the catch data used, the absence of species-specific data are a cause for concern. Given that Portuguese dogfish has a deeper bathymetric distribution than the leafscale gulper shark, the combined series may mask important trends in their respective abundance. Further refinement of species-specific catch and effort data, perhaps considering other reference fleets should be carried out. Such work would be particularly valuable for the fisheries that have taken place for the longest duration (French trawl and Portuguese longline fisheries). The stock of Portuguese dogfish certainly has not stabilized during the 1990s. Estimates of maximum sustainable yield (MSY) and intrinsic population growth rate (r) derived from stock production models cannot be usefully applied with the current model fits.

Advice given for these stocks in 2008 was based on trends in cpue and landings for the two species combined in French trawl fisheries and for separate species in Portuguese longline fisheries.

#### Benchmarked assessment methodology

Leafscale gulper shark is assessed using trends in;

- Standardised cpue indices from Portuguese commercial fisheries;
- Presence/absence in Scottish and Irish surveys disaggregated by depth;
- French lpue indices; species-specific indices will be used when they become available. Until then, the combined "sikis" index may be used with caution to provide historical trends in combined lpue.

## G. Biological reference points

No appropriate biological reference points have been identified for these stocks.

## H. Other issues

None.

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## 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.

## 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 h 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 h 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.

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 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), 81cm (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 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 a further four 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 data sets 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, and one with England & Wales selectivity. The Scottish and England & Wales selectivities were estimated by fitting to proportions-by-length-category data derived from Scottish and England & Wales commercial landings data bases.

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.

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 Scottish selectivity, and three England & Wales 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:

$$N^s_{y+1,a} = \begin{cases} \Phi^s R_{y+1} & a = 0 \\ (N^s_{y,a-1} e^{-M_{a-1}/2} - \sum_j C^s_{j,y,a-1}) e^{-M_{a-1}/2} & 0 < a \le A-1 \\ (N^s_{y,A-1} e^{-M_{A-1}/2} - \sum_j C^s_{j,y,A-1}) e^{-M_{A-1}/2} + (N^s_{y,A} e^{-M_A/2} - \sum_j C^s_{j,y,A}) e^{-M_A/2} & a = A \end{cases} \qquad \text{1a}$$

where $s$=$f$ or $m$, $\Phi^s$ 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:

$$B_y = \sum_s \sum_a w^s_a N^s_{y,a} \qquad \text{1b}$$

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:

$$N_{pup,y} = \sum_{a=1}^{A} P'_a P''_a N^f_{y,a} \qquad \text{2a}$$

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:

$$Q_y = 1 + (Q_{fec} - 1)(1 - N_{pup,y} / R_0) \qquad \text{2b}$$

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:

$$R_y = Q_y N_{pup,y}\, e^{\varepsilon_{r,y}} \qquad \text{2c}$$

where the recruitment variability parameter $\sigma_r$ is assumed known (0.2 for the base case), and recruitment residuals $\varepsilon_{r,y}$ are estimated.

### Fecundity

Fecundity, expressed as number of pups per pregnant female of age $a$, is modelled as follows:

$$P'_a = \begin{cases} 0 & l_a^f < l_{mat00}^f \\ b_{fec}\left(l_a^f + \sqrt{(l_a^f + a_{fec}/b_{fec})^2 + \gamma^2} - \sqrt{(a_{fec}/b_{fec})^2 + \gamma^2}\right)/2 & l_a^f \geq l_{mat00}^f \end{cases} \qquad 3$$

where $l_{mat00}^f$ is the female length-at-first maturity (Table 2.5), and □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 $l_a^f \geq l_{mat00}^f$.

#### 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:

$$F_{j,y} = \frac{C_{j,y}}{\sum_a e^{-M_a/2} \sum_s w_{a+\frac{1}{2}}^s S_{com,j,a}^s N_{y,a}^s} \qquad 4a$$

where $w_{a+\frac{1}{2}}^s$ is the mid-year mean weight of animals of sex *s* and age *a*, and $S_{com,j,a}^s$ 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:

$$F_{prop5-30,y} = \sum_j \frac{1}{26} \sum_{a=5}^{30} \left[ \frac{\sum_s S_{com,j,a}^s N_{y,a}^s (F_{j,y} S_{com,j,a}^s)}{\sum_s S_{com,j,a}^s N_{y,a}^s} \right] \qquad 4b$$

Catch-at-age (in numbers) is estimated as follows:

$$C_{j,y,a}^s = F_{j,y} S_{com,j,a}^s N_{y,a}^s e^{-M_a/2} \qquad 4c$$

#### Commercial selectivity

Commercial selectivity-at-age is calculated from commercial selectivity-by-length category parameters as follows:

$$S_{com,j,a}^{s*} = \begin{cases} S_{c2,j} & 16 \leq l_a^s < 55 \\ S_{c3,j} & 55 \leq l_a^s < 70 \\ S_{c4,j} & 70 \leq l_a^s < 85 \\ 1 & l_a^s \geq 85 \end{cases} \qquad 5a$$

so that:

$$S_{com,j,a}^s = S_{com,j,a}^{s*} / \max_j (S_{com,j,a}^{s*}) \qquad 5b$$

where $l_a^s$ 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=sco* or *e&w*) 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 one additional length category (the 16–54 cm category is split into 16–31 and 32–54), leading to four selectivity parameters to be estimated ($S_{s1}$, $S_{s2}$, $S_{s3}$ and $S_{s4}$).

#### 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]:

$$R_0 = \frac{N_0^{f,preg}}{\Phi^f \left[ \sum_{a=0}^{A-1} P''_a e^{-\sum_{i=0}^{a-1} M_i} + P''_A \frac{e^{-\sum_{i=0}^{A-1} M_i}}{1-e^{-M_A}} \right]} \qquad 6$$

#### Natural mortality for pups (Mpup)

With the possibility of estimating the fecundity parameters $a_{fec}$ and $b_{fec}$ (equation 2.3), the natural mortality parameter $M_{pup}$ (Table 2.5) 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 $F_{MSY}$ 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 Scottish and England & Wales fleets (average over most recent five years; equations 2.4a-b) to estimate $F_{MSY}$. The selectivity for the second approach is therefore calculated as follows:

$$S^{s,cur}_{MSY,j,a} = \bar{f}_{rat,j}\, S^{s}_{com,j,a} \qquad \text{8b}$$

where $S^{s}_{com,j,a}$ is from equation 2.5b, and $\bar{f}_{rat,j}$ is a five-year average as follows:

$$\bar{f}_{rat,j} = \frac{1}{5}\sum_{y=2005}^{2009}\frac{F_{j,y}}{\sum_j F_{j,y}} \qquad \text{8c}$$

where $F_{j,y}$ is from equation 2.4a. In order to calculate MSY parameters, the first step is to express population dynamics on a per-recruit basis. Therefore, taking equations 2.1a and 2.4c, the equivalent per-recruit equations (dropping the $y$ subscript) are given as:

$$N^{s}_{pr,a} = \begin{cases} \Phi^{s} & a = 0 \\ \Phi^{s}\prod_{i=0}^{a-1}\left(1-\sum_j F_{mult}S^{s}_{MSY,j,i}\right)e^{-M_i} & 0 < a \le A-1 \\ \Phi^{s}\dfrac{\prod_{i=0}^{A-1}\left(1-\sum_j F_{mult}S^{s}_{MSY,j,i}\right)e^{-M_i}}{\left(1-\sum_j F_{mult}S^{s}_{MSY,j,A}\right)(1-e^{-M_A})} & a = A \end{cases} \qquad \text{8d}$$

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 $\ge l^{f}_{mat00}$ 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:

$$N_{pup,pr} = \sum_{a=1}^{A} P'_a P''_a N^{f}_{pr,a} \qquad \text{8e}$$

Recruitment can be expressed in terms of $N_{pup,pr}$ by re-arranging equations 2b–c (omitting the process error term) as follows:

$$R = \frac{R_0}{N_{pup,pr}}\left[1 - \frac{(1/N_{pup,pr} - 1)}{Q_{fec} - 1}\right] \qquad \text{8f}$$

Yield can then be calculated as follows for the first ($Y^{mat}$) and second ($Y^{cur}$) approaches:

$$Y^{mat} = R\sum_{s}\sum_{a=0}^{A}\left(F_{mult}S^{s,mat}_{MSY,a}w^{s}_{a}N^{s}_{pr,a}\right) \tag{8g}$$

and

$$Y^{cur} = R\sum_{s}\sum_{a=0}^{A}\sum_{j}\left(F_{mult}S^{s,cur}_{MSY,j,a}w^{s}_{a+\frac{1}{2}}N^{s}_{pr,a}e^{-M_a/2}\right) \tag{8h}$$

MSY is found by solving for the $F_{mult}$ value that maximises equation 8g or 8h, and the corresponding $F_{MSY}$ 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 $F_{MSY}$.

#### 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:

$$-\ln L_{sur} = \tfrac{1}{2}\sum_{y}[\ln(2\pi\sigma^{2}_{sur,y}) + \varepsilon^{2}_{sur,y}] \tag{9a}$$

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:

$$\varepsilon_{sur,y} = [\ln(I_{sur,y}) - \ln(q_{sur}N_{sur,y})]/\sigma_{sur,y} \tag{9b}$$

$N_{sur,y}$ is the "available" mid-year abundance corresponding to $I_{sur,y}$, and is calculated as follows:

$$N_{sur,y} = \sum_{s}\sum_{a}S^{s}_{sur,a}[N^{s}_{y,a}e^{-M_a/2} - \sum_{j}C^{s}_{j,y,a}/2] \tag{9c}$$

##### *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):

$$-\ln L_{pcom,j} = k_{pcom,j}\sum_{y}\sum_{L}\varepsilon_{pcom,j,y,L} \tag{10a}$$

where $k_{pcom,j}$ is the effective sample size, and the multinomial residual $\varepsilon_{pcom,j,y,L}$ is:

$$\varepsilon_{pcom,j,y,L} = -\frac{n_{pcom,j,y}}{\overline{n}_{pcom,j}}p_{j,y,L}[\ln(\hat{p}_{j,y,L}) - \ln(p_{j,y,L})] \tag{10b}$$

with $n_{pcom,j,y}$ representing the number of samples on which estimates of proportions by length category are based, and $\overline{n}_{pcom,j}$ the corresponding average (over $y$). Because actual sample sizes were not available for the commercial data (only raised sample sizes), all model runs assumed $n_{pcom,j,y} = \overline{n}_{pcom,j}$, but a sensitivity test is included which considers the raised sample sizes for the commercial data. 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 one additional length category (the 16–54 cm category is split into 16–31 and 32–54). 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:

$$-\ln L_{fec} = \tfrac{1}{2} \sum_{y=1960;2005} \sum_{k=1}^{K_y} [\ln(2\pi\sigma_{fec}^2) + \varepsilon_{fec,k,y}^2] \qquad 11a$$

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:

$$\varepsilon_{fec,k,y} = [P'_{k,y} - \hat{P}'_{k,y}] / \sigma_{fec} \qquad 11b$$

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 $\sigma_{fec}$ exists as follows:

$$\sigma_{fec} = \sqrt{\frac{\sum_{y=1960;2005} \sum_{k=1}^{K_y} (P'_{k,y} - \hat{P}'_{k,y})^2}{(K_{1960} + K_{2005})}} \qquad 11c$$

#### *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 $\sigma_r$ 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.

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.

### 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.
- 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 data set 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.

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, long line 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

$F_{MSY}$=0.024, as estimated by the current assessment, assuming average selection over 2005–2009.

### 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 | expert opinion |
| | | |
| $l_a^s$ | Mean length-at-age $a$ for animals of sex $s$ $$l_a^s = L_\infty^s (1 - e^{-\kappa^s (a - t_0^s)})$$ | |
| $L_\infty^f$, $L_\infty^m$ | 110.66, 81.36 | average from literature |
| $\kappa^f$, $\kappa^m$ | 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<br>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 |

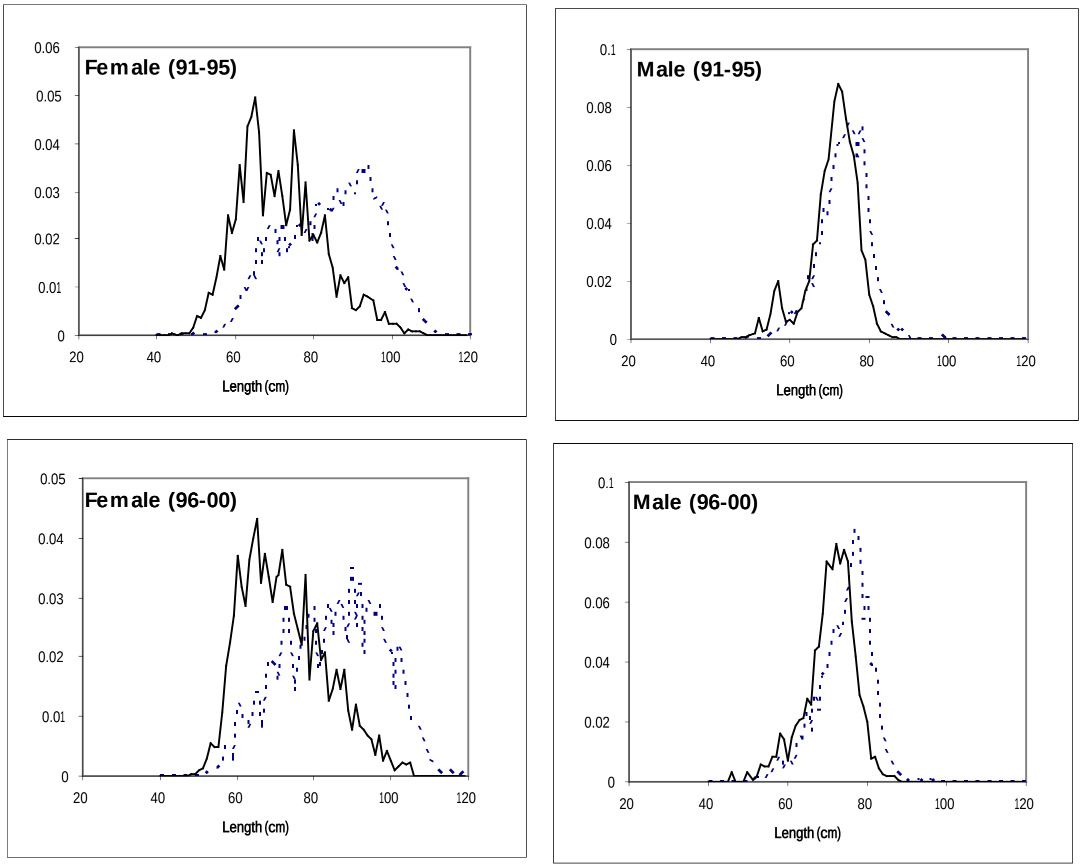



**Figure 1. Northeast Atlantic spurdog. Comparison of length frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK (E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.**

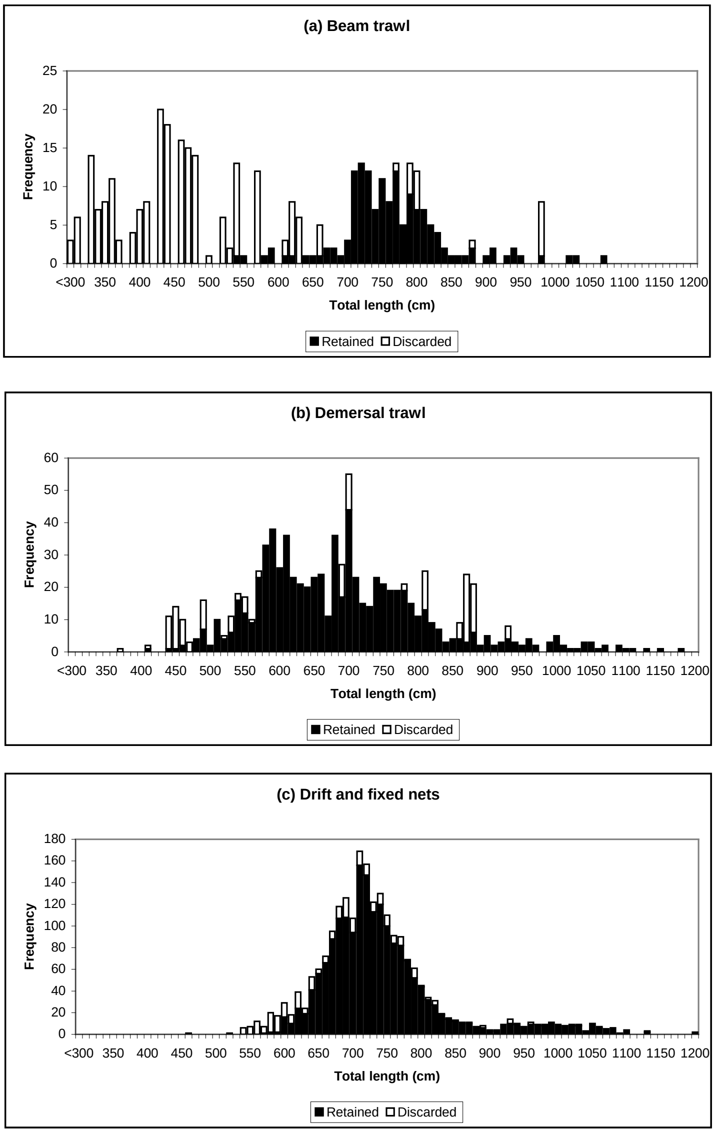
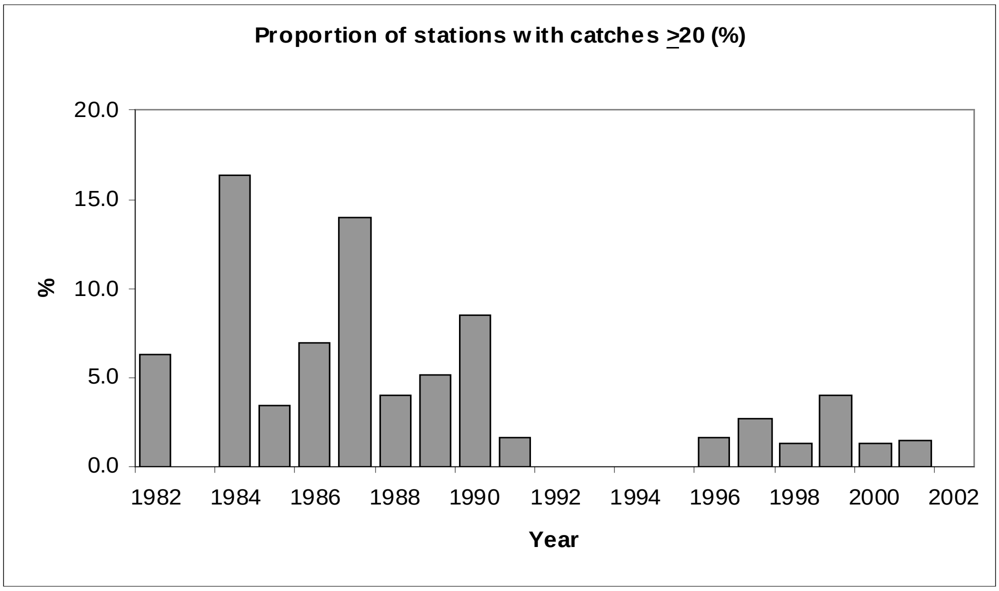



**Figure 2. Northeast Atlantic spurdog. Length distribution of discarded and retained in fisheries in the North Sea and Celtic Seas ecoregions for (a) beam trawl, (b) demersal trawl and (c) drift and gillnets. These data (1999–2006) are aggregated across individual catch samples (Source: UK (E&W) Discards surveys).**



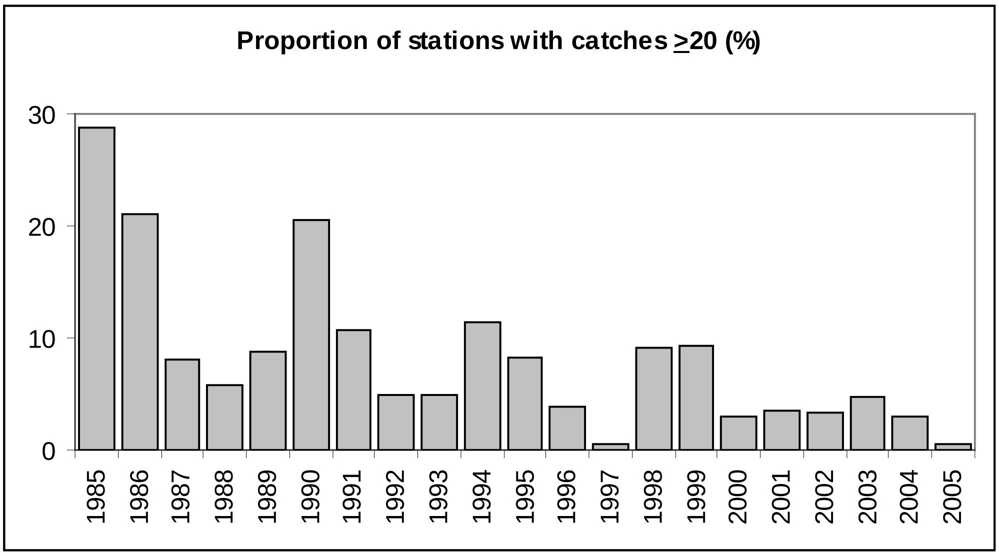
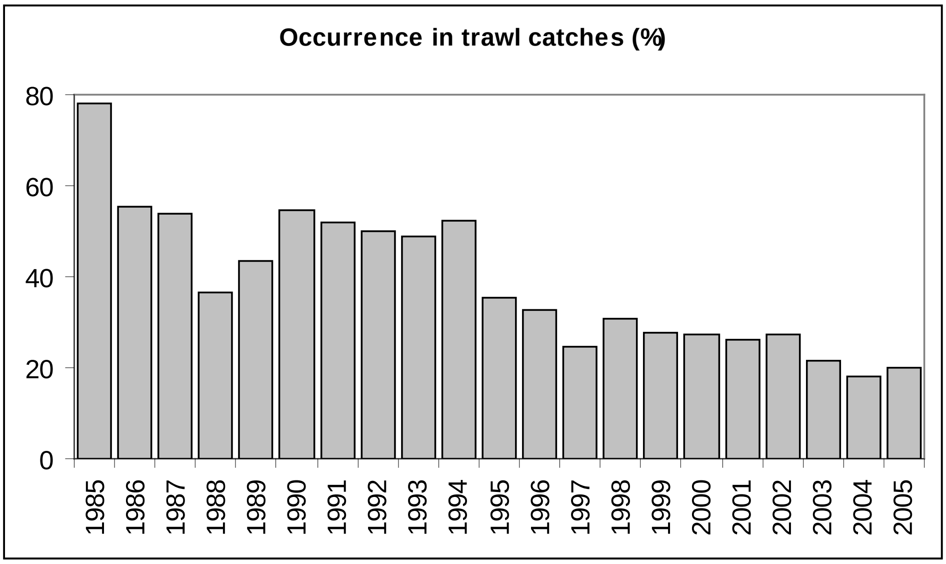




**Figure 3. Northeast Atlantic spurdog. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h$^{-1}$. (Source: ICES, 2006).**

a)




b)

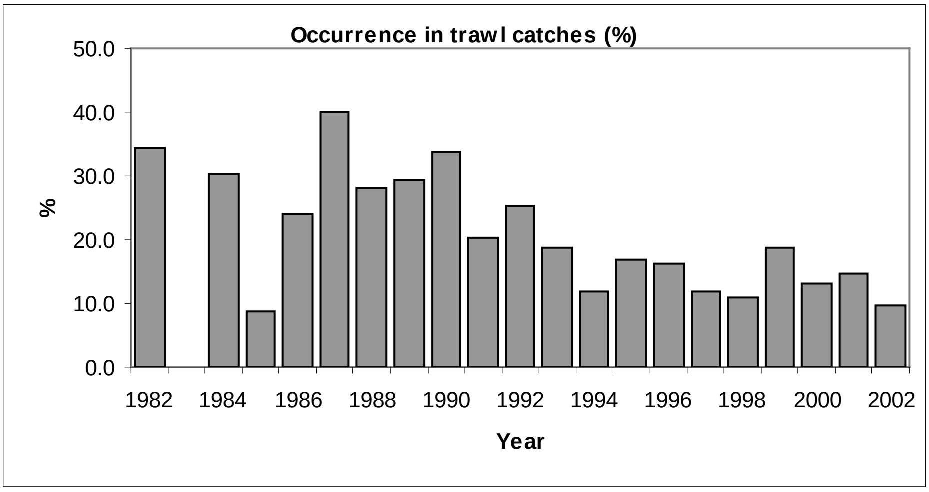
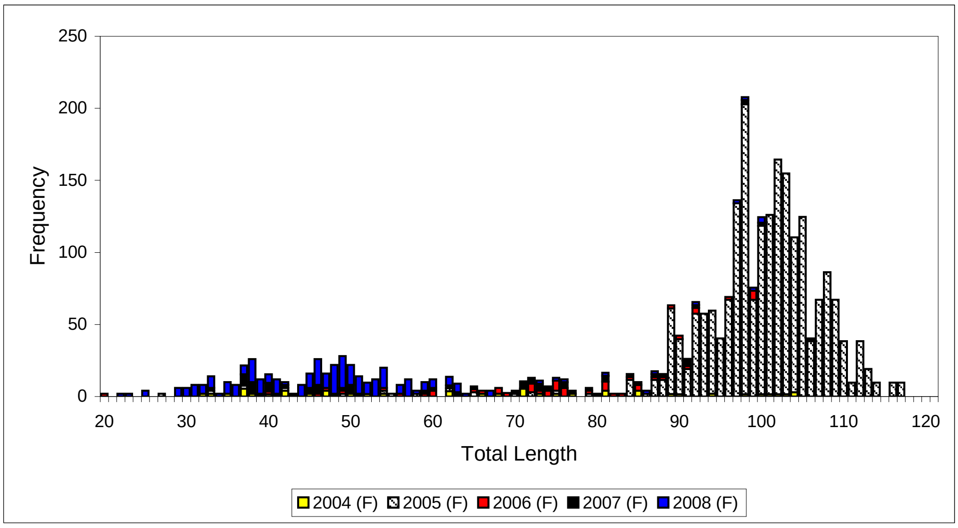



**Figure 4. Northeast Atlantic spurdog. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).**



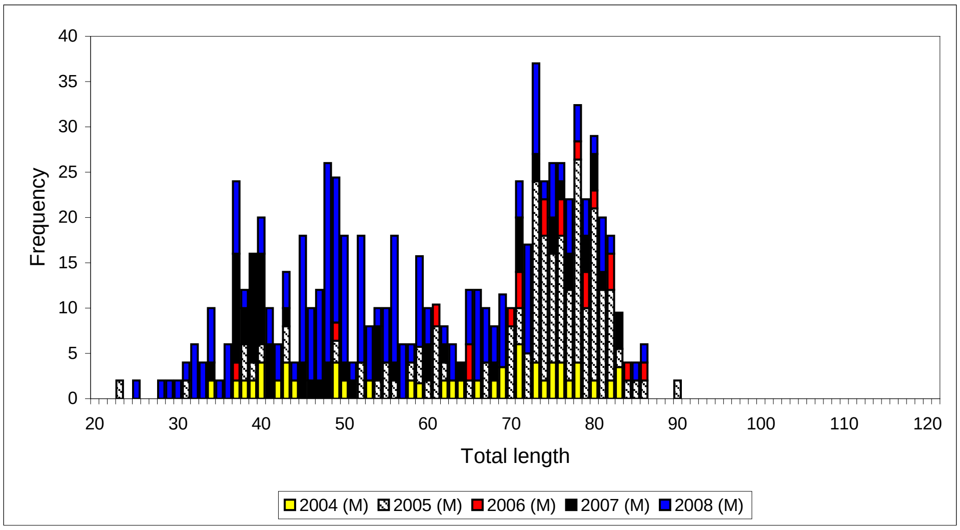




**Figure 5. Northeast Atlantic spurdog. Temporal variations in length frequencies of female (top) and male (bottom) spurdog in UK (E&W) Q4 survey.**

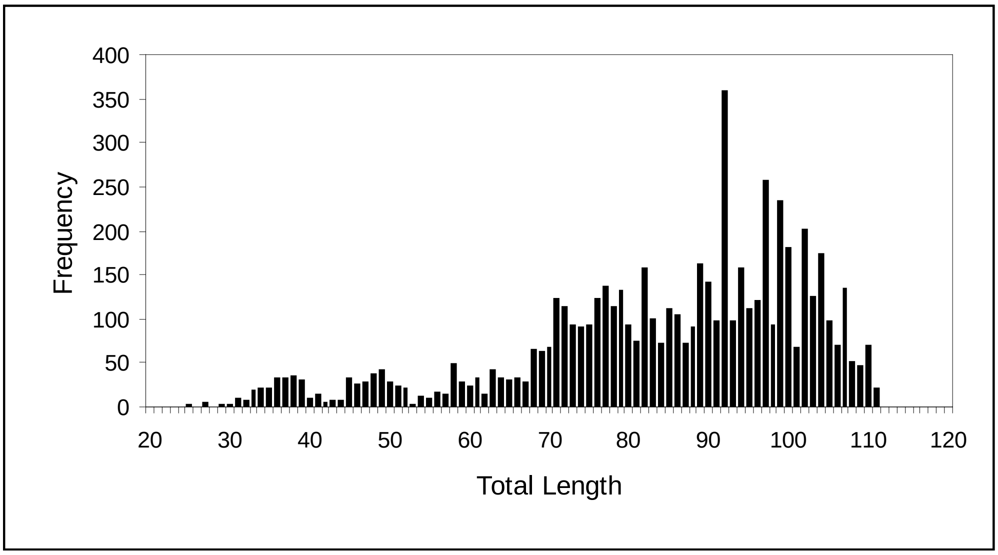



**Figure 6. Northeast Atlantic spurdog. Length frequencies of spurdog in UK (NI) GFS Q4 survey 1992–2008.**

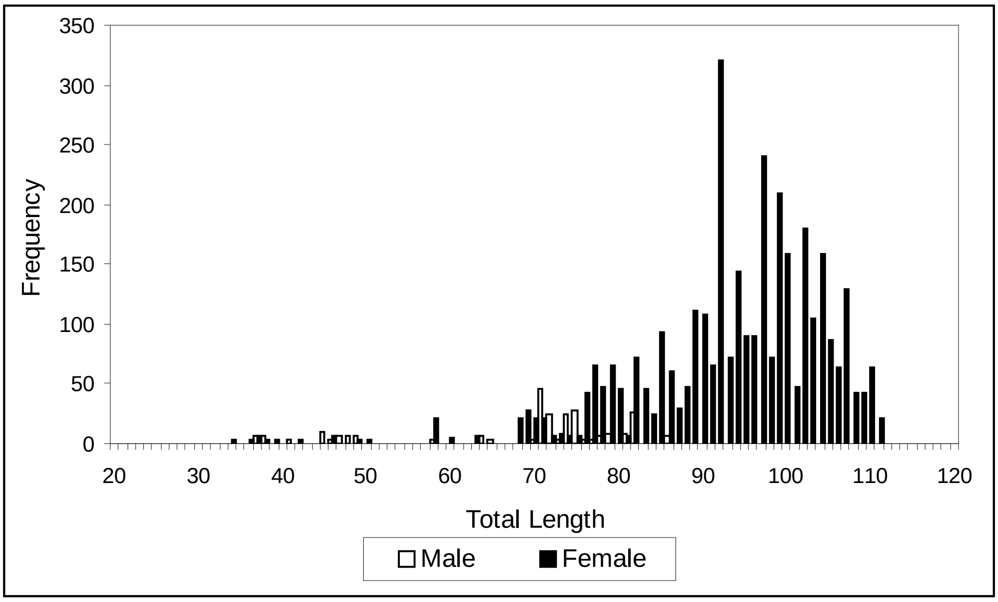



**Figure 7. Northeast Atlantic spurdog Sex segregated length frequencies of spurdog in UK (NI) GFS Q4 survey 2006–2008.**

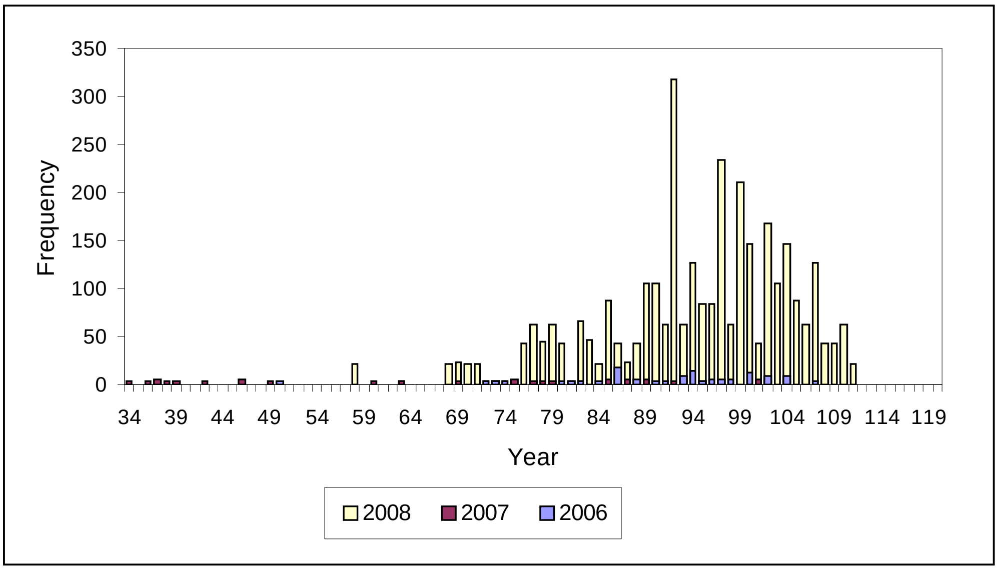



**Figure 8. Northeast Atlantic spurdog. Length frequencies of female spurdog in UK (NI) GFS Q4 survey 2006–2008. Dominance of large females observed in 2008 influenced by single large haul.**

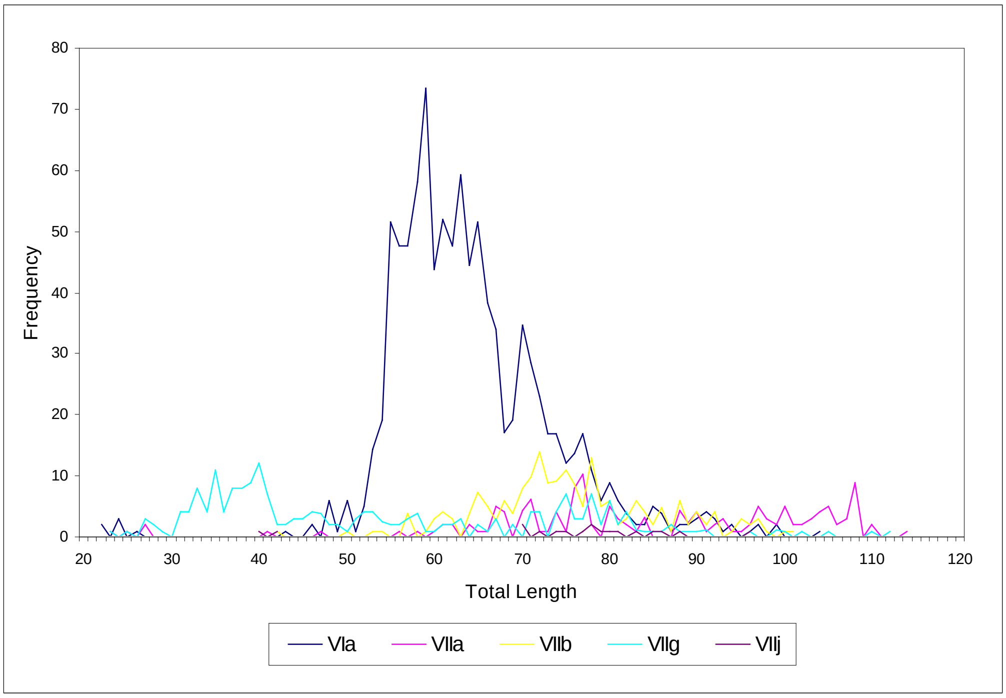



**Figure 9. Northeast Atlantic spurdog. Variation in length frequencies of spurdog by region generated from MI GFS Q3 survey.**

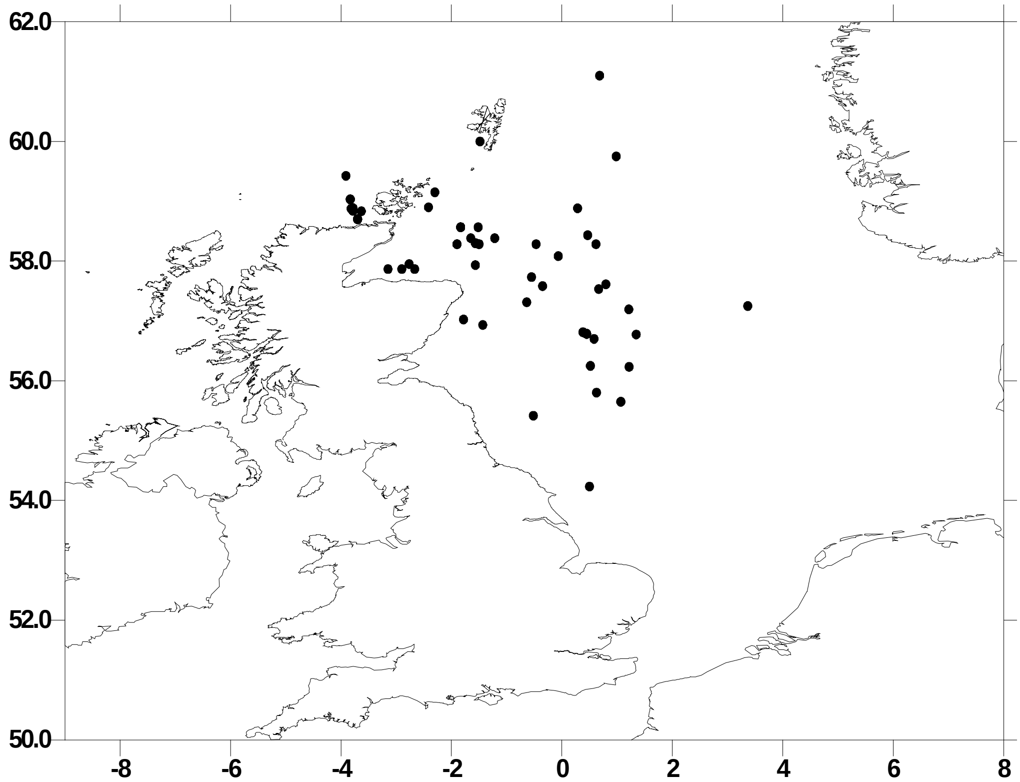
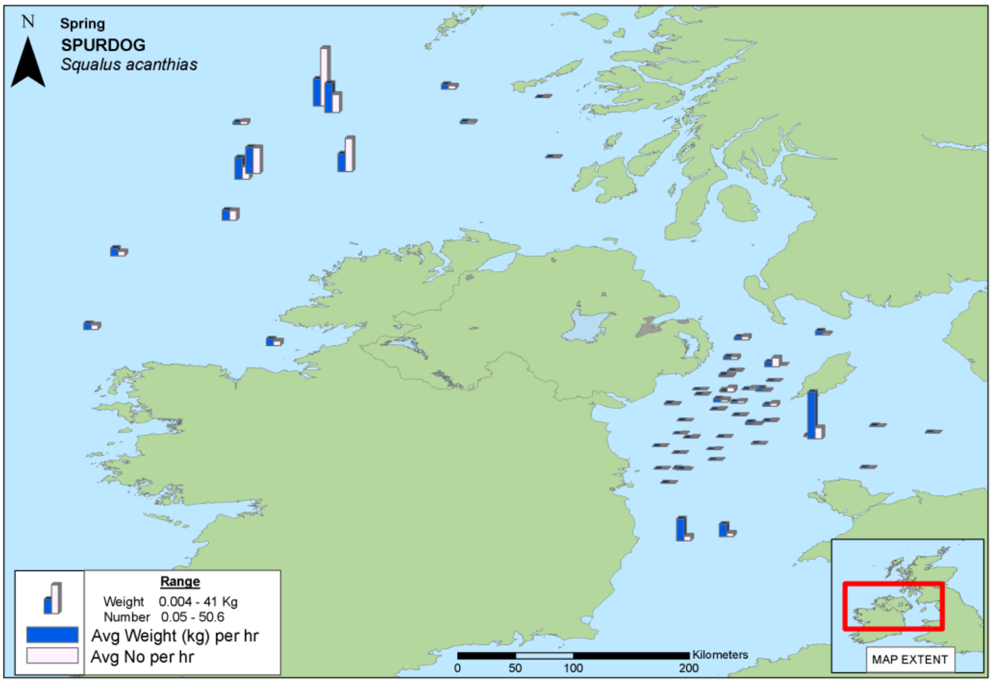



**Figure 10. Northeast Atlantic spurdog. Occurrence of spurdog pups (ind≤250 mm) in North Sea (Source of dta: DATRAS, downloaded 25 June 2009).**



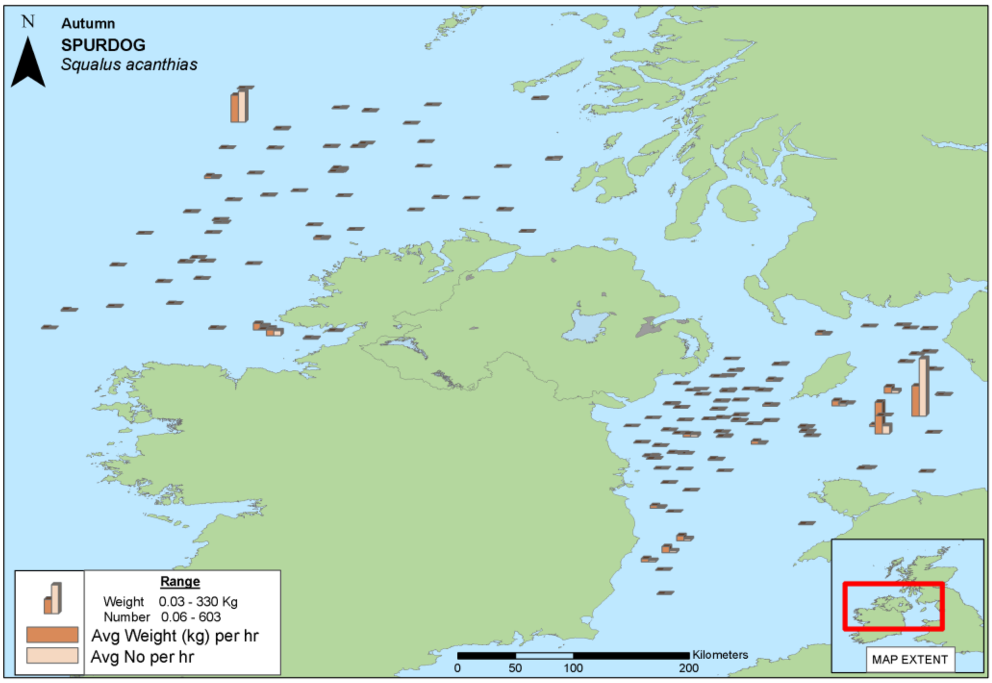




**Figure 11. Northeast Atlantic spurdog. Seasonal distribution, average abundance (No. per hr.) and average weight (Kg per hr) of spurdog *Squalus acanthias* in VIIa(N) and VIa(S) as estimated from research surveys (see NIEA. 2008).**

# Annex 5: Technical minutes for the Review Group on Elasmobranch Fishes

- RGEF
- By correspondence, 13–15 September 2010
- Participants: Henn Ojaveer (Chair), Tore Jakobsen, Maurice Clarke and Graham Johnston (Chair of WG).
- Working Group: WGEF

## Review notes

1.8. The Working Group should be commended for attempting to define the terminology in conservation advice, where a clarification is sorely needed, not least because environmental NGOs tend to use extinction rather freely.

2.3. It is unclear from the text whether it is the length frequency distribution in percent or in actual numbers that is not representative of the total landings of UK (E&W), although presumably it is the former. Since this distribution is used in the model, it would be useful if some information on the potential error could be added.

Table 6.2. Only one column (preferably >50 cm) is needed. Having two columns with in practice the same information is just confusing.

15.12. It seems that management by TAC is rather useless if TACs need to be kept stable to avoid increased discarding. Perhaps the Working Group could propose other measures?

### The spurdog model

The model obviously suffers from lack of data, both on length frequency from landings by some of the major countries and by limited geographical survey coverage (as pointed out by the WG). The former may not be a large problem, provided that the maximum landing size is effective. Concerning the latter, catch history reveals some differences between areas, which probably is linked to the fisheries, but also could reflect changes in the stock distribution. The WG also points to the need for further attempts to obtain sex-specific abundance indices. Considering the size difference between males and females, the close relationship between mature females and pup production, and probably also a fairly systematic difference in sex catch composition by gear and area, this should be encouraged.

The model seems well designed to deal with the data available and their limitations.

#### *Estimation of $F_{MSY}$*

Compared to most other stocks in the ICES area, the spurdog has the advantage of having a close relationship between pup production and mature females, reducing the problem of choosing the appropriate stock–recruitment relationship which may be crucial in $F_{MSY}$ estimation. Thus, the main source of error in the $F_{MSY}$ estimate for spurdog is probably the selection pattern which is estimated based on data from a limited part of the fishery and possibly also the sex distribution in the catches. However, even if the estimate should be somewhat biased, the relative changes in F foreseen in management advice are probably fairly robust with respect to the resulting TAC.