ICES WGEF Report 2007

ICES Advisory Committee on Fishery Management
ICES CM 2007/ACFM:27
Ref. LRC

Report of the Working Group on Elasmobranch Fishes (WGEF)

22–28 June 2007

Galway, Ireland

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

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk
Recommended format for purposes of citation:
ICES. 2007. Report of the Working Group Elasmobranch Fishes (WGEF), 22–28 June 2007, Galway, Ireland. ICES CM 2007/ACFM:27. 318 pp.

Contents

Executive Summary

WGEF has updated data relevant to elasmobranchs fish and fisheries, and made progress in "assessing" the overall status of demersal stocks in the North Sea, Celtic Seas and Biscay and Iberian waters. Specific issues relating to the evidence for listing various elasmobranchs species on the OSPAR List of Threatened and Declining Species was undertaken by correspondence prior to the meeting, with the supporting text provided in this report (see Section 21).

The first part of the report covers addresses spurdog (Section 2) and various deep-water squaliform sharks, including leafscale gulper shark and Portuguese dogfish (Section 3) and kitefin shark (Section 4), with data for other deep-water sharks and skates summarized in Section 5. These sections have updated information on the landings, fisheries and management applicable. Deep-water sharks will be addressed in greater detail in 2008.

The report then updates information on the various pelagic species, including porbeagle (Section 6), basking shark (Section 7), blue shark (Section 8), shortfin mako (Section 9), tope (Section 10), thresher shark (Section 11) and other pelagic species (Section 12). Although no assessments have been undertaken for these species, it is planned to undertake exploratory assessments for some of these species in 2008. Catch data for many of these species are severely limited, due to a lack of species-specific reporting, although many nations have reported species-specific information in the most recent years.

The next part of the report focuses on demersal elasmobranchs (including skates) from continental shelf eco-regions of the ICES area, which are updated for the Barents Sea (Section 13), Norwegian Sea (Section 14), Iceland and East Greenland (Section 16), Faroe Islands (Section 17) and the Azores and mid-Atlantic Ridge (Section 20).

Much of the work undertaken by WGEF in 2007 was to examine the status of demersal elasmobranchs in the North Sea and eastern English Channel (Section 15), Celtic Seas (Section 18) and Bay of Biscay/Iberian (Section 19) eco-regions. For most of the species in these areas, there is no accurate delineation of stock structure, and further biological studies (tagging, genetics etc.) are required to verify the identity of the stocks. To date, WGEF have examined species by ICES Division (or adjacent Divisions). Whereas this may be appropriate for coastal, oviparous species (in the absence of other information), it is more problematic for some of the offshore species (e.g. cuckoo ray). Much of the landings data, especially historical information, is for species-groups (e.g. "skates and rays"), and the absence of species-specific catch data also hampers a detailed stock assessment.

Ostensibly, some of the most appropriate data with which to examine the status of demersal elasmobranchs should be information collected during fishery-independent trawl surveys. Nevertheless, there are some problems associated with these data sets. Existing surveys (in terms of the gear, survey grid etc.) are designed primarily for commercial teleosts, and so may not be ideal for elasmobranch fishes. For example, beam trawls probably have a low catch efficiency for larger batoids; some elasmobranchs are locally abundant in some areas, and surveys may have few hauls in such areas. Hence, survey data typically contain a large number of zero hauls and occasional hauls with large numbers of individuals. Although there are ways to examine such data (see Section 1.10), catch rates of elasmobranchs are low and have wide confidence limits. Other problems associated with survey data include species mis-identifications that are apparent in some data sets, and limited time-periods of some of the more recent IBTS surveys in southern and western areas.

The examination of survey trends has enabled WGEF to provide qualitative "assessments" of the general status of many of the more common elasmobranch stocks, based on their relative abundance in surveys and/or their spatial distribution. Some of the smaller bodied species (e.g.

lesser-spotted dogfish and spotted ray) show stable or increasing catch rates across various surveys, and there are indications that smoothhounds are also increasing in southern areas (although reliable species-specific data are unavailable for this genus). For some of the medium-sized species (such as smalleyed ray and thornback ray) catch rates seem to be relatively stable, although the North Sea stock of thornback ray has declined in its area of distribution. Other species that are locally abundant in certain areas include blonde and undulate rays. The management of locally abundant elasmobranch resources may need to be precautionary. Some coastal elasmobranchs (e.g. angel shark and white skate) that may have been more common historically are now rare/absent in surveys.

1 Introduction

1.1 Terms of Reference

The Working Group Elasmobranch Fishes [WGEF] (Chair: Jim Ellis, UK) will meet in Galway, Ireland from 22–28 June 2007, to:

a) Update the description of elasmobranch fisheries (including those on deep-water sharks) in the ICES area and compile landings and discard statistics by ICES Subarea and Division; (generic ToR).
b) Assess the stock status and stock identity of demersal elasmobranchs in the following eco-regions: North Sea, Skagerrak and Eastern Channel, Celtic Seas, Biscay and Iberia.
c) Update data for other species/stocks that are scheduled for consideration in 2008 and 2009.
d) Prepare for a joint assessment working group with ICCAT in 2009 on blue shark and shortfin mako shark.
e) Report on the development of a standard exchange format to facilitate the submission of biological, fisheries,discards and survey data to WGEF.
f) produce a photo-ID key for elasmobranchs in the ICES area (together with IBTSWG).
g) Compile all available conversion factors for elasmobranch species.
h) assess and report on the evidence that is the basis for the nominations to the OSPAR List of Threatened and/or Declining Species and Habitats of:

• Porbeagle shark (*Lamna nasus*),

• Blue shark (*Prionace glauca*),

• Northeast Atlantic spurdog (*Squalus acanthias*),

• Leafscale gulper shark (*Centrophorus squamosus*),

• Gulper shark (Centrophorus granulosus),

• Portuguese dogfish (*Centroscymnus coelolepis*),

• Thornback ray (*Raja clavata*),

• White skate (*Rostraja alba*) and

• Angel shark (*Squatina squatina*).

i) The purpose of the assessments is to ensure that the data used to support the nominations are sufficiently reliable and adequate to serve as a basis for conclusions that these species can be identified as threatened and/or declining species according to OSPAR's Texel/Faial criteria.
j) Work towards the production of an ICES Cooperative Research Report on the "Status of Elasmobranchs in the NE Atlantic" in 2008.

WGEF will report to ACFM by 20 July 2007 and make its report available for the attention of the Living Resources Committee.

Table 1.1. Specific terms of reference addressed in the report.

TOR	DESCRIPTION	SECTION
a	Update descriptions of elasmobranch fisheries	2–20
b	Assess the stock status and stock identity of demersal elasmobranchs.	15, 18,19
c	Update data for other species/stocks for consideration in 2008 and 2009	2–20
d	Prepare for a joint assessment working group with ICCAT in 2009 blue shark and shortfin mako shark	1, 8,9
e	Report on the development of a standard exchange format to facilitate the submission of biological, fisheries, discards and survey data	1
f	Produce a photo-ID key for elasmobranchs in the ICES area	21
g	Compile all available conversion factors for elasmobranch species	21
h	Assess and report on the evidence on the basis for the nominations of the various elasmobranch species to the OSPAR List of Threatened and/or Declining Species and Habitats	21
i	Work towards the production of an ICES Cooperative Research Report on the "Status of Elasmobranchs in the NE Atlantic" in 2008	1

Table 1.2. Generic terms of reference for WGEF, as agreed by AMAWGC in 2007 (From ICES, 2007a).

TERM OF REFERENCE (WGEF)	YEAR	COMMENTS
1) set appropriate deadlines for submission of data. Data submitted after the deadline can be disregarded at the discretion of the WG Chair.	2007	We have had this system in place for some time for most data (e.g. landings and those data identified by stock coordinators). Other data sets (e.g. discards data) are usually brought to the WG in raw form for exploratory analyses. The 2007 meeting will address the use of Intercatch for providing species composition information from market sampling programmes.
2) compile all relevant fisheries data, including data on different catch components (landings, discards, bycatch) and data on fishing effort. Data should be disaggregated by fisheries/fleets.	2007	This is a routine task undertaken by the WG, in terms of landings, bycatch and fishery descriptions. It is suggested that WGEF examine those effort data compiled by the regional assessment groups (for mixed demersal fisheries) and WGDEEP (for deep-water fisheries) and then identify which targeted elasmobranch fisheries require the collation of effort data.
3) assess the state of the stocks according to the schedule for benchmark and update assessments as shown below.	2007	Assessments will be undertaken for demersal elasmobranchs, as scheduled

TERM OF REFERENCE (WGEF)	YEAR	COMMENTS
4) provide specific information on possible deficiencies in the 2007 assessments and forecasts, •any major inadequacies in the data on landings, effort or discards; •any major expertise that was lacking •any major inadequacies in research vessel surveys data, •any major difficulties in model formulation or available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified	2007	We will continue this process
5) consider knowledge on important environmental drivers for stock productivity (based on input from e.g. WGRED and for the North Sea NORSEPP). If such drivers are considered important for management advice, incorporate such knowledge into assessment and prediction and comment on the consequences for long term targets of high yield and low risk.	2007	Low priority. Many of these stocks are long lived and with a reproductive strategy that results in a closer relationship between stock and recruitment. It is less likely that there environmental drivers than for short lived species.
6) consider existing knowledge of important impacts of fisheries on the ecosystem	2007	We will continue this process
7) Evaluate existing management plans and develop options for management strategies including target and limit reference points. If mixed fisheries are considered important consider the consistency of target reference points and management strategies	2007	There are few existing management plans for elasmobranchs, those that do exist will be considered, though there are unlikely to be sufficient data for a quantitative evaluation
8) assess the influence of individual fleet activities on the stocks. For mixed fisheries, assess the technical interactions;	2007	We will take a qualitative approach in 2007 to identify the interactions with WGDEEP, WGNSSK, NSWG, SSWG, WGHMM
9) provide an overview of major regulatory changes (technical measures, TACs, effort control and management plans) and evaluate or assess their (potential) effects.	2007	This is a routine task for the WG
10) where misreporting and/or discarding is considered significant provide qualitative and where possible quantitative information, by fisheries and the describe the methods used to obtain the information and its influence on the assessment and predictions.	2007	We will start the process this year
11) present an overview of the sampling on a national basis of the basic assessment data for the stocks considered according to the template that is supplied by the Secretariat	2007	We will start the process this year, with special emphasis on market sampling for skates and rays
12) implement the roadmap for medium and long term strategy of the group as developed in AMAWGC	2007	This is a routine task for the WG

1.2 Participants

Tom Blasdale	UK
Maurice Clarke	Ireland
Guzman Diez	Spain (Basque Country)
Helen Dobby	UK (Scotland)
Jim Ellis (Chair)	UK (England and Wales)
Edward Farrell	Ireland
Ivone Figueiredo	Portugal
Boris Frentzel-Beyme	Germany
Peter Green	Ireland (part-time)
Henk Heessen	The Netherlands
Kristin Helle	Norway
Graham Johnston	Ireland
Dave Kulka	Canada
José De Oliveira	UK (England and Wales)
Mario Pinho	Portugal (Azores)
William Roche	Ireland (part-time)
Bernard Seret	France
Charlott Stenberg	Sweden
Francisco Velasco	Spain
Tom Williams	Norway

1.3 Background

The Study Group on Elasmobranch Fishes (SGEF), having been established in 1989, was re-established in 1995 and had meetings in that year, 1997 and 1999. Assessment of elasmobranch species had proved very difficult due to a lack of data. The 1999 meeting was held concurrently with the EC-funded Concerted Action Project meeting (FAIR CT98–4156) allowing for a greater participation from various institutes around Europe. The next meeting of the group was in 2002, where exploratory assessments were carried out for the first time. Assessments were attempted for 8 of the 9 case study species considered by the EC-funded DELASS Contract (CT99–055). The success of this meeting was due to 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. The main gap in the knowledge was a quantification of catches of elasmobranchs in the ICES area.

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) in relation to the needs of these analytical models and stock identity; and to carry out such assessments as are required by

ICES' customers. In 2003, the first meeting of this group would review the final DELASS report, consider national and international sampling schemes, including those carried out under the EU Data Collection Regulation, and report to PGCCDBS, and make arrangements to carry out assessments for such elasmobranch stocks.

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 the FAO FISHSTAT database, data from national scientists and other data submitted to ICES. 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 dogfishes. 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 have been provided for spurdog, kitefin shark, thornback ray (North Sea) and deepwater sharks (combined). ACFM produced advice on these species, basking shark and porbeagle, based on the WGEF report. This advice was adopted only by Norway and only in the case of the basking shark. A standard reporting and presentation format was adopted for catch data and best estimates of catch by species were provided for the first time.

In 2006, work continued on refining catch estimates and compiling available biological data. Progress was made in some eco-regions. Work was begun on developing standard reporting formats for length frequency, maturity and CPUE data. WGEF continued to support the advisory process based on feedback from ACFM. The group developed a "roadmap" presenting an organizational plan for assessing the various stocks over the following 3 years.

In 2007, WGEF met in Galway, with the demersal elasmobranchs of three eco-regions (North Sea, Celtic Seas and Bay of Biscay/Iberian waters) subject to more detailed study and assessment, 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 additional tagging studies ongoing), 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. 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 the past three meetings.

Stock assessment of many elasmobranchs is particularly difficult owing to a lack of species-specific catch data and the straddling and/or highly migratory nature of some of these stocks, especially with regards deepwater and pelagic sharks. In 2004, the International Commission for the Conservation of Atlantic Tunas (ICCAT) convened a working group to assess the status of two pelagic species, blue and shortfin mako shark. These are trans-North Atlantic stocks and ICES is unable to conduct any meaningful stock assessments. An ICCAT sub-group on shark assessment met in Uruguay in 2007, although this data preparation meeting overlapped with WGEF. Closer coordination between this ICCAT sub-group and WGEF in the future is required. WGEF will maintain close collaboration with WGDEEP to refine catch and effort data and to support the advisory process. This will require that catch and effort data being made available to WGDEEP is also made available to WGEF.

1.4 Future planning of the work of the group

To satisfy the requirement that each working group plans its short and medium term objectives WGEF presents a plan for the next four years. It is planned that WGEF will meet every year in the next four years, because this approach keeps the momentum of the group. Assessments of stock status will usually be conducted on a 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 1.3 presents this plan.

Table 1.3. 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 and advice)

Stocks	2007	2008	2009	2010
Spurdog	1	1	2	1
Portuguese dogfish and Leafscale gulper shark	1	2	1	2
Kitefin shark	1	2	1	2
Other deepwater sharks	1	2	1	2
Porbeagle	1	2	1	1
Basking shark	1	2	1	1
Blue shark in the NE Atlantic	1	2	1	1
Shortfin mako in the NE Atlantic	1	2	1	1
Tope in the NE Atlantic (and Mediterranean?)	1	1	1	1
Thresher shark in the North Atlantic and Mediterranean	1	2	1	1
Other Pelagic species	1	1	1	1
Demersals in Barents Sea	1	1	1	1
Demersals in Norwegian Sea	1	1	1	1
Demersals in North Sea (III, IV, VIId)	2	1	2	1
Demersals at Iceland and east Greenland	1	1	1	1
Demersals at the Faroe Islands	1	1	1	1
Demersals in the Celtic Seas	2	1	2	1
Demersals in Biscay and Iberian waters	2	1	2	1
Demersals in the Azores and Mid Atlantic Ridge	1	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.

Deepwater sharks are scheduled for next assessment in 2008, in WGEF. In that year, WGEF should work closely with WGDEEP to collate reliable and up to date CPUE and survey data. WGEF will expect to have access to CPUE and other data as reported to WGDEEP. At present the most important time series of data, from French trawlers, is not available in sufficient detail for meaningful analysis. If exchange and storage of data, through Intercatch and other means, is achieved, then WGEF and WGDEEP can expect to be able to conduct assessments of deepwater sharks in 2008. At the same time, deepwater skates, including those in the Mid Atlantic Ridge area, should be dealt with.

WGEF had expected to examine the status of pelagic sharks in 2009, at a joint meeting with ICCAT. Given that the ICCAT shark sub-group met in June 2007 for a data preparatory meeting, and intend to meet in 2008 for an assessment meeting, WGEF should also be involved in this meeting. It will also be important for WGEF members to spend the intervening period further preparing the data required for these stocks. As many of the reported landings for pelagic sharks are classed as "various sharks nei", any ICES states having more detailed species-specific landings data for pelagic sharks should ensure such data are available. Data on catches of other large pelagic fishes (tuna and billfish) are also required; as such data can be informative about patterns in high seas fishing activity.

For spurdog it is recommended that next assessment be conducted in 2009. The intervening period should be used to collate as comprehensive a dataset of length, survey and CPUE data as possible.

Given the limitations and/or paucity of biological, survey and commercial data for many elasmobranchs, assessments are necessarily experimental in WGEF, so the group does not present its roadmap in the context of benchmark or update assessments. ICES may be asked for advice on particular stocks in particular years, out of synchrony with WGEF's plans. WGEF recommends that ICES draw upon the latest ACFM advice, where available, for such requests.

1.5 Current ICES Working Groups of relevance to the WG

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

Several elasmobranchs are taken in North Sea demersal fisheries, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 15). WGNSSK should note that the south-western North Sea 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.

1.5.2 Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS)

Several elasmobranchs are taken in the waters covered by WGNSDS, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 18). WGNSDS should note that common skate *Dipturus batis,* which has declined in many inshore areas of northern Europe, may be locally abundant in parts of VIa. 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*.

1.5.3 Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS)

Several elasmobranchs are taken in the waters covered by WGNSDS, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 18). WGSSDS should note the Bristol Channel is locally important for smalleyed ray *Raja microocellata*, as well as being an important nursery ground for various small sharks (e.g. smoothhounds and tope) and skates and rays.

1.5.4 Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP)

Deep-water sharks are caught in several mixed trawl fisheries and in mixed and directed longline and gillnet fisheries in the northeast Atlantic. The most important species are *Centrophorus squamosus* and *Centroscymnus coelolepis* but a number of other species are also included in landings. In some deep-water trawl fisheries, decreasing catches and restrictive quotas for the target teleost species may mean that deep-water sharks have effectively become the target species. Until 2002 deep-water sharks were assessed by WGDEEP and close cooperation between WGDEEP and WGEF would greatly benefit the assessment of these species. This could be achieved by co-locating these working groups in 2008.

1.5.5 Working Group on Fish Ecology (WGFE)

In 2007, WGFE examined the distribution of selected fish species in the OSPAR area (including starry ray *Amblyraja radiata* in the North and Barents Sea), abundance-occupancy relationships, essential fish habitat (including juvenile elasmobranchs) and the development of EcoQO's for fish communities (ICES, 2007b). WGEF recommend that WGFE be asked to identify the spatial distribution and physical characteristics of elasmobranch nursery grounds.

1.5.6 International Bottom Trawl Survey Working Group (IBTSWG)

In 2007, IBTSWG provided maps of the distribution of a variety of demersal elasmobranchs from the IBTS surveys in western areas (ICES, 2007c). WGEF considered that these plots provide useful information and hope that IBTSWG will continue such work. Following on from WKTQD (see Section 1.5.7), and from the examination of survey data undertaken in IBTSWG and WGEF, it is becoming obvious that there are errors in the DATRAS database resulting from misidentifications and potential confusion between starry ray (or thorny skate) and thornback ray.

WGEF consider that it is unacceptable that such erroneous data remain uncorrected, especially as ICES provides advice to the EC on the status of demersal elasmobranchs in this ecoregion, and recommend that ICES, national laboratories and IBTSWG, with the help of WGEF members, ensure that survey data for skates and rays (as well as other taxa) are corrected or amended as appropriate.

1.5.7 Workshop on Taxonomic Quality Issues in the DATRAS Database (WKTQD)

In 2007, a one-off workshop on taxonomic data quality in the DATRAS database has held in Copenhagen. The report (ICES, 2007d) details many of the taxonomic and other errors that persist in the DATRAS database. WGEF acknowledge the work undertaken in the workshop and recommend that ICES and national laboratories address data quality issues as soon as possible (see above).

1.5.8 Stock Identification Methods Working Group (SIMWG)

Given the poorly understood nature of stock identification in important elasmobranch stocks, including demersal skates (Rajidae) and deep-water sharks, SIMWG considered deep-water stocks (ICES, 2006a) and stated:

> Deep-sea sharks in Subareas V, VI, VII, VIII, and IX-The category deep-sea sharks includes several species that all share the characteristics of low fecundity and long life spans. For none of the species is the stock structure known. There is no information on stock structure or biology that would suggest that subdividing of the current management area is justified or practical at the present time. However, it is reiterated that an aim should be to collect and compile species-specific data on areas of distribution, landings, and exploitation levels. Sharks are often taken in mixed fisheries along with e.g. roundnose grenadier and black scabbardfish, and the management should be consistent for all these species.

WGEF would recommend that SIMWG examine stock identification issues for demersal skates (Rajidae) in the North Sea, Celtic Seas and Bay of Biscay/Iberian eco-regions.

1.5.9 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 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 standardised and appropriate methods for raising species composition data.

It is recommended that PGCCDBS provide the necessary supporting information to ensure that data collection (including species identification) and raising procedures (by gear, season, ICES Division and nation) for skate and ray sampling are standardised across laboratories. Such work may be best conducted in the form of a one-off workshop.

1.5.10 Workshop on using fishers to sample catches (WKUFS)

Self-sampling schemes may be useful methods for collecting data from those areas/fisheries not readily available to either market or field sampling. Hence, any future sampling schemes could provide valuable information on the skates taken in inshore fisheries and elasmobranchs taken in deep-water fisheries. Although the report from this recent workshop was not available to the group, WGEF would ask that WKUFS recognise that there is a need for species-specific data for various elasmobranchs, and given that their taxonomic identification is a major issue for some of these species, appropriate identification information would be required.

1.5.11 Study Group on Age-length Structured Assessment Models (SGASAM)

The third and final meeting of the Study Group on Age-Length Structured Assessment Models (SGASAM) took place in November 2006. Length-structured models are considered useful when problems with age determination do not permit the use of age-structured models or make such models less reliable, and also in cases when it is thought such models provide a better description of the fishery and biological processes. A number of length- and age-length-structured assessment tools of differing complexity have been presented at previous meetings of this SG, and such novel assessment methods may be appropriate for some elasmobranch stocks. As this SG has come to the end of its lifetime, it has been suggested that work on using length-structure in assessment methods should for the time being be covered by the Methods WG (WGMG).

1.5.12 Working Group on Fish Technology and Fish Behaviour (WGFTFB)

Annex 8 of ICES (2007e) provided a useful overview of technical issues relating to fisheries in the North Sea, northern shelf and southern shelf areas. In general, high fuel prices have led to some changes in fleet behaviour. For example, there has been a gradual shift in the Dutch beam trawl fleet from beam trawling to twin trawling for other species (e.g. *Nephrops*). Other fisheries have also directed more effort to *Nephrops*.

Changes that may have an effect on elasmobranch stocks include that Belgian beam trawlers are increasingly being equipped with 3D mapping sonar, which has opened up new areas to fishing (e.g. close to wrecks). Belgian trials with outrigger trawls have indicated a high bycatch of rays. French vessels have switched from anchovy and tuna pelagic trawling to bottom trawling for anglerfish in recent years, and this is likely to continue given the continued closure of the anchovy fishery.

The provision of such information by FTFB is welcomed. WGEF would recommend that WGFTFB be requested to provide (a) more details on the bycatch of rays in outrigger trawls and (b) review temporal changes in the fishing patterns of high seas pelagic fisheries taking pelagic sharks.

1.6 Other fisheries meetings of relevance to WGEF

1.6.1 ICCAT

ICCAT's Standing Committee on Research and Statistics (SCRS) Shark Species Group held a Data Preparatory Meeting (June 25–29, 2007) in Punta del Este (Uruguay). The objective of this meeting being to carry out the necessary data compilation and analyses to facilitate assessments in 2008. The last ICCAT assessments for Atlantic blue shark and shortfin mako were undertaken in 2004. The data preparation meeting intends to update data on relative abundance and examine estimates of historical catches and dead discards from bycatch and targeted fisheries. It is also hoped that first estimates of catches of other pelagic sharks, including thresher sharks and oceanic white tip will be made.

ICES WGEF had hoped to assess deep-water sharks in 2008 (in conjunction with WGDEEP) and to assess pelagic sharks in 2009. Given the ICCAT schedule, it is now considered that WGEF should also participate with the ICCAT meeting in 2008. WGEF also recommend that ICES liase with ICCAT to ensure that the meetings of WGEF and the ICCAT Shark Species Group do not clash in the future, and facilitate the possibilities of joint meetings.

1.6.2 FAO

An FAO expert group met in Rome in March 2007 in order to examine proposals to list several species of fish and marine invertebrate on CITES Appendices (see Section 1.7.2).

With regards porbeagle, the FAO Ad Hoc Expert Panel (FAO, 2007) concluded that:

The available evidence does not support the proposal to include the porbeagle shark, Lamna nasus, in CITES Appendix II.

Porbeagles in the northeast Atlantic Ocean may meet Appendix II criteria, but the limited data that were available were not sufficient to assess the extent of the decline.

Though adequate management measures are in place in some regions, there are others where some form of management is urgently needed.

With regards spurdog, the FAO Ad Hoc Expert Panel (FAO, 2007) concluded that:

The available evidence does not support the proposal to include Squalus acanthias under CITES Appendix II.

The northeast Atlantic population meets the decline criterion for listing on Appendix II.

There are serious fisheries management failures for some individual populations. Catches from the northeast Atlantic stock, both internally traded in the EU and imported, need to be curtailed.

With regards sawfish (although largely occurring outside the ICES area, they occurred historically in southerly Iberian waters), the FAO Ad Hoc Expert Advisory Panel concluded "*that the available evidence did support the proposal to include all species of Pristidae in Appendix I of CITES in accordance with Article II, paragraph 1 of the Convention*."

1.7 Nature conservation issues of relevance to the WG

1.7.1 IUCN Redlist Process for the northeast Atlantic

The IUCN Shark Specialist Group (SSG) is currently undertaking a global marine assessment of the red list status of all chondrichthyan species. This is proceeding primarily through a series of regional and generic (e.g. deepwater, batoid) workshops. Results from these workshops are combined to produce global and in some cases regional or population assessments. A peer review process approves assessments prior to publication.

The Northeast Atlantic Red List Workshop was held in February 2006, with species restricted to the southern edge of the ICES area reviewed at a Western African workshop in June 2006. Some of the results from these earlier workshops are still undergoing peer review prior to submission to the Red List Programme, and all other unpublished assessments are now in preparation. All published and submitted chondrichthyan fish assessments (the latter are approved and submitted to the Red List Programme for publication the following year) can be downloaded from http://www.flmnh.ufl.edu/fish/organizations/ssg/redlistdefault.htm.

1.7.2 Convention on International Trade in Endangered Species (CITES)

Three species of shark, two of which occur in the ICES area (basking shark *Cetorhinus maximus* and white shark *Carcharodon carcharias*) are currently listed on Appendix II of CITES. Sawfish (Pristidae) were added to Appendix I of CITES in 2007, and are mentioned here as *Pristis pristis* and *P. pectinata* were historically present at the very south of the ICES area.

1.7.3 OSPAR

OSPAR Biodiversity Committee have tentatively accepted nominations for eight elasmobranchs to be listed as Threatened and Declining in the OSPAR area (see Section 21 for the WGEF reviews of the original nominations), and OSPAR intend to improve the case study reports prior to soliciting final OSPAR MASH Working Group approval.

1.7.4 Shark Alliance

The Shark Alliance, a Brussels-based coalition of environmental groups, conservationists and scientists was formed in 2006. In October 2006 it convened a workshop to review fisheries and conversion factors for elasmobranchs, covering EC waters and EC fleets elsewhere (see Hareide *et al*., 2007).

1.8 Mixed fisheries advice for 2007

The ICES mixed fisheries advice for the Celtic Seas and North Sea ecoregions was as follows:

Fisheries in the Celtic Sea, Southwest of Ireland, Western Channel, and northern part of the Bay of Biscay should in 2007 be managed according to the following rules, which should be applied simultaneously. They should fish:

- With no catch or discard of spurdog and cod in VIIe–k;
- without jeopardizing the recommended reduction in fishing mortality of sole and plaice in Divisions VIIfg; plaice and sole in Division VIIe; and Celtic Sea herring and VIa VIIbc herring;
- concerning deepwater stocks fished in Subareas VII and VIII, see Volume 9 (*of ICES Advice*);
- within the biological exploitation limits for all other stocks

Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without catch or discards of cod in Subarea VI;
- with the lowest possible catch for whiting in VIa;
- without catch or discards of spurdog;
- without jeopardizing the recommended reduction in fishing mortality of haddock in Division VIa;
- concerning deep water stocks fished in Subarea VI, see Volume 9 (*of ICES Advice*);
- within the biological exploitation limits for all other stocks.

Fisheries in the Irish Sea VIIa should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without bycatch or discards of cod, sole, and spurdog, and with minimal catch of whiting;
- without jeopardizing the recommended reduction in fishing mortality of haddock;
- within the biological exploitation limits for all other stocks

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually, then fishing should not be permitted.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2007 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks (see text table above);
- where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- with minimum bycatch of spurdog, porbeagle, and thornback ray and skate.

1.9 Data availability

1.9.1 Provision of data before working group

It was agreed by the group that all data should be submitted to the working group by the 1st May each year. In 2007, the supply of landings data and, in most instances, collation of survey data was achieved by this deadline.

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 which 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.

1.9.2 Landings data

In 2005–06, 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).

These archive landings tables were updated in 2006 and 2007 by the WG. 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 2005 (ICES, 2006b; Johnston *et al.*, 2006). However the working group's best estimates are still considered inaccurate for a number of reasons:

Quota species may be reported as elasmobranchs to avoid exceeding quota, which would lead to over-reporting.
Fishermen may not take care when completing landings data records, for a variety of reasons.
Administrations may not consider that it is important to collect accurate data for these species.
Some species could be underreported to avoid highlighting that bycatch is a significant problem in some fisheries.
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 due to revisions by reporting parties. WGEF aims to arrive at an agreed set of data for each species and will document any changes to these data sets in the relevant working group report.

WGEF has made further progress on TOR d, in terms of the collation of pelagic shark data, and these data are presented in the relevant sections. They are still considered incomplete however, as some major shark fishing nations have periods where either no data, or only generic data, are available. There have been some improvements in the reporting of species-specific data in recent years.

WGEF still has some problems in disaggregating landings data from France and Spain. This is partly because scientists with knowledge of these high seas fisheries do not attend WGEF. For WGEF to fulfil its medium term goal of compiling definitive datasets of landings it will be necessary to have the cooperation of those institutes collecting data from swordfish and tuna fisheries.

1.9.3 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.

1.9.4 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 stressed 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 only 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.

1.10 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 assess the status of the species/stocks.

In 2007 WGEF focused on demersal elasmobranchs in the North Sea, Celtic Seas and Bay of Biscay/Iberian coastal waters. Analyses focused on the more abundant species (e.g. *Raja clavata, Raja montagui, Leucoraja naevus* and *Scyliorhinus canicula*). Other demersal elasmobranchs present in the various eco-regions are summarised in Table 1.4.

Table 1.4: Occurrence of demersal elasmobranchs by eco-region and approximate abundance (0=Absent; 1: Vagrants occasionally recorded; 2: Historical (known to have occurred, but no recent authenticated records); 3: Uncommon (occasionally taken in surveys, but data probably only reliable to confirm presence); 4: Regular (often caught, though in low numbers and sporadically, maybe suitable for presence/absence analyses; 5: Common (caught routinely and in reasonable numbers, maybe worthwhile to examine trends in CPUE; 6: Common (as 5) and also well known, in terms of life-history and/or stock identity (other methods may be developed). *Some species occurring in the English Channel are only observed in the western English Channel (VIIe)

	Species	Barents sea	Norwegian Sea	North Sea	Irish Sea	VIIf	English Channel	Celtic/West IRL	West Scotland	Rockall	Faroe	Iceland	Greenland	Biscay	Portugal	Azores	Deep
Thornback ray	*Raja clavata*	3	4	5–6	6	6	5–6	4–5	4	3	2	2	0	5	4–5	5–6	0
Blonde ray	*Raja brachyura*	0	3	4	4–5	4–5	4	4–5	3	0	0	0	0	3	4–5	0	0
Spotted ray	*Raja montagui*	0	3	5	5	4–5	5	4–5	4	1	0	0	0	4–5	4–5	0	0
Undulate ray	*Raja undulata*	0	0	1	1	1	4	4–5	0	0	0	0	0	3	4–5	0	0
Small-eyed ray	*Raja microocellata*	0	0	1	1	5	4	4–5	1	0	0	0	0	3	4–5	0	0
Brown ray	*Raja miraletus*	0	0	0	0	0	0	0	0	0	0	0	0	0	4–5	0	0
Kukujev's ray	*Raja kukujevi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Deepwater ray	*Raja bathyphila*	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0	2
Round ray	*Rajella fyllae*	2	4	3	0	0	0	0	3	0	2	2	2	2	0	0	2
Bigelow's ray	*Rajella bigelow*	0	0	0	0	0	0	0	1–3	2	0	0	0	0	0	2	2
Shagreen ray	*Leucoraja fullonica*	1	3	3	1	1	0–3*	4–5	3	3	2	2	2	2	3	3	2
Cuckoo ray	*Leucoraja naevus*	0	0	5	5	3	1–4*	5	4	0	0	0	0	5	4–5	0	0
Sandy ray	*Leucoraja circularis*	0	3	3	1	1	0	3	3	3	0	0	0	3	3	0	0
Electric ray	*Torpedo nobiliana*	0	0	3	1	1	1	1	2	0	0	0	0	2	3	3	0
Marbled electric ray	*Torpedo marmorata*	0	0	2	0	0	2	0	0	0	0	0	0	3	3	0	0
Common torpedo	*Torpedo torpedo*	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0
Common Stingray	*Dasyatis pastinaca*	0	0	3	1	1	1	1	0	0	0	0	0	3	3	3	0
Pale ray	*Bathyraja pallida*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Richardson's ray	*Bathyraja richardsoni*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Spinytail ray	*Bathyraja spinicauda*	1	3	1	0	0	0	0	0	0	2	2	2	0	0	0	2
Blue ray	*Breviraja caerulea*	0	0	0	0	0	0	0	3	2	0	0	0	3	0	0	2
Starry skate	*Amblyraja radiata*	4	3	5	0	0	0	0	3	0	2	2	2	0	0	0	2
Arctic skate	*Amblyraja hyperborea*	1	3	1	0	0	0	0	0	0	2	2	2	0	0	0	2
Sailray	*Dipturus linteus*	2	3	3	0	0	0	0	0	0	2	2	2	0	0	0	2
Longnose skate	*Dipturus oxyrinchus*	0	3	1	0	0	1	1	3	0	2	0	0	3	3	3	2
Norwegian skate	*Dipturus nidarosiensis*	0	3	3	0	0	0	1	0	2	0	2	0	3	0	0	2
Common skate	*Dipturus batis*	1	3	3	3	3	2–3	3–4	3–4	3	2	2	2	2	3	3	2
White skate	*Rostroraja alba*	0	0	2	2	2	2	2–3	1	0	0	0	0	2	3	0	0
Angel shark	*Squatina squatina*	0	0	2	2	2	2	2–3	2	0	0	0	0	2–3	2–3	0	0

	Species	Barents sea	Norwegian Sea	North Sea	Irish Sea	VIIf	English Channel	Celtic/West IRL	West Scotland	Rockall	Faroe	Iceland	Greenland	Biscay	Portugal	Azores	Deep
Smooth-hound	*Mustelus* spp.	0	0	5	4–5	4–5	4–5	4–5	3	0	0	0	0	3	3–4	0	0
Lesser spotted dogfish	*Scyliorhinus canicula*	0	2	5	5	5	5	5	5	0	0	0	0	5	5	0	0
Greater spotted dogfish	*Scyliorhinus stellaris*	0	0	1	4	4	4	3–4	3	0	0	0	0	4	3–4	0	0
Blackmouth catshark	*Galeus melastomus*	1	4	1	3	0	0–1	4	4	0	2	0	0	5	5	0	2
Madeiran ray	*Raja maderensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0

1.10.1 Statistical modelling of survey data

The poor quality of catch information (in terms of landings species composition) for many of the elasmobranch species means that often, the only species specific data are from surveys. Elasmobranch survey data are characterised by a large number of zero and low catch-rate hauls, but also occasional catches comprising large numbers of individuals. This very skewed distribution of haul catch rate data, which is typical for species which demonstrate a patchy spatial distribution, means that simple arithmetic mean catch rates may not be good indices of abundance and are likely to have very wide confidence intervals. Additionally there may be other factors which impact on the catch rate other than abundance (e.g. spatial distribution) which will add to the variance in a non-stratified survey.

Statistical modelling of CPUE data is becoming an increasingly popular method of obtaining 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 which is not a consequence of changes in population size.

The most common method for standardising CPUE data is the use of generalized linear models (GLMs; Nelder and Wedderburn, 1972) which were first used as an approach to standardising catch and effort data by Gavaris (1980). In recent years the use of this approach has increased, particularly for standardising commercial catch rate data (Goni *et al.*, 1999, Battaile & Quinn, 2004, Bishop *et al.*, 2004), and an overview of recent approaches can be found in Maunder and Punt (2004) and Venables and Dichmont (2004).

The basic assumption of a GLM is that there is a linear relationship between some function (g) of the expected value of the response variable (y_i) and the explanatory variables (x_j) which can be numerical or a factor:

$$\mathrm{g}(y_i) = \sum_{j=1}^{N} \beta_j x_{ij}$$

Generalised additive models (GAMs) are an extension to GLMs (Hastie *et al.*, 2001) in which the linear predictor is replaced by

$$\mathrm{g}(y_i) = \sum_{j=1}^{N} s_j(x_j)$$

where s_j is a smooth function such as a spline or loess smoother. GAMs are useful for describing the relationship between variables when the functional form of the relationship is not known. Such approaches have also been used in the analysis of fishery catch effort data and in particular in pelagic species (Bigelow *et al*., 1999: blue shark, Rodriguez-Marin *et al.,* 2004: bluefin tuna) to investigate spatial effects on catch rate.

Model selection involves choosing a distribution for the response variable (e.g. normal, exponential, Poisson, etc), a link function and an appropriate set of explanatory variables. The distribution and link function are chosen by examining plots of deviance residuals against fitted values for systematic patterns and trends. Backward stepwise selection, a procedure which involves initially including all likely covariates and then dropping out those which do not help explain variance in the data, was used to select an appropriate set of explanatory variables. A less *ad hoc* method of choosing the 'best' model might be to use an appropriate information criterion such as Akaike (AIC). However, when dealing with large data sets (as is the case here), AIC has a tendency to choose very complex models, retaining a large number of covariates. Smooth terms are represented using penalized regression splines with smoothing parameters selected by cross validation.

In the analysis carried out here, the response variable was chosen to be catch (in terms of numbers) per haul. In data sets where haul duration varied (e.g. Scottish West coast- due to the combined analysis of a number of different surveys), the duration was included in the model as an offset term. Explanatory variables which were investigated here (when available) included year, month, spatial distribution (either statistical rectangle or lat-long), depth and gear type. Year, depth, month and lat-long were included as smooth terms while statistical rectangle was modelled as a factor. All analyses were carried out using the R(2004) statistical programming package.

In all model fits, year (and month where available) were estimated to be significant terms. Statistical rectangle proved to be a better predictor of spatial variability than latitude and longitude and was therefore retained in all models. In most cases depth also proved to be a significant explanatory variable, although with very large confidence intervals at deeper depths, possibly due to some confounding with the estimated spatial effect (i.e. some statistical rectangles are on average deeper than others) and also due to the low number of samples from deeper water. On the Scottish west coast the effect of gear type was also investigated. However this proved not to be significant, possibly due to confounding with either the spatial or depth variable. For example, the deepwater gear is used only in deepwater and the GOV trawl is not used in deepwater, so any effect of gear type is impossible to distinguish from the effect of depth. Estimated effects for each species/area combination are shown in the relevant chapters of this report.

Within the R framework a wide range of distributional assumptions and link functions can be explored including the standard distributions (such as Gaussian, gamma, poisson), but also more flexible distributions known as 'quasi' distributions. This family of distributions is defined by a link function and variance, but the 'dispersion' parameter is estimated and so enables the model to produce a better fit to over-dispersed data. The model fits were generally poor, explaining up to about 50% of the deviance. The most appropriate plots of deviance residuals (see Figure 1.1 for typical example) were obtained using a quasi Poisson distribution (i.e. log link, variance proportional to mean and fitted dispersion). Although the model is allowed to estimate the dispersion in the data, there are generally still some problems apparent in the residual distribution and some divergence from normality. The disproportionate number of residuals just below zero and too many large positive residuals may be the result of the high number of zero observations which the model is unable to account for (see below for further discussion). There are generally no systematic trends in residuals by year or statistical rectangle while the decline in residual variance with depth is consistent with the decline in mean catch rate with depth.

Some further exploratory work was carried out at this meeting into alternative methods for modelling data with a large number of zeros. A currently fashionable method for dealing with data with a large number of zeros is the 'delta-GAM' method (Lo *et al*., 1992; Stefansson, 1996) or 'hurdle' model which actually combines two models-one for the probability of a positive observation (typically logistic) and the 2nd for the catch rate, conditioned on it being positive (often poisson). Some preliminary model fits using this method (not presented) appeared promising, giving particularly good residual distributions (and showed results, in terms of estimated effects, consistent with those of the single GAM with estimated dispersion). Additionally, the use of so called zero-inflated models may also be worth investigating (Martin *et al*., 2005). These models are also expressed in two parts: the probability of a zero (1), and the probability of particular count which may, or may not, be zero (2). There are fewer examples of the use of zero-inflated models in fisheries (Minami *et al*., 2007) though they are more widely used to model abundance in other areas of ecology (Barry & Welsh, 2002; Potts & Elith, 2006). Both of these two stage approaches that account for excess zeros are less easily implemented in R than the single GAMs described previously and as a result were not fully explored at this WG.

For a number of the stocks to which this method was applied (VIIa: thornback ray, cuckoo ray, VIa: thornback ray, lesser spotted dogfish) a relatively rigorous approach was taken to model fitting in terms of choice of distribution, link function and explanatory variables (with interaction terms where possible) including an investigation into whether spatial effects appeared to be constant through time. Ideally this procedure should be followed for all combinations of species and area. However, due to the limitations of time, few model checks were made for many of the other species/area combinations (in particular the North Sea). In such cases the fitted model assumed a log link function, variance proportional to mean squared or mean with an estimated dispersion parameter. In particular, no checks were made that the assumption of a fixed spatial distribution was appropriate, although in many cases the estimated distribution appeared consistent with prior knowledge about stock distribution.

To conclude, such statistical analyses show potential as a way of obtaining abundance indices from survey data. Although, the general estimated trends appear robust to alternative model assumptions, the magnitude of the variations should be treated with caution while this analysis is still preliminary. A number of issues require further work in order to make the analysis more complete:

- A more rigorous statistical procedure, in terms of choice of link function, distribution and covariates should be implemented across all species/area combinations
- Further exploration of the two-stage approaches for dealing with data with a large number of zeros should be further investigated and may prove more appropriate than the currently implemented over-dispersed Poisson.
- Much of the survey data were provided to the WG in terms of length frequency per haul and therefore the analysis focused on catch rate in terms of total numbers. However, an analysis of catch rate in terms of biomass may be a more suitable indicator of stock trends. Alternatively, it may be possible to categorise the more common species into a small number of size classes and then investigate trends in catch rate by size class.
- Throughout the analysis presented here, spatial effects are modelled using statistical rectangle which uses a large number of degrees of freedom. A more sensible approach may be to work with groups of statistical rectangles such as ICES round-fish area.

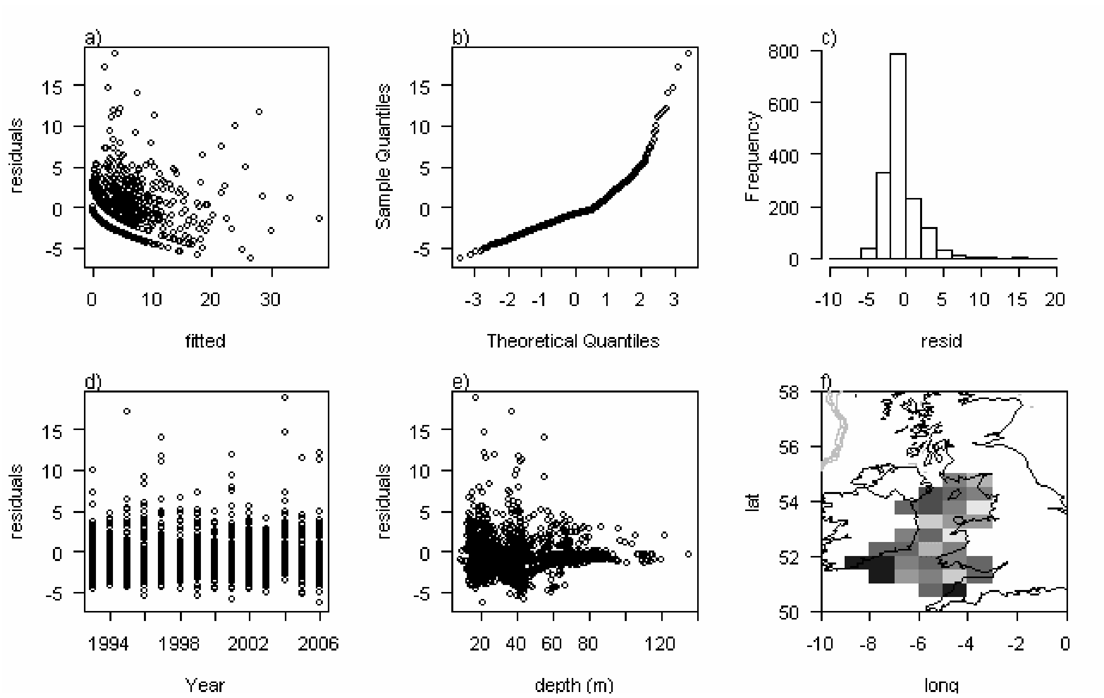


Figure 1.1. Deviance residual plots for typical model fit (Irish Sea thornback ray) : a) residuals vs fitted values, b) & c) distribution of deviance residuals, d)-f) distribution of residuals vs estimated model effects (Year, depth & statistical rectangle).

1.10.2 Demographic methods

Demographic models, which rely primarily on life-history parameters, are often used in situations where data are not available to support dynamic fishery models. They are the most widely-used form of population model for elasmobranch stocks (Simpfendorfer, 2004). Cortés (2002) applied a stochastic version of a classic demographic model to 41 populations of sharks to calculate population statistics and to investigate the sensitivity of the estimate of the rate of population increase, *r*, to a range of demographic parameters. He found that juvenile survival, age at maturity and reproduction accounted for most of the variation in *r*.

Given the lack of suitable time-series data for thornback ray in the North Sea and Eastern Channel, the Working Group pursued an explorataory demographic analysis, based on life-history tables (Simpfendorfer, 1998, 2004, Gedamke *et al.*, 2007). This method estimates the rate of population increase, *r*, based on the Euler-Lotka equality (Simpfendorfer, 2004):

$$\sum_{a=0}^{a_{\max}} l_a m_a e^{-a \cdot r} = 1 \qquad 1$$

where l_a is the proportion of animals surviving to the beginning of age class a:

$$l_a = l_{a-1} e^{-M_{a-1}} \qquad 2$$

M_a is the natural mortality at age a, m_a is the natality at age a (female egg-production per female), and $a_{\max}$ is the maximum age. For oviparous species, such as thornback ray, egg mortality (M_{egg}) can be incorporated by setting $l_0 = e^{-M_{egg}}$. In the exploratory analysis presented for thornback ray, age 0 mortality (M_0) is differentiated from age 1+ mortality (M_{1+}, held constant from age 1 onward). These mortalities can also be expressed in terms of survival ($S_x = e^{-M_x}$, $x = egg$, 0 or 1+).

When conducting demographic analyses based on life-history tables, care should be taken when interpreting the estimate of *r*, because of density-dependent effects on demographic parameters. In order to obtain an estimate of *r* that reflects the intrinsic rate of population increase, r_{int}, input parameters for the life-history tables need to be representative of a severely depleted population, when uncrowded conditions allow for the greatest per capita rate of growth (Gedamke *et al.*, 2007), otherwise the value of *r* obtained from the analysis falls somewhere between 0 (virgin conditions) and r_{int}. The exploratory analysis for thornback ray assumes that the value of S_0 used pertains to severely depleted conditions, and following the lead of several authors (Cortés, 2007, Gedamke *et al.*, 2007), that all compensatory response occurs in S_0. The values used for S_{egg}, S_0 and S_{1+} in the exploratory analysis for thornback ray are, however, guesstimates, and not based on observed data. Therefore, two sets of values reflecting a "High S" and a "Low S" scenario are used. Uncertainty about reproductive rates is also reflected by two scenarios, "oocytes per female" and "egg cases per female". Fecundity from the oocyte-length relationship (Capapé, 1976) was used as an upper limit of fecundity, with the observed number of egg-cases deposited by captive-held females (38–66, Ellis, unpublished) used as a lower limit Table 1.5 summarises the life-history parameters used in the analysis.

Table 1.5. Thornback ray in the North Sea and Eastern Channel. Demographic parameter inputs and relationships used in the exploratory analysis. All parameters refer to females.

<table>
<tr><th></th><th>SCENARIO 1</th><th>SCENARIO 2</th></tr>
<tr><td>Maturity
$a_{mat} = 4$
$a_{50} = 6.1$
$a_{95} = 8$</td><td colspan="2">$O_a = \begin{cases} 0 & , a < a_{mat} \\ 1/[1+e^{-\ln(19)(a-a_{50})/(a_{95}-a_{50})}] & , a \geq a_{mat} \end{cases}$</td></tr>
<tr><td>Growth
$K = 0.14$
$L_\infty = 118$
$t_0 = -0.88$</td><td colspan="2">$L_a = L_\infty(1-e^{-K(a-t_0)})$</td></tr>
<tr><td>Reproduction
$a_{fec} = 2.588$
$b_{fec} = -135.17$</td><td>Oocytes per female
$E_a = a_{fec} L_a + b_{fec}$</td><td>Egg cases per female
$E_a = \begin{cases} 0 & , a < 4 \\ 38 & , 4 \leq a < 7 \\ 48 & , 7 \leq a < 10 \\ 66 & , a \geq 10 \end{cases}$</td></tr>
<tr><td>Q (sex ratio) = 0.5</td><td colspan="2">Female egg-production per female
$m_a = O_a E_a Q$</td></tr>
<tr><td>Survival</td><td>High S</td><td>Low S</td></tr>
<tr><td>S_{egg}</td><td>0.55</td><td>0.25</td></tr>
<tr><td>S_0</td><td>0.80</td><td>0.70</td></tr>
<tr><td>S_{1+}</td><td>0.85</td><td>0.75</td></tr>
</table>

Table 1.6 represents a full life-history table for the "Oocytes per female" reproduction and "High S" survival scenario, while Table 1.7 summarise key results for all reproduction-survival scenarios considered.

Table 1.6. Thornback ray in the North Sea and Eastern Channel. Exploratory life-history table. Results are for the "Oocytes per female" reproduction and "High S" survival scenario. The estimate of r_{int} is 0.42. Parameters are defined in equations 1 and 2 (with corresponding text), and Table 1.5. The value of r that leads to the equality in equation 1 is r_{int}.

A	L_A	M_A	$L_A \cdot M_A$	$A \cdot L_A \cdot M_A$	$E^{-A \cdot R}$	$L_A \cdot M_A \cdot E^{-A \cdot R}$
0	0.55	0	0.00	0.00	1.00	0.00
1	0.44	0	0.00	0.00	0.66	0.00
2	0.37	0	0.00	0.00	0.43	0.00
3	0.32	0	0.00	0.00	0.28	0.00
4	0.27	0	0.08	0.32	0.19	0.01
5	0.23	3	0.64	3.19	0.12	0.08
6	0.20	12	2.42	14.50	0.08	0.19
7	0.17	28	4.58	32.06	0.05	0.24
8	0.14	39	5.50	44.02	0.03	0.19
9	0.12	46	5.55	49.96	0.02	0.13
10	0.10	52	5.27	52.69	0.01	0.08
11	0.09	56	4.86	53.50	0.01	0.05
12	0.07	60	4.41	52.97	0.01	0.03
					$\Sigma\, l_a \cdot m_a \cdot e^{-a \cdot r}$	1.00

Table 1.7. Thornback ray in the North Sea and Eastern Channel. Results from the exploratory life-history table given in Table 1.6, but also considering further scenarios. Results are shown for four reproduction-survival scenarios. The equations are as given in Simpfendorfer (2004).

	Description	Calculation	Oocytes per female		Egg cases per female	
			High S	Low S	High S	Low S
r_{int}	intrinsic rate of population increase	Table 2	0.420	0.193	0.370	0.141
R_0	net reproductive rate	$\sum_{a=0}^{a_{max}} l_a \cdot m_a$	33.3	4.9	20.5	3.1
G	generation time	$\sum_{a=0}^{a_{max}} a \cdot l_a \cdot m_a / R_0$	9.1	8.6	8.9	8.4
$t_{\times 2}$	population doubling time	$\ln(2)/r_{int}$	1.65	3.59	1.87	4.93
P_a	stable age distribution of population	$l_a \cdot e^{-a \cdot r_{int}} / \sum_{a=0}^{a_{max}} l_a \cdot e^{-a \cdot r_{int}}$				
		0	0.34	0.19	0.31	0.16
		1	0.23	0.16	0.22	0.14
		2	0.15	0.13	0.15	0.12
		3	0.10	0.11	0.10	0.10
		4	0.06	0.09	0.07	0.09
		5	0.04	0.07	0.05	0.08
		6	0.03	0.06	0.03	0.07
		7	0.02	0.05	0.02	0.06
		8	0.01	0.04	0.02	0.05
		9	0.01	0.03	0.01	0.04
		10	0.01	0.03	0.01	0.04
		11	0.00	0.02	0.01	0.03

	DESCRIPTION	CALCULATION	OOCYTES PER FEMALE		EGG CASES PER FEMALE	
			HIGH S	LOW S	HIGH S	LOW S
		12	0.00	0.02	0.00	0.03

Table 1.7 indicates that estimates are more sensitive to the survival scenarios than to the reproductive scenarios, although estimates of generation time are relatively insensitive to all scenarios considered. Estimates of r_{int} range from 0.14 to 0.42 for the scenarios considered, highlighting the need to provide more reliable estimates of input parameters if this range is to be narrowed. Rather than focus on the absolute values in Tables 1.6–1.7, this type of demographic analysis may more usefully provide qualitative guidelines in terms of protecting certain life-history stages of the population through technical measures such as gear restrictions and minimum or maximum landing sizes (Cortés, 2007). The approach taken in the exploratory analysis was therefore to consider fishing mortality F by replacing equation 2 as follows:

$$l_a = l_{a-1} e^{-M_{a-1} - (\rho_{i,a} + d\delta_{i,a})F} \qquad 3$$

where ρ is the selectivity for the retained portion of the thornback ray commercial catch, δ the selectivity for the discarded portion, and d a discard mortality factor (a value of 0 implies that all discarded animals survive, and 1 that all discarded animals die). Four selectivity scenarios (i) were considered in the analysis, reflecting greater protection of juveniles or adults through the imposition of minimum/maximum landing sizes (gear selectivity is assumed to remain unchanged in all cases). Selectivity scenario 1 is assumed to reflect, approximately, the current situation for thornback ray in terms of commercial exploitation. A further three discard mortality scenarios are considered (d = 0.9, 0.5 or 1) to reflect uncertainty with regard to this parameter. The selectivity scenarios considered are shown in Table 1.8.

Table 1.8. Thornback ray in the North Sea and Eastern Channel. Overall commercial gear selectivity, γ, and four options for the selectivity of the retained portion of the commercial catch, ρ. Discard selectivity, δ, is the difference between these two ($\delta_{i,a} = \gamma_a - \rho_{i,a}$). Gear selectivity was assumed to be 0.1 for 0-group fish with fish of 1+ assumed to have a full selectivity in commercial (trawl) fisheries. Retained catch selectivity (Option 1) was based on observed discarding patterns (see ICES, 2006b) from observer programmes. Length-at-age (cm) is based on Table 1.5.

a	LENGTH-AT-AGE L_a	GEAR SELECTIVITY γ_a	RETAINED CATCH SELECTIVITY $\rho_{1,a}$	$\rho_{2,a}$	$\rho_{3,a}$	$\rho_{4,a}$
0	13.7	0.1	0	0	0	0
1	27.3	1	0	0	0	0
2	39.2	1	0	0	0	0
3	49.5	1	1	0	1	1
4	58.4	1	1	1	1	1
5	66.2	1	1	1	1	1
6	73.0	1	1	1	1	1
7	78.8	1	1	1	1	1
8	84.0	1	1	1	0	1
9	88.4	1	1	1	0	0
10	92.3	1	1	1	0	0
11	95.6	1	1	1	0	0
12	98.6	1	1	1	0	0

In order to explore the effect of changes in minimum/maximum landing sizes on the thornback ray population, a similar approach was used as in Simpfendorfer (1998), namely, replacing equation 2 with 3, to re-examine the life-history table by solving for the value of F that leads to $r = 0$, while maintaining the equality in equation 1. Although this approach has limitations because of density-dependent compensation in demographic parameters such as S_0 with changes in population size (Cortés, 2007, Gedamke *et al.*, 2007), this was partially addressed by considering three S_0 scenarios (S_0, $0.8S_0$ and $0.6S_0$), reflecting compensation for less depleted conditions. However, because the exploratory analysis only considers results for selectivity scenarios 2–4 in terms relative to selectivity scenario 1, and because density-dependent effects should act in the same manner for the four selectivity scenarios, it was thought that this limitation (not properly accounting for density-dependent compensation with population size when considering the effect of F) was of less concern in the exploratory analysis.

Table 1.9 summarises the various scenarios considered in the exploratory analysis, while Table 1.10 presents results for all scenarios. Values shown in Table 1.10 were derived by calculating the value of F that would lead to $r = 0$ under the constraint of equation 1, and then (for all scenario combinations other than with selectivity) expressing results for selectivity scenarios 2–4 as $(F_i\text{-}F_1)/F_1$ in percentage terms (the subscript indicating selectivity scenario). Therefore, for all other scenario combinations, the comparison of the selectivity scenarios (comparison of values within each cell, demarcated by solid lines in Table 1.10) shows the effect of changing the current commercial selectivity for thornback ray by introducing minimum/maximum landing sizes. A positive percentage in Table 1.10 thus indicates that F could be increased further before a value of $r = 0$ is encountered (all values in Table 1.10 are non-negative because selectivity scenarios 2–4 provide greater protection than the current situation, reflected by scenario 1). An alternative interpretation is that, under the assumption that F is proportional to fishing effort, and that fishing effort does not increase for thornback ray, the greater the value in Table 1.10, the greater the benefits (in terms of protecting thornback ray) when moving from the current situation to the given selectivity scenario. This is because of the reduced impact of this selectivity scenario on the life-history stages of the population for the same level of effort.

Table 1.9. Thornback ray in the North Sea and Eastern Channel. All the scenarios considered in the exploratory analysis.

	Description	Options
1	Reproduction scenarios	(a) Oocytes per female (b) Egg cases per female
2	Survival scenarios	(a) High S (b) Low S
3	Selectivity scenarios	(a) current selectivity (b) additional protection for juveniles (c) additional protection for adults (d) as (c) but slightly less protection for adults
4	Discard mortality scenarios	(a) $d = 0.9$ (high discard mortality) (b) $d = 0.5$ (discard mortality reflecting 50% effective F) (c) $d = 0.0$ (no discard mortality)
5	S_0 scenarios	(a) S_0 (unchanged from severely depleted level) (b) $0.8S_0$ (c) $0.6S_0$

Table 1.10. Thornback ray in the North Sea and Eastern Channel. *F* (equation 3) that leads to *r* = 0 under the constraint of equation 1, expressed in terms relative to selectivity scenario 1 as percentage change. All scenarios considered are described in Table 1.9.

		High S			Low S		
		S_0	$0.8S_0$	$0.6S_0$	S_0	$0.8S_0$	$0.6S_0$
(a) Oocytes per female							
$d = 0.9$	sel. 2	2%	2%	2%	2%	1%	1%
	sel. 3	1%	1%	1%	1%	1%	1%
	sel. 4	0%	0%	0%	0%	1%	1%
$d = 0.5$	sel. 2	11%	10%	10%	10%	9%	9%
	sel. 3	4%	5%	5%	6%	6%	7%
	sel. 4	2%	2%	2%	3%	3%	4%
$d = 0$	sel. 2	40%	38%	35%	29%	28%	26%
	sel. 3	12%	13%	15%	17%	18%	19%
	sel. 4	4%	5%	6%	7%	8%	9%
(b) Egg cases per female							
$d = 0.9$	sel. 2	2%	2%	2%	2%	2%	1%
	sel. 3	1%	1%	1%	1%	1%	1%
	sel. 4	0%	0%	0%	1%	1%	1%
$d = 0.5$	sel. 2	11%	11%	10%	10%	9%	9%
	sel. 3	4%	5%	5%	6%	7%	7%
	sel. 4	2%	2%	3%	3%	3%	4%
$d = 0$	sel. 2	46%	42%	38%	30%	28%	26%
	sel. 3	12%	13%	15%	17%	18%	20%
	sel. 4	5%	5%	6%	8%	9%	10%

Selectivity scenario 2 (greater protection of juveniles) shows the greatest change relative to selectivity scenario 1 (current selectivity), indicating that selectivity scenario 2 potentially provides the greatest benefits compared to the other options considered in terms of protecting thornback ray. Improvements for selectivity scenario 3 are more modest, and are smallest for selectivity scenario 4. However, any benefits are rapidly eroded as discard mortality is increased. Results as expressed in Table 1.10 appear to be relatively insensitive to S_0 and reproduction scenarios, although absolute values of other life-history traits are more sensitive to these scenarios (Table 1.7). Results in Table 1.10 are only mildly sensitive to survival scenarios, with the "Low S" scenario showing a more contracted range across selectivity scenarios than the "High S" scenario.

Any absolute values from this exploratory demographic analysis need to be treated with caution, particularly as there is little or no empirical basis for some of the input parameters used (e.g. those relating to survival), and the range of inputs used result in a wide range of estimates for r_{int}. Nevertheless, a comparison of the effect of selectivity changes (resulting from an imposition of minimum/maximum landing sizes) appears to be robust across a wide range of scenarios in terms of highlighting selectivity scenario 2 (greater protection of juveniles) as leading to the greatest benefits in terms of protecting thornback ray. This finding (greater protection of juveniles as a preferred management strategy) appears to be supported by other studies (e.g. Galucci *et al.*, 2006, Cortés, 2007).

1.10.3 Catch-free relative ASPM

Porch *et al*. (2006) devised a model-based framework for estimating reference points, stock status and recovery times that does not require catch data and other measures of absolute abundance, and that may have useful application to elasmobranch species for which reliable catch data are not available. It is essentially an age-structured production model (ASPM; Hilborn, 1990, Restrepo and Legault, 1998) recast in terms relative to pre-exploitation levels. It is developed within a Bayesian framework to allow incorporation of auxiliary information, such as from meta-analyses of similar stocks or anecdotal information. Population dynamics commence from virgin conditions, and fishing mortality and relative recruitment are modelled as first order lognormal autoregressive processes with deviates estimated where sufficient data are available. The estimation of fishing mortality requires an index of fishing effort for the historical period where no other data are available, to allow projection from virgin conditions.

The approach has been used to provide stock assessment advice for the data-poor goliath grouper stock off southern Florida (Porch *et al*., 2006), relying on data from the fishery and surveys for selectivity parameters, and on three indices of abundance and anecdotal information concerning population depletion levels. The proxy used for historical effort was the US Census for Florida. The method has also been applied to dusky shark in the US Atlantic and Gulf of Mexico (Cortés *et al*., 2006), where data inputs included five indices of abundance (from surveys and fishery logbooks), and historic effort (nominal number of hooks) from the pelagic longline fleet, extracted from the ICCAT database.

The method was considered for application to the thornback ray population in the North Sea and Eastern Channel, for which reliable catch information is not available. However, a closer inspection of the available survey data for thornback ray (Eastern Channel/southern North Sea beam trawl survey, and quarter 1 International Bottom Trawl Survey) revealed that these data were highly variable and may not be suitable for a stock assessment model that requires information on population trends.

1.11 ICES Cooperative research report

Over the past decade considerable progress has been made as far as our knowledge of elasmobranchs, their biology, fisheries and management in the Northeast Atlantic is concerned. This is mainly due to the EU co-funded DELASS-project that was proposed and carried out by the members of the ICES Study Group on Elasmobranch Fishes, the work done for two meetings of the STECF Elasmobranch sub-group in 2002 and 2003, and the reports produced over the last years by WGEF. During the meeting in 2006 the idea was launched to write an ICES Cooperative Research Report documenting our current state of knowledge.

A proposal for the structure of the report and the format for the chapters, worked out for demersal elasmobranchs in the North Sea, were presented during the meeting. In broad lines the structure and format will resemble the current Working Group report. (Groups of) members of the Working Group will be allocated to write the text of the different chapters. It was agreed that the text will be written over the autumn of 2007 and that the editing of the report will be done by Maurice Clarke, Jim Ellis and Henk Heessen during the first half of 2008.

1.12 Working documents presented

The following working documents and presentations were supplied:

- Teresa Moura and Ivone Figueiredo: Trends in landings and effort data for deepwater sharks fishery off Portugal Mainland (Abstract only)
- Tom Williams, Michaela Aschan and Kristin Helle: Distribution of Chondrichthyan species along the North-Norwegian coast (Working Document

and presentation detailing some of the demersal elasmobranchs taken in trawling operations conducted as part of the Annual Autumn Acoustic Survey (1992-2005) in the coastal waters of the Norwegian and Barents Sea)

- Mário Rui Pinho: Rays occurrence in the Azores (ICES area Xa2) (abstract and table only)
- Peter Green: CFB Marine Sportfish Tagging Programme 1970–2006 (Powerpoint presentation only)
- Teresa Moura, Bárbara Serra Pereira and Ivone Figueiredo: Conversion factors for some elasmobranch species in Portuguese continental waters (summary graphs and equations only)
- Díez1 G., Santurtún, M., Ruiz, J., Iriondo, A., Gonzalez. I., & Artetxe, I.: The long line Basque fishery on blue shark (*Prionace glauca*) in the Bay of Biscay (1998–2006) (Working Document describing data from the Basque fishery for blue shark)
- Teresa Moura, Pedro Bordalo-Machado and Ivone Figueiredo: Trends in landings and effort data for deepwater sharks' fishery off Portugal mainland (Working Document)
- Pedro Bordalo-Machado and Ivone Figueiredo: Method for mapping skates and rays abundance in Portuguese mainland waters using bottom trawl surveys data. Case study: Thornback ray (Working Document and presentation)
- Ed Farrell: *Mustelus* spp. and their identification (Powerpoint presentation only)

1.13 References

Barry, S. C. and A. H. Welsh. 2002. Generalized additive modelling and zero inflated count data. Ecological Modelling 157, 179–188.

Battaile, B.C., Quinn II, T.J., 2004. Catch per unit effort standardization of the eastern Bering Sea walleye Pollock (*Theragra chalcogramma*) fleet. Fisheries Research 70, 161–177.

Bigelow, K. A., C. H. Boggs and X. He. 1999. Environmental effects on swordfish and blue shark catch rates in the US North Pacific longline fishery. Fisheries Oceanography 8, 178–188.

Bishop, J., W. N. Venables and Y.-G. Wang. 2004. Analysing commercial catch and effort data from a Penaeid trawl fishery. A comparison of linear models, mixed models, and generalised estimating equations approaches. Fisheries Research 70, 179–193.

Capapé, C. (1976). Contribution à la biologie des Rajidae des côtes tunisiennes III. *Raja clavata* Linné, 1758: Répartition géographique et bathymétrique, sexualité, reproduction et fécondite. Bull. Mus. Nat. Hist., 3e Ser., no. 393:907–922.

Cortés, E. 2007. Chondrichthyan demographic modelling: an essay on its use, abuse and future. Marine and Freshwater Research 58: 4–6.

Cortés, E. 2002. Incorporating uncertainty into demographic modelling: application to shark populations and their conservation. Conservation Biology 16: 1048–1062.

Cortés, E., Brooks, E., Apostolaki, P. and C.A. Brown 2006. Stock assessment of dusky shark in the U.S. Atlantic and Gulf of Mexico. Sustainable Fisheries Division Contribution SFD-2006-014, Panama City Laboratory Contribution 06-05. NMFS SE Fish. Sci. Ctr. Panama City, FL.: 155pp.

FAO. 2007. Second FAO *ad hoc* expert advisory panel for the assessment of proposals to amend Appendices I and II of CITES concerning commercially-exploited aquatic species. Rome, Italy, 26–30 March 2007.

Gallucci, V.F., Taylor, I.G. and K. Erzini 2006. Conservation and management of exploited shark populations based on reproductive value. Canadian Journal of Fisheries and Aquatic Sciences 63: 931–942.

Gavaris, S., 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Canadian Journal of Fisheries and Aquatic Science 37, 2272–2275.

Gedamke, T., Hoenig, J.M., Musick, J.A. and W.D. DuPaul 2007. Using demographic models to determine intrinsic rate of increase and sustainable fishing for elasmobranchs: pitfalls, advances and applications. North American Journal of Fisheries Management 27: 605–618.

Goñi, R., F. Alvarez and S. Adlerstein. 1999. Application of generalized linear modeling to catch rate analysis of Western Mediterranean fisheries: the Castellón trawl fleet as a case study. Fisheries Research 42: 291–302.

Hareide, N.R., J. Carlson, M. Clarke, S. Clarke, J. Ellis, S. Fordham, S. Fowler, M. Pinho, C. Raymakers, F. Serena, B. Seret, and S. Polti. 2007. European Shark Fisheries: a preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association, 59 pp.

Hastie, T., R. Tibshirani and J. Friedman. 2001. The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, 533pp.

Hilborn, R. 1990. Estimating the parameters of full age-structured models from catch and abundance data. Bull. Int. N. Pac. Fish. Commn 50: 207–213.

ICES. 2006a. Report of the Stock Identification Methods Working Group (SIMWG), By Correspondence. ICES CM 2006/LRC:12. 33 pp.

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

ICES. 2007a. Report of the Annual Meeting of Assessment related Working Group Chairs (AMAWGC), 19–23 February 2007, ICES Headquarters. Document Number. 54 pp.

ICES. 2007b. Report of the Working Group on Fish Ecology (WGFE), 5–9 March 2007, Nantes, France. ICES CM 2007/LRC:03. 217 pp.

ICES. 2007c. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 27–30 March 2007, Sète, France. ICES CM 2007/RMC:05. 195 pp.

ICES. 2007d. Report of the Workshop on Taxonomic Quality Issues in the DATRAS Database, 23–25 January 2007, ICES Headquarters. In prep.

ICES. 2007e. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 23–27 April 2007, Dublin, Ireland. ICES CM 2007/FTC:06, 197 pp.

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.

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

Martin, T. G., B. Wintle, J. Rhodes, P. M. Kuhnert, S. A. Field, S. Low Choy, A. J. Tyre and H. P. Possingham. 2005. Zero tolerance ecology: improving ecological inference by modelling the source of zero observations. Ecology Letters 8, 1235–1246.

Maunder, M.M. and Punt, A.E., 2004. Standardizing catch and effort data: a review of recent approaches. Fisheries Research 70, 141–149.

Minami, M. C. E. Lennert-Cody, W. Gao and M. Roman-Verdesoto. 2007. Modeling shark bycatch: The zero-inflated negative binomial regression model with smoothing. Fisheries Research 84, 210–221.

Nelder, J. A. and R. W. M. Wedderburn. 1972. Generalized linear models. Journal of the Royal Statistical Society, Series A. 135, 370–384.

Porch, C.E., Eklund, A.-M. and G.P. Scott 2006. A catch-free stock assessment model with application to goliath grouper (*Epinephelus itajara*) off southern Florida. Fishery Bulletin 104: 89–101.

Potts, J. M. and J. Elith. 2006. Comparing species abundance models. Ecological Modelling 199, 153–163.

Restrepo, V. R. and C. M. Legault 1998. A stochastic implementation of an age-structured production model. In Fishery Stock Assessment Models. Ed. by F. Funk, T.J. Quinn II, J. Heifetz, J.N. Ianelli, J.E. Powers, J.F. Schweigert, P.J. Sullivan and C.-I. Zhang. Alaska Sea Grant College Program Report No. AK-SG-98–01, University of Alaska Fairbanks: 435–450.

Rodr´ıguez-Mar´ın, E., Arrizabalaga, H., Ortiz, M., Rodr´ıguez-Cabello, C., Moreno, G., Kell, L.T., 2003. Standardization of bluefin tuna, *Thunnus thynnus*, catch per unit effort in the baitboat fishery of the Bay of Biscay (Eastern Atlantic). ICES Journal of Marine Science 60, 1216–1231.

R Development Core Team, 2004. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.r-project.org/.

Simfendorfer, C.A. 1998. Mortality estimates and demographic analysis for the Australian sharpnose shark, *Rhizoprionodon taylori*, from northern Australia. Fishery Bulletin 97: 978–986.

Simfendorfer, C.A. 2004. Demographic models: life tables, matrix models and rebound potential. Chapter 9. In Elasmobranch Fisheries Management Techniques. Ed. by J.A. Musick and R. Bonfil. Asia-Pacific Economic Cooperation: [x] + 370pp. Available Online: http://www.flmnh.ufl.edu/fish/organizations/ssg/EFMT2004.htm (accessed June 2007).

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

Venables, W.N., and Dichmont, C.M., 2004. GLMs, GAMs, GLMMs: an overview of theory for applications in fisheries research. Fisheries Research 70, 315–333.

2 Spurdog in the North East Atlantic

2.1 Stock distribution

Spurdog, *Squalus acanthias*, has a worldwide distribution in temperate and boreal waters. WGEF consider there to be a single North East Atlantic stock. See Section 2 of ICES (2006) for further details.

2.2 The fishery

2.2.1 History of the fishery

The peak fishery for North East Atlantic spurdog occurred in the 1960s–1980s. The development of this fishery is described in ICES (2006) and Pawson *et al*., (In press). 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 in some years the Norwegian Sea (II). Outside these areas, landings are generally low. The main exploiters of spurdog are France, Ireland, Norway and the UK.

2.2.2 The fishery in 2006

In the UK (E&W), just over 50% of spurdog landings were taken in line and net fisheries in 2006, with most landings coming from Sub-area VII and in particular the Irish Sea. Such fisheries are likely to be closer inshore and may target aggregating mature female spurdog. Recent reports from the fishing industry also indicate that fleet behaviour has been affected by rising fuel costs (ICES, 2007) with many boats fishing closer to home to reduce costs. Such behaviour may mean that there could be increased fishing effort on inshore aggregations. Most Scottish landings are taken from the northern North Sea and west of Scotland. Effort in the Scottish demersal trawl fleet is likely to have reduced in recent years due to decommissioning of vessels and days at sea regulations and therefore the effort on spurdog due to this fleet may well have been reduced, with about 45% of Scottish spurdog landings originating from demersal trawl fisheries.

The Irish fishery for spurdog mainly consists of bottom otter trawlers, with less than 30% of landings coming from line and gillnet fisheries. Most landings are reported from Division VIa and Division VIIg.

In 2007 Norway introduced measures to restrict fisheries on spurdog (see Section 2.2.4).

No information was available on French fisheries for spurdog.

2.2.3 ICES advice applicable

In 2006 ICES advised that**:**

> ‘The stock is depleted and may be in danger of collapse. Target fisheries should not be permitted to continue, and bycatch in mixed fisheries should be reduced to the lowest possible level. A TAC should cover all areas where spurdog are caught in the northeast Atlantic. This TAC should be set at zero for 2007.’

2.2.4 Management applicable

The following table summarises ICES advice and actual management applicable for northeast Atlantic spurdog during 2001–2007:

Year	Single stock exploitation boundary (tonnes)	Basis	TAC (IIa(EC) & IV) (tonnes)	TAC IIIa , I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
2001	No advice	-	8870	-	16015[1)]
2002	No advice	-	7100	-	9301
2003	No advice	-	5640	-	10426
2004	No advice	-	4472	-	6047
2005	No advice	-	1136	-	5636
2006	F=0	Stock depleted & in danger of collapse	1051	-	3002
2007	F=0	Stock depleted & in danger of collapse	841[(2)]	2828	

(1) The WG estimate of landings in 2001 may include some mis-reported 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.

New for 2007 is the bycatch quota for the North Sea TAC, where spurdog "*shall not comprise more than 5 % by live weight of the catch retained on board*". This measure is designed to prevent fisheries targeting aggregations.

Also new for 2007 is a TAC covering areas outside the EC waters of IIa and IV, covering ICES sub-areas IIIa, I, V, VI, VII, VIII, XII and XIV (EU and international waters). The TAC is set to 2828 t for 2007 (total landings for all areas except IIa & IV was 2087 t in 2006). The quota for this area is not allocated between member states, but might be in 2008.

The TAC for spurdog in the North Sea and the Norwegian Sea (IIa (EC) & IV) has been reduced annually, with the TAC in 2007 (841 t) based on a reduction of about 20% of that set in 2006.

In 2007 Norway introduced a general ban on fishing and landing of spurdog in the Norwegian economic zone and in international waters in ICES areas I-XIV. However, boats less than 28 m in length are allowed to fish for spurdog with traditional gear inshore and in territorial waters (4 nm). Spurdog caught as bycatch in other fisheries have to be landed and Fiskeridirektoratet are allowed to stop the fishery when catches reach last years level. Norway has a 70 cm minimum landing size.

2.3 Catch data

2.3.1 Landings

Total annual landings, as estimated by the WG for the NE Atlantic stock of spurdog are given in Table 2.1 and illustrated in Figure 2.1. The estimated landings for 2006 were 3000 t, compared to over 6000 t in 2004. There were some updates to officially reported data from previous years.

2.3.2 Discards

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

A recent study on the estimated short-term discard mortality of otter trawl captured spurdog in the Northwest Atlantic showed 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.

2.3.3 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 some generic dogfish landing categories, there can be some misreporting (ICES, 2006).

2.4 Commercial length frequencies

2.4.1 Landings length compositions

Length compositions were presented in ICES (2006), and no new analyses of length data from either market sampling or discard trips were undertaken.

2.4.2 Quality of data

WGEF examined length frequency data collected from UK fisheries landings (ICES, 2006), and future studies should examine any data that may also available for other fisheries involved in the spurdog fishery (e.g. from Norway, France and Ireland).

2.5 Commercial catch-effort data

No studies of commercial CPUE data were undertaken.

2.6 Research vessel surveys

2.6.1 Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. The following survey data were discussed in ICES (2006):

- English first-quarter Celtic Sea groundfish survey: years 1982–2002.
- English fourth-quarter Celtic Sea groundfish survey: years 1983–1988.
- English North Sea third-quarter groundfish survey 1977–2003.
- DARD (mainly quarter 3) Irish Sea groundfish survey 1991–2001.
- Scottish first-quarter west coast groundfish survey: years 1985–2006.
- Scottish fourth-quarter west coast groundfish survey: years 1985–2005.
- Scottish first-quarter North Sea groundfish survey: years 1985–2006.
- Scottish third-quarter North Sea groundfish survey: years 1985–2005.

Further examination of IBTS data will be conducted in future meetings of WGEF. Both Ireland and UK (England and Wales) now participate in the fourth quarter westerly IBTS surveys, and preliminary studies of these data will be undertaken in 2009.

2.6.2 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 (Figure 2.2), with catch rates also decreasing, although catch rates are highly variable (ICES, 2006). 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.

2.6.3 Length distributions

No new information were presented.

2.7 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 Northeast 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 grams.

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 74cm (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 = 0.4312.L – 32.146 (n=179; Ellis unpublished)

Natural mortality is 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.

2.8 Exploratory assessment models

2.8.1 Previous assessments

No new assessments were conducted in 2007. Exploratory assessments undertaken in 2006 included a delta-lognormal GLM-standardised index of abundance and a population dynamic model. Preliminary results from this model confirmed 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).

Models developed in earlier studies of WGEF could be better 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).

Earlier meetings of SGEF and WGEF have attempted to undertake assessments of NE Atlantic spurdog. The methods employed during the 2002 SGEF meeting (ICES, 2002) and DELASS project (Heessen, 2003) included catch curve analysis and separable VPA using length distributions sliced according to growth parameters from the scientific literature, and a Bayesian assessment using a stock production model, with a prior for the intrinsic rate of increase set by demographic methods.

2.8.2 Simulation of effects of maximum landing length regulations

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

Preliminary simulation studies of various Maximum Landing Length (MLL) scenarios were undertaken by ICES (2006), although better estimates of discard survivorship from various commercial gears are required to better examine the efficacy of such measures.

2.9 Quality of Assessments

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

2.9.1 Catch data

The WG has provided estimates of total landings of Northeast Atlantic spurdog and has used these, together with UK length frequency distributions in the assessment described above. However, there are still concerns over the quality of these data due to:

- uncertainty in the historical level of catches due to landings being reported by generic dogfish categories
- uncertainty over the accuracy of the landings data due to species mis-reporting
- lack of commercial length frequency information for countries other than the UK
- low levels of sampling of UK landings and lack of length-frequency data in recent years
- lack of discard information

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 due to the typically highly skewed distribution of catch-per-unit effort

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

2.10 Reference points

No reference points have been proposed for this stock.

2.11 Management considerations

Perception of state of stock

All analyses presented in previous reports of WGEF have indicated that the NE Atlantic stock of spurdog has been declining rapidly and is at 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 small fraction of its virgin biomass (< 10%).

In addition, spurdog are less frequently caught in groundfish surveys than they were 20 years ago, and the preliminary analysis of Scottish survey data presented in 2006 (and in Dobby *et al.*, 2005) indicate significant declines in catch-rate (> 75% decline in CPUE since 1985). Input data are too limited to give an accurate estimate of current stock status in terms of absolute biomass and fishing mortality, but the illustrated trends in the stock biomass are undeniable.

Stock distribution

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

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. There should be a single TAC area.

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 long-line 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 high proportion of mature females should be strictly regulated. Additional management measures which would deter the targeting of mature females could include, for example a maximum landings length (MLL). See Section 2.10 of ICES (2006) for simulations on MLL.

North Sea fisheries are, from 2007, also regulated by a bycatch quota, and spurdog should not comprise more than 5% by live weight of the catch retained on board.

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.

While 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.

2.12 References

Aasen, O. 1964. The exploitation of the spiny dogfish (*Squalus acanthias* L.) in European waters. Fiskeridir. Skr. Ser. Havunders., 13(7): 5–16.

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

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

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

Fahy, E. 1989. The spurdog *Squalus acanthias* (L.) fishery in south-west Ireland. Ir. Fish. Invest. Part B: Mar., 32: 22 pp.

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

Henderson, A.C., Flannery, K., Dunne, J. 2001. Growth and reproduction in spiny dogfish *Squalus acanthias* L. (Elasmobranchii: Squalidae), from the west coast of Ireland. Sarsia, 87(5): 350–261.

Holden, M. J. 1968. The rational exploitation of the Scottish-Norwegian stock of spurdogs (*Squalus acanthias* L.). Fishery Investigations, Series II, 25(8), MAFF, London, 27 pp.

Holden, M. . and Meadows, P. S. 1962. The structure of the spine of the spurdog fish (*Squalus acanthias* L.) and its use for age determination. Journal of the Marine Biological Association of the United Kingdom, 42: 179–197.

Heessen, H.J.L. (Ed.) 2003. Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 603 pp.

ICES. 2002. Report of the Study Group on Elasmobranch Fishes. ICES CM 2002/G:08, 119 pp.

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

ICES. 2007. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 23–27 April 2007, Dublin, Ireland. ICES CM 2007/FTC:06, 197 pp.

Jones, T. S. and Ugland, K. I. 2001. Reproduction of female spiny dogfish, *Squalus acanthias*, in the Oslofjord. Fish. Bull., 99: 685–690.

Mandelman, J. W., and Farrington, M. A. 2006. The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*). Fisheries Research 83: 238–245.

Pawson, M. G., Ellis, J. R. and Dobby, H. (in press) The evolution and management of spurdog *Squalus acanthias* fisheries in the North-East Atlantic. In: Management and Biology of Dogfish Sharks, Proceedings of the fi rst International Symposium. American Fisheries Society Symposium.

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

Sosinski, J. 1977. Polish investigations on the Scottish Norwegian spurdog (*Squalus acanthias*) in 1974. Ann. Biol., Copenhagen, 32: 178–179.

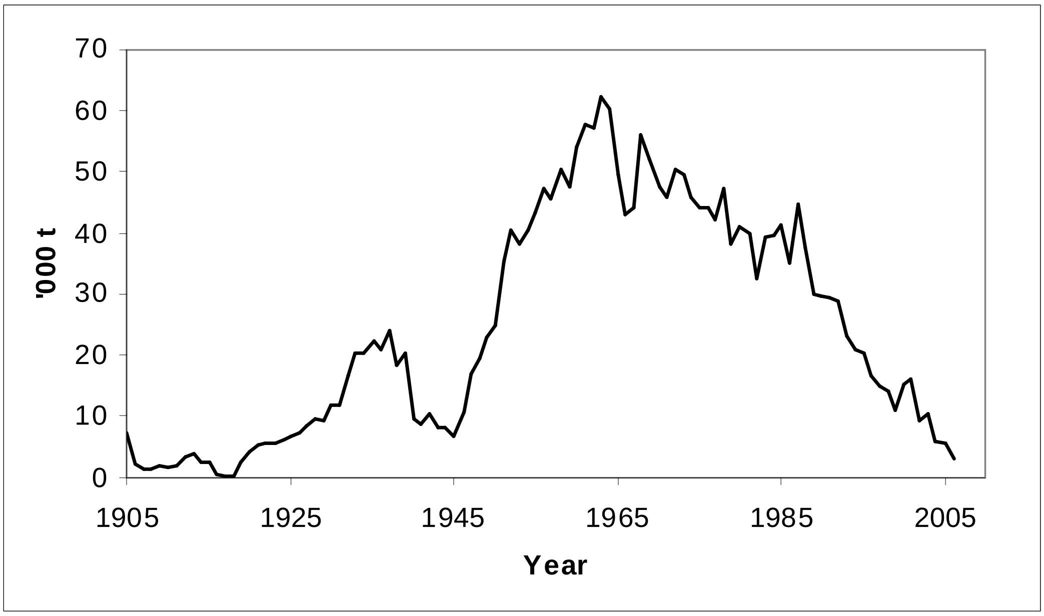
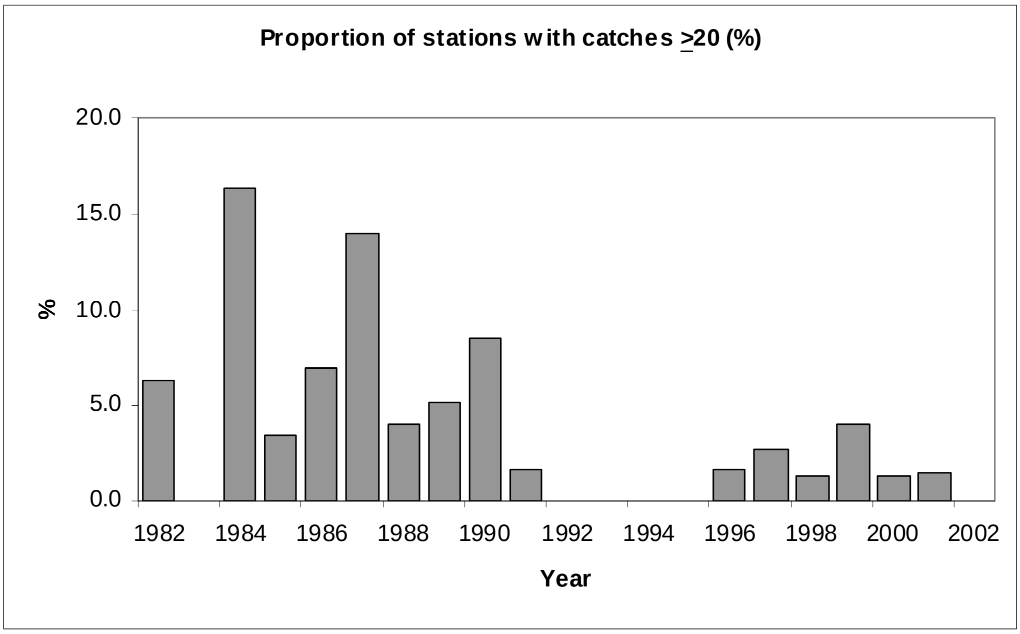


Figure 2.1. Northeast Atlantic spurdog. WG estimates of total international landings of NE Atlantic spurdog (1905–2006).



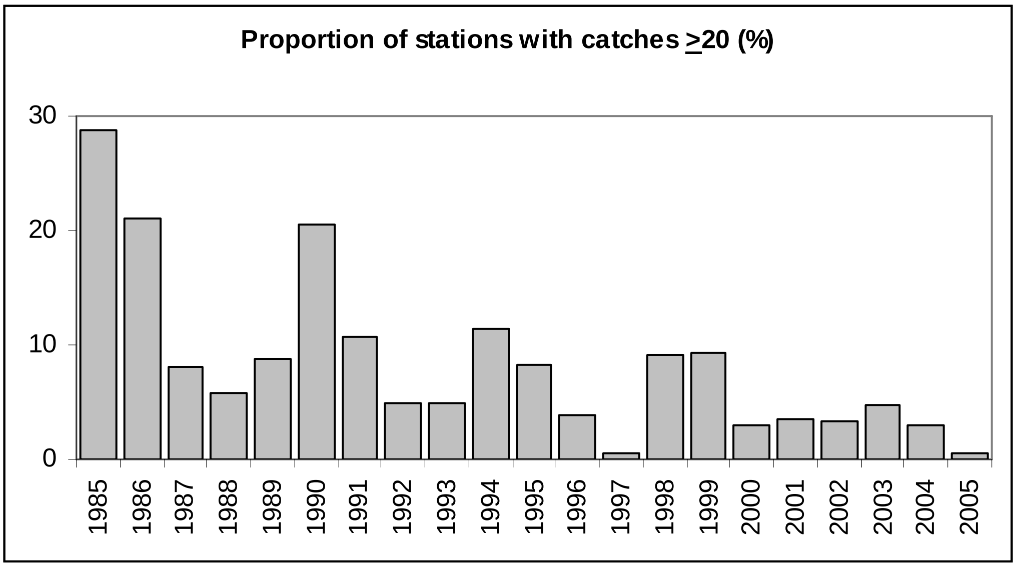


Figure 2.2. Northeast Atlantic spurdog. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast survey (Q1, 1985–2005, bottom) in which CPUE was ≥ 20 ind.h^{-1}. (Source: ICES, 2006).

Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2006).

Year	Landings (Tonnes)	Year	Landings (Tonnes)	Year	Landings (Tonnes)
1947	16893	1967	44116	1987	44898
1948	19491	1968	56043	1988	37730
1949	23010	1969	52074	1989	30204
1950	24750	1970	47557	1990	29874
1951	35301	1971	45653	1991	29447
1952	40550	1972	50416	1992	28819
1953	38206	1973	49412	1993	23159
1954	40570	1974	45684	1994	21034
1955	43127	1975	44119	1995	20245
1956	46951	1976	44064	1996	16707
1957	45570	1977	42252	1997	14957
1958	50394	1978	47235	1998	14088
1959	47394	1979	38201	1999	11200
1960	53997	1980	40943	2000	15533
1961	57721	1981	39961	2001	16015
1962	57256	1982	32402	2002	9301
1963	62288	1983	39386	2003	10426
1964	60146	1984	39449	2004	6047
1965	49336	1985	41126	2005	5636
1966	42713	1986	35098	2006	3002

3 Deepwater "siki" sharks in the northeast Atlantic (IV–XIV)

3.1 Stock distribution

A number of species of deepwater sharks are exploited in the ICES area. This section deals with *Centrophorus squamosus* and *Centroscymnus coelolepis*, which are of greatest importance to commercial fisheries.

For the purposes of this section, the term "siki" is used to describe the combination of leafscale gulper shark and Portuguese dogfish. Although these species have very differing biological traits, it has been necessary for ICES to combine them for assessment purposes. This is because landings data for both species were combined for some of the main countries for most of the time since the beginning of the fishery. The term "siki" as used here does not have the same meaning as in commercial fisheries, where it encompasses all commercially exploited deepwater sharks.

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 shows 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.). In the absence of more clear information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

Portuguese dogfish (*Centroscymnus coelolepis*) is widely distributed in the Northeast Atlantic. Stock structure and its dynamics are poorly understood. Specimens below 70 cm have been very rarely recorded in the NE Atlantic. There is a lack of knowledge on 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.

In the absence of more clear information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted. This does not consider that the biology and available information on distribution of these two species is different. However in the absence of better data, it is the best approach possible.

3.2 The fishery

3.2.1 History of the fishery

Fisheries taking these species were described extensively in ICES (2006), and little new information is available in 2007. STECF (2006) presented a review of available information on deepwater shark gillnet fisheries.

3.2.2 The fishery in 2006

C. squamosus and *C. coelolepis* are both taken in several mixed trawl fisheries in the northeast Atlantic and in mixed and directed longline and gillnet fisheries.

It is known that a new gillnet and longline fisheries developed in Subarea VIII and Division IXb in 2006 (Table 3.3). This represents a displacement of effort from VI and VII, due to the ban on gillnet fishing in those areas. Reported landings are about 250 t, from UK registered vessels. In Subarea VIII the main species landed by this fishery were deep-water-sharks (23 tons) and the deep-water crab (*Chaceon* spp.) 22 tons. In Subarea IX the most important species landed were deep-water crab (283 tons) and several deep-water sharks (135 tons, plus 31 tons of livers and oil).

3.2.3 ICES advice applicable

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 are depleted. CPUE for both species in the northern area have displayed strong downward trends leading to the conclusion that the stocks were being exploited at unsustainable levels. In Division IXa, CPUE series, although short, appear to be stable.

In 2006, ICES advised that no target fisheries should be permitted unless there are 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 bycatch of Portuguese dogfish and leafscale gulper shark in fisheries targeting other species.

3.2.4 Management applicable

In 2007, the TAC for deepwater sharks in Sub-areas V, VI, VII, VIII and IX is 2,472 t. In 2008, the TAC for these species in these areas will be reduced to 1646 t. In 2007 and 2008, the TAC for deepwater sharks is set at 20 t annually in Sub-area X, and 99 t in Sub-area XII. These TACs apply to the following list of species: Portuguese dogfish (*Centroscymnus coelolepis*), leafscale gulper shark (*Centrophorus squamosus*), birdbeak dogfish (*Deania calceus*), kitefin shark (*Dalatias licha*), greater lanternshark (*Etmopterus princeps*), velvet belly (*Etmopterus spinax*), black dogfish (*Centroscyllium fabricii*), gulper shark (*Centrophorus granulosus*), blackmouth dogfish (*Galeus melastomus*), mouse catshark (*Galeus murinus*), Iceland catshark (*Apristurus* spp.). In Subarea X, *Deania hystricosum* and *Deania profundorum* are also on this list.

A number of effort regulations apply to these deepwater 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 deepwater species. Council Regulation (EC) No 27/2005 set a limit of effort (killowat*days) at 90% the 2003 level for 2005, and in at 80% for 2006.

Council Regulation 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 Sub-area XII. A maximum bycatch of deepwater shark of 5% is allowed in hake and monkfish gillnet catches. This ban does not cover Sub-areas VIII or IX. In 2006, the ban on gillnetting originally applied to waters deeper than 200 m, but this was revised to 600 m, in 2007.

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

In 2006, STECF reviewed deepwater gillnet fisheries, including those targeting deepwater sharks. STECF recommended the maintenance of the closure of shark gillnetting, and to permit hake and monk netting in waters shallower than 600 m. The 600 m depth limit was considered best to avoid the main deepwater shark species being caught.

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 Table 3.1. In 2006, WGEF produced estimates of landings of each of these species. This has not been updated for the most recent year, but will be conducted again at the next benchmark assessment.

It can be seen that landings have declined from around 10 000 t from 2001 to 2004, to about 2000 t in 2006 (Figures 3.1 and 3.2). The decline is due partly to the quota restrictions. Another reason is the gillnet bans, and it can be seen that the proportion of international landings from the gillnet fishing countries (UK and Germany) have declined. Recent landings are the lowest since the fishery reached full development in the early 1990s and much lower than TACs available (7100 t).

3.3.2 Discarding

In the early years of the fishery, discarding was thought to be negligible in the majority of trawl and longline fisheries although some discarding may have occurred in the first years before markets were fully developed.

However, with the quotas for deepwater sharks becoming restrictive, it is likely that discarding has increased. Discarding can be expected to be greatest where there are relatively high TACs for other species caught along with deepwater sharks. In northern areas, discarding is considered to be lower, because shark abundance in mixed fisheries is much lower in recent years. In southern areas, where shark abundance is relatively stable, it may be expected that discarding has increased, due to restrictive quotas for sharks.

Between 2001 and 2004, Irish trawlers have discarded their entire catch of leafscale gulper sharks. This was based on crew preferences, not market factors.

Some discarding of rotten deepwater sharks, due to excessive soak times, has been recorded in gillnet fisheries (STECF, 2006).

3.3.3 Quality of the catch data

Historically, much of the catch data were aggregated. Although many nations have improved species-specific reporting of landings in recent years, some of these data may contain mis-identifications.

There are no reliable estimates of levels of misreporting of these species but it is believed to be a minor problem. Immediately prior to the introduction of quotas for deepwater species in 2001, it is believed that some vessels may have logged deep-water sharks as other species in an effort to build up track record. It is 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 under-reporting has occurred. It can be expected that some vessels with restrictive quotas for deepwater fish may misreport more valuable species as deepwater sharks.

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

3.4 Commercial catch composition

3.4.1 Species composition

Of the main fishing countries, only Portugal provides reliable species-specific landings data. For other states' data, WGEF, in 2006, estimated the proportions of these species based on ratios. These estimates suggest little difference in the landings of either species from 1990 to 1998, and since 2004. From 1998 to 2004, Portuguese dogfish predominated, suggesting fishing in progressively deeper waters. In recent years (2001 onwards) smaller squaloid sharks have been retained. Some of these landings are reported in Section 5.

3.4.2 Length composition

No new information since 2006.

3.4.3 Quality of catch and biological data

WGEF finds it difficult to quantify landings data when MS report data for both live weight and for livers. This potentially can lead to duplication of data and over estimation of landings. WGEF asks all MS to explain how landings of livers are raised to total live weight, and to report if duplication could be happening.

3.5 Commercial catch-effort data

In 2006, WGEF summarized all the available CPUE series (see Figures 3.3–3.5). RGWGEF noted that the time series of CPUE for IXa was short. Therefore, in 2007, new information was available from Portuguese longline fisheries in Sub-area IX (Moura *et al.*, 2007 WD). Two series of landings, effort and unstandardised lpue were presented, one representing fishing trips from vessels landing more than 1 t, the other, for vessels landing more than 10 t. Further analyses of these data will be undertaken next year.

3.6 Fishery-independent surveys

See section 5.6.

3.7 Life-history information

No new information since 2006.

3.8 Commercial catch-effort data

No new assessments were conducted in 2007.

3.9 Quality of assessments

No new assessments were conducted in 2007.

3.10 Reference Points

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

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.

CPUE of both species has shown a strong decline in northern areas (sub-areas V, VI, VII and XII). WGEF has made great progress in clarifying this trend. In Subarea IX, CPUE appears to be stable, and new data available in 2007, shows a relatively stable pattern over the entire history of the Portuguese fishery, since 1989.

The ban on gillnetting in VI and VII has led to some diversion of effort to VIII and IX and also to West Africa. These landings from IXb, are in a new, previously unexploited area. WGEF expresses concern that new fisheries are developing in VIII and IXb, without prior evaluation of sustainable catches having been carried out.

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

3.12 References

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

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

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

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

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

Moura, T.,Figueiredo, I., Neves, A., Farias, I., Pereira, B. S. and Reproductive data on Portuguese dogfish *Centroscymnus coelolepis*, shark *Centrophorus squamosus* and gulper shark *Centrophorus granulosus* exploited in the Portuguese continental slope. Working Document.

Rihan, D., Muligan, M., Hareide, N.-R. 2005. Irish gillnet retrieval survey for lost gear MFV India Rose Rockall & Porcupine Bank, August 8th–September 3rd, 2005.

STECF, 2006. Report of the STECF working group on deep-sea gillnet fisheries. Commission Staff Working Paper. 52 pp.

Table 3.1. Deepwater "siki" sharks in the northeast Atlantic. 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	2003	2004	2005	2006
IV a	.	12	8	10	140	63	98	78	298	227	81	55	1	3	10	16	5	4	4
Va	.	.	.	.	1	1	.	.	.	.	5	.	1	.	.	.	.	.	.
Vb	.	.	140	75	123	97	198	272	391	328	552	469	410	475	215	300	229	239	192
VI	.	8	6	1013	2013	2781	2872	2824	3639	4135	4133	3471	3455	4459	3086	3855	2754	1102	624
VII	.	.	.	265	1171	1232	2087	1800	1168	1637	1038	895	892	2685	1487	3926	3477	842	323
VIII	.	.	6	70	62	25	36	45	336	503	605	531	361	634	669	746	674	376	208
IX	560	507	475	1075	1114	946	1155	1354	1189	1311	1220	972	1049	1130	1198	1180	1125	1033	1325
X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
XII	.	.	.	1	2	7	9	139	147	32	56	91	890	719	1416	849	767	134	.
XIV	.	.	.	.	.	.	.	.	.	9	15	.	.	.	12	4	.	.	.
Unknown Area	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1323	34
	560	527	635	2509	4626	5152	6455	6512	7168	8182	7705	6484	7059	10105	8093	10876	9031	5054	2710

Table 3.2. Deepwater "siki" sharks in the northeast Atlantic. Working group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) by country.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	.	.	140	1288	3104	3468	3812	3186	3630	3095	3177	3079	3519	3684	2103	1454	1189	866	726
UK (Scotland)	.	20	14	24	165	469	743	801	576	766	1007	625	623	2429	1184	1594	1135	802	184
UK (England and Wales)	.	.	.	104	80	174	387	986	1036	2202	1494	1019	413	320	335	4027	3610	1533	537
Ireland	.	.	.	.	.	.	.	33	5	.	3	2	138	454	577	493	764	381	113
Iceland	.	.	.	.	1	1	.	.	.	.	5	.	.	.	.	.	.	.	.
Spain (Basque C)	.	.	.	.	.	.	.	.	286	473	561	450	280	608	621	719	563	359	78
Portugal	560	507	481	1093	1128	946	1155	1354	1189	1314	1260	1036	1108	1151	1198	1180	1125	1033	1072
Germany	.	.	.	.	148	91	358	92	164	106	40	214	265	431	518	640	NA	79	.
Estonia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	53	4	.	.	.
Lithuania	.	.	.	.	.	.	.	.	.	.	.	.	.	14	40	28	.	.	.
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.
Spain (Gallicia)	.	.	.	.	.	.	.	.	.	.	.	.	572	615	1381	737	626	NA	NA
Faroe Island	.	.	.	.	.	3	.	60	282	226	158	54	23	NA	NA	NA	NA	NA	NA
Norway	.	.	.	.	.	.	.	.	.	.	.	5	118	399	75	.	19	.	.
Total	560	527	635	2509	4626	5152	6455	6512	7168	8182	7705	6484	7059	10105	8093	10876	9031	5053	2710

Table 3.3. Deepwater "siki" sharks in the northeast Atlantic. Landings by species, gear and area for UK fishery in deepwaters of VIII and IX.

		2005	2006	
Species	Gear	VIII	VIII	IX
Alfonsino (Beryx)	Nets		3	
Bairds Smoothhead	Nets		14	
Birdbeak dogfish	Nets		0,2	4
Bluemouth redfish	Nets		8	
Conger eels	Bottom trawl	1		
	Lines	76	72	
	Nets	1	2	
Deepwater red crab	Nets		22	283
	Pots			6
Dogfish (scyliorhinidae)	Bottom trawl	3		
Greater forkbeard	Bottom trawl	0,01		
	Lines	0,03		
Gulper shark	Nets		0,1	9
Kitefin shark	Nets		0,1	4
Leafscale gulper shark	Nets		2	3
Ling	Bottom trawl	0,02		
	Lines	17	30	
	Nets	1	15	
Livers and oils	Lines			
	Nets		3	31
	Pots			1
Longnose velvet dogfish	Lines			13
	Nets		17	82
Portuguese dogfish	Lines			1
	Nets		1	17
Sea breams	Lines		0,1	
	Nets		0,03	
Unidentified sharks	Nets		1	1

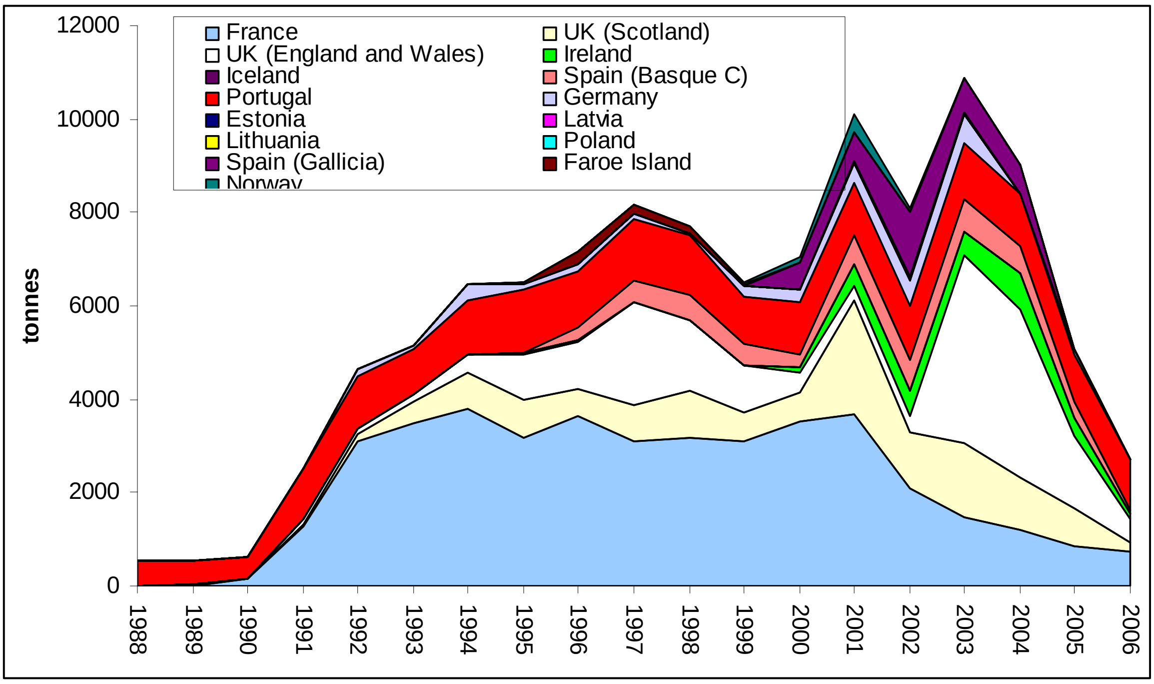


Figure 3.1. Deepwater "siki" sharks in the northeast Atlantic. Working group estimates of landings, by country.

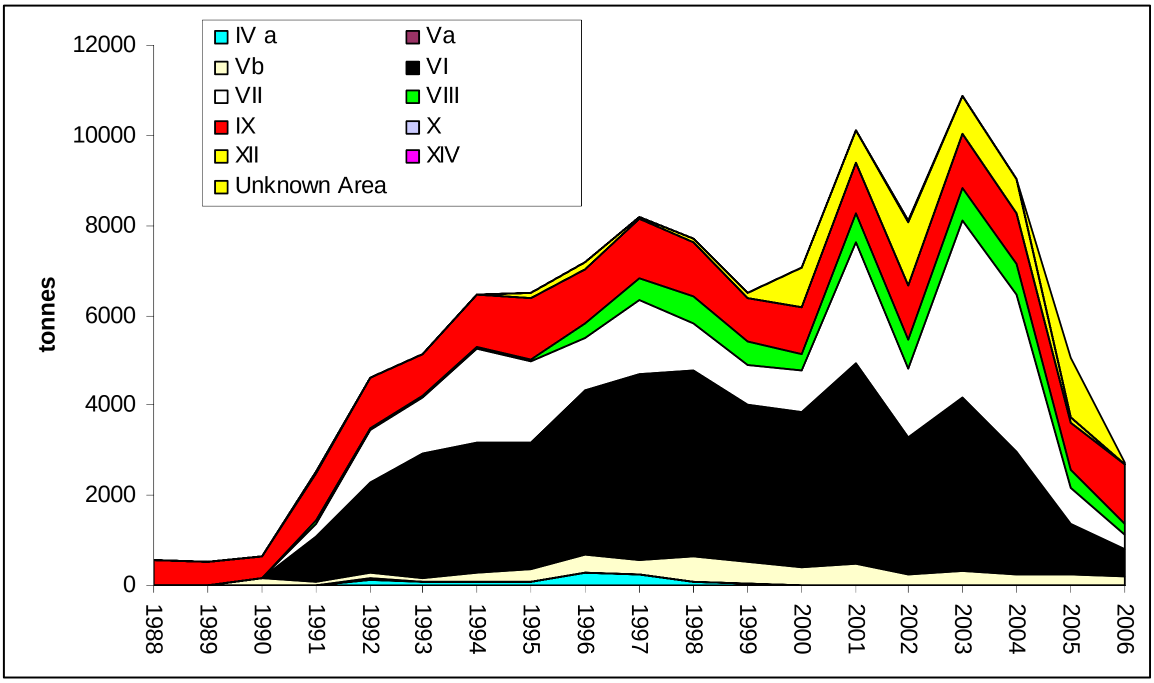


Figure 3.2. Deepwater "siki" sharks in the northeast Atlantic. Working group estimates of landings, by ICES Subarea.

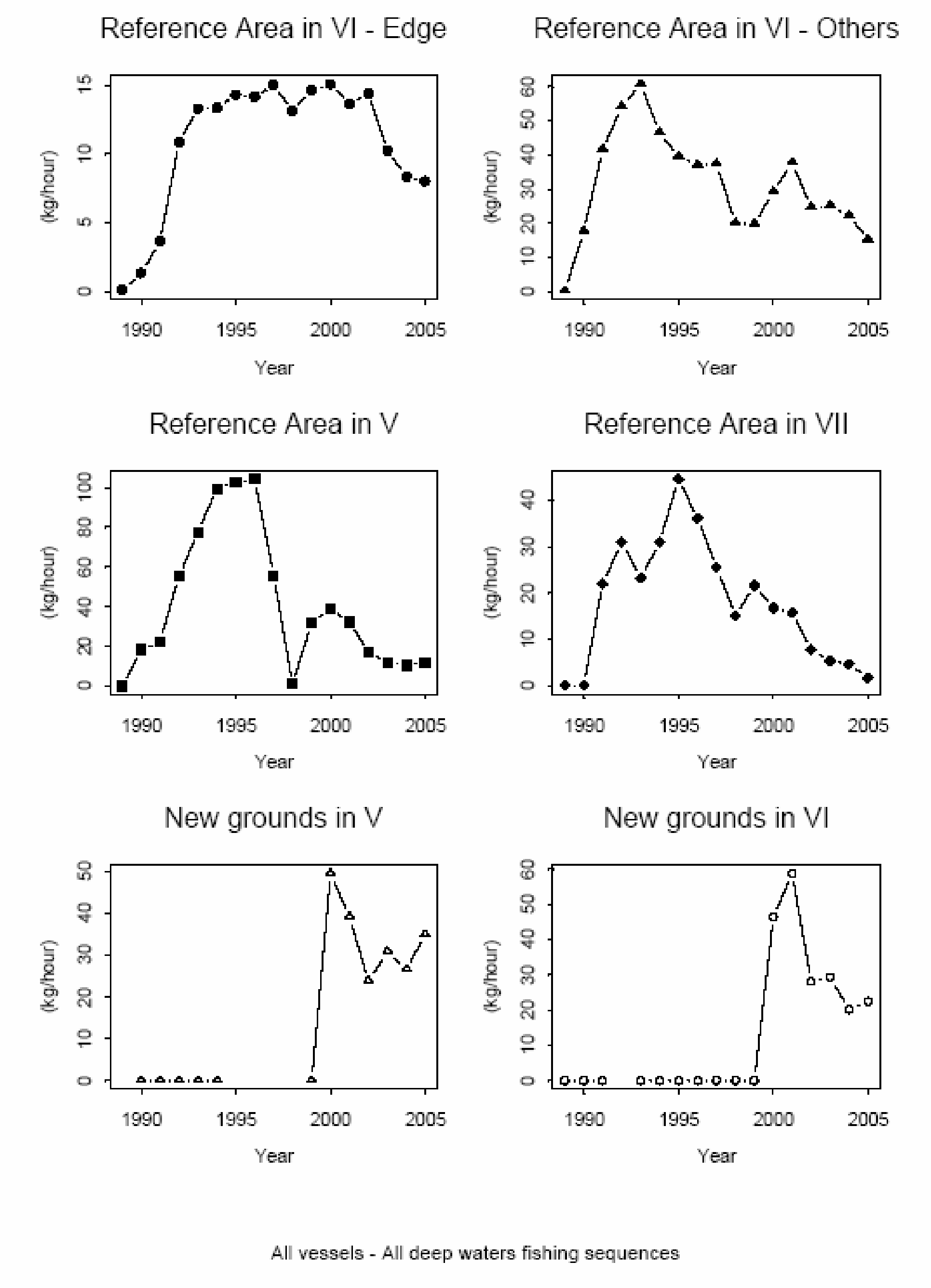


Figure 3.3. Deepwater "siki" shark in the northeast Atlantic. French CPUE of "sikis" by ICES Subarea (Biseau, 2006 WD)

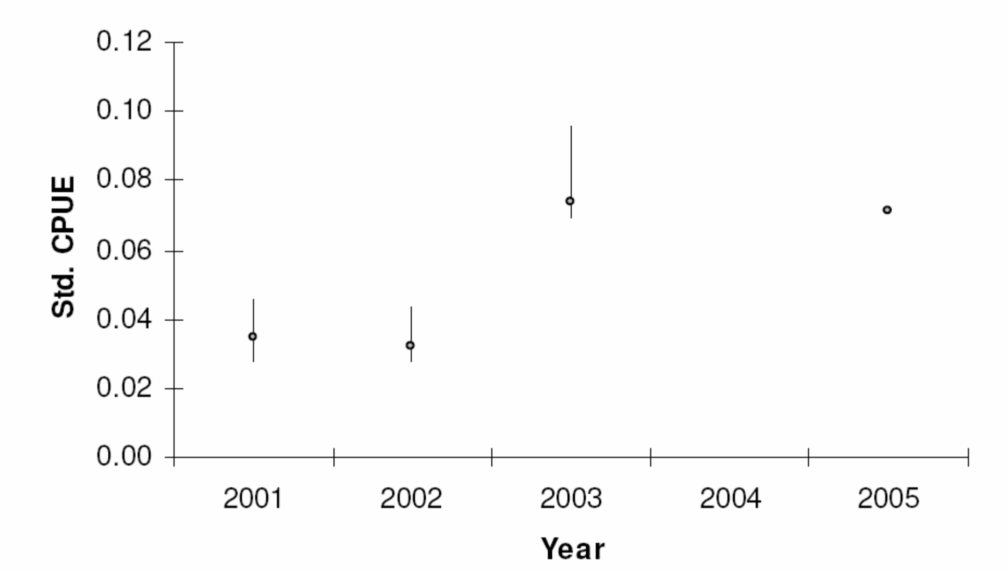


Figure 3.4. Deepwater "siki" shark in the northeast Atlantic. Portuguese dogfish, Portuguese longline standardized and unstandardized CPUE values from ICES Subarea IX (Figueiredo and Machado, 2006 WD)

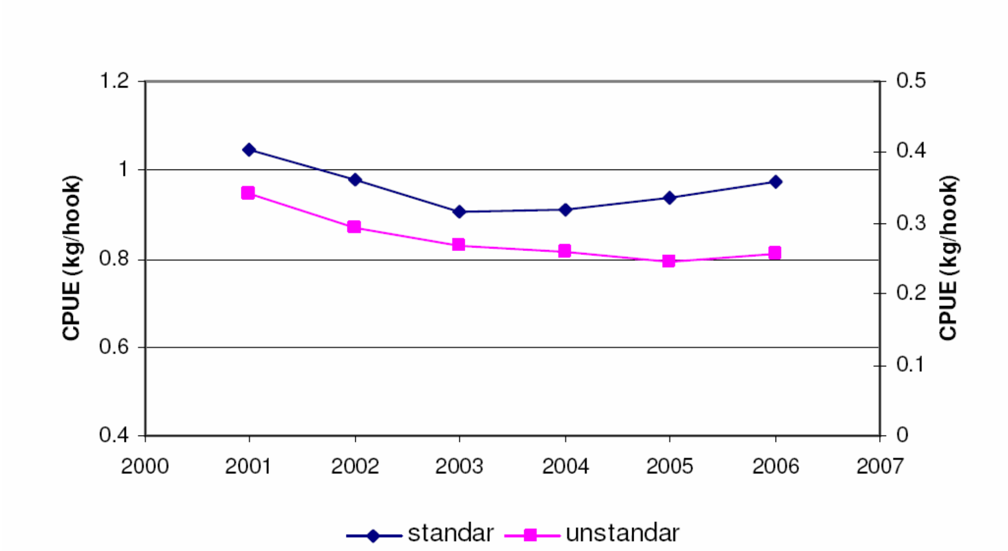


Figure 3.5. Deepwater "siki" shark in the northeast Atlantic. Leafscale gulper shark, Portuguese longline standardized median CPUE values (+/- 75 and 25 % percentiles) from ICES Subarea IX (Figueiredo and Machado, 2006 WD)

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

4.1 Stock distribution

Kitefin shark *Dalatias licha* is widely distributed in deeper waters of the North Atlantic (from Norway to north-western Africa and the Gulf of Guinea, including the Mediterranean, and Northwest Atlantic). Stock identity of kitefin shark in NE Atlantic is unknown. However the resource seems to be more abundant in the south area of the Mid Atlantic Ridge (ICES Area X).

Elsewhere in the NE Atlantic, kitefin shark is recorded infrequently. Kitefin shark has a low abundance in Sub-areas V–VII. It is caught as bycatch in mixed deepwater fisheries in these areas, though in much lower abundance than the main deepwater sharks (Section 3), and the species composition of the landings is not accurately known.

For the assessment purpose 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 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 fishery in 2006

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

Kitefin from the Azores is now a bycatch from different deep-water fisheries, with landings in 2004–2006 period less than about 15 t.

4.2.3 ICES Advice applicable

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”.

4.2.4 Management applicable

Deepwater 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 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.

4.3 Catch data

4.3.1 Landings

The catches reported from each country, for the period 1988 to 2006 are given in Table 4.1 and total historical catches from 1972 to 2005 in Figure 4.1.

While the UK (E&W), France and Ireland have official reported landings of kitefin shark in these areas, it is considered by the group that these have been misidentified, and are more likely to be either Portuguese dogfish or leafscale gulper shark.

4.3.2 Discards

Three individuals were recorded as bycatch in Irish horse mackerel fisheries in ICES Subarea VIIc at 300m depth.

4.3.3 Quality of catch data

Deepwater 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 deepwater sharks. Official landings come exclusively from the commercial first sale of fresh fish on the auctions. Landings that are not sold on the auctions, as the frozen or processed fish, are not taken in account on the statistics provided to ICES. In some areas it is known that some additional Azorean catches are not contained in the reported data. Therefore, data in Table 4.1 are 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 10 years), because the survey is not designed for the species, and will not provide reliable indices of relative abundance (Pinho, 2005).

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 (age 6).

4.8 Exploratory assessment models

4.8.1 Previous assessments of stock status

Stock assessments of kitefin shark were made during the 80s, using 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 hand lines 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 BMSY.

4.8.2 Stock Assessment

No new assessment of the species status was not done during this WGEF 2007 meeting, since no new data were available.

4.9 Quality of assessments

No new assessments were undertaken. Commercial data need to be examined in relation to the price of liver oil.

4.10 Reference points

In common with other deepwater 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. 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 fishery was to be established it should be accompanied by a scientifically robust experimental fishery.

4.12 References

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

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

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

Pinho, M. R. 2005. Elasmobranchs of the Azores. WGEF 2005 working document.

Silva, H. M. da 1987. An assessment of the Azorean stock of Kitefin Shark, *Dalatias Licha*. ICES Copenhagen.

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

COUNTRY	SUB-AREA	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
France	VII	.	.	.	.	.	.	.	.	.	.	.
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 4.1. continued Kitefin shark in the Northeast Atlantic. Working group estimates of landings (t) of Kitefin Shark *Dalatias licha.*

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

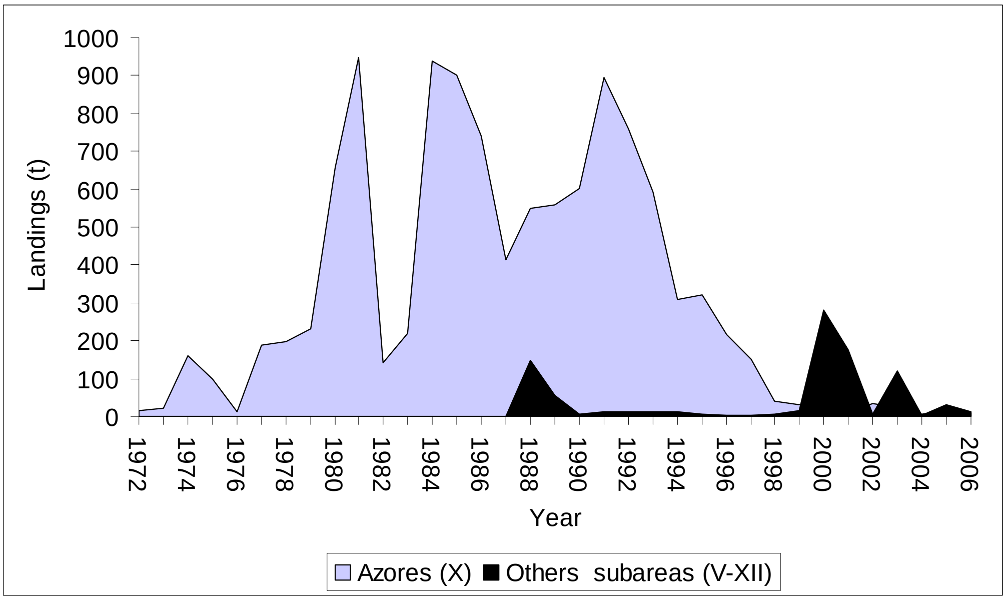


Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin by ICES statistical areas.

5 Other deepwater 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, leafscale gulper shark and kitefin shark. In general, these species have lower commercial value than the species dealt with in the previous sections. Little information exists on the majority of the species presented here other than annual landings data for some species, which are probably incomplete.

The species and generic landings categories for which landings data are presented are: Gulper shark (*Centrophorus granulosus*), birdbeak dogfish (*Deania calceus*), longnose velvet dogfish (*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 *Centroscyllium fabricii, Centroscymnus 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*), spinetail 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* and *Leucoraja fullonica* may occur in deep-water, but their main areas of distribution extend to continental shelf waters and they are not considered in this section.

5.2 The fishery

5.2.1 History of the fishery

Most catches of other deepwater shark and skate species are taken in mixed trawl, longline and gillnet fisheries together with Portuguese dogfish, leafscale gulper shark and deep-water teleost species. These fisheries were described in some detail in Section 3 of ICES (2005) and updated in Section 3 of this report.

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. In 2006, UK gillnetters targeted Portuguese dogfish and leafscale gulper sharks in Sub-Area VIII & IX with a bycatch of gulper shark, birdbeak dogfish and longnose velvet dogfish (Table 3.3). 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 & XIV:

Several species of deep-water shark and skate are caught as bycatch in mixed deep-water trawl fisheries in sub areas 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 have increasingly been 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.

5.2.2 The fishery in 2006

Targeted gillnet and longline fisheries for deepwater sharks formerly operated in Sub-Areas VI and VII. The principal target species were Portuguese dogfish and leafscale gulper sharks, with a bycatch of gulper shark, birdbeak dogfish and longnose velvet dogfish. Since 2007, setting of gillnets at depths greater than 600 m has been banned-this may have led to an increase in longlining for these species and has certainly led to displacement of gillnetting effort to Sub-Areas IV, VIII & IX (see STECF 2006).

5.2.3 ICES advice applicable

ICES advice on deepwater sharks mainly relates to the species mentioned in Section 3 and kitefin shark (Section 4). No specific advice has been 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 (*Centroscymnus coelolepis*), Leafscale gulper shark (*Centrophorus squamosus*), Birdbeak dogfish (*Deania calceus*), Kitefin shark (*Dalatias licha*), Greater lanternshark (*Etmopterus princeps*), Velvet belly (*Etmopterus spinax*), Black dogfish (*Centroscyllium fabricii*), Gulper shark (*Centrophorus granulosus*), Blackmouth dogfish (*Galeus melastomus*), Mouse catshark (*Galeus murinus*), Iceland catshark (*Apristurus spp.*). In Subarea XII, *Deania hysticosum* and *Deania profundorum* are added to this list.

In 2007, the TAC for deepwater sharks in Sub-areas V, VI, VII, VIII and IX is 2,472 t. In 2008, the TAC for these species in these areas will be reduced to 1,646 t. In 2007 and 2008, the TAC for deepwater sharks is set at 20 t annually in Sub-area X and 99 t in Sub-area XII.

No TACs apply to deepwater skates.

5.3 Catch data

5.3.1 Landings

Gulper shark *Centrophorus granulosus*

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

The trend of Portuguese landings in Subarea IX reflects the activity of the target longline fishery mentioned above. The Portuguese landings from Subarea X are considered underestimated since the species is mainly discarded (Pinho, 2005, 2006). Other countries reported very small landings from Sub-areas VI and VII since 2002. Reported landings of this species by UK vessels in Sub areas VI and VII are considered to be misidentified leafscale gulper sharks.

Birdbeak dogfish *Deania calceus*

Reported landings of birdbeak dogfish are presented in Table 5.2. Four European countries have reported landings of birdbeak dogfish: UK (England and Wales, and Scotland), Spain and Portugal.

The Portuguese landings from subareas IX and X are considered underestimated since the species is mainly discarded. The majority of Spanish landings are from sub-area XII, where values have been decreasing. No Spanish data are available for 2004.

Longnose velvet dogfish *Centroscymnus crepidater*

Reported landings of longnose velvet dogfish are presented in Table 5.3. Five European countries have reported landings: UK (England and Wales, and Scotland), France, Spain and Portugal.

Landings in 2005 were highest recorded, largely due to the inclusion of catches from UK gillnetters. France reported landings from almost every sub-area/ division considered, however, the figures were very low. Spain presented annual values of over 50 tonnes/year in Sub-area XII in 2000 and 2001, but after that no data were made available. The Portuguese landings from Sub-Areas IX and X are considered underestimated since the species is mainly discarded.

Black dogfish *Centroscyllium fabricii*

Reported landings of Black dogfish are presented in Table 5.4. Four European countries have reported landings: UK (England and Wales), Iceland, France and Spain.

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 on the species have decreased from about 400 tonnes in 2001 to 35 tonnes in 2006. These landings are mainly from Division Vb and Subarea VI. Iceland reported very few landings, all from Division Va. The largest annual landings reported by Spain came from Subarea XII in 2000 (85 Tonnes) and 2001 (91 Tonnes).

Landings of this species may also be included in the grouped category “Aiguillat noir” and other mixed categories including siki sharks.

Velvet belly *Etmopterus spinax*

Reported landings of velvet belly are presented in Table 5.5. Three European countries have reported landings of velvet belly: Denmark, UK (England &Wales) and Spain.

Greatest landings are from Denmark. Landings began in 1993, peaked in 1998 at 359 tonnes and have since declined to under 10 tonnes.

Lantern sharks ”nei” (*Etmopterus* spp)

Reported landings of lantern sharks “nei” are presented in Table 5.7. Three European countries have reported landings: France, Spain and Portugal.

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

French landings began in 1994, peaked at 3000 tonnes in 1996 then declined to less than 10 tonnes by 1999. There is doubt as to whether these landings are actually of this species and further investigation will be required in 2008. Spanish landings began in 2000, peaked at over 300 tonnes in 2002. 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.

Blackmouth dogfish *Galeus melastomus*

Reported landings of blackmouth dogfish are presented in Table 5.6. Three European countries have reported landings: Ireland, Spain and Portugal.

Portuguese landings began in 1990, rose to over 30 tonnes in 1996 and have remained steady at that level. Spanish landings began in 1996, peaked at 35 tonnes in 2002 and have since declined to low levels.

"Aiguillat noir"

This is a generic category only used by France to register landings on small deepwater squalid sharks, including black dogfish, longnose velvet dogfish and lantern sharks "nei". Landings of aiguillat noir are presented in Table 5.6. French landings were over 100 tonnes in 2000 and 2001 but have since been less than 40 tonnes.

Deep-water skates

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*". Some species-specific landings data is available for *Dipturus lintea* in SubAreas V and XIV (Table 16.1) but this is likely to be incomplete. *Dipturus nidarosiensis* accounted for 1% of skates recorded in biological sampling in Irish ports between 2001 and 2007 (Table 18.7). Many of the species considered here have low commercial value and are generally discarded. Other species live beyond the depth range of commercial fisheries and are therefore caught rarely.

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, although evidence suggests that some fisheries are now retaining the smaller species shark 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 (WD, 2003).

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 under-estimated. Landings reported by UK vessels for 2003/2004 were considered to be unreliably identified and were therefore amalgamated into a mixed deepwater sharks (siki) category together with Portuguese dogfish and leafscale gulper shark. In 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

No new information is available.

5.5 Commercial catch-effort data

No new information is available.

5.6 Fishery-independent surveys

5.6.1 Greenland demersal surveys in XIVb

Groundfish research surveys were done by Iceland in Division Va and by Greenland and Germany in XIVb (Jørgensen, 2006 WD), covering the area between 61º45' N and 67º N at depths from 400 to 1500 m. The surveys are conducted with an ALFREDO III trawl. Nine elasmobranch species were caught and these are discussed in Section 16 of this report. Total catches of elasmobranch species are shown in Table 16.2.

5.6.2 Scottish deepwater surveys in Division VIa

FRS has conducted deepwater surveys (depth range 300–1900 m) to the West of Scotland since 1996. Since 1998, these have been reasonably consistent in terms of survey design, gear and area covered. Chondricthyan species diversity in the survey peaks between 1000–1500 m with 11 species of skate and six chimaera species. The most abundant species in terms of catch rate in Kg hr^{-1} are *C. crepidator* and *D. calceus*. A more detailed preliminary analysis of the catch rate data 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 5.3.

Jones *et al.* (2005) conducted a preliminary analysis of CPUE of eight deep-water sharks caught in Scottish surveys between 1998 and 2004 (Figure 5.4). CPUE in the surveys was also compared with CPUEs from exploratory fishing by MAFF in the 1970s (Figure 5.5). These comparisons must be treated with caution as Scottish surveys over the period have not been entirely standardised with respect to the depth range fished, and the historic surveys used very different gear.

5.6.3 Future coordination of deep-water surveys

In response to a request from NEAFC in 2007 and building on the response given to an EC request in 2006, WGDEEP made recommendations for the coordination of deep-water surveys in The NEAFC Convention Area (ICES, 2007). The recommendation included proposals for a number of new, dedicated deep-water surveys and extension of existing shelf surveys to greater depths. It was proposed that one or several ICES Planning Groups for International Northeast Atlantic Deepwater Surveys be formed to co-ordinate the prioritised surveys in three geographical areas:

- an internationally co-ordinated trawl survey of the European continental slope from ICES sub-areas VI in the north to IX in the south,
- an internationally co-ordinated trawl and acoustic survey of the Mid-Atlantic Ridge
- an internationally co-ordinated acoustic and trawl survey for greater argentine and roundnose grenadier in ICES areas II, Va, Vb & IIIa

5.7 Life-history information

No new information available.

5.8 Exploratory assessment models

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

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 multi-species context with particular attention to the management of leafscale gulper shark and Portuguese dogfish (Section 3) and kitefin shark (Section 4).

5.12 References

Allain, V., Bisseau, A., & Kergoat, B. 2002. Preliminary estimates of French deepwater fishery discards in the Northeast Atlantic Ocean. Fisheries Research, 60: 185–192.

Blasdale, T. & Newton A.W. 1998. Estimates of discards from two deepwater fleets in the Rockall Trough. ICES CM 1998/O11.

Clarke, M., 2002. Deepwater longline survey on the continental slopes of Porcupine Bank, Rockall Bank and Hatton Bank. Fisheries Leaflet, 186. Dublin.

ICES. 2006. Report of the Working Group on Elasmobranch Fishes (WGEF), 14–21 June 2005, Lisbon, Portugal. ICES CM 2006/ACFM:03, 224 pp.

ICES. 2007. Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 8–15 May 2007, ICES Headquarters. ICES CM 2007/ACFM:20, 478 pp.

Jones, E, Beare, D, Dobby, H, Trinkler, N, Burns, F, Peach, K and Blasdale, T. 2005. The potential impact of fishing activity on the ecology of deepwater chondrichthyans from the east of Scotland. ICES CM 2005/N:16.

Jørgensen, O. A. 2006 Elasmobranchs at East Greenland, ICES Division 14B. Working Document (WGEF, 2006).

Moltu, P. 1932. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten aktietrykk 1932.

Pinho, M. R. 2005. Elasmobranches of the Azores. Working Document (WGEF 2005).

Pinho, M. R. 2006. Elasmobranch statistics from the Azores (ICES Area X).Working Document (WGEF, 2006).

Rabben, B. 1982–83. Folk ved havet. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten trykkeri. ISBN 82–990398–03–05.

STECF. 2003. Report of the subgroup on resource status (SGRST) of the Scientific, Technical and Economic for Fisheries (STECF): Elasmobranch Fisheries. Brussels 22–25 July 2003.

STECF, 2006. Report of the STECF working group on deep-sea gillnet fisheries. Commission Staff Working Paper. 52 pp.

Table 5.1. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of gulper shark.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
UK (England and Wales)	+	+	+	+	+	+	+	2	n.a.	+	+
UK (Scotland)	+	+	+	+	+	+	+	23	17	+	0
Ireland	+	+	+	+	+	+	+	2	n.a.	n.a.	
Portugal	242	291	187	95	54	96	159	203	89	62	104
Spain	+	+	+	+	+	+	8	+	n.a.	n.a.	0
Total	242	291	187	95	54	96	167	230	106	62	104

Table 5.2. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of birdbeak dogfish.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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
Total	.	.	.	.	13	38	72	75	195	194	94

Table 5.3. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of longnose velvet dogfish.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	.	.	.	+	+	+	13	10	8	6	0
UK (Scotland)	.	.	.	+	+	+	+	21	7	97	128
UK (England and Wales)	.	.	.	.	.	.	.	+	+	113	281
Portugal	.	.	.	.	1	3	4	2	1	.	.
Spain	.	.	.	.	85	68	n.a.	n.a.	n.a.	n.a.	0
Total	.	.	.	+	86	71	17	33	16	216	409

Table 5.4. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of black dogfish.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	.	.	.	+	382	395	47	90	49	.	35.1
Iceland	4	.	.	.	.	.	+	+	n.a.	.	
UK (England and Wales)	.	.	.	.	.	.	.	+	+	5	
Spain	.	.	.	.	85	91	n.a.	n.a.	n.a.	.	
Total					467	486	47	90	49	5	35

Table 5.5. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of velvet belly.

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

Table 5.6. Other deepwater 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
Ireland	.	.	.	.	.	.	.	+	1	.	.
Spain (Basque c.)	.	.	+	.	+	.	.	.	+	.	4
Spain	4	3	6	2	4	1	35	1	.	4	
Portugal	35	29	22	23	39	36	52	29	57	38	29
Total	39	32	28	25	43	37	87	30	58	41	32

Table 5.7. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of lantern sharks "nei".

COUNTRY	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	846	2388	2888	2150	2043	+	+	+	+	+	+	.	
Spain	.	.	.	.	.	.	38	338	99	n.a.	n.a.	.	
Portugal	+	+	+	+	.	.	+	.	.	.	+	+	0.02
Total	846	2388	2888	2150	2043	+	38	338	99	+	+	+	0

Table 5.8. Other deepwater 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
France	.	.	.	.	123	165	11	37	21	5	
Total	.	.	.	.	123	165	11	37	21	5	

Table 5.9. Other deepwater sharks and skates from the northeast Atlantic. Working group estimates of landings of Greenland sharks.

COUNTRY	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Iceland	38	42	44	61	71	86	50	45	57	57	61	66	n.a.	
Total	38	42	44	61	71	86	50	45	57	57	61	66	n.a.	

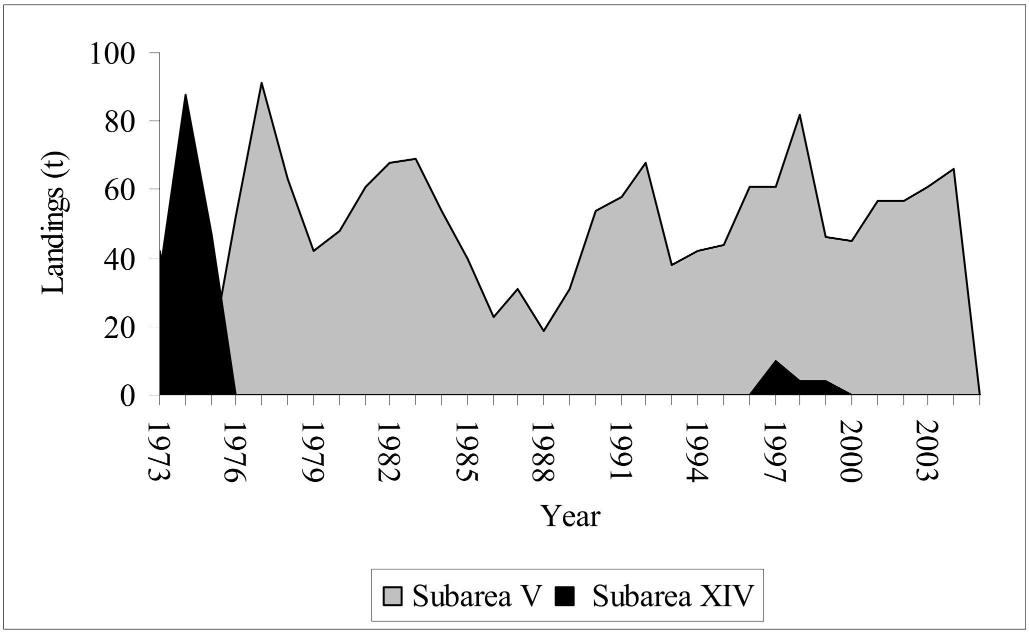


Figure 5.1. Other deepwater sharks and skates from the northeast Atlantic. Landings of Greenland shark from Subareas V and XIV.

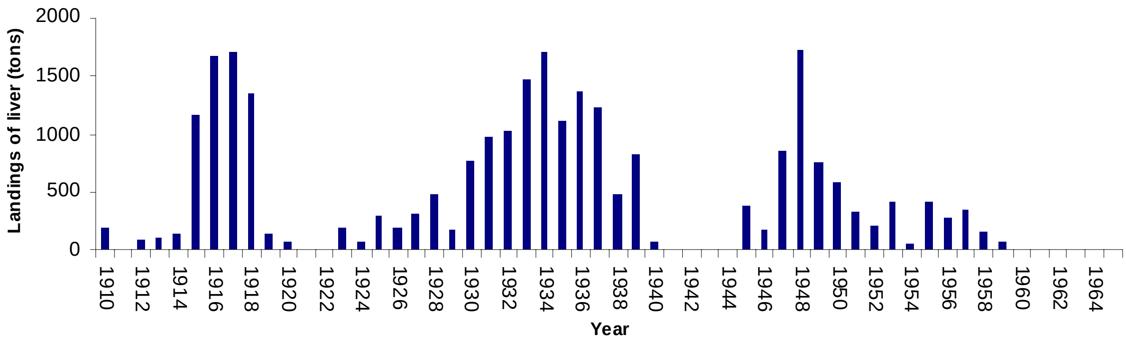


Figure 5.2. Other deepwater sharks and skates from the northeast Atlantic. Time series of landings of Greenland shark livers from Norway (Hareide, 2006 WD).

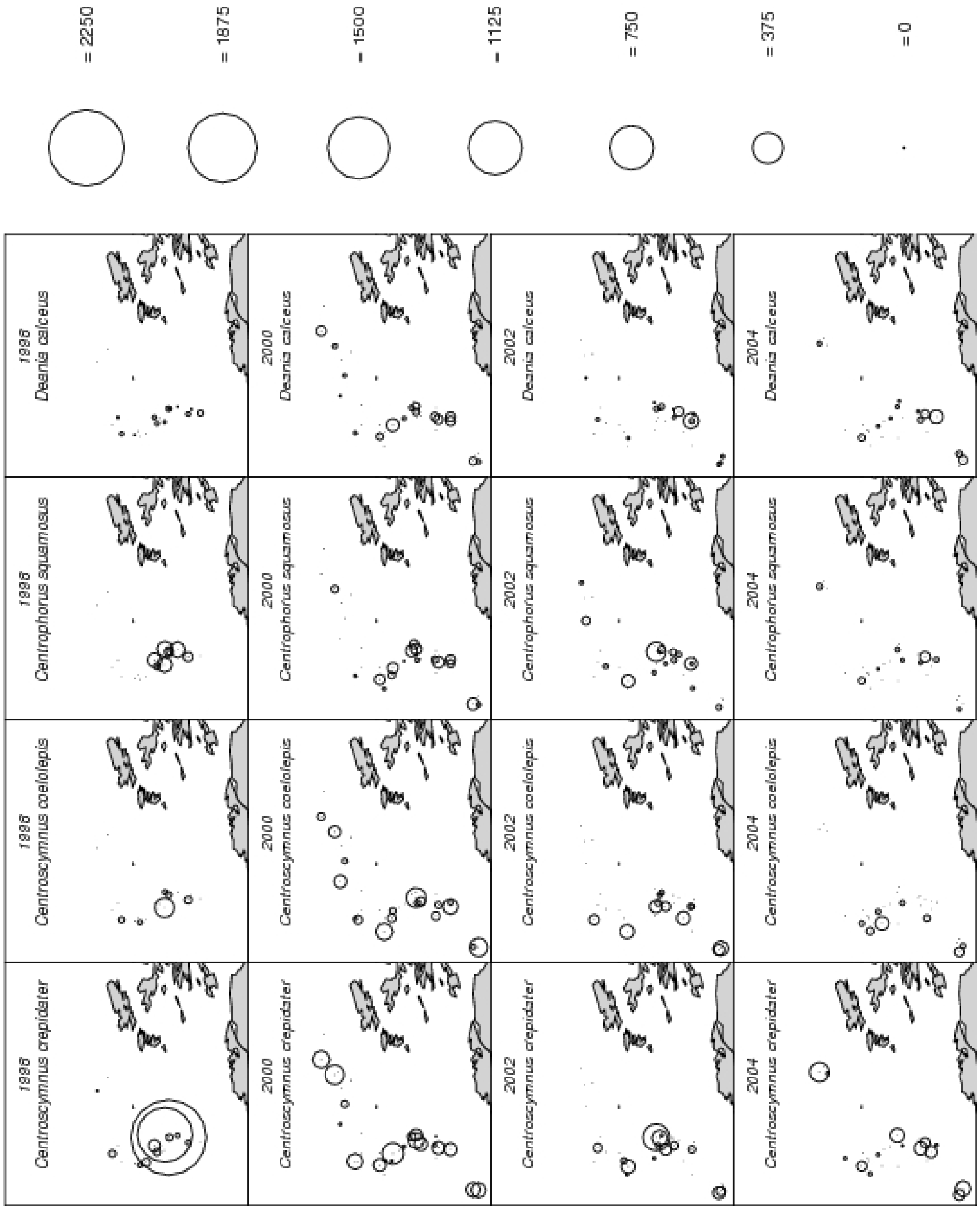


Figure 5.3 Other deepwater sharks and skates from the northeast Atlantic. Spatial distribution (kgs per hour) of four deep-water Squaliforme species recorded during the FRS deep-water surveys, 1998–2004.

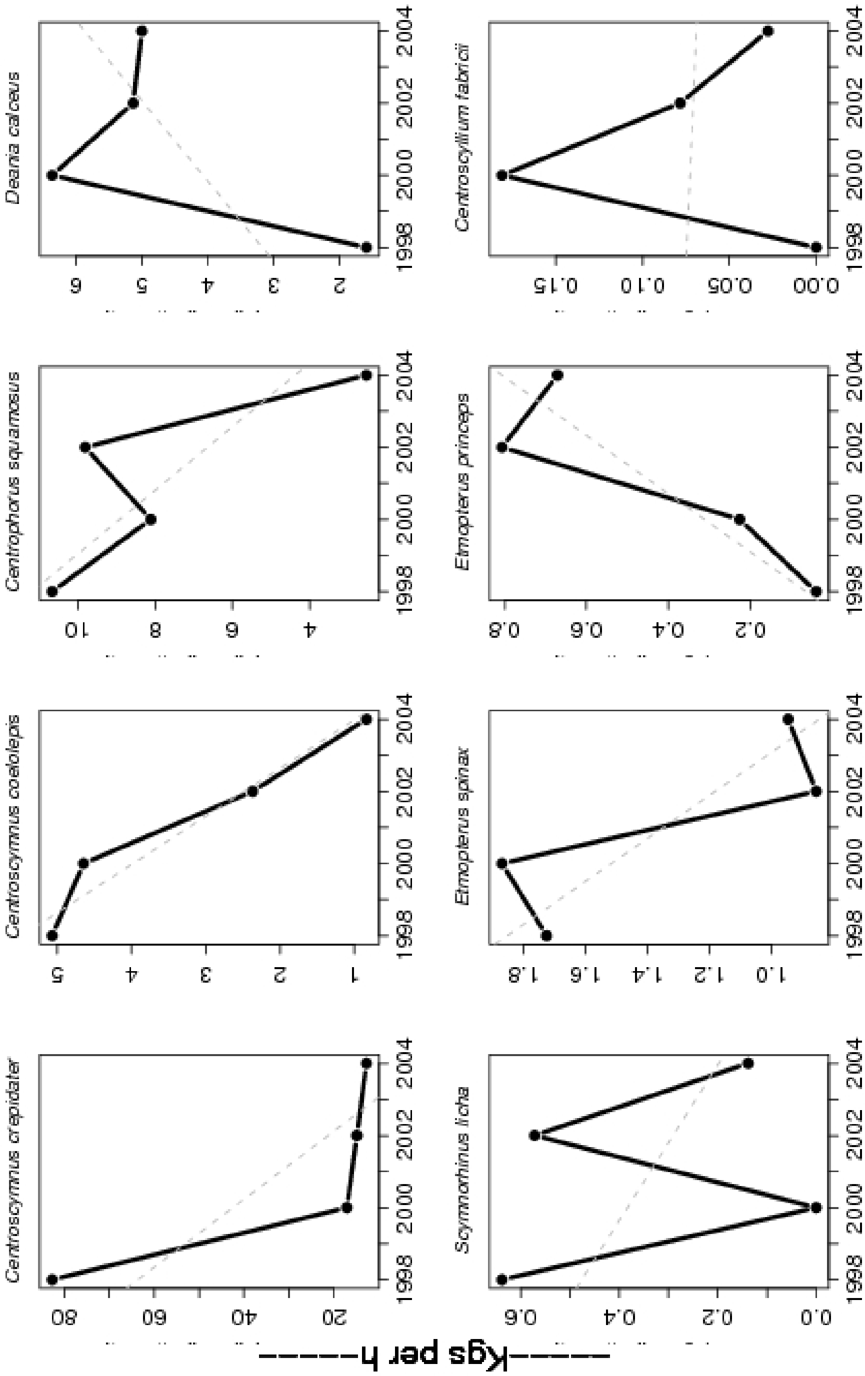


Figure 5.4. Other deepwater sharks and skates from the northeast Atlantic. Change in CPUE (kgs per hour) in Scottish surveys in division VIa between 1998 and 2004 for eight deep-water species.

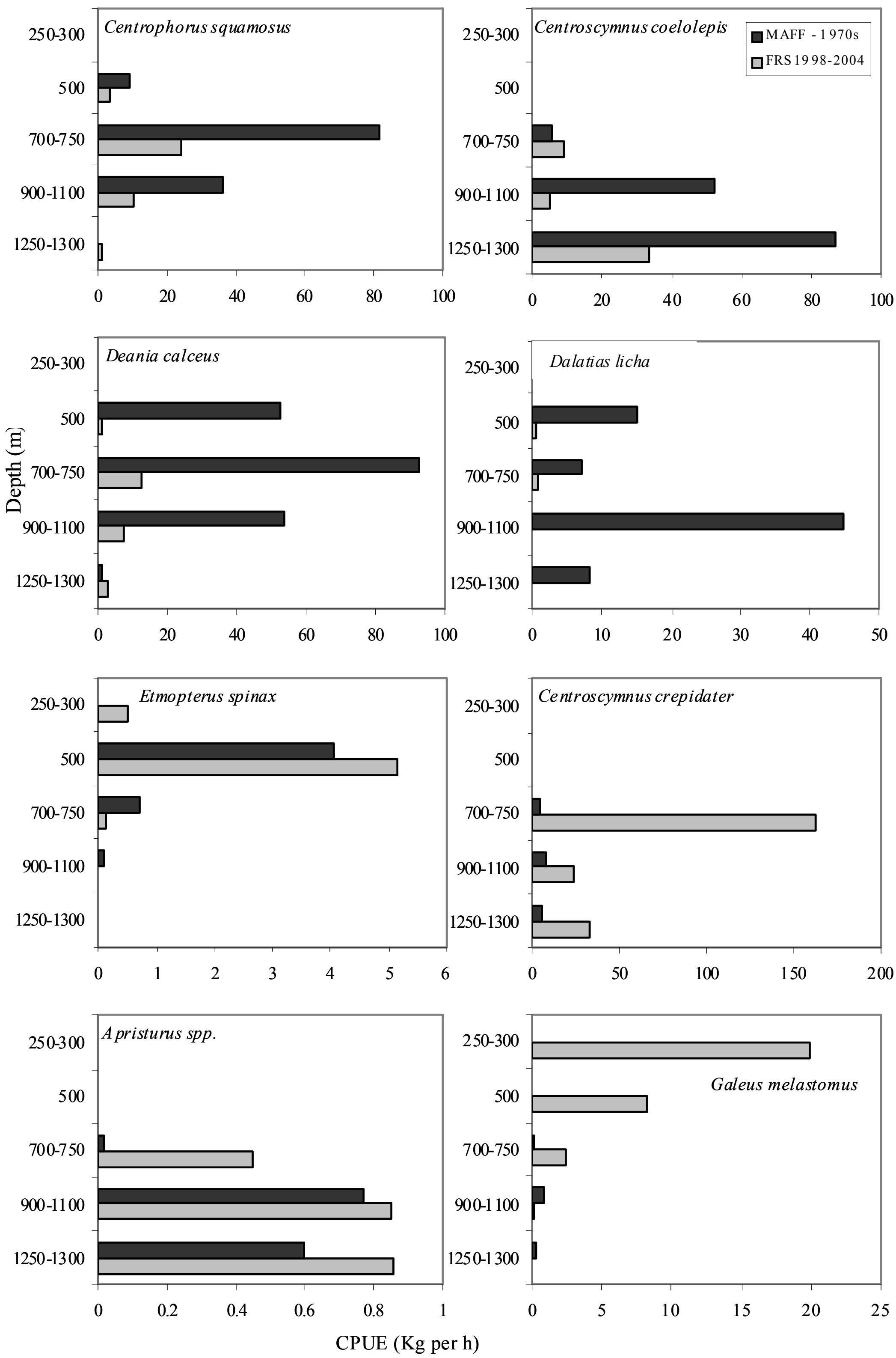


Figure 5.5. Other deepwater sharks and skates from the northeast Atlantic. Comparison of catch rates (kgs per hour) for eight species of deep-water shark caught during MAFF and FRS deep-water surveys. Note: in this plot all the data from the FRS and MAFF surveys are pooled.

6 Porbeagle in the North East Atlantic (Subareas I–XIV)

6.1 Stock distribution

The DELASS project (Heessen, 2003) considered that a single stock of porbeagle *Lamna nasus* occurred in the North East Atlantic, hence in the entire ICES area. A separate stock is considered to exist in the North West Atlantic (Campana *et al*., 1999, 2001). A transatlantic migration for this species has been reported (Green, 2007 WD; Figure 6.1), and so further tagging studies are required to better examine stock structure. North-western Africa is considered part of the stock area, but catch data are unavailable for this part of the CECAF area.

6.2 The fishery

6.2.1 History of the fishery

Porbeagle is a highly migratory and schooling species. Sporadic targeted fisheries develop on these schools, and such fisheries are highly profitable (Gauld, 1989). The main countries catching porbeagle are Spain and France. However in the past, important fisheries were prosecuted by Norway, Denmark and Faeroe Islands. In addition, the species is taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain. Detailed descriptions of individual national fisheries were presented by WGEF in 2006 (ICES, 2006).

6.2.2 The fishery in 2006

No new information

6.2.3 ICES advice applicable

In 2006, ICES stated that available information from Norwegian and Faroese fisheries showed that landings had declined strongly and these fisheries had ceased in the ICES area. These fisheries had not resumed, implying that the stock has not recovered, at least in the areas where those fisheries took place. ICES further stated that the available information from the French fishery suggested that CPUE reached a peak in 1994 and declined afterwards. French CPUE had been stable at a much lower level since 1999, despite a relatively constant number of vessels involved.

In 2006, ICES advised that no targeted fishing for porbeagle should be permitted on the basis of its life history and vulnerability to fishing. In addition, measures should be taken to prevent bycatch of porbeagle in fisheries targeting other species, particularly in the depleted northern areas. In 2005, ICES advised that, given the apparent depleted state of this stock, no fishery should be permitted on this stock. This advice was further considered by STECF in 2006 (see Section 3 of STECF, 2006), and STECF reiterated that no directed fishing for porbeagle in the NE Atlantic be permitted and that additional measures be taken to prevent bycatch of porbeagles in fisheries targeting other species.

6.2.4 Management applicable

Although, in 2006, the Commission for the European Communities proposed establishing a TAC for porbeagle for European Community waters and community vessels in ICES Sub-areas I–XIV of 240 t (CEC, 2006), the final EC regulations No 41/2006 did not list a TAC for porbeagle, and it is unclear if a TAC will be established in the future.

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. The ban will be reviewed in December 2007, based on latest scientific information.

It is forbidden to catch and land porbeagle in Sweden.

In 2006, Germany proposed that porbeagle be added to Appendix II of CITES. This proposal did not get the support of the required majority at the CITES Conference of Parties in 2007 (see 6. 11 for further discussion).

6.3 Catch data

6.3.1 Landings

Available landings data are thought to be incomplete. Data derived from FISHSTAT are presented in Figure 6.2 for the Atlantic as a whole, and for NE Atlantic and NW Atlantic separately. They show the evolution of the Norwegian/Faroese fishery from NE to NW Atlantic. Figure 6.3 shows available estimates of landings available to the WGEF. There are considerable gaps in these data. Spain only reported data in a small number of years, but in those years, these landings were very high. French data were revised based on Biseau (2006, WD) and *Bulletin des Statistiques.*

Table 6.1 presents available data. Japanese landings were reported for NEA to ICCAT in only two years (1996 and 1997); though WGEF considers that Japanese landings are higher. Other non-ICES countries expected to take porbeagle as a bycatch in tuna fisheries in the North East Atlantic are Republic of Korea and Taiwan (Province of China). In 2006, WGEF found very good correspondence between FISHSTAT data reported to ICCAT and ICES (ICES, 2006).

No new information is available from France on its directed fishery. In the absence of more detailed data, it is not possible to improve on the analysis of French CPUE conducted in 2006 by WGEF (Figure 6.4).

6.3.2 Discards

No information available, although as a high value species, it is likely that specimens caught as bycatch are landed and not discarded.

6.3.3 Quality of catch data

Landings data are incomplete and further studies are required to better collate catch data. For some nations, porbeagle will have been reported within “sharks *nei*”, and there can be some confusion with mako *Isurus oxyrinchus.*

6.4 Commercial catch composition

No data available.

6.5 Commercial catch-effort data

A preliminary analysis of data from the French fishery was undertaken in 2006 (see Section 6 of ICES, 2006).

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 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), although less information is available for the NE Atlantic stock.

6.8 Exploratory assessment models

6.8.1 Previous studies

Assessments have been undertaken for the NW Atlantic stock (e.g. Campana *et al.*, 1999, 2001), for which there are more data.

6.8.2 Stock assessment

No assessment was undertaken.

6.9 Quality of assessments

The limitations of the available landings data and absence of fishery-independent information hampers assessments for this stock.

6.10 Reference points

No reference points have been proposed for this stock.

6.11 Management considerations

WGEF considered all available data in 2006. Apart from some updated landings, no new information has become available since then. Further analysis of CPUE from the French fishery could be conducted, but more detailed data are required.

In the absence of new information WGEF reiterates that this species is considered biologically sensitive, and can be considered highly susceptible to exploitation. The available information, from Norwegian and Faroese fisheries suggests that the stock is depleted. These fisheries have ceased and have not resumed. That no new fisheries have developed has been considered by WGEF to indicate that the stock has not recovered.

WGEF is not concerned about potential misidentification in the landings from the Norwegian fishery (FAO, 2007), and is satisfied that these data are a reliable record of Norwegian removals from the stock.

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 though 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.

In the southern part of the stock's distribution, the only ongoing target fishery is that of France. CPUE reached a peak in 1994 and has since declined. The decline since 1999 has been more marked, despite relatively constant number of vessels involved. Most recent CPUE is the lowest since the early years of the fishery. Although more detailed information could be made available, WGEF considers it is likely that this stock has experienced a decline in this area.

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

A maximum landing length (MLL) may constitute a useful management measure in targeted fisheries and should be evaluated. Jensen *et al.* (2002) report 218 cm FL as L_{50} for females in the NW Atlantic. This may be considered a candidate maximum landing length. Additionally, measures should be taken to mitigate bycatch. Experience from surface longline fishing shows that porbeagles are usually captured alive. Therefore, a mitigation policy might be implemented by releasing porbeagle.

All fisheries dependent data should be provided by the member states having fisheries for this stock as well as other countries long-lining in the ICES area.

In 2006, the EC DG FISH commissioned a report (Oceanic Development and MegaPesca, 2007) to advise on whether the trade-related elements of the German proposal for CITES Appendix II listing demonstrated that porbeagle would become threatened with extinction if its trade was not subject to strict regulation. Oceanic Development and MegaPesca (2007) stated that it was not possible to demonstrate that the species would be threatened with extinction unless trade was regulated. However this DG FISH request appears to refer more to the terms of CITES Appendix I, rather than Appendix II, listing. Appendix I includes those "*species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances*", whereas Appendix II covers those "*species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival*" (see: http://www.cites.org/).

In 2007, FAO convened an expert panel to consider the proposal to add porbeagle to Appendix II of CITES (FAO, 2007). The panel stated that NE Atlantic porbeagle may meet Appendix II criteria, though the data available were considered insufficient to quantify the extent of the decline. The FAO expert panel considered that the Norwegian catch trends are likely to have been influenced by a decline in heavily fished inshore areas and redirection of effort to previously lightly exploited offshore areas. FAO (2007) further stated that, though such a pattern seems difficult to reconcile with the picture of a highly migratory species, relatively distinct sub-populations are possible. FAO (2007) suggested that there may be a potential problem of species misidentification with other species as porbeagle in the early catch statistics, though further details of this were not provided in the panel report.

6.12 References

Biseau, A. 2006 Chapter Taupe Catch data of porbeagle in French artisanal fishery on porbeagle. Working Document.

Campana, S. E., Marks, L., Joyce, W., Hurley, P., Showell, M., and Kulka, D. 1999. An analytical assessment of the porbeagle shark shark (*Lamna nasus)* population in the Northwest Atlantic. Canadian Stock Assessment, Research Document 1999/158, Ottawa.

Campana, S. E., Joyce, W., Marks, L. and Harley, S.. 2001 Analytical Assessment of the porbeagle shark (*Lamna nasus*) population in the Northwest Atlantic, with estimates of longterm sustainable yield. Canadian Stock Assessment, Research Document, 2001/067, Ottawa.

Cassoff, R.M., Campana, S.E. and Myklevoll, S. 2007. Changes in baseline growth and maturation parameters of Northwest Atlantic porbeagle, *Lamna nasus*, following heavy exploitation. Canadian Journal of Fisheries and Aquatic Sciences, 64: 19–29.

CEC (2006). Proposal for a Council Regulation fixing for 2007 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. Brussels, 5.12.2006 COM(2006) 774 final, 212 pp.

FAO 2007. Second FAO *ad hoc* expert advisory panel for the assessment of proposals to amend appendices I and II of CITES concerning commercially-exploited aquatic species FAO Fisheries Report No. 833. Rome. 140 pp.

Gauld J. A., 1989 Records of porbeagles landed in Scotland, with observations on the biology, distribution and exploitation of the species, Scottish Fisheries Research Report 45. Dept. Ag., Edinburgh, Scotland: 1–15.

Green, P. 2007 WD. Central Fisheries Board marine sportfish tagging programme 1970 to 2006. Working document to WGEF, 2007.

Heessen, H. J. L. (Ed.) 2003. Development of elasmobranch assessements DELASS. Final report of DG Fish Study Contract 99/055, 603 pp.

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

Jensen, C.F., Natanson, L.J., Pratt, H.L., Kohler, N.E. and Campana, S.E. 2002. The reproductive biology of the porbeagle shark (*Lamna nasus*) in the western North Atlantic Ocean. Fishery Bulletin, 100: 727–738.

Natanson, L.J., Mello, J.J. and Campana, S.E. 2002. Validated age and growth of the porbeagle shark (*Lamna nasus*) in the western North Atlantic Ocean. Fishery Bulletin 100, 266–278.

Oceanic Development and MegaPesca ., 2007. Analysis of the trade aspects of the German proposals to list of two species of shark (Porbeagle *Lamna nasus* and spiny dogfish *Squalus acanthias* in Appendix II of the CITES Convention. Final Report of Fisheries Partnership Agreement Framework FISH/2006/20. 64 pp.

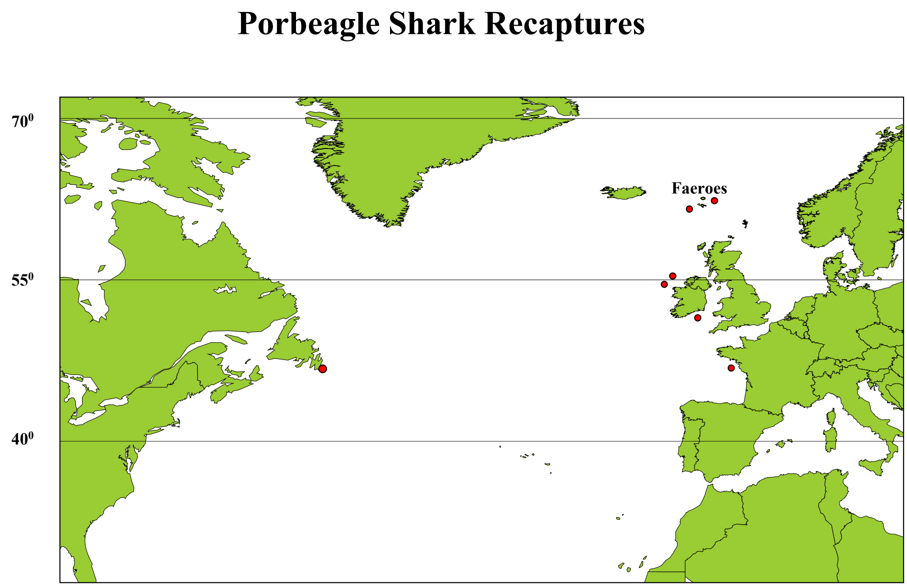
STECF, 2006. 22nd Report of the Scientific, Technical and Economic Committee for Fisheries. Brussels, 3–7 April, 50pp.

Table 6.1. Porbeagle in the NE Atlantic. Available porbeagle landings data (tonnes) by country. Data derived mainly from FISHSTAT. Data from 1973 to 1977 for France revised from Bulletin des Statistiques, data from 1990 to 2005 for France revised from data provided by Biseau (2006, WD). Landings from non-ICES countries in ICES area are not available.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Denmark	87	117	177	187	219	113	136	156	185	84	45
Faeroe Islands	5	.	.	1	7	9	25	8	6	17	12
France	105	97	292	302	554	835	1092	898	768	200	793
Germany	6	3	4	.	.	.	.	.	.	.	.
Iceland	2	2	4	3	3	.	1	1	1	1	1
Ireland	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.
Norway	230	165	304	259	77	76	106	84	93	33	33
Portugal	.	.	.	.	.	.	.	.	.	.	.
Spain	.	.	.	.	.	2087	.	.	.	.	.
Sweden	.	.	3	.	.	5	1	8	5	6	5
UK (Eng.Wal. Nl.+)	14	15	16	25	.	.	1	3	2	1	2
UK (Scot)	13	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	462	399	800	777	860	3125	1362	1158	1060	342	891

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	38	72	115	58	34	35	48	87	81	91	94
Faeroe Islands	.	38	35	59	24	99	120	69	302	179	506
France	411	254	260	273	440	341	575	305	462	642	816
Germany	.	.	.	.	.	.	.	.	.	1	.
Iceland	1	1	1	1	1	1	.	.	1	3	4
Ireland	.	.	.	.	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.	.	.	.	.
Norway	97	80	24	25	12	27	45	35	43	24	26
Portugal	.	.	.	3	3	2	2	1	.	1	1
Spain	.	.	.	.	.	.	.	.	.	.	.
Sweden	9	10	8	5	3	3	2	2	4	3	.
UK (Eng.Wal. Nl.+)	5	12	6	3	3	15	9	NA	NA	NA	NA
UK (Scot)	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	561	467	449	427	520	523	801	499	893	944	1447

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	87	72	69	86	109	74	76	.	21	20	3	.
Faeroe Islands	372	82	96	66	10	.	8	10	14	NA	NA	NA
France	643	475	494	419	371	354	367	448	434	377	301	199
Germany	.	.	.	2	.	16	.	3	5	6	5	0
Iceland	6	5	3	4	2	2	3	2	0	1	0	1
Ireland	.	.	.	.	3	2	6	NA	11	18	NA	4
Netherlands	.	.	.	.	.	.	.	.	.	.	1	0
Norway	28	31	19	28	34	23	17	.	5	24	11	28
Portugal	1	1	1	1	.	1	.	.	.	1	.	.
Spain	.	31	125	681	1002	1507	932	16	89	10	NA	NA
Sweden	.	1	1	.	.	.	1	.	.	5	0	.
UK (Eng.Wal. Nl.+)	NA	NA	NA	1	8	11	11	6	NA	NA	NA	11
UK (Scot)	.	.	.	.	.	.	1	.	.	.	.	.
Japan	NA	3	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	1137	701	810	1288	1539	1990	1422	485	579	463	321	243



NOS TAGGED TO DEC. '06	74
NOS RECAPTURED TO DEC. '06	7

DAYS AT LIBERTY	71 - 3947
DISTANCE TRAVELLED	89 - 2300
RECAPTURE RATE	9.45%

Figure 6.1. Porbeagle in NE Atlantic. Recapture locations of porbeagle sharks, from Irish Central Fisheries Board tagging programme (Green, 2007 WD).

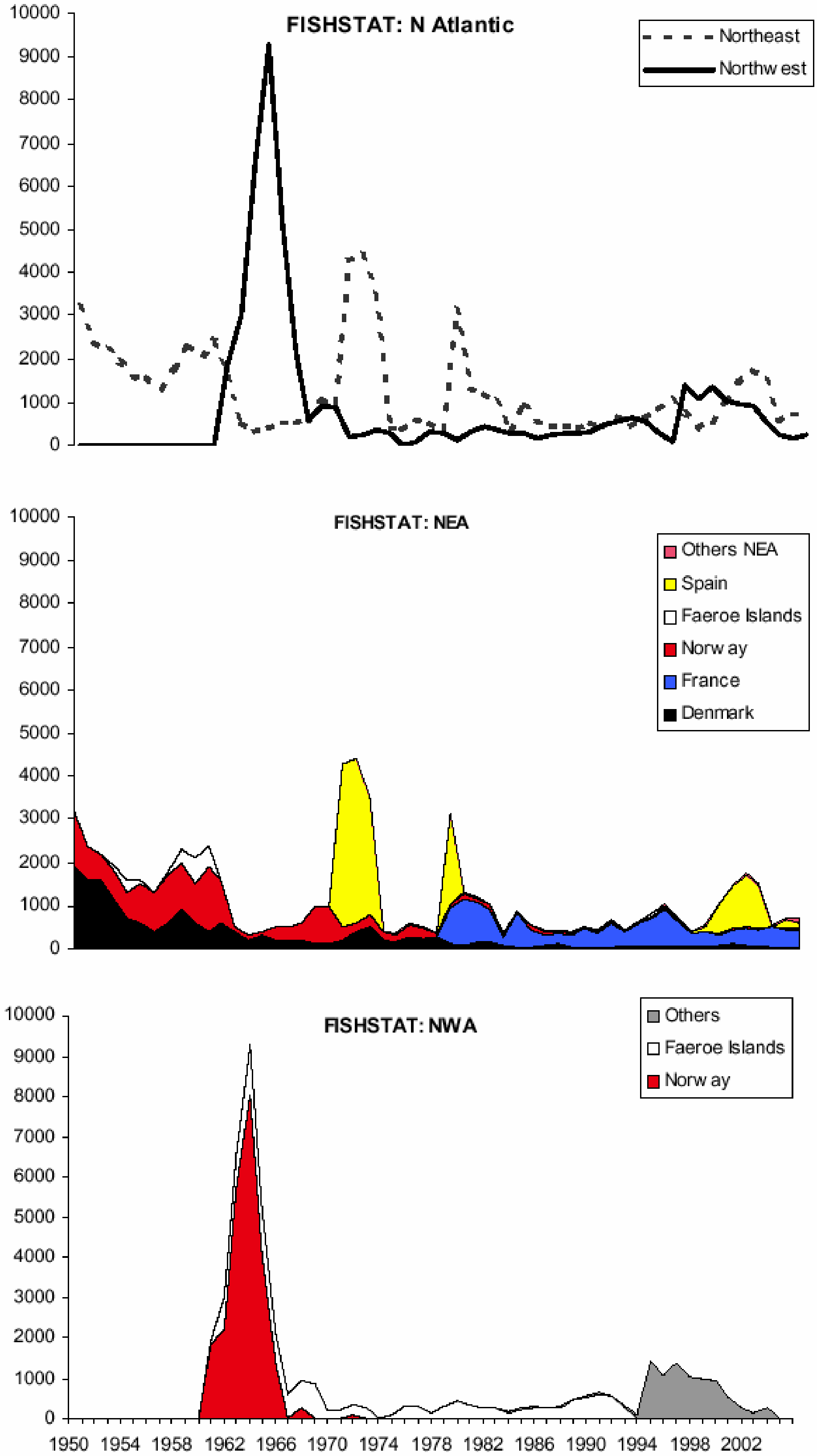


Figure 6.2. Porbeagle in NE Atlantic. Available landings data from 1950 to 2005, for NE Atlantic, NE Atlantic and both combined.

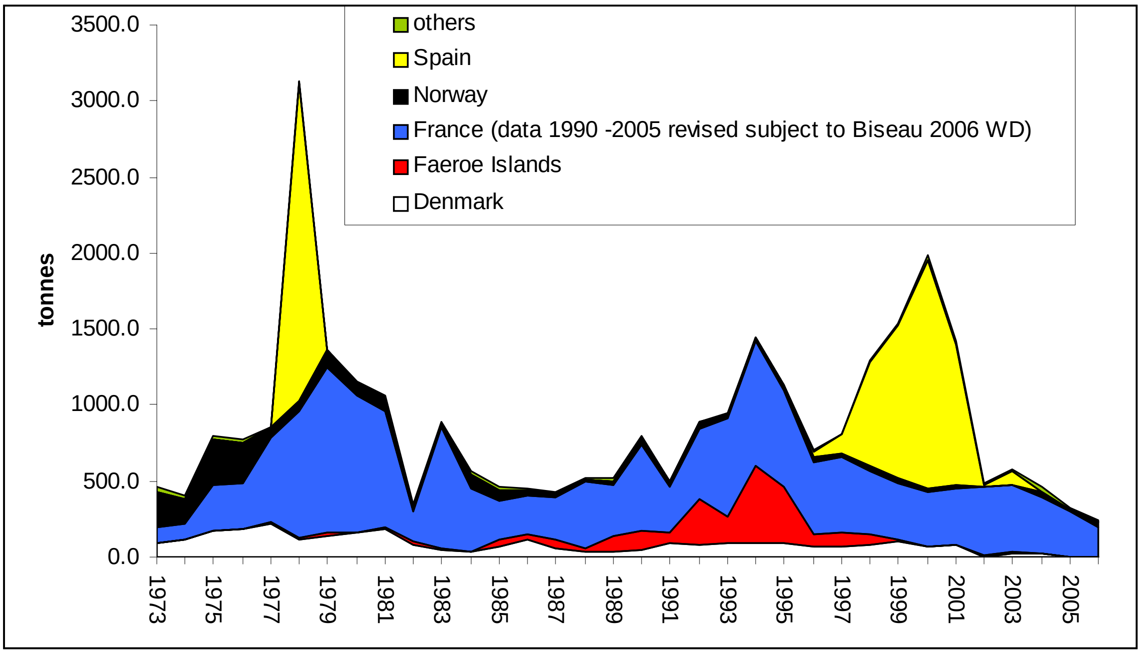


Figure 6.3. Porbeagle in the NE Atlantic. Total porbeagle landings (tonnes) by country in the ICES area.

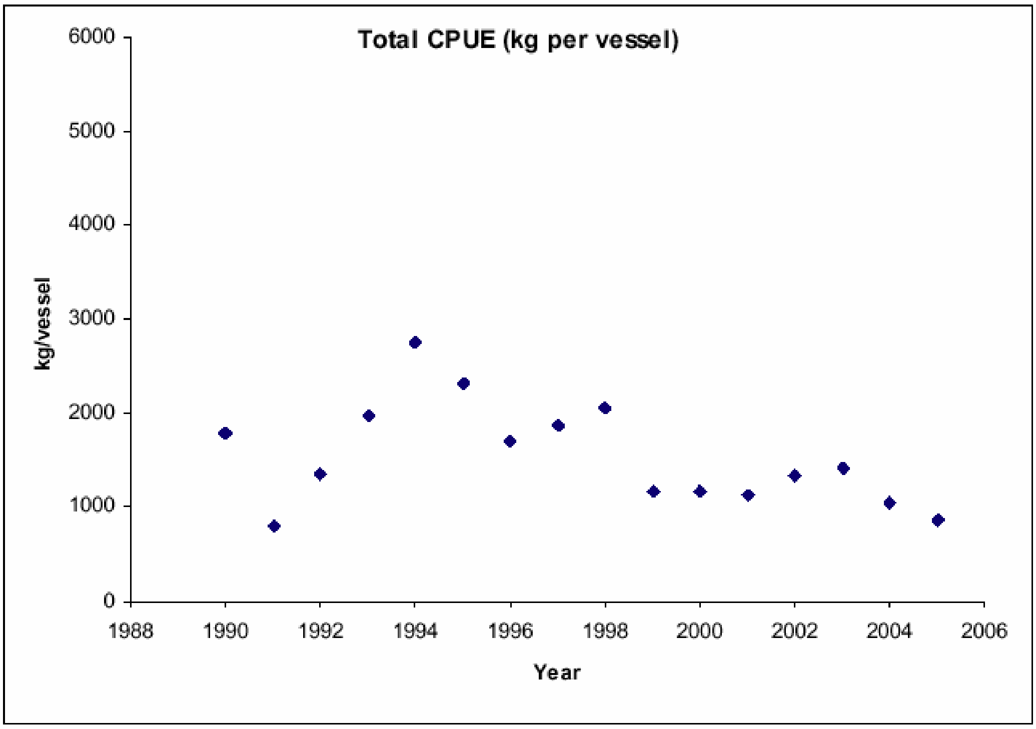


Figure 6.4. Porbeagle in the NE Atlantic. French CPUE available for 1989 to 2005, from Biseau (2006, WD).

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

7.1 Stock distribution

WGEF considers that a single stock of basking sharks *Cetorhinus maximus* exists in the ICES area. There is no information on transatlantic migrations. A genetics study underway in the UK aims to differentiate distinct stocks globally (Sims *et al.,* 2005, Noble *et al*., 2006).

7.2 The fishery

7.2.1 History of the fishery

Norwegian fishermen 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 he claims that it started before 1750 in north 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 farther 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 finishing by in August or, less commonly, September (Myklevoll, 1968). Basking sharks were caught using handheld 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, 1982–83). 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 Faeroes. Norwegian fishermen 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 have since declined (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changed markedly from year to year, possibly due to the unpredictable nature of the sharks' inshore migration (Stott, 1982).

McNally (1976) and Parker and Stott (1965) describe 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 fish 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 a significant decline in catch records occurred 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 fishermen who took over from them. Average annual catches were 489 in 1956–1960, 107 in 1961–65, and then about 50–60 *per annum* for the remaining years of the fishery (Figure 7.4).

Fairfax (1998) summarises 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 full time at the basking shark during the summer season and others more opportunistic. These took a total of ~970 sharks between 1946 and 1953 (during a period when Norwegian vessels were also catching in these waters).

Oil prices rose again in the mid 1970s. About 500 sharks were taken off eastern Ireland in 1974–75, 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 a total of 333 sharks (Fairfax, 1998).

The price of liver and fins for the period 1965 through the end of the 1980s are given in Figure 7.3. For liver there was a steady increase in the price until the end of the period when the prices dropped dramatically. It is thought that the decline was due to new supply of deepwater shark liver. This price drop was coincided with increase in the price of fins. This increase was a result of rising demand for shark fin in Southeast Asia and compensated for the decline in oil prices.

More recent data on the price changes for basking shark fins are from The Norwegian Fishermen's Sales Organisation (Norges Råfisklag) and cover the period 1996 to 2006. This shows that the value of fins has remained relative stable during this period (Figure 7.5.). Inflation has not been taken into account and thus there has been a negative trend in the compensation the fishermen received for the fins.

7.2.2 The fishery in 2006

There is in 2006 no targeted fishery for basking sharks in Norway, UK or Ireland.

In 2006 the Norwegian bycatch of basking sharks was only 16 t, which was considerably less than in 2005 (100 t approximately). It is not known whether this decrease is related to marked price reductions (see Figure 7.5), and hence lower incentive to land catches, or that release of live specimens has increased, or because actual abundance has declined.

ICES Advice applicable

ACFM advice in 2006 was for a zero TAC in 2007.

Management applicable

Based on ICES advice Norway banned all directed fisheries for basking shark in 2006, the ban is continued in 2007. Live specimens caught as bycatch must be released, while dead or dying specimens can be landed and sold as before. This regulation expires at the end of 2007, but an extension of the ban will be evaluated by the Norwegian fisheries authorities.

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)

The basking shark has been protected from killing, taking, disturbance, possession and sale in UK territorial (12 nautical miles) waters since 1998. They are also protected in two UK Crown Dependencies: Isle of Man and Guernsey (Anon., 2002). In Sweden it is forbidden to fish for or to land basking shark.

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 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 Convention encourages the Range States of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international co-operation) 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 north-east Atlantic) list of threatened and / or declining species in 2004.

7.3 Catch data

7.3.1 Landings

Landings data for 1993–2006 are presented in Table 7.1, and Figure 7.1 shows the landings for 1973–2006. These data were extracted from FishStat Plus database for 1973–2001. The table and figure include landings from Portugal (1991–2005), from France (2005–2006) and landings data from Norway (1993–2006). 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 to 1.5 tonnes.

Table 7.2 shows the Norwegian catches of basking sharks by gear type reported to the Norwegian Directorate of Fisheries during the years 1990 through 2006. This shows that the direct catch with harpoons decreased by the end of the 1990s and has remained at a very low level since 2000 with no reported direct catches for the years 2001 and 2004. The bycatch taken by other gears varies with no obvious trend during this period.

No official landings data for the Norwegian fishery are available for the fishery before 1926. Records of liver landings are available from 1926 to 1990 and from 1990 to 2006 landings are recorded as round weight (Figure 7.2, Hareide (2006, WD)).

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 the summer months 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 fishermen 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 fishermen's ropes, amounting to some 4–5 fish annually. Fairfax (1998) reports that basking sharks are sometimes brought up from deep water trawls near the Scottish coast during winter. Valeiras *et al.* (2001) reported that of 12 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).

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 conversion factor used to convert from liver weight to whole fish weight is 10 and 100 for fins. The conversion factor of 10 for liver weight is most likely too high because according to Phillips (1947) and, McNally (1976) the basking shark liver comprises about 17–25% of the total body weight (of up to 7 tonnes). Therefore, the official live weights reported prior to 1990 probably are overestimations and should be adjusted downwards. Before this adjustment can be done a thorough examination of the landed catches has to be done to find out whether it was liver or fins that were landed.

A meeting on conversion factors for different species of sharks was held in Brussels in 2006. At this meeting two conversion factors for basking sharks were estimated based on French data. The French conversion factor for fresh chilled gutted fish is 1.33, meaning 100 kg of gutted fish landed is equivalent to 133 kg round weight. There is no French factor for liver, but if we assume that 100% of the viscera is liver (33kg), the conversion factor would be:

Liver weight/Total weight = 33/133 = 4.03

If we assume that 90% of the viscera is liver:

Liver weight/Total weight = (33*0.9)/133 = 3.63

Based on these conversion factors the Norwegian catches will be recalculated and the new data will be presented in the 2008 WGEF report.

7.4 Commercial catch composition

No new information.

7.5 Commercial catch-effort data

There are no effort or CPUE data available for the latest years. However in Hareide (2006, WD), the numbers of Norwegian vessels involved in this fishery and the landings for 13 of the years between 1965 and 1985 were used to calculate a simple estimate of effort. The highest 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 7.3). For this time 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 time period.

7.6 Fishery-independent surveys

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 with 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*., 2005; Southall *et al*., 2005).

In addition there are a number of possible sources of data that may be utilized better. 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.

7.7 Life-history information

No new information available.

7.8 Exploratory assessment models

No assessments have been undertaken.

7.9 Quality of assessments

No assessments have been undertaken.

7.10 Reference Points

No reference points have been proposed for this stock.

7.11 Management considerations

- At present there is no directed fishery for this species. The Working Group considers that no targeted fishery should be permitted unless a reliable estimate of a sustainable exploitation rate is available.
- The TAC area should correspond to the stock's distribution, thus the entire ICES area.
- Proper quantification of bycatch and discarding of this species in the 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 and carcasses or biological material made available for research.

7.12 References

Anon. 2002. Convention on International Trade in Endangered Species (CITES), 2002. Inclusion of Basking Shark *Cetorhinus maxiumus* in Appendix II. Proponent: United Kingdom (on behalf of the Member States of the European Community). 12th Meeting of the Conference of Parties Proposal 36.

Berrow, S. D. 1994. Incidental capture of elasmobranchs in the bottom set gill-net fishery off the south coast of Ireland. Journal of Marine Biological Association UK, 74: 837–847.

Berrow, S. D. and Heardman, C. 1994. The basking shark *Cetorhinus maximus* (Gunnerus) in Irish waters-patterns of distribution and abundance. Proceedings of the Royal Irish Academy, 94B, 2: 101–107.

Bonfil, R. 1994. Overview of world elasmobranch fisheries. FAO Fisheries Technical Paper 341. FAO, Rome.

Doyle, J. I., Solandt, J.-L., Fanshawe, S., Richardson, P. 2005. Marine Conservation Society Basking Shark Report 1987–2004. Marine Conservation Society, Ross on Wye, UK.

Fairfax, D. 1998. The basking shark in Scotland: natural history, fishery and conservation. Tuckwell Press, East Linton, Scotland. 206 pp.

Hareide, N. R. 2006. History of Norwegian fishery for basking shark (*Cetorhinus maximus*). Working document. ICES Working Group on Elasmobranch Fishes. 6 pp.

Kunzlik, P. A. 1988. The Basking Shark. Scottish Fisheries. Information Pamphlet, No. 14. Department of Agriculture and Fisheries for Scotland. Aberdeen.

McNally, K. 1976. The Sun-Fish Hunt. Blackstaff Press, Belfast.

Moltu, P. 1932. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten aktietrykk.

Myklevoll, S. 1968. Basking shark fishery. Commer. Fish. Rev., 30**:** 59–63.

Noble, L. R., Jones, C. S. Sarginson, J., Metcalfe, J. D., Sims, D. W. and Pawson, M. G. 2006. Conservation Genetics of Basking Sharks. Final Report for Defra Tender CR0288. Report to Wildlife Species Conservation Division, Defra, UK.

Parker, H. W. and Stott, F. C. 1965. Age, size and vertebral calcification in the basking shark *Cetorhinus maximus* (Gunnerus). Zoologische Mededelingen, 40: 305–319.

Phillips, J. B. 1947. Basking shark fishery revived in California. California Fish and Game. Vol 34: 11–23.

Rabben, B. 1982–83. Folk ved havet. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten trykkeri-1982–1983. ISBN 82–990398–03–05.

Sims, D.W., Southall, E.J., Metcalfe, J.D., and Pawson, M.G. 2005. Basking Shark Population Assessment. Report to Global Wildlife Division, Defra, UK.

Southall, E. J., Sims, D. W., Metcalfe, J. D., Doyle, J. I., Fanshawe, S., Lacey, C., Shrimpton, J., Solandt, J-L. and Speedie, C. D. 2005. Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data. Journal of the Marine Biological Association of the UK**.**, 85: 1083–1088.

Stott, F. C. 1982. A note on catches of basking sharks, *Cetorhinus maximus* (Gunnerus), off Norway and their relation to possible migration paths*.* Journal of Fish Biology, 21(2): 227–230.

Strøm, H. 1762. Beskrivelse av fogderiet Søndmør. Del 1. Sorøe 1762.

Valeiras J, Lopez, A and Garcia, M. 2001. Geographical, seasonal occurrence, and incidental fishing capture of the basking shark *Cetorhinus maximus* (Chonricthyes: Cetorhinidae). Journal of the Marine Biological Association, 80: 3712/1–3.

Table 7.1. Basking sharks in the northeast Atlantic. Total landings of basking sharks in ICES Areas I–X (t).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
I & II	2910	1505	105	1979	1054	137	77	293	200	135	319	180	218	16
III & IV	.	257	4	.	106	.	.	.	.	.	.	.	.	.
VII	.	.	.	.		.	.	.	.	.	.	.	1	+
VIII	.	.	.	.	1	.	.	.	0	0	0	0	+	.
IX	.	.	.	1	1	.	.	.	.	.	1	+	2	.
X	.	.	.	.	.	.	.	.	1	.	.	.	.	.
TOTAL	2910	1762	109	1980	1162	137	77	293	201	135	320	180	221	16

Table 7.2. Basking sharks in the northeast Atlantic. Norwegian catches (t) of basking sharks by gear as reported to the Norwegian Directorate of Fisheries during the years 1990 through 2006.

	Area IIa							Area IVa		Total
Year	Harpoon	Gillnets	Drift nets*	Undefined nets	Bottom trawl	Danish seine	Hooks and line	Harpoon	Gillnets	
1990	1622	.	60	.	.	.	.	249	.	1932
1991	1131	.	17	.	.	.	.	475	.	1623
1992	3039	.	218	.	206	.	14	181	.	3658
1993	2885	24	.	.	2	.	.	.	.	2910
1994	1505	0	.	.	.	.	.	257		1762
1995	97	7	.	.	.	.	.	.	4	108
1996	1763	204	.	3	.	8	1	.	.	1979
1997	773	275	.	.	.	.	6	106	.	1159
1998	92	39	.	.	.	.	6	.	.	137
1999	7	63	.	6	1	.	.	.	.	77
2000	98	172	.	.	23	.	.	.	.	293
2001	.	192	.	.	8	.	.	.	.	200
2002	22	106	.	.	7	.	.	.	.	135
2003	11	286	.	.	23	.	.	.	.	319
2004	.	181	.	.	.	.	.	.	.	181
2005	118	97	.	1	3	.	.	.	.	218
2006	.	16	.	.	.	.	.	.	.	16

*** These drift nets for salmon was banned after 1992**

Table7.3. Basking sharks in the northeast Atlantic. Norwegian landings of liver (t), number of vessels participating in the fishery and estimate of CPUE.

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

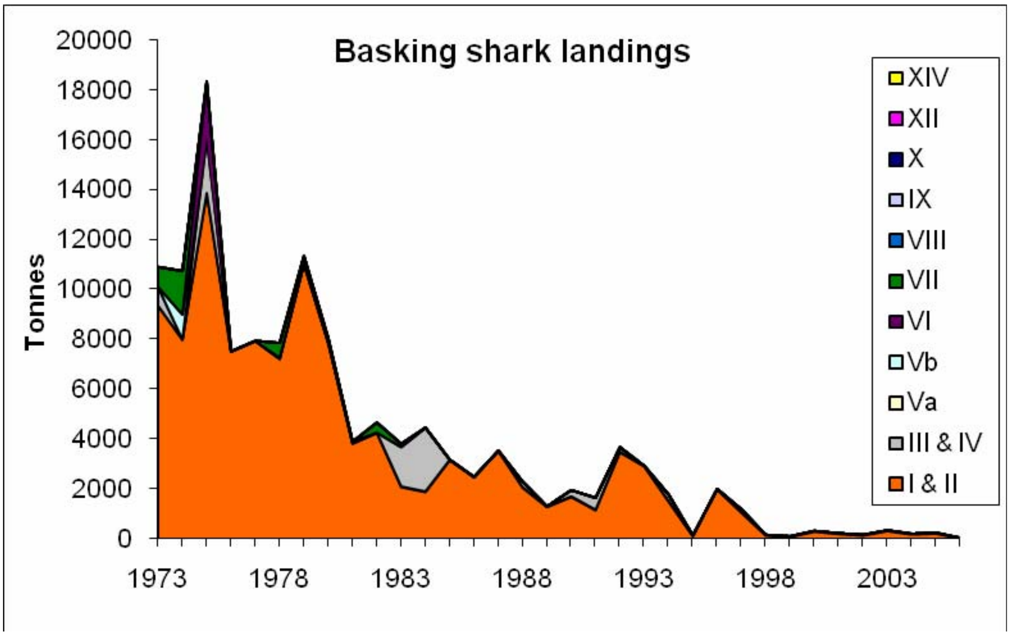


Figure7.1. Basking sharks in the northeast Atlantic. Total landings (t) of basking sharks, 1973–2006.

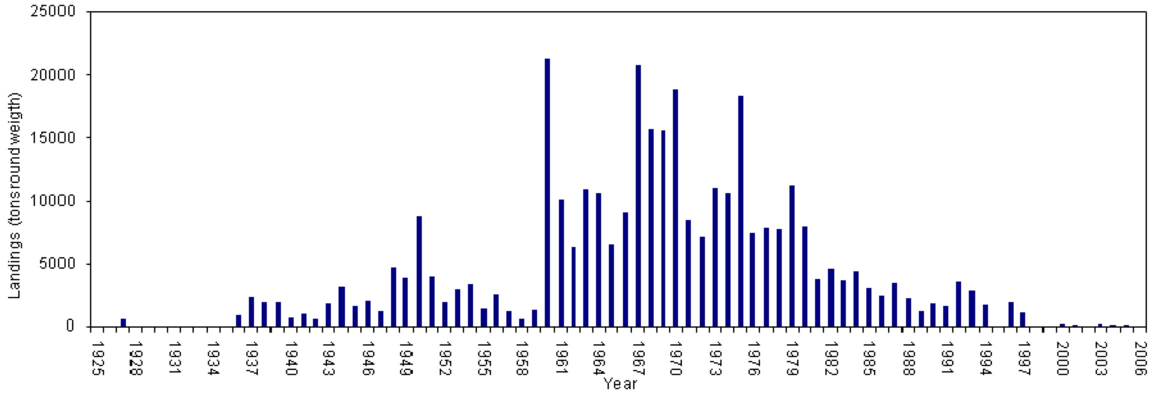


Figure 7.2. Basking sharks in the northeast Atlantic. Official Norwegian landings (t), 1926–2006.

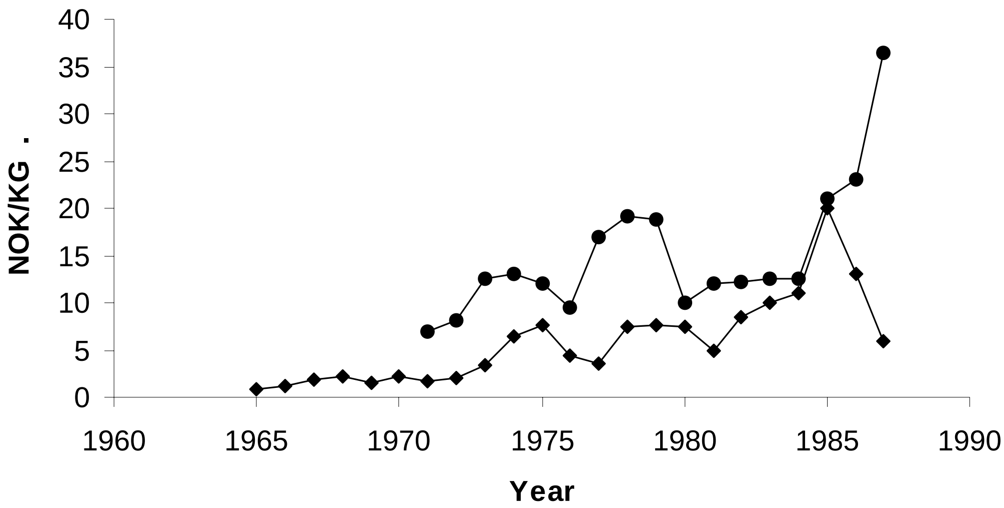


Figure 7.3. Basking sharks in the northeast Atlantic. Prices (NOK/KG) of liver (diamonds) and fins (circles) (Hareide, 2006 WD).

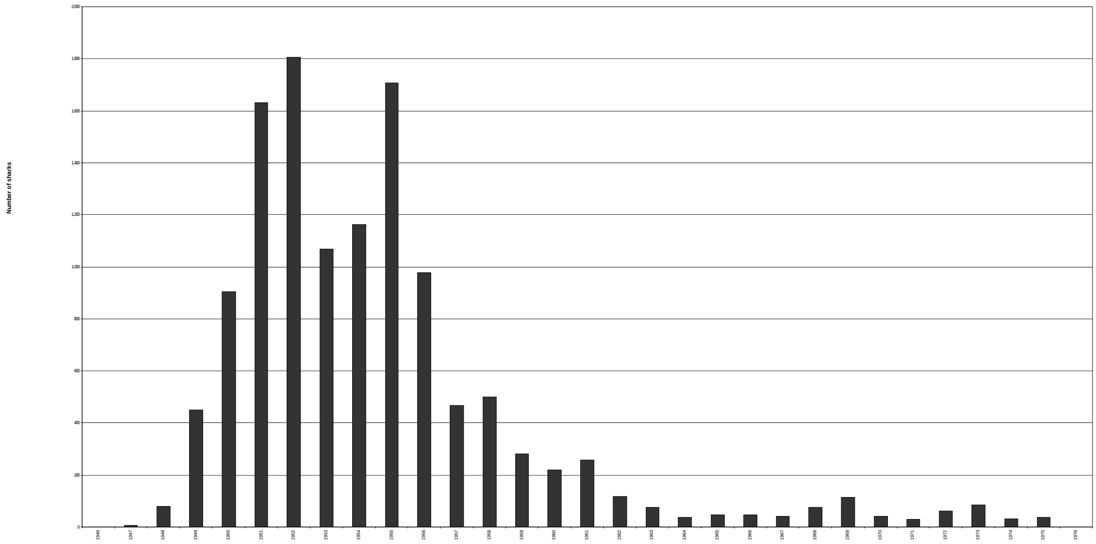


Figure 7.4. Basking sharks in the northeast Atlantic. Catches (number of sharks) at Achill Island, Ireland, 1947–1975.

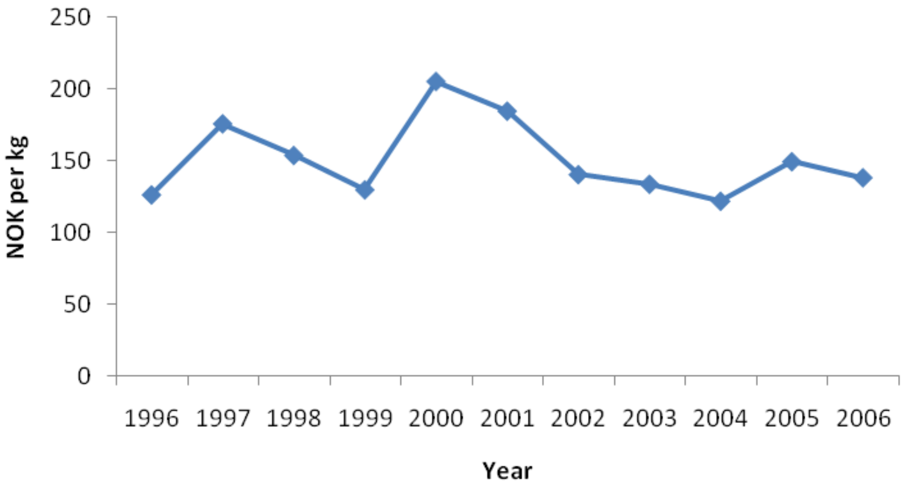


Figure 7.5. Basking sharks in the northeast Atlantic. Price changes for basking shark fins (NOK per kg) for the period 1996 to 2006. The data were provided by The Norwegian Fishermen's Sales Organisation (Norges Råfisklag).

8 Blue shark in the North Atlantic (FAO Areas 27, 21, 34 and 31)

8.1 Stock distribution

The DELASS project and the ICCAT pelagic shark assessment working group (ICCAT, 2005) considers there to be a single stock of blue shark *Prionace glauca* in the North Atlantic (Heessen, 2003; Fitzmaurice *et al*., 2005). Thus the ICES area is only part of the stock area.

Assessment of this stock is considered to be the responsibility of ICCAT (ICES, 2006). Much of the data summarised here originates from studies in the Northwest Atlantic. WGEF presents a section on blue shark here, to help summarise available data and aid the process of assessment 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 sharks 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 at this species, it is a major bycatch in many fisheries for tunas and billfishes, where it can comprise up to 70% of the total catches (ICCAT, 2005). Observer data indicated that substantially more sharks are caught as bycatch than reported in catch statistics. For the entire North Atlantic, catch is estimated to exceed 100 000 t with mortality estimates between 26 000 to 37 000 t. Blue sharks are also caught in considerable numbers in recreational fisheries, including in the ICES area (Campana *et al*., 2005).

A detailed description of the Basque fishery was presented by Diez *et al.* (2007, WD). This WD shows that blue shark used to be a traditional and rather low bycatch of many Basque (Spanish) fleets operating in the Bay of Biscay (ICES Divisions VIIIa, b, c, d). Since 1998 however, a small fleet of Basque longliners spend part of their yearly activity targeting blue sharks in the Bay of Biscay. Blue sharks are caught predominantly in ICES Areas VII, VIII, IX, X and XII.

8.2.2 The fishery in 2006

Diez *et al.* (2007, WD) updated information for the Basque (Spanish) targeted fishery, with no new information available for other fleets.

8.2.3 ICES advice applicable

ACFM has never provided advice for blue shark in the ICES area. Because this species is not a unit stock in the ICES area, and because ICCAT will be responsible for assessment of this species, ICES has not been asked to provide advice.

8.2.4 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.

ICCAT completed a preliminary stock assessment in 2004, but no management recommendations were made.

8.3 Catch data

8.3.1 Landings

Available landings data, from FISHSTAT, for FAO areas 27, 21 and 34 are presented in Table 8.1 and in Figure 8.1 and 8.2. Complete landings data are not available, and are totally lacking for FAO area 31. Reported landings rose from very low levels, in the mid 1990s, to under 17 000 t in 2003, after fluctuating around 11 000 t prior to this. The majority of reported landings are from Area 34. The rapid increase in reported blue shark catches in 1997 coincides with Spain starting to report landings. Earlier data are missing. In addition, it is thought that the landings data for blue shark are unreliable due to the amount of pelagic sharks that are thought to be declared under generic sharks "nei" categories (Johnston *et al.,* 2005).

8.3.2 Discards

Numbers for discards in the North Atlantic are reported by USA, Canada and UK (Bermuda) for 1987–2005 in longline operations, however the numbers for the latter two countries are negligible, whereas USA reported discards in quantities of 63 to 1136 t/year, averaging at around 390 t/year over time (ICCAT 2006). Discards can be presumed to be far higher than reported (Campana *et al*., 2005), especially in high seas fisheries. Shark bycatch in some fisheries are finned (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), although the USA, Canada and EC have taken measures to stop finning. If left intact, survival rates for discarded sharks can be high, the proportion of blue sharks alive at hauling longlines is given between 80–90% and about 60% of these sharks released may survive (Campana *et al*., 2005).

There is considerable bycatch of blue sharks in Japanese and Taiwanese tuna longliners operating in the Atlantic. Documentation is incomplete, estimates given in Matsunaga and Nakano (2005) indicate bycatch levels of 2000 to 6000 t annually for the North Atlantic. Freshly reported data by Taiwanese vessels show blue shark catches of 692, 1206 and 1272 t for the years 2003–2005 respectively (ICCAT, 2006). Boyd (2007) reported that one Japanese bluefin tuna observer fishing trip in 1997 yielded 186 sharks for 166 bluefin tuna. The extent of bycatch of blue sharks cannot be interpreted from present data, but available evidence suggests that longline operations can catch more blue shark bycatch than target fish.

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.

8.4 Commercial catch composition

No new information.

8.5 Commercial catch-effort data

No new information.

8.6 Fishery independent surveys

A few sources of fishery independent information are available (e.g. Simpfendorfer *et al*., 2002), mainly from the NW Atlantic where fishery independent studies have been conducted and regular survey and monitoring cruises are operated by US National Marine Fisheries Service (NMFS).

No fishery-independent information from the NE Atlantic is available, although records from recreational fisheries may be available.

8.7 Life-history information

Various studies have compiled data on biological information on this species in the North Atlantic and other areas. Some of these data are summarised in Table 8.2 (Growth parameters), Table 8.3. (Length-weight relationship) and Table 8.4 (other life-history parameters).

The NMFS also conducts a Cooperative Shark Tagging Program (CSTP) (NMFS, 2005), with tagging in the NE Atlantic also being undertaken under the auspices of the Irish Central Fishing Board Tagging Program (Green, 2007 WD) and UK Shark Tagging Program, and there have been other earlier European tagging studies (e.g. Stevens, 1976).

8.8 Exploratory assessment models

8.8.1 Previous assessments

No full-scale benchmark assessment has been conducted to date due to limitations on available data for this species. ICCAT completed a preliminary stock assessment in 2004, but no management recommendations were made. 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. The authors 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.

A recent study of the population trends of Atlantic pelagic predatory fishes reported that blue sharks have declined over 60% in recent decades (e.g. Baum *et al*., 2003), though this study has attracted some controversy (see Baum *et al*., 2005 and Burgess *et al*., 2005a,b). Other studies on blue shark have shown smaller declines (e.g. Campana *et al*., 2005), or significant declines in males only (Simpfendorfer *et al*., 2002).

8.8.2 Stock assessment

No assessment was undertaken.

8.9 Quality of assessments

Preliminary assessments undertaken by ICCAT are conditional on several assumptions, including the estimates of historical shark catch (with fins not always included in landing statistics), the relationship between catch rates and abundance, the initial state of the stock in 1971, as well as uncertainty in some life-history parameters.

8.10 Reference points

No reference points have been proposed for this stock.

8.11 Management considerations

Catch data of pelagic sharks are considered unreliable. ICCAT uses three sources of data when assessing pelagic shark stocks; reported data, tuna ratios and market data. Reported data to ICCAT are the declared landings made by each member state to ICCAT and the FAO. These data correspond to the data available to WGEF and the resulting estimate, fluctuating between 10 000 t and 15 000 t since reporting started in 1997 (Figure 8.1).

The tuna ratios are a comparison of the observed bycatch of these shark species in the tuna fisheries with the amount of tuna landings declared. Conservative estimates (ICCAT, 2005) for the Atlantic calculated from tuna catch ratios indicate catches of blue sharks constantly well above 20 000 t throughout since 1971 (Figure 8.3). These catches peaked at over 50 000 t annually in the early 1990s and decline after that.

Market data is based on observations on the amount of sharks or fins on sale in the large Asian fish markets. As part of their 2004 assessment, ICCAT compared these three figures (Figure 8.3). Observations on fin trade markets in Asia led to even higher estimates of catch numbers of Atlantic tuna longliners, ranging from 130 000 to 180 000 t of blue shark annually in the recent past (Clarke, 2006; ICCAT, 2005).

The EU implemented a ban on shark finning in 2003, (EC 1185/2003), with vessels requiring a Special Permit in order to process sharks at sea (i.e. enabling them to land fins and carcasses separately, but at a defined ratio). The effectiveness of this regulation has been discussed by Hareide *et al*. (2007).

Clearly, the working group catch estimate is an underestimate. Besides unaccounted discards and the 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 “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.

8.12 References

Aasen, O. 1966. Blahaien, *Prionace glauca* (Linnaeus, 1758). Fisken og Havet; 1; pp. 1–15.

Baum, J. K., Kehler, D. and Myers, R. A. 2005. Robust estimates of decline for pelagic shark populations in the Northwest Atlantic and Gulf of Mexico. Fisheries, 30: 27–30.

Baum, J. K., Myers, R. A, Kehler, D. G., Worm, B., Harley, S. J. and Doherty, P. A. 2003. Collapse and conservation of shark populations in the Northwest Atlantic. Science, 299: 389–392.

Burgess, G. H., Beerkircher, L. R., Cailliet, G. M., Carlson, J. K., Cortes, E., Goldman, K. J.; Grubbs, R. D., Musick, J. A., Musyl, M. K. and Simpfendorfer, C. A. 2005a. Is the collapse of shark populations in the Northwest Atlantic Ocean and Gulf of Mexico real? Fisheries, 30: 19–26.

Burgess, G. H., Beerkircher, L. R., Cailliet, G. M., Carlson, J. K., Cortes, E., Goldman, K. J.; Grubbs, R. D., Musick, J. A., Musyl, M. K. and Simpfendorfer, C. A. 2005b. Reply to "Robust estimates of decline for pelagic shark populations in the Northwest Atlantic and Gulf of Mexico". Fisheries, 30: 30–31.

Boyd, J.M. 2007. Report of an observer trip on a Japanese tuna longliner in the northeast Atlantic in 1997. Irish Fisheries Investigations. In press.

Campana, S. E., Marks, L., Joyce, W. Kohler, N. 2005. Catch, by-catch, and indices of population status of blue shark (*Prionace glauca*) in the Canadian Atlantic. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers. ICCAT 58(3): 891–934.

Castro, J. I. 1983. The sharks of North American waters. Texas A&M Univ. Press, College Station, TX, 180 pp.

Clarke S. C., McAllister M. K., Milner-Gulland E. J., Kirkwood G. P., Michielsens C. G. J., Agnew D.J., Pikitch E.K., Nakano H. and Shivji M.S., 2006. Global estimates of shark catches using trade records from commercial markets. *Ecology Letters*, (2006) 9: 1115–1126.

Diez, G., Santurtún, M., Ruiz, J., Iriondo, A., Gonzalez, I. and Artetxe, I. 2007. The longline Basque Fishery on blue shark (*Prionace glauca*) in the Bay of Biscay (1998–2006)

Working Document for ICES Working Group on Elasmobranch Fishes, Galway 22–28 June 2007.

Fitzmaurice, P, Green, P., Keirse, G., Kenny, M. and Clarke, M. 2005. Stock discrimination of blue shark, based on Irish tagging data SCRS/2004/124 Col. Vol. Sci. Pap. ICCAT, 58(3): 1171–1178.

García-Cortés, B. and J. Mejuto, 2002. Size-weight relationships of the swordfish (*Xiphias gladius*) and several pelagic shark species caught in the Spanish surface longline fishery in the Atlantic, Indian and pacific oceans. Col. Vol. Sci. Pap. ICCAT, 54 (4): 1132–1149.

Green, P. 2007. Central Fisheries Board Tagging Programme 1970 to 2006. Working document to WGEF 2007 (powerpoint display).

Hareide, N.R., J. Carlson, M. Clarke, S. Clarke, J. Ellis, S. Fordham, S. Fowler, M. Pinho, C. Raymakers, F. Serena, B. Seret, and S. Polti. 2007. European Shark Fisheries: a preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association EEA 2007, 71 p.

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

ICCAT. 2005. Report of the 2004 Inter-Sessional Meeting of the ICCAT Subcommittee on Bycatches: Shark Stock Assessment. SCRS/2004/014.

ICCAT. 2006. Chapter 8.12 SHK-Sharks Report of the Standing Committee on Research and Statistics (SCRS) ICCAT. PLE-014/2006 Madrid, Spain, October 2-6, 2006 106–113.

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

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.

Kohler N.F., Casey J.G. and Turner P.A., 1995. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fishery Bulletin, 93: 412–418.

Matsunaga, H. and Nakano, H. 2005. Estimation of Shark Catches by Japanese Tuna Longline vessels in the Atlantic Ocean.SCRS/2004/116 Col. Vol. Sci. Pap. ICCAT, 58(3): 1096–1105.

NMFS 2006. Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. pp. 1600.

Simpfendorfer, C. A., Hueter, R. E., Bergman, U. and Connett, S. M. H. 2002. Results of a fishery-independent survey for pelagic sharks in the western North Atlantic, 1977–1994. Fisheries Research, 55: 175–192.

Skomal, G. B. and L.J. Natanson, 2002. Age and growth of the blue shark (*Prionace glauca*) in the North Atlantic Ocean. Col. Vol. Sci. Pap. ICCAT, 54 (4): 1212–1230.

Skomal, G. B. and L.J. Natanson, 2003. Age and growth of the blue shark (*Prionace glauca*) in the North Atlantic Ocean. Fishery Bulletin 101:627–639.

Stevens, J. D. (1975). Vertebral rings as a means of age determination in the blue shark (*Prionace glauca*). Journal of the Marine Biological Association of the United Kingdom 55, 657–665.

Stevens, J. D. 1976. First results of shark tagging in the North-east Atlantic, 1972–1975. Journal of the Marine Biological Association of the United Kingdom 56: 929–937.

Table 8.1. Blue shark in the North Atlantic. Available landings data 1982–2006 (Source Fao Fishstat & ICES). These data are a considerable underestimate of real landings. Catches reported by Taiwan R.O.C., Japan and P.R.China. are for the entire Atlantic Source: ICCAT.

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Area 27	Denmark	.	.	.	.	.	.	.	2	2	1	1	.	1
	France	9	8	14	39	50	67	91	79	130	174	260	315	338
	Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.
	Spain (Basque)	.	.	.	.	.	.	.	.	.	.	.	.	.
	Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.
	UK (E, W & N.I..)	.	.	.	.	.	.	.	.	7	.	.	.	.
	Uk (Scotland)	.	.	.	.	.	.	.	.	1	.	.	.	.
Area 34	Benin	.	.	.	.	.	.	.	.	.	.	.	.	.
	China	.	.	.	.	.	.	.	.	.	.	.	.	.
	Liberia	.	.	.	.	.	.	.	.	.	.	.	.	.
	Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.
	Spain	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.
Area 21	Canada (Maritims)	N.A.	.	.	.	.	.	.	.	.	.	.	.	.
	Canada (Nfld)	.	.	.	.	.	.	.	.	.	.	.	.	.
All Atlantic	Taiwan - R. O. C.	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.
	Japan	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2596
	China - P. R.	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.
	Total	9	8	14	39	50	67	91	81	140	175	261	315	2935

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Area 27	Denmark	2	3	1	1	.	2	.	13	6	1	0	.
	France	285	320	270	238	166	218	69	35	49	42	57	107
	Ireland	.	.	.	.	67	22	66	11	3	.	.	.
	Spain (Basque)	.	673	439	383	550	442	457	482	367	390	384	484
	Portugal	.	.	.	.	886	1133	1006	1209	2170	323	516	75
	UK (E, W & N.I..)	.	.	.	7	.	84	63	35	28	.	5	22
	Uk (Scotland)	.	.	.	1	.	12	9	5	4	.	.	.
Area 34	Benin	.	.	6	4	27	.	.	.	9	7	.	.
	China	.	.	.	.	.	.	750	420	600	.	.	.
	Liberia	.	.	.	.	76	70	.	.	.	25	.	.
	Portugal	.	.	.	.	.	351	557	668	1292	661	.	.
	Spain	N.A.	N.A.	12183	9541	9225	7820	7958	7159	10080	9955	N.A.	N.A.
Area 21	Canada (Maritims)	.	.	.	.	53	18	.	2	6	.	.	.
	Canada (Nfld)	.	.	.	.	.	.	.	3	.	.	.	.
All Atlantic	Taiwan - R. O. C.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	692	1206	1272	N.A.
	Japan	1589	1044	996	850	893	494	532	742	830	1470	N.A.	N.A.
	China - P. R.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	750	420	600	N.A.	N.A.	N.A.
	Total	287	996	12899	10176	11050	10172	10935	10041	14614	11404	963	688

Table 8.2. Blue shark in the North Atlantic. Von Bertalanffy growth parameters from various studies (L_∞ in cm (TL), k in years-1, t_0 in years).

AREA	L_∞	K	T_0	SEX	STUDY
North Atlantic	394	0,133	-0,801	Combined	Aasen (1966)
North Atlantic	423	0,11	-1,035	Combined	Stevens (1975)
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)

Table 8.3. Blue shark in the Atlantic. Length-Weight relationships from various studies and Areas. (RW= Round Weight, DW= Dressed Weight).

AREA	EQUATION	N	SEX	STUDY
Northwest Atlantic	RW= 0,000003841 x $FL^{3.1313}$	4529	Combined	Kohler *et al.* (1995)
Northeast Atlantic	DW= 0,000000804 x $FL^{3.232}$	354	Combined	García-Cortés and Mejuto (2002)
Atlantic	RW= 0,00000392 x $TL^{3,41}$	17	Male	Stevens (1975)
Atlantic	RW= 0,00000131 x $TL^{3,20}$	450	Female	Stevens (1975)
Atlantic	RW= 0,0000003184 x $TL^{3,1313}$	4529	Combined	Castro (1983)

Table 8.4. Blue shark in the Atlantic. Life-history parameters from various sources.

SEX	MAX. SIZE (cm TL)	MAX. AGE (years)	SIZE AT MATURITY (cm TL)	AGE AT MATURITY (years)	GESTATION PERIOD (months)	LITTER SIZE (number of pups)
Male	~ 383	16–20	~ 220	~ 5		
Female	~ 383	16–20	178–227	~ 5	9–12	14–82

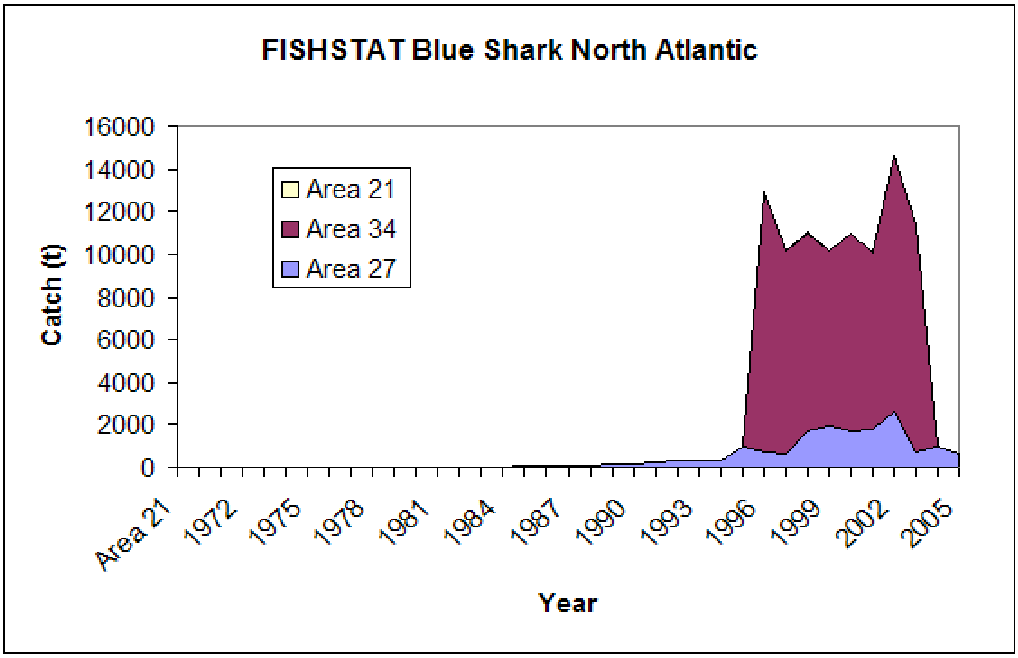


Figure 8.1. Blue Shark in the North Atlantic. Available landings data 1970–2006 (Source Fao Fishstat & ICES). Reported catches from Area 34 are almost exclusively by Spain, reporting from 1997 to 2004. The sum of data are a considerable underestimate of real landings. Graph excluding data for entire Atlantic by Taiwan R.O.C., Japan and P.R.China.

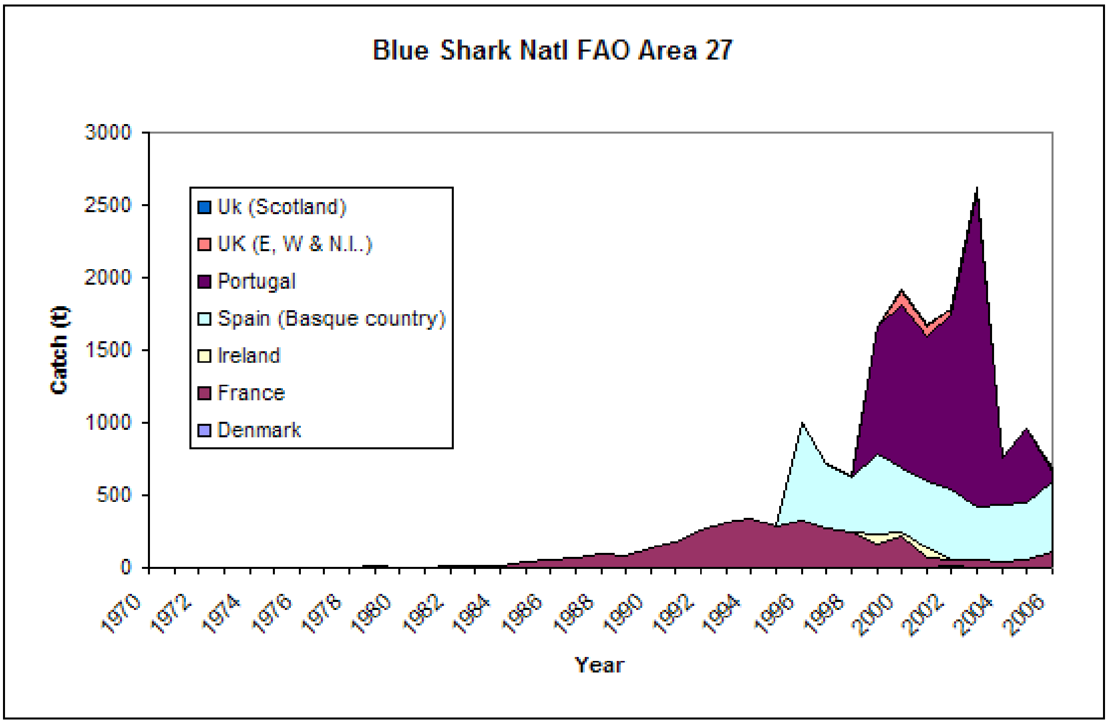


Figure 8.2. Blue Shark in the North Atlantic FAO Area 27. Available landings data 1970–2006 (Source FAO Fishstat & ICES).

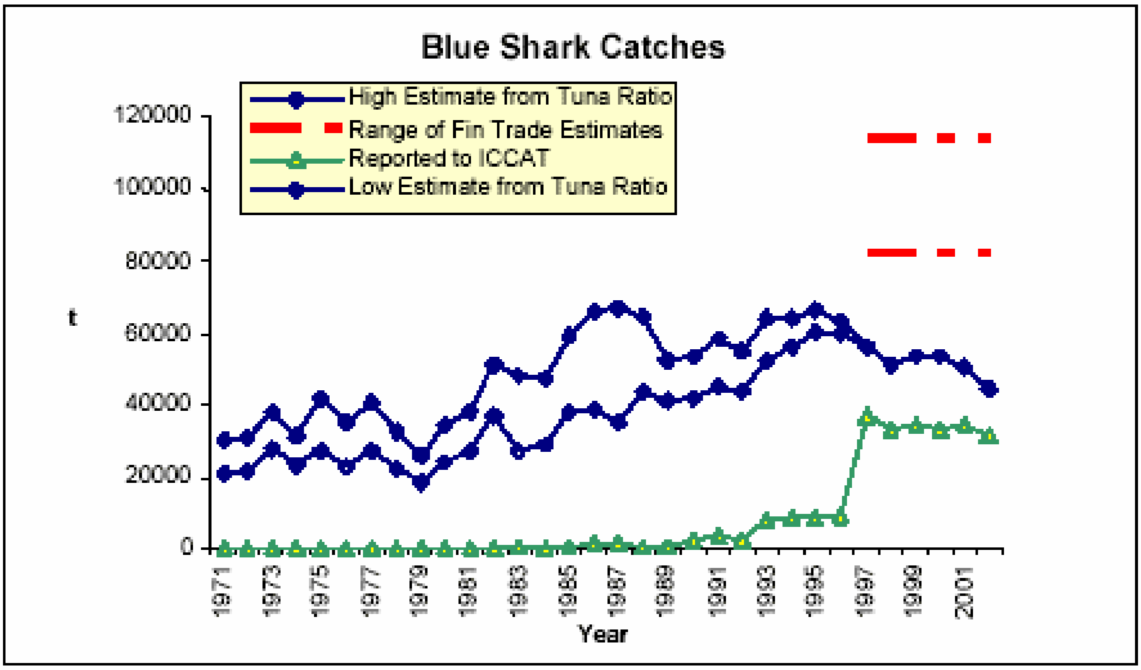


Figure 8.3. Blue shark in the Atlantic. Comparison of shark catch reported to ICCAT with estimates resulting from tuna to shark ratios and from fin trade data for blue sharks in the Atlantic. Source: ICCAT.

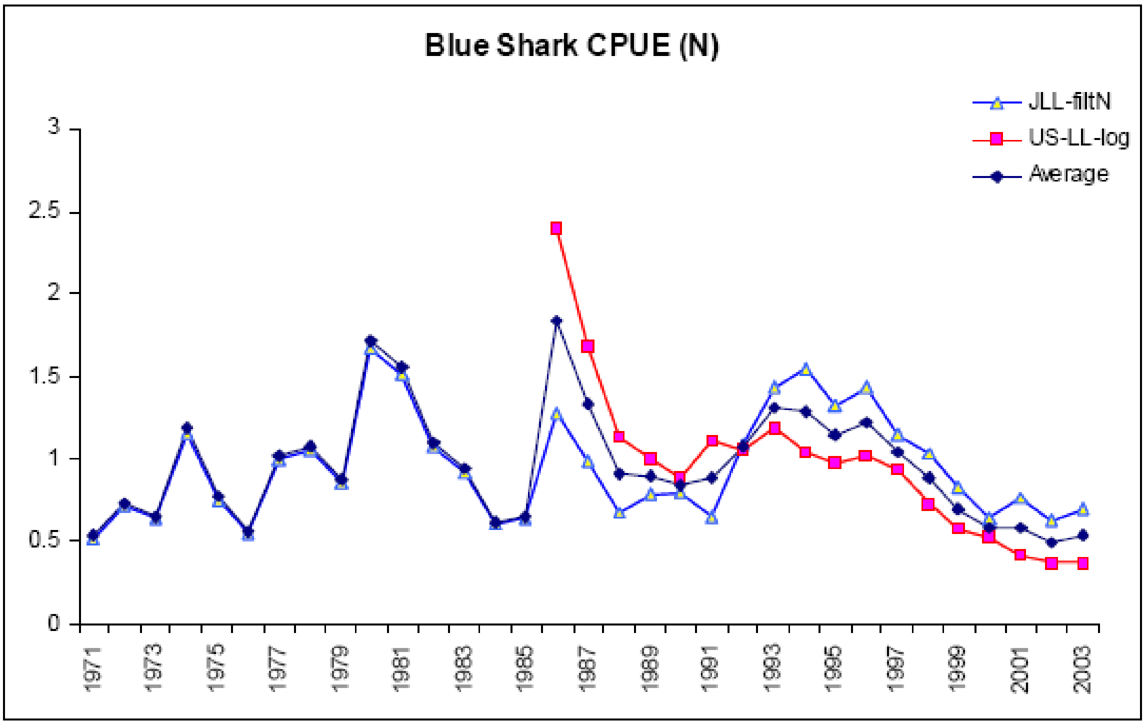


Figure 8.4. Blue Shark in the North Atlantic. CPUE indices calculated at ICCAT assessment 2004 (JLL: Japanese longline logbook data US-LL: US-American longline logbook data).

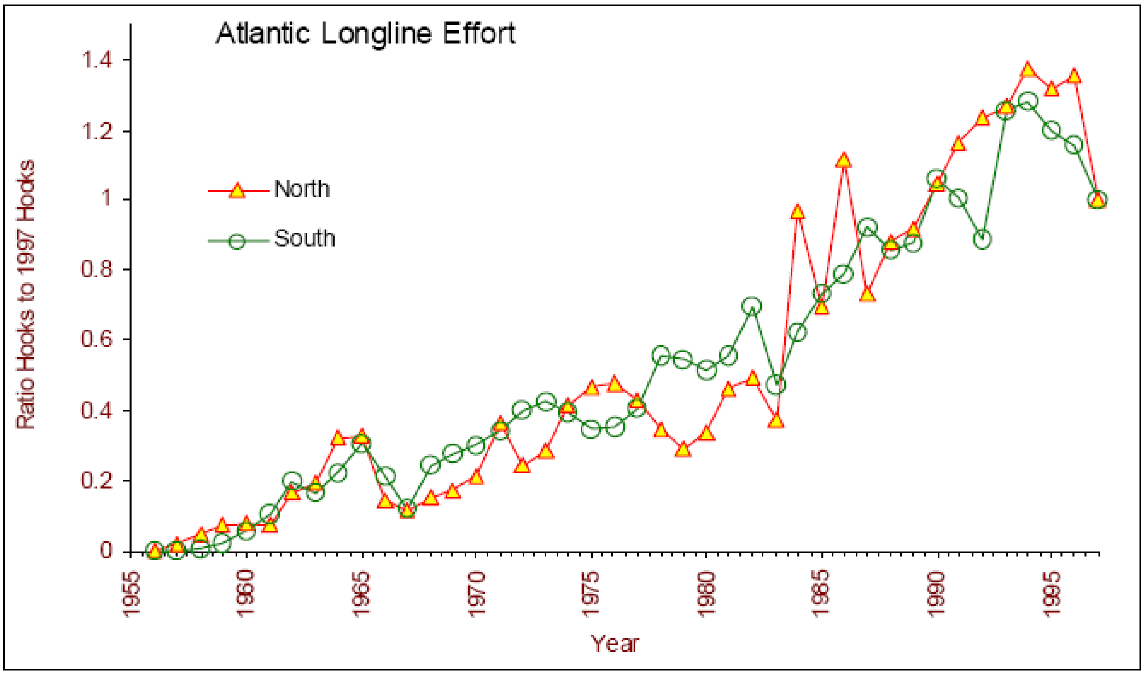


Figure 8.5. Blue Shark in the North Atlantic. Overall longline effort in the North and South Atlantic from 1956–1997. Source: ICCAT.

9 Shortfin mako in the north Atlantic (FAO Areas 27, 21, 34 and 31)

9.1 Stock distribution

The ICCAT pelagic shark assessment working group considers there to be a single stock of shortfin mako *Isurus oxyrinchus* in the North Atlantic, a conclusion also supported by genetic analysis of mako sharks from the Atlantic (Schrey and Heist, 2002, Heist *et al*., 1996). Therefore, the ICES area is only part of the North Atlantic stock. Further information in this report includes data from the entire North Atlantic.

9.2 The fishery

9.2.1 History of the fishery

The shortfin mako is a highly migratory pelagic species that is caught frequently as a bycatch, mostly in longline fisheries targeting tuna and billfish. Like porbeagle shark, it is a relatively high-value species (cf blue shark, which is of lower commercial value). Recreational fisheries on both sides of the North Atlantic also catch this species, although some of these fish are released.

9.2.2 The fishery in 2006

No new information.

9.2.3 ICES advice applicable

ACFM has never provided advice for shortfin mako shark in the ICES area. Because this species is not a unit stock in the ICES area, and because ICCAT will be responsible for assessment of this species, ICES has not been asked to provide advice.

9.2.4 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.

ICCAT completed a provisional stock assessment in 2004 (ICCAT, 2005) but no management recommendations were made.

9.3 Catch data

9.3.1 Landings

Landings data for FAO areas 27, 21 and 34 are presented in Table 9.1 and Figure 9.1 shows the combined catches for these areas. Catch data for FAO area 31 are not available. In the ICES area, shortfin mako is reported predominantly from Portuguese and Spanish fisheries in Subareas, VIII, IX, and X. However, records from as far north as Hatton Bank (northwest of Ireland) from Japanese tuna longliners are available (Boyd, 2007). Data used for this report (Table 9.1 and Figure 9.2) is compiled from the FishStat databases, covering the major part of North Atlantic management areas. No or minimal catches have been reported to ICES in 2005 and 2006. The information given in this report therefore is incomplete for the area of the entire North Atlantic.

Reported landings data were very low before 1997, with recent landings above 1000 t (Figure 9.1). The sudden appearance of shortfin mako catches in the statistics reflects the onset of documentation of these catches rather than the onset of landings.

ICCAT data show low levels of reported catches in the 1980s and early 1990s (with a peak of about 3000 t in 1985), with an increase since 1993 (Figure 9.3), peak landings of around 5000 t reported in 1997, and landings staying above 4000 t since. These reported catches are higher than that reported to ICES. Estimated catches, as calculated from tuna catch ratios, indicated catches of shortfin mako constantly above 4000–6000 t since 1971 (Figure 9.3) (see papers in ICCAT (2005) and references cited therein), with peak catches of over 10 000 t in the mid-1990s. The comparative evaluation indicates the uncertainty encountered in documenting this species' appearance in the tuna longline fishery.

There is considerable bycatch of shortfin mako sharks in Japanese and Taiwanese tuna longliners operating in the Atlantic. Estimates given in Matsunaga and Nakano (2005) indicate bycatch levels in Japanese longline operations of 300 to 500 t of shortfin mako annually for the North Atlantic. More information on bycatch is available but couldn't be reviewed in detail for this report.

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 program stated that of the sharks caught alive, 23% were released alive and 61% retained (ICCAT 2005).

While 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) does occur for this species as well, which may result in undocumented catches and mortality. Observations on fin trade markets in Asia and the numbers of fins traded there led to estimated 13 000–18 000 t of shortfin mako annually (Figure 9.3) (ICCAT, 2005).

The discrepancy between reported landings data and estimated catch data is likely to reflect discards due to finning. 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.

9.5 Commercial catch-effort data

CPUE data were compiled at the ICCAT assessment in 2004 (ICCAT, 2005), 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.

9.6 Fishery-independent surveys

Few sources of fishery-independent information are available, mainly from the NW Atlantic (e.g Simpfendorfer *et al*., 2002). Where fishery-independent studies have been conducted and regular monitoring cruises are operated by US National Marine Fisheries Service (NMFS). No fishery-independent information from the NE Atlantic is 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 Tables 9.2 (growth parameters), 9.3. (Length-weight relationships) and 9.4 (other life-history parameters).

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

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 of the assumptions underlying the model need to be completed before stronger conclusions can be drawn (ICCAT 2005, 2006).

9.8.2 Stock assessment

No assessment was undertaken.

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.

9.10 Reference points

No reference points have been proposed for this stock.

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 an underestimate. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic “nei” categories. 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 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 are currently assessing the Atlantic shortfin mako stock to determine possible threat level (NMFS, 2006).

9.12 References

Boyd, J. (In Prep.) Report of observer trip on a Japanese tuna longliner Koshin Maru #8. Irish Fishery Bulletin.

DFO, 2006. Recovery Potential Assessment Report of Shortfin Mako Sharks in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/051.

García-Cortés, B. and J. Mejuto, 2002. Size-weight relationships of the swordfish (*Xiphias gladius*) and several pelagic shark species caught in the Spanish surface longline fishery in the Atlantic, Indian and Pacific Oceans. Coll. Vol. Sci. Pap. ICCAT, 54 (4): 1132–1149.

Green, P. 2007. The Central Fisheries Board Shark Tagging Programme 1970–2006. Working document to WGEF (Powerpoint Presentation).

Heist E. J., Musick J. A., Graves J. E. 1996. Genetic population structure of the shortfin mako (*Isurus oxyrinchus*) inferred from restriction fragment length polymorphism analysis of mitochondrial DNA. *Canadian Journal of Fisheries and Aquatic Sciences* **53**, 583–588.

ICCAT, 2005. Report of the 2004 Inter-sessional Meeting of the ICCAT Subcommittee on By-catches: shark stock assessment. Coll. Vol. Sci. Pap. ICCAT, 58(3): 799–890.

ICCAT. 2006. Chapter 8.12 SHK-Sharks Report of the Standing Committee on Research and Statistics (SCRS) Madrid, Spain, October 2-6, 2006. ICCAT. PLE-014/2006, 106–113.

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

Kohler, N. E., J. G. Casey and P. A. Turner, 1995 Length-weight relationships for 13 species of sharks from the western North Atlantic. Fishery Bulletin 93, 412–418.

Matsunaga, H., Nakano, H. 2005. Estimation of Shark Catches by Japanese Tuna Longline vessels in the Atlantic Ocean. SCRS/2004/116 Col. Vol. Sci. Pap. ICCAT, 58(3): 1096–1105.

Natanson, L., Kohler, N. E., Ardizzone, D., Cailliet, G. M., Wintner, S. and Mollet, H. 2006. Validated age and growth estimates for the shortfin mako, *Isurus oxyrinchus*, in the North Atlantic Ocean. Environmental Biology of Fishes 77, 367–383.

NMFS 2006. Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. pp. 1600.

Pratt, H. L., Jr. and Casey, J. G. 1983. Age and growth of the shortfin mako, *Isurus oxyrinchus*, using four methods. Canadiuan Journal of Fisheries and Aquatic Sciences, 40:1944–1957.

Schrey, A., and E. J. Heist. 2002. Microsatellite markers for the shortfin mako and cross-species amplification in Lamniformes. Conservation Genetics, 3:459–461.

Simpfendorfer, C. A., Hueter, R. E., Bergman, U. and Connett, S. M. H. 2002. Results of a fishery-independent survey for pelagic sharks in the western North Atlantic, 1977–1994. Fisheries Research, 55: 175–192.

Table 9.1. Shortfin mako in the North Atlantic (FAO Areas 21, 27 & 34). Available landings (tonnes) of shortfin mako by country. (Source FAO Fishstat & ICES).

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Area 27	Portugal	4	.	.	.	.	.	.	160	183	186	107	542	328	12	15,4
	Spain	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	255	11	5
	UK (E, W & N.I.)	.	.	.	.	.	.	.	2	3	2	1	1	.	.	.
Area 34	Portugal	.	.	.	.	.	.	.	.	42	42	68	151	42	.	.
	Spain	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	468	N.A.	N.A.
	Benin	.	.	.	.	.	.	.	4	3	1	.	.	.	.	.
	China	.	34	45	23	27	19	74	126	191	22	208	260	.	.	.
	Côte d'Ivoire	13	7	17	12	.	92	38	.	.	.	.	.	.	.	.
	Liberia	.	.	.	.	15	.	.	10	9	15	.	.	.	.	.
	Philippines	.	.	.	.	.	.	.	.	116	.	.	.	.	.	.
Area 21	Canada (Maritimes)	.	.	.	.	.	.	.	53	54	56	67	67	.	.	.
	Canada (Newfndlnd)	.	.	.	.	.	.	11	16	21	.	7	.	.	.	.
	USA	.	.	.	.	.	.	.	21	.	.	.	.	.	.	.
	Total	17	41	62	35	42	111	123	392	622	324	458	1021	1093	23	20,4

Table9.2. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Growth parameters from 2 studies.

Area	L_∞	k	T_0	Sex	Study
Northwest Atlantic	302	0,266	-1	Male	Pratt & Casey (1983)*
Northwest Atlantic	345	0,203	-1	Female	Pratt & Casey (1983)*
Northwest Atlantic	253	0,125	71,6	Male	Natanson *et al.* (2006)**
Northwest Atlantic	366	0,087	88,4	Female	Natanson *et al.* (2006)**

*** Formation of 2 vertebral bands annually assumed and von Bertalanffy growth function used t_0 in years.**

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

Table 9.3. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Length-Weight relationships from 2 studies and Areas. (RW= Round Weight, DW= Dressed Weight).

Area	Equation	N	Sex	Study
Northwest Atlantic	$RW=0,0000052432 \times FL^{3.1407}$	2081	Combined	Kohler *et al.* (1995)
Northeast Atlantic	$DW= 0,000002808 \times FL^{3.202}$	17	Combined	García-Cortés and Mejuto (2002)

Table 9.4. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Life-history parameters from various sources.

Sex	Max. size (cm TL)	Max. age (years)	Size at maturity (cm TL)	Age at maturity (years)	Gestation Period (months)	Litter size (number of pups)
Male	~ 275	~ 30	~ 180	~ 8		
Female	~ 400	~ 32	~ 260	~ 18–20	15–18	10–18

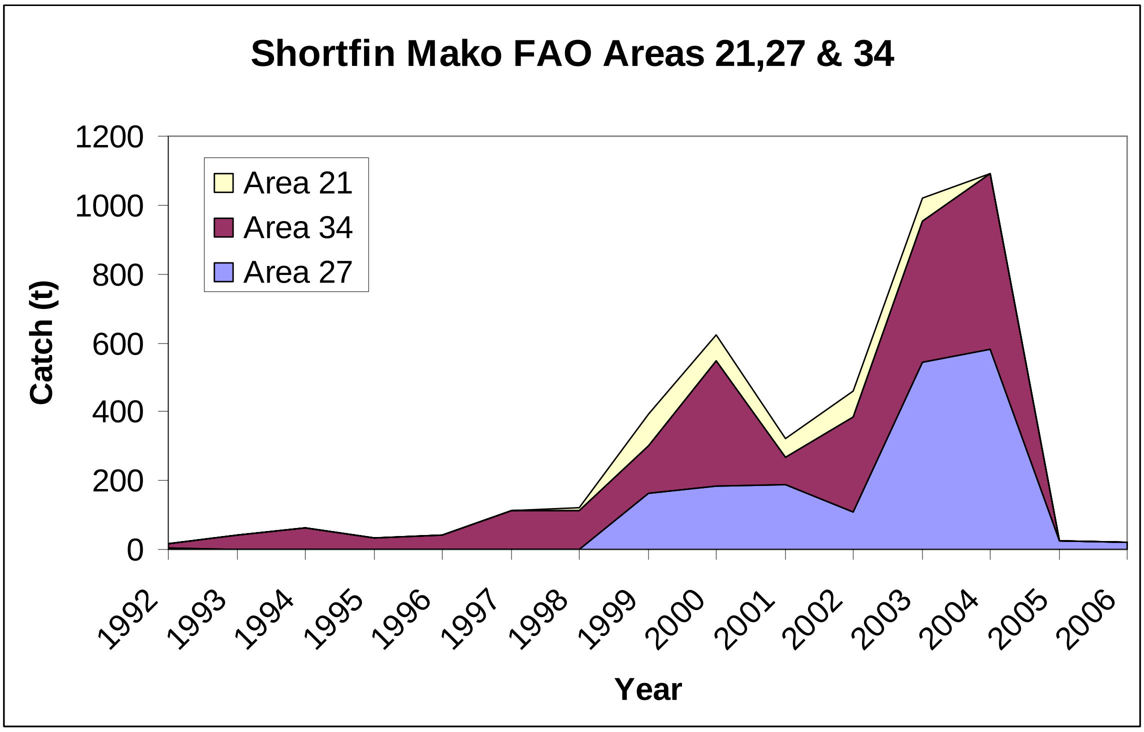


Figure 9.1. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Available landings (tonnes) from North Atlantic by FAO Areas 27, 21 & 34. Reporting has been minimal or the years 2005 and 2006.

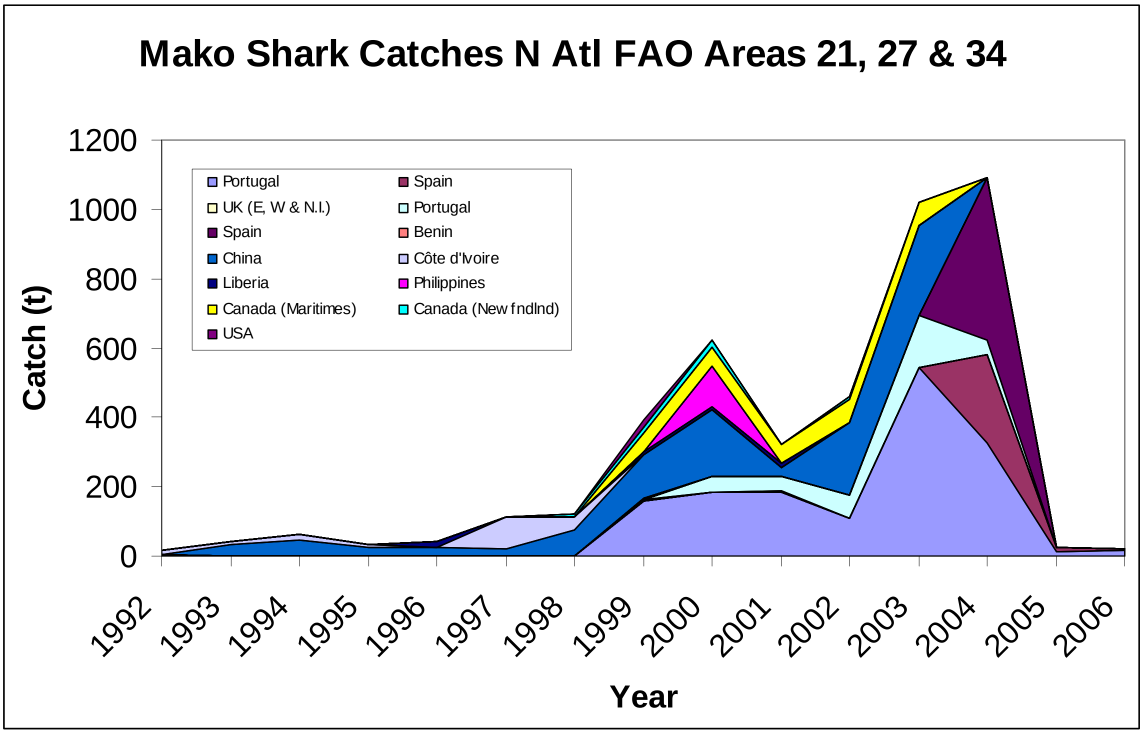
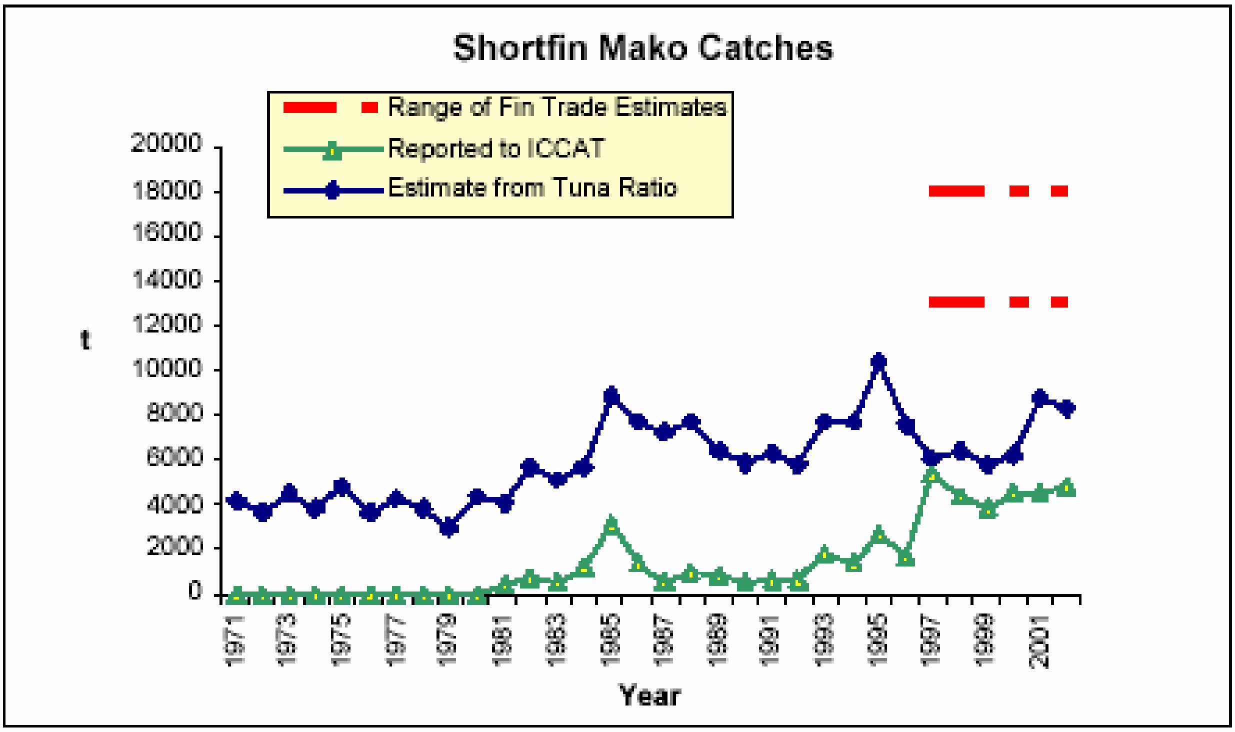


Figure 9.2. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Available landings (tonnes) from North Atlantic (Areas 27, 21, 34) by country. Reporting has been minimal or the years 2005



and 2006.

Figure 9.3. 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).

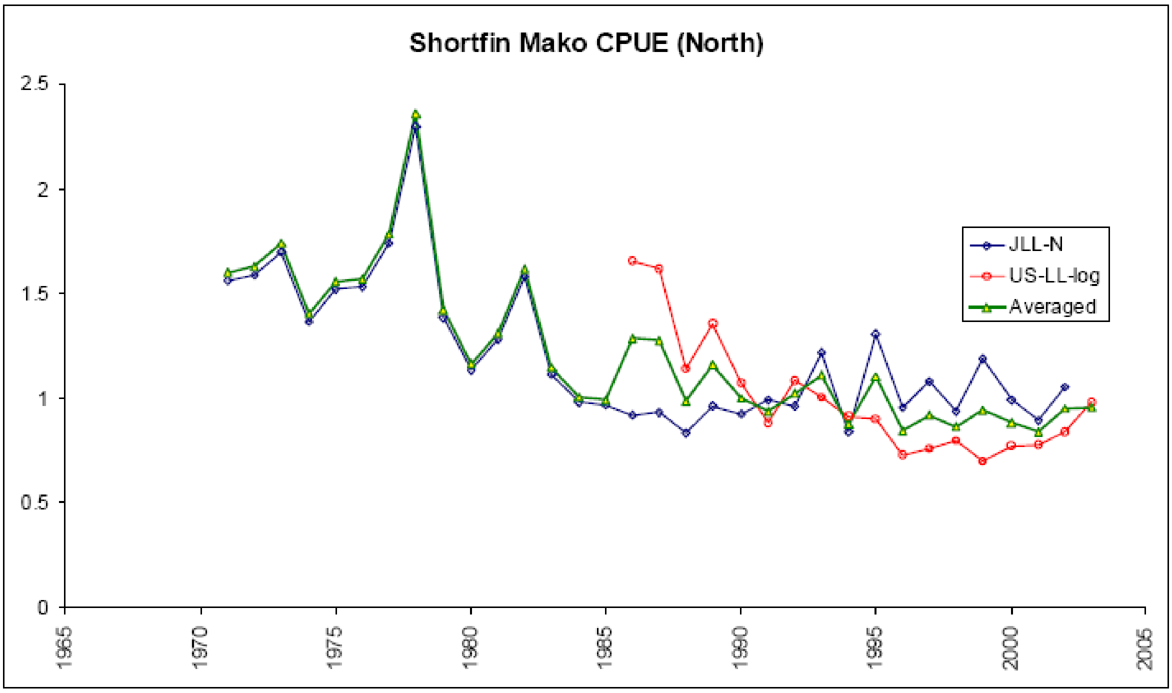


Figure 9.4. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. CPUE indices calculated at ICCAT assessment 2004 (JLL: Japanese longline logbook data US-LL: US-American longline logbook data).

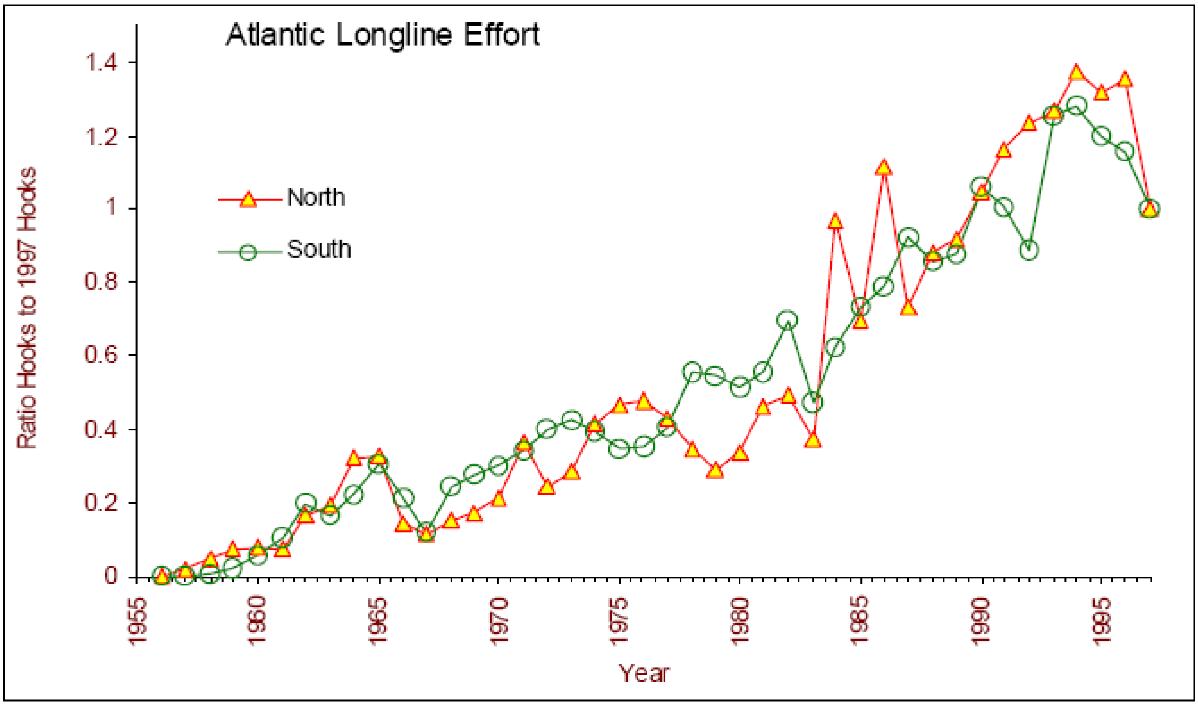


Figure 9.5. Shortfin mako (*Isurus oxyrinchus*) in the North Atlantic. Overall longline effort in the North and South Atlantic from 1956–1997. Source: ICCAT (2005).

10 Tope in the North East Atlantic and Mediterranean

Tope were first addressed by WGEF in 2006 (ICES, 2006), and this section only updates landings data (Table 10.1, Figure 10.2), the fishery in 2006 (Section 10.2.3) and management considerations (Section 10.11).

10.1 Stock distribution

WGEF considers that there is a single stock of tope (or school shark, *Galeorhinus galeus*) in the ICES area, with the centre of the distribution ranging from Scotland and southern Norway southwards to the coast of north-western 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 sub-areas II, III and V areas where tope tend to be an occasional vagrant).

This stock, however, extends beyond the ICES area and into the Mediterranean Sea and the CECAF area. Though the distribution of tope along the western sea board of Africa, and the degree of mixing (if any) between North East and South East Atlantic tope stocks are unclear, tope tagged in the ICES area have been recaptured as far south as the Canary Islands. Tope do not occur in the North West Atlantic.

Hence, the North East Atlantic tope stock covers the ICES Area (II–X), Mediterranean Sea (Subareas I–III) and northern part of the CECAF area, and any future assessment of the North-east Atlantic tope stock may need to be undertaken in conjunction with the General Fisheries Commission for the Mediterranean (GFCM) and Fishery Committee for the Eastern Central Atlantic (CECAF).

The stock unit identified by WGEF was based on published tagging studies (e.g. Holden and Horrod, 1979; Stevens, 1976, 1990; Irish Central Fisheries Board, unpublished data), which clearly indicate that tagged fish move widely throughout the north-eastern Atlantic (Figure 10.1). There are several on-going tagging programmes, which may provide further information on the stock in the future.

Tope tend to most commonly reported in continental shelf waters, though tag returns suggest that they occasionally move further offshore. Tope are primarily piscivorous (Ellis *et al*., 1996; Morato *et al*., 2003), feeding on a variety of pelagic and demersal fish and cephalopods.

10.2 The fishery

10.2.1 History of the fishery

Currently there are no targeted commercial fisheries for tope in the north-eastern Atlantic, though they are taken as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic set gears. Though tope are discarded in some fisheries, due to their low market value, 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.

Landings data on this species are limited, as they are often included as "dogfishes and hounds" (DGH). Nevertheless, England and France have some species-specific landings data, and there are also limited data from Denmark, Ireland, Portugal and Spain in recent years.

Many of the reported landings are from the English Channel, Celtic Sea and northern Bay of Biscay (Bonfil, 1994). Tope is also caught in Spanish fisheries in the western Cantabrian Sea (Galicia), where about 80% of the landings are from longline vessels, with the remainder from trawl and small gillnets (Anon., 2003). Tope also feature in the catches off mainland Portugal, and are an important component of Azorean bottom long line fisheries (Heessen, 2003;

Morato *et al*., 2003). Tope are also caught in offshore long-line fisheries is this area (Pinho, 2005).

10.2.2 The fishery in 2006

There were no major changes to the fishery noted in 2006. It has been suggested that there may be a greater retention of tope in some UK inshore fisheries operating in ICES Division IVc, as a result of bycatch limits on skates and rays (see Section 15), although no data are currently available to examine this.

10.2.3 ICES Advice applicable

ACFM has never provided advice for this stock.

10.2.4 Management applicable

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

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. dogfishes and hounds). Reported species-specific landings, which commenced in 1978 for French fisheries, are given in Table 10.1, with these landings relatively stable in recent years, at about 500 $t.y^{-1}$ (Figure 10.2).

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 mis-reporting or under-reporting is not known.

Landings indicate that France is one of the main nations landing tope (though data for 1980 and 1981 were not available). The United Kingdom also land tope, though species-specific data are not available prior to 1989. Since 2001, Ireland, Portugal and Spain have also declared species-specific landings, though recent data were not available for Spanish fisheries.

10.3.2 Discards

Though some discards information is available from various nations, data are limited for most nations and fisheries. The length-frequency of tope observed in UK (England and Wales) discard sampling for demersal trawl fisheries and drift and fixed net fisheries are illustrated in Figure 10.3. These are raw data that, due to the small sample size of fish involved, have been aggregated across years (2001–2006) and ICES Divisions (IV b-c, VII a, d-k) and have not been raised to fleet level. It indicates that juvenile tope tend to be discarded in demersal trawl fisheries, though larger individuals are usually retained, with tope caught in drift and fixed net fisheries usually retained. Smaller individuals (<60 cm total length) were not recorded during observer trips in the fixed and drift net fisheries, which could be due to gear selectivity or that these fisheries do not overlap with juvenile tope in space/time.

10.3.3 Quality of catch data

Catch data are of poor quality, and biological data are not collected under the Data Collection Regulations. Some generic biological data are available (see Section 10.7).

10.4 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 (due to low gear selectivity), and they are only caught occasionally in most GOV trawl and other otter trawl surveys.

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 north-eastern 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. The tendency for many surveys to now have short trawl durations (e.g. of less than one hour) may also affect the likelihood of catching tope. Nevertheless, survey data may provide useful indications of areas where juvenile tope are caught.

10.6.3 Length distributions

The size distributions of fish caught in surveys around the British Isles are illustrated in Figure 10.4. These data are aggregated across years for the various surveys, and all surveys are described in Ellis *et al*. (2005a, b). Survey data from 4 m beam trawl surveys operating in the English Channel (July, 1990–2005), and Bristol Channel and Irish Sea (September, 1990–2005) only catch tope very infrequently. Surveys in the North Sea (Granton trawl and GOV trawl, August, 1977–2005) sample a large part of the overall size range, including pups 31–45 cm long, and other juveniles. Surveys in the Celtic Sea (Portuguese high headline trawl, March, 1982–2003) sampled mostly larger individuals and comparatively few juveniles were recorded during this survey, although this survey has now ceased.

Q4 IBTS surveys in the Irish and Celtic Seas (November, modified GOV with rockhopper ground gear, 2004–2005) also sample small numbers of tope, with specimens tagged and released wherever possible. 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.

10.7 Life-history information

There have been few studies describing the age and growth and reproduction of tope in the north-eastern Atlantic (e.g. Capapé and Mellinger, 1988), and there is no routine monitoring of length, weight and maturity at age for either survey or commercial catches. Due to the importance of tope in Australian and South American fisheries, there have been several biological studies of these stocks (e.g. Peres and Vooren, 1991; Ward and Gardner, 1997; Hurst *et al*., 1999; West and Stevens, 2001; Lucifora *et al*., 2004).

Tope is an aplacentally viviparous shark, with gestation lasting approximately one year, and may therefore have an annual reproductive cycle, though it is unknown whether tope in the north-eastern Atlantic have resting periods between pregnancies. Studies on the South West Atlantic tope stock indicate that it has a triennial reproductive cycle (Peres and Vooren, 1991).

Tope is a long-lived species, with longevity of at least 36 years, based on tag returns and age and growth studies (e.g. Moulton *et al*., 1989; Peres and Vooren, 1991).

The ovarian and uterine fecundity has been estimated as 14–44 and 10–41 for specimens in the Mediterranean Sea (Capapé and Mellinger, 1988), and litter size increases with maternal length. Pups are born after a twelve month gestation period at a size of about 30–40 cm (Compagno, 1984).

Males and females mature at lengths of about 125–158 cm and 140+ cm respectively (Capapé and Mellinger, 1988), with first spawning occurring at a length of about 150 cm. Though no age at maturity data are available for the North East Atlantic stock, 50% maturity in males and females in the South West Atlantic occurs at about 11 years (111 cm) and 15 years (123 cm) (Peres and Vooren, 1991).

Though there are no published age and growth studies of the North East Atlantic tope stock, tope from other areas have been aged successfully using vertebrae (e.g. Ferreira and Vooren, 1991; Francis and Mulligan, 1998) and tag returns (Grant *et al*., 1979).

Recruitment: 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 10.5). Most of the records for pups recorded in UK surveys are from the southern North Sea (IV c), though they have also been recorded in the northern Bristol Channel (VII f), and fishermen in this area have reported catching large numbers of juvenile tope in this area. Given the low catch rates and high variability of pups and juveniles in surveys, these data are unlikely to be sufficiently robust to estimate annual recruitment. Other sources of information regarding pupping grounds may be available from the commercial and recreational fishing sectors.

Pupping and nursery grounds: There is limited information on the distribution of tope pups, though they have been reported to occur in certain inshore areas (e.g. southen North Sea, Bristol Channel). 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. Nevertheless, protecting pupping and nursery habitats has been considered an important tool for the Australian stock, where seasonal closures and gear restrictions to protect pregnant females migrating to pupping grounds have been used (Walker, 1999).

10.8 Exploratory assessment models

10.8.1 Previous studies

No previous assessments have been made of tope in the north-east Atlantic, though 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.

10.8.3 Stock assessment

No assessment was undertaken, due to insufficient data.

10.9 Quality of the assessment

No assessment was undertaken, due to 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 over-exploitation, 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 currently a non-target species in commercial fisheries, though some of the bycatch is discarded, due to the low market value in many areas. There was the suggestion of developing a targeted commercial fishery in the southern North Sea (e.g. *Fishing News*, 17 and 24 June 2005), though has not proceeded at the present time.

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 (Ripley, 1946; Walker, 1999; Paul and Sanders, 2001). Evidence from these fisheries suggest that targeted fisheries would need to be managed quite conservatively, as targeted fisheries off California collapsed, the Australian fishery's long history of management has only very recently enabled some stock recovery to begin (Olsen, 1954, 1959, 1984; Walker, 1999), and there is concern over the seriously depleted status of the south-western Atlantic stock (Eilia *et al.*, 2005). 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

Anon. 2003. Report of the subgroup on resource status (SGRST) of the Scientific, Technical and Economic for Fisheries (STECF): Elasmobranch Fisheries. Brussels 22–25 July 2003.

Bonfil, R. 1994. Overview of world elasmobranch fisheries. FAO Fisheries Technical Paper, No. 341. FAO, Rome, 119 pp.

Capapé, C. and Mellinger, J. 1988. Nouvelles données sur la biologie de la reproduction du milandre, *Galeorhinus galeus* (Linné, 1778), (Pisces, Triakidae) des côtes tunisiennes. Cahiers Biologie Marine, 29: 135–146.

Compagno, L. J. V. 1984. FAO Species Catalogue. Sharks of the World: an annotated and illustrated catalogue of shark species known to date. Part 2: Carcharhiniformes. FAO Fisheries Synopsis No. 125, Vol. 4(2): 251–655.

Eilia, I., Rodriguez, A., Hasan, E., Reyna, M.V. and Amoroso, R. 2005. Biological observations of the tope shark, *Galeorhinus galeus*, in the Northern Patagonian Gulfs of Argentina. Journal of Northwest Atlantic Fishery Science, 35: 261–265.

Ellis, J. R., Cruz-Martinez, A., Rackham, B.D. and Rogers, S. I. 2005a. The distribution of chondrichthyan fishes around the British Isles and implications for conservation. Journal of Northwest Atlantic Fishery Science, 35: 195–213.

Ellis, J. R., Dulvy, N. K., Jennings, S., Parker-Humphreys, M. and Rogers, S.I. 2005b. Assessing the status of demersal elasmobranchs in UK waters: A review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Ellis, J. R., Pawson, M.G. and Shackley, S. E. 1996. The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the North-East Atlantic. Journal of the Marine Biological Association of the United Kingdom, 76: 89–106.

Ferreira B. P. and Vooren C. M. 1991. Age, growth and structure of vertebra in the school shark *Galeorhinus galeus* (Linnaeus, 1758) from southern Brazil. Fishery Bulletin, 89: 19–31.

Francis, M. P. and Mulligan, K. P. 1998. Age and growth of New Zealand school shark, *Galeorhinus galeus*. New Zealand Journal of Marine and Freshwater Research, 32: 427–440.

Grant, C. J., Sandland, R. L. and Olsen, A. M. 1979. Estimation of growth, mortality and yield per recruit of the Australian school shark, *Galeorhinus australis* (Macleay), from tag recoveries. Australian Journal of Marine and Freshwater Research, 30: 625–637.

Heessen, H. J. L. (ed) 2003. Development of Elasmobranch Assessments – DELASS: DG Fish Study Contract 99/055.

Holden, M. J. and Horrod, R. G. 1979. The migrations of tope, *Galeorhinus galeus* (L.), in the eastern North Atlantic as determined by tagging. Journal du Conseil International pour l'Exploration de la Mer, 38(3): 314–317.

Hurst, R. J., Bagley, N. W., McGregor, G. A. and Francis, M. P. 1999. Movement of the New Zealand school shark, *Galeorhinus galeus*, from tag returns. New Zealand Journal of Marine and Freshwater Research, 33: 29–48.

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

Lucifora, L., Menni, R. and Escalante, A. 2004. Reproductive biology of the school shark, *Galeorhinus galeus*, off Argentina: support for a single southwestern Atlantic population with synchronized migratory movements. Environmental Biology of Fishes, 71: 199–209.

Morato, T., Sola, E., Gros, M. P. and Menezes, G. 2003. Diets of thornback ray (*Raja clavata*) and tope (*Galeorhinus galeus*) in the bottom longline fishery of the Azores, northeastern Atlantic. Fishery Bulletin, 101: 590–602.

Moulton, P. L., Saddlier, S. R. and Knuckey, I. A. 1989. New time-at-liberty record set by tagged school shark *Galeorhinus galeus* caught off southern Australia. North American Journal of Fisheries Management, 9: 254–255.

Olsen, A. M. 1954. The biology, migration, and growth rate of the school shark, *Galeorhinus australis* (Macleay) (Carcharhinidae) in south-eastern Australian waters. Australian Journal of Marine and Freshwater Research, 5: 353–410.

Olsen, A. M. 1959. The status of the school shark fishery in south-eastern Australian waters. Australian Journal of Marine and Freshwater Research, 10: 150–176.

Olsen, A. M. 1984. Species synopsis of school shark, *Galeorhinus australis* (Macleay, 1881). 42 pp. (Food and Agriculture Organisation of the United Nations: Rome.)

Paul, L. J. and Sanders, B. M. 2001. A description of the commercial fishery for school shark, *Galeorhinus galeus*, in New Zealand, 1945 to 1999. New Zealand Fisheries Assessment Report 2001/32. 49 p.

Peres, M. B. and Vooren, C. M. 1991. Sexual development, reproductive cycle, and fecundity of the school shark *Galeorhinus galeus* off southern Brazil. Fishery Bulletin, 89: 655–667.

Pinho, M. R. 2005. Elasmobranches of the Azores (ICES Area X). ICES WGEF 2005 Working Document, 20 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.

Ripley, W. E. 1946. The soupfin shark and the fishery. California Division of Fish and Game Fish Bulletin*,* 64: 7–37.

Stevens, J. D. 1976. First results of shark tagging in the north-east Atlantic, 1972–1975. Journal of the Marine Biological Association of the United Kingdom, 56: 929–937.

Stevens, J. D. 1990. Further results from a tagging study of pelagic sharks in the north-east Atlantic. Journal of the Marine Biological Association of the United Kingdom, 70(4): 707–720.

Walker, T. I. 1999. *Galeorhinus galeus* fisheries of the world. In 'Case studies of management of elasmobranch fisheries'. FAO Fisheries Technical Paper 378/2. 24, 728–773.

Ward, R. D. and Gardner, M. G. 1997. Stock structure and species identification of school and gummy sharks in Australasian waters. Project FRRF 93/11 and FRDC 93/64. CSIRO Marine Research: Hobart, Tasmania, Australia, 92 pp.

West, G. J. and Stevens, J. D. 2001. Archival tagging of school shark, *Galeorhinus galeus*, in Australia: initial results. Environmental Biology of Fishes, 60: 283–298.

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 1978–2005. These data are considered an under-estimate 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	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	32	22	na	na	26	26	13	31	13	14	18	12	17	16
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK	na	na	na	na	na	na	na	na	na	na	na	18	14	21
Total (IIIa-IV)	32	22	0	0	26	26	13	31	13	14	18	30	31	37
ICES Division VI-VII														
France	522	2076	na	na	988	1580	346	339	114	1491	621	407	357	391
Ireland	na	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	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK	na	na	Na	na	na	na	na	na	na	na	na	56	45	47
Total (VI-VII)	522	2076	0	0	988	1580	346	339	114	1491	621	463	402	438
ICES Division VIII														
France	na	237	na	na	na	63	119	52	103	97	66	39	34	38
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK	+	+	+	+	+	+	+	+	+	+	+	-	-	-
Total (VIII)	0	237	0	0	0	63	119	52	103	97	66	39	34	38
ICES Division IX														
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Total (IX)														
ICES Division X														
Portugal	34	15	51	77	42	24	29	24	24	24	34	23	56	81
Total (X)	34	15	51	77	42	24	29	24	24	24	34	23	56	81
Other														
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Area 34 (Central East Atlantic)														
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL LANDINGS	578	2350	51	77	1056	1693	507	446	128	1626	739	555	523	594

Table 10.1. (continued). Tope in the North East Atlantic and Mediterranean. Reported species-specific landings (Tonnes) for the period 1978–2005. These data are considered an under-estimate 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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	-	-	-	-	-	-	-	3	8	4	5	5	5	8	na
France	10	11	12	8	11	5	11		11	11	6	6	3	3	6
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
UK	15	15	20	25	14	22	13	13	13	11	13	12	8	10	15
Total (IIIa-IV)	25	26	32	33	25	27	24	16	32	26	24	23	16	21	21
ICES Division V-VII															
France	235	240	235	265	314	409	312		368	394	324	284	209	181	293

ICES Division IIIa–IV	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ireland	na	na	na	na	na	na	na	na	na	4	1	6	4	na	7
Spain	na	na	na	na	na	na	na	na	na	+	242	3	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	+	+	3	15	10	.
UK	53	47	51	38	39	33	42	61	97	71	60	55	64	66	73
Total (VI-VII)	288	287	286	303	353	442	354	61	465	469	627	351	292	257	373
ICES Division VIII															
France	34	40	54	44	78	40	46	+	71	58	49	60	16	29	40
Spain	na	na	na	na	na	na	na	na	na	9	13	10	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	9	6	10	10	14	12
UK	-	-	-	-	-	-	-	-	-	1	+	3	8	6	5
Total (VIII)	34	40	54	44	78	40	46	0	71	77	68	83	34	49	57
ICES Division IX															
Spain	na	na	na	na	na	na	na	na	na	na	na	na	76	na	na
Total (IX)															
ICES Division X															
Portugal	80.3	115	116	124	79.6	104	128	129	142	81.7	77.3	69	51	45	45
Total (X)	80.3	115	116	124	79.6	104	128	129	142	81.7	77.3	69	51	45	45
Other															
France	-	-	-	-	-	-	-	386	-	2	-	-	-	-	-
Area 34 (Central East Atlantic)															
Portugal	-	-	-	-	-	-	-	-	2	1	2	98	na	na	Na
TOTAL LANDINGS	427	468	488	504	536	613	552	592	712	657	798	624	469	372	497

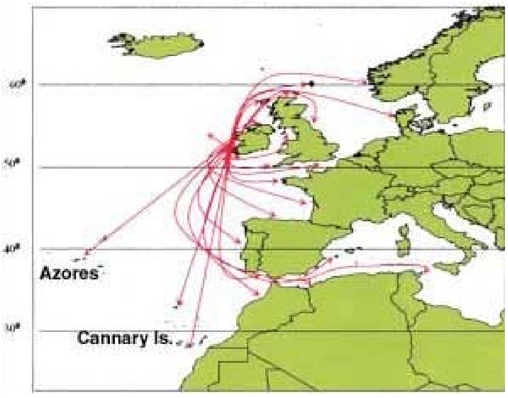


Figure 10.1. Tope in the North East Atlantic and Mediterranean. Location of tag returns from the tope tagging programme coordinated by the Central Fisheries Board (Ireland). Source: http://www.cfb.ie/fisheries_research/tagging/tope.htm.

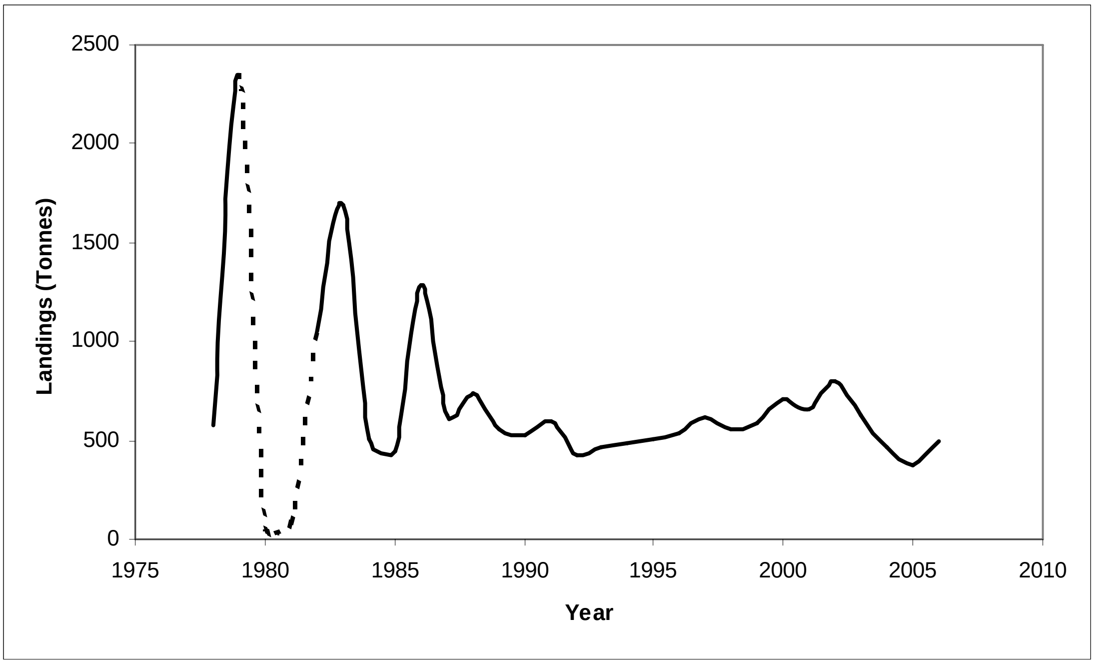
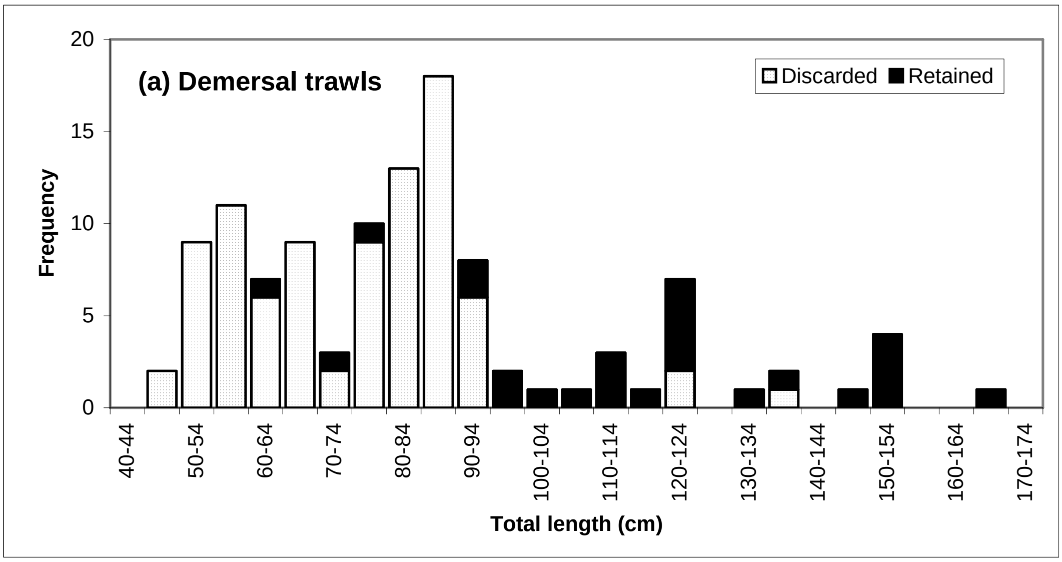


Figure 10.2. Tope in the North East Atlantic and Mediterranean. Annual landings of tope. These data are considered an under-estimate as some tope are landed under generic landings categories, and no species-specific landings data are available for the Mediterranean Sea and North-west African waters.



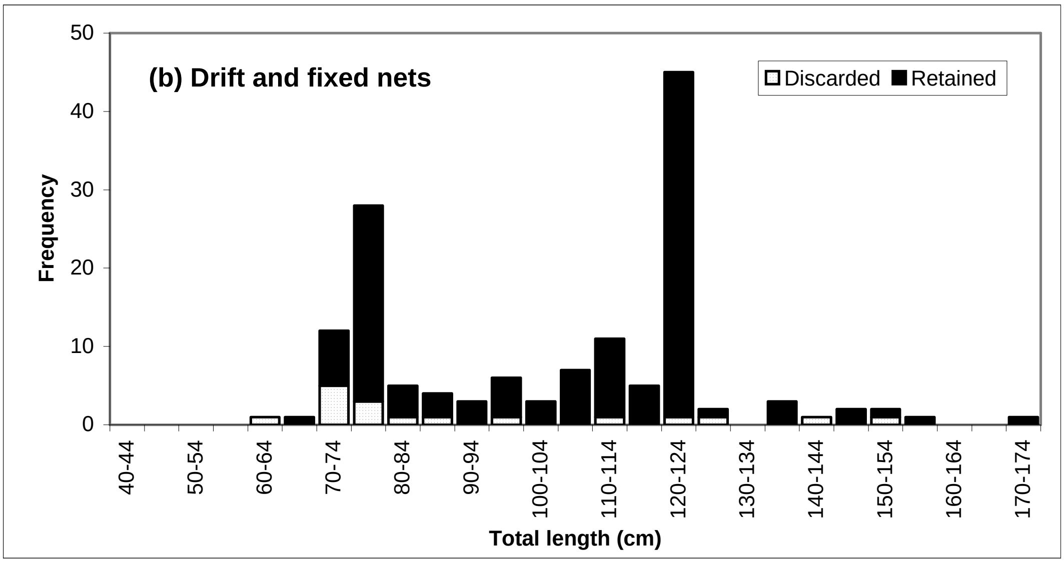


Figure 10.3. Tope in the North East Atlantic and Mediterranean. Length frequency of discarded and retained tope in (a) demersal trawl and (b) drift and fixed net fisheries as observed in UK (England and Wales) discard sampling.

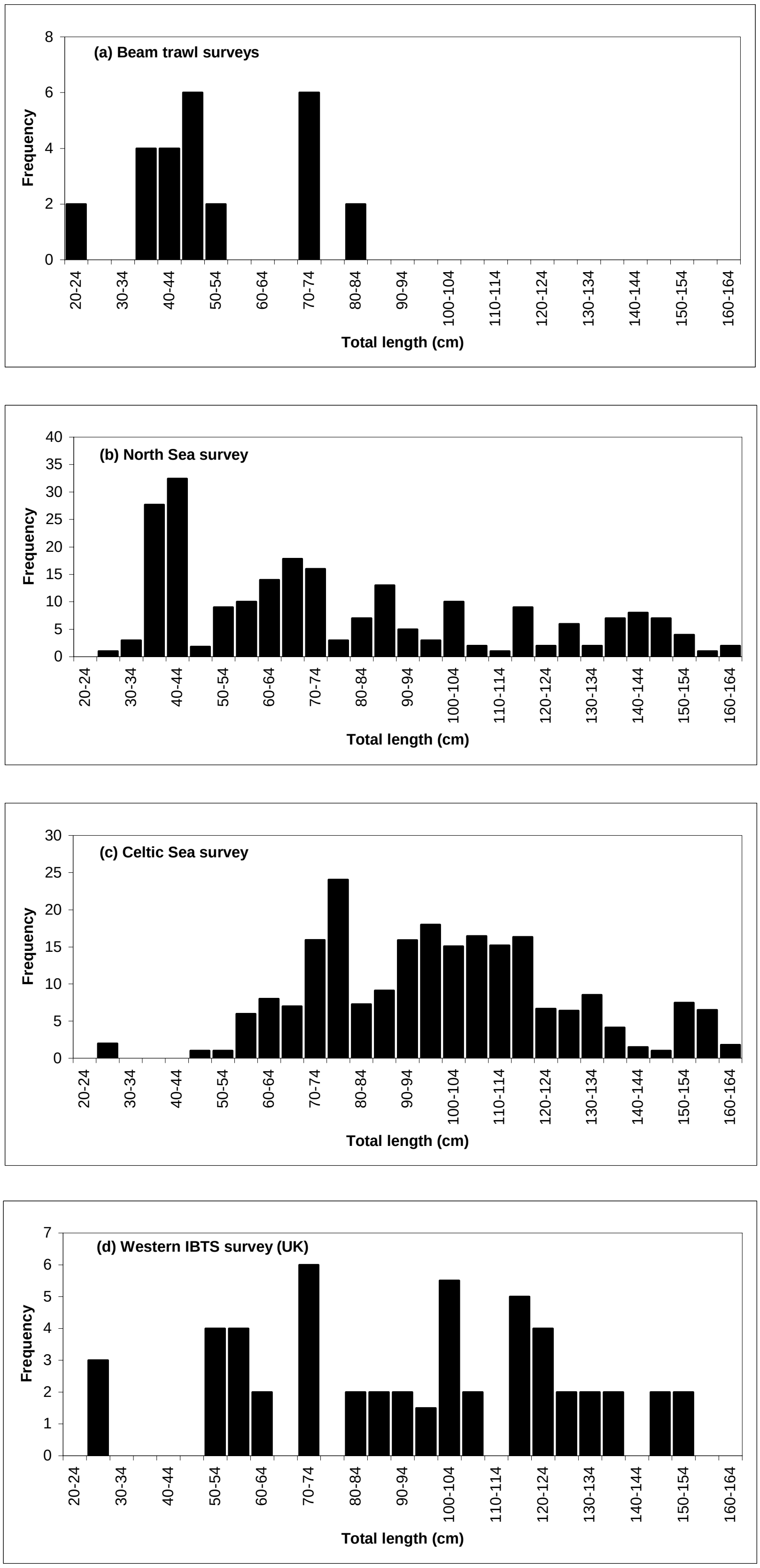


Figure 10.4. Tope in the North East Atlantic and Mediterranean. Length frequency graphs for UK surveys including (a) beam trawl surveys in the English Channel, Bristol Channel and Irish Sea; (b) North Sea; (c) Celtic Sea and (d) Irish Sea and Celtic Sea. For further information on these surveys see Sections 15 and 18.

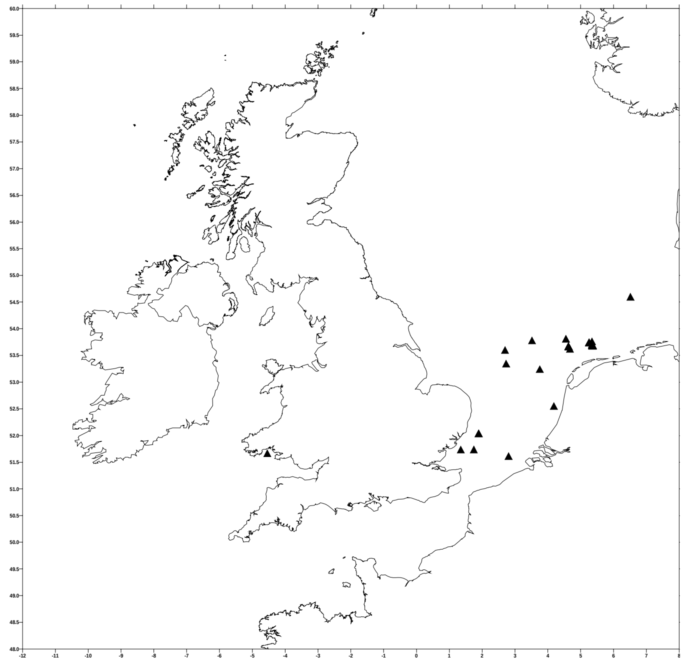


Figure 10.5. Tope in the North East Atlantic and Mediterranean. Sites where tope pups (24–45 cm total length) have been reported during UK surveys.

11 Thresher sharks in the North East Atlantic

11.1 Stock distribution

Two species of thresher sharks occur in the ICES areas: common thresher *Alopias vulpinus* and bigeye thresher *A. superciliosus.* Of these, *A. vulpinus* is the dominant species in the ICES area. There is little information on the stock identity of these circumglobal sharks. In the absence of records of transatlantic migrations, WGEF assume there to be a single NE Atlantic and Mediterranean stock of *A. vulpinus*. This stock could possibly be extended to the CECAF area.

11.2 The Fishery

11.2.1 The fishery

There is no target fisheries for thresher sharks in the NE Atlantic; although they are taken as a bycatch in longline and driftnet fisheries (e.g. Buencuerpo *et al.*, 1998; Macias *et al.*, 2003; Mejuto *et al.*, 2001: Tudela *et al.*, 2005). 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 mostly unreliable, because it is likely that the two species (*Alopias vulpinus* and *A. superciliosus*) are mixed in the records.

11.2.2 The fishery in 2006

No information

11.2.3 ICES advice applicable

ICES does not provide advice on 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 19 to 190 t in the NE Atlantic (ICCAT data-Table 11.1, Figure 11.1) and from 12 to 152 t for the ICES areas (Table 11.2). The main landing countries are Portugal (80 t in 2005), Spain (54 t in 2005) and France (18 t in 2005).

Thresher sharks have been caught in area IV, but the main catches occur in areas VII to IX. ACFM has never provided advice for this stock.

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 available (e.g. FAO, ICCAT, national data).

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.

11.4 Commercial catch composition

No data available.

11.5 Commercial catch-effort data

There are no CPUE data available for the ICES area. However rough estimates have been given for the driftnet fishery in the Alboran Sea (7000 individuals/year, 0.7–1.5 ind./fishing operation, 0.092–0.117 ind./km net set). Additionally, some CPUE data for *A. vulpinus* have been provided for the Italian swordfish fisheries in the frame of the STECF report (2003): 0.9 kg/1000 hooks, 1.2 kg/haul, 0.006 to 0.02 individuals/1000 hooks for the longline fisheries and 0.002 individuals/ 1000 m net for the driftnet fisheries in 1998–1999.

11.6 Fishery-independent surveys

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

11.7 Life-history information

Threshers are active, strong-swimming sharks. They are oceanic and coastal sharks occurring in tropical to cold-temperate seas. They are found from the surface to 500 depth (deepest record 723 m). Threshers are mostly epipelagic, but may stay at 200–500 m depth over the continental slope during the day and in open waters at 80–130 at night. They can be found far away offshore, but they are commonest over the continental and insular shelves.

In the NE Atlantic, *A. vulpinus* has been recorded from Norway to the Mediterranean Sea and the Black Sea, and off Madeira and the Azores, and *A. superciliosus* from Portugal, Spain and recently from UK (Thorpe, 1997), also from Madeira and the Azores, and in the Mediterranean Sea. Their main biological parameters are summarized in Table 11.3.

Biological data of the NE Atlantic thresher sharks are also very scarce; very few studies have been published (e.g. Moreno *et al.*, 1989; Moreno & Moron, 1992; Munoz-Chapuli, 1984; Rey & Munoz-Chapuli, 1992). However, most of biological parameters have been obtained thanks to studies on NW Atlantic, California and Taiwan longline fisheries (cf. Table 11.3).

A nursery area for *A. superciliosus* is suspected in the waters off the southwestern Iberian Peninsula (Moreno and Moron, 1992). Also, the same authors observed aggregations of gravid females of *A. vulpinus* in the Strait of Gibraltar.

Juvenile *A. vulpinus* are recorded occasionally in the English Channel and southern North Sea (Ellis, 2004).

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.

Despite its midrange intrinsic rebound potential (Table 11.3), the management of *Alopias vulpinus* is of concern, as shown by the quick decline of the USA Pacific fishery targeted on this species and which ended in the 1990 due to overfishing (Hanan *et al.*, 1993; Cailliet *et al.*, 1993).

11.8.2 Stock assessment

No assessment was undertaken, due to 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, due to insufficient data.

11.10 Reference points

No reference points have been proposed for these stocks

11.11 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, 2006) consider that *Alopias* spp. are particularly vulnerable to overexploitation and in need of close monitoring because of its high vulnerability resulting from its low fecundity and relatively high age of sexual maturity. Precautionary management measures could be adopted for the NE Atlantic thresher sharks, due to the fishing effort for large pelagic fishes in the region.

11.12 References

Bedford D. W. 1985. Pelagic shark/swordfish drift gill net fishery. California Department of Fish & Game, Management Information Document: 74 pp.

Bowman R. E., Stillwell C.E., Michaels W.L., and Grosslein M.D., 2000. Food of northwest Atlantic fishes and two common species of squid. NOAA Technical Memoir. *NMFS-NE*, 155: 138 p.

Buencuerpo V., Rios S., and Moron J. 1998. Pelagic sharks asociated with the swordfish, *Xiphias gladius*, fishery in he eastern North Atlantic Ocean and the Strait of Gibraltar. Fishery Bulletin, 96(4): 667–685.

Caillet G.M., and Bedford D.W. 1983. The biology of three pelagic sharks from California waters, and their emerging fisheries: a review. California Coop. Oceanic Fish. Invest. Report, 24: 57–69.

Cailliet G.M., Martin L.K., Harvey J.T., Kusher,D. and Welden B.A. 1983. Preliminary studies on the age and growth of blue, *Prionace glauca*, common thresher, *Alopias vulpinus*, and shortfin mako, *Isurus oxyrinchus*, sharks from California waters. In: Proceedings of the International workshop on age determination of oceanic pelagic fishes: Tunas, billfishes and sharks (E.D.Prince & L.M.Pulos, eds.) NOAA Technical Report NMFS*,* 8: 179–188.

Castro J. 1983. The Sharks of North American Waters. Texas A&M University: Texas A&M University Press, 192 pp.

Chen C.-T., Liu K.-M., and Chang Y.-C. 1997. Reproductive biology of the bigeye thresher shark, *Alopias superciliosus* (Lowe, 1839) (Chondrichthyes: Alopidae), in the northwestern Pacific. Ichthyological Research, 44(3) : 227–235.

Claro R., and García-Arteaga J. P. 1994. Crecimiento. p.321–402. *In*: R. Claro (ed.) Ecología de los peces marinos de Cuba. Instituto de Oceanologia Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo (CIQRO), México.

Compagno L.J.V. 2001. An annotated and illustrated catalogue of shark species known to date. Volume 2 Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO Species Catalogue for Fishery Purposes, 1(2): 269 pp.

Ellis J.R. 2004. The occurrence of thresher shark off the Suffolk coast. Transactions of the Suffolk Naturalists' Society*,* 40: 73–80.

Gilmore R.G. 1983. Observations on the embryos of the longfin mako, *Isurus paucus,* and the bigeye thresher, *Alopias superciliosus*. *Copeia,* 1983(2): 375–382.

Hanan D.A., Holts D.B., and Coan A.L. Jr. 1993. The California drift gillnet fishery for sharks and swordfish, 1981–1982 through 1990–91. California Department of Fish Game, Fishery Bulletin, 175: 95 pp.

Kohler N.F., Casey J.G., and Turner P.A. 1995. Length-weight relationships for 13 species of sharks from he western North Atlantic. Fishery Bulletin, 93: 412–418.

Liu K.-M., Chiang P.-J., and Chen C.-T. 1998. Age and growth estimates of the bigeye thresher shark, *Alopias superciliosus*, in northeastern Taiwan waters. Fishery Bulletin, 96(3): 482–491.

Liu K.-M., Chang Y.-T., Ni I.-H., and Jin C.-B. 2006. Spawning per recruit analysis of the pelagic thresher shark, *Alopias pelagicus*, in the eastern Taiwan waters. Fisheries Research, 82: 56–64.

Macias D., Gomez-Vives M.J., and de la Serna J.M. 2003. Desembarcos de especies asociadas a la pesqueria de palangre de superficie dirigido al pez espada (*Xiphias gladius*) en el Mediterraneao durante 2001 y 2002. ICCAT SCRS/2003/137. *In*: Collection ICCAT Scientific Papers 56(3): 981–986 (2004).

Megalofonou P., Yannopoulos C., Damalas D., De Metrio G., Deflorio M. de la Serna J.M. and Macias D. 2005. Incidental catch and estimated discards of pelagic sharks from the swordfish and tuna fisheries in the Mediterranean Sea. Fishery Bulletin, 103(4): 620–634.

Mejuto J., Garcias-Cortes B. and de la Serna J.M. 2001. Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediteranean Sea. ICCAT SCRS/2001/049. *In*: Collection ICCAT Sientific Papers 54(4): 1150–1163 (2002).

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.

Moreno, J.A., Parajua, J.L. and Moron, J. 1989. Breeding biology and phenology of *Alopias vulpinus* (Bonnaterre, 1788) (Alopiidae) in the north-eastern Atlantic and western Mediterranean. Scientia Marina (Barcelona), 53(1): 37–46.

Munoz-Chapuli, R. 1984. Ethologie de la reproduction chez quelques requins de l'Atlantique Nord-Est. Cybium, 8(3): 1–14.

Nakamura, H. 1935. On the two species of the thresher shark from Formosan waters. Memoir of the Faculty of Science and Agriculture, Taihoku Imperial University, 14(1): 1–6.

Natanson L.J. 2002. Preliminary investigations into the age and growth of the shortfin mako, *Isurus oxyrinchus*, white shark, *Carcharodon carcharias*, and thresher shark, *Alopias vulpinus*, in the western North Atlantic Ocean. ICCAT Collective volume of scientific papers, 54(4): 1280–1293.

Preti, A., Smith, S. E. and Ramon, D. A. 2001. Feeding habits of the common thresher shark (*Alopias vulpinus*) sampled from the California-based drift gill net fishery, 1998–1999 Reports of California Cooperative Oceanic Fisheries Investigations, 42: 145–152.

Preti, A., Smith, S. E. and Ramon D. A. 2005. Diet differences in the thresher shark (*Alopias vulpinus*) during transition from a warm-water regime to a cool-water regime off California-Oregon, 1998–2000. Reports of California Cooperative Oceanic Fisheries Investigations, 45, 118–125.

Rey, J.C. and Munoz-Chapuli, R. 1992. Intra and interspecific association of large pelagic fishes inferred from catch data of surface longline. Environmental biology of fishes, 35(1): 95–103.

Sierra, L. M., Claro, R. and Popova, O. A. 1994. Alimentacion y relaciones tróficas. p. 263–284. *In*: Rodolfo Claro (ed.) Ecología de los Peces Marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo, Mexico.

Smith, S. E., Au, D. W. and Show C. 1998. Intrinsic rebound potentials of 26 specis of Pacific sharks. Marine and Freshwater Research*,* 49(7): 663–678.

STECF. 2003. Report of the subgroup on resource status (SGRST) of the Scientific, Technical and Economic for Fisheries (STECF): Elasmobranch Fisheries. Brussels 22–25 July 2003.

Tudela, S., Kai, A., Maynou, F., El Andalossi, M. and Guglielmi, P. 2005. Drifnet fishing and biodiversity conservation: the case study pf the large-scale Moroccan drifnet fleet operating in the Alboran Sea (SW Mediterranean). Biological Conservation, 121: 65–78.

Thorpe, T., 1997. First occurrence and a new length record for the bigeye threseher shark in the North-East Atlantic. Journal of Fish Biology, 50: 222–224.

Visser, I. N., 2005. First observations of feeding on thresher (*Alopias vulpinus*) and hammmerheade (*Sphyrna zygaena*) sharks by killer whales (*Orcinus orca*) which specialise on elasmobanchs as prey. Aquatic Mammals, 31(1): 83–88.

Table 11.1. Thresher sharks in the North East Atlantic. Landings of thresher sharks by Spain, Portugal and France from 1997 to 2005 (ICCAT data). Landings prior to 1997 are in combined sharks.

ICCAT	Spain				Portugal			France	Total
Year	A. vul	A. sup.	Alopias spp.	Total	A. vul	Alopias spp.	Total	A. vulpinus	Europe
1997	27	138	25	190					190
1998	37	104	27	168					168
1999 [1]	15	44	32	91	1		1		51
2000	3	16	23	42		2	2		44
2001	17	35	57	109		2	2		111
2002	9	38	2	49	21		21		70
2003	7	18	1	26	17		17		43
2004	16	37	6	59	21		21	24	104
2005								19	19

1 Data from ICCAT document SCRS/2001/049 providing the landings of thresher sharks by the Spanish longline fleet in 1999. In the ICCAT database, the total landings for 1999 are 50 t.

Table 11.2. Thresher sharks in the North East Atlantic. Estimates of landings of thresher sharks (*Alopias* spp.) by country and ICES sub-area.

Country	Denmark	France	Ireland	Portugal	Portugal	Spain	UK (E&W)	Total
ICES subarea	IV	VII to IX	VII–VIII	VII–IX	W Africa	VII–IX	IV	
1984		3						3
1985		6						6
1986		2		7				9
1987		7		11	+			18
1988		12		103	+			115
1989		10		13	+			23
1990		9		14	+			23
1991		13		31	1			45
1992		14		13	+			27
1993		14		12	+			26
1994		11		16				27
1995		13		7				20
1996		7		13	+			20
1997		13		37	1	53		104
1998		7		24	2	54		87
1999		21		12	+	36		69
2000		116		15		1		132
2001		113		25				138
2002		11		21				32
2003	+	11	+	17		3		31
2004		13	+	33		84		130
2005		18		80		54		152
2006		12	+				+	12

Table 11.3a. Thresher sharks in the North East Atlantic. Summary of biological parameters for *Alopias vulpinus.*

Parameter	Values	Sample size	Area	Reference
Reproduction	Ovoviviparous with oophagy			Compagno, 2001
Litter size	2–7, usually 2–4		NW Atl.	Castro, 1983
Gestation period	9 months			Bedford, 1985
Age at maturity	3–8 years			Caillet & Bedford, 1983
Male maturity size	314–420 cm			Compagno, 2001
Female maturity size	315–400 cm			Compagno, 2001
Size at birth (TL)	114–160 cm			Castro, 1983
Maximum size (TL)	573 cm possibly 610 cm			Compagno, 2001
Life span	45–50 years			Caillet *et al*. 1983
Nursery area in NE Atl.	Aggregation of gravid females in the Strait of Gibraltar		NE Atl.	Moreno & Moron, 1992
Length-weight relationship	For both sexes : $W(kg) = 1.8821 \times 10^{-4} FL (cm)^{2.5188}$	88	Florida	Kohler *et al*. 1995
Fork length-total length relationship	FL (cm) = 0.5474 x TL (cm) + 7.0262		Florida	Kohler *et al*. 1995
Growth parameters	$L_\infty = 651$ cm $T_0 = -2.36$ K = 0.100		California	Claro *et al.* 1994
R_{2m} : intrinsic rebound	$R_{2m} = 0.069$		Pacific	Smith *et al.* 1998
Diet	Anchovy, hake, mackerel, sardine, squid, pelagic crabs			Preti *et al.* 2001 Visser, 2005
Trophic level	4.37 – 4.53		NW Atl.	Bowman *et al.* 2000

Table 11.3b. Thresher sharks in the North East Atlantic. Summary of biological parameters for *Alopias superciliosus.*

PARAMETERS	VALUE	SAMPLE SIZE	AREA	REFERENCE
Reproduction	Ovoviviparous with oophagy		Taiwan NW Atl.	Chen *et al*. 1997 Gilmore 1993
Litter size	Usually 2 (range: 3–4)		Taiwan	Chen *et al.* 1997 Liu *et al*. 1998
Gestation period	Possibly 12 months		Taiwan	Liu *et al*. 1998
Age at maturity age	Males : 9–10 years Females : 12–13 years			Liu *et al*. 1998
Male maturity size	276 cm (TL) 270–287 cm (TL) 180 cm (FL)	6 200	NE Atl. Taiwan NW Atl.	Moreno & Moron, 1992 Chen *et al.* 1997 Kohler *et al.* 1995
Female maturity size	341 cm (TL) 332–342 cm (TL) 214 cm (FL)	10 429	NE Atl. Taiwan NW Atl.	Moreno & Moron, 1992 Chen *et al.* 1997 Kohler *et al.* 1995
Size at birth (TL)	135–140 cm		Taiwan	Liu *et al*. 1997
Maxium size (TL)	461 cm			Nakamura, 1935
Life span	Males : 19 years Females : 20 years		Taiwan	Liu *et al*., 1998
Nursery area in NE Atl.	Off southwestern Iberian Peninsula		NE Atl..	Moreno & Moron, 1992
Length-weight relationship	Males : W (kg) = 0.0372 x $TL(cm)^{2.57}$ Females : W (kg) = 0.0102 x $TL(cm)^{2.78}$ Combined : W (kg) = 0.0091 x $FL(cm)^{3.080}$	65 175 55	Taiwan Taiwan Florida	Liu *et al.* 1998 Liu *et al.* 1998 Kohler *et al.* 1995
Fork length-total length relationship	FL = 0.5598 TL + 17.666	55	Florida	Kohler *et al.* 1995
Growth	Males : L_∞ = 218 cm (TL) T_0 = - 4.24 K = 0.088/year Females : L_∞ = 224 cm (TL) T_0 = - 4.21 K = 0.092/year	321 vertebral counts 821 length-frequency analysis	Taiwan	Liu *et al*. 1998
R_{2m} : intrinsic rebound	R_{2m} = 0.032		Pacific	Smith *et al.* 1998
Diet	Pelagic and demersal fishes and squids			Castro, 1983
Trophic level	4.47 4.4 – 4.5		NW Atl. Cuba	Bowman *et al.* 2000 Sierra *et al.* 1994

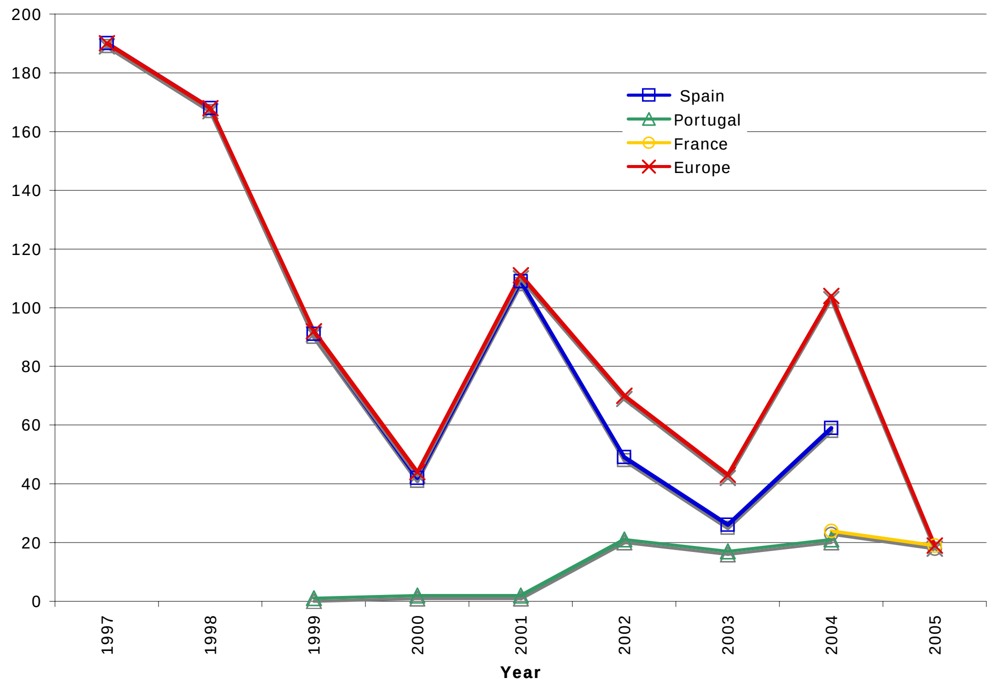


Figure 11.1. Thresher sharks in the North East Atlantic. Reported landings of thresher sharks by Spain, Portugal and France from 1997 to 2005 (ICCAT data).

12 Other pelagic sharks in the North East Atlantic

12.1 Ecosystem description and stock boundaries

Besides shortfin mako (*Isurus oxyrinchus*), porbeagle (*Lamna nasus*), blue shark (*Prionace glauca*), basking shark (*Cetorhinus maximus*), thresher sharks (*Alopias* spp.) and tope (*Galeorhinus galeus*), which are treated in separate sections, several other pelagic sharks and rays occur in the ICES areas, including:

- white shark, Carcharodon carcharias
- longfin mako, *Isurus paucus*
- spinner skark, 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*
- pelagic stingray, Pteroplatytrygon violacea
- devil ray, *Mobula mobular*

Major taxa such as the hammerhead sharks (*Sphyrna* spp.) and the requiem sharks (e.g. several *Carcharhinus* spp.) are mainly tropical to warm temperate species, and are often coastal pelagic species. There is limited information with which to examine the stock structure of these species. Other species are truly oceanic (*I. paucus, C. falciformis* and *C. longimanus*), and are likely to have either North Atlantic or Atlantic stocks, although once again, data are lacking. Most of these species are found in the southern parts of the ICES areas (e.g. off the Iberian Peninsula), though some may occasionally occur further north.

The North Atlantic pelagic ecosystem is affected by the subtropical anticyclonic Atlantic gyre, and it is influenced by subtropical water intrusions and subject to strong seasonality (see ICES, 2007).

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. great white; tiger; pelagic stingray, devil ray). Among these species, some 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 2006

No new information

12.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

12.2.4 Management applicable

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

EC Regulation No. 41/2006 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.

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. Reported species-specific landings are given in Table 12.1. Portugal and Spain have reported landings of hammerheads and the requiem sharks in ICES sub-areas VI, VIII, IX and X, totalling 86 t in 2004. Since 1997, landings are also recorded in the ICCAT data base (Table 12. 2) for the NE Atlantic by Spain and Portugal, totalling 475 t of hammerhead and requiem sharks in 2004. 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 is no catch recorded for the other pelagic species (longfin mako, white shark, tiger shark, manta ray and pelagic stingray) in national data sets, nor in the ICCAT data base except for some sporadic records of 1 to 10 t of tiger and silky sharks.

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

12.3.2 Discards

No data available. Some species are usually retained, although pelagic stingray are 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).

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 & 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 indivuals/1000 hooks in 1996 to 0.35 ind./1000 hooks in 1997.

12.6 Fishery-independent surveys

No data were available.

12.7 Biological parameters

A summary of the main biological parameters are given in Table 12.4.

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.

12.8 Stock assessment

12.8.1 Previous studies

No previous assessments have been made of these stocks in the NE Atlantic.

12.8.2 Stock assessment

No assessment was undertaken, due to insufficient data.

12.9 Quality of the assessment

No assessment was undertaken, due to 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 which hampers the provision of management advice.

Some of the species have conservation status: for example white shark is listed on Appendix II of the Barcelona Convention, Appendix II of the Bern Convention, Appendices I/II of the CMS and Appendix I of CITES.

12.12 References

Branstetter, S. 1987. Age, growth and reproductive biology of the silky shark, *Carcharhinus falciformis* and the scalloped hammerhead , *Sphyrna lewini,* from the northwestern Gulf of Mexico. *Environmental Biology of Fishes*, 19(19): 161–173.

Branstetter, S. 1990. Early life-history implications of selected Carcharinoid and Lamnoid sharks of the Northwest Atlantic. NOAA Technical Report NMFS, 90: 17–28.

Castro, J., de la Serna, J.M., Macias, D., and Mejuto J. 2000. Estimaciones centificas preliminares de los desembarcos de especies asociadas realizados por la flota española de palange de superficie en 1997 y 1998. ICCAT SCRS/1999/082, Collection of Scientific Papers, 51(6): 1882–1893.

Cramer, J. 1999. Pelagic longline bycatch. ICCAT Working document SCRS/99/90.

Cramer J., Bertolino A. and Scott G.P. 1998. Estimates of recent shark bycatch by U.S. vessels fishing for Atlantic tuna and tuna-like species. ICCAT SCRS/1997/058, Collection of Scientific Papers, 48(3): 117–128.

Cramer, J., and Adams H. M. 1998. Pelagic longline bycatch. ICCAT Working document SCRS/98/113.

ICES. 2007. Report of the Working Group for Regional Ecosystem Description (WGRED), 19–23 February 2007, ICES Headquarters, Copenhagen. ICES CM 2007/ACE:02. 153 pp.

Mejuto, J., Garcia-Cortes, B., and de la Serna, J. M. 2002. Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea. ICCAT SCRS/2001/049, Collection of Scientific Papers, 54(4): 1150–1163.

Piercy, A. N, Carlson, J. K, Sulikowski, J. A., and Burgess, G. H. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrna lewini*, in the north-west Atlantic Ocean and Gulf of Mexico. Marine and Freshwater Research, 58: 34)40.

Shungo, O., Hideki, N. and Sho, T. 2003. Age and growth of the silky shark *Carcharhinus falciformis* from the Pacfic Ocean. Fisheries Sciences, 69(3): 456.

Spinger, S. 1967. Social organizations of shark populations. *In*: Gilbert P.W. (ed.) Sharks, Skates and Rays. John Hopkins Press, Baltimore, 149–174.

Seki, T., Taniuchi, T., Nakano, H., and Shimizu, M. 1998. Age, growth and reproduction of the oceanic whitetip sharl from the Pacific Ocean. Fisheries Sciences, 64: 14–20.

Stevens, J. D., and Lyle, J. M. 1989. Biology of three hammerhead sharks (*Eusphyrna blochii, Sphyrna mokarran and S. lewini*) from northern Australia. Australian Journal of Marine and Freshwater Research, 40: 129–146.

Yokota, L. and Lessa, R. P. 2006. A nursery area for sharks and rays in Northeastern Brazil. Environmental Biology of Fishes, 75: 349–360.

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.

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	IX a, b		VIb	IX	IXb	X	Total	IX a, 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 North East Atlantic. NE Atlantic landings of hammerhead and requiem sharks by Spain and Portugal recorded in the ICCAT data base.

ICCAT	Spain					Portugal	Spain	Portugal	
NE Atlantic	Sphyrna spp.	Sphyrna lewini	Sphyrna mokarran	Sphyrna zygaena	Total Sphyrna	Sphyrna spp.	Requiem sharks	Requiem sharks	Total
1997	353				353				353
1998	343	3	1	3	350		158		508
1999							60		60
2000	312			1	313				313
2001	249			4	253		100		353
2002	263			1	264		80		344
2003	231				231	6	86	155	478
2004	364	2		12	378		97		475

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. 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 K= 0.065 T_0 = -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 225 F	6-7 7-9	12	2-15	57-87	25	L_∞ = 291/315 K= 0.153 / 0.1 T_0 = -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 K= 0.210 T_0 = -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 K= 0.103 / 0.1 T_0 = 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 K= 0.039/ 0.038 T_0 = -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 K= 0.046 T_0 = -6.45	4.23-4.49
Night shark Carcharhinus signatus	Atlantic 0-600 m	280	Viviparous	185-200			4-12	60		L_∞ = 256 / 265 K= 0.124 / 0.114 T_0 = -2.54 / - 2.7	4.44-4.5
Tiger shark Galeocerdo cuvier	Circumglobal 0-350 m	740	Ovivivparous	316-323	8-10	13-16	10-82	51-104	50	L_∞ = 388 / 440 K= 0.18 / 0.107 T_0 = -1.13 / -2.35	4.54-4.63

	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
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 T_0 = -0.41 / - 0.75	4.0-4.21
Great hammaerhead 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 Eco-region and stock boundaries

The eight species inhabiting the offshore area of the Barents Sea eco-region are starry ray (or thorny skate) *Amblyraja radiata*, Arctic skate *Amblyraja hyperborea*, round skate *Rajella fyllae*, common skate *Dipturus batis*, spinytail skate *Bathyraja spinicauda*, sailray *Dipturus linteus*, long-nose skate *Dipturus oxyrinchus* and shagreen ray *Leucoraja fullonica* (Andriyashev, 1954; Dolgov, 2000; Dolgov *et al.,* 2004b). All species may be taken as bycatch in fisheries. No directed fishery target skates in the Barents Sea. Of these eight species, few occur in great abundance, with *A. radiata* the dominant species, comprising 96% by number of total number and about 92% by weight of skates caught in surveys or as bycatch. The following most abundant species are arctic and round skate (3% and 2% by number respectively). The rest of the species are scarce (Dolgov *et al.*, 2004b; Drevetnyak *et al*., 2005).

A total of eight species have also been shown to inhabit the coastal area. The species diversity differs from that listed in the offshore area with *D. oxyrinchus* and *D. linteus* absent and thornback ray *Raja clavata* present. Spurdog *Squalus acanthias* is also present in this area (Section 2).

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 eco-region. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this eco-region and neighboring 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 blue catfish (*Anarhichas denticulatus*), cod and Greenland halibut (*Reinhardtius hippoglossoides*). These are conducted through all seasons and have a skate bycatch, which is generally discarded at sea. 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, with an average of 1250 t per year. Thorny skate accounted for 90–95% of the total skate bycatch.

The names and locations of Russian statistical fisheries areas are shown in Figure 13.1 (Anon., 1957; Dolgov *et al.,* 2004a).

13.2.2 The fishery in 2006

No new information

13.2.3 ICES advice applicable

ACFM has never provided advice for any of the stocks within this region.

13.2.4 Management applicable in 2006

There are no TACs or other management measures for any of the demersal elasmobranch species in this region.

13.3 Catch data

13.3.1 Landings

Data for the most recent years are either preliminary or unavailable and are for all skate and ray landings combined. The landings data given here are for ICES Division I (Figure 13.2 and Table 13.1). The peak in Russian landings in the eighties corresponds with an experimental fishery for skates and rays, whereby bycatches were landed as opposed to discarded (Dolgov personal communication, 2006). Landings from the most westerly parts of the Barents Sea eco-region fall within subarea II, and are described in Section 14.

13.3.2 Discards

Initial estimates done by Dolgov *et al*. (2005) indicate that the total annual bycatch of skate from commercial trawl and long-line fisheries in the Barents Sea ranged from 723–1891 t. Thorny skate accounted for 90–95% of the total skate catch.

13.3.3 Quality of catch data

Species-specific data are lacking.

13.4 Commercial catch composition

13.4.1 Species and size composition

No new commercial data were available to WGEF. Larger skates are more often caught in long-line fisheries than in the trawl fisheries. Dolgov *et al.* (2005) described a 1:1 sex ratio in commercial catches for all skate species except *A. hyperborea*, of which males dominated in the long-line fishery (Table 13.2).

13.4.2 Quality of catch data

Only limited data are available.

13.5 Commercial catch-effort data

Relative CPUE data are available for *A. radiata*, *A. hyperborea*, *R. fyllae* and *D. batis,* and *A. radiata*, *A. hyperborea* and *D. batis* 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 are given in Table 13.4 and Figure 13.11.

For Russian fishing vessels, Dolgov *et al*. (2004a) estimated total catch composition based on data derived by observers for each fishery area and month. The biomass of bycatch species for each area and time period was estimated using the assumption that actual catch composition corresponded with that given by observer data for each area. This method was stated as being associated with high uncertainty levels of approximately ±45%. The data obtained by this bycatch assessment agreed with distribution and abundance of observed species obtained by surveys in the same area.

Catch data from other nations are limited.

13.6 Fishery-independent surveys

13.6.1 PINRO surveys

For the offshore areas, data from survey cruises are available from Dolgov *et al.* (2004b) and Drevetnyak *et al*. (2005) covering the years from 1998–2001, describing distribution and habitat utilization for six species and abundance and relative biomass estimates of five species of skates in the Barents Sea. Species examined were *A. radiata*, *A. hyperborea*, *R. fyllae*, *D. batis*, *B. spinicauda* and *D. linteus*.

For each species depth of capture is documented in Figure 13.3. Abundance and biomass estimates for 1997–2003 are given in Table 13.3. Figure 13.10 shows the proportion of skates in the total catch of demersal fish by area in the Barents Sea, average for 1996–2001 (from Dolgov *et al*., 2004b).

The species composition of skates caught in the Barents Sea differs from those recorded in the Norwegian Deep and north-eastern Norwegian Sea (Skjaeraasen and Bergstad, 2000, 2001). While thorny skate 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. Obtained data on stocks of *A. radiata* and *R. fyllae* remained almost unchanged during the survey timeframe, possibly suggesting stable stocks in the examined area (Dolgov *et al*., 2004b). The abundance estimate of these authors for *A. radiata* over the period of 1997–2005 varied from 99 × 10^6 animals in 1997 to 161 × 10^6 animals in 2002 and averaged 142 × 10^6 animals. Estimated biomass varied between 72 000 and 122 000 t with an average of 98 100 t. The following most abundant skate species were *A. hyperborea* and *R. fyllae*, with an average abundance of 2.4 × 10^6 and 2.6 × 10^6 animals each, and an average biomass of 3000 t and 1400 t, respectively. The abundance of *D. batis* and *B. spinicauda* was lower (0.6 × 10^6 and 0.7 × 10^6 animals respectively), though the biomass of *D. batis* was estimated at 2900 t due to the large size of the fish, while the biomass of *B. spinicauda* did not exceed 800 t. *A. radiata* were distributed throughout the area of investigation, while the distribution of other species (*R. fyllae*, *D. batis*, *B. spinicauda*, and *D. linteus*) was limited to the areas of distribution of Atlantic water, occurring mainly in the southwestern part of the Barents Sea. The preferred depths and temperatures of these species in the Barents Sea correspond well with the data of Skjaeraasen and Bergstad (2001) for the southern distribution area of skates on the slope of the eastern Norwegian Sea. However, it should be noted that the northern border of some species' distributions in the Barents Sea is much further north than previously described in the literature.

13.6.2 Norwegian Coastal Survey

For the coastal area, the distribution and diversity of elasmobranch species' in North-Norwegian coastal areas were assessed and presented by Williams *et al*. (2007). The northern portion of the coastal area presented in this working document is related to the Barents Sea eco-region. For the purposes of this report, the Norwegian coastal area included in the Barents Sea eco-region is defined as the Norwegian Directorate of Fisheries Statistical Areas 03 and 04 (Fiskeridirektoratet, 2004). The total period used in this working document was from 1992 to 2005; however the surveys of 1993 and 1994 did not cover this part of the Norwegian coastline. Further descriptions of the surveys are given in Section 14 and in more detail by Williams (2007) and Williams *et al.* (2007).

Seven skate species were recorded from the Norwegian coastal area of the Barents Sea. Average catch rates for the majority of species were low (see Table 13.5). Presence/absence analyses were carried out for all species. Primarily due to the low catch rates, no shifts in species abundances could be detected as occurring either along the coastline or over time. There were no notable absences of species that were previously known to inhabit this area.

A. radiata was the most abundant species. This species was caught in every survey and is distributed along the whole coast. A total of 509 individuals were recorded at depths between 30–515m. The catch rates of each survey varied between 20 and 65 individuals, but no obvious changes in abundance were shown to occur over time.

R. clavata appeared to possibly be the next most abundant species with 64 individuals recorded at depths between 41–465 m. However, the data regarding this species must be treated with caution. The known distribution for *R. clavata* does include isolated areas within this region, but this region does represent the northern limit for this species. Before accepting these data as truly representative, the possibility of taxonomic confusion with *A. radiata* or other similar looking species needs to be addressed.

Over all the surveys, 36 individuals of *R. fyllae* were recorded between the depths 98–415 m. With the exception of two that were caught in 1995, no individuals were recorded before the survey in 2000. Distribution appears to be along the entire coastline.

A total of ten *B. spinicauda* were recorded between depths of 48–410 m. These catches were spread fairly evenly along the coast.

Seven individuals of *D. batis* were logged with the depth range: 229–425 m. Catches occurred both in the earlier and the later surveys. Three were identified near the eastern limit of the survey at longitude 30°E. In the 1997 survey, five individuals of *L. fullonica* were recorded in four separate trawl samples. All were caught between the depths of 82–380 m, and within a short area of coastline between longitudes 20°E to 25°E. In the 2002 survey, three individuals of *A. hyperborea* were recorded at longitude 23°E at depths of 80 m and 202 m.

13.6.3 Quality of survey data

There are concerns regarding the accuracy of skate species identification with regard to the Norwegian Autumn Coastal Survey data. This is particularly relevant for confusion between *A. radiata* and *R. clavata*, and possibly other short-nosed species (rays). A more detailed discussion is given in Section 14, and also in Williams (2007) and Williams *et al.* (2007). Length-frequency data from the Norwegian coastal area were not available at the WGEF.

13.7 Life-history information

Length data are available for *A. radiata, A. hyperborea* and *R. fyllae* (Table 13.2). Length-frequency data also from *D. batis* and *B. spinicauda* (Figures. 13.4–13.7) from bycatch assessments and survey cruises respectively. The abundance and biomass of *A. radiata* by size groups are shown in Figures 13.8 and 13.9 (from Drevetnyak *et al*., 2005).

A. radiata, A. hyperborea and *R. fyllae* spawn in the Barents Sea (Berestovsky, 1994; Dolgov pers. obs.) whereas the scarcity of small-sized juvenile blue and spinytail skate and sailray and the absence of mature specimens of these species suggest that their main spawning areas may be outside the Barents Sea.

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 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. *B. spinicauda, D. batis, A. hyperborea* and *L. fullonica* are listed as Data Deficient in the Norwegian Red List (2006). 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 over-fishing. Issues regarding misidentification of some species during surveys needs to be resolved before sound and reliable advice can be given for elasmobranchs in the Barents Sea eco-region.

13.12 References

Andriyashev, A. P. 1954. Fishes of the Arctic seas of the USSR. Guide to identification of USSR fauna of the Zoological Institute of the USSR Academy of Science, Acad. Sci. Press, No. 53 M.; L., 566 pp. (in Russian).

Anon. 1957. Map of Fishing Areas of the Barents Sea (in Russian). Trudy PINRO, Murmansk, Vyp. 10, 281 pp.

Berestovsky, E. G. 1994.Reproductive biology of skates in the Arctic seas. J.Voprosy Ichthyologii, 34(2): 212–218 (in Russian).

Dolgov, A. V. 2000. New data on composition and distribution of the Barents Sea ichthyofauna. ICES C.M. 2000/Mini:12, 13 pp.

Dolgov, A.V., Grekov, A.A., Shestopal, I.P. and Sokolov, K.M. 2004a. By-catch of Skates in Barents Sea. Journal of Northwest Atlantic Fisheries Science 35, 357–366.

Dolgov, A.V., Drevetnyak, K.V. and Gusev, E.V. 2004b. Skate Stocks in Barents Sea. Journal of Northwest Atlantic Fisheries Science 35, 249–260.

Dolgov, A. V., A. A. Grekov, I. P. Shestopal, and K. M. Sokolov. 2005. By-catch of Skates in Trawl and Long-Line Fisheries in the Barents Sea e-Journal of Northwest Atlantic Fishery Science **V35**:11.

Drevetnyak, K. V. Dolgov, A. V., Sokolov, K. M., Gusev, E. V. and Grekov, A. A. 2005. Skates in the Barents Sea: stock status and catch by fishing fleet. ICES CM 2005/ N:11, 14 pp.

Fiskeridirektoratet. 2004. Website in Norwegian. Statistical area maps available as pdf files: http://www.fiskeridir.no/fiskeridir/fiskeri/statistikk/kart/kart_lokasjon_og_omraade

Skjaeraasen, J. E. and Bergstad, O. A. 2000. Distribution and feeding ecology of *Raja radiata* in the northeastern North Sea and Skagerrak (Norwegian Deep). ICES Journal of Marine Science, 57: 1249–1260.

Skjaeraasen, J. E. and Bergstad, O. A. 2001. Notes on the distribution and length composition of *Raja linteus, R. fyllae, R. hyperborea* and *Bathyraja spinicauda* (Pisces: Rajidae) in the deep northeastern North Sea and on the slope of the eastern Norwegian Sea. ICES Journal of Marine Science, 58: 21–28.

Williams, T. 2007. Cartilaginous fishes along the North-Norwegian coast. Distributions and densities with regard to fishing and sea temperature. Master thesis in International Fisheries Management. Norwegian College of Fishery Science. University of Tromsø, 62 pp. http://www.ub.uit.no/munin/handle/10037/975.

Williams, T., M. Aschan, and K. Helle. 2007. Distribution of Chondrichthyan species along the North-Norwegian coast. *in* Working Document for the ICES Elasmobranch Working Group (WGEF) 2007.

Table 13.1. Demersal Elasmobranchs in The Barents Sea. Total landings of skates and rays from ICES area I, 1973–2006. Total landings (tonnes).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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.
Iceland	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	1	3	4	8	2	2	2	1
Portugal	.	.	100	11	1	.	.	.	.	.	.
Russian Federation	.	.	.	.	.	1126	168	93	3	1	n.a.
Spain	.	.	.	.	.	.	.	.	.	.	.
UK - England & Wales	78	46	49	33	70	9	8	4	.	1	.
UK – Scotland	.	.	1	2	2	.	.	.	.	.	.
Total of submitted data	78	46	150	129	125	1183	184	99	5	4	1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.
Germany	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	.	.	.	2
Iceland	.	.	.	.	.	.	.	.	.	1	.
Norway	10	11	3	14	7	4	1	5	24	29	72
Portugal	.	.	.	.	.	.	.	.	.	.	.
Russian Federation	563	619	2137	2364	2051	1235	246	n.a.	399	390	369
Spain	.	.	.	.	.	.	.	.	.	.	.
UK - England & Wales	.	.		2	.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
UK – Scotland	.	.	.	.	.	.	.	.	.	.	.
Total of submitted data	573	630	2140	2380	2058	1239	247	5	423	420	443

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	.	.	.	.	.	.	.	n.a.	n.a.	n.a.		
France	.	.	.	.	.	.	.	.	.	.	.	
Germany	.	.	.	.	.	.	.	n.a.	n.a.	n.a.		
Iceland	.	.	1	.	.	4	.	n.a.	n.a.	n.a.		
Norway	9	27	3	13	21	12	30	26	2	1	4	13
Portugal	.	.	.	.	.	.	.	n.a.	n.a.	n.a.	.	
Russian Federation	.	.	399	790	568	502	218	173	38	n.a.		
Spain	7	.	.	.	.	.	.	n.a.	n.a.	n.a.	.	
UK - England & Wales	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	.	
UK – Scotland	.	.	.	.	.	.	.	n.a.	n.a.	n.a.	.	
Total of submitted data	16	27	403	803	589	518	248	199	40	1	4	13

Table 13.2. Demersal Elasmobranchs in The Barents Sea. Mean length and sex ratio of some skate species (thorny skate *A. radiata*, arctic skate *A. hyperborea*, round skate *R. fyllae*, from Dolgov *et al.*, 2004a).

		Fishing Gear			
	Sex	Research bottom trawl (16 mm)	Trawl (125 mm)	Trawl (135 mm)	Longline
Thorny skate					
Mean length, cm	Males	38.0	44.3	43.5	46.8
	Females	37.8	42.8	42.3	46.6
Number of fish	Males	7517	3909	3504	1658
	Females	8075	4972	3834	1721
Sex ratio (M:F)		1:1.1	1:1.3	1:1.1	1:1
Arctic skate					
Mean length, cm	Males	58.4	56.6	52.6	64.5
	Females	55.1	55.0	54.6	68.3
Number of fish	Males	606	215	213	822
	Females	355	123	159	97
Sex ratio (M:F)		1:0.6[1]	1:0.6[1]	1:0.7[1]	1:0.1[1]
Round skate					
Mean length, cm	Males	43.2	46.2	48.2	51.9
	Females	40.4	45.0	45.3	48.7
Number of fish	Males	91	14	19	131
	Females	103	24	32	98
Sex ratio (M:F)		1:1.1	1:1.7[1]	1:1.7[1]	1:0.7

[1] Statistically significant (Chi-square test).

Table 13.3. Demersal Elasmobranchs in The Barents Sea. Estimated abundance (x 10^6 fish) and biomass (x 10^3 t) of five skate species Thorny skate, *A. radiata*, round skate, *R. fyllae*, arctic skate, *A. hyperborea*, blue skate *D. batis*, spinytail skate, *B. spinicauda* and sail ray in the Barents Sea during 1998–2001. (from Drevetnyak *et al.*, 2005).

Species		Year							Average
		1997	1998	1999	2000	2001	2002	2003	
Thorny skate	Abundance	99.55	167.00	130.57	135.62	140.32	161.31	160.58	142.14
	Biomass	71.71	106.32	88.68	91.56	95.42	121.68	111.29	98.09
Round skate	Abundance	1.00	2.50	0.33	4.18	3.21	3.38	3.81	2.63
	Biomass	0.51	1.34	1.26	2.26	1.24	1.45	1.68	1.39
Arctic skate	Abundance	2.30	1.86	0.78	6.18	1.46	0.83	3.23	2.38
	Biomass	2.49	2.73	1.35	7.42	2.32	1.57	3.28	3.02
Blue skate	Abundance	-	1.41	0.30	0.75	0.27	0.34	0.23	0.55
	Biomass	-	1.25	3.99	2.64	5.17	1.58	2.91	2.92
Spinytail skate	Abundance	-	-	0.05	1.06	0.51	0.98	1.07	0.72
	Biomass	-	-	0.01	1.44	0.41	0.88	1.33	0.81
All skates	Abundance	172.77	132.03	147.47	145.77	166.84	168.92	168.92	148.43
	Biomass	111.64	95.29	105.32	104.56	127.16	120.49	120.49	106.23

Table 13.4. Demersal Elasmobranchs in The Barents Sea. Russian catches of skates in the bottom trawl and longline fisheries by area in the Barents Sea and adjacent waters in 1996–2001 (tonnes, calculated using data on discards) (from Dolgov *et al.*, 2004a).

YEAR	RUSSIAN EEZ	GREY ZONE	NORWEGIAN EEZ	SPITZBERGEN AREA	INTERNATIONAL WATERS	TOTAL
1996	305	209	106	99	4	723
1997	543	57	72	135	6	857
1998	860	607	164	236	22	1 891
1999	524	607	233	287	17	1 668
2000	335	491	334	365	14	1 539
2001	337	197	104	191	9	838

Table 13.5. Demersal Elasmobranchs in The Barents Sea. Catch data (number of individuals per species) for the Barents Sea eco-region from the Autumn Bottom Trawl Surveys of the North Norwegian Coast, from 1992 and 1995–2005.

YEAR	NUMBER OF SAMPLES	AMBLYRAJA RADIATA	BATHYRAJA SPINICAUDA	RAJELLA FYLLAE	RAJA CLAVATA	DIPTURUS BATIS	LEUCORAJA FULLONICA	AMBLYRAJA HYPERBOREA	SQUALUS ACANTHIAS
1992	110	61	0	0	19	1	0	0	1
1993	–								
1994	–								
1995	52	32	0	3	1	0	0	0	0
1996	56	39	0	0	0	0	0	0	1
1997	63	30	0	0	5	0	5	0	1
1998	55	40	2	0	4	0	0	0	1
1999	73	26	0	0	22	1	0	0	0
2000	78	67	1	11	8	1	0	0	0
2001	69	34	0	1	0	1	0	0	0
2002	90	20	0	3	0	0	0	3	0
2003	69	65	3	4	1	2	0	0	0
2004	55	65	4	9	4	1	0	0	0
2005	63	30	0	5	0	0	0	0	0
Total catch		509	10	36	64	7	5	3	4
Total % of positive samples		29%	1%	3%	4%	1%	<1%	<1%	<1%
Catch rate (No. per survey)		46.2	0.9	3.2	5.8	0.6	0.5	0.3	0.4

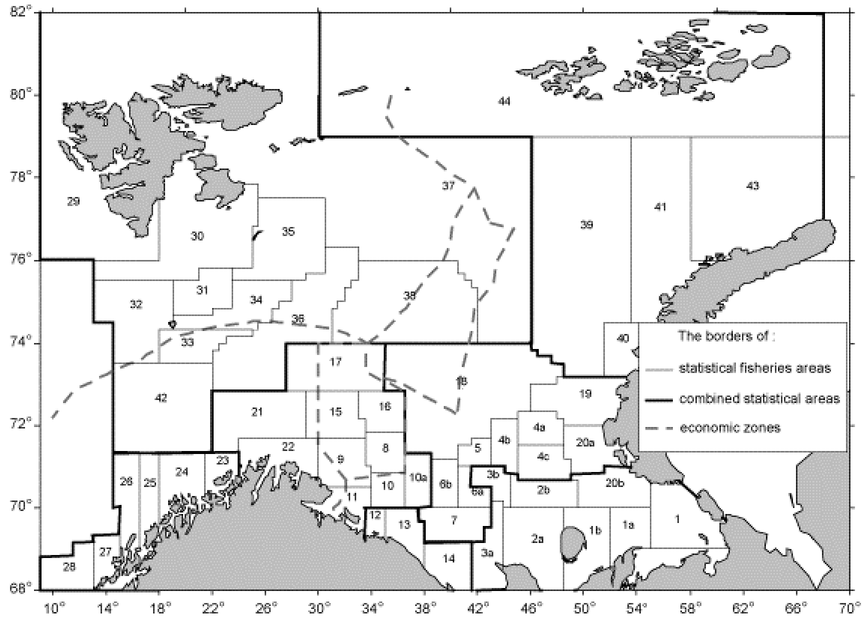


Figure 13.1. **Demersal elasmobranchs in the Barents Sea.** Map of Russian statistical fisheries areas in the Barents Sea (from Dolgov *et al.,* 2004a).

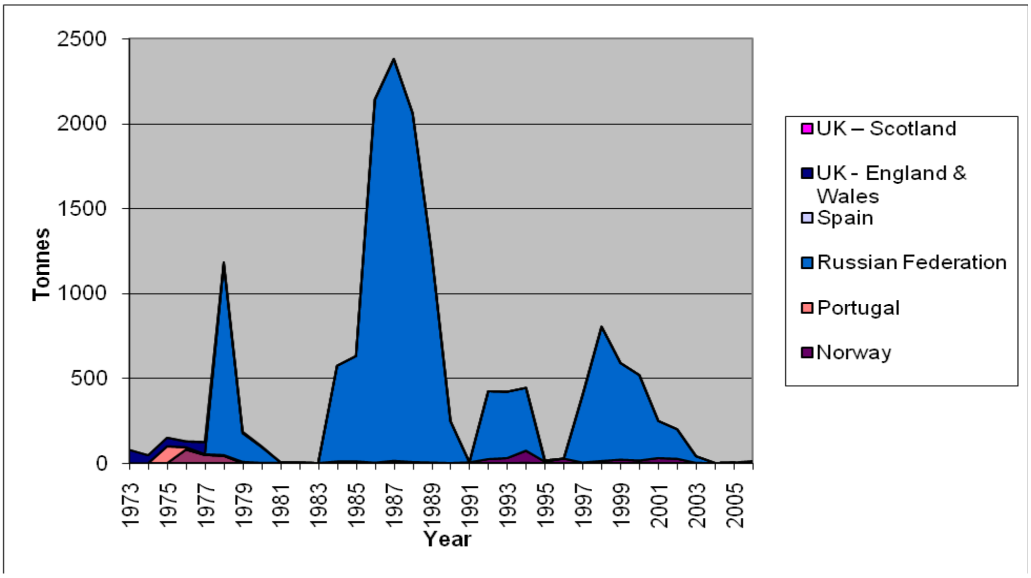


Figure 13.2. Demersal elasmobranchs in the Barents Sea. Skates & Rays from ICES Area I, 1973–2006. Total landings (tonnes).

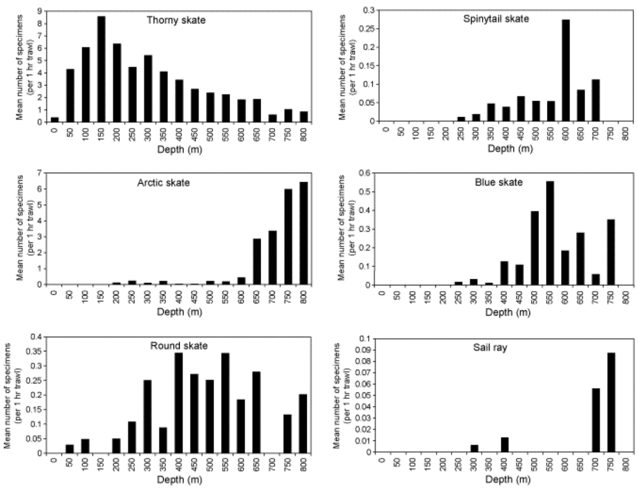


Figure 13.3. Demersal elasmobranchs in the Barents Sea. **Bathymetric conditions in the habitat of various skate species in the Barents Sea (thorny skate *A. radiata*, arctic skate *A. hyperborea*, round skate *R. fyllae*, blue skate *D. batis*, spinytail skate *B. spinicauda* and sail ray *D. Lintea*) (from Dolgov *et al.*, 2004b).**

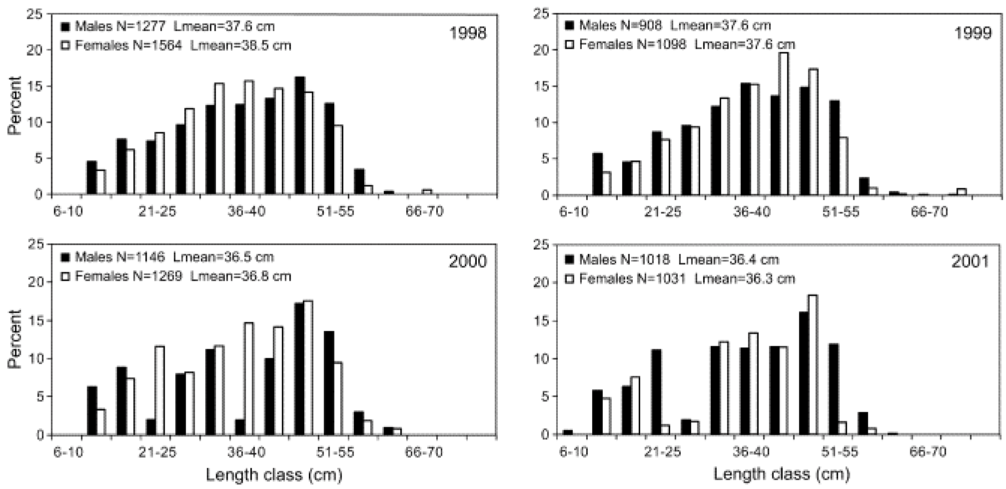


Figure 13.4. Demersal elasmobranchs in the Barents Sea. **Size distribution of *A. radiata* during 1998–2001 (from Dolgov *et al.*, 2004b).**

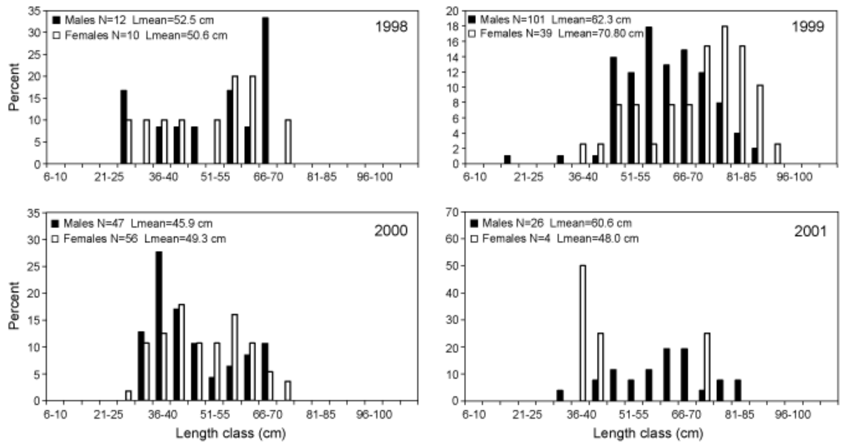


Figure 13.5. Demersal elasmobranchs in the Barents Sea. Size distribution of *A. hyperborea* during 1998–2001 (from Dolgov *et al.*, 2004b).

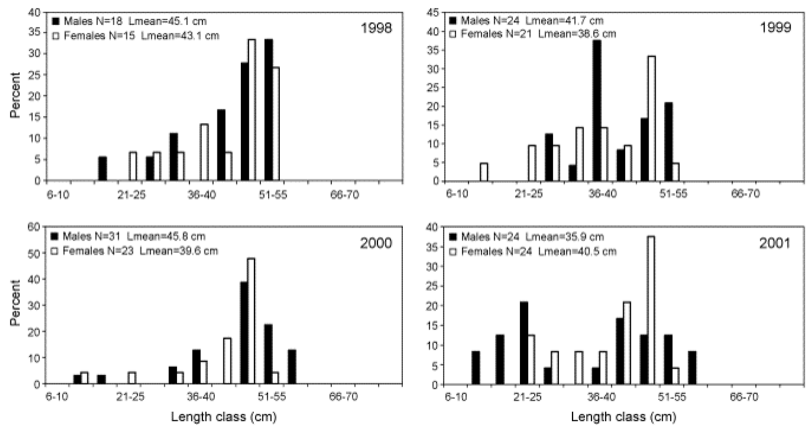


Figure 13.6. Demersal elasmobranchs in the Barents Sea. Size distribution of *R. fyllae* during 1998–2001 (from Dolgov *et al.*, 2004b).

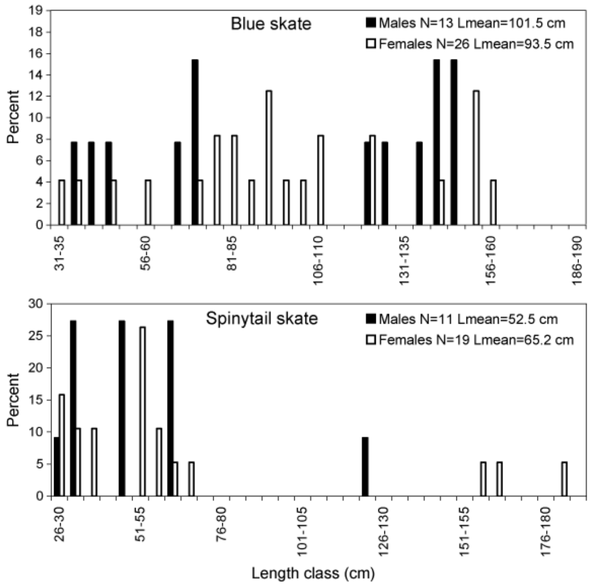


Figure 13.7. Demersal elasmobranchs in the Barents Sea. Size distribution of blue skate *D. batis* and spinytail skate *B. spinicauda* during 1998–2001. (from Dolgov *et al.*, 2004b).

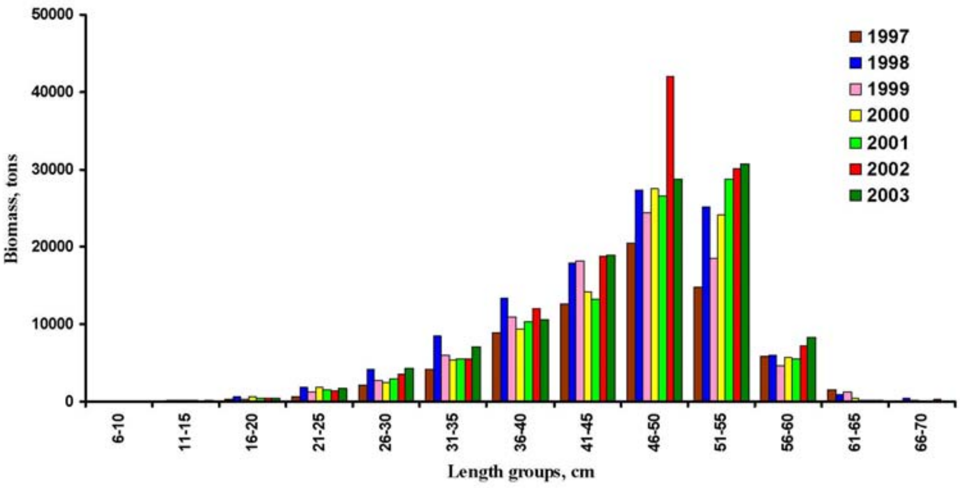


Figure 13.8. Demersal elasmobranchs in the Barents Sea. Dynamics of biomass of thorny skate by size groups (From Drevetnyak *et al.*, 2005).

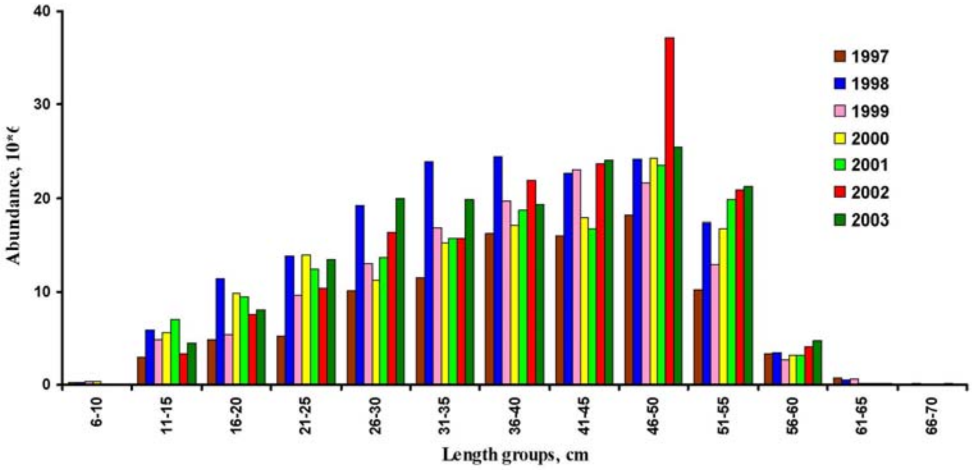


Figure 13.9. Demersal elasmobranchs in the Barents Sea. Dynamics of abundance of thorny skate by size groups (From Drevetnyak *et al.*, 2005).

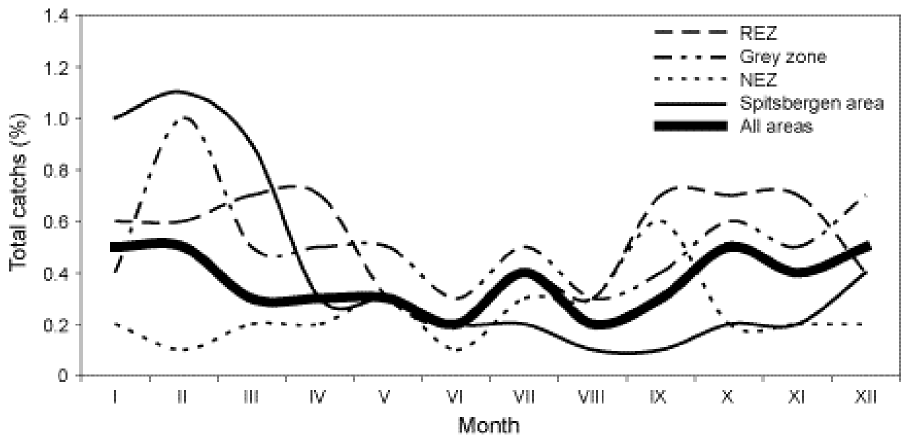


Figure 13.10. Demersal elasmobranchs in the Barents Sea. Proportion of skates in the total catch of demersal fish by area in the Barents Sea, average for 1996–2001. (from Dolgov *et al.*, 2004b).

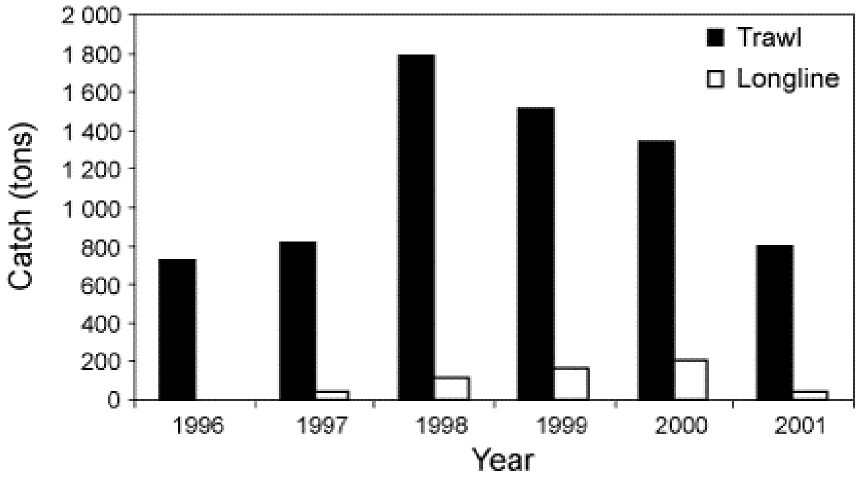


Figure 13.11. Demersal elasmobranchs in the Barents Sea. Catch of skates in trawl and long-line fisheries in the Barents Sea in 1996–2001. (from Dolgov *et al.*, 2004b).

14 Demersal Elasmobranchs in The Norwegian Sea

14.1 Eco-region and stock boundaries

Williams *et al.* (2007) noted that 17 elasmobranch species were present along the Norwegian coastal area included in the Norwegian Sea eco-region (Table 14.1). Starry ray (thorny skate) *Amblyraja radiata* is the most abundant skate species. Whilst abundances are higher in the north, this species does occur in fairly high numbers at all latitudes along the coast. Longnosed skate *Dipturus oxyrinchus* is mainly distributed in the southern section of coastline south of below latitude 65°N. The other species found in the coastal area are thornback ray *Raja clavata,* common skate *Dipturus batis,* sandy ray *Leucoraja circularis*, round skate *Rajella fyllae*, shagreen ray *Leucoraja fullonica,* Norwegian skate *Dipturus nidarosiensis,* sailray *Dipturus linteus,* arctic skate *Amblyraja hyperborea,* spotted ray *Raja montagui,* blonde ray *Raja brachyura* and spinetail ray *Bathyraja spinicauda.* The other species 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*.

Little information is available about skate and ray species inhabiting the offshore area of the Norwegian Sea eco-region. Skjaeraasen and Bergstad (2001) noted several species of skates in the Norwegian Sea and the Norwegian Deep. Corresponding to ICES Division II, *A. hyperborea* and *B. spinicauda* were found in bottom trawls mainly in depths of 800–1400 m and 650–850 m respectively. *A. hyperborea* has not been recorded in the Norwegian Deep (Section 15). Other species occurring in this area are *A. radiata, D. batis, D. linteus, D. nidarosiensis, D. oxyrinchus, L. circularis, L. fullonica, R. clavata, R. fyllae*. A more thorough description of rajiform elasmobranchs from the Norwegian Sea can be found in Stehmann and Bürkel (1984).

Stock boundaries are not known for the species in this area, neither are the potential movements of species between the coastal and offshore areas. Parts of the adjacent Norwegian coastal area have been included within the Barents Sea eco-region. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this eco-region and neighboring 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 teleost species. Landings data for skates and rays are shown in Table 14.2 and Figure 14.1 for the years 1973–2006.

14.2.2 The fishery in 2006

No new information.

14.2.3 ICES advice applicable

ACFM has never provided advice for any of the stocks within this region.

14.2.4 Management applicable

There are no TACs or other management measures for any of the demersal skate species in this region.

14.3 Catch data

14.3.1 Landings

Data are very limited and only available for ICES Division II for all skate and ray landings combined (Figure 14.1 and Table 14.2). This area covers all of the Norwegian Sea eco-region, but also includes the most westerly parts of the Barents Sea eco-region (Section 13).

Overall landings throughout time have been low and totalling around 200–300 t per year for all fishing countries, with moderate fluctuations and one massive temporal peak in the late 1980s when Russian fisheries landed over 1900 t of skates and rays in 1987, subsequently dropping to low levels two years later again. This peak was due to an experimental fishery, when bycatches of skates and rays were landed, whilst normally they are discarded (Dolgov, pers. comm. 2006). Russia and Norway are the main countries landing skates and rays from the Norwegian Sea. Landings data are not resolved to species and are provided by Norway and France in the most recent years.

14.3.2 Discard data

No information.

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

No information.

14.4.2 Quality of the data

Information on the species composition of commercial catches is required.

14.5 Commercial catch-effort data

No information.

14.6 Fishery-independent surveys

For offshore areas, Skjaeraasen and Bergstad (2001) noted that *A. hyperborea* were caught in considerable numbers over a length range of 14–97 cm and a mean of about 60 cm, whereas *B. spinicauda* were scarce in distribution.

The distribution and diversity of elasmobranchs in North-Norwegian coastal areas were assessed and presented by Williams *et al.* (2007). The southern portion of the coastal area studied is incorporated within the Norwegian Sea eco-region. For the purposes of this report, the inshore boundary between the Norwegian and the Barents Sea is defined as the border between Norwegian Directorate of Fisheries Statistical Areas 04 and 05, as shown in Fiskeridirektoratet (2004). Data for this assessment were taken from demersal trawl surveys carried out annually during the autumn months from 1992 to 2005. From 1995–2005 each annual survey covered the entire coastal area included in the Norwegian Sea eco-region. In the three previous surveys, the coastline was split into 3 parts. 1992 covered north of 69°42’N, 1993 covered from 66°19’N to 69°27’N, and in 1994 from 62°28’N to 65°24’N. A Campelen 1800 shrimp trawl was used as standard for all surveys. Door spread was constrained by strapping to approximately 47m for the majority of samples. The headline height was 4.5m ± 0.5m.

13 skate species and four species of sharks were recorded as inhabiting the coastal region. Average catch rates for the majority of species were low (see Table 14.1). Presence/absence analyses were carried out for all species and shifts in abundances by latitude were assessed for the more abundant species. There were no notable absences of species that were previously known to inhabit this area.

A. radiata was the most abundant of the skate species. A total of 226 individuals were recorded over all surveys. Abundances appeared to be higher at the most northerly latitudes, but it occurred in all latitudinal bands along the coastline. *A. radiata* was the only species shown to have significant annual changes in average abundances over the total survey area. From 2002 until 2003, abundances were shown to have increased from 2 to 5 individual km^{-2}. This species was recorded and appears to be similarly abundant at all depths (<50->700 m).

65°N appeared to be the northern distribution limit of *D. oxyrinchus*. 106 individuals were recorded throughout all surveys, with almost half of these being caught in 1994. The high catch rate in 1994 was spread over 25 positive trawl samples covering depths of less than 50 m to over 650 m, and the latitudinal range 62°N to 65°N.

33 individuals of *R. clavata* were recorded throughout the surveys. It was shown to occur at all latitudes, however no latitudinal or temporal trends in abundance were identified. *R. clavata* appears to be more abundant in shallower areas, but was caught in areas as deep as 460 m. There is particular concern regarding the validity of the data for this species with regard to identification. Further scrutiny of the data could well lead to disagreement with the description given here.

In total 24 individuals of *D. batis* were caught in specific areas along the whole coastline covered by the survey. Most were taken in the surveys in 1997 and 1998 (seven caught in each year). Depth of capture ranged from 85–420 m.

A total of 20 individuals of *R. fyllae* were recorded from depths between 83–365 m. The distribution of observations was mainly confined to along the coastline north of 67°N. Four individuals were observed between 2002 and 2004 further south between 62° and 65°N.

A total of 20 individuals of *L. fullonica* were identified, six of which were caught in one trawl during the 2001 survey. Depth of capture ranged from 77–512 m.

Records of *Dipturus nidarosiensis* only occurred in five of the surveys from 1996 to 2004 and up to three specimens per year were taken. Depths ranged from 130–590 m. All observations were made below 64°N with the exception of one individual caught in the Lofoten area (approx. 68°N) in the 1997 survey.

Five individuals of *A. hyperborea* were recorded at depths between 170–620 m. *R. montagui*, *R. brachyura* and *L. circularis* were caught between 62 and 64°N, which appears to be the northern limit of these species distributions. All three species were caught at shallower depths, less than 250 m, and mostly in areas less than 100 m deep.

One individual of *B. spinicauda* was identified in 1993 at 315 m at approximately 68°N. The only observation of *D. linteus* occurred in 1997. One individual was identified in the Lofoten region at 68°N at a depth of 588 m.

For the non-skate species, *E. spinax,* appeared to be the most abundant elasmobranchs present, followed by *G. melastomus* and *S. acanthias.* The number of individuals recorded during the surveys exceeded 8000 for the two former species. Latitudinal abundance trends of these small shark species all indicated a southerly distribution, with few or no individuals caught above latitude 65°N. All appear to inhabit the same broad range of depths (<50–>700 m).

Throughout all the surveys, only one *S. microcephalus* was identified. This occurred in the 1993 survey at approximately 69°N at a depth of 480 m.

No clear shifts in abundance over time were detected for any species. Annual observed abundances are shown in Figures 14.3 and 14.4. A more robust assessment is necessary to better identify temporal trends in abundances.

14.6.1 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 is given in Williams *et al.* (2007) and Williams (2007). To summarise here, there are concerns about misidentification with regard to skates (Rajidae), and in particular the possible confusion between *A. radiata* and *R. clavata*. In some cases identification of these species is clearly dubious, where the two shifts on a particular survey consistently identified opposite species during the same period (see Figure 14.2). Observations made during the 2006 survey indicated that identification deficiencies might exist for other northerly short-nosed Rajidae species that are commonly grouped as rays (Williams, 2007). In addition, the literature available on survey vessels was not optimal for classifying skates. Some skate species are known to vary considerably in morphology and colour. There can also be confusion with different life stages and locations. The pictures and photos used for identification can be misleading if they represent specimens found in more southern areas where specimens may look quite dissimilar. One example of this is *D. batis*. The current literature used is particularly inefficient for the purpose of identifying juvenile *D. batis*.

The survey data for skates must be thoroughly examined before these are used in assessments. In its present form they jeopardise the validity of any assessment. In order to achieve a satisfactory quality of survey data in the future better identification practices, with more applicable literature, need to be put in place (see Section 21) and the development of appropriate field identification guides is therefore a high priority.

14.7 Life-history information

No new information.

14.8 Exploratory assessment models

No assessments have been conducted, due to insufficient data.

14.9 Quality of assessments

No assessments have been conducted, due to insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated.

14.10 Reference points

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

14.11 Management considerations

There are no TACs for any of the demersal skates in this region. Eight of the species included in this section are listed in the Norwegian Red List (2006) as data deficient. 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 eco-regions.

14.12 References

Fiskeridirektoratet. 2004. Website in Norwegian. Statistical area maps available as pdf files: http://www.fiskeridir.no/fiskeridir/fiskeri/statistikk/kart/kart_lokasjon_og_omraade.

Skjaeraasen, J. E. *and* Bergstad, O. A. 2001. Notes on the distribution and length composition of *Raja linteus, R. fyllae, R. hyperborea* and *Bathyraja spinicauda* (Pisces: Rajidae) in the deep northeastern North Sea and on the slope of the eastern Norwegian Sea. ICES Journal of Marine Science, 58: 21–28.

Stehmann, M., and Bürkel, D. L. 1984. Rajidae. *In* Fishes of the north-eastern Atlantic and Mediterranean, Vol 1, pp. 163–196. Ed. by P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese. UNESCO, Paris, 510 pp.

Williams, T. 2007. Cartilaginous fishes along the North-Norwegian coast. Distributions and densities with regard to fishing and sea temperature. Master thesis in International Fisheries Management. Norwegian College of Fishery Science. University of Tromsø, 62 pages, http://www.ub.uit.no/munin/handle/10037/975.

Williams, T., M. Aschan, and K. Helle. 2007. Distribution of Chondrichthyan species along the North-Norwegian coast. *in* Working Document for the ICES Elasmobranch Working Group (WGEF) 2007.

Table 14.1. Demersal elasmobranchs in the Norwegian Sea. Catch data (number of individuals per species) for the Norwegian Sea eco-region 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	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	27776	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 Subdivision II+IIa+IIb.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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.
Faeroe Islands				5	2	1	1				
France			1	68	61	18	2	1	12	109	2
Germany		1	52	12	59	114	84	85	53	7	2
Iceland											
Netherlands							2				
Norway	201	158	89	34	99	82	126	191	137	110	96
Portugal				34	39						
Russian Federation						302	99	39			
Spain											28
UK - Eng+Wales +N.Irl	65	18	14	20	90	10	6	2			
UK - Scotland	2	1			1						
Total of Submitted Data	268	178	157	173	351	527	320	318	202	226	128

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium											
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Faeroe Islands			4		15		42		2		
France	6	5	11	21	42	8	56	11	15	9	7
Germany	112	124	102	95	76	32	52				
Iceland											
Netherlands											
Norway	150	104	133	214	112	148	216	235	135	286	151
Portugal										22	11
Russian Federation	537	261	1633	1921	1647	867	208		181	112	257
Spain		17	5		9						
UK - Eng+Wales +N.Irl	5	1	2	4		2	1		1		
UK - Scotland				2	1						
Total of Submitted Data	810	512	1890	2257	1902	1057	575	246	334	429	426

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium								n.a.	n.a.	n.a.	0	
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5	n.a.	n.a.		
Faeroe Islands						n.a.		n.a.	2	n.a.		
France	8	6	8	5	n.a.	5	4	7	2	7	8	
Germany						2		2	2	7	0	
Iceland							4		n.a.	n.a.		
Netherlands								n.a.	n.a.	n.a.		
Norway	239	198	169	214	239	244	233	118	111	135	133	146
Portugal		10	28	46	10	6	3	n.a.	8	n.a.	.	
Russian Federation			77	139	247	400	113	38	6	n.a.		
Spain	3		3	15	6		7	11	32	n.a.	.	
UK - Eng+Wales +N.Irl	1	4			1			n.a.	n.a.	n.a.	.	0
UK - Scotland					1	1	1	3	3	n.a.	.	4
Total of Submitted Data	251	218	285	419	504	658	365	184	166	149	141	150

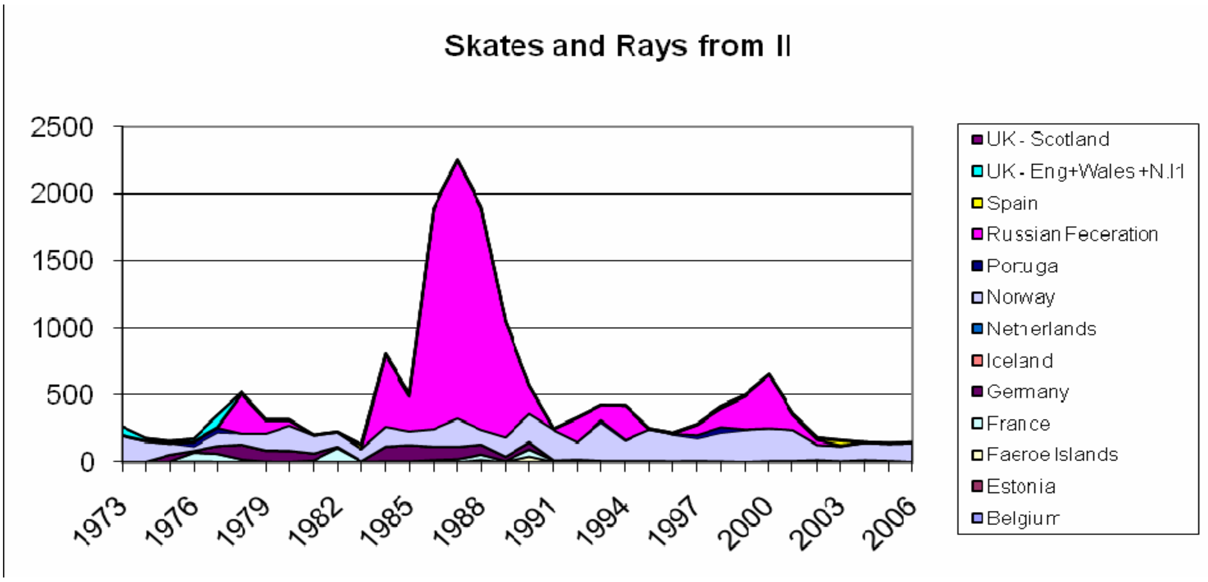


Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Area 27 Subdivision II+IIa+IIb 1973–2006.

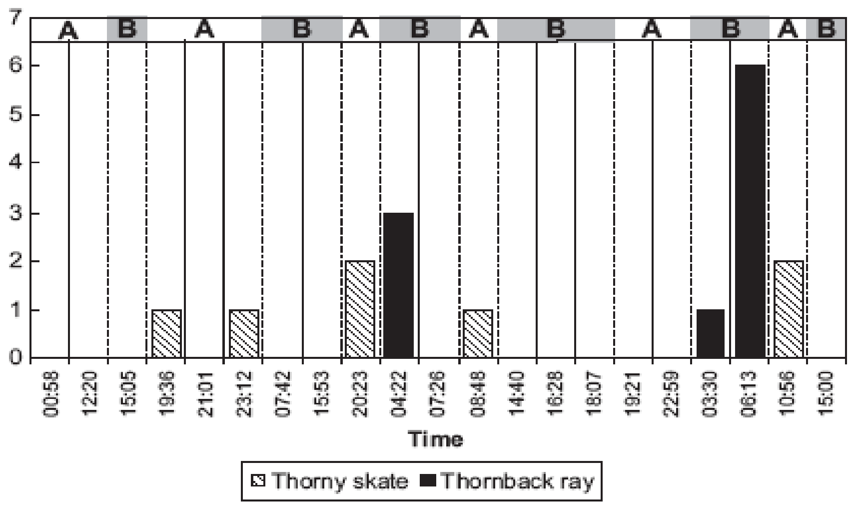


Figure 14.2. Demersal elasmobranchs in the Norwegian Sea. Differences in species identification between shift patterns during bottom trawl survey of the Norwegian coastline from the 25th-30th September 1992, latitude 69°N.

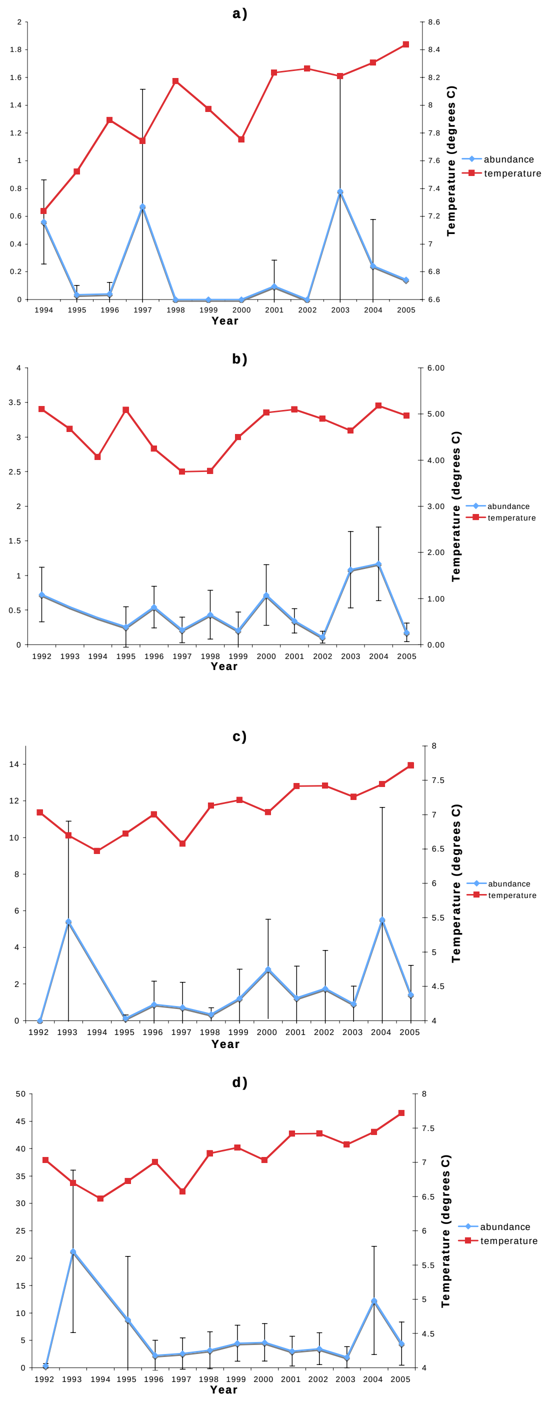


Figure 14.3 Demersal elasmobranchs in the Norwegian Sea. Species abundance with 95% confidence intervals against temperature for a) *Dipturus oxyrinchus* in area 62°N, b) *Amblyraja radiata* in area East(69-71°N), c) velvetbelly in area West(69-71°N) and d) *Chimaera monstrosa* in area West(69–71°N).

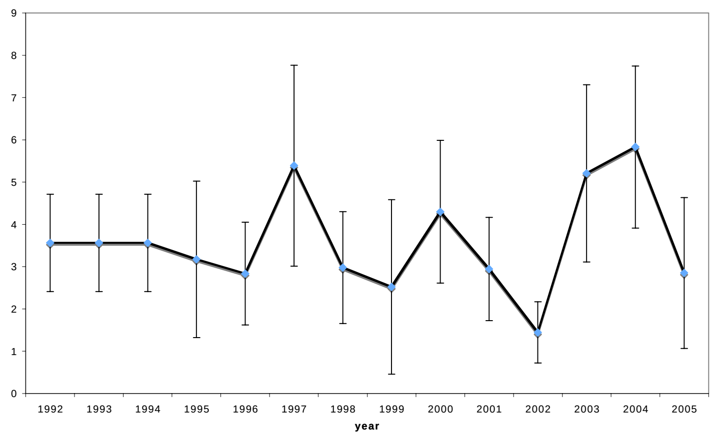


Figure 14.4. Demersal elasmobranchs in the Norwegian Sea. Average annual mean densities in number km^{-2} (with 95% confidence intervals) for *Amblyraja radiata* (1992–94 given as one average).

15 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel

15.1 Eco-region and stock boundaries

In the North Sea about 10 skate and ray species occur as well as seven demersal shark species. Thornback ray *R. clavata,* is probably the most important ray for the commercial fisheries. Preliminary assessments for this species were presented in ICES (2005), based on research vessel surveys. This year the landings data have been updated and some further analyses of survey data undertaken. WGEF is concerned over the possibility of misidentifications of skates in some of the IBTS surveys (especially between *R. clavata* and starry ray (or thorny skate) *Amblyraja radiata*.

For most species dealt with in this section the stock boundaries are not well known. The stocks of cuckoo ray *L. naevus*, spotted ray *R. montagui*, *R. clavata* and the lesser-spotted dogfish *S. canicula* probably continue into the waters west of Scotland (and for *R. clavata, R. montagui,* lesser spotted dogfish also into the western English Channel). The stock boundary of common skate *D. batis* is likely to continue to the west of Scotland and into the Norwegian Sea. The stock boundary of *Mustelus mustelus* and *M. asterias* 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 tangle nets and long-line. For a description of the demersal fisheries see the Report of the North Sea Demersal Working Group (ICES, 2006a) and the report of the DELASS project (Heessen, 2003).

15.2.2 The fishery in 2006

No new information.

15.2.3 ICES advice applicable

In 2005 ICES provided advice for 2006 for these stocks. Target fisheries for common skate *D. batis* and thornback ray *R. clavata* should not be permitted, and bycatch in mixed fisheries should be reduced to the lowest possible level. Moreover, ICES advised that if the fisheries for rays continue to be managed with a common TAC for all ray species, this TAC should be set at zero for 2006.

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 set at 2190 t, 20% less than that for 2006 (on no particular scientific ground). This TAC is 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”.

Within the North Sea area, the Kent and Essex Sea Fisheries Committee (England) has a minimum 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*, and rabbit fish *Chimaera monstrosa*. Furthermore, fishing for and landing of lesser-spotted dogfish, *R. clavata* and *D. batis* is prohibited.

15.3 Catch data

15.3.1 Landings

The landings tables for all skates and rays combined (Table 15.1–15.4) and for lesser-spotted dogfish (Table 15.5) were updated. Figure 15.1 shows the total international landings of rays and skates from IIIa, IV and VIId since 1903. Data from 1973 onwards are WG estimates.

15.3.2 Discard data

Information on discards in the different demersal fisheries is being collected by several countries. Length frequency distributions of discarded and retained elasmobranchs, covering the period from 1998–2006, were provided by UK England and illustrated in ICES (2006b).

15.3.3 Quality of the catch data

Species-specific landings data are not available. Several nations now have market sampling and discard observer programmes that can provide information on the species composition, although comparable information is lacking for earlier time periods.

15.4 Commercial catch composition

15.4.1 Species and size composition

Only France and Sweden provided landings data by species but these data were not considered to be reliable. For France it was concluded that the species composition was probably based on landings from fisheries to the west of the British Isles rather than on landings from the North Sea. For example, a significant part of the landings is reported to consist of *D. oxyrinchus*. Also a species like *Torpedo marmorata* is reported to be landed in greater quantities than *R. montagui*, whereas from all other sources it is apparent that marbled electric ray only occurs rarely in the North Sea, whereas the spotted ray is one of the most common skates.

Until 2004 Sweden reported small landings of common skate *D. batis*, since December 2004 landings of sailray *D. lintea* were reported.

Some other countries collect information of species composition of the landings based on market sampling programmes (Belgium, UK England, UK Scotland, the Netherlands) but only part of these were available to the WG. Data for the landings by the Dutch beam trawl fleet are presented in Table 15.6. For this fleet *R. clavata* and *R. montagui* are the main species landed, together with some *R. brachyura* and negligible amounts of *L. naevus* and *A. radiata*.

UK (England & Wales) has undertaken some market sampling of North Sea rays, primarily at Lowestoft, but with some limited data for other ports (e.g. Scarborough). Preliminary analyses of these data confirm that *R. clavata* is the dominant species in longline, gillnet and trawl fisheries, with *R. montagui* and *R. brachyura* of secondary importance. *L. naevus*, which occurs in the northwestern part of the North Sea, was only a significant constituent in trawl fisheries (Table 15.7).

In Table 15.8 and 15.9 some length composition data for North Sea rays and skates are presented from UK (England & Wales) (based on discard information) and the Netherlands (based on market sampling).

There are no effort data specifically for North Sea rays and skates.

15.4.2 Quality of data

Two countries provided species-specific landings data, based on information from logbooks or auctions, but these were not considered reliable. The WG is of the opinion that only actual market sampling will provide reliable data on the species composition of landings and discards. Such data are now being collected by several countries but only part is reported to the WG.

Sampling should cover various regions, gears and seasons to provide reliable species composition data. More robust protocols for ensuring correct identification are also needed.

The peak in the landings of rays and skates in 1981 is the result of one year with exceptionally high landings reported by France for IV and VIId. This is likely to be caused by misreporting. WGEF is not aware of recent misreporting to take place, although may occur in 2007 due to the bycatch quota.

15.5 Commercial catch-effort data

There are no effort data specifically for North Sea skates and rays.

15.6 Fishery-independent surveys

15.6.1 Availability of survey data

Fishery-independent data are available for the North Sea, Skagerrak and Kattegat from the International Bottom Trawl Survey (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). Average catch rates for all 21 species of elasmobranch caught during the quarter 1 IBTS are given in Table 15.10. According to this table starry ray *A. radiata* is by far the most abundant species in this area. Distribution maps are provided in ICES (2005) and ICES (2006b).

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). Among the sharks, spurdog has clearly declined markedly over time (see Section 2), whereas lesser-spotted dogfish, tope and smoothhounds have increased markedly, although catch rates of tope are low. The remaining shark species are caught only infrequently and no trend could be detected.

Among the skates, trends were less clear. Starry ray *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 the cuckoo ray *L. naevus* and spotted ray *R. montagui*. Common skate *D. batis* showed an overall decline, supporting the findings of ICES (2006b) while sandy ray *L. circularis* and shagreen ray *L. fullonica* appear to have somewhat increased in abundance, but catch rates are low and interannual variability is high, due to many years with zero observations. The thornback ray *R. clavata* has largely remained stable in recent years, with one outlier in 1991 owing to a single exceptionally large catch (confirmed record). However, the long-term trend in *R. clavata* is markedly downward and the species is considered depleted (ICES, 2006b). Also blonde ray *R. brachyura* does not show a specific trend (Daan *et al.,* 2005).

Ellis *et al.* (2005) provided length-frequency data and abundance trends based on survey catches in UK waters. Lesser-spotted dogfish showed a small increase in the eastern Channel. *A. radiata* showed 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.

As part of the CHARM-project, Martin *et al.* (2005) used data from the Channel Ground Fish Survey (IFREMER) and the East Channel Beam Trawl Survey (CEFAS) for the years 1989–

2004 to study the distribution and essential habitats of thornback ray *R. clavata* and lesser-spotted dogfish in the eastern Channel. Migratory patterns related to spawning and nursery areas are shown. An apparent trend for lesser-spotted dogfish distribution to be increasing towards the Straits of Dover and into the North Sea was evident over the period 1990–2004. It is also apparent from these surveys that the SE English coast is an important habitat for *Raja clavata*.

15.6.2 Quality of survey data

More in-depth analysis of the quality of IBTS data would indicate that there are species-identification problems associated with several nations, with some of the confusion originating from confusion between starry ray (or thorny skate, *A. radiata*) and thornback ray *R. clavata*. For the 2007 assessment, the following data filtering was implemented, in order to maximise standardised data collection and omitting questionable data:

- All data collected before 1979 were excluded
- All data on skates and rays supplied by Norway were excluded
- All data from the Netherlands for 1979 were excluded
- All data from France for 1988 were excluded
- Data for *R. clavata* from France for 1998 were considered to be *A. radiata,* and vice versa
- The exceptionally large catch of rays by the Netherlands (1991, haul 29, 35F0) should be noted. The large quantity of rays in the haul can be confirmed by WGEF, though its impact on survey estimates should be evaluated.

15.6.3 GAM analyses of survey trends

The analysis carried out in this section follows the method outlined in Section 1.10. The analysis focuses on the most abundant species caught in the Q1 IBTS across this eco-region: thornback ray, cuckoo ray, starry ray and lesser-spotted dogfish. Only the 'filtered' Q1 IBTS data (see above) were used and, as haul and depth data were not available at the WG, the model effects were year and statistical rectangle only.

Thornback Ray: The results of the fitted GAMs are shown in Figure 15.3. The year effect estimated by the model shows some fluctuations over the 25–year time period, with an increase through the 1980s, followed by a decline to the mid 1990s and then a subsequent increase. Catch rates are estimated to be highest across a small number of statistical rectangles in the south-western North Sea specifically those around the Thames estuary and the Wash. Across the rest of the North Sea, catch rates are generally estimated to be low. The inclusion of the single exceptionally large catch of rays by the Netherlands described above led to a particularly poor residual plot. Additionally the estimated effects were particularly sensitive to the inclusion of this point and therefore it was excluded from further modelling.

Cuckoo Ray: Figure 15.4 shows the estimated temporal and spatial effects for cuckoo ray in the North Sea. Again there is an apparent increase through the 1980s followed by a decline, although in recent years catch rates seem to have stabilised. The main areas of high survey catch rates are located off the eastern coast of Scotland and also further north around Orkney and Shetland with lower estimated catch rates across the rest of the North Sea.

Starry Ray: Figure 15.5 shows the estimated effects from the fitted GAM. The estimated year effect shows an increase over the first part of the time series, but a decrease since around 2000. Highest catches are estimated to occur in the statistical rectangles in the central North Sea, particularly in the east.

Lesser Spotted Dogfish: Figure 15.6 shows the results of the fitted GAM. The estimated temporal trend in catch rate shows a significant increase over the whole time series of data.

Estimated catch rates are generally higher in the western North Sea, particularly in the north and extreme south.

Due to time constraints at the WG, 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. A cursory examination of residual plots indicated that assuming a log link function, with variance proportional to mean and estimated dispersion parameter gave a reasonable residual pattern. 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. Further discussion of this method can be found in Section 1.10.1

15.6.4 Estimation of abundance and spatial analysis-application of the SPANdex method

15.6.4.1 Introduction

Catch per unit effort from research surveys is commonly used as an indicator of fish abundance. However, survey catch rates on their own reflect only local fish density unless spatial components i.e. extent of the stock and density variations within the stock/survey boundaries are constant. This situation rarely occurs, given that the distribution of many marine species is dynamic and contagious, to varying degrees. Thus, a spatial as well as a density component is required to derive reliable estimates of abundance.

To satisfy the assumption of the proportionality of catch rates to stock abundance, Gulland (1955) proposed compartmentalization of the total area of stock distribution into sub-areas within which density could be considered constant, referred to as a stratified design. Subdividing an area increases the likelihood that fish density will be closer to homogeneity within the subareas. Environmental variables such as depth or temperature can be used as the primary stratification criterion, assuming that the fish distribute differentially by those factors. However, although such environmental variables do to varying degrees affect distribution, how fish distribute is far more complex. Thus, the assumption of homogeneity of density within environmentally-based strata is rarely met.

An alternate method for estimating abundance, SPANdex or SPANS index of abundance, see Kulka (1998a,b); Kulka and Pitcher (2001), makes use of the observed distribution of the fish to create density strata with post-stratification. That is, how the fish are actually distributed is used to define the stratification. Thus, this approach does not depend on pre-defined factors such as depth in survey stratification schemes that do not fully relate to how fish distribute and in fact may bear little relationship to distribution for some species. Rather, it takes into account, inter-annual changes in distribution both in terms of extent of the stock and spatial variation in density because the strata are formulated based on how the fish are actually distributed.

Further, within the ICES area as a whole, survey design varies and includes not only random, but stratified and also grid surveys. The technique of creation of density strata through post-stratification of survey set data can be applied to these various survey designs.

The purpose of this exercise is to use SPANdex to examine changes in abundance and distribution of four common species of skates (*Amblyraja radiata, Leucoraja naveus, Raja clavata* and *Raja montagui*) in the North Sea using the SPANdex approach. The resulting density strata also provide a visual representation of distribution changes over time in the form of maps.

15.6.4.2 Methods

The density surfaces (distribution based strata) were created using potential mapping in SPANS (Anon., 2003). Potential mapping as a point to surface interpolation technique is appropriate for the analysis data typified by a high degree of variance and uneven distribution (Anon., 2003). Because observed fish density is used as the stratifying variable, it greatly reduces within strata variability of density (mean number or mean weight per tow). Extent and location of density constant subareas is allowed to vary according to distributional changes of the fish. That is, the technique makes use of the geo-referenced catch rate data to define location and extent of the density strata.

The technique converts geo-referenced point data in this case survey set mean number per tow to surfaces that describe spatial density of fish. It is a form of spatial moving average or summation using a circle of specified radius (Kulka, 1998). To bring about the transformation of point data to a continuous surface, a circle is placed around the starting position of each set. The process is repeated for each data point (set location). Each circle takes the value of the point at the middle. A further averaging takes place where the circles overlap. The circle fragments resulting from overlaying of all circles each have a unique value. These values are assigned to an underlying grid. These values then are grouped into a user-defined classification.

The optimum size of the scanning circle is one that matches the scale of the data ideally at the size of fish schools to capture maximum resolution. For fisheries survey applications, fishing sets are far wider spaced than to allow the delineation of such resolution. In this case circle diameter was enlarged to 24 km to eliminate gaps between circles and to provide a smooth result in the resulting surface.

Further, the area was "cookie cut" to prevent extrapolation outside of the survey area. This prevents circles around survey points close to the edge of the survey area (including sets near land) from extending beyond the survey footprint, such that the resulting density surface is constrained on all sides by the land/water boundary and 700 m.

SPANS groups the results of the calculation into user-defined intervals (classes). In this case interval values were defined by equal areas per class, that is, each density stratum interval value resulted from the survey area being divided into approximately 15 equal areas based on the density distribution of the fish. Each density stratum is not necessarily contiguous as it is defined values like values of mean number tow that may appear at different locations throughout the survey area. These classifications, or post-stratified density strata and their corresponding locations are shown on the distribution maps (Figures 15.7–15.10).

A mean catch rate is calculated for each "SPANdex" stratum from the all of the points (sets) that fall within the bounds of the stratum. The mean density and area (in km^2) of each class is used to estimate an abundance index using the formula from Kulka *et al.* (1996). The formula for calculation, Equation 2 below, is an areal expansion based on the area of each stratum and the average catch rate within the stratum (refer example Table 15.11):

$$B = nS \{(a \times c)/[(t \times w)/h)]\} \qquad \text{Equation 1}$$

Where B = biomass index; n = number of catch rate classes; a = area of catch rate class (km^2); c = mean (or midpoint) of catch rate class (#/tow); t = average tow length (km); w = wingspread of net (km); h = average number of hours per tow.

Quarter 1 catch rate data from the North Sea IBTS survey employing a GOV demersal trawl, from 1980 to 2006 were used in this analysis. Catch rate data were standardized to one hour and tow speed was 4 knots. Wingspread of the net was estimated at 20 m.

Catchability (q) was not available to adjust relative estimates of abundance presented in this analysis to absolute estimates. However, it is likely that a low q for skate species results in a minimum estimate as presented.

The high density area was selected as the top two density categories. Spatial changes, area occupied overall and at the centre of mass (area occupied where the fish concentrated), as well as the changes in relative abundance, were calculated annually.

15.6.4.3 Results and Discussion

Raja clavata: R. clavata is restricted mainly to the south-western extent of the North Sea (Figure 15.7). As indicated above, survey indices of abundance increased during the 1980s, followed by a decline to the mid 1990s, and with a recent increase (Figure 15.12A, left panel). The manner in which total area occupied (AO) changed over time, fluctuating but lower after the mid-1990s (Figure 15.12D, left panel) bore little resemblance to the pattern of abundance. Most of the abundance is concentrated in a small area to the southwest of the survey area. Present total AO is only 44% of the extent of the species in the 1980s (Figure 15.11).

Leucoraja naevus: L. naevus is restricted mainly to the northwestern parts of the North Sea, a pattern consistent over time (Figure 15.8). It has also undergone a substantial increase in abundance, similar to what was observed for *A. radiata*. However, the spatial dynamics were somewhat different (Figure 13, right panel). Relative abundance increased to the mid-1990s, decreased then stabilized near the long-term average for about the past ten years. The relationship between total (and high density) area occupied and abundance was low. Total area occupied and the high density area occupied to a lesser extent increased over time, a pattern dissimilar to the abundance trend (Figure 15.13D). Percent of abundance located at the centre of mass was higher (i.e. *L. naevus* were considerably more concentrated) and more constant over time compared to *A. radiata* (Figure 15.13E). Degree of concentration decreased somewhat over time, indicating that the species became slightly more dispersed as its AO increased.

Amblyraja radiatia: A. radiata is the most extensively distributed species of the four skates examined, concentrated mainly in the central part of the North Sea, extending from the British coast at 56ºN to the south coast of Norway (Figure 15.9). Their distribution was consistent over time, although has undergone a substantial change in abundance. During the 1980s, although the overall area occupied was similar to periods of higher abundance observed in later years, the degree of density within the total distribution was much lower. Total area occupied was only 12% less during years of lower abundance, 1980–1988 compared to the period of highest abundance during 1989–1996 (Figure 15.13A, left panel). However, area where fish were most highly concentrated (highest two classes in Figure 15.9) underwent a considerably higher change. In 1980–1988, the area of high concentration amounted to <2% of total AO, while in 1988–1996, when abundance was higher, the area of high concentration comprised 26% of AO. This suggests that in the case of *A. radiata*, most of the change, in the form of reduction in density, occurred at the centre of mass and that a simple AO would be of limited value in describing spatial dynamics of the species. Reductions in overall AO may not become apparent until very large changes have taken place in the population. Kulka *et al.* (2005) described changes in the distribution of *A. radiata* on the Grand Banks of Newfoundland, where a simple description of AO was not adequate to describe the spatial dynamics, particularly the “hyper-aggregation” that occurred there (refer to Rose and Kulka (1999) for a description of hyper-aggregation).

On an annual basis, the relative abundance of *A. radiata* increased from 1980 to 1993, fluctuated until 2000 then declined to a level close to the long-term average. (Figure 15.13, panel A). During that period, with the exception of the first three years of the series, the trend in AO was flat (Figure 15.13 D-E). In contrast, area occupied at the highest level of density followed a pattern similar to the changes in relative abundance. Expressed in another way, the relationship between total AO and abundance was not linear (Figure 15.13B) but was linear for between abundance and high density AO (Figure 15.13C). This indicates spatial dynamics relating to changes abundance were occurring at the centre of mass whereas at the “fringe” of the population, actually making up the majority of the total AO, there was little change over time.

Raja montagui: R. montagui is restricted mainly to the western extent of the North Sea particularly to the north where it extends into VIa and in the south-western North Seat (Figure 15.10). It. has undergone the greatest change of the four species in the form of an increase in both abundance (Figure 15.12A, right panel) and AO (Figure 2). Both total AO and high density AO have increased steadily over time and thus there is a significant linear relationship (r^2=0.9 for high density AO) between AO (total and high density) with abundance (Figure 15.12B-C). This consistency in pattern was observed only for this species. As for *R. clavata* and *L. naevus*, most of the abundance of *R. montagui* was consistently concentrated at the centre of mass of the species (Figure 15.12E).

15.6.4.4 Conclusion

All four skate species appear to have maintained or increased their abundance since 1980. However, for at least two species, AO has varied in a manner quite different from changes in abundance. In all cases high density AO (at the centre of mass) corresponded more closely to the observed abundance changes. Total AO, reflecting extent of the distribution of a species is often used as one metric of population status (IUCN, 2001). However, it is clear, from this comparison of spatial dynamics in relation to changes in abundance of four species of skates in the North Sea that total AO may be misleading. Total AO may not reflect population changes and therefore should be used with caution when being used to assess the status of species. A clear example of this is the large decline in total AO of *R. clavata* which did not match changes in abundance. *R. clavata* has become more concentrated at the centre of mass. This type of pattern should however be regarded with caution particularly if the species is becoming more concentrated where fishing effort is high.

Two methods undertaken this year; the GAM method (Section 15.6.3.) and SPANdex modeling (above) were used to examine changes in abundance and spatial variation in the more commonly occurring skate species in the North Sea. Both methods produced similar results, with spatial and annual trends in abundance broadly consistent for all species. These results still need to be examined in relation to any temporal changes in survey design, especially in terms of survey effort in roundfish area 5.

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 maximise the sample sizes.

Demographic modelling (see Section 1.10.2) 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 *Raja clavata* were 38–66 eggs over the course of the egg-laying season, whereas other studies using oocyte counts and the proportion of females carrying eggs have suggested that the fecundity may be >100.

No information is available on recruitment, although parts of the southern North Sea (e.g. Thames area) is known to have large numbers of juveniles (Ellis *et al.*, 2005).

15.8 Exploratory assessment models

15.8.1 Previous assessments of *Raja 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 thornback ray 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. Both models include season, area and period effect:

Binomial model: log(p/(1-p)) = area + season + period

Gamma model: log(Catch numbers) = area + season + period

where p is the probability of a haul with a catch, and "1-p" is the probability of a haul without a catch of thornback ray. ICES roundfish areas were used for the definition of the area parameter; quarter of the year for the season parameter; and the years 1967–1976, 1977–85, 1986–92 and 1993–2002 as the period parameter. Individual models were fitted for each 10 cm length class and for all length classes combined. These models were implemented using the SAS® GEMOD procedure.

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 show a concentration in the south-west 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 south-western 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

Earlier analyses of survey data undertaken by ICES (2002, 2005) may have been compromised by misidentifications in submitted IBTS data, and so the extent of the decline in distribution reported in previous reports may be exaggerated. The distribution of thornback ray in the southern North Sea has contracted to the south-western North Sea, and they are now infrequent in the south-eastern North Sea, where they previously occurred (as indicated by historical surveys), although the perceived decline in catches in the north-eastern North Sea may have been based, at least in part, bycatches of starry ray. Excluding questionable records from analyses indicate that the area occupied by thornback ray has declined, with the stock concentrated in the south-western North Sea, with catch trends in IVc more stable/increasing in recent times.

15.10 Reference points

No reference points have been proposed for thornback ray or other stocks in this eco-region.

15.11 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. They are usually landed and reported in mixed categories such as “skates and rays” and “sharks”. For assessment purposes species- specific landings data are essential. The examples given above of species-specific landings based on logbook and/or auction data, and similar data based on market-sampling programmes, clearly show that only actual sampling of the catches and landings provides reliable data.

Since a TAC was introduced for North Sea skates and rays in 1999 it has always been higher than the landings (Table 15. 12 and Figure 15.4). This TAC, however, has gradually been reduced, for example from 2005 to 2006 by 15% and from 2006 to 2007 by 20%. In its 2006 report WGEF mentioned that the 2006 TAC might become restrictive for some countries and that discarding was therefore expected to increase. Discard survivorship is not known for skates and rays caught in commercial gears, although there are currently studies to evaluate discard survivorship.

WGEF was informed that the "skate" bycatch quota has impacted on UK fishermen operating in coastal waters of the Outer Thames area and east coast. For example, some IVc landings may be reported as originating from VIId, and certain fisheries may now be landing other species (e.g. tope, smoothhounds, lesser-spotted dogfish etc.) in order to increase the amount of thornback ray that can be landed (rays and skates may comprise no more than 25% by live weight of the catch retained on board). These fish may then be dumped when they have served their purpose. Such ‘loopholes’ can be a problem when managing through ratios. Additionally, if skates and rays are retained at the start of a fishing trip, but subsequent fishing does not comprise large quantities of other commercial species that can be landed; this can result in discarding of dead fish. In terms of managing the inshore fleet, measures other than ratios (e.g. trip limits, size restrictions) might be more appropriate measures for decreasing fishing mortality on the stock.

Due to effort restrictions, and high fuel prices, effort may divert to small inshore fisheries that may target skates and rays. The main areas of thornback ray occur in the Thames estuary and the Wash in the southwestern North Sea.

The TAC for rays and skates should only apply to areas IIIa, IV and VIId and not to IIa since this only a part of IIa belongs to the present North Sea eco-region.

Technical interactions of fisheries in this eco-region are shown in Table 15.13.

15.12 References

Anon. 2003. Geomatica V. 9 Users Guide. PCI Geomatics, 50 West Wilmot St. Richmond Hill. Ont.

Daan, N., Heessen, H.J.L., and ter Hofstede, R. 2005. North Sea Elasmobranchs: distribution, abundance and biodiversity. ICES CM 2005/N:06.

Ellis, J. R., Dulvy, N. K., Jennings, S., Parker-Humphreys, M., and Rogers, S.I., 2005. Assessing the status of demersal elasmobranchs in UK waters: a review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Gulland, J.A. 1955. Estimation of growth and mortality in commercial fish populations. MAFF Fishery Investigations, London, (2) 18 (9), 47 pp.

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

ICES. 2002. Report of the Working Group of elasmobranch fishes. ICES CM 2002/G:08.

ICES. 2005. Report of the Working Group on elasmobranch fishes. ICES CM 2005/ACFM:03.

ICES. 2006a. Working Group on the assessment of demersal stocks in the North Sea and Skagerrak (WGNSSK). 6–15 September 2005, ICES Headquarters Copenhagen. ICES CM 2006/ACFM:09.

ICES. 2006b. Report of the Working Group on ELasmobranch Fishes (WGEF), 14–21 June 2005, Lisbon, Portugal. ICES CM 2006/ACFM:03, 224 pp.

IUCN 2001. IUCN Redlist Categories and Criteria Ver. 3.1 Prepared by the Species Survival Commission (www.IUCN.org/themes/ssc/red-lists.htm).

Kulka, D. W 1998a. Spatial analysis of northern Atlantic cod distribution with respect to bottom temperature and estimation of biomass using potential mapping in SPANS. DFO Atl. Fisheries Research Document 98/13 34 pp.

Kulka, D. W., 1998b. SPANdex - SPANS geographic information system process manual for creation of biomass indices and distributions using potential mapping. DFO Atl. Fisheries Research Document 98/60 28 pp.

Kulka, D.W., A.T. Pinhorn, R.G. Halliday, D. Pitcher, and D. Stansbury. 1996. A fish stock abundance index employing spatial analysis to adjust for concentration of fishing effort, using cod in NAFO Divisions in 2J3KL as an example. Fish Res., 28/3 321–342.

Kulka, D.W., and Pitcher, D.A. 2001. Spatial and temporal patterns in trawling activity in the Canadian Atlantic and Pacific. ICES CM 2001/R:02 57 pp.

Kulka, D. W., M. R. Simpson, and C. M. Miri. 2006. An assessment of thorny skate (*Amblyraja radiata* Donovan, 1808) on the Grand Banks of Newfoundland. 06/44, N5269, 66p.

Martin, C. S., Vaz, S., Ernande, B., Ellis, J. R., Eastwood, P. D., Coppin, F., Harrop, S., Meaden, G. J., and Carpentier, A., 2005. Spatial distributions (1989–2004) and preferential habitats of thornback ray and lesser-spotted dogfish in the eastern English Channel. ICES CM 2005/N:23, 27 pp.

Rose, G.A., and D.W. Kulka. 1999. Hyper-aggregation of fish and fisheries: how CPUE increased as the northern cod declined. Canadian Journal of Fisheries and Aquatic Science 56: 1–10.

Serra-Pereira, B., Figueiredo, I., Bordalo-Machado, P., Farias, I., Moura, T., and Serrano Gordo, L., 2005. Age and growth of *Raja clavata* Linnaeus, 1758–evaluation of ageing precision using different types of caudal denticles. ICES CM 2005/N:17.

Walker, P. A. 1999. Fleeting images: Dynamics of North Sea Ray populations. PhD Thesis, University of Amsterdam, the Netherlands, 145 pp.

Table 15.1 **Total landings (t) of Rajidae in III**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	.	.	.	.	.	.	.		0	0
Denmark	16	7	11	41	56	22	36	127	62	
Germany	.	+	.	.	.	+			.	1
Iceland	.	.	.	.	.		.			
Netherlands	n.a.	.	.	.	.	.			0	0
Norway	160	134	208	123	154		163	85	94	51
Sweden	5	1	2	2	12	13	9		10	18
UK (E&W_NI_+)	.	.	.	.	.	.	.	.	0	0
UK (Scotland)	.	.	.	.	.	.	.	.	0	
Total of submitted data	181	142	221	166	222	35	208	212	166	69

Table 15.2 **Total landings (t) of Rajidae in IV**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	428	373	336	332	370	436	323	276	327	350
Denmark	33	20	45	93	65	34	33	23	23	
Faroe Islands	.	.	.	n.s.	n.s.					
France	52	47	n.s.	31	61	62	36	37	34	15
Germany	35	9	16	23	11	22		17	29	16
Iceland	.	.	.	.	.		.			0
Ireland	.	.	.	.	.		.		0	0
Netherlands	n.a.	609	515	693	834	805	686	561	680	603
Norway	106	180	152	161	173		113	77	87	69
Poland	.	.	.	.	.					
Sweden	+	+	+	+	+	+	+	20	0	0
UK (E&W_NI_+)	1009	794	618	516	476	500	537	550	434	348
UK (Scotland)	1494	1381	965	860	822	853	741	512	404	374
Total of submitted data	3157	3413	2647	2709	2812	2711	2469	2073	2018	1775

Table 15.3 **Total landings (t) of Rajidae in VIId**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	117	66	93	69	79	113	153	96	94	109
France	896	738	ns	693	729	725	796	695	602	687
Germany	.	.	.	+	.	.	.	0	.	0
Ireland	.	.	.	.	.	.	2	0	0	0
Netherlands	na	.	.	.	.	.	.	.		13
Spain	na	na	na	na	na	na	na	+	0	
UK (E&W_NI_+)	213	246	437	355	169	140	186	157	147	139
UK (Scotland)	+	+	.	.	.	.	.	.	0	2
Total of submitted data	1226	1050	530	1117	977	978	1137	948	843	948

Table 15.4 **Combined landings (t) of Rajidae in IIIa, IV and VIId**

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	545	439	429	401	449	548	476	372	422	459
Denmark	49	27	56	134	121	56	69	151	85	0
Faroe Islands	.	.	.	n.s.	n.s.	.	.	.	0	0
France	948	785	n.s.	724	790	725	796	n.s.	636	701
Germany	35	9	16	23	11	22	.	.	29	17
Iceland	.	.	.	.	.	.	.	.	0	0
Ireland	.	.	.	.	.	.	2	0	0	0
Netherlands	n.a.	609	515	693	834	805	686	561	680	615
Norway	266	314	360	284	327	.	276	162	181	120
Poland	.	.	.	.	.	.	.	.	0	0
Spain	na	na	na	na	na	na	na	+	0	0
Sweden	5	1	2	2	12	.	9	20	10	18
UK (E&W_NI_+)	1222	1040	1055	871	645	640	723	707	580	487
UK (Scotland)	1494	1381	965	860	822	853	741	512	404	375
Total of submitted data	4564	4606	3398	3992	4011	3649	3778	2484	3027	2793

Table 15.5. 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
Belgium	NA	NA	NA	NA	226	91.4	265
France	1633	1811	1899	1777	1472	1614	1453
UK (E&W)	NA	NA	NA	13	57	92	118
UK (Scotland)	.	.	1	5	3	22	6
	1633	1811	1900	1795	1758	1819.4	1842

Table 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel.: species specific landings (t) for North Sea rays and skates. Data for the Netherlands beam trawl fishery, based on market sampling.

YEAR	A. RADIATA	L. NAEVUS	R. BRACHYURA	R. CLAVATA	R. MONTAGUI	TOTAL
2000	1.2	3.2	135.9	264.9	287.6	693
2001	1.7	4.0	115.2	314.5	398.5	834
2002	not available					805
2003	not available					383
2004	-	-	116.0	217.3	228.0	561
2005	1.0	1.4	168.6	131.6	262.7	565
2006	-	-	155.6	251.9	208.5	616

Table 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: preliminary quantification of species composition (% in numbers) of rays in UK North Sea fisheries based on market sampling of longline, otter trawl and gillnet catches (From UK (England & Wales) market sampling in 2004).

SPECIES	LONGLINE	OTTER TRAWL	GILLNETS
Amblyraja radiata	0	1.9	0
Leucoraja naevus	0.6	5.4	0
Raja brachyura	8.6	8.5	1.9
Raja clavata	78.8	79	97.7
Raja montagui	11.9	5.2	0.5

Table 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: North Sea rays and skates. Length frequency distributions (numbers in '000).

North Sea rays and skates
Length frequency distributions (numbers in '000)
Country: the Netherlands
Gear: beam trawl
Category: landings

R. clavata					*R. montagui*					*R. brachyura*				
length	2000	2001	2005	2006	length	2000	2001	2005	2006	length	2000	2001	2005	2006
25					25					25				
30	0.6	1.9	3.0	0.3	30	3.5	0.5	0.9	0.5	30				
35	9.4	11.2	7.8	8.6	35	34.2	6.3	4.7	2.5	35	1.2	1.0	0.3	1.5
40	16.8	19.9	14.2	13.4	40	75.6	33.5	14.0	15.8	40	1.2	1.5	2.1	5.5
45	17.5	20.3	11.2	26.2	45	85.9	60.3	36.9	52.5	45	1.2	3.3	6.0	3.9
50	23.0	36.4	18.2	40.0	50	58.3	72.5	47.6	59.6	50	2.7	5.6	7.7	3.5
55	16.0	35.3	12.9	26.6	55	42.7	54.6	49.9	34.6	55	3.1	4.9	9.6	7.7
60	12.1	22.8	14.7	20.0	60	26.1	42.4	44.2	25.3	60	0.6	5.3	6.8	7.5
65	5.3	15.3	5.7	16.7	65	10.4	16.1	13.7	4.7	65	1.0	3.6	8.0	7.6
70	5.3	5.2	6.2	11.8	70	2.0	2.3	0.9	1.1	70	1.6	2.1	6.1	4.5
75	4.7	5.5	5.2	8.1	75	0.3		0.1		75	1.8	2.7	3.1	5.4
80	3.7	3.5	2.2	3.7	80					80	1.6	1.9	4.2	5.1
85	3.4	2.3	1.8	1.9	85					85	1.1	1.5	3.1	2.3
90	1.2	0.6	0.7	0.9	90					90	0.5	1.9	2.4	2.0
95	0.8	0.3	0.1		95					95	0.1	0.6	1.6	1.2
100					100					100	0.1		0.2	0.3
105					105					105			0.3	
110	0.1				110					110				
total	**119.8**	**180.5**	**103.9**	**178.2**	**total**	**339.2**	**288.4**	**212.9**	**196.6**	**total**	**17.7**	**35.8**	**61.5**	**58.0**

Table 15.9 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: Length distributions (numbers) of discards and landings from discard observations in the years 1998–2006.

Country: UK England
Gear: all gears combined
Category: discards and landings

	Raja brachyura		*Leucoraja naevus*		*Raja montagui*		*Dipturus batis*		*Amblyraja radiata*		*Raja clavata*	
length	discarded	retained	discarded	retained	discarded	retained	discarded	retained	discarded	retained	discarded	retained
5			2						10		22	
10	4		126		94		8		106		626	
15	43		232		62		55		1224		1911	
20	21		227		106	1	55		6879		994	
25	58		117	19	84	1	15	1	8368	52	1301	2
30	82	15	60	87	108	41	3	8	9005	147	1256	15
35	134	30	246	83	123	32		3	7802	118	636	53
40	16	56	127	38	211	38		1	9882	143	579	145
45	18	40	97	60	76	93			7379	53	779	410
50	12	29	50	88	19	119		1	2105	3	200	651
55	3	35	7	54	21	161			75	4	16	885
60		32	8	14		105			8			814
65		27		1		51				1		546
70		18										570
75		8								2		400
80		2										181
85		2										82
90		2										21
95		3										4
100		4										
105		2										
110												
115												
120												
sum	391	306	1299	444	904	642	136	14	52843	523	8320	4781

Table 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: average catch rate (N per hour, 1977–2004) for elasmobranchs caught during the quarter 1 IBTS in the North Sea, Skagerrak and Kattegat (from Daan *et al.*, 2005).

Starry ray	Amblyraja radiata	4.1321
Thornback ray	Raja clavata	1.8511
Spurdog	Squalus acanthias1.	1554
Lesser spotted dogfish	Scyliorhinus canicula	0.6167
Cuckoo ray	Leucoraja naevus	0.3233
Spotted ray	Raja montagui	0.2554
Smoothhound	Mustelus spp.	0.2128
Rabbitfish	Chimaera monstrosa	0.0272
Common skate	Dipturus batis	0.0151
Blonde ray	Raja brachyura	0.0107
Velvet-belly	Etmopterus spinax	0.0062
Tope	Galeorhinus galeus	0.0038
Shagreen ray	Leucoraja fullonica	0.0025
Nursehound	Scyliorhinus stellaris	0.0020
Sandy ray	Leucoraja circularis	0.0012
Undulated ray	Raja undulata	0.0007
Common stingray	Dasyatis pastinaca	0.0006
Long-nosed skate	Dipturus lintea	0.0006
Greenland shark	Somniosus microcephalus	0.0005
Blackmouth dogfish	Galeus melastomus	0.0003
Porbeagle	Lamna nasus	0.0002

Table 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Example of a SPANdex calculation of relative abundance for *A. radiata* 15 level density stratification created by potential mapping of survey mean number per tow is illustrated in Fig. x.1. Rel. abundance is calculated by the formula illustrated in the Methods.

1980			Relative
Area sq km	Mean # per tow	Abundance #	Abundance #/1000
373002	0	0	0
15075	0	0	0
15475	0	0	0
13443	0.25	45,366	45
15511	0	0	0
14697	0	0	0
16335	2	441,010	441
19655	0.416667	110,551	111
18320	0.1	24,730	25
16809	0.461538	104,725	105
16894	1.2	273,661	274
17282	3	699,865	700
15430	2	416,577	417
20970	0.5	141,536	142
18259	3.8	936,612	937
607,157	13.73	**3,194,632**	***3,195***

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	3038
2000	6060	3708
2001	4848	3684
2002	4848	3649
2003	4121	3502
2004	3503	2322
2005	3220	2846
2006	2737	2793
2007	2190*	

*** Considered as bycatch quota. These species shall not comprise more than 25% by live weight of the catch retained on board.**

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

		Cod 347d	Cod katt.	Had 34	Vhg 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																		

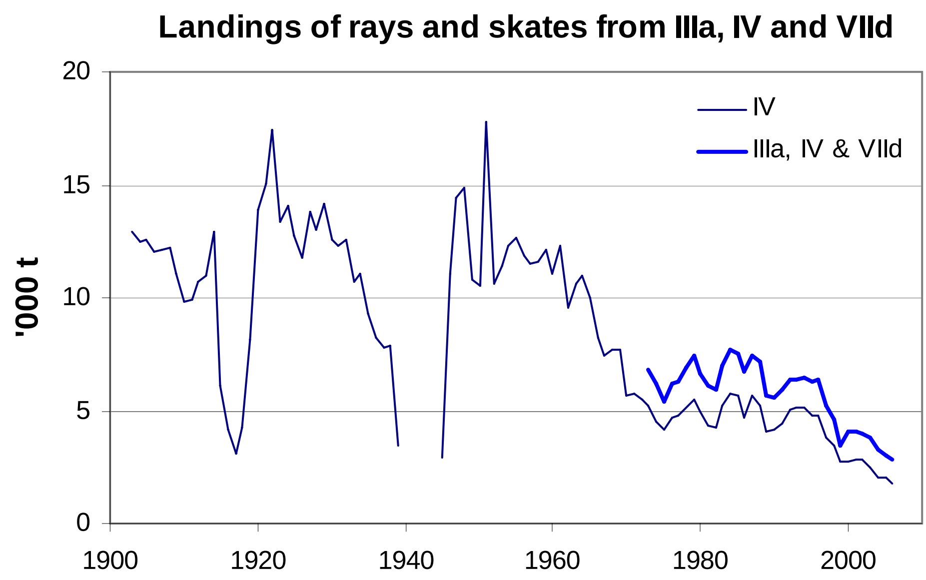


Figure 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates since 1903. From 1973 based on WG estimates.

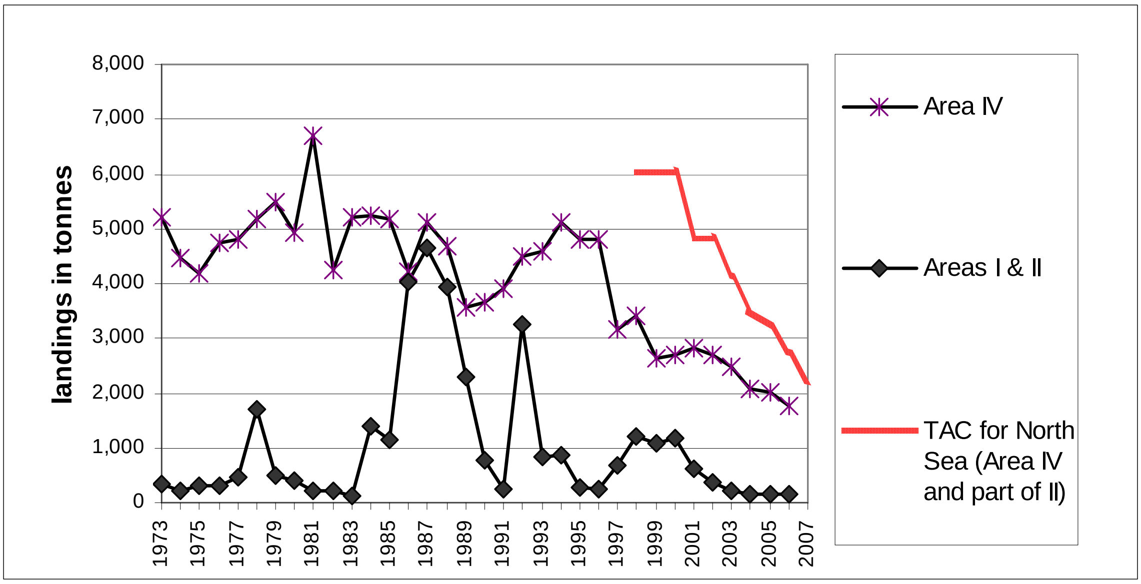


Figure 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates from areas IV and I & II, and EC TAC for the North Sea.

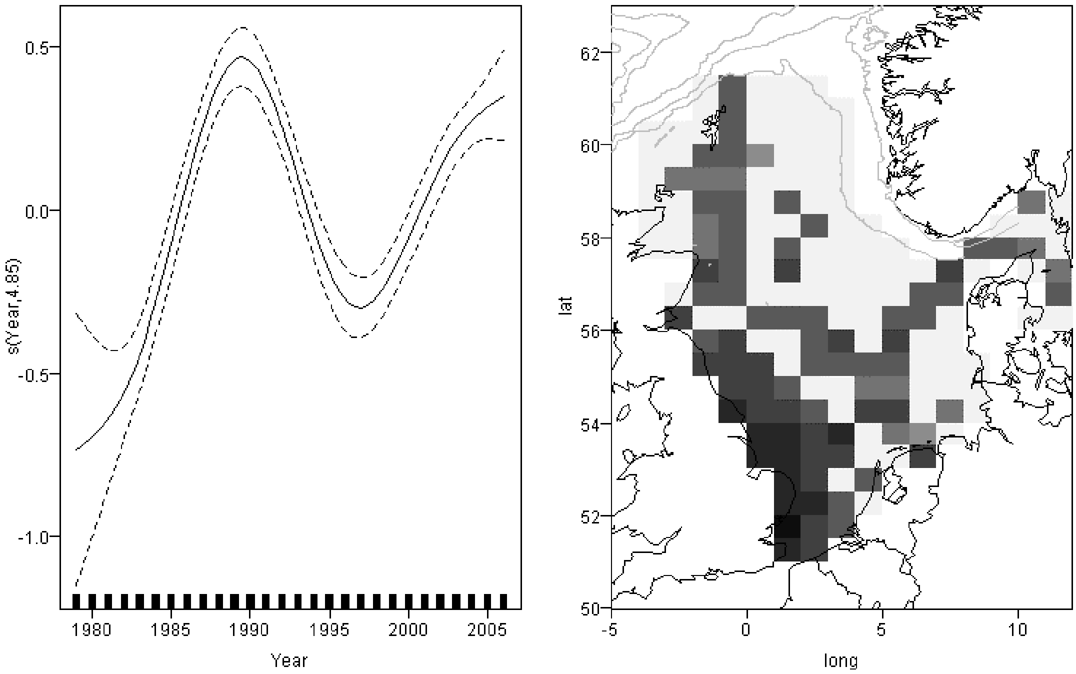


Figure 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Thornback ray in the North Sea. Results of GAM analysis of the 'filtered' Q1 IBTS data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey.

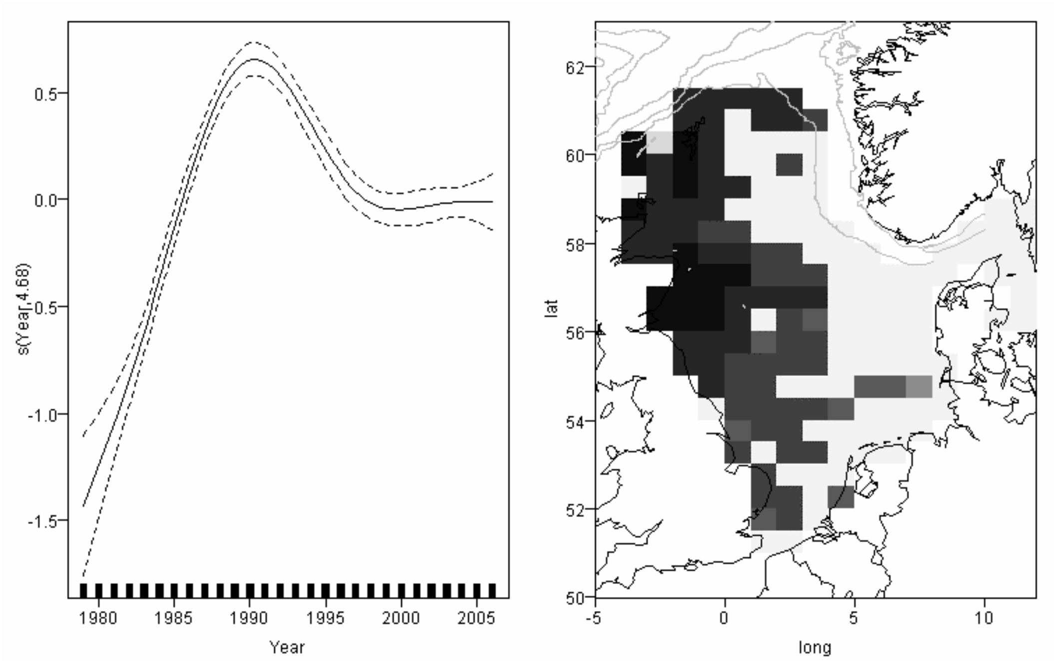


Figure 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Cuckoo ray in the North Sea. Results of GAM analysis of the 'filtered' Q1 IBTS data. Estimated year and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey.

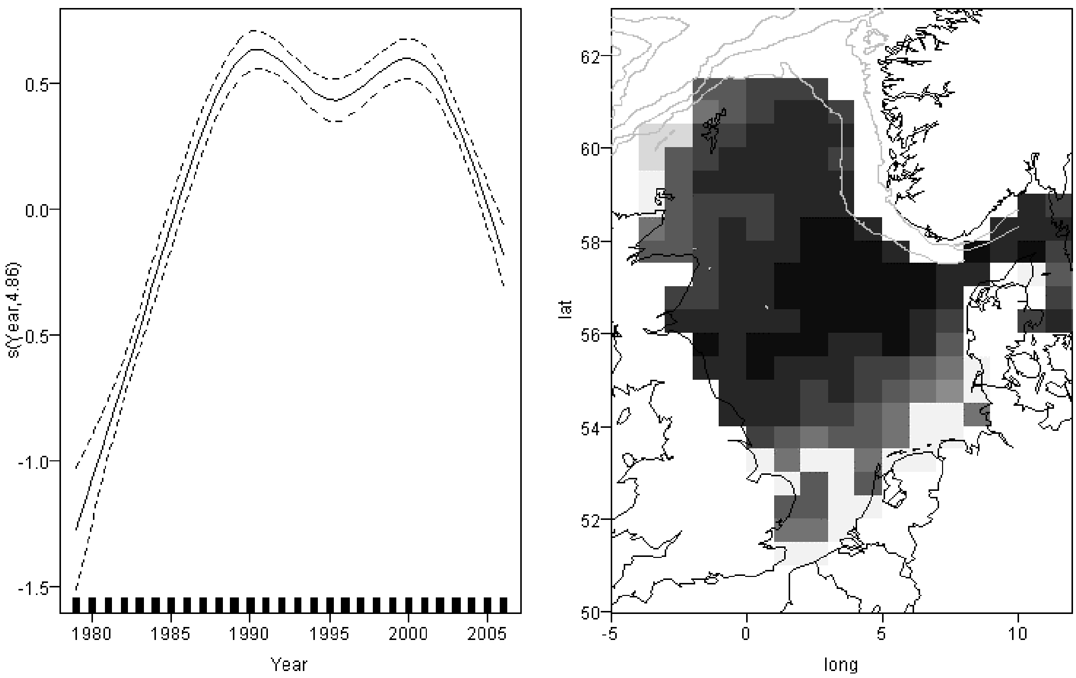


Figure 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Starry ray in the North Sea. Results of GAM analysis of the 'filtered' Q1 IBTS data. Estimated year and spatial effects are on a log scale. Zero catch areas are very pale grey.

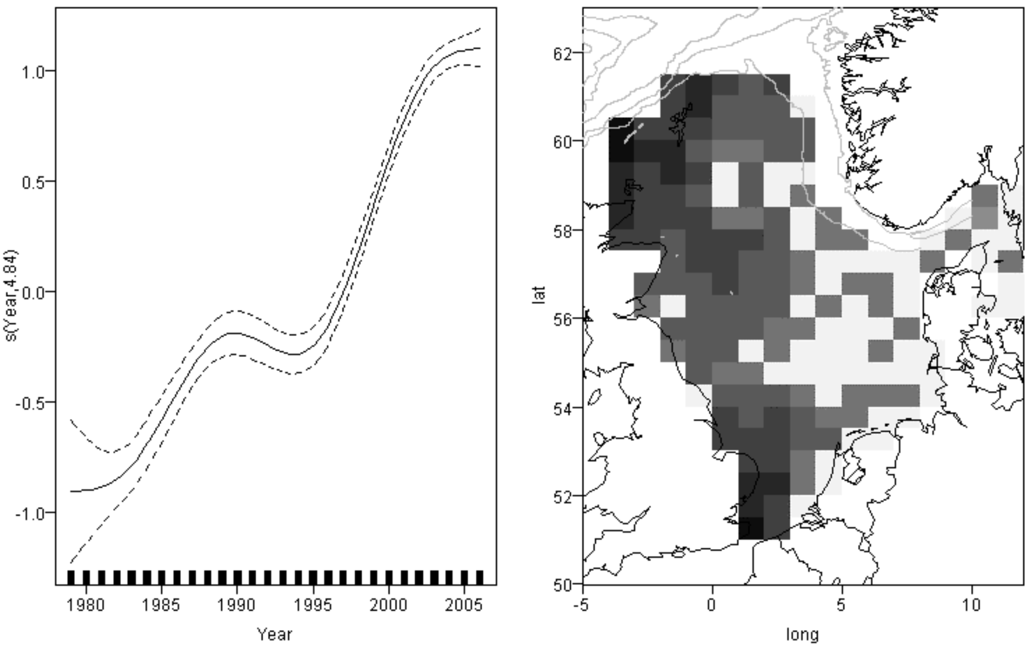


Figure 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Lesser-spotted dogfish in the North Sea. Results of GAM analysis of the 'filtered' Q1 IBTS data. Estimated year and spatial effects are on a log scale. Zero catch areas are very pale grey.

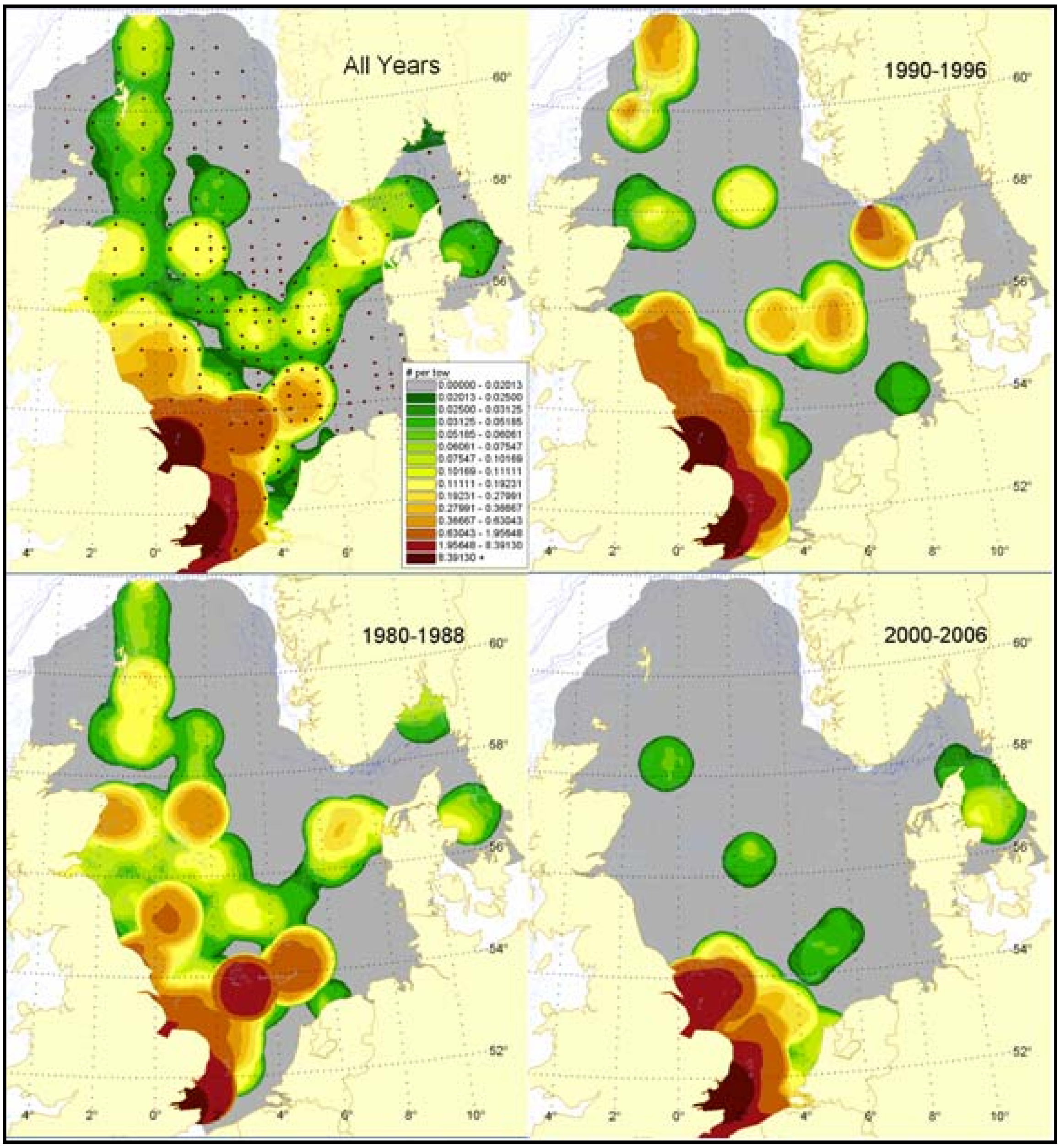


Figure 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja clavata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on “All Years” map are grid averaged survey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

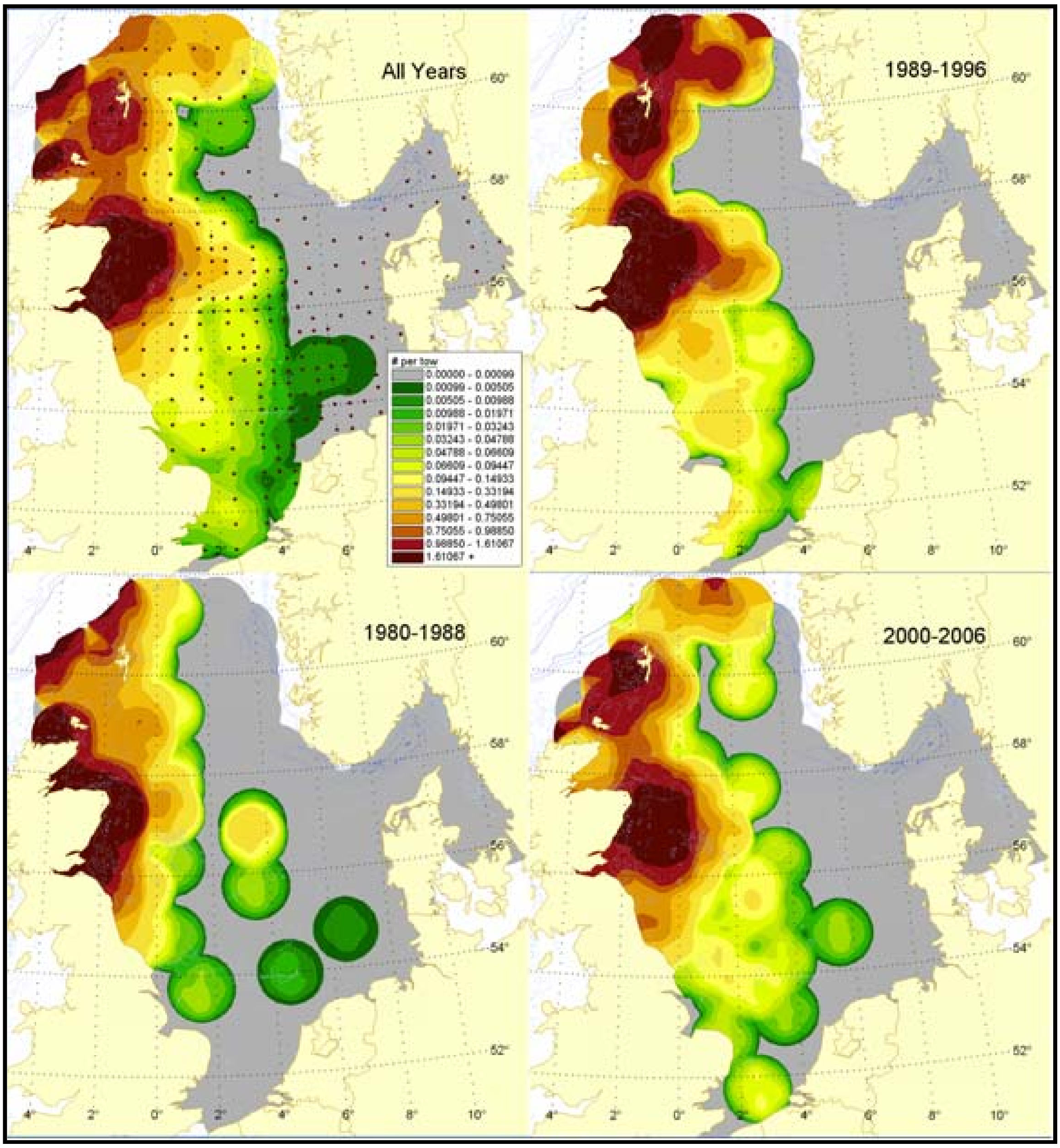


Figure 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Leucoraja naveus* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location.

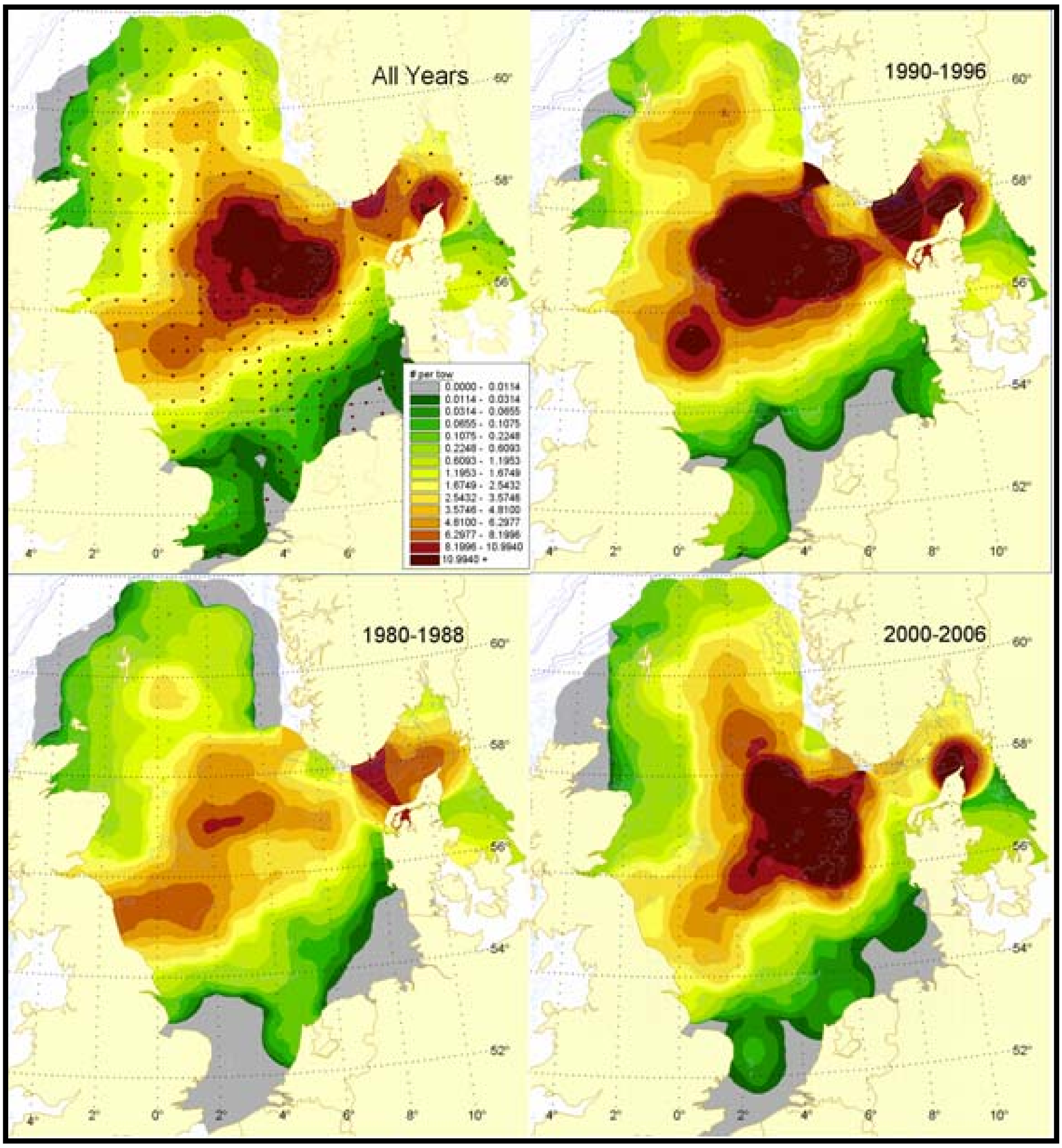


Figure 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Amblyraja radiata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location.

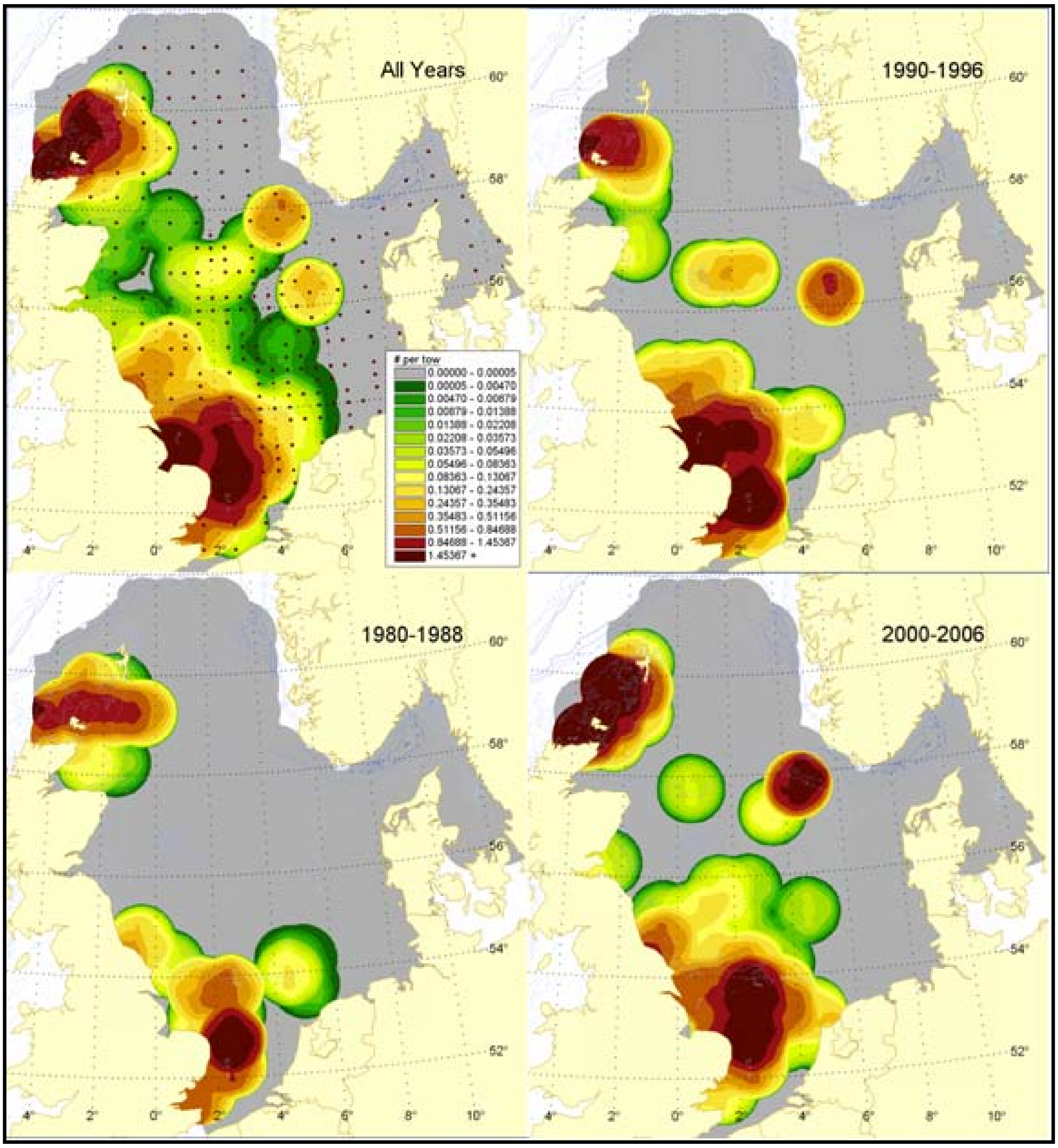


Figure 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja montagui* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location.

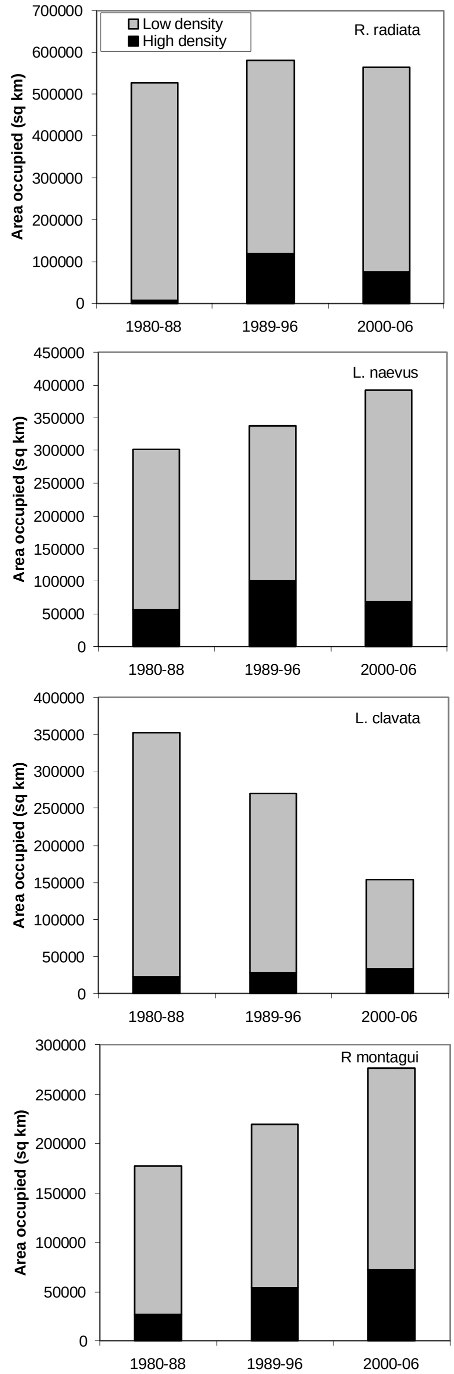


Figure 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Area occupied during three periods illustrated in the distribution maps for *Amblyraja radiata, Leucoraja naevus, Raja clavata* and *R. montagui* (see Figures 15.7–15.10).

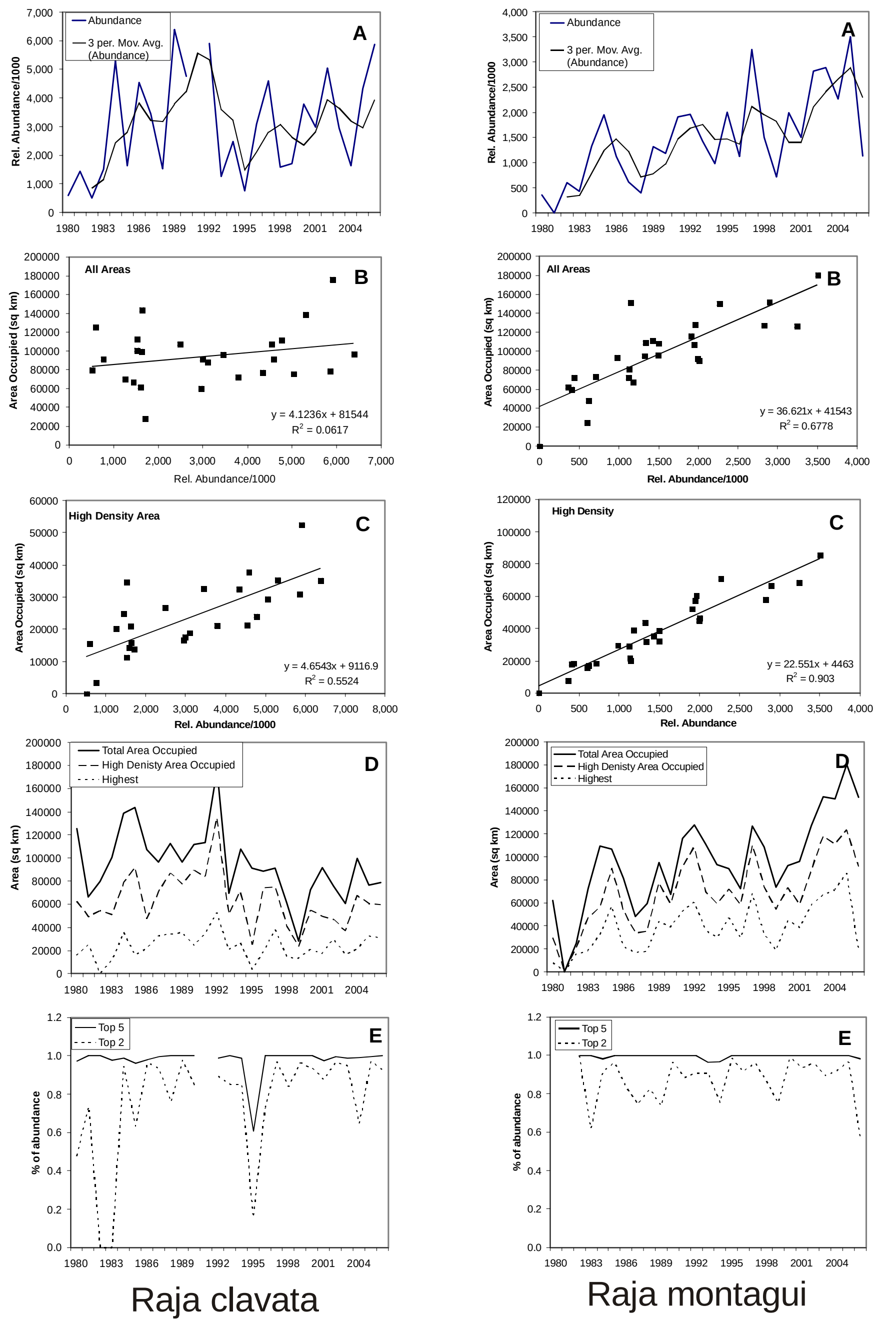


Figure 15.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Spatial patterns observed for *R. clavata* and *R. montagui* in the North Sea. A–Annual estimates of relative abundance using SPANdex. A 3 year running average is represented to smooth the high inter-annual variation of the estimates. B-Relationship between total area occupied and relative abundance. C-Relationship between high density area occupied and relative abundance. D-Area occupied (refer to legends of Figures 15.7 and 15.10 for top 2 and top 5 density strata). E-Degree of concentrations - % of abundance that occurred within the top 2 and top 5 density strata.

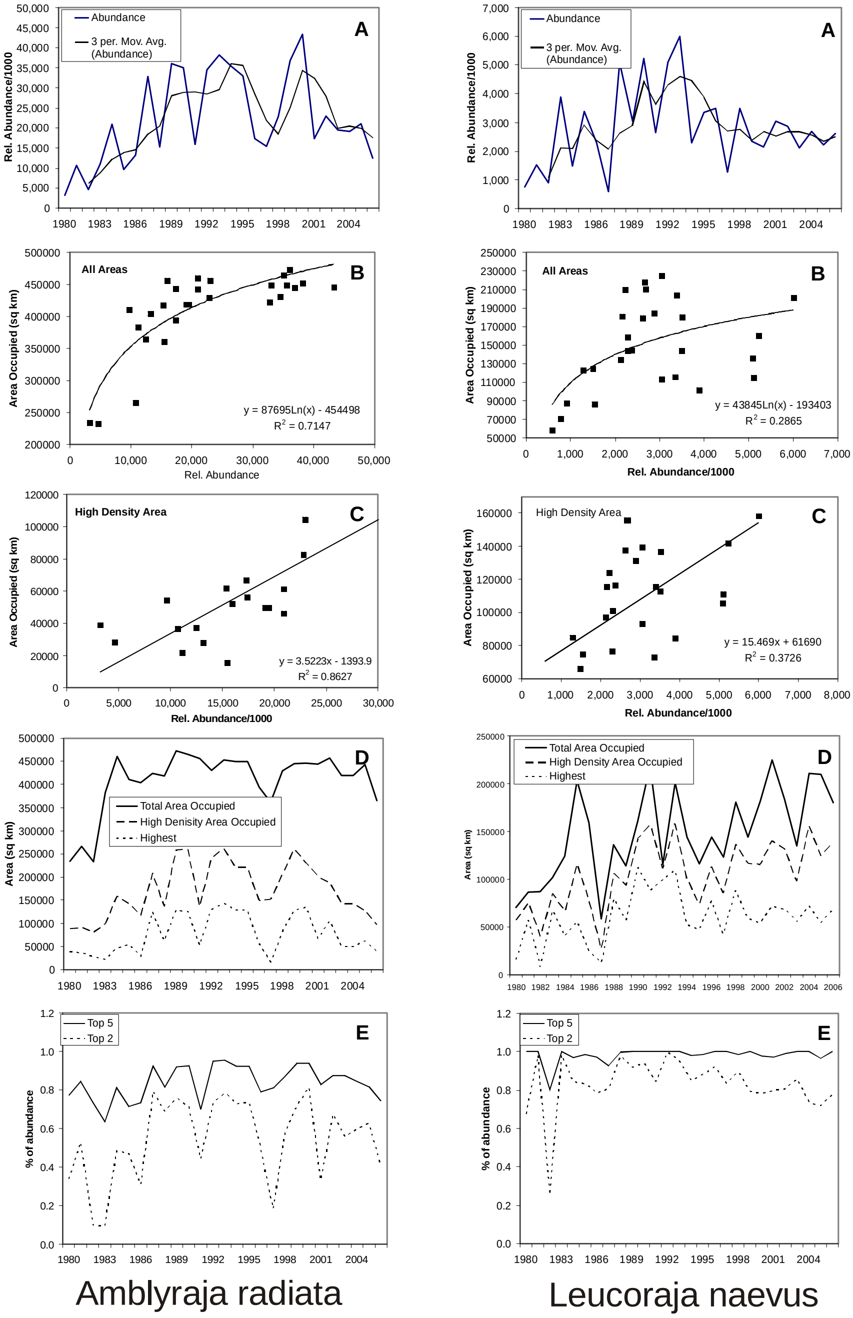


Figure 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Spatial patterns observed for *A. radiata* and *L. naevus* in the North Sea. A-Annual estimates of relative abundance using SPANdex. A 3 year running average is represented to smooth the high inter-annual variation of the estimates. B-Relationship between total area occupied and relative abundance. C-Relationship between high density area occupied and relative abundance. D-Area occupied (refer to legends of Figure 15.8 and 15.9 for top 2 and top 5 density strata). E-Degree of concentrations - % of abundance that occurred within the top 2 and top 5 density strata.

16 Demersal Elasmobranchs at Iceland and East Greenland

16.1 Eco-region and stock boundaries

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species. *Bathyraja spinicauda* (spinytail skate), *Rajella bathyphila* (deepwater ray), *Rajella fyllae* (round skate), *Amblyraja hyperborea* (Arctic skate), *Amblyraja radiata* (starry/thorny skate), *Malacoraja spinacidermis* (roughskin skate), chimaeras, Iceland catshark *(Apristurus laurussonii)*, black dogfish (*Centroscyllium fabricii)* and greenland shark *(Somniosus microcephalus)* have all been caught in groundfish surveys of eastern Greenland, with shagreen ray *Leucoraja fullonica* and sailray *Dipturus linteus* also recorded off Iceland. Spurdog (*Squalus acanthias)*, Portuguese dogfish *(Centroscymnus coelolepis),* porbeagle *(Lamna nasus)* and basking shark *(Cetorhinus maximus)* are caught in the area as well.

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 eco-region 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.

16.2.2 The fishery in 2006

No new information.

16.2.3 ICES advice applicable

ACFM has not provided advice on these stocks.

16.2.4 Management applicable

No new information.

16.3 Catch data

16.3.1 Landings

Reported catches of rays and chimeras from Iceland (Subarea V) and E. Greenland (XIV) can be found in Table 16.1. Estimates of landings were derived from the ICES database, with two exceptions. Estimated landings for *Amblyraja radiata* (starry ray) from 1982–2002 and for *Dipturus batis* (common skate) from 1977–2002 are taken from Icelandic national data. These amounts added, closely approximate what is recorded as *Raja* rays nei in FishStat in those years. Therefore, *Raja* rays nei from 1977 to 1991 are calculated by subtracting the FishStat reported amount of Raja rays nei from the published records of *D. batis* and *A. radiata*.

Between 1973 and 2006, 13 countries: Belgium, Faeroe Island, France, Germany, Greenland, Iceland, Norway, Portugal, Spain and UK have reported landings of skates, rays, demersal sharks and chimaeras from Subareas Va (Iceland) and XIVa and XIVb (east Greenland). However, this section deals only with the rays and chimaeras as the sharks are dealt with in Section. 2 (spurdog), 3 (Portuguese dogfish), 5 (other deepwater sharks), 6 (porbeagle) and 7 (basking shark) of this report.

There are reported landings for elasmobranchs from area Va from Germany and Iceland but none from area XIVa for 2006.

Skate landings peaked at 2100 t in 1995 and have averaged about 1500 t since (Table 16.1, Figure 16.1). Ninety-three percent of the ray catches came from Subarea Va. The share taken by Iceland from this area increased from <50% in the 1970’s to 100% from 1999 to 2004.

Prior to 1992, all rays, with the exception of *Amblyraja radiata* (starry ray) and *Dipturus batis* (common skate) were reported as *Raja* rays nei. *A. radiata* and *D. batis* made up 47% of the catch since 1992 when it is thought that all species were reported to species. Only minor amounts of *Leucoraja fullonica*, (shagreen ray) *Dipurus linteus*, (sail ray) and *Bathyraja spinicauda* (spinytail skate) were reported. The 20 t of *Bathyraja spinicauda* reported in 2004 as preliminary statistics in 2005 suggest some expansion of effort in deep water in that year.

As a species, *D. batis* been shown to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas. Further investigation into *D. batis* and other rays in Iceland and east Greenland is required, including from fishery independent sources.

An average of only 60 t of chimaeras were reported from 1991–2004 and were not reported previously to 1993. Catches peaked in 1991 at 499 t.

Information on bycatch of elasmobranches in East Greenland waters is unavailable but several species are probably taken and discarded in the fishery for cod, shrimp and Greenland halibut. 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' N and 67º N at depths from 400 to 1500 m. The area between 63ºN and 64ºN north was not covered by the survey as the bottom topography was too steep and rough. The surveys are aimed at Greenland halibut *(Reinhardtius hippoglossoides)* but all fish species have been recorded. The surveys are conducted with an ALFREDO III trawl with a wingspread of about 21 m, a height of 5.8 m, and a mesh size on 30 mm in the codend and rock hopper ground gear. These data were presented to the WGEF in a working paper by O. Jørgensen last year (ICES, 2006) and are summarized in Table 16.2. On the east coast of Greenland, the hydrographic conditions are dominated shoreward by the cooler (0–3ºC) East Greenland Current and offshore by the warmer (3–5ºC) Irminger Current, both flowing southward.

Examination of Icelandic survey data is still to be undertaken.

16.7 Life-history information

No new information.

16.8 Exploratory assessment models

No assessments have been conducted, due to insufficient data.

16.9 Quality of assessments

No assessments have been conducted, due to 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. 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 starry ray. It is widespread and abundant in this and adjacent waters.

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.

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

Table 16.1. Demersal Elasmobranchs at Iceland and east Greenland. Reported catches of rays and chimeras from Iceland (Subarea V) and E. Greenland (XIV) that are noted reported in other sections.

WG Estimates of Landings (t) of skates and chimaeras in ICES Area Va and XIV													
Va		**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Common skate	Iceland	230	183	176	123	112	151	121	84	125	147	169	140
Sailray	Iceland	.	.	.	.	.	.	.	.	1	8	20	8
Shagreen ray	Iceland	24	19	16	12	21	27	37	32	17	23	17	18
Starry ray	Iceland	1726	1498	1416	1296	1132	1058	1200	1796	1491	1013	657	530
Raja rays nei	Faeroe Islands	9	2	2	7	5	.	2	1	.	8	.	
	Germany[1]	.	.	.	2	1	1	1	.	1	1	.	1
	Portugal	.	.	1	.	.	.	.	.	.	.	.	
	UK	.	.	.	.	.	.	1	.	.	1	.	
	UK	.	.	.	.	.	.	.	.	.	.	.	1
Raja rays nei	Total	9	2	3	9	6	1	4	1	1	10	0	1
Rabbit fish	Iceland	106	.	15	29	3	5	1	.	1	.	.	.
	Total	2095	1702	1626	1469	1274	1242	1363	1913	1636	1201	864	698
XIV													
Raja rays nei	Portugal	.	.	.	.	.	.	1	.	.	.	.	.
	UK - Scotland	.	.	.	.	.	.	.	.	1	.	.	.
	Total	0	0	0	0	0	0	1	0	1	0	0	0
XIVa													
Raja rays nei	Germany	9	.	.	.	.	7	.	.	.	.	.	.
	Norway	.	.	.	.	.	.	.	.	1	.	.	.
	Total	9	0	0	0	0	7	0	0	1	0	0	0
XIVb													
Blue skate	Norway	.	.	.	.	.	3	.	.	.	.	.	.
Shagreen ray	Iceland	.	.	.	.	.	.	.	.	.	.	.	.
Raja rays nei	Faeroe Islands	.	.	.	.	.	.	.	1	.	.	.	.
	Germany	.	.	.	1	.	.	.	.	.	.	.	.
	Norway	7	10	2	19	8	3	6	5	.	.	.	.
	Russian Fed.	.	.	.	.	.	.	.	.	.	2	.	.
	Spain	.	.	.	.	.	.	.	.	15	.	.	.
	UK	4	.	.	1	2	.	.	.	.	.	.	.
	Norway	.	.	.	.	.	.	.	2	.	.	.	6
Raja rays nei	Total	11	10	2	21	10	3	6	7	15	2	.	6
Rabbit fish	Norway	.	.	.	.	.	.	.	.	1	5	.	.
Spotted ratfish	Ireland	.	.	.	.	.	.	1	.	.	.	.	.
	Total	22	20	4	42	20	9	13	15	31	9	0	12
Grand Total		2126	1722	1630	1511	1294	1258	1377	1928	1669	1210	864	710

[1] Iceland, starry ray-For the years 1977–1992 data are based on published records, could also include *R. linteus.*

[2] Germany and Fed. Rep. of Germany combined.

[3] Since 1993 data are available by gear and by month.

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 (ºC)	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

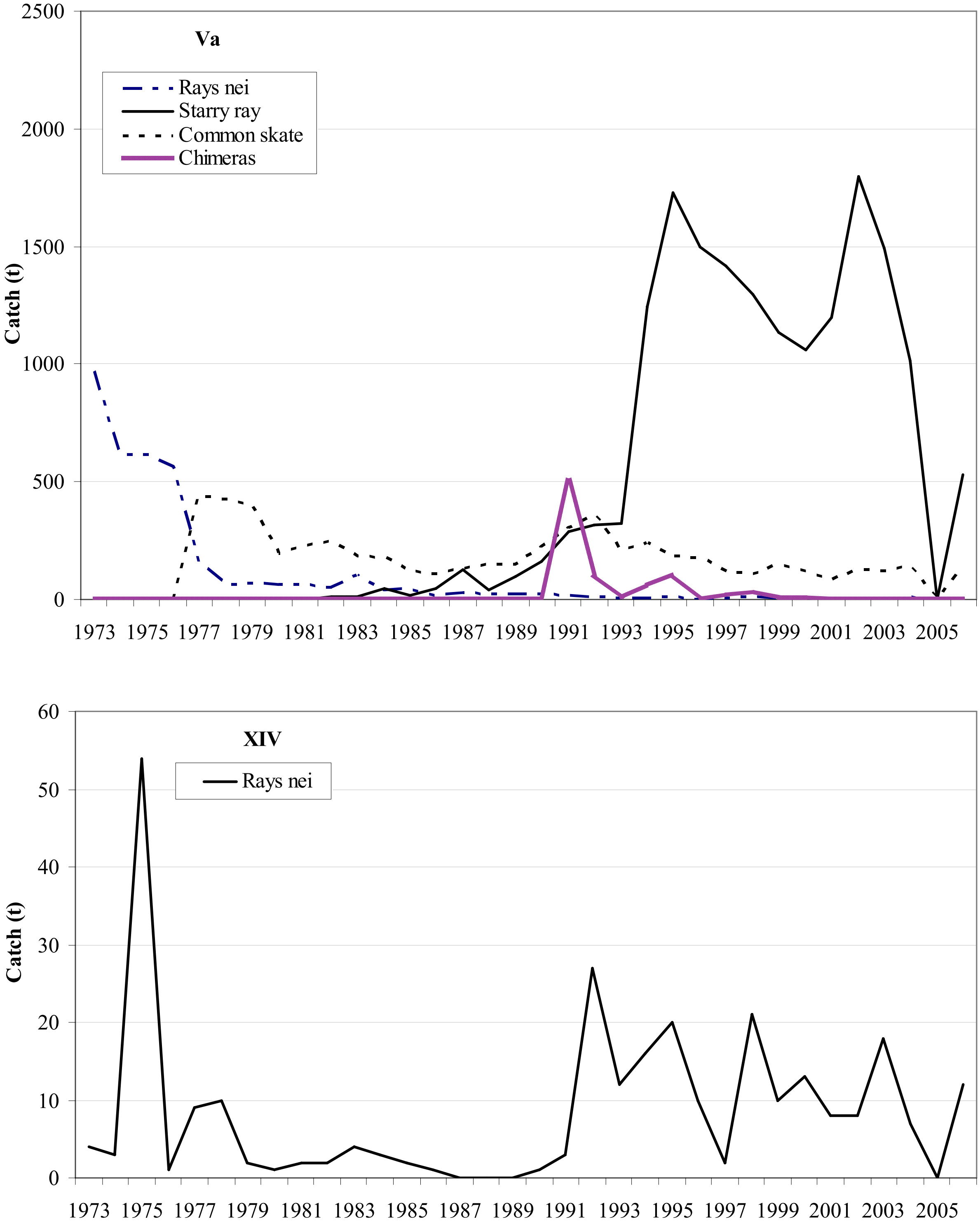


Figure 16.1. Demersal Elasmobranchs at Iceland and east Greenland. WG estimates of the most commonly reported rays and chimeras in Va (upper panel) and in XIV (lower panel), 1973–2006.

17 Demersal elasmobranchs at the Faroe Islands

17.1 Eco-region and stock boundaries

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. *Dipturus batis, Dipturus oxyrinchus, Leucoraja fullonica, Raja clavata* and *Amblyraja radiata* have all been recorded.

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 eco-region and neighbouring areas.

17.2 The fishery

17.2.1 History of the fishery

Since 1973, nine countries (Denmark, Faroes, France, Germany (and Fed. Rep Germany), Netherlands, Norway, Poland, UK and Russia) have reported catches 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 which are occasionally able to obtain quotas to fish in Faroese waters targeting gadoids and deepwater 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. In all cases, it is likely that demersal elasmobranchs represent a minor to moderate bycatch in fisheries targeting other species.

17.2.2 The fishery in 2006

No new information.

17.2.3 ICES advice applicable

ACFM 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 rays, mainly unidentified, are presented in Table 17.1 and rabbitfish in Table 17.2. No reports are available in 2005. French reported landings of *D. batis* (common skate) do not represent the entire catch of this species and an unknown quantity is included in the category of unidentified rays for all counties. Total landings of rays and rabbitfish by all countries are combined in Figure 17.1.

17.3.2 Discards

The amount of discarding of skates and demersal sharks from this area are 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 rays in Division Vb, with the exception of French landings (2000–2003) and Russian landings (2004) of *Dipturus batis* (common skate), and one record of *Dipturus oxyrinchus* (longnose skate) (France, 2001) were reported as *Raja* rays, not elsewhere identified (nei). There were no port sampling data available to split these catches by species. It is likely that catches included *D. batis, Leucoraja fullonica, Raja clavata* and *Amblyraja radiata.*

There is no information regarding size or sex ratio from commercial landings.

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) summarised 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 summarised in Table 17.3. 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.

17.8 Exploratory assessment models

No assessments have been conducted, due to insufficient data being available to the 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 rays declined from 1973 to 2003 but increased to about 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.

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.

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 Division Vb												
Species	**Country**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Dipturus batis	France	1	1	3	.	3	2	2	3	5	1	2
	Russian Fed.	.	.	.	.	.	.	.	.	35	n/a	
Dipturus oxyrinchus	France	.	.	.	.	.	3	.	.	.	0	0
Raja rays nei	Faroe Islands	165	178	144	175	n/a	76	25	98	272	n/a	
	France	1	1	.	.	23	99	.	5	71	6	20
	Germany	.	.	.	1	1	.	.	2	1	n/a	1
	Norway	60	14	45	45	50	21	15	5	.	n/a	10
	UK	4	11	7	6	35	27	12	8	20	n/a	2
Total Vb		231	205	199	227	112	228	54	121	404	7	35

Table 17.2. Demersal elasmobranchs at the Faroe Islands. Reported landings of Rabbitfish from the Faroes area (Division Vb).

WG Estimates of Landings (t) of Rabbitfish in ICES Division Vb												
Species	**Country**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Rabbit fish	France	.	.	.	.	54	.	66	67	.	n/a	
	Norway	.	.	.	.	.	1	17	2	3	n/a	
Rabbit fish	UK	1	.	.	.	.	.	.	1	.	n/a	
Total Vb		1				54	1	83	70	3	n/a	

Table 17.3. 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	*	*	**	***	***	***	**

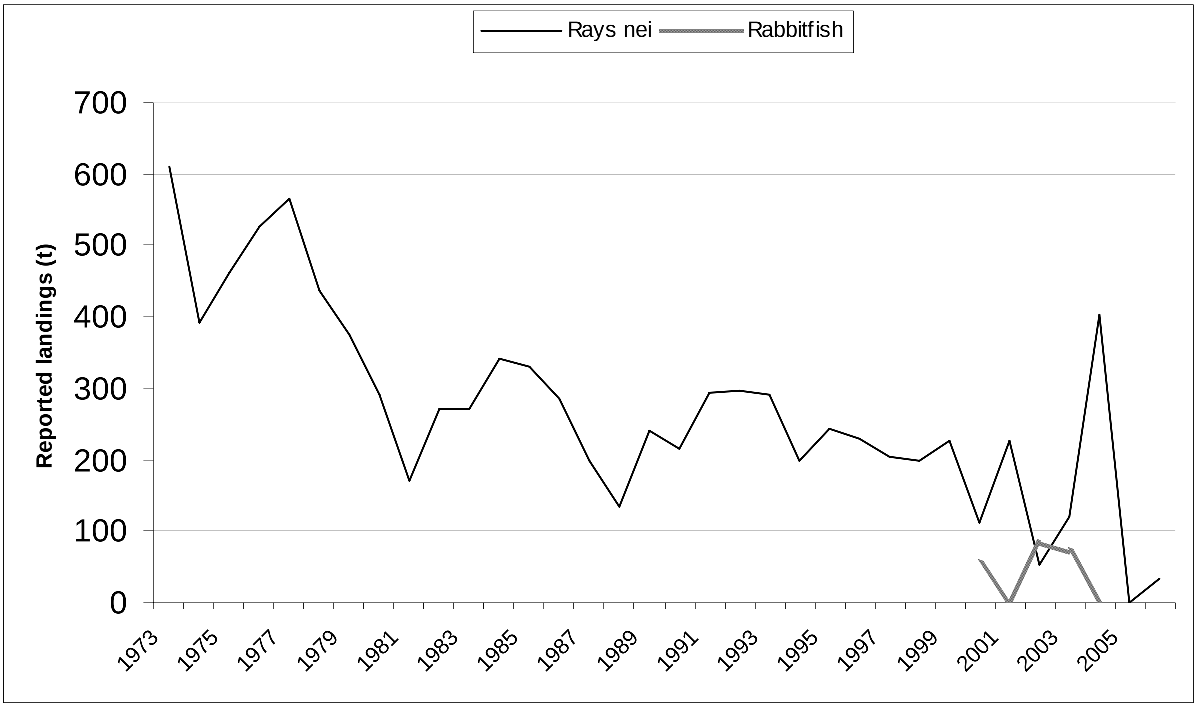


Figure 17.1. Demersal elasmobranchs at Faroe Islands. Reported landings of rays and rabbitfish from Division Vb based on ICES FISHSTAT.

18 Demersal elasmobranchs in the Celtic Seas (ICES Subareas VI & VII (Except Division VIId))

18.1 Eco-region and stock boundaries

The Celtic Seas eco-region 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), although the south-western sector of ICES Division VIIk is contained in the oceanic northeast Atlantic eco-region. This eco-region broadly equates with the area covered by the North-western waters RAC. The following provides a general overview of the different areas within the Celtic Seas eco-region. Whereas some demersal elasmobranchs, such as spurdog *Squalus acanthias* (see Section 2) and lesser-spotted dogfish *Scyliorhinus canicula,* are widespread throughout this region, there are some important regional differences in the distributions of other species, which are described below.

Other than spurdog (Section 2) and tope (Section 10), the main species of shark taken in demersal fisheries in this eco-region are lesser-spotted dogfish, smooth-hounds *Mustelus* spp. and greater-spotted dogfish *Scyliorhinus stellaris*. Sixteen species of skate and ray are recorded in the area (see Table 1.4.), the most abundant skates being thornback ray *Raja clavata*, cuckoo ray *Leucoraja. naevus*, blonde ray *R. brachyura*, spotted ray *R. montagui,* undulate ray *R. undulata*, common skate *Dipturus batis*, shagreen ray *L. fullonica* and smalleyed ray, *R. microocellata*. Other batoids (stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana*) may be observed in this eco-region, 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.

Some of the rarer demersal elasmobranch species that previously occurred in this area include white skate *Rostroraja alba* and angel shark *Squatina squatina* and there are few or no recent records of these species in survey data.

West of Scotland (VIa): The main demersal elasmobranchs occurring in the shelf waters west of Scotland include lesser-spotted dogfish and various skates, especially *Raja clavata*, *Leucoraja naevus* and *Dipturus batis.* Offshore species, such as black mouth dogfish *Galeus melastomus, L. fullonica* and sandy ray *L. circularis* are distributed mainly towards the edge of the continental shelf.

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 is little fisheries-independent data available from this area. *Raja clavata, Raja brachyura, Raja fyllae, Dipturus oxyrinchus, Leucoraja circularis, Dipturus batis, Raja montagui, Leucoraja fullonica* and blackmouth dogfish have been recorded in Scottish surveys in this area.

Irish Sea (VIIa): The more common demersal elasmobranchs in the Irish Sea include spurdog (see Section 2) and lesser-spotted dogfish. *R. clavata* and *R. montagui* are also abundant, especially in inshore areas, with *R. montagui* and *L. naevus* the dominant skate species on the coarser grounds further offshore. *Raja brachyura* occur sporadically in the main Irish Sea, though are locally abundant in parts of St George's Channel. In the south-western Irish Sea *R. microocellata* is also present. Tope (see Section 10), smooth-hounds and greater-spotted dogfish all occur in this area, with these species locally abundant in Cardigan Bay and off Anglesey.

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, though is typically restricted to inshore, rocky grounds. Undulate ray *Raja undulata* is found in a very localised population on the south-west coast of Ireland, with occasional records in the English Channel. *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 black-mouth dogfish, *D. batis, L. fullonica* and *L. circularis.*

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 *Raja clavata* (Chevolot *et al.*, 2006), the stock identity for many of these species is poorly known. Further studies on stock structure are required, especially for species such as *Leucoraja naevus*, which have a more offshore distribution. 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).

18.2 The fishery

18.2.1 History of the fishery

Most skate and ray species in the Celtic Seas eco-region 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 trawls and bottom-set gillnets, with the Belgian fishery carried out by a beam-trawl fleet. There are also beam trawls from Ireland, the UK and the Netherlands in this area.

There are also some localised fisheries that target *R. clavata* using longline and tangle nets. There is a small fishery off south-east Ireland targeting various skate species in the southern Irish Sea (Area VIIa), using rockhopper otter trawls and beam trawls, and some UK trawlers may 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 bycatch in various trawl and gillnet fisheries (see above). Due to the low market value of these species, they tend to be discarded by some nations, though some of marketable sizes are sometimes retained. A largely unknown quantity is retained for use as bait in the Irish Sea and Bristol Channel whelk *Buccinum undatum* fishery, and the northwest Ireland crab fishery, and these may not routinely be declared in the landings.

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. (see Chapter 5).

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.

18.2.2 The fishery in 2006

No new information specifically relating to elasmobranchs. Changes in fishing patterns in these areas are summarised by WGNSDS and WGSSDS.

Due to pressure from environmental NGOs based in the UK, some supermarket chains reduced the amount of 'skate' being sold. After discussions between industry, fish processors, NGOs and SeaFish, some of the larger skate processors claim to have stopped processing those skates with a dark ventral surface (e.g. common skate). Data from discards trips and market sampling in 2007 should be examined in order to evaluate whether there is increased discarding of common skate.

18.2.3 ICES advice applicable

ACFM has never provided advice for any of the stocks within this region.

18.2.4 Management applicable

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

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

Under Regulation 850/98 a minimum mesh size of 220 mm is required for gillnets targeting rays and skates (those catching <70% skates and rays) in Subareas VI and VII.

Within UK waters, the South Wales Sea Fisheries Committee (SFC), and the Cumbria SFC has a bylaw stipulating a minimum landing size for skates and rays.

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 localised populations on the Irish West coast. There are no other known specific closed areas for the protection of elasmobranchs.

Dipturis batis and *Squatina squatina* were removed from the Irish Specimen Fish List in 1975 and 2005 respectively.

18.3 Catch data

18.3.1 Landings

Landings tables for skates (Rajidae) by country are provided in Tables 18.1a–g. Landings for the entire data series available are shown in Figure 18.1. Landings by area with in the eco-region are illustrated in Figures 18.2 a-f. Where species-specific landings have been provided they have been included in the total for the relevant year. While there are about 15 countries involved in the fisheries in this eco-region, only six of these (Belgium, France, Ireland, UK (England & Wales), UK (Scotland) and Spain) have continuously landed large amounts of skates.

Landings appear as a series off 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. While landings have fluctuated considerably over the time series, they have been in a constant decline since 2003, and the 2006 landings of approximately 10 000 t are the lowest in the time series.

West of Scotland (VIa):

Reported landings in this sub-division are at their lowest point since 1973. Average landings of around 3000 t in the early 1990s are now down to less than 1000 t. Landings by the UK (Scotland) in particular are at an all time low.

Rockall (VIb):

Reported landings of skates and rays from Rockall have usually been less than 1000 t per year. Increased landings in the mid 1990s are due to 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).

Irish Sea (VIIa):

Reported landings of skates and rays in the Irish Sea vary considerably, ranging from over 5000 t in the late 1980s to 1500 t in 1995, before increasing again to 3000 t. Landings are again at a low level. This may be due to effort changes due to the cod recovery programme in the area. Most landings are from Ireland and the UK (England & Wales).

Bristol Channel (VIIf):

Reported landings from Division VIIf have declined for four years now. Only three countries, the UK (England & Wales), France and Belgium land skates and rays from this area, with landings normally between 1100–1600 t per year.

Western English Channel, Celtic Sea and west of Ireland (VIIb,c,e,g-k):

Reported landings from divisions VIIb,c,j,k increased dramatically in the late 1990s, to more than 4000 t, but have subsequently declined to approximately 1000 t per year. The highest landings have consistently occurred in the southern parts of this eco-region (Divisions VIIe,g,h), but landings from here have declined each year for the last seven years and are now at their lowest point since 1974. Most skates are landed under generic landing categories, though France, Spain (Basque Country) and Belgium provide some species-specific landings data (Tables 18.2–18.4). These data suggest that the four major commercial species in French fisheries (Table 18.2) 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. The importance of *R. clavata* and *L. naevus* is also apparent in Spanish (Basque country) and Belgian landings data (Tables 18.3–18.4).

Though 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 18.5a 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 categorised. Due to 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 is now rarely reported in landings data (Table 18.5b). It is believed that the peak in UK landings in 1997 from VIIj–k (Figure 18.3) are misreported anglerfish (also called monkfish), as *S. squatina* is more of a coastal species. French landings have declined from > 20 t in 1978 to 1 t in 2000.

18.3.2 Discards

Species information on the numbers of skates caught by the Irish discard observer programme is presented in Tables 18.6a and 18.6b. Without comparable landings data, however, they cannot be used to split national landings data. Likewise, because of the small number of data points in certain years, this information cannot be used to show trends in skate discarding.

Table 18.6a shows discard rates of skates around Ireland, based on data from the Irish discard observer programme (Borges *et al.,* 2005). Discard rates can be seen to fluctuate between 11–56% of the catch. Similarly, Table 18.6b shows the discard rates of *Scyliorhinid* dogfish. Most lesser-spotted dogfish caught are discarded, with discard rates generally over 60%. The low value (30%) in 1993 may be an artefact of the low number of samples in this year.

Figures 18.4–18.5 show the discard and retention rates of some common species in beam trawl and demersal trawl fisheries, from UK and Irish discard programmes. Data for other fisheries, such as gillnet and long-line fisheries are more limited.

These studies indicate that skates below a certain size tend to be discarded, regardless of species. While this size varies from vessel to vessel, in general, it is around 47 cm, though UK demersal fisheries land *R. clavata* of a smaller size. As skates are usually landed by grade (size) in mixed boxes, there is no size selection between different species. The only exception is in some fisheries taking *D. batis.* This species is now rarely caught by the Irish demersal trawl fleet, and in some fisheries are usually discarded when caught, regardless of size. However, *D. batis* are still caught and retained by the UK trawl fleet (but see 18.2.2).

It has been suggested that buyers and processors do not favour the largest skates (e.g. adult *D. batis*), and discarding of this species may also be more prevalent in areas where there are important recreational fisheries targeting common skate.

Some information on the discard patterns of small demersal sharks is available. Lesser-spotted dogfish are generally discarded (Figure 18.6), and there is also some discarding of smoothhounds, though specimens >50 cm length are retained in some fisheries.

Figure 18.6c shows dogfish discard per unit effort in the Irish trawl fishery. This also shows the very high discarding rate in 1996, but thereafter shows high fluctuations between years. No new discard information was available from Ireland and it is hoped that further information will be available for a future meeting of this group.

Lesser-spotted dogfish is known to have a high survivorship (Revill *et al.*, 2005). The survivorship of smoothhounds and skates in not known, although studies being undertaken in the UK are hoped to provide such data for skates in the near future.

West of Scotland (VIa):

Table 18.7 shows the raised weights of different skates from the Scottish discard programme. It should be noted that these data are based on a small sample size and the raising factors used are very large; the figures presented here should therefore be considered as indicative rather than accurate estimates.

Rockall (VIb):

No area-specific discard information available.

Irish Sea (VIIa):

Both large and small dogfish are discarded in the Irish Sea. The highest rate of discarding took place in 1996. In 2002 there was a peak of small dogfish discarded, coinciding with anecdotal reports of an increase in dogfish numbers in the area. Dogfish are not discarded by some boats in this area, as they can be sold as bait for the whelk fishery. These may not be recorded in the logbook.

Bristol Channel (VIIf):

No area-specific discard information were available.

Western English Channel, Celtic Sea and west of Ireland (VIIb,c,e,g-k):

Discard sampling in VIIg highlights the prevalence of juvenile (<25 cm) *Scyliorhinus* spp. in comparison to the other areas (Figure 18.6a), suggesting that this area may be an important nursery ground for lesser-spotted dogfish, as also indicated from groundfish surveys (Ellis *et al*., 2005). Figure 18.6b presents data showing the variation in mean size of lesser-spotted dogfish by area (Borges *et al*., 2005). The majority of discarded dogfish on the west coast of Ireland are small individuals. In addition, some temporal variation can be seen.

There was a particularly high rate of discarding in 2000 in Subdivisions VIIj and VIIb, while in 1997, very high numbers of dogfish were discarded in VIIb,c,g. Fishing on the Porcupine Bank (VIIc) shows very high numbers of juvenile dogfish discarded.

18.3.3 Quality of catch data

Though commercial landings data are available, many of the species under consideration are landed under generic landings categories (e.g. “skates and rays”). In recent years, various laboratories have begun market sampling that will improve estimates of the species composition.

There is no quota for skates and rays in this region. This means that there is a strong incentive for fishers to log quota species as ray, leading to overestimation of catch quantities. Mis-reporting of quota species as elasmobranchs is known to occur, 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.

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.

WGEF has also noted some mis-identifications in species-specific landings and market sampling data. For example, whilst *R. brachyura* is an important component of Belgian landings (Table 18.4), this species is absent from French landings data (Table 18.2). This suggests that species identification problems (or confusion between names) may occur in some landings data. The near absence of species-specific landings data for *R. brachyura*, a large-bodied species that is subject to localised targeted fisheries, is a cause for concern, and landings for this species may have been combined with those of *R. montagui*.

That species identification may be a problem is also highlighted by the high proportion of *L. circularis* reported in VIIf (Table 18.4), as this species is only rarely recorded in this area, and this category is thought to refer to *R. microocellata*, a species that is locally abundant in VIIf.

If landed, dogfishes may be landed as “dogfishes and hounds” (e.g. smooth-hounds, scyliorhinids, spurdog and tope), “dogfishes and hounds nei”, and other generic categories. The widespread and inconsistent use of “nei” categories is a major concern (Johnston *et al.,* 2005). Improved species-specific landings data are required, given that existing market sampling programmes tend not to monitor these species.

Due to concerns over the quality of reported species-specific landings, 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 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 has some recent information on species composition become available for various countries (Heessen, 2003). Some countries have continued to provide landings by species but most are supplied as mixed species information. Species breakdown per country (where available) is supplied in Tables 18.2–18.4 and 18.8.

The species breakdowns show different species compositions for the different areas within this eco-region. Belgian species-specific landings (Table 18.4) for VIIa shows that the most prevalent species in the landings are *R. clavata*, followed by *R. brachyura* and *R. montagui*. In VIId, *R. clavata* is still the most common species, while *R. montagui* is the next most prevalent, followed by *R. brachyura.* Spanish data (Table 18.3) for the whole of sub-areas VI–VIII has *L. naevus* as the most common species, followed by *R. clavata* and *R. montagui.* However the different data sources show different species compositions for the same areas. For instance, the Belgian landings data for VIIa shows that the most common species is *R. clavata*, whereas the Irish discard sampling for the same area (Table 18.8) shows that the most common species is *R. montagui*. More worryingly, the French (Table 18.2) or Spanish data show no *R. brachyura* in their species composition, possibly because these are included in landings of *R. montagui*.

Historical data on species composition are available for some earlier studies, and much of this information has now been collated (Table 18.8). These historical sources including several detailed studies on the skate communities of the Celtic Sea and west of Scotland (Du Buit, 1966, 1968, 1970, 1972; Quéro and Guéguen, 1981). More recently, there have been several studies of the commercial skate landings from Irish fisheries (Fahy, 1988, 1989a, b, c, 1991; Fahy and O'Reilly, 1990; Gallagher, 2000; Gallagher *et al*., 2005a). Some of these different studies show considerable differences in species composition. The 1966 study in the Celtic Sea (VIIg) showed a proportion of *L. naevus* in the catch of 0.91. However in 1997, the proportion of this species in catches from VIIa and VIIg was 0.39.

Seasonal changes in species composition of landings have been reported in the Irish Sea (Gallagher, 2000), with either *R. clavata* or L. *naevus* dominating. Changes in the dominant sex of these species were also shown. The exact percentage change in species composition varied from port to port, implying that changes in species composition may be caused by local rather than widespread changes in population structure.

18.4.2 Size composition

Only limited market sampling data is available for these species. While elasmobranch sampling effort has increased, it is recommended that emphasis be placed on the sampling of these species as part of on-going 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 are provided in Figure 18.7.

18.4.3 Quality of data

There is still some concern over some of the species identifications being reported. Although several national laboratories are undertaking market sampling, more critical analyses of these data are required to ensure that species identification issues are resolved and that the methods of raising the data are appropriate and can allow for seasonal, geographical and gear-related differences in the species composition of skate landings to be examined.

Some working group members provide 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 this group.

18.5 Catch per unit effort

18.5.1 Commercial CPUE

Most elasmobranchs in this eco-region are caught as a bycatch in demersal fisheries directed at teleosts. Landings per unit effort (lpue) by Basque Country fisheries in Divisions VI, VII and VIII between 1994 and 2005, is presented in Diez *et al.* (2006), and is further examined in Section 19. For *Rajidae* in VII, lpue peaked in 1996 at 150 kg/day, decreased to a low of 17 kg/day in 2003, but has been increasing since. This is similar to the trends shown in Biscay waters. However, lpue in VI has been decreasing since 2002.

Preliminary analyses of skate CPUE from the Irish otter trawl fishery in VIIa was examined by the WGEF. 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 these data can be used for further analyses.

Dpue of lesser spotted dogfish in VII has been decreasing slightly since 1999, even though surveys indicate an increase in abundance of this species (Figure 18.6c).

18.5.2 Recreational CPUE

The Irish Central Fisheries Board began an effort recording programme in 1981 in Tralee Bay. Two charter-angling vessels record all their catch each year. These data (Figure 18.8) from southwest Ireland shows that catches of *R. undulata*, a species that forms a discreet 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 1990s. 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

18.6.1 Surveys in the eco-region

Several fishery-independent surveys operate in the Celtic Seas eco-region.

18.6.1.1 IBTS Q4 Westerly surveys

UK (Scotland), UK (England and Wales), Ireland, France and Spain (see below) undertake trawl surveys in the Celtic Seas eco-region, as part of the internationally-coordinated Q4 IBTS surveys for southern and western waters (see Figure 18.9). The trawls used in all these surveys are not standardised (see Table 18.9), though 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 Spanish Porcupine bottom trawl survey, coordinated within the IBTSWG, aims to collect data on the distribution and relative abundance, and biological information of commercial fish in Porcupine bank area (ICES Division VIIb-k) (Figure 18.10). 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. 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.

The UK (England and Wales) survey has only used a standardised gear since 2004, and data from this survey should be examined in the future, when a longer time-series is available. Similarly, the time series available from the Irish Groundfish Survey (IGFS) on the west coast of Ireland is also too short to provide data for analyses of temporal trends.

The French EVHOE survey has been carried out in the Bay of Biscay since 1987 and in the Celtic Sea since 1995, when it came under the IBTS.

18.6.1.2 Beam trawl surveys

An annual survey with a 4 m-beam trawl is undertaken in the Irish Sea and Bristol Channel each September on board RV *Corystes* (see Ellis *et al*. (2005) for a description of the survey). The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in relatively shallow water. 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.

18.6.1.3 Other surveys

Northern Ireland: Rockhopper trawl surveys of the Irish Sea are undertaken by DARD, though no recent data were available at the meeting. This survey may soon coordinate with the southern and western IBTS (ICES, 2007).

UK (England and Wales): A Q1 survey with Portuguese High Headline Trawl (PHHT) was undertaken from 1982 to 2003, though the survey grid was most standardised between 1987 and 2002. Since 2004, the basis of the field programme changed to collecting additional biological data for commercial species, and so is not standardised with previous years.

UK (Scotland): There is also a Q1 west coast survey covering a similar area to the Q4 survey. A Q3 survey of the Rockall Bank has 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.

Ireland: An annual survey to collect maturity data on commercially important species takes place during the peak spawning season in the spring. This survey began in 2004. Different areas are surveyed each year, so annual trends cannot be derived. An annual deepwater 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 500–2000 m.

18.6.2 Species composition of Rajidae in surveys

Groundfish surveys may be able to provide some trends on the relative abundance of various demersal elasmobranchs, including the more abundant skates, lesser-spotted dogfish and smoothhounds. 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.

Several species of skate and ray are recorded in surveys, with catches on the shelf dominated by *R. clavata, R. montagui, R. brachyura* and *L. naevus*. These species are recorded regularly and occasionally in comparatively large numbers, in both otter trawl and beam trawl surveys.

Trawl surveys on offshore grounds, such as the Rockall and deepwater surveys carried out by Scotland, sample mostly larger individuals and offshore species (e.g. *Leucoraja* spp. and *Dipturus* spp.).

The species composition (by numbers and biomass) was calculated for some of the surveys described above. The UK survey of the Celtic Sea caught primarily *L. naevus* and *R. clavata,* with *L. fullonica* also relatively frequent in this area. *D. batis* is also an important member of the skate catch in this region (Table 18.10). This survey sampled extensively over the Celtic Sea, including near the edge of the continental shelf.

Data from Irish groundfish surveys (Figures 18.11–18.12) indicate there are several regional differences in relative abundance of different species, and in relative numbers by area. In particular, the numbers of skates caught in VIIj is much lower than in any other part of this eco-region. As also shown by UK surveys, *R. clavata* and *R. montagui* are the dominant species in most parts of the region.

Some of the more abundant skates, including *R. clavata, R. montagui, R. microocellata* and *L. naevus*, are caught in appreciable numbers in various surveys. Preliminary analyses of these survey data indicate that catch rates are quite variable, though catch rates for most of the more common species appear stable.

West of Scotland (VIa):

The Irish Groundfish Survey (Figure 18.11) shows that *L. naevus*, *R. montagui* and *R. clavata*, are found in almost equal proportions in this area.

Rockall (VIb):

Only presence/absence data available.

Irish Sea (VIIa):

The IGFS (Figure 18.11) shows *R. montagui* as the most abundant ray species, followed by *R. clavata* and *L. naevus*. *L. naevus* is most abundant on coarse offshore grounds. *R. brachyura* is also found in significant quantities in the Irish Sea, much higher than in the other sub-areas in this region. These relative proportions were also seen in the 2006 Irish biological survey (Table 18.12).

Beam trawl surveys in the coastal waters of the Bristol Channel, Irish Sea and western English Channel confirm that, numerically, *R. montagui, R. clavata* are the most abundant skates (Table 18.11). The relative abundance of lesser-spotted dogfish has been stable in the Irish Sea (Figure 8.19).

Bristol Channel (VIIf):

UK beam-trawl surveys show that *R. clavata* is the most abundant ray, followed by *R. microocellata* and *R. montagui* (Table 18.11). *R. microocellata* is found predominantly in the shallower waters in this area, replacing *L. naevus*, which is rarely found in shallow water here.

Western English Channel, Celtic Sea and west of Ireland (VIIb, c, e, g-k):

Beam trawl surveys show *R. clavata* as the most abundant ray species, followed by *R. montagui* and *R. undulata* (Table 18.11). Almost all the *R. undulata* records come from VIIe.

The IGFS records *R. clavata* as the most abundant in VIIb and VIIj, followed by *L. naevus* and *R. montagui* (Figure 18.12), with *R. montagui* as the most abundant in VIIg.

Raja spp. are generally found in the inshore waters of the region, with *L. naevus* is most abundant on coarse offshore grounds in this sub-area, with *L. circularis, L. fullonica* and *D. batis* found in the deeper parts of the Celtic Sea and on the edge of the continental shelf.

18.6.3 Trends in survey data

West of Scotland (VIa):

The Irish groundfish survey has not been carried out in this area long enough to show trends, therefore the only source of data is the Scottish survey. These data are further analysed in Section 18.8.2.

Rockall (VIb):

No data are available.

Irish Sea (VIIa):

CEFAS 4 m beam trawl survey is the only survey for this area examined (Figure 18.19), although the IBTS (UK) Q4 surveys should provide data in the future, and DARD surveys need to be examined.

Raja clavata: While there are annual fluctuations in the catch rates each year in the CEFAS survey (Figure 18.19), there does appear to be a general increase over time.

Leucoraja naevus: Catch rates declined from about two per hour in the early 1990s and has fluctutated between 1 and 1.5 since, with a slight downward trend.

Raja montagui: Relative abundance was stable/slightly increasing from 1994–2002. After this numbers fluctuated on a greater scale, although there appears to be a slight increase over time.

Raja brachyura: Only caught in low numbers and no trends are apparent.

Scyliorhinus canicula: Catch rates appear stable. There was a slight increase in 2004, followed by a slight decrease.

Scyliorhinus stellaris: There was a peak in catches of this species in 1999, after which numbers dropped to previous levels. Since then catch rates appear to be stable/increasing. The low mean catch rate is partly attributed to the spatial distribution of this species, which is generally restricted to the coarse grounds off Anglesey and the Lleyn Peninsula, and in Cardigan Bay. Although they are regularly observed in tows in this area, only low numbers are caught.

Mustelus asterias: Only caught in low numbers in this survey (beam trawls tend to only sample the smaller size classes), although catch rates appear to be stable.

Dipturus batis was reported to be extirpated in the Irish Sea (Brander, 1981) and this species has not been recorded in the beam-trawl survey.

Bristol Channel (VIIf):

CEFAS 4 m beam trawl survey is the only survey available for this area (Figure 18.19), although IBTS (UK) Q4 surveys do have several stations in VIIf and will provide data in the future.

Raja clavata: While there are significant fluctuations in the catch rates of this species, there appears to have been a general increase since 2000.

Raja microocellata: Catch rates range between 1–6 per hour, with a peak in 1998, and otherwise no trend.

Raja montagui: Catch rates vary between 1–2 per hour in this area, although appear to be stable.

Scyliorhinus canicula: Catch rates appear stable, with peaks in certain years.

Scyliorhinis stellaris: Average catch rates are low, due to the coarse grounds preferred by this species not sampled extensively in the survey. This species is recorded in most years and catches seem stable.

Mustelus asterias: This species has shown an increase in mean catch rates from low levels to about 6 per hour in 2005.

Raja brachyura: Only caught in low numbers and no trends are apparent.

Western English Channel, Celtic Sea and west of Ireland (VIIb,c,e,g-k):

Several surveys take place in this area, including Irish, French and Spanish groundfish surveys.

Raja clavata: The French EVHOE surveys showed stable catch rates, but with a very large peak in abundance in 2001 (Figure 18.20b). This can be attributed to very large catches of juvenile *R. clavata* on this survey (Figure 18.21a). This was not shown by the UK PHHT survey (Figure 18.18), which showed a slight decline from very low numbers in that year. The overall trend in the UK PHHT survey is downwards. There were peaks in catch rates in the late 1980's and in 1994, and recent catch rates have been at low levels.

The peak abundance in the UK survey was in 1994, after which abundances remained at a low level, although there appears to have been a slow increase since 2000.

Leucoraja naevus: Different surveys show slightly different patterns of abundance for this species. The Spanish survey in the Porcupine Bank shows a peak in abundance in 2003 (Figure 18.17b), followed by a decline, with subsequent low but stable catch rates. The UK PHHT Q1 survey shows large fluctuations in annual abundance (Figure 18.18), with peak abundance in 1996, followed by a sharp decline to low levels since 1997, with catch rates of this species in the Irish Sea beam trawl survey also generally stable (Figure 8.19). The French EVHOE survey (Figure 18.20) shows a peak in abundance in 2002, with the lowest catches in 2000. The relative abundance in the Celtic Sea/Biscay region may have increased in recent years (Figure 18.20), as reported from the French EVHOE survey (Mahé and Poulard, 2005), but catches are variable.

Leucoraja circularis: Only the Spanish Porcupine Bank survey covers this species area of distribution and showed this species in any quantity (Figure 18.17c). Peak catches were in 2003. The following year catches were at their lowest point in the series. Since then the numbers appear stable, although this is a very short time series.

Leucoraja fullonica: Only the UK PHHT Q1 survey seemed to show this species in quantity. There are large fluctuations in catches, before 1997, with numbers per hour approaching zero in 1992 and also in 2001. More recent catch rates were at low levels, and the cessation of this survey precludes further analyses of recent trends.

Scyliorhinus canicula: Lesser-spotted dogfish is abundant and widespread over most parts of the Celtic Seas eco-region. Like many elasmobranchs, it often aggregates by size and sex, and these aggregations can result in occasional large catches. All surveys show increasinge/stable catch rates of lesser-spotted dogfish in recent years, although there is some variation in when the increase was first detected. The Spanish Porcupine survey shows an increasing trend for *Scyliorhinus canicula* to the west of Ireland. (Figure 18.17a), while relative abundance of lesser-spotted dogfish has been stable in the Celtic Sea (Figure 8.18). The French survey showed a general increase in the Celtic Sea/Bay of Biscay (Figure 18.20, Mahé and Poulard, 2005), with this study indicating that the increase was associated with an increase in the abundance of smaller individuals. Both The UK survey and the French survey show an increase from 2000 on, but the Spanish survey on the Porcupine Bank (Figure 18.17a) does not show a significant increase until 2003.

The UK survey in the Celtic Sea showed 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.

18.6.4 Size composition of demersal elasmobranchs

Preliminary analyses of the size distribution of the demersal elasmobranchs was undertaken in 2006. This study was to illustrate the life-history stages that may be represented in the various surveys, and so as to gauge whether existing surveys are likely to be appropriate for examining the pups, juveniles and adults of demersal elasmobranchs.

Several groundfish surveys, such as the earlier CEFAS PHHT survey (Figure 18.13) and the more recent and ongoing CEFAS beam trawl survey (Figure 18.14) and Irish Groundfish Survey (Figures 18.15 and 18.16), can provide annual data in the Celtic Seas. Of these, the beam trawl survey that takes place in Q3 shows the highest proportion of small (<20 cm) skates of each species. Within the surveys, some species are only caught in relatively low numbers. Nevertheless, some of these species, such as *R. microocellata*, show several modes in size range. As age data are not available for these species, these modes may possibly be used to estimate relative age abundances for younger age classes.

Other relatively common species show similar size distributions across surveys and areas. For example, *R. clavata* has a similar size distribution in both CEFAS and Irish surveys. However the French EVHOE survey showed a very large increase in small fish in 2001 (Figure 18.21) Minor differences are apparent in other species, with the length distribution of *R. montagui* having a peak of 39 cm in division VIa and 47 cm in VIIb (Figure 18.15). Similarly, *L. naevus* tend to be slightly smaller in VIa (peak at 55 cm) than in VIIb (peak at 59 cm).

18.6.5 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. More detailed studies are required to examine available data for:

Raja undulata in Tralee Bay (VIIj)
Raja microocellata in the Bristol Channel (VIIf)
Scyliorhinus stellaris off Anglesey and the Lleyn Peninsula (VIIa)

Although some of these local populations may be sampled with a reasonable number of trawl stations (e.g. *R. microocellata*) in VIIf, the number of trawl stations sampling other 'local' populations may currently be more limited.

18.6.6 Quality of data

The genus *Mustelus* is a problematic taxon, and it is likely that there is some confusion between *M. asterias* and *M. mustelus*. Hence, analyses for these species should use aggregated data for the two species. *Mustelus* spp. and tope may also be misidentified.

There are several identification problems with certain skate and ray 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* do not occur over much of this eco-region), 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.

18.7 Life-history information

Some length-weight information and maturity information is available from various groundfish surveys. Various published biological studies have also provided maturity and age data for skates in the Celtic Seas (e.g. 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. Maturity information from the Irish Biological Surveys from the West of Ireland and Irish Sea are presented in Table 18.12, with corresponding maturity scales used in these and Cefas surveys summarised in Table 18.13.

Due to the low catch rates of skates in various national surveys, it is recommended that WGEF examine all recent maturity data available, including both survey and commercial data, from those nations collecting data in the Celtic Seas eco-region in order to come up with more accurate estimates of length at maturity for the dominant species.

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 survey (EVHOE) data, a surplus production model and catch curve analysis. The results of these exploratory assessments did not give consistent results. *L. naevus* had shown signs of an increase in number, followed by a decrease in the 1990s (Heesen, 2003). Longer-term CPUE data and a better knowledge of the stock are required.

18.8.2 Survey-only analyses

Due to the paucity of data, formal stock assessments cannot be undertaken for many species or areas at the present time. WGEF has examined survey data to ascertain the general status of the stocks of interest, including *R. clavata, L. naevus, R. montagui* and *Scyliorhinus canicula* in VIa and parts of sub-area VII. Preliminary examinations of survey trends have been undertaken for most species (Section 18.6), with some stocks subject to further studies (see below).

18.8.2.1 GAM of survey data

The analysis carried out in this section follows the method outlined in Section 1.10. The ICES Divisions within this eco-region are surveyed by different nations, and therefore results are presented for each species within each ICES Division (or group of divisions). The most abundant species caught in the surveys across this eco-region are: thornback ray, cuckoo ray, spotted ray and lesser-spotted dogfish and therefore the analyses focuses on these.

Division VIa

The analyses for Division VIa species make use of catch rate data in terms of numbers per hour from: Scottish Q1 and Q4 groundfish surveys, deepwater surveys (described above) and data from a number of other surveys carried out as part of various EC projects (e.g. monkfish). These other surveys (deepwater, monkfish) use a variety of gears, so as well as including spatial, temporal and depth effects in the model, the effect of gear on survey catch rate was also considered. However, as the deepwater gears are generally used only in deepwater, the effect of gear and depth is somewhat confounded and therefore a gear effect was not included in any of the models presented. Additionally, depth is likely to be confounded with the spatial effect as some statistical rectangles are on average deeper than others. However, the inclusion of depth as an explanatory model tended to give an improved fit to the data (without changing significantly the estimates of general spatial distribution) and therefore depth was retained in the model.

Raja clavata: Figure 18.22a shows the estimated effects from the fitted GAM. The survey catch rates in terms of N/hr are estimated to have been higher in recent years than in the mid 1990s. Highest catches are estimated to occur in the statistical rectangles around St Kilda and in waters less than 250 m deep. The seasonal pattern is rather uncertain, probably because most of the 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 18.22b. The year effect estimated by the model shows some fluctuations over the 20-year time period, although recent catch rates are estimated to be the highest in the time series. The estimated spatial distribution indicates lower catch rates in the Minches and Clyde with higher catch rates in the more offshore areas of the shelf. Catch rate is 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 shows an increasing trend over time (Figure 18.22c). The highest catch rates are estimated to come from statistical rectangles to the south and north of the Hebrides.

Scyliorhinus canicula: Figure 18.22d shows the results of the fitted GAM. The estimated temporal trend in catch rate shows a significant increase between 1990 and 2003 and has stabilised since then. Highest catch rates are 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 18.23a shows the estimated effects from the fitted statistical models. The model estimates that there has been a significant increase in catch rate (N/hr) over the period for which data are available (1993–2006). The highest catch rates come from Cardigan Bay and the other statistical rectangles around the coast of Wales, with lower catch rates apparent in more southerly and north-westerly regions.

Leucoraja naevus: The results of the analysis for cuckoo ray in VIIa/VIIf are shown in Figure 18.23b. The statistical model estimates a small (but marginally significant) decline in catch rate over the 14 years of survey data. The estimated spatial distribution of survey catch rates shows 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.

Raja montagui: Figure 18.23b shows the results of the fitted GAM for spotted ray in the Irish Sea and Bristol Channel. The model estimates a significant increase in catch rate over the time series of available data. Catch rates are 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 18.23d. The statistical model estimates a significant increase in catch rate over the 14 years of survey data. The estimated spatial distribution of survey catch rates shows 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.

18.8.3 Stock Status

In the absence of formal stock assessments for the species and stocks in this eco-region, the following provides a qualitative summary of the general status of the major species.

West of Scotland (VIa):

Raja clavata: Uncertain, although catch rates seem to be stable/increasing 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 montagui: Survey catches are stable/increasing.

Scyliorhinus canicula: Survey catches are stable/increasing.

Dipturus batis: Local populations still exist.

Rockall (VIb):

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

Irish Sea (VIIa):

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

Leucoraja naevus: Uncertain, with the different surveys giving contrasting signals. There is a slight downward trend in catch rates. Better delineation of the stock structure is required to aid in the interpretation of these survey indices.

Raja montagui: Survey catches are stable/increasing.

Raja brachyura: Uncertain. No trends are apparent from surveys.

Dipturis batis: 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 Belfast Lough), although there is no evidence to suggest that *D. batis* has reappeared elsewhere in VIIa.

Scyliorhinus canicula: Survey catches are stable/increasing.

Scyliorhinus stellaris: Uncertain. Survey catches are stable/increasing, but only reported from coarse ground stations in low 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. The problems of identification of species within this genus makes stock assessment difficult.

Bristol Channel (VIIf):

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.

Raja montagui: Survey catches seem to be stable/increasing.

Raja brachyura: Uncertain. No trends are apparent from surveys.

Scyliorhinus canicula: Survey catches are stable/increasing.

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

Mustelus spp.: Uncertain. 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):

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

Leucoraja naevus: Uncertain, with the different surveys giving contrasting signals. d The Spanish survey shows 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 montagui: Survey catches are stable/increasing.

Leucoraja circularis: Uncertain. Survey catches appear stable, but only a short time series is available.

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

Scyliorhinus canicula: Survey catches are stable/increasing.

Mustelus spp.: Uncertain. Survey catches in the PHHT 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

Data are insufficient for a full stock assessment. Species-specific catch data are not available. There have, however, been improvements in the collection of species-composition data in recent years, and there is some historical information on species composition for earlier time periods.

The stock identity 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.

Age and growth studies have only been undertaken for the more common skate species, and IBTS 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.

Surveys provide the most reliable species-specific information, and there are several surveys operating in the area. The French and UK (Scotland) IBTS surveys and the UK (England and Wales) beam trawl survey have been undertaken for 10–20 years, with other surveys covering a shorter time frame. Such data may be appropriate for examining the general status of the more common demersal elasmobranchs.

The identification of skate species is considered to be reliable for recent surveys, although there are suspected to be occasional mis-identifications. It is recommended that any analyses of smoothhounds use the combined data for *M. asterias* and *M. mustelus.*

18.10 Reference points

No reference points have been proposed for these stocks.

18.11 Management considerations

There are no TACs for any of the other relevant species in this region.

Technical interactions for fisheries in this eco-region are shown in Table 18.14.

It has been difficult for WGEF to deal with elasmobranchs in this region adequately. This is due to a lack of species-specific landings data, limited knowledge of the species composition of skates in commercial landings (including taxonomic confusion in some data sets), poor knowledge of stock structure and limited time-series of some of the fishery-independent surveys in this eco-region.

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 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 so further studies to better define the stock structure are required.

The relative abundance of lesser-spotted dogfish *Scyliorhinus canicula*, smoothhounds *Mustelus* spp. and spotted ray *Raja montagui* in this eco-region appear to be stable/increasing.

Other species

Contemporary surveys occasionally record other skate species, such as undulate ray, though catch rates of these species are highly variable. The absence of *R. alba* and *S. squatina* in contemporary surveys, as noted by ICES (2006) is cause for concern.

There are anecdotal and historical reports suggesting that localised populations of white skate *Rostroraja alba* were targeted in fisheries in the western English Channel, Baie de Douarnanez (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 eco-region 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 show that these sharks can migrate further than previously thought. While 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 (Figure 18.24) (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, and that it is not subject to any conservation legislation, a zero TAC for Subareas VII–VIII may benefit this species.

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 examine the current status of these species in sub-areas VI and VII should be undertaken next year. Future analyses should examine the long-terms 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.

18.12 References

Borges, L; Rogan, E; Officer, R. 2005. Discarding by the demersal fishery in the waters around Ireland. Fish. Res., 76(1): 1–13.

Brander, K. 1981. Disappearance of common skate *Raia batis* from the Irish Sea. Nature, 290: 48–49.

Chevolot, M., Ellis J.R., Hoarau, G., Rijnsdorp, A.D., Stam W.T. and Olsen J.L. 2006. Population structure of the thornback ray (Raja clavata) in British waters. Journal of Sea Research, 56: 305–316.

Diez, G., Iriondo, A., Ruiz, J., Quincoces, I., González, I., Santurtun, M. and Artetxe I. 2006. Lesser spotted dogfish, rays and spurdog Landings Per Unit Effort and preliminary discards data of Basque fleets operating in sub-areas VI, VII and VIII in the period 1994–2005. Working Document presented at the 2006 WGEF.

Du Buit, M. H. 1966. Etude de la population des raies d'un secteur sud de la Mer Celtique. Bulletin de la Société Scientifique de Bretagne, 41: 249–256.

Du Buit, M. H. 1968. Les raies (genre *Raja*) de la pêche française: écologie et morphométrie des principales espèces atlantiques. Travaux du Laboratoire de Biologie Halieutique, 1: 19–117.

Du Buit, M. H. 1970. Repartition des selaciens demersaux au nord de l'Ecosse. Travaux du Laboratoire de Biologie Halieutique, 3: 5–18.

Du Buit, M. H 1972. Etude du stock de raies de la Mer Celtique. Travaux du Laboratoire de Biologie Halieutique, 6: 13–31.

Ellis, J. R., Dulvy, N. K., Jennings, S., Parker-Humphreys, M. and Rogers, S. I. 2005. Assessing the status of demersal elasmobranchs in UK waters: A review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Fahy, E. 1988. Irish fisheries for ray (Rajidae): Sampling a multi-species product. ICES CM 1988/G:7, 8 pp.

Fahy, E. 1989a. Fisheries for ray (Batoidei) in Western statistical area VIIa, investigated through the commercial catches. Irish Fisheries Investigations (New Series), 34, 14 pp.

Fahy, E. 1989b. Growth parameters of rays (Batoidei) in irish waters, from material examined in commercial catches. ICES CM 1989/G:59, 11 pp.

Fahy, E. 1989c. Segregation of rays in commercial catches. ICES CM 1989/G:60, 14 pp.

Fahy, E. 1991. The south eastern ray *Raja* spp. fishery, with observations on the growth of rays in Irish waters and their commercial grading. Irish Fisheries Investigations (New Series)*,* 37, 18 pp.

Fahy, E. and O'Reilly, R. 1990. Distribution patterns of rays (rajidae: Batoidei) in Irish waters. Irish Naturalists' Journal, 23(8): 316–320.

Gallagher, M. J. 2000. The fisheries biology of commercial ray species from two geographically distinct regions. PhD. Thesis. Trinity College, University of Dublin. 240 pp.

Gallagher, M. J., Jeal, F., and Nolan, C. P. 2005a. An investigation of the Irish ray fishery in ICES Divisions VIIa and VIIg. Journal of Northwest Atlantic Fishery Science, 35: 1–13.

Gallagher, M. J., Nolan, C.P. and Jeal, F. 2005b. Age, growth and maturity of the commercial ray species from the Irish Sea. Journal of Northwest Atlantic Fishery Science, 35: 47–66.

Green, P. 2007. CFB Marine Sportfish Tagging Programme 1970–2006. Working Document to WGEF 2007.

Heessen, H. J. L. (ed) 2003. Development of Elasmobranch Assessments – DELASS: DG Fish Study Contract 99/055.

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

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

ICES. 2006. Report of the Working Group on Fish Ecology (WGFE), 13–17 March 2006, Copenhagen. ICES CM 2006/LRC:06, 154 pp.

ICES. 2007. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 27–30 March 2007, Sète, France. ICES CM 2007/RMC:05. 195 pp.

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.

Mahé, J. C. and Poulard, J.C. 2005. Spatial Distribution And Abundance Trends Of Main Elasmobranchs Species In The Bay Of Biscay And The Celtic Sea From Bottom Trawl Surveys. ICES CM 2005/N:04, 27 pp.

Pawson, M., Nichols, V. 1994. Recapture patterns of rays tagged in the Bristol Channel and Irish Sea. In Proceedings of the Second European Shark and Ray Workshop. Tag and Release Schemes and Shark and Ray Management Plans, 15–16 February 1994 (Fowler, S.L. and Earll, R.C., eds.), pp. 10–13.

Quéro, J. C. and Guéguen, J. 1981. Les raies de la mer Celtique et du Canal de Bristol abondance et distribution. Science et Pêche, Bulletin de l'Institute des Pêches maritimes, 318, 22 pp.

Revill, A., Dulvy, N. K. and Holst, R. 2005. The survival of discarded lesser-spotted dog¢sh (*Scyliorhinus canicula*) in the western English Channel beam trawl fishery. Fisheries Research, 71: 121–124.

Rogers, S. and Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. ICES Journal of Marine Science, 57: 866–881.

Table 18.1. Demersal elasmobranchs in the Celtic Seas. Nominal landings (tonnes) of skates and rays (Source: ICES).

TABLE 18.1A	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIA																
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	.	2	.	1	2	7	1	2	2	4	2	4	2	8	9	4	4
Denmark	.	+	+	+	+	+	+	.	+	+	.	.	.	.	.	0	
Faeroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	na	
France	711	621	603	606	437	553	526	384	333	0	321	278	212	183	149	181	174
Germany	.	.	.	.	2	.	1	4	16	7	1	1	.	3	0	.	0
Ireland	150	200	350	331	265	504	681	596	488	388	274	238	311	364	363	186	176
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Norway	71	38	82	56	9	74	29	20	50	29	49	20	25	2	2	10	4
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Spain	.	43	.	.	.	.	47	58	69	34	2	.	9	27	14	14	0
UK - (E,W&N.I.)	57	77	72	70	101	138	101	69	157	67	108	65	114	159	66	26	18
UK – Scotland	2007	2026	1605	1419	1429	1980	2606	1879	1460	1324	1316	1263	1136	1307	1012	623	369
Total	2996	3007	2712	2483	2245	3256	3992	3012	2575	1853	2073	1869	1809	2053	1488	1043	744

TABLE 18.1B	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIB																
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Estonia	.	.	.	.	.	.	.	.	.	.	.	56	1	.	.	.	
Faeroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	na	na	
France	3	13	0	4	0	0	0	0	0	0	7	5	5	2	6	15	0
Germany	.	.	.	6	25	17	49	26	36	67	76	8	1	6	22.3	22	6
Ireland	.	.	.	24	23	60	68	23	15	28	20	10	1	18	7.28	9	24
Norway	203	248	234	170	272	176	95	101	98	59	120	80	44	61	45.95	39	82
Portugal	.	.	.	.	.	56	.	25	26	24	29	17	31	18	na	0	0
Russian Federation	.	.	.	.	.	.	.	.	.	.	5	8	.	.	na	na	
Spain	.	14	.	.	.	.	328	410	483	322	347	158	36	46	0.5	0	0
UK - (E,W&N.I.)	4	11	12	21	28	73	175	105	134	147	156	120	92	47	47.8	20	20
UK – Scotland	76	67	57	70	98	97	83	91	101	123	204	97	79	146	164	59	51
Total	286	353	303	295	446	479	798	781	893	770	964	559	290	344	294	164	183

TABLE 18.1C	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIIA																
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	298	209	230	107	224	218	265	298	398	542	504	724	997	830	860	860	593
France	712	890	642	550	330	293	282	151	285	n.s.	163	343	349	322	183	192	114
Ireland	1811	1400	1301	679	514	438	438	593	692	827	759	807	1032	1086	825	786	645
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4	4	6	+	+	+	+	.	0
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0
UK - (E,W&N.I.)	1378	1226	1150	1003	748	606	789	824	1009	936	671	983	863	1184	533	1252	271
UK (Scotland)	227	163	107	96	86	42	55	80	52	33	86	80	68	67	38	30	65
Total	4426	3888	3430	2435	1902	1597	1829	1946	2440	2342	2189	2937	3309	3489	2256	3120	1689

TABLE 18.1D	TOTAL LANDINGS (T) OF RAJIDAE IN AREA VIIF																
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	135	155	128	96	117	108	89	116	121	103	90	91	117	134	210	208	138
Denmark	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
France	326	607	663	565	468	394	432	485	464	453	538	642	526	536	478	429	305
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Ireland	.	.	.	.	.	.	.	.	1	.	.	.	1	1	15	8	6
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Norway	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Spain (b)	.	.	.	.	.	.	8	10	12	1	.	3	.	.	.	.	0
UK - (E,W&N.I.)	666	627	705	638	630	589	676	664	624	560	613	691	920	766	609	631	653
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Total	1127	1389	1497	1299	1215	1091	1205	1275	1222	1117	1241	1427	1564	1437	1312	1276	1101

TABLE 18.1E	TOTAL LANDINGS (T) OF RAJIDAE IN AREA VIIEGH																
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	242	97	183	209	172	203	177	293	260	240	223	248	347	576	407	432	582
Denmark	1	.	1	+	0	+	.	.	.	.	.	.	.	.	.	.	
France	7734	7077	6477	5873	5836	6029	6425	7093	6114	6098	5710	5603	5273	5588	4261	4517	3740
Germany	.	.	.	.	.	.	.	.	.	.	.	.	+	.	3	.	
Ireland	100	68	.	120	106	162	349	479	446	408	203	481	729	838	844	334	315
Netherlands	na	na	na	na	na	na	na	na	9	na	7	7	11	.	.	.	1
Norway	5	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Spain (b)	.	21	.	.	.	.	312	932	1178	2647	1706	1142	653	31	15	9	1
UK - (E,W&N.I.)	1211	638	751	735	869	997	953	1098	1167	796	932	880	775	804	811	1024	727
UK (Scotland)	.	.	.	1	.	.	.	2	.	2	.	2	.	.	149	3	1
Total	9293	7901	7412	6938	6983	7391	8216	9897	9173	10191	8781	8374	7788	7837	6490	6318	5366

TABLE 18.1F	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIIBCJK																
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	0	0	0	0	0	0	0	0	0	24	5	0	5	1	na	0	0
France	781	541	546	298	224	297	375	599	500	ns	568	362	272	192	101	257	255
Germany	0	0	0	7	18	3	4	9	17	10	21	7	+	3	15	17.07	0
Ireland	350	400	619	602	625	735	757	811	741	740	653	383	354	435	511	464.7	473
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Spain (b)	0	124	0	0	0	0	1341	1676	1978	2419	2573	1205	2939	1281	7	16	19
UK - (E,W&N.I.)	5	53	71	88	201	361	469	468	376	352	597	545	373	350	364	269	176
UK (Scotland)	14	15	10	34	43	73	58	36	67	121	189	162	124	226	70	58	77
Total	1150	1133	1246	1029	1111	1469	3004	3599	3679	3642	4601	2664	4062	2487	968	1081	1016

Table 18.1g	Total landings (t) of *Rajidae* in the Celtic Seas																
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	675	463	541	413	515	536	532	709	781	913	824	1067	1467	1549	1485	1503	1316
Denmark	1	.	2	+	.	+	.	.	.	.	.	.	.	.	.	0	0
Estonia	.	.	.	.	.	.	.	.	.	.	.	56	1	.	.	.	0
Faeroe Islands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	na	0
France	10267	9749	8931	7896	7295	7566	8040	8712	7696	6551	7307	7233	6637	6823	5178	5591	4587
Germany	0	0	0	13	45	20	54	39	69	84	98	16	2	12	40	39	7
Ireland	2411	2068	2270	1756	1533	1898	2294	2502	2382	2390	1909	1919	2428	2742	2565	1787	1640
Netherlands	na	na	na	na	na	na	na	na	13	4	13	7	11	na	na	0	1
Norway	279	286	316	226	281	250	124	121	148	88	169	111	69	63	48	49	101
Poland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Portugal	.	.	.	.	.	56	.	25	26	24	29	17	31	18	na	0	0
Russian Federation	.	.	.	.	.	.	.	.	.	.	5	8	.	.	na	na	0
Spain	0	202	0	0	0	0	2036	3086	3720	5423	4628	2508	3637	1385	37	39	20
UK - (E,W&N.I.)	3321	2632	2761	2555	2577	2764	3163	3228	3467	2858	3077	3283	3137	3310	2431	3222	1865
UK – Scotland	2324	2271	1779	1620	1656	2192	2802	2088	1680	1603	1795	1604	1407	1746	1433	773	562
Total	19278	17671	16600	14479	13902	15282	19044	20510	19981	19938	19854	17830	18828	17648	13217	13004	10099

Table 18.2a. Demersal elasmobranchs in the Celtic Seas. Species-Specific French Landings, all areas combined.

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	10430	11544	8035	8989	8956	7504

*** WGEF consider that records *of R. montagui* also include landings of *R. brachyuran.***

Table 18.2b. Demersal elasmobranchs in the Celtic Seas. Species-Specific French Landings for Subareas VI and VII.

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.***

 # IncludingD. batis, R. alba, D. oxyrinchus, D. nidarosiensis.

Table 18.3. 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
L. naevus	330.3	290.9	290.0	287.0
R. asterias	0.0	0.1	0.0	0.0
R. batis	8.3	9.6	0.0	0.0
R. clavata	51.7	107.9	65.1	47.1
R. fullonica	5.3	33.5	0.0	1.5
R. montagui	2.7	6.2	20.9	5.1
R. oxyrhinchus	0.0	0.2	0.0	0.0
R. undulata	0.5	0.0	0.0	0.1
Total	398.8	448.4	376.0	340.9

No data available for 2004

Table 18.4. 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 18.5a. 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 18.5b. 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
Belgium	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
France (ICES)	0	0	0	0	0	24	19	0	0	18	13
UK (E,W &N.I.)	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

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	0	0	0	0	0	0	0	0	0	0	0
France (Bulletin)	9	11.5	0	8	13	9	5	4	2	2	2
France (ICES)	9	13	14	12	2	2	2	1	1	1	1
UK (E,W &N.I.)	0	0	0	0	0	2	1	1	0	0	0
Total	18	24.5	14	20	15	13	8	6	3	3	3

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	0	0	0	0	0	0	0	0	0	+	+	
France (Bulletin)	2	2	2	0	0	0	0	0	0	0	0	0.125
France (ICES)	2	1	0	0	1	+	+	+	0	+	+	
UK (E,W &N.I.)	0	0	47	0	0	0	0	0	0	0	0	0.042
Total	4	3	49	0	1	0	0	0	0	0	0	0.167

Table 18.6a. Demersal elasmobranchs in the Celtic Seas. Discard rates of rays and skates in the Celtic Seas. (Source: Irish discard monitoring programme, 1993–2004).

	1995	1996	1997	1998	1999	2000	2001
Number of trips	6	35	33	21	16	12	14
Number of hauls/set	60	193	222	118	163	52	74
Tonnes	1835	373	1004	581	920	231	906
Discard rate (%)	56	17	33	23	32	11	33

Table 18.6b. Demersal elasmobranchs in the Celtic Seas. Discard rates of *Scyliorhinid* dogfish in the Celtic Seas. (Source: Irish discard monitoring programme, 1993–2004).

	1995	1996	1997	1998	1999	2000	2001
Number of trips	4	35	34	28	18	14	15
Number of hauls/set	45	260	273	161	181	73	86
Tonnes	638	3238	2388	1467	2998	2516	1371
Discard rate (%)	30	87	75	62	86	86	73

Table 18.7. Demersal elasmobranchs in the Celtic Seas. Estimated weight (tonnes) of rays and skates discarded by the Scottish Fleet to the west of Scotland (Subarea VIa), 1999–2000. (Source: UK (Scotland) Discard Observer Programme).

	1999	2000
L. naevus	205.8	194.1
D. batis	269.1	13.2
R. montagui	98.3	67.4
L. fullonica	0	3.1
A. radiata	0	0
R. clavata	14.3	16.9
L. fullonica	0.2	0
Total	587.7	294.7

Table 18.8. Elasmobranchs in the Celtic Seas. Proportion of skates (Rajidae) from earlier studies in the Celtic Seas eco-region.

Study	Year	Area	Category	D. batis	D. oxyrinchus	L. circularis	L. fullonica	L. naevus	R. brachyura	R. clavata	R. microocellata	R. montagui	R. undulata	R. alba
Du Buit (1966)	1960's	Celtic Sea	All	+	+	0.01	0.01	0.91	-	0.05	-	0.02	-	-
Du Buit (1972)	1971	Celtic Sea	All	0.01	+	0.04	0.20	0.70	+	0.04	-	0.02	-	-
Du Buit (1968)	1964	Douarnenez	All	0.08	+	+	+	+	0.12	0.58	0.02	0.16	+	0.05
	1964	Lorient	All	0.24	0.02	0.03	0.04	0.13	0.03	0.47	-	0.05	-	-
	1964	Concarneau	All	0.27	0.01	0.00	0.08	0.29	+	0.31	+	0.04	+	+
Quero & Gueguen (1981)	1977-1980	Bristol Channel, Celtic Sea, Cardigan Bay	All	+	-	-	0.01	0.08	0.02	0.67	0.04	0.19	+	-
Fahy (1989)	1987-1988	Irish waters	Small	0.01	-	-	+	0.26	0.21	0.25	+	0.28	-	-
	1987-1988	Irish waters	Medium	0.02	-	-	0.02	0.21	0.19	0.27	0.03	0.25	+	+
	1987-1988	Irish waters	Large	0.02	-	-	0.03	0.04	0.45	0.33	0.02	0.11	+	-
Gallagher *et al.* (2005)	1997	VIIa,g	All	-	-	-	-	0.39	0.34	0.05	-	0.22	-	-

Table 18.9. Demersal elasmobranchs in the Celtic Seas. Summary details of western IBTS surveys in Celtic Seas eco-region. Adapted from ICES (2004).

Country	UK (Scot)	France	Spain (Porcupine)	Ireland	UK (E & W)
Institute	MLA	IFREMER	IEO	MI	CEFAS
Survey Area	VI, VIIa	VIIf-j, VIII	Porcupine	VIa, VII	VIIa, e-h
Depth range (m)	20–200	30–400	180–800	15–200	15–200
Initiated (as per quarter)	1992	1997	2001	2003	2003
Quarter	4	4	3 & 4	4	4
Research vessel	Scotia	Thalassa	Vizconde de Eza	Celtic Explorer	Endeavour
Gear Type	GOV 36/47	GOV 36/47	Porcupine BACA 40/52	GOV 36/47	GOV 36/47 (fine ground) GOV 35/45 (Rock-hopper)
Exocet Kite	Yes	No	No	No	No
Groundgear	Bobbins	Rubber disks and Chains Rubber and metal disks	Synthetic wrapped wire core double coat	Rubber disks + chain (type A + D)	Groundgear A (fine ground); rubber disks + hoppers (12–16”)

Table 18.10. Demersal elasmobranchs in the Celtic Seas. Proportion of skates in fishery independent surveys in the Celtic Sea (Portuguese High Headline Trawl, all stations north of 48ºN, 1984–2002).

Species	Numbers	Biomass
L. naevus	0.62	0.43
R. clavata	0.13	0.22
L. fullonica	0.10	0.10
R. montagui	0.09	0.08
D. batis	0.03	0.10
R. microocellata	0.02	0.04
R. brachyura	0.01	0.02
D. oxyrhinchus	+	0.01
L. circularis	+	+
D. nidarosiensis	+	+
R. undulata	+	+

Table 18.11. Demersal elasmobranchs in the Celtic Seas. Proportion of skates (by numbers) in fishery independent surveys in the Celtic Seas (CEFAS 4m beam trawl surveys, 1988–2005, all stations).

Species	VIIa	VIIf	VIIg	VIIe
R. brachyura	0.05	0.06	0.02	0.05
L. naevus	0.16	0.01	0.13	0.01
R. microocellata	+	0.30	0.14	0.03
R. montagui	0.30	0.19	0.40	0.39
R. clavata	0.48	0.45	0.32	0.48
R. undulata	+	-	-	0.04
L. circularis *	-	+	-	-
L. fullonica	-	-	+	-

*** The validity of the reported specimen from this area is questionable**

Table 18.12. Demersal elasmobranchs in the Celtic Seas. Maturity of male and female skate species from (a) west of Ireland (2005) and (b) Irish Sea (2006) (Source: Irish Biological Survey, 2005-2006).

		Females						Males			
		Maturity						Maturity			
	Species	1	2	3	4	5	6	1	2	3	4
(a) West of Ireland	R. brachyura	-	1	1	1	-	-	1	2		1
	L. naevus	16	-	-	-	-	-	11	3	2	
	R. montagui	10		2	1	-	-	-	2		1
	R. clavata	11	8	4	1	-	-	9	3	3	5
	Total	37	9	7	3	-	-	21	10	5	7
(b) Irish Sea	R. brachyura	6	2	2	-	-	-	5	1	8	1
	L. naevus	17	6	1	2	-	-	12	2	3	1
	R. montagui	44	17	6	-	-	1	28	24	15	16
	R. clavata	10	2	2	-	-	-	9	3	2	1
	Total	77	27	11	2	-	1	54	30	28	19

Table 18.13. Demersal elasmobranchs in the Celtic Seas. Maturity keys used on Irish biological surveys and on CEFAS groundfish surveys.

Irish Biological surveys			CEFAS Four-stage key		
Stage	Females	Males	Stage	Females	Males
1	Juvenile	Juvenile	A	Juvenile	Juvenile
2	Maturing virgin	Maturing virgin	B	Maturing	Maturing
3	Mature	Mature	C	Mature	Mature
4	Active	Active	D	Active	Active
5	Laying				
6	Spent				

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

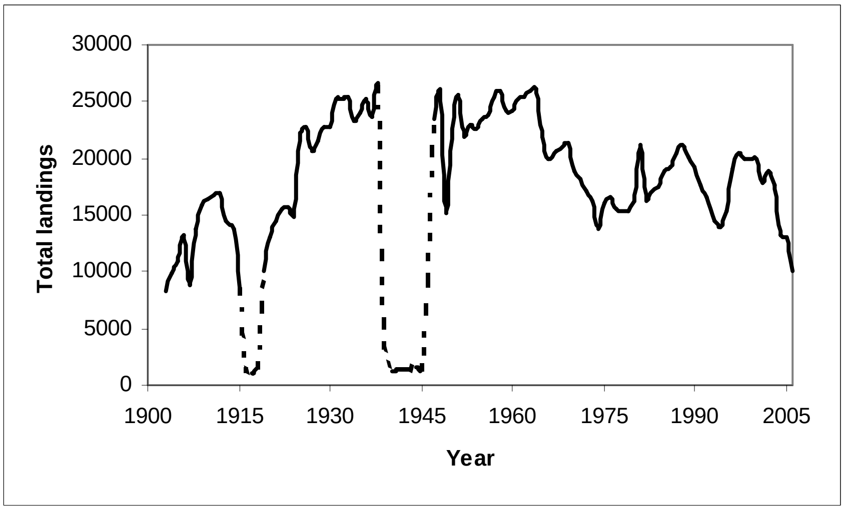


Figure 18.1a. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of *Rajidae* in the Celtic Seas (ICES Subareas VI and VII (including VIId)), from 1903–2006 (Source: ICES).

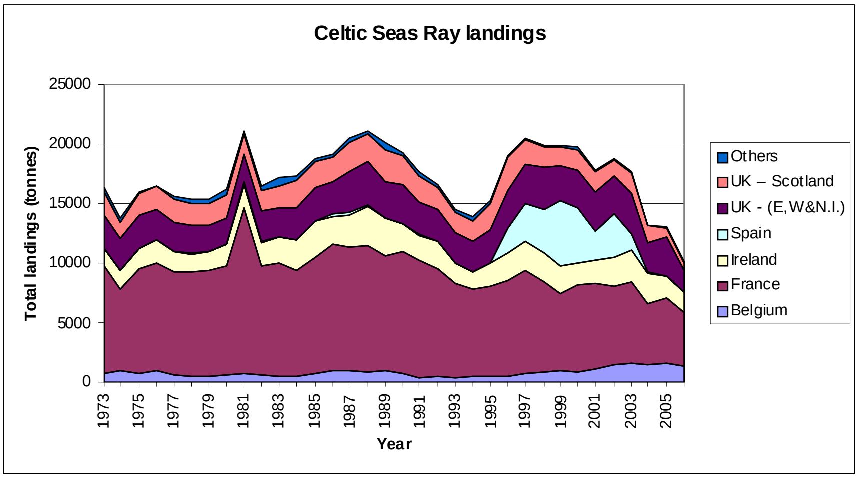


Figure 18.1b. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of *Rajidae* by nation in the Celtic Seas from 1973–2006 (Source: ICES).

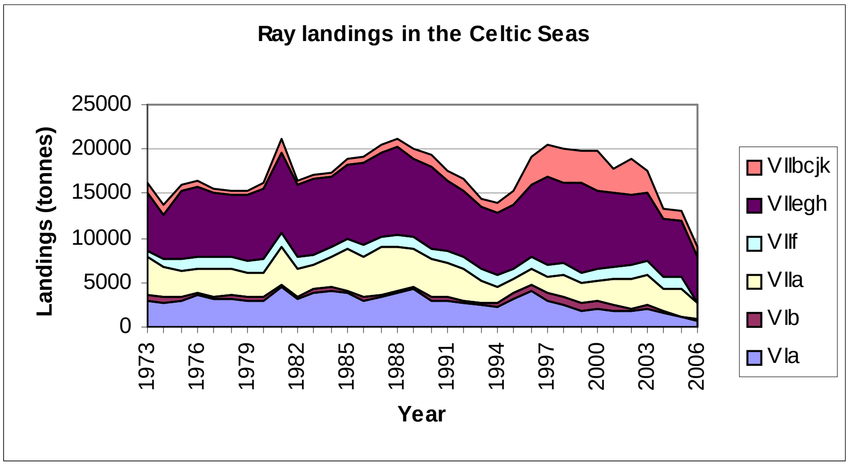


Figure 18.1c. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of *Rajidae* by ICES Division in the Celtic Seas from 1973–2006 (Source: ICES).

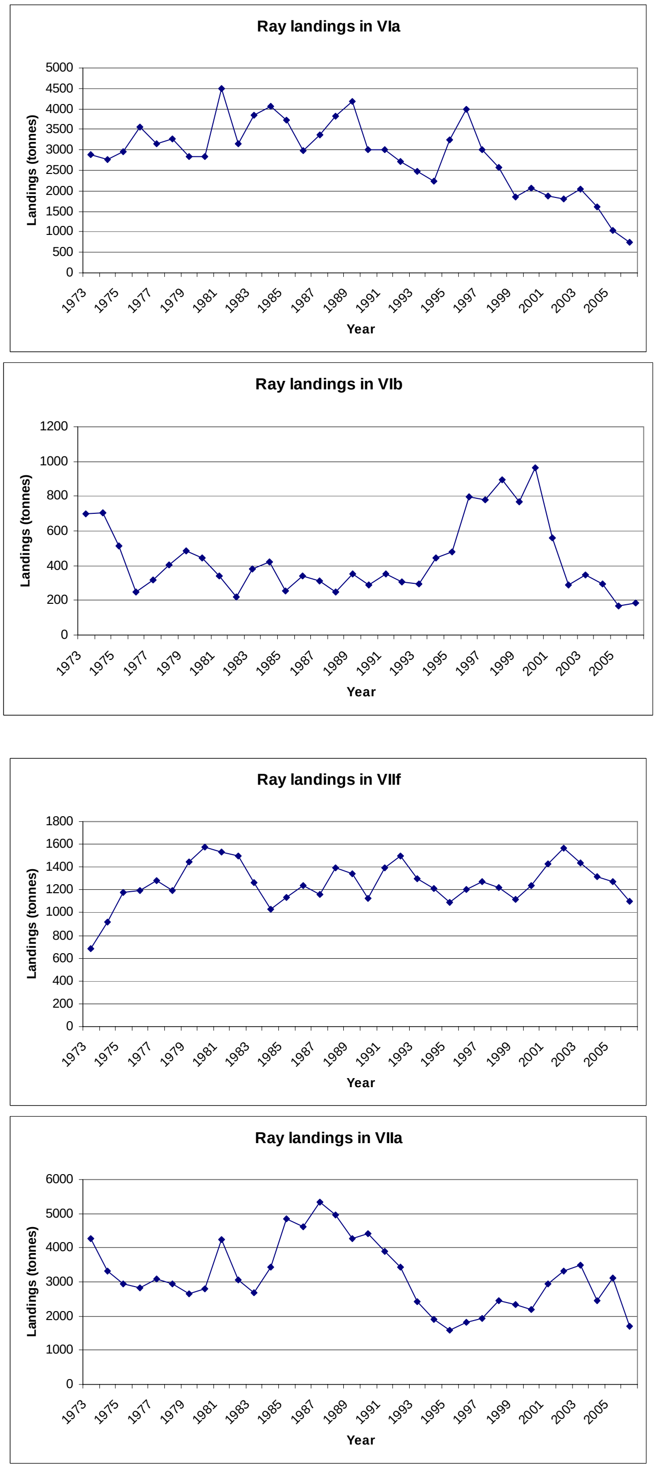
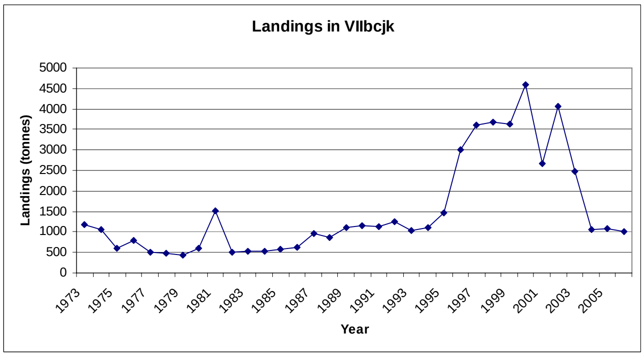


Figure 18.2 a-d. Demersal elasmobranchs in the Celtic Seas. Landings (tonnes) of *Rajidae* by ICES Division in the Celtic Seas from 1973–2006 (Source: ICES).



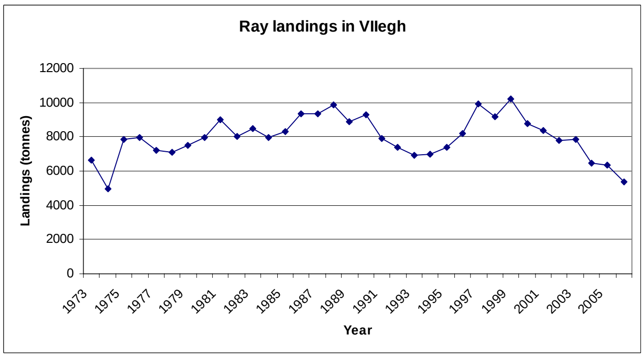
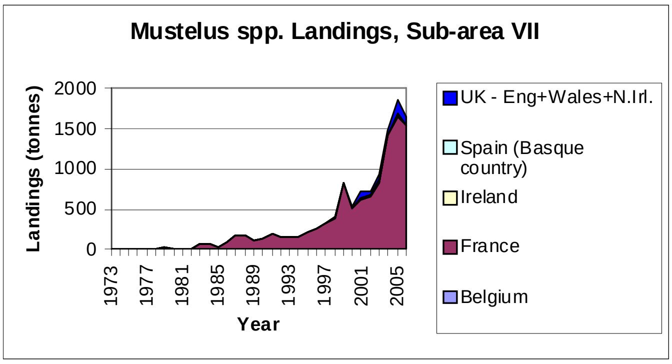


Figure 18.2 e-f. Demersal elasmobranchs in the Celtic Seas. Landings (tonnes) of *Rajidae* by ICES Division in the Celtic Seas from 1973–2006 (Source: ICES).



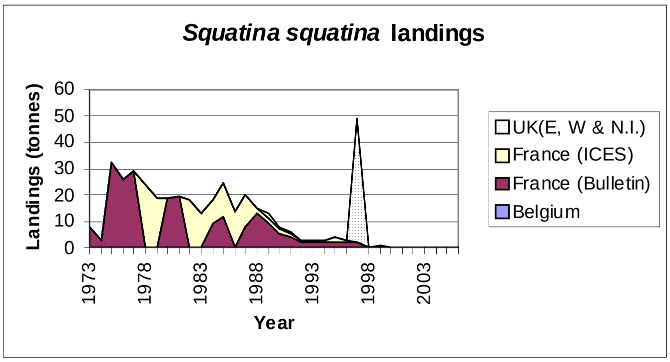


Figure 18.3. Demersal elasmobranchs in the Celtic Seas. Total landings of *Musetlus* spp. and *Squatina squatina* (Source: ICES and Bulletin de Statistiques des Peches Maritimes).

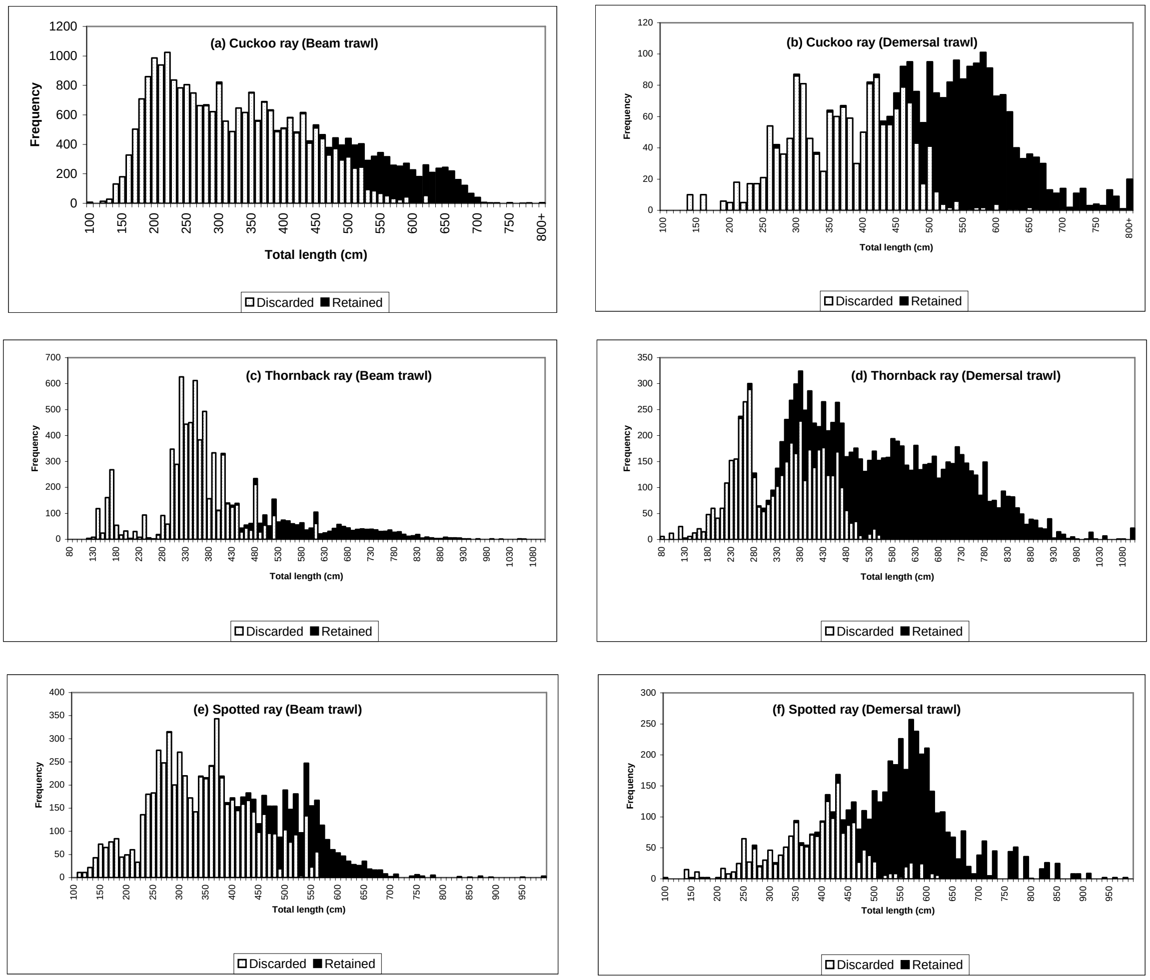


Figure 18.4a. Demersal elasmobranchs in the Celtic Seas. Length distributions of (a–b) cuckoo ray, (c–d) thornback ray and (e–f) spotted ray discarded and retained in beam trawls and demersal trawl fisheries in western waters (ICES Subarea VII). Data aggregated across individual catch samples for the years 1998–2006 (Source: UK (E&W) Discard Surveys).

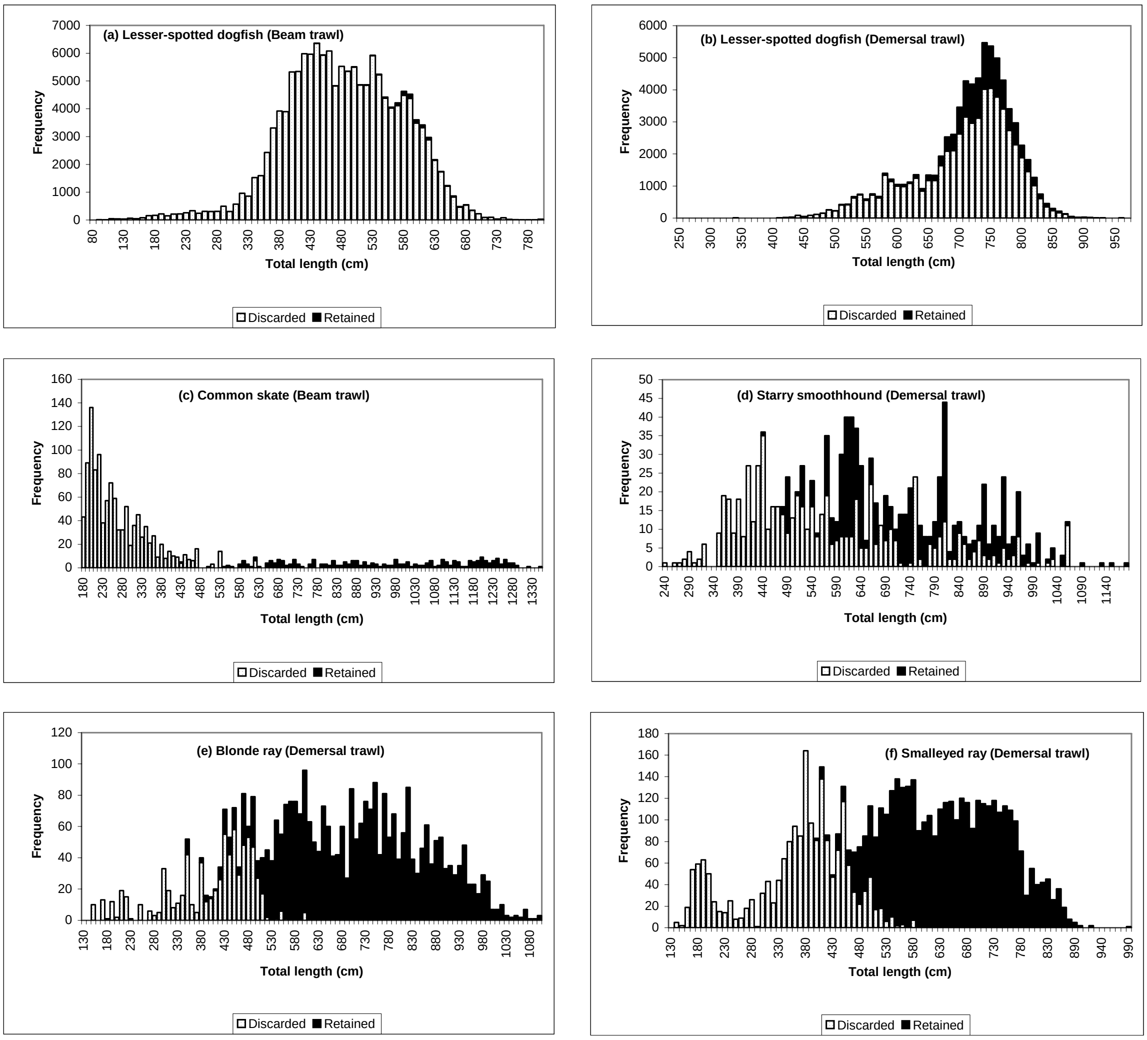


Figure 18.4b. Demersal elasmobranchs in the Celtic Seas. Length distributions of (a-b) lesser-spotted dogfish, (c) common skate, (d) starry smoothhound, (e) blonde ray and (f) smalleyed ray discarded and retained in beam trawl and demersal trawl fisheries in western waters (ICES Subarea VII). Data aggregated across individual catch samples for the years 1998–2006 (Source: UK (E&W) Discard Surveys).

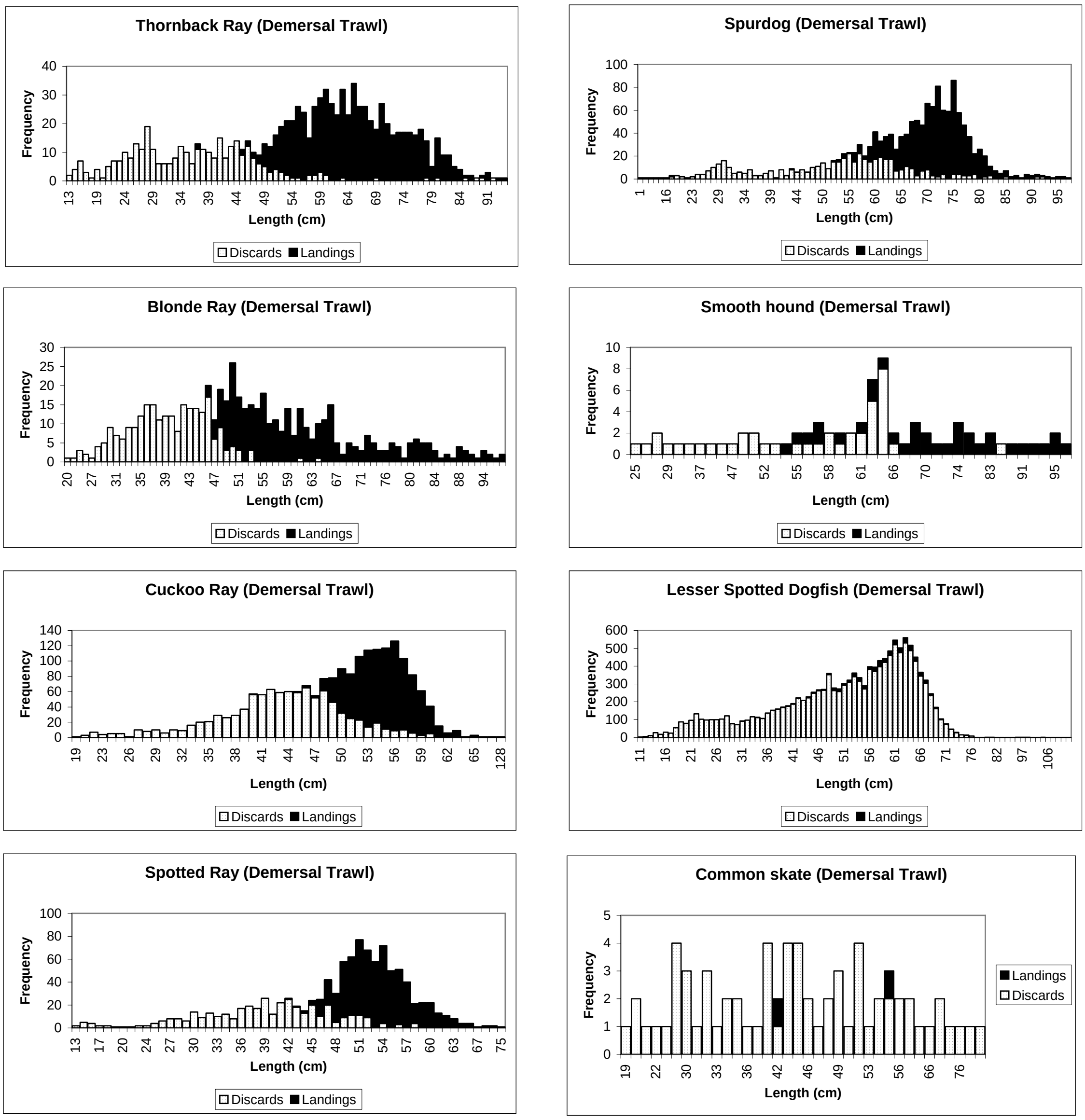


Figure 18.5. Demersal elasmobranchs in the Celtic Seas. Length distribution of elasmobranch species discarded and retained in Irish demersal trawl fisheries in the Celtic Seas. These data are aggregated across individual catch samples for all demersal gears and divisions combined. (Source: Irish Discard Observer Programme).

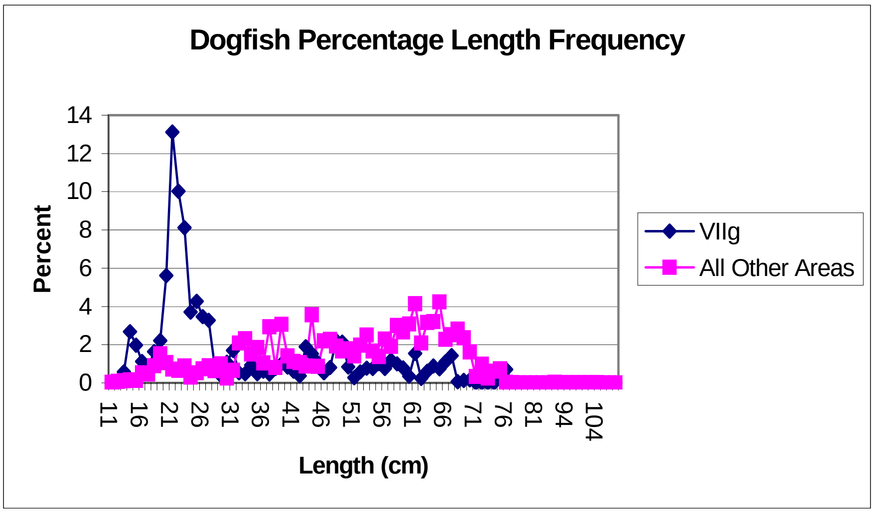


Figure 18.6a. Demersal elasmobranchs in the Celtic Seas. Length frequency of dogfish (*Scyliorhinus* spp.) in Division VIIg in comparison to other areas (Source: Irish Discard Observer Programme).

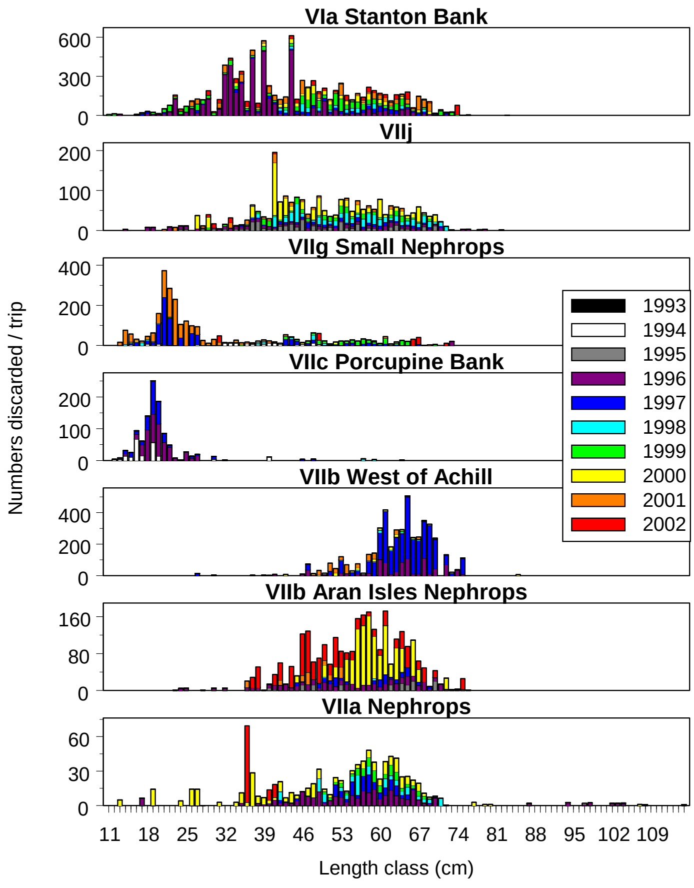


Figure 18.6b. Demersal elasmobranchs in the Celtic Seas. Numbers of S. canicula discarded per trip in ICES Divisions VIa and VIIa–c,g,j. (Source: Irish Discard Observer Programme).

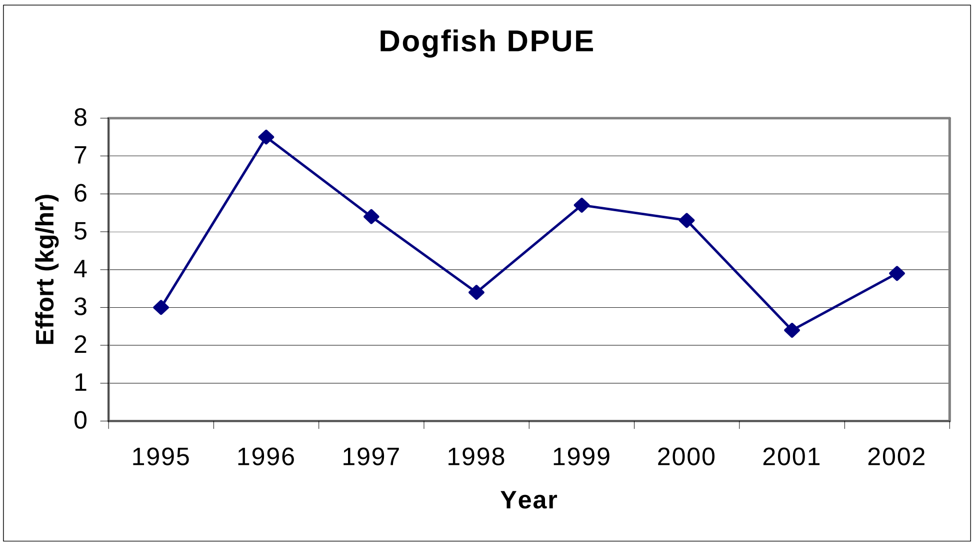


Figure 18.6c. Demersal elasmobranchs in the Celtic Seas. Dogfish Discard Per Unit Effort by the Irish trawl fishery. (Source: Irish Discard Observer Programme).

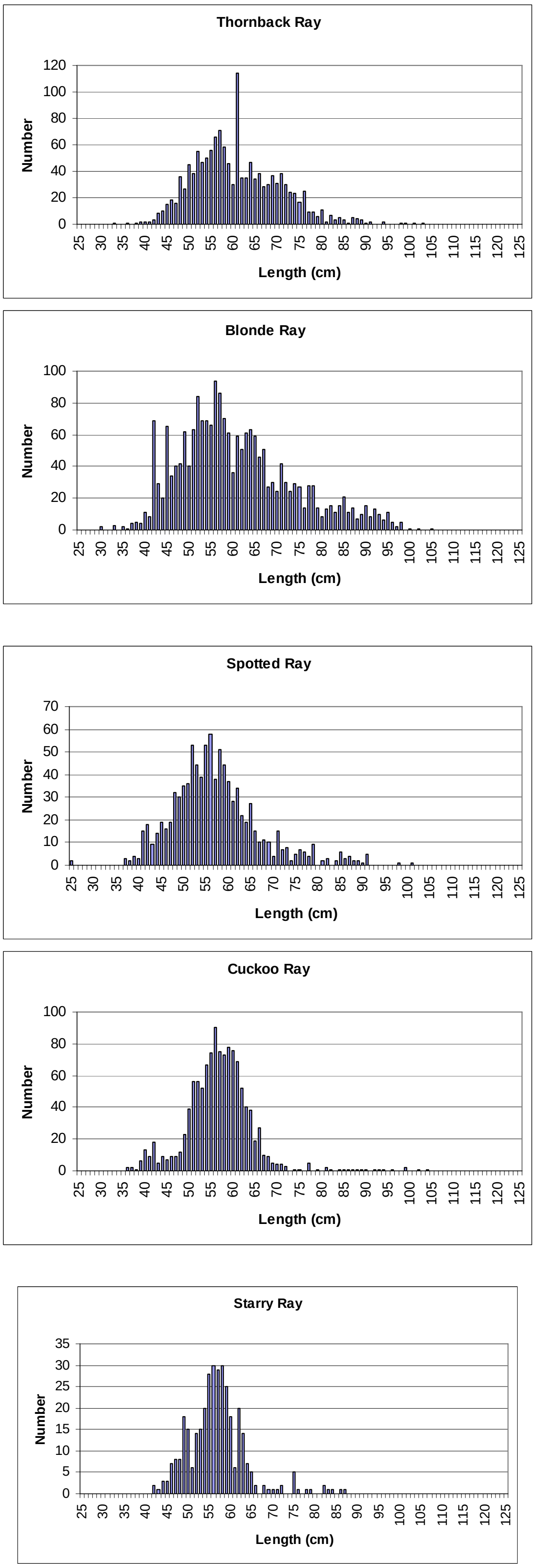


Figure 18.7 a-f. Demersal elasmobranchs in the Celtic Seas. Length frequencies of the five most common species sampled from the Irish Port Sampling programme, 2002–2007.

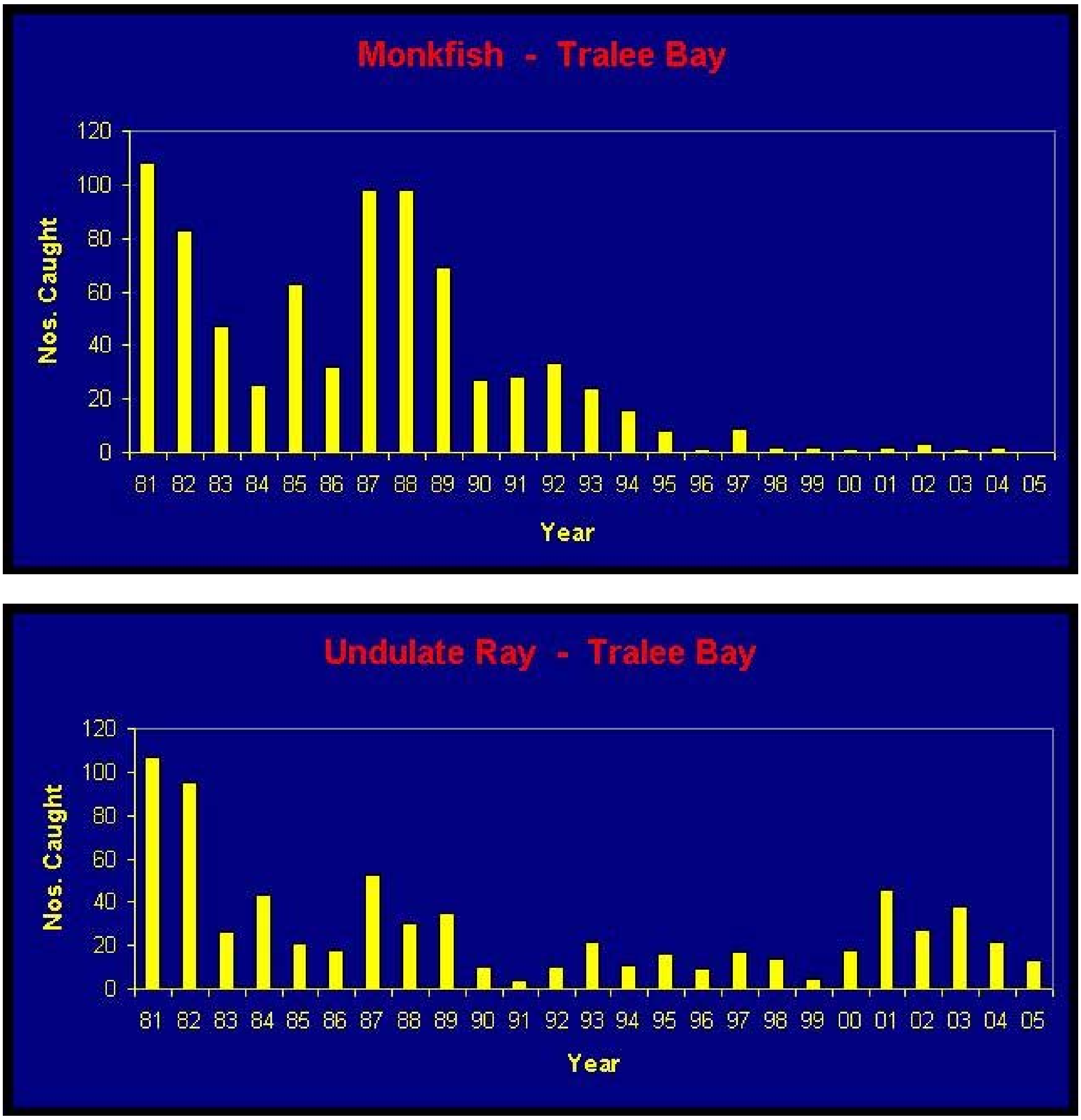


Figure 18.8. Demersal Elasmobranchs in the Celtic Seas. Angling effort of two charter boats in Tralee Bay 1981–2005 of monkfish (angel shark *Squatina squatina)* and undulate ray *R. undulata.* Source: Irish Central Fisheries Board.

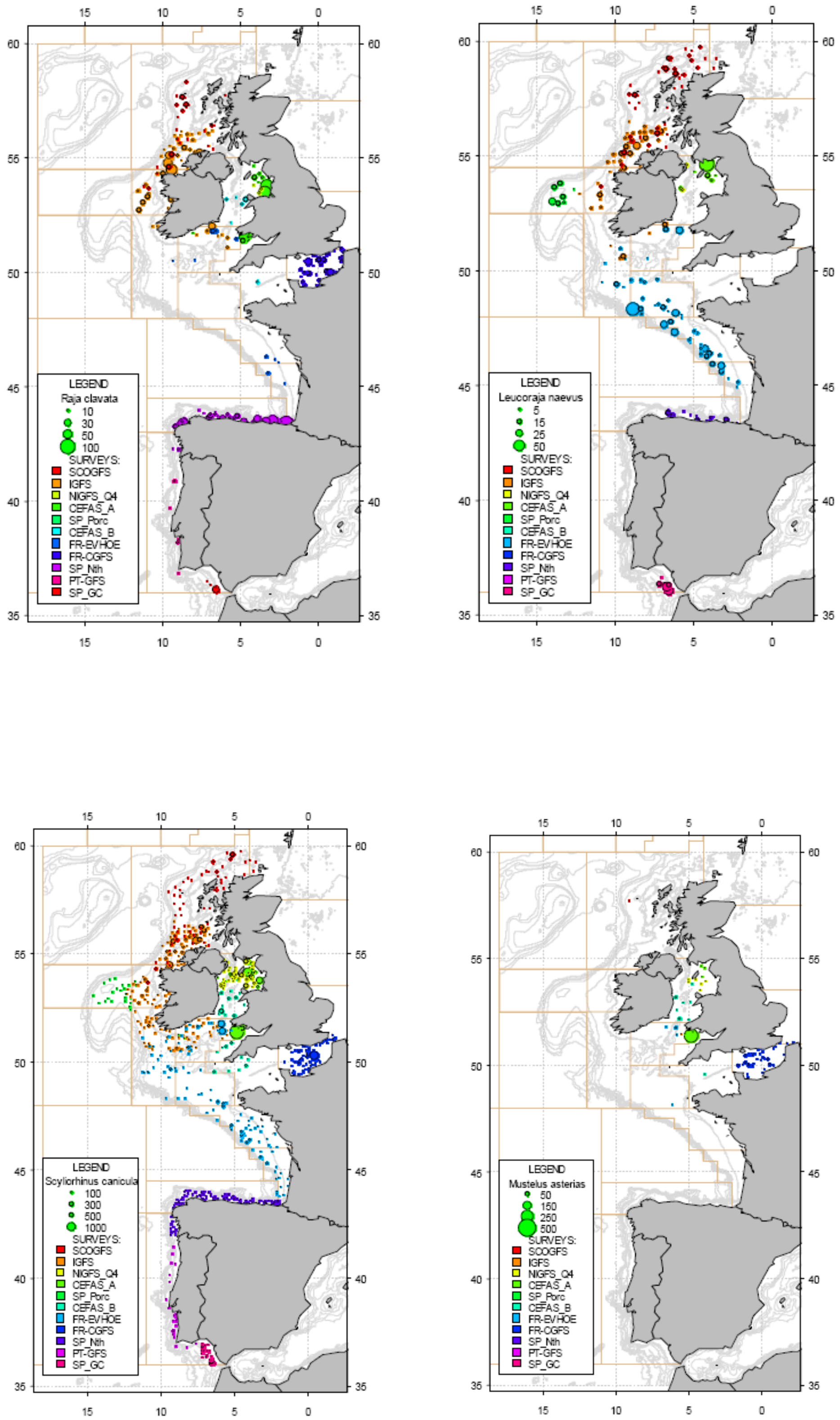


Figure 18.9. Demersal elasmobranchs in the Celtic Seas. Catches, in numbers per hour, of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, lesser-spotted dogfish *Scyliorhinus canicula* and starry smooth hound *Mustelus asterias* in Q4 IBTS surveys in the Western and Southern Areas in 2006. 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, 2007).

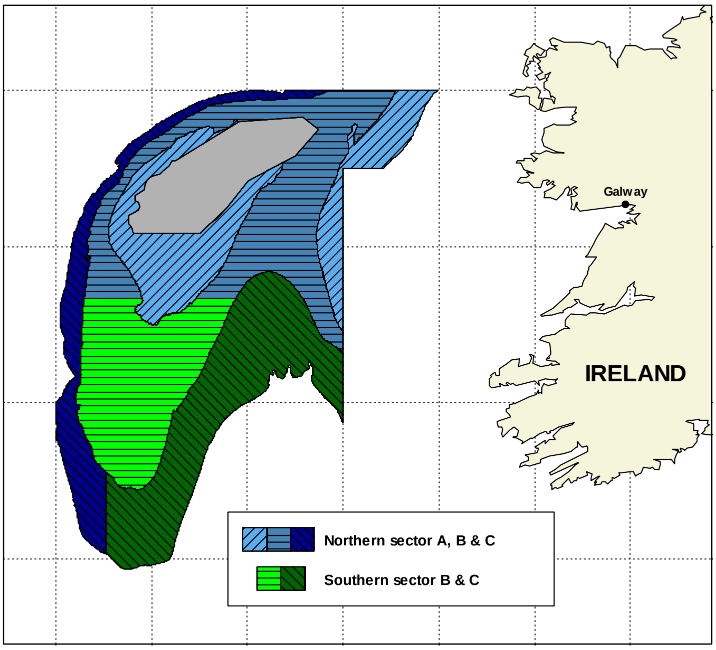


Figure18.10. Demersal Elasmobranchs in the Celtic Seas. Area covered and sampling design of Spanish Groundfish Survey in Porcupine bank. Depth strata are 190–300 m, 301–450 m and 450–800 m. The grey area in the middle of the bank corresponds to a non-trawlable rocky mound not sampled in the survey.

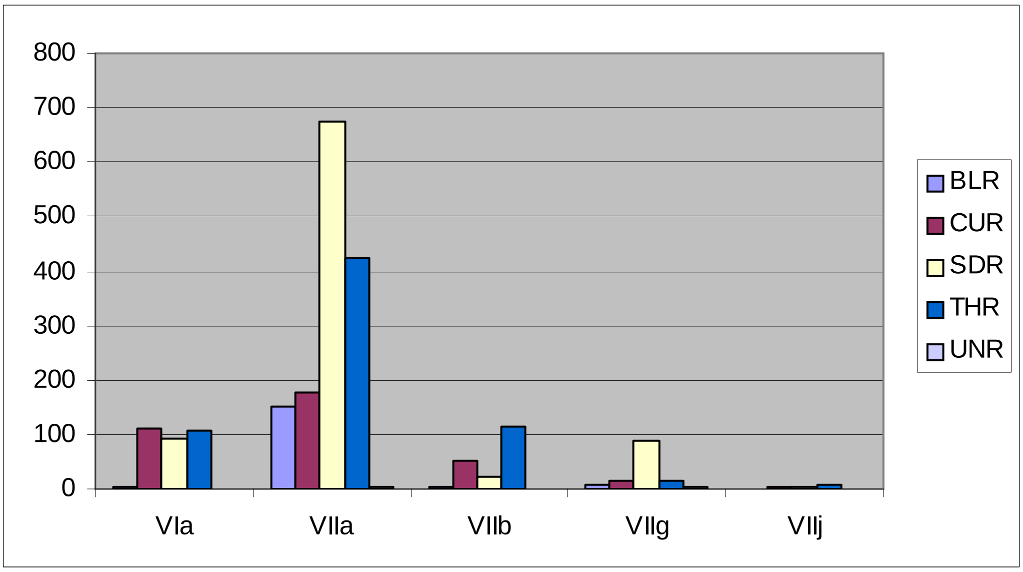


Figure 18.11. Demersal elasmobranchs in the Celtic Seas. Number of *Leucoraja naevus* (CUR), *Raja brachyura* (BLR), *R. clavata* (THR), *R. montagui* (SDR), and *Raja undulata* (UNR) in ICES divisions VIa and VIIa,b,g,j. Data from Irish Groundfish Survey, 1993–2004.

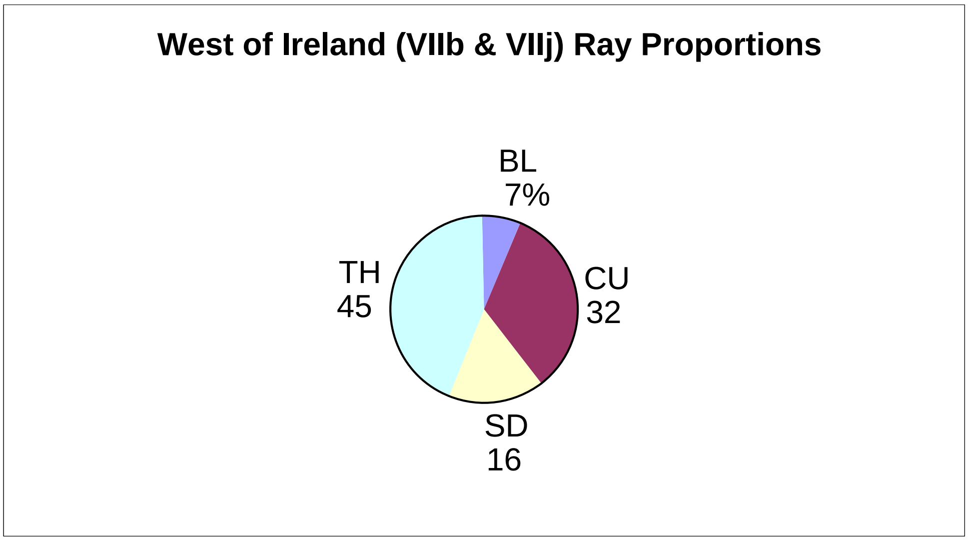


Figure 18.12. Demersal elasmobranchs in the Celtic Seas. Proportions of *Leucoraja naevus* (CUR), *Raja brachyura* (BLR), *R. clavata* (THR), and *R. montagui* (SDR) in ICES Divisions VIIb,j. Data from Irish Biological Survey 2005.

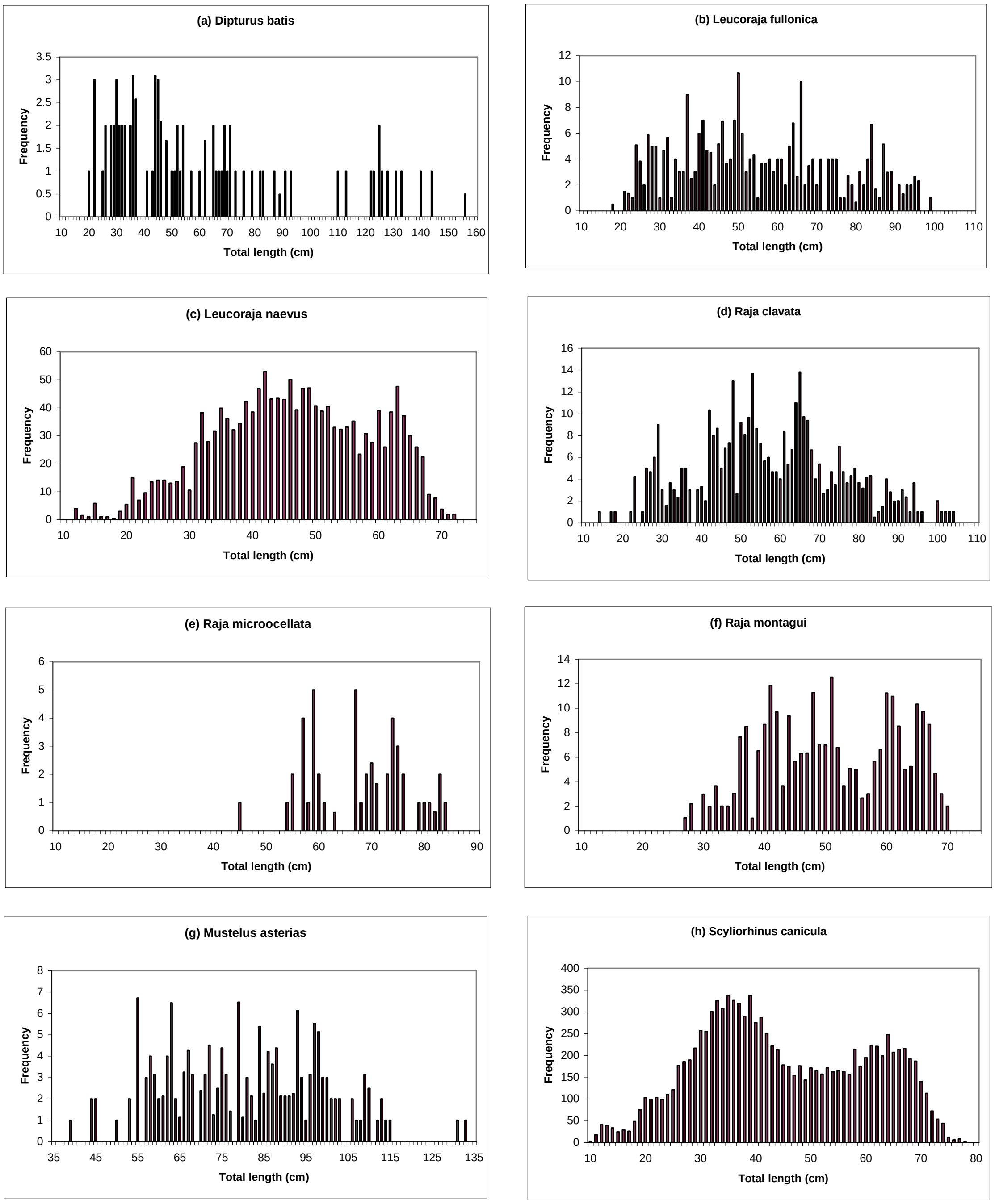


Figure 18.13. Demersal elasmobranchs in the Celtic Seas. Length distribution of (a) *Dipturus batis*, (b) *Leucoraja fullonica*, (c) *L. naevus*, (d) *Raja clavata*, (e) *R. microocellata*, (f) *R. montagui*, (g) *Mustelus asterias* and (h) *Scyliorhinus canicula* in the Celtic Sea (Cefas Celtic Sea survey, Q1, PHHT, 1982–2002, all stations in Subarea VII).

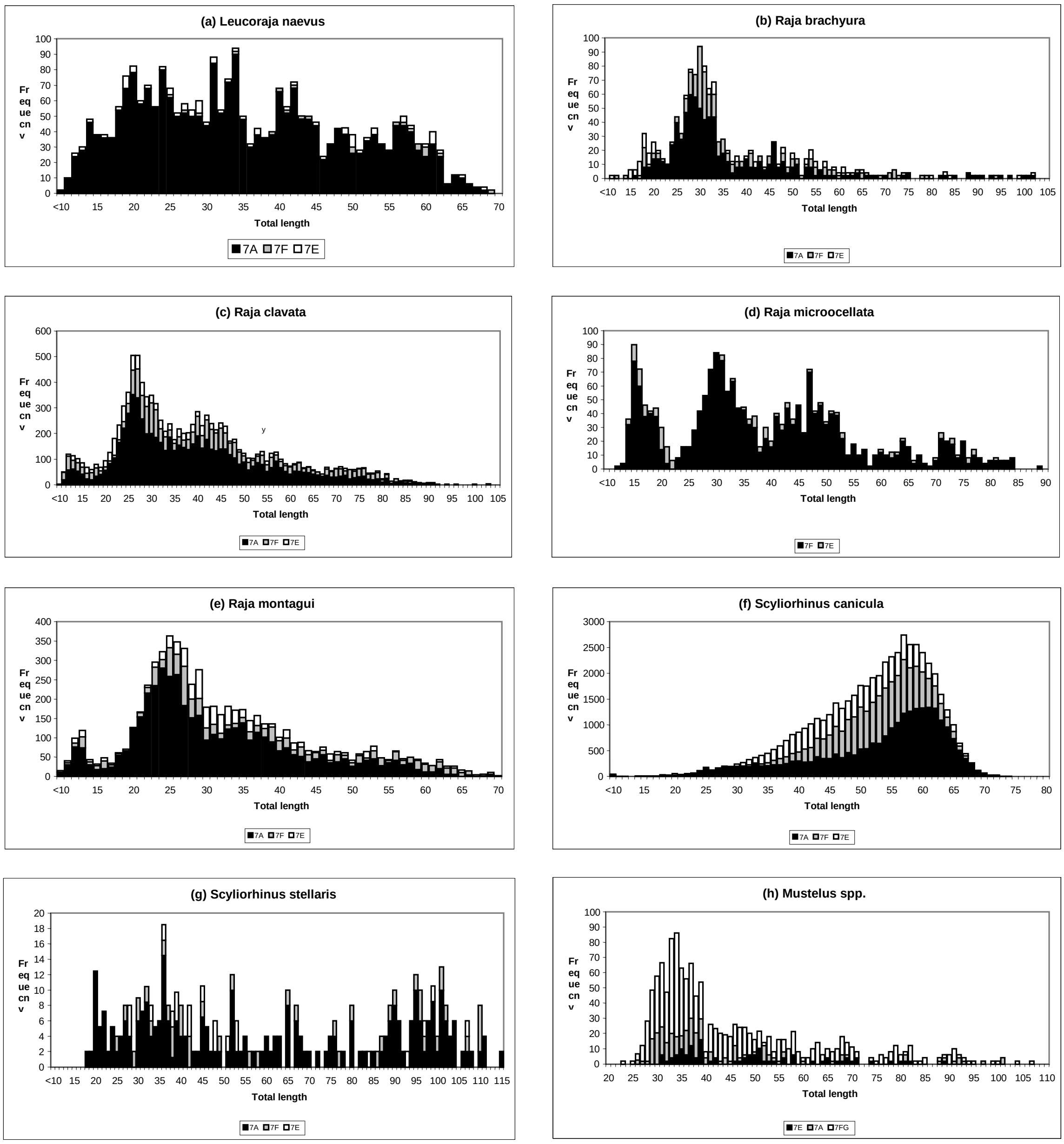


Figure 18.14. Demersal elasmobranchs in the Celtic Seas. Length distribution of (a) *Leucoraja naevus,* (b) *R. brachyura,* (c) *R. clavata,* (d) *R. microocellata,* (e) *R. montagui,* (f) *Scyliorhinus canicula,* (g) *S. stellaris* and (h) *Mustelus* spp. in the Irish Sea, Bristol Channel and western English Channel (Cefas 4m-beam trawl survey, Q3, 1988–2005, all stations in Divisions VIIa, e, f).

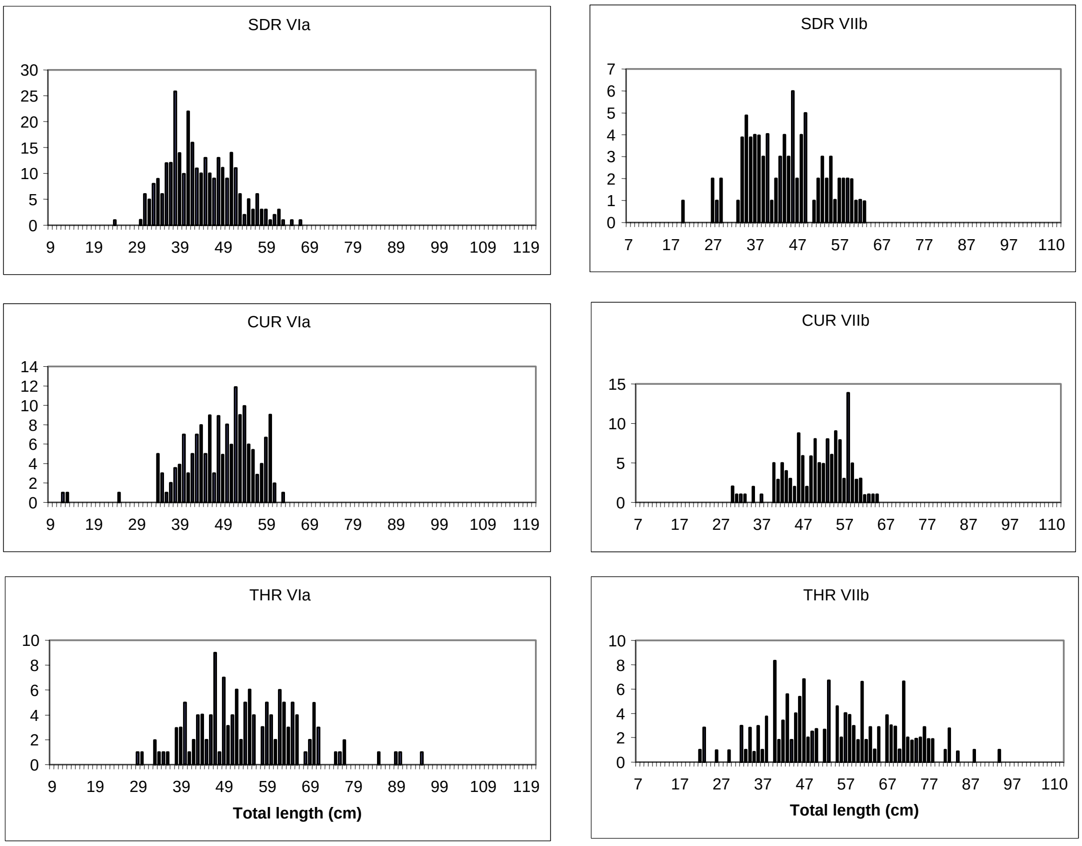


Figure 18.15. Demersal elasmobranchs in the Celtic Seas. Comparison of length distributions and frequencies of three ray species: spotted ray (SDR), cuckoo ray (CUR) and thornback ray (THR) from VIa and VIIb. Data taken from Irish Groundfish Survey, 1999–2005.

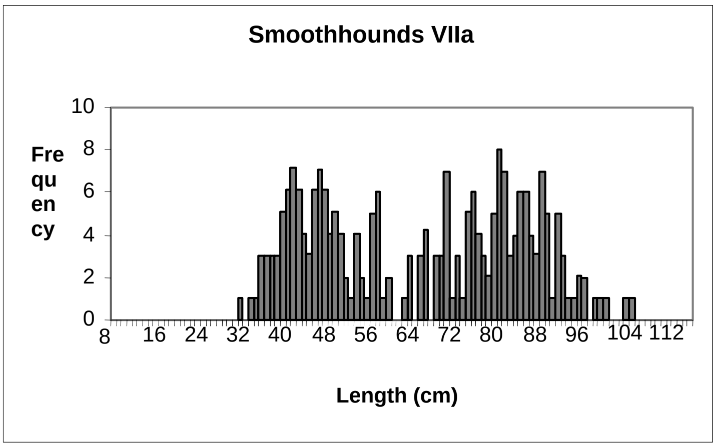


Figure 18.16. Demersal elasmobranchs in the Celtic Seas. Length frequency of smooth-hounds (*Mustelus* spp.) from area VIIa. Data from Irish Groundfish Survey, 1999–2005.

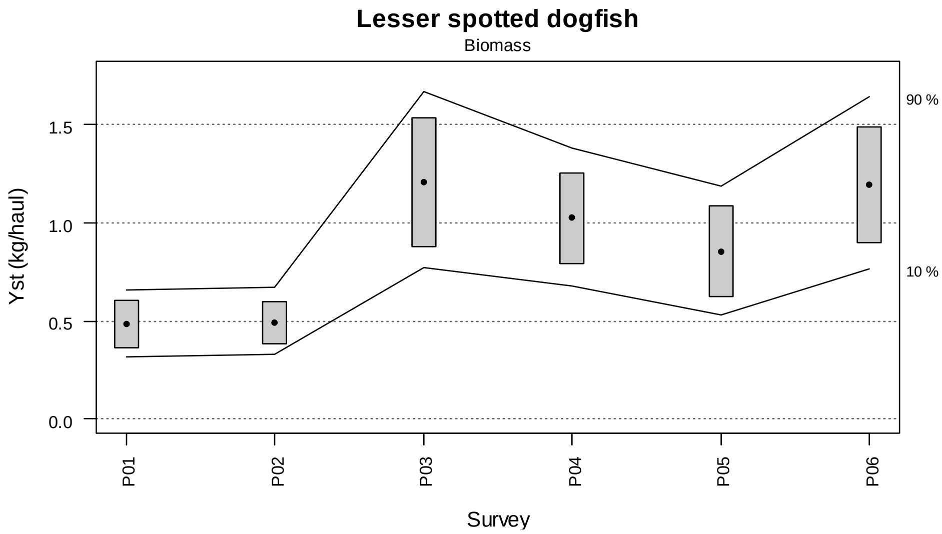


Figure 18.17a. Demersal Elasmobranchs in the Celtic Seas. Biomass abundance indices of lesser spotted dogfish from Spanish Groundfish Survey in Porcupine bank between 2001–2006 (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals).

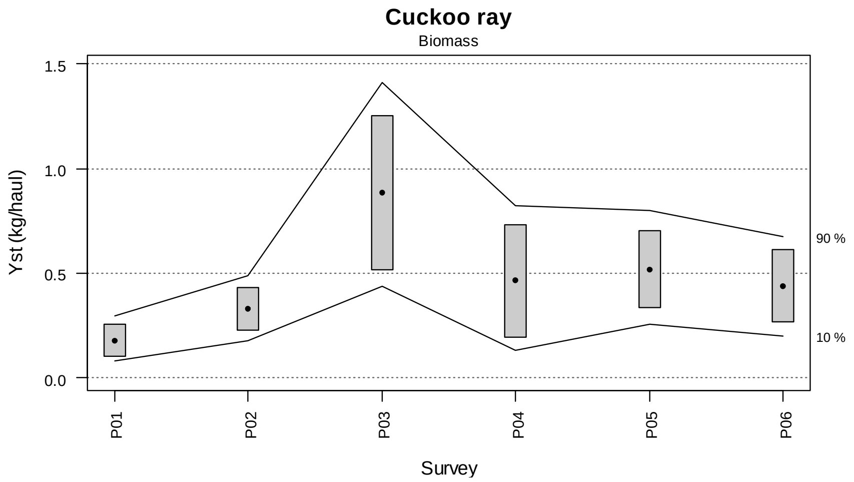


Figure 18.17b. Demersal elasmobranchs in the Celtic Seas. Biomass abundance indices (kg/30' haul) of cuckoo ray from Spanish Groundfish Survey in Porcupine bank between 2001–2006 (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals).

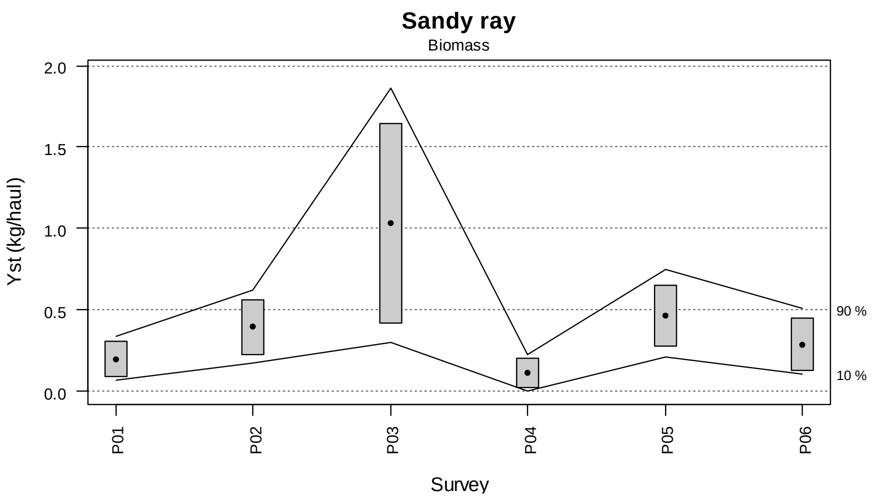


Figure 18.17c. Biomass abundance indices (kg/30' haul) of sandy ray from Spanish Groundfish Survey in Porcupine bank between 2001–2006 (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals).

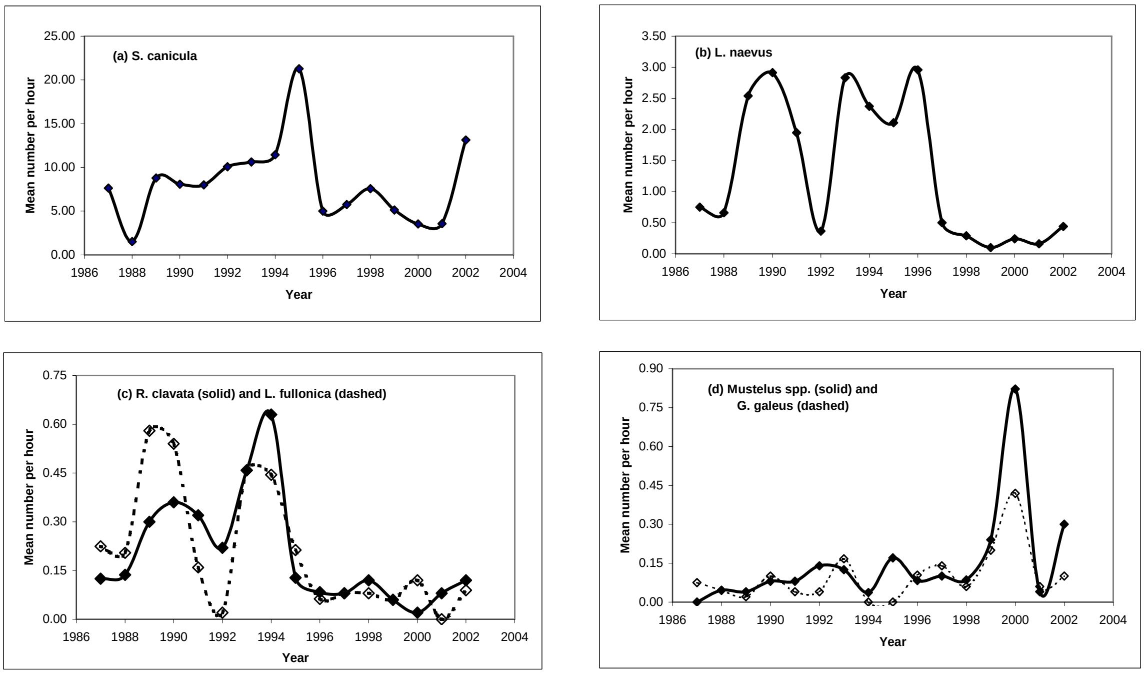


Figure 18.18. Demersal elasmobranchs in the Celtic Seas. Trends in relative abundance (no.h^{-1}) of (a) *Scyliorhinus canicula,* (b) *Leucoraja naevus,* (c) *Raja clavata* and *L. fullonica,* and (d) *Mustelus* spp. and *Galeorhinus galeus* in the Celtic Sea (Cefas Celtic Sea survey, Q1, PHHT, 1987–2002, data from 50 fixed stations that were fished most years).

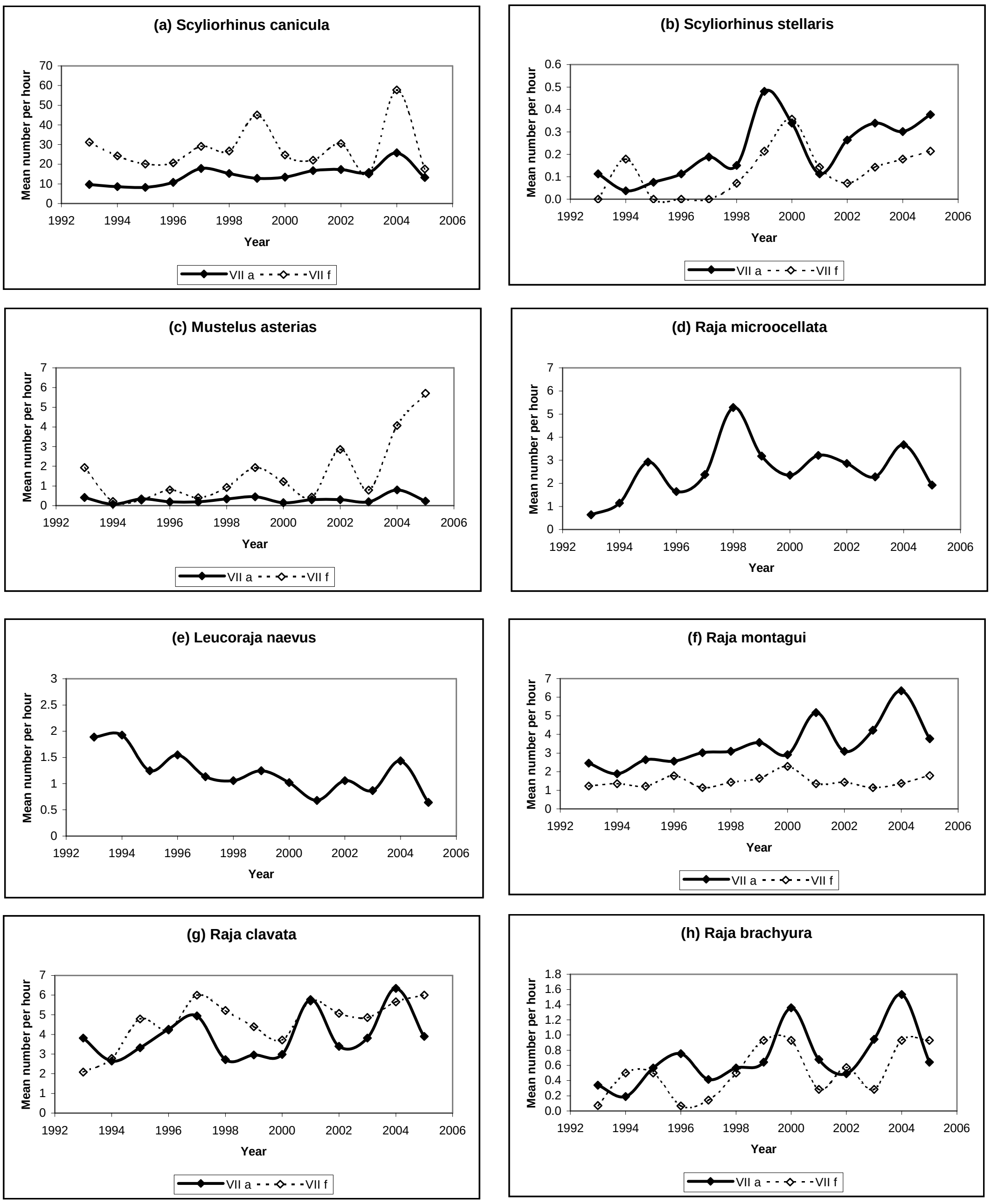


Figure 18.19. Demersal elasmobranchs in the Celtic Seas. Trends in relative abundance (no.h^{-1}) of (a) *Scyliorhinus canicula,* (b) *S. stellaris,* (c) *Mustelus asterias*, (d) *Raja microocellata,* (e) *Leucoraja naevus,* (f) *Raja montagui,*(g) *R. clavata* and (h) *R. brachyura* in the Irish Sea (VIIa) and Bristol Channel (VIIf). (Cefas 4m-beam trawl survey, Q3, 1993–2005, based on those fixed stations fished each year (28 stations in VIIf, 53 stations in VIIa).

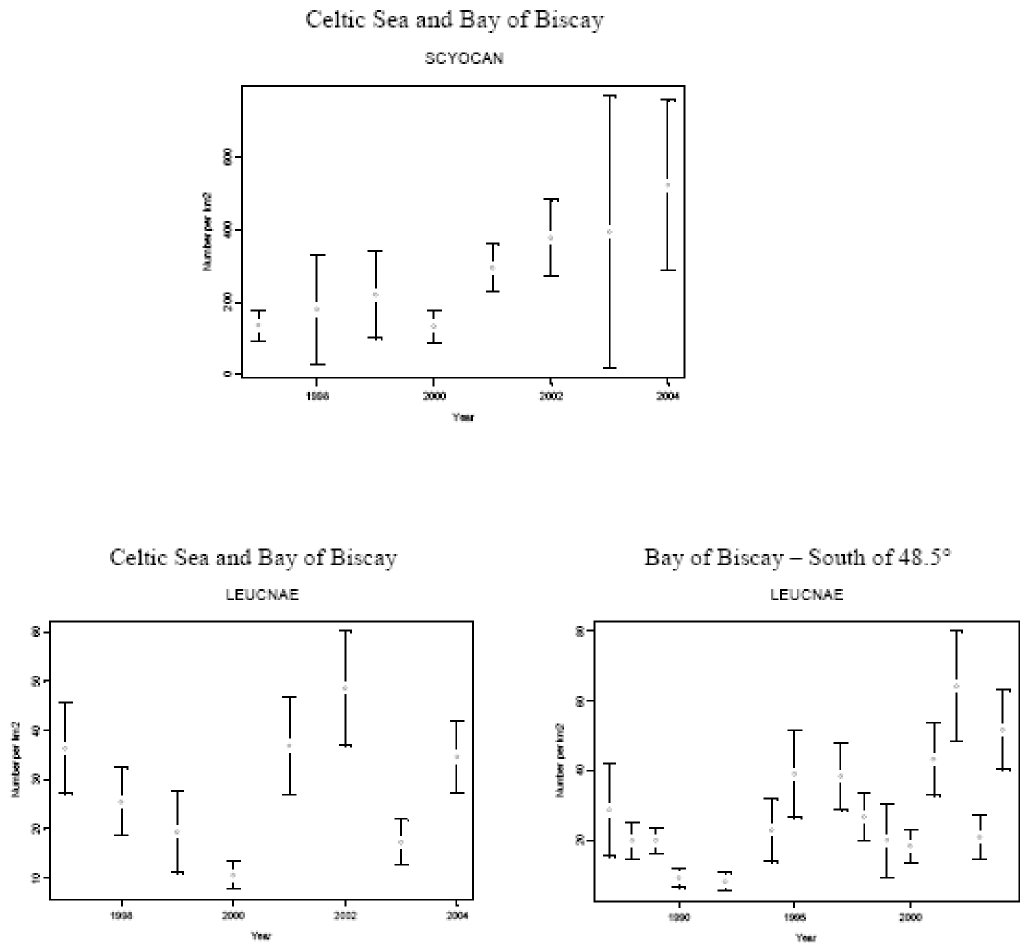


Figure 18.20. Demersal elasmobranchs in the Celtic Seas. Relative abundance of (top) lesser-spotted dogfish in the Celtic Seas and Bay of Biscay; and (bottom) *Leucoraja naevus* in the Celtic Seas and Bay of Biscay (Source: French EVHOE survey; from Mahé and Poulard, 2005).

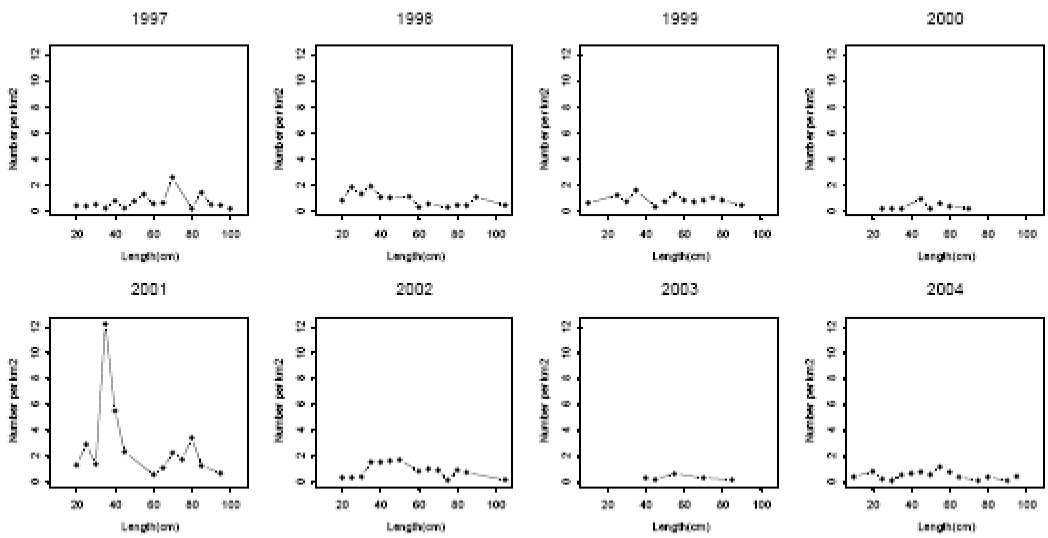


Figure 18.21a. Demersal elasmobranchs in the Celtic Seas. Length distribution of *R. clavata* in the Celtic Sea, 1997–2004. (Source: French EVHOE survey; from Mahé and Poulard, 2005).

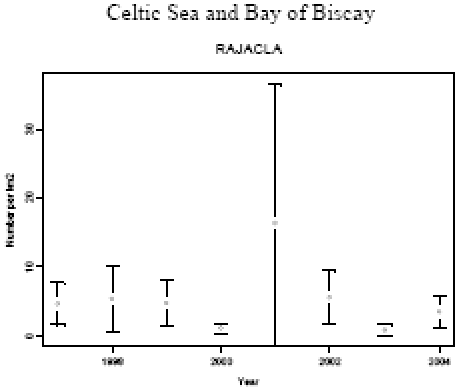


Figure 18.21b. Demersal elasmobranchs in the Celtic Seas. Relative abundance of *R. clavata* in the Celtic Sea, 1997–2004. (Source: French EVHOE survey; from Mahé and Poulard, 2005).

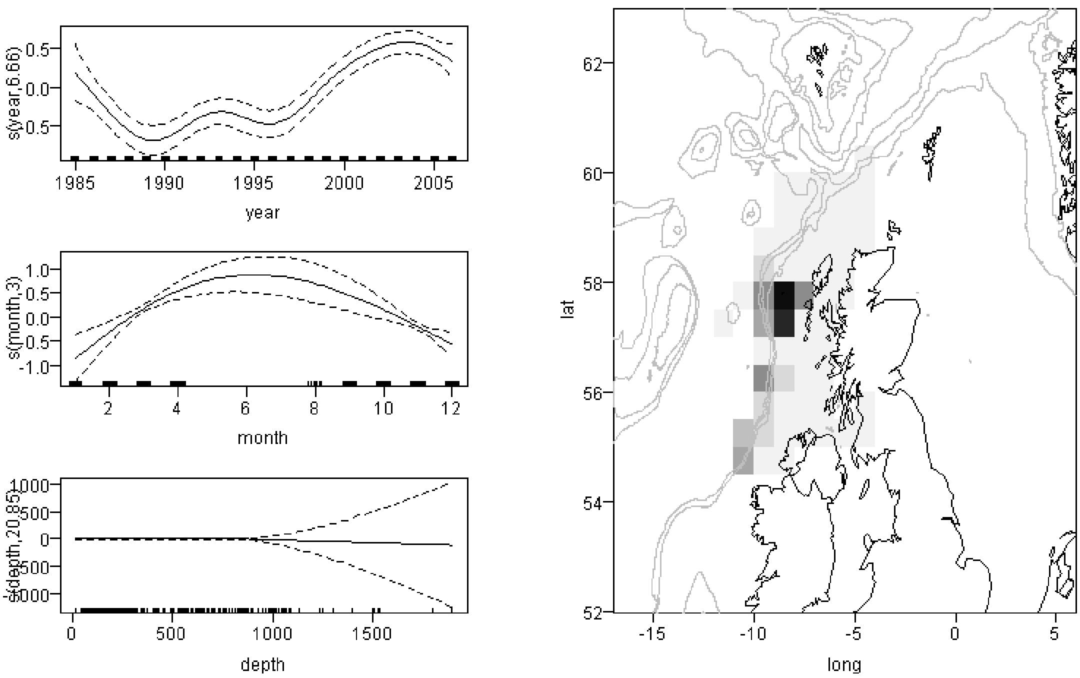


Figure 18.22a. Demersal Elasmobranchs in the Celtic Seas. Thornback ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey catch rate data (log scale). Models are for N/hr.

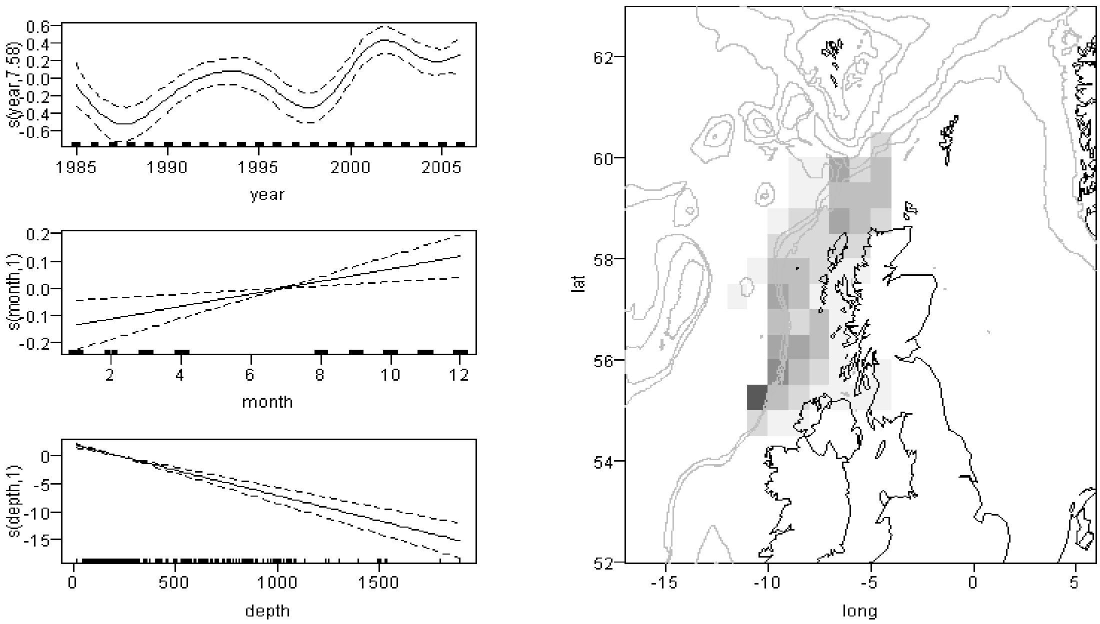


Figure 18.22b. Demersal Elasmobranchs in the Celtic Seas. Cuckoo ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data (log scale). Models are of N/hr.

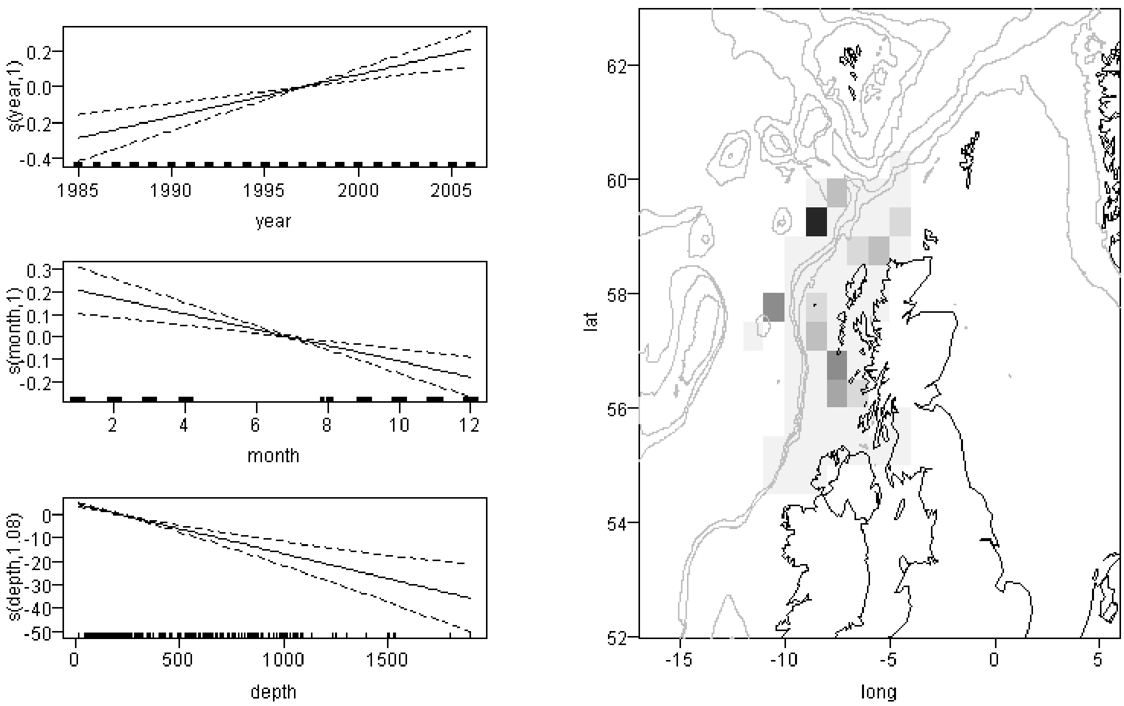


Figure 18.22c. Demersal Elasmobranchs in the Celtic Seas. Spotted ray in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data (log scale). Models are for N/hr.

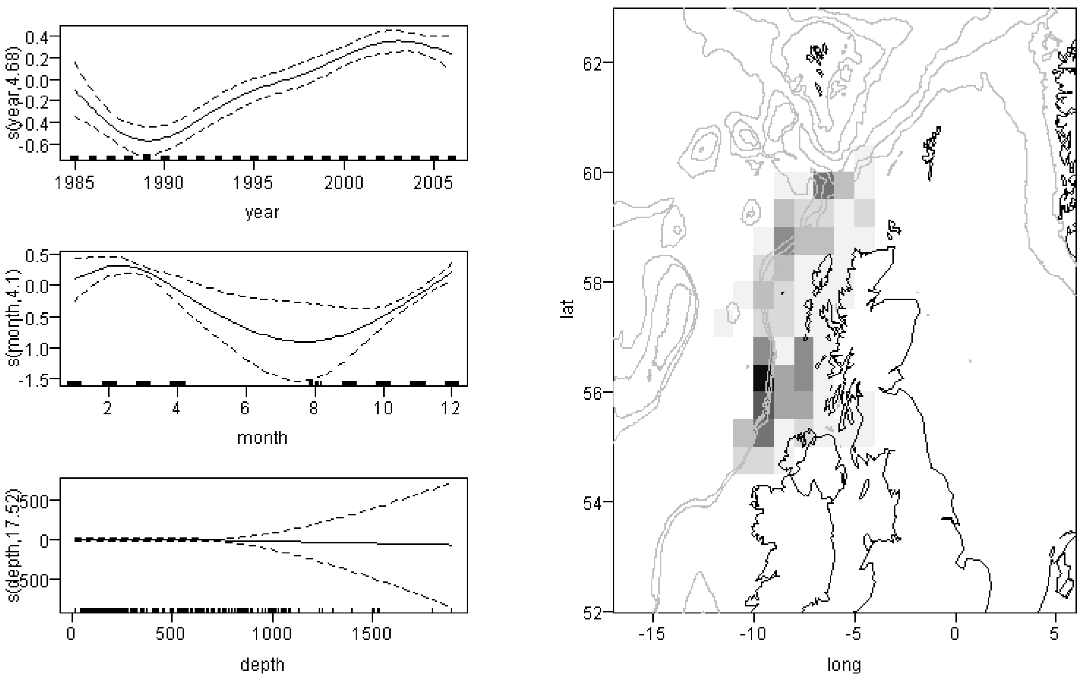


Figure 18.22d. Demersal Elasmobranchs in the Celtic Seas. Lesser spotted dogfish in Division VIa. Estimated effects (year, month, depth and statistical rectangle) from the GAM analysis of Scottish survey data. (N/hr)

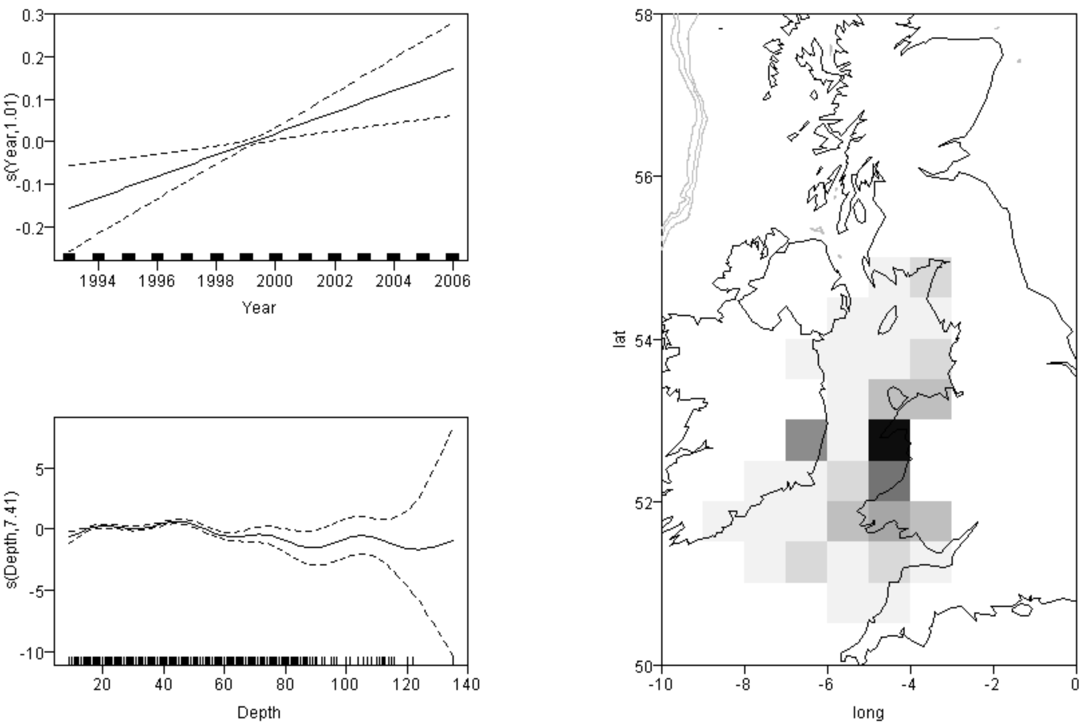


Figure 18.23a. Demersal Elasmobranchs in the Celtic Seas. Thornback ray in Divisions VIIa & VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.

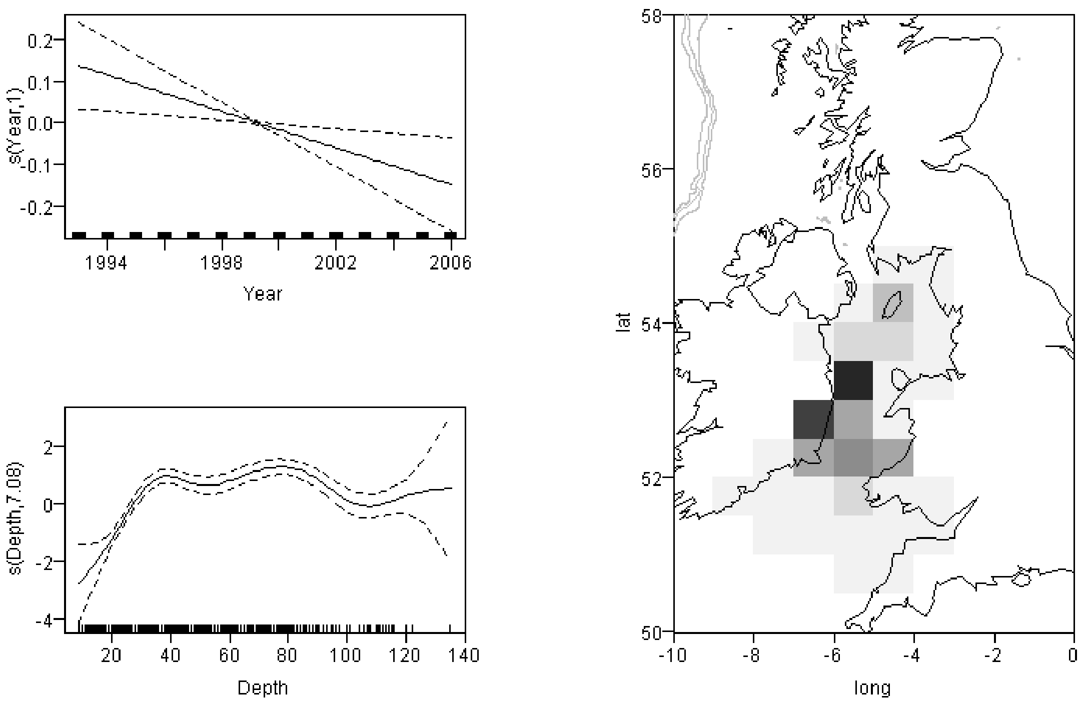


Figure 18.23b. Demersal Elasmobranchs in the Celtic Seas. Cuckoo ray in Division VIIa & VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.

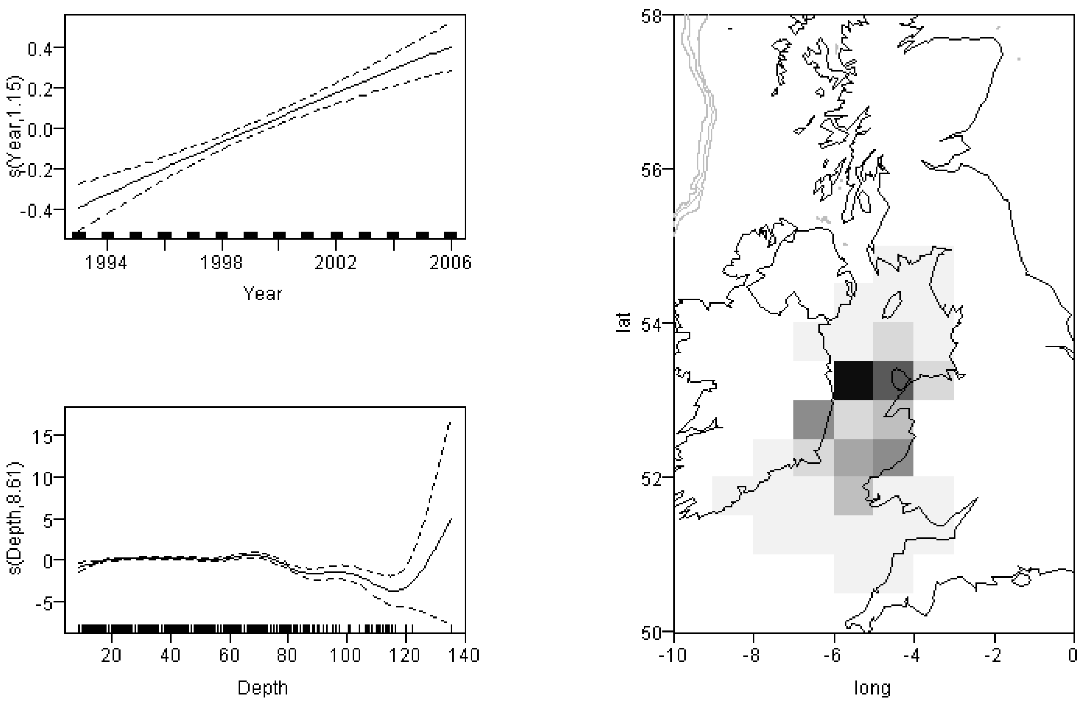


Figure 18.23c. Demersal Elasmobranchs in the Celtic Seas. Spotted ray in Division VIIa & VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.

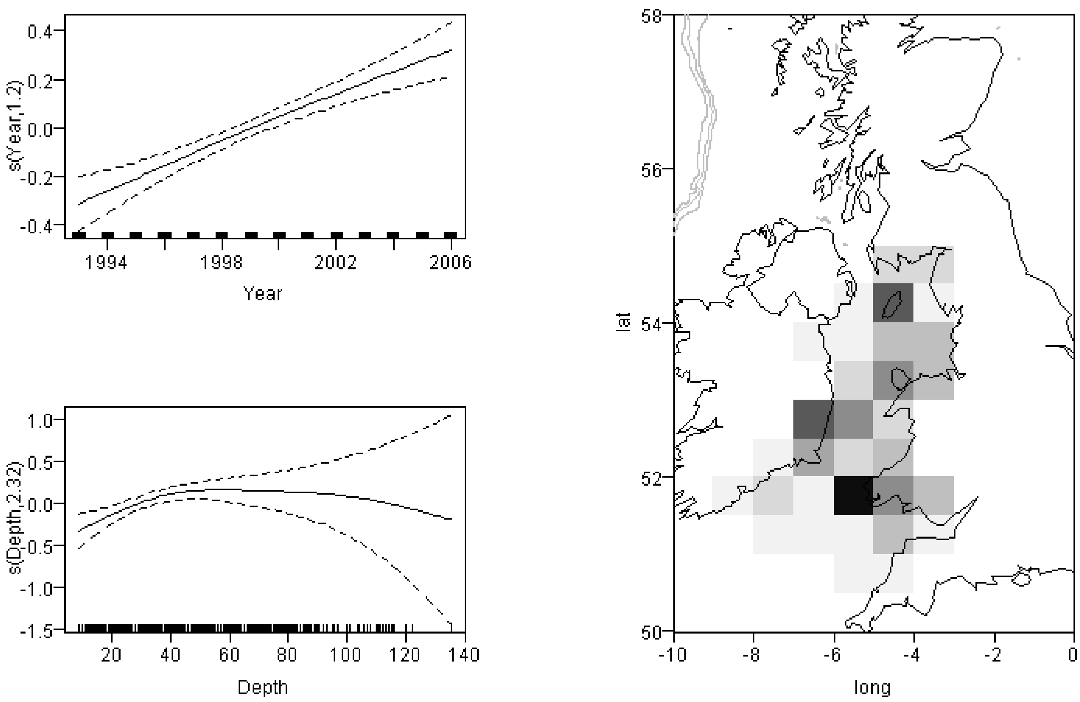


Figure 18.23d. Demersal Elasmobranchs in the Celtic Seas. Lesser spotted dogfish in Division VIIa & VIIf. Estimated effects (year, depth and statistical rectangle) from the GAM analysis of UK (E & W) beam trawl survey data (log scale). Model of N/hr.

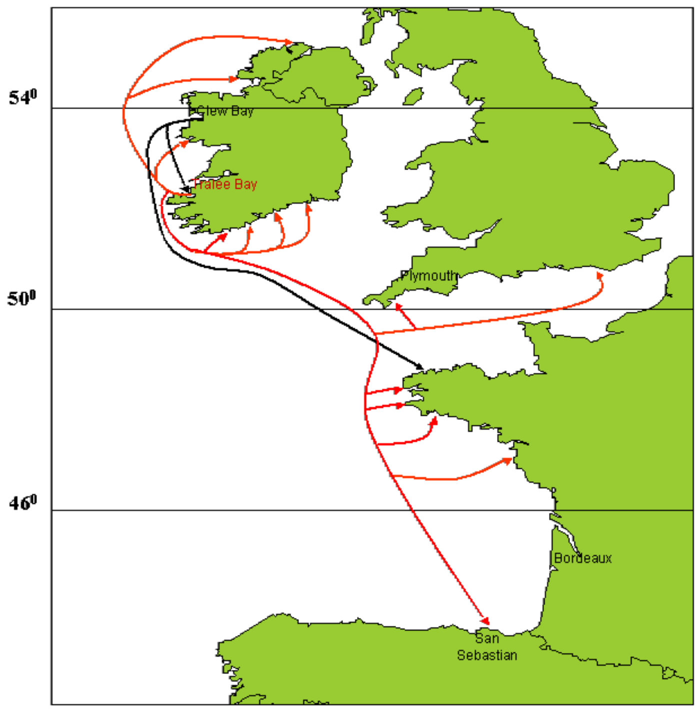


Figure 18.24. Demersal elasmobranchs in the Celtic Seas. *Squatina squatina* migration patterns, 1970–2006. n=190. Source Irish Central Fisheries Board.

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 teleost and crustaceans. Associated with these, several species of skate are also landed, mainly in the ports of Matosinhos, Peniche and Portimão.

Trying to describe the distribution of each species and to identify self-containing stocks the 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.

Three species are considered as the more valuable to be assessed:

Scyliorhinus canicula: Lesser-spotted dogfish populations would best be assessed as local populations, due to the availability of fisheries statistics and biological data, assessing this species within ICES Divisions mentioned.

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 in a preliminary assessment of this species.

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 a preliminary assessment of this species.

No management stocks are defined for any of the three main demersal species landed either at Bay of Biscay or at Iberian landing ports. The geographical distribution of these species is fairly well known, but their stock structure is still unknown.

Other species in the area include Raja brachyura, R. microocellata, R. miraletus, Raja montagui,R. undulata, L. fullonica, Dipturus batis, D. oxyrinchus, Rostroraja alba, Galeorhinus galeus (see Section 10), Galeus melastomus, Mustelus spp. and Squatina squatina, but the biology and stock structure 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 a 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 rays 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 (cuckoo ray *Leucoraja naevus* and thornback ray *Raja clavata*) and the small demersal shark *Scyliorhinus canicula*. 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.

The main gear in subarea VIIIc is the bottom trawl fleet that targets a mixture of gadoids and flatfish at depths of 100–300 m over the continental shelf and catches skates *(R. clavata, L. naevus, R. montagui, R. brachyura, R. undulata* and *R. microocellata*) and dogfish. In 1994, a total of 7089 t of elasmobranchs were caught by trawl fleet in the Cantabrian Sea, of which 87% were discarded (Perez *et al.,* 1996). *S. canicula* is usually discarded in the Spanish fishery in the Cantabrian Sea (VIIIc) and only 10–25% is actually landed (ICES, 2002a). In the case of skates, the highest landings are those from bottom trawls (75%) followed by longline (21%) and gillnet (3%). Occasionally there have been landings from purse seine or traps (Fernández *et al.,* 2002).

The main fishing gear taking demersal elasmobranchs in VIIIa,b,d is the Basque otter trawler fleet (using "baka"-type trawls) targeting hake, anglerfish and megrim. The most important elasmobranch species landed by this fleet is *Scyliorhinus canicula,* reaching on average 299 t/year since 1996. The most abundant skates are *L. naevus* and *R. clavata,* which accounted for 77% and 17% respectively of the skate catch composition in the period 2000–2006. In these subdivisions small quantities of other skates (including *L. fullonica, R. montagui, D. batis,* and *D. oxyrinchuis*) are also landed.

Mainland Portugal

Off mainland Portugal (IXa), lesser-spotted dogfish *Scyliorhinus canicula* 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 uses primarily trammel nets. The artisanal fleet also use different types of fishing gear, such as longline and gillnet, and account for the highest landing records (75% of the annual skate and ray landings). The mixed nature of the fisheries catching skates and rays pose serious problems on the estimation of important fishery parameters.

Since 2003, the minimum sampling programme was implemented (according to the EU council regulation 1543/2000) in the three main landing ports: Matosinhos (north off Portugal), Peniche (center off Portugal) and at Portimão (south coast of Portugal). This programme allowed the estimation of the species composition, the number of individuals by length class and sex, and individual total weight in the landings. Under this programme the eight skate species most common identified were: *Rostroraja alba*, *Raja brachyura*, *Raja microocellata*, *Raja clavata*, *Raja miraletus*, *Raja montagui*, *Raja undulata* and *Leucoraja naevus*. *R. miraletus* was the least frequently observed species in the sampling.

In official statistics, and excluding *Leucoraja naev*us (usually correctly identified), there are still some problems on species discrimination. In the last years other species have begun to appear in the official statistics (*Raja brachyura*, *R. clavata* and *R. montagui*). The precision of *L. naevus* discrimination at Portuguese landings might be related to the small size and soft consistency of the flesh of the species that determines a reduction of its commercial value. Landings of *L. naevus* have represented 1–8% of the total annual catch since 2003. Between 1996 and 2002 landings of this species have oscillated around 20 t/year. Since 2002 landings have tended to increase. However this increase seems only to reflect the effort made at the landing ports to discriminate this species (Pereira *et al*., 2006, WD).

France

No information on the description of French fisheries was available for the WGEF 2007.

19.2.2 The fishery in 2006

No new information.

19.2.3 ICES advice applicable

ACFM has never provided advice for elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa).

19.2.4 Management applicable

No new information.

19.3 Catch data

19.3.1 Landings

Skate landings for the period 1996–2006 are given in Table 19.1a-d. Historically the main countries reporting international landings since 1973 in Subarea VIII are France, Spain and Portugal. Table 19.1e summarises the combined skate landings for both areas, and an average of 4 311 t/year have been landed in Biscay and Iberian waters since 1996, with a maximum of 5 172 t registered in 1997. French and Spanish (Basque Country) skate landings come mainly from Divisions VIIIa,b while Spanish landings are more important in Division VIIIc. The annual landings of skates and rays of Portugal in Subarea IXa in recent years have been stable, around 1 500 t between 1996 and 2006. Some other countries such as Belgium, Netherlands and UK, have minor skate landings in these areas.

Landings of skates since 1973 show 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 coincides with a misreporting period of Spanish landings, but since 1996 the landings seem to have stabilized between 4000 and 5000 t/year (Figure 19.1).

The lesser-spotted dogfish landings by Division reported to the WG are shown in Table 19.2. As in the case of skates, French and Spanish (Basque Country) landings of lesser-spotted dogfish landings come mainly from Divisions VIIIa,b, while Spanish landings come from Division VIIIc. Until 2004, all the Portuguese landings of this species (around 600–700 t/year) were from Division IXa, but an important reduction of this country’s landings can be observed since 2005. The total historical landings of lesser-spotted dogfish in Biscay and Iberian waters have been quite stable since 1996, with no less 1500 t/year and a peak between 1997 and 1999 (Table 19.2; Figure 19.2).

The information about the historical landing series of other elasmobranch species such as smoothhounds (*Mustelus mustelus* and *Mustelus asterias*) and angel shark (*Squatina squatina*) are poor. Of these species, only smooth hounds are landed in significant quantities in subarea VIII, mainly by the French and Spanish fleets from 2000–2006 (on average 371 t per year for both countries combined). 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, c).

Angel shark landings in Subarea VIII have always been very low and only 11 t were recorded in 2005 and 2006 by France (Table 19.4). In subarea IX, 66 t of this species were reported in 2002 by the Spanish fleet and no onwards data are available.

Species-specific landings for Subarea VIII and Division IXa have been provided by some countries. According with this table the most important species landed in last years in decreasing order are *L. naevus, R. clavata, R. brachyura, R. montagui, R. undulata,* and *L. circularis* (Table 19.5).

19.3.2 Discards

No new information about discards is available for the WGEF 2007.

19.3.3 Quality of the catch data

Landings were collated from data provided by working group members. Landings estimates for 2006 in this area were provided by Belgium, France, Portugal, Spain (Basque Country), Spain and UK. Commercial landings of skates are not reported on a species-specific basis (although there is market sampling to collect species composition data).

Misreporting data is not considered a problem in any Division.

19.4 Commercial catch compositions

19.4.1 Species and size composition

No new information was presented on species or length composition.

19.4.2 Quality of the catch data

Despite last years advances in the quality of the samplings, there is difficulty on getting reliable information about species composition of skate landings in Divisions IXa and VIII in recent years. To solve this problem the estimates of specific composition of landings rays of some countries (Portugal and Spain (Basque Country)) are based in the proportions of each species obtained by means of specific samplings carried out in previous years (see foot note in Table 19.5).

19.5 Commercial catch-effort data

An update of lpue data (Diez *et al.,* 2006) of the Basque Country's trawler fleet (Baka otter trawlers fishing in VIIIabd and VIIIc areas) has been presented this year.

The lpue data are referred to the main elasmobranch species landed by the fleets: lesser-spotted dogfish, Rajidae (mainly *Leucoraja naevus* and *Raja clavata*) and spurdog.

Effort for each fleet was obtained from the information provided yearly by the log books filled out by the skippers of most of the ships landing in Ondarroa (ON) port. Effective fishing effort for each fleet was calculated using the following formula:

Effort = fishing days = trips * (mean days/trip)

The higher lpue of *S. canicula* in the two areas is recorded from a vessel using "baka" trawler gear-ON operating in Division VIIIc. The highest effort and lpue was recorded in 2003 (114 days) and 2006 (664 kg/day) respectively (Table 19.6b).

Historically the most important landings of this species come from "baka" trawler fleet-ON operating in Division VIIIa,b,d (Table 19.6a). On average since 1994 this fleet lands 249 t/year, and the highest lpue (157 kg/day) was recorded in 2002. Lpue trend of Baka Trawler of VIIIa,b,d of the three species is shown in Figure 19.9.

The highest lpue values for Rajidae come from "baka" trawler-ON in Division VIIIa,b,d. A peak of 199 kg/day was reached in 1998, but since this year a continuous decrease has been observed (Table 19.7a). Although the effort of "baka" trawler-ON in 2006 in VIIIc is similar to the one in 2005, the landings reported in this year were twice higher (Table 19.7b).

By far, the highest spurdog lpue of all fleets were reached in 2002 and 2003 by the Baka trawler-ON in VIIIc, but has been decreasing since then and, in 2005, no spurdog landings were reported by this vessel (Table 19.8b and Figure 19.10). "Baka" Trawler lpues in the rest of areas are much lower than in VIIIc (Table 19.8a).

In 2006 a study program was initiated at Peniche landing port aiming to identify and describe the fishing segments that compose the mixed-fishery fleet, with positive landings of skates and rays. The second aim of this study is to estimate the nominal fishing effort on skates and rays by species, using as effort unit the number of fishing hours per trip, length of nets and number of hooks per fishing operation. Continuing collection of this data will allow having some reliable effort information in the future.

19.6 Fishery-independent surveys

Several IBTS surveys operate in this and the Celtic Seas eco-regions (see Figure 18.2)

19.6.1 Surveys of the Cantabrian Sea

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 for the main commercial species (including lesser-spotted dogfish, *L. naevus* and *R. clavata*); number, weight and length distribution of non commercial fish species captured were also collected. Survey design (Figure 19.3) 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 elasmobranch species more common in the catches are lesser-spotted dogfish and *R. clavata*, both of them more abundant in ICES division VIIIc than in IXa, and *L. naevus* that only is not found in IXa North ICES division area (Figures 19.4–6). Black-mouth dogfish is also abundant in the catches, although the largest abundances are found in grounds deeper than those covered in this survey. Other elasmobranch species caught in the survey (in decreasing frequency of appearance) are: *R. montagui*, *Etmopterus spinax*, *Scyliorhinus stellaris*, *Deania calcea*, *Hexanchus griseus*, *Scymnodon ringens*, *Leucoraja circularis*, *Raja undulata, Dalatias licha*, *Squalus acanthias*, *Raja brachyura*, *Raja microocellata*, *Galeorhinus galeus*, *Dipturus oxyrinchus*, *D. nidarosiensis* and *Mustelus mustelus*.

Lesser-spotted dogfish abundance levels in Division VIIIc remained stable in the time series (Figure 19.4). *R. clavata* in Division VIIIc shows an increasing trend since 1995, with peaks in 2000, 2001 and 2006 (Figure 19.5). *L. naevus* also shows an increasing trend from 1997 to 2001, and since then its abundance has been variable within the previous range (Figure 19.6).

19.6.2 Portuguese groundfish survey

The Portuguese groundfish surveys have been conducted since 1979 twice a year (in Summer and Autumn), covering Division IXa in Portuguese waters and aiming to characterise the demersal fauna from the continental shelf to the fringe of the slope (Cardador *et al.*, 1997). The area surveyed extends from latitude 41°20' N to 36°30' N, and from 20–750 m depth. A fixed sampling scheme has been recently adopted in these surveys. A total of 97 fixed stations are planned, spread over 12 sectors. Each sector is subdivided into 4 depth ranges: 20–100 m, 101–200 m, 201–500 m and 501–750 m, with a total of 48 strata. The positions of the 97 fixed stations were selected based on common stations made during 1981–1989 surveys and taking into account that at least two stations by stratum should be performed. A maximum of 30 supplementary stations are planned, fixed in each season, to be carried out if ship time is available or to replace positions that due to various reasons are not possible to accomplish. The fishing gear used is a Norwegian Campelen Trawl 1800/96 NCT with a 20 mm codend mesh size. The main characteristic of this gear is the groundrope with bobbins. The mean vertical opening is 4.6 m and the mean horizontal opening between wings and doors is 15.1 m and 45.7 m, respectively. The polyvalent trawl doors used are rectangular (2.7 m x 1.58 m) with an area of 3.75 m^2 and weighing 650 Kg.

Although not specially designed for estimating demersal elasmobranch abundance indices Portuguese groundfish surveys have produced data on skate and ray species. A spatial method to estimate thornback abundance was developed. This method uses a regular grid with size dependent on fishing hauls geographic distance and yield (number/hour) value based on the relative importance of hauls coverage area within individual grid cells. The procedure used is detailed by Bordalo-Machado and Figueiredo (2007 WD). The visual analysis of the maps (Figures 19.7 and 19.8), produced by using this methodology, revealed a large number of fishing hauls by survey with no catches of thornback ray. Moreover, the catches on the species also varied considerably in space. These characteristics were more frequently found in the north of the Portuguese coast, where no fishing hauls were carried out in some of the surveys held. Another aspect that can be seen in the maps was the numerous changes on fishing hauls between surveys. This situation was not considered adequate for temporal analyses of species abundance at more local scales. Thornback ray estimated yields for the Portuguese continental coast ranged from <1 to 76 no./h in the period 1997–2005 (Bordalo-Machado and Figueiredo, 2007 WD).

19.7 Life-history information

No new information is available for the WGEF 2007.

The tagging program carried out since 1993 by the IEO in the Cantabrian Sea is still active, but there is not new information about the recapture rates since 2006.

19.8 Exploratory assessment models

19.8.1 Previous assessments

Two previous assessments for *L. naevus* in subareas VII and VIII and for *S. canicula* in VIIIc were attempted in the DELASS project (Heessen, 2003) and in the meeting of SGEF 2002 (ICES, 2002a) respectively. In the case of *S. canicula* tagging data, landings and effort for the period 1996–2001, CPUE series since 1991, length distributions and trawl survey abundance indices were available for the analysis. Dynamic surplus production, Separable VPA and Survey-only models were chosen for this assessment. A summary of data available for the assessments is shown in Table 19.9.

Although these models were considered as useful tools for the assessment, neither of the results obtained by the models was considered satisfactory for these species due to the shortage of biological information and difficulty in collating a long time-series of landings and effort. More detailed information is provided in ICES (2002a).

19.8.2 Exploratory analyses

No new assessments were conducted during this WG, although preliminary analyses of survey data (see above) and catch rates were undertaken.

Updated information of trawler fleet confirmed that the lpues for *S. canicula* in Divisions VIIIa,b,d have been increasing since 1994 and has shown high values in VIIIc for the last 5 years. This information suggests that in last years the population of *S. canicula* in subarea VIII may be increasing, or at least is in a stable condition, as also indicated by bottom trawl survey indices. On the other hand, data from subarea IX indicate a slight decrease of landings since 1998, although this reduction is more noticeable since 2004. Although in this area *S. canicula* is essentially a bycatch from other fisheries, so the decrease on landings registered during the last two years could be related to changes in the effort distribution targeting different species, and to better discrimination of the species at Portuguese landing ports.

The analysis of trawler fleet lpue since 1996 indicates that there has been a decrease in skate abundance (mainly cuckoo ray and thornback ray) in Division VIIIa,b,d since the maximum reached in 1998. Landings also show a continuous decrease from 1996 to 2004, but a recovery is observed since 2005.

In VIIIc, although landings reported do not show clear trends, results obtained from surveys carried out in this area indicate an increase of thornback ray biomass since 1996. Less clear is the situation of cuckoo ray, showing continuous peaks in the biomass index since 1988, although an overall view of historical series of biomass index seems to indicate a continuous, but slight, increase of abundance.

Data on skates and rays from surveys in Subarea IX were available, but they proved to be inadequate for abundance estimation. According to the landings series the situation of skate stocks in the area seems to be stable, ranging between 1300–2000 t in since 1996, with an average of 1666 t/year.

The state of other elasmobranchs stocks (smooth hounds and angel shark) is less clear due to the relative low amount of landings reported, the short length and the gaps in the historical series, and the difficulties in the identification of smooth hounds species. Taking all these aspects into consideration, the available landing data of smooth hounds (*Mustelus* spp.) showed that landings of in subarea VIII have been increased strongly since 1996 from 151 t to 499 t. In Subarea IX *Mustelus* spp landings have been stable since the maximum recorded in 1999.

However, in order to clarify these considerations, better information on species composition of landings (especially for skates and rays) in Subarea VIII is necessary.

19.9 Quality of assessments

No stock assessments were conducted. More information on the stock identity is required. The absence of species-specific landings for skates is problematic, although estimates of species composition are available for recent years.

19.10 Reference points

No reference points have been proposed for the stocks in this eco-region.

19.11 Management considerations

According to the historical series on landings and the information available from the surveys, Lesser-spotted dogfish and rays (*L. naevus* and *R. clavata*) stocks in divisions VIIIc and IXa seem to be stable or slightly increasing in abundance. Only skates in ICES Division VIIIa, b, d seem to be decreasing in abundance, according to the landing time series.

The situation and structure of the stocks of other elasmobranch species less frequent in the landings (e.g. *Squatina squatina*) remains unknown.

Technical interactions of fisheries in the eco-region are shown in Tables 19.9a and 19.9b.

19.12 References

Cardador, F.; Sanchez, F.; Pereiro, F.J.; Borges, M.F.; Caramelo, A.M.; Azevedo, M.; Silva, A.; Pérez, N.; Martins, M.M.; Olaso, I.; Pestana, G.; Trujillo, V. and Fenandez, A. (1997) Groundfish surveys in the Atlantic Iberian Waters (ICES divisions VIIIc and IXa): history and perspectives. ICES C. M. 1997/Y: 8. 30pp.

Diez, G., Iriondo, A., Ruiz, J., Quincoces, I., González, I., Santurtun, M. and Artetxe, I. 2006. Lesser spotted dogfish, rays and spurdog Landings Per Unit Effort and preliminary discards data of Basque fleets operating in sub-areas VI, VII and VIII in the period 1994–2005. Working Document presented at the 2006 WGEF.

Fernández, A., Rodriguez-Cabello, C., Gancedo, R., Punzón, A., Olaso, I., and Cendrero, O. 2002. Overview of continental shelf elasmobranch fisheries in the Cantabrian Sea. NAFO Symposium on Elasmobranch Fisheries. Santiago de Compostela (Spain), 11–13 September 2002. NAFO, SCR Doc. 02/115.

Heessen, H. J. L. (Ed.) 2003. Development of elasmobranch assessements DELASS. Final report of DG Fish Study Contract 99/055, 603 pp.

ICES. 2002a. Report of the Study Group of the Elasmobranch Fishes (SGEF). ICES CM 2002/G:08.

ICES, 2002b. Manual for The International Bottom Trawl Surveys in the Western And Southern Areas. Revision II. Addendum to ICES CM 2002/D:03. Dublin, Ireland 8–11 April 2002.

Mahé, J. C. and Poulard, J. C.. 2005. Spatial distribution and abundance trends of main elasmobranches species in the Bay of Biscay and Celtic Sea from bottom trawl surveys. ICES CM 2005/N:04.

Machado, P. B., Serrano Gordo, L., and Figueiredo, I. 2004. Skate and ray species composition in mainland Portugal from the commercial landings. Aquatic Living Resources, 17(2): 231–234.

Machado, P. B. and Figueiredo, I., 2006. Skates and Rays in the Portuguese continental coast - Preliminary results from 26 years of IPIMAR demersal surveys.Working Document presented at the 2006 WGEF.

Pereira, B. S., Moura, T., Figueiredo, I., Farias, I. and Gordo, L. S. 2006. Pilot study to estimate fishing effort on rays and skates fisheries in Portugal mainland. Working Document presented at the 2006 WGEF.

Pérez, N., Pereda, P., Uriarte, A., Trujillo, V., Olaso, I., and Lens, S.. 1996. Descartes de la flota española en el área del ICES. Datos y Resúmenes. Inst. Esp. de Oceanogr., 2: 142 pp.

Rodríguez-Cabello, C., Sánchez, F., Fernández, A., and Olaso, I.. 2001. Is the lesser spotted dogfish (*Scyliorhinus canicula*) from the cantabrian sea, a unique stock ?. ICES CM 2001/O:06, 18 pp.

Rodriguez-Cabello, C., and Sánchez, F. 2005. Mortality estimates of *Scyliorhinus canicula* in the Cantabrian Sea using tag-recapture data. Journal of Fish Biology, 66: 1116–1126.

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 AREA VIIIAB										
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	12	6	11	11	6	11	14	11	8	12	14
France	1771	2058	1879	1479	1173	991	989	934	1006	1677	1463
Netherlands	.	.	.	.	.	1	.	.	.	.	.
Spain	872	906	724	677	146	76	323	27	20	9	12
Spain (Basque Country)	*	*	*	*	297	337	*	252	242	278	218
UK (E&W_NI_+)	22	76	13	7	2	3	4	4		8	40
UK (Scotland)	.	.	.	.	.	.	.	.	.	1	.
Total of submitted data	2677	3046	2627	2174	1623	1418	1330	1228	1276	1986	1748

*** Included in Spanish Landings**

TABLE 19.1B	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIIID										
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	46	50	60	52	43	66	64	73	63	97	61
Spain	89	92	74	2	1	1	9	5	40	**	**
Spain (Basque Country)	*	*	*	*	0	2	*	0	1	0	1
UK (E&W_NI_+)											3
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.
Total of submitted data	135	143	134	54	44	69	73	78	104	97	64

*** Included in Spanish Landings**

TABLE 19.1C	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA VIIIC										
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	0	0	1	1	1	0	0	0	0	0	0
Netherlands	.	.	.	.	.	.	.	.	.	.	.
Portugal	11	7	10	4	4	5	.	.	264	0	.
Spain	0	321	345	226	424	978	352	1004	511	546	430
Spain (Basque Country)	*	*	*	*	5	16	*	21	21	20	14
UK (E&W_NI_+)											
UK (Scotland)	.	.	.	.	.	.	.	.	.	.	.
Total of submitted data	11	328	356	231	434	999	352	1025	796	567	444

*** Included in Spanish Landings**

TABLE 19.1D	TOTAL LANDINGS (T) OF *RAJIDAE* IN AREA IXA										
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
France	n.a.	n.a.	n.a.	n.a.	0	0	0	0	0	0	.
Portugal	1534	1512	1485	1420	1528	1591	1521	1598	1614	1303	1544
Spain	58	143	197	276	285	416	339	342	325,2	300	364
Total of submitted data	1592	1655	1682	1696	1813	2007	1860	1940	1939	1602	1908

TABLE 19.1E	COMBINED LANDINGS (T) OF *RAJIDAE* IN BISCAY AND IBERIAN WATERS										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	12	6	11	11	6	11	14	11	8	12	14
France	1816	2109	1940	1532	1217	1057	1054	1006	1069	1774	1524
Netherlands	.	.	.	.	.	1	.	.	.	.	.
Portugal	1545	1519	1495	1424	1532	1596	1521	1598	1878	1303	1602
Spain	1019	1462	1340	1181	855	1471	1022	1378	895	855	806
Spain (Basque Country)	*	*	*	*	302	354	*	273	264	298	233
UK (E&W_NI_+)	22	76	13	7	2	3	4	4	0	8	43
UK (Scotland)	.	.	.	.	.	.	.	.	.	1	.
Total of submitted data	4415	5172	4800	4155	3914	4493	3615	4270	4115	4252	4223

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 AREA VIIIAB											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	.	.	.	.	.	.	.	.	9	10	13
France	568	645	753	399	403	390	330	470	638	651	709
Spain	0	0	63	0	7	7	28	1	0	0	2
Spain (Basque Country)	223	270	336	254	247	277	353	318	254	335	318
UK (E&W)								2		3	0
Total	791	915	1152	653	658	674	711	791	900	1000	1041

TABLE 19.2B LESSER SPOTTED DOGFISH (*SCYLIORHINUS CANICULA*) LANDINGS (T) IN AREA VIIID											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	5	4	4	5	5	2	2	4	4	4	7
Spain	0	0	97	0	78	0	0	0	0	*	*
Spain (Basque Country)	0	0	0	0	0	0	1	0	1	0	2
Total	5	4	101	5	84	2	3	4	5	4	8

TABLE 19.2C LESSER SPOTTED DOGFISH (*SCYLIORHINUS CANICULA*) LANDINGS (T) IN AREA VIIIC											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	0	0	0	1	1	1	1	1	1	3	5
Spain	417	458	375,6	448	167	188	65	114	88	143	168
Spain (Basque Country)	11	8	8	9	5	10	52	65	63	66	73
Total	428	466	384	458	173	198	117	180	152	212	246

TABLE 19.2D LESSER SPOTTED DOGFISH (*SCYLIORHINUS CANICULA*) LANDINGS (T) IN AREA IXA											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Spain	3	6	19	34	30	39	39	69	86	88	92
Portugal	667	691	689	882	757	734	673	658	677	385	185
Total	670	697	708	916	787	773	711,8	727	763	472	276

TABLE 19.2E COMBINED LANDINGS (T) OF LESSER SPOTTED DOGFISH (*SCYLIORHINUS CANICULA*) IN BISCAY AND IBERIAN WATERS	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	.	.	.	.	.	.	.	.	9	10	13
France	573	648	756	405	409	393	333	475	643	658	721
Spain	420	464	555	482	283	234	132	184	174	231	262
Spain (Basque Country)	234	278	344	263	253	287	405	384	318	401	392
UK (E&W)	.	.	.	.	.	.	.	2	.	3	
Portugal	667	691	689	882	757	734	673	658	677	385	185
Total	1894	2081	2345	2033	1701	1647	1542	1703	1820	1688	1572

Table 19.3. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of Smooth hounds by sub-area and country (Source: ICES).

TABLE 19.3A - SMOOTH HOUNDS UNIDENT. (*MUSTELUS* SPP.) - ICES AREA VIII	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	.	.	.	.	.	.	.	.	+	0,1	0,1
France	98	113	158	+	231	272	351	145	370	359	436
Portugal	.	.	.	.	+	.	.	.	1	.	.
Spain (Basque Country)	53	56	57	46	61	58	85	58	56	54	62
Total	151	169	215	46	292	330	436	203	427	413	499

TABLE 19.3B - SMOOTH HOUND (*MUSTELUS MUSTELUS*) - ICES AREA IX	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Portugal	5	2	4	4	2	2	2	1	1	10	25
Total	5	2	4	4	2	2	2	1	1	10	25

TABLE 19.3C. - SMOOTH HOUNDS UNIDENT. (*MUSTELUS* SPP.) - ICES AREA IX	1999	2000	2001	2002	2003	2004	2005	2006
Portugal	72	39	41	43	50	35	24	11
Total	72	39	41	43	50	34	24	11

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 19.4 - ANGEL SHARK (*SQUATINA SQUATINA*) - ICES AREA VIII	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	.	.	.	+	1	+	+	+	7	11	11
UK (E&W_NI_+)	.	.	.	.	.	.	.	.	.	.	0
Total	.	.	.	+	1	+	+	+	7	11	11

Table 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Species-specific landings (rays and skates in t) by country in Subareas VIII, and Division XIa, all gears combined. These data are included in theTables 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
Belgium	2002	VIIIa,b						15	6		0									
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	0	9	208	47	0	6	0	0	0	0					
Spain (Basque Country)*	2005	VIII		3	0	0	11	235	53	0	7	0	0	0	0					
Spain (Basque Country)*	2006	VIII		3	0		6	179	41		5	0			0					
Portugal	2002	IXa						13	2											1505
Portugal	2003	IXa						18	351	78	56	126				578	2			

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.
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		

*** 2004 and 2006 landings are based on the average species proportion of 2000–2003.**

*** *Provisional data (except for *L. naevus*): 2005 and 2006 landings based in the species proportion of 2004.**

Table 19.6. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Lesser-spotted dogfish (t), effective effort (fishing days = trips*(days/trip)) and lpue (landings in kg/day) of different fleets landing in the Basque Country (Spain) ports in the period 1994–2006.

(a)	BAKA TRAWL-ON-VIIIA,B,D		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
1994	112	5619	20
1995	202	4474	45
1996	206	4378	47
1997	242	4286	56
1998	303	3002	101
1999	231	2337	99
2000	228	2227	102
2001	217	2118	103
2002	331	2107	157
2003	303	2296	132
2004	235	2159	109
2005	320	2263	141
2006	311	2398	130

(b)	BAKA TRAWL-ON-VIIIC		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
2002	43	99	430
2003	58	96	604
2004	56	114	487
2005	63	106	595
2006	70	105	669

Table 19.7. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Rajidae* spp. (t), effective effort (fishing days = trips*(days/trip)) and lpue (landings in kg/day) of different fleets landing in the Basque Country (Spain) ports in the period 1994–2006.

(a)	BAKA TRAWL-ON-VIIIA,B,D		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
1994	179	5619	32
1995	505	4474	113
1996	471	4378	108
1997	549	4286	128
1998	598	3002	199
1999	362	2337	155
2000	272	2227	122
2001	292	2118	138
2002	265	2107	126
2003	219	2296	95
2004	177	2159	82
2005	233	2263	103
2006	185	2398	77

(b)	BAKA TRAWL-ON-VIIIC		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
2002	6	99	58
2003	7	96	73
2004	10	114	89
2005	4	106	37
2006	9	105	87

Table 19.8. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Spurdog spp. (t), effective effort (fishing days = trips*(days/trip)) and lpue (landings in kg/day) of different fleets landing in the Basque Country (Spain) ports in the period 1994–2006.

(a)	BAKA TRAWL-ON-VIIIA,B,D		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
1994	32	5619	6
1995	23	4474	5
1996	45	4378	10
1997	34	4286	8
1998	25	3002	8
1999	12	2337	5
2000	38	2227	17
2001	9	2118	4
2002	12	2107	5
2003	3	2296	1
2004	1	2159	0
2005	3	2263	2
2006	3	2398	1

(b)	BAKA TRAWL-ON-VIIIC		
YEAR	LANDINGS (T)	EFFORT (DAYS)	LPUE (KG/DAYS)
2002	14	99	140
2003	5	96	56
2004	3	114	26
2005	0	106	1
2006	3	105	31

Table 19.9. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Data available and description of the characterisitics of information used in the assessmet of *Leucoraja naevus* in Subareas IV and VIII in the DELASS project (Heessen, 2003).

DATA AVAILABLE	DESCRIPTION OF INFORMATION	SOURCE
Catch and effort data	kg and value, and effort (hours) by rectangle, fleet, gear and month. Period: 1986–1998	French fleet,
Ray Species Composition	By ICES sub-area for the years 1988–98.	French landings
Length frequency data	For areas combined. Period:1989–97	French landings
Age compositions	Estimated by using NORMSEP software from the Incremental Growth method. Not separated for discards and landings.	Abrahamson 1971, Charuau and Biseau 1989
Survey data	Weight and number by station (depth and latitude) and sex. Period: 1987–2000	French EVHOE survey data
Discards data	50% in numbers or between 13 and 35% in weight	Estimates
Discards data length compositions	For 1997 for all areas	French cuckoo ray discards
Biological data	K (year-1), Linf (cm), t0 (year) by sex. Length-weight relationship:W = 2.36 10-6 * L3.233	Du Buit 1977; Charuau and Biseau 1989

Table 19.10a. Demersal elasmobranchs in the Bay of Biscay and Iberian waters. Technical interactions in Biscay waters.

	Anchovy VIII	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 Southern	Horse Mackerel Western	Mackerel North East Atlantic	Megrim VII, VIIIabd	Nephrops Area L: VIIbcjk	Nephrops Area M: VIIfgh+VIIa	Nephrops VIIIa,b	Nephrops VIIIc	Plaice VIIbc	Plaice VIIe	Plaice VIIfg	Plaice VIIhjk	Sardine VIIIc, IXa	Sole VIIbc	Sole VIIe	Sole VIIfg	Sole VIIhjk	Sole VIIIab	Sprat VIIde	Whiting VIIe-k	Seabass	Skates and rays	Pelagic and migratory sharks	Demersal sharks
Anchovy VIII		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Anglerfish budegassa VIIb-k, VIIIabd	N		H	L	L	M	0	0	0	0	0	M	M	L	M		L	L	L	L	0	L	L	L	L	M		L		H		H
Anglerfish piscatorius VIIb-k, VIIIabd	N	T		L	L	M	0	0	0	0	0	M	M	M	M		L	L	L	L	0	L	L	L	L	M		L		H		H
Cod VIIe-k	N	T	T		H	L	0	0	0	0	0	L	L	M	0	0	0	L	M	L	0	0	L	L	L	0	0	H/M		H	L	H
Haddock VIIb-k	N	T	T	T		L	0	0	0	0	0	L	M	M	0	0	L	L	L	L	0	L	L	L	L	0	0	H	0	H	L	H
Hake Northern	N	T	T	T			0	0	0	0	0	M	M	L	M		L		0	L	0	L		0	L	L		L		H	L	H
Herring Celtic Sea and Division VIIj	N	N	N	N	N	N		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0		0
Herring VIa(S) and VIIbc	N	N	N	N	N	N	N		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0		0
Horse Mackerel Southern	N	N	N	N	N	N	N	N		0	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Horse Mackerel Western	N	N	N	N	N	N	N	N	N		H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Mackerel North East Atlantic	N	N	N	N	N	N	N	N				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Megrim VII, VIIIabd	N	T, BT	T, BT	T		T	N	N	N	N	N		H	M	M		L			L	0	L		L	L	0		L		H		H
Nephrops Area L: VIIbcjk	N	NT	NT	NT	NT	NT	N	N	N	N	N	NT		0	0	0	L	0	0	L	0	L	0	0	L	0	0	M		L		L
Nephrops Area M: VIIfgh+VIIa	N	NT	NT	NT	NT	NT	N	N	N	N	N	NT	N		0	0	0	0	0	L	0	0	0	L	L	0	0	M		L		L
Nephrops VIIIa,b	N	NT	NT	N	N	NT	N	N	N	N	N	NT	N	N		0	0	0	0	0	0	0	0	0	0	M	0	0		L		L
Nephrops VIIIc	N			N	N		N	N	N	N	N		N	N	N		L		0	0	0	L	0	0	0	0		0		L		L
Plaice VIIbc	N			N			N	N	N	N	N		NT	N	N			0	0	0	0	L	0	0	0	0	0	L	0	H		H
Plaice VIIe	N	OT, BT	OT, BT	OT, BT	N		N	N	N	N	N		N	N	N		N		0	0	0	0	H	0	0	0	0	L		H		H
Plaice VIIfg	N	OT, BT	OT, BT	OT, BT	OT, BT	N	N	N	N	N	N		N	N	N	N	N	N		0	0	0	0	H	0	0	0	L		H		H
Plaice VIIhjk	N			BT, OT			N	N	N	N	N		NT	N	N		N	N	N		0	0	0	0	L	0	0	L	0	H		H
Sardine VIIIc, IXa	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		0	0	0	0	0	0	0	0	0		0
Sole VIIbc	N			N			N	N	N	N	N		N	N	N			N	N	N	N		0	0	0	0	0	L	0	H		H
Sole VIIe	N	BT, OT	BT, OT	BT, OT	N		N	N	N	N	N		N	N	N	N	N	BT, OT	N	N	N	N		0	0	0	0	L		H		H
Sole VIIfg	N	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	N	N	BT	N	NT	N	N	N	N	BT, OT	N	N	N	N		0	0	0	L		H		H
Sole VIIhjk	N			BT, OT			N	N	N	N	N		N	N	N		N	N	N	T, BT	N	N	N	N		0	0	L	0	H		H
Sole VIIIab	N	BT	BT	N	N	BT	N	N	N	N	N	N	N	N	NT	N	N	N	N	N	N	N	N	N	N		0	0	0	H		H
Sprat VIIde	N	N	N	N	N				N	N	N		N	N	N		N	N	N	N	N	N	N	N	N	N		0				
Whiting VIIe-k	N	T	T	T	T		N	N	N	N	N		NT	NT	N		N	N	BT, OT		N	N	N	BT, OT		N			0	H		H
Seabass	N						N	N	N	N	N										N					N		0				
Skates and rays	N	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	N	BT, OT	NT	NT	NT	NT	BT, OT	BT, OT	BT, OT	BT, OT	N	BT, OT		BT, OT	BT, OT	BT	N	BT,OT				
Pelagic and migratory sharks	NA	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	N	BT, OT					BT, OT	BT, OT	BT, OT	BT, OT	N	BT, OT		BT, OT	BT, OT	BT	N	BT,OT				
Demersal sharks	N	BT, OT	BT, OT	BT, OT	BT, OT	BT, OT	N	N	N	N	N	BT, OT	NT	NT	NT	NT	BT, OT	BT, OT	BT, OT	BT, OT	N	BT, OT		BT, OT	BT, OT	BT	N	BT,OT				

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 are taken together in some fisheries but are mainly caught independently of each other and their fisheries linkage is therefore low; O: the stocks are never or only rarely caught together and they are thus not linked in the fisheries; na: information not available.

T: Trawl; BT: Beam trawl; OT: Otter trawl; NT: Nephrops trawl; N: none

Table 19.10b. Demersal elasmobranchs in the Bay of Biscay and Iberian waters. Technical interactions in Iberian waters.

	Hake VIIIc+IXa	Anglerfish ' VIIIc+Ixa	Megrims' VIIIc+IXa	Nephrops Cantabrian FU 31	Nephrops North Galiza FU 25	Nephrops West Galiza + North Portugal FUs 26+27	Nephrops SW and South Portugal FUs 28+29	Nephrops Cadiz FU 30	Horse mackerel IXa	Blue whiting VIIIc+IXa	Black scabbardfish IXa	Red seabream IX and X
Hake VIIIc+IXa		**H**	**H**	**L**	**H**	**H**	**H**	**H**	**H**	**M**	**L**	**L**
Anglerfish VIIIc+IXa	PT-SP-trawls and PT-SP-gillnets		**H**	**L**	**H**	**H**	**H**	**0**	**M**	**L**	**0**	**L**
Megrims VIIIc+IXa	PT-trawl, PT-gillnets	PT-trawl, PT-gillnets		**L**	**L**	**L**	**H**	**0**	**M**	**L**	**0**	**L**
Nephrops Cantabrian FU 31	SP-Trawl	SP-Trawl	SP-Trawl		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nephrops North Galiza FU 25	SP-Trawl	SP-Trawl	SP-Trawl	None		**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nephrops West Galiza + North Portugal FUs 26+27	SP-Trawl PT- trawl	SP-Trawl PT-trawl	SP-Trawl PT-trawl	None	None		**0**	**0**	**L**	**L**	**0**	**0**
Nephrops SW and South Portugal Fus 28+29	Crustacean PT-trawl	Crustacean PT-trawl	Crustacean PT-trawl	None	None	None		**0**	1.1 L	1.2 M	**0**	**0**
Nephrops Cadiz FU 30	SP-Trawl	None	None	None	None	None	None		**M**	**H**	**0**	**0**
Horse mackerel Ixa	PT-trawls, PT-artisanal, SP-trawl- H SP GOV -L	PT-trawl, PT-gillnets SP-trawl- H SP GOV -L	PT-trawl, PT-gillnets SP-trawl- H SP GOV -L	None	None	SP-Trawl PT-trawl	Crustacean PT-trawl	SP-Trawl		**M**	**0**	**0**
Blue whiting VIIIc+Ixa	PT-trawls SP-trawl SP pair trawl	Crustacean PT-trawl SP-trawl	Crustacean PT-trawl SP-trawl	SP-Trawl-L	SP-Trawl-L	SP-Trawl-L	Crustacean PT-trawl	SP-Trawl	PT-trawls SP-trawl SP-pair Trawl SP GOV -L		**0**	**0**
Black scabbardfish Ixa	PT-Longline	None	None	None	None	None	None	None	None	None		**0**
Red seabream IX and X	PT-artisanal	PT-artisanal	PT-artisanal	None	None	None	None	None	PT-artisanal	None	None	

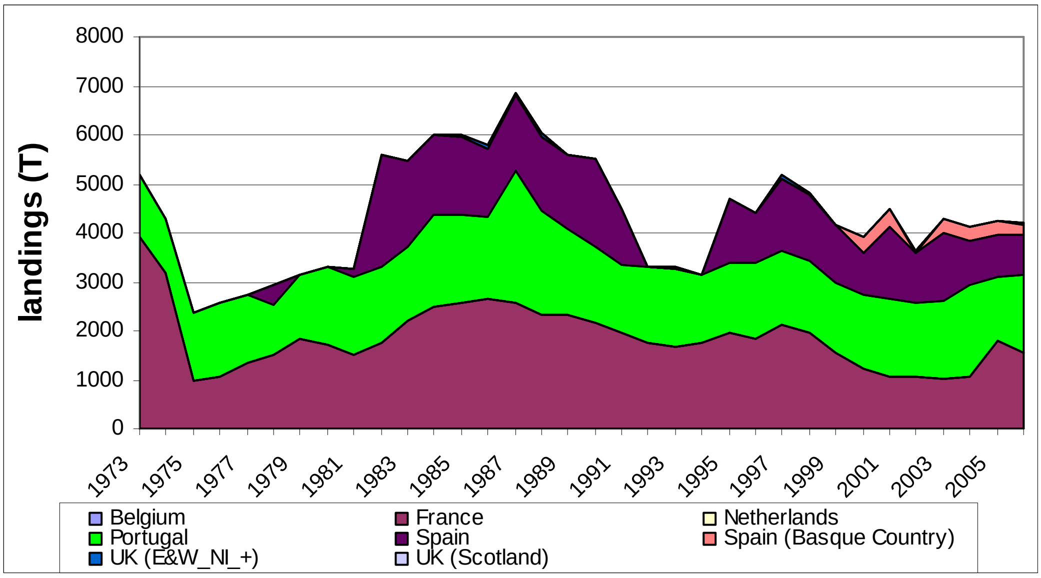


Figure 19.1. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of Rajidae spp in Divisions VIIIab, VIIId, VIIIc and IXa.

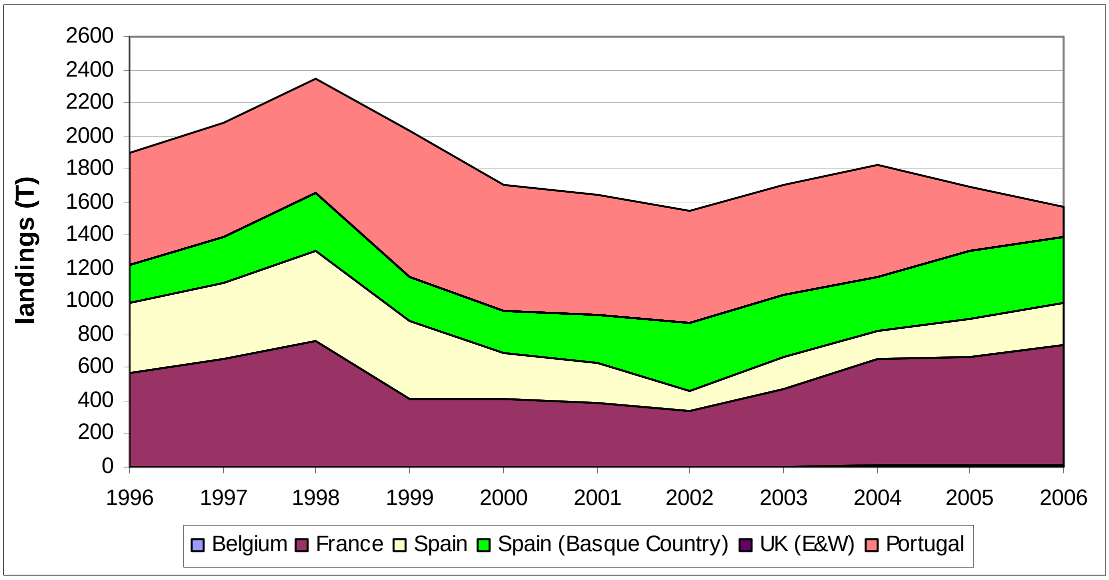


Figure 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of Lesser-spotted dogfish Divisions VIIIab, VIIId, VIIIc and IXa.

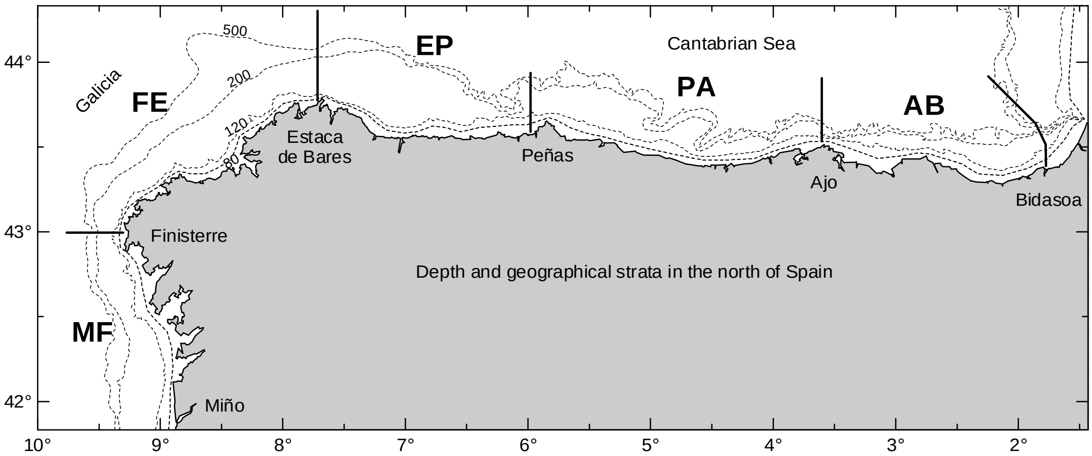
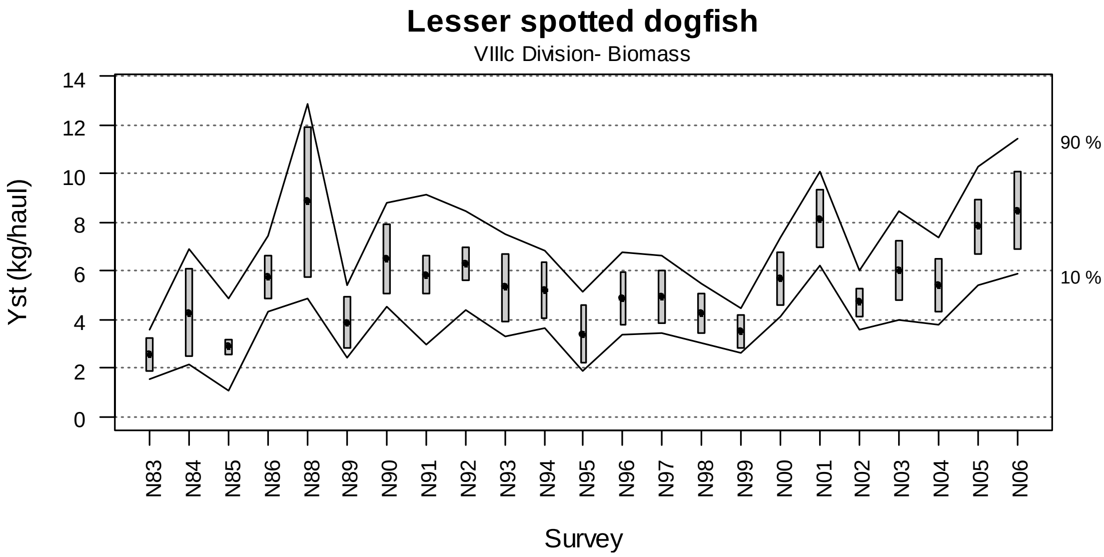


Figure 19.3. Design of the IBTS North of Spanish Coast groundfish survey showing geographical sectors and depth stratification.



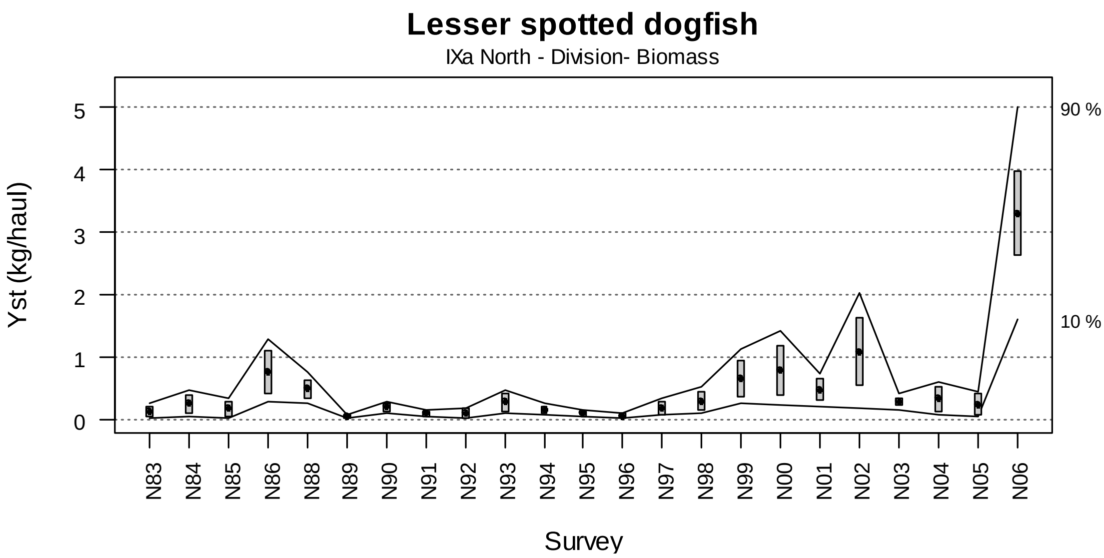


Figure 19.4. Biomass abundance indices of lesser spotted dogfish in ICES Divisions VIIIc and IXa from SPGFS (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals.

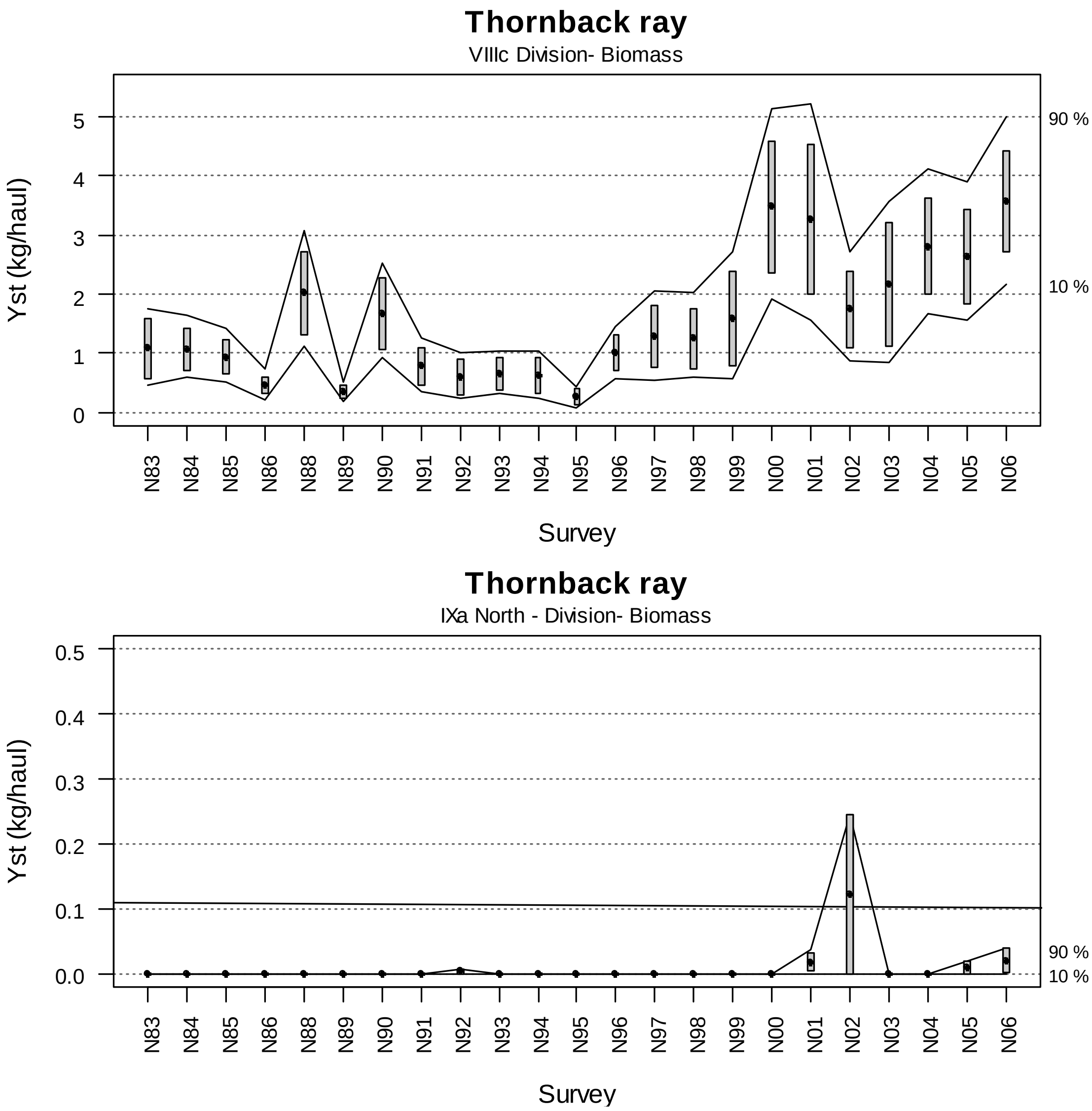


Figure 19.5. Biomass abundance indices of thornback ray in ICES Divisions VIIIc and IXa from SPGFS (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals.

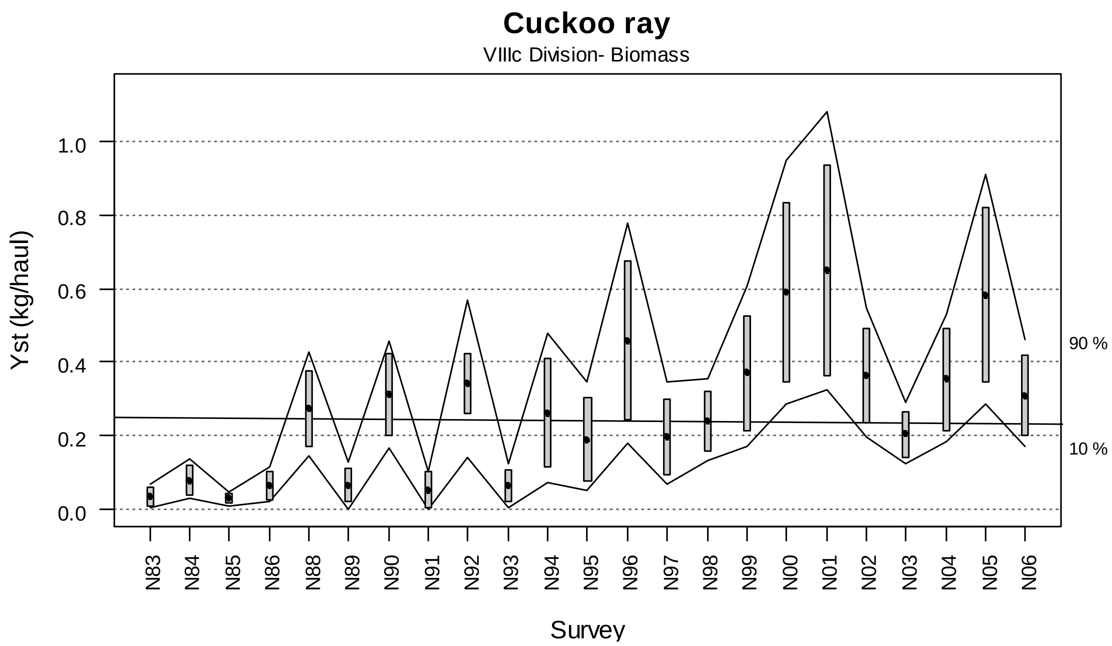


Figure 19.6. Biomass abundance indices of cuckoo ray in ICES Divisions VIIIc from SPGFS (boxes show parametric SE and lines 80% bootstrap estimated confidence intervals.

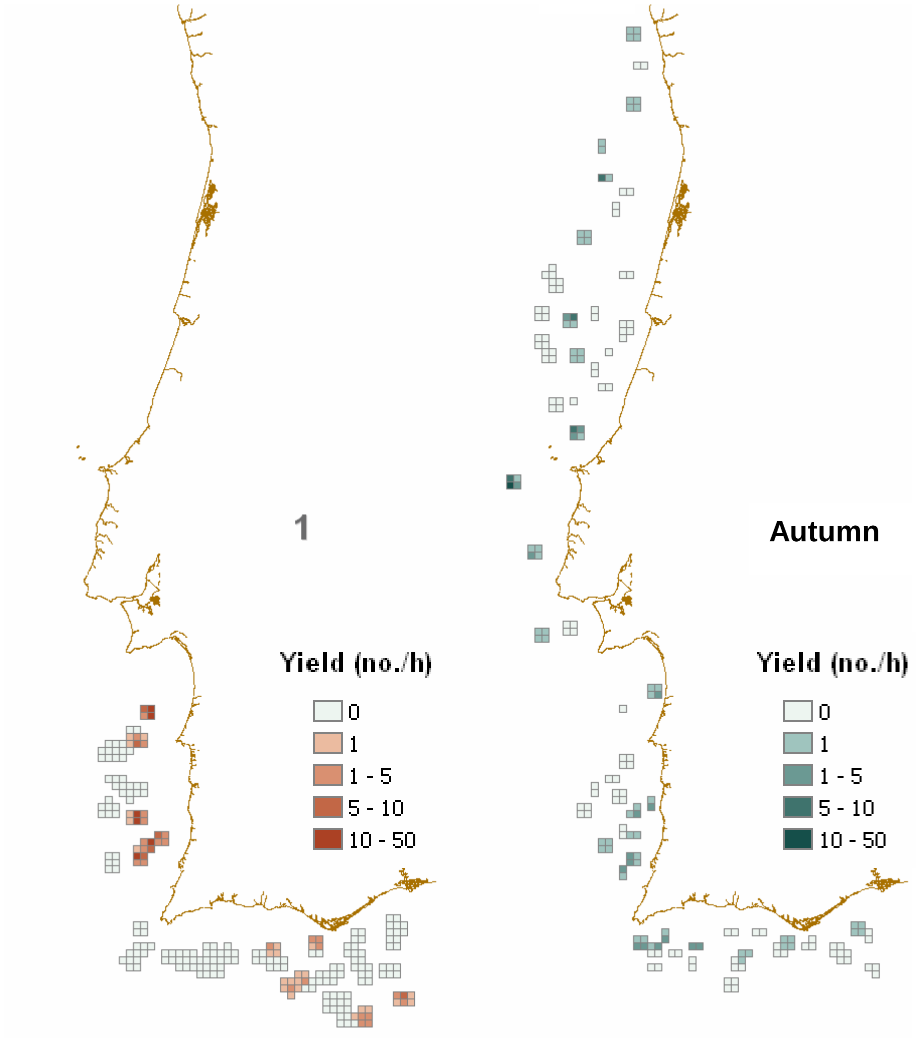


Figure 19.7. Thornback ray yield (no./h) estimates for two surveys held in the Portuguese continental coast during summer and autumn seasons of 2003.

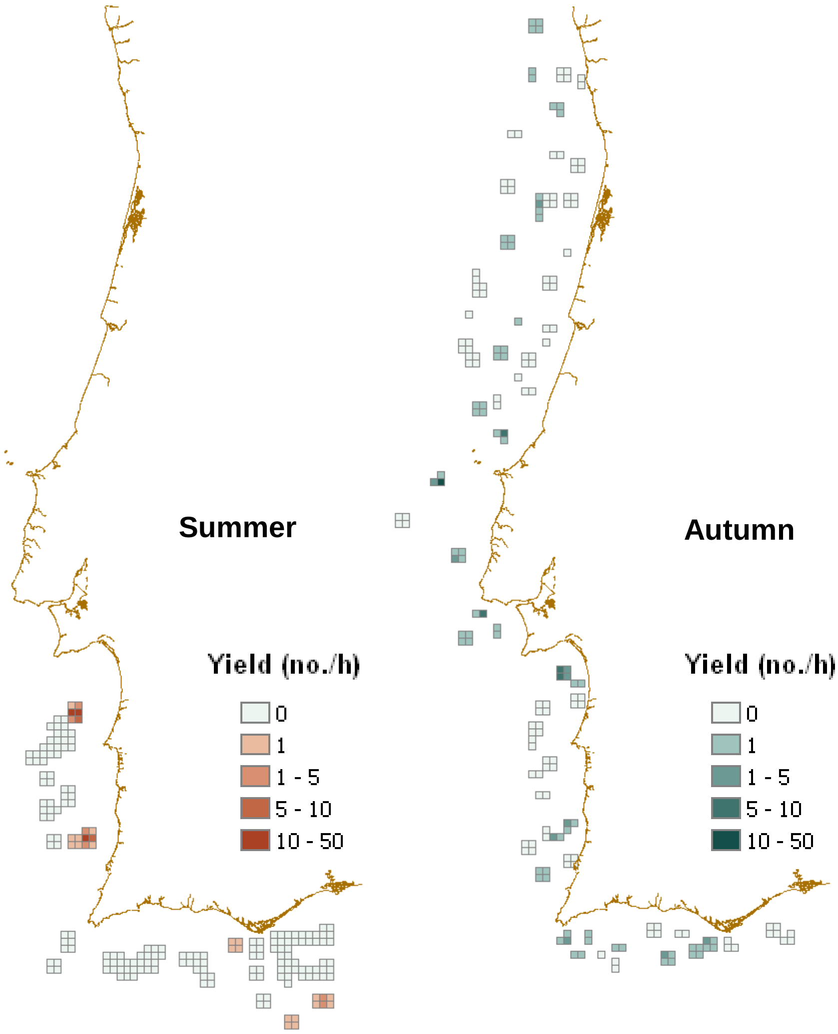


Figure 19.8. Thornback ray yield (no./h) estimates for two surveys held in the Portuguese continental coast during summer and autumn seasons of 2004.

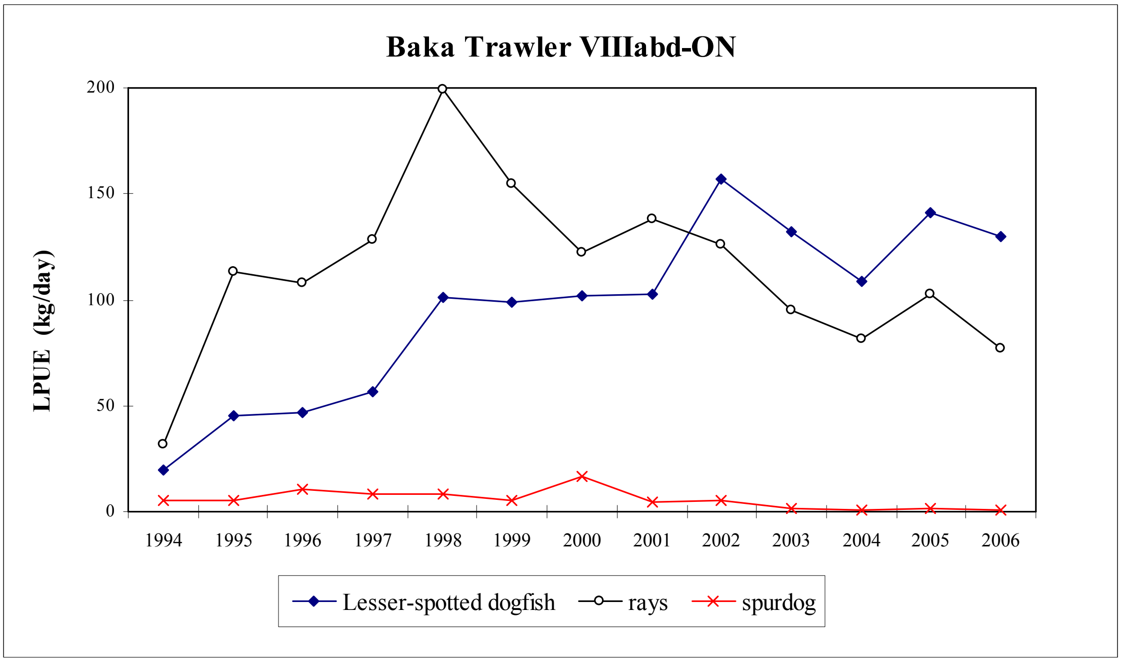


Figure 19.9. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Lpue (landings in kg/day) trends of Baka Trawler of VIIIabd landing in Ondarroa (Basque Country –Spain-) port in the period 1994–2006.

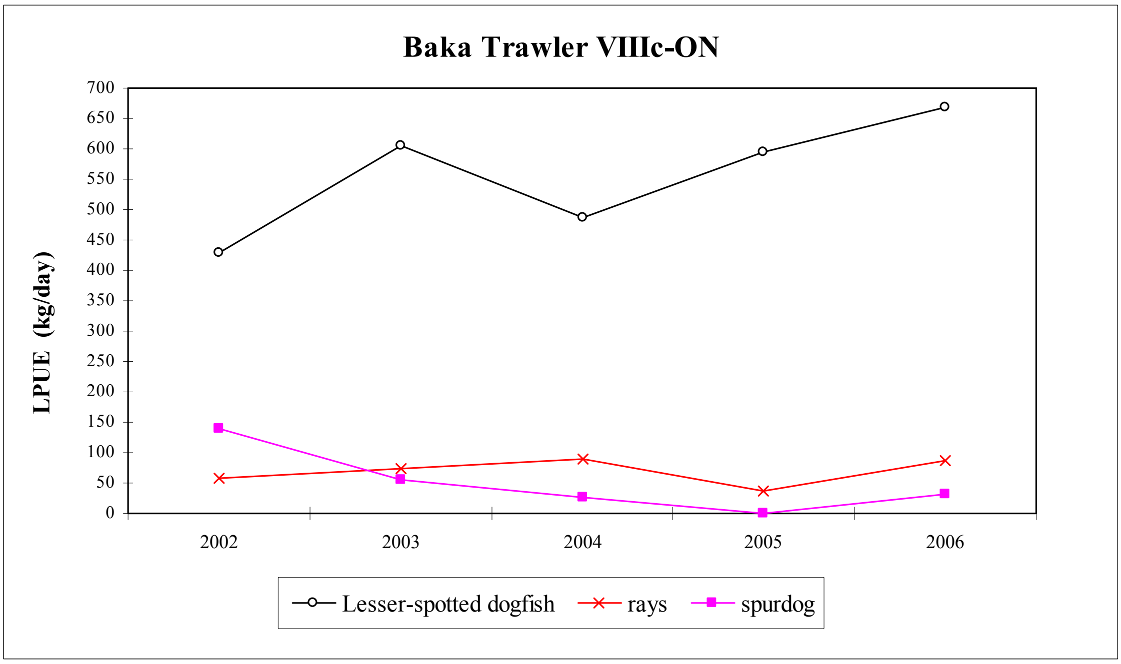


Figure 19.10. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Lpue (landings in kg/day) trends of Baka Trawler of VIIIc landing in Ondarroa (Basque Country –Spain-) port in the period 1994–2006.

20 Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge

20.1 Eco-region and stock boundaries

The Mid-Atlantic Ridge (MAR) (ICES Area X, XII, XIV) is an extensive and diverse area, which includes several types of ecosystems, abyssal plains, seamounts, active underwater volcanoes, chemosynthetic ecosystems and islands, as a natural extension of this large ecosystem.

For most species dealt with in this section the stock boundaries are not well known. The main species of demersal elasmobranchs observed in this ecoregion are deepwater elasmobranch species (*Centrophorus* spp., *Centroscymnus* spp., *Deania* spp., *Etmopterus* spp., *Hexanchus griseus, Galeus marinus, Somniosus microcephalus, Pseudotriakis microdon*, *Scymnodon obscurus, Centroscyllium fabricii. Raja* spp. etc.; see Sections 3 and 5), particularly whenever the gear fishes deeper than 600 m, yet most of these may be discarded due to their low commercial value (ICES, 2005). In the Azores area the kitefin shark (*Dalatias licha*) and tope (*G. galeus*) are the most important commercial demersal elasmobranchs (see Sections 4 and 10 respectively).

Of the skates, the most abundant species in sub-area X are 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, like stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana*, *and,* are also observed in this eco-region. These species are generally discarded if caught in commercial fisheries. Some of the scarcer demersal elasmobranchs observed on MAR includes *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 eco-region and neighboring 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 and few vessels find the MAR fisheries profitable.

20.2.2 The fishery in 2006

Demersal elasmobranches are caught in the Azores EEZ by a multispecies demersal fishery, using hand-lines 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).

There is no new reported information from MAR.

20.2.3 ICES advice applicable

ACFM has never provided advice for these stocks.

20.2.4 Management applicable

No new information. See Section 20.11 for existing Management considerations.

20.3 Catch data

20.3.1 Catch data

The catches reported from each country and subarea are given in Tables 20.1, 20.2 and 20.3. Historical landings of rays reported for area X and XII are presented in Figure 20.1.

20.3.2 Discards

No new information on discards was presented.

20.3.3 Quality of catch data

Species-specific landings data are not currently available for skates landed in this region.

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 Minimum Sampling Program. Landings statistics on rays and skates from Azorean fisheries are reported under generic common 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 is available.

20.6 Fishery-independent surveys

Since 1995 DOP has carried out an annual spring demersal bottom longline survey running on the Azores. A comprehensive resume of the elasmobranch species occurring in the Azores (ICES Subarea X) and fisheries associated as well as the available information on species distribution by depth, was already described by Pinho (2005 WD). No new information is available since there was no survey during 2006.

Raja clavata is one of demersal elasmobranch species most commonly reported on this survey. Relevant biological information available from surveys on this species was updated and presented to last year WGEF meeeting (Pinho, 2006 WD). Annual abundance indices are presented in Figure 20.2; Abundance indices by depth strata in Figure 20.3 and length composition in Figure 20.4.

Information on elasmobranchs recorded on MAR available from the literature (Hareide and Garnes, 2001) was presented in the WGEF 2005 report (ICES, 2005). There is no new information.

20.7 Life-history information

No new information.

20.8 Exploratory assessment methods

No assessments have been conducted, due to insufficient data.

20.9 Quality of assessments

No assessments have been conducted, due to insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated in the future.

20.10 Reference points

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

20.11 Management considerations

In 1998, the Azorean government implemented 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 hand lines are permitted) and vessel type. 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). TAC´s for deep-water sharks were implemented for ICES areas V, VI, VII, VIII, IX, X and XII.

WGEF considers that the elasmobranch fauna of Mid-Atlantic Ridge in Subareas X and XII is poorly understood. The species of demersal elasmobranchs are probably little exploited in comparison to continental Europe. The eco-region is considered to be a sensitive area. Consequently, commercial fisheries taking demersal elasmobranchs in this area should not be allowed to proceed unless studies are conducted that can demonstrate what sustainable exploitation levels should be.

20.12 References

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

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

Pinho, M. R. 2005. Elasmobranches of the Azores. Working Document (WGEF 2005).

Pinho, M. R. 2006. Elasmobranch statistics from the Azores (ICES Area X).Working Document (WGEF, 2006).

Table 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea X.

ICES SUBAREA X												
	SPECIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Azores	Rajidae	48	29	35	52	43	32	55	62	71	99	117
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.
Azores	Sharks	+	+	4	12	+	n.a.	138	256	328	n.a.	n.a.
	Total	48	30	40	65	43	32	194	318	399	99	117

ICES SUBAREA X									
	SPECIES	1999	2000	2001	2002	2003	2004	2005	2006
Azores	Rajidae	103	83	68	70	89	72	50	62
France	Rajidae			2	.	.	.	.	.
Spain	Rajidae		24	29				.	.
Azores	Bluntnose six-gill shark	n.a.	n.a.	n.a.	7	2	1	1	n.a
Azores	Sharks	6	18	22	n.a.	n.a.	n.a.	3	n.a
	Total	109	125	121	77	91	73	53	62

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
UK	Rays and skates	1	1	6	1	.	.
UK	Sharks	-	6.7	-	-	113	.
	Total	1	7	6	1	113	0

Table 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XIV.

ICES SUBAREA XIX							
COUNTRY	SPECIES	2001	2002	2003	2004	2005	2006
UK	Rays and skates	+	+	-	-	-	.
Norway	Rajidae						6
	Total	0.3	0.4	-	-	-	6

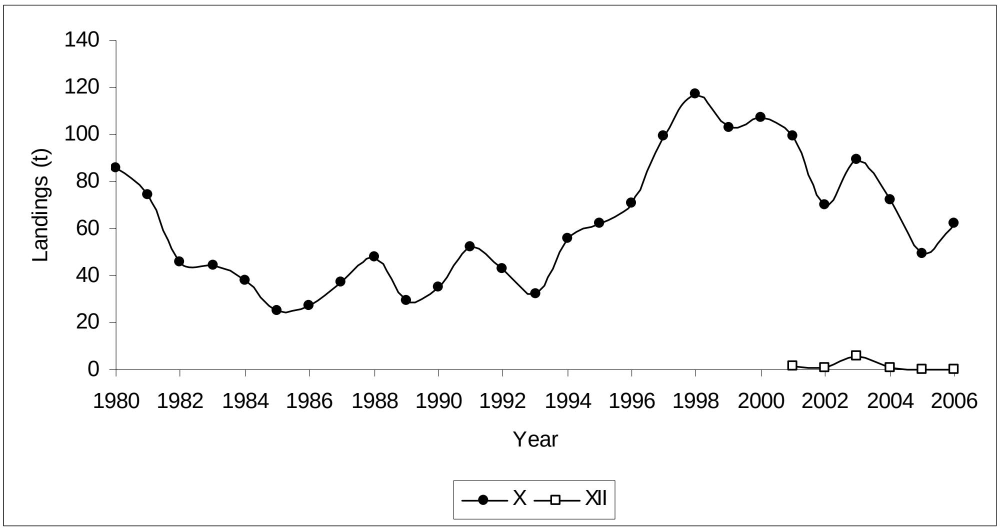


Figure 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Historical landings of rays from Azores (Ices Subarea X) amd MAR (ICES Subarea XII).

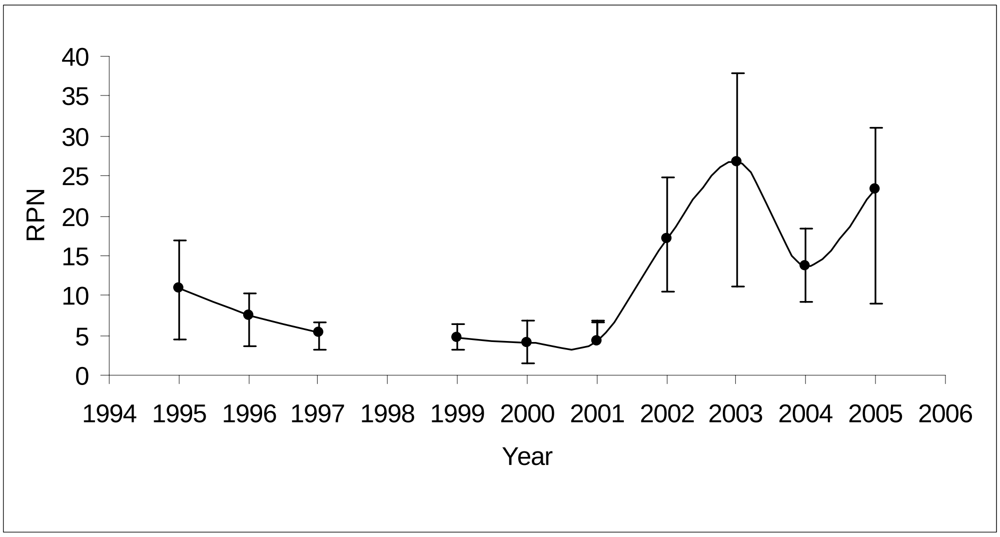


Figure 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Annual Relative Population Numbers (RPN) of Raja clavata from the Azores (ICES X). RPN is the Reltive Population numbers (Average CPUE by depth stratum weighted by the stratum size and summed across strata and areas).

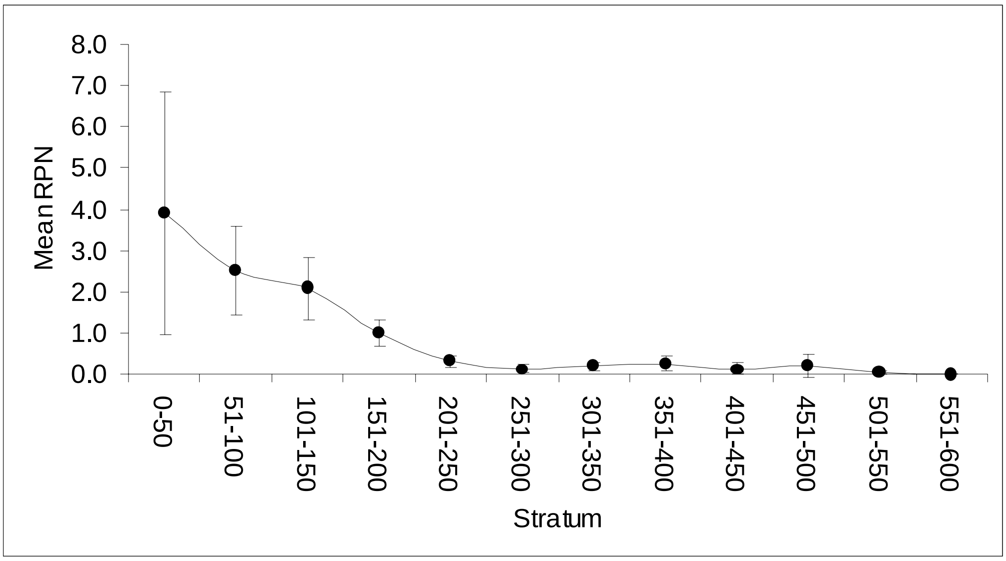


Figure 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Mean Relative Population Numbers (RPN), for the period 1995–2005, of Raja clavata by depth from the Azores (ICES X). RPN is the Reltive Population numbers (Average CPUE by depth stratum weighted by the area size).

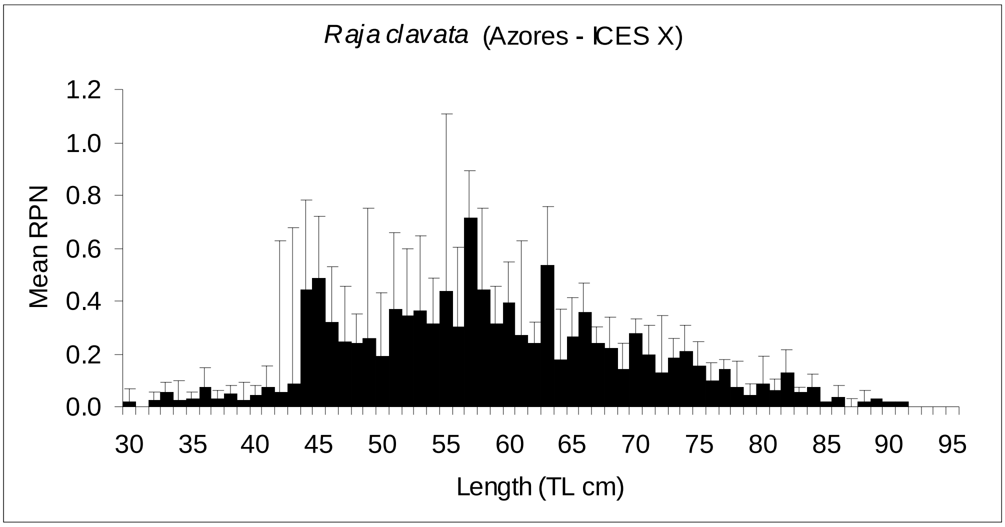


Figure 20.4. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* caught at the Azorean demersal spring bottom longline surveys during the period 1995-2005. RPN is the Relative Population Numbers (Average frequency proportions by length, station and stratum weighted by the abundance index of the stratum and summed across strata and area).

21 Other issues

This section discusses the following TORs:

(f) produce a photo-ID key for elasmobranchs in the ICES area (together with IBTSWG).

(g) Compile all available conversion factors for elasmobranch species.

(h) assess and report on the evidence that is the basis for the nominations to the OSPAR List of Threatened and/or Declining Species and Habitats of porbeagle shark (Lamna nasus), blue shark (Prionace glauca), Northeast Atlantic spurdog (Squalus acanthias), leafscale gulper shark (Centrophorus squamosus), gulper shark (Centrophorus granulosus), Portuguese dogfish (Centroscymnus coelolepis), thornback ray (Raja clavata); white skate (Rostroraja alba) and angel shark (Squatina squatina). The purpose of the assessments is to ensure that the data used to support the nominations are sufficiently reliable and adequate to serve as a basis for conclusions that these species can be identified as threatened and/or declining species according to OSPAR's Texel/Faial criteria.

21.1 Production of a photo-ID key for elasmobranchs in the ICES area

There has been some progress in the development of keys for various elasmobranch groups, including skates and rays. For example:

- Taxonomic keys and line drawings for deep-water sharks and skates and rays were made available to several laboratories participating in the DELASS project.
- IMARES have provided various laboratories with their Zeus photo catalogue.
- DFO have organised for an identification guide to NW Atlantic skates to be developed, and a draft of this key was presented to WGEF.
- Cefas have started to developing an electronic version of a taxonomic key for skates and rays with photographs.
- The Shark Trust and SeaFish have distributed keys (some with photographs, some with illustrations) for use by recreational anglers and fish processors, etc.

There is still the requirement to obtain high quality photographic images of fresh specimens for several of the less common elasmobranch species. It is suggested that IBTS should take the lead in compiling photographic images of those elasmobranchs occurring in shelf seas (including the egg-cases of oviparous species), and WGDEEP take the lead for collating images of deep-water species. The process of collating such images would be facilitated by having a site on Sharepoint, which could then act as a repository for photographs.

21.2 Compilation of available conversion factors

Hareide *et al.* (2007) provided a brief overview of some of the available conversion factors, with many others collated by the STECF elasmobranch sub-group.

A preliminary compilation of conversion factors is given in Table 21.1, and members of WGEF will attempt to address data gaps, so that a more comprehensive compilation can be included as part of the future Cooperative Research Report.

21.3 Nominations to the OSPAR list of 'Threatened and Declining Species and Habitats": A review of the elasmobranch proposals

21.3.1 Introduction

Currently three elasmobranch species are listed by OSPAR: basking shark *Cetorhinus maximus,* common skate *Dipturus batis* and spotted ray *Raja montagui* (OSPAR, 2006a), though other species were proposed in 2001 (angel shark *Squatina squatina*, stingray *Dasyatis pastinaca*, thornback ray *Raja clavata*, lesser-spotted dogfish *Scyliorhinus canicula*, spurdog

Squalus acanthias, white skate *Rostroraja alba*, tope *Galeorhinus galeus*, porbeagle *Lamna nasus* and blue shark *Prionace glauca*). The Study Group on Elasmobranch Fishes reviewed all these proposals (ICES, 2002).

In 2006, both Germany (OSPAR, 2006b) and the World Wide Fund for Nature (WWF) (OSPAR, 2006c) nominated further species to be included on the OSPAR list of Threatened and Declining Species and Habitats. The Working Group on Elasmobranch Fishes (WGEF) was asked to:

"Assess and report on the evidence that is the basis for the nominations to the OSPAR List of Threatened and/or Declining Species and Habitats of:

- Porbeagle shark (*Lamna nasus*),
- Blue shark (*Prionace glauca*),
- Northeast Atlantic spurdog (*Squalus acanthias*),
- Leafscale gulper shark (*Centrophorus squamosus*),
- Gulper shark (Centrophorus granulosus),
- Portuguese dogfish (Centroscymnus coelolepis),
- Thornback ray (*Raja clavata*),
- White skate (*Rostroraja alba*), and
- Angel shark (Squatina squatina).

The purpose of the assessments is to ensure that the data used to support the nominations are sufficiently reliable and adequate to serve as a basis for conclusions that these species can be identified as threatened and/or declining species according to OSPAR's Texel/Faial criteria."

Species considered for listing as Threatened and Declining Species and Habitats by OSPAR are evaluated using the six 'Texel/Faial' criteria - Global importance, Regional importance, Keystone species, Rarity, Decline and Sensitivity. These criteria were reviewed recently by the Working Group on Fish Ecology (ICES, 2004).

21.3.2 Porbeagle shark (*Lamna nasus*)

Porbeagle shark in OSPAR regions I-V was nominated by Germany and WWF.

Global importance: Porbeagle is a widely distributed pelagic species, and tagging studies have traditionally suggested that there are separate NW and NE Atlantic stocks. There are however, no published scientific studies proving these stocks are genetically distinct, as stated in the WWF nomination. The German nomination stated that the stock in the OSPAR area was “genetically isolated”, which is unlikely as occasional transatlantic migrations have been reported. The OSPAR area is not of Global Importance to porbeagle, which both nominations suggested, as the Texel-Faial criteria refer to the species level (OSPAR, 2003). If the Texel-Faial criteria were amended to examine stocks of organisms, then the OSPAR area would be considered of Global Importance to the NE Atlantic porbeagle stock.

Regional Importance: No supporting information was given, which highlights the lack of information on important grounds for this species within the OSPAR/ICES area.

Rarity: Porbeagle was stated as being rare, though there was no evidence given to support this.

Sensitivity: Porbeagle shark was listed as Very Sensitive, which is wholly appropriate given the low reproductive capacity of this species.

Keystone species: No supporting information.

Decline: The WWF nomination stated that porbeagle were “Severely declined to extirpated”. Given that there are still occasional targeted fisheries, porbeagle cannot be considered "extirpated", though there have likely been declines in the population. Given that there are no stock assessments or fishery-independent survey information for porbeagle, the decline has been based on the expert judgement of landings data and fishing patterns.

Threats: Porbeagle is still taken as a bycatch in commercial fisheries and localised, seasonal fisheries still target aggregations of this species, as stated in the nomination. Given the high value of the species, these fisheries are likely to continue.

Other comments (WWF nomination): The comments on the finning regulations in the section on current management are conservation lobbying, with the sentence "*unpunished* ***finning of two out of three sharks caught***" unsubstantiated and, in terms of high-value species such as porbeagle, probably not a major issue.

Other comments (German nomination): The 'Decline' section in the German proposal repeats text in the first and third paragraphs. Within the 'Threat' section, porbeagle would be better described as aggregating instead of schooling. Within the 'Expert judgement' section, it is stated that porbeagle is to be listed under HELCOM and in 'Management considerations' it stated that they are critically endangered in Turkish waters. Though occurring in the Skagerrak, porbeagle would not be expected to be anything but a vagrant further in the Baltic Sea and listing species on the periphery of their range and/or in unsuitable habitats is inappropriate. Additionally, using such listings as further justification for conservation listings elsewhere is also inappropriate. Within the section 'Management considerations' the sentence "*It is important that fisheries and trade is not allowed in the OSPAR Maritime Area*" is questionable, given that they can be a bycatch in various fisheries. The IUCN have listed North-East Atlantic porbeagle shark as Critically Endangered.

Completeness, sufficiency and interpretation of data: Though there are insufficient data to assess the North-East Atlantic stock of porbeagle shark, this species has likely declined, is not expected to recover in the short-term and is considered very sensitive to over-exploitation.

Conclusion: Although robust data are lacking, WGEF considered that more data could and should have been presented in the nominations to provide a more robust argument to list porbeagle shark as a Threatened and Declining species in OSPAR regions I–V. Both ICES and STECF consider porbeagle to be depleted in the NE Atlantic, and stocks elsewhere in the world, including the NW Atlantic, are also considered depleted. Therefore it seems appropriate to list porbeagle as a Threatened and Declining species in OSPAR regions I–V.

21.3.3 Blue shark (Prionace glauca)

Blue shark in OSPAR regions II-V was nominated by WWF.

Global importance: Blue shark is a widely distributed pelagic species. The nomination suggested that the OSPAR area was of Global Importance to blue shark, though WGEF considered that the OSPAR area was not of Global Importance to this species, as blue shark has a circumglobal distribution, and that there is considered to be a single North Atlantic stock. The supporting text highlighted that parts of the OSPAR region contain important areas for female aggregations, as well as pupping and nursery grounds, though this text would be more appropriate under Regional Importance.

Regional Importance: Though there was no supporting g information to suggest that the OSPAR area was of Regional Importance to blue shark, some of the supporting text under Global Importance suggests that parts of the OSPAR area are regionally important to blue shark.

Rarity: Blue shark is one of the most abundant pelagic sharks and is considered to be one of the more productive shark species. The nomination stated that it was "Not yet" rare, though it would be better stated as 'No'.

Sensitivity: Blue shark was listed as Sensitive. Even though one of the more productive shark species, it may be appropriate for this species to be considered as 'Sensitive'.

Keystone species: The nomination stated that blue shark was a Keystone species, though there was no supporting information/evidence.

Decline: The nomination stated that there was a "Probability of significant decline", though there were no supporting data. Though some published studies have observed declines, some of these studies have been controversial, and other studies have given mixed signals. Though large numbers of blue shark have been taken in offshore fisheries and continue to be harvested, there is no consistent evidence that the stock has declined to such an extent to warrant conservation action, although improved fisheries assessment and management are required.

Threats: Blue shark is still taken as a bycatch in various commercial fisheries, including high value pelagic fisheries targeting tuna and swordfish, and localised, seasonal fisheries may also target blue shark in some areas.

Other comments: The sentence "*There is strong concern that the insufficiency/lack of data camouflages the real decline of the North Atlantic population*" is unsubstantiated. The comments on the finning regulations in the section on current management are conservation lobbying, with the sentence "*unpunished* ***finning of two out of three sharks caught***" unsubstantiated. The nomination mis-spelt *Prionace* as *Prion* and as *Prianace*.

Completeness, sufficiency and interpretation of data: There are insufficient data to assess the North Atlantic stock of blue shark, though this remains one of the most abundant pelagic sharks in the area. Under Sufficiency of data, the nomination stated "ICCAT…", though did not complete the sentence/paragraph, indicating that the review has not made best use of available ICCAT data.

Conclusion: WGEF considered that there were no data in the nomination to conclude that blue shark should be listed as a Threatened and Declining species.

21.3.4 Northeast Atlantic spurdog (*Squalus acanthias*)

Spurdog in OSPAR regions I-V was nominated by WWF and Germany.

Global importance: Spurdog is a widely distributed species, and tagging studies have shown only occasional transatlantic migrations, suggesting separate NW and NE Atlantic stocks. The WWF nomination suggested that the OSPAR area was of Global Importance to spurdog, though the German nomination did not feel it was globally important. WGEF considered that the latter was correct, as the Texel-Faial criteria operate at the species level (OSPAR, 2003). Given the different interpretations in the two nominations in terms of Global importance, it is recommended that OSPAR better clarify the application of the Texel-Faial criteria so that it is clear whether they refer to species or discrete stocks of marine fish-an issue raised previously by WGFE (ICES, 2004).

Regional Importance: No supporting information was given, which highlights the lack of published studies on important grounds for this species within the OSPAR/ICES area.

Rarity: Spurdog is routinely reported in research vessel surveys, is landed in commercial fisheries and is widespread, and so it cannot realistically be cited as Rare, as stated in the WWF proposal. Indeed, the WWF proposal subsequently stated "*Although naturally abundant*…" which contradicts their view of this species being rare.

Sensitivity: Spurdog was listed as Very Sensitive (by WWF), which is appropriate given its slow growth rate, late maturation, low fecundity, protracted gestation period, and the aggregating nature of mature and gravid females.

Keystone species: No

Decline: The WWF nomination stated that spurdog had "Severely declined", though the data presented in this nomination did not utilise many of the studies undertaken by WGEF since 2002 that would support this assertion. Indeed, ignoring the variety of exploratory stock assessments made by WGEF and in the DELASS project and even stating "*no stock assessments are known for any of the European fisheries for picked dogfish*" indicates that this nomination has not made a thorough review of existing data and studies.

The German nomination makes better use of recent WGEF studies, though the second paragraph of the Decline section is potentially misleading. The section that stated "*When a linear regression was fitted to the log transformed data of these annual landings, projections were made for a three-generation period in the past, with a reduction of landed biomass of 43%. Taking into account that this species continues to be fished nowadays and there are no perspectives of reducing exploitation levels for the future, future projections were also made, and another 43% reduction of landed biomass in the next three generations estimated*" is of dubious merit. Extrapolating such declines in landings covering a short time period (1987–2002) to three generations before and after is neither a robust nor appropriate analysis, given that it (a) ignores potential changes in fisheries patterns, (b) that these landings data may also include another species of *Squalus*, (c) applying and extrapolating log transformed data to population trajectories can result in a poor fit, and that (d) the Portuguese waters considered are the southern limit of what is considered a single NE Atlantic stock, of which the main part of the stock is further north in ICES sub-areas IIa-VIIIa.

Threats: Spurdog is still taken as a bycatch in various demersal fisheries and localised, seasonal fisheries may still target aggregations of this species. What the nomination did not highlight is that aggregations of mature and gravid females may be targeted.

Other comments (WWF Nomination): The comments on the finning regulations in the section on current management are conservation lobbying, with the sentence "*unpunished* ***finning of two out of three sharks caught***" unsubstantiated, and potentially misleading as finning is not known to be a major issue in fisheries for spurdog. The nomination should have a consistent use of one common name (it uses spurdog and picked dogfish).

Other comments (German Nomination): Some of the text in the Decline section is repeated under Management considerations. It is stated under Management considerations that spurdog is to be listed under HELCOM. Though common in the Skagerrak, the less saline waters of the Baltic are only the fringe of the geographical distribution of spurdog. Listing species on the periphery of their range and/or in unsuitable habitats is inappropriate. Furthermore, citing such questionable listings as part of the justification for conservation measures elsewhere is also inappropriate.

Completeness, sufficiency and interpretation of data: Given the studies have been undertaken by WGEF in recent years (ICES, 2006a,c), the nominations were neither robust nor as comprehensive as they could have been.

Conclusion: WGEF considered that much more data could and should have been presented in the nominations to provide a more robust argument for listing spurdog as a Threatened and Declining species in OSPAR regions I-V.

21.3.5 Leafscale gulper shark (*Centrophorus squamosus*)

Leafscale gulper shark in OSPAR regions I-V was nominated by Germany and WWF.

Global importance: Leafscale gulper shark are widely distributed in deep waters of the Atlantic, Indian and Pacific Oceans, and that the OSPAR area is not identified as of global importance is correct, though taxonomic evaluations of this genus and stocks of species are required. Once again, if the Texel/Faial criteria referred to stocks, and not species, then the OSPAR area could be considered of global importance for the North-east Atlantic stock, as WGEF considers all *C. squamosus* in the ICES/OSPAR area to constitute a single stock, though there may be linkages with the North-west Atlantic and western Africa.

Regional importance: The information presented is accurate and complete and sufficient to support the conclusion.

Rarity: The WWF nomination stated that this species was rare, though this is probably erroneous due to it being quite abundant in commercial fisheries, and as it has a widespread distribution.

Sensitivity: The information given on reproduction in the German nomination was incorrect. Compagno (1984) suggested that *Centrophorus squamosus* gives birth to litters of about 5 young (not 1, as stated), with ovarian fecundity estimates of up to 10 mature oocytes (Girard and DuBuit, 1999; Clarke *et al*., 2001). Though the gestation period is not yet known, it is likely to be at least as long as for related species, i.e. approximately 22–24 months (Last and Stevens 1994, Cox and Francis 1997). It could be stated that this is one of the most sensitive sharks, on the basis of its low reproductive output. Preliminary age estimates (Clarke *et al*., 2002) suggest that this is the longest-lived shark species yet examined.

Keystone species: No

Decline: The principal reference used to evaluate decline (White, 2003) does not appear in the reference list. The source of the information was probably the 2003 IUCN Red-list assessment, which was produced by W. T. White. This assessment contains a serious error in that the longline CPUE figures quoted are actually for *C. coelolepis* not, as stated, mixed catches of *C. coelolepis* and *C. squamosus*. These incorrect figures are the principal evidence used by the OSPAR proposal to evaluate decline. Figure 1 in the German nomination, which is not referred to in the text, is taken from the 2005 WGEF report (see Figure 3.6 in ICES (2006a)), which referred to the CPUE of *Centroscymnus coelolepis.* ICES (2006c) provides more robust time-series information.

The 2005 and 2006 meetings of the ICES Working Group on Elasmobranch Fisheries made considerable progress in producing single species CPUE series. 11 series were considered by ICES 2006c covering the period from 1993 to 2005. These series are presented in graphic form in the OSPAR proposal but are not referred to in the text. Inclusion of these in the proposal would have provided strong evidence on which to evaluate decline, however, without them, the argument is much weaker.

The evidence of declines were based on various fishery-independent and commercial time series information, with some of these surveys either restricted in temporal or spatial extent. The nomination should have added the caveats that (a) the status of leafscale gulper shark from outside these fishing grounds is unknown and (b) it is unclear as to how the commercial time series information is affected by any changes in fishing patterns.

Threats: It is stated in the proposal that a stock analysis will shortly be available from the DELASS project. This report has in fact been available since January 2003. It is also wrongly stated that Alain *et al*. (2003) found that siki sharks are a major part of the discard of the French deep-water trawl fisheries. This paper in fact showed that the entire catch of siki was landed. Inclusion of quantitative landings data would have greatly strengthened this section. Total international landings for this species are estimated in ICES 2006c. The species is taken as an important bycatch in trawl, longline and gillnet fisheries. It is exploited for its flesh for human consumption and for its squalene rich liver. It is not exploited for fish meal. The information on development of fisheries in ICES (2006a, c) is relevant here.

Completeness, sufficiency and interpretation of data: Much of the data used to support this proposal relate to a different species and are entirely useless to assess the species in question. The biological information used to demonstrate sensitivity is also incorrect. Considerable amounts of data now exist on this species, including species-specific CPUE series, international landings data and exploratory stock assessments. If these data had been used a much stronger case might have been made for OSPAR listing. Available data have shown an expansion in fisheries, increasing landings and declining catch rates, although it is recognised that some of the data on catch rates cover a short time period. Available biological data is of good quality and shows that the species is among the most vulnerable shark species in the OSPAR area. Within the section on Management considerations, the information on “ghost fishing” has been controversial, and appropriate caveats should have been mentioned.

Special note: In the Management Considerations section it should be noted that there are no obvious measures that could mitigate bycatch of this shark in commercial fisheries.

Conclusion: WGEF considered that more data could and should have been presented in the nominations to provide a more robust argument, though it is appropriate to list Leafscale gulper shark as a Threatened and Declining species in OSPAR regions I-V.

21.3.6 Gulper shark (*Centrophorus granulosus*)

Gulper shark in OSPAR regions IV-V was nominated by Germany and WWF.

Global importance: Gulper shark are widely distributed in deep waters of the Atlantic, Indian and Pacific Oceans, and that the OSPAR area is not identified as of global importance is correct, though taxonomic evaluations of this genus and stocks of species are required.

Regional importance: The information presented in the OSPAR proposal is accurate and complete and sufficient to support the conclusion.

Rarity: No information was provided, though given the uncertain taxonomic status of this species, it would be difficult to assess its rarity. The main distribution of the species in the ICES area is IXa. It is considered by WGEF to be rare in waters from VIIIc northwards.

Sensitivity: Much of the information presented is accurate and complete and sufficient to support the conclusion, though the estimated fecundity of one should be treated as a minimal value, as other studies have reported multiple embryos and there may be some taxonomic uncertainty with *C. uyato*.

Keystone species: No

Decline: The OSPAR nomination is based on an estimated decline of 80–95% in the North East Atlantic. This is taken from a 2006 IUCN Red-list evaluation which used a Delury depletion model using data from Portuguese fisheries. Details of this modelling are not published and so it is impossible to assess its appropriateness. The modelling assumes constant effort between 1990 and 2004; however, this assumption is highly questionable. Little further information is available on this species and it is likely that catches from the Portuguese fishery represent the best evidence on which to assess its status. It should also be noted that data for this species could be compromised by taxonomic mis-identifications.

Threats: Information on fisheries used in the OSPAR assessment is inaccurate. Reported landings of this species in northern area trawl fisheries were considered by WGEF to result from misidentification of *C. squamosus* (ICES, 2006c). Targeted fisheries in Sub-area IX no longer operate and recent catches are only bycatch in fisheries for black scabbard fish, and the cessation of the targeted fishery was also influenced by the market price of liver oil. In the section Threat and link to human activities, the nomination assumes that declining catches reflect declining stocks, though changes in fishing patterns and market prices may also lead to declining catches, and such caveats should have been mentioned.

Completeness, sufficiency and interpretation of data: Very limited data are available on this species. The only data available to WGEF were landings data from Portuguese, Spanish and UK fisheries. These were not considered sufficient to assess the stock. The Delury model used in the 2006 IUCN Red-list assessment was based on very large assumptions and so it provides only a very crude indication of stock status.

Conclusion: WGEF considered that the data available were insufficient to assess the status of the stock/species and that there was no robust justification in the nomination to list this species as a Threatened and Declining species. However WGEF is concerned at the declining landings of this species in IXa, especially as the biological characteristics of this species would make it sensitive to over-exploitation. The available data show a decline of about 90% since the early 1990s, though it is recognised that this is at least partly due to fluctuations in the price of liver oil or changing fishing patterns.

21.3.7 Portuguese dogfish (Centroscymnus coelolepis)

Portuguese dogfish was nominated by Germany for OSPAR regions I-IV and by WWF or OSPAR regions I-V. It is unclear as to why the German nomination excluded OSPAR region V,

Global importance: Portuguese dogfish are widely distributed in deep waters of the Atlantic and Pacific Oceans, and that the OSPAR area is not identified as of global importance is correct. Once again, if the Texel/Faial criteria referred to stocks, and not species, then the OSPAR area could be considered of global importance for the North-east Atlantic stock, as WGEF considers all *C. coelolepis* in the ICES/OSPAR area to constitute a single stock (though it has been suggested that there are distinct local populations) and that this stock may have some linkages with the North-west Atlantic and western Africa.

Regional importance: The information presented in the OSPAR proposal is accurate and complete and sufficient to support the conclusion.

Rarity: The WWF nomination stated that this species was rare, though this is probably erroneous due to it being sufficiently abundant to feature in commercial fisheries, and as it has a widespread distribution.

Sensitivity: This section of the OSPAR proposal is quoted directly from work undertaken by WGEF in 2005 (ICES, 2006a) and the working group therefore considers it to be accurate and complete. However, the information presented by WGEF in 2006 (ICES, 2006c) is more up to date and based on more robust information. It can also be stated that this is one of the most sensitive sharks, on the basis of its low reproductive output. Though age, growth and gestation period are not yet known, it is likely to be similar to that of related species.

Keystone species: No

Decline: The OSPAR proposal bases its evaluation of decline on combined catches of *C. coelolepis* and *Centrophorus squamosus* in Norwegian and Irish longline surveys between 1997 and 2001. Species specific data were recorded on these surveys and were presented in ICES (2003). These data, rather than the combined data, should have been used. Figure 1 in the German nomination, which is not referred to in the text, is taken from the 2005 WGEF report (see Figure 3.7 in ICES (2006a)) and is CPUE of *Centrophorus squamosus*. ICES (2006c) provides more robust time-series information.

The evidence of declines were based on various fishery-independent and commercial time series information, with some of these surveys either restricted in temporal or spatial extent.

The nomination should have added the caveats that (a) the status of Portuguese dogfish from outside these fishing grounds is unknown and (b) it is unclear as to how the commercial time series information is affected by any changes in fishing patterns.

Threats: It is stated in the proposal that a stock analysis will shortly be available from the DELASS project. This report has in fact been available since January 2003. The information presented on fisheries is accurate (except that siki sharks are landed, not discarded, by French fisheries), but would have been greatly improved by the inclusion of quantitative landings data. Total landings for this species in the ICES area were estimated by ICES 2006c.

Completeness, sufficiency and interpretation of data: Considerably more data are available than were used in this proposal, including species-specific CPUE series, international landings data and exploratory stock assessments. These data are available in the reports of the ICES WGEF (ICES 2003, 2006a and 2006c) and in the DELASS Report (Heessen, 2003) and would have allowed a more reliable assessment of the status of the stock to be made. Within the section Expert judgement, the German nomination incorrectly refers to gulper shark. Within the section on Management considerations, the information on "ghost fishing" has been controversial, and appropriate caveats should have been mentioned.

Special note: In the Management Considerations section it should be noted that there are no obvious measures that could mitigate bycatch of this shark in commercial fisheries.

Conclusion: WGEF considered that more data could and should have been presented in the nominations to provide a more robust argument, though it is appropriate to list Portuguese dogfish as a Threatened and Declining species in OSPAR regions I-V.

21.3.8 Thornback ray (*Raja clavata*)

Thornback ray in OSPAR regions I-IV was nominated by Germany.

Global importance: Thornback ray is widely distributed in the eastern Atlantic and Mediterranean, and the OSPAR area is not of Global Importance to the species. The sentence "*While this species used to be very common in temperate waters in the past, it was much rarer in warmer to equatorial waters*" is confusing.

Regional Importance: There was no supporting information to suggest that the OSPAR area was of Regional Importance to thornback ray.

Rarity: No information was given in the nomination, though as one of the most frequently recorded and widespread skates in the NE Atlantic, it should not be considered rare.

Sensitivity: Thornback ray can be considered sensitive, though the supporting text was poorly written. The sentence "*The young may tend to follow large objects, such as their mother*" is not an aspect of their ecology that WGEF was aware of and may be unsubstantiated conjecture (and highlights a lack of critical appraisal of source information used on FishBase). The phrase "*the persistent and rapid decline of thornback stocks*" is unsubstantiated and inappropriate.

Keystone species: No

Decline: The nomination stated that there was a "*some evidence of decline in catch rates*", which is a more fitting statement than "*the persistent and rapid decline"* mentioned elsewhere in the nomination. Attributing the decline in *R. clavata* to the study by Chevolot *et al.* (2005), which is a genetics paper, is strange seeing that papers by Walker & Heessen (1996) and Walker and Hislop (1998) or WGEF reports would have provided a more robust support. The nomination often stated that ICES advice has been for a zero TAC, but fails to mention the caveat that this is recommended if 'skates and rays' were managed under a common TAC. Though the nomination cites studies illustrating a decline in the North Sea stock(s), there is no evidence presented that would indicate declines elsewhere in the OSPAR area. Indeed, preliminary analyses of survey trends from the English Channel and Irish Sea suggest more stable abundance trends (e.g. Ellis *et al.*, 2005). The sentence "there is no doubt that the species has massively declines in the North Sea and other areas is unsubstantiated, as there is no published evidence of "massive" declines outside the North Sea.

Threats: *R. clavata* is still taken as a bycatch in various demersal fisheries and localised, seasonal fisheries may target this species, as stated in the nomination. The nomination did not highlight the fact that seasonal aggregations of mature females could be targeted.

Other comments: The section on Sufficiency of data stated "*Landing data on Raja clavata are available for OSPAR Maritime Area*", though no accurate and complete species-specific landings data are available.

The section on management considerations stated "Raja clavata stocks would benefit from a zero fishing quota, and a reduction of bycatch in mixed fisheries. Incidentally caught specimens should be immediately returned alive into the sea", though such a sweeping statement is not justified as there is no indication that catch rates have declined throughout the OSPAR region.

The sub-section entitled ICES Evaluation correctly stated that WGEF concluded that the distribution area and abundance had declined, though failed to mention that this was for *R. clavata* in the North Sea. WGEF has not made comparable statements for this species in other ICES areas.

The section on Threat and link to human activities stated "*The species is now extinct in the Wadden Sea, restricted to small areas in the central North Sea (Westernhagen, 1998)*", though all available information suggest it is mostly restricted to the south-western North Sea, from the Thames to the Wash (see ICES, 2006a; ICES-Fishmap) and not the central North Sea.

The section on Current status stated that *R. clavata* is "*Lower risk/near threatened (IUCN 2000); re-evaluation is in preparation, with an upgrading expected*". In reality the IUCN (2006) re-evaluation did not upgrade *Raja clavata* to a Threatened status, and to imply otherwise is both misleading and inappropriate. As per many of the nominations, *R. clavata* has also been "*Accepted by HELCOM HABITAT 2006 for listing, and is part of the HELCOM red list"*, though once again, the less saline waters of the Baltic are not optimal habitat for *R. clavata* and using such questionable listings as a basis for further listings is not appropriate.

Completeness, sufficiency and interpretation of data: There were insufficient data presented to assess *R. clavata* over its entire range, and no evidence of widespread declines across OSPAR regions III-IV. Though declines in the North Sea (OSPAR region II) have been documented, and some of this information was included in the nomination, the exclusion of data from elsewhere in the OSPAR region is a cause of concern.

Conclusion: WGEF considered that there were insufficient data presented to conclude that thornback ray should be listed as a threatened and/or declining species over OSPAR regions I-IV. The North Sea thornback ray stock(s) have declined and sufficient information could have been presented to justify listing *R. clavata* as a Threatened and Declining species in OSPAR region II (North Sea).

21.3.9 White skate (Rostroraja alba)

White skate in OSPAR regions II-IV was nominated by Germany.

Global importance: White skate is (or was) widely distributed in the eastern Atlantic and Mediterranean, and the OSPAR area is not of Global Importance to the species. The nomination stated that white skate was "most common around the British Isles" which is probably incorrect, as historical accounts suggest this southerly species was on locally abundant in certain areas of the western and southern parts of the British Isles, with these areas being the northern limits for the species. This section also stated "*Nevertheless, as the populations of this species are severely declining throughout its range*" is unsubstantiated, and the status of white skate off southern Africa is unclear.

Regional Importance: There was no supporting information to suggest that parts of the OSPAR area are of Regional Importance to white skate, which reflects the lack of current information on this species. Anecdotal, historical information would suggest that this species was locally abundant in certain areas, though none of this information was presented.

Rarity: Though no information was given in the nomination, this species could be considered as now being rare due to its absence in research vessel surveys (ICES, 2006b) and scarcity in commercial catches (ICES, 2006c).

Sensitivity: White skate can be considered sensitive from a biological viewpoint, though identifying them as "sensitive to eutrophication" seems irrelevant.

Keystone species: No

Decline: There are several pieces of anecdotal evidence that could have been presented and several papers that could have been cited (e.g. Quéro & Cendrero, 1996; Rogers & Ellis, 2000), to better document the widespread disappearance of this species. In terms of the statement that it was "last sighted 1880" is erroneous, as they were still present in catches during the second half of the 20th century.

Threats: White skate may still be taken as a bycatch in various demersal fisheries.

Other comments: The statement "Studies of the population genetics are urgently necessary to assess possible genetic differences between populations of different areas" seems superfluous, given that it would be very difficult to get a meaningful sample size. In terms of 'urgent requirements', identifying any remnant populations would seem to be far more important. In terms of Management considerations, measures to reduce fishing mortality are very relevant, though "efforts to reduce eutrophication" are irrelevant.

Completeness, sufficiency and interpretation of data: There are insufficient data to quantify declines in *Rostroraja alba* over its entire range, though there is consistent anecdotal evidence of widespread declines in OSPAR regions III and IV. Though some of this information was cited, not all the available information was included in the nomination.

Conclusion: Although heavily dependent on anecdotal information and expert judgement, WGEF considered that there was a justifiable rationale in the nomination for listing white skate as a Threatened and Declining species in OSPAR regions II-IV.

21.3.10 Angel shark (*Squatina squatina*)

Angel shark in OSPAR regions II-IV was nominated by Germany.

Global importance: Angel shark is widely distributed in the eastern Atlantic and Mediterranean, and the OSPAR area is not of Global Importance to the species.

Regional Importance: There was no supporting information to suggest that parts of the OSPAR area are of Regional Importance to angel shark, which reflects the lack of information on this species. Given that anecdotal information on this species suggests that they can be locally abundant, as also documented for other species of angel shark elsewhere in the world, it may be that they are of Regional importance.

Rarity: Though no information was given in the nomination, this species could be considered as now being rare due to its absence in research vessel surveys (ICES, 2006b) and scarcity in commercial catches (ICES, 2006c).

Sensitivity: Angel shark can be considered highly sensitive from a biological viewpoint, as stated in the nomination, though the sensitivity to eutrophication is unsubstantiated and potentially misleading.

Keystone species: No information

Decline: The nomination included much anecdotal information that indicates that a species that was formerly recorded sporadically or was locally abundant is now rarely observed. Landings data (Figure 1) are incomplete, and better data for the Celtic Seas eco-region are available in ICES (2006c).

Threats: Angel shark may still be taken as a bycatch in various demersal fisheries, especially in inshore waters.

Other comments: As per many of the nominations, *S. squatina* has been listed as "*Endangered under IUCN criteria in HELCOM area"*, though once again, the less saline waters of the Baltic are not optimal habitat for *S. squatina* and using such questionable listings as a basis for further listings is not appropriate.

Completeness, sufficiency and interpretation of data: There are currently insufficient data to fully quantify declines in *Squatina squatina* over its entire range, though there is consistent anecdotal evidence of widespread declines in OSPAR regions II and IV and semi-quantitative data shows a decline in OSPAR region III. Most of the available information was included, though the most recent WGEF report (ICES, 2006c) provides a better indication of declines in commercial landings.

Conclusion: Although heavily dependent on anecdotal information and expert judgement, WGEF considered that there was a justifiable rationale in the nomination for listing angel shark as a Threatened and Declining species in OSPAR regions II-IV.

21.3.11 Summary

WGEF has reviewed nominations for nine elasmobranchs species. Nominations of the various species were inconsistent in the type and quality of data included, and the formats of the WWF and German nominations were very different. The OSPAR nominations also used a variety of terminology (extinct, extirpated, severe decline etc.), with the use of such terms not applied consistently.

It is suggested that OSPAR could usefully adopt a standardised scheme for applying the Texel-Faial criteria and a standardised template for presenting species nominations. More robust guidelines for the application of the decline criterion are also needed using a standardised terminology.

WWF and Germany had both submitted nominations for four species.

It is suggested that OSPAR members should be encouraged to submit joint nominations, so that only one nomination per species is prepared and reviewed, and hopefully this nomination can then be of better quality.

The Global importance criterion was not applied consistently, due to some nominations applying it at the species level, others at the stock level.

OSPAR should be asked to explicitly state whether the Texel-Faial criteria are to be applied at the species level or at the stock level, as this was not consistently applied in the current nominations.

Several of the species nominations cited other conservation listings under the Management considerations section (e.g. IUCN and HELCOM listings). In terms of the latter, the HELCOM area only covers the Baltic Sea and the Kattegat as far north as 57° 44.43'N, and so would only cover marginal habitat for porbeagle, thornback ray and, to a lesser extent, spurdog.

WGEF felt it was inappropriate to list species on the fringes of their distribution and that referring to such questionable listings is not a robust argument to support listing under OSPAR.

21.4 References

Allain, V., Biseau, A. & Kergoat, B. 2003. Preliminary estimates of French deepwater fishery discards in the Northeast Atlantic Ocean. Fisheries Research, 60(1): 185–192.

Anon. 2003a. Report of the subgroup on resource status (SGRST) of the Scientific, Technical and Economic for Fisheries (STECF): Elasmobranch Fisheries. Brussels 22–25 July 2003.

Bigelow, H.B. and Schroeder, W.C. 1948. Sharks. In Fishes of the Western North Atlantic Part One. Memoir one, Sears Foundation for Marine Research, Yale University, 576pp.

Bonfil, R. 1990. Contribution to the fisheries biology of the silky shark, Carcharhinus falciformis (Bibron, 1839) from Yucatan, Mexico. MS Thesis University College of North Wales, Bangor, UK. 77pp.

Bonfil, R. 1994. Overview of world elasmobranch fisheries. FAO Fisheries Technical Paper, No. 341. FAO, Rome, 119 pp.

Bonfil, R.S., D. De Anda and R. Mena, 1990. Shark fisheries in Mexico: The case of Yucatan as an example. In: H.L. Pratt lr., S.H. Gruber and T. Taniuchi (eds.). Elasmobranchs as living resources: advances in biology, ecology, systematics, and the status of fisheries. NOAA Techn. Rep. NMFS 90, pp. 427–441.

Branstetter, S. 1987. Age and growth estimates for blacktip, Carcharhinus limbatus , and spinner, C. brevipinna , sharks from the northwestern Gulf of Mexico. SO: Copeia, no. 4, pp. 964-974.

Cannizzaro L., Garofano G., Levi D., Rizzo P., Gancitano S. 1995a. Raja clavata (L., 1758) nel Canale di Sicilia: crescita, distribuzione e abbondanza. Biol. Mar. Medit., 2 (2): 257–262

Cannizzaro L., Rizzo P., Levi D., Gancitano S. 1995b. Age determination and growth of Squalus blainvillei (Risso, 1826). Fish. Res., 23: 113–125.

Casas, J.M., C. Piñeiro and R. Bañón (2001). Maturity and other biological aspects of main deep-water squalid sharks, in the north and northwest of the Iberian Peninsula (ICES Division VIIIc, Ixa and Ixb). NAFO, 2001. Poster 58. Symposium "Deep-sea Fisheries".

Castro, J., J.M. de la Serna, D. Macias, and J. Mejuto, 2000. Preliminary scientific estimates of bycatch landings by the Spanish surface longline fleet in 1997 and 1998. (SCRS/99/082). ICCAT. Collect. Sci. Pap. vol. 51, no. 1, pp. 1882–1894.

Charuau, A. and Biseau, A. 1989. Etude d'une gestion optimale des pecheries de langoustine en de poissons demersaux en Mer Celtique. Rapport IFREMER DRV-89.009, 89.010 and 89.011-RH Lorient (three parts).

Chevolot, M., Reusch, T.B.H., Boele-Bos, S., Stam, W.T. & Olsen, J.L. 2005. Characterization and isolation of DNA microsatellite primers in *Raja clavata* L. (thornback ray, Rajidae). Molecular Ecology Notes, 5: 427–429.

Clarke, M.W., Connolly, P.L. and Bracken, J.J. 2001. Aspects of the reproduction of deepwater sharks *Centroscymnus coelolepis* and *Centrophorus squamosus* from west of Ireland and Scotland. Journal of the Marine Bbiological Association of the UK. 81. 1019–1029.

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

Compagno, L.J.V., 1984. FAO species catalogue. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Sypnosis Nº 125, Vol. 4 Part 2. 633pp.

Cox, G., and Francis, M.. 1997. Sharks and rays of New Zealand. Cambridge University Press, Christchurch, New Zealand.

Ellis, J.R., Dulvy, N.K., Jennings, S., Parker-Humphreys, M. and Rogers, S.I. 2005b. Assessing the status of demersal elasmobranchs in UK waters: A review. Journal of the Marine Biological Association of the United Kingdom, 85: 1025–1047.

Fernández, A., C. Rodriguez-Cabello, R. Gancedo, A. Punzón, I. Olaso and O. Cendrero, 2002. Overview of continental shelf elasmobranch fisheries in the Cantabrian Sea. NAFO Symposium on Elasmobranch Fisheries. Santiago de Compostela (Spain), 11–13 September 2002. NAFO, SCR Doc. 02/115.

Girard, M. 2000. Distribution et reproduction de deux espèces de requins de grands fonds, les «sikis», Centrophorus squamosus et Centroscymnus coelolepis exploités dans l'Atlantique Nord-Est. Rennes: L'Ecole Nationale Superieure Agronomique de Rennes, These de Docteur, 214 pp.

Girard, M. and DuBuit, M.H. 1999. Reproductive biology of two deepwater sharks from west of the British Isles, *Centrophorus squamosus* and *Centroscymnus coelolepis* (Chondrichthyes: Squalidae). Journal of the Marine Biological Association of the UK, 79. 923–231.

Guitart Manday, D. 1975. Las pesquerias pelágico-oceanicas de corto radio de acción en la región noroccidental de Cuba. Academia de Ciencias de Cuba, Instituto de Oceanología. Serie Oceanología 31. 26 pp.

Hareide, N.R., J. Carlson, M. Clarke, S. Clarke, J. Ellis, S. Fordham, S. Fowler, M. Pinho, C. Raymakers, F. Serena, B. Seret, and S. Polti. 2007. European Shark Fisheries: a preliminary investigation into fisheries, conversion factors, trade products, markets and management measures. European Elasmobranch Association, 59 pp.

Heessen, H.J.L. (Ed.) 2003. Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 603 p.

ICES, 1997 Report of the study group on elasmobranch fishes. ICES CM, CM 1997/G:2: 123pp.

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

ICES. 2003. Report of the Study Group of the Elasmobranch Fishes (SGEF). 28 April–2 May 2003. Vigo, Spain. ICES CM 2003/G:09

ICES. 2004. Report of the Working Group on Fish Ecology (WGFE). 2–7 April 2004, ICES, Copenhagen. ICES CM 2004/G:09; 257pp.

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

ICES. 2006b. Report of the Working Group on Fish Ecology (WGFE), 13–17 March 2006, ICES, Copenhagen. ICES CM 2006/LRC:06, 154 pp.

ICES. 2006c. Report of the Working Group of the Elasmobranch Fishes (WGEF). 14–21 June 2006, ICES, Copenhagen. ICES CM 2006/ACFM:31 Ref. LRC.

Kohler, N.E., J.G. Casey and P.A. Turner 1995. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fish. Bull. 93: 412–418.

Last, P.R. & Stevens, J.D. 1994. Sharks and Rays of Australia, pp. 259–260. CSIRO. 513 pp.

Lyle, J.M. 1987. Northern pelagic fish stock research programme: summary of catch and effort data. Dept. of Industries and Development, Northern Territory. Fish. Rep. 16. 54 pp.

Moura, T., Bordalo-Machado, P. and Figueiredo, I. 2007. Trends in landings and effort data for deepwater sharks' fishery off Portugal mainland. Working document to be presented to WGEF Galway, June 2007.

OSPAR. 2003. Criteria for the identification of species and habitats in need of protection and their method of application (The Texel-Faial Criteria). Reference Number: 2003–13; OSPAR 03/17/1-E, Annex 5; 13pp.

OSPAR. 2006a. Case reports for the initial list of threatened and/or declining species and habitats in the OSPAR maritime area. Publication Number 2006/276, 1–150.

OSPAR. 2006b. Species nominations to the initial OSPAR list of Threatened and/or Declining Species and Habitats. Presented by Germany. Meeting of the Working Group on Marine Protected Areas Species and Habitats (MASH), Horta (The Azores): 2–5 October 2006. MASH 06/3/8-E, 43 pp.

OSPAR. 2006c. Completing the OSPAR List of Threatened and/or Declining Species and Habitats: nominations for addition of species and habitats to the Initial List Presented by WWF Meeting of the Working Group on Marine Protected Areas Species and Habitats (MASH), Horta (The Azores): 2–5 October 2006. MASH 06/3/10-E, 48pp.

Quéro, J.C. & Cendrero, O. 1996. Incidence de la pêche sur la biodiversité ichtyologique marine: Le bassin d'Arcachon et le plateau continental sud Gascogne. Cybium, 20:323–356.

Rogers, S.I. & Ellis, J.R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. ICES Journal of Marine Science, 57: 866–881.

Rosa, A., G. Menezes, G., Melo, O., Pinho., M.R. 2006. Weight–length relationships of 33 demersal fish species from Azores archipelago. Fisheries Research 80 (2006) 329–332.

Stevens, J.D. 1975. Vertebral rings as a means of age determination in the blue shark (Prionace glauca). Journal of the Marine Biological Association of the United Kingdom, 55: 657–665.

Van der Elst, R.1981. A guide to the common sea fishes of Southern Africa.C. Struik, Cape Town. 367 pp.

Walker P.A. & Heessen H.J.L. 1996. Long-term changes in ray populations in the North Sea. ICES Journal of Marine Science, 53, 1085–1093.

Walker P.A. & Hislop J.R.G. 1998. Sensitive skates or resilient rays? Spatial and temporal shifts in ray species composition in the central and northwestern North Sea between 1930 and the present day. ICES Journal of Marine Science, 55, 392–402.

Table 21.1. Available conversion factors for elasmobranchs.

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Alopias vulpinus		$DW = 0{,}298\ TL^{0{,}974}$					97/50 DG XIV
Alopias vulpinus		TL = 1,733FL + 14,778					97/50 DG XIV
Galeorhinus galeus		$TL = 59{,}9703\ DW^{0{,}315287}$					97/50 DG XIV
Isurus oxyrinchus		$TL = 66{,}7584\ DW^{0{,}323385}$					97/50 DG XIV
Isurus oxyrinchus		TL = 1,134 FL – 1,811					97/50 DG XIV
Lamna nasus		$DW = -\ 7{,}680\ TL^{2{,}050}$					97/50 DG XIV
Lamna nasus		TL = 1,115 FL + 12,883					97/50 DG XIV
Prionace glauca		$DW = 1{,}787 \times 10\text{-}6\ TL^{3{,}096}$					97/50 DG XIV
Prionace glauca		TL = 1,175FL + 4,103					97/50 DG XIV
Sphyrna zygaena		TL = 1,252 FL + 5,215					97/50 DG XIV
Cetorhinus maximus		$W = 0.00494\ TL^{3.00}$					Bigelow *et al.*, 1948
Carcharhinus plumbeus		$W = 0.00419\ TL^{3.48}$					Bonfil *et al.*, 1990
Carcharhinus falciformis		$W = 0.0019\ TL^{3.19}$					Bonfil, 1990
Odontaspis ferox		$W = 0.00589\ TL^{3.00}$					Bonfil, 1995
Carcharhinus falciformis		$W = 0.00201\ TL^{3.23}$					Branstetter, 1975
Carcharhinus brevipinna		$W = 0.00751\ TL^{2.97}$					Branstetter, 1987
Carcharhinus limbatus		$W = 0.0144\ TL^{2.87}$					Branstetter, 1987
Sphyrna lewini		$W = 0.0126\ TL^{2.81}$					Branstetter, 1987
Carcharhinus falciformis		$W = 0.0464\ SL^{2.75}$					Brouard *et al*., 1984
Hexanchus nakamurai		$W = 0.00124\ FL^{3.47}$					Brouard *et al.*, 1984
Squalus megalops		$W = 0.0126\ SL^{2.88}$					Brouard *et al*., 1984
Squalus blainvillei	F	$W = 0.0037\ TL^{3.07}$					Cannizzaro *et al*., 1995
Squalus blainvillei	M	$W = 0.0033\ TL^{3.09}$					Cannizzaro *et al.*, 1995
Centrophorus granulosus		$W = 0{,}0002\ TL^{3{,}7225}$					Casas *et al*., 2001.
Centrophorus squamosus		$W = 0{,}0002\ TL^{3{,}6554}$					Casas *et al*., 2001.
Centroscymnus coelolepis		$W = 0{,}0002\ TL^{3{,}8188}$					Casas *et al.*, 2001.
Deania calcea		$W = 0{,}0007\ TL^{3{,}4158}$					Casas *et al.*, 2001.

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Scymnodon ringens		$W = 0{,}005\ TL^{3{,}0841}$					Casas *et al.,* 2001.
Prionace glauca		TW =DW 2.4074					Castro *et al.*, 2000
Leucoraja naevus		$W = 2{,}36 \times 10^{-6}\ TL^{3{,}233}$					Charuau & Biseau, 1989
Sphyrna lewini	F	$W = 0.00282\ TL^{3.13}$					Chen *et al*., 1990
Sphyrna lewini	M	$W = 0.00135\ TL^{3.25}$					Chen *et al.,* 1990
Carcharodon carcharias		$W = 0.00827\ TL^{3.14}$					Compagno, 1984
Galeorhinus galeus		$DW = 0{,}0099\ FL^{2{,}8838}$					Heessen 2003
Galeus melastomus		$W = 0{,}0018\ TL^{3{,}1035}$					Heessen 2003
Leucoraja naevus		$W = 0{,}0037\ TL^{3{,}1403}$					Heessen 2003
Leucoraja naevus		TL = 0,5932 Wth – 1,1682					Heessen 2003
Mustelus asterias		$DW = 0{,}003\ FL^{3{,}1196}$					Heessen 2003
Mustelus mustelus		$DW = 0{,}0092\ FL^{2{,}8563}$					Heessen 2003
Raja clavata		$W = 0{,}0035\ TL^{3{,}1705}$					Heessen 2003
Raja clavata		TL = 0,7167 Wth – 0,343					Heessen 2003
Raja montagui		$W = 0{,}0011\ TL^{3{,}4613}$					Heessen 2003
Scyliorhinus canicula		$DW = 0.0563\ TL^{2{,}3183}$					Heessen 2003
Scyliorhinus canicula		$W = 0.0021\ TL^{3.1189}$					Heessen 2003
Scyliorhinus canicula		W = 1.165 GW + 15.679					Heessen 2003
Scyliorhinus canicula	M	$W = 0.0018\ TL^{3.1573}$					Heessen 2003
Scyliorhinus canicula	M	$GW = 0.0017\ TL^{3.1307}$					Heessen 2003
Scyliorhinus canicula		W=1.156 GW+8.28					Heessen 2003
Scyliorhinus canicula	F	$W = 0.0016\ TL^{3.2037}$					Heessen 2003
Scyliorhinus canicula	F	$GW = 0.0019\ TL^{3.1009}$					Heessen 2003
Scyliorhinus canicula		W=1.290 GW-16.16					Heessen 2003
Squalus acanthias		$DW = 0{,}0035\ FL^{3{,}0626}$					Heessen 2003
Leucoraja naevus		$W = 0.00236\ TL^{3.23}$					Dorel, 1986
Raja brachyura		W = 0.00281 TL 3.23					Dorel, 1986
Raja brachyura		$W = 0.00281\ TL^{3.23}$					Dorel, 1986

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Raja clavata		$W = 0.00319\ TL^{3.19}$					Dorel, 1986
Raja clavata		$W = 0.00324\ TL^{3.20}$					Dorel, 1986
Raja microocellata		$W = 0.00494\ TL^{3.12}$					Dorel, 1986
Raja montagui		$W = 0.00201\ TL^{3.31}$					Dorel, 1986
Raja undulata		$W = 0.00415\ TL^{3.12}$					Dorel, 1986
Scyliorhinus canicula		$W = 0.00308\ TL^{3.03}$					Dorel, 1986
Scyliorhinus canicula		$W = 0.00364\ TL^{2.78}$					Dorel, 1986
Centrophorus granulosus		$W = 0{,}000338\ TL^{3{,}5902}$					FAIR CT 95 0655
Centrophorus squamosus		$W = 0{,}000373\ TL^{2{,}3591}$					FAIR CT 95 0655
Centroscymnus coelolepis		$W = 0{,}167179\ TL^{2{,}3678}$					FAIR CT 95 0655
Deania calcea		$W = 0{,}000190\ TL^{3{,}6890}$					FAIR CT 95 0655
Etmopterus spinax		$W = 0{,}002151\ TL^{3{,}1903}$					FAIR CT 95 0655
Galeus melastomus		$W = 0{,}008609\ TL^{2{,}7347}$					FAIR CT 95 0655
Scymnodon ringens		$W = 0{,}005118\ TL^{3{,}0857}$					FAIR CT 95 0655
Leucoraja naevus		WL = 0.2305 TL + 0.2003					Fernández *et al*., 2001
Leucoraja naevus		Wth = 0.5734 TL – 0.4038					Fernández *et al*., 2001
Leucoraja naevus		WW = 0.1941 W + 8.1796					Fernández *et al*., 2001
Raja clavata		WL = 0.33 TL – 0.9383					Fernández *et al.,* 2001
Raja clavata		Wth = 0.7004 TL + 0.0773					Fernández *et al.,* 2001
Raja clavata		WW = 0.2415 W + 8.339					Fernández *et al*., 2001
Raja montagui		WL = 0.2919 TL – 0.2516					Fernández *et al*., 2001
Raja montagui		Wth = 0.6491 TL + 1.4817					Fernández *et al*., 2001
Raja montagui		WW = 0.2422 W + 11.97					Fernández *et al*., 2001
Centrophorus squamosus	M	$W = 2{,}10 \times 10^{-5}\ TL^{2{,}7}$					Girard, 2000
Centroscymnus coelolepis	M	$W = 2{,}10 \times 10^{-5}\ TL^{2{,}79}$					Girard, 2000
Centrophorus squamosus	F	$W = 1{,}10 \times 10^{-6}$ TL 3,35					Girard, 2001
Centroscymnus coelolepis	F	$W = 5{,}10 \times 10^{-7}\ TL^{3{,}61}$					Girard, 2001
Centroscyllium fabricii		$W = 0.0009\ TL^{3.42}$					Gordon *et al*., 1994
Centroscymnus coelolepis		$W = 0.0043\ TL^{3.12}$					Gordon *et al*., 1994

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Deania calcea		$W = 0.0012\ TL^{3.26}$					Gordon *et al.,* 1994
Etmopterus princeps		$W = 0.0028\ TL^{3.15}$					Gordon *et al.*, 1994
Etmopterus spinax		$W = 0.0018\ TL^{3.24}$					Gordon *et al.*, 1994
Scymnodon ringens		$W = 0.0043\ TL^{3.12}$					Gordon *et al.*, 1994
Carcharhinus falciformis		$W = 0.00878\ SL^{3.09}$					Guitart Manday, 1975
Isurus oxyrinchus		$W = 0.0012\ FL^{3.46}$					Guitart Manday, 1975
Squalus acanthias		$W = 0.00396\ TL^{3.00}$					Gunderson *et al.*, 1988
Galeorhinus galeus		$W = 0.0068\ FL^{2.94}$					Hurst *et al.,* 1990
Centroscymnus coelolepis		$W = 0,0043\ TL^{3,12}$					ICES CM 1997/G :2
Centroscymnus crepidater		$W = 0,0024\ TL^{3,25}$					ICES CM 1997/G :2
Dalatias licha	M	$W = 5,13x10\text{-}5\ TL^{2,52}$					ICES CM 1997/G :2
Galeus melastomus	F	$W = 0,002\ TL^{3.05}$					ICES CM 1997/G :2
Scymnodon ringens		$W = 0,0043\ TL^{3,12}$					ICES CM 1997/G :2
Dalatias licha	F	$W = 1,50x10^{-4}\ TL^{2,35}$					ICES CM 1997/G :3
Galeus melastomus	M	$W = 0,002\ TL^{3.07}$					ICES CM 1997/G :3
Centrophorus squamosus		$W = 0,002072\ TL^{3,214}$					Irish Marine Inst. Survey
Centroscymnus coelolepis		$W = 0,0004583\ TL^{3,611}$					Irish Marine Inst. Survey
Deania calcea		$W = 0,001230\ TL^{3,258}$					Irish Marine Inst. Survey
Rhizoprionodon acutus	F	W = 0.00233 FL 3.14					Kasim, 1991
Rhizoprionodon acutus	M	W = 0.00964 FL 2.85					Kasim, 1991
Alopias superciliosus		$W= 0.00911\ FL^{3.08}$					Kohler *et al.*, 1995
Alopias superciliosus		FL = 0.5598 TL + 17.6660					Kohler *et al.*, 1995
Alopias vulpinus		$W= 0.0183FL^{2.52}$					Kohler *et al.*, 1995
Alopias vulpinus		FL = 0.5474 TL + 0.8865					Kohler *et al.*, 1995
Carcharhinus altimus		$W= 0.00102FL^{3.46}$					Kohler *et al.*, 1995
Carcharhinus altimus		FL = 0.8074 TL + 0.9872					Kohler *et al.*, 1995
Carcharhinus falciformis		$W = 0.0154FL^{2.92}$					Kohler *et al.*, 1995
Carcharhinus falciformis		FL = 0.8388 TL - 2.6510					Kohler *et al.*, 1995
Carcharhinus obscurus		$W = 0.0324FL^{2.79}$					Kohler *et al.*, 1995

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Carcharhinus obscurus		FL = 0.8396 TL - 3.1902					Kohler *et al.*, 1995
Carcharhinus plumbeus		$W = 0.0109\ FL^{3.01}$					Kohler *et al.*, 1995
Carcharhinus plumbeus		FL = 0.8175 TL + 2.5675					Kohler *et al.*, 1995
Carcharodon carcharias		$W = 0.00758FL^{3.09}$					Kohler *et al.*, 1995
Carcharodon carcharias		FL = 0.9442 TL - 5.7441					Kohler *et al.*, 1995
Isurus oxyrinchus		$W = 0.00524\ FL^{3.14}$					Kohler *et al.*, 1995
Isurus oxyrinchus		FL = 0.9286 TL - 1.7101					Kohler *et al.*, 1995
Lamna nasus		$W = 0.0148\ TL^{2.96}$					Kohler *et al.,* 1995
Lamna nasus		FL = 0.8971 TL + 0.9877					Kohler *et al.,* 1995
Prionace glauca		$W=0.0000031841\ FL^{3.1313}$					Kohler *et al.*, 1995
Prionace glauca		$W = 0.00318FL^{3.13}$					Kohler *et al.*, 1995
Prionace glauca		FL = 0.8313 TL + 1.3908					Kohler *et al.*, 1995
Sphyrna lewini		$W = 0.00777\ FL^{3.07}$					Kohler *et al.*, 1995
Sphyrna lewini		FL = 0.7756 TL - 0.3132					Kohler *et al.*, 1995
Rhizoprionodon acutus		$W = 0.0079\ TL^{2.99}$					Krishnamoorthi *et al.*, 1986
Sphyrna lewini		$W = 0.00556\ TL^{3.16}$					Letourneur *et al.*, 1998
Carcharhinus melanopterus		$W = 0.00325\ TL^{3.65}$					Lyle, 1987
Prionace glauca		W = GW 1.1938					Mejuto, 2001
Etmopterus spinax		$W = 0.003\ TL^{3.13}$					Merella *et al.*, 1997
Raja asterias		$W = 0.0018\ TL^{3.27}$					Merella *et al.*, 1997
Raja clavata		$W = 0.0024\ TL^{3.20}$					Merella *et al.*, 1997
Raja miraletus		$W = 0.0018\ TL^{3.25}$					Merella *et al.*, 1997
Raja polystigma		$W = 0.0003\ TL^{3.78}$					Merella *et al.,* 1997
Scyliorhinus canicula		$W = 0.0016\ TL^{3.16}$					Merella *et al.*, 1997
Squalus blainvillei		$W = 0.012\ TL^{3.37}$					Merella *et al.*, 1997
Raja miraletus		$W = 0.00246\ TL^{3.29}$					Moutopoulos *et al.,* 2000
Raja radula		$W = 0.00515\ TL^{3.07}$					Moutopoulos *et al.*, 2000
Alopias superciliosus		$W= 0.0351\ SL^{2.44}$					Quevedo *et al.*, 1984
Carcharhinus falciformis		$W = 0.019FL^{2.93}$					Quevedo *et al.*, 1984

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Isurus oxyrinchus		$W = 0.05\ FL^{2.32}$					Quevedo *et al.*, 1984
Raja clavata	F	$W = 0.00843\ TL^{3.30}$					Ryland *et al.*, 1984
Raja clavata	M	$W = 0.00187\ TL^{3.17}$					Ryland *et al.*, 1984
Raja microocellata	F	$W = 0.00489\ TL^{3.41}$					Ryland *et al.*, 1984
Raja microocellata	M	$W = 0.00893\ TL^{3.31}$					Ryland *et al.*, 1984
Raja montagui	F	$W = 0.00364\ TL^{3.44}$					Ryland *et al.*, 1984
Raja montagui	M	$W = 0.00183\ TL^{3.24}$					Ryland *et al.*, 1984
Sphyrna lewini		$W = 0.00399\ TL^{3.03}$					Stevens *et al.*, 1989
Sphyrna mokarran		$W = 0.00123\ TL^{3.24}$					Stevens *et al.*, 1989
Carcharhinus plumbeus		$W = 0.0058\ TL^{3.31}$					Stevens *et al.*, 1991
Prionace glauca	F	$W = 0.0131\ TL^{3.2}$					Stevens, 1975
Prionace glauca	M	$W = 0.00392\ TL^{3.41}$					Stevens, 1975
Raja miraletus		$W = 0.001\ TL^{3.44}$					Ungaro, 2001
Carcharhinus brachyurus		$W= 0.0104\ TL^{2.9}$					van der Elst, 1981
Carcharhinus obscurus		$W = 0.00945\ TL^{2.93}$					van der Elst, 1981
Carcharias taurus		$W = 0.0106\ TL^{2.94}$					van der Elst, 1981
Carcharodon carcharias		$W = 0.00321\ TL^{3.18}$					van der Elst, 1981
Dasyatis pastinaca		$W = 0.0251\ DW^{3.11}$					van der Elst, 1981
Galeorhinus galeus		$W = 0.0109\ TL^{2.83}$					van der Elst, 1981
Himantura uarnak		$W = 0.0848\ DW^{2.72}$					van der Elst, 1981
Pristis pectinata		$W = 0.00171\ TL^{3.04}$					van der Elst, 1981
Pteromylaeus bovinus		W = 0.00025 DW 3.84					van der Elst, 1981
Pteromylaeus bovinus		$W = 0.00025\ DW^{3.84}$					van der Elst, 1981
Rhizoprionodon acutus		$W = 0.0151\ TL^{2.72}$					van der Elst, 1981
Sphyrna zygaena		$W = 0.00142\ TL^{3.3}$					van der Elst, 1981
Squalus acanthias		$W = 0.00147\ TL^{3.22}$					van der Elst, 1981
Squalus megalops		$W = 0.0116\ TL^{2.78}$					van der Elst, 1981
Himantura uarnak		$W = 0.0624\ DW^{2.83}$					van der Elst, 1988
Carcharhinus limbatus		$W = 0.00714\ TL^{3.01}$					van der Elst,1981

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Centroscymnus coelolepis	F	$W = 0.00061\ TL^{3.71}$					Yano *et al*., 1984
Centroscymnus coelolepis	M	$W = 0.0231\ TL^{2.81}$					Yano *et al*., 1984
Centroscymnus owstoni	F	W = 0.00102 TL 3.61					Yano *et al*., 1984
Centroscymnus owstoni	M	W = 0.0463 TL 2.68					Yano *et al*., 1984
Centroscymnus crepidater		$W = 0.0003\ TL^{3.67}$	0.959	57	44.0–94.0 cm	Azores	Rosa *et al*., 2006
Deania calcea		$W = 0.0005\ TL^{3.480}$	0.916	381	61.0–111.0 cm	Azores	Rosa *et al*., 2006
Deania profundorum		$W = 0.0004\ TL^{3.5}$	0.957	219	36.0–104.0 cm	Azores	Rosa *et al*., 2006
Dipturus batis		$W = 0.0010\ TL^{3.391}$	0.986	32	52.0–130.0 cm	Azores	Rosa *et al*., 2006
Etmopterus pusillus		$W = 0.0030\ TL^{3.097}$	0.949	307	21.5–49.0 cm	Azores	Rosa *et al*., 2006
Etmopterus spinax		$W = 0.0050\ TL^{2.934}$	0.947	987	17.5–48.0 cm	Azores	Rosa *et al*., 2006
Galeorhinus galeus		W = 0.0050 TL 2.951	0.983	235	49.0–162,0 cm	Azores	Rosa *et al*., 2006
Leucoraja fullonica		$W = 0.0016\ TL^{3.232}$	0.935	13	53.0–93.0 cm	Azores	Rosa *et al*., 2006
Raja clavata		$W = 0.0058\ TL^{3.022}$	0.930	404	37.0–89.0 cm	Azores	Rosa *et al*., 2006
Centrophorus squamosus		$W = 0{,}0000007\ TL^{3{,}413}$	0.98	12	81,5–110 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Centroscymnus coelolepis		$W= 0{,}19\ e^{0{,}0373TL}$	0.7742	18	79,5–112 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Deania spp.		W = 0,106 TL - 6,4774	0.8996	10	82–108 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Galeorhinus galeus		$GW= 0{,}00000587\ FL^{2{,}9964}$	0.91145	83	56–140 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Galeus melastomus		W= 34,154 TL - 1441,1	0.8627	18	43–71 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Leucoraja fullonica		$W = 0{,}000001042\ L^{3{,}2399}$	0.93275	26	32–99 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Leucoraja naevus		$W= 0{,}000002773\ L^{3{,}1332}$	0.925	678	17,5–72 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Mustelus spp.		$GW= 0{,}00000766\ FL^{2{,}9338}$	0.8378	130	55–112 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Raja clavata		$W = 0{,}000002371\ L3^{,1693}$	0.95305	296	30–133 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Raja montagui		$W = 0{,}0000003725\ L^{3{,}46958}$	0.9587	21	44–99 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Scyliorhinus canicula		W = 2,6217 TL - 789,43	0.6918	1234	36,9–76 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Squalus acanthias		$GW= 0{,}00000809\ FL^{2{,}9048}$	0.878	300	43–108 cm	ICES VIIIabd	G.Diez, updated from STECF 2003
Alopias superciliosus		$W= 0.00183\ SL^{3.45}$					Guitart Manday, 1975
Centrophorus squamosus		GW=-0.0527*0.728TW	0.87	12		ICES IXa	Moura *et al*., 2007 (WD)
Centroscymnus coelolepis	F	$GW=7E\text{-}07 * TL^{3.4318}$	0.9	780		ICES IXa	Moura *et al*., 2007 (WD)
Centroscymnus coelolepis	M	$TW=9E\text{-}6 * TL^{2.9384}$	0.68	50		ICES IXa	Moura *et al*., 2007 (WD)

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Leucoraja naevus		$GW=3E-10 * TL^{3.416}$	0.91	0.91		ICES IXa	Moura *et al.*, 2007 (WD)
Leucoraja naevus		DiL=-8.4917+ 0.5069 TL	0.94	255		ICES IXa	Moura *et al.*, 2007 (WD)
Leucoraja naevus		DiW=-8.4479+ 0.5957* TL	0.94	261		ICES IXa	Moura *et al.*, 2007 (WD)
Raja brachyura		$GW=1E-9 * TL^{3.2266}$	0.98	224		ICES IXa	Moura *et al.*, 2007 (WD)
Raja brachyura		DiL=-5.9413+ 0.5612* TL	0.98	200		ICES IXa	Moura *et al.*, 2007 (WD)
Raja brachyura		DiW=17.045+ 0.6951* TL	0.98	227		ICES IXa	Moura *et al.*, 2007 (WD)
Raja clavata		$GW=8E-10 * TL^{3.311}$	0.99	938		ICES IXa	Moura *et al.*, 2007 (WD)
Raja clavata		DiL=-8.4746+ 0.5205* TL	0.99	1125		ICES IXa	Moura *et al.*, 2007 (WD)
Raja clavata		DiW=-12.066+ 0.7201* TL	0.99	1271		ICES IXa	Moura *et al.*, 2007 (WD)
Raja clavata	M	GonW=0.6597*Exp(1.424*GW)	0.82	600		ICES IXa	Moura *et al.*, 2007 (WD)
Raja montagui		$GW=7E-10 * TL^{3.3455}$	0.98	256		ICES IXa	Moura *et al.*, 2007 (WD)
Raja montagui		DiL=-14.651+ 0.5442* TL	0.99	454		ICES IXa	Moura *et al.*, 2007 (WD)
Raja montagui		DiW=7.7134+ 0.6687* TL	0.97	257		ICES IXa	Moura *et al.*, 2007 (WD)
Raja undulata		$GW=3E-09 * TL^{3.1355}$	0.95	121		ICES IXa	Moura *et al.*, 2007 (WD)
Raja undulata		DiL=23.528+ 0.5105* TL	0.91	121		ICES IXa	Moura *et al.*, 2007 (WD)
Raja undulata		DiW=71.623+ 0.567* TL	0.95	121		ICES IXa	Moura *et al.*, 2007 (WD)
Raja undulata	M	GonW=3.244*Exp(0.6036*TL)	0.85	67		ICES IXa	Moura *et al.*, 2007 (WD)
Centrophorus squamosus	F	$TW= 2x10^{-6} TL^{3.159}$	0.966	134	347–1440 mm	ICES IXa	Anon (2003)
Centrophorus squamosus	F	PCL= 0.839 TL - 70.565	0.975	90	877–1440 mm	ICES IXa	Anon (2003)
Centrophorus squamosus	M	$TW= 2x10^{-5} TL^{2.837}$	0.810	258	877–1204 mm	ICES IXa	Anon (2003)
Centrophorus squamosus	M	PCL= 0.778 TL - 2.042	0.879	164	877–1204 mm	ICES IXa	Anon (2003)
Centroscymnus coelolepis	F	$TW= 1x10^{-6} TL^{3.279}$	0.767	553	767–1208 mm	ICES IXa	Anon (2003)
Centroscymnus coelolepis	F	SL= 0.826 TL + 55.364	0.951	104	767–1163 mm	ICES IXa	Anon (2003)
Centroscymnus coelolepis	M	$TW= 3x10^{-6} TL^{3.119}$	0.884	53	682–1000 mm	ICES IXa	Anon (2003)
Dalatias licha	F	$TW= 9x10^{-7} TL^{3.274}$	0.986	69	364–1610 mm	ICES IXa	Anon (2003)
Dalatias licha	F	SL= 0.876 TL + 20.938	0.952	50	400–1610 mm	ICES IXa	Anon (2003)
Dalatias licha	M	$TW= 1x10^{-6} TL^{3.227}$	0.986	122	321–1285 mm	ICES IXa	Anon (2003)
Dalatias licha	M	SL= 0.903 TL + 13.676	0.933	96	3211285 mm	ICES IXa	Anon (2003)

Species	sex	Biometric relationships	R2	Sample size	Length range	Subarea	References
Deania profundorum	F	TW= 5x10-7 x TL3.288	0.996	96	270–918 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	F	TW= $1x10^{-6}$ $TL^{3.248}$	0.978	34	227–456 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	F	SL= 0.978 TL -4.076	0.996	557	105–426 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	F	AL= 0.618 TL -11.242	0.974	566	105–456 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	M	TW= $2x10^{-6}$ $TL^{3.111}$	0.991	34	163–442 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	M	SL= 0.925 TL +0.661	0.993	219	119–398 mm	ICES IXa	Anon (2003)
Etmopterus pusillus	M	AL= 0.591 TL -10.110	0.984	232	116–470 mm	ICES IXa	Anon (2003)
Etmopterus spinax	F	TW= $1x10^{-3}$ $TL^{3.413}$	0.983	44	107–376 mm	ICES IXa	Anon (2003)
Etmopterus spinax	F	SL= 0.932 TL +0.012	0.987	131	126K466 mm	ICES IXa	Anon (2003)
Etmopterus spinax	F	AL= 0.650 TL -1.806	0.993	63	152–466 mm	ICES IXa	Anon (2003)
Etmopterus spinax	M	TW= $2x10^{-3}$ $TL^{3.331}$	0.988	36	107–394 mm	ICES IXa	Anon (2003)
Etmopterus spinax	M	SL= 0.932 TL +0.012	0.987	131	118–428 mm	ICES IXa	Anon (2003)
Etmopterus spinax	M	AL= 0.612 TL -1.199	0.941	52	163–428 mm	ICES IXa	Anon (2003)
Galeus melastomus	F	TW= $2x10^{-6}$x $TL^{3.104}$	0.993	4732	83–771 mm	ICES IXa	Anon (2003)
Galeus melastomus	F	SL= 0.972 x TL -2.416	0.999	952	134–761 mm	ICES IXa	Anon (2003)
Galeus melastomus	M	TW= $2x10^{-6}$x $TL^{3.044}$	0.994	3902	109–963 mm	ICES IXa	Anon (2003)
Galeus melastomus	M	SL= 0.978 x TL -4.076	0.999	869	130–705 mm	ICES IXa	Anon (2003)
Galeus melastomus	F	TW= $8x10^{-7}$x $TL^{3.232}$	0.994	42	234–1420 mm	ICES IXa	Anon (2003)

22 Suggested ToRs for 2008

The roadmap developed by WGEF in 2006 suggested that the WG focus on deep-water elasmobranchs in 2008 and pelagic sharks in 2009. ICCAT's Standing Committee on Research and Statistics (SCRS) Shark Species Group held a data preparation meeting in June 2007 (which clashed with WGEF) and intend to meet in 2008 for assessing pelagic sharks in the Atlantic Ocean. WGEF considered that the group should work with WGDEEP for assessing deep-water sharks and also with ICCAT for the assessment of pelagic sharks. The WGEF report from these two sub-groups could then be completed by correspondence. Hence, WGEF would propose the following:

The Working Group on Elasmobranch Fishes [WGEF] (Chair: Jim Ellis, UK) will meet as two sub-groups during 2008. The first sub-group will meet at a joint meeting with WGDEEP (Venue and date to be confirmed) to:

a) Update the description of elasmobranch fisheries for deep-water and demersal species in the ICES area and compile landings, effort and discard statistics by ICES Subarea and Division;
b) Assess the stock identity and stock status of deep-water sharks in the ICES area;
c) Work towards the production of an ICES Cooperative Research Report on the "Status of Elasmobranchs in the NE Atlantic" by finalising those chapters relating to deep-water sharks and demersal elasmobranchs;
d) Compile available photographic images of deep-water elasmobranchs and demersal skates and rays to support the production of a photo-ID key for the elasmobranchs of the ICES area, and draft a supporting key for the identification of deep-water and demersal elasmobranchs.

The second sub-group will meet at a joint meeting with the ICCAT Shark Assessment sub-group (Venue and date to be confirmed) to:

e) Update the description of elasmobranch fisheries for pelagic sharks in the ICES area and evaluate landings and discard statistics for North Atlantic stocks;
f) Assess the stock status of pelagic sharks (blue shark, shortfin mako, porbeagle) in the North Atlantic;
g) Work towards the production of an ICES Cooperative Research Report on the "Status of Elasmobranchs in the NE Atlantic" by finalising those chapters relating to pelagic sharks and demersal elasmobranchs;
h) Compile available photographic images of pelagic elasmobranchs to support the production of a photo-ID key for the elasmobranchs of the ICES area, and draft a supporting key for the identification of pelagic elasmobranchs.

WGEF will report to ACFM by 30th July 2008 and make its report available for the attention of the Living Resources Committee.

Supporting information

Priority	High. The work of the Group is essential if ICES is to provide advice on elasmobranch stocks, as required by the MOU with the EU.
Justification	The work done within WGEF has included development of assessment methodology for a selection of elasmobranch case-study species, which have very different population and reproductive dynamics from the conventionally assessed teleosts. ICES is expected to give management advice for elasmobranch stocks (MoU between ICES and EC), and the scientific remit of this Group will be to adopt and extend these methods and review and define data requirements (fishery, survey and biological parameters) in relation to the needs of these analytical models and stock identity, and to carry out such assessments as required by ICES customers. Spurdog, skates and rays, lesser-spotted dogfish and porbeagle are mentioned as new species the EC wants advice on, according to the new EC-ICES MOU. It is important that the progress made by WGEF through the EU-funded DELASS project is maintained and

	built upon.
Relation to Strategic Plan	Directly relevant, it allows ICES to respond to requested advice on elasmobranch fisheries. It is also necessary to ensure that elasmobranchs are considered in the ecosystem approach and in fleet-based forecasts that ICES will be carrying out.
Resource Requirements	No specific resource requirements, beyond the need for members to prepare for and participate in the meeting.
Participants	Most countries are now participating in the group and membership includes biologists, mathematicians, fisheries specialists and environmentalists. There is a wide variety of interests represented. Delegates from France and Spain attended in 2007, and it is hoped that expertise from these nations will continue. In 2008, WGEF would benefit from attracting fisheries scientists with a knowledge of high seas fisheries for large pelagic fishes.
Secretariat Facilities	Support is required to extract survey data from ICES databases. Otherwise very little input required from secretariat.
Financial	It is hoped to publish the work of WGEF as a CRR.
Linkages to Advisory Committees	WGEF reports to ACFM
Linkages to other Committees or Groups	Close cooperation with LRC is essential. This should include presentation of WGEF report at LRC meetings. WGEF needs to maintain close working relationships with regional demersal assessment groups (WGNSSK, WGNSDS, WGSSDS, WGDEEP), relevant survey and biology working groups (e.g. IBTSWG, WGFE, SIMWG) and other fisheries and assessment groups (e.g. WGFTFB, WGMG, PGCCDBS). In terms of pelagic sharks, WGEF should work in cooperation with ICCAT's SCRS shark species sub-group.

Annex 1: WGEF list of participants 2007

NAME	ADDRESS	PHONE/FAX	EMAIL
Tom Blasdale	JNCC Dunnet House 7 Thistle Place Aberdeen AB10 1UZ United Kingdom	Tel: +44 1224 655708 Fax: +44 1224 621488	tom.blasdale@jncc.gov.uk
Maurice Clarke	The Marine Institute Rinville Oranmore Co. Galway Ireland	Tel: +353 91 387400 Fax: +353 1 8205078	maurice.clarke@marine.ie
Guzman Diez	AZTI Txatxarramendi Ugartea Z/G 48395 Sukarrieta (Bizkaia) Spain	Tel: + 34 946029400 Fax: +34 946870006	gdiez@suk.azti.es
Helen Dobby	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	Tel: +44 1224 876544 Fax: +44 1224 295511	h.dobby@marlab.ac.uk
Jim Ellis (Chair)	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	Tel: +44 1502 524300 Fax: +44 1502 513865	jim.ellis@cefas.co.uk
Edward Farrell	School of Biology and Environmental Science, University College Dublin, Belfield, Dublin 4 Ireland	Tel: Fax:	Edward.farrell@ucd.ie
Ivone Figueiredo	IPIMAR Avenida de Brasilia PT-1449-006 Lisbon Portugal	Tel: + 351 21 3027131 Fax: + 351 21 3017948	ivonefig@ipimar.pt
Boris Frentzel-Beyme	Biozentrum Grindel und Zool. Museum Universität Hamburg Martin-Luther-King-Platz 3 20146 Hamburg Germany	Tel: + 49 (0) 40 37082822 Fax:	borisfbeyme@elasmo.de
Peter Green	Central Fisheries Board, Swords Business Park, Balheery Rd., Swords, Co. Dublin, Ireland	Tel: + 353 (01) 8842600 Fax: +353 (01) 8360060	
Henk Heessen	IMARES P.O. Box 68 NL-1970 AB IJmuiden Netherlands	Tel: +31 255 564 692 Fax: +31 255 564 644	henk.heessen@wur.nl

NAME	ADDRESS	PHONE/FAX	EMAIL
Kristin Helle	Demersal Fish Division Institute of Marine Research P.O. Box 1870 Nordnes 5817 Bergen Norway	Tel: +47 55238601 Fax: +47 55235393	kristin.helle@imr.no
Graham Johnston	The Marine Institute Rinville Oranmore Co. Galway Ireland	Tel: +353 91 387205 Fax:	graham.johnstone@marine.ie
Dave Kulka	Dept. of Fisheries & Oceans Northwest Atlantic Fisheries Centre P.O. Box 5667 St John's, Nfld A1C 5X1 Canada	Tel: +1 709 772 2064 Fax: +1 709 772 5469	KulkaD@dfo-mpo.gc.ca
José de Oliveira	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	Tel: +44 1502 527 7 27 Fax: +44 1502 524 511	jose.deoliveira@cefas.co.uk
Mario Pinho	Departament Occeanography and Fisheries DOP Universidade dos Açores Caiz Sta Cruz 9909 862 Horta, Azores Portugal	Tel: +351 292 200 400 Fax: +351 292 200411	maiuka@notes.horta.uac.pt
William Roche	Central Fisheries Board, Swords Business Park, Balheery Rd., Swords, Co. Dublin, Ireland	Tel: + 353 (01) 8842600 Fax: +353 (01) 8360060	william.roche@cfb.ie
Bernard Seret	Muséum national d'histoire naturelle Dep. Systématique et Evollution 55 rue Buffon B.P. 51 F-75231 Paris Cedex 05 France	Tel: +33 1 40 79 37 38 Fax:	seret@mnhn.fr
Charlott Stenberg	Swedish Board of Fisheries P.O. Box 423 401 26 Gothenburg Sweden	Tel:+46 31 743 04 20 Fax:+46 31 743 04 44	charlott.stenberg@fiskeriverket.se
Francisco Velasco	Instituto Español de Oceanografía Centro Oceanográfico de Santander P.O. Box 240 E-39080 Santander Spain	Tel: +34 942 291060 Fax +34 942 275072	francisco.velasco@st.ieo.es
Tom Williams	Norwegian College of Fishery Science, University of Tromsø, Breivika, N-9037 Tromsø, Norway.	Tel: +47 77646953 Fax: +47 77629100	tomjwilliams75@hotmail.com

Annex 2: Recommendations

RECOMMENDATION	ACTION
In order to have a better indication of the spatial distribution and physical characteristics of nursery grounds of elasmobranchs, it is recommended that the Working Group on Fish Ecology "*identify the spatial distribution and physical characteristics of elasmobranch nursery grounds*" (see Section 1.5.5).	ToR for WGFE
Given that analyses of survey data (often the only species-specific information available for some demersal elasmobranchs) may have been compromised by inadequate taxonomic identification, it is recommended that "*ICES, national laboratories and IBTSWG, with the help of WGEF members, ensure that survey data for skates and rays (as well as other taxa) are corrected or amended as appropriate*" (see Section 1.5.6).	National laboratories should check their survey data to ensure that species identifications (particularly for skates and rays) are correct (e.g. by examining size frequency and distribution data). The ICES Data centre and IBTSWG should critically appraise data held in the DATRAS database.
Given that our knowledge of the stock identity of many demersal elasmobranchs is poorly known (see Sections 1.9.4, 15, 18, 19), WGEF would ask that SIMWG "*examine stock identification issues for demersal skates* (Rajidae) *in the North Sea, Celtic Seas and Bay of Biscay/Iberian eco-regions*" (see Section 1.5.8).	ToR for SIMWG
Given that some of the data collected for skates (Rajidae), and possibly other elasmobranchs, from market sampling and discard surveys is compromised by inaccurate species identification, and that raising procedures and data origins are often not supplied, it is recommended that PGCCDBS "*provide the necessary supporting information to ensure that data collection (including species identification) and raising procedures (by gear, season, ICES Division and nation) for skate and ray sampling are standardised across laboratories*" (see Section 1.5.9).	ToR for PGCCDBS
WGEF welcomed the information provided by WGFTFB to the main assessment working groups. WGEF would ask that WGFTFB provide WGEF with (a) more details on the bycatch of rays in outrigger trawls and (b) review temporal changes in the fishing patterns of high seas pelagic fisheries taking pelagic sharks.	ToR for WGFTFB
In order to ensure that the meetings of WGEF and the ICCAT Shark Species Group do not clash in the future, it is recommended that the ICES Secretariat liase with ICCAT and facilitate the possibility of a joint meetings in 2008 (see Section 1.6.1).	ICES Secretariat to liase with ICCAT

Annex 3: ACFM sub-group Review of the Working group on Elasmobranch Fishes [RGEF]

Copenhagen, 3–4 September 2007

Composition of the review group

ACFM sub-group chair: Massimiliano Cardinale (Sweden)

ICES WGEF chair: Jim Ellis (UK)

Reviewers: Fátima Cardador (Portugal) and Joachim Groger (Germany)

ICES Secretariat: Claus Hagebro

General considerations

The members of the ACFM review group (ESRG) consider that the WG has answered those TORs relevant to providing advice. ESRG commended the WGEF for their progress in the compilation and validation of basic data and for the appropriateness of the methods used for assessing the stock dynamics. There are still problems with species identification and thus with collation of species disaggregated landings data. However, dedicated market sampling has been put in place in the recent past and this hopefully might improve the situation in the future. There is some evidence of improvements in species-specific reporting in recent years (2005 and 2006), which is welcomed by the WGEF and ESRG. Quality of catch data is still an issue since species misreporting is a common event especially for non-quota species.

Discard data often shows high variability, possibly due to low sample size. However, in the view of the large proportion of individuals that can be discarded for some of the species, estimates of discard are important. Also, many of the species are caught alive in demersal mixed fisheries. In this context, ESRG considers that it is crucial to have robust estimates of survivorship of the different species in the different fisheries, as the release of individuals of threatened species might represent a valid management option in the future. ESRG also supports the proposal of having dedicated surveys for deep-sea sharks.

Considering the difficulties linked to the data quality, the ESRG consider that all available information on the general biology, especially reproductive biology, and ecology of the species should be provided. "*Biological and ecological information should constitute the core of the advice in the case of data poor situations, as for several elasmobranch species. In such cases, more importance for the advice should be given to evaluating life- history traits of the exploited species more than on the landings or catch statistics itself, especially when considering the low productivity, high longevity, aggregation behaviour of those species and hence vulnerability to fishing*".

Moreover, crucial information for stock status evaluation should be represented by trends in mean length, average maximum length, length range and diversity index of size, areas occupied, changes in length/maturity, and other viable indices of stock status from both survey and landings data and that information should be collated into species specific stock annexes. Moreover, the ESRG consider that distribution maps, when data are available, of the species should be provided for all species using available survey data. Information on ecology and biology of the different species should be collated by following the approach of SGRESP, compiling "ID-cards" for each stock. These would then be incorporated into the Stock Annex and also appear in the planned Cooperative Research Report. ESRG also recommends including species illustrations and demographic information in the stock ID of the Cooperative Research Report.

In terms of the future work of WGEF, and given the potential changes in the schedule and procedures for the provision of ICES advice, the WGEF will likely need to reconsider their roadmap. One option would be a two-year cycle, whereby the WGEF meets in parallel with WGDEEP (e.g. in 2008, 2010 etc.), and (i) undertakes the assessment and drafting of advice with regards deep-water sharks (with WGDEEP) and (ii) undertakes data collation and exploratory analyses for demersal (and pelagic) elasmobranchs. In intervening years (2009, 2011 etc.), WGEF should meet to undertake assessments of demersal elasmobranchs and spurdog. In order to minimise the risk of losing assessment scientists and modellers to other WGs, such a group could usefully meet outside the main assessment period, finalise the advice by the end of the year, so that it can be provided the following year (this would also allow, if required, the opportunity for regional assessment WGs to consider the WGEF advice in relation to regional/mixed fisheries/ecosystem advice). In terms of pelagic sharks, the ICES Secretariat should liase with ICCAT, so that a sub-group of WGEF can meet with the ICCAT shark sub-group for assessing these species.

A great deal of effort has been deployed to improve the format and editing of the report as pointed out by the former ESRG. ESRG consider that the structure of the report has been greatly improved especially concerning the consistency between the different sections. However, the WG should dedicate further attention to the formatting of tables and figures. Section 1.5 provides an overview and comments to relevant and useful ICES Expert Groups. Some recommendations are presented as Recommendations in Annex 2 while other comments which should be noted by the groups risk standing unnoticed. These comments could be presented as "actions" or "notes" in future reports.

Most of the species covered in the report have a wide distribution across the ICES area. As such they are likely to be relatively unaffected by ongoing climate change. In the case of some of the demersal shark and ray species, there may however be local climate change effects.

Generally, although further effort should be deployed to solve multi-species aggregated landings data and stock identity and, collate basic biological and ecological information of the assessed species, ESRG considers that presented information are robust enough to form the base of the advice for elasmobranchs in the North Atlantic waters. However, management considerations should be stressed tightly.

Introduction

The introduction gives a wide overview of the report. Sources of the basic landings data are given in section 1.9 although for several species difficulties arise since landing statistics are given by group of species. Effort is dedicated to provide data for individual species although for many groups of species this need to be addressed in future reports. Nevertheless, specific splitting procedures are given in the relevant sections. Spain and France were better represented in the 2007 meeting although not all national data were available. Recommendations (Annex 2) made by WGEF are considered appropriate.

Ageing elasmobranchs is still problematic and this impedes the use of traditional analytical assessment models. In this context, ESRG welcome the attempt to make use of standardized survey data to describe historical trends of abundance and biomass of different species of elasmobranchs. Considering the difficulties to obtain precise species disaggregated landings data, ESRG considers it crucial to maximise, whenever possible, the use of survey data in order to elucidate trends in stock abundance and biomass. Nevertheless, there are issues related to survey data sets. Particularly, existing surveys are designed to target demersal teleost species and thus might not be appropriate to collect representative samples of elasmobranchs, especially species which attain a large adult size. Also, additional work should be committed to validate species identification from historical surveys, as apparent species misidentifications were evident in some areas.

However, there are still issues with the survey data treatment and choice of error distribution linked with the classical "patchy" distribution of demersal species (i.e. large number of observations with zeroes and very high/low numbers) that needs further work. The model diagnostics (including parameter settings and estimates) need to be presented for each final model for each stock. Given the poor data situation the robustness of the models need to be tested, for instance, by leaving out data points or years. In the longer run, a more comprehensive analysis of the sensitivity regarding models needs to be done (simulations and scenario testing) and presented (for example in tabular form). The sensitivity of the results on the parameter settings need to be tested by changing the input parameters, either deterministically or stochastically, assuming some range of variation or upper and lower bounds.

Length information might be used to derive preliminary estimates of historical trend in individual size and total mortality and this should be explored in the future.

Additional, experienced modelers from different fields and/or WGs should be invited to attend WGEF in the future.

Spurdog in the North East Atlantic

In 2007, WGEF updated some of the available landings data and included references to some new information on the biology, including a study on discard survivorship. Further studies on discard survivorship (i.e. from commercial operations) are required to allow for some of the modeling undertaken in previous years to be used more effectively. WGEF should address the concerns of the 2006 ESRG when undertaking further studies of spurdog at future meetings (see Annex 3 of ICES, 2006).

The WG has highlighted the main concerns related to the data quality (i.e. landings and discard) and stock identity (see also General considerations) and this is now well considered and explained in earlier WG reports. Landings data for this stock should also be presented by nation.

As already pointed out by former ESRGs, more attention should be give to improving the quality of the index of abundance and validation of the life history parameters be undertaken prior to more statistical modeling in the future. Further comments on models were given by the ESRG in 2006, and these should be addressed in future assessments.

Before further analyses are conducted it will be necessary to make a proper collation of available IBTS data that allows coverage of the entire distribution area of this migratory stock within the shortest time window (e.g. based around the Q4 western IBTS). Those data could also be used to elucidate the migratory patterns of this species over the North East Atlantic. Although some of the SW IBTS surveys only cover a short time period at the moment, preliminary analyses of new SW IBTS surveys in the Celtic Seas eco-region could usefully be undertaken in the future, and more recent studies of the Northern Ireland groundfish surveys are also needed. Analyses of survey data should also explore CPUE biomass indices when modeling spurdog dynamics. Results of the single surveys should also be briefly presented. Mapping the spatial distribution of mature females and pups taken in surveys could also be usefully examined.

Length information should be used more extensively (for commercial and fishery-independent data) and presenting trends in average maximum length and diversity index of size could be useful. Although length data from commercially caught spurdog in UK fisheries has been explored, WGEF is yet to evaluate any data that may be available from Irish, Norwegian and French fisheries.

Spurdog are one of the elasmobranchs that occur regularly on *Nephrops* grounds, further analyses from discard observer data in order to ascertain the potential impacts of expanding *Nephrops* fisheries could be usefully evaluated.

Management considerations are quite vague and difficult to interpret. This section is more a description of the stock status more than a message for the managers. The ESRG has preferred WGEF to be more specific in expressing their management considerations for this stock.

The WGEF management consideration that there should be a single TAC is appropriate.

Deepwater "siki" sharks in the Northeast Atlantic

In 2007, WGEF updated some of the available landings data. These landings data need to be viewed in the context of TAC and quota regulations, and including the TAC on figures of landings data would facilitate interpretation of landings data. The text says that landings have declined since 2003 due to quotas and fishery restrictions. Although the text states that there is clear evidence of CPUE decline (Figures 3.4-3.5), these figures are not in the report and the reader is referred to the 2006 report. It is questionable to say that landings have declined since 2003. It could be argued for a period of expansion of the fisheries in 1990–97, a stable in 1998–2001 and fluctuation since 2002. The recent decline in landings needs to be considered in the light of TAC and quota restrictions, as well as spatial-temporal changes in fishing patterns.

WGEF provides valuable insights into the state of the stocks. However, the RG noted that little use was made of the survey data (e.g. Scottish trawl survey from 1998), beyond treating them as CPUE series together with the commercial data.

Detailed information on the distributions of both species (plus other deep-water species) could be given, in addition to an indication of the proportion of the two species compared to the other deep-water sharks would be useful.

Given the long life of these species and the clear evolution in national involvement and areas, there is a need to obtain information on gear/vessel/area changes for this fishery, possibly via WGFTFB.

WGEF should also note that there is some evidence for illegal landings available. WGEF suggests that discarding is a minor problem but lists a range of more serious discarding examples. These do not suggest that this is a minor problem indeed and definitely needs better data to quantify this. Any available information on discarding from deep-water fisheries needs to be collated and presented.

It is to be regretted that there are still some commercial CPUE data that are not being made available to the WG. The 2005 ESRG suggested that GLM using possible changes in fleets and fishing patterns was required. This has been done but the results still need to be presented.

WGEF should ensure that the concerns of the previous ESRG (see Annex 3 of ICES, 2006) are addressed when undertaking further assessment of Portuguese dogfish and leafscale gulper shark in 2008.

Kitefin shark (entire ICES area)

The ESRG noted that no new information was available. As the fishery is driven by market (fish oil price), the directed fishery has ceased for the last few years. In such a situation only fisheries independent surveys could reveal stock development trends. Survey information is not presented; although this survey does not cover most of the stock range, and so catch rates are very low.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Other deepwater sharks from the Northeast Atlantic (ICES Subareas IV-XIV)

The reviewers noted that little information is available and hence no stock assessments were performed. In 2007, deep-water skates (covered in Section 18 of the 2006 report) were also included within this section.

There is still the need to develop liver weight and other conversion factors for these species. The RG also recommends that existing national landings and biological data as well as discard estimates should be made available to the next WGEF meeting.

As some surveys (Azorean demersal longline, Greenland demersal and Scottish Deepwater surveys) are available, the CPUE trends based on abundance index or frequency of occurrence for some species in some areas could be useful in order to evaluate the stock status. The WGEF report presented findings from the Scottish deepwater survey, although this only covered a short-time period and the results presented should only be considered as an exploratory analysis.

It is stated that special attention should be made for management of Portuguese dogfish and leafscale gulper shark, and, in this context, information on by-catch ratios should be presented.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Porbeagle in the North East Atlantic (ICES Sub-areas I-XIV)

As for most of the elasmobranchs treated here, landings data quality is a major problem in assessing this stock. Spain has only provided landings data since 1996, and WGEF should attempt to compile landings data prior to this time. Similarly, landings from the UK in the mid-1990s (when targeted fisheries operated in the south-west UK) need to be included in the catch table.

WGEF obtained a fishery dependent CPUE time-series in 2006, but new data were not available in 2007. These data could help to elucidate the status of the stock at future meetings of WGEF. More work will be devoted during the next year to evaluating both landings and French fishery-dependent CPUE data. Although useful, the CPUE time series is short especially when considering that porbeagle fishery has a long tradition and the species is particularly sensitive to exploitation.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Basking shark in the North East Atlantic (ICES Subareas I-XIV)

In 2007, WGEF updated landings, though given that there has been a zero TAC, recent landings have been low. ESRG consider that it is important to know which types of fishery have currently the higher discard rates of basking shark.

The liver weight conversion is a problem here as for many other shark species, and the value used still needs to be investigated further, as suggested by the previous ESRG.

On a broader scale, ESRG was concerned that the high value attached to shark fins might encourage an increase in targeting of this species, and encouraged further investigation of the fin market.

Improvements to the formatting of some of the figures in this section are required.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Blue shark in the North Atlantic (FAO areas 21, 27, 34 and 31)

In 2007, WGEF updated landings of blue shark, although species-specific data for several nations were not compiled. However the landing estimates are considered an underestimate, and better data need to be available to the working group to elucidate stock trends. A more robust analysis of reported catches of blue shark (and other pelagic sharks) needs to be undertaken, and such data need to be viewed in relation to the evolution of pelagic fisheries for tuna and swordfish.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Shortfin mako in the North Atlantic (FAO Areas 27, 21, 34 and 31)

In 2007, WGEF updated landings of shortfin mako shark. However the landing estimates are considered an underestimate, and better data need to be available to the working group to elucidate stock trends. A more robust analysis of reported catches of shortfin mako shark (and other pelagic sharks) needs to be undertaken, and such data need to be viewed in relation to the evolution of pelagic fisheries for tuna and swordfish.

See general comment on the use of biological and ecological information (in *italics* in General considerations)

Tope in the North-East Atlantic and Mediterranean

Tope was first addressed by WGEF in 2006, and only landings data have been updated. WGEF has devoted good effort to summarizing existing knowledge on fisheries and landings. However the landing estimates are unreliable and insufficient and, more data need to be available to the working group to elucidate stock trends.

See general comment on the use of biological and ecological information (in *italics* in General considerations).

Thresher sharks in the North-East Atlantic

It is the first time that thresher sharks are included in the report. WGEF put a good effort to summarize existing knowledge on their biology, fisheries and landings. However the landing estimates are unreliable and insufficient and, more data need to be available to the working group to elucidate stock trends. A more robust indication for the delineation of the stock boundary is needed. Given the low fecundity of this species, it may be particularly sensitive to exploitation.

See general comment on the use of biological and ecological information (in italics in General considerations).

Other pelagic sharks in the North-East Atlantic

It is the first time that these species are included in the report. WGEF deployed a great effort to summarize existing knowledge on their biology, fisheries and landings. However the landing estimates are unreliable and insufficient and, more data need to be available to the working group to elucidate stock trends. It is difficult to see what further can be done in the assessment forum for these species, beyond updating the information and bibliography in this section.

See general comment on the use of biological and ecological information (in italics in General considerations).

Demersal elasmobranchs in the Barents Sea

In 2007, landings were updated and new fishery-independent survey information from Norwegian coastal waters was presented. However, the time series is relatively short and only one species (*A. radiata*) is caught regularly and in some numbers. The data compilation and analysis are planned to be finalized and presented in 2008. Time series of CPUE, mean length and length range information should be also included in the future.

Demersal elasmobranchs in the Norwegian Sea

In 2007, landings were updated and new fishery-independent survey information from Norwegian coastal waters was presented. WGEF has devoted a good effort to summarizing our existing knowledge on fisheries and landings in this area. However the landing estimates are unreliable and insufficient and more data need to be available to the working group to elucidate stock trends. Given the uncertainty regarding accurate taxonomic identification in fishery-independent surveys, these data may hamper assessing the status of skates in this eco-region.

Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel

The RG found that some consistency in referring to species names is needed and either common English or scientific names should be used consistently (i.e. scientific names for skates, common names for demersal sharks). ESRG also suggests that it might be useful to present nomenclature and the links between names in some tabular form (allocation/translation table)

ESRG considers that although the data from biological sampling of demersal elasmobranchs are partly available, these data were still not fully presented at the WGEF. National data should be made available for the next WGEF meeting. For assessment purposes species-specific data are essential (logbook or auction based, market sampling, etc) that are partly still lacking. The RG recommends that the data collection design under the DCR needs to be made transparent and be evaluated, especially a standardized data collection design, raising procedure and reporting data format is needed. ESRG further suggests that robust estimates of survivorship of the different species in the different fisheries should be provided (see comments in General considerations).

ESRG recommends that the WG evaluate utility of using effort (i.e. VMS) data as a potential source to derive an index and description of effort (by vessel/gear type combinations such as segments, metiérs or fleets). In the longer term, effort data might be important as fishery independent data are limited that could be used to produce also CPUE time series from fishery dependent sources.

In the short term, the available life history information (e.g. maturity data derived from surveys) should be collated. The requirements for updating age-length keys, fecundity, etc should be evaluated.

Analyses using GAM and the SPANdex method were performed to derive survey trends for each of the four species thornback ray, cuckoo ray, starry ray, lesser-spotted dogfish and these methods were considered appropriate here. However, it was difficult to see where the Q1 IBTS filtering procedure was used, and the reader should have been referred to the relevant section. Also, the WG should improve both GAM and SPANdex fitting and presentation of the results, including a comprehensive sensitivity analysis, choice of appropriate error distribution and presentation of parameter settings and estimates (see comments in Introduction). In figures 15.3 to 15.6, the colors in the right panels need to be explained by some legend

ESRG acknowledge the additional attempts to present new results of two exploratory assessments that have been carried out and were based on specific survey data. An earlier model for thornback ray was also summarized, and the WGEF should consider re-running this model with contemporary and filtered survey data.

The utility of other survey data (e.g. beam trawl surveys) in this eco-region should be undertaken in future meetings of the WGEF.

Finally, an explorative search of candidate assessment models that can be used in data poor situations should be undertaken given slow growing species; (i.e. Bayesian methods, length-based models, IWC type models: http://www.iwcoffice.org/meetings/reportsmain.htm), the potential adoption of "shark population models" from other regions such as US Georges Bank (e.g. see NMFS http://www.nefsc.noaa.gov/sos/spsyn/op/dogfish/ or http://www.nefsc.noaa.gov/nefsc/publications/tm/tm150/tm150.pdf) and Australia.

Demersal elasmobranchs in Iceland and East Greenland

No major comment except that more data need to be made available to the WGEF. The WG appear to have access to survey series in Iceland, Greenland and from Germany. These were used for current distributions and length frequency, but not to develop time series of distribution changes, catch rates or presence/absence of the species. This should be completed for future meetings. The major fishing nation in this area (Iceland) provides species-specific landings information for skates.

Demersal elasmobranchs at Faroe Islands

No major comment except that more data need to be made available to the WGEF. No species-specific landings data (or species composition data) were available to the WGEF. A very general summary of survey information was provided this year, but more rigorous examination of raw survey data should be undertaken at future meetings of the WGEFE.

Demersal elasmobranchs in the Celtic Seas (ICES Subareas VI & VII (except Division VIId))

ESRG acknowledge the effort devoted to improve the structure of this section of the report, including updating of landings, discards, size frequency data and an extensive analysis of survey trends. However, given the range of areas and species in this ecoregion, it is still problematic to achieve a well-structured description of the status of the different stocks. A solution might be represented to focus on specific relatively data-rich situation but this is obviously a matter of priority.

There are still problems with species identification and thus with collation of species disaggregated landings data. Also, the WGEF should be aware of current studies regarding discard survivorship of the different species in the different fisheries (see comments in General considerations).

ESRG welcome the attempt to use “semi-standardised” survey data (i.e. GAM) to provide vital information on stock status, distribution and size composition of several species in the area. However, further effort should be devoted to attempt a “full-standardisation” (i.e. swept area method and GAM) of surveys that overlap in common areas. This might increase sample size and area coverage and thus improve stock estimates. There is the need to better define the stock identity and to ensure that analyses of survey data are appropriate for these stock areas. Also, the ESWG should improve GAM fitting and presentation of the results, including a comprehensive sensitivity analysis and parameter settings / estimates (see comments in Introduction).

Also, the ESWG should consider collating historical data on species and size composition and undertake analysis of historical trends in individual size and total mortality.

Also, additional work should be committed to validate species identification from historical surveys data (see comments in General considerations). ESRG considered appropriate the analysis of the distribution areas and densities or presence/absence from surveys data for selected species as suggested by ESRG in 2005. Preliminary analysis of those data indicated that, with the exception of cuckoo ray, all the studied species showed a stable or increasing trend in the last decade. ESRG consider the interpretation of the trends as made by the WGEF as appropriate. WGEF should explore alternative methods for qualify trends of the rarer species.

Demersal elasmobranchs in the Bay of Biscay and Iberian waters (ICES Subare VIII and Division IXa)

The stock structures of *Raja clavata, Leucoraja naevus* and *Scyliorhinus canicula* are not accurately known, although the management units (by Divisions VIIIa,b, VIIIc, VIIId and IXa) are considered appropriate until better information becomes available.

Other species in the area include *Raja brachyura, R. microocellata, R. miraletus, R. montagui, R. undulata, L. fullonica, Dipturus batis, D. oxyrinchus, Rostroraja alba, Galeus melastomus, Mustelus* spp. and *Squatina squatina*, but the biology and stock structure of these species is less well known. WGEF should collate available survey and biological information for these species in future meetings.

Spanish and Portuguese fisheries are well described but no French information was presented. The RG recommend that more detailed investigations of French fisheries and French survey data from the Bay of Biscay are undertaken in future meetings of WGEF.

The landings are reported by groups of species for skates and rays (Rajidae) and by species for lesser spotted dogfish (*Scyliorhinus canicula*), Smooth hounds (*Mustelus* spp, *Mustelus mustelus*) and Angel shark (*Squatina squatina*) for 1996-2006 periods. These data are shown in tables 19.1a to 19.1e. In the case of Rajidae the Figure 19.1 shows the evolution of the landings for 1973-2006. ESRG recommend keeping the table data (Table 19.1a) with the complete data series.

The RG recommend that given the long *S. canicula* Spanish tagging programme, some further results and interpretations would have been useful.

Previous meetings of WGEF have undertaken preliminary modelling for *L. naevus* (VII and VIII) and *S. canicula* (VIIIc). However WGEF considered that the results obtained by these models were not satisfactory due to the short time series of the biological information, landings and effort. In 2007, WGEF focused studies on fishery-independent survey data and ESRG recommends that such studies are probably the best way forward and methods applied to the North Sea and Celtic Seas stocks could usefully be applied to the major stocks in this eco-region (see also issues related to this methodology in Introduction).

Table 19.10b concerning the Technical interactions in Iberian waters are not relevant for the elasmobranchs because these species are not included. WGEF should include skates, rays and dogfishes in this table if it to be of value to the report.

Demersal rays in the Azores and Mid-Atlantic Ridge

Information is scarce in this area apart from the Azores. Survey indicates that the catch rates of thornback rays are stable, although landings have declined in recent years. Neither data set is commented on by the WGEF. As in many of these fisheries species and stock identification is a problem, and there is little market or discard information. WGEF should analyze survey data in more detail and using similar methods as applied to stocks elsewhere, as these are probably the best data for managing these stocks.

See general comment on the use of biological and ecological information (in *italics* in General considerations).