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## Executive Summary

The ICES Working Group on Elasmobranch Fishes, 2013 (Chair, Ivone Figueiredo, Portugal) was held at IPMA, Lisbon, Portugal from the 17–21 June 2013. Seventeen Expert Group members attended, with thirteen more contributing via correspondence. One representative of EC-DGMare attended as an observer to the group for a portion of the meeting. Nine ICES member states were represented.

ICES WGEF meets annually, but normally provides advice on a biennial basis. Although 2013 was not an assessment and advice year, a revision of the fine-scale taxonomic or geographical units for the provision of advice for demersal elasmobranchs was undertaken, which will inform on those assessments to be conducted in 2014.

Two special requests were received:

- A special request from the European Commission to ICES to provide advice on the appropriateness to amend the list of deep-sea sharks, considering: i) to exclude blackmouth catshark (*Galeus melastomus*); ii) to include lowfin gulper shark (*Centrophorus lusitanicus*); and
- A special request from the European Commission to ICES to provide advice on exploring alternative and/or complementary management measures such as closed areas/seasons or effort restrictions which may better protect demersal elasmobranchs.

Twenty-four Working Documents were presented to the Group, mainly relating to survey results and port-sampling schemes. Several working documents presented results from national projects to better understand the spatial and temporal dynamics of demersal elamobranchs, including some species currently listed as 'prohibited species'.

Most elasmobranch stocks are considered to be data-limited. ICES WKLIFE expert group has explored and proposed data deficient assessment methods as tools to substantiate management advice. In 2013 WGEF conducted an exploratory Productivity and Susceptibility Analysis (PSA) and evaluated its potential use on qualitative assessment and advice, particularly in the case of stocks for which otherwise no advice could historically be given. The utility of this approach in aiding the MSFD implementation and identification of candidate indicator species was also discussed.

Under the EU Marine Strategy Framework Directive elasmobranchs are a relevant group of species to determine the Good Environmental Status (GES) of ecosystems, including for descriptor 1 (biodiversity), descriptor 3 (commercial fish stocks) and descriptor 4 (foodwebs). In 2011 the WGEF gave an overview of MSFD and the identified elements of WGEF work that could contribute to evaluate the status for MSFD descriptors and determining GES. This year the work progressed by looking at the indicators in more detail, in particularly by analysing their relevance for elasmobranchs and what progress various member states had made.

The following stocks were addressed at the 2013 WGEF meeting:

| Species/Assemblage | Area | Assessment type |
|---|---|---|
| Spurdog | Northeast Atlantic | Updated information |
| Leafscale gulper shark and Portuguese dogfish | Northeast Atlantic (IV-XIV) | Updated information |
| Kitefin shark | Northeast Atlantic (entire ICES area) | Updated information |
| Other Deepwater sharks | Northeast Atlantic (ICES Subareas IV-XIV) | Updated information |
| Porbeagle | Northeast Atlantic (ICES Subareas I-XIV) | Updated information |
| Basking | Northeast Atlantic (ICES Subareas I-XIV) | Updated information |
| Blue | North Atlantic (North of 5ºN) | Updated information |
| Mako | North Atlantic (North of 5ºN) | Updated information |
| Tope | Northeast Atlantic and Mediterranean | Updated information |
| Tresher | Northeast Atlantic and Mediterranean | Updated information |
| Other Pelagic sharks | Northeast Atlantic | Updated information |
| Demersal elasmobranchs | Barents Sea | Updated information |
| Demersal elasmobranchs | Norwegian Sea | Updated information |
| Demersal elasmobranchs | North Sea, Skgerrak, Kattegat and eastern Channel | Updated information |
| Demersal elasmobranchs | Iceland and East Greenland | Updated information |
| Demersal elasmobranchs | Faroes Islands | Updated information |
| Demersal elasmobranchs | Celtic Seas (ICES Subareas VI and VII except Division VIId) | Updated information |
| Demersal elasmobranchs | Bay of Biscay and Iberian waters (ICES Subarea VIII and Division IXa) | Updated information |
| Demersal elasmobranchs | Azores and Mid-Atlantic Ridge | Updated information |
| Smooth-hounds | Northeast Atlantic | Updated information |

Because of the increasing number of stocks that require advice and the complexity in the methods underpinning $F_{MSY}$-based advice it was agreed that WGEF should meet at IPMA Lisbon for the 2014 assessment year where a broader participation of experts is likely to occur. WGEF proposed to meet for ten days in June 2014.

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

# 1 Introduction

## 1.1 Terms of Reference

2012/2/ACOM19 The **Working Group on Elasmobranch Fishes** (WGEF), chaired by Ivone Figueiredo, Portugal, will meet at Lisbon, Portugal, 17–21 June 2013 to:

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

b ) Update the description of elasmobranch fisheries for deep-water, pelagic and demersal species in the ICES area and compile landings, effort and discard statistics by ICES subarea and division, and catch data by NEAFC area;

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

d ) Update the description of fisheries in both the NEAFC and ICES area(s) by compiling data on catch/landings, fishing effort (inside versus outside the EEZs, in spawning areas, areas of local depletion, etc.), and discard statistics at the finest spatial resolution possible by ICES subarea and division and NEAFC RA;

e ) In order to support a rolling provision of advice, biennial or less frequency, the working group is asked to propose a schedule of assessments, to provide advice on a rolling basis over the period 2013–2015 for all the stocks in the group. The aim of this schedule should be to have advice every year for a subset of the stocks. The guidance from ACOM and WKLIFE should be considered in this regard. Considering the considerations of ACOM, WKLIFE and WKFREQ;

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

g ) Review options for fine-scale taxonomic or geographical units for the provision of advice for demersal elasmobranchs;

h ) Determine the additional data requirements for certain statistical and model techniques for the 2014 stock assessment cycle;

i ) Consider the application of the Marine Strategy Framework Directive indicators for elasmobranchs;

j ) Initiate the necessary planning for a future PSA for elasmobranchs in the ICES area by

  i ) Reviewing existing approaches; and

  ii ) Intersessionally, compiling the input of parameters required for a regional PSA.

WGEF will report by 1 August 2013 for the attention of ACOM.

## 1.2 Special requests

Two requests from European Commission were received.

- A request from European Commission to advice on exploring alternative and/or complementary management measures such as closed are-

as/seasons or effort restrictions which may better protect demersal elasmobranchs on exploring management measures other than TACs for skates and rays, in particularly. An observer from the EC attended discussions of this request and the opinion to the request is dealt in Appendix 3; and

- A request from the European Commission to provide advice on the appropriateness to amend the list of deep-sea sharks, considering: i) to exclude blackmouth catshark (*Galeus melastomus*); ii) to include lowfin gulper shark (*Centrophorus lusitanicus*). An observer from the EC attended discussions of this request and the opinion to the request is dealt in Appendix 4.

## 1.3 Participants

The following WGEF members attended the meeting:

| | |
|---|---|
| Ole Thomas Albert | Norway |
| Tom Blasdale | UK |
| Cristina Rodriguez Cabello | Spain |
| Massimiliano Cardinale | Sweden |
| Guzman Diez | Spain (Basque Country) |
| Jim Ellis | UK (England and Wales) |
| Ivone Figueiredo (Chair) | Portugal |
| Graham Johnston | Ireland |
| Catarina Maia | Portugal |
| Sophy McCully | UK (England and Wales) |
| Francis Neat | UK (Scotland) |
| Barbara Pereira | Portugal |
| Mario Rui Pinho | Portugal (Azores) |
| Matthias Schaber | Germany |
| Bernard Seret | France |
| Alain Tetard | France |
| Paddy Walker | The Netherlands |
| Fernando Nieto-Conde (Observer) | EC - DGMare |

The following WGEF members assisted by correspondence:

| | |
|---|---|
| Steven Beggs | UK (Northern Ireland) |
| Gerard Bias | France |
| Maurice Clarke | Ireland |
| Helen Dobby | UK (Scotland) |
| Andrey Dolgov | Russia |
| Armelle Jung | France |
| Pascal Lorance | France |
| Kelle Moreau | Belgium |
| José De Oliveira | UK (England and Wales) |
| Teresa Moura | Portugal |
| Harriet van Overzee | The Netherlands |
| Francisco Velasco | Spain |
| Tone Vollen | Norway |

## 1.4 Background and history

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

sessments for elasmobranch species had proven very difficult because of the lack of data. The 1999 meeting was held concurrently with an EC-funded Concerted Action Project meeting (FAIR CT98-4156) allowing for a greater participation from various European institutes. Exploratory assessments were carried out for the first time at the 2002 SGEF meeting, covering eight of the nine case study species considered by the EC-funded DELASS project (CT99-055). The success of this meeting was as a consequence of the DELASS project, a three-year collaborative effort involving fifteen fisheries research institutes and two subcontractors. Though much progress was made on methodology, there was still much work to be done, with the paucity of species-specific landings data a major data issue.

In 2002, SGEF recommended the Group be continued as a working group. The medium-term remit of this WG being to adopt and extend the methodologies and assessments for elasmobranchs prepared by the EC-funded DELASS project; to review and define data requirements (fishery, survey and biological parameters) for stock identification, analytical models and to carry out such assessments as are required by ICES customers.

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

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

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

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

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

blue shark, and to further refine data available for the NE Atlantic stock of porbeagle (ICES, 2008a).

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

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

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

In June 2012 WGEF met at IPMA in Lisbon. This meeting was a full assessment meeting during which both stock updates and draft advice were provided. Two special requests, one from NEAFC and the other from the NWWRAC (via the EC), were also answered.

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

Interest in the work of WGEF from other RFMOs has increased, with regular contact and cooperation between WGEF and ICCAT and the GFCM.

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

## 1.5 Planning of the work of the group

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

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

In 2010 WGEF proposed that in years where advice is required (2012, 2014, etc.) that the meetings would be of eight-day duration. However, where new assessments were not required (e.g. 2011), the meetings could be reduced to five days, assuming no additional Terms of Reference or special requests were made that would require additional time.

In 2013 it was agreed to change the cycle that WGEF has so far worked. It was also considered that despite the increasing complexity in the methodology underpinning $F_{MSY}$-based advice particularly during assessment year, it was agreed that to have the next meeting in Lisbon.

- It was considered that having the meeting in Lisbon would benefit the work of WGEF, since it would maximise participation;
- It was also noted that having the meeting in June would facilitate the participation of quantitative assessment scientists, as meeting earlier in the year could clash with other assessment groups;
- Hence, it was proposed that WGEF will meet in Lisbon, Portugal, for ten days in June 2014;
- It was also agreed that given the increased number of stocks that WGEF has to deal with, the addition of a co-chair would facilitate the meeting and inter-sessional work.

## 1.6 ICES approach to $F_{MSY}$

Most elasmobranch species are slow growing, with low production. Some species, such as basking shark, are on several lists of 'threatened' or 'endangered' species. They may also be listed under international trade agreements such as the Convention on the International Trade on Endangered Species (CITES), which may place limitations on fishing for or trade in these species.

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

## 1.7 Community plan of action for sharks

An Action Plan for the Conservation and Management of Sharks (EU, 2009) was adopted by the European Commission in 2009. Further detail on this plan and its relevance to this WG can be found in the 2009 WG Report.

## 1.8 Conservation advice

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

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

These ideas are discussed in detail below.

### Extinction vs. extirpation

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

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

In terms of a standardized approach to the terminology of lost species, we would propose the following:

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

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

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

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

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

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

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

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

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

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

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

Additionally, there is a rationale that a list of prohibited species should not be changing regularly, as this could lead to confusion for both the fishing and enforcement communities.

In 2010 undulate ray, *Raya undulata* was placed on the prohibited species list. This had not been recommended by ICES. Following a request from commercial fishers, the European Commission asked ICES to give advice on this listing. ICES reiterated that undulate ray would be better managed under local management measures and that there was no justification for placing undulate ray on the prohibited species list. However, to-date, there has been no change in the listing of this species.

## 1.9 Sentinel fisheries

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

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

## 1.10 Mixed fisheries regulations

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

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

## 1.11 Current ICES expert groups of relevance to the WGEF

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

Several elasmobranchs are taken in North Sea demersal fisheries, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 15). WGNSSK should note that the Greater Thames Estuary is the main part of the North Sea distribution of thornback ray *Raja clavata* and may also be an important nursery ground for some small shark species, such as tope and smooth-hounds. Thornback ray is an important species in ICES Division IVc, and is taken in fisheries targeting sole (e.g. trawl and gillnet), cod (e.g. trawl, gillnet and longline), as well as in targeted fisheries.

#### Working Group for the Celtic Seas Ecoregion (WGCSE)

Several elasmobranchs are taken in the waters covered by WGCSE, including spurdog (see Section 2), tope (Section 10) and various skates and rays (Section 18). WGCSE should note that common skate *Dipturus batis*-complex, which has declined in many inshore areas of northern Europe, may be locally abundant in parts of ICES Division VIa and the deeper waters of the Celtic Sea (VIIh–j). Thornback ray is abundant in parts of the Irish Sea, especially Solway Firth, Liverpool Bay and Cardigan Bay. The Lleyn Peninsula is an important ground for greater-spotted dogfish *Scyliorhinus stellaris*. WGSCE should also note that the Bristol Channel is of high local importance for small-eyed ray *Raja microocellata*, as well as being an important nursery ground for various small sharks (e.g. smooth-hounds and tope) and other rajids.

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

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

In 2008, WGEF met in parallel with WGDEEP in order to assess and provide advice on deep-water sharks (see Sections 3–5). In February 2010 WGDEEP held a benchmark assessment of deep-water stocks (WKDEEP; ICES 2010a). Two WGEF members attended in order to carry out an assessment of the deep-water shark species *Centrophorus squamosus* and *Centroscymnus coelolepis*. These assessments were updated with 2009 landings and survey data and expanded upon at this meeting.

#### International Bottom-trawl Survey Working Group (IBTSWG)

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

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

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

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

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

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

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

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

A maximum landing length (100 cm) was introduced for 2009. Since then there has been a complete ban on landing spurdog, so this measure is not currently relevant.

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

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

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

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

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

#### Working Group on the Bycatch of Endangered Species (WGBYC)

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

#### Working Group on Beam Trawl Surveys (WGBEAM)

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

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

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

#### Working Group on Deep–water Ecology (WGDEC)

WGDEC formed in 2007 and has met annually since then. The main role of the group is to map vulnerable marine ecosystems in the deep-sea and to advise on spatial conservation measures. Through their association with various deep-water habitats and their need for conservation action, deep-sea sharks are relevant to work undertaken by WGDEC.

#### Workshop on Sexual Maturity Staging of Elasmobranchs (WKMSEL)

The first workshop met in October 2010, following a recommendation from PGCCDBS. Its objectives were to agree on a common maturity scale for elasmobranchs, both oviparous and viviparous species, across laboratories and compare existing scales and standardize maturity determination criteria. Although WGEF

agrees that standardization across laboratories is important, there are concerns over some of the new scales proposed. In particular, the increase in the number of stages compared with other scales used will lead to some problems if introduced. These include:

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

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

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

## 1.12 Other fisheries meetings of relevance to WGEF

### ICCAT

WGEF has conducted joint assessments with ICCAT in 2008 and 2009. These were useful in pooling information on highly migratory pelagic shark species, including porbeagle, blue shark and short-fin mako. It is intended that these collaborations continue to usefully assess and update knowledge of pelagic shark species. ICCAT shark specialist subgroup also recommends maintaining links and sharing data with WGEF. In 2012 a representative of WGEF attended the ICCAT Ecological Risk Assessment and shortfin mako stock assessment in Faro, Portugal. Data from this meeting were used in the WGEF account of shortfin mako (Chapter 9).

### General Fisheries Commission for the Mediterranean (GFCM)

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

1 ) Expert Meeting on the status of Elasmobranchs in the Mediterranean and Black Sea (Sfax Tunisia, 20–22 September 2010);

2 ) Workshop on Stock Assessment of Selected Species of Elasmobranchs (Brussels Belgium, 12–16 December 2011);

3 ) Workshop on Age Determination (Antalya Turkey, 8–12 October 2012);

4 ) Bibliographic review to sum up the information gathered during the above mentioned meetings, published in 2012 within the GFCM Series Studies and Reviews; and

5 ) Publication of a technical manual on age determination of elasmobranchs.

The Chair of WGEF was invited to attend and Chair the 2nd elasmobranch stock assessment of the GFCM. It was felt that both ICES and the GFCM would benefit from this interaction due to the overlap in the distribution of certain stocks, and also in comparing stock assessment methods for data-poor stocks. This was a highly successful meeting, with several elasmobranch stocks assessed for the first time. WGEF encourages co-operation and sharing of data, information and expertise with the GFCM and other RFMOs.

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

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

## 1.13 Relevant biodiversity conservation issues

ICES work on elasmobranch fish is becoming increasingly important as a source of information to various multilateral environmental agreements concerned about the conservation status of some species. Table 1.1 lists species occurring in the ICES area that are being considered within these fora.

**Table 1.1. Species listed by Multilateral Environmental Agreements.**

| | Multinational Environmental Agreement | | | |
|---|---|---|---|---|
| Species | OSPAR | CMS | CITES | Bern |
| Spurdog *Squalus acanthias* | ✓ | App II | Proposed, Rejected 2010 | |
| Gulper shark *Centrophorus granulosus* | ✓ | | | |
| Leafscale gulper shark *Centrophorus squamosus* | ✓ | | | |
| Portuguese dogfish *Centroscymnus coelolepis* | ✓ | | | |
| Angel shark *Squatina squatina* | ✓ | | | App III (Med) |
| Sawfish *Pristis pristis* and *P. pectinata* | | | App I | |
| Common skate *Dipturus batis* | ✓ | | | |
| White skate *Rostroraja alba* | ✓ | | | App III (Med) |
| Thornback ray *Raja clavata* | ✓(North Sea) | | | |
| Spotted ray *Raja montagui* | ✓ (North Sea) | | | |
| Giant devil ray *Mobula mobular* | | | | App II (Med) |
| Basking shark *Cetorhinus maximus* | ✓ | App I and II | App II | App II (Med) |
| White shark *Carcharodon carcharias* | | App I and II | App II | App II (Med) |
| Shortfin mako shark *Isurus oxyrinchus* | | App II | | App III (Med) |
| Longfin mako shark *Isurus paucus* | | App II | | |
| Porbeagle shark *Lamna nasus* | ✓ | App II | Accepted 2013 | App III (Med) |
| Blue shark *Prionace glauca* | | | | App III (Med) |

### OSPAR Convention

The OSPAR Convention (www.ospar.org) guides international cooperation on the protection of the marine environment of the Northeast Atlantic. It has 15 Contracting Parties and the European Commission, representing the European Community. The OSPAR list of threatened and/or declining species and habitats, developed under the OSPAR Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area, provides guidance on the future conservation priorities and research needs of marine biodiversity (species and habitats) at risk in this region. To date, eleven elasmobranch species are listed (Table 1.1), either across the entire OSPAR region or in areas where they are declining. Background Documents that summarize the status of each of these species and propose actions and measures to be taken, including through ICES, are currently under development.

#### Convention on the Conservation of Migratory Species (CMS)

CMS recognizes the need for countries to cooperate in the conservation of animals that migrate across national boundaries, if an effective response to threats operating throughout a species' range is to be made. The Convention actively promotes concerted action by the range states of species listed on its Appendices. The CMS Scientific Council has determined that in all 35 shark and ray species, globally, meet the criteria for listing in the CMS Appendices (Convention on Migratory Species 2007). Table 1.1 lists Northeast Atlantic elasmobranch species that are currently included in the Appendices. CMS Parties should strive towards strictly protecting the endangered species on Appendix I, conserving or restoring their habitat, mitigating obstacles to migration and controlling other factors that might endanger them. The range states of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international cooperation) are encouraged to conclude global or regional agreements for their conservation and management (www.cms.int).

#### Convention on International Trade in Endangered Species (CITES)

CITES was established in recognition that international cooperation is essential to the protection of certain species from overexploitation through international trade. It creates the international legal framework for the prevention of trade in endangered species of wild fauna and flora and for the effective regulation of international trade in other species which may become threatened in the absence of such regulation. Species threatened with extinction may be listed in Appendix I, essentially banning commercial international trade in their products. Appendix II of CITES includes "*species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival*". Trade in these species is closely monitored and allowed only after exporting countries provide evidence that such trade is not detrimental to populations of the species in the wild (e.g. where fisheries are regulated). Table 1.3 lists elasmobranch species occurring in the Northeast Atlantic that are listed in the Appendices or currently known to be proposed for listing. Resolution Conf. 12.6 encourages parties to identify endangered shark species that require consideration for inclusion in the Appendices if their management and conservation status does not improve; several other ICES species are included in these lists. Decision 13.42 encourages parties to improve their data collection and reporting of catches, landings and trade in sharks (at species level where possible), to build capacity to manage their shark fisheries, and to take action on several species-specific recommendations from the Animals Committee (CITES 2009).

## 1.14 ICES fisheries advice

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

Maximum sustainable yield is a broad conceptual objective aimed at achieving the highest possible yield over the long term (an infinitely long period of time). It is non-specific with respect to: (a) the biological unit to which it is applied; (b) the models used to provide scientific advice; and (c) the management methods used to achieve MSY. The MSY concept can be applied to an entire ecosystem, an entire fish community, or a single fish stock. The choice of the biological unit to which the MSY concept is applied influences both the sustainable yield that can be achieved and the associated management options. Implementation of the MSY concept by ICES will first be applied to individual fish stocks. Further information on the background to MSY and

how it is applied to fish stocks by ICES can be found in the General Context to ICES Advice .

## 1.15 Data availability

#### Provision of data prior to working group

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

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

The group agreed that cpue from surveys should be provided as disaggregated raw data, and not as compiled data. The group agreed that those survey abundance estimates that are not currently in the DATRAS database are also provided as raw data by individual countries.

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

#### Landings data

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

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

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

WGEF aims to allocate progressively more of the "nei" landings data over time, and some statistical approaches have been presented to WGEF (see ICES, 2006; Johnston *et al*., 2006). However the Working Group's best estimates are still considered inaccurate for a number of reasons:

i ) Quota species may be reported as elasmobranchs to avoid exceeding quota, which would lead to overreporting;

ii ) Fishers may not take care when completing landings data records, for a variety of reasons;

iii ) Administrations may not consider that it is important to collect accurate data for these species;

iv ) Some species could be underreported to avoid highlighting that bycatch is a significant problem in some fisheries;

v ) Some small inshore vessels may target (or have a bycatch of) certain species and the landings of such inshore vessels may not always be included in official statistics.

The data may also be imprecise as a result of revisions by reporting parties. WGEF aims to arrive at an agreed set of data for each species and will document any changes to these datasets in the relevant working group report.

#### Discards

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

#### Stock structure

This Report presents the status and advice of various demersal, pelagic and deep-water elasmobranchs by individual stock component. The identification of stock structure has been based upon the best available knowledge to date (see the stock-specific chapters for more details). However, it has to be emphasized that overall, the scientific basis underlying the identity of many of these demersal and deep-water stocks is currently weak. In most of the cases, the identification of stock is based on the distribution and relative abundance of the species, limited knowledge of movements and migrations, reproductive mode, and consistency with management units. Therefore, the WG considers that the stock definitions proposed in the report are limited for many species, and in some circumstances advice may refer to 'management units' mostly preliminary. The WG recommends that increased research effort be devoted to clarifying the stock structure of the different demersal and deep-water elasmobranchs being investigated by ICES.

#### Length measurements

Further information on the issues of different types of length measurement can be found in Section 1.15 of the 2010 WGEF report.

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

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

#### Other issues–*Dipturus* complex

Two papers (Iglesias *et al*., 2010; Griffiths *et al*., 2010), demonstrated that *Dipturus batis*, frequently referred to as common skate, is in fact a complex of two species, mislabelled since the 1920s. *D. batis* is a confusion of *D. flossada* (blue skate) and *D. intermedia* (flapper skate).

In 2012 a special request was received from the European Commission to determine whether these species could be reliable identified and whether they have different distributions, with regard to the possible setting of separate TACs for the two species. This special request is dealt with in Annex IV of 2012 WGEF report. This report will

refer to the *Dipturus batis* complex, as an alternative to erroneously referring to the individual species each time.

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

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

## 1.16 Methods and software

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

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

Hence, the work undertaken by WGEF often precludes the formal stock assessment process that is used for many commercial teleosts stocks, and the analyses of survey, biological and landings data are used more to evaluate the status of the species/stocks.

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

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

## 1.17 InterCatch

WGEF has not used InterCatch for its landings figures. Landings figures are supplied by individual members. These are considered to be superior to official statistics as regional laboratories can better provide information on local fisheries. In addition, the problems of the use of generic categories and species misidentification can be better evaluated in advance by WGEF members.

## 1.18 Working documents presented

The following working documents (with a brief summary included) were provided:

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A., Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-01.

Abstract: Since 2000, research vessel groundfish surveys and other field programmes have been used as platforms to opportunistically tag and release various elasmobranch species, including smooth-hounds *Mustelus* spp. (n=717), greater-spotted dogfish *Scyliorhinus stellaris* (n=567) and tope *Galeorhinus galeus* (n=159). Additional opportunities during Fishery Science Partnership (FSP) and Defra-funded research projects that targeted other elasmobranch species have also been used to tag these species. Overall, 74% of the releases were from groundfish surveys. Most specimens were tagged and released with Petersen disc and were tagged around much of the British Isles, although the greatest tagging activity occurred in the Irish Sea, Celtic Sea and, to a lesser extent, the western English Channel and southern North Sea. The overall return rate was relatively low (1.6%), and to date a total of 24 fish were returned (eight greater-spotted dogfish, four tope and 12 smooth-hounds). Nevertheless, the recaptured fish were at liberty for a total 9568 days. Although the number of returns was limited, useful information was obtained about their biology and behaviour that would not have been realised if it was not for the programme. In general greater-spotted dogfish were recaptured close to their release positions, and there was no indication of mixing between the western English Channel and Irish Sea. In contrast, tope and smooth-hounds travelled further and there was mixing between the North Sea and Celtic Seas ecoregions. The greatest time at liberty for an individual fish was for a 2403 days for a tope, and the furthest that a fish had travelled was 408 km, which was for a smooth-hound that had travelled from the western English Channel to the southern North Sea in 73 days, recording the highest average daily speed of 5.6 km/day.

Delamare, A., Hennache, C., Stéphan, È., Biais, G. 2013. Bay of Biscay undulate ray (*Raja undulata*) abundance assessment by mark–recapture method. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-02.

Abstract: Results of a tagging operation that suggests that the undulate ray population is closed in the central part of the Bay of Biscay regarding emigration or immigration. This was the first step of the RaieBECA project, which the second step aims at carrying out a recapture survey to estimate the abundance of this population. The methodology that could be implemented for this survey is presented, considering the conditions that are necessary to use the Lincoln-Petersen estimator. The quality of the results that may be provided by this survey is discussed. The conclusion is that there is no guarantee to get a robust population abundance estimate but, nevertheless an interest to plan a future tagging-recapture project well designed. If all the partners of the project agree on its interest, this survey could be planned in autumn 2013.

Dransfeld, L. 2013. Elasmobranch assessment for the Irish MSFD. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-03.

Abstract: The status of six elasmobranch species (*Squalus acanthias, Scyliorhinus canicula, Raja clavata, Leucoraja naevus, Centrophorus squamosus* and *Centroscymnus coelolepis*) is assessed under Descriptors 1 and 3 of the MSFD, looking at distribution range and pattern, population condition, abundance and Fishing mortality. Data

from the Irish Groundfish Survey and the Irish Deepwater survey are used in the assessments.

Ellis, J. R.,McCully, S. R. 2013. An overview of the sharks, skates and rays (*Elasmobranchii*) and rabbit fish (*Holocephali*) of the British Isles, and prioritisation of species of interest. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-04.

Abstract: This Working Document provided an updated taxonomic list of the chondrichthyan fish around the British Isles. All species were qualitatively scored in terms of conservation interest, commercial importance, importance of the UK to the species range and their biological susceptibility (in terms of maximum size and reproductive mode). The highest ranking species were subsequently examined in relation to availability of relevant fisheries and survey data, assessments and advice, and important data gaps that hampered the ability of ICES to provide advice identified.

Fernández-Zapico, O., Velasco, F., Baldó, F., Rodríguez-Cabello, C., Ruiz-Pico, S. 2013. Results on main elasmobranch species captured during the 2001-2012 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-05.

Abstract: This working document presents the results of the most significant elasmobranch fish species caught on the Porcupine Bank during Spanish bottom trawl surveys (2001–2012). The most abundant species in biomass in these surveys were blackmouth catshark (*Galeus melastomus*), birdbeak dogfish (*Deania calcea*), knifetooth dogfish (*Scymnodon ringens*), velvet belly lantern shark (*Etmopterus spinax*), lesser spotted dogfish (*Scyliorhinus canicula*), bluntnose sixgill shark (Hexanchus griseus), sandy ray (*Leucoraja circularis*), cuckoo ray (*Leucoraja naevus*) and common skate (*Dipturus* spp.). Biomass, spatial distribution and length ranges were analysed. Many of these species occupy mainly the deep soft grounds covered in the survey, particularly *D. calcea*, *S.ringens* and *D. profundorum*.

Figueiredo, I., Serra-Pereira, B. 2013. Modelling *Raja clavata* abundance from Portuguese IBTS data (1990–2011) using GLMM with Tweedie distribution. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-06.

Abstract: The present study aims to evaluate the annual trend in abundance of *Raja clavata* based on the data collected at IBTS surveys held along the Portuguese coast, by the adjustment of a Generalized linear mixed model (GLMM) assuming a Tweedie distribution for the observations. The results show that the Tweedie distribution applied to the present dataset is the most appropriate model when the proportion of zeros is high. This overall approach proves to be adequate for being applied to similar situations as *Raja clavata*, when commercial catch data have a short time-series and when survey data has a high frequency of zeroes abundances.

Lagarto, N., Moura, T., Farias, I., Figueiredo, I. 2013.Sampling information from deep-water sharks caught in the black scabbardfish fishery from mainland Portugal. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-07.

Abstract: This working document presents data from deep-water sharks collected under the DCF on the Portuguese mainland deep-water longline métier in 2012. The relative frequency and length distribution of each identified species are present. Misidentification problems at the species level persist at Sesimbra fishing port.

Leblanc, N., Tetard, A., Legrand, V. 2013. RAIMOUEST: the French fishery of rays in the Western English Channel (VIIe). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-08.

Abstract: The landing ban of *Raja undulata* has raised misunderstanding for French fishermen's, particularly for those fishing in the Normano-Breton Gulf, where this species is abundant (Southeast of ICES Division VIIe) with an extension to the North Coast of the Cotentin (in ICES Division VIId). In this context, the RAIMOUEST project has been established as a professional and scientist partnership in order to improve fisheries data on the main ray species caught in the normano-breton gulf (*Raja undulata*, *Raja brachyura*, *Raja microocellata*, *Raja clavata* and *Raja montagui*). The objectives were the identification of fisheries for rays, production of stocks status indicators (catch, landings, Catch per Unit of Effort indices, length distribution, abundance indices of adults and recruits) and the geo-localization of potential areas for spatial protection measures. The aim of RAIMOUEST project is thus to re-evaluate the perception of the state of these stocks, and subsequently, to propose appropriate and concerted management measures for sustainable exploitation of these resources. Furthermore RAIMOUEST contributes to the RECOAM project carried out by APECS in Atlantic and English Channel coastal waters on the main ray species (Stéphan *et al.*, 2013). The present working document summarizes the already collected information and presents the first results on ray fisheries characterization, as well as, on stock status indicators.

Maia, C., Serra-Pereira, B., Figueiredo, I. 2013. Skates and rays estimates of landings by species from the Portuguese vessels operating in ICES Division IXa. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-09.

Abstract: Problems on skate landings discriminated by species persist at Portuguese continental fishing ports, which turns landing data and fishing effort estimates per species not a straightforward issue. In order to overcome these problems, IPMA has initiated under the Data Collection Framework (DCF), a pilot study focusing fisheries with positive landings of skates in Portugal mainland, which is still ongoing. The present report focuses on the polyvalent segment and aims to estimate total landing weight (in Kg) and fishing effort (in number of trips) per species. According to the available data two different methodologies are applied. Estimated average proportions and standard deviations for each skate species are present for each of the sampled fishing ports, as well as, the estimated fishing effort.

Moura, T., Fernandes, A., Figueiredo, I., Alpoim, R. 2013. Pilot Study on the Portuguese trammelnet fishery in ICES Division IXa. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-10.

Abstract: The fishery targeting anglerfish (*Lophius piscatorius* and *Lophius budegassa*) is one of the most important artisanal mixed fisheries in Portugal mainland. Exploitation depths have historically been down to 600 m deep until the implementation of the Annex III to Regulation (EC) No 43/2009 which states that Community vessels shall not deploy gillnets, entanglingnets and trammelnets at any position where the charted depth is greater than 200 m in the above mentioned areas in ICES zones IIIa, IVa, Vb, Via, VIb, VIIbcjk, VIII, IX, X, XII. To evaluate the level of bycatch and discards of sharks and to increase the knowledge on the fishery, a pilot study on the Portuguese trammelnet fishery targeting anglerfish in ICES Division IXa started in May 2012 under the PNAB/DCF. This working document presents information about the latter, based on fishery-dependent data and on board information collected in the first eight months of the project. A total of eight shark species (62 specimens) were caught in 16 sampled hauls. 46 specimens were identified as *Scyliorhinus canicula* and only four specimens of the species included in the list of deep-water sharks under the TAC established by the European Commission were caught between 600 and 630 m

deep: *Chlamydoselachus anguineus*, *Dalatias licha*, *Galeus melastomus* and *Centroselachus crepidater*.

Moura, T., Prista, N., Figueiredo, I. 2013. Productivity-susceptibility analysis of the bycatch species taken in the deep-water longline fishery from Portugal mainland. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-11.

Abstract: This study represents a first attempt to use Productivity and Susceptibility Analysis (PSA) approach to assess the vulnerability of bycatch species caught in the black scabbardfish. Results show that, despite more vulnerable than teleosts, elasmobranchs present differences in risk levels between species which are possibly associated to different life strategies, captured by the attributes used. Some problems related to the use of some attributes for deep-water species, to weighting and lack of species-specific information were detected and should be discussed for further improvements.

Neat, F. 2013. Deep-water Elasmobranch Times-series Analysis; Indices of relative abundance based on Scottish deep-water trawl survey. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-12.

Abstract: The present report summarizes data from the Scottish deep-water trawl operating between depths of 300–2030 along the continental shelf slope of Scotland since 1998. Relative abundance indices for several deep-water elasmobranchs are presented.

Pinho, M. R. 2013. Update of the Azorean elasmobranchs fishery data (ICES Area X). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-13.

Abstract: More than 40 elasmobranch species are listed as occurring in the Azores. These species cover pelagic, benthopelagic and benthic habitats from shallow to deep-water strata in areas around coastal of the islands, banks and seamounts. However, only about 17 shark species are identified by the auctions from the landings. Elasmobranchs catches from the Azores (ICES sub-area X) are mainly a bycatch from three main fisheries: the swordfish fishery, the demersal fishery and the black scabbardfish fishery. This paper updates the elasmobranchs landings from the Azores, ICES Area X for 2013 WGEF meeting.

Pinho, M. R. 2013. Updating elasmobranchs survey data from the Azores (ICES X). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-14.

Abstract: This paper updates the elasmobranchs information from the Azorean bottom longline survey, ICES Division Xa2. Information on species, abundance by depth and length is provided.

Prista, N., Fernandes, C. 2013. Discards of elasmobranchs by the Portuguese bottom otter trawl and deep-water set longline fisheries operating in ICES Division XIa (2004–2012). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-15.

Abstract: This Working Document compiles the information available on the discards of elasmobranchs produced by Portuguese vessels operating with bottom otter trawl and deep-water set longlines that target black scabbardfish in Portuguese ICES Division IXa. The data were collected by the Portuguese on board sampling programme (EU DCR/NP) between 2004 and 2012. We describe the on board sampling programme, estimation algorithms and data quality assurance procedures and provide

results for three fisheries: the crustacean bottom otter trawl fishery (OTB_CRU), the demersal bottom otter trawl fish fishery (OTB_DEF) and the deep-water set longline fishery that targets black scabbardfish (LLS_DWS). Discards of elasmobranchs were uncommon on these fisheries with exception of *Galeus melastomus* (OTB_CRU), *Etmopterus* spp. (all fisheries) and *Scyliorhinus canicula* (OTB_CRU, OTB_DEF). Fleet level estimates of discards of *Galeus melastomus* in the OTB_CRU fishery were updated. The low frequency of occurrence of elasmobranch taxa in the trawl hauls and longline sets sampled on board indicates that discards can be assume negligible in the majority of stock assessments carried out by WGEF 2013.

Prista, N., Serra-Pereira, B., Figueiredo, I. 2013. Using SARIMA models for monitoring landings-per-unit of effort of cuckoo ray *Leucoraja naevus*: a methodological proposal. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-16.

Abstract: The cuckoo ray (*Leucoraja naevus*) in ICES Division IXa is an example of a data-limited stock that is still to be subject to stock assessment. To date the state of the stock remains unknown, a situation that led ICES to advise a 20% reduction (e.g. ICES, 2012). The SARIMA methodology used in this report is not a stock assessment method but it does provide for an objective and statistically sound means of analyzing readily available data from severely data-limited fisheries and is able to detect major events on the fishery that could go unnoticed or unquantified. As such, it constitutes a useful, and yet little explored, tool for fisheries monitoring.

Roche, W., O'Reilly, S. 2013. Inland Fisheries Ireland note on recent Angel shark (*Squatina squatina*) angling and tagging activity in Ireland. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-17.

Abstract: The report on the tagging activity of *Squatina squatina* in Tralee Bay, Southwest Ireland, is updated with the number of captures and recaptures from 1970–2011. The rapid decline in the numbers being tagged over the past two decades, and recent poor angling catches support the 'endangered' status of angel shark.

Rodríguez-Cabello, C., Velasco, F., Pérez, M., Baldó, F., Fernández-Zapico, O., Ruiz-Pico, S. 2013. Data on *Dipturus* species caught in 2012 Porcupine survey (ICES Area VII). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-18.

Abstract: Several *Dipturus* specimens were caught on the Porcupine Bank area during the Spanish (IEO) bottom trawl survey carried out in 2012. In order to check the identification of these species, muscle samples were collected to perform genetic analyses. A total of 16 specimens were caught, however samples were collected only from ten specimens. Besides three individuals were frozen and taken to the laboratory to complete the morphological analysis. The results indicated that six specimens corresponded to *D. nidarosiensis* and four to *D. cf. flossada*. Biological data and distribution of these species is presented.

Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello, C., Punzón, A., Serrano, A., Fernández-Zapico, O., Blanco, M. 2013. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-19.

Abstract: This working document presents the results on the most significant elasmobranch fish species in the Spanish Groundfish Survey on Northern Spanish shelf in 2012. In decreasing order the main species in biomass terms in this survey are *Scyliorhinus canicula*, *Raja clavata*, *Galeus melastomus*, *Raja montagui*, *Etmopterus spinax* and *Leucoraja naevus*. Biomass, distribution and length ranges were analysed. A marked

increase in biomass of almost all species with regard to previous years was found, especially in *S. canicula* and *R. clavata* in Division IXa. *L. naevus* and *G. melastomus* were the only species which decreased in Division VIIIc.

Serra-Pereira, B., Maia, C., Figueiredo, I. 2013. Remarks on the reproduction strategy of *Raja undulata* from mainland Portugal. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-20.

Abstract: Regarding the urgent need for information about *Raja undulata* as a protected species and the need to obtain knowledge about its reproductive dynamics and reproductive potential, a publication is in preparation to address that, in the particular case of mainland Portugal. In this paper, an update of the reproductive parameters available for the species was compiled. In addition, information was gathered about occurrence areas and spawning sites of the species, mainly in the north and central regions. As a final output of that work, an estimate of the intrinsic growth rate of *R. undulata* was obtained, based on the estimated biological parameters, allowing determining the level of sensibility compared to others species.

Silva, J. F., Ellis, J. R., Catchpole, T. L., Righton, D. 2013. Bycatch and discarding patterns of dogfish and sharks taken in commercial fisheries around the British Isles. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-21.

Abstract: The discard and retention patterns of dogfish and sharks taken as a bycatch in UK commercial fisheries were examined. Data were collected primarily on English vessels fishing on the continental shelf of the North Sea ecoregion (ICES Divisions IV a–c, VIId) and Celtic Seas ecoregion (ICES Divisions VIa, VIIa–c,e–k). Vessels examined represented four main gear types (otter, beam and *Nephrops* trawls, and gillnet), with only limited data available for longline and mid-water trawl. Beam trawlers generally captured proportionally more small (juvenile) dogfish than otter trawlers. Gillnets were the most size selective gear. Data on the elasmobranch catches from *Nephrops* trawlers were frequently too limited to draw an accurate discard/retention pattern, which may reflect a low catchability of sharks by this gear and/or that elasmobranchs are not abundant on these muddy fishing grounds. In general, juvenile sharks (Triakidae and Squalidae) were usually discarded, and larger fish retained, whilst catsharks (Scyliorhinidae) were generally discarded. Discarding patterns are discussed in relation to recent changes in management regulations.

Stéphan, E., Hennache, C., Delamare, A., Legrand, V., Leblanc, N. 2013.The French RECOAM project : study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-22.

Abstract: The RECOAM project was set up to contribute to a better knowledge of five skate species, blonde ray (*Raja brachyura*), small-eyed ray (*Raja microocellata*), thornback ray (*Raja clavata*) and spotted ray (*Raja montagui*) and particularly undulate ray (*Raja undulata*), working in two areas of the French waters of particular interest, one in the western English Channel and one in the Bay of Biscay. The project aims to collect information on biology parameters as sex and length-at-maturity, species movement patterns through mark and recapture methods, identification of important grounds and on stock and population structure. The present working document summarizes the already collected information and presents the first results for each one of the species addressed.

Tétard, A. 2013. Distribution of Elasmobranches from the French program of observations at sea aboard fishing vessels (ObsMer). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-23.

Abstract: This paper presents a review of the distribution of elasmobranch species from data collected by the French observations at sea aboard fishing vessels. We believe that this new approach can provide valuable information on this species group in addition of the information given by the survey.

Vollen, T. 2013. Data on spurdog from two Norwegian surveys; the Shrimp survey and the Coastal survey - updated with new data in 2013. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013-24.

Abstract: The present report summarizes data from two Norwegian survey series showing increased abundance of juvenile spurdog (<35 cm) over the last decade, and stable or increasing trend for larger specimens.

## 1.19 References

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

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

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

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

GFCM. 2013. Report of the thirteenth session of the sub-committee on marine environment and ecosystems (SCMEE). FAO HQs, Rome, Italy, 18–20 February 2013. 55 p.

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

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

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

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

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

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

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

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

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

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

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

# 2 Spurdog in the Northeast Atlantic

## 2.1 Stock distribution

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

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

Analyses of microsatellite data conducted by Verissimo *et al.* (2010, a WD submitted to WGEF) found genetic homogeneity between east and west Atlantic spurdog, but the authors suggested this could be accomplished by transatlantic migrations of a very limited number of individuals. Further information on the stock structure and migratory pattern of northeast Atlantic spurdog can be found in the stock annex.

## 2.2 The fishery

Spurdog has a long history of exploitation in the Northeast Atlantic and WG estimates of total landings are shown in Figure 2.1a and Table 2.1. The main exploiters of spurdog have historically been France, Ireland, Norway and the UK (Figure 2.1b and Table 2.2). The main fishing grounds for the NE Atlantic stock of spurdog are the North Sea (IV), West of Scotland (VIa) and the Celtic Seas (VII) and, during the decade spanning the late 1980s to 1990s, the Norwegian Sea (II) (Table 2.3). Outside these areas, landings have generally been low. The fishery has changed significantly in recent years. More restrictive quotas, a maximum landing length in EU waters and bycatch regulations have meant that target fisheries have declined and recent landings are mainly taken as a bycatch in trawl, gillnet and seine fisheries. Further details of the historical development of the fishery can be found in the stock annex.

### 2.2.1 The fishery in 2012

The prohibition of landing catches of spurdog by EU vessels has resulted in a significant change in the spatial distribution of the reported landings. Although landings across all ICES subareas have declined in recent years, those from the Celtic Seas area (Subareas VI and VII) have declined at a greater rate than those from Subareas II–IV. In 2012, the latter areas accounted for 70% of the total landings of spurdog due to less restriction on the fishery.

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

No other countries reported significant landings of spurdog, in 2012. Landings reported by Denmark, France, Iceland and Netherlands accounted for 27–51 tonnes each, while no other nation reported more than 2 tons. Notably, with the zero TAC from 2011, the landings from UK vessels (which were traditionally one of the major exploiters of the spurdog stock) have now reduced to one tonne.

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

### 2.2.2 ICES advice applicable

In 2012, ICES provided the following advice for spurdog:

ICES advises on the basis of the precautionary approach that there should be no targeted fishery and that catches in mixed fisheries be reduced to the lowest possible level. A rebuilding plan should be developed for this stock.

### 2.2.3 Management applicable

The following table summarizes ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2012:

| Year | Single-stock exploitation boundary (tonnes) | Basis | TAC (IIa(EC) and IV) (tonnes) | TAC IIIa , I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes) | TAC IIIa(EC) (tonnes) | TAC I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes) | WG landings (NE Atlantic stock) (tonnes) |
|---|---|---|---|---|---|---|---|
| 2001 | No advice | - | 8870 | - | - | - | 16 693[1] |
| 2002 | No advice | - | 7100 | - | - | - | 11 020 |
| 2003 | No advice | - | 5640 | - | - | - | 12 246 |
| 2004 | No advice | - | 4472 | - | - | - | 9365 |
| 2005 | No advice | - | 1136 | - | - | - | 8356 |
| 2006 | F=0 | Stock depleted and in danger of collapse | 1051 | - | - | - | 4054 |
| 2007 | F=0 | Stock depleted and in danger of collapse | 841 [2] | 2828 | - | - | 2853 |
| 2008 | No new advice | No new advice | 631 [2,3] | - | - | 2004 [2] | 1753 |
| 2009 | F=0 | Stock depleted and in danger of collapse | 316 [3,4] | - | 104 [4] | 1002 [4] | 2563 |
| 2010 | F=0 | Stock depleted and in danger of collapse | 0 [5] | | 0 [5] | 0 [5] | 1251 |
| 2011 | F=0 | Stock depleted and in danger of collapse | 0 [6] | | 0 | 0 [6] | 578 |
| 2012 | F=0 | Stock below possible reference points | 0 [6] | | 0 | 0 [6] | |

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

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

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

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

**(5)Bycatches are permitted up to 10% of the 2009 quotas established in Annex Ia to Regulation (EC) No. 43/2009 under the following conditions:catches taken with longlines of tope shark (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calceus*), leafscale gulper shark (*Centrophorus***

***squamosus*), greater lantern shark (*Etmopterus princeps*), smooth lantern shark (*Etmopterus pusillus*) and Portuguese dogfish (*Centroscymnus coelolepis*) and spurdog (*Squalus acanthias*) are included (Does not apply to IIIa); a maximum landing size of 100 cm (total length) is respected;the bycatches comprise less than 10% of the total weight of marine organisms on board the fishing vesselCatches not complying with these conditions or exceeding these quantities shall be promptly released to the extent practicable.**

**([6]) Catches taken with longlines of tope shark (*Galeorhinus galeus*), kitefin shark (*Dalatias licha*), bird beak dogfish (*Deania calcea*), leafscale gulper shark (*Centrophorus squamosus*), greater lanternshark (*Etmopterus princeps*), smooth lanternshark (*Etmopterus pusillus*), Portuguese dogfish (*Centroscymnus coelolepis*) and spurdog (*Squalus acanthias*) are included. Catches of these species shall be promptly released unharmed to the extent practicable.**

In all EU regulated areas, the TAC for spurdog has been retained at zero for 2012. No landings are permitted, in contrast to 2010 when landings were allowed under a by-catch TAC (equal to 10% of the 2009 quotas) provided certain conditions were met including a maximum landing length and bycatch ratio limits.

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

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

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

### 2.2.4 Landings

Total annual landings (over a 60 year time period), as estimated by the WG for the NE Atlantic stock of spurdog are given in Table 2.1 and illustrated in Figure 2.1a. Preliminary estimates of landings for 2012 were 443 t. Some updates have been made to the WG estimates of pre-2012 total landings.

### 2.2.5 Discards

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

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

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

Preliminary observations on the discard-retention patterns of spurdog as observed on UK (English) vessels were presented in 2010 (Figure 2.2), although further studies of these data, including analyses over time, are required to view the results in relation to management measures. Discard rates have not been estimated.

Further information on discards and discard survival can be found in the stock annex.

### 2.2.6 Quality of the catch data

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

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

It is not known whether the 5% bycatch ratio (implemented in 2008) or the maximum landing length (in 2009) led to misreporting (although the buyers and sellers legislation should deter this) or increased discarding. However, quotas since 2010 have certainly been restrictive for certain countries which is likely to have led to increased discard rates. Estimates of dead discards are not available.

## 2.3 Commercial length frequencies

### 2.3.1 Landings length compositions

Sex disaggregated length–frequency samples are available from UK(E&W) for the years 1983–2001 and UK(Scotland) for 1991–2004 for all gears combined. The Scottish length–frequency distributions appear to be quite different from the length–frequency distributions obtained from the UK(E&W) landings, with a much larger proportion of small females being landed by the Scottish fleets. Figure 2.3 shows landings length–frequency distributions averaged over five year intervals. The Scottish data have been raised to total Scottish reported landings of spurdog while the UK(E&W) data have only been raised to the landings from the sampled boats, a procedure which is likely to mean that the latter length frequencies are not representative of total removals by the UK(E&W) fleet. For this reason, the UK(E&W) length frequencies are assumed to be representative only of the landings by the target fleet from this country.

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

### 2.3.2 Discard length compositions

There are no international estimates of discard length frequencies.

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

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

### 2.3.3 Quality of data

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

## 2.4 Commercial catch-effort data

No commercial cpue data were available to the WG.

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

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

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

Large numbers of spurdog were caught during the first sampling trip, of which 217 were tagged with Petersen discs and released. The second sampling trip yielded few

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

## 2.5 Fishery-independent information

### 2.5.1 Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. Beam trawl surveys are not considered appropriate for this species, due to the low catchability of spurdog in this gear type. However, the surveys coordinated by IBTS have higher catchability and the gears are considered suitable for this species. Spatial coverage of the North and Celtic Seas represents a large part of the stock range (Figure 2.5). For further details of these surveys and gears used see ICES (2010, 2012). The following survey data have been used in earlier analyses by WGEF:

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

A full description of the current groundfish surveys can be found in the stock annex.

Norwegian data on spurdog from the Shrimp survey (NO-shrimp-Q1) and the Coastal survey (NOcoast-Aco-Q4) were presented to the WGEF in 2013 (Vollen, 2013 WD). The survey coverage is shown in Figure 2.6, and general information on the surveys can be found in Table 2.4.

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

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

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

### 2.5.2 Length–frequency distributions

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

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

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

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

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

In the Norwegian Shrimp and Coastal surveys the length–frequency distribution was rather uniform overall years, with the length group 71–75 cm being the most abundant (Figure 2.10). Increased occurrence of smaller individuals (<35 cm) could be seen in later years, primarily in the shrimp survey (Figure 2.11).

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

### 2.5.3 Cpue

Spurdog survey data are typically characterised by highly variable catch rates due to occasional large hauls and a significant proportion of zero catches. Time-series plots of frequency of occurrence (proportion of non-zero hauls) and catch rate (confidence intervals not shown) for the UK( E&W) (Figure 2.12) and Irish (Figure 2.13) surveys are shown. These short time-series show apparently stable frequency of occurrence and catch rates.

Average catch rates (in numbers per hour) from the NS-IBTS is shown in Figure 2.14. Although the time-series is noisy, it appears that average catch rates are lower in recent years than at the beginning of the time-series.

Frequency of occurrence (5-year running mean) and average catch rate (in numbers per hour zero hauls not included, with 5-year running mean,) from the Norwegian Survey trends from the Norwegian Shrimp and Coastal surveys are shown in Figure 2.15. The frequency of occurrence declined for the Shrimp survey from late 1980s and reached a low in late 1990s. Since then, the Shrimp survey shows an increasing trend, whereas the Coastal survey shows a decreasing trend. With regards to average catch range, numbers are variable but a decrease can be seen from the 1980s to the late 1990s for the Shrimp survey. For the Coastal survey, a peak could be seen around 2004, but it should be noted that results are generally based on very few stations.

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

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

### 2.5.4 Statistical modelling

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

Data from four Scottish surveys listed above (1990–2009 or 2010) were considered in the analysis (Rockall was not included due to the very low numbers of individuals caught in this survey). The dataset consists of length–frequency distributions at each trawl station, together with the associated information on gear type, haul time, depth, duration and location. Each survey dataset used in this analysis contains over 1000 hauls and the North Sea Q3 contains over 1500. For each haul station, catch-rate was calculated: total weight caught divided by the haul duration to obtain a measure of catch-per-unit of effort in terms of g/30 min.

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

The analysis was conducted in stages: initially each survey was considered separately then the model fitted to all survey data combined. Because the aim was to obtain an index of temporal changes in the cpue, year was always included as a covariate (factor) in the model. Other explanatory variables included were area (Scottish demersal sampling area, see Dobby *et al.*, 2005 for further details) and month and interactions

terms were also investigated. Variables which explained greater than 5% of the deviance were retained in the model. All variables were included as categorical variables.

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

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

- the survey data analysed only covers a proportion of the stock distribution;
- further attempts should be made to obtain sex-specific abundance indices.

## 2.6 Life-history information

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

The biological parameters used in the assessment can be found in the stock annex.

## 2.7 Previous analyses

### 2.7.1 Previous assessments

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

### 2.7.2 Simulation of effects of maximum landing length regulations

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

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

## 2.8 Assessment

### 2.8.1 Introduction

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

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

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

The implementation for spurdog was coded in AD Model Builder (Otter Research). The approach is similar to Punt and Walker (1998), but uses fecundity data from two periods (1960 and 2005) in an attempt to estimate the extent of density-dependence in pup-production (a new feature compared to ICES, 2006) and fits to the Scottish groundfish surveys index of abundance, and proportion-by-length-category data from both the survey and commercial catches (aggregated across gears). Five categories were considered for the survey proportion-by-length-category data, namely length groups 16–31 cm (pups); 32–54 cm (juveniles); 55–69 cm (sub-adults); and 70–84 cm (maturing fish) and 85+ cm (mature fish). The first two categories were combined for the commercial catch data to avoid zero values.

A closer inspection of the survey proportions-by-length-category data showed a greater proportion of males than females in the largest two length categories. This could indicate a lower degree of overlap between the distribution of females and the survey area compared to males, and requires both a separate selectivity parameter to be fitted for the largest two length categories, and the survey proportion-by-length-

category data to be fitted separately for females and males. However, the low numbers of animals in the largest length category (85+) resulted in the occurrence of zeros in this length category, so the approach this year has been to combine the two largest length categories (resulting in a total of four length categories: 16–31 cm, 32–54 cm, 55–69 cm, and ≥70 cm) when fitting to survey proportions-by-length-category data for females and males separately.

The only estimable parameters considered are the total number of pregnant females in the virgin population ( $N_0^{f,preg}$ ), Scottish survey selectivity-by-length-category (four parameters), commercial selectivity-by-length-category for the two fleets (six parameters, three reflecting non-target selectivity, and three target selectivity), extent of density-dependence in pup production ($Q_{fec}$), and constrained recruitment deviations (1960–2010). Although two fecundity parameters could in principle be estimated from the fit to the fecundity data, these were found to be confounded with $Q_{fec}$, making estimation difficult, so instead of estimating them, values were selected on the basis of a scan over the likelihood surface. The model also assumes two commercial catch exploitation patterns that have remained constant since 1905, which is an oversimplification given the number of gears taking spurdog, and the change in the relative contribution of these gears in directed and mixed fisheries over time, but sensitivity tests are included to show the sensitivity to this assumption. Growth is considered invariant, as in the Punt and Walker (1998) approach, but growth variation could be included (Punt *et al*., 2001). The population dynamics model is described in more detail in the stock annex.

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

- To address the concern about appropriate raising procedures for the England and Wales length–frequency data, and the concern that these data are likely heavily biased towards targeted fisheries, the estimated Scottish selectivity is treated as "non-target", and England and Wales selectivity as "target", and alternative scenarios for allocating landings data to non-target and target fisheries are explored. Further details are provided in the Appendix to Chapter 02, WGEF 2011 (response R1.2).
- To address the concern that Scottish survey proportions-by-length-category data are dominated by the occasional large tow of spurdog when these occur, these data were recalculated by using the same spatial stratification that forms the basis of the delta-lognormal GLM standardisation of the survey abundance indices. Further details are provided in the Appendix to Chapter 02, WGEF 2011 (response R1.5).
- To account for the lack of large females in the Scottish surveys, likely resulting from lack of availability to the survey, the two largest length categories have been combined to form a 70+ category, and separate selectivity parameters defined for males and females in this length category. Furthermore, the survey proportion-by-length-category data are fitted separately for females and males.
- To account for the presumed lack of targeting as a result of management restrictions throughout the distribution area from 2008 onwards, landings data are assumed to come entirely from non-target fisheries from 2008 onwards.

### 2.8.2 Life-history parameters and input data

Calculation of the life-history parameters $M_a$ (instantaneous natural mortality rate), $l_a^s$ (mean length-at-age for animals of sex $s$), $w_a^s$ (mean weight-at-age for animals of sex $s$), and $P_a''$ (proportion females of age $a$ that become pregnant each year) are summarised in Table 2.6, and described visually in Figure 2.20.

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

The Scottish survey abundance index (biomass catch rate) was derived on the basis of applying a delta-lognormal GLM model to four Scottish surveys over the period 1990–2010, and is given in Table 2.8 along with the corresponding CVs. The proportions-by-length category data derived from these surveys, along with the actual sample sizes these data are based on, is given in Table 2.9 separately for females and males.

Table 2.10 lists the proportion-by-length-category data for the two commercial fleets considered in the assessment, along with the raised sample sizes. Because these raised sample sizes do not necessarily reflect the actual sample sizes the data are based on (as they have been raised to landings), these sample sizes have been ignored in the assessment (by setting $n_{pcom,j,y} = \overline{n}_{pcom,j}$ in equation 10b of the stock annex); a sensitivity test conducted in ICES (2010) showed a lack of sensitivity to this assumption.

The fecundity data (see Ellis and Keable, 2008 for sampling details) are given as pairs of values reflecting length of pregnant female and corresponding number of pups, and are listed in Tables 2.11a and b for the two periods (1960 and 2005).

### 2.8.3 Summary of model runs

| Category | Description | Figures | Tables |
|---|---|---|---|
| •Base case run | | 2.21–29, 2.33–34 | 2.12–16 |
| •Retrospective | A 6-year retrospective analysis, using the base case run and omitting one year of data each time | 2.30 | |
| •Sensitivity | | | |
| Qfec | A comparison with an alternative Qfec value that reflects the upper bound within the 95% probability interval of Figure 2.17c, with a demonstration of the deterioration in model fit to the survey abundance index for higher Qfec values | 2.31 | |
| Targeting scenarios | A comparison of alternative assumptions about targeting:<br>Tar 1: the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980–1984)<br>Tar 2: as for WGEF in 2010 (Scottish landings are "non-target", E&W "target", and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984)<br>Tar 3: as for Tar 2 but with E&W split 50% "non-target" and 50% "target"<br>Tar 4: as for Tar 1, but with pre-1980 selection entirely non-target<br>Tar 5: as for Tar 1, but with pre-1980 selection entirely target | 2.32 | 2.12 |

### 2.8.4 Results for base case run

#### Model fits

Fecundity data available for two periods presents an opportunity to estimate the extent of density-dependence in pup-production ($Q_{fec}$). However, estimating this parameter along with the fecundity parameters $a_{fec}$ and $b_{fec}$ for the two time periods was not possible because these parameters are confounded. The approach therefore was to plot the likelihood surface for a range of fixed $a_{fec}$ and $b_{fec}$ input values, while estimating $Q_{fec}$, and the results are shown in Figure 2.21. The optimum in Figure 2.21c indicates that the data does contain information about $Q_{fec}$, but the lack of a clearly defined optimum (the curve is flat around the optimum) indicates that this information is limited. Therefore, although the two periods of fecundity data are essential for the estimation of $Q_{fec}$, further information that would help with the estimation of this parameter would be useful. Figure 2.21d indicates a near-linear relationship between $Q_{fec}$ and MSYR (defined in terms of the biomass of all animals $\geq l^{f}_{mat00}$), so additional information about MSYR levels typical for this species could be used for this purpose (but was not attempted here).

The value of $Q_{fec}$ chosen for the base case run (1.98) corresponded to the lower bound of the 95% probability interval shown in Figure 2.17c. Lower $Q_{fec}$ values correspond to lower productivity, so this lower bound is more conservative than other values in the probability interval. Furthermore, sensitivity tests presented later show that higher

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

Figure 2.22 shows the model fit to the Scottish surveys abundance index, Figure 2.23a to the Scottish and England & Wales commercial proportion-by-length-category data, and Figure 2.23b to the Scottish survey proportion-by-length-category data, the latter fitted separately for females and males. Model fits to the survey index and commercial proportion data appear to be reasonably good with no obvious residual patterns, and a close fit to the average proportion-by-length-category for the commercial fleets. Figure 2.23b indicates a poorer fit to the survey proportions compared to the commercial proportions.

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

#### Estimated parameters

Model estimates of the total number of pregnant females in the virgin population $(N_0^{f,preg})$, the extent of density-dependence in pup production ($Q_{fec}$), survey catchability ($q_{sur}$), and current (2011) total biomass levels relative to 1905 and 1955 ($B_{depl05}$ and $B_{depl55}$), are shown in Table 2.12a ("Base case") together with estimates of precision. Estimates of the natural mortality parameter $M_{pup}$, the fecundity parameters $a_{fec}$ and $b_{fec}$, and MSY parameters ($F_{prop,MSY}$, MSY, $B_{MSY}$ and MSYR) are given in Table 2.12b. Table 2.13 provides a correlation matrix for some of the key estimable parameters (only the last five years of recruitment deviations are shown). Correlations between estimable parameters are generally low, apart from the commercial selectivity parameters associated with length categories 55–69 cm and 70–84 cm, and $Q_{fec}$ vs. $q_{sur}$.

Estimated commercial- and selectivity-at-age patterns are shown in Figure 2.26, and reflect the relatively lower proportion of large animals in the survey data when compared to the commercial catch data, and the higher proportion of smaller animals in the Scottish commercial catch data compared to England & Wales (see also Figure 2.23). It should be noted that females grow to larger lengths than males, so that females are able to grow out of the second highest length category, whereas males, with an L∞ of <85 cm (Table 1 in the stock annex) are not able to do so (hence the commercial selectivity remains unchanged for the two largest length categories for males). The divergence of survey selectivity for females compared to males is a reflection of the separate selectivity parameters for females/males in the largest length category (70+ for surveys).

A plot of recruitment vs. the number of pregnant females in the population, effectively a stock–recruit plot, is given in Figure 2.27a together with the replacement line (the number of recruiting pups needed to replace the pregnant female population under no harvesting). This plot illustrates the importance of the $Q_{fec}$ parameter in the model: a $Q_{fec}$ parameter equal to 1 would imply the expected value of the stock–recruit points lies on the replacement line, which implies that the population is incapable of replacing itself. A further exploration of the behaviour of $Q_y$ and $N_{pup,y}$ (equations 2a and b in the stock annex) is shown in Figure 2.27b.

#### Time-series trends

Model estimates of total biomass ($B_y$) and mean fishing proportion ($F_{prop5\text{-}30,y}$) are shown in Figure 2.28 together with observed annual catch ($C_y = \sum_j C_{j,y}$). They indicate a strong decline in spurdog total biomass, particularly since the 1940s (to around 15% of pre-exploitation levels, Table 2.12a), which appears to be driven by relatively high exploitation levels, given the biological characteristics of spurdog. $F_{prop5\text{-}30,y}$ appears to have declined in recent years with $B_y$ levelling off. Figure 2.29 shows total biomass ($B_y$), recruitment ($R_y$) and mean fishing proportion ($F_{prop5\text{-}30,y}$) together with approximate 95% probability intervals. The fluctuations in recruitment towards the end of the time-series are driven by information in the proportion-by-length-category data. Table 2.14 provides a stock summary (recruitment, total biomass, landings and $F_{prop5\text{-}30,y}$).

### 2.8.5 Retrospective analysis

A six year retrospective analysis (the base case model was re-run, each time omitting a further year in the data) was performed, and is shown in Figure 2.30 for the total biomass ($B_y$), mean fishing proportion ($F_{prop5\text{-}30,y}$) and recruitment ($R_y$). There are almost no signs of retrospective bias.

### 2.8.6 Sensitivity analyses

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

a ) $Q_{fec}$

The $a_{fec}$ and $b_{fec}$ values that provided the lower bound of the 95% probability interval ($Q_{fec}$=1.98; Figure 2.21c) was selected for the base case run. This sensitivity test compares it to the runs for which the $a_{fec}$ and $b_{fec}$ input values provide the optimum ($Q_{fec}$=2.37) and upper bound ($Q_{fec}$=3.43). Model result are fairly sensitive to these options (Figure 2.31a), but higher $Q_{fec}$ values, although still within the 95% probability interval, lead to a deterioration in the fit the Scottish survey abundance index, as demonstrated in Figure 2.31b. This is part justification for selecting the lower bound as the base case value.

b ) Alternative targeting scenarios

Alternatives targeting scenarios for both the post-1980s landings data (for which data are available by nation) and the pre-1980s landings data (not available by nation) are explored in this set of sensitivity analyses. The alternative scenarios are listed in Section 2.8.3, and results shown in Figure 2.32 and Tables 2.12a and b. These results indicate a general lack of sensitivity to alternative assumptions about targeting, with estimates of depletion levels ranging from 13–18% for $B_{depl05}$, and 16–23% for $B_{depl55}$.

### 2.8.7 Projections

The base case assessment is used as a basis for future projections under a variety of catch options. These are based on a proportion of the average landings for the period 2006–2010 (0.25, 0.5, 0.75 and 1), and a proportion of the TAC in 2009 (0.1 and 1), assuming that the catch in 2011 will be 142.2 tons (10% of the TAC in 2009). An additional catch option is included to explore consequence for the stock of returning to the levels of landings taken in the 1980s (average around 36 000 t). Results are given in Table 2.15, expressed as total biomass in future relative to the total biomass in 2011, and are illustrated in Figure 2.33a for the average catch options, and in Figure 2.33b

for the 2009 TAC and $F_{prop,MSY}$ options. Further catch options related to multiples of status-quo $F_{prop}$, and to $F_{prop,MSY}$ (=0.029), assuming that the catch in 2011 would be 540 tons [based on the assumption of a zero catch by EC nations, with landings estimated for the Faroe Islands and Iceland (mean annual landings for 2006–2010) and Norway (estimated as 50% of 2010 landings, given there will be a reduced target fishery, but that dead discards must be landed)], are given in Table 2.16.

### 2.8.8 Conclusion

The base case model shows almost no retrospective bias and provides reasonable fits to most of the available data. Sensitivity tests show the model to be sensitive to the range of $Q_{fec}$ values that fall within the 95% probability interval for corresponding fecundity parameters. However, results show a marked deterioration of the model fit to the Scottish survey abundance index as $Q_{fec}$ increases, thereby justifying the selection of the more conservative lower bound as the base case value ($Q_{fec}$=1.98). The model is relatively insensitivity to alternative targeting scenarios, including assumptions about selection patterns prior to 1980, with total biomass depletion levels in 2011 relative to 1905 ranging from 13 to 18%. The base case model is therefore presented as the final assessment model for spurdog and a summary plot of the base case run, showing landings and estimates of recruitment, mean fishing proportion (with $F_{prop,MSY}$=0.029) and total biomass, together with estimates of precision, is given in Figure 2.34, and Table 2.14.

Results from the current model confirm that spurdog abundance has declined, and that the decline is driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation.

A comparison with the 2010 assessment is provided in Figure 2.35.

## 2.9 Quality of assessments

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

### 2.9.1 Catch data

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

- uncertainty in the historical level of catches because of landings being reported by generic dogfish categories;
- uncertainty over the accuracy of the landings data because of species misreporting;
- lack of commercial length–frequency information for countries other than the UK (UK landings are a decreasing proportion of the total and therefore the length–frequencies may not be representative of those from the fishery as a whole);

- low levels of sampling of UK landings and lack of length–frequency data in recent years when the selection pattern may have changed due to the implementation of a maximum landing length (100 cm);
- lack of discard information.

### 2.9.2 Survey data

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

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

### 2.9.3 Biological information

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

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

### 2.9.4 Assessment

As with any stock assessment model, the assessment relies heavily on the underlying assumptions, particularly with regard to life-history parameters (e.g. natural mortality and growth), and on the quality and appropriateness of input data. The inclusion of two periods of fecundity data has provided valuable information that allows estimation of $Q_{fec}$, and projecting the model back in time is needed to allow the 1960 fecundity dataset to be fitted. Nevertheless, the likelihood surface does not have a well-defined optimum, and additional information, such as on appropriate values of MSYR for a species such as spurdog, would help with this problem. Further refinements of the model are possible, such as including variation in growth. Selectivity curves also cover a range of gears over the entire catch history, and more appropriate assumptions (depending on available data) could be considered.

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

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

## 2.10 MSY considerations

Exploitation status is below $F_{prop,MSY}$, as estimated from the results of the assessment. However, biomass has declined to record low level in recent years and therefore to allow the stock to rebuild, catches should be reduced to the lowest possible level in 2013 and 2014. 2011 projections assuming status quo $F_{prop}$ (linked to total assumed catch of 540 t in 2011) suggest that the stock will rebuild by 9–15% of its 2011 level by 2015 (Table 2.16).

## 2.11 Reference points

$F_{prop,MSY}$=0.029, as estimated by the current assessment, assuming average selection (2008–2010), reflecting a non-target selection pattern.

## 2.12 Conservation considerations

In 2006 the IUCN categorised Northeast Atlantic spurdog as Critically Endangered. This categorisation has not been subject to peer-review and was based on previous assessment which has a more pessimist view of the stock status than the more recent one.

## 2.13 Management considerations

#### Perception of state of stock

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

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

There is some suggestion that survey catch rates have started to increase in recent years (Figure 2.12).

#### Stock distribution

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

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

#### Biological considerations

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

#### Fishery and technical considerations

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

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

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

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

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

The survivorship of discards of juvenile spurdog is not known.

## 2.14 References

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

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

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.

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

Ellis, J.R., Doran, S., Dunlin, G., Hetherington, S., Keable, J., and Skea, N. 2010. Spurdog in the Irish Sea. Cefas, Lowestoft, Fisheries Science Partnership; 2009; Programme 9, Final Re-

port, 28 pp. (available electronically at http://www.cefas.co.uk/data/fisheries-science-partnership-(fsp)/2008–2009-programme.aspx).

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

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

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

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

ICES. 2012. Report of theInternational Bottom Trawl Survey Working Group, (IBTSWG) 27–30 March 2012, Lorient, France. ICES CM 2012/SSGEST:03 158pp.

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

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

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 48, 719–31.

Punt, A. E., Pribac, F., Walker T. I. and B.L. Taylor. 2001. Population modelling and harvest strategy evaluation for school and gummy shark, Report of FRDC 99/102. CSIRO Marine Research, Hobart.

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

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

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

Vollen, T. 2012. Date on spurdog from two Norweigan surveys; the Shrimp survey (1984–2012) and the Coastal survey (1996–2011). Working document for the ICES Elasmobranch Working Group (WGEF) 2012.

**Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2012).**

| Year | Landings (tonnes) | Year | Landings (tonnes) | Year | Landings (tonnes) |
|---|---|---|---|---|---|
| 1947 | 16 893 | 1969 | 52 074 | 1991 | 29 562 |
| 1948 | 19 491 | 1970 | 47 557 | 1992 | 29 046 |
| 1949 | 23 010 | 1971 | 45 653 | 1993 | 25 636 |
| 1950 | 24 750 | 1972 | 50 416 | 1994 | 20 851 |
| 1951 | 35 301 | 1973 | 49 412 | 1995 | 21 318 |
| 1952 | 40 550 | 1974 | 45 684 | 1996 | 17 294 |
| 1953 | 38 206 | 1975 | 44 119 | 1997 | 15 347 |
| 1954 | 40 570 | 1976 | 44 064 | 1998 | 13 919 |
| 1955 | 43 127 | 1977 | 42 252 | 1999 | 12 384 |
| 1956 | 46 951 | 1978 | 47 235 | 2000 | 15 890 |
| 1957 | 45 570 | 1979 | 38 201 | 2001 | 16 693 |
| 1958 | 50 394 | 1980 | 40 968 | 2002 | 11 020 |
| 1959 | 47 394 | 1981 | 39 961 | 2003 | 12 246 |
| 1960 | 53 997 | 1982 | 32 402 | 2004 | 9365 |
| 1961 | 57 721 | 1983 | 37 046 | 2005 | 8356 |
| 1962 | 57 256 | 1984 | 35 193 | 2006 | 4054 |
| 1963 | 62 288 | 1985 | 38 674 | 2007 | 2853 |
| 1964 | 60 146 | 1986 | 30 910 | 2008 | 1759 |
| 1965 | 49 336 | 1987 | 42 355 | 2009 | 2563 |
| 1966 | 42 713 | 1988 | 35 569 | 2010 | 1248 |
| 1967 | 44 116 | 1989 | 30 278 | 2011 | 580 |
| 1968 | 56 043 | 1990 | 29 906 | 2012 | 443 |

**Table 2.2. Spurdog in the NE Atlantic. WG estimates of total landings by nation (1980–2012).**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 1097 | 1085 | 1110 | 1072 | 1139 | 920 | 1048 | 979 | 657 | 750 | 582 | 393 | 447 | 335 | 396 | 391 |
| Denmark | 1404 | 1418 | 1282 | 1533 | 1217 | 1628 | 1008 | 1395 | 1495 | 1086 | 1364 | 1246 | 799 | 486 | 212 | 146 |
| Faroe Islands | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2 | 3 | 25 | 137 | 203 | 310 |
| France | 17 514 | 19 067 | 12 430 | 12 641 | 8356 | 8867 | 7022 | 11 174 | 7872 | 5993 | 4570 | 4370 | 4908 | 4831 | 3329 | 1978 |
| Germany | 43 | 42 | 39 | 25 | 8 | 22 | 41 | 48 | 27 | 24 | 26 | 6 | 55 | 8 | 21 | 100 |
| Iceland | 36 | 22 | 14 | 25 | 5 | 9 | 7 | 5 | 4 | 17 | 15 | 53 | 185 | 108 | 97 | 166 |
| Ireland | 108 | 476 | 1268 | 4658 | 6930 | 8791 | 5012 | 8706 | 5612 | 3063 | 1543 | 1036 | 1150 | 2167 | 3624 | 3056 |
| Netherlands | 217 | 268 | 183 | 315 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Norway | 5925 | 3941 | 3992 | 4659 | 4279 | 3487 | 2986 | 3614 | 4139 | 5329 | 8104 | 9633 | 7113 | 6945 | 4546 | 3940 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 3 | 2 | 128 | 188 | 250 | 323 | 190 | 256 |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 0 | 0 | 8 | 653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sweden | 399 | 308 | 398 | 300 | 256 | 360 | 471 | 702 | 733 | 613 | 390 | 333 | 230 | 188 | 95 | 104 |
| UK (E&W) | 9229 | 9342 | 8024 | 6794 | 8046 | 7841 | 7047 | 7684 | 6952 | 5371 | 5414 | 3770 | 4207 | 3494 | 3462 | 2354 |
| UK (Sc) | 4994 | 3970 | 3654 | 4371 | 4957 | 6749 | 6267 | 8043 | 8075 | 8024 | 7768 | 8531 | 9677 | 6614 | 4676 | 8517 |
| Total | 40 968 | 39 961 | 32 402 | 37 046 | 35 193 | 38 674 | 30 910 | 42 355 | 35 569 | 30 278 | 29 906 | 29 562 | 29 046 | 25 636 | 20 851 | 21 318 |

| Country | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 430 | 443 | 382 | 354 | 400 | 410 | 23 | 11 | 13 | 20 | 17 | 0 | 0 | 7 | 1 | 0 | 0 |
| Denmark | 142 | 196 | 126 | 131 | 146 | 156 | 107 | 232 | 219 | 82 | 68 | 0 | 0 | 0 | 14 | 26 | 31 |
| Faroe Islands | 51 | 218 | 362 | 486 | 368 | 613 | 340 | 224 | 295 | 225 | 271 | 241 | 144 | 462 | 179 | 104 | 0 |
| France | 1607 | 1555 | 1286 | 998 | 4342 | 4304 | 2569 | 1705 | 1062 | 2426 | 715 | 453 | 366 | 577 | 348 | 131 | 42 |
| Germany | 38 | 21 | 31 | 54 | 194 | 304 | 121 | 98 | 138 | 144 | 6 | 0 | 0 | 1 | 1 | 1 | 1 |
| Iceland | 156 | 106 | 80 | 57 | 107 | 199 | 276 | 200 | 142 | 71 | 75 | 36 | 52 | 102 | 58 | 53 | 51 |
| Ireland | 2305 | 2214 | 1164 | 904 | 905 | 1227 | 1214 | 1416 | 1076 | 940 | 614 | 558 | 163 | 214 | 26 | 11 | 2 |
| Netherlands | 0 | 0 | 0 | 0 | 28 | 39 | 27 | 10 | 25 | 41 | 34 | 28 | 26 | 5 | 7 | 2 | 27 |
| Norway | 2748 | 1567 | 1293 | 1461 | 1643 | 1424 | 1091 | 1119 | 1054 | 1010 | 790 | 616 | 711 | 543 | 541 | 246 | 284 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 120 | 100 | 46 | 21 | 2 | 3 | 4 | 4 | 9 | 6 | 10 | 9 | 4 | 2 | 2 | 3 | 2 |
| Russia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 0 | 0 | 28 | 95 | 372 | 363 | 306 | 135 | 17 | 71 | 106 | 16 | 15 | 32 | 6 | 4 | 0 |
| Sweden | 154 | 196 | 140 | 114 | 123 | 238 | 0 | 275 | 244 | 170 | 148 | 95 | 9 | 80 | 5 | 0 | 0 |
| UK (E&W) | 2670 | 3066 | 4480 | 4461 | 3654 | 4516 | 2823 | 3109 | 1729 | 1887 | 434 | 386 | 91 | 194 | 8 | 0 | 2 |
| UK (Sc) | 6873 | 5665 | 4501 | 3248 | 3606 | 2897 | 2120 | 3708 | 3342 | 1263 | 766 | 415 | 178 | 345 | 56 | 1 | 1 |
| Total | 17 294 | 15 347 | 13 919 | 12 384 | 15 890 | 16 693 | 11 020 | 12 246 | 9365 | 8356 | 4054 | 2853 | 1759 | 2564 | 1251 | 580 | 443 |

**Table 2.3. Spurdog in the NE Atlantic. WG estimates of landings by ICES subarea (1980–2012).**

| Area | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 |
| I and II | 138 | 20 | 28 | 760 | 40 | 120 | 137 | 417 | 1559 | 2808 | 4296 | 6614 | 5063 | 5102 | 3124 | 2725 |
| III and IV | 20 544 | 16 181 | 11 965 | 11 572 | 10 557 | 11 136 | 8986 | 11 653 | 10 800 | 10 423 | 11 497 | 9264 | 10 505 | 6591 | 4360 | 7347 |
| V | 45 | 27 | 18 | 27 | 5 | 22 | 9 | 41 | 6 | 73 | 182 | 133 | 336 | 335 | 364 | 484 |
| VI | 4590 | 4011 | 5052 | 7007 | 8491 | 12422 | 8107 | 9038 | 7517 | 6406 | 5407 | 6741 | 6268 | 5927 | 5622 | 5164 |
| VIIA | 2722 | 4013 | 4566 | 4001 | 6336 | 6774 | 6458 | 7305 | 5569 | 3389 | 2801 | 2527 | 2669 | 2700 | 2313 | 1185 |
| VIIB,C | 704 | 925 | 424 | 1777 | 2178 | 1699 | 1197 | 2401 | 1579 | 893 | 369 | 293 | 316 | 2009 | 1175 | 1004 |
| VIID,E, F | 6693 | 8210 | 5989 | 4664 | 2450 | 1280 | 1644 | 2892 | 2120 | 1634 | 1339 | 1122 | 852 | 785 | 800 | 760 |
| VIIG–K | 4793 | 5479 | 3881 | 6924 | 4902 | 4965 | 3864 | 8106 | 6175 | 4477 | 3736 | 2495 | 2622 | 1745 | 2680 | 2034 |
| VIII | 739 | 1095 | 479 | 312 | 234 | 257 | 507 | 497 | 242 | 174 | 273 | 367 | 406 | 435 | 406 | 602 |
| IX | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 2 | 4 | 4 | 2 | 5 | 7 | 5 |
| X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XII | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| XIV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 |
| Other or unspecified | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Total | 40 968 | 39 961 | 32 402 | 37 046 | 35 193 | 38 674 | 30 910 | 42 355 | 35 569 | 30 278 | 29 906 | 29 562 | 29 046 | 25 636 | 20 851 | 21 318 |

| Area | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltic | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I and II | 1853 | 582 | 607 | 779 | 894 | 462 | 357 | 440 | 423 | 685 | 498 | 312 | 337 | 230 | 190 | 92 | 130 |
| III and IV | 5299 | 4977 | 3895 | 2705 | 2475 | 2516 | 1904 | 2395 | 2163 | 1019 | 742 | 550 | 490 | 554 | 407 | 185 | 187 |
| V | 217 | 320 | 442 | 545 | 879 | 1406 | 808 | 583 | 677 | 473 | 457 | 352 | 211 | 565 | 240 | 155 | 51 |
| VI | 4168 | 3412 | 2831 | 2715 | 5977 | 5624 | 3169 | 3398 | 2630 | 2841 | 851 | 502 | 165 | 265 | 75 | 0 | 1 |
| VIIA | 1650 | 1534 | 1771 | 2153 | 1599 | 1878 | 1529 | 2021 | 938 | 605 | 411 | 280 | 74 | 114 | 3 | 1 | 0 |
| VIIB,C | 603 | 450 | 854 | 1037 | 1028 | 816 | 527 | 588 | 432 | 358 | 270 | 262 | 56 | 95 | 7 | 0 | 1 |
| VIID,E, F | 852 | 646 | 443 | 411 | 438 | 555 | 295 | 268 | 278 | 290 | 174 | 197 | 162 | 314 | 166 | 109 | 43 |
| VIIG–K | 2229 | 2984 | 2656 | 1822 | 2161 | 2846 | 2130 | 2339 | 1739 | 1973 | 531 | 338 | 196 | 340 | 112 | 14 | 1 |
| VIII | 408 | 418 | 308 | 171 | 405 | 469 | 269 | 134 | 56 | 97 | 85 | 50 | 64 | 80 | 38 | 17 | 26 |
| IX | 2 | 2 | 2 | 3 | 19 | 8 | 11 | 5 | 14 | 7 | 35 | 9 | 4 | 5 | 4 | 7 | 2 |
| X | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XII | 0 | 12 | 104 | 22 | 14 | 41 | 22 | 74 | 12 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XIV | 0 | 0 | 0 | 0 | 0 | 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other or unspecified | 12 | 10 | 6 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 5 | 0 | 0 |
| Total | 17 294 | 15 347 | 13 919 | 12 384 | 15 890 | 16 693 | 11 020 | 12 246 | 9365 | 8356 | 4054 | 2853 | 1759 | 2563 | 1248 | 580 | 443 |

**Table 2.4. Spurdog in the NE Atlantic. Norwegian Shrimp and Coastal survey, 1984–2013. Month of survey, mean duration of tows, total number of stations, number of stations with spurdog, total number of spurdog caught, and mesh size used.**

| Year | Survey | Month of survey | Mean duration (h) | # of stations | # of stations with spurdog | # spurdogs caught | Mesh size | Survey | Month of survey | Mean duration (h) | # of stations | # of stations with spurdog | # spurdogs caught | Mesh shze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | S | 10–11 | 0.96 | 59 | 10 | 67 | | | | | | | | |
| 1985 | S | 10–11 | 1.00 | 86 | 29 | 303 | | | | | | | | |
| 1986 | S | 10–11 | 0.96 | 57 | 26 | 341 | | | | | | | | |
| 1987 | S | 10–11 | 0.99 | 93 | 29 | 90 | | | | | | | | |
| 1988 | S | 10–11 | 0.97 | 102 | 29 | 87 | | | | | | | | |
| 1989 | S | 10–11 | 0.50 | 89 | 11 | 18 | 35 | | | | | | | |
| 1990 | S | 10–11 | 0.49 | 77 | 19 | 130 | 35 | | | | | | | |
| 1991 | S | 10–11 | 0.52 | 101 | 11 | 38 | 35 | | | | | | | |
| 1992 | S | 10–11 | 0.50 | 99 | 12 | 22 | 35 | | | | | | | |
| 1993 | S | 10–11 | 0.50 | 106 | 10 | 14 | 35 | | | | | | | |
| 1994 | S | 10–11 | 0.47 | 101 | 10 | 18 | 35 | | | | | | | |
| 1995 | S | 10–11 | 0.48 | 102 | 8 | 15 | 35 | C | 9–10 | 0.43 | 29 | 6 | 22 | 40 |
| 1996 | S | 10–11 | 0.50 | 103 | 4 | 15 | 35 | C | 9–10 | 0.45 | 22 | 5 | 9 | 40 |
| 1997 | S | 10–11 | 0.49 | 93 | 10 | 18 | 35 | C | 8–9 | 0.42 | 44 | 1 | 2 | 20 |
| 1998 | S | 10–11 | 0.49 | 95 | 9 | 14 | 20 | C | 10–11 | 0.47 | 33 | 8 | 106 | 20 |
| 1999 | S | 10–11 | 0.50 | 97 | 4 | 7 | 20 | C | 10–11 | 0.44 | 34 | 2 | 4 | 20 |
| 2000 | S | 10–11 | 0.50 | 98 | 5 | 18 | 20 | C | 10–11 | 0.47 | 28 | 6 | 12 | 20 |
| 2001 | S | 10–11 | 0.50 | 70 | 2 | 3 | 20 | C | 10–11 | 0.42 | 17 | 5 | 64 | 20 |
| 2002 | S | 10–11 | 0.50 | 77 | 1 | 1 | 20 | C | 10–11 | 0.46 | 37 | 4 | 43 | 20 |
| 2003 | S | 10–11 | 0.53 | 68 | 12 | 34 | 20 | C | 10–11 | 0.44 | 23 | 4 | 21 | 20 |

| Year | Survey | Month of survey | Mean duration (h) | # of stations | # of stations with spurdog | # spurdogs caught | Mesh size | Survey | Month of survey | Mean duration (h) | # of stations | # of stations with spurdog | # spurdogs caught | Mesh shze |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | S | 5–6 | 0.50 | 60 | 7 | 48 | 20 | C | 10–11 | 0.37 | 33 | 5 | 104 | 20 |
| 2005 | S | 5–6 | 0.51 | 86 | 7 | 12 | 20 | C | 10–11 | 0.46 | 18 | 2 | 17 | 20 |
| 2006 | S | 1–2 | 0.49 | 43 | 9 | 33 | 20 | C | 10–11 | 0.30 | 34 | 8 | 52 | 20 |
| 2007 | S | 1–2 | 0.50 | 64 | 14 | 27 | 20 | C | 10–11 | 0.35 | 36 | 7 | 35 | 20 |
| 2008 | S | 1–2 | 0.51 | 73 | 13 | 52 | 20 | C | 10–11 | 0.56 | 7 | 0 | 0 | 20 |
| 2009 | S | 1–2 | 0.47 | 92 | 16 | 39 | 20 | C | 10–11 | 0.39 | 19 | 0 | 0 | 20 |
| 2010 | S | 1–2 | 0.47 | 95 | 20 | 34 | 20 | C | 10–11 | 0.36 | 26 | 3 | 25 | 20 |
| 2011 | S | 1–2 | 0.49 | 97 | 18 | 43 | 20 | C | 10–11 | 0.33 | 20 | 5 | 6 | 20 |
| 2012 | S | 1–2 | 0.47 | 63 | 14 | 71 | 20 | C | 10–11 | 0.36 | 31 | 5 | 9 | 20 |
| 2013 | S | 1–2 | 0.38 | 100 | 35 | 177 | 20 | | | | | | | |

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

| Binomial model | Df | Deviance | Resid df | Resid dev | % | P(>\|Chi\|) |
|---|---|---|---|---|---|---|
| | | | 5384 | 6088.5 | | |
| as.factor(year) | 20 | 59.26 | 5364 | 6029.3 | 5 % | 9.28E–06 |
| as.factor(month) | 10 | 1015.62 | 5354 | 5013.7 | 69 % | <2.20E–16 |
| as.factor(roundarea) | 19 | 388.71 | 5335 | 4625 | 26 % | <2.20E–16 |

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

**Table 2.6. Northeast Atlantic spurdog. Description of life-history equations and parameters.**

| Parameters | Description/values | Sources |
|---|---|---|
| Ma | Instantaneous natural mortality at age a: $M_a = \begin{cases} M_{pup} e^{-a \ln(M_{pup}/M_{adult})/a_{M1}} & a < a_{M1} \\ M_{adult} & a_{M1} \le a \le a_{M2} \\ M_{til} / [1 + e^{-M_{gam}(a-(A+a_{M2})/2)}] & a > a_{M2} \end{cases}$ | |
| aM1, aM2 | 4, 30 | expert opinion |
| Madult, Mtil, Mgam | 0.1, 0.3, 0.04621 | expert opinion |
| Mpup | Calculated to satisfy balance equation 2.7 | expert opinion |
| | | |
| $l_a^s$ | Mean length-at-age a for animals of sex s $l_a^s = L_\infty^s (1 - e^{-\kappa^s (a - t_0^s)})$ | |
| $L_\infty^f$, $L_\infty^m$ | 110.66, 81.36 | average from literature |
| □f, □m | 0.086, 0.17 | average from literature |
| $t_0^f$, $t_0^m$ | -3.306, -2.166 | average from literature |
| | | |
| $w_a^s$ | Mean weight at age a for animals of sex s $w_a^s = a^s (l_a^s)^{b^s}$ | |
| af, bf | 0.00108, 3.301 | Bedford *et al.*, 1986 |
| am, bm | 0.00576, 2.89 | Coull *et al.*, 1989 |
| | | |
| $l_{mat00}^f$ | Female length at first maturity 70 cm | average from literature |
| | | |
| $P_a''$ | Proportion females of age a that become pregnant each year $P_a'' = \frac{P_{\max}''}{1 + \exp\left[-\ln(19)\frac{l_a^f - l_{mat50}^f}{l_{mat95}^f - l_{mat50}^f}\right]}$ where $P_{\max}''$ is the proportion very large females pregnant each year, and $l_{matx}^f$ the length at which x% of the maximum proportion of females are pregnant each year | |
| $P_{\max}''$ | 0.5 | average from literature |
| $l_{mat50}^f$, $l_{mat95}^f$ | 80 cm, 87 cm | average from literature |

**Table 2.7. Northeast Atlantic spurdog. Landings used in the assessment, with the allocation to "Non-target" and "Target" as assumed for the base case run. Estimated Scottish selectivity (based on fits to proportions by length category data for the period 1991–2004) is assumed to represent "non-target" fisheries, and estimated England and Wales selectivity (based on fits to proportions by length category data for the period 1983–2001) "target" fisheries. The allocation to "Non-target" and "Target" shown below is based on categorising each nation as having fisheries that are "non-target", "target" or a mixture of these from 1980 onwards. An average for the period 1980–1984 is assumed for the "non-target"/"target" split prior to 1980, while all landings from 2008 onwards are assumed to come from "non-target" fisheries.**

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

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

| Year | Index | CV |
|---|---|---|
| 1990 | 161.2 | 0.33 |
| 1991 | 94.3 | 0.33 |
| 1992 | 79.9 | 0.32 |
| 1993 | 152.5 | 0.32 |
| 1994 | 136.8 | 0.36 |
| 1995 | 52.4 | 0.46 |
| 1996 | 86.0 | 0.36 |
| 1997 | 54.9 | 0.36 |
| 1998 | 81.6 | 0.35 |
| 1999 | 178.7 | 0.34 |
| 2000 | 73.1 | 0.37 |
| 2001 | 95.8 | 0.34 |
| 2002 | 94.6 | 0.34 |
| 2003 | 88.5 | 0.35 |
| 2004 | 63.4 | 0.37 |
| 2005 | 80.4 | 0.37 |
| 2006 | 65.2 | 0.36 |
| 2007 | 91.0 | 0.33 |
| 2008 | 77.3 | 0.36 |
| 2009 | 65.2 | 0.37 |
| 2010 | 95.5 | 0.56 |

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

| | $n_{psur,y}$ | 16-31 | 32-54 | 55-69 | 70+ |
|---|---|---|---|---|---|
| *Females* | | | | | |
| 1990 | 539 | 0.0112 | 0.2685 | 0.1265 | 0.1272 |
| 1991 | 962 | 0.0636 | 0.1218 | 0.1092 | 0.1123 |
| 1992 | 145 | 0.1430 | 0.1514 | 0.2055 | 0.0424 |
| 1993 | 398 | 0.1259 | 0.1635 | 0.0788 | 0.1296 |
| 1994 | 1656 | 0.0744 | 0.2426 | 0.0519 | 0.0352 |
| 1995 | 2278 | 0.0572 | 0.3087 | 0.0779 | 0.1520 |
| 1996 | 230 | 0.0722 | 0.2381 | 0.0831 | 0.0684 |
| 1997 | 167 | 0.0438 | 0.2011 | 0.0955 | 0.0815 |
| 1998 | 446 | 0.0361 | 0.2404 | 0.1201 | 0.1731 |
| 1999 | 186 | 0.0316 | 0.0787 | 0.0331 | 0.1079 |
| 2000 | 1994 | 0.0962 | 0.2136 | 0.0456 | 0.1149 |
| 2001 | 118 | 0.0132 | 0.2060 | 0.0735 | 0.1363 |
| 2002 | 148 | 0.0428 | 0.0789 | 0.1773 | 0.1879 |
| 2003 | 224 | 0.0123 | 0.1578 | 0.0788 | 0.1898 |
| 2004 | 63 | 0.0412 | 0.0834 | 0.1240 | 0.0597 |
| 2005 | 121 | 0.0243 | 0.1434 | 0.1568 | 0.0756 |
| 2006 | 92 | 0.0360 | 0.1130 | 0.1727 | 0.0413 |
| 2007 | 148 | 0.0314 | 0.1628 | 0.0866 | 0.1810 |
| 2008 | 232 | 0.0708 | 0.1590 | 0.0127 | 0.1047 |
| 2009 | 233 | 0.0427 | 0.1175 | 0.2547 | 0.1167 |
| 2010 | 3483 | 0.2101 | 0.2125 | 0.1145 | 0.0004 |
| *Males* | | | | | |
| 1990 | 1044 | 0.0204 | 0.1300 | 0.0575 | 0.2587 |
| 1991 | 1452 | 0.0711 | 0.1273 | 0.0824 | 0.3123 |
| 1992 | 154 | 0.2324 | 0.0534 | 0.0504 | 0.1215 |
| 1993 | 644 | 0.0503 | 0.1202 | 0.1555 | 0.1762 |
| 1994 | 2467 | 0.0832 | 0.1809 | 0.1472 | 0.1847 |
| 1995 | 1905 | 0.0566 | 0.1259 | 0.0478 | 0.1738 |
| 1996 | 453 | 0.0597 | 0.1480 | 0.1237 | 0.2068 |
| 1997 | 270 | 0.0228 | 0.1033 | 0.0803 | 0.3716 |
| 1998 | 436 | 0.0207 | 0.0974 | 0.0969 | 0.2155 |
| 1999 | 503 | 0.0269 | 0.2437 | 0.1136 | 0.3646 |
| 2000 | 2045 | 0.0100 | 0.1144 | 0.0799 | 0.3255 |
| 2001 | 221 | 0.0141 | 0.1045 | 0.0753 | 0.3771 |
| 2002 | 264 | 0.0252 | 0.0654 | 0.1209 | 0.3016 |
| 2003 | 392 | 0.0209 | 0.0818 | 0.1257 | 0.3328 |
| 2004 | 190 | 0.0045 | 0.1397 | 0.1250 | 0.4225 |
| 2005 | 225 | 0.0297 | 0.0572 | 0.1506 | 0.3622 |
| 2006 | 180 | 0.0846 | 0.0992 | 0.1027 | 0.3505 |
| 2007 | 262 | 0.0048 | 0.1643 | 0.1555 | 0.2135 |
| 2008 | 395 | 0.0699 | 0.1482 | 0.0669 | 0.3678 |
| 2009 | 417 | 0.0252 | 0.1247 | 0.0719 | 0.2466 |
| 2010 | 2465 | 0.0035 | 0.1699 | 0.0817 | 0.2074 |

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

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

**Table 2.11a. Northeast Atlantic spurdog. Fecundity data for 1960, given as length of pregnant female ($l^f$) and number of pups ($P'$). Total number of samples is 783.**

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

**Table 2.11b. Northeast Atlantic spurdog. Fecundity data for 2005, given as length of pregnant female ($l^f$) and number of pups ($P'$). Total number of samples is 179.**

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

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

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

**Table 2.12b. Northeast Atlantic spurdog. Estimates of other estimates of interest for the base-case run, and two sensitivity tests for assuming alternative selectivity-at-age prior to 1980. [Note, estimates of $M_{pup}$, $a_{fec}$ and $b_{fec}$ are the same in all cases.]**

| | Base case | Tar 4: historic non-target | Tar 5: historic target |
|---|---|---|---|
| $M_{pup}$ | 0.757 | | |
| $a_{fec}$ | -12.615 | | |
| $b_{fec}$ | 0.184 | | |
| $F_{prop,MSY}$ | 0.0291 | 0.0298 | 0.0276 |
| MSY | 20 451 | 20 461 | 20 848 |
| $B_{MSY}$ | 964 562 | 928 275 | 1 018 670 |
| $M_{SYR}$ | 0.0294 | 0.0308 | 0.0285 |

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

| | $N_0^{f,preg}$ | $S_{c2,non\text{-}tgt}$ | $S_{c2,tgt}$ | $S_{c3,non\text{-}tgt}$ | $S_{c3,tgt}$ | $S_{c4,non\text{-}tgt}$ | $S_{c4,tgt}$ | $S_{s1}$ | $S_{s2}$ | $S_{s3}$ | $S_{s4}$ | $Q_{fec}$ | $\varepsilon_{r,06}$ | $\varepsilon_{r,07}$ | $\varepsilon_{r,08}$ | $\varepsilon_{r,09}$ | $\varepsilon_{r,10}$ | $q_{sur}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $N_0^{f,preg}$ | 1 | | | | | | | | | | | | | | | | | |
| $S_{c2,non\text{-}tgt}$ | -0.11 | 1 | | | | | | | | | | | | | | | | |
| $S_{c2,tgt}$ | -0.01 | 0.00 | 1 | | | | | | | | | | | | | | | |
| $S_{c3,non\text{-}tgt}$ | -0.23 | 0.41 | 0.01 | 1 | | | | | | | | | | | | | | |
| $S_{c3,tgt}$ | -0.04 | 0.02 | 0.08 | 0.08 | 1 | | | | | | | | | | | | | |
| $S_{c4,non\text{-}tgt}$ | -0.30 | 0.42 | 0.01 | 0.88 | 0.10 | 1 | | | | | | | | | | | | |
| $S_{c4,tgt}$ | -0.18 | 0.07 | 0.10 | 0.21 | 0.56 | 0.25 | 1 | | | | | | | | | | | |
| $S_{s1}$ | 0.03 | -0.05 | -0.01 | -0.14 | -0.10 | -0.15 | -0.16 | 1 | | | | | | | | | | |
| $S_{s2}$ | 0.06 | -0.06 | -0.01 | -0.16 | -0.11 | -0.17 | -0.17 | 0.48 | 1 | | | | | | | | | |
| $S_{s3}$ | 0.08 | -0.05 | -0.01 | -0.10 | -0.05 | -0.12 | -0.10 | 0.39 | 0.51 | 1 | | | | | | | | |
| $S_{s4}$ | 0.03 | -0.04 | -0.01 | -0.09 | -0.07 | -0.09 | -0.10 | 0.31 | 0.39 | 0.33 | 1 | | | | | | | |
| $Q_{fec}$ | -0.01 | 0.05 | 0.01 | 0.21 | 0.20 | 0.21 | 0.27 | -0.14 | -0.12 | -0.01 | -0.05 | 1 | | | | | | |
| $\varepsilon_{r,06}$ | -0.01 | 0.00 | 0.00 | -0.01 | -0.01 | 0.00 | -0.01 | 0.00 | -0.03 | -0.03 | 0.00 | -0.02 | 1 | | | | | |
| $\varepsilon_{r,07}$ | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.06 | 0.00 | 0.00 | -0.01 | -0.01 | 1 | | | | |
| $\varepsilon_{r,08}$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.02 | -0.06 | 0.00 | 0.00 | -0.01 | -0.01 | -0.02 | 1 | | | |
| $\varepsilon_{r,09}$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.02 | -0.08 | 0.00 | 0.00 | -0.01 | -0.01 | -0.02 | -0.03 | 1 | | |
| $\varepsilon_{r,10}$ | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | -0.19 | -0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 1 | |
| $q_{sur}$ | -0.31 | 0.02 | 0.00 | -0.06 | -0.18 | -0.05 | -0.17 | -0.09 | -0.23 | -0.36 | -0.34 | -0.63 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 1 |

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

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

**Table 2.15. Northeast Atlantic spurdog. Assessment projections under different future catch options. Estimates of total biomass relative to the total biomass in 2011 are shown, assuming that the catch in 2011 is 142.2 tons. Point estimates are given in the upper third of the table with corresponding lower and upper values (reflecting ±2 standard deviations) given in the middle and bottom third of the table. All landings from 2008 onwards are assumed to be taken by non-target fisheries only.**

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

**Table 2.16. Northeast Atlantic spurdog. Further assessment projections under *status quo* $F_{prop}$ scenarios. Estimates of total biomass relative to the total biomass in 2011 for different future catch options, assuming that the catch in 2011 is 540 tons. Point estimates are shown in the upper third of the table with corresponding lower and upper values (reflecting ±2 standard deviations) given in the middle and bottom third of the table. All landings from 2008 onwards are assumed to be taken by non-target fisheries only.**

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

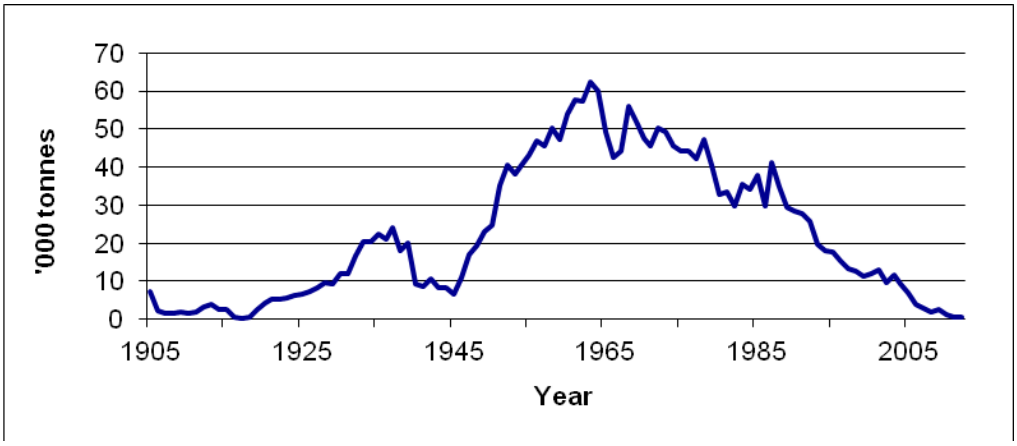



**Figure 2.1a. Spurdog in the NE Atlantic. WG estimates of total international landings of NE Atlantic spurdog (1905–2012).**

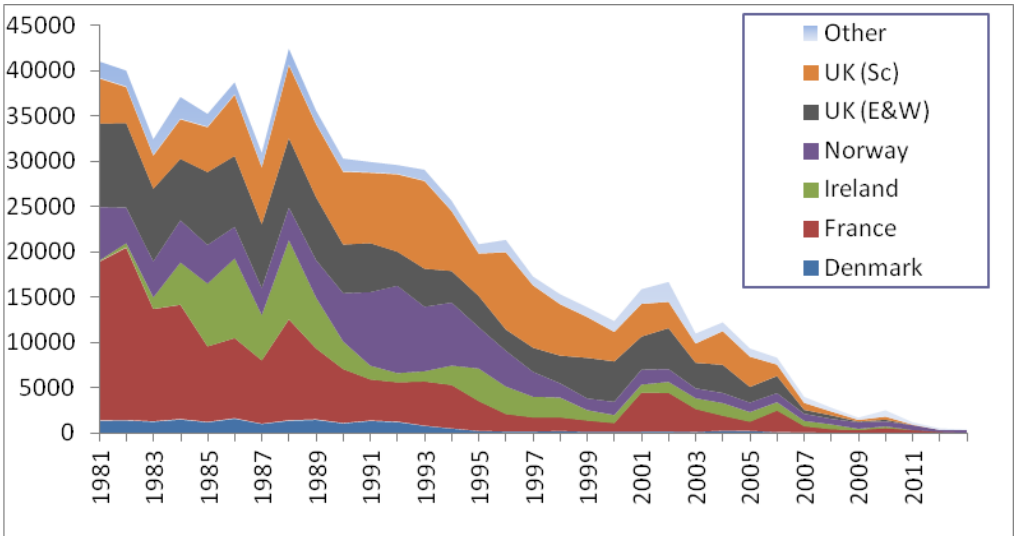



**Figure 2.1b. Spurdog in the NE Atlantic. WG estimates of landings by nation (1980–2012).**

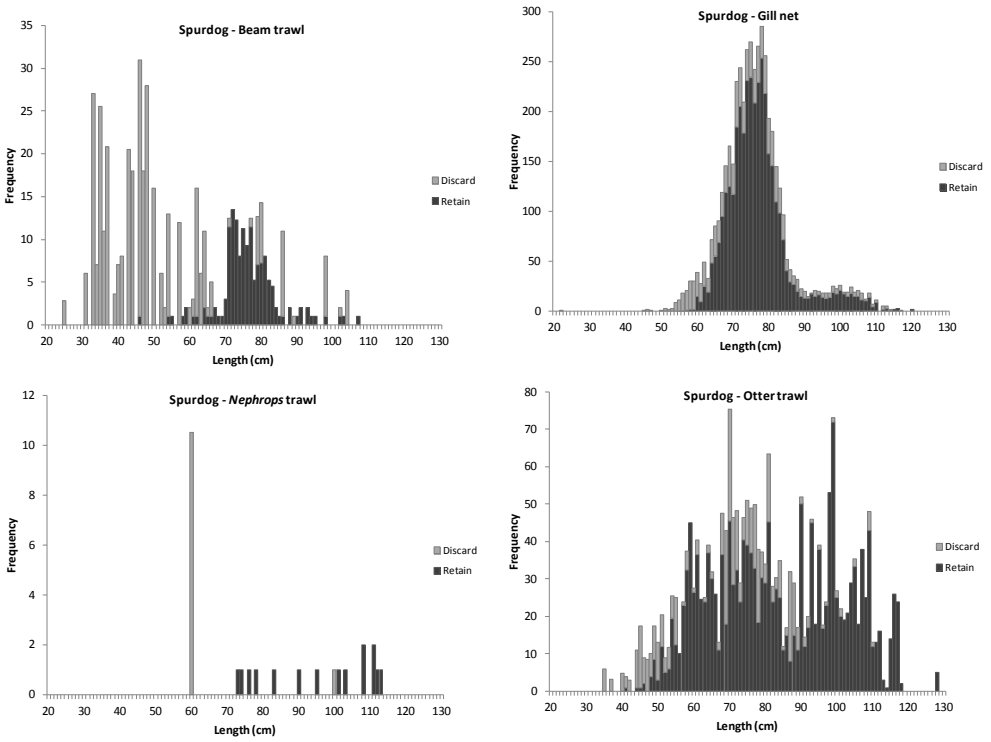



**Figure 2.2. Spurdog in the NE Atlantic. Discard-retention patterns of spurdog taken in UK (English) vessels using beam trawl, gillnet, *Nephrops* trawl and otter trawl.**

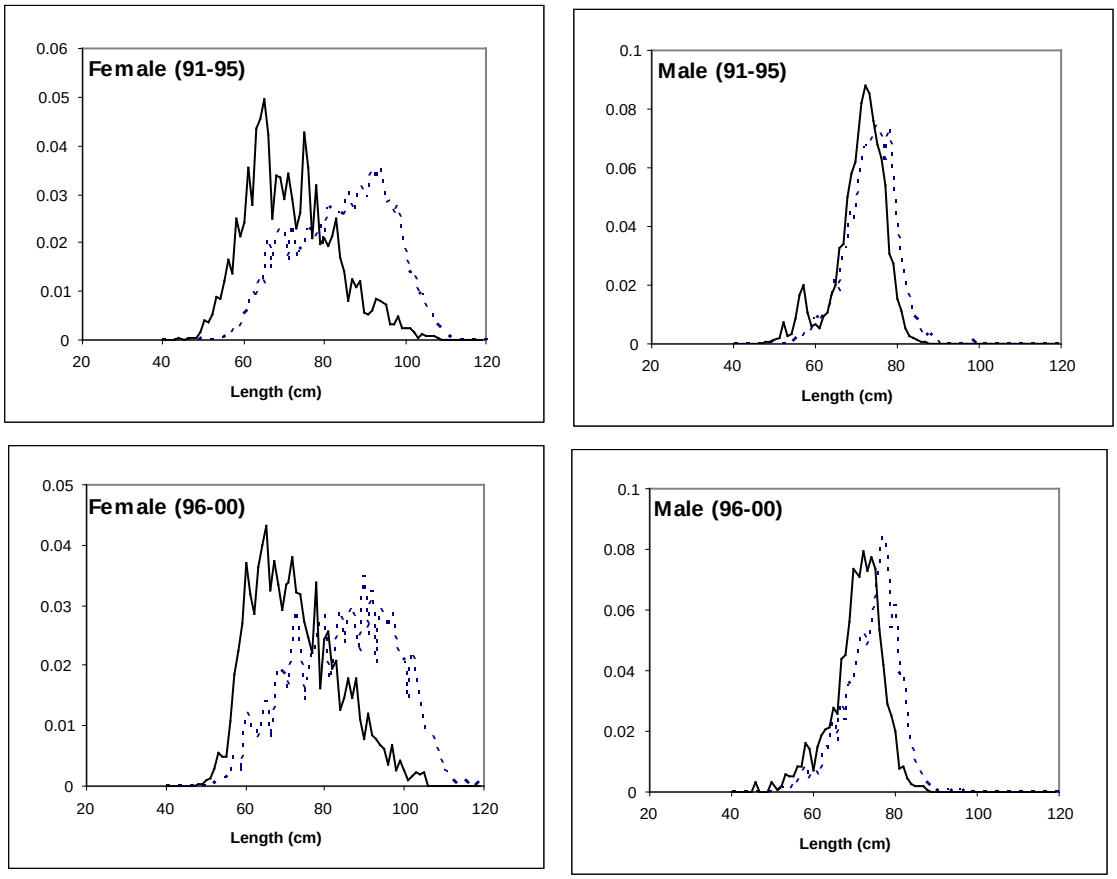



**Figure 2.3. Spurdog in the NE Atlantic. Comparison of length–frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK(E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five year intervals.**

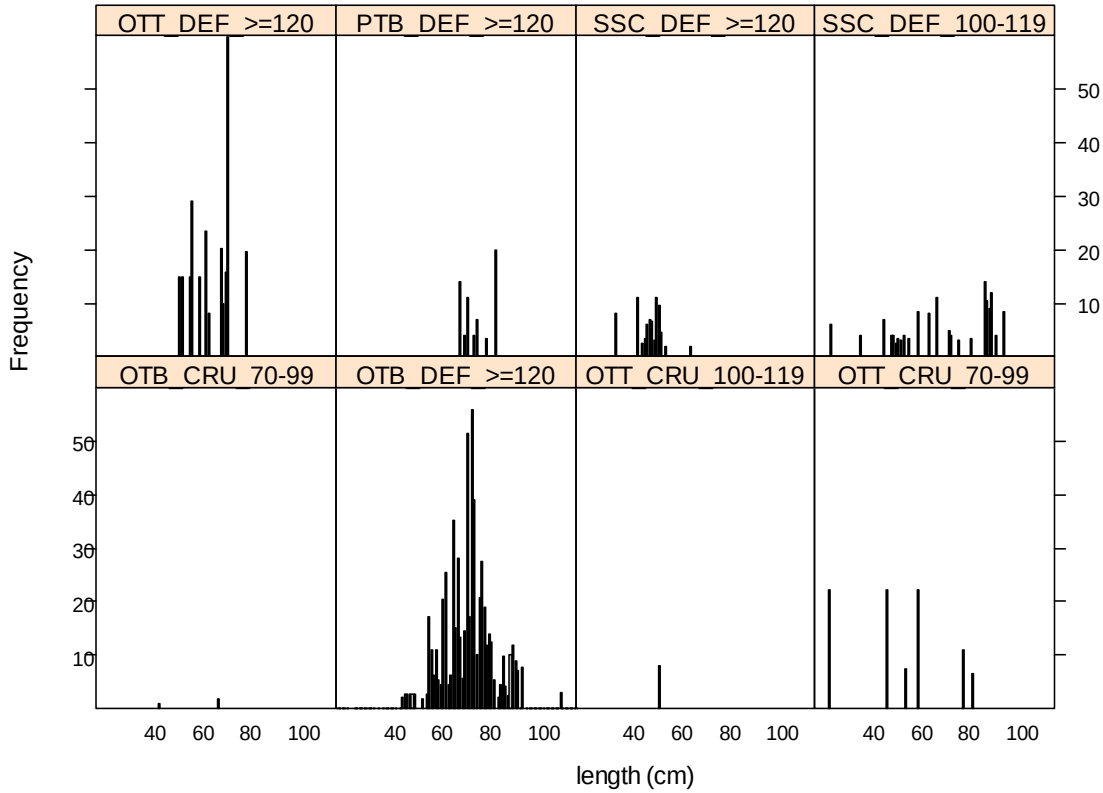



**Figure 2.4. Spurdog in the NE Atlantic. Length distributions of spurdog caught on Scottish observer trips in 2010. Data are aggregated across trips for each gear category. Gear codes relate to gear type, target species and mesh size. OTT – Otter trawl twin; PTB – Pair trawl bottom; SSC – Scottish Seine;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

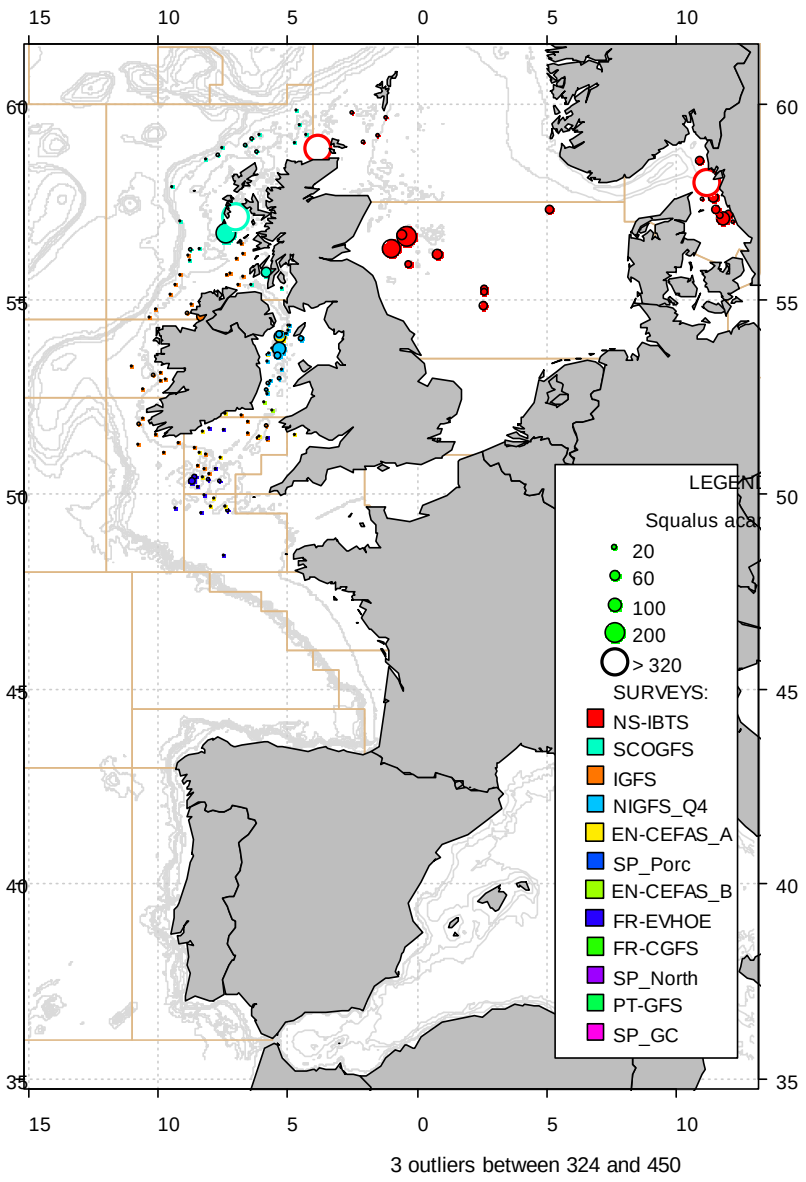



**Figure 2.5. Spurdog in the NE Atlantic. Captures of spurdog as reported in the 2011 IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey (From ICES, 2012).**

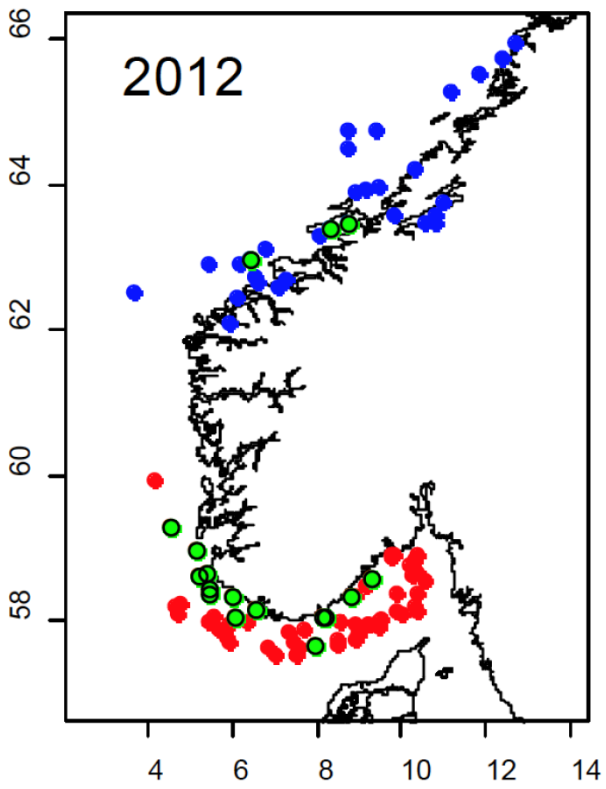



**Figure 2.6. Spurdog in the NE Atlantic. Map of stations in the Coastal survey (northernmost, blue) and Shrimp survey (southernmost, red) in 2012. Stations with spurdog catches are given as green circles.**

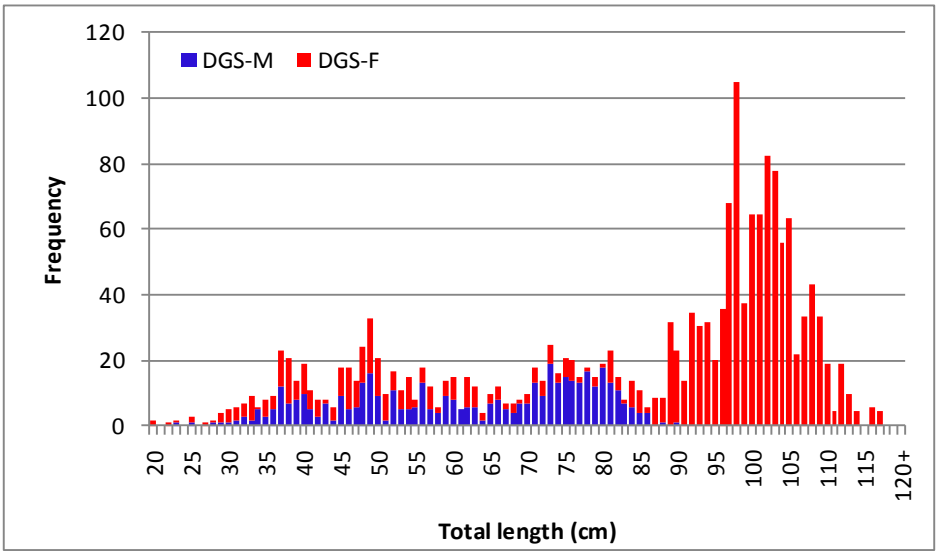



**Figure 2.7a. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid and additional tows). Length distribution highly influenced by a single haul of large females.**

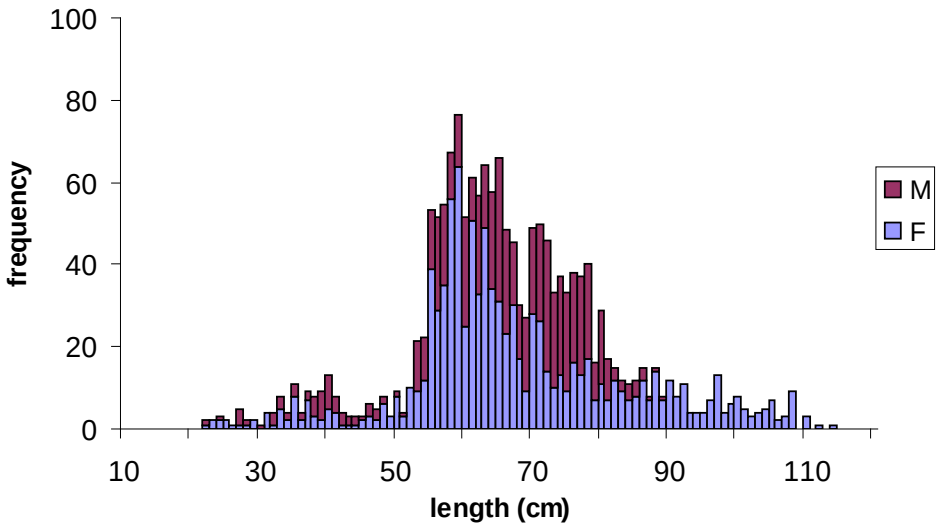



**Figure 2.7b. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Irish Q3 Celtic Seas groundfish survey (2003–2009).**

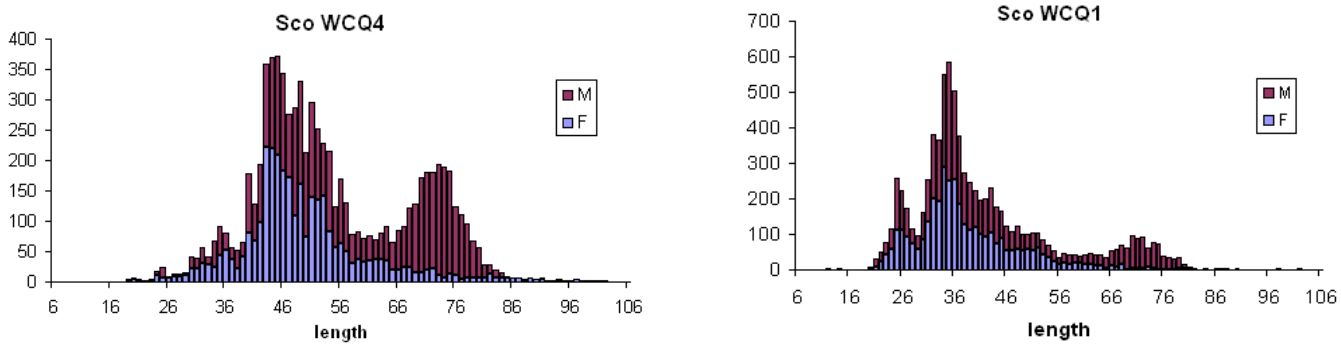



**Figure 2.8. Spurdog in the NE Atlantic. Length distribution of spurdog captured in the Scottish Q1 and Q4 groundfish surveys (1990–2010). Length–frequency distributions highly influenced by a small number of hauls containing many small individuals.**

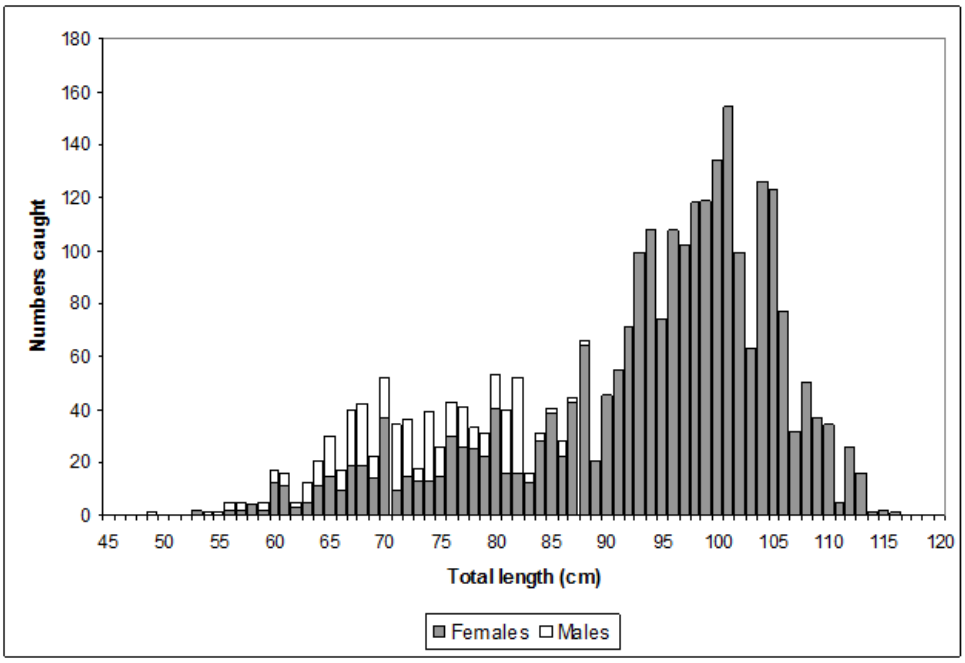
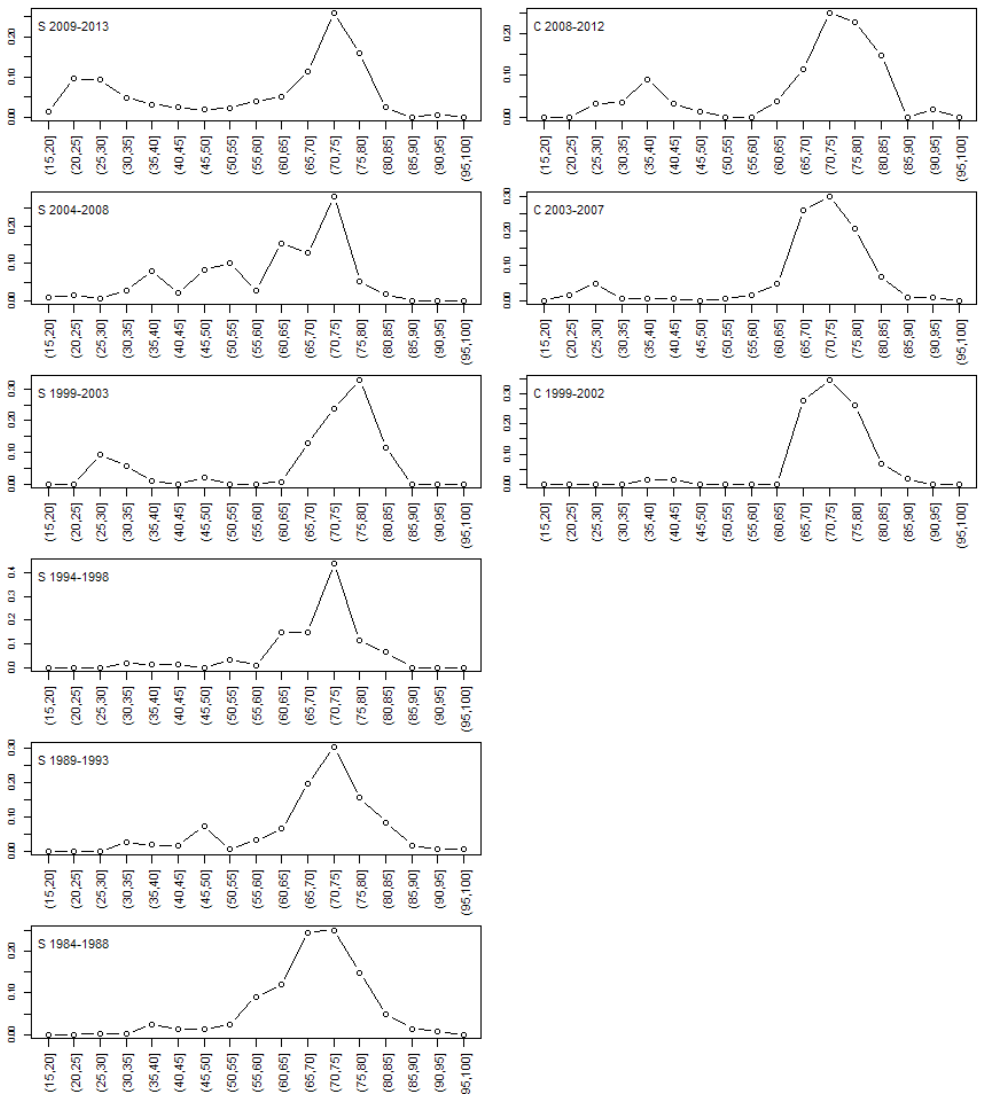



**Figure 2.9. Spurdog in the NE Atlantic. Total length–frequency of male and female spurdog taken during the UK(E&W) FSP survey, raised for those catches that were sub-sampled (n = 2517 females and 356 males).**


S 2009-2013
C 2008-2012
S 2004-2008
C 2003-2007
S 1999-2003
C 1999-2002
S 1994-1998
S 1989-1993
S 1984-1988
(15,20]
(20,25]
(25,30]
(30,35]
(35,40]
(40,45]
(45,50]
(50,55]
(55,60]
(60,65]
(65,70]
(70,75]
(75,80]
(80,85]
(85,90]
(90,95]
(95,100]

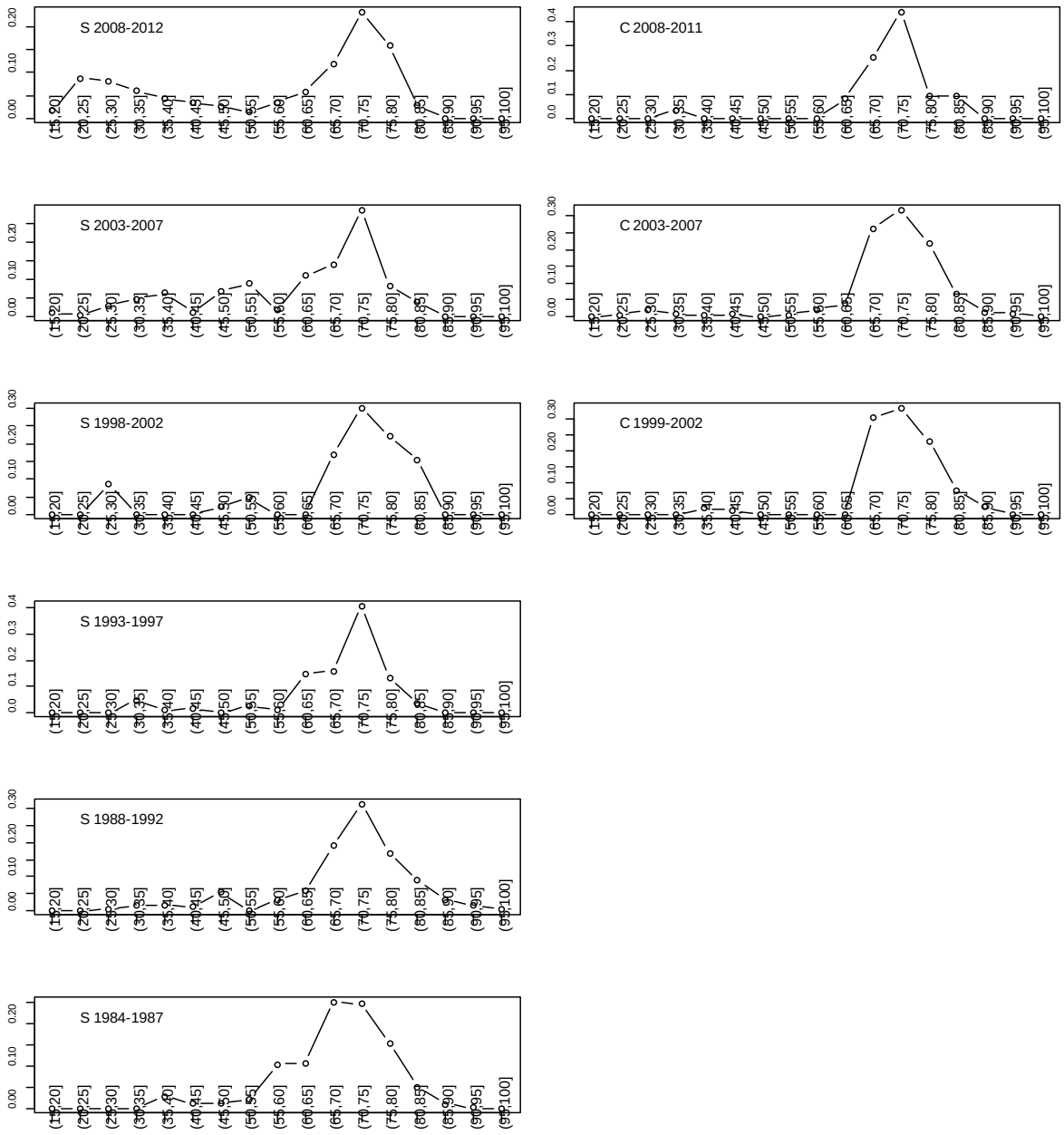



**Figure 2.10. Spurdog in the NE Atlantic. Relative length–frequency distributions (5 cm length groups and five year periods) for the Shrimp survey (left) and Coastal survey (right).**

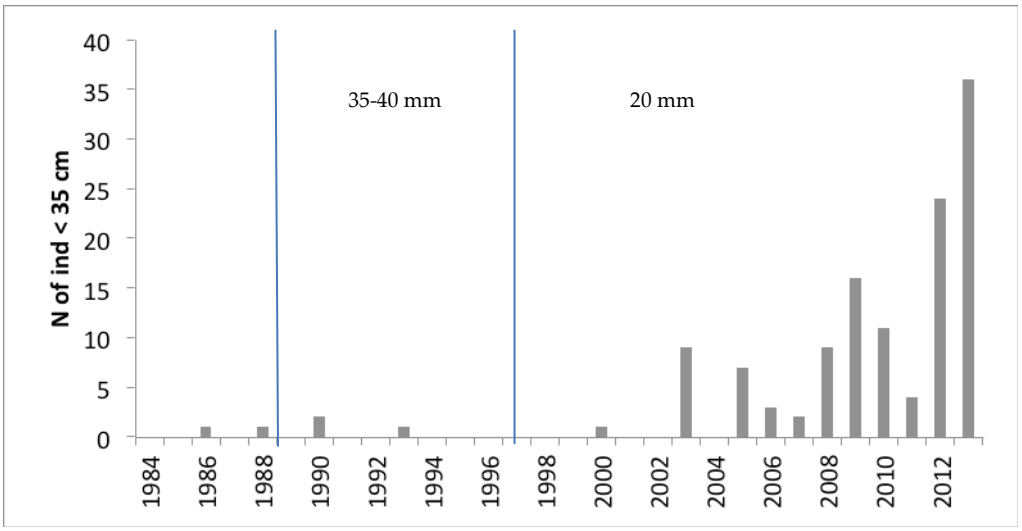
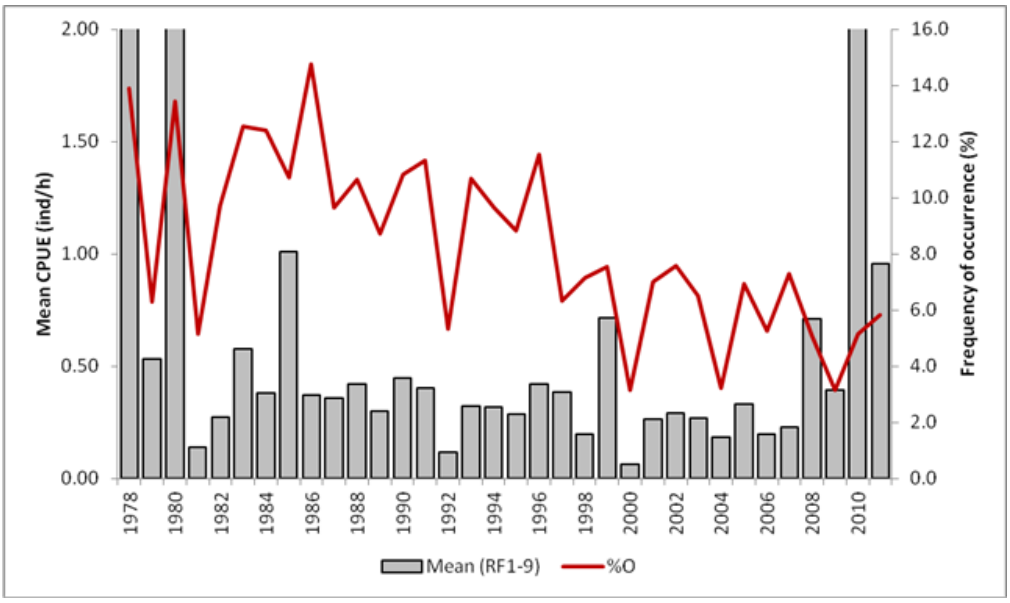



**Figure 2.11. Spurdog in the NE Atlantic. Frequency of individuals <35 cm length, both Norwegian surveys combined. Mesh size used within each time period is given.**



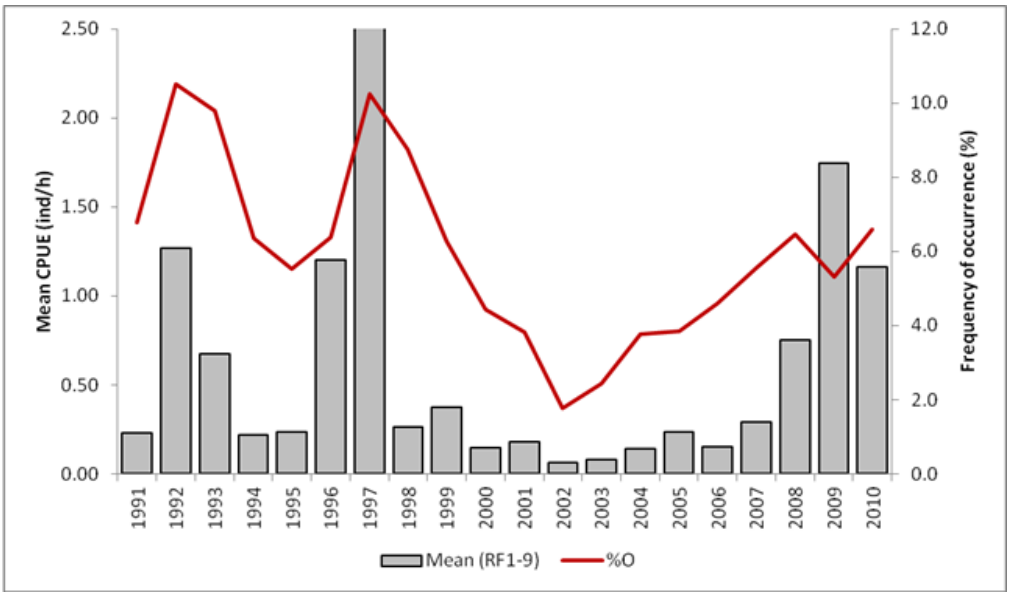




**Figure 2.12. Spurdog in the NE Atlantic. Catch rates in the UK (England and Wales) westerly IBTS Q1 Survey, top, (1978–2011) and Q3 Survey, below (1991–2011). Mean cpue (numbers per hour, columns) and frequency of occurrence (red line) are shown.**

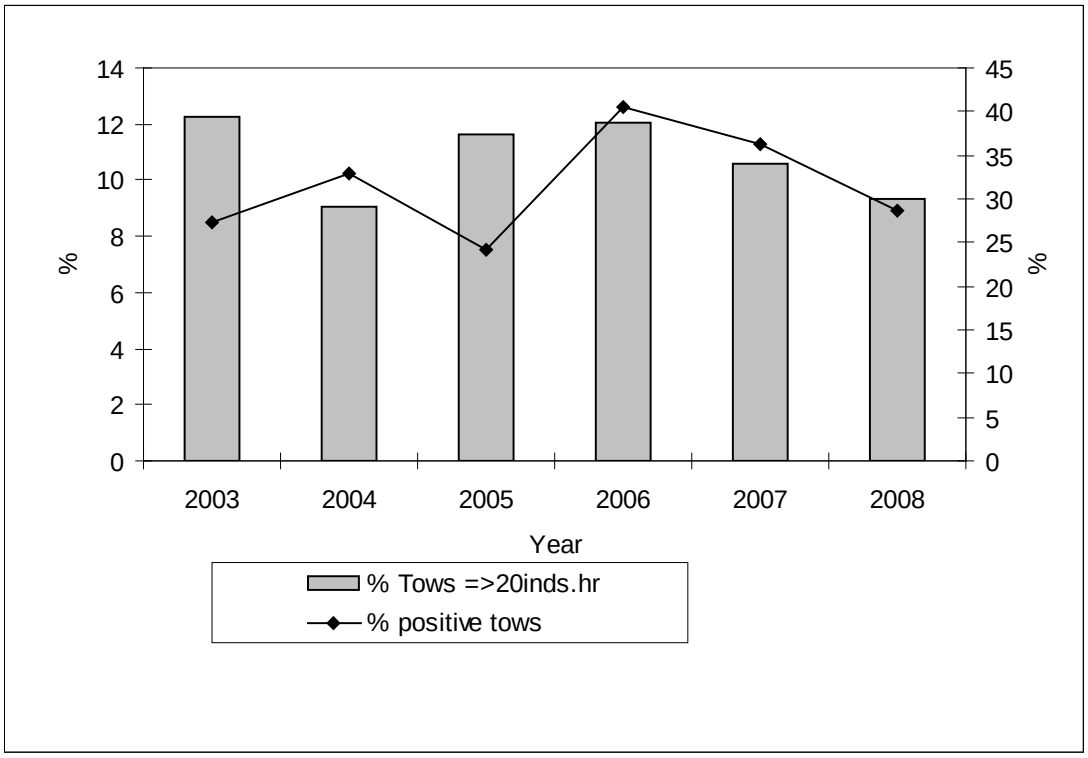



**Figure 2.13. Northeast Atlantic Spurdog. Proportion of survey hauls in Irish Q3 groundfish survey 2003–2008, ICES Area VII, in which nominal cpue was ≥20 per one hour tow, and percentage of tows in which spurdog occurred.**

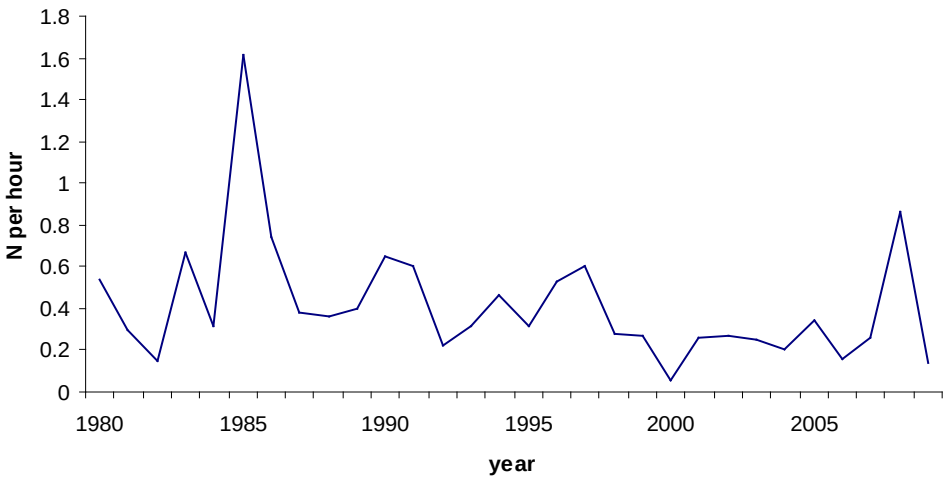
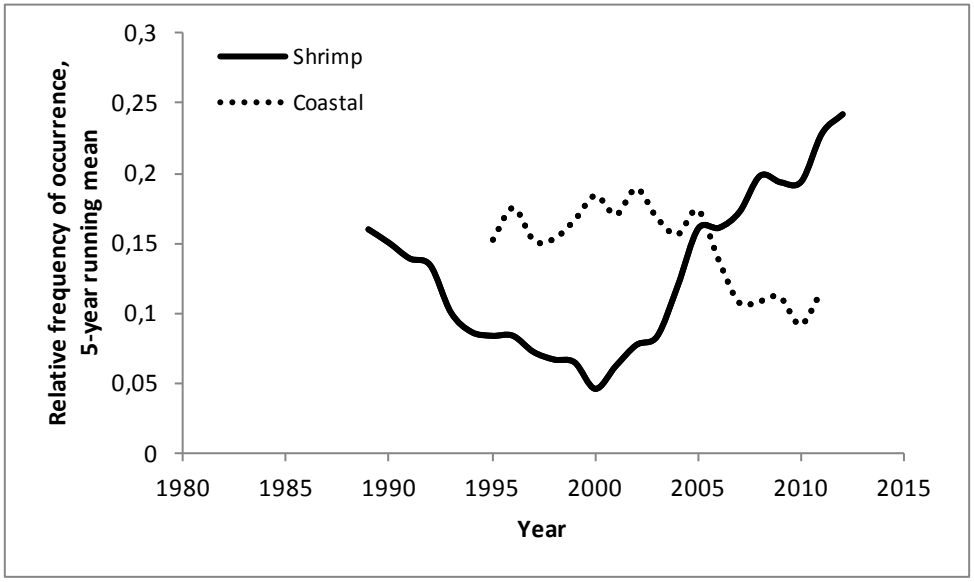



**Figure 2.14. Spurdog in the NE Atlantic. Average catch rate in numbers per hour from the North Sea IBTS.**



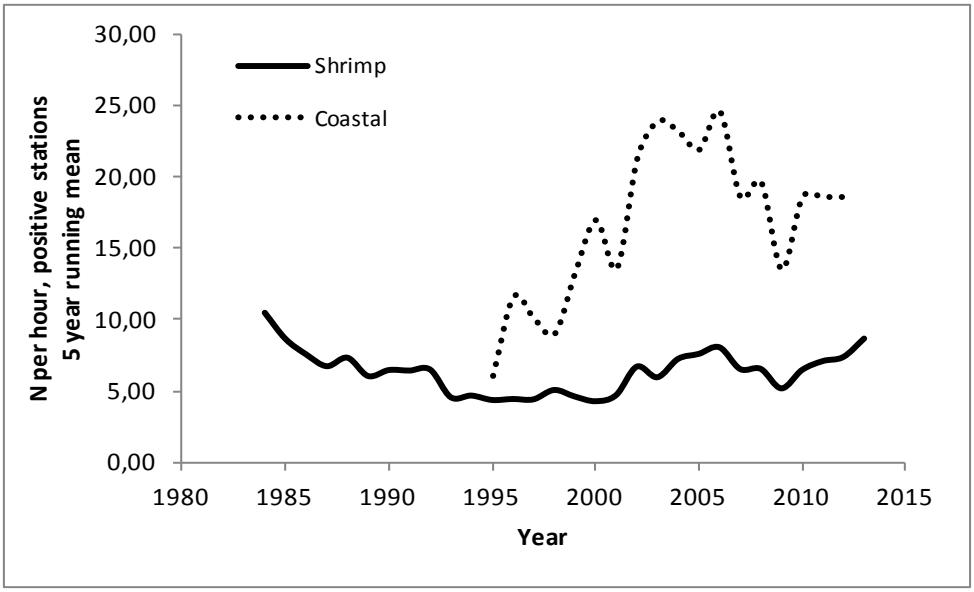
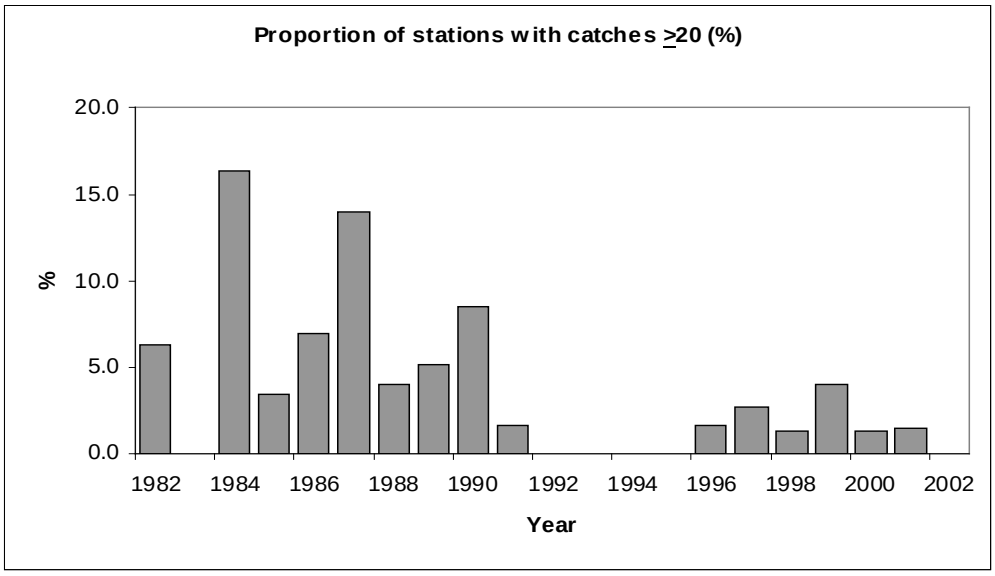




**Figure 2.15. Spurdog in the NE Atlantic. Frequency of occurrence (top) and numbers per trawl hour of spurdog for Coastal survey and Shrimp survey. A five year running mean is used.**



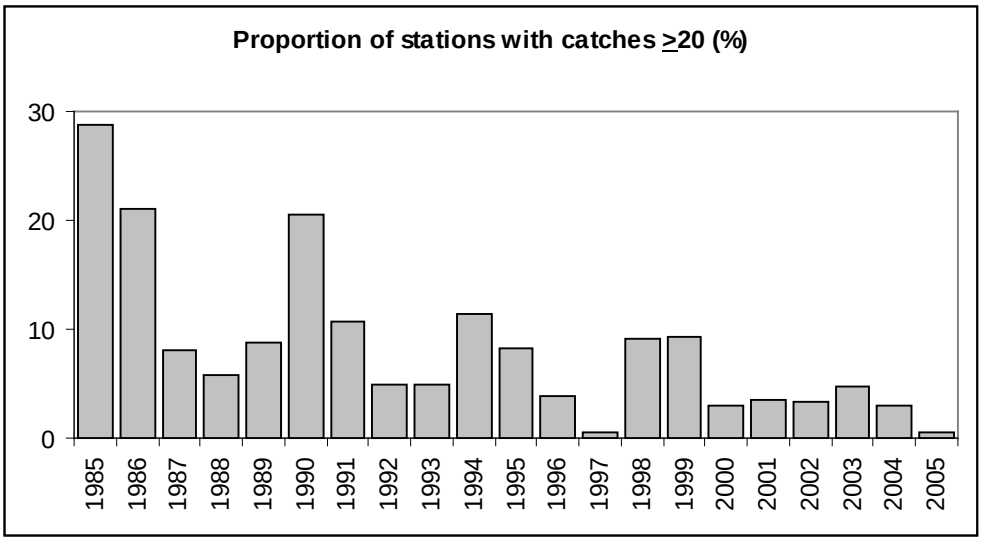
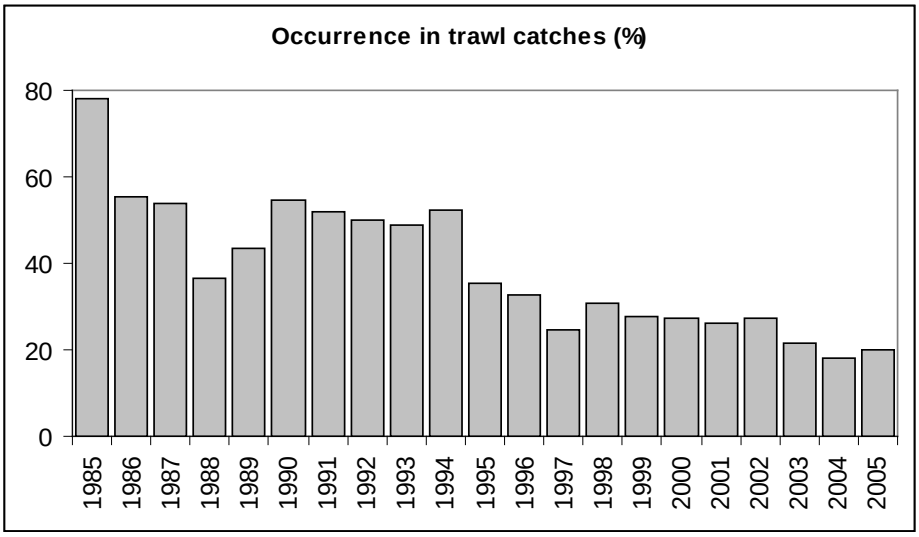




**Figure 2.16. Spurdog in the NE Atlantic. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (VIa) survey (Q1, 1985–2005, bottom) in which cpue was ≥20 ind.h–1. (Source: ICES, 2006).**

a)




b)

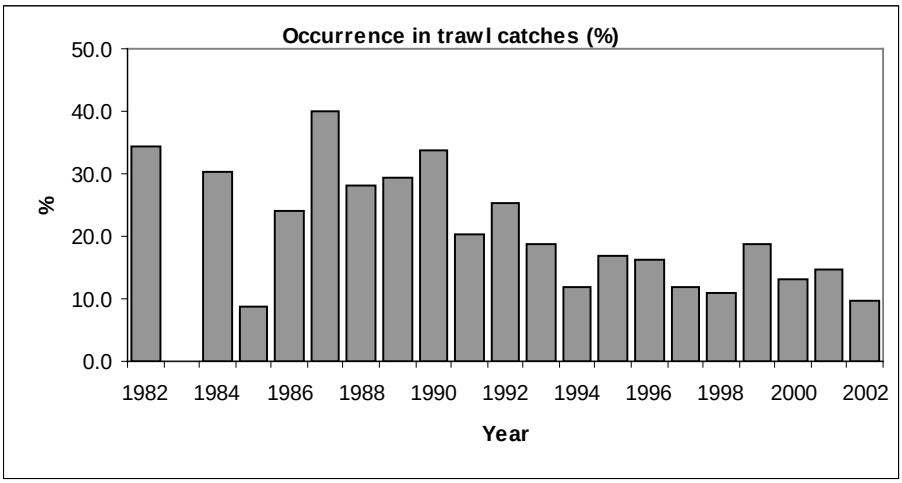



**Figure 2.17. Spurdog in the NE Atlantic. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (VIa) survey (Q1, 1985–2005).**

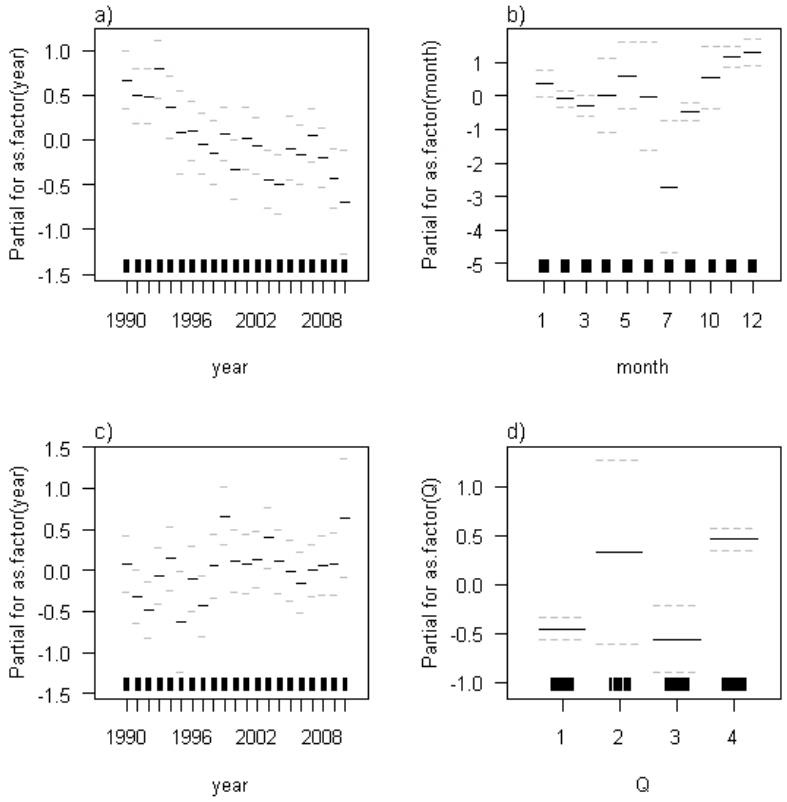



**Figure 2.18. Northeast Atlantic spurdog. Estimated year and quarter effects (± 1 s.e.) from the delta-lognormal GLM: binomial model shown in a) and b), and lognormal results in c) and d) (log scale).**

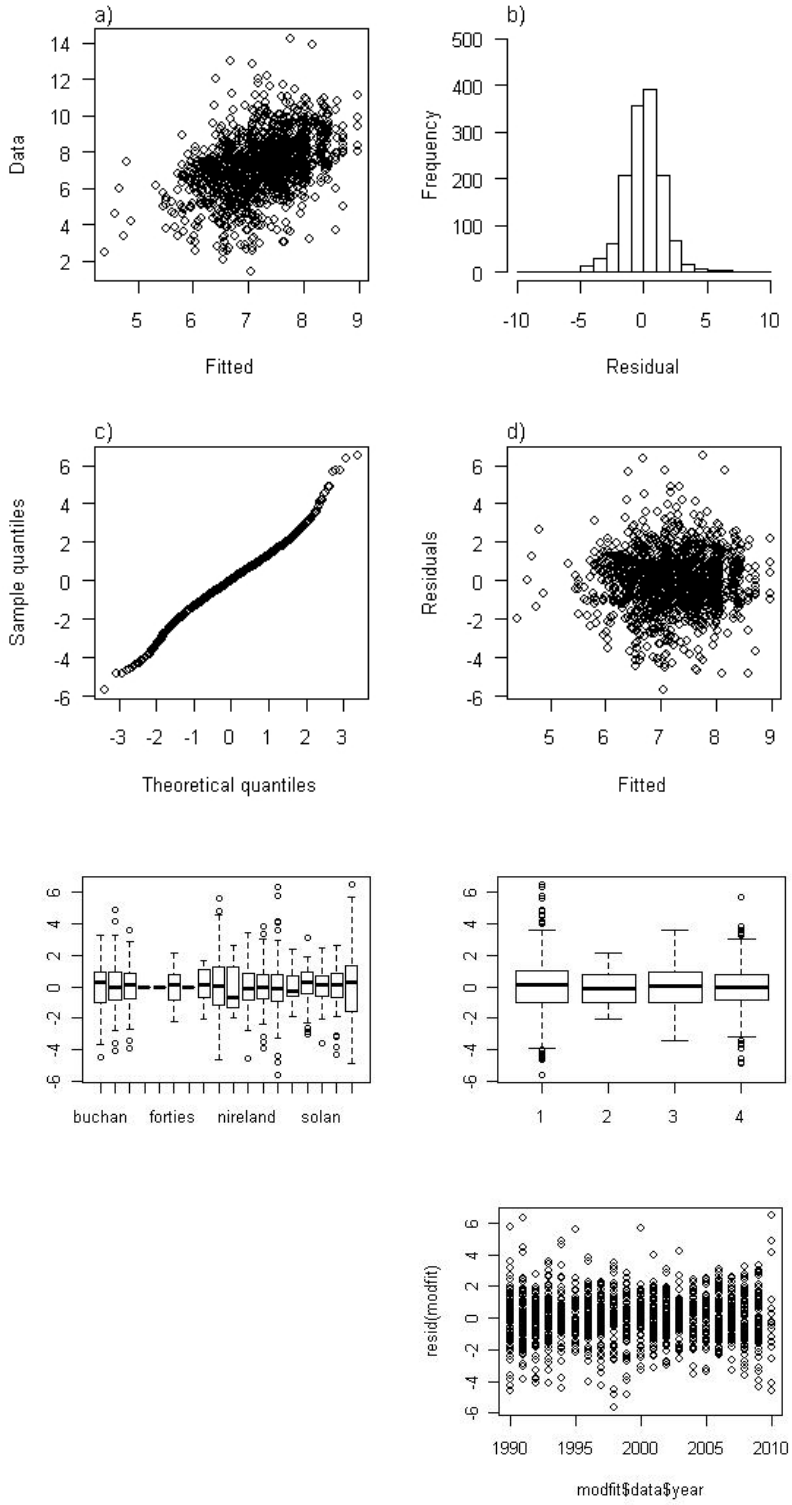



**Figure 2.19. Northeast Atlantic spurdog. Analysis of Scottish survey data. Residual plot of final lognormal model fit: a) observed vs. fitted values, b) histogram of residuals, c) normal Q-Q plot, d) residuals vs. fitted values and e), f) and g) residuals vs. area, quarter and year.**

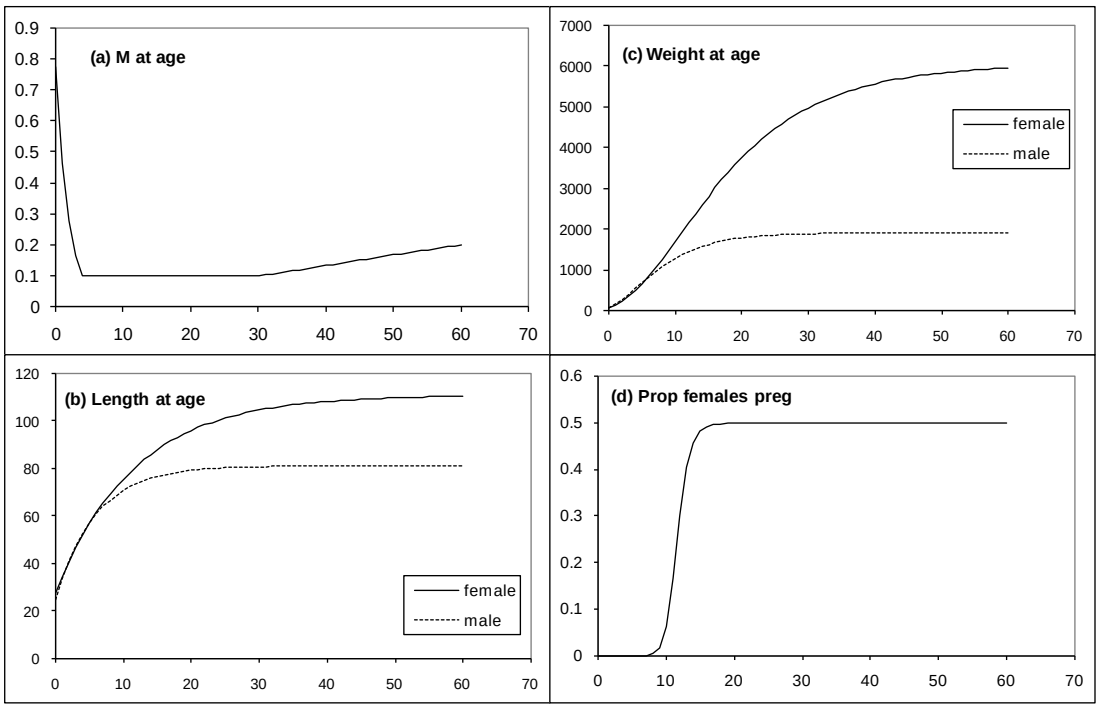



**Figure 2.20. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.5.**

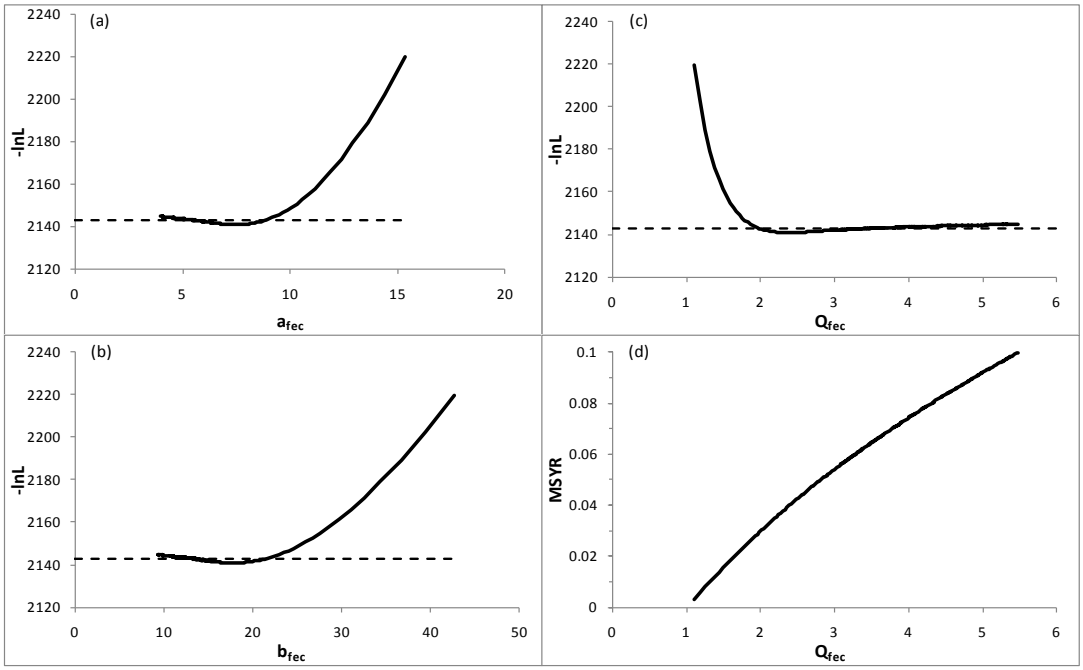



**Figure 2.21. Northeast Atlantic spurdog. Negative loglikelihood (-ln*L*) for a range of (a) $a_{fec}$ and (b) $b_{fec}$ values, with (c) corresponding $Q_{fec}$. Plot (d) shows MSYR (MSY/$B_{MSY}$) vs. $Q_{fec}$. Using the likelihood ratio criterion, the hashed line in plots (a)-(c) indicate the minimum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

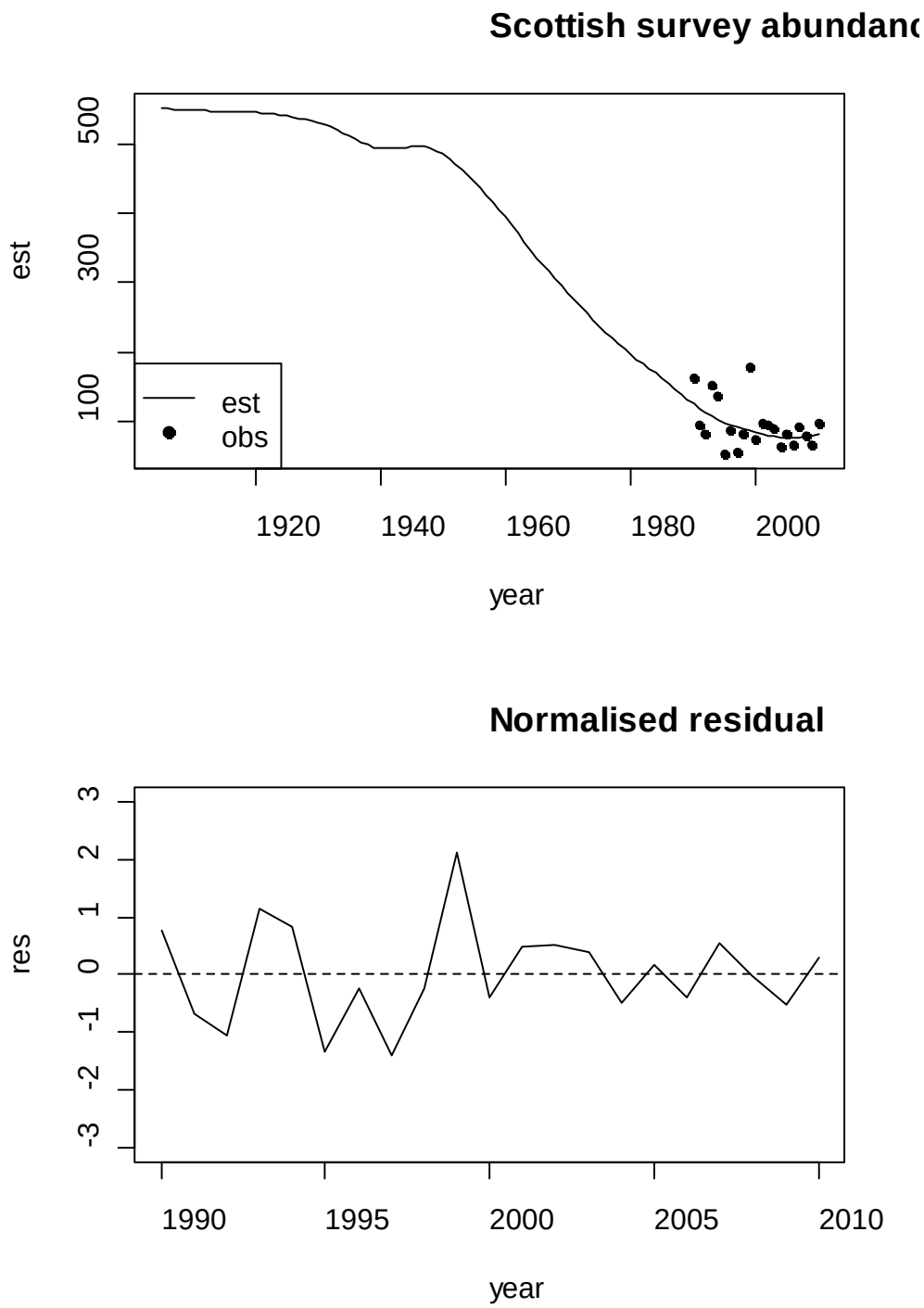



**Figure 2.22. Northeast Atlantic spurdog. A Model fit to the Scottish surveys abundance index (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in equation 2.9b) (bottom).**

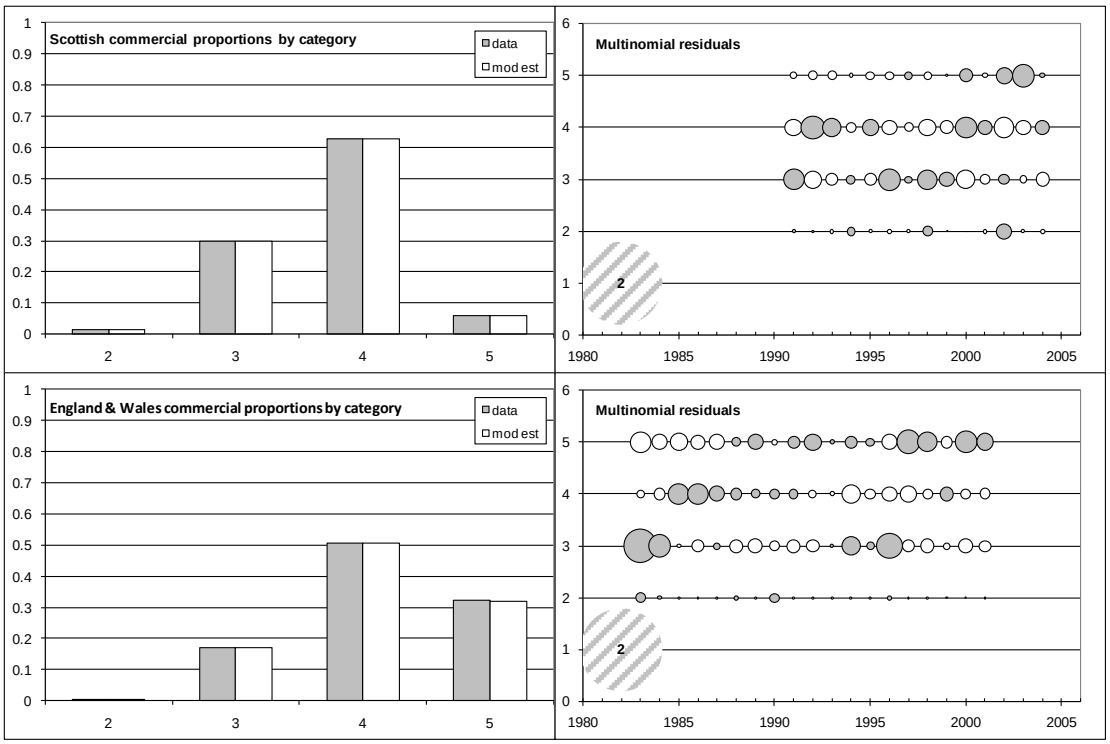



**Figure 2.23a. Northeast Atlantic spurdog. Model fits to the Scottish (top row) and England & Wales (bottom row) commercial proportions-by-length category data for the base-case run. The left-hand side plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The right-hand side plots show multinomial residuals ($\varepsilon_{pcom,j,y,L}$ in equation 2.10b), with grey bubbles indicating positive residuals (not the same interpretation as residuals in Figure 2.18), bubble area being proportional to the size of the residual (the light-grey hashed bubble indicates a residual size of 2, and is shown for reference), and length category indicated on the vertical axis. The length categories considered are 2: 16–54 cm; 3: 55–69 cm; 4: 70–84 cm; 5: 85+ cm.**

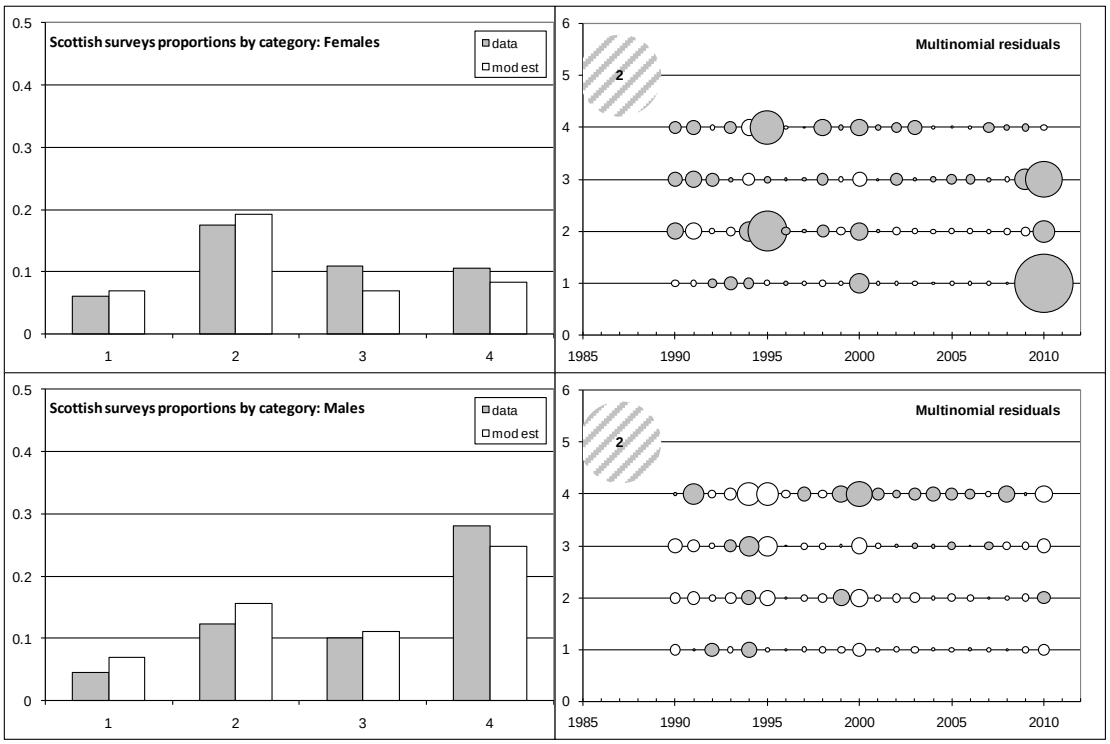



**Figure 2.23b. Northeast Atlantic spurdog. Model fits to the Scottish survey proportions-by-length category data for the base-case run for females (top row) and males (bottom row). A further description of these plots can be found in the caption to Figure 2.19a. Length categories considered are 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70+ cm.**

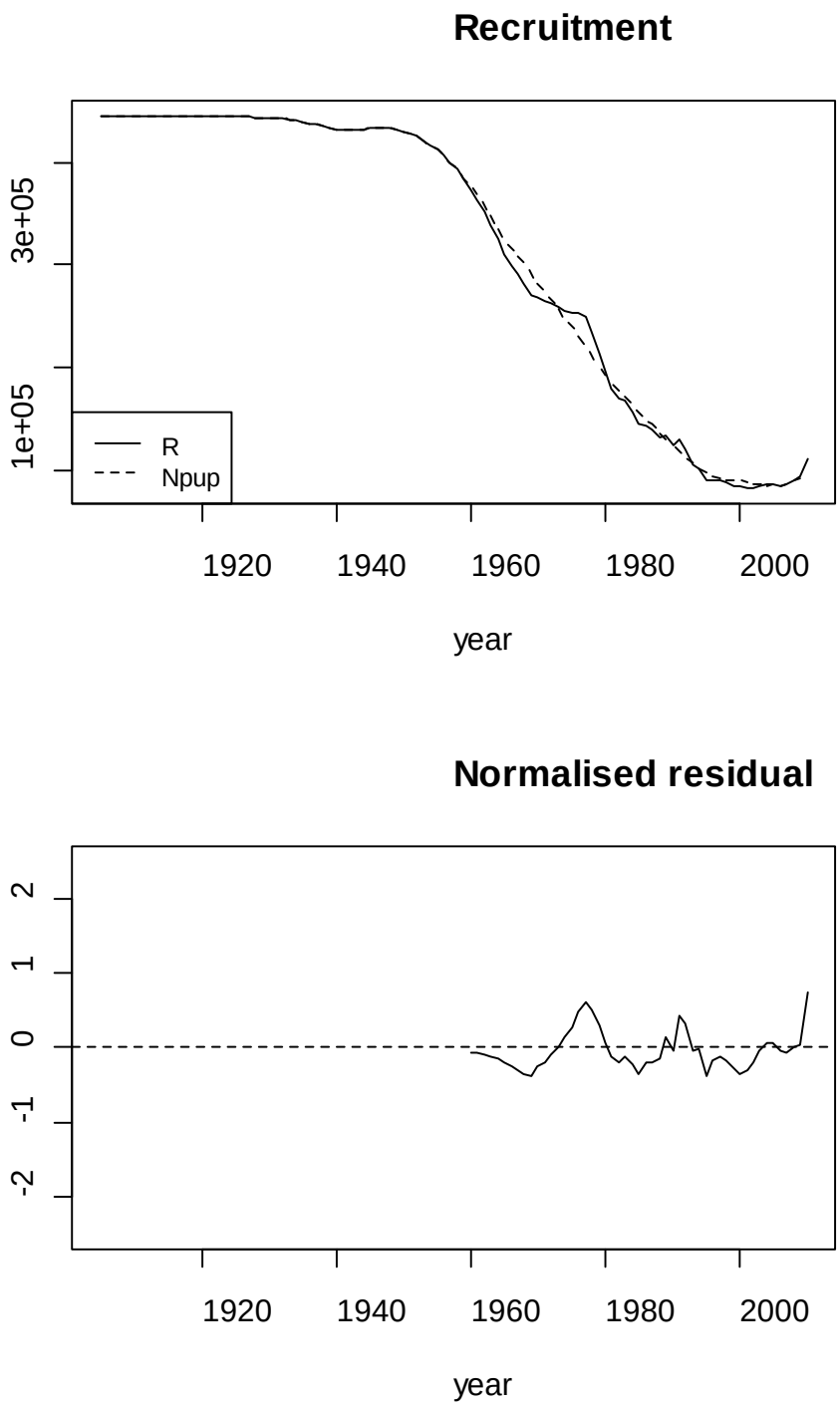



**Figure 2.24. Northeast Atlantic spurdog. A comparison of the deterministic ($N_{pup}$) and stochastic ($R$) versions of recruitment (equations 2.2a–c) (top panel) with normalised residuals ($\varepsilon_{r,y}/\sigma_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model) (bottom).**

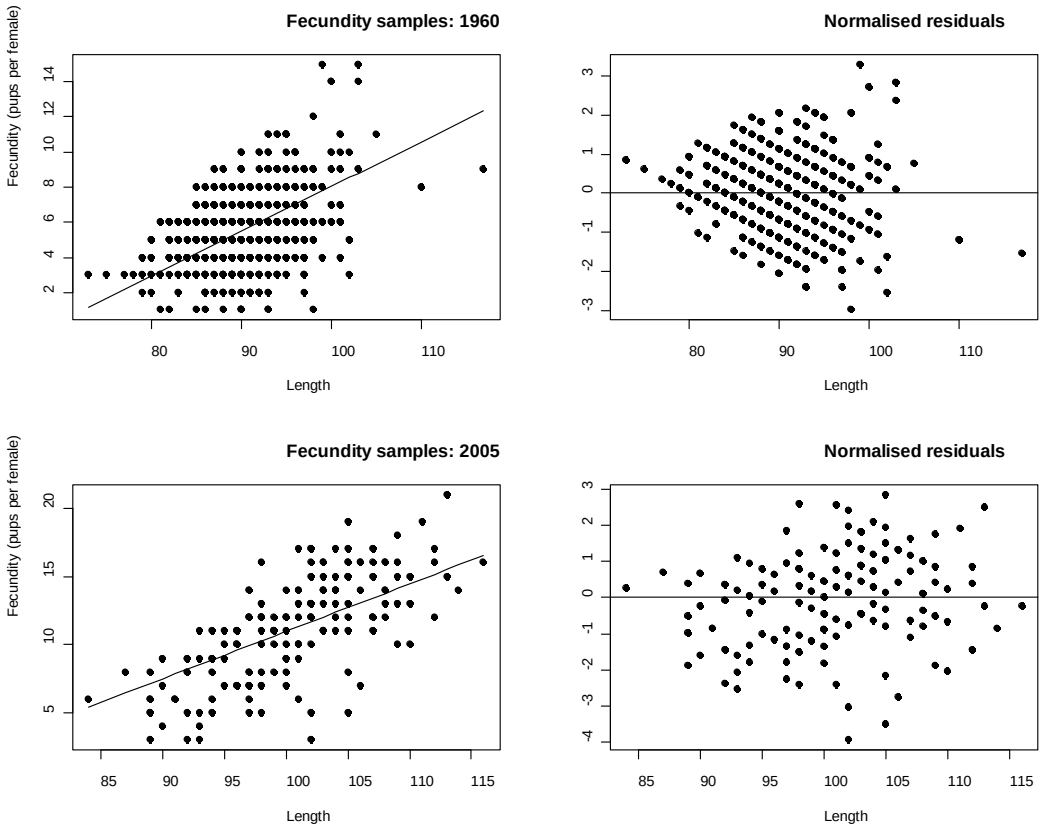



**Figure 2.25a. Northeast Atlantic spurdog. Fecundity data from two periods: top 1960 and bottom 2005, with fits shown on the left, and normalised residuals ($\varepsilon_{fec,k,y}$ in equation 2.11b) on the right.**

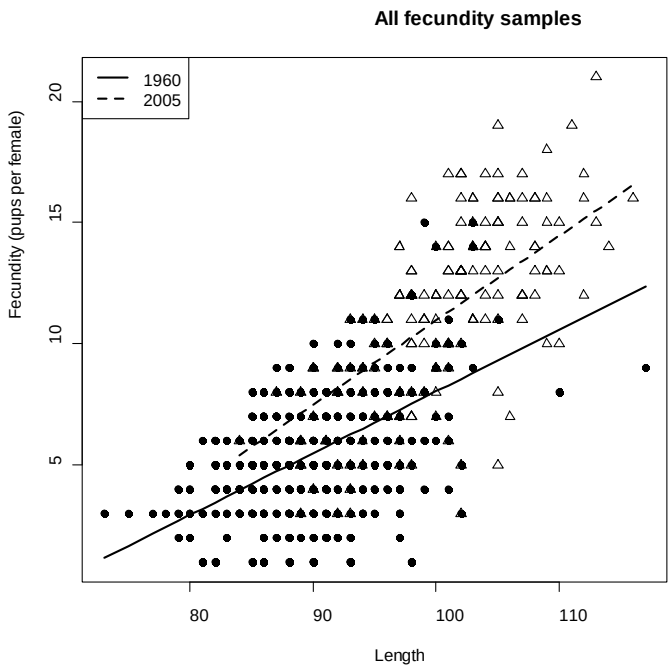



**Figure 2.25b. Northeast Atlantic spurdog. Plotting all the fecundity data together, with the fitted curves (open triangles=1960, solid circles=2005; note overlap of triangles with circles).**

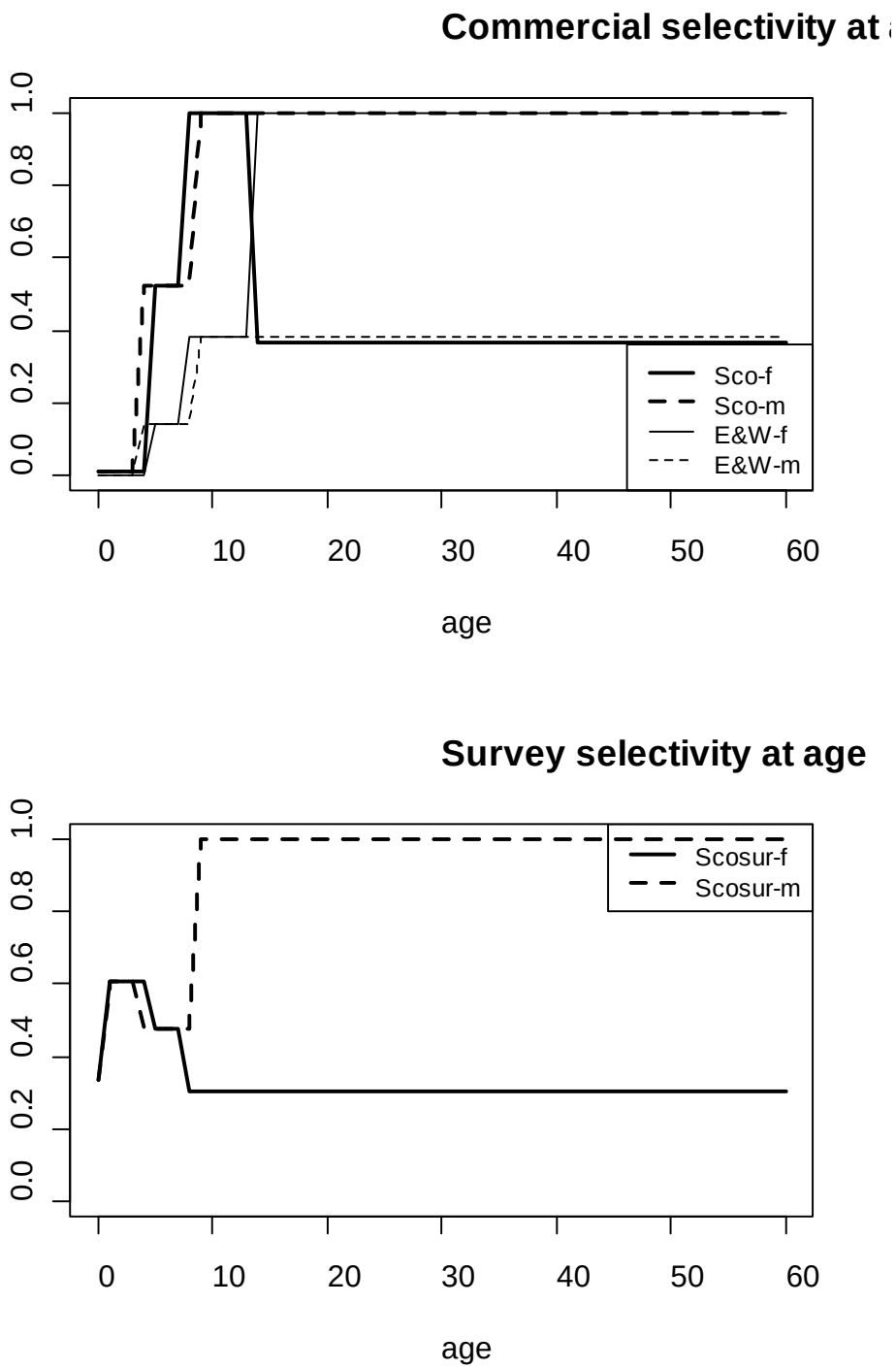



**Figure 2.26. Northeast Atlantic spurdog. Estimated commercial (top panel) and survey (bottom) selectivity-at-age curves for the base-case run. The two commercial fleets considered have Scottish (Sco) and England & Wales (E&W) selectivity, which differ by sex because of the life-history parameters for males and females (Table 2.5). The survey selectivity relies on Scottish survey data.**

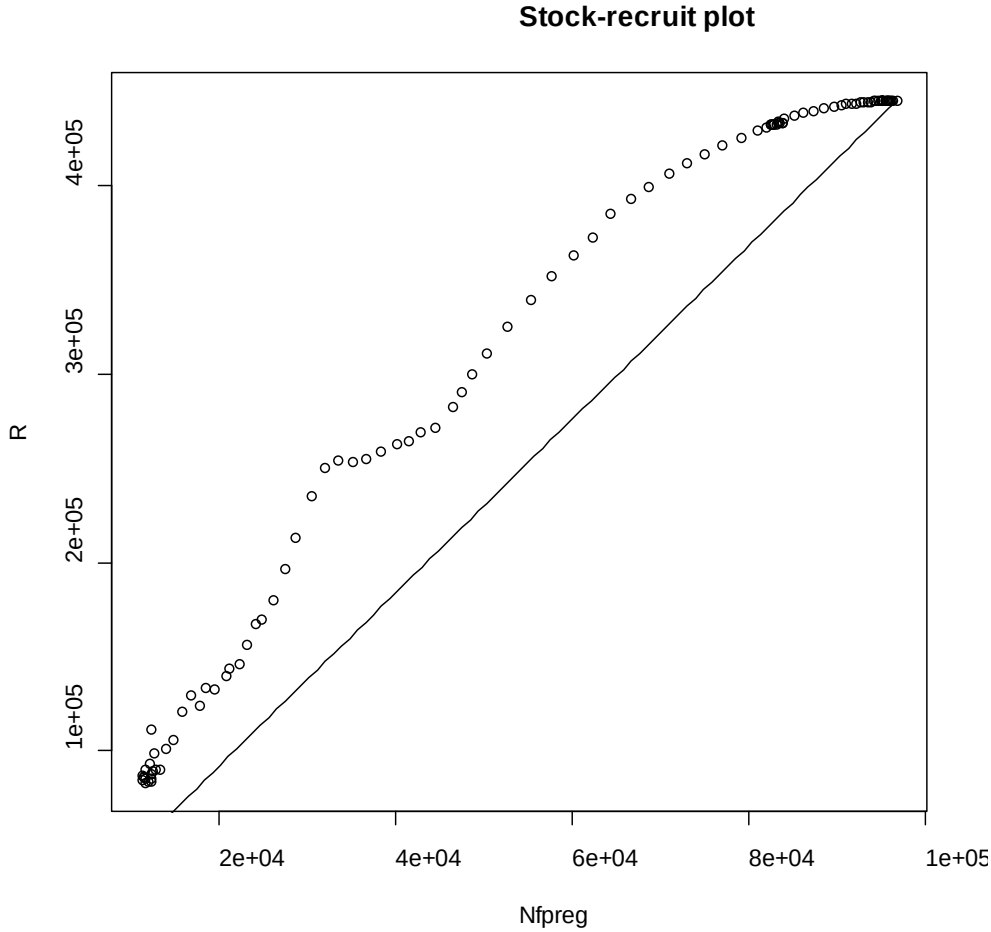



**Figure 2.27a. Northeast Atlantic spurdog. A plot of recruitment (*R*) vs. number of pregnant females (open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).**

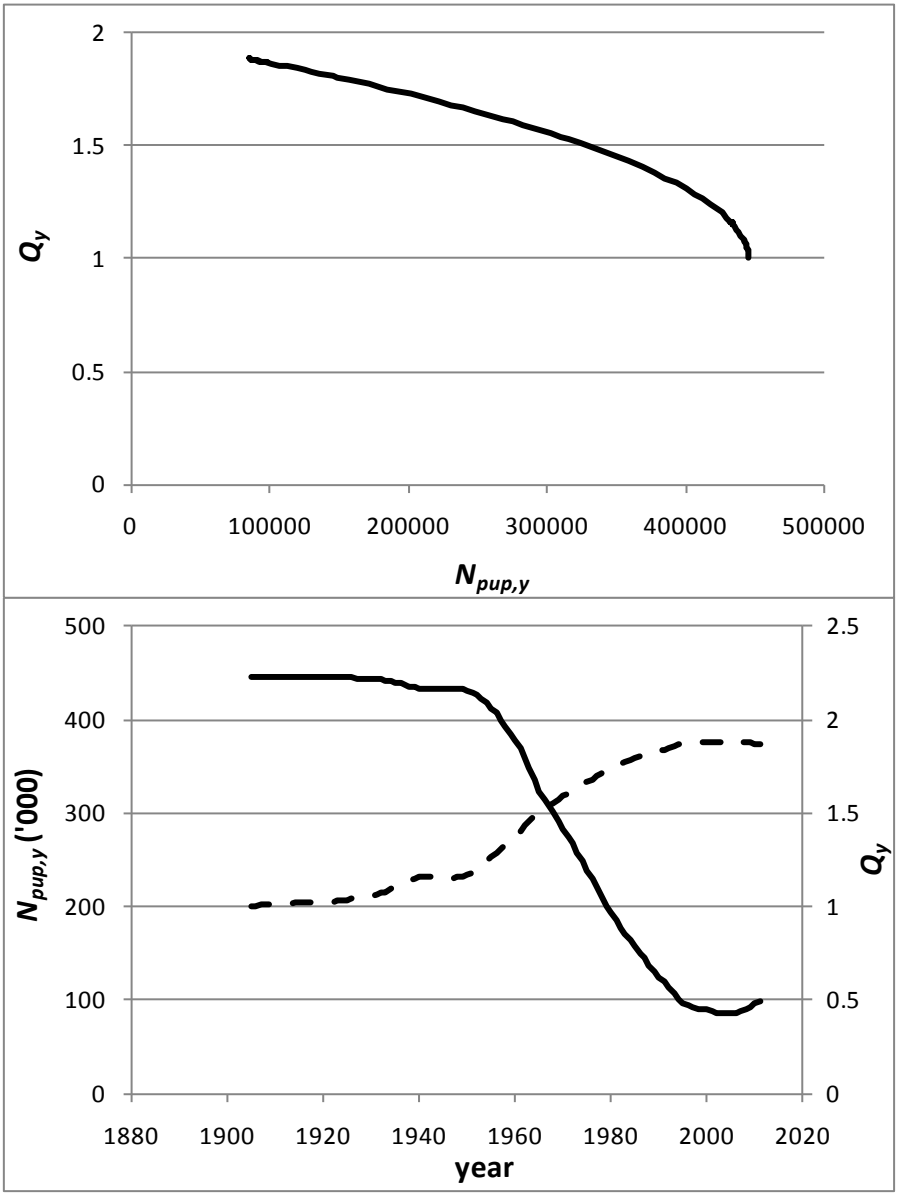



**Figure 2.27b. Northeast Atlantic spurdog. A plot of the density-dependent factor $Q_y$ (equation 2.2b) against the number of pups $N_{pup,y}$ (top), and both plotted against time (bottom; solid line for $N_{pup,y}$, and hashed line for $Q_y$).**

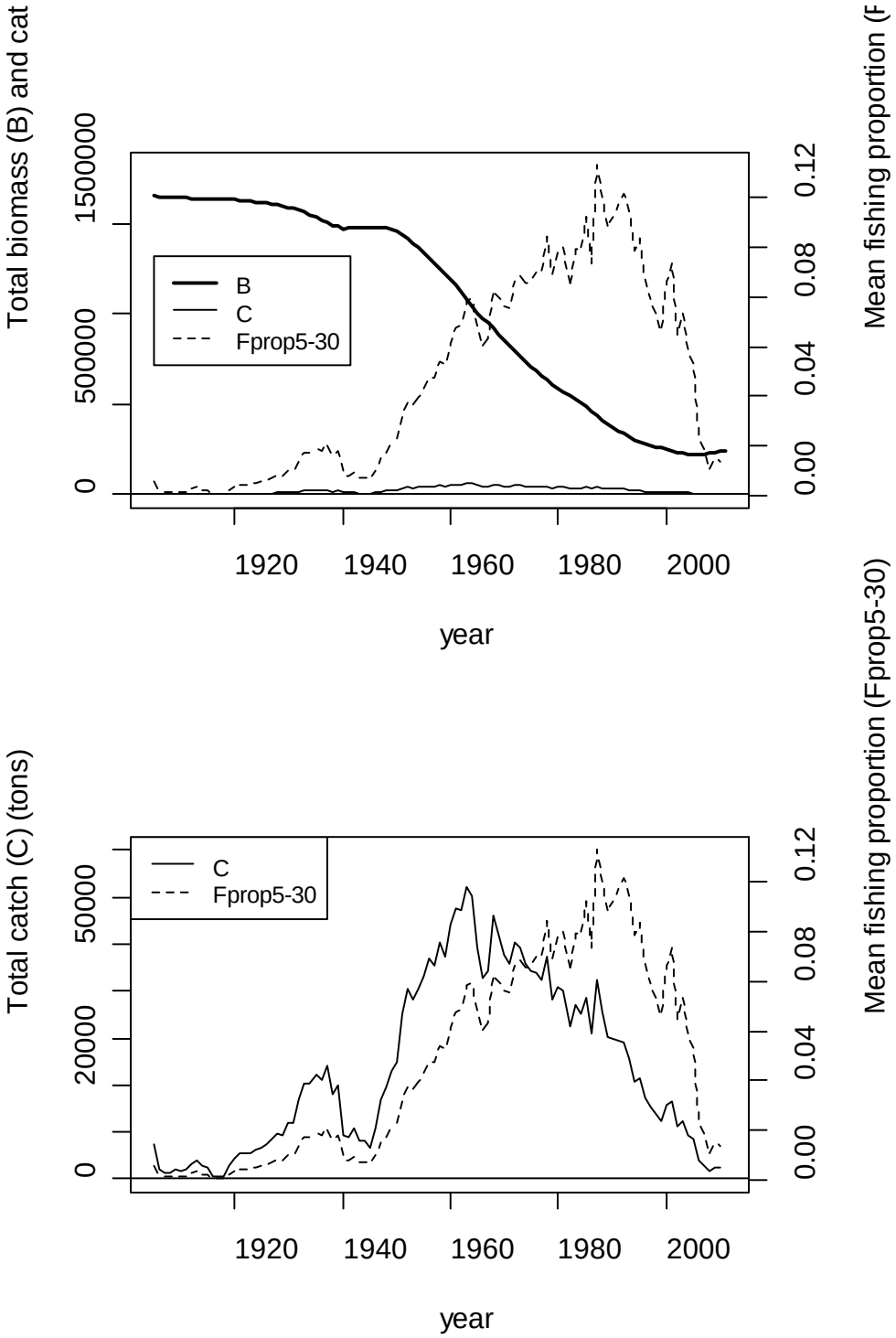



**Figure 2.28. Northeast Atlantic spurdog. Estimates of total biomass (*B*) and mean fishing proportion ($F_{prop5\text{-}30}$) are shown in the top panel together with observed total annual catch (*C*), with the bottom panel repeating the information, but without the total biomass to show more detail in *C*.**

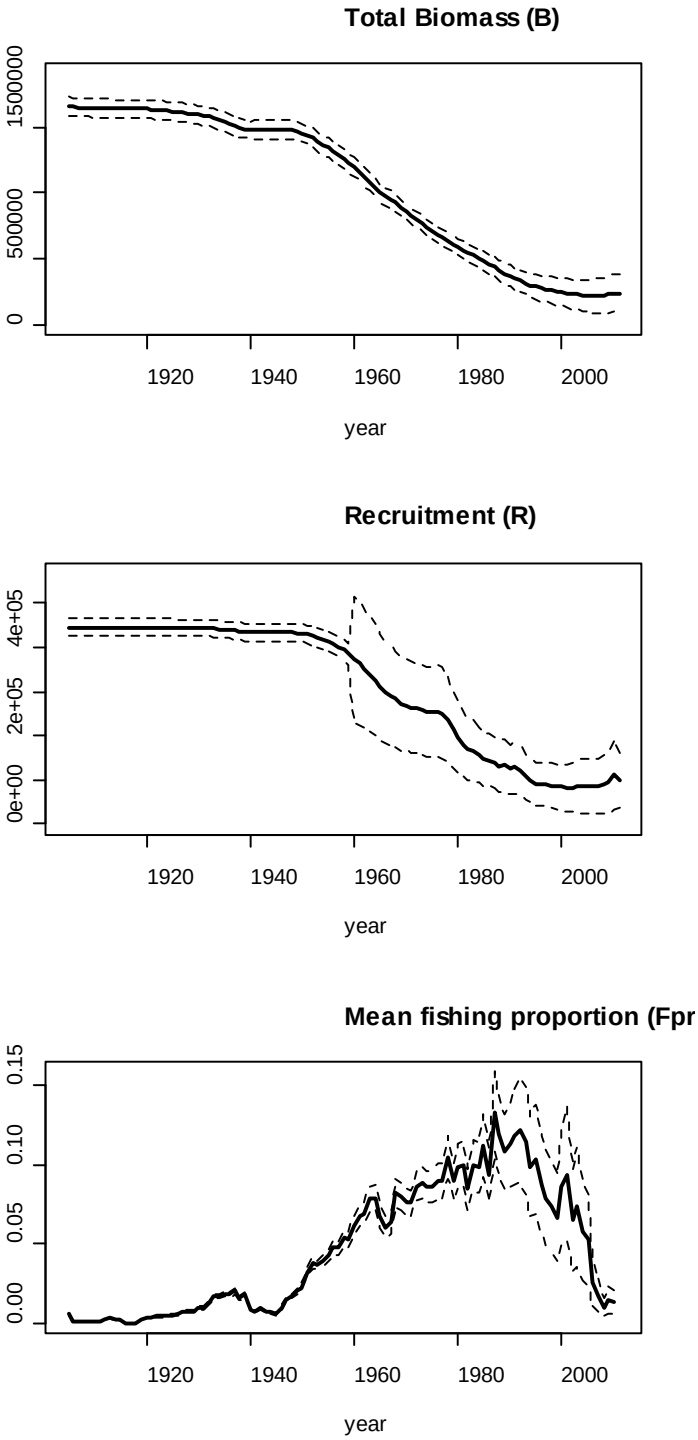



**Figure 2.29. Northeast Atlantic spurdog. Total biomass (*B*), recruitment (*R*) and mean fishing proportion ($F_{prop5\text{-}30}$) together with approximate 95% probability intervals (±2 Hessian-based standard deviations).**

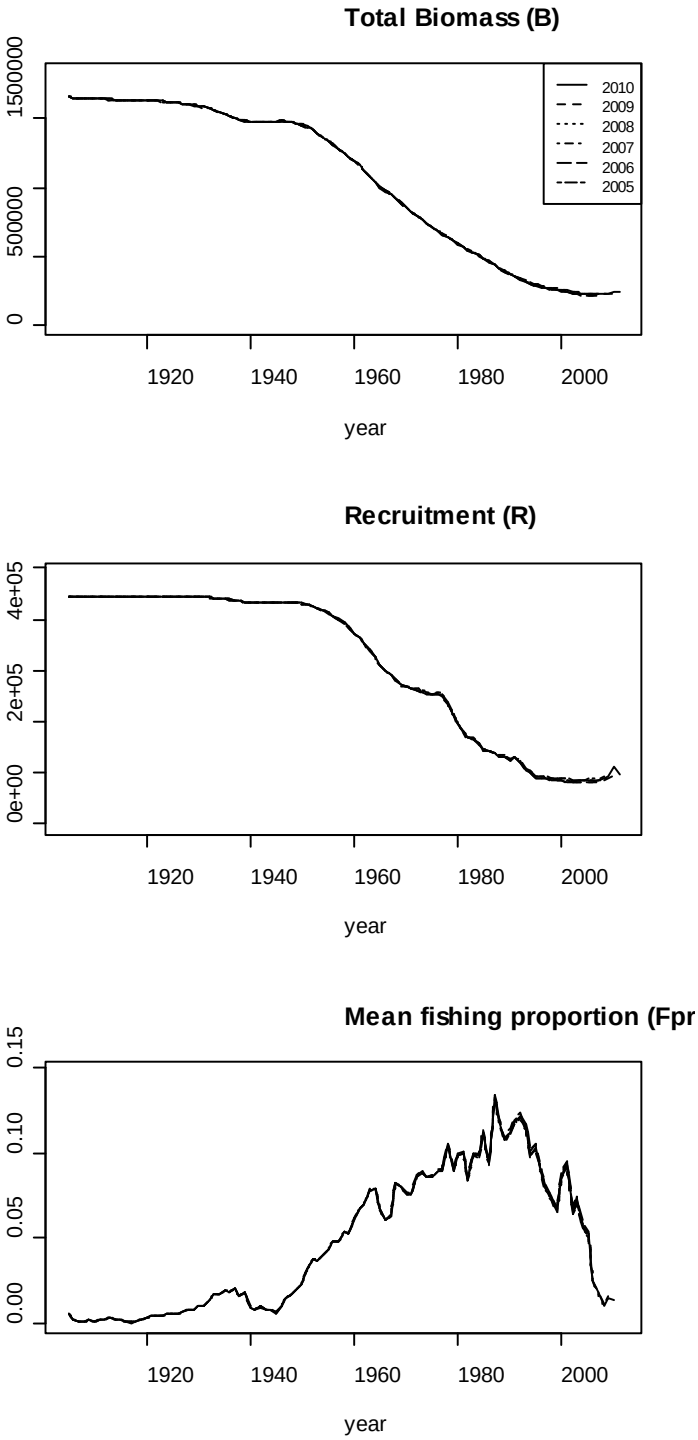



**Figure 2.30. Northeast Atlantic spurdog. A repeat of Figure 2.25 (omitting probability intervals for clarity), giving a six year retrospective comparison (the model was re-run, each time omitting a further year in the data).**

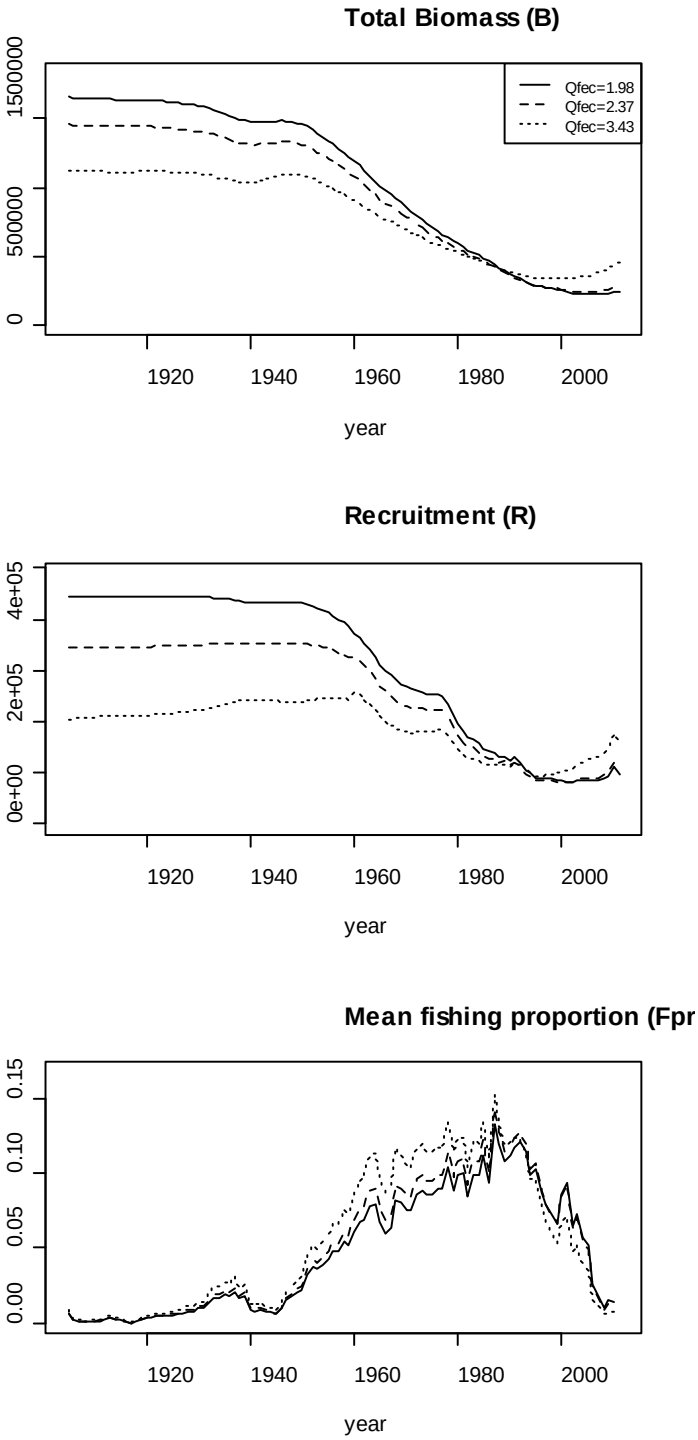



**Figure 2.31a. Northeast Atlantic spurdog. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production ($Q_{fec}$). Three alternative values are considered, related to the smallest, optimum (in terms of lowest –ln$L$) and largest value of $Q_{fec}$ below the hashed line in Figure 2.17c (respectively 1.98 [base case], 2.37 and 3.43).**

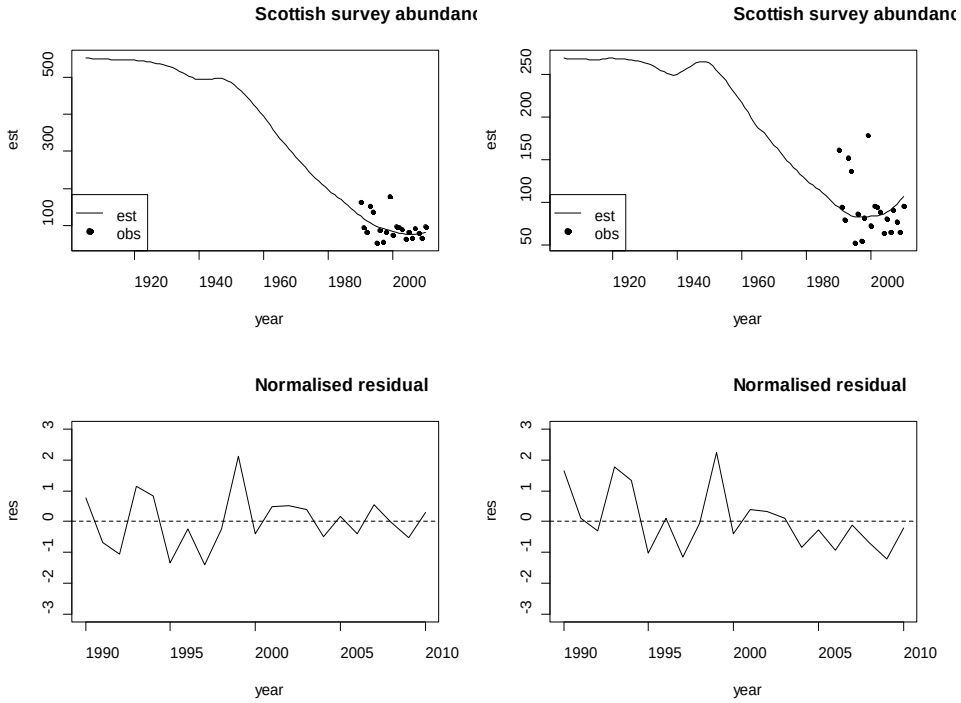



**Figure 2.31b. Northeast Atlantic spurdog. A demonstration of the deterioration of the model fit to the Scottish survey data as $Q_{fec}$ increases. Left-hand side: $Q_{fec}$=1.98; right-hand side: $Q_{fec}$=3.43.**

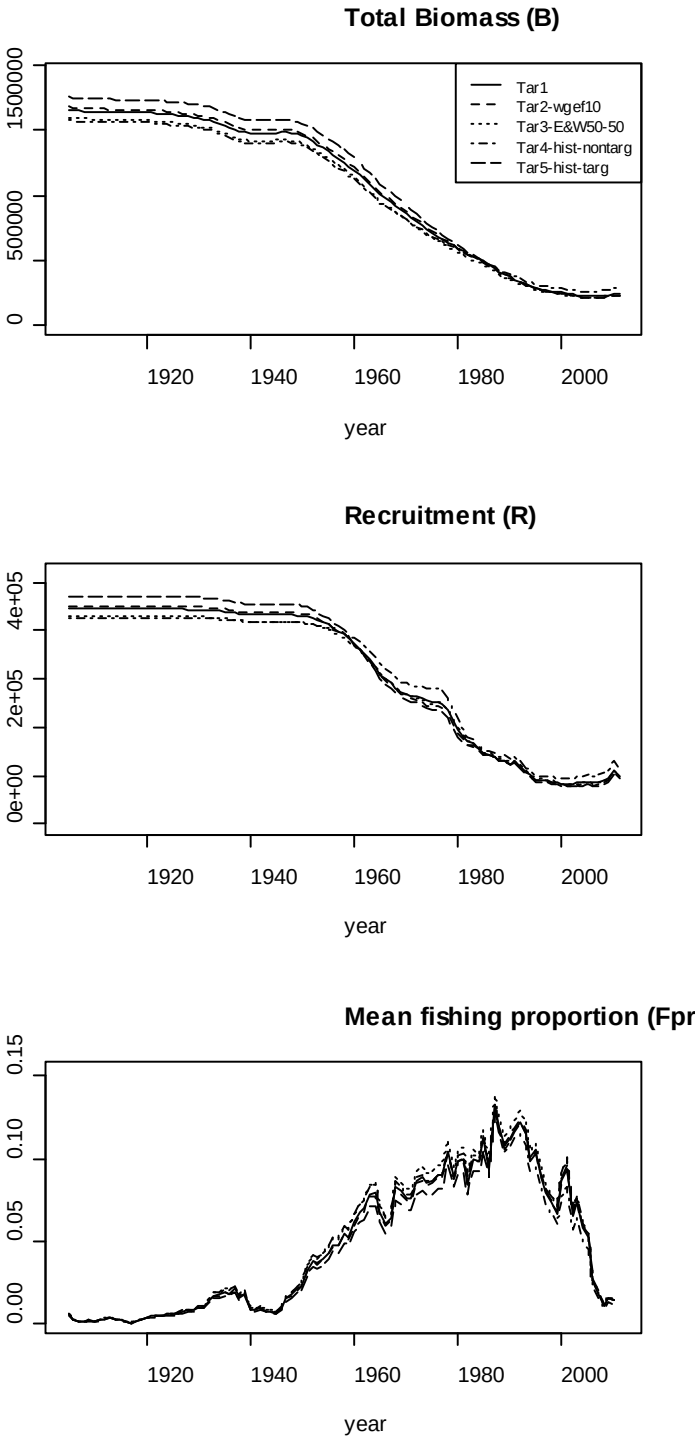



**Figure 2.32. Northeast Atlantic spurdog. A comparison of the alternative targeting scenarios, where fishing is defined as either "non-target" (Scottish selectivity) or "target" (England & Wales selectivity). Tar 1 is the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980–1984), Tar 2 is as for WGEF in 2010 (Scottish landings are "non-target", E&W "target", and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984), Tar 3 as for Tar 2 but with E&W split 50% "non-target" and 50% "target", and Tar 4 and 5 as for Tar 1, but with pre-1980 selectivity entirely non-target (former) or target (latter).**

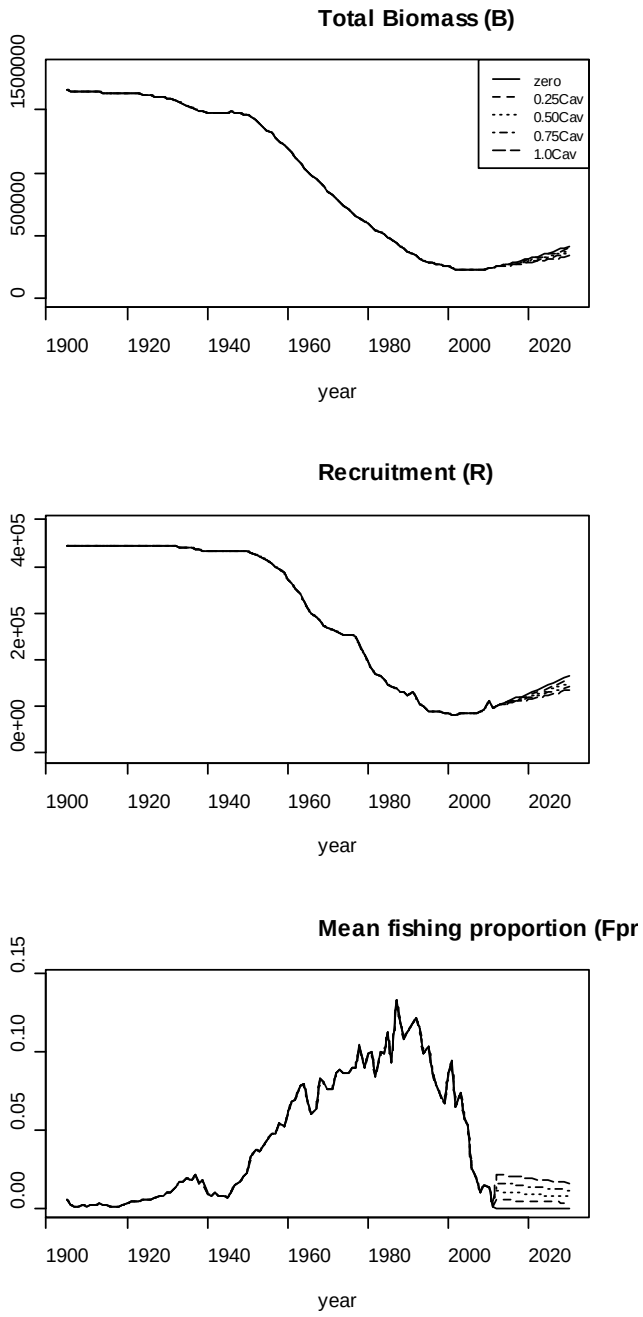



**Figure 2.33a. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the average catch for 2005–2009 (Cav=3913 tons).**

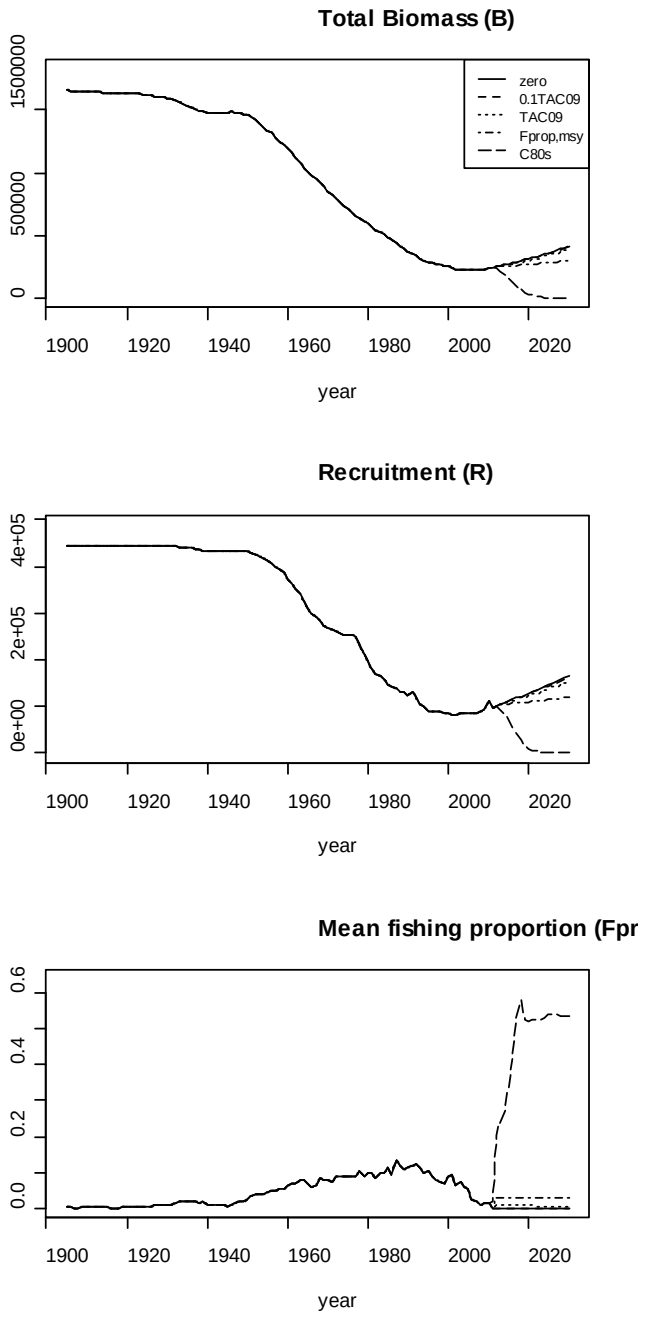



**Figure 2.33b. Northeast Atlantic spurdog. 20-year projections for different levels of future catch, expressed as a proportion of the 2009 TAC (TAC09=1422 tons). These are shown together with zero exploitation, exploitation at $F_{prop,MSY}$., and exploitation at the average catch level of the 1980s (C80s).**

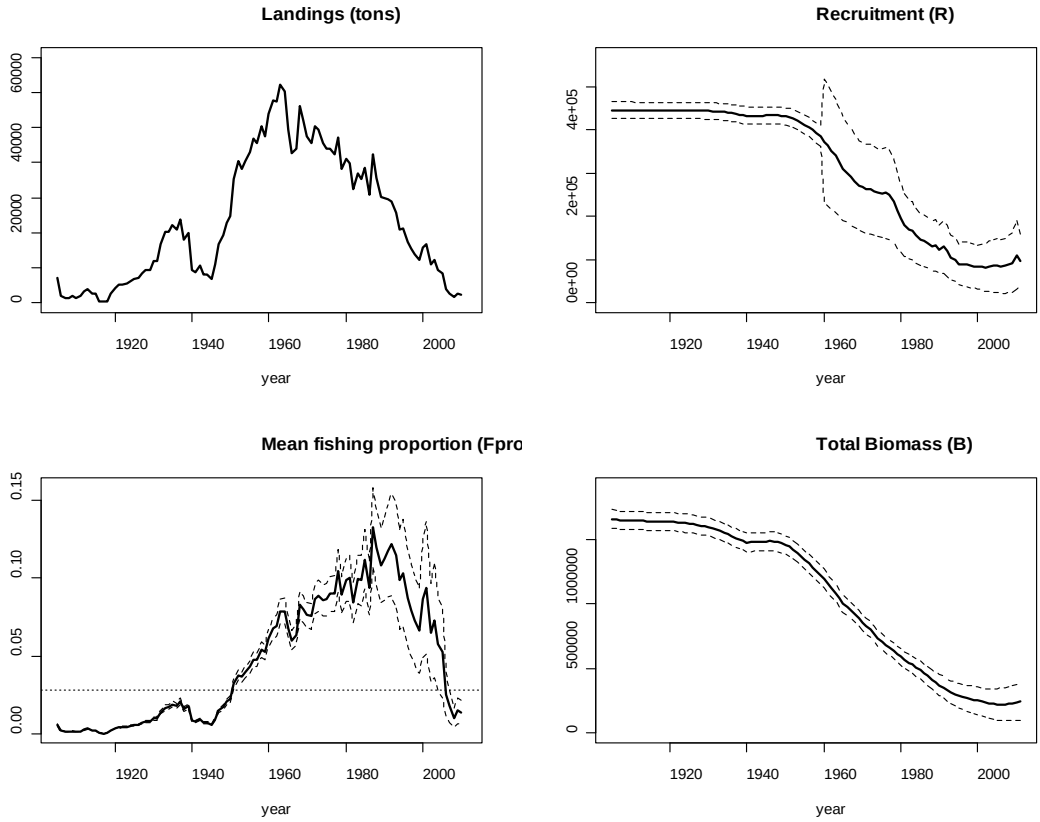



**Figure 2.34. Northeast Atlantic spurdog. Summary four-plot for the base-case, showing long-term trends in landings (tons), recruitment (number of pups), mean fishing proportion (average ages 5–30, dotted horizontal line=$F_{MSY}$=0.028) and total biomass (tons). Hashed lines reflect estimates of precision (±2 standard deviations).**

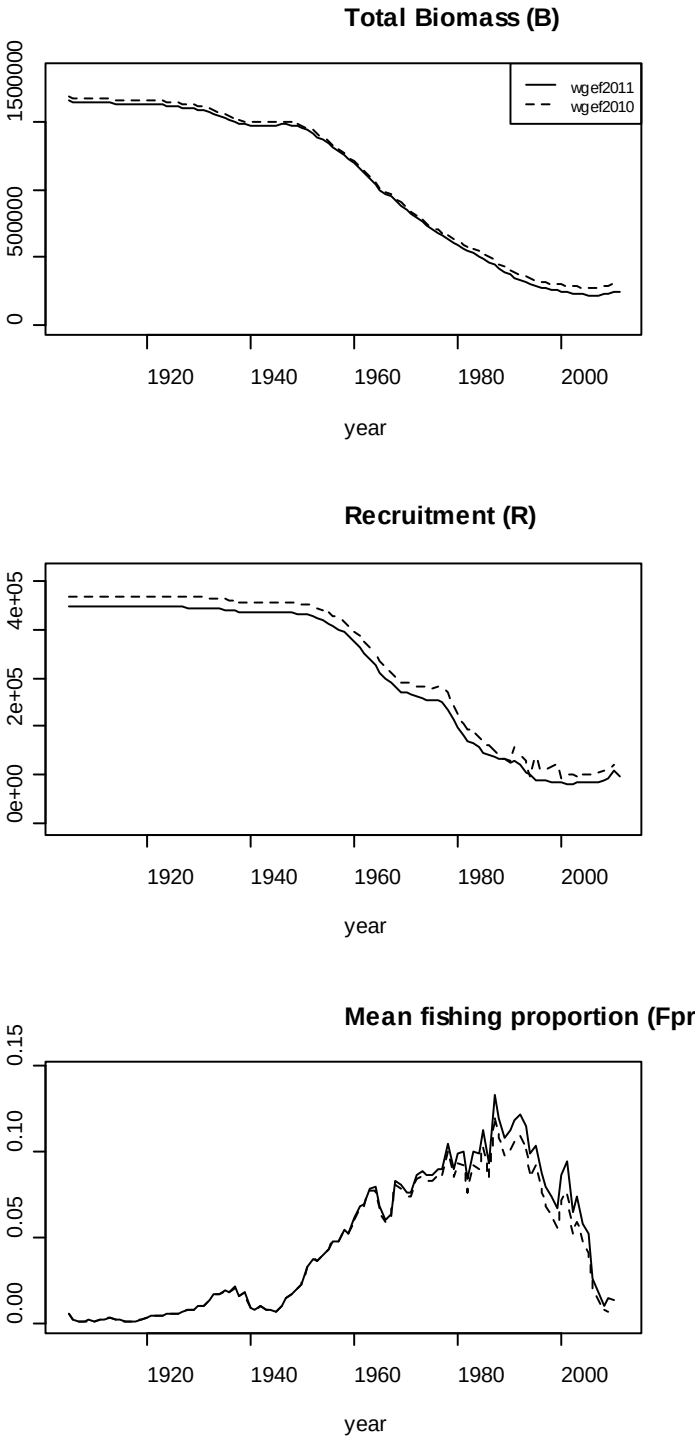



**Figure 2.35. Northeast Atlantic spurdog. Comparison with last year's assessment.**

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

## 3.1 Stock distribution

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

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

### 3.1.1 Leafscale gulper shark

**Leafscale gulper shark** (*Centrophorus squamosus*) has a wide distribution in the NE Atlantic from Iceland and Atlantic slopes south to Senegal, Madeira and the Canary Islands. On the Mid-Atlantic Ridge it is distributed from Iceland to the Azores (Hareide and Garnes, 2001) The species can live as a demersal shark on the continental slopes (depths between 230–2400 m) or have a more pelagic behaviour, occurring in the upper 1250 m of oceanic water in areas with depths around 4000 m (Compagno and Niem, 1998). Available evidence suggests that this species is highly migratory (Clarke *et al*., 2001; 2002). Available information reveals that pregnant females and pups are found in Portugal, both the mainland (Moura *et al.*, 2006 WD) and Madeira, whereas pre-pregnant and spent females are found in the northern areas (Clarke *et al*., 2001; 2002; Garnes, pers. Com.). A molecular study did not reject the null hypothesis of genetic homogeneity among NE Atlantic collections using six nuclear loci (Verissimo *et al*., 2012). The same study however shows that females are less dispersive than males and possibly philopatric. In the absence of more clear information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

### 3.1.2 Portuguese dogfish

**Portuguese dogfish** (*Centroscymnus coelolepis*) is widely distributed in the NE Atlantic. Stock structure and dynamics are poorly understood. Specimens below 70 cm have been recorded very rarely in the NE Atlantic, suggesting that newborns tend to school in nurseries located in restricted geographical areas that are not commercially exploited (Moura and Figueiredo, 2012WD). There is a lack of knowledge of migrations, though consistent results among studies show that females move to shallower waters for parturition and vertical migration seems to occur (Girard and du Buit, 1999; Clarke *et al.*, 2001; Moura and Figueiredo, 2012WD). The same size range and maturity stages exist in both the northern and southern ICES continental slopes. This information may suggest that, unlike the leafscale gulper shark, this species is not highly migratory, though it is widely distributed. Preliminary genetic work (Moura *et al*., 2008 WD) did not reject the null hypothesis that there was no significant difference between the northern and southern areas. In this study the authors expressed some concerns on how to interpret the results. In another study on genetic population structure of the Portuguese dogfish within the eastern Atlantic Ocean (including the northern sector of the mid-Atlantic ridge) no evidence of genetic population structure was found (Verissimo *et al*., 2011). Although the microsatellites are considered a powerful tool for stock discrimination, the number used could be insufficient to infer about existence of a single, well-mixed population.

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

## 3.2 The fishery

### 3.2.1 History of the fishery

Fisheries taking these species are described in stock annexes for Leafscale gulper shark and Portuguese dogfish.

### 3.2.2 ICES advice applicable

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

### 3.2.3 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters at different ICES subareas are summarized in the table below. The deep-sea shark category includes the following species: Deep-water catsharks (*Apristurus* spp.); frilled shark (*Chlamydoselachus anguineus*), gulper shark (*Centrophorus granulosus*), leafscale gulper shark (*Centrophorus squamosus*), Portuguese dogfish (*Centroscymnus coelolepis*), longnose velvet dogfish (*Centroscymnus crepidater*), black dogfish (*Centroscyllium fabricii*); birdbeak dogfish (*Deania calcea*); kitefin shark (*Dalatias licha*); greater lanternshark (*Etmopterus princeps*); velvet belly (*Etmopterus spinax*); blackmouth catshark (blackmouth dogfish) (*Galeus melastomus*); mouse catshark (*Galeus murinus*); six-gilled shark (*Hexanchus griseus*); sailfin roughshark (sharpback shark) (*Oxynotus paradoxus*); knifetooth dogfish (*Scymnodon ringens*) and Greenland shark (*Somniosus microcephalus*).

| fishing opportunities | V, VI, VII, VIII, IX | X | XII (includes also *Deania histricosa* and *Deania profondorum* |
|---|---|---|---|
| 2005 and 2006 | 6763 | 14 | 243 |
| 2007 | 2472[1] | 20 | 99 |
| 2008 | 1646[1] | 20 | 49 |
| 2009 | 824[1] | 10[1] | 25[1] |
| 2010 | 0[2] | 0[2] | 0[2] |
| 2011 | 0[3] | 0[3] | 0[3] |
| 2012 | 0 | 0 | 0 |
| 2013 | 0 | 0 | 0 |
| 2014 | 0 | 0 | 0 |

**[1] Bycatches only. No directed fisheries for deep-sea sharks are permitted.**

**[2] Bycatches of up to 10% of 2009 quotas are permitted.**

**[3] Bycatches of up to 3% of 2009 quotas are permitted.**

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

Council Regulation (EC) No 41/2007 banned the use of gillnets by Community vessels at depths greater than 600 m in ICES Divisions VIa, b, VII b, c, j, k and Subarea XII. A maximum bycatch of deep-water shark of 5% is allowed in hake and monkfish gillnet catches.

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

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

## 3.3 Catch data

### 3.3.1 Landings

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

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

Landings have declined from around 10 000 t from 2001 to 2004, 1 t in 2012 (Figures 3.1 and 3.2). The decrease in landings is mostly related with the imposition of the TAC, which has been set at zero catch since 2010.

### 3.3.2 Discarding

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

**Portugal.** The onboard sampling programme of Portuguese commercial vessels that operate deep-water set longlines to target black scabbardfish (métier LLD_DWS_0_0_0) is included in the EU DCF/NP. The programme is carried out by IPMA/INRB, I.P. and started in mid-2005. Six and nine fishing trips were sampled in 2011 and 2012 respectively (Prista and Fernandes, 2013WD). Sampling goals were fixed at three trips per quarter and sampled trips and vessels were selected in a quasi-random way (Fernandes *et al*., WD 2001). Reasons for lower coverage are mostly related to vessels not having space onboard to accommodate observers and/or being unable to guarantee their safety under bad weather conditions, logistic constrains in accessing ports of departure, and after 2009 an increasing need to allocate observers to other fisheries, namely set gill/trammelnets that also target demersal stocks.

Table 3.3 presents haul information of sampled trips and sets and the frequency of occurrence (%) of Portuguese dogfish and leafscale gulper sharks in the discards of the sets sampled. It was not possible to raise discards sampled in the longline fishery to fleet level due to suspected bias in sampled trips with respect to vessel size and fishing ground. Specifically, larger vessels and vessels that operate in the northern reaches of the Portuguese coast appear to have been more sampled in recent years than in the early stages of the sampling programme.

Summary data of length–frequency and sex-ratio of elasmobranchs caught, retained and discarded by the Portuguese longline fishery targeting black scabbardfish are presented in Table 3.4.

**Spain**. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES Subareas VI, VII, VIIIc and North IX, was started in 1988; however, it did not have yearly continuity until 2003. The sampling strategy and the estimation methodology used follows the "Workshop on Discard Sampling Methodology and Raising Procedures" guidelines (ICES, 2003) and more detail of this applied to this area is explained in Santos *et al*. (WD 2010).

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

**France.** A summary of French onboard observation data for the deep-sea licensed fishing fleet is presented in Table 3.6. Note that this table includes raw observation data without any raising to the total fleet activity data. The level of discards raised to the total fleet activity with proper sampling stratification was estimated to 20% in 2011 (Dubé *et al.*, 2012). Hauls used in the nested grid analysis are a subset of observations from Table 3.6 restricted to ICES Division VIa, from where the bulk of French landings of deep-sea species came in recent years.

An exploratory technique for estimating total catch of Portuguese dogfish and leaf-scale gulper shark (equivalent to discards since the introduction of the 0 TAC in 2010) using cpue from observed sampling raised to fleet level with VMS data is described in Section 3.5. This analysis could not be completed for years after 2007 due to lack of availability of VMS data for those years and hence estimates of discards are presented this year. Further analysis is expected to allow estimates of discards from the French fleet to be estimated in future years.

### 3.3.3 Quality of the catch data

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

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

In the past misreporting was considered a minor problem but this are likely to have changed recently as a reaction to the EU restrictive measures adopted for deep-water sharks. Data provided as a result of the DCF landing sampling programme at Sesimbra landing port in 2009 and 2010 revealed the existence of high misidentification problems (Lagarto *et al.*, 2012 WD). Samples collected cover around 1% of the total landed weight (Serra-Pereira *et al.*, 2011WD). Further information is provided in Chapter 5, Other Deep-water Sharks.

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

## 3.4 Commercial catch composition

### 3.4.1 Species composition

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

However, in the absence of reliable spatial data at a higher resolution than is currently available to national institutes, no further work has been carried out and no species level landings estimates are presented in 2013.

### 3.4.2 Length composition

New length–frequency information for leafscale gulper and for Portuguese dogfish is provided for the Portuguese longline fishery operating in ICES Division IXa (Lagarto *et al*., 2013 WD). Misidentification problems were detected at the landing port of Sesimbra for individuals assigned to *Centrophorus lusitanicus* commercial category. Portuguese dogfish and leafscale gulper shark were found to comprise 31.4% and 47,4% respectively of sampled landings declared as *Centrophorus lusitanicus.* These landings were sampled for length–frequency and the results presented in Figures 3.3 and 3.4.

### 3.4.3 Quality of catch and biological data

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

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

## 3.5 Commercial catch–effort data

Following the imposition of a zero TAC for deep-sea sharks in EU fisheries, it is no longer possible to extend existing French logbook and tallybook data lpue series beyond 2009. A method to estimate catch from on onboard observation data collected in application of the DCF and regulation 2347/2002 and VMS is presented.

Onboard observations are carried out under operational constraints. For example an observer may have little choice about the vessel to board owing to small number of vessels in the deep-water fishing fleets. As a consequence, the assumption that observed trip represent a random sample of all deep-sea trips may be questionable. Furthermore, onboard observations are point data and it is of interest to assess geographical variations in sharks catches and catch rates. Nevertheless, the distribution of the deep-sea fishing activity is concentrated along the continental slope, typically forming a narrow contour with some areas of concentrated activity and some areas of scattered and intermittent fishing. As a consequence estimating geographical variations from a standard grid mapping may not be appropriate. To solve this problem, the use of a spatial nested grid was tried following the approach used for VMS point data presented by Gerritsen *et al*. (2013). In the application presented here, the point data used to drawn a nested grid were on-board observations. Regularly gridded VMS data were used as fishing effort data to raise the estimated catch and cpue from onboard observation data to the total fishing activity. VMS data used here consisted of number of vessels records, estimated total time at sea, fishing time, and fishing effort, aggregated per 10'x10' spatial grid cells and by year from 2003 to 2007, for all French vessels holding of deep-water fishing permit.

#### Nested grid

One single nested grid was drawn based on the spatial distribution of the observed deep-sea hauls from years 2004 to 2012 (Figures 3.5 and 3.6). A grid with large cells of fixed size is first drawn, the number of data point per cell is estimated, and cells containing more than a given number of $N$ points, arbitrarily fixed = $N$=15 are split in two smaller cells. The cells are first divided by longitude and if a further split is needed, i.e. if the number of data points (hauls) in a divided cell is still >$N$, cells are then split

by latitude, and so on, cells are divided alternatively by longitude and latitude. The process is repeated up to seven times, starting from a maximum cell size of 1.33 decimal degrees (dd) by 0.67 dd, corresponding to 80'x40', chosen so that after the 5th division, the cell size is 0.16 dd x 0.16 dd, corresponding to a size of 10'x10', i.e. the cell size at which available VMS data was available.

### Cpue and catch estimates

The cpue by haul and species (or group of species) was calculated for all observed hauls. For each haul, the catch (landings + discards) was divided by the product of the vessel engine's power and of the haul duration:

$$Cpue = C/E$$

Where *cpue* is the Catch Per Unit of Effort, in $kg.kW^{-1}.h^{-1}$

*C* is the catch of the species for the haul, in kg

*E* is the fishing effort, calculated as the vessel power in kW multiplied by the haul duration is hours.

Then, the mean cpue per cell was calculated. Because the number of hauls per year and per cell was often low, years were aggregated. The cpue was calculated from all years (2004–2012) combined and for two sets of years (2004–2009 and 2010–2012). Owing to the slow dynamics of deep-sea sharks cpue are not expected to vary strongly in subsequent years expect in case of rapid depletion which might not happen at the current effort level. Further analysis will be required to determine whether other methods of amalgamating data, for example, amalgamating cells together spatially may be more appropriate.

To estimate the total catch from the fleet, cpues per cell was raised to the total fishing effort from VMS. VMS effort was available at the spatial resolution of 10'x10' (see example on Figure 3.7 for 2007) for years 2003 to 2007 where VMS was available to this preliminary study. To combine the two spatially structured data, two cases were treated (i.) when nested grid cells are larger or equal to 10'x10', and (ii.) when the nested grid cells are smaller than 10'x10'. In the first case, the effort inside each cpue nested grid cell was summed up. This is possible owing to the choice of the nested grid cell size: all cells larger than 10'x10' are multiples of 10'x10' cells, allowing the summation of VMS effort to the nested grid cell size. In the second case, the VMS effort in the 10'x10' cells was assumed to be apportioned in smaller nested grid cells in the same ratio as on-board observations. In areas where the nested grid has a high spatial resolution, on-board observations are quite numerous and are expected to provide a good sampling of the distribution of the fishing. Note that overall, the sampling fraction of the deep-water fishery was 14.6% in 2011 (Dubé *et al*., 2012).

### Results

Data are still preliminary, the mapping of data suggest that some data errors still need fixing, for example a few high deep-sea shark cpue appear on the shelf (Figures 3.8 and 3.9), which might come from erroneous locations. So far this approach was applied to *Centrophorus squamosus* and *Centroscymnus coelolepis* combined, i.e."siki sharks". Results by species are not yet fully available, although species were reliably identified at least from 2009.

In Figure 3.9, white cells indicate either cells where 0 cpue hauls were observed or cells with no hauls. In particular in recent years there was no observation in several

large cells (Figure 3.8, centre) as a result of the reduced fishing effort over time and the associated shrinkage of the area fished by the French fleet. Care should be taken not to interpret a greater number of white cells as an overall reduction in cpues. Representing only the small cells provides a view of the core fishing area (Figure 3.10).

The spatial distribution of the total effort by year using the nested grid is presented in Figure 3.10 for years where VMS data was available.

The total catch was calculated by summing up catches per grid cells for 2003–2007. The estimated catch compare fairly well with French landings of siki sharks in the same years (Table 3.7), suggesting that the approach is reliable and that it may be applied to estimate catch in more recent years where there are no more landings data. This was not done for WGEF 2013 meeting as recent VMS data were not available. Results presented here should be considered preliminary and were not fully scrutinised. It should be considered that this analysis suggest there is a potential to derive both cpues and landings estimates from onboard observations and VMS for species that are no longer landed owing to current 0 TACs. There is a potential for a trend-based assessment to be carried out in 2013 from this approach.

## 3.6 Fishery-independent surveys

Marine Scotland Science has conducted deep-water surveys in Subarea VI at depths ranging from 300–2300 m since 1996. The survey can be considered to be standardised in terms of depth coverage since 1998.

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

These and other surveys are part of a planned coordinated survey in the ICES area, through the Planning Group on North East Atlantic Continental Slope Surveys (WGNEACS). WGNEACS 2012 was mainly dedicated to the design of a longline survey in Bay of Biscay and Iberian waters. One of its main objectives would be to clarify the distribution of all the deep-water sharks and to provide data to monitor their stock status, in the absence of fisheries data.

## 3.7 Life-history information

No new information.

## 3.8 Assessments

### 3.8.1 Exploratory assessment

A Generalized Linear Model (GLM) with negative binomial distribution (to account for occasional large catches and frequent zero values) was applied to catches of Portuguese dogfish and leafscale gulper shark in the Scottish deep-water survey from 1998 to 2012. Data was restricted to hauls at depths between 700 and 2030 m for Portuguese dogfish and between 500 and 2030 m for leafscale gulper shark. Year was the only factor included in the model. Number of haul and catch rates in numbers/hour are presented in Table 3.8.

Numbers per hour by haul and model fits are presented in Figures 3.11 and 3.12. No significant trend was observed for Portuguese dogfish (p=0.25). For leafscale gulper shark there was a significant decline in abundance (p<0.001) across the period.

In 2012, generalized additive models with a Tweedie distribution were fitted to both abundance and biomass of sharks in the coordinated Scottish and Irish deep-water surveys (see stock annex for details of the method used). The factors considered were Latitude, Longitude, Depth, Duration of the fishing operation and Year. Year, Latitude and Longitude and Depth were significant variables in the models for both species. Year effect on abundance for both species is shown in Figures 3.13 and 3.14. Results for Portuguese dogfish are consistent with the GLM with no trend observed in abundance between 2000 and 2011. For leafscale gulper shark, no trend was observed between 2000 and 2009, however the lowest value was observed in 2011.

## 3.9 Reference points

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

## 3.10 Management considerations

No management advice is given in 2013.

## 3.11 References

Dubé, B., Dimeet, J., Rochet, M.-J., Tétard, A., Gaudou, O., Messannot, C., Fauconnet, L., Morizur, Y., Biseau, A., Salaun, M. 2012. Observations à bord des navires de pêche professionnelle. Bilan de l'échantillonnage 2011. http://archimer.ifremer.fr/doc/00109/21976/, 298 pp.

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

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

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

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

Gerritsen, H. D., Minto, C., Lordan, C. 2013. How much of the seabed is impacted by mobile fishing gear? Absolute estimates from Vessel Monitoring System (VMS) point data. ICES Journal of Marine Science. doi:10.1093/icesjms/fst017.

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

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

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

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

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

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

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

Moura, T.,Figueiredo, I., Neves, A., Farias, I., Pereira, B. S. and Gordo, L. 2006. WD. Reproductive data on Portuguese dogfish *Centroscymnus coelolepis*, Leafscale gulper shark *Centrophorus squamosus* and gulper shark *Centrophorus granulosus* commercially exploited in the Portuguese continental slope. Working Document.

Prista, N. and Fernandes, A.C. 2013. On-board observations on elasmobranchs caught by a Portuguese deep-water set longline shery (2005–2011). Working Document ICES WGEF. 8p.

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

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

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

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

**Table 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) by ICES area.**

| | IV a | Va | Vb | VI | VII | VIII | IX | X | XII | XIV | Unknown Area | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 560 | 0 | 0 | 0 | 0 | 560 |
| 1989 | 12 | 0 | 0 | 8 | 0 | 0 | 507 | 0 | 0 | 0 | 0 | 527 |
| 1990 | 8 | 0 | 140 | 6 | 0 | 6 | 475 | 0 | 0 | 0 | 0 | 635 |
| 1991 | 10 | 0 | 75 | 1013 | 265 | 70 | 1075 | 0 | 1 | 0 | 0 | 2509 |
| 1992 | 140 | 1 | 123 | 2013 | 1171 | 62 | 1114 | 0 | 2 | 0 | 0 | 4626 |
| 1993 | 63 | 1 | 97 | 2781 | 1232 | 25 | 946 | 0 | 7 | 0 | 0 | 5152 |
| 1994 | 98 | 0 | 198 | 2872 | 2087 | 36 | 1155 | 0 | 9 | 0 | 0 | 6455 |
| 1995 | 78 | 0 | 272 | 2824 | 1800 | 45 | 1354 | 0 | 139 | 0 | 0 | 6512 |
| 1996 | 298 | 0 | 391 | 3639 | 1168 | 336 | 1189 | 0 | 147 | 0 | 0 | 7168 |
| 1997 | 227 | 0 | 328 | 4135 | 1637 | 503 | 1311 | 0 | 32 | 9 | 0 | 8182 |
| 1998 | 81 | 5 | 552 | 4133 | 1038 | 605 | 1220 | 0 | 56 | 15 | 0 | 7705 |
| 1999 | 55 | 0 | 469 | 3471 | 895 | 531 | 972 | 0 | 91 | 0 | 0 | 6484 |
| 2000 | 1 | 1 | 410 | 3455 | 892 | 361 | 1049 | 0 | 890 | 0 | 0 | 7059 |
| 2001 | 3 | 0 | 475 | 4459 | 2685 | 634 | 1130 | 0 | 719 | 0 | 0 | 10105 |
| 2002 | 10 | 0 | 215 | 3086 | 1487 | 669 | 1198 | 0 | 1416 | 12 | 0 | 8093 |
| 2003 | 16 | 0 | 300 | 3855 | 3926 | 746 | 1180 | 0 | 849 | 4 | 0 | 10876 |
| 2004 | 5 | 0 | 229 | 2754 | 3477 | 674 | 1125 | 0 | 767 | 0 | 0 | 9031 |
| 2005 | 4 | 0 | 239 | 1102 | 842 | 376 | 1033 | 1 | 134 | 0 | 1323 | 5054 |
| 2006 | 4 | 0 | 195 | 638 | 323 | 208 | 1325 | 0 | 0 | 0 | 34 | 2727 |
| 2007 | 3 | 0 | 590 | 737 | 94 | 23 | 517 | 0 | 1 | 61 | 0 | 2025 |
| 2008 | 1 | 0 | 171 | 621 | 111 | 27 | 463 | 0 | 0 | 0 | 0 | 1393 |
| 2009 | 1 | 0 | 24 | 54 | 4 | 105 | 33 | 0 | 0 | 0 | 0 | 220 |
| 2010 | 1 | 0 | 46 | 43 | 4 | 5 | 5 | 0 | 0 | 0 | 0 | 104 |
| 2011 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |

**Table 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) in the Northeast Atlantic by country.**

| | France | UK (Scot) | UK (E&W) | Ireland | Iceland | Spain (Basque) | Portugal | Germany | Estonia | Latvia | Lithuania | Poland | Russia | Spain (Galicia) | Faeroe Island | Norway | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 560 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 560 |
| 1989 | 0 | 20 | 0 | 0 | 0 | 0 | 507 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 527 |
| 1990 | 140 | 14 | 0 | 0 | 0 | 0 | 481 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 635 |
| 1991 | 1288 | 24 | 104 | 0 | 0 | 0 | 1093 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2509 |
| 1992 | 3104 | 165 | 80 | 0 | 1 | 0 | 1128 | 148 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4626 |
| 1993 | 3468 | 469 | 174 | 0 | 1 | 0 | 946 | 91 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 5152 |
| 1994 | 3812 | 743 | 387 | 0 | 0 | 0 | 1155 | 358 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6455 |
| 1995 | 3186 | 801 | 986 | 33 | 0 | 0 | 1354 | 92 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 6512 |
| 1996 | 3630 | 576 | 1036 | 5 | 0 | 286 | 1189 | 164 | 0 | 0 | 0 | 0 | 0 | 0 | 282 | 0 | 7168 |
| 1997 | 3095 | 766 | 2202 | 0 | 0 | 473 | 1314 | 106 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 0 | 8182 |
| 1998 | 3177 | 1007 | 1494 | 3 | 5 | 561 | 1260 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 158 | 0 | 7705 |
| 1999 | 3079 | 625 | 1019 | 2 | 0 | 450 | 1036 | 214 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 5 | 6484 |
| 2000 | 3519 | 623 | 413 | 138 | 0 | 280 | 1108 | 265 | 0 | 0 | 0 | 0 | 0 | 572 | 23 | 118 | 7059 |
| 2001 | 3684 | 2429 | 320 | 454 | 0 | 608 | 1151 | 431 | 0 | 0 | 14 | 0 | 0 | 615 | 0 | 399 | 10105 |
| 2002 | 2103 | 1184 | 335 | 577 | 0 | 621 | 1198 | 518 | 53 | 0 | 40 | 8 | 0 | 1381 | 0 | 75 | 8093 |
| 2003 | 1454 | 1594 | 4027 | 493 | 0 | 719 | 1180 | 640 | 4 | 0 | 28 | 0 | 0 | 737 | 0 | 0 | 10876 |
| 2004 | 1189 | 1135 | 3610 | 764 | 0 | 563 | 1125 | 0 | 0 | 0 | 0 | 0 | 0 | 626 | 0 | 19 | 9031 |
| 2005 | 866 | 802 | 1533 | 381 | 0 | 359 | 1033 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5053 |
| 2006 | 744 | 184 | 537 | 113 | 0 | 78 | 1072 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2727 |
| 2007 | 855 | 86 | 23 | 36 | 0 | 0 | 522 | 0 | 0 | 0 | 1 | 0 | 500 | 0 | 0 | 0 | 2023 |
| 2008 | 802 | 49 | 7 | 8 | 0 | 0 | 463 | 0 | 0 | 0 | 62 | 0 | 0 | 0 | 3 | 0 | 1393 |
| 2009 | 52 | 30 | 0 | 0 | 0 | 84 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 220 |
| 2010 | 73 | 21 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 104 |
| 2011 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

**Table 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Frequency of occurrence (%) of Portuguese dogfish and leafscale gulper sharks in the discards of the sets sampled in the Portuguese longline fishery for black scabbardfish(2005-2012).**

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

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

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

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

| YEAR | CELTIC SEA (SUBAREAS (VI–VII)) | | | IBERIAN WATERS (DIVISIONS (VIIIC–IXA)) | | |
|---|---|---|---|---|---|---|
| | Sampled trips | Total trips | Raised discards (tonnes) | Sampled trips | Total trips | Raised discards (tonnes) |
| 2003 | 9 | 1172 | 0 | 51 | 18 036 | 0 |
| 2004 | 11 | 1222 | 0 | 53 | 20 819 | 0 |
| 2005 | 10 | 1194 | 0 | 97 | 11 693 | 4.5 |
| 2006 | 13 | 1152 | 3.2 | 75 | 18 352 | 4.1 |
| 2007 | 12 | 1233 | 0 | 95 | 17 750 | 0 |
| 2008 | 11 | 1206 | 67.3 | 103 | 15 114 | 0 |
| 2009 | 15 | 1304 | 61.1 | 116 | 14 486 | 85.9 |
| 2010 | | | 0 | | | 29.2 |
| 2011 | | | 0 | | | 0.9 |
| 2012 | | | 173.4 | | | 0.7 |

**Table 3.6. Summary of French onboard observation data for the deep-sea licensed fishing fleet. Number of fishing vessels, trips, haul and days-at-sea observed per year. Accumulated total landings, total discards, proportion landed, proportion discarded, and landings and discards of deep-water species during observed trips.**

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|
| Number of vessels observed | 22 | 13 | 6 | 1 | 10 | 15 | 17 | 11 | 10 |
| Number of fishing trip | 29 | 15 | 9 | 1 | 11 | 32 | 36 | 27 | 24 |
| Number of hauls | 280 | 152 | 118 | 11 | 222 | 586 | 561 | 414 | 352 |
| Number of days at sea | 333 | 172 | 119 | 14 | 141 | 343 | 455 | 321 | 269 |
| Total observed catch (t) | 660 | 341 | 189 | 4 | 378 | 1438 | 1300 | 1162 | 939 |
| Total landings (t) | 401 | 213 | 108 | 4 | 318 | 1120 | 1180 | 990 | 808 |
| Total discards (t) | 258 | 129 | 81 | 1 | 61 | 318 | 119 | 171 | 130 |
| Proportion landed | 0.61 | 0.63 | 0.52 | | 0.84 | 0.77 | 0.90 | 0.85 | 0.86 |
| Proportion discarded | 0.39 | 0.37 | 0.48 | | 0.16 | 0.23 | 0.10 | 0.15 | 0.14 |
| Catch of deep-water species (t) | 378 | 298 | 161 | 1 | 298 | 1213 | 1057 | 983 | 776 |
| Landings of deep-water species (t) | 201 | 180 | 88 | >1 | 254 | 926 | 968 | 827 | 667 |
| Discards of deep-water species (t) | 178 | 117 | 72 | >1 | 45 | 287 | 89 | 156 | 108 |

**Table 3.7. Catch of siki sharks per year estimated from Onboard observation cpue (average 2004–2012) multiplied by VMS effort in 2003–2007 compared to logbook landings (all French landings) in the same years.**

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

**Table 3.8. Data included in the GLM analysis of Scottish deep-water survey data: numbers of hauls within the specified depth range, numbers of individuals caught and numbers caught per hour.**

| | *C. coelolepis* | | | *C. squamosus* | | |
|---|---|---|---|---|---|---|
| Year | N hauls | N fish | Mean NpH | N hauls | N fish | Mean Nph |
| 1998 | | | | 18 | 57 | 1.54 |
| 2000 | 22 | 103 | 2.34 | 28 | 70 | 1.25 |
| 2002 | 19 | 63 | 1.78 | 27 | 66 | 1.45 |
| 2004 | 15 | 27 | 0.90 | 22 | 18 | 0.41 |
| 2005 | 14 | 39 | 1.39 | 19 | 46 | 1.21 |
| 2006 | 22 | 35 | 0.84 | 33 | 37 | 0.64 |
| 2007 | 15 | 35 | 1.16 | 22 | 19 | 0.65 |
| 2008 | 22 | 40 | 1.09 | 31 | 14 | 0.39 |
| 2009 | 30 | 31 | 0.99 | 38 | 20 | 0.79 |
| 2011 | 22 | 33 | 1.35 | 28 | 1 | 0.04 |
| 2012 | 27 | 33 | 1.52 | 34 | 14 | 0.47 |

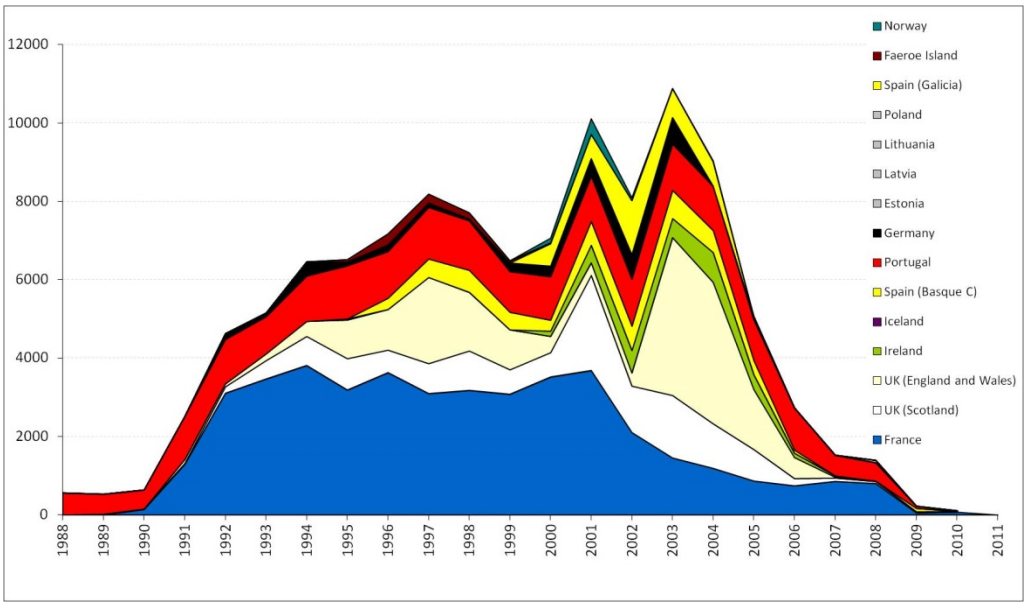



**Figure 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by country.**

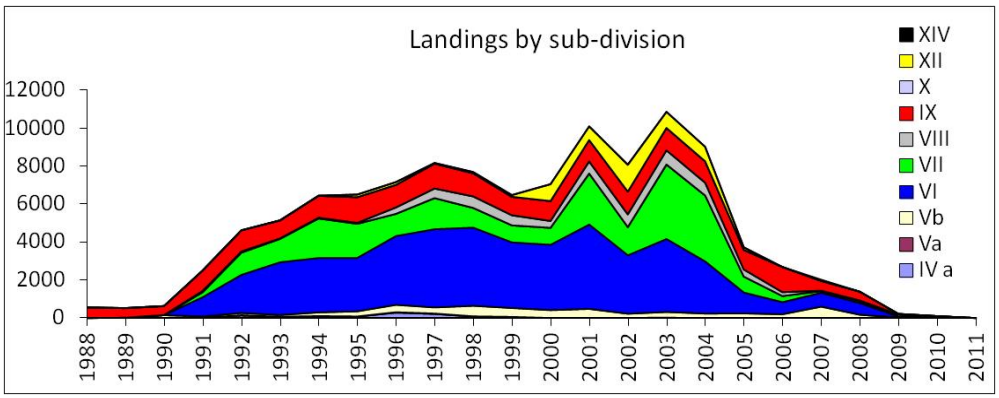



**Figure 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Working Group estimates of combined landings of the two species, by ICES Subarea.**

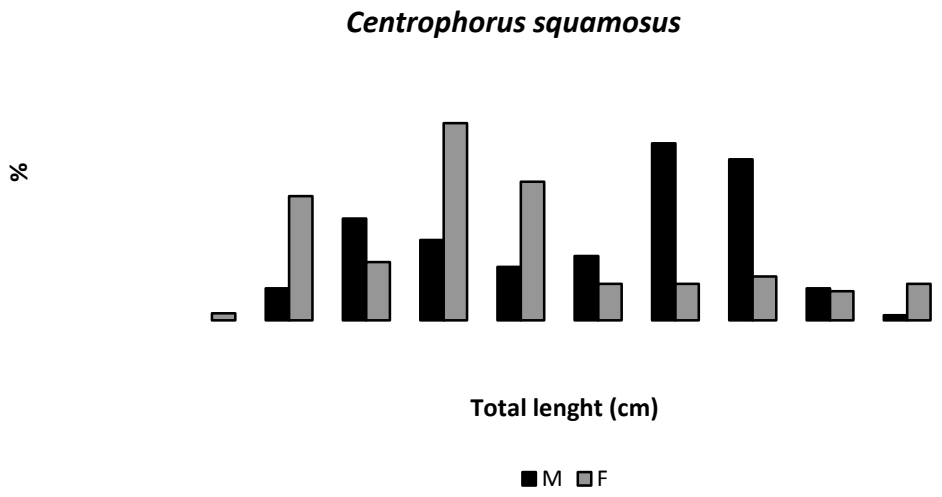



**Figure 3.3.** ***Centrophorus squamosus*****. Length–frequency distribution at Sesimbra landing port in 2012 (n=229).**

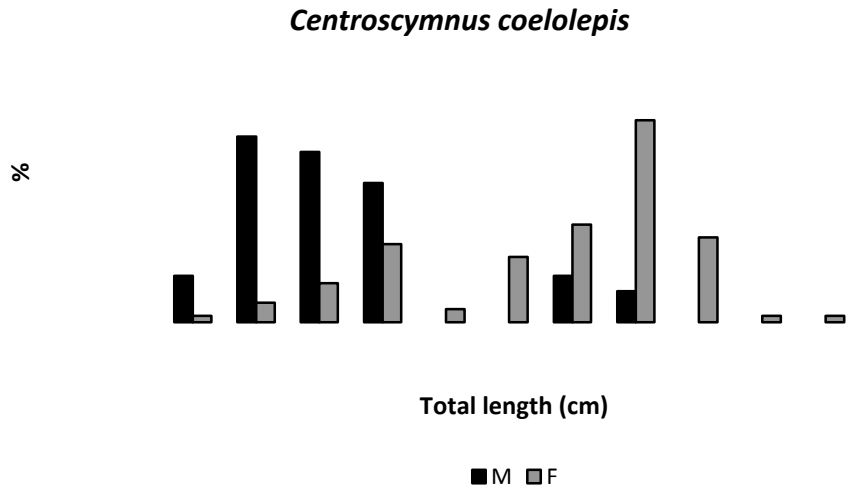



**Figure 3.4.** ***Centroscymnus coelolepis*****. Length–frequency distribution at Sesimbra landing port in 2012 (n=135).**

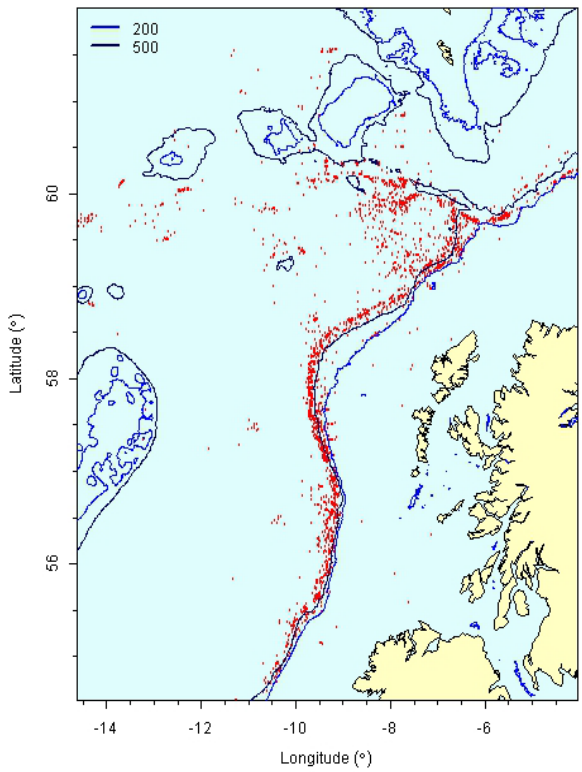



**Figure 3.5. Spatial distribution of the onboard observations of hauls from licensed deep-sea fishing French trawlers, from years 2004–2012.**

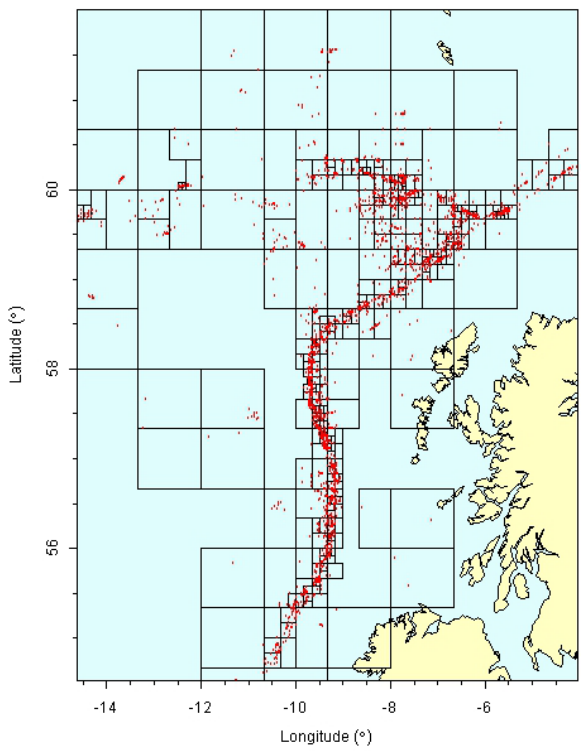



**Figure 3. Nested grid built based on French on-board observations from years 2004 to 2012.**

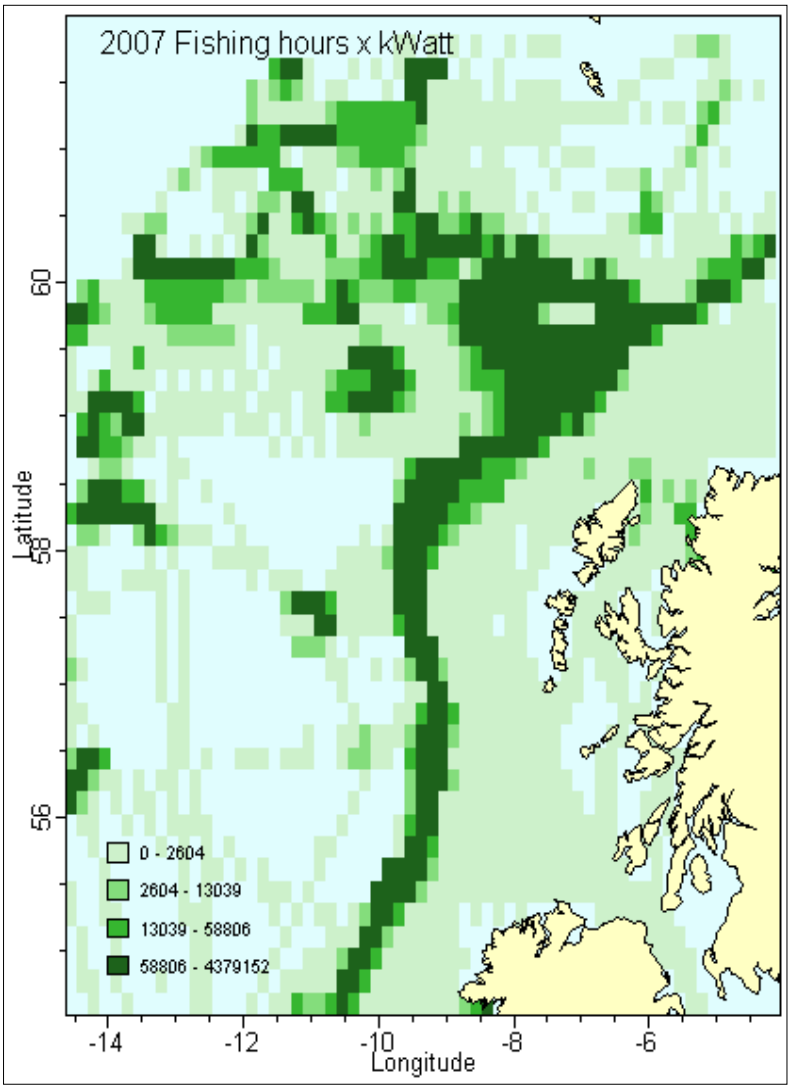



**Figure 1.7. Fishing effort (kW.h) from the VMS data set spatially distributed into a 10'x10' cell size grid, for the year 2007.**

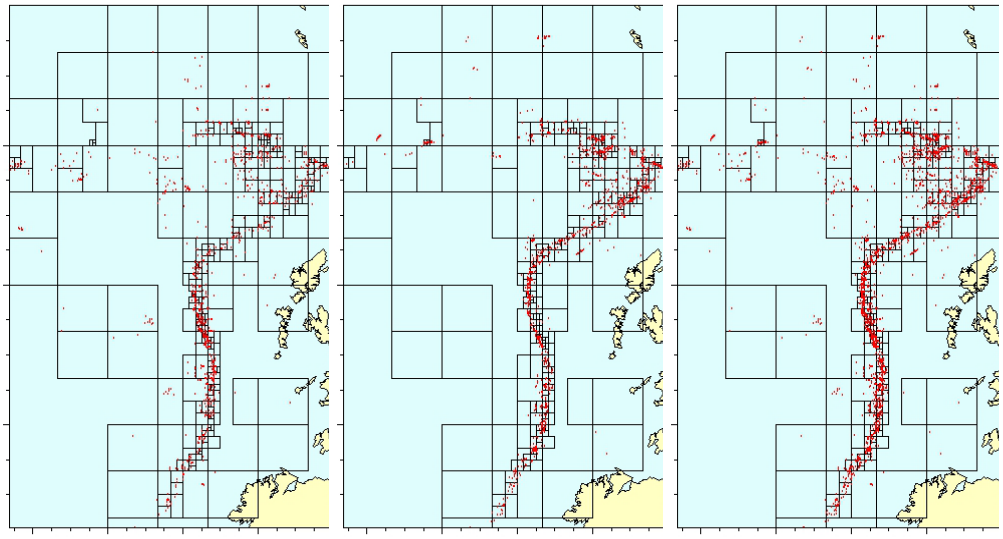


**Figure 3.8. Geographical distributions of on-board observations in the nested grid, left years 2004–2009 combined, middle years 2010–2012, right all years (2004–2012).**

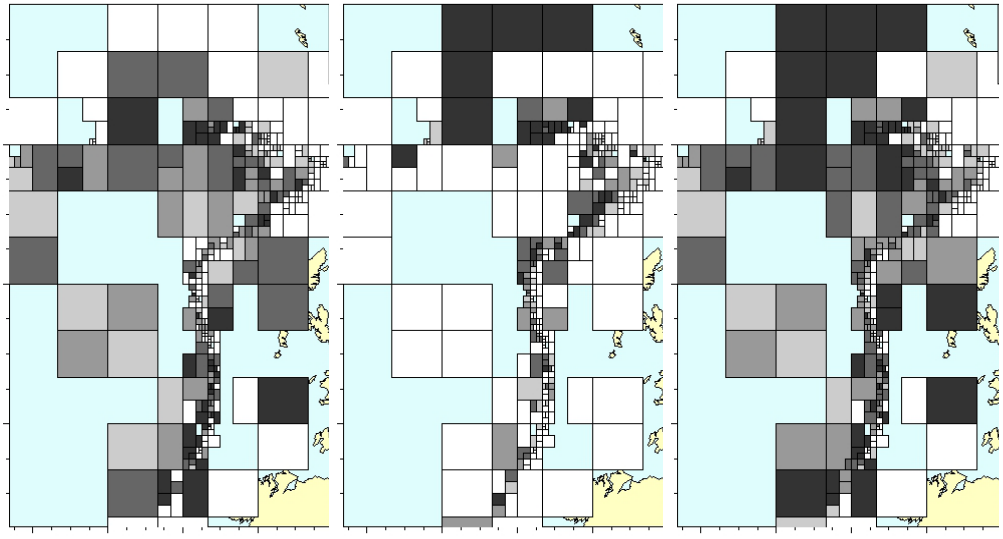


**Figure 3.9. Spatial distribution of siki sharks cpue spatial, in nested grids cells, left years 2004–2009 combined, middle years 2010–2012, right all years (2004–2012).**

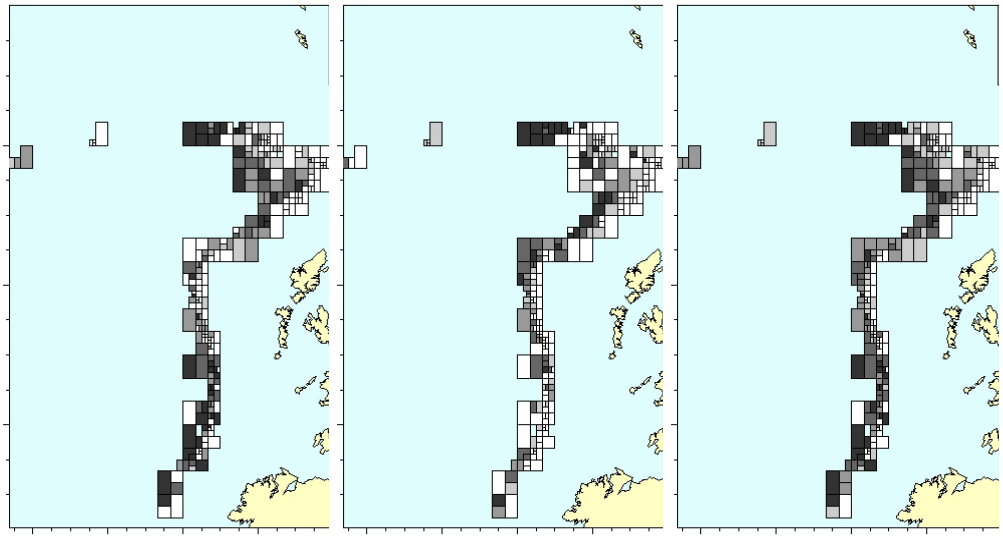


**Figure 3.10. Spatial distribution of siki sharks cpue spatial, in nested grids cells, left years 2004–2009 combined, middle years 2010–2012, right all years (2004–2012).**

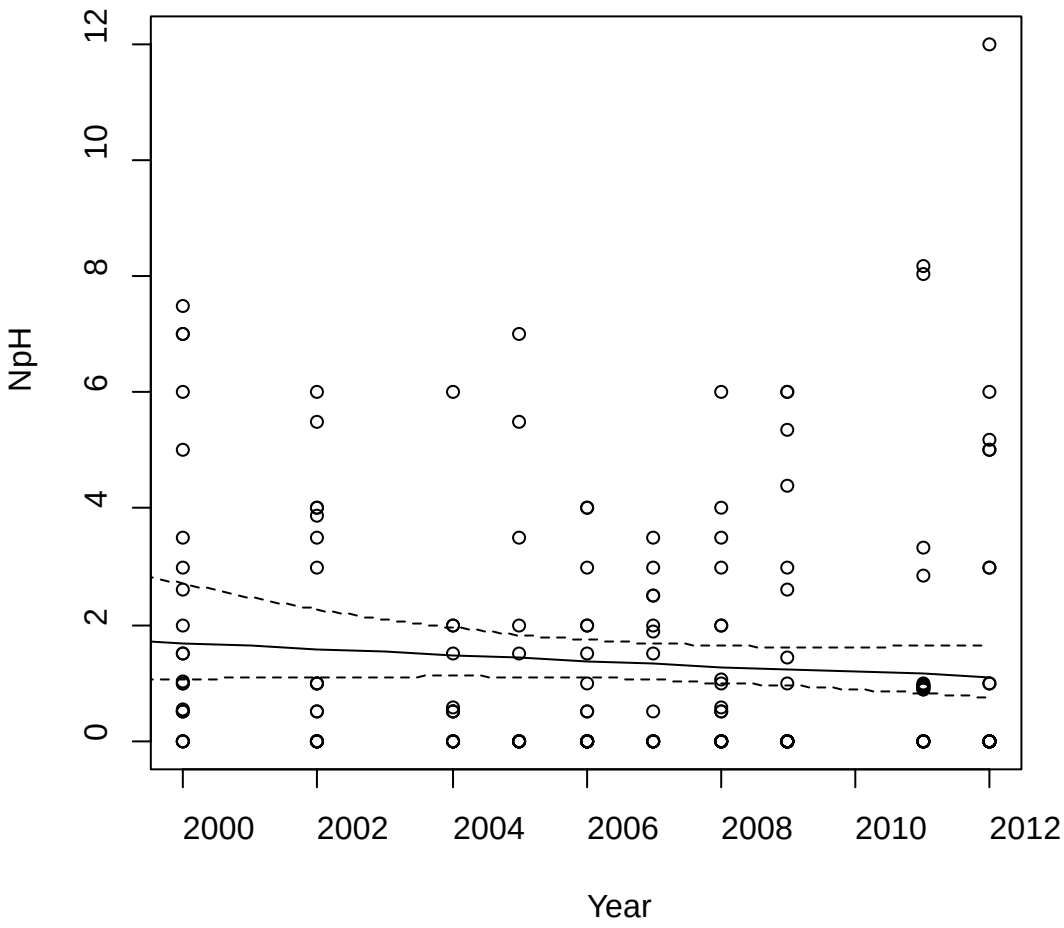



**Figure 3.11. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Relative abundance of *C. coelolepis* (Number per Hour trawling) from Scottish deep-water survey (depth range 700–2030 m). Negative binomial GLM. No significant trend (P = 0.25). Line of best fit shown with dashed line = 95% confidence limits.**

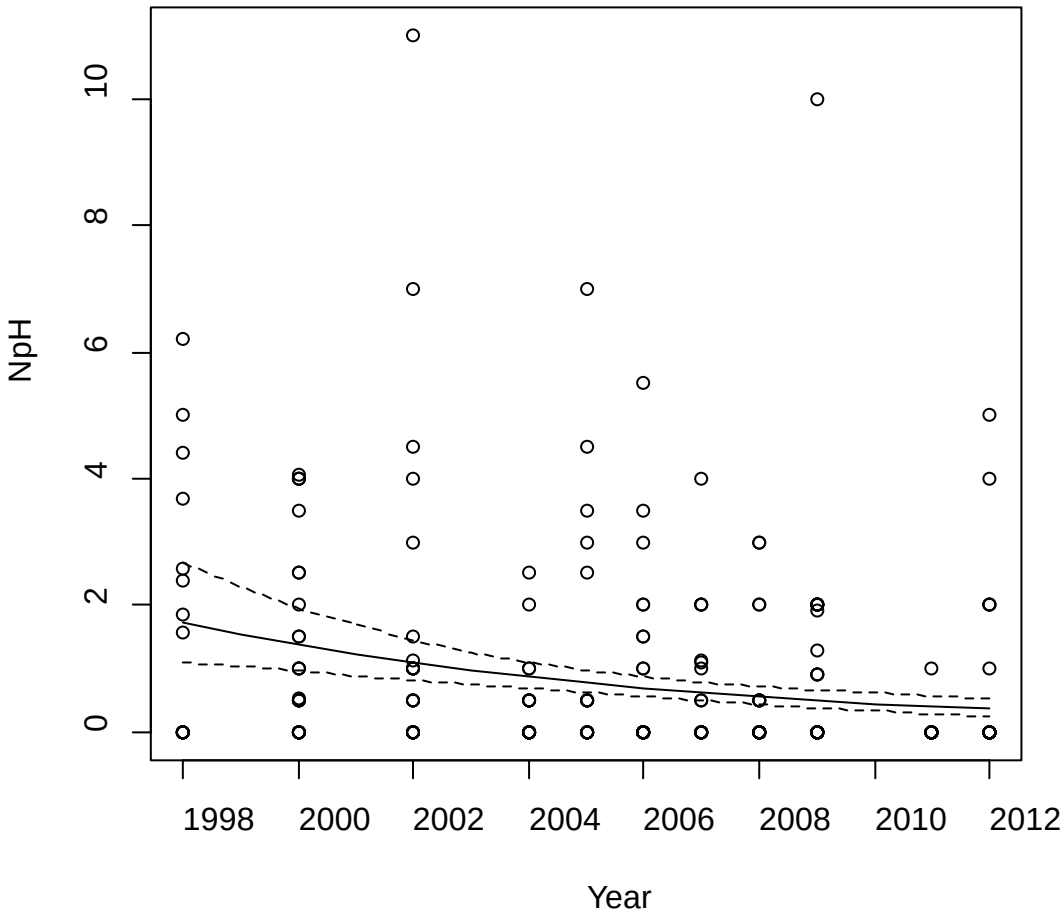



**Figure 3.12. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Relative abundance of *C. squamosus* (Number per Hour trawling) from Scottish deep-water survey (depth range 500–2030 m). Negative binomial GLM. Significant decline over years (P < 0.001). Line of best fit shown with dashed line = 95% confidence limits.**

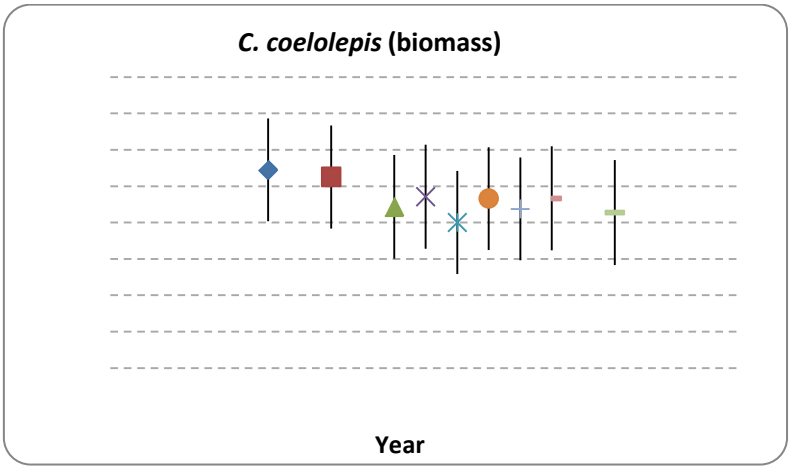



**Figure 3.13. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Results of the generalized additive model applied to the Portuguese dogfish data. Year effect on the biomass (weight per hour).**

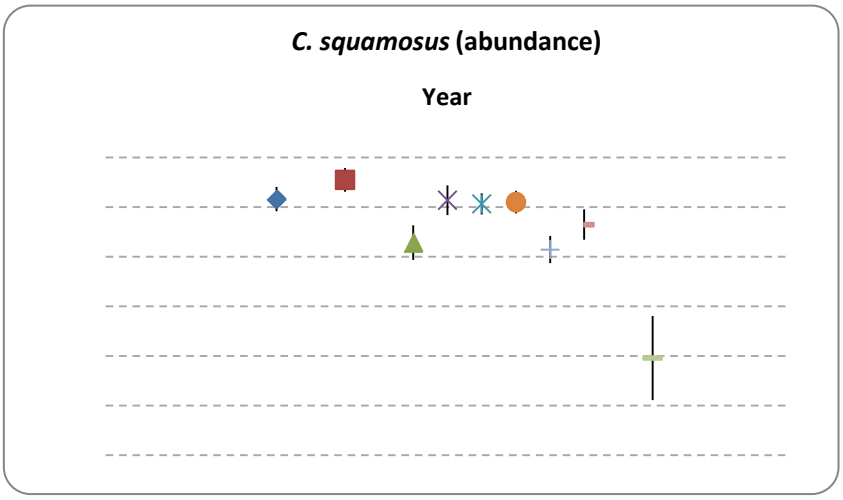



**Figure 3.14. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV). Results of the generalized additive model applied to the leaf-scale gulper shark data. Year effect on abundance (number per hour).**

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

## 4.1 Stock distribution

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

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

For assessment purposes the Azorean stock is considered as a management unit (ICES Subarea X).

## 4.2 The fishery

### 4.2.1 History of the fishery

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

### 4.2.2 The historic fishery

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

### 4.2.3 The fishery in 2011 and 2012

Kitefin from the Azores is now a bycatch from different demersal/deep-water mixed hook and line fisheries, with landings in the period 2004–2009 usually 10 t or less, less than 2t during 2010 and 2011 and zero at 2012 (WD Pinho, 2013a). Catches of kitefin in other areas continues to remain at low levels (Table 4.1).

### 4.2.4 ICES advice applicable

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

This is similar to the advice since 2006 where ICES has 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 identi-

fied and a management strategy, including appropriate monitoring requirements has been decided upon and is implemented".

#### 4.2.5 Management applicable

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

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

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

For 2009 the Regional Government introduced new technical measures for the demersal/deep-water fisheries (Portaria n.º 43/2009 de 27 de Maio de 2009) including area restrictions by vessel size and gear, and gear restrictions (hook size and maximum number of hooks on the longline gear). During 2010 a seamount (condor seamount) was closed to demersal/deep-water fisheries under a multidisciplinary project to study its dynamic (http://www.condor-project.org/).

### 4.3 Catch data

#### 4.3.1 Landings

The landings reported from each country, for the period 1988–2012 are given in Table 4.1 and total historical landings 1972–2012 in Figure 4.1.

#### 4.3.2 Discards

No new data was presented this year. Discards rates between 15% and 85% of the kitefin caught by set were reported from the sampled Azorean longliners during 2004–2010 (ICES, 2012). During 2011 and 2012 the discards may have increased due to management restrictions, or landed as not identified elasmobranchs.

Scattered and lower level of kitefin discards were reported from the Spanish trawl fleets operating on the Iberian waters (Division VIIIc, IXa) for the period 2010–2012.

#### 4.3.3 Quality of catch data

Deep-water sharks taken in the Azores are usually gutted, finned, beheaded and also skinned. Only the trunks and, in some cases, the livers are used. Species misidentification is a problem with deep-water sharks. The Azorean landings data reported to ICES come exclusively from the commercial first sale of fresh fish on the auctions. Therefore, data in Table 4.1 may be an underestimate of total landings.

### 4.4 Commercial catch composition

No new information.

## 4.5 Commercial catch-effort data

No new information.

## 4.6 Fishery-independent surveys

Existing surveys rarely catch kitefin shark (because the surveys are not designed for the species, and will not provide relevant information for the assessment. Relative abundance of kitefin (Number per hour trawling) from Scottish deep-water trawl survey (depth range 500–1000 m) was submitted to the group and are presented in Table 4.2. Low numbers (less than ten individuals per year) are caught in this survey. Relative abundance of kitefin (number or weight per hour trawling) from the Spanish ground fish survey on the Porcupine bank were presented also to the group (WD Zapico *et al*., 2013) and are presented in Figures 4.2 and 4.3. A total of 177 individuals were caught during these twelve survey years.

From the Azorean longline survey only 55 individuals were caught during the period 1995–2012 (WD Pinho, 2013b). Mean relative abundance per year by stratum from the Azores survey is resumed in Figure 4.4. Length compositions for those areas are presented in Figures 4.5, 4.6 and 4.7.

## 4.7 Life-history information

There is no new information available.

Individuals less than 98 cm are scarce in the region suggesting that spawning and juveniles probably occurs in deep-water or non-exploited areas. Male kitefin shark are more available to the fishery at 100 cm (age 5) and females at 120 cm (age 6).

## 4.8 Exploratory assessment models

### 4.8.1 Previous assessments of stock status

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

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

### 4.8.2 Stock assessment

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

## 4.9 Quality of assessments

No new assessments were undertaken.

## 4.10 Reference points

No reference points have been proposed for this stock.

## 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. Fisheries for kitefin shark have been affected by fluctuations in the price of shark liver oil. An analysis of liver oil prices may provide some information on historical exploitation levels of this species.

There are no fishery-independent surveys to monitor the stock. The working group considers that the development of a fishery should not be permitted unless data on the level of sustainable catches will be available. If an artisanal, sentinel fishery will be established it should be accompanied by a data collection programme.

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

## 4.12 References

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

ICES. 1998. Report on the Study Group on the Biology and Assessment of Deep Sea Fisheries Resources. ICES CM 1998/ACFM:12.

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

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

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

Pinho, M. R. 2005. Elasmobranchs of the Azores. ICES Working Document. WGEF 2005.

Pinho, M. R. 2013a. Update of the Azorean elasmobranchs fishery data (ICES Area X). ICES Working Document WGEF 2013.

Pinho, M. R. 2013b. Updating elasmobranchs survey data from the Azores (ICES X).ICES Working Document WGEF 2013.

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

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

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

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

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

**Table 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin (Number per hour trawling) from Scottish deep-water survey (depth range 500–1000 m), ICES Area VI.**

| Year | N° hauls | N° fish | Mean Nph |
|---|---|---|---|
| 1998 | 17 | 2 | 0.05 |
| 2000 | 13 | 0 | 0.00 |
| 2002 | 16 | 4 | 0.13 |
| 2004 | 14 | 2 | 0.07 |
| 2005 | 13 | 4 | 0.15 |
| 2006 | 20 | 8 | 0.20 |
| 2007 | 15 | 7 | 0.23 |
| 2008 | 20 | 5 | 0.13 |
| 2009 | 27 | 1 | 0.06 |
| 2011 | 15 | 1 | 0.07 |
| 2012 | 18 | 0 | 0.00 |

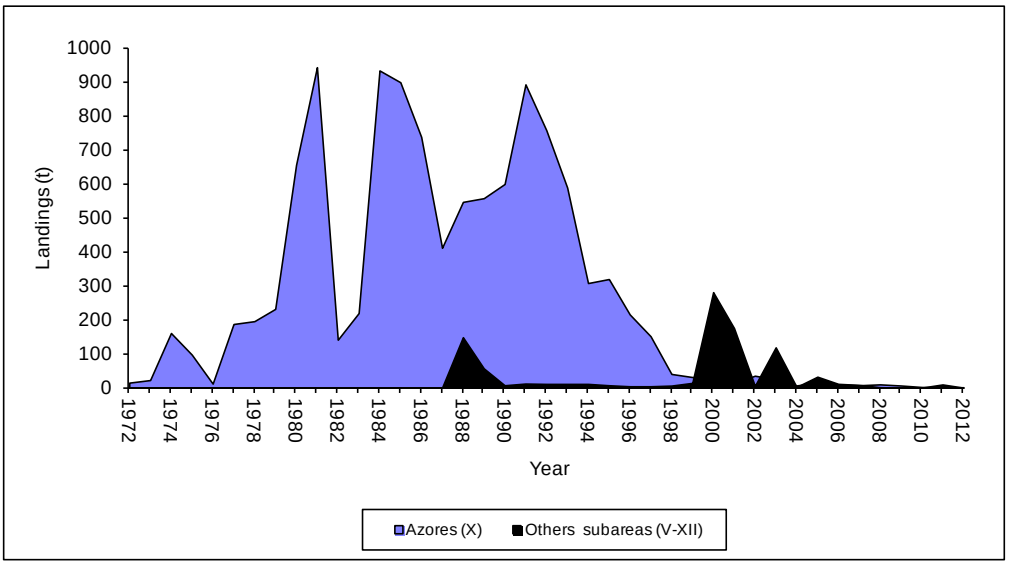



**Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin by ICES division.**

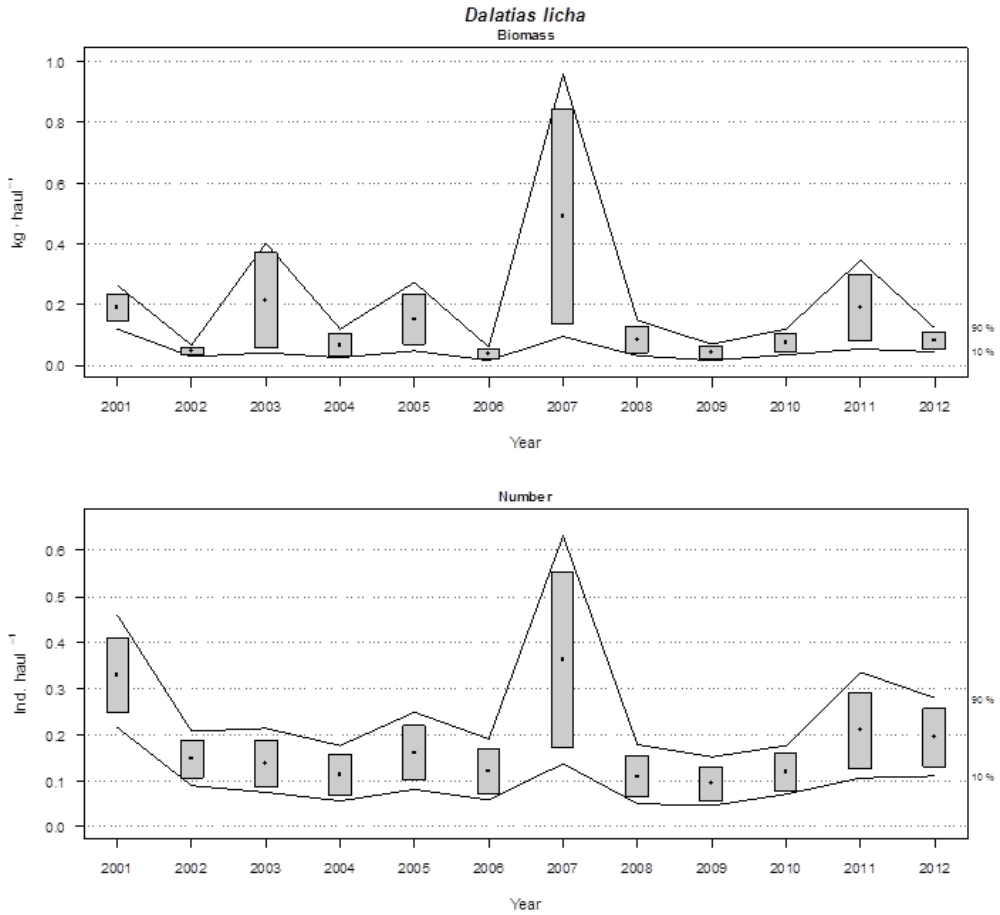



**Figure 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin, in number and weight (Kg) per hour trawling, from the Spanish groundfish survey on the Porcupine bank.**

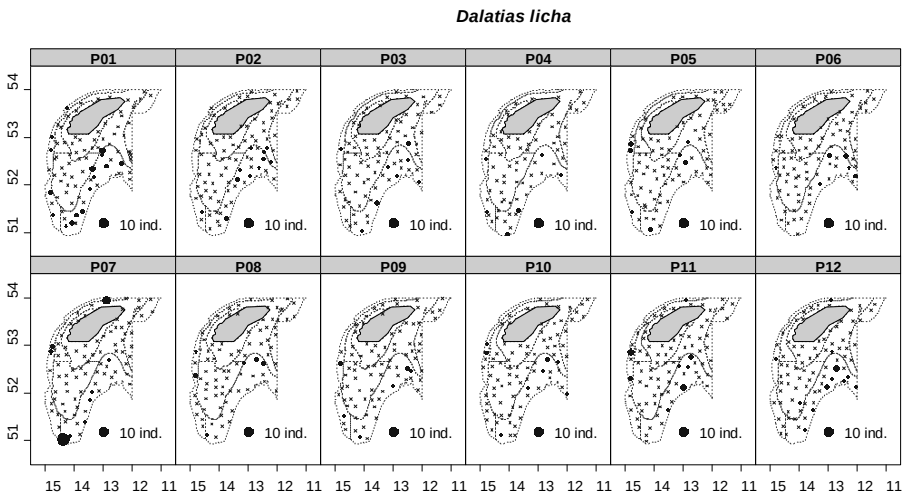



**Figure 4.3. Kitefin shark in the Northeast Atlantic. Annual (2001–2012) spatial distribution of kitefin on the Porcupine bank survey.**

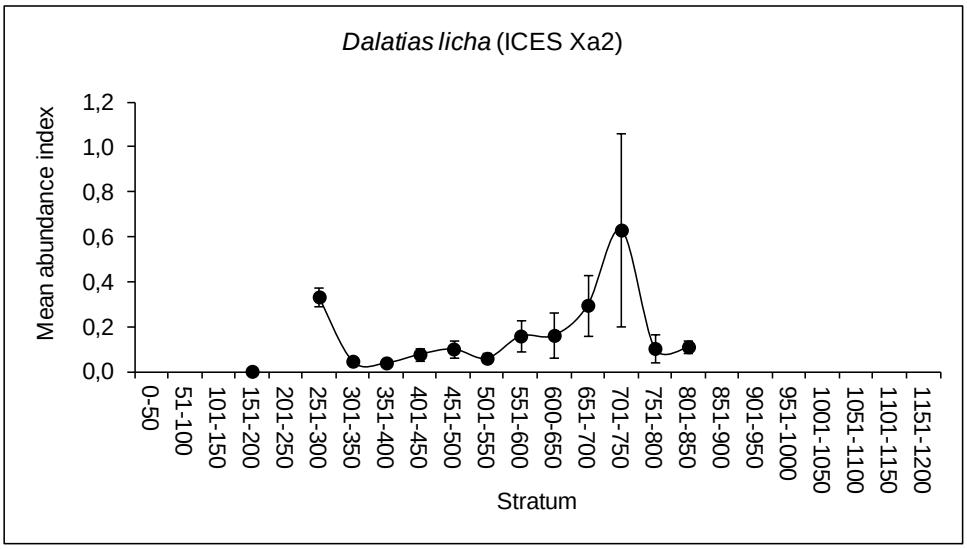



**Figure 4.4. Kitefin shark in the Northeast Atlantic. Mean annual relative abundance of kitefin shark by stratum, for the period 1995–2012, from the Azorean demersal spring bottom longline survey. Bars are the 95% confidence interval.**

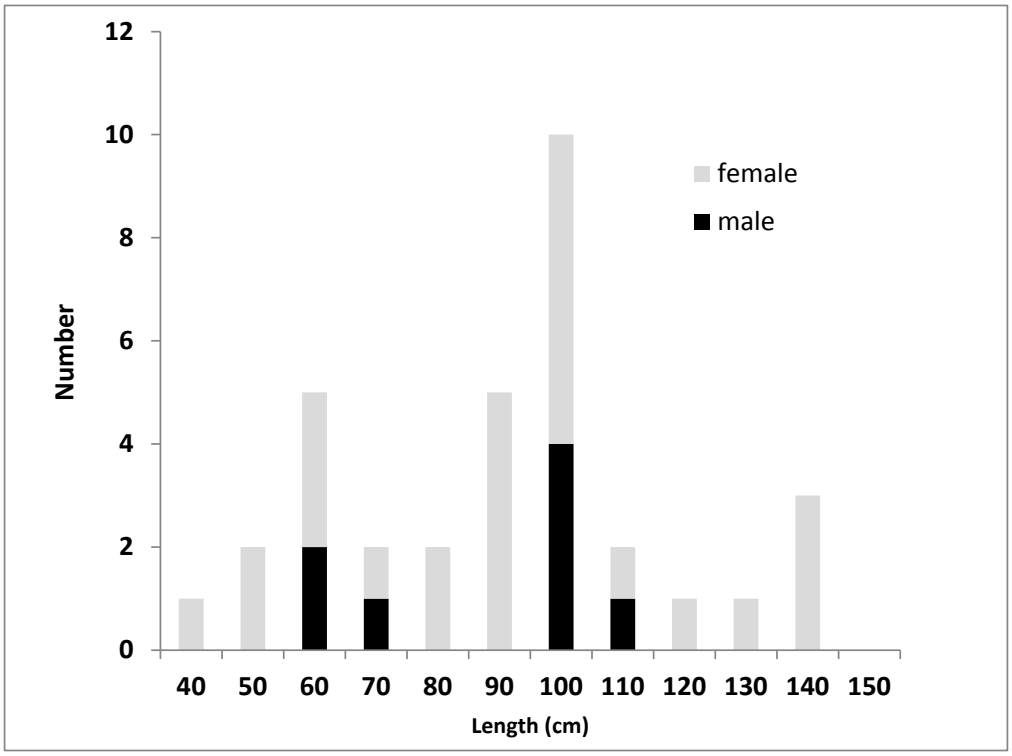



**Figure 4.5. Kitefin shark in the Northeast Atlantic. Length composition of kitefin from Scottish deep-water survey (depth range 500–1000 m), ICES Area VI.**

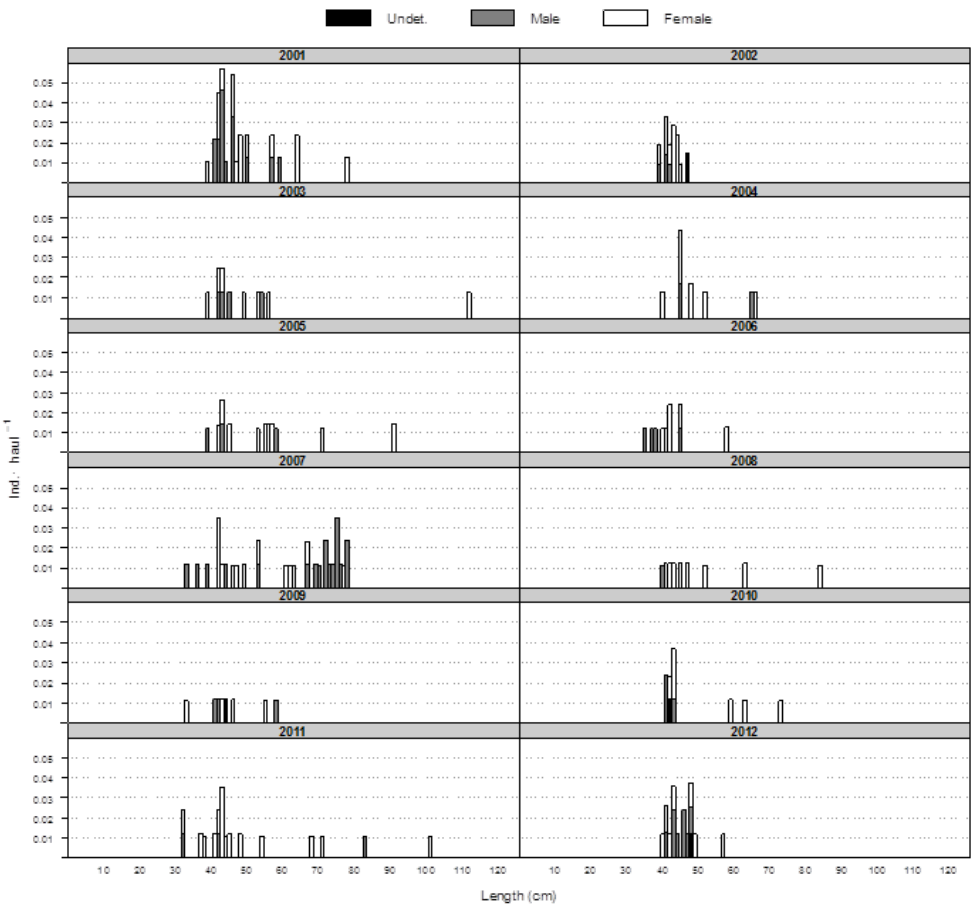



**Figure 4.6. Kitefin shark in the Northeast Atlantic. Annual length composition of kitefin from the Spanish groundfish survey on the Porcupine Bank.**

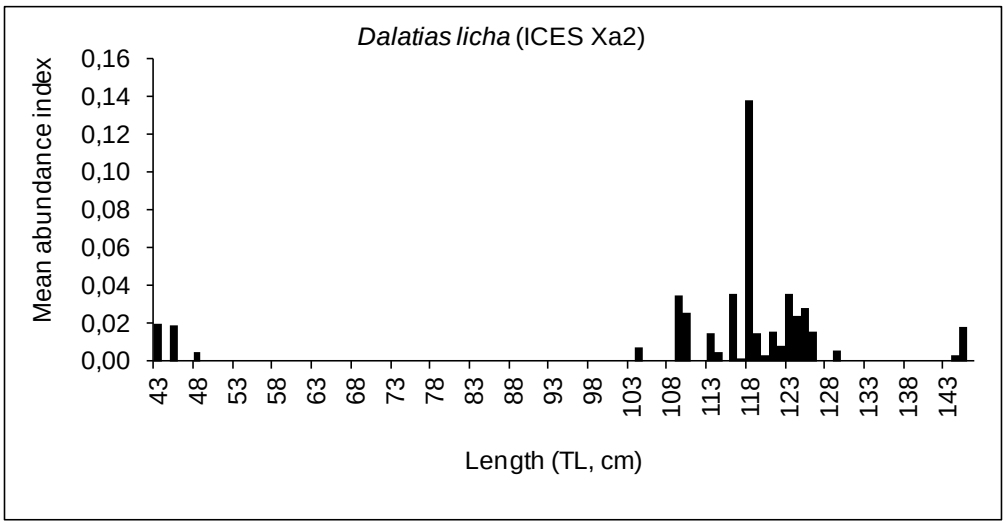



**Figure 4.7. Kitefin shark in the Northeast Atlantic. Mean length composition of kitefin from the Azorean bottom longline fishery for the period 1995–2012.**

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

## 5.1 Stock distributions

This section includes information about deep-water elasmobranch species other than Portuguese dogfish and leafscale gulper shark (see Section 3) and kitefin shark (see Section 4). Limited information exists on the majority of the species presented here other than annual landings data for some species, which are were very low in 2012 due to zero TAC for most species. In addition, it is likely that the available landings data for some species may be unreliable due to problems with species identification. For example gulper shark may be sometimes confounded due to morphological similarity with other similar species such as *C. niaukang*, *C. lusitanicus* and *C. harrissoni* (Compagno *et al.,* 2005).

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

14 species of skate (Rajidae) are known from deep water in this area: Arctic skate (*Amblyraja hyperborea*), Jensen's skate (*Amblyraja jenseni*), Krefft's skate (*Malacoraja kreffti*), roughskin skate (*Malacoraja spinacidermis*), deep-water skate (*Rajella bathyphila*), pallid skate (*Bathyraja pallida*), Richardson's skate (*Bathyraja richardsoni*), Bigelow's skate (*Rajella bigelowi*), round skate (*Rajella fyllae*), Mid-Atlantic skate (*Rajella kukujevi*), spinytail skate (*Bathyraja spinicauda*), sailray (*Dipturus lintea*), Norwegian skate (*Dipturus nidarosiensis*) and blue pygmy skate (*Neoraja caerulea*). Most of these species are poorly known. Species such as *Dipturus batis* complex and *Leucoraja fullonica* may occur in deep water, but their main areas of distribution extend to much shallower waters and they are not considered in this section.

## 5.2 The fishery

### 5.2.1 History of the fishery

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

### 5.2.2 The fishery in 2012

Since 2010, EU TACs for deep-water sharks have been set at zero with only as very small allowance for bycatch (see Section 5.2.4 below). Consequently, reported landings of most of the species covered in this chapter in 2012 were very low or zero. As most of these species are taken as bycatch in mixed fisheries, it is likely that discarding has increased.

Reported catches in the directed Portuguese longline fishery for gulper shark (*C. granulosus)* reduced to zero in 2010.

### 5.2.3 ICES advice applicable

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

### 5.2.4 Management applicable

Prior to 2010 in EC waters, a combined TAC was set for a group of deep-water sharks. These include Portuguese dogfish, leafscale gulper shark, birdbeak dogfish, kitefin shark, greater lanternshark (*Etmopterus princeps*), velvet belly, black dogfish, gulper shark, blackmouth catshark, mouse catshark (*Galeus murinus*), longnose velvet dogfish, frilled shark, bluntnose sixgill shark, sailfin roughshark, Greenland shark, knitetooth dogfish and Iceland catshark (*Apristurus* spp.). In Subarea XII, rough longnose dogfish (*Deania histricosa*) and arrowhead dogfish (*Deania profundorum*) are also included on the list.

In 2010, TACs in all areas were reduced to zero with an allowance for bycatch of 10% of 2009 TACs. For 2011, the bycatch allowance was reduced to 3% of 2009 TACs and in 2012 no allowance for bycatch was permitted. This remains the status quo in 2013.

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

## 5.3 Catch data

### 5.3.1 Landings

#### Gulper shark *Centrophorus granulosus*

Reported landings of gulper shark are presented in Tables 5.1 and 5.10.

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

Other countries reported very small landings from Subareas VI and VII since 2002. Reported landings of this species by UK vessels in Subareas VI and VII are considered to be misidentified. These data have been included in Working Group estimates of "siki sharks".

#### Birdbeak dogfish *Deania calcea*

Reported landings of birdbeak dogfish are presented in Tables 5.2 and 5.10. It is likely that landings reported as this species include other species in the same genus, particularly in Portuguese landings from Subareas X (Pinho, 2010 WD). Misidentification problems were detected in mainland Portuguese landing ports with two differently species of *Deania* being observed in catches; *D. calcea* and *D. profundorum*.

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

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

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

Reported landings of longnose velvet dogfish are presented in Tables 5.3 and 5.10. It is likely that some landings of this species are also included in data for "siki sharks" (see Section 3) and in other mixed categories.

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

#### Black dogfish *Centroscyllium fabricii*

Reported landings of black dogfish are presented in Tables 5.4 and 5.10. Landings of this species may also be included in the grouped category "*Aiguillat noir*" and other mixed categories including siki sharks.

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

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

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

#### Velvet belly *Etmopterus spinax*

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

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

#### Lantern sharks nei *Etmopterus* spp.

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

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

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

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

Few landings data have been reported since 2003.

#### "*Aiguillat noir*"

This is a generic category only used by France to record landings on small, deep-water squaliform sharks mainly of black dogfish (*Centroscyllium fabricii*) with lesser quantities of longnose velvet dogfish and lantern sharks nei. Reported landings started in 2000 (249 t) then declined from 266 t in 2001 to 1 t in 2007, since when there have been no reported landings. Landings are presented in Tables 5.7 and 5.10.

#### Greenland shark *Somniosus microcephalus*

Landings were reported from Icelandic fisheries in Subareas Va and XIV. The catch reached 91 tonnes in 1998 and has since declined. Landings are presented in Tables 5.8 and 5.10.

#### *Centrophorus lusitanicus*

Reported landings of this species in Portuguese landings in 2009–2012 (Tables 5.9. and 5.10) data are believed to refer to misidentified *C. squamosus,,C. coelolepis, S. ringens, D. calcea* and *D. profundorum* (Serra-Pereira *et al*., WD 2011; Lagarto *et al*., 2012 WD).

### 5.3.2 Discards

**Azores, Portugal.** Discards from the Azorean observer programme was provided in Pinho and Canha (2011 WD) (Table 5.11). This was not updated in 2012 and no new information was available in 2013.

**Portugal (mainland).** Discards data from the Portuguese longline fishery were presented. *Etmopterus* spp., *C. crepidater* and *D. licha* are between the species with higher percentage of discards. However, from these, only *Etmopterus* spp (most of them assigned to *E. pusillus*) are frequent. Estimates of percentage discarded by species from deep-water longlines and demersal bottom trawls (Prista and Fernandes, 2012) are given in Table 5.12. To evaluate the level of bycatch and discards of deep-water sharks in the Portuguese trammelnet fishery a pilot study was made in ICES Division IXa (Moura *et al*., 2013 WD). Bycatch of deep-water sharks was generally very low and is presented in Table 5.13.

**Spain**. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES Subareas VI, VII, VIIIc and North IX, was started in 1988; however, it did not have yearly continuity until 2003. The sampling strategy and the estimation methodology used follows the "Workshop on Discard Sampling Methodology and Raising Procedures" guidelines (ICES, 2003) and more detail of this applied to this area is explained in Santos *et al*. (2010). An update estimate of Spanish deep-water elasmobranch discards for 2012 in Celtic Sea Subareas (VI and VII) and since 2003 is presented in Table 5.14.

### 5.3.3 Quality of the catch data

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

## 5.4 Commercial catch composition

### 5.4.1 Species and size compositions

Total length–frequency on correctly identified specimens of *D. calcea* and *S. ringens* from the Portuguese longline fishery in 2012 is presented in Figures 5.1 and 5.2 respectively.

### 5.4.2 Commercial catch-effort data

No new information is available.

## 5.5 Fishery-independent surveys

### 5.5.1 ICES Subarea VII

Data from the Spanish survey on Porcupine Bank (SpPGFS-WIBTS-Q4) was made available. The species analysed are: blackmouth dogfish (*Galeus melastomus*) birdbeak dogfish (*D. calcea*), Knifetooth dogfish (*S. ringens*), velvet belly lantern shark (*E. spinax*) and bluntnose sixgill shark (*H. griseus*). Stratified biomass indexes are presented in Figures 5.3 to 5.7.

### 5.5.2 ICES Divisions VIIIc and IXa

The Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters has covered this area annually since 1983 (except in 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranchs. In 2012 elasmobranchs made up ca. 11% of the total fish catch (Figures 5.19–5.21). Information for *E. spinax*, *H. griseus*, *S. ringens*, and *Deania spp.* was presented (Ruiz-Pico *et al.*, 2013 WD). In the Portuguese PtGFS-WIBTS-Q4 taking place in the southern occidental and southern coast the deep-water shark with higher catches is *D. profundorum*. This survey is designed for crustacean species and operates until 700 m depth. Mean catches by strata are presented in Figure 5.8, for the period between 2005 and 2009.

### 5.5.3 ICES Subarea X

Data from the Azorean bottom longline survey (ICES AREA Xa2; ARQDACO(P)-Q1) was presented (Pinho, 2012 WD). *Deania* sp. and *Etmopterus* are between the most representative (abundant) species on the survey. *C. crepidater* and *D. batis* were common but much less abundant. The other species occurred in a very low numbers (on average between one and four individuals per year). Depth range and length composition are available. However, it should be remarked that the gear configuration used is not adapted for all the species (Pinho, 2013 WD).

### 5.5.4 ICES Subarea VI

Data from the Scottish deep-water trawl survey were made available. This survey samples from 300 to 2000 m along the continental slope between approximately 55°N and 59°N (see Neat *et al.*, 2010 for details). An index of relative abundance was generated for the following species; birdbeak dogfish, greater lanternshark (*Etmopterus princeps*), velvet belly, black dogfish, blackmouth catshark, longnose velvet dogfish, bluntnose sixgill shark, mouse catshark (*Galeus murinus*), Pale catshark (*Apristurus aphyodes*.). A subset of hauls was selected for the depth range of each species (defined as the maximum and minimum depth of occurrence). Abundance indexes are presented in Figures 5.9 to 5.17 with corresponding Tables giving number of hauls, fish caught and mean numbers per hour.

## 5.6 Life-history information

No new information was available on life history of the deep-water sharks.

## 5.7 Exploratory models of relative abundance

### 5.7.1 ICES Division VII

Spanish survey on Porcupine Bank (SpPGFS-WIBTS-Q4) on ICES Subarea VII (VIIc and VIIk) presented abundance indexes for some species listed and commented below. The most abundant species in biomass in these surveys were blackmouth catshark *(Galeus melastomus),* birdbeak dogfish *(Deania calcea),* knifetooth dogfish *(Scymnodon ringens),* velvet belly lantern shark *(Etmopterus spinax),* bluntnose sixgill shark *(Hexanchus griseus).* For more detailed information see Fernández-Zapico *et al.*, 2013.

#### Blackmouth catshark (*Galeus melastomus*)

*Galeus melastomus* was the most abundant especies, with catch values around 44 kg and 90.2 individuals per haul, thus representing about 74% and 88% of the elasmobranchs mean stratified biomass and abundance per haul. The stratified biomass and abundance trends were similar. Although a slightly lower capture was found in 2011, *G. melastomus* showed an increasing trend during the last five years after the remarkable drop in 2006, having registered a significant increment in the last survey (Figure 5.3).

#### Birdbeak dogfish (*Deania calcea*)

This species represented a small percentage of the elasmobranchs mean stratified biomass caught (8.3%, with catch ca. 5 kg/haul) and of the stratified abundance caught (1.5%, being the catch value of 1.6 individuals per haul). In the last survey, catch values of 2011 remained more or less stable at similar relatively high levels (Figure 5.4). In previous years, the stratified biomass and abundance was quite variable, this probably is related to this species dwelling in the depth limits covered in this survey, according to Velasco *et al.* (2010).

#### Knifetooth dogfish (*Scymnodon ringens*)

The average stratified catch for this species was of 1.5 individuals and around 4 kg per haul, that is to say, *S. ringens* represented a small percentage of the elasmobranchs mean stratified abundance caught (1.4%) and of the stratified biomass caught (6.7%). The stratified biomass showed an increasing trend after the drop in 2005,

while the stratified abundance showed a steady trend in the last five years (Figure 5.5).

#### Velvet belly lantern shark (*Etmopterus spinax*)

*E. spinax* represented about 2% of the elasmobranchs mean stratified biomass caught (ca. 1 kg per haul) while it showed about 6% of the stratified abundance caught (6.1 individuals per haul). The stratified biomass and abundance were low in the overall time-series. In 2012 a slightly recover can be appreciated after the low catch values in 2011 (Figure 5.6).

#### Bluntnose sixgill shark (*Hexanchus griseus*)

This species represented a small percentage of the elasmobranchs mean stratified abundance caught (0.3%; 0.29 individual per haul) and of the stratified biomass caught (1.15%; 0.69 kg per haul). The stratified biomass was quite steady along the historical series, between 0.5 and 1 Kg per haul, with the exception of 2003, remaining at these values in 2012. The abundance by contrast in 2012 slightly decreased (Figure 5.7).

#### Other species

Other species with very low abundance have been previously reported in the area (Velasco *et al*., 2010; Fernández-Zapico *et al*., 2011; Ruiz-Pico *et al.,* 2012), namely *Centroscymnus crepidater*, *Galeus murinus* and *Rajella fyllae*. However, in 2012 none of these species were caught.

### 5.7.2 ICES Division VI

Preliminary analyses were carried out to identify trends in the data using a general linear model with a negative binomial distribution (to take account of frequent zero catch values and occasional large catches).

#### Birdbeak dogfish (*Deania calcea*)

The relative abundance of this species between depths of 400–1500 m on the Scottish slope has remained stable (around three individuals per hour) for the past 14 years (Figure 5.9 and Table 5.14.) Preliminary analyses using negative binomial GLM suggest no significant trend over time.

#### Black dogfish (*Centroscylium fabricii*)

The relative abundance of this species between depths of 800–1800 m from Scottish deep-water survey has remained stable (around five individuals per hour) for the past 14 years (Figure 5.10 and Table 5.16). Variation is very high with occasional large catches. Preliminary analyses using negative binomial GLM suggest no significant trend over time.

#### Long–nose velvet dogfish (*Centroselachus crepidater*)

The relative abundance of this species between depths of 500–1800 m from Scottish deep-water survey has been variable (averaging five individuals per hour, but with occasional very high catches) for the past 14 years (Figure 5.11 and Table 5.17). Preliminary analyses using negative binomial GLM suggest a decreasing trend over time, but this may be unduly influenced by an exceptionally high catch in 1998.

#### Velvet belly lantern shark (*Etmopterus spinax*)

The relative abundance of this species between depths of 300–1000 m from Scottish deep-water survey has been variable (averaging seven individuals per hour), for the past 14 years (Figure 5.12 and Table 5.18). Preliminary analyses using negative binomial GLM suggest no trend over time.

#### Black-mouth dogfish (*Galeus melostomus*)

The relative abundance of this species between depths of 300–1000 m from Scottish deep-water survey has been variable (averaging ten individuals per hour), for the past 14 years (Figure 5.13 and Table 5.19). Preliminary analyses using negative binomial GLM suggest no trend over time.

#### Greater lantern shark (*Etmopterus princeps*)

The relative abundance of this species between depths of 800–1800 m from Scottish deep-water survey has been variable (averaging three individuals per hour), for the past 14 years (Figure 5.14 and Table 5.20). Preliminary analyses using negative binomial GLM suggest no trend over time.

#### Bluntnose six-gill shark (*Hexanchus griseus*)

The relative abundance of this species between depths of 300–800 m from Scottish deep-water survey was averaging less than one individual per hour, for the past 14 years (Figure 5.15 and Table 5.21). Preliminary analyses using negative binomial GLM suggest no trend over time.

#### Mouse cat-shark (*Galeus murinus*)

The relative abundance of this species between depths of 500–1500 m from Scottish deep-water survey was, in average one individual per hour, for the past 14 years (Figure 5.16 and Table 5.22). Preliminary analyses using negative binomial GLM suggest no trend over time.

#### Pale cat-shark (Aprsiturus aphyodes)

The relative abundance of this species between depths of 800–2030 m from Scottish deep-water survey was in average four individual per hour, for the past 14 years (Figure 5.17 and Table 5.23). Preliminary analyses using negative binomial GLM suggest an increasing trend over time.

#### Deep-water skates and rays

Most species of skates and rays in the Scottish deep-water survey occur at such low frequency that times-series analysis are inappropriate. Total number of each of the species, blue pygmy skate (*Neoraja caerulea*), Mid-Atlantic skate (*Rajella kukujevi*), round skate (*Rajella fyllae*), deep-water skate (*Rajella bathyphila*), Bigelow's skate (*Rajella bigelowi*), Richardson's skate (*Bathyraja richardsoni*), Jensen's skate (*Amblyraja jenseni*), Krefft's skate (*Malacoraja kreffti*), per year across all depths is presented (Table 5.24).

### 5.7.3 ICES Division VIIIc and IXa

The abundance indices series for some deep-water elasmobranchs caught in the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters is shown below. However the majority of these species are usually found at deeper waters than those

covered by this survey (additional hauls) and thus the abundance indices must be taken with caution.

#### *Etmopterus spinax* (velvet belly)

Around a 50% of the biomass of this scarce elasmobranch was found in standards hauls and the other half was found deeper than 500 m. In IXa Division, *E. spinax* did not appear in standard hauls and it was really scarce in additional hauls. However, in Division VIIIc, the catches of this species increased reaching the highest value of the overall time-series (Figure 5.18).

#### *Deania* spp.

Before 2009 *D. calcea* was recorded together with *D. profundorum*. In that year, *D. profundorum* was described within the area (Sanjuan *et al*., 2012); therefore the results previously reported as *D. calcea* are now merged into *Deania* spp. The results of the comparative analysis between *D. calcea* and *D. profundorum* in the last four years showed an increase in the catches of *D. calcea* in 2012, after being absent in the two previous years, whereas *D. profundorum* remained steady in the catches from 2010 in both divisions (Figure 5.20).

#### Other shark species

Other shark species which are common in the additional deeper hauls although they are scarce or absent on the stratified catches are *Hexanchus griseus* and *Scymnodon ringens*. *H. griseus* also increased in 2012 whereas *S. ringens* showed the low steady catches from 2010 (Figure 5.19).

## 5.8 Quality of assessments

No assessments undertaken.

## 5.9 Reference points

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

## 5.10 Management considerations

No management advice is given in 2013.

## 5.11 References

Compagno, L., Dando, M. and Fowler, S. 2005. Sharks of the World. Collins Field Guide. Harper Collins Publishers, London, 368 p.

Fernández-Zapico O., Velasco F., Baldó F. Rodríguez-Cabello C., and Ruiz-Pico S. 2013. Results on main elasmobranch species captured during the 2001–2012 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document ICES WGEF. 26 p.

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

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

Lagarto, N., Moura, T., Farias, I. and Figueiredo, I. 2013. Sampling information from deep-water sharks caught in the black scabbardfish fishery from mainland Portugal. Working Document ICES WGEF 2013. 3 p.

Moura, T, Fernandes, A., Figueiredo,I. and Aplpoim, R. 2013 Pilot Study on the Portuguese trammel nets fishery in ICES Div. IXa. Working document ICES WGEF.

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

Pinho, M. R. 2010. Update landings of elasmobranches from the Azores (ICES Area X). Working Document ICES WGEF, 2010-19: 10 pp.

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

Pinho, M.R. 2013. Updating elasmobranchs information from the annual Azorean bottom longline survey (ICES Area Xa2). Working Document ICES WGEF.

Prista, N. and Fernandes, A.C. 2012. On-board observations on elasmobranchs caught by a Portuguese deep-water set longline fishery (2005–2011). Working Document ICES WGEF. 8p.

Ruiz-Pico S., Velasco F., Rodríguez-Cabello C., Punzón A., Serrano A., Fernández-Zapico O., Blanco M. 2013. Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf. Working document ICES WGEF. 18 p.

Sanjuán, A., De Carlos, A., Rodríguez-Cabello, C., Bañón, R., Sánchez, F. and Serrano, A. 2012. Molecular identification of the arrowhead dogfish *Deania profundorum* (Centrophoridae) from the northern waters of the Iberian peninsula, Marine Biology Research, 8:9, 901–905. dx.doi.org /10.1080/17451000.2012.692160.

Santos J., H. Araújo, I. Salinas and N. Pérez. 2010. Elasmobranches Results from Spanish Discard Sampling Programme. ICES WGEF.2010. 6 p.

Serra-Pereira, B., Moura, T., Farias, I., Maia, C., Lagarto, N., Veiga, N., and Figueiredo, I. 2011. Information on sharks, rays and skates landings from mainland Portugal. Working Document ICES WGEF. 13 p.

Velasco F., Serrano A., Punzón A. and Blanco M. 2010. Results on main elasmobranch species captured in the bottom trawl surveys in the Spanish Northern Shelf, ICES Divisions VIIIc and IXa North. Working Document for the Working Group on Elasmobranch Fishes (WGEF), 2010, Horta, 22–29 June, 10 pp.

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

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

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

| Country | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 1056 | 801 | 958 | 886 | 344 | 423 | 242 | 291 | 187 | 95 | 54 |
| Spain | | | | | | | | | | | |
| TOTAL | 1056 | 801 | 958 | 886 | 344 | 423 | 242 | 291 | 187 | 95 | 54 |

| Country | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 96 | 159 | 203 | 89 | 62 | 104 | 132 | 93 | 13 | 6 | 1 | 1 |
| Spain | | 8 | | n.a. | n.a. | | | | | | + | |
| TOTAL | 96 | 167 | 203 | 89 | 62 | 104 | 132 | 93 | 13 | 6 | 1 | 1 |

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

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | | | 5 | | | | | | | | | | |
| UK(E and W) | | | | + | + | 47 | 19 | | | | | | |
| UK(Scotland) | | 1 | + | 3 | 38 | 2 | | | | | | | |
| France | | | | | | | | | 5 | | | + | |
| Portugal | 13 | 37 | 67 | 72 | 157 | 145 | 74 | 43. | 66 | 22 | 5 | 1 | 1 |
| TOTAL | 13 | 38 | 72 | 75 | 195 | 194 | 93 | 43. | 71 | 22 | 5 | 1 | 1 |

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

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | + | + | 13 | 10 | 8 | 6 | | | 5 | | | | |
| UK(Scotland) | + | + | + | 21 | 7 | 97 | 128 | 19 | | | | | |
| UK(E&W) | | | | + | + | 113 | 281 | | | | | | |
| Ireland | | | | | | | | | | | | | 1 |
| Portugal | 1 | 3 | 4 | 2 | 1 | | | 1 | | 27 | + | | |
| Spain | 85 | 68 | n.a. | n.a. | n.a. | n.a. | | | | | | | |
| TOTAL | 86 | 71 | 17 | 33 | 16 | 216 | 409 | 20 | 5 | 27 | 0 | 0 | 1 |

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

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 382 | 395 | 47 | 90 | 49 | | 35 | | 137 | | | + | |
| Iceland | | | + | + | n.a. | | | | | | | | |
| UK(E&W) | | | | + | + | 5 | | | | | | | |
| Spain | 85 | 91 | n.a. | n.a. | n.a. | | | | | | | | |
| TOTAL | 467 | 486 | 47 | 90 | 49 | 5 | 35 | 0 | 137 | 0 | 0 | 0 | 0 |

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

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway | | | | | | | | | | | |
| Denmark | | | | 27 | + | 10 | 8 | 32 | 359 | 128 | 25 |
| UK(Scotland) | | | | | | | | | | | |
| UK(England and Wales) | | | | | | | | | | | |
| Spain | | | | | | | | | | | |
| TOTAL | | | | 27 | + | 10 | 8 | 32 | 359 | 128 | 25 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway | | | | | | | | | | | 4 | |
| Denmark | 52 | | | | | | | | | | | |
| UK(Scotland) | | | | | | | 8 | | | | | |
| UK(England and Wales) | | | | | 8 | | | | | | 2 | |
| Spain | | 85 | | | | | | | | | 1 | |
| TOTAL | 52 | 85 | | | 8 | | 8 | | | | 7 | 0 |

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

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| France | | | | | 846 | 2388 | 2888 | 2150 | 2043 | + | + |
| Spain | | | | | | | | | | | 38 |
| Portugal | | | | | + | + | + | + | | | + |
| UK(Scotland) | | | | | | | | | | | |
| TOTAL | | | | | 846 | 2388 | 2888 | 2150 | 2043 | + | 38 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | + | + | + | + | | | 0 | 0 | | | + | |
| Spain | 338 | 99 | | | | | | | | | | |
| Portugal | | | | + | + | + | 0 | 0 | + | 0 | | |
| UK Scotland | | | | | | | | 20 | | | | |
| TOTAL | 338 | 99 | + | + | + | + | 0 | 0 | + | 0 | 0 | 0 |

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

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | | | | | | | | | | | |
| Spain (Basque c.) | | | | | | | | | + | | + |
| Spain | | | | | | | 4 | 3 | 6 | 2 | 4 |
| France | | | | | | | | | | | |
| Portugal | 17 | 17 | 16 | 20 | 37 | 29 | 35 | 29 | 22 | 23 | 39 |
| Norway | | | | | | | | | | | |
| TOTAL | 17 | 17 | 16 | 20 | 37 | 29 | 39 | 32 | 28 | 25 | 43 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | | | + | 1 | | | | 0 | | | | |
| Spain (Basque c.) | | | | + | | 4 | | 4 | 4 | 3 | | |
| Spain | 1 | 35 | 1 | | 4 | | | 28 | | | + | 2 |
| France | | | | | | | | | | | 3 | |
| Portugal | 36 | 52 | 29 | 57 | 38 | 29 | 26 | 15 | 12 | 7 | | |
| Norway | | | | | | | | | | | 18 | 31 |
| TOTAL | 37 | 87 | 30 | 58 | 41 | 32 | 26 | 47 | 16 | 10 | 21 | |

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

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 123 | 165 | 11 | 37 | 21 | 5 | | | | | | | |
| TOTAL | 123 | 165 | 11 | 37 | 21 | 5 | | | | | | | 0 |

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

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Iceland | 54 | 58 | 68 | 41 | 42 | 43 | 61 | 83 | 91 | 55 | 45 |
| TOTAL | 54 | 58 | 68 | 41 | 42 | 43 | 61 | 83 | 91 | 55 | 45 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iceland | 57 | 56 | 55 | 58 | 54 | 24 | 3 | 34 | 26 | 43 | 18 | 14 |
| TOTAL | 57 | 56 | 55 | 58 | 54 | 24 | 3 | 34 | 26 | 43 | 18 | 14 |

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

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Portugal | n.a. | n.a. | 423 | 271 | 584 | 689 |
| | | | 314 | 271 | 584 | 689 |

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

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

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gulper Shark | 96 | 167 | 203 | 89 | 62 | 104 | 132 | 93 | 20 | 7 | 3 | 1 |
| Birdbeak Dogfish | 38 | 72 | 75 | 195 | 194 | 94 | 43 | 72 | 22 | 5 | 1 | 2 |
| Black Dogfish | 486 | 47 | 90 | 49 | 5 | 35 | | 137 | | | + | 0 |
| Longnose Velvet Dogfish | 71 | 17 | 33 | 16 | 216 | 409 | 23 | 2 | 27 | 0 | 0 | 1 |
| Velvet Belly | 52 | 85 | | | 8 | | 8 | | | | 23 | 0 |
| Blackmouth Dogfish | 37 | 87 | 30 | 59 | 41 | 32 | 26 | 47 | 16 | 7 | 21 | 0 |
| Lantern Shark NEI | 338 | 99 | | | | | | 20 | | | | 0 |
| *Aiguillat noir* | 165 | 11 | 37 | 21 | 5 | | | | | | | |
| Greenland Shark | 57 | 56 | 55 | 58 | 54 | 24 | 3 | 34 | 26 | 43 | 16 | 14 |
| Angular Roughshark | | | | 75 | 99 | 52 | | | 54 | 46 | 17 | |
| *Centrophorus lusitanicus* | | | | | | | | | 311 | 271 | 584 | 689 |
| Knifetooth dogfish | | | | | | | 196 | 0 | 83 | 115 | 4 | 5 |
| *Deania profundorum* | | | | | | | n.a. | n.a. | n.a. | n.a. | 5 | 1 |
| TOTAL | 1340 | 641 | 523 | 562 | 684 | 750 | 432 | 404 | 560 | 494 | 674 | 746 |

**Table 5.11. Discards of deep-water shark species (numbers) recorded by Azores observers 2005–2010.**

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

**Table 5.12. Frequency of occurrence (%) of deep-water sharks in the discards of the hauls sampled onboard the Portuguese fisheries by gear type: crustacean bottom otter trawl - OTB_CRU; demersal fish bottom otter trawl - OTB_DEF; deep-water set longline fishery that targets black scabbardfish LLS_DWS (2004–2012). "---" indicates no occurrence;**

| FISHERY | YEAR | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| OTB_CRU | *Deania calcea* | 5 | 5 | 3 | 4 | 9 | 2 | 2 | 2 | 4 |
| | *Centrophorus granulosus* | --- | --- | --- | --- | --- | --- | 1 | --- | 1 |
| | *Deania profundorum* | --- | --- | --- | --- | --- | --- | --- | 2 | --- |
| | *Etmopterus* spp. | 36 | 24 | 50 | 22 | 17 | 8 | 11 | 25 | 29 |
| | *Galeus melastomus* | 57 | 51 | 50 | 38 | 38 | 25 | 24 | 27 | 46 |
| OTB_DEF | *Deania calcea* | 1 | --- | --- | --- | --- | --- | --- | --- | --- |
| | *Etmopterus* spp. | 4 | 3 | 1 | --- | --- | 2 | --- | --- | --- |
| | *Galeus melastomus* | 8 | 2 | 4 | 3 | 2 | 1 | 2 | --- | --- |
| LLS_DWS | *Centroscymnus coelolepis* | --- | 33 | 20 | 33 | --- | 17 | 11 | --- | --- |
| | *Centroscymnus crepidater* | --- | --- | 80 | 67 | 25 | 17 | 22 | 17 | 11 |
| | *Centroscymnus cryptacanthus* | --- | --- | --- | --- | 25 | --- | --- | --- | --- |
| | *Deania calcea* | --- | --- | --- | --- | 25 | 17 | 11 | --- | 22 |
| | *Squalus* spp. | --- | --- | --- | --- | --- | --- | --- | --- | 11 |
| | Deep-water sharks nei | --- | --- | --- | --- | --- | --- | 22 | --- | --- |
| | *Centrophorus squamosus* | --- | --- | --- | --- | --- | --- | 11 | --- | --- |
| | *Deania profundorum* | --- | --- | --- | --- | --- | --- | --- | --- | 11 |
| | *Etmopterus* spp. | --- | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | *Galeus melastomus* | --- | --- | --- | --- | 75 | 17 | 33 | 50 | 56 |
| | *Scymnodon ringens* | --- | 67 | --- | 67 | --- | 17 | --- | --- | --- |

**Table 5.13. Number and catch weight of anglerfish (*Lophius* spp.) and sharks by 100 m depth strata. *Lophius* spp. combines *Lophius piscatorius* and *Lophius budegassa*.n, number of sampled specimens; West, estimated weight (based on length–weight relationships). From Moura *et al*. (2013).**

| | | | Depth strata | | | | |
|---|---|---|---|---|---|---|---|
| | **Total** | **Total** | 100–200 | 200–300 | 300–400 | 400–500 | >500 |
| **Species** | **n** | **$W_{est}$ (kg)** | n | n | n | n | n |
| *Chlamydoselachus anguineus* | 1 | 0.5 | | | | | 1 |
| *Etmopterus pusillus** | 1 | 0.2 | | | | | 1 |
| *Dalatias licha* | 2 | 10.8 | | | | | 2 |
| *Galeus melastomus* | 7 | 4.8 | 1 | 1 | 1 | | 4 |
| *Centroselachus crepidater* | 2 | 4.7 | | | | | 2 |
| *Mitsukurina owstoni** | 2 | 15.1 | | | 2 | | |
| *Mustelus* spp.* | 1 | NA | | | | | 1 |
| *Scyliorhinus canicula** | 46 | 22,9 | 6 | 33 | 6 | | 1 |
| *Lophius* spp. | 775 | 2302.1 | 76 | 550 | 93 | 0 | 56 |
| Nº hauls | 16 | | 3 | 6 | 3 | 0 | 4 |

*** sharks not included in the deep-water shark TAC list for the NE Atlantic.**

**Table 5.14. Spanish discard data of deep-water shark species. In bold weight discarded (tons.) of demersal elasmobranches and below in italics. CV of estimations by fishing ground. For detailed information see (Santos *et al.*, 2010).**

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

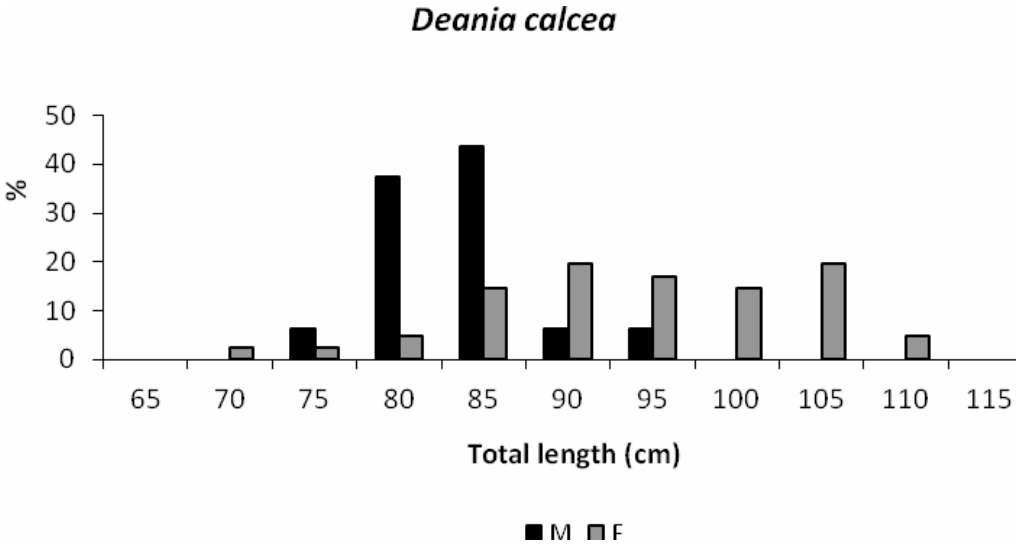



**Figure 5.1. Other deep-water sharks and skates from the Northeast Atlantic. *Deania calcea*. Length–frequency distribution in 2012. From Lagarto *et al.*, 2013, WD.**

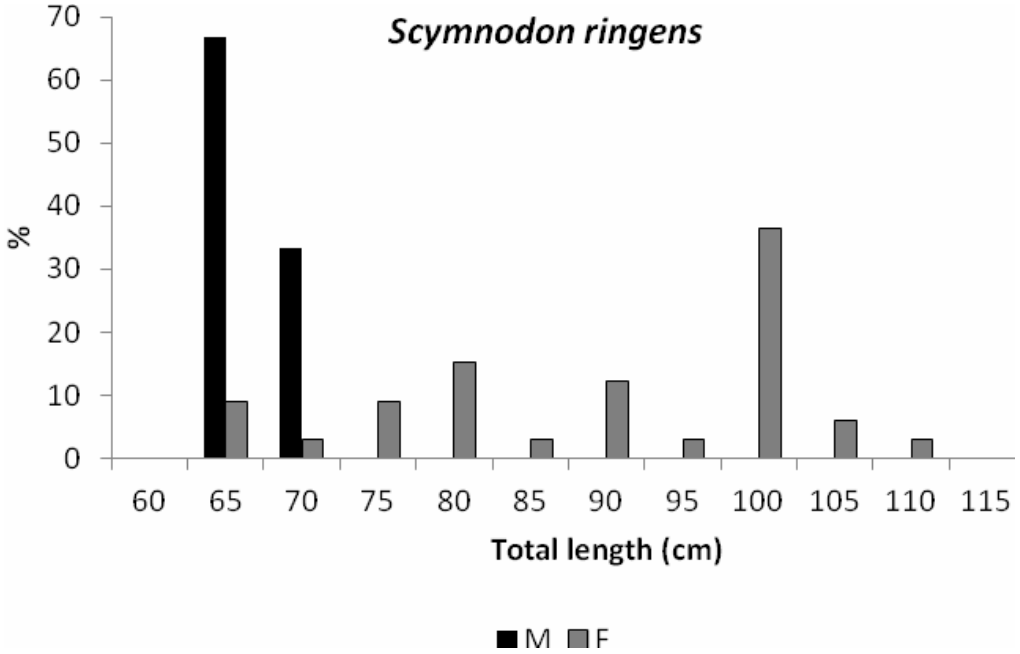



**Figure 5.2. Other deep-water sharks and skates from the Northeast Atlantic. *Scymnodons ringens*. Length–frequency distribution in 2012. From Lagarto *et al.*, 2013, WD.**

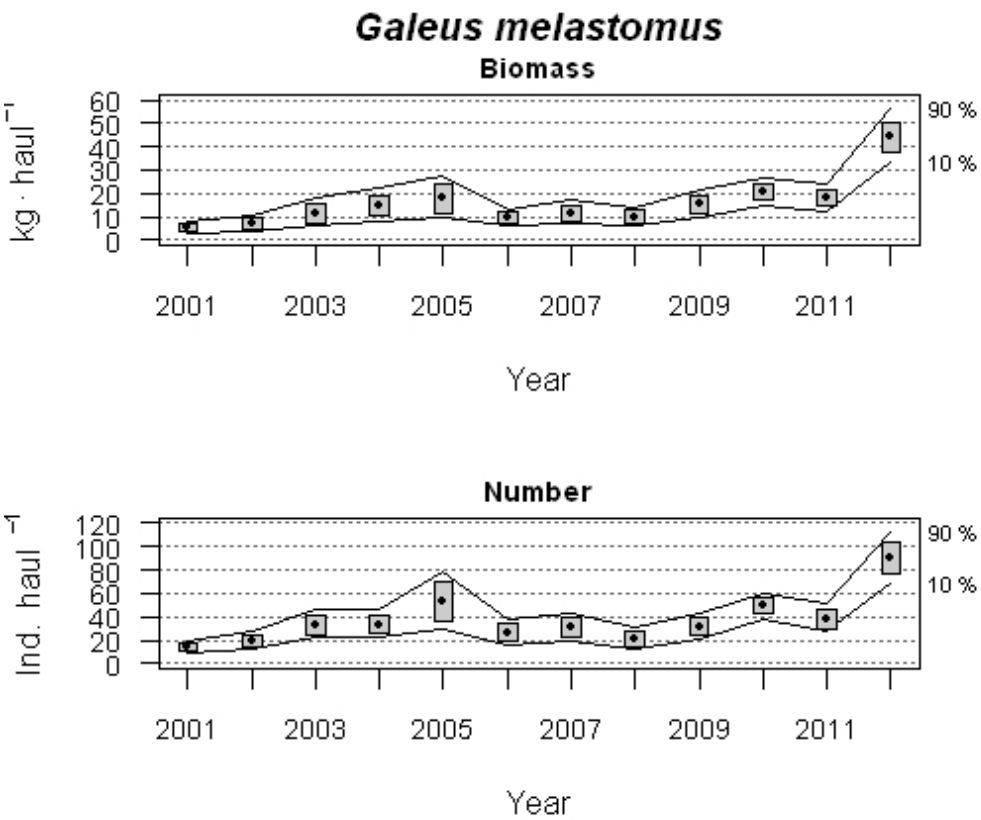



**Figure 5.3. Changes in blackmouth dogfish (*Galeus melastomus*) biomass index (Kg haul-1) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2012, WD).**

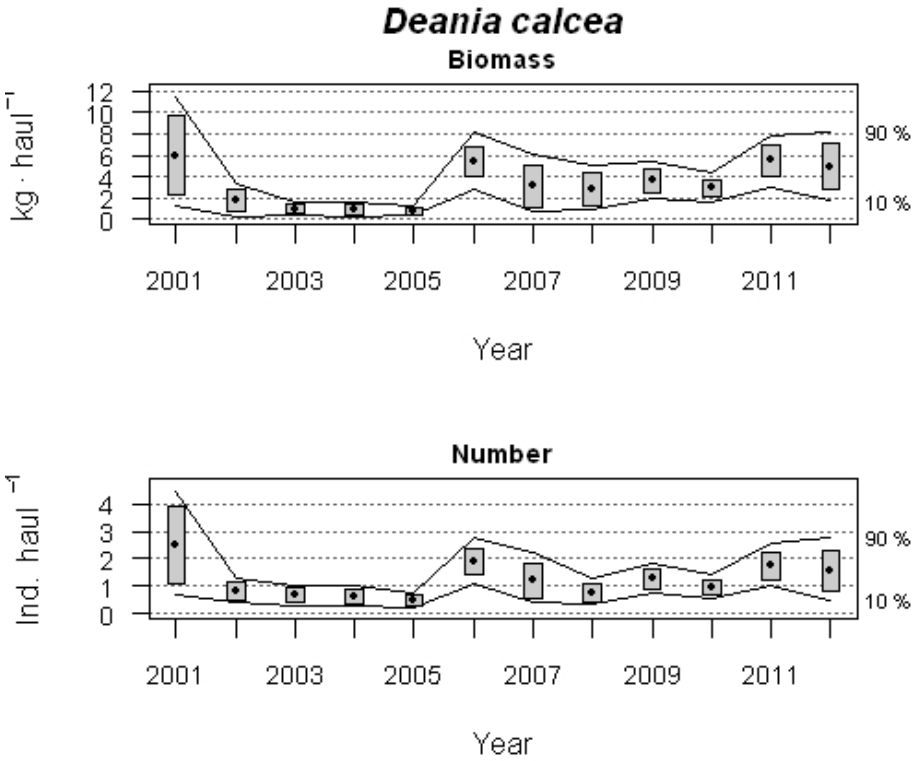



**Figure 5.4. Changes in birdbeak dogfish (*Deania calcea*) biomass index (Kg haul-1) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2012, WD).**

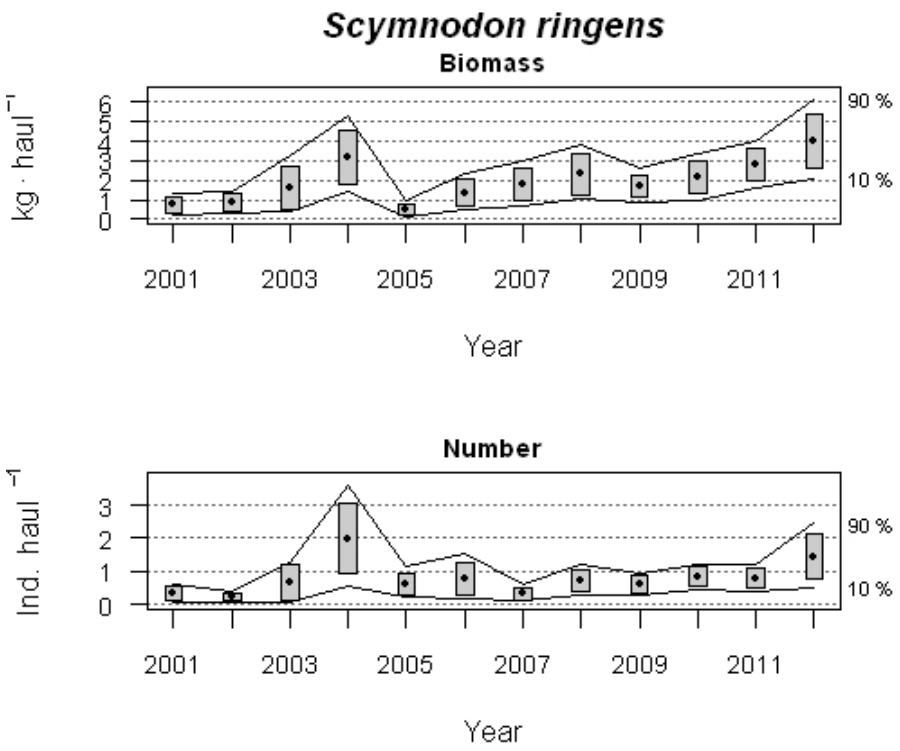



**Figure 5.5. Changes in knifetooth dogfish (*Scymnodon ringens*) biomass index (Kg haul-1) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2013, WD).**

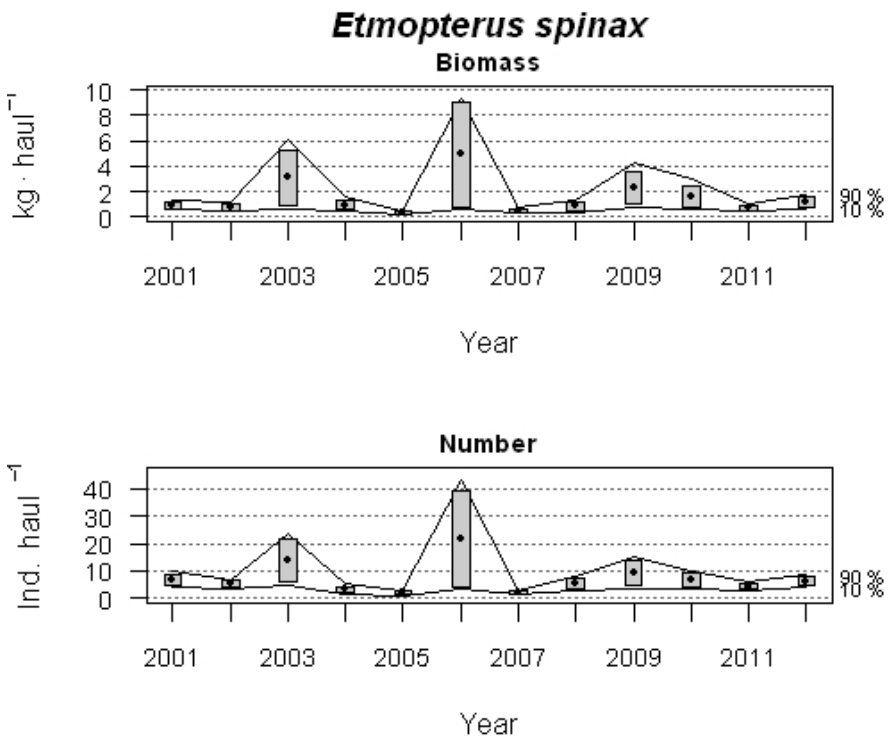



**Figure 5.6. Changes in velvet belly (*Etmopterus spinax*) biomass index (Kg haul-1) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2013, WD).**

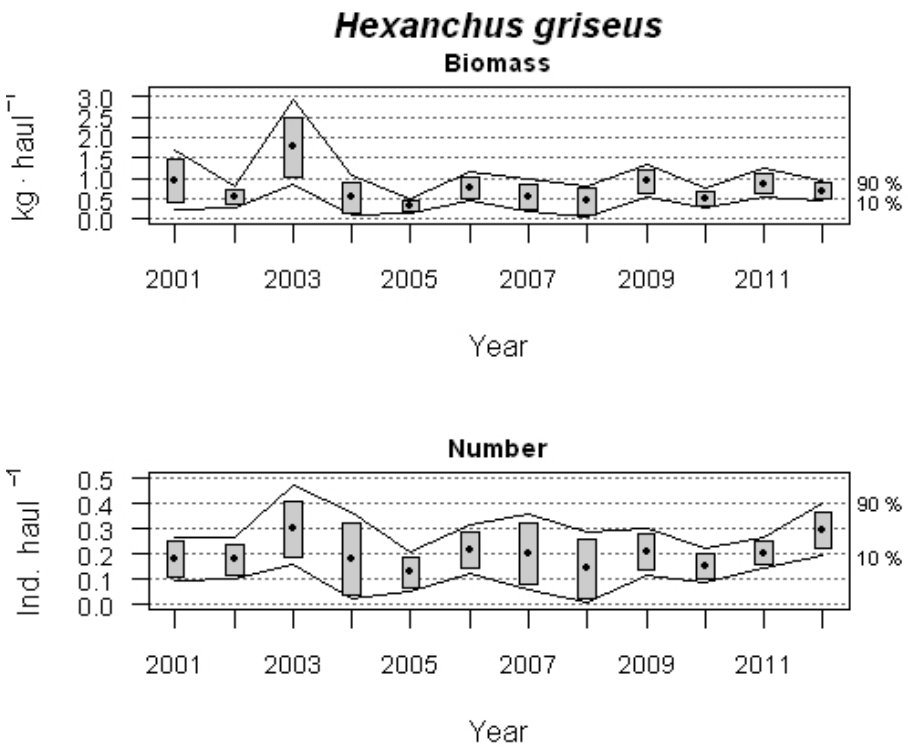



**Figure 5.7. Changes in bluntnose sixgill shark (*Hexanchus griseus*) biomass index (Kg haul-1) during Porcupine survey (SpPGFS-WIBTS-Q4) time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2013, WD).**

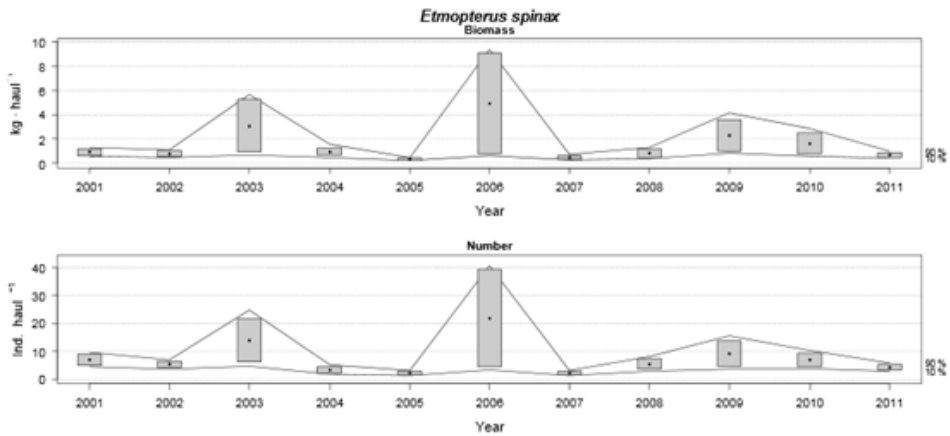



**Figure 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Changes in *Etmopterus spinax* biomass index (Kg haul-1) during North Spanish shelf bottom trawl survey (SpGFS-WIBTS-Q4) time-series (1983–2011 except 1987). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.*, (2012, WD).**

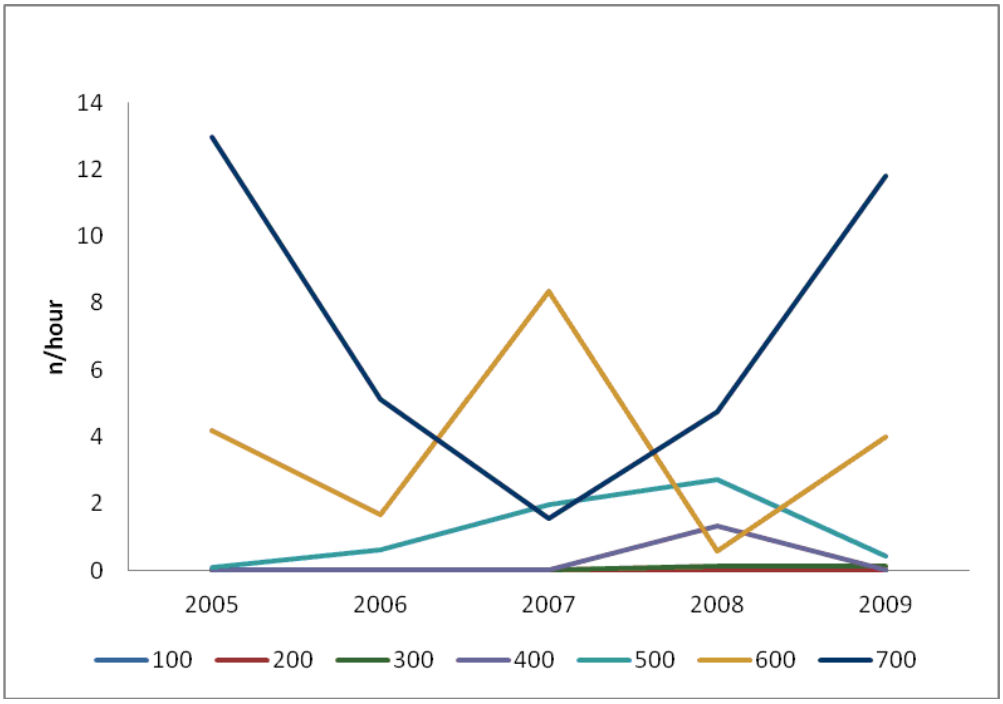



**Figure 5.8. Changes in birdbeak dogfish (*Deania calcea*) abundance index (Kg haul-1) during PtGFS-WIBTS-Q4 (2005–2009). Coefficient of variation is high and thus is not presented.**

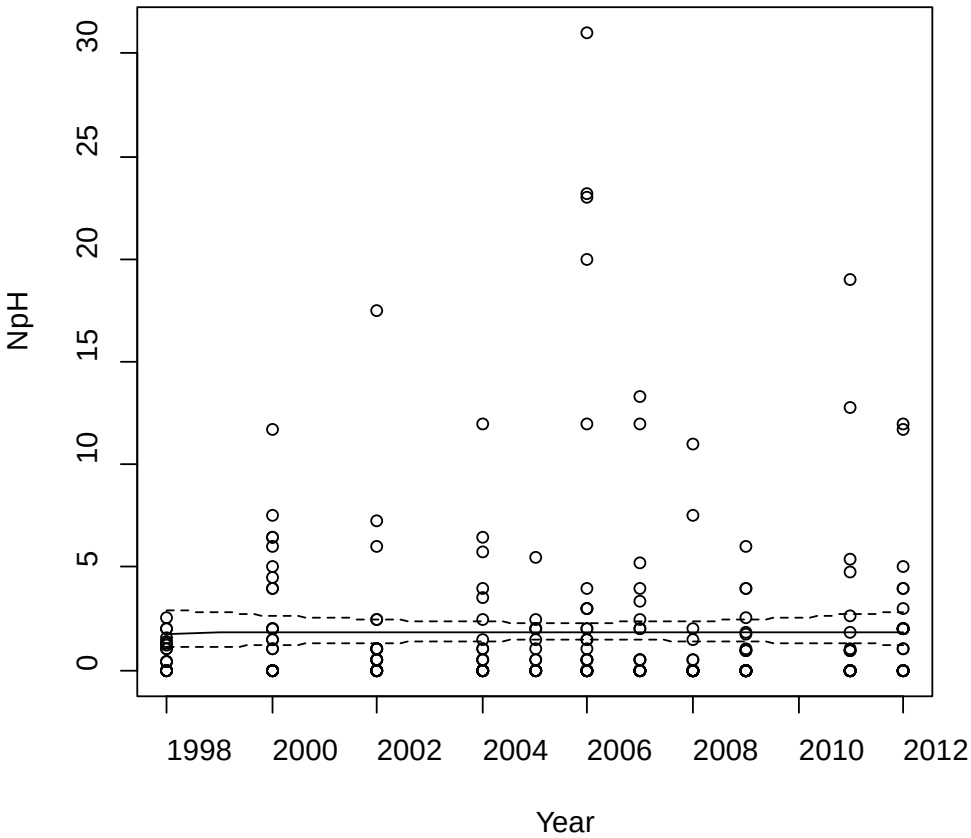



**Figure 5.9. Relative abundance of birdbeak dogfish *Deania calcea* (Number per Hour trawling) from Scottish deep-water survey time-series (depth range 400–1500 m).**

**Table 5.15. Summary data for *D. calcea* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean NpH |
|---|---|---|---|
| 1998 | 19 | 28 | 0.81 |
| 2000 | 27 | 133 | 2.47 |
| 2002 | 27 | 79 | 1.62 |
| 2004 | 24 | 73 | 1.63 |
| 2005 | 18 | 35 | 0.97 |
| 2006 | 33 | 160 | 4.01 |
| 2007 | 21 | 67 | 2.19 |
| 2008 | 28 | 42 | 0.82 |
| 2009 | 34 | 22 | 0.70 |
| 2011 | 24 | 51 | 2.09 |
| 2012 | 25 | 45 | 2.23 |

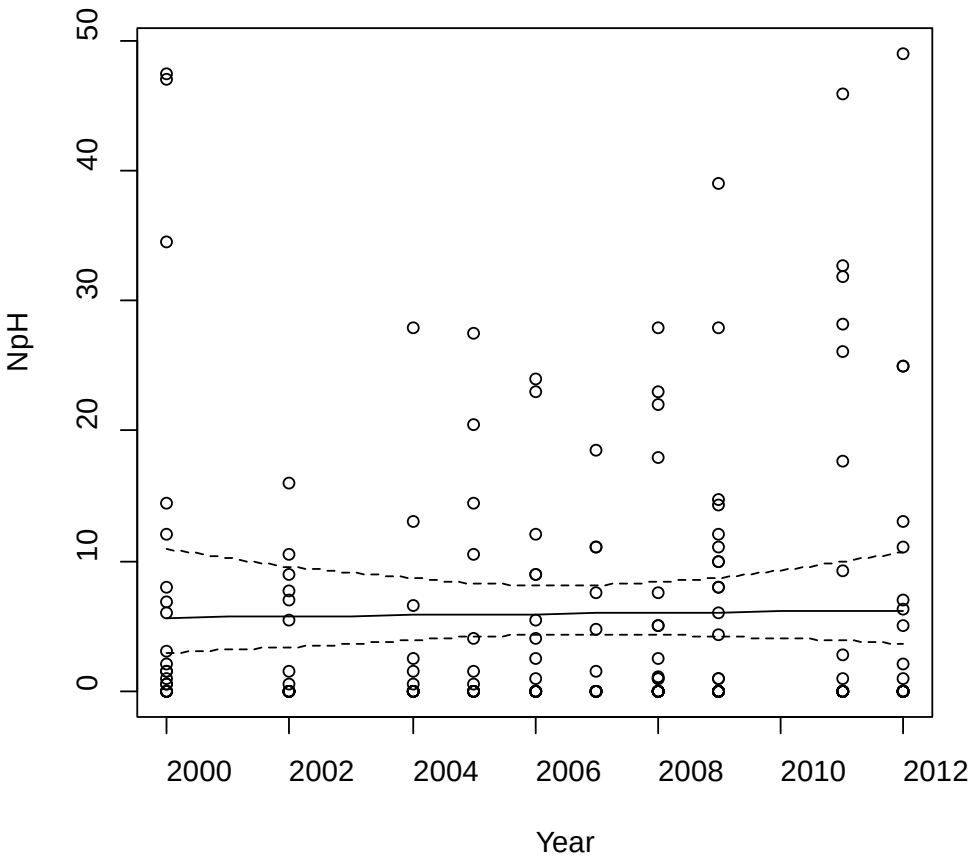



**Figure 10. Relative abundance of *Centroscylium fabricii* (Number per Hour trawling) from Scottish deep-water survey (depth range 500–2030 m).**

**Table 5.16. Summary data for *C. fabricii* from Scottish deep-water survey.**

| YEAR | N HAULS | N FISH | MEAN N P H |
|---|---|---|---|
| 2000 | 20 | 372 | 9.32 |
| 2002 | 16 | 107 | 3.61 |
| 2004 | 14 | 104 | 3.71 |
| 2005 | 14 | 158 | 5.64 |
| 2006 | 19 | 180 | 4.74 |
| 2007 | 15 | 109 | 3.61 |
| 2008 | 22 | 175 | 5.19 |
| 2009 | 29 | 138 | 5.77 |
| 2011 | 21 | 214 | 9.30 |
| 2012 | 22 | 144 | 6.55 |

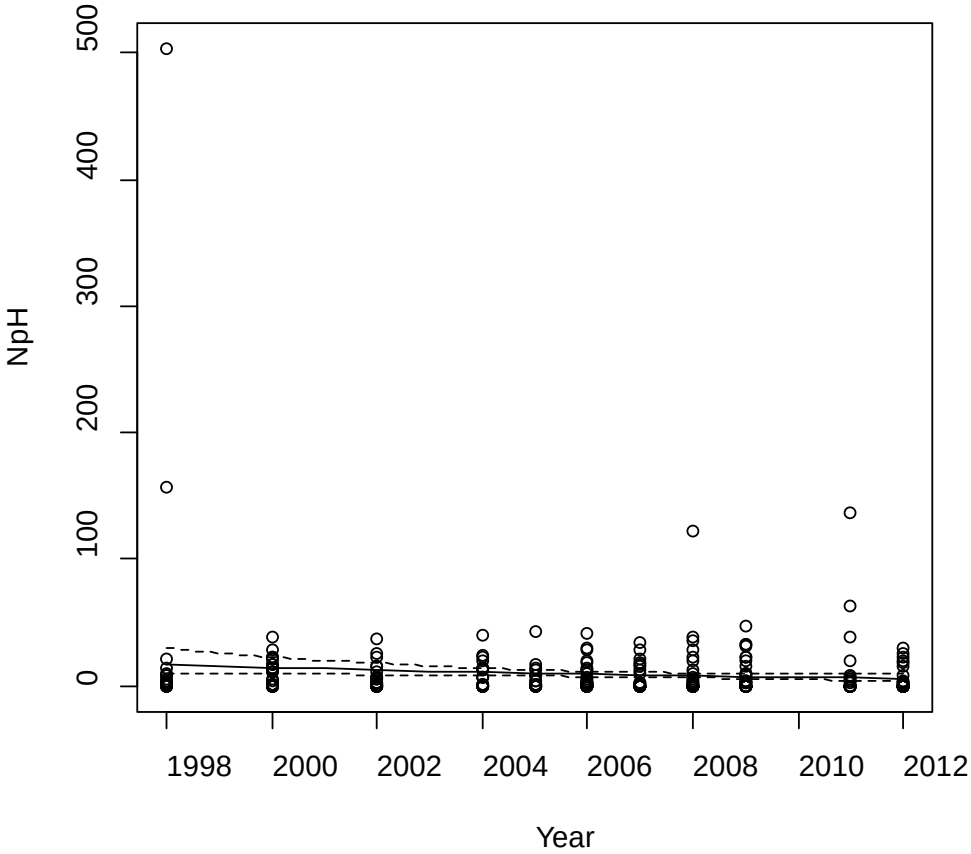



**Figure 5.11. Relative abundance of long nosed velvet dogfish, *Centroselachus crepidator* (Number per Hour trawling) from Scottish deep-water survey (depth range 500–1800 m).**

**Table 5.17. Summary data for *C. crepidator* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean Nph |
|---|---|---|---|
| 1998 | 18 | 1054 | 40.99 |
| 2000 | 28 | 524 | 9.41 |
| 2002 | 27 | 277 | 5.93 |
| 2004 | 22 | 341 | 8.19 |
| 2005 | 19 | 248 | 6.53 |
| 2006 | 33 | 304 | 6.55 |
| 2007 | 22 | 239 | 7.32 |
| 2008 | 31 | 528 | 10.06 |
| 2009 | 38 | 250 | 7.26 |
| 2011 | 28 | 288 | 10.35 |
| 2012 | 31 | 126 | 4.87 |

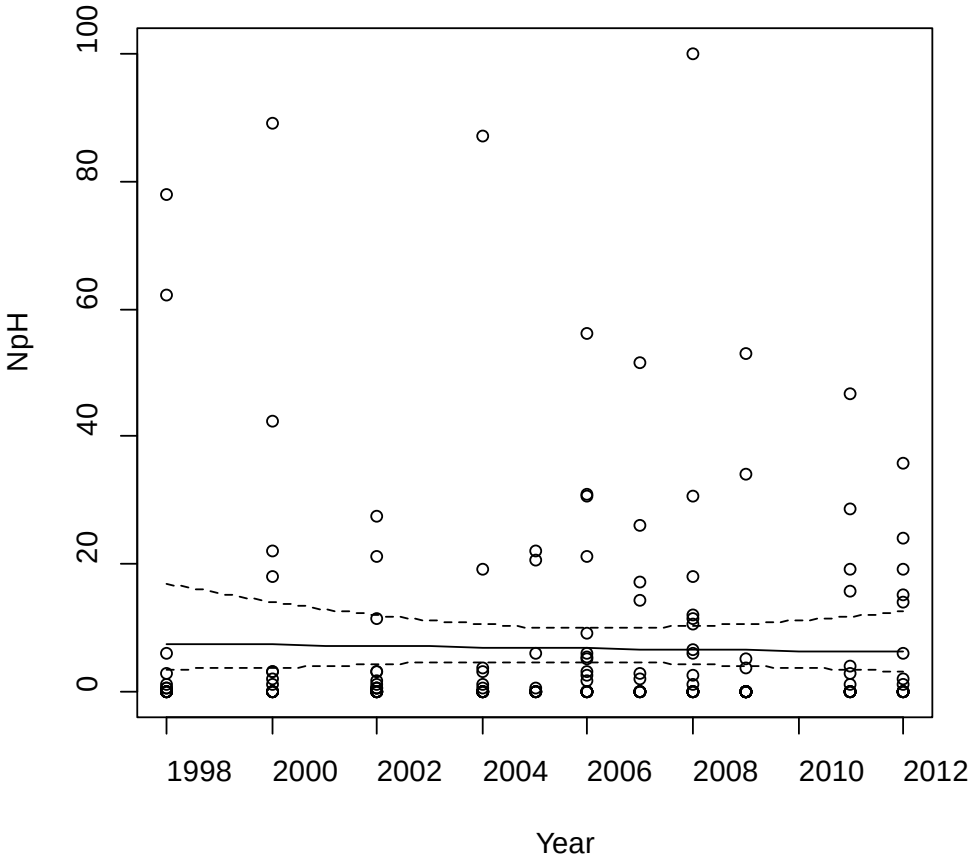



**Figure 5.12. Relative abundance of velvet-belly shark, *Etmopterus spinax* (Number per Hour trawling) from Scottish deep-water survey (depth range 300–1000 m).**

**Table 5.18. Summary data for *C. crepidator* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean NpH |
|---|---|---|---|
| 1998 | 18 | 319 | 8.36 |
| 2000 | 18 | 360 | 10.04 |
| 2002 | 21 | 134 | 3.34 |
| 2004 | 18 | 137 | 6.33 |
| 2005 | 13 | 98 | 3.77 |
| 2006 | 21 | 264 | 8.14 |
| 2007 | 15 | 222 | 7.57 |
| 2008 | 20 | 263 | 9.92 |
| 2009 | 27 | 96 | 3.54 |
| 2011 | 16 | 112 | 7.37 |
| 2012 | 18 | 105 | 6.49 |

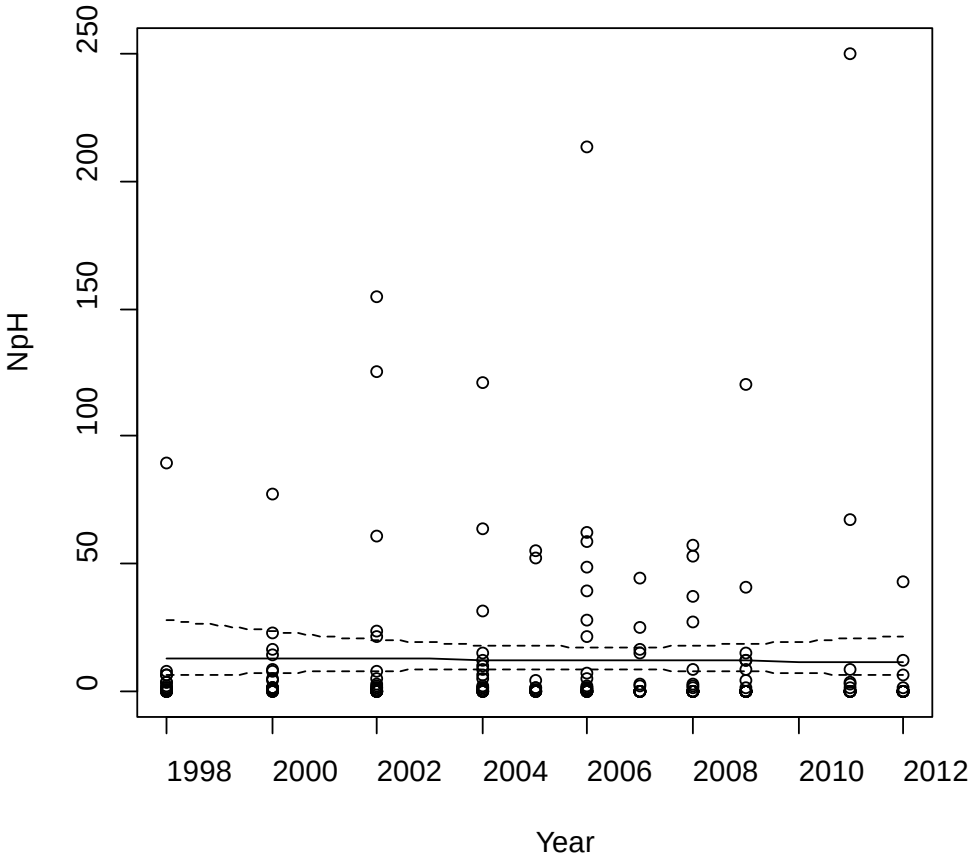



**Figure 5.13. Relative abundance of black-mouth dogfish, *Galeus melastomus* (Number per Hour trawling) from Scottish deep-water survey (depth range 300–1000 m).**

**Table 5.19. Summary data for *G. melastomus* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean Nph |
|---|---|---|---|
| 1998 | 18 | 225 | 6.72 |
| 2000 | 18 | 323 | 8.97 |
| 2002 | 21 | 811 | 19.32 |
| 2004 | 18 | 526 | 15.33 |
| 2005 | 13 | 227 | 8.73 |
| 2006 | 21 | 941 | 23.29 |
| 2007 | 15 | 205 | 7.03 |
| 2008 | 20 | 364 | 9.38 |
| 2009 | 27 | 165 | 7.84 |
| 2011 | 16 | 336 | 20.80 |
| 2012 | 18 | 56 | 3.43 |

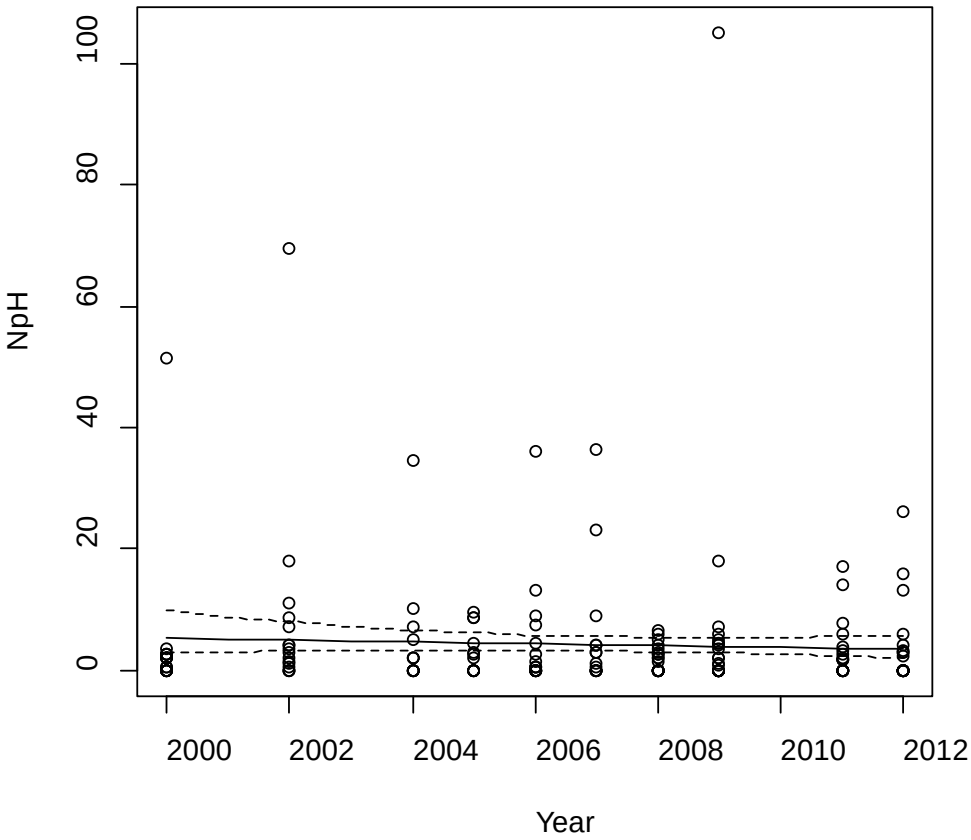



**Figure 5.14. Relative abundance of greater lantern shark, *Etmopterus princeps* (Number per Hour trawling) from Scottish deep-water survey (depth range 800–1800 m).**

**Table 5.20. Summary data for *E. princeps* from Scottish deep-water survey.**

| Year | N hauls | N fish | NpH |
|---|---|---|---|
| 2000 | 20 | 148 | 3.70 |
| 2002 | 16 | 247 | 8.33 |
| 2004 | 14 | 123 | 4.48 |
| 2005 | 14 | 77 | 2.75 |
| 2006 | 19 | 102 | 3.97 |
| 2007 | 15 | 163 | 5.62 |
| 2008 | 22 | 57 | 1.74 |
| 2009 | 29 | 149 | 5.62 |
| 2011 | 21 | 68 | 2.96 |
| 2012 | 22 | 74 | 3.46 |

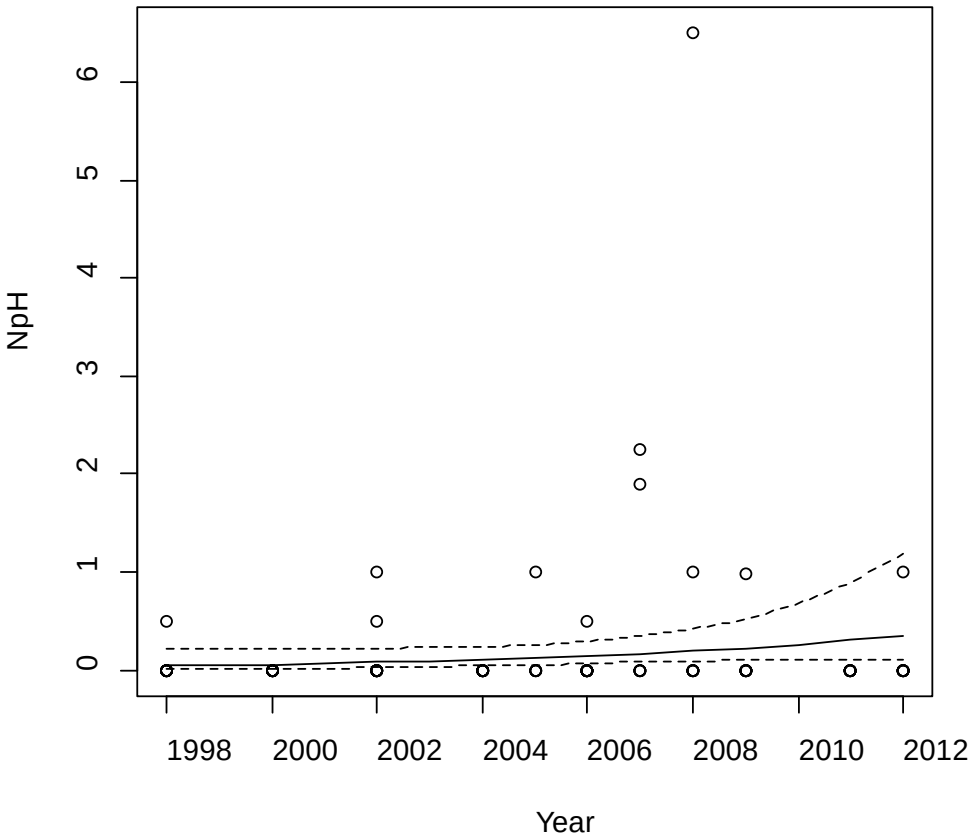



**Figure 5.15. Relative abundance of blunt-nose six-gilled shark, *Hexanchus griseus* (Number per Hour trawling) from Scottish deep-water survey (depth range 300–800 m).**

**Table 5.21. Summary data for *H. griseus* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean NpH |
|---|---|---|---|
| 1998 | 12 | 1 | 0.04 |
| 2000 | 13 | 0 | 0.00 |
| 2002 | 15 | 3 | 0.10 |
| 2004 | 12 | 0 | 0.00 |
| 2005 | 6 | 2 | 0.17 |
| 2006 | 15 | 1 | 0.03 |
| 2007 | 7 | 8 | 0.59 |
| 2008 | 9 | 15 | 0.83 |
| 2009 | 10 | 1 | 0.10 |
| 2011 | 9 | 0 | 0.00 |
| 2012 | 10 | 1 | 0.10 |

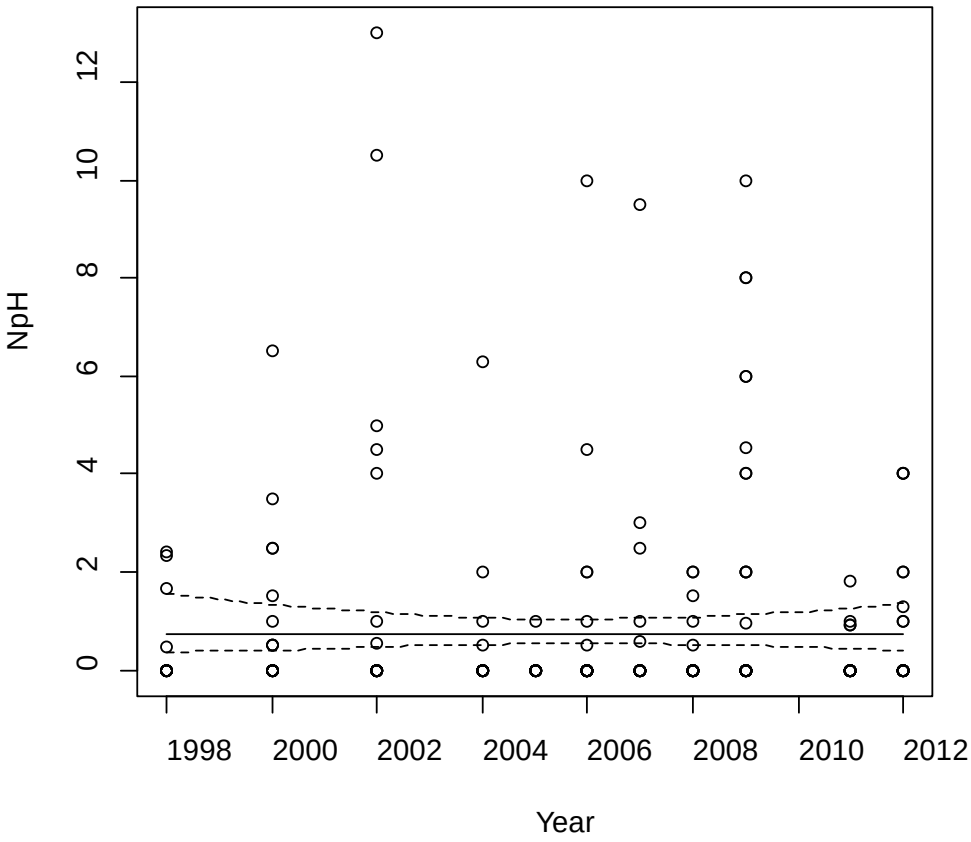



**Figure 5.16. Relative abundance of mouse cat shark, *Galeus murinus* (Number per Hour trawling) from Scottish deep-water survey (depth range 500–1500 m).**

**Table 5.22. Summary data for *G.murinus* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean NpH |
|---|---|---|---|
| 1998 | 18 | 16 | 0.38 |
| 2000 | 24 | 38 | 0.79 |
| 2002 | 25 | 64 | 1.54 |
| 2004 | 21 | 18 | 0.47 |
| 2005 | 18 | 2 | 0.06 |
| 2006 | 32 | 30 | 0.63 |
| 2007 | 21 | 33 | 0.79 |
| 2008 | 28 | 12 | 0.25 |
| 2009 | 34 | 38 | 1.69 |
| 2011 | 23 | 5 | 0.20 |
| 2012 | 25 | 17 | 0.77 |

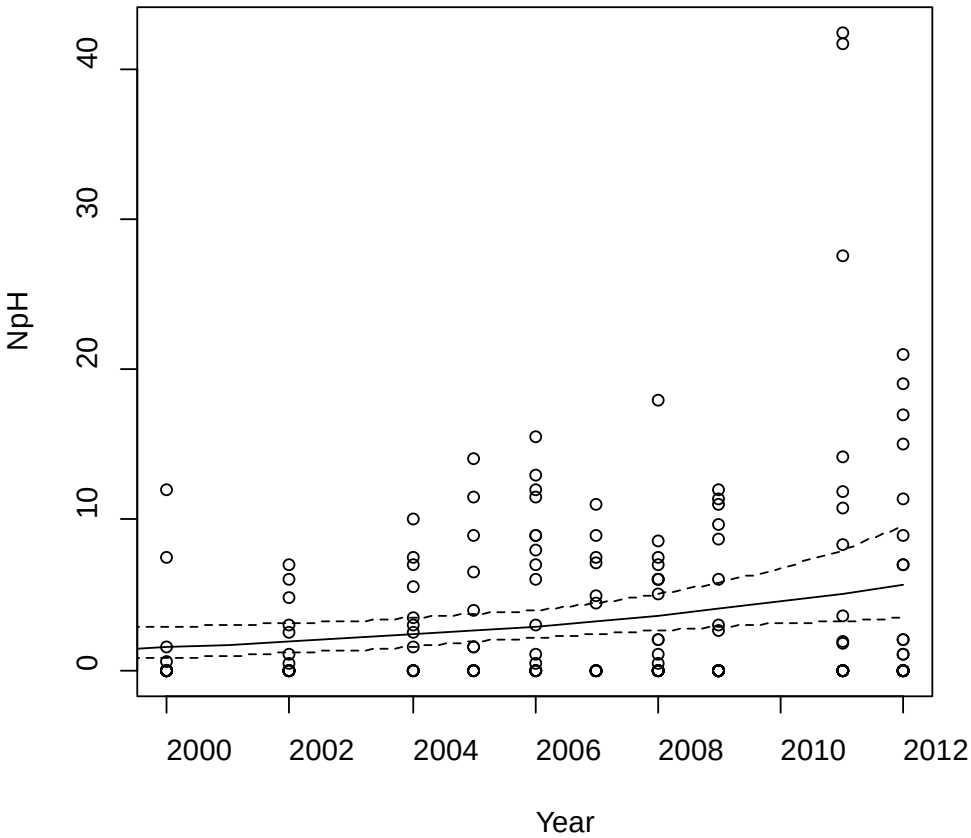



**Figure 5.17. Relative abundance of pale catshark, *Apristurs aphyodes* (Number per Hour trawling) from Scottish deep-water survey (depth range 800–2030 m).**

**Table 5.23. Summary data for *A. aphyodes* from Scottish deep-water survey.**

| Year | N hauls | N fish | Mean NpH |
|---|---|---|---|
| 2000 | 20 | 43 | 1.08 |
| 2002 | 16 | 49 | 1.55 |
| 2004 | 14 | 81 | 2.89 |
| 2005 | 14 | 96 | 3.43 |
| 2006 | 19 | 174 | 5.03 |
| 2007 | 15 | 89 | 2.94 |
| 2008 | 22 | 100 | 3.16 |
| 2009 | 29 | 64 | 2.22 |
| 2011 | 21 | 178 | 7.80 |
| 2012 | 26 | 105 | 4.32 |

**Table 5.24. Total number of deep-water skates and rays from Scottish deep-water survey across all depths and all years of time-series: blue pygmy skate (*Neoraja caerulea*), Mid-Atlantic skate (*Rajella kukujevi*), round skate (*Rajella fyllae*), deep-water skate (*Rajella bathyphila*), Bigelow's skate (*Rajella bigelowi*), Richardson's skate (*Bathyraja richardsoni*), Jensen's skate (*Amblyraja jenseni*), Krefft's skate (*Malacoraja kreffti*).**

| YEAR | N. CAERULEA | R. KUKUKUJEVI | R. FYLLAE | R. BATHYPHILA | R. BIGELOWI | B. RICHARDSONI | JENSENI | M. KREFTI |
|---|---|---|---|---|---|---|---|---|
| 1998 | 1 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 1 | 0 | 6 | 2 | 2 | 0 | 0 | 0 |
| 2002 | 4 | 1 | 9 | 4 | 0 | 0 | 1 | 1 |
| 2004 | 0 | 1 | 7 | 1 | 0 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 |
| 2006 | 0 | 0 | 7 | 2 | 1 | 0 | 0 | 0 |
| 2007 | 1 | 0 | 4 | 1 | 1 | 0 | 6 | 2 |
| 2008 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 |
| 2009 | 0 | 0 | 8 | 0 | 2 | 2 | 1 | 1 |
| 2011 | 0 | 4 | 4 | 0 | 1 | 0 | 1 | 0 |
| 2012 | 5 | 0 | 6 | 0 | 1 | 2 | 6 | 0 |
| **Total** | **12** | **6** | **70** | **10** | **9** | **4** | **18** | **4** |

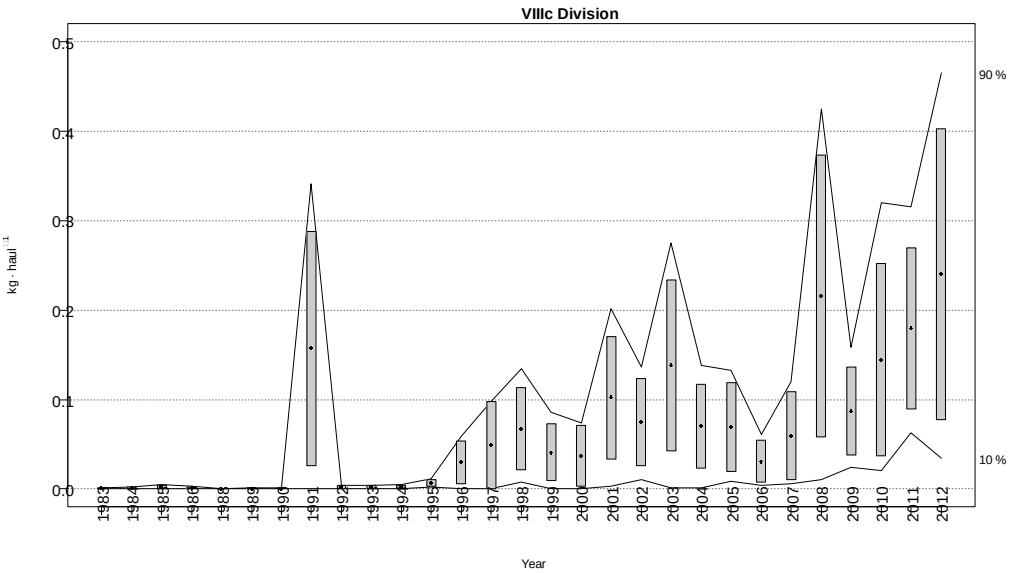



**Figure 5.18. Changes in *Etmopterus spinax* biomass index during the North Spanish shelf bottom trawl survey time-series (1983–2012 but in 1987) in the VIIIc division covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha$= 0.80, bootstrap iterations = 1000).**

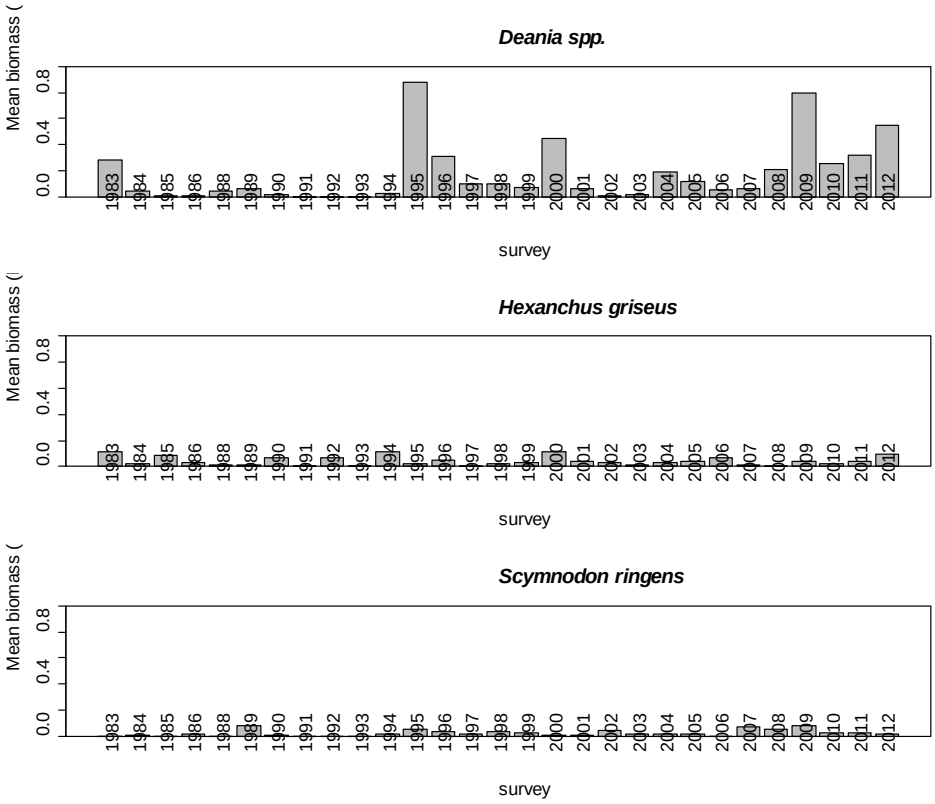



**Figure 5.19. Evolution in the catches in biomass of *Deania* spp., *Hexanchus griseus* and *Scymnodon ringens* during the North Spanish shelf bottom trawl survey time-series (1983–2012 but in 1987).**

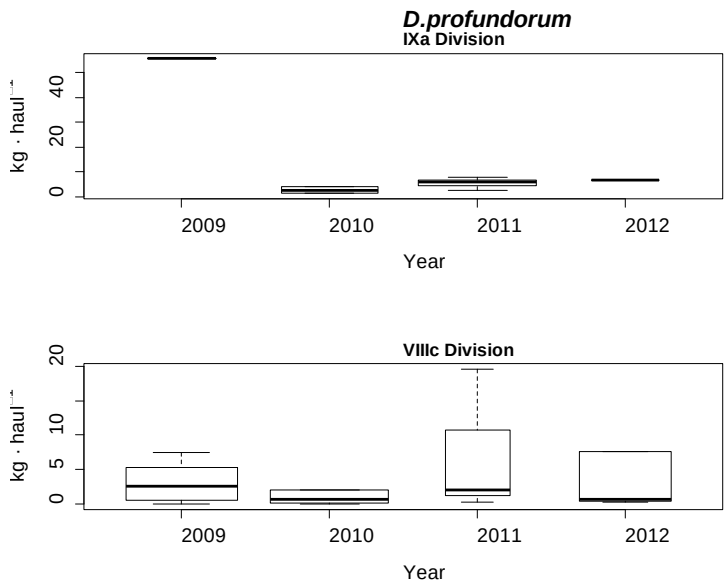



**Figure 5.20. Evolution in the catches in biomass of *Deania profundorum* between 2009 and 2012 in the two ICES divisions.**

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

## 6.1 Stock distribution

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

The information used to identify the stock unit is in the stock annex (WGEF 2011).

A transatlantic migration has been reported (Green, 2007) and more recently a porbeagle tagged with a pop-up archival transmission tag off Ireland crossed over half of the North Atlantic before the tag was released (Bendall *et al*., 2012). Furthermore, a recent work (Pade, 2009) has confirmed that some gene flow occurs across the North Atlantic.

## 6.2 The fishery

### 6.2.1 History of the fishery

The main countries catching porbeagle in the last decade were France and, to a lesser extent, Spain, UK and Norway. The only regular, directed target fishery that has existed recently was the French fishery (although there have been occasional targeted fisheries in the UK). However, historically there were important Norwegian, Danish and Faroese target fisheries. In addition, the species is taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain.

A detailed history of the fishery is in the stock annex.

### 6.2.2 The fishery in 2012

No fishery has been allowed since the implementation of a zero TAC in 2010. However, some landings are reported in 2012 as in the previous two years (Table 6.1a). The 2012 best working group estimate (48 t) is the highest figure since the zero TAC was implemented. However, it is thought that the previous two years data are underestimates, due to misreporting. Furthermore, all data since 2010 must be considered as unrepresentative of removals, as dead discards are not quantified. The landings in 2012, are reported mainly by France (27 t), with smaller contributions from Norway (17 t), Denmark (3 t) and Iceland (2 t). Landings of less than 1 t were reported by the UK, Germany and Spain, a likely consequence of bycatch in mixed fisheries.

### 6.2.3 ICES advice applicable

The advice is biennial and consequently the 2012 advice remains valid for 2013 and 2014:

"ICES advises on the basis of the precautionary approach that no fishing for porbeagle should be permitted. Landings of porbeagle should not be allowed. A rebuilding plan should be developed for this stock."

Prior to this advice, in 2008 and 2010, ICES reiterated the precautionary advice of:

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

In 2010, ICES also advised that there was no catch option that would be compatible with the ICES MSY framework. In 2012, stock status was unknown, with a qualitative evaluation indicating that the stock is depleted. No reliable quantitative assessment (or reference points) could be presented for this stock; therefore, fishing possibilities could not be projected.

### 6.2.4 Management applicable

Since 2012, EC Regulations 23/2010, 57/2011 and 44/2012 have prohibited fishing for porbeagle in EU waters and, for EU vessels, to fish for, to retain on board, to tranship and to land porbeagle in international waters.

EC Regulation 40/2008 established a TAC for porbeagle taken in EC and international waters of I, II, III, IV, V, VI, VII, VIII, IX, X, XII and XIV of 581 t. In 2009, the TAC was reduced to 436 t (a decrease of 25%) and regulations stated that "*A maximum landing size of 210 cm (fork length) shall be respected*" (EC Regulation No 43/2009).

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

EC Regulation 1185/2003 prohibits the removal of shark fins of this species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

In 2007 Norway banned all direct fisheries for porbeagle, based on the ICES advice. In the period 2007–2011, specimens taken as bycatch could be landed and sold. Since 2011, live specimens must be released, whereas dead specimens can be landed (but this is not mandatory). The number of specimens landed must be reported in addition to weight. From 2011, the regulations also include recreational fishing. However, since 2012, landings of porbeagle are not remunerated.

## 6.3 Catch data

### 6.3.1 Landings

Tables 6.1a, b and Figures 6.1–6.2 show the historical landings of porbeagle in the Northeast Atlantic. From 1971 upwards, France remained the major contributor.

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

More detailed information on landings is presented in the stock annex.

### 6.3.2 Discards

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

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

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

### 6.3.3 Quality of catch data

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

## 6.4 Commercial catch composition

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

The composition by weight class (<50 kg and ≥50 kg) of the French fishery catches reveals that the proportion of large porbeagle in the landings has decreased since 1993 (Table 6.2).

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

### 6.4.1 Conversion factors

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

## 6.5 Commercial catch-effort data

A cpue series was presented at the 2009 WGEF for the French targeted fishery (Biais and Vollette, 2009). It was based on 17 boats which had landed more than 500 kg of porbeagle per year for more than six years after 1972 and more than four years from 1999 onwards (to include a boat which has entered recently in the fishery, given the limited number of boats in recent years). This series is longer than the previous ones (in stock annex) and it provides catch and effort (days at sea) by vessel and month. A GLM analysis was carried out at 2009 ICCAT-ICES porbeagle stock assessment meeting to get a standardized cpue series.

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

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

This absence of trend in the last part of the times-series has been confirmed by an analysis of the effect of porbeagle aggregating behaviour, as well as an effect of cooperation between skippers. The analysis was carried out for years 2001–2008 for which period detailed data were available (Biais and Vollette, 2010). This analysis showed also that local abundance in the French fishing area may likely be multiplied/divided by two between successive years. Consequently, short term changes must be consid-

ered with caution when using French cpue to assess a stock abundance trend of the Northeast Atlantic stock.

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

## 6.6 Fishery-independent surveys

No fishery-independent survey data are available for the NE Atlantic, although records from recreational fisheries may be available. Tagging studies are the only fishery-independent data currently available (see Section 6.8).

## 6.7 Life-history information

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

Saunders *et al.* (2011) report on the migration of three porbeagles tagged off Ireland with archival pop-up tags (PAT) in 2008 and 2009. One shark migrated 2400 km to the northwest of Morocco, residing around the Bay of Biscay for about 30 days. The other two remained more localized in off-shelf regions around the Celtic Sea/Bay of Biscay and off western Ireland. They occupied a vertical depth range of 0–700 m in waters of 9–17°C. They were positioned higher in the water column by night than by day. The Irish tagging programme is continuing.

The United Kingdom (Cefas) launched a tagging programme in 2010 to address the issue of bycatch of porbeagle and to further promote the understanding of their movement patterns in UK marine waters. Altogether, 21 satellite tags were deployed between July 2010 and September 2011, and 15 tags popped off after two to six months. However, four tags failed to communicate. The tags attached to sharks in the Celtic Sea generally popped off to the south of the release positions while those to sharks off the northwest coast of Ireland popped off in diverse positions. One of them popped off in the western part of North Atlantic, one close to the Gibraltar Straits and another in the North Sea. Several tags popped off close to the point of release (Bendall *et al.*, 2012).

In June–July 2011, France (Ifremer and IRD) joined this international tagging effort in cooperation with Cefas by a survey on the shelf edge in the West of Brittany. Three PATs were deployed by Ifremer-IRD and three by Cefas (results in Bendall *et al.*, 2012). Pop off dates were set at 12 months for three Ifremer-IRD PSATs which were all used to tag large females (LT>2 m). One has popped off prematurely in February 2012 near Norway, a bit north of the Arctic Circle. The two others popped off after 12 months according to schedule, rather close to the tagging position. They revealed large migrations of these sharks; going westwards up to Mid-Atlantic Ridge for one of them and from latitudes comprise between 60°N and 36°S (Gibraltar). The French tagging programme have deployed nine more PATs in June 2013, again attached on large females (mean LT= 2.35 m) and for a planned release at twelve months.

Information on sex-ratio segregations, the likelihood of a nursery ground in the Saint Georges Channel, the diet and on life-history parameters were provided by a research programme carried out by the NGO APECS (Hennache and Jung, 2010) and are available in the stock annex.

Since the cessation of target fisheries, there are some limited data (n=19) available for bycaught porbeagle in the Celtic Sea (Bendall *et al.*, 2012). The length–frequencies ranged from 117–250 cm total length (Figure 6.6), with corresponding body weights

of 12–94 kg. There was an even sex ratio, indicating that in this area (during September 2011) the sexes mixed, with fully mature males, but no fully mature female fish represented in the bycatch.

### 6.7.1 Genetic information

A preliminary study of the genetic diversity (mitochondrial DNA haplotype and nucleotide diversities) was carried out recently on 156 individuals from the Northeast Atlantic and Northwest Atlantic, demonstrating no significant population structure across the North Atlantic. It has shown mtDNA haplotype diversity is very high, and sequence diversity is low, suggesting that most females breed, indicating the stock is likely to be genetically robust (Pade, 2009), although further confirmation is required.

## 6.8 Exploratory assessment models

### 6.8.1 Previous studies

The first assessment of the NE Atlantic stock was carried out in 2009 by the joint ICCAT/ICES meeting using a Bayesian Surplus Production (BSP) model (Babcock and Cortes, 2009) and an age structured production (ASP) model (Porch *et al.*, 2006).

### 6.8.2 Stock assessment

The 2009 assessments have not been updated since.

#### * BSP model

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

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

#### *ASP model

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

Depending on the assumed F in the historic period (the model estimated value was considered to be unrealistic), the 2008 relative spawning–stock fecundity (SSF2008/SSFMSY) was estimated between 0.21 and 0.43 and the 2008 relative fishing mortality rate ($F_{2008}$ /$F_{MSY}$) between 2.54 and 3.32.

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

### 6.8.3 Stock projections

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

#### Yield and biomass per recruit

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

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

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

### 6.8.4 Population dynamics model

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

## 6.9 Quality of assessments

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

Hence, it must be noted that:

- There was a lack of cpue data for the peak of the fishery.
- Catch data are considered underestimates, as not all nations have reported catch data throughout the time period.
- The cpue index used in the assessment was French fleet catch per day. An analysis carried out on years 2001–2008 shows that local abundance varies

likely a lot between consecutive years in the French fishing area. Hence, this series may not be reflective of stock abundance.

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

## 6.10 Reference points

No reference points have been proposed for this stock.

ICCAT uses $F/F_{MSY}$ and $B/B_{MSY}$ as reference points for stock status of pelagic shark stocks. These reference points are relative metrics rather than absolute values. The absolute values of $B_{MSY}$ and $F_{MSY}$ depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

## 6.11 Conservation considerations

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

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

In 2013, a renewed proposal to list porbeagle shark on Appendix II of CITES was accepted at the Conference of Parties (16) Bangkok. However, the implementation of this listing has been delayed by 18 months (14 September 2014) to enable Range States and importing States to address potential implementation issues.

## 6.12 Management considerations

WGEF/ICCAT considered all available data in 2009. This included updated landings data and cpue from the French and Spanish fisheries. An analysis of the French cpue was undertaken in 2010. It showed that large changes of local abundance may occur in the fishing area and consequently, these cpue should be used with caution to get an abundance index as long as information on porbeagle spatial distribution remains limited.

Using the French cpue series as well as the Spanish cpue series (Figure 6.5), stock projections based on the BSP model demonstrated that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and that the recovery to $B_{MSY}$ could be achieved within 25–50 years under nearly all model scenarios. However, management should account for both the uncertainty in the input parameters for this assessment and the low productivity of the stock.

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

The Norwegian and Faroese fisheries have ceased and have not resumed. That no fisheries had developed before restrictive quotas were put in place is considered by WGEF to indicate that the stock had not recovered. However, the time that has elapsed since the end of the northern fisheries is probably longer than the generation time of the stock, so recovery may have taken place although not detected. However, the social and economic environment may have changed too much to allow fisheries resumption in the same countries and fisher knowledge may have been lost. Furthermore, feeding grounds may have moved in relation with changes in prey abundance and distribution. But, in the absence of any quantitative data to demonstrate

stock rebuilding, and in regard of this species' low reproductive capacity, WGEF considers the stock is probably still depleted.

WGEF considers that target fishing should not proceed without a programme to evaluate sustainable catch levels. However, WGEF underlined that the present fishing ban hampers any quantitative assessment in the near future.

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

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

Studies on porbeagle bycatch should be continued to get operational ways to reduce bycatch and to improve the post-release survivorship of discarded porbeagle.

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

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

## 6.13 References

Babcock, B. A., and Cortes, E. 2009. Bayesian surplus production model applied to porbeagle catch, cpue and effort data. ICCAT, Collective Volume of Scientific Papers, SCRS/2009/068, 7pp.

Bendall, V. J., Ellis, J. R., Hetherington, S. J., McCully, S. R., Righton, D., and Silva, J. R. 2012. Preliminary observation on the biology and movements of porbeagle *Lamna nasus* around the British Isles. Working document to the ICES Working Group on Elasmobranch Fishes, Lisbon, June 19–26 2012.

Biais, G., and Vollette, J. 2009. Cpue of the French porbeagle fishery. WGEF Working Document. 3 pp.

Biais, G., and Vollette, J. 2010. The use of the French long line cpue to provide an abundance index for porbeagle in the North East Atlantic. ICES Annual Science Conference, Nantes, 20–24 September 2010, Poster ICES CM 2010 / E:42.

Campana, S.E., Gibson, A.J.F., Fowler, M., Dorey A. and Joyce, W. 2013. Population dynamics of Northwest Atlantic porbeagle (*Lamna nasus*), with an assessment of status and projections for recovery. Canadian Science Advisory Secretariat. Research Document 2012/096: 88 p.

Ellis, J. R., and Shackley, S. E. 1995. Notes on porbeagle sharks, *Lamna nasus*, from the Bristol Channel. Journal of Fish Biology, 46: 368–370.

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

Hennache, C. and Jung, A. 2010. Etude de la pêche palangrière de requin taupe de l'île d'Yeu. Rapport Final. Association pour l'étude et la conservation des sélaciens (APECS), http://www.asso-apecs.org/IMG/pdf/APECS_EPPARTIY_Rapport_ final_BD.pdf. 64pp.

ICCAT. 2009. Report of the 2009 Porbeagle Stock Assessments Meeting. Copenhagen, Denmark, 22–27 June, 2009. ICCAT, Collective Volume of Scientific Papers, SCRS/2009/014. 42pp.

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

ICES. 2009. Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. 90 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.

Mejuto, J., and Garcés, A. G. 1984. Shortfin mako, *Isurus oxyrinchus*, and porbeagle, *Lamna nasus*, associated with longline swordfish fishery in NW and N Spain. ICES CM 1984/G:72 Demersal Fish Committee.

Mejuto, J., Ortiz, J., García-Cortés, B., Ortiz de Urbina, J. and Ramos-Cartelle, A. M. 2009. Historical data and standardized catch rates of porbeagle (*Lamna nasus*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*Xiphias gladius*) in the Atlantic Ocean. ICCAT, Collective Volume of Scientific Papers , SCRS/2009/053. 23 pp.

Pade, N. 2009. Molecular and Spatial Ecology of Porbeagle Sharks, *Lamna nasus* (Bonnaterre, 1788), in the North Atlantic Ocean. Unpublished PhD thesis, University of Aberdeen, Scotland.

Porch, C. E., Eklund, A-M. and Scott, G. P. 2006. A catch-free stock assessment model with application to goliath grouper (*Epinephelus itajara*) off southern Florida. Fishery Bulletin, 104(1): 89–101.

Saunders, R. A., Royer, F., and Clarke, M. W. 2011. Winter migration and diving behaviour of porbeagle shark, *Lamna nasus*, in the Northeast Atlantic. ICES Journal of Marine Science, 68(1): 166–174.

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

Stevens, J., Fowler, S. L., Soldo, A., McCord, M., Baum, J., Acuña, E. and Domingo, A. 2006a. *Lamna nasus* (Northeast Atlantic subpopulation). In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.2. www.iucnredlist.org.

Stevens, J., Fowler, S. L., Soldo, A., McCord, M., Baum, J., Acuña, E., and Domingo, A. 2006b. *Lamna nasus* (Northwest Atlantic subpopulation). In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.2. <www.iucnredlist.org>.

**Table 6.1a. Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2012). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.**

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

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

**Table 6.1a. (continued). Porbeagle in the NE Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2012). Data derived from ICCAT, FAO, ICES and national data. Data are considered an underestimate.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 107 | 73 | 76 | 42 | 21 | 20 | 4 | 3 | 2 | 2 | 4 | 0 | 2 | 3 |
| Faroe Is | 10 | 13 | 8 | 10 | 14 | 5 | 19 | 21 | 13 | 11 | 13 | 14 | NA | 0 |
| France | 273 | 361 | 339 | 439 | 394 | 374 | 246 | 185 | 347 | 239 | 305 | 9 | 2 | 27 |
| Germany | 0 | 17 | 1 | 3 | 5 | 6 | 5 | 0 | | 2 | 0 | 0 | 0 | 0 |
| Iceland | 3 | 2 | 4 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 2 |
| Ireland | 8 | 2 | 6 | 3 | 11 | 18 | 3 | 4 | 8 | 7 | 3 | 0 | 0 | 0 |
| Netherlands | . | 0 | | | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| Norway | 34 | 23 | 17 | 14 | 19 | 24 | 11 | 27 | 10 | 12 | 10 | 12 | 10 | 17 |
| Portugal | 0 | 15 | 4 | 11 | 4 | 57 | 10 | 6 | 2 | 1 | 0 | 0 | 0 | 0 |
| Spain | 15 | 11 | 23 | 49 | 22 | 9 | 10 | 26 | 6 | 143 | 73 | 60 | 2 | 0 |
| Sweden | 1 | 1 | 1 | . | . | 5 | 0 | . | 1 | 0 | 0 | 0 | 0 | 0 |
| Spain (Basque Country) | 41 | 38 | 45 | 16 | 22 | 10 | 11 | 5 | 16 | 13 | 3 | 0 | 0 | 0 |
| UK(Eng, Wal & Nl) | 6 | 7 | 10 | 7 | 25 | 24 | 24 | 11 | 26 | 14 | 11 | 0 | 0 | 0 |
| UK(Scot) | . | . | 1 | . | . | . | . | . | . | 1 | 0 | 2 | 0 | 0 |
| Japan | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | 0 |
| Total | 498 | 563 | 535 | 596 | 537 | 553 | 343 | 289 | 431 | 446 | 423 | 98 | 17 | 48 |

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

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

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

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

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

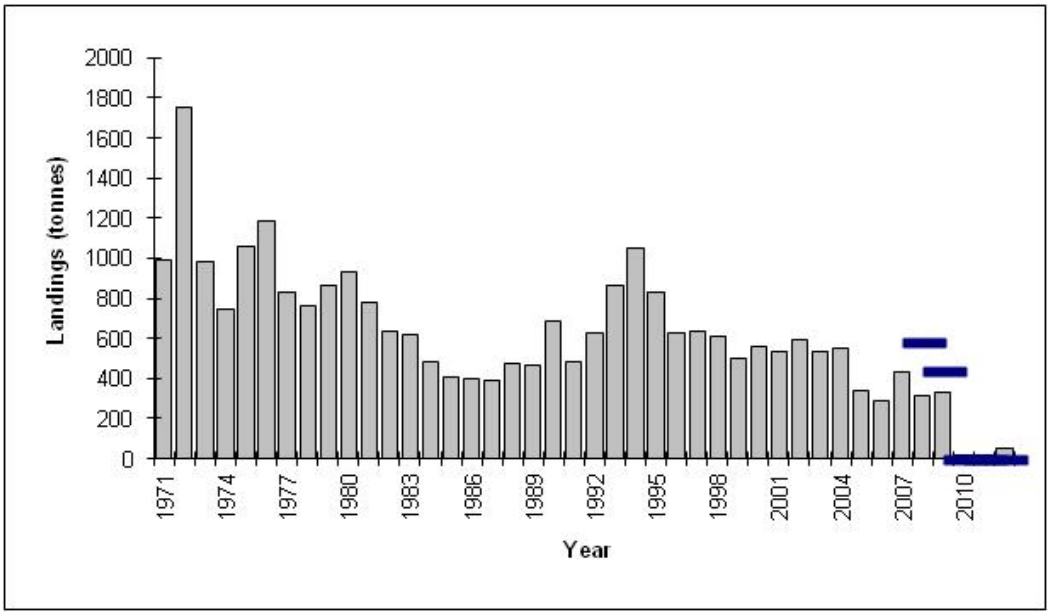
| Stock | L–W relationship | Sex | n | Length range | Source |
|---|---|---|---|---|---|
| NW Atlantic | W = (1.4823 x 10–5) LF 2.9641 | C | 15 | 106–227 cm | Kohler *et al.*, 1995 |
| NE Atlantic (Bristol Channel) | W = (1.292 x 10–4) LT 2.4644 | C | 71 | 114–187 cm | Ellis and Shackley, 1995 |
| NE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

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

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

**Table 6.5. Fishing mortality, yield, biomass and SSB relative to that achieved at the effort level corresponding to the $F_{0.1}$ level for a flat-topped selection pattern with maximum selection-at-age 3.**

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



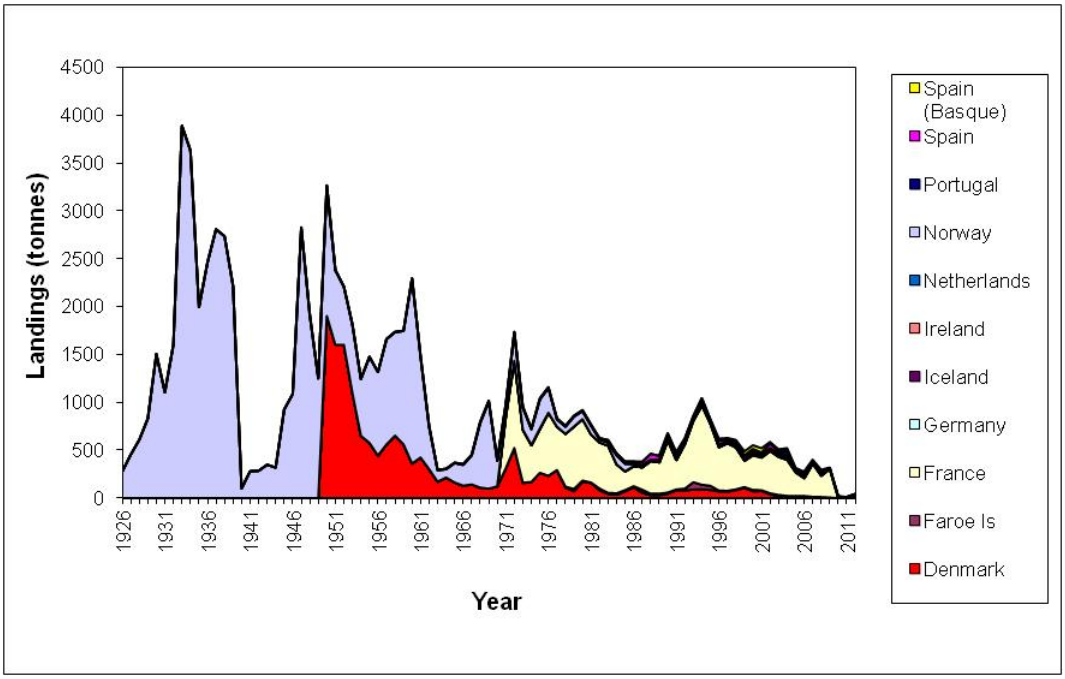




**Figure 6.1. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2012 (top, black lines indicates 2008–2012 TAC) and longer term trend in landings (1926–2012) for those fleets reporting catches.**

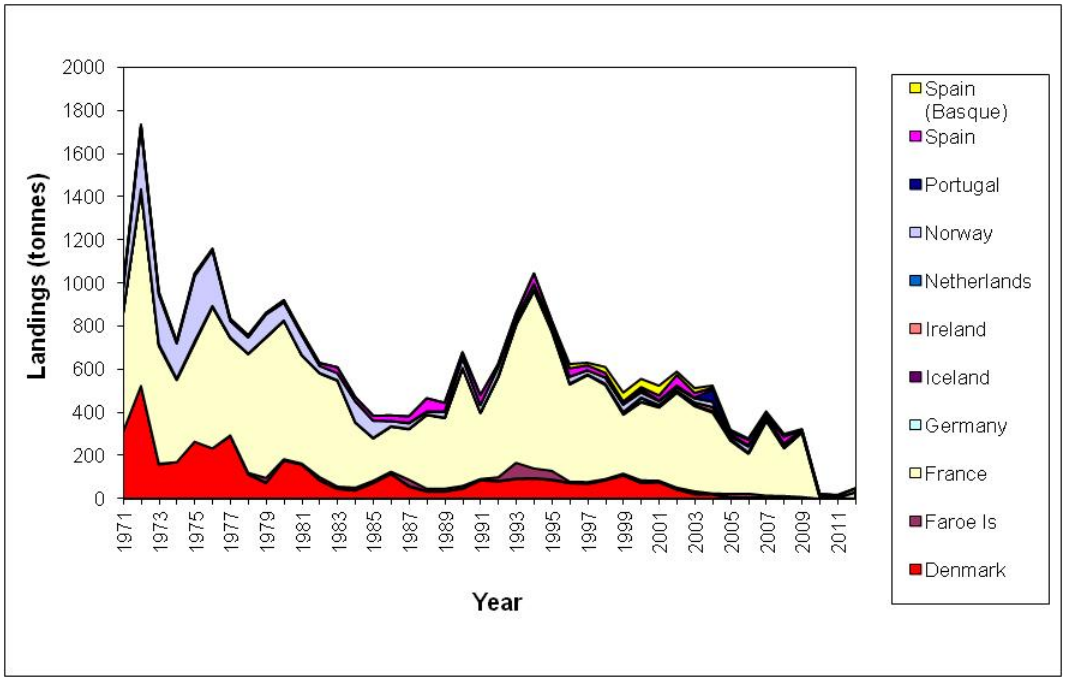



**Figure 6.2. Porbeagle in the NE Atlantic. Working Group estimates of landings of porbeagle in the NE Atlantic for 1971–2012 by country.**

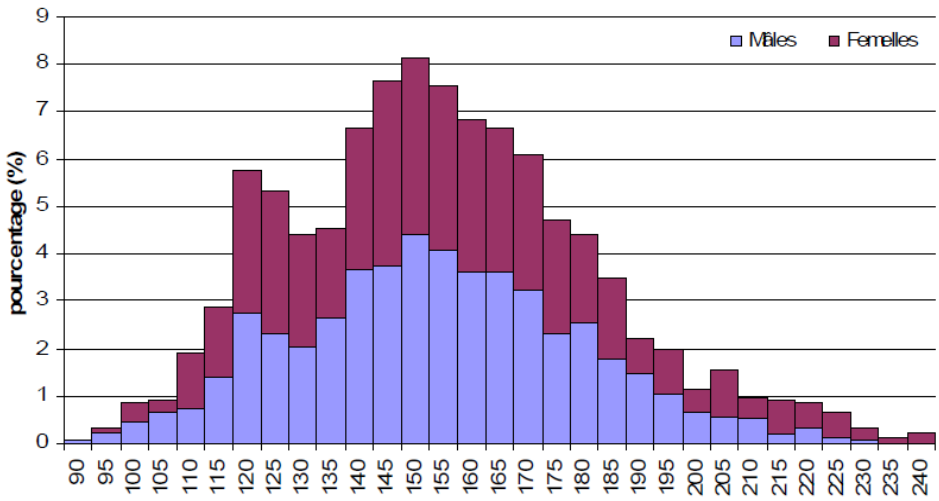



**Figure 6.3. Porbeagle in the NE Atlantic. Length–frequency distribution of the landings of the Yeu porbeagle targeted fishery in 2008–2009 (n =1769). Source: Hennache and Jung, 2010.**

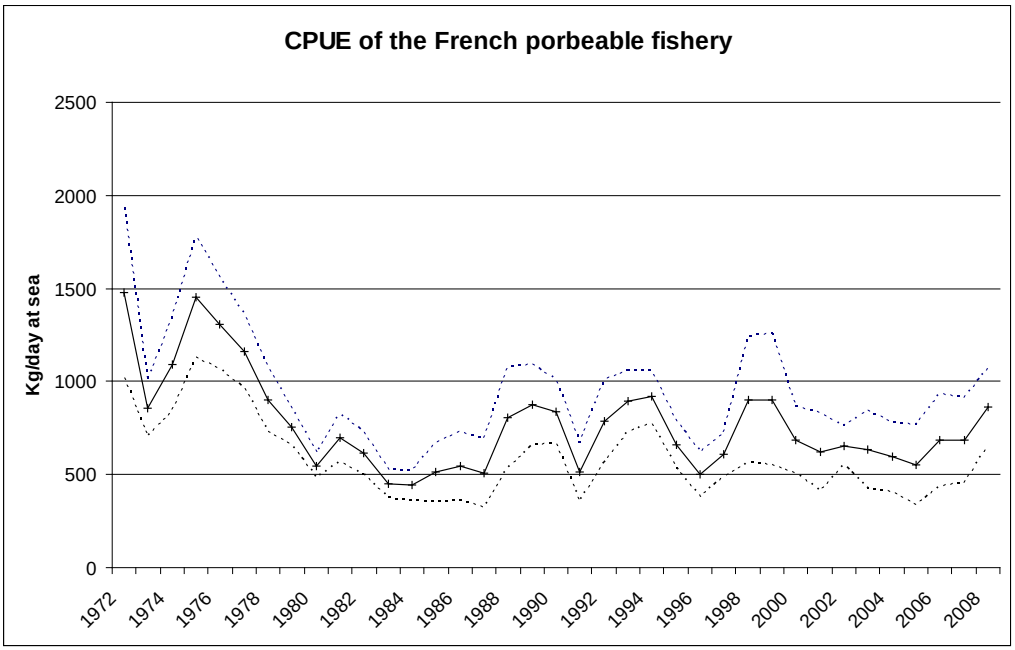



**Figure 6.4. Porbeagle in the NE Atlantic. Nominal cpue (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (±2 SE of ratio estimate). From Biais and Vollette, 2009.**

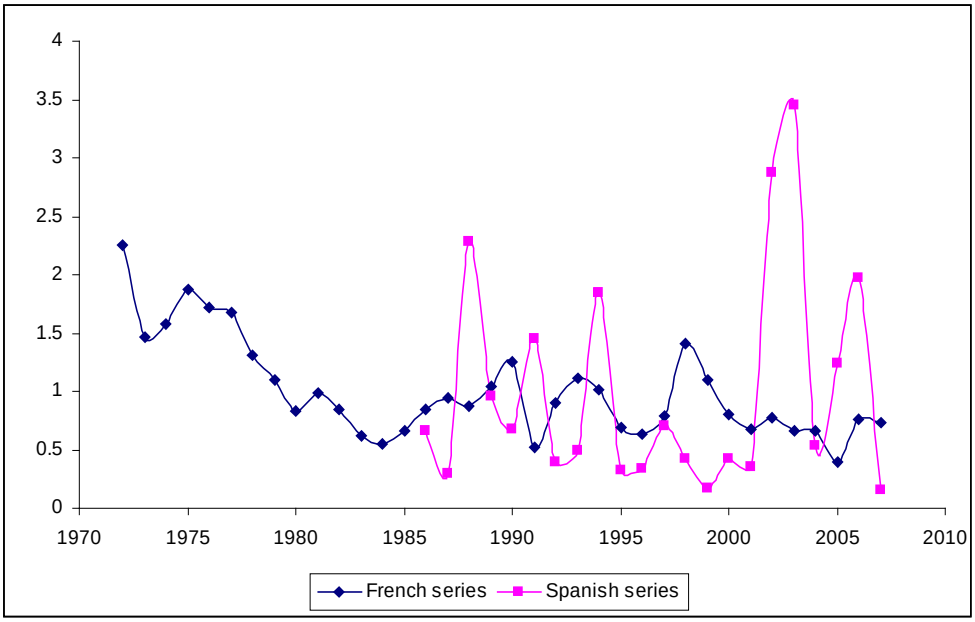



**Figure 6.5. Porbeagle in the NE Atlantic. Temporal trends in standardized cpue for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the NE Atlantic (1986–2007).**

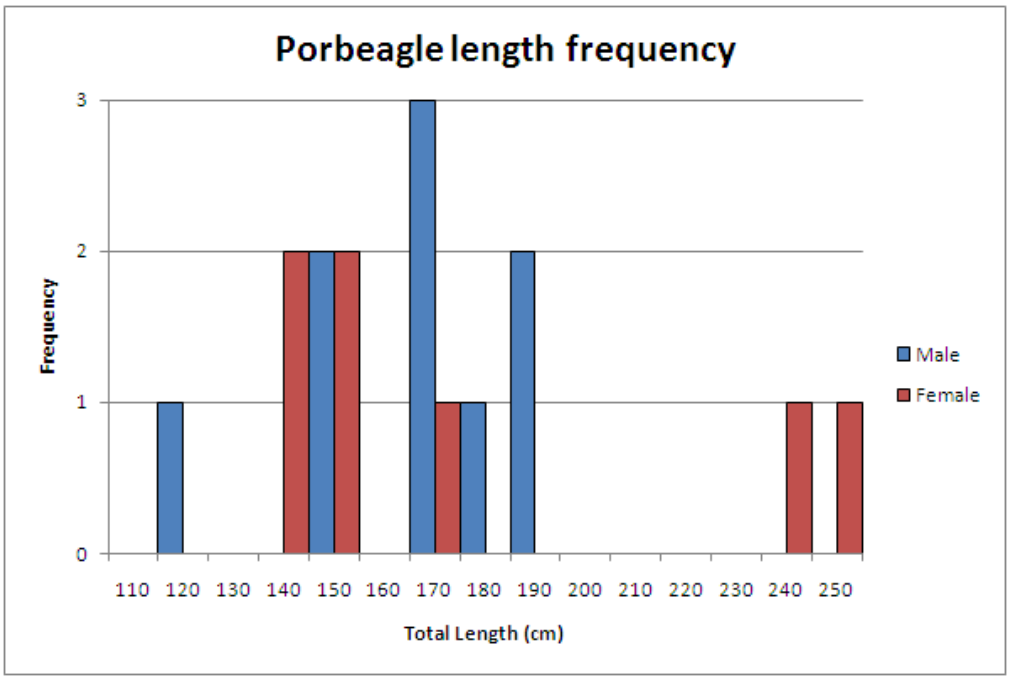



**Figure 6.6. Length–frequency distribution of male and female porbeagle bycaught in fixed gill-nets within ICES Divisions VIIf–h during September 2011 (Bendall *et al.*, 2012).**

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

## 7.1 Stock distribution

In the eastern Atlantic, basking shark *Cetorhinus maximus* is present from Iceland, Norway and as far north as the Russian White Sea (southern Barents Sea) extending south to the Mediterranean (Compagno, 1984; Konstantinov and Nizovtsev, 1980). WGEF considers that basking shark in the ICES area exists as a single stock and management unit. However, the WGEF is aware of recent tagging studies demonstrating both transatlantic and transequatorial migrations, as well as migrations into tropical areas and mesopelagic depths (Gore *et al*., 2008; Skomal *et al*., 2009). Marked seasonality of basking shark sightings and significant correlation between the duration of the sightings season in each year and the North Atlantic Oscillation, has been reported (Witt *et al*., 2012). A genetic study by Hoelzel *et al*. (2006) indicates panmixia, whereas Noble *et al*. (2006) suggested little gene flow between populations in the northern and southern hemispheres. A rough estimate of the population size was given by Hoelzel *et al*. (2006). Migration and mixing levels have yet to be fully determined.

## 7.2 The fishery

### 7.2.1 History of the fishery

The fishery for basking sharks goes back as far as the middle or end of the 1700s, both in Norwegian, Irish and Scottish waters (Moltu, 1932; Strøm, 1762; Parker and Stott, 1965; Myklevoll, 1968; McNally, 1976; Fairfax, 1998)., Up to 1000 individuals may have been taken in Irish waters each year at the height of the fishery. All fisheries stopped during the mid-1800s when the sharks became very scarce.

The Norwegian fleet resumed the fishery in 1920. The landings increased during the 1930s as the fishery gradually expanded to offshore waters across the North Sea and south and west of Ireland, Iceland and Faroes. During 1959–1980, catches ranged between 1266 and 4266 sharks per year, but subsequently declined (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changed markedly from year to year, possibly as a consequence of the unpredictable nature of the shark's inshore migration (Stott, 1982).

In Irish waters the basking shark fishery started again in 1947. Between 1000 and 1800 sharks were taken each year from 1951 to 1955 (an average of 1475/year), but there was a decline in catch records from 1956. Average annual catches were 489 individuals from 1956–1960, 107 individuals from 1961–1965, then about 50–60 individuals per year for the remaining years of the fishery (Parker and Stott, 1965; McNally, 1976).

The Scottish fishery started up in the 1940s. In all around 970 sharks were taken between 1946 and 1953 (during a period when Norwegian vessels were also catching basking sharks in these waters).

From 1977–2007, an estimated total of 12 347 basking sharks were caught by Norway and Scotland, and of these Norway landed 12 014 individuals with an annual maximum of 1748 individuals landed in 1979 (Figure 7.1).

Data from the Norwegian Directorate of Fisheries revealed that the nominal value of fins increased dramatically from 1979 to 1992, was variable during 1993–2005, and decreased after 2005.

Further information on the history of the fishery is included in the stock annex.

### 7.2.2 The fishery in 2012

There was no directed fishery for basking sharks in Norway, UK or Ireland in 2012. Five basking sharks (22 t) were caught and landed as dead bycatch in Norway in 2012.

### 7.2.3 ICES advice applicable

ICES advice has been for a zero TAC since 2006. In 2010, the advice for 2011 and 2012 was: "Zero TAC. Basking shark should remain on the prohibited species list of the EU TAC regulation."

### 7.2.4 Management applicable

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

Based on ICES advice, Norway banned all directed fisheries and landing of basking shark in 2006 in the Norwegian Economical Zone and in ICES Areas I–XIV, and the ban has continued in 2007–2012. Live specimens caught as bycatch have to be released immediately, although dead or dying specimens can be landed. Since 2012, landings of basking sharks are not remunerated. Bycatch that is not landed should still be reported (since 2012). Bycatch should be reported both in number of individuals and weight (since 2009).

The basking shark has been protected from killing, taking, disturbance, possession and sale in UK territorial (twelve nautical miles) waters since 1998. They are also protected in two UK Crown Dependencies: Isle of Man and Guernsey (Anon., 2002).

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

## 7.3 Catch data

### 7.3.1 Landings

Landings data within ICES Areas I–XIV from 1977–2011 are presented in Table 7.1, and Figure 7.1. Landings of basking shark peaked in 1979 at a total of 5266 t, and declined rapidly towards 1988. A new peak in landings was seen in 1992, with 1697 t basking shark landed. Since the ban in direct fishery in 2006/2007, yearly landings have been <30 t.

Reported landings data come from UK (Gue.; 1984 and 2009), Portugal (1991–2008), France (1990–2008) and Norway (1977–2011). Most catches are from Subareas I, II and IV and are taken by Norway. For Portugal and France the reported landings were between 0.3 and 2 t. Landings for Portugal in 2004 and 2007 from FishStat were higher, but needs to be confirmed.

Catch in numbers from Scotland and Norway (2007–2012) are presented in Figure 7.2. The trends are very similar to those of landings in biomass, with a first maximum of 1748 individuals in 1979, a second maximum of 573 individuals in 1992, and less than ten individuals after 2006.

The conversion factors used for Norwegian landings (liver and fin weight to live weight) were revised during ICES WGEF 2008. Table 7.2 shows old and revised numbers.

Table 7.3 shows the proportions (%) of basking sharks caught by various gears as reported to the Directorate of Fisheries in Norway from 1990–2011. Harpoon was the major gear during most of the 1990s, but remained at a relatively low level from 2000, except for 2005 which was the last year with directed fishery. After the ban of directed fishery was introduced in 2006, bycatch has been taken primarily in gillnets.

Further information on Norwegian landings of liver and fins, and corresponding official and revised landings in live weight and numbers is included in the stock annex.

### 7.3.2 Discarded bycatch

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

Berrow (1994) estimated 77–120 sharks were caught annually in the gillnet fishery in the Celtic Sea. Berrow and Heardman (1994) received 28 reports on sharks being entangles in fishing gear around the Irish coast in 1993. In the Isle of Man, bycatch in herring and pot fishery (entanglement in ropes) amounts to 14–20 sharks annually. Bonfil (1994) estimated that 50 sharks were taken annually by the oceanic gillnet fleet in the Pacific Ocean. Fairfax (1998) reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter, and Valeiras *et al.* (2001) reported that of twelve reported basking sharks that were incidentally caught in fixed entanglementnets in Spanish waters between 1988 and 1998, three sharks were sold on at landing markets, three live sharks were released, and three dead sharks were discarded at sea. More detailed information can be found in the stock annex.

The French NGO APECS reported on 15 accidental bycatches (Jung *et al.*, 2012). The bycatches were from the Iroise Sea, Atlantic Ocean and Mediterranean. Data on these bycatches with catch location, gear, and biological data can be found in Table 7.4 together with similar data on eleven bycatches from the Norwegian coast, published in Norwegian media.

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

Five specimens of basking shark were caught and discarded by the Norwegian Coastal Reference Fleet in 2007–2009 (Vollen, 2010 WD). All specimens were caught in gillnets by vessels <15 m in ICES Subdivision II.

The requirement for EU fleets to discard all basking sharks caught as bycatch means that information cannot be obtained on these catches. A better protocol for recording and obtaining scientific data from bycatches is necessary for assessing the status of the stock.

### 7.3.3 Quality of the catch data

The official Norwegian conversion factor used to convert from liver weight and fin weight to live fish was revised in 2008 (Table 7.2). The official Norwegian catch statistics were unchanged from 1977 to 1999, but from 2000–2008 the revised catch figures are applied.

Further information on the revision of the conversion factor is included in the stock annex.

## 7.4 Commercial catch composition

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

## 7.5 Commercial catch-effort data

There are no effort or catch per unit of effort (cpue) data available for the latest years, as there has been no targeted fishery.

Cpue data from the Norwegian fishery in 1965–1985 can be found in the stock annex.

## 7.6 Fishery-independent surveys

Several countries, e.g. Norway, Denmark, Ireland, conduct scientific whale counting surveys. During these surveys observations of basking sharks are normally noted. All French scientific surveys (MEDIT, EVHOE, PELGAS, etc.) as well as military planes and vessels collect the basking shark sightings and report them annually to NGO APECS. A national sight counting program also exists on all the coasts of France; most of the contributions comes from sailors or fishers. A number of Norwegian commercial vessels also regularly report observations of whales. A request for reporting the sightings of basking sharks might yield useful effort-related data.

## 7.7 Life-history information

A summary of the knowledge of basking shark habitat, reproduction, growth and maturity, food and feeding, and behaviour can be found in the stock annex.

### Habitat

In a study from 2008, the Irish Basking Shark Study Group tagged two basking sharks with archival satellite tags (Berrow and Johnston, 2010 WD). Both sharks remained on the continental shelf for most of the tagging period. Shark A spent most time in the Irish and Celtic Seas with evidence of a southerly movement in winter to the west coast of France (Figure 7.3). Movements of Shark B were more constrained, remaining off the southwest coast for the whole period with locations off-the-shelf edge and in the Porcupine Bight (Figure 7.3). The greatest depths recorded were 144 m and 136 m, respectively, demonstrating that although Shark B was located over deep water off-the-shelf edge, it was not diving to large depths. The sharks were within 8 m of the surface for 10% and 6% of the time. The study demonstrated that basking sharks were present in Irish waters throughout the winter period and were active and did not hibernate.

French national sigthing program reports about 90 basking sharks encountered off the French coasts every year. The maximum of sighting occurs in May, the two majors areas are the south of Brittany and the Casquet in The Chanel (Jung *et al.*, WD 2012). Early sightings are reported off the island of Corsica in February–March; in 2011 one basking shark were reported in Saint Pierre et Miquelon.

Skomal *et al.* (2009) shed further light on apparent winter disappearance of the basking shark. Through satellite archival tags and a novel geolocation technique they demonstrated that sharks tagged in temperate feeding areas off the coast of southern

New England moved to the Bahamas, the Caribbean Sea, and onward to the coast of South America and into the southern hemisphere. When in these areas, basking sharks descended to mesopelagic depths (200–1000 m) and in some cases remained there for weeks to months at a time. The authors concluded that basking sharks in the western Atlantic Ocean, which is characterized by dramatic seasonal fluctuations in oceanographic conditions, migrate well beyond their established range into tropical mesopelagic waters. In the eastern Atlantic Ocean, however, only occasional dives to mesopelagic depths have been reported in equivalent tagging studies (Sims *et al.*, 2005). It is hypothesized that, in this area, the relatively stable environmental conditions mediated by the Gulf Stream may limit the extent to which basking sharks need to move during winter to find sufficient food.

The NGO APECS tagged ten basking sharks in 2009 (Stéphan *et al.*, 2011). The sharks were tagged with pop-up archival tags (PATs). Eight PATs were deployed in the Irish Sea in cooperation with the Manx Wildlife Trust and three PATs in the Iroise Sea (West Brittany). The PATs released from five to 245 days later. All the sharks tagged in the Irish Sea moved southwards, within the Irish Sea or to the Celtic Sea and, one of them, to the south of the Bay of Biscay. One of the PATs set in the Iroise Sea in 2009 popped off after five days but the second after 38 days and, during this short period, the shark moved quickly northwards, up to West Scotland by the west of Ireland. In 2010–2012, PATs have also been deployed by APECS (2011 only), Manx Basking Shark Watch and the Irish Basking Shark Study Group. Data processing of transmitted information has not yet been completed.

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

Manx Basking Shark Watch deployed five SPOTs in June 2013 off the Isle of Man; APECS deployed a PAT tag on a 6 meter female in Brittany for eight months' data collection.

## 7.8 Exploratory assessment models

No assessments have been undertaken.

## 7.9 Quality of assessments

No assessments have been undertaken.

Further information on migration on and stock mixing is required.

## 7.10 Reference points

No reference points have been proposed for this stock.

## 7.11 Conservation considerations

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

The Northeast Atlantic subpopulation of basking shark is listed as "Endangered" in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species. Globally, the species is listed as "Vulnerable" (IUCN, 2012).

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

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

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

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

## 7.12 Management considerations

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

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

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

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

## 7.13 Spatial information

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

## 7.14 References

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

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.

Berrow, S. D. and Johnston, E. 2010. Basking shark telemetry and tracking in Ireland. Working document for ICES Elasmobranch Working Group (WGEF) 2010.

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

Compagno, L. J. V. 1984. ''FAO Species Catalogue. IV. Sharks of the World. 1. Hexanchiformes to Laminiformes.'' Food and Agriculture Organisation of the United Nations, Rome.

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

Gore, M., Rowat, D., Hall, J., Gell, F. R., and Ormond, R. F. 2008. Trans-Atlantic migration and deep mid-ocean diving by basking shark. Biol. Lett. 4: 395–398.

Hoelzel, A. R., Shivji, M. S., Magnussen, J., and Francis, M. P. 2006. Low worldwide genetic diversity in the basking shark (*Cetorhinus maximus*). Biol. Lett. 2: 639–642.

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

IUCN. 2012. IUCN Red List of Threatened Species. Version 2012.1. http://www.iucnredlist.org>. Downloaded on 22 June 2012.

Jung, A., Wargnier, A., Stéphan, E. and Lefranc, A. 2012. APECS Elasmobranch observation programs off French coasts. Working Document. ICES Working Group on Elasmobranch Fisheries. WD2012-17. 3 pp.

Konstantinov, K. G., and Nizovtsev, G. P. 1980. The basking shark *Cetorhinus maximus*, in Kandalaksha Bay of the White Sea. J. Ichthyol. 19: 155–156.

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.

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.

Sjøtun, K., Fredriksen, S., Heggøy, E., Husa,V., Langangen, A., Lindstrøm, E-A., Moy, F., Rueness, J. and Åsen, P. A. 2010. Cyanophyta, Rhodophyta, Chlorophyta, Ochrophyta – In: Kålås, J.A., Viken, Å., Henriksen, S. and Skjelseth, S. (eds.) 2010. The 2010 Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Norway.

Stéphan E., Gadenne H. and Jung A. 2011. Sur_les_traces_du_requin_pelerin. Rapport final du programme de suivi par satellite de requins pèlerins en Atlantique Nord-Est,http://www.asso-apecs.org/IMG/pdf/Rapport_finalSur_les_traces_du_requin_pelerin_-_Fev_2011.pdf, 37p.

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.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working document for ICES Elasmobranch Working Group (WGEF) 2010.

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

Witt, M.J., Hardy, T., Johnson, L., Mcclellan, C.M., Pikesley, S.K., Ranger, S., Richardson, P.B., Solandt, J.-L., Speedie, C., Williams, R. and Godley, B.J. 2012. Basking sharks in the northeast Atlantic: spatio-temporal trends from sightings in UK waters. Marine Ecology Progress Series 459: 121–134.

Witt, M.J., Doherty, P.D., Hawkes, L.A., Brendan J. Godley, B.J., Graham, R.T., and Henderson, S.M. 2013. Basking shark satellite tagging project: post-fieldwork report. *Scottish Natural Heritage Commissioned Report* No. 555.

**Table 7.1. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2010. "."=zero catch, "+" = <0.5 t.**

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I & II | 3680 | 3349 | 5120 | 3642 | 1772 | 1970 | 967 | 873 | 1465 | 1144 | 164 | 96 |
| III & IV | . | . | . | . | . | . | 734 | 1188 | . | . | . | 10 |
| Va | . | . | . | . | . | . | . | . | . | . | . | . |
| Vb | . | 14 | . | 83 | 28 | . | . | . | . | . | . | . |
| VI | . | . | . | . | . | . | . | . | . | . | . | . |
| VII | . | 278 | 139 | . | . | 186 | 60 | 1 | . | . | . | . |
| VIII | . | . | 7 | . | . | . | . | . | . | . | . | . |
| IX | . | . | . | . | . | . | . | . | . | . | 1 | . |
| X | . | . | . | . | . | . | . | . | . | . | . | . |
| XII | . | . | . | . | . | . | . | . | . | . | . | . |
| XIV | . | . | . | . | . | . | . | . | . | . | . | . |
| TOTAL | 3680 | 3641 | 5266 | 3725 | 1800 | 2156 | 1761 | 2062 | 1465 | 1144 | 165 | 106 |
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| I & II | 593 | 781 | 533 | 1613 | 1374 | 920 | 604 | 792 | 425 | 55 | 31 | 117 |
| III & IV | . | 116 | 220 | 84 | . | 157 | 23 | . | 43 | . | . | . |
| Va | . | . | . | . | . | . | . | . | . | . | . | . |
| Vb | . | . | . | . | . | . | . | . | . | . | . | . |
| VI | . | . | . | . | . | . | . | . | . | . | . | . |
| VII | . | . | . | . | . | . | . | . | . | . | . | . |
| VIII | . | 1 | + | + | . | + | 1 | + | 2 | 1 | 1 | 1 |
| IX | + | . | + | + | + | 1 | 1 | 1 | 1 | . | 1 | 1 |
| X | . | . | . | . | . | . | . | . | . | . | . | . |
| XII | . | . | . | . | . | . | . | . | . | . | . | . |
| XIV | . | . | . | . | . | . | . | . | . | . | . | . |
| TOTAL | 593 | 897 | 753 | 1697 | 1374 | 1078 | 629 | 793 | 471 | 56 | 33 | 119 |
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| I & II | 80 | 54 | 128 | 72 | 87 | 6 | 26 | 4 | . | . | 4 | 22 |
| III & IV | . | + | . | . | . | . | . | . | . | . | . | |
| Va | . | . | . | . | . | . | . | . | . | . | . | |
| Vb | . | . | . | . | . | . | . | . | . | . | . | |
| VI | . | . | . | . | . | . | . | . | . | . | . | |
| VII | . | . | . | . | 1 | + | . | + | + | . | . | |
| VIII | . | . | . | . | + | + | + | 2 | . | . | . | |
| IX | 2 | 1 | 1 | 1 | 2 | . | 8 | . | . | . | . | |
| X | 1 | . | . | 26 | . | . | 3 | . | . | . | . | |
| XII | . | . | . | . | . | . | . | . | . | . | . | |
| XIV | . | . | . | . | . | . | . | . | . | . | . | |
| TOTAL | 83 | 55 | 129 | 99 | 90 | 7 | 38 | 7 | + | 0 | 4 | 22 |

**Table 7.2. Norwegian landings of liver (kg) and fins (kg) of basking shark (*Cetorhinus maximus*) during 1977–2007, estimated landings in live weight (conversion factors of 4.64 for liver and 40.0 for fins), estimated numbers of landed individuals (from landings of both liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins), ICES and Norwegian official landings (applying conversion factors of 10.0 for liver (1977–1995), 100.0 fins (1996–1999), 100.0 for fins (ICES 2000–2008), and 40.0 for fins (Norway 2000–2008)), and landings recommended used by ICES WGEF 2008. In 1995 and 1997, landings of whole individuals measuring 3760 kg (one individual) and 7132 kg (two individuals), respectively, were reported. These weights are included in the official and revised landings and in the estimation of landed numbers.**

| Year | Liver (kg) | Fins (kg) | Catch from liver (tonnes) | Catch from fins (tonnes) | Landed numbers (livers – fins) | ICES official landings (tonnes) | Norway official landings (tonnes) | Recom-mended by ICES WGEF 2008 |
|---|---|---|---|---|---|---|---|---|
| 1977 | 793 153 | 0 | 3680.2 | 0.0 | 1223 | 7931.5 | 7931.5 | 3680.2 |
| 1978 | 784 687 | 0 | 3640.9 | 0.0 | 1210 | 7846.9 | 7846.9 | 3640.9 |
| 1979 | 1 133 477 | 95 070 | 5259.3 | 3802.8 | 1748–1330 | 11 334.8 | 11 334.8 | 5259.3 |
| 1980 | 802 756 | 60 851 | 3724.8 | 2434.0 | 1238–851 | 8027.6 | 8027.6 | 3724.8 |
| 1981 | 387 997 | 27 191 | 1800.3 | 1087.6 | 598–380 | 3880.0 | 3880.0 | 1800.3 |
| 1982 | 464 606 | 31 987 | 2155.8 | 1279.5 | 716–447 | 4646.1 | 4646.1 | 2155.8 |
| 1983 | 379 428 | 24 847 | 1760.5 | 993.5 | 585–348 | 3794.3 | 3794.3 | 1760.5 |
| 1984 | 444 171 | 23 505 | 2061.0 | 940.2 | 685–329 | 4441.7 | 4441.7 | 2061.0 |
| 1985 | 315 629 | 16 699 | 1464.5 | 668.0 | 487–234 | 3156.3 | 3156.3 | 1464.5 |
| 1986 | 246 474 | 12 138 | 1143.6 | 485.5 | 380–170 | 2464.7 | 2464.7 | 1143.6 |
| 1987 | 35 244 | 3148 | 163.5 | 125.9 | 54–44 | 352.4 | 352.4 | 163.5 |
| 1988 | 22 761 | 1927 | 105.6 | 77.1 | 35–27 | 227.6 | 227.6 | 105.6 |
| 1989 | 127 775 | 10 367 | 592.9 | 414.7 | 197–145 | 1277.8 | 1277.8 | 592.9 |
| 1990 | 193 179 | 18 110 | 896.4 | 724.4 | 298–253 | 1931.8 | 1931.8 | 896.4 |
| 1991 | 162 323 | 18 337 | 753.2 | 733.5 | 250–256 | 1623.2 | 1623.2 | 753.2 |
| 1992 | 365 761 | 37 145 | 1697.1 | 1485.8 | 564–520 | 3657.6 | 3657.6 | 1697.1 |
| 1993 | 291 042 | 34 360 | 1350.4 | 1374.4 | 449–481 | 2910.4 | 2910.4 | 1374.4 |
| 1994 | 176 220 | 26 922 | 817.7 | 1076.9 | 272–377 | 1762.2 | 1762.2 | 1076.9 |
| 1995 | 10 450 | 15 571 | 52.2 | 626.6 | 17–219 | 108.3 | 108.3 | 626.6 |
| 1996 | 41 283 | 19 789 | 191.6 | 791.6 | 64–277 | 1978.9 | 1978.9 | 791.6 |
| 1997 | 57 184 | 11 520 | 272.5 | 467.9 | 90–163 | 1159.1 | 1159.1 | 467.9 |
| 1998 | 3 | 1366 | 0.0 | 54.6 | 19 | 136.6 | 136.6 | 54.6 |
| 1999 | 20 | 770 | 0.1 | 30.8 | 11 | 77.0 | 77.0 | 30.8 |
| 2000 | 51 | 2926 | 0.2 | 117.0 | 41 | 292.6 | 117.0 | 117.0 |
| 2001 | 0 | 1997.5 | 0.0 | 79.9 | 28 | 199.7 | 79.9 | 79.9 |
| 2002 | 0 | 1351.5 | 0.0 | 54.1 | 19 | 135.2 | 54.1 | 54.1 |
| 2003 | 0 | 3191.5 | 0.0 | 127.7 | 45 | 319.2 | 127.7 | 127.7 |
| 2004 | 0 | 1808.3 | 0.0 | 72.3 | 25 | 180.8 | 72.3 | 72.3 |
| 2005 | 0 | 2180.5 | 0.0 | 87.2 | 30 | 218.1 | 87.2 | 87.2 |
| 2006 | 0 | 160 | 0.0 | 6.4 | 2 | 16.0 | 6.4 | 6.4 |
| 2007 | 0 | 653 | 0.0 | 26.1 | 9 | 65.3 | 26.1 | 26.1 |
| 2008 | 0 | 98 | 0.0 | 3.9 | 1 | 9.8 | 3.9 | 3.9 |

**Table 7.3. Basking sharks in the Northeast Atlantic. Proportions (%) of basking sharks caught in different gears as reported to the Norwegian Directorate of Fisheries from 1990–2011.**

| Year | Area IIa | | | | | | | Area IVa | |
|---|---|---|---|---|---|---|---|---|---|
| | Harpoon | Gillnets | Driftnets* | Undefined nets | Bottom Trawl | Danish seine | Hooks and line | Harpoon | Gillnets |
| 1990 | 84,0 | | 3,1 | | | | | 12,9 | |
| 1991 | 69,7 | | 1,0 | | | | | 29,3 | |
| 1992 | 83,1 | | 6,0 | | 5,6 | | 0,4 | 4,9 | |
| 1993 | 99,1 | 0,8 | | | 0,1 | | | | |
| 1994 | 85,4 | | | | | | | 14,6 | |
| 1995 | 89,8 | 6,5 | | | | | | | 3,7 |
| 1996 | 89,1 | 10,3 | | 0,2 | | 0,4 | 0,1 | | |
| 1997 | 66,7 | 23,7 | | | | | 0,5 | 9,1 | |
| 1998 | 67,2 | 28,5 | | | | | 4,4 | | |
| 1999 | 9,1 | 81,8 | | 7,8 | 1,3 | | | | |
| 2000 | 33,4 | 58,7 | | | 7,8 | | | | |
| 2001 | | 96,0 | | | 4,0 | | | | |
| 2002 | 16,3 | 78,5 | | | 5,2 | | | | |
| 2003 | 3,4 | 89,7 | | | 7,2 | | | | |
| 2004 | | 100 | | | | | | | |
| 2005 | 54,1 | 44,5 | | 0,5 | 1,4 | | | | |
| 2006 | | 100 | | | | | | | |
| 2007 | | 100 | | | | | | | |
| 2008 | | 100 | | | | | | | |
| 2009 | | | | | | | | | |
| 2010 | | | | | | | | | |
| 2011 | | 50 | | | | | 50 | | |

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

**Table 7.4. Basking sharks in the Northeast Atlantic. Bycatches reported from France (A. Jung, WGEF 2012) and Norwegian bycatches reported in media.**

| Nation | Day | Month | Year | Geog. area | Lat | Lon | Gear | Depth | Length | Weight (kg) | Comment | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 25 | Jan | 2010 | Iroise Sea | 48.549 | 5.124 | Gillnet | | 4–5 m | | Released alive | Jung, 2012 |
| France | 8 | May | 2010 | Atlanic | 46.236 | 1.592 | Gillnet | | 4.6 m | | Discarded | Jung, 2012 |
| France | 27 | May | 2010 | Atlantic | 47.247 | 2.964 | Gillnet | | 3.4 m | | Discarded, samples, museum collection | Jung, 2012 |
| France | | May | 2009 | Mediter-ranean | 42.935 | 3.063 | Gillnet | | 6–7 m | | | Jung, 2012 |
| France | | May | 2009 | Mediter-ranean | 42.935 | 3.063 | Gillnet | | 6–7 m | | | Jung, 2012 |
| France | | May | 2009 | Mediter-ranean | 42.935 | 3.063 | Gillnet | | 6–7 m | | | Jung, 2012 |
| France | 31 | May | 2009 | Atlantic | 47.768 | 4.211 | | | 2.5–3 m | | Released alive | Jung, 2012 |
| France | 18 | Nov | 2009 | Atlantic | 43.427 | 1.695 | | | 3.5–4 m | | Discarded | Jung, 2012 |
| France | 27 | Apr | 2009 | Mediter-ranean | 45.841 | 1.531 | Bottom trawl | 20 m | | | Discarded | Jung, 2012 |
| France | 20 | May | 2009 | Mediter-ranean | 43.051 | -3.391 | Pelagic trawl | 45 m | 5 m | | Discarded | Jung, 2012 |
| France | 30 | May | 2011 | Mediter-ranean | 43.328 | -5.203 | Gillnet | | 3–6 m | | Released alive | Jung, 2012 |
| France | 3 | Aug | 2011 | Iroise Sea | 48.233 | 4.483 | Gillnet | | 3–6 m | | Discarded, samples | Jung, 2012 |
| France | 19 | Apr | 2011 | Atlantic | 47.760 | 4.205 | Gillnet | 30 m | 3–6 m | | Discarded, samples, immature | Jung, 2012 |
| France | 6 | May | 2011 | Atlantic | 47.745 | 4.218 | Gillnet | | 3–6 m | | Released alive, genetic sample | Jung, 2012 |
| France | 4 | Nov. | 2011 | Celtic Sea | | | | | 4 m | | Obsmer data, genetic sample | |
| France | 17 | May | 2013 | Atlantic | 47.780 | 4.210 | Gillnet | | 3.3 m | | Discarded, samples, immature male | Jung 2013 |
| Norway | | Dec | 2006 | Atlantic | 59.03 | 9.80 | Gillnet | 50 m | 3.5 m | 350 | Approx. position | Media |
| Norway | | Sep | 2006 | Atlantic | 58.81 | 9.90 | Gillnet | | ~4 m | 500 | Discarded, approx. position | Media |
| Norway | | Aug | 2007 | Atlantic | 61.97 | 5.02 | Gillnet | | 4.5 m | 250 | Discarded, approx. position | Media |
| Norway | | | 2007 | Atlantic | 64.13 | 8.20 | Gillnet | | 4 m | 500 | Approx. position | Media |
| Norway | | Sep | 2007 | Atlantic | 58.45 | 8.86 | Gillnet | | 4–5 m | | Approx. position | Media |
| Norway | | July | 2008 | Atlantic | 68.11 | 14.18 | | | | | Approx. position | Media |
| Norway | | July | 2008 | Atlantic | 62.36 | 47.00 | Gillnet | | | | Released alive, approx. position | Media |

| Nation | Day | Month | Year | Geog. area | Lat | Lon | Gear | Depth | Length | Weight (kg) | Comment | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway | | July | 2011 | Atlantic | 70.29 | 27.28 | Gillnet | | ~10 m | | Discarded, approximate position | Media |
| Norway | | July | 2011 | Atlantic | 71.11 | 23.96 | Gillnet | | | | Released alive, approx. position | Media |
| Norway | | May | 2012 | Atlantic | 68.78 | 11.86 | Gillnet | | ~10 m | ~1 t | Landed, approx. position | Media |
| Norway | | May | 2012 | Atlantic | 62.48 | 5.86 | Gillnet | | | | Landed, approx. position | Media |

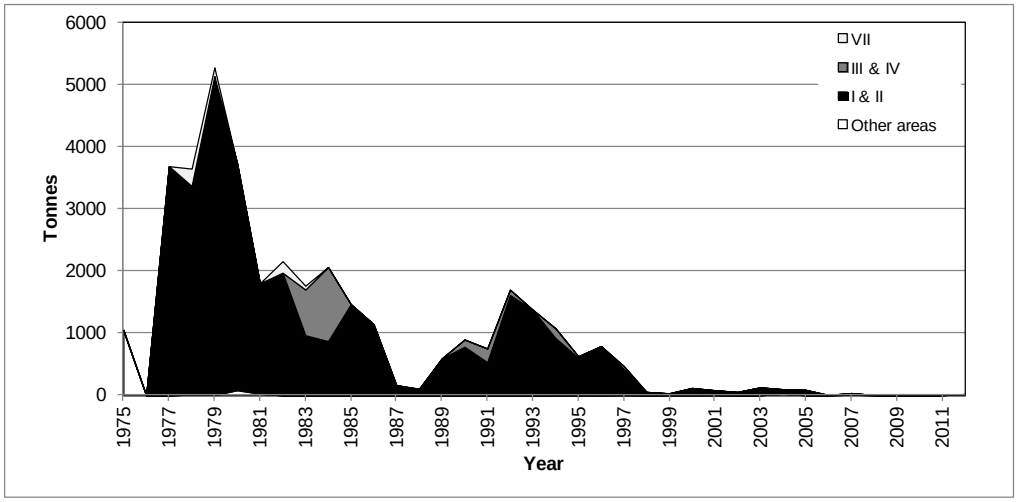



**Figure 7.1. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I–XIV from 1977–2012.**

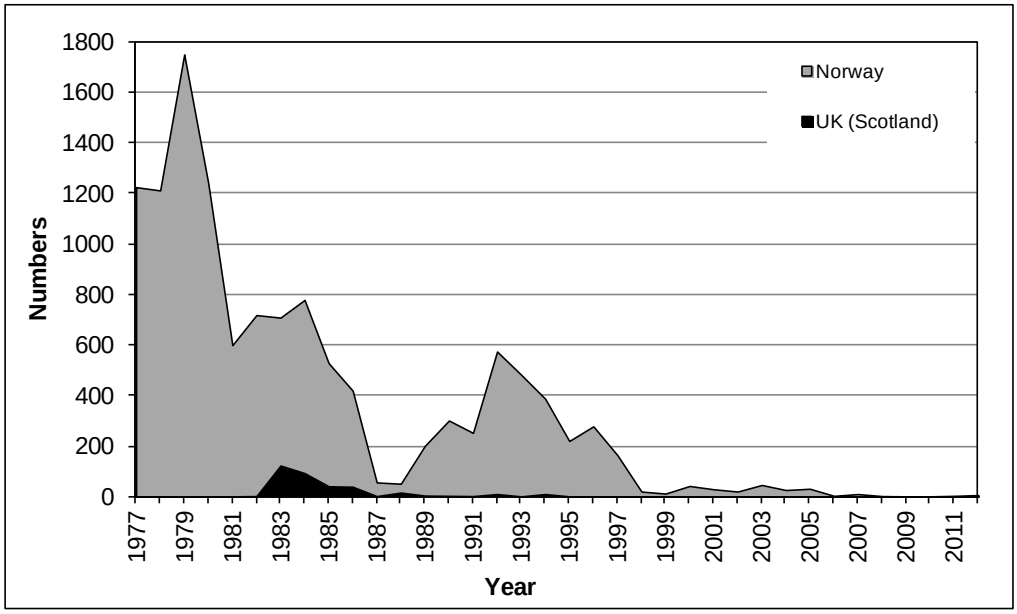



**Figure 7.2. Basking sharks in the Northeast Atlantic. Numbers of basking sharks caught by Norway and Scotland from 1977–2010 in ICES Areas I–XIV from 1977–2012.**

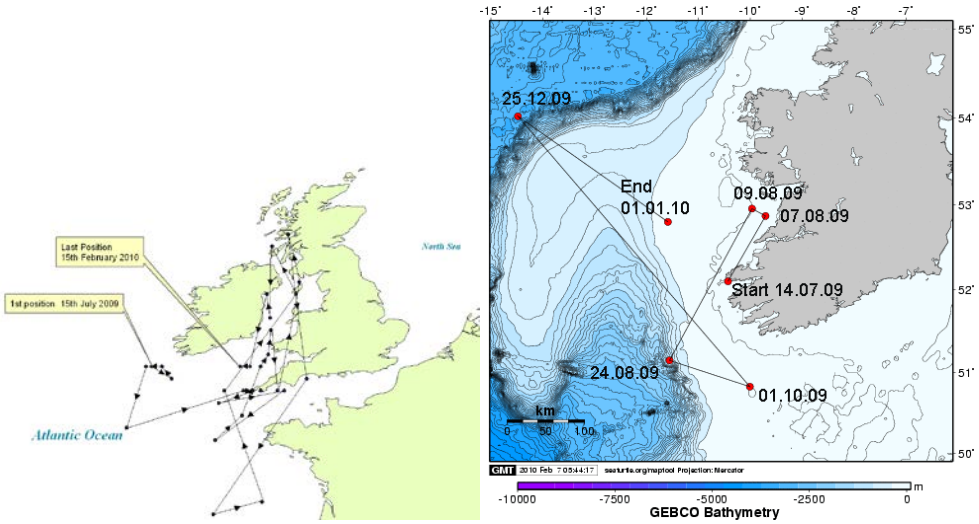



**Figure 7.3. Basking sharks in the Northeast Atlantic. Geolocations from basking shark A (left, sex=male) and B (right, sex=unknown). Source Berrow and Jackson, 2010.**

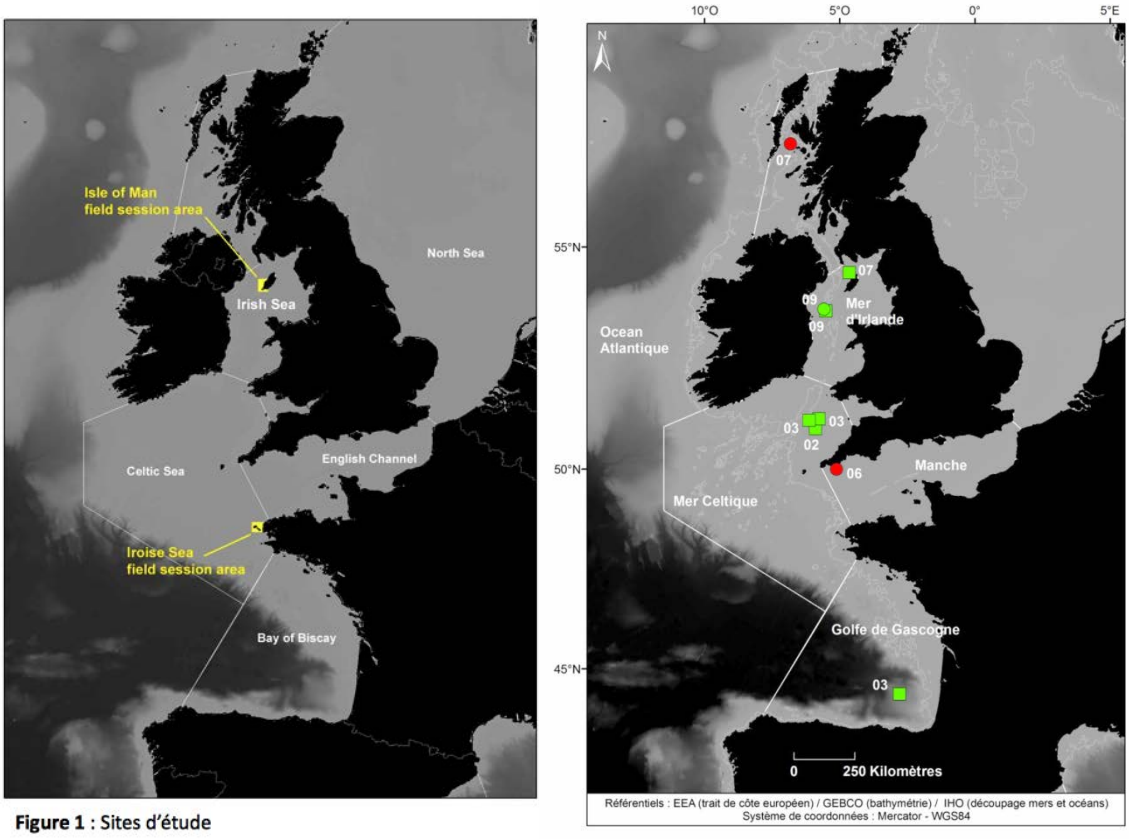



**Figure 7.4. Basking sharks in the Northeast Atlantic. Tagging locations and recapture positions of PAT-tagged Basking shark from the APECS tag programme 2009–2010. Source: Stéphan *et al.*, 2011.**

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

## 8.1 Stock distribution

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

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

## 8.2 The fishery

### 8.2.1 History of the fishery

In recent years, more information has become available about fisheries taking blue shark in the North Atlantic. Although the available data are limited, it offers some information on the situation in fisheries and trends. Although there are no large-scale directed fisheries for this species, it is a major bycatch in many fisheries for tunas and billfish, where it can comprise up to 70% of the total catches and thereby exceed the actual catch of targeted species (ICCAT, 2005).

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

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

### 8.2.2 The fishery in 2012

Traditionally catches of this species reported to ICES have been minimal (0 to ~2500 t over the last 35 years), therefore in this report the more comprehensive data from ICCAT are presented in the catch table (Table 8.1). The main country reporting landings of this species to ICES in 2012 was Spain, where catch was 682 t. This fishery is an artisanal directed pelagic shark longline fishery (Basque country), where the majority of landings are from just two fishing vessels. There were also comparatively low levels (<300 t) also reported by France, Portugal (Azores) and the UK.

### 8.2.3 Advice applicable

ACOM has never provided advice for blue shark in the ICES area. Assessment of this stock is considered to be the responsibility of ICCAT. No specific management advice has been provided by ICCAT for this stock, to date.

### 8.2.4 Management applicable

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

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

## 8.3 Catch data

### 8.3.1 Landings

It is difficult to accurately quantify landings of blue shark in the North Atlantic, as data can be incomplete, and generic reporting of shark catches has resulted in underestimation. Furthermore landings data from different sources (ICCAT, FAO and national statistics) vary a lot. Table 8.1 gives the Task I catch data (total landings and discards by stock, flag and major gears) collated by ICCAT, and which appears to provide the most complete landings for this species. ICCAT consider that the reported landings of blue shark were underestimated more so in the early part of the time-series (prior to 1997), with official landings and estimates of a comparable magnitude since 1997, with annual landings in the region of 20 000–40 000 t. However, in 2012 North Atlantic landings were estimated at 74 390 t which represents an increase of nearly 50% on 2010. In the ICES area, blue shark is reported predominantly by Spain, Portugal, Japan and USA, with landings by these countries accounting for 85% of the annual landings in 2012 (Figure 8.1). In 2012, several countries reported landings for the first time including Namibia, South Africa, Uruguay and the Korean Republic. The Mediterranean landings declined to about 40 t, caught by Spain. Italy appears to have stopped catching the species. The national data reported to ICES for 2012 totalled 1135 t, with the majority of this being reported by Spain (682 t) and Azores.

Landings data of blue shark from FAO (FishStat) by major fishing area are shown in Figure 8.2. Figure 8.3 present the different landings reported to ICCAT and FAO respectively. Data reported to ICCAT were not considered reliable estimates for the 2008 stock assessment. Therefore, for the assessment purposes, two other estimates of landings for this stock were prepared (Table 8.2 and Figure 8.4), the tuna ratio and the fin trade index. The tuna ratio estimates derive from logged observations of shark catches relative to tuna catches and are considered conservative by ICCAT because they do not consider all fisheries (ICCAT, 2008). The fin trade index is inferred from systematic trade observations of shark fins in the Asian market and used to calculate caught shark weights based on catch effort data from the ICCAT database (Clarke *et al*., 2006; ICCAT, 2008).

### 8.3.2 Discards

The low value of blue shark means that it is not always retained for the market. The most valuable parts of the blue shark are its fins. In some fisheries the fins of blue sharks are retained and the carcasses discarded, although various national and EC measures have been brought in to prevent this practice, generally referred to as finning. Accurate estimates of discarding are required in order to quantify total removals from the stock. Currently no such estimates are available. Differences between estimated and reported catch in various fisheries (ICCAT, 2008 and references cited therein) suggest that discarding is very widespread in fisheries taking blue shark.

Discard estimates are available only for fisheries from USA, Canada and UK (Bermuda). Numbers for the latter country are negligible. USA reported discards in quanti-

ties of 63–1136 t.year$^{-1}$, averaging about 390 t.year$^{-1}$ over time (ICCAT, 2006). Discards from Canadian fisheries have been estimated at about 1000 t annually in recent years (ICCAT, 2008) compared with estimated annual landings of about 2000 t.

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

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

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

### 8.3.3 Quality of catch data

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

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

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

## 8.4 Commercial catch composition

Incomplete information is available on blue shark composition in commercial catches. Japanese catches (landings and discards) from tuna longliners in the North Atlantic are estimated to have fluctuated between 2000–4500 t in recent years. These are higher than reported landings of the target species (bluefin tuna) from Japanese longliners in this period (ICCAT, 2008). Another study of Japanese bluefin tuna longline fishing demonstrated that the ratio of blue shark to the target species was about 1:1 (Boyd,

2008). Data from observed fishing for bluefin tuna by a Chinese Taipei (Taiwanese) vessel in the southern North Atlantic found that blue shark accounted for 76% of shark bycatch, though no information was presented on the percentage of blue shark in the total catch (Dai and Jang, 2008). Blue shark and shortfin mako shark are estimated together to account for between 69% and 72% of catches from Spanish and Portuguese surface longliners in the North Atlantic (Oceana, 2008).

### 8.4.1 Conversion factors

Information on the length–weight relationship is available from several scientific studies (Table 8.3) and information on length–length relationships is summarized in Table 8.4a by sex and Table 8.4b for both sexes combined. Campana *et al*., 2005 calculated the conversion relationships between dressed weight ($W_D$) and live weight or round weight ($W_R$) for NW Atlantic blue shark (n=17) to be:

$$W_R = 0.4 + 1.22\ W_D$$

$$W_D = 0.2 + 0.81\ W_R$$

For gutted fish from French fisheries the DW/RW is 75.19%. There is also a factor for landed round weight to live weight (96.15%), meaning that there is a 4% reduction in weight because of lost moisture (Hareide *et al*., 2007). There have been various estimates of fin weight to body weight (see: Mejuto and García-Cortés, 2004; Santos and Garcia, 2005; Hareide *et al*., 2007; Santana-Garcon *et al*., 2012; Biery and Pauly, 2012).

## 8.5 Commercial catch–effort data

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

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

Details of these series are available in ICCAT, 2008 and are presented in Figure 8.5.

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

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

with broader spatial extents received greater weightings than those with more restricted spatial coverage.

## 8.6 Fishery-independent surveys

No fishery-independent information from research vessel surveys is available, and although such data exist for parts of the NW Atlantic (Hueter *et al*., 2008), there are no scientific fishery-independent data from the NE Atlantic. A Survey from 1977–1994 conducted by the US NMFS documented a decline among juvenile males blue sharks by 80%, however this decline did not display among juvenile female animals, which also occur in fewer numbers in the area, the western North Atlantic off the coast of Massachusetts (Hueter *et al*., 2008). The authors concluded that vulnerability to overfishing in blue sharks is present despite their enhanced levels of fecundity relative to other carcharhinid sharks.

## 8.7 Life-history information

The blue shark is common in pelagic oceanic waters throughout the tropical and temperate oceans worldwide. It has one of the widest ranges of all the shark species. It may also be found close inshore and in estuaries. In a recent satellite telemetry study Queiroz *et al.* (2010) described complex and diverse type behaviours depending on water stratification and/or depth (see Figure 8.6). Female blue shark tagged in the Western channel were able to spend up to 70 days in this shelf edge area in the Bay of Biscay; whereas tagged juveniles described a relatively extensive vertical movement away from the southern nursery areas. Blue shark inhabited waters with a large temperature range from 10°C to 20°C. The US National Marine Fisheries Service also conducts a Cooperative Shark Tagging Programme (CSTP; Kohler *et al*., 1998; NMFS, 2006), with tagging in the NE Atlantic also being undertaken under the auspices of the Inshore Fisheries Ireland (formerly the Irish Central Fishing Board) Tagging Programme (Green, 2007 WD) and UK Shark Tagging Programme, and there have been other earlier European tagging studies (e.g. Stevens, 1976). Figure 8.7 shows the tag and release results presented by ICCAT (2012), highlighting the large number tagged to date, and the vast horizontal movements undertaken by blue shark in the Atlantic.

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

Adult blue sharks have no known predators; however, subadults and juveniles are eaten by both shortfin makos and white sharks as well as by sea lions. Fishing is likely to be a major contributor to adult mortality. A recent first estimation of the fishing mortality rate via satellite tagging re-capture by fishing vessel was giving a range from 9 up to 33% (Quieroz *et al.*, 2010).

Various studies have compiled data on biological information on this species in the North Atlantic and other areas. Some of these data are summarized in Table 8.5 (growth parameters), and Table 8.3 (length–weight relationships) and Table 8.6 (other life-history parameters). Based on life-history information, blue shark is considered to be among the most productive shark species (ICCAT, 2008).

## 8.8 Exploratory assessment models

### 8.8.1 Previous assessments

In 2004, ICCAT completed a preliminary stock assessment (ICCAT, 2005). Although the North Atlantic Stock appeared to be above biomass in support of MSY, the assessment remained highly conditional on the assumptions made. These assumptions included (i) estimates of historical shark catch, (ii) the relationship between catch rates and abundance, (iii) the initial state of the stock in 1971, and (iv) various life-history parameters. It was pointed out that the data used for the assessment did not meet the requirements for proper assessment (ICCAT, 2006), and further research and better-resolved data collection for this species was highly recommended.

In 2008, three models were used in assessments conducted by ICCAT (ICCAT, 2008 and references cited therein): a Bayesian surplus production model, an age-structured model that did not require catch data (catch-free model), and an age-structured production model.

Preliminary modelling with the Bayesian surplus production model produced estimates of stock size well above MSY levels (1.5–2* $B_{MSY}$), and estimated F to be very low (at $F_{MSY}$ or well below it). The carrying capacity of the stock was estimated so high that the increasing estimated catches (25–62 000 t over the time-series) generated very low F estimates. Sensitivity analyses found that the stock size estimate was sensitive to the weighting of the Irish cpue series. Equal weighting of this and the other series produced a stock size at around $B_{MSY}$. All other sensitivity analyses found similar results to the base case run, with the stock well above MSY levels.

The age-structured biomass model displayed varying results with either a strong decrease in biomass throughout the series to about 30% of virgin levels, or a less pronounced decline. The prior for the virgin biomass assigned high values to a very small number of biomass values but also indicated that the range of plausible values of this parameter is very wide (long tail). This is probably because there is not enough information in the data to allow the model to provide a more narrow range of plausible values than the one started with and thus provide a more precise estimate of the biomass of the stock.

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

### 8.8.2 Stock status

In 2008, ICCAT tentatively concluded that biomass was estimated to be above the level that would support MSY (ICCAT, 2008). These results agreed with earlier work (ICCAT, 2005). Stock status appeared to be close to unfished biomass levels and fishing mortality rates well below those corresponding to the level at which MSY is reached. However, ICCAT, 2008 pointed out that the results are heavily dependent on the underlying assumptions. In particular the choice of catch data to be used, the weighting of cpue series and various life-history parameters can be expected to be of great importance. ICCAT did not have time to conduct a sensitivity analysis of the input data and assumptions (ICCAT, 2008).

Owing to these underlying weaknesses, no firm conclusions could be drawn from the preliminary assessments conducted by ICCAT. ICCAT, 2008 stated that most models used predicted that this stock was not overfished. However, ICCAT did not use these

assessments to make conclusions about stock status and has not provided management advice based on these analyses.

An updated blue shark assessment by ICCAT has not yet been scheduled.

## 8.9 Quality of assessments

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

## 8.10 Reference points

ICCAT uses $F/F_{MSY}$ and $B/B_{MSY}$ as reference points for stock status of this stock. These reference points are relative metrics rather than absolute values. The absolute values of $B_{MSY}$ and $F_{MSY}$ depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

## 8.11 Management considerations

The stock status of blue shark in the North Atlantic remains unclear. Catch data are highly unreliable. Some cpue series are existent, and where data are available, mainly reveal declines since the mid-1990s. Further work is required to explain the downward trends and to quantify removals from the stock.

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

Blue shark is considered to be one of the most productive sharks in the North Atlantic. As such, it can be expected to be more resilient to fishing pressure than other pelagic sharks. However the high degree of susceptibility to longline fishing and the poor quality of the information available to assess the status of this stock is a cause for concern. Given that this species is a significant bycatch, especially in tuna and billfish fisheries, better data should be made available by the countries whose fleets catch it.

## 8.12 References

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

Biery, L., and Pauly, D. 2012. A global review of species-specific shark fin to body mass ratios and relevant legislations. *J. Fish. Biol.*, 80 : 1643–1677.

Boggs, C. H. 1992. Depth, capture time and hooked longevity of longline-caught pelagic fish. Timing bites of fish with chips. Fish. Bull. 90:642−658.

Boyd, J.M. 2008. The Japanese bluefin tuna longline fishery in the Northeast Atlantic: Report of an Irish observer. Irish Fisheries Investigations No.20/2008.

Buencuerpo, V., Ríos, S., and Morón, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin* 96: 667–685.

Campana, S., Gonzalez, P., Joyce, W. And Marks, L. 2002. Catch, bycatch and landings of blue shark (*Prionace glauca*) in the Canadian Atlantic. Canadian Stock Assessment, Research Document, 2002/101, Ottawa.

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.

Campana, S. E., Joyce, W., and Manning, M. J. 2009. Bycatch and discard mortality in commercially caught blue sharks *Prionace glauca* assessed using archival satellite pop-up tags. Mar. Ecol. Prog. Ser. 387:241–253.

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

Castro, J.A. and J. Mejuto. 1995. Reproductive parameters of blue shark, *Prionace glauca*, and other sharks in the Gulf of Guinea. Mar. Freshwater Res. 46:967–973.

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

Cortés, E. 1999. Standardized diet compositions and trophic levels of sharks. ICES Journal of Marine Science 56:707–717.

Dai, X.J and Jiang, R.L. 2008. Shark bycatch observation in the ICCAT waters by Chinese longline observer in 2007. ICCAT SCRS/2008156.

Diez, G. A., and J. E. Serafy. 2005. Longline-caught blue shark (*Prionace glauca*): factors affecting the numbers available for live release. Fish. Bull. 103:720−724.Díez G., Santurtún, M., Ruiz, J., Iriondo, A., Gonzalez. I. And Artetxe, I. 2007. The long line Basque fishery on blue shark (*Prionace glauca*) in the Bay of Biscay (1998–2006). Working Document for ICES Working Group on Elasmobranch Fishes, Galway. 22–28 June, 2007, 9 pp.

Fitzmaurice, P, Green, P., Keirse, G., Kenny, M. And Clarke, M. 2005. Stock discrimination of blue shark, based on Irish tagging data. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers 58(3): 1171–1178.

Francis, M. P., and Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus, Isurus oxyrinchus,* and *Prionace glauca*) from New Zealand. *Fishery Bulletin* 103: 489–500.

Francis, M. P., L. H. Griggs and S. J. Baird. 2001. Pelagic shark bycatch in the New Zealand tuna longline fishery. Mar. Freshwat. Res. 52:165−178.Francis, M. P. And Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus, Isurus oxyrinchus* and *Prionace glauca*) from New Zealand. Fishery Bulletin, 103(3): 489–500.

García-Cortés, B. and J. Mejuto. 2002. Size–weight relationships of the swordfish (*Xiphias gladius*) and several pelagic shark species caught in the Spanish surface longline fishery in the Atlantic, Indian and pacific oceans. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 54 (4): 1132–1149.

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

Hareide, N.R., 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.

Henderson, A. C., Flannery, K. And Dunne, J. 2001. Observations on the biology and ecology of the blue shark in the north-east Atlantic. Journal of Fish Biology 58: 1347–1358.

Holmes B. H., Steinke D., Ward R. D. 2009. Identification of shark and ray fins using DNA barcoding Fisheries Research 95:280–288. Hueter, R. E. and. Simpfendorfer, C. 2008. Case Study: Trends in Blue Shark Abundance in the Western North Atlantic as Determined by a Fishery-Independent Survey. In: Sharks of the Open Ocean; M. D. Chami, E. K. Pikitch and E. Babcock (eds.) 236–241.

Hueter, R. E. and. Simpfendorfer, C. 2008. Case Study: Trends in Blue Shark Abundance in the Western North Atlantic as Determined by a Fishery-Independent Survey. In: Sharks of the Open Ocean; M. D. Chami, E. K. Pikitch and E. Babcock (eds.) 236–241.

ICCAT. 2005. Report of the 2004 Intersessional Meeting of the ICCAT Subcommittee on By-catches: Shark Stock Assessment. SCRS/2004/014.

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

ICCAT. 2008. Report of the 2008 shark stock assessments meeting. Madrid, Spain, 1–5 September, 2008. SCRS/2008/017–SHK Assessment, 89 pp.

ICCAT. 2012. Chapter 4.1 Shortfin Mako Stock Assessment and Ecological Risk Assessment Meeting. Olhao, Portugal June 11–18, 2012.

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.

Kohler, N.E., Casey, J. G. and Turner, P. A. 1998. NMFS cooperative shark tagging programme, 1962–1993: An atlas of shark tag and recapture data. Marine Fisheries Review, no 60, National Marine Fisheries Service, 86 pp.

Kohler N.F., Turner P.A., Hoey, J.J., Natanson, L.J., and Briggs, R. 2002. Tag and recapture data for three pelagic shark species: blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and porbeagle (*Lamna nasus*) in the North Atlantic Ocean. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 54 (4): 1231–1260.

MacNeil MA, Campana SE. 2002. Comparison of whole and sectioned vertebrae for determining the age of young blue shark (*Prionace glauca*). J. Northw. Atl. Fish. Sci. 30:77–82.

Mejuto J. and García-Cortés B. 2004. Preliminary relationships between the wet fin weight and body weight of some large pelagic sharks caught by the Spanish surface longline fleet. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 56(1): 243–253.

Mejuto J. and García-Cortés B. 2005. Reproductive and distribution parameters of the blue shark *Prionace glauca*, on the basis of on-board observations at sea in the Atlantic, Indian and Pacific Oceans. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 58(3): 951–973.

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

Oceana. 2008. Description of European Union surface longline fleet operating in the Atlantic Ocean and compilation of detailed EuroStat data on shark catches by EU fleets in the Atlantic shark catches. ICCAT SCRS 2008/158.

Palma, C., Ortiz, M., de Bruyn, P., Kell, L. and Pallares, P. 2012. Building a consolidated database to crosscheck ICCAT Task-I nominal catch, against EUROSTAT and FAO equivalent statistics. *ICCAT SCRS 2012/078*.

Poisson, F., Gaertner, J.C., Taquet, M., Durbec, J.P., and Bigelow, K. 2010. Effects of lunar cycle and fishing operations on longline-caught pelagic fish: fishing performance, capture time, and survival of fish. Fish. Bull. 108:268–281.

Pratt, H. L. 1979. Reproduction in the blue shark, *Prionace glauca*. Fish. Bull. 77:445–470.

Queiroz N, Humphries N.E., Noble L.R., Santos A. M, Sims D. W. 2010. Short-term movements and diving behaviour of satellite-tracked blue sharks *Prionace glauca* in the northeastern Atlantic Ocean. Mar Ecol Prog Ser, Vol. 406: 265–279.

Santana-Garcon, J., Fordham, S. and Fowler, S. 2012. Blue shark *Prionace glauca* fin-to-carcass-mass ratios in Spain and implications for finning ban enforcement. Journal of Fish Biology, 80(5): 1895–1903.

Santos, M. N., and Garcia, A. 2005. Factors for conversion of fin weight into round weight for the blue shark (*Prionace glauca*). International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 58(3): 935–941.

Sebastian H., Haye P. A. and Shivji M. S. 2008. Characterization of the pelagic shark-fin trade in north-central Chile by genetic identification and trader surveys. Journal of Fish Biology 73, 2293–2304. Skomal, G.B. 1990. Age and growth of the blue shark, *Prionace glauca*, in the North Atlantic. Master's Thesis. University of Rhode Island, Kingston, RI. 82 pp.

Skomal, G. B. 1990. Age and growth of the blue shark, *Prionace glauca*, in the North Atlantic. M.S. thesis, 82 p. Univ. Rhode Island, Kingston, RI.

Skomal, G. B. and L.J. Natanson. 2002. Age and growth of the blue shark (*Prionace glauca*) in the North Atlantic Ocean. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, 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.

Smith, S. E., Au, D. W. and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Research, 49: 663–78.

Stevens, J. D. 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.

Stevens J.D., Bradford R.W., West, G.J. 2010. Satellite tagging of blue sharks (*Prionace glauca*) and other pelagic sharks of eastern Australia: depth behaviour, temperature experience and movements. Marine Biology, 157:575–591.

**Table 8.1. Blue shark in the North Atlantic. Landings (t) by country 1978–2011 from ICCAT Task I catch data (November 2012). These are considered underestimates, especially prior to 1997.**

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

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

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

| Stock | Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Atlantic | Belize | | | | | | | | | | 114 | 461 | 1282 |
| | Brasil | 7 | | | | | | | | | | | 1980 |
| | Canada | 624 | 581 | 836 | 346 | 965 | 1134 | 977 | 843 | + | + | + | + |
| | Cape Verde | | | | | | | | | | | | + |
| | China P.R. | | 185 | 104 | 148 | | | | 367 | 109 | 88 | 53 | 240 |
| | Chinese Taipei | | | | 171 | 206 | 240 | 588 | 292 | 110 | 73 | 99 | 2286 |
| | EU.Denmark | 2 | 1 | 13 | 5 | 1 | | | | | | + | |
| | EU.España | 24112 | 17362 | 15666 | 15975 | 17314 | 15006 | 15464 | 17038 | 20788 | 24465 | 26094 | 44966 |
| | EU.France | 395 | 207 | 221 | 57 | 106 | 120 | 99 | 167 | 119 | 84 | 122 | 115 |
| | EU.Ireland | 31 | 66 | 11 | 2 | + | + | | + | + | + | + | 1 |
| | EU.Netherlands | | | | | | | | | + | 1 | | |
| | EU.Portugal | 2081 | 2110 | 2265 | 5643 | 2025 | 4027 | 4338 | 5283 | 6167 | 6252 | 8261 | 14151 |
| | EU.United Kingdom | 12 | 9 | 6 | 4 | 6 | 5 | 3 | 6 | 6 | 96 | 8 | 10 |
| | FR.St Pierre et Miquelon | | | | | | | | | | 1 | | |
| | Japan | 273 | 350 | 386 | 558 | 1035 | 1729 | 1434 | 1921 | 2531 | 2007 | 1793 | 3130 |
| | Mexico | + | 6 | | | | | | + | | | + | + |
| | Panama | | | | | | | 254 | 892 | 613 | 1575 | | |
| | Senegal | | | 456 | | | | | 43 | 134 | 255 | 56 | 203 |
| | Trinidad and Tobago | | | 6 | 3 | 2 | 1 | 1 | + | 2 | 8 | 9 | + |
| | U.S.A. | 429 | 145 | 68 | | 72 | 68 | 47 | 54 | 137 | 107 | 172 | 1183 |
| | UK.Bermuda | | | | | | | + | + | + | + | + | |
| | Korea Rep. | | | | | | | | | | | | 662 |

| Stock | Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Namibia | | | | | | | | | | | | 2957 |
| | South Africa | | | | | | | | | | | | 318 |
| | Uruguay | | | | | | | | | | | | 725 |
| | Venezuela | | | | | 9 | 26 | 10 | 18 | 7 | 71 | 74 | 117 |
| **N.Atlantic Total** | | **27965** | **21022** | **20037** | **22911** | **21740** | **22357** | **23215** | **26925** | **30722** | **35196** | **37204** | **74326** |
| Mediterranean | EU.Cyprus | 9 | | | 3 | 6 | 5 | | | | | | |
| | EU.España | 31 | 6 | 3 | 3 | 4 | 8 | 61 | 3 | 2 | 7 | 48 | 38 |
| | EU.France | | | | | | | | + | + | + | 1 | |
| | EU.Italy | | | | | 113 | 1 | 95 | 46 | 75 | 175 | 165 | |
| | EU.Malta | + | + | + | + | + | 1 | + | 2 | 2 | 2 | 1 | 1 |
| | EU.Portugal | 5 | 41 | 14 | 3 | | 56 | 22 | | | | 2 | |
| | Japan | | | | 1 | 1 | 2 | | | 2 | + | | |
| **Med TOTAL** | | **44** | **47** | **17** | **10** | **125** | **72** | **178** | **51** | **82** | **185** | **216** | **39** |
| **N.ATL AND MED TOTAL** | | **28010** | **21069** | **20053** | **22921** | **21865** | **22429** | **23394** | **26976** | **30803** | **35381** | **37420** | **74365** |

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

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

**Table 8.3. Blue shark in the North Atlantic. Length–weight relationships for *Prionace glauca* from different populations. Lengths in cm, and weights in kg unless specified in equation. $W_R$ = round weight; $W_D$ = dressed weight.**

| Stock | L (cm) W (kg) relationship | Sex | n | Length range (cm) | Source |
|---|---|---|---|---|---|
| NE Atlantic | WD = (8.04021 x 10-7) LF 3.23189 | C | 354 | 75–250 (LF) | García-Cortés and Mejuto, 2002 |
| NW Atlantic | WR = (3.1841 x 10-6) LF 3.1313 | C | 4529 | | Castro, 1983 |
| Atlantic | WR = (3.92 x 10-6) LT 3.41 | Male | 17 | | Stevens, 1975 |
| Atlantic | WR = (3.184 x 10-7) LT 3.20 | Female | 450 | | Stevens, 1975 |
| NW Atlantic | WR = (3.2 x 10-6) LF 3.128 | C | 720 | | Campana *et al.*, 2005 |
| NW Atlantic | WD = (1.7 x 10-6) LF 3.205 | C | 382 | | Campana *et al.*, 2005 |

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

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

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

**Table 8.4 (b). Blue shark in the North Atlantic. Length–length relationships for both sexes combined of *Prionace glauca* from various populations and sources.**

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

**Table 8.5. Blue shark in the North Atlantic. Von Bertalanffy growth parameters from various studies. ($L_\infty$ in cm (TL), k in years-1, $t_0$ in years).**

| Area | L∞ | k | t0 | Sex | Study |
|---|---|---|---|---|---|
| North Atlantic | 394 | 0.133 | -0.801 | Combined | Aasen, 1966 |
| North Atlantic | 423 | 0,11 | -1.035 | Combined | Stevens, 1975 |
| NW Atlantic | 343 | 0.16 | -0.89 | Males | Skomal, 1990 |
| NW Atlantic | 375 | 0.15 | -0.87 | Females | Skomal, 1990 |
| NE Atlantic | 377 | 0.12 | -1.33 | Combined | Henderson *et al*., 2001 |
| North Atlantic | 282 | 0.18 | -1.35 | Males | Skomal and Natanson, 2002 |
| North Atlantic | 310 | 0.13 | -177 | Females | Skomal and Natanson, 2002 |
| North Atlantic | 287 | 0.17 | -1.43 | Combined | Skomal and Natanson, 2003 |
| NW Atlantic | 300 | 0.68 | -0.25 | Combined | MacNeil and Campana, 2002 (whole ages) |
| NW Atlantic | 302 | 0.58 | -0.24 | Combined | MacNeil and Campana, 2002 (section ages) |

**Table 8.6. Blue shark in the North Atlantic. Biological parameters for blue shark.**

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Reproduction | Placental viviparity | | | various |
| Litter size | 25–50 (30 average) | | | various |
| Size-at-birth (LT) | 30–50 cm | | | various |
| Sex ratio (males: females) | 1.5:1 | | NE Atlantic | García-Cortés and Mejuto, 2002 |
| | 1:1.44 | | NE Atlantic | Henderson *et al.*, 2001 |
| | 1.33:1 | | NW Atlantic | Kohler *et al.*, 2002 |
| | 1:2.13 | | NE Atlantic | Kohler *et al.*, 2002 |
| | 1:1.07 | 801 | NE Atlantic (N. coast Spain) | Mejuto and García-Cortés, 2005 |
| | 1:0.9 | 158 | NE Atlantic (S. coast Spain) | |
| | 1:0.38 | 2187 | N central Atlantic | |
| | 1:0.53 | 4550 | NW Atlantic | |
| Gestation period | 9–12 months | | | Campana *et al.*, 2002 |
| % of females revealing fecundation signs | 0.74 | 415 | NE Atlantic (N. coast Spain) | Mejuto and García-Cortés, 2005 |
| | 0 | 76 | NE Atlantic (S. coast Spain) | |
| | 36.27 | 601 | N central Atlantic | |
| | 18.15 | 1573 | NW Atlantic | |
| % of pregnant females | 0 | 415 | NE Atlantic (N. coast Spain) | Mejuto and García-Cortés, 2005 |
| | 0 | 76 | NE Atlantic (S. coast Spain) | |
| | 14.6 | 601 | N central Atlantic | |
| | 9.8 | 1573 | NW Atlantic | |
| Male age-at-maturity (years) | 4–6 | | | various |
| Female age-at-maturity (years) | 5–7 | | | various |
| Male length-at-maturity | 180–280 cm (LF) | | NW Atlantic | Campana *et al.*, 2002 |
| | 190–195 cm (LF) | | | Francis and Duffy, 2005 |
| | 201 cm (LF; 50% maturity) | | NW Atlantic | Campana *et al.*, 2005 |

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

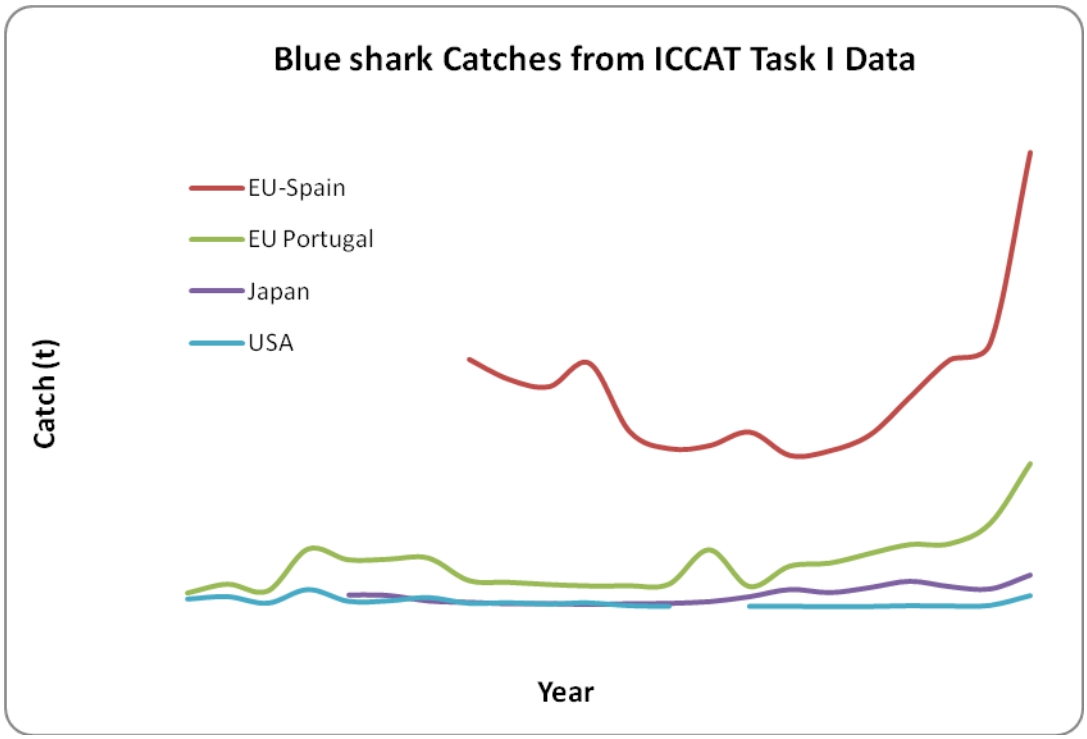



**Figure 8.1. Blue shark landing in the Atlantic for the four major countries (85% of the catches) (Source: ICCAT Task I data, version November 2012).**

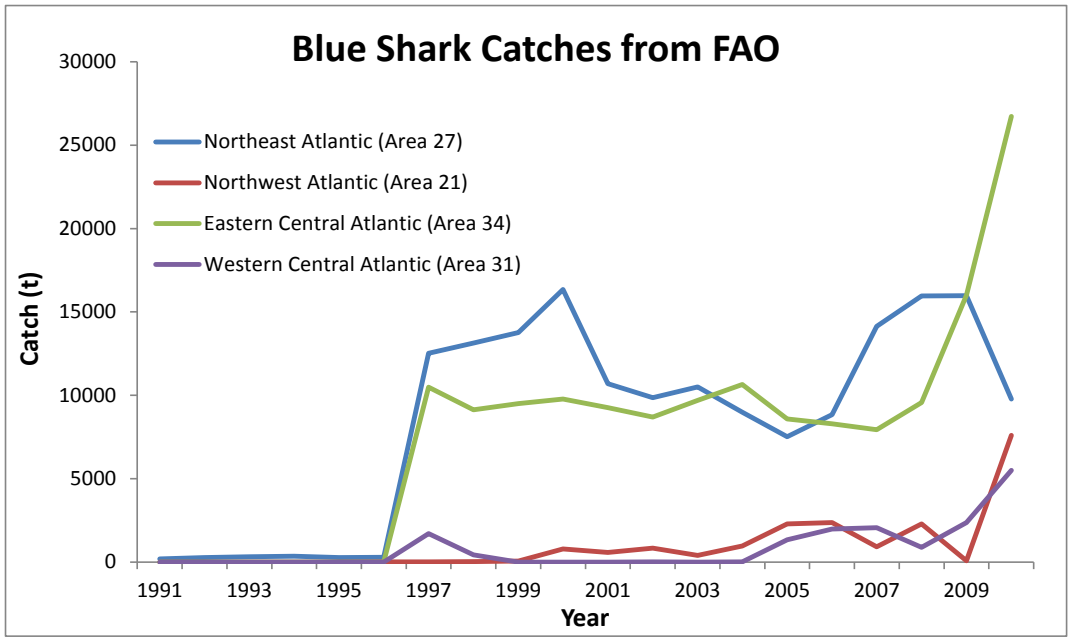



**Figure 8.2. Blue shark landing in the Atlantic Ocean for the different areas (Source: FAO, 2012).**

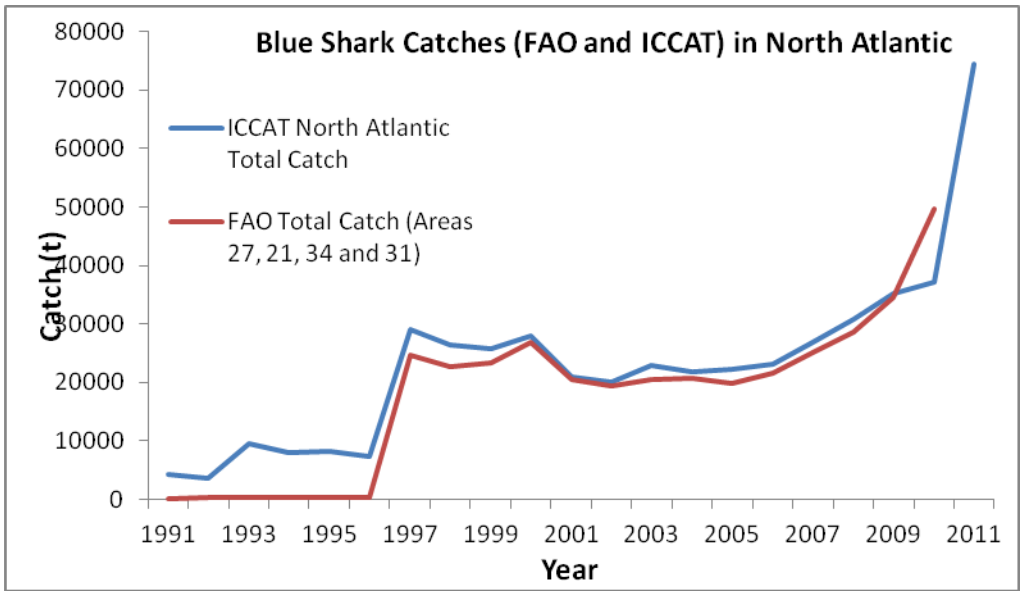



**Figure 8.3. Blue shark landings in the North Atlantic from FAO and ICCAT data.**

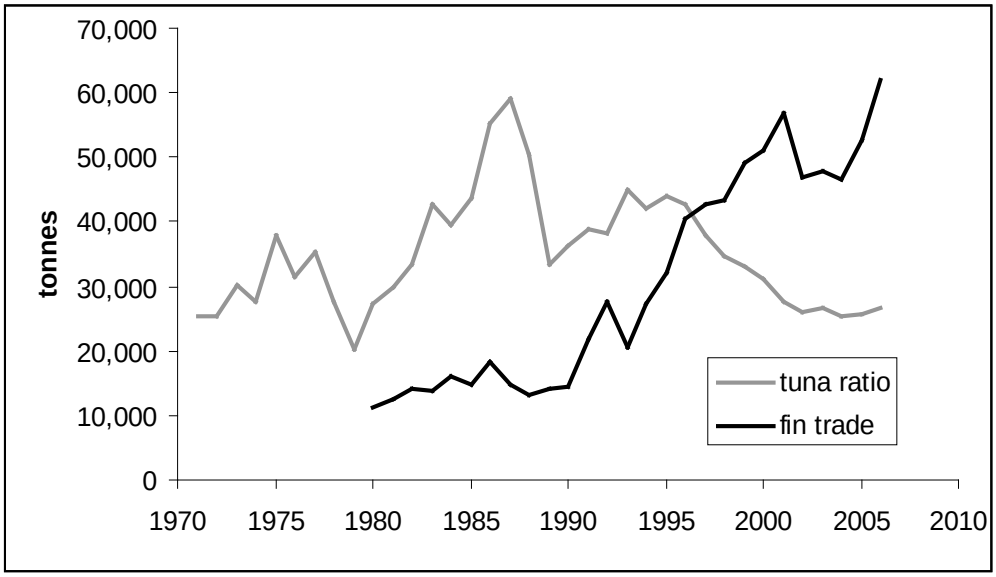



**Figure 8.4. Blue shark in the North Atlantic. Two estimates of catch, as presented by ICCAT 2008. Tuna ratio: resulting from application of the method of estimating catches using the ICCAT reported data and the ratio of tunas to shark catch; fin trade: based on the medians scaled to effort partitioned into north and south management units based on effort in the ICCAT database.**

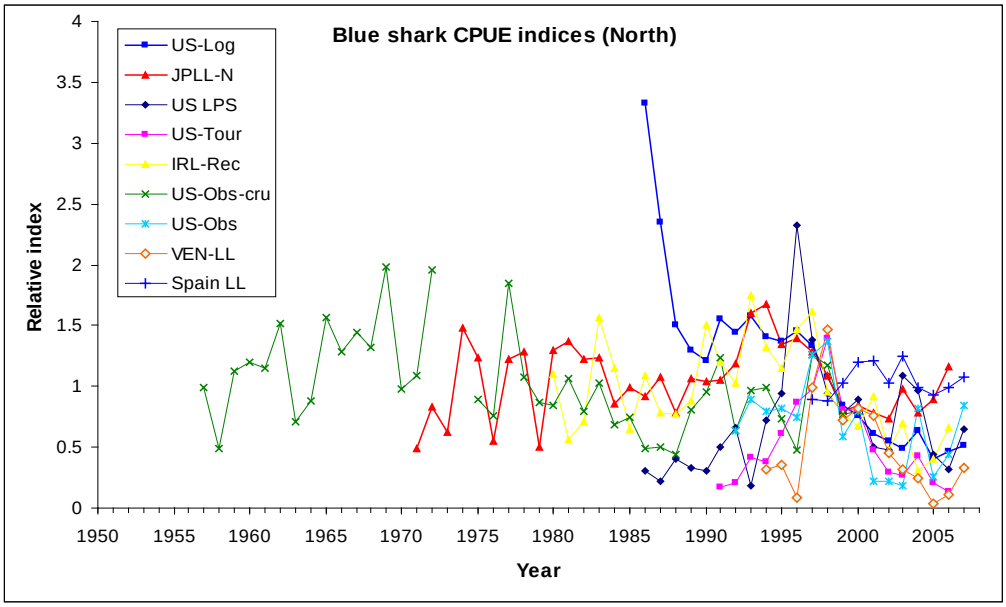



**Figure 8.5. Blue shark in the North Atlantic. Cpue indices used in ICCAT assessment in 2008. Indices presented on a relative scale ((Source: ICCAT assessment 2008).**

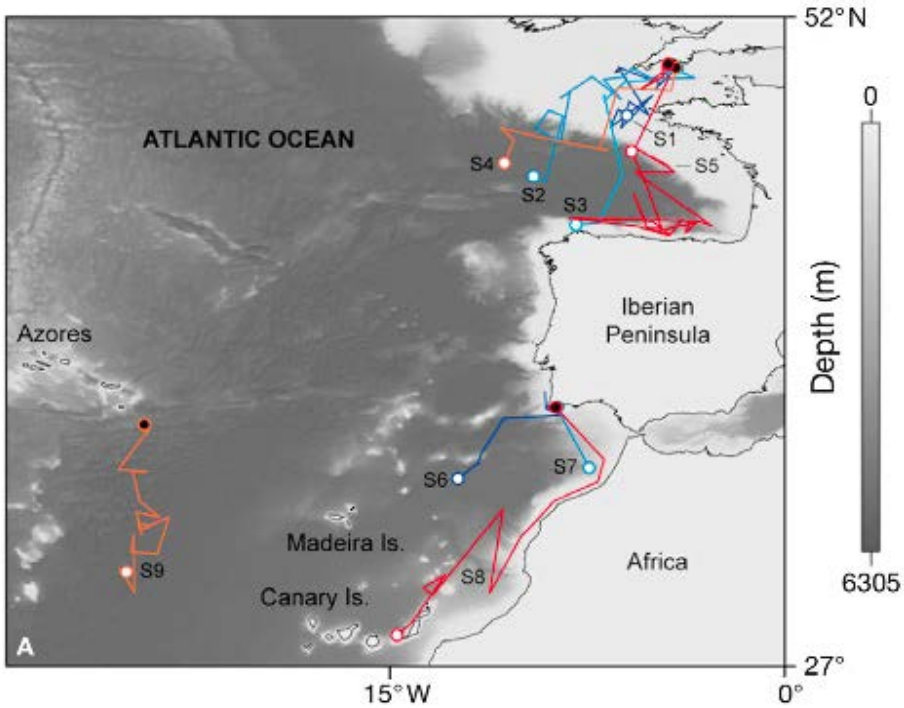
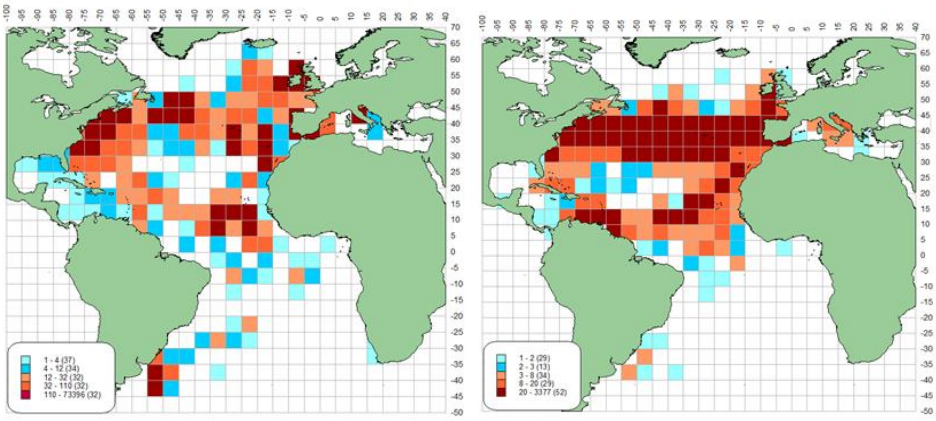
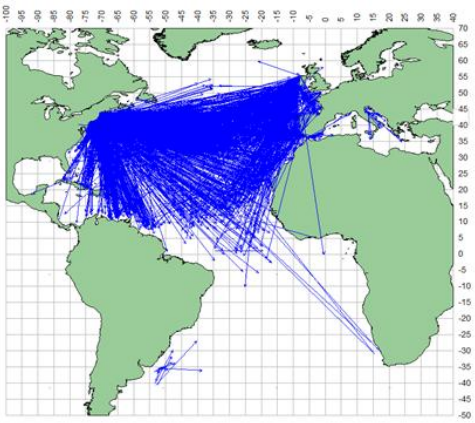



**Figure 8.6. Blue shark (*Prionace glauca*) Pop-off satellite-tagged blue shark movement patterns. (A) General movements overlaid on bathymetry; black circles denote tagging locations and white circles the pop-up/capture locations. (B to J) Individual tracks overlaid on sea surface temperature maps;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




**a)** **b)**



**c)**

**Figure 8.7. Blue shark tagging maps, presented by ICCAT (2012), showing a) density of releases, b) density of recoveries, and c) straight line displacement between release and recovery locations.**

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

## 9.1 Stock distribution

There is considered to be a single-stock of shortfin mako *Isurus oxyrinchus* in the North Atlantic. This conclusion is based on genetic analyses and tagging studies (e.g. Kohler *et al.*, 2002). The International Commission for the Conservation of Atlantic Tunas (ICCAT) tagging database contains over 9200 releases and 1200 recaptures (13% return rate), with around 60% of sharks still at large within two years (Figure 9.1). Almost all releases and recaptures were concentrated in the northeast coast of the US. Genetic studies (Heist *et al*., 1996; Schrey and Heist, 2002) have found no evidence to suggest separate east and west populations in the Atlantic; however the North Atlantic population appears to be isolated from those of other oceans. Therefore, the ICES area is only part of the North Atlantic stock.

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

## 9.2 The fishery

### 9.2.1 A history of the fishery

Shortfin mako is a highly migratory pelagic species that is caught frequently as a bycatch, mostly in surface longline fisheries that traditionally target tuna and billfish, and in other high seas tuna fisheries. Like porbeagle shark, it is a relatively high-value species (cf blue shark, which is of lower commercial value), and thus is normally retained (Campana *et al*., 2005). Recreational fisheries on both sides of the North Atlantic also catch this species, with relatively large quantities reported to ICCAT (178 t in 2011) arising from sport and rod and reel fisheries. In these fisheries, some fish are also released alive. Babcock (2012) provides an index of abundance of shortfin mako catch rates from the US East Coast from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS). A total of 711 shortfin mako shark were reported between 1981 and 2010. There were 252 686 trips in the included strata, of which about 0.2% of the trips caught at least one mako shark. They are also taken in Mediterranean fisheries (STECF, 2003). Tudela *et al*., 2005 observed 542 shortfin mako taken as a bycatch in 4140 km of driftnets set in the Alboran Sea between December 2002 and September 2003.

### 9.2.2 The fishery in 2012

Traditionally catches of this species reported to ICES have been minimal (7 to ~1000 t over the last 20 years); therefore in this report data from ICCAT are presented in the catch table (Table 9.1). The main country reporting landings of this species to ICES in 2012 was Portugal (Azores), where catch was 24.0 t. There were low levels (<2 t) also reported by France and the U.K. (including Scotland).

### 9.2.3 Advice applicable

ICES does not provide advice for this stock. Assessment of this stock is considered to be the responsibility of ICCAT. The last ICCAT assessment (2012) recommends, as a precautionary approach, that the fishing mortality of shortfin mako sharks should not be increased until more reliable stock assessment results are available for both the north and south stocks.

### 9.2.4 Management applicable

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

## 9.3 Catch data

### 9.3.1 Landings

Available landings data from ICCAT Task I catch data (total landings and discards by stock, flag and major gears) are presented in Table 9.1. These values may be considered underestimates, because of the inconsistent or generic reporting of shark catches by fleets. Catch series of "unclassified" shark groups represent about 20% on average (ranging from 11% to 32% between 1994 and 2002) of the total ICCAT Task I database of shark catches, and were not included here.

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

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

Previous ICCAT shortfin mako assessments used two other estimates of landings for this stock, the tuna ratio (logged observations of shark catches relative to tuna catches) and the fin trade index (shark fin trade observations from the Asian market used to calculate caught shark weights based on catch effort data; Clarke *et al.*, 2006; ICCAT 2005 and 2008). These figures were much higher than actual reported landings.

### 9.3.2 Discards

Although discard data are also given in Table 9.1, these are considered a large underestimate, with the USA longline being the only fleet to report a small amount of discards from 1987–1996 (1–38 t) and 2007–2010 (7–20 t). There are no reported discards from the Mediterranean, or 2011. The actual level of shortfin mako bycatch is difficult to estimate, as available data are limited and documentation is incomplete. A report of the US pelagic longline observer programme stated that of the sharks caught alive, 23% were released alive and 61% retained (ICCAT 2005).

Shortfin mako is a high value species, and many European fisheries land shortfin mako gutted (usually with the head on). Although in some fisheries shortfin mako sharks are landed for their meat, finning (i.e. the practice of removing a fin or fins of a shark and returning the remainder of the shark's carcass to the sea) may occur for this species as well, which may result in undocumented catches and mortality in some fleets.

### 9.3.3 Quality of catch data

Catch data are considered an underestimate, 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. Despite some important Task I catch series being recovered in recent years, ICCAT considers that the overall catch preserves its underestimated nature, in particular before 2000.

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

## 9.4 Commercial catch composition

No new information.

### 9.4.1 Conversion factors

Scientific estimates for the length–weight relationship for shortfin mako are summarized in Table 9.2, conversion factors for different length measurements in Table 9.3. Shortfin mako can be landed in various forms, whole, dressed, with or without heads, fins only, etc. It is therefore important that appropriate conversion factors for these landings are used. FAO (based on Norwegian data) use conversion factors for fresh, gutted, and gutted and headed sharks of 87% and 77%, respectively (Hareide *et al.*, 2007).

## 9.5 Commercial catch–effort data

Cpue data were compiled at the ICCAT assessment in 2004 (ICCAT, 2005) and in 2008, and these indicated a declining trend for this species in the North Atlantic for the years 1975–2004. In the 2012 North Atlantic shortfin mako assessment, six cpue series from longline fleets were presented, from Portugal, Spain, USA, Uruguay, Japan and Brazil, and additionally another series was also provided from the US Recreational Fishery (Figure 9.5).

The US pelagic longline logbook programme (1986–2010) and the US pelagic longline observer programme (1992–2010) indexes of abundance showed a concave shape, marked by an initial decline until the late 1990s, followed by an upward trend to 2010 (Cortés, 2012). The MRFSS data (1981–2010) showed high variability, with high catches in the mid-1990s, followed by a decline, then a stable trend over the last ten years (Babcock, 2012). Standardized cpue from logbook data of the Japanese tuna longline fishery in the North Atlantic Ocean (1994 and 2010) ranged from 0.07 to 0.1 between

1994 and 2005, and then showed continuous increasing trend (Semba *et al*., 2012). A filtering method removed assumed unreliable data. In general, the available cpue series showed increasing or flat trends for the final years of each series (since the last stock assessment).

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

## 9.6 Fishery-independent surveys

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

## 9.7 Life-history information

Only a few studies have compiled data on biological information on this species. Data available for the North Atlantic stock is given in Table 9.2 (Length–weight relationships), Tables 9.4 (growth parameters), and 9.5 (other life-history parameters). The NMFS of the USA also conducts a Cooperative Shark Tagging Programme (CSTP), which collaborates with the Shark Tagging Programme of Inland Fisheries Ireland (formerly the Irish Central Fisheries Board) (Green, 2007 WD; NMFS, 2006).

### 9.7.1 Habitat

Shortfin mako is a common, extremely active, offshore littoral and epipelagic species found in tropical and warm-temperate seas from the surface down to at least 500 m (Compagno, 2001). They are seldom found in waters below 16°C, and in the western North Atlantic they only move onto the continental shelf when surface temperatures exceed 17°C. Observations from South Africa indicate that this species prefers clear water (Compagno, 2001).

### 9.7.2 Nursery grounds

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

### 9.7.3 Diet

Shortfin mako feed primarily on fish, with a wide variety of both pelagic and demersal species observed in stomach contents (Compagno, 2001). In the NW Atlantic, bluefish (*Pomatomus saltatrix*) is the most important prey species and comprises about 78% of the diet (Stillwell and Kohler, 1982). These authors estimated that a 68 kg shortfin mako might consume about 2 kg of prey per day, and could eat about 8–11 times its body weight per year. Stillwell (1990) subsequently suggested that shortfin mako may consume up to 15 times their weight per year.

Shortfin mako sampled off southwest Portugal had teleosts as the principal component of their diet (occurring in 87% of the stomachs and accounting for over 90% of

the contents by weight), whereas crustaceans and cephalopods were also relatively important in their diet; other elasmobranchs were only present occasionally (Maia *et al.*, 2006). The diets of shortfin mako in South African waters indicated that elasmobranchs could be important prey, and marine mammals can also make up a small proportion of the diet (Compagno, 2001).

### 9.7.4 Life-history parameters

The life-history parameters of the shortfin mako from studies to-date are summarized in Table 9.5.

## 9.8 Exploratory assessment models

### 9.8.1 Previous assessments

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

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

### 9.8.2 Stock assessment

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

Additionally, as in the 2008 assessment, the catch-free model was applied to the North Atlantic stock. In general, the catch-free model is an age-structured production model (CFASPM) that derives all the fishery information from cpues rather than a combination of catches and cpues (ICCAT, 2012). A simple length-based method was also employed to check assumptions about selectivity made and for choosing starting or for fixing values.

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

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

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

## 9.9 Quality of assessment

Assessments undertaken by ICCAT are conditional on several assumptions, including the estimates of historical shark catch, the relationship between catch rates and abundance, the initial state of the stock, as well as uncertainty in some life-history parameters.

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

## 9.10 Reference points

ICCAT uses $F/F_{MSY}$ and $B/B_{MSY}$ as reference points for stock status of this stock. These reference points are relative metrics rather than absolute values. The absolute values of $B_{MSY}$ and $F_{MSY}$ depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

## 9.11 Management considerations

Catch data of pelagic sharks are considered unreliable, as many sharks are not reported on a species-specific basis, and some fisheries may have only landed fins. As already stated, the landings data are unreliable and particularly pre-2000 should be considered an underestimate. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic "*nei*" categories. The consolidation of three databases (ICCAT, FAO and EUROSTAT) by the ICCAT Secretariat should also strengthen the reliability of catch data in the future.

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

In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Atlantic population of the shortfin mako as threatened (DFO, 2006). In 1995 the Fisheries Management Plan for pelagic sharks in Atlantic Canada established a catch limit of 100 t annually for the Canadian pelagic longline fishery as well as advising release of live catch.

The shortfin mako was listed as Lower Risk Near Threatened until 2008 when it was listed as Vulnerable both globally and regionally in the North Atlantic in the IUCN Red List (Cailliet *et al*., 2009).

## 9.12 References

Anon. 2005. Report of the 2004 Inter-sessional Meeting of the ICCAT Sub-Committee on By-Catches: Shark Stock Assessment (Tokyo, Japan, June 14 to 18, 2004). Collect. Vol. Sci. Pap. ICCAT, 58(3): 799–890.

Babcock, E., A. 2010. Updated index of abundance for shortfin mako sharks from the U.S. marine recreational fisheries statistics survey. *ICCAT SCRS 2012/077*.

Bishop, S. D. H., Francis, M. P., Duffy, C., Montgomery, J. C. 2006. Age, growth, maturity, longevity, and natural mortality of the shortfin mako shark (*Isurus oxyrinchus*) in New Zealand waters. *Marine and Freshwater Research* 57: 143–154.

Buencuerpo, V., Ríos, S., and Morón, J. 1998. Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin* 96: 667–685.

Cailliet, G.M., Cavanagh, R.D., Kulka, D.W., Stevens, J.D., Soldo, A., Clo, S., Macias, D., Baum, J., Kohin, S., Duarte, A., Holtzhausen, J.A., Acuña, E., Amorim, A. & Domingo, A. 2009. *Isurus oxyrinchus (Atlantic subpopulation)*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1.

Cailliet, G. M., L. K. Martin, J. T. Harvey, D. Kusher, and B. A. Weldon. 1983. Preliminary studies on the age and growth of the blue shark, *Prionace glauca*, common thresher, *Alopias vulpinus*, and shortfin mako, *Isurus oxyrinchus*, from California waters. *In* Proceedings of the international workshop on age determination of oceanic pelagic fish: tunas, billfish, and sharks (E. D. Prince and L. M. Pulos, eds.), p. 179–188. US Dep. Commer., NOAA Tech. Rep. NMFS 8.

Campana, S. E., Marks, L., and Joyce, W. 2004. Biology, fishery and stock status of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. Canadian Stock Assessment, Research Document 2004/094, Ottawa.

Campana, S. E., Marks, L., and Joyce, W. 2005. The biology and fishery of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. *Fisheries Research* 73: 341–352.

Casey, J. G., and Kohler, N. E. 1992. Tagging studies on the shortfin mako shark (*Isurus oxyrinchus*) in the western North Atlantic. *Australian Journal of Marine and Freshwater Research*, 43: 45–60.

Castro, J. I., Woodley, C. M., and Brudek, R. L. 1999. A Preliminary Evaluation of the Status of Shark Species. FAO Fisheries Technical Paper 380, Rome.

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

Cliff, G., S. F. J. Dudley, and B. Davis. 1990. Sharks caught in the protective gillnets off Natal, South Africa. 3. The shortfin mako shark *Isurus oxyrinchus* (Rafinesque). *South African Journal of Marine Science*, 9:115−126.

Compagno L.J.V. 2001. An annotated and illustrated catalogue of shark species known to date. Volume 2 Bullhead, mackerel and carpet sharks (*Heterodontiformes*, *Lamniformes* and *Orectolobiformes*). *FAO Species Catalogue for Fishery Purposes*, 1(2): 109 pp.

Cortés, E. 1999. Standardized diet compositions and trophic levels of sharks. ICES Journal of Marine Science 56:707–717.

Cortés, E. 2000. Potential rates of increase and rates of increase per generation for three species of pelagic sharks from the Atlantic Ocean. Col.Vol.Sci.Pap. ICCAT, 51(6): 1822–1828.

Cortés, E. 2012. Standardised catch rates of mako sharks from the US pelagic longline logbook and observer programs using a generalized linear mixed model. *ICCAT SCRS 2012/070*.

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

Di Natale A. and Pelusi P. 2000. Effetti della pesca col palangaro derivante sui grandi pelagici e sulle specie accessorie nel Mediterraneo Centrale. Rapporto al Ministero per le Politiche Agricole e Forestali, DGPA, Roma-IV Piano Triennale.

Francis, M. P., and Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus, Isurus oxyrinchus,* and *Prionace glauca*) from New Zealand. *Fishery Bulletin* 103: 489–500.

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

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

Manday, D.G. 1975. Las pesquerias pelagico-oceanicas de corto radio de accíon en la regíon noroccidental de Cuba. Ser. Oceanol. Acad. Cienc. Cuba 31:1–26.

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.

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

Hueter, R. E. and. Simpfendorfer, C. 2008. Case Study: Trends in Blue Shark Abundance in the Western North Atlantic as Determined by a Fishery-Independent Survey. In: Sharks of the Open Ocean; M. D. Chami, E. K. Pikitch and E. Babcock (eds.) 236–241.

ICCAT. 2005. Report of the 2004 Intersessional Meeting of the ICCAT Subcommittee on 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.

ICCAT. 2008. Report of the 2008 shark stock assessments meeting. Madrid, Spain, 1–5 September, 2008. SCRS/2008/017–SHK Assessment, 89 pp.

ICCAT. 2011. Chapter 8.12 SHK-Sharks Report of the Standing Committee on Research and Statistics (SCRS) Madrid, Spain, October 3–7, 2011. ICCAT. 2011-016, 167-180.

ICCAT. 2012. Report of the 2012 shortfin mako stock assessment and ecological risk assessment meeting. Olhão, Portugal. June 11 to 18, 2012.

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.

Kohler, N.F., Turner, P.A., Hoey, J.J., Natanson, L.J., and Briggs, R. 2002. Tag and recapture data for three pelagic shark species: blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and porbeagle (*Lamna nasus*) in the North Atlantic Ocean. Col. Vol. Sci. Pap. ICCAT, 54 (4): 1231–1260.

Maia, A., Queiroz, N., Correia, J.P. and Cabral, H. 2006. Food habits of the shortfin mako, *Isurus oxyrinchus*, off the southwest coast of Portugal. *Environmental Biology of Fishes*, 77:157–167.

Maia, A., Queiroz, N., Cabral, H.N., Santos, A.M. and Correia, J.P. 2007. Reproductive biology and population dynamics of the shortfin mako, *Isurus oxyrinchus* Rafinesque, 1810, off the southwest Portuguese coast, eastern North Atlantic. *Journal of Applied Ichthyology* 23(3): 246.

Mejuto, J. and Garcés, A. G. 1984. Shortfin mako, *Isurus oxyrinchus*, and porbeagle, *Lamna nasus*, associated with longline swordfish fishery in NW and N Spain. ICES CM 1984/G:72 Demersal Fish Committee.

Mollet, H. F., Cliff, G., Pratt, H. L., and Stevens, J. D. 2000. Reproductive biology of the female shortfin mako, *Isurus oxyrinchus*, Rafinesque, 1810, with comments on the embryonic development of lamnoids. *Fishery Bulletin* 98: 299–318.

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

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.

Palma, C., Ortiz, M., de Bruyn, P., Kell L. and Pallares, P. 2012. Building a consolidated database to crosscheck ICCAT Task-I nominal catch, against EUROSTAT and FAO equivalent statistics. *ICCAT SCRS 2012/078*.

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

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

Semba, Y., Yokawa, K. and Hiraoka, Y. 2012. Standardized CPUE of shortfin mako (Isurus oxyrinchus) caught by the Japanese tuna longline fishery in the Atlantic Ocean. *ICCAT SCRS 2012/074*.

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

Smith, S. E., Au, D. W., and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. *Marine and Freshwater Research.* 49: 663–78.

STECF. 2003. Report of the Subgroup on Resource Status (SGRST) of the Scientific, Technical and Economic Committee for Fisheries (STECF): Elasmobranch Fisheries. Brussels, 22–25 July 2003. Commission Staff Working Paper SEC (2003) 1427.

Stevens, J. D. 1983. Observations on reproduction in the shortfin mako *Isurus oxyrinchus*. *Copeia* 1983:126–130.

Stevens, J. 2008. The biology and ecology of the shortfin mako shark, *Isurus oxyrinchus*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M.D. Camhi, E.K. Pikitch and E.A. Babcock, Eds.). Blackwell Publishing, Oxford, UK, 87–94.

Stevens, J. D., and S. E. Wayte. 1999. A review of Australia's pelagic shark resources. FRDC Proj. Rep. 98/107, 64 p.

Stillwell, C.E. 1990. The ravenous mako. In: Discovering sharks. A volume honouring the work of Stewart Springer (S.H. Gruber, Ed.). Underw. Nat., Bull. American Litter. Soc., 19–20(4/1): 77–78.

Stillwell, C.E. and N.E. Kohler. 1982. Food, feeding habits, and estimates of daily ration of the shortfin mako (*Isurus oxyrinchus*) in the Northwest Atlantic. *Canadian Journal of Fisheries and Aquatic Sciences,* 39: 407–414.

Strasburg, D. W. 1958. Distribution, abundance, and habits of pelagic sharks in the Central Pacific Ocean. *Fisheries Bulletin* 138: 335–361.

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

Wood, A. D., Collie, J. S. and Kohler, N. E. 2007, Estimating survival of the shortfin mako *Isurus oxyrinchus* (Rafinesque) in the north-west Atlantic from tag–recapture data. Journal of Fish Biology, 71: 1679–1695. doi: 10.1111/j.1095-8649.2007.01634.x.

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

| Year | | | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Landings | North Atlantic | | 797 | 953 | 2193 | 1526 | 3109 | 2019 | 3533 | 3798 | 2738 | 2546 | 2639 | 3377 | 3792 | 5174 | 3472 | 3370 | 4075 | 3559 | 4109 | 4181 | 3821 |
| | Mediterranean | | | | | | | | 6 | 8 | 5 | 4 | 7 | 2 | 2 | 2 | 17 | 10 | 2 | 1 | 1 | 2 | 2 |
| Landings | ATN | Longline | 584 | 699 | 1523 | 1195 | 1663 | 1771 | 3369 | 3648 | 2645 | 2254 | 2424 | 3129 | 3792 | 4755 | 3172 | 3105 | 3907 | 3375 | 3571 | 3554 | 3257 |
| | | Sport (inc. rod and reel) | 210 | 250 | 667 | 318 | 1422 | 232 | 164 | 150 | 71 | 292 | 215 | 248 | + | 333 | 282 | 257 | 159 | 157 | 163 | 168 | 178 |
| | | Other gear codes | 3 | 4 | 3 | 13 | 25 | 15 | 12 | 18 | 21 | 22 | 12 | 18 | 103 | 86 | 18 | 7 | 9 | 26 | 375 | 459 | 386 |
| | MED | Longline | | | | | | | 6 | 8 | 5 | 4 | 7 | 2 | 2 | 2 | 17 | 10 | 2 | 1 | 1 | 2 | 2 |
| Landings | ATN | Belize | | | | | | | | | | | | | | | | | | | 23 | 28 | 69 |
| | | Brasil | | | | | | | | | | + | | | | | | | | | | | |
| | | Canada | | | | | 111 | 67 | 110 | 69 | 70 | 78 | 69 | 78 | 73 | 80 | 91 | 71 | 72 | 43 | 53 | 41 | 37 |
| | | China P.R. | | | | | | | | | | + | | | | | | | 81 | 16 | 19 | 29 | 18 |
| | | Chinese Taipei | | | | | | | | | | | | | 84 | 57 | 19 | 30 | 25 | 23 | 11 | 13 | 15 |
| | | EU.España | | | | | | | 2416 | 2199 | 2051 | 1566 | 1684 | 2047 | 2068 | 3404 | 1751 | 1918 | 1816 | 1895 | 2216 | 2091 | 1667 |
| | | EU.France | | | | | | | | | | | | | | | | | | | 15 | 2 | + |
| | | EU.Portugal | 314 | 220 | 796 | 649 | 657 | 691 | 354 | 307 | 327 | 318 | 378 | 415 | 1249 | 473 | 1109 | 951 | 1540 | 1033 | 1169 | 1432 | 1045 |

| Year | | | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EU.United Kingdom | | | | | | | | | 2 | 3 | 2 | 1 | 1 | 1 | + | + | + | 1 | 15 | + | + |
| | | FR.St Pierre et Miquelon | | | | | | | | | | | | | | | | | 1 | 2 | | 4 | + |
| | | Japan | 157 | 318 | 425 | 214 | 592 | 790 | 258 | 892 | 120 | 138 | 105 | 438 | 267 | 572 | | | 82 | 131 | 98 | 116 | 85 |
| | | Korea Rep. | | | | | | | | | | | | | | | | | | | | | 27 |
| | | Maroc | | | | | | | | | | | | | | | | | | | | | 420 |
| | | Mexico | | | | | 10 | | | | | 10 | 16 | | 10 | 6 | 9 | 5 | 8 | 6 | 7 | 8 | 8 |
| | | Panama | | | | | | | | | 1 | + | | | | | | + | 49 | 33 | 39 | | |
| | | Philippines | | | | | | | | | 1 | | | | | | | | | 1 | | | |
| | | Senegal | | | | | | | | | | | | | | | | | 8 | 17 | 21 | + | 1 |
| | | St. Vincent and Grenadines | | | | | | + | | | 3 | | | | | | | | | | | | |
| | | Sta. Lucia | | | | | | | | | | | | | | | | | | + | | + | |
| | | Trinidad and Tobago | | | | | | | | | 1 | | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | |
| | | U.S.A. | 326 | 415 | 972 | 663 | 1739 | 470 | 407 | 347 | 159 | 454 | 395 | 415 | 142 | 521 | 469 | 386 | 381 | 354 | 385 | 394 | 408 |
| | | UK.Bermuda | | | | | | | 1 | 2 | 2 | | | | | | | + | + | + | + | + | + |
| | | Venezuela | | | | | | | | | | | | | | 58 | 20 | 6 | 11 | 2 | 35 | 22 | 20 |
| | MED | EU.Cyprus | | | | | | | | | | | | | | | | 1 | 1 | + | + | + | 1 |
| | | EU.España | | | | | | | 6 | 7 | 5 | 3 | 2 | 2 | 2 | 2 | 2 | 4 | 1 | + | + | 1 | 2 |
| | | EU.France | | | | | | | | | | | | | | | | | | | + | | |

| Year | | | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EU.Portugal | | | | | | | | 1 | | 1 | 5 | | + | | 15 | 5 | | | | + | |
| | | Japan | | | | | | | | | | | | | | | | | | + | | | |
| Discards * | ATN | Longline | 11 | 38 | 24 | 21 | 29 | 1 | | | | | | | | | | | 7 | 9 | 20 | 9 | |
| | | Other surf. | | | | | | | | | 2 | | | | | | | | + | 1 | + | + | |
| Discards * | ATN | Mexico | | | | | 1 | | | | | | | | | | | | + | | | | |
| | | U.S.A. | 11 | 38 | 24 | 21 | 28 | 1 | | | | | | | | | | | 7 | 10 | 20 | 9 | |
| | | UK.Bermuda | | | | | | | | | 2 | | | | | | | | | | | | |
| Total Landings and Discards | ATN | | 808 | 991 | 2217 | 1547 | 3138 | 2020 | 3533 | 3798 | 2740 | 2546 | 2639 | 3377 | 3792 | 5174 | 3472 | 3370 | 4082 | 3569 | 4129 | 4190 | 3821 |
| | MED | | | | | | | | 6 | 8 | 5 | 4 | 7 | 2 | 2 | 2 | 17 | 10 | 2 | 1 | 1 | 2 | 2 |

**Table 9.2. Shortfin mako in the North Atlantic. Length–weight relationships for *Isurus oxyrinchus* from different populations.**

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

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

**Table 9.3. Shortfin mako in the North Atlantic. Length–length relationships for male, female and both sexes combined from the NE Atlantic and Straits of Gibraltar (Source: Buencuerpo *et al.*, 1998). $L_S$ = standard length; $L_F$ = fork length; $L_T$ = total length; $L_{UC}$ = upper caudal lobe length.**

| Females | Males | Combined |
|---|---|---|
| LF = 1.086 LS + 1.630 (n=852) | LF = 1.086 LS + 1.409 (n=911) | LF = 1.086 LS + 1.515 (n=1763) |
| LT = 0.817 L S + 0.400 (n=852) | LT = 1.209 LS + 0.435 (n=681) | LT = 1.207 LS + 0.971 (n=1533) |
| LUC = 3.693 L S + 13.094 (n=507) | LUC = 3.795 L S + 10.452 (n=477) | LUC = 3.758 LS + 11.640 (n=1054) |
| LT = 1.106 LF + 0.052 (n=853) | LT = 1.111 LF – 0.870 (n=911) | LT = 1.108 LF – 0.480 (n=1746) |

**Table 9.4. Shortfin mako in the North Atlantic. Growth parameters from two studies. Formation of two vertebral bands annually assumed and von Bertalanffy growth function used $t_0$ in years.**

| Area | $L_\infty$ | k | $t_0$ | Sex | Study |
|---|---|---|---|---|---|
| Northwest Atlantic | 302 | 0.266 | –1 | Male | Pratt and Casey, 1983 |
| Northwest Atlantic | 345 | 0.203 | –1 | Female | Pratt and Casey, 1983* |
| Atlantic | 373.4 | –0.203 | 1.0 | Female | Cortés, 2000* |
| Northwest Atlantic | 253 | 0.125 | 71.6 | Male | Natanson *et al*., 2006** |
| Northwest Atlantic | 366 | 0.087 | 88.4 | Female | Natanson *et al*., 2006** |

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

**Table 9.5. Shortfin mako in the North Atlantic. Life-history information available from the scientific literature.**

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Reproduction | Ovoviviparous with oophagy | | | Campana *et al*., 2004 |
| Litter size | 4–25 | 35 | Worldwide | Mollet *et al*., 2000 |
| | 12–20 | | | Castro *et al*., 1999 |
| Size at birth ($L_T$) | 70 cm | 188+ | Worldwide | Mollet *et al*., 2000 |
| Sex ratio (males: females) | 1:1 | 2188 | NW Atlantic | Casey and Kohler, 1992 |
| | 1:0.4 | | NE Atlantic (Spain, Azores) | Mejuto and Garces, 1984 |
| | 1:0.9 | | NE, N central Atlantic and Med | Buencuerpo *et al*., 1998 |
| | 1.0:1.4 | 17 | NE Atlantic | García-Cortés and Mejuto, 2002 |
| Gestation period | 15–18 | 26 | Worldwide | Mollet *et al*., 2000 |
| Male age-at-first maturity (years)* | 2.5 | | | Pratt and Casey, 1983 |
| | 9 | | | Cailliet *et al*., 1983 |
| Male age-at-median maturity (years) | 7 | 145 | New Zealand | Bishop *et al*., 2006 |
| Female age-at-first maturity (years)* | 5 | | | Pratt and Casey, 1983 |
| Female age maturity (years) | 19 | 111 | New Zealand | Bishop *et al*., 2006 |
| | 7 | | | Pratt and Casey, 1983 |
| Male length-at-first maturity ($T_L$) | 195 cm | | | Stevens, 1983 |

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Male length-at-maturity ($T_L$) | 197–202 cm (median) | 215 | New Zealand | Francis and Duffy, 2005 |
| | 180 cm ($L_F$) | | NE Atlantic (Portugal) | Maia *et al*., 2007 |
| | 200–220 | | Worldwide | Pratt and Casey, 1983; Mollet *et al*., 2000 |
| Female length-at-first maturity ($T_L$) | 265–280 cm | | | Cliff *et al*., 1990 |
| Female length-at-maturity ($T_L$) | 301–312 (median) | 88 | New Zealand | Francis and Duffy, 2005 |
| | 270–300 cm ($L_T$) | | Worldwide | Pratt and Casey, 1983; Mollet *et al*., 2000 |
| Age-at-recruitment (year) | 0–1 | | | Stevens and Wayte, 1999 |
| Male maximum length ($T_L$) | 296 cm | | | Compagno, 2001 |
| Female maximum length ($T_L$) | 396 cm<br>408 cm (estimated) | | | Compagno, 2001 |
| Lifespan (years) | 11.5–17 (oldest aged) | | | Pratt and Casey, 1983 |
| | 45 (estimated longevity) | | | Cailliet *et al*., 1983 |
| Natural mortality (M) | 0.16 | | Pacific | Smith *et al*., 1998 |
| Annual survival estimate | 0.79 (95% C.I. 0.71–0.87) | | | Wood *et al*. 2007 |
| Growth parameters | 61.1 cm year–1 first year<br>40.6 cm year–1 second year<br>5.0 cm month–1 in summer<br>2.1 cm month–1 in winter | 262 | NE Atlantic (Portugal) | Maia *et al*., 2007 |
| Maximum age (estimated from von Bertalanffy growth eqn.) | 28 | | | Smith *et al*., 1998 |
| Productivity (R2m) estimate: intrinsic rebound | 0.051 (assuming no fecundity increase) | | Pacific | Smith *et al*., 1998 |

| Parameter | Values | Sample Size | Area | Reference |
|---|---|---|---|---|
| Potential rate of increase per year | 8.5% | | Atlantic | Cortés, 2000 |
| Population doubling time $T_D$ (years) | 13.6 (assuming no fecundity increase) | | Pacific | Smith *et al*., 1998 |
| Generation time (years) | ~ 9 | | Atlantic | Cortés, 2000 |
| Trophic level | 4.3 | 7 | | Cortés, 1999 |

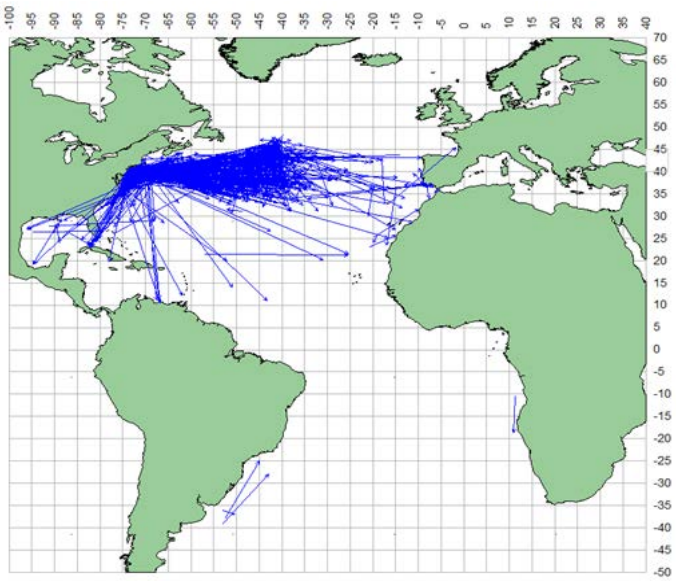


**Figure 9.1. Shortfin mako in the North Atlantic Tag and Release distributions for Shortfin Mako in the Atlantic Ocean (a = Density of releases, b = Density of recoveries, c = Straight displacement between release and recovery locations.). Figure courtesy of ICCAT.**

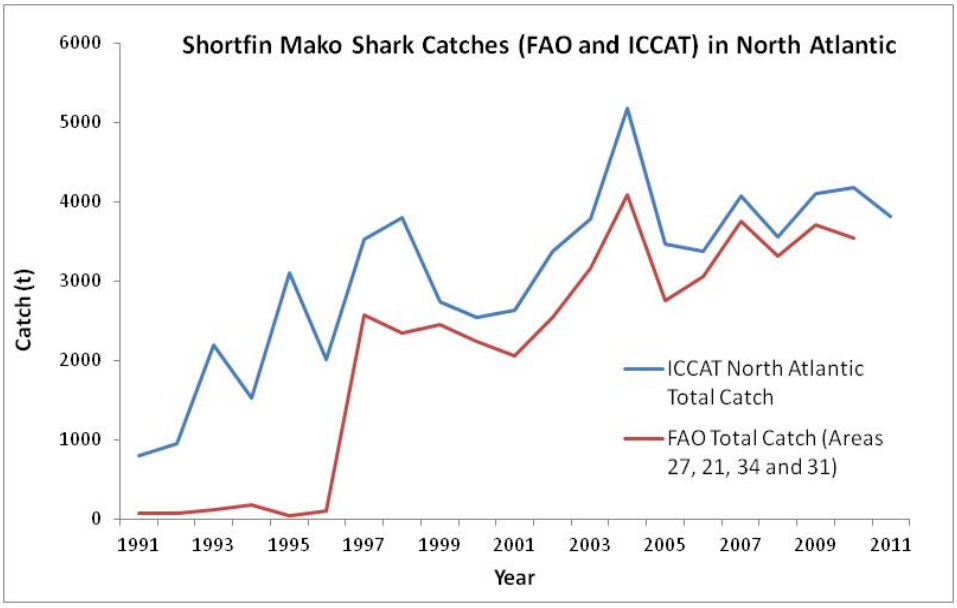



**Figure 9.2. Shortfin mako in the North Atlantic Total catches (t) of shortfin mako in the North Atlantic reported to FAO and ICCAT.**

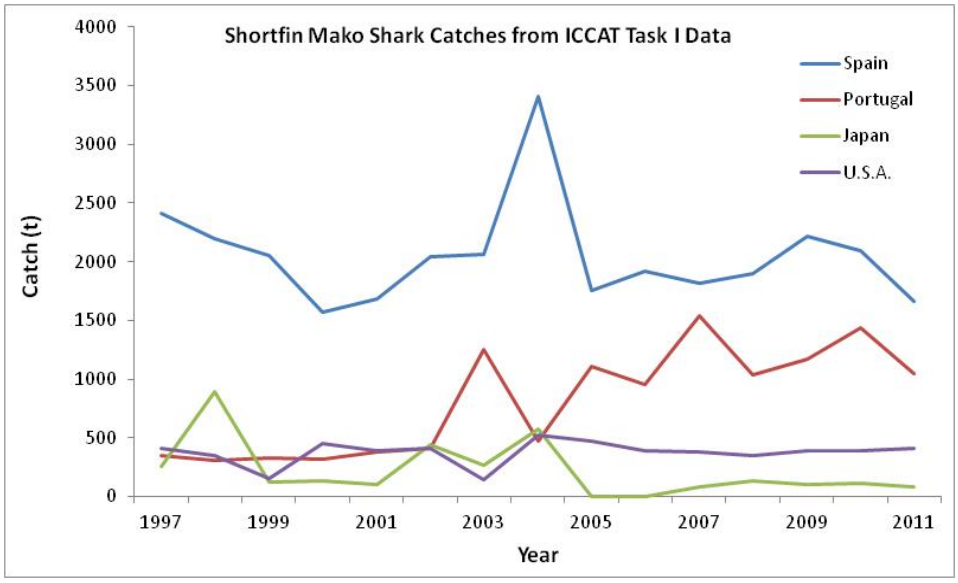



**Figure 9.3. Shortfin mako in the North Atlantic Total catches (t) made by the major countries (accounting for 84% of total landings) landing shortfin mako in the North Atlantic reported to ICCAT.**

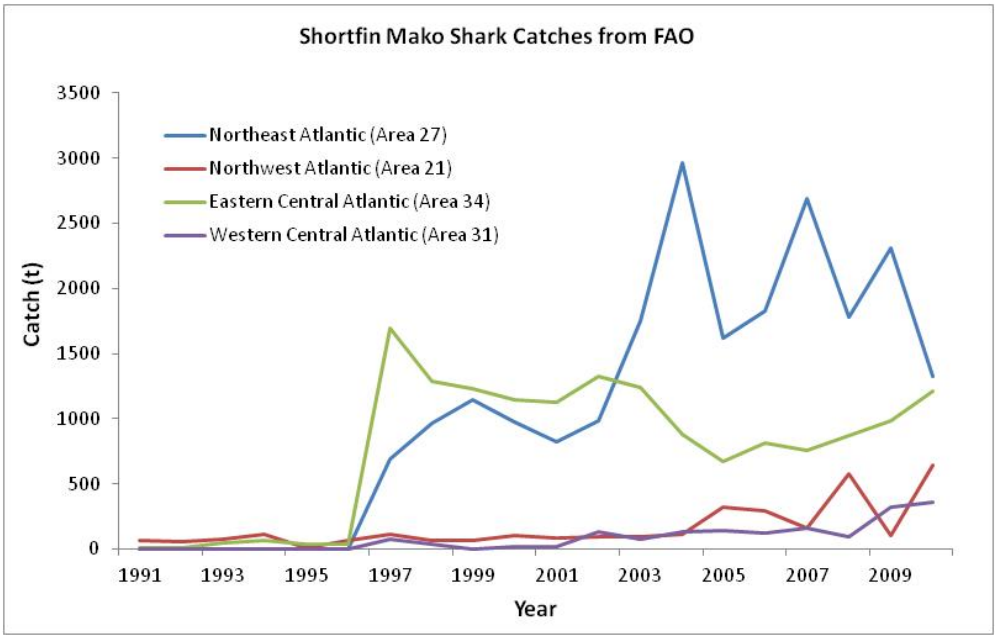



**Figure 9.4. Shortfin mako in the North Atlantic Total catches (t) of shortfin mako reported to FAO by major fishing area.**

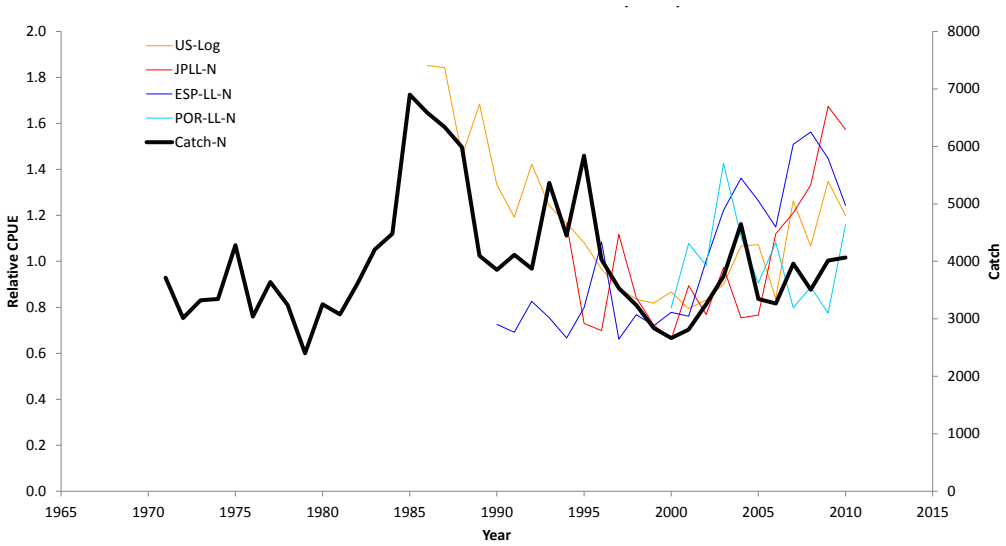



**Figure 9.5. Shortfin mako in the North Atlantic Indices of abundance for North Atlantic shortfin mako shark, along with total catches input into the BSP model used in the ICCAT 2012 assessment. Figure courtesy of ICCAT.**

# 10 Tope in the Northeast Atlantic

## 10.1 Stock distribution

WGEF considers there to be a single-stock of tope (or school shark, *Galeorhinus galeus*) in the ICES area. This stock is distributed from Scotland and southern Norway southwards to the coast of northwestern Africa and Mediterranean Sea. The stock area therefore, covers ICES Subareas II–X (where Subareas IV and VI–X are important parts of the stock range, and Subareas II, III and V areas where tope tend to be an occasional vagrant). The stock also extends to the northern part of the CECAF area, and may extend to the Mediterranean Sea (Subareas I–III).

The information used to identify the stock unit is summarized in the stock annex 2009.

## 10.2 The fishery

### 10.2.1 History of the fishery

Currently there are no targeted commercial fisheries for tope in the NE Atlantic. Tope are taken as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic set gears. Though tope are discarded in some fisheries, other fisheries land this species as bycatch.

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

### 10.2.2 The fishery in 2012

There were no major changes to the fishery noted in 2012.

### 10.2.3 ICES Advice applicable

ICES provided advice for this stock for the first time in 2012. Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 20%. Because the data for catches of tope are not fully documented and considered unreliable (due to the historic use of generic landings categories), ICES is not in a position to quantify the result.

Measures to identify pupping areas should be taken.

### 10.2.4 Management applicable

Longline fishery of tope is forbidden by EU regulation n°57/2011 of 18th January 2011 in ICES Areas I, IIa, IV, V, VI, VII, VIII, XII and XIV.

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

## 10.3 Catch data

### 10.3.1 Landings

No accurate estimates of catch are available, as many nations that land tope will report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). Reported species-specific landings, which commenced in 1978 for French fisheries, are given in Table 10.1 and Figure 10.1. Landings indicate that France is one of the main nations landing tope (though data for 1980 and 1981 were not available). The UK also land tope, although species-specific data are lacking for the earlier years. Since 2001, Ireland, Portugal and Spain have also declared species-specific landings.

No species-specific catch data for the Mediterranean Sea and off Northwest Africa are available. The degree of possible misreporting or underreporting is not known. Overall available landings appear relatively stable from 1982 to 2003 at around 500 t per year and at 400 t per year since 2004, with a drop to ~300 t in 2011 and 2012.

### 10.3.2 Discards

Though some discards information is available from various nations, data are limited for most nations and fisheries. Preliminary studies from the UK Discard programme (Silva *et al*., 2013 WD) have indicated that juvenile tope tend to be discarded in demersal trawl fisheries and larger individuals are usually retained. Tope caught in drift and fixed net fisheries are usually retained.

Figure 10.2 shows the retained and discarded topes from the UK Discard programme (Silva *et al*., 2013 WD). In demersal trawl fisheries, topes of 50–94 cm TL are generally discarded and those over 94 cm TL often retained. In drift and fixed net fisheries, tope are mostly retained and ranged mainly from 70 to 124 cm TL.

### 10.3.3 Quality of catch data

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

Following the publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Workshop on Stock Assessment of selected species of Elasmobranchs in the GFCM area, WGEF believes that collaboration should continue between ICES and the GFCM. This will encourage the sharing of information and aid the better understanding of elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

## 10.4 Commercial catch composition

No new data available.

## 10.5 Commercial catch–effort data

No data available.

## 10.6 Fishery-independent information

### 10.6.1 Availability of survey data

Although several fishery-independent surveys operate in the stock area, data are limited for most of these. This species is not sampled appropriately in beam trawl surveys (because of low gear selectivity). They are only caught occasionally in GOV trawl and other otter trawl surveys in the North Sea.

More recently, Q4 IBTS surveys in the Celtic Seas ecoregion have been observed to sample small numbers of tope, with some nations tagging and releasing specimens where possible (ICES, 2008). Irish IBTS surveys also record small numbers of tope, although one haul (40E2, VIa) in 2006 yielded 59 specimens. Southern and western IBTS surveys may cover a large part of the stock range, and more detailed analyses of these data are required. UK surveys in this area generally capture larger tope at the southern entrance to St George's Channel, and in 2011 several juveniles were captured in the Irish Sea.

During the EVHOE scientific surveys, 19 individuals were caught (five in 2009, seven in 2010, and seven in 2011) in the Celtic Sea area, consisting of eleven males of 55–152 cm TL and eight females of 53–134 cm TL (Ramonet *et al.*, 2012). Lorance (2011) reported ca. two tope per year for the EVHOE cruises in the Bay of Biscay for the period 1992–2010.

In their atlas of the fishes observed during the scientific surveys, Trenkel *et al.* (2009) provide maps of densities (ind.km$^{-2}$) for tope (Figure 10.3), showing higher densities in the western English Channel and Celtic Sea.

### 10.6.2 Cpue

Analyses of catch data would need to be undertaken with care, as tope is a relatively large-bodied species (up to 200 cm length in the NE Atlantic), and adults are strong swimmers that forage both in pelagic and demersal waters. Hence, they are probably not sampled effectively in IBTS surveys, and survey data generally include a large number of zero hauls.

### 10.6.3 Length distributions

In 2009, data were presented on length distributions found in the Celtic Sea ecoregion during fisheries independent surveys conducted by England and Ireland during quarter 4 (Figure 10.4). Irish surveys recorded 145 tope (2003–2009), of which 110 (76%) were male. English surveys recorded 90 tope, with 56 males (62%) and 34 females (38%). The lengths ranged from 40–163 cm. The length distributions found between the surveys are noticeably different, with many more large males found in the Irish survey; 75% of the males were greater than 130 cm. The English surveys have a more evenly distributed length range.

Figure 10.5 shows the length distributions of topes caught in various UK surveys in 2004–2009. In the beam trawl survey (Figure 10.5a), two peaks were observed, at 30–54 cm TL and 70–84 cm TL respectively. In the North Sea survey (Figure 10.5b) a wide range from 30 to 164 cm TL was observed, with a main peak at 30–44 cm TL. Wide ranges were also observed in the Celtic Sea survey (Figure 10.5c), and in the western IBTS survey (Figure 10.5d), from 44 to 164 cm TL and from 70 and 120 cm TL, respectively.

### 10.6.4 Tagging information

159 tope were tagged and released by Cefas over the period 1961–2013, predominately in the Irish Sea and Celtic Sea (Figure 10.6) (Burt *et al*., 2013). Fish were also tagged in the western English Channel and North Sea but in very low numbers (n = 9) (Figure 10.7). Tope were tagged over a wide length range (41–162 cm LT), the majority being males, with a male to female sex ratio of 1.5:1. A total of four tope were recaptured, and were, on average, at liberty for 1195 days, with a maximum recorded time at liberty of 2403 days. Over the period individual fish had travelled relatively large distances (112–368 km), and all had moved from one ICES division to another. For example, the fish that was at liberty the longest that was released in Cardigan Bay (VIIa) in November 2003 was later captured in June 2010 just to the east of the Isle of Wight. It is also noted that a tag from a tope was returned to Cefas from southern Spain, and although release information could not be located, it is thought it may have referred to fish tagged in the 1970s.

In 2012 The UK(Scotland) started an electronic (archival data storage tags that record pressure and temperature) and conventional tagging programme for tope. To date, 13 tope have been tagged and there have been two returns recently reported from France and Portugal (conventional tag). The data have not yet been downloaded and investigated. Further releases are planned in 2013.

The Irish Marine Sportfish Tagging Programme has tagged tope off the Irish coast since 1970. Four fish have been recaptured in the Mediterranean Sea. (Inland Fisheries Ireland, *pers comm*., Fitzmaurice 1994).

A tope shark tagged on 38th July 2001 off Greystone (Ireland) as part of this programme, was caught on 9th May 2013 off Bastia, Corsica (Mediterranean Sea), showing a migration route of 3900 km in twelve years (cf. nicematin.com, 29 May 2013, "Le long périple d'un requin hâ, de l'Irlande à la Corse").

## 10.7 Life-history information

Much biological information is available for tope in European seas and elsewhere in the world. These are summarized in the stock annex of the 2009 report (ICES 2009).

The following relationships and ratios were calculated by Séret and Blaison (2010):

> $TL = 0.0119\ W^{2.7745.}$ with TL in cm and W in g for 10 specimens of 60–140 cm TL;
>
> Life weight / eviscerated weight = 1.28 (s.d. 0.05);
>
> Life weight / dressed weight (eviscerated, headed, skinned) = 2.81 (s.d. 0.13);
>
> Smallest mature male 110 cm TL, smallest mature female 130 cm TL, fitting with the ranges 120–135 and 134–140 cm TL observed for other populations.

**Pupping and nursery grounds:** Pups (24–45 cm length) are occasionally caught in groundfish surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas (Figure 10.7). Most of the records for pups recorded in UK surveys are from the southern North Sea (IVc), though they have also been recorded in the northern Bristol Channel (VIIf).

The lack of more precise data on the location of pupping and nursery grounds, and their importance to the stock, precludes spatial management for this species at the present time.

A genetic study (Chabot and Allen, 2009) on the eastern Pacific population including comparisons with samples from Australia, South and North America and UK, shows that there is little to no gene flow between these populations, meaning an apparent lack of migration.

## 10.8 Exploratory assessment models

### 10.8.1 Previous studies

No previous assessments of NE Atlantic tope have been made. Several assessment methods have been applied to the South Australian stock (e.g. Punt and Walker, 1998; Punt *et al*., 2000; Xiao and Walker, 2000).

### 10.8.2 Data exploration and preliminary modelling

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

### 10.8.3 Stock assessment

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

## 10.9 Quality of the assessment

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

## 10.10 Reference points

No reference points have been proposed for this stock.

## 10.11 Conservation considerations

The IUCN list tope as Vulnerable (globally) and as Data Deficient in the NE Atlantic (Gibson *et al.,* 2008).

## 10.12 Management considerations

Tope is considered highly vulnerable to overexploitation, as they have a low population productivity, relatively low fecundity and protracted reproductive cycle. Furthermore, unmanaged, targeted fisheries elsewhere in the world have resulted in stock collapse (e.g. off California and in South America).

Tope are also an important target species in recreational fisheries; though there are insufficient data to examine the relative economic importance of tope in the recreational angling sector, this may be high in some regions.

Tope is, or has been, a targeted species elsewhere in the world, including Australia/New Zealand, South America and off California. Evidence from these fisheries (see stock annex and references cited therein) suggests that targeted fisheries would need to be managed exerting low level of exploitation.

Australian fisheries managers have used a combination of a legal minimum length, a legal maximum length, legal minimum and maximum gillnet mesh sizes, closed seasons and closed nursery areas. However as the species are mainly taken in mixed fisheries in the ICES area, many of these measures are of less utility.

## 10.13 References


Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal, 17–21 June 2013. 12pp.

Chabot, C. L., and Allen, L. G. 2009. Global population structure of the tope (*Galeorhinus galeus*) inferred by mitochondrial control region sequence data. *Molecular Ecology*, 18: 545–552.

Fitzmaurice, P. 1994. Tagging studies of blue sharks and topeoff the Irish coast. p. 17. In: S.L. Fowler and R.C. Earll (ed.) Proceedings of the Second European Shark and Ray Workshop,15–16 February 1994, Tag and Release Schemes and Shark and Ray Management Plans.

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

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

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

Lorance, P. 2011. Les populations ichtyologiques démersales profondes de la sous-région marine Golfe de Gascogne, contribution thématique DCSMM, evaluation de l'état initial, carcatéristique biologique-biocenoses. EE-110526-Ichtyologie-profonde VI- GDG- 26 mai 2011, 9 p.

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.

Ramonet M., Jung, A., Salaun M., Pawlowski, L., Bellail, R., Mahé, J-C., Poisson, F. and Biseau, A. 2012. Elasmobranch morphometric relationship and sexual maturity stages from EVHOE scientific survey in Northeast Atlantic Ocean from 2007 to 2011 campaigns. WGEF WD, June 2012, 26 p.

Séret, B. and Blaison A., 2010. Requins et raies des pêches françaises. Axe 2. Facteurs de conversion. Convention DPMA / IRD. Rapport, 31 p.

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

Trenkel, V.M., Berthelé, O., Lorance, P., Bertrand, J., Brind'Amour, A., Cochard, M.-L., Coppin, F., Leauté, J.-P., Mahé, J.- C., Morin, J., Rochet, M.-J., Salaun, M., Souplet, A., Vérin, Y. 2009. Atlas des grands invertébrés et poissons observés par les campagnes scientifiques. Bilan 2008. Ifremer, Nantes, EMH : 09-003. 100 p.

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 Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2012. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and are limited for Northwest African waters.**

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICES Division IIIa–IV | | | | | | | | | | | | |
| Denmark | - | - | - | - | - | - | - | - | - | - | - | - |
| France | na | na | na | 32 | 22 | na | na | 26 | 26 | 13 | 31 | 13 |
| Sweden | - | - | - | - | - | - | - | - | - | - | - | - |
| UK (E&W) | na | na | na | na | na | na | na | 8 | 10 | 31 | 36 | 94 |
| UK(Scotland) | | | | | | | | | | | | |
| Total (IIIa–IV) | 0 | 0 | 0 | 32 | 22 | 0 | 0 | 34 | 36 | 44 | 67 | 107 |
| ICES Division V–VII | | | | | | | | | | | | |
| France | na | na | na | 522 | 2076 | na | na | 988 | 1580 | 346 | 339 | 1141 |
| Ireland | na | na | na | na | na | na | na | na | na | na | na | na |
| Netherlands | | | | | | | | | | | | |
| Spain | na | na | na | na | na | na | na | na | na | na | na | na |
| Spain (Basque country) | - | - | - | - | - | - | - | - | - | - | - | - |
| UK(E&W) | na | na | na | na | na | na | na | 63 | 51 | 28 | 23 | 21 |
| UK(Scotland) | | | | | | | | | | | | |
| Total (VI–VII) | | | | 522 | 2076 | 0 | 0 | 1051 | 1631 | 374 | 362 | 1162 |
| ICES Division VIII | | | | | | | | | | | | |
| France | na | na | na | na | 237 | na | na | na | 63 | 119 | 52 | 103 |
| Spain | na | na | na | na | na | na | na | na | na | na | na | na |
| Spain (Basque country) | - | - | - | - | - | - | - | - | - | - | - | - |
| UK(E&W) | - | - | - | + | + | + | + | + | + | + | + | 1 |
| UK(Scotland) | | | | | | | | | | | | |
| Total (VIII) | | | | 0 | 237 | 0 | 0 | 0 | 63 | 119 | 52 | 104 |
| ICES Division IX | | | | | | | | | | | | |
| Spain | na | na | na | na | na | na | na | na | na | na | na | na |
| Total (IX) | | | | | | | | | | | | |
| ICES Division X | | | | | | | | | | | | |
| Portugal | 18 | na | na | 24 | 15 | 51 | 77 | 42 | 24 | 29 | 24 | 24 |
| Total (X) | 18 | | | 24 | 15 | 51 | 77 | 42 | 24 | 29 | 24 | 24 |
| Other | | | | | | | | | | | | |
| France | - | - | - | - | - | - | - | - | - | - | - | - |

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UK(E&W) | - | - | - | - | - | - | - | - | - | - | - | - |
| CECAF area | | | | | | | | | | | | |
| Portugal | - | - | - | - | - | - | - | - | - | - | - | - |
| TOTAL LANDINGS | 18 | 0 | 0 | 578 | 2350 | 51 | 77 | 1127 | 1754 | 567 | 505 | 1397 |

**Table 10.1. (continued). Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2012. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and limited for Northwest African waters.**

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES Division IIIa–IV** | | | | | | | | | | | | | |
| Denmark | - | - | - | - | - | - | - | - | - | - | . | . | 3 |
| France | 14 | 18 | 12 | 17 | 16 | 10 | 11 | 12 | 8 | 11 | 5 | 11 | |
| Sweden | - | - | - | - | - | - | - | - | - | - | . | . | . |
| UK(E&W) | 28 | 22 | 18 | 14 | 21 | 15 | 15 | 19 | 25 | 14 | 22 | 12 | 14 |
| UK(Scotland) | | | | - | - | - | - | - | - | - | . | . | . |
| Total (IIIa–IV) | 42 | 40 | 30 | 31 | 37 | 25 | 26 | 31 | 33 | 25 | 27 | 23 | 17 |
| **ICES Division V–VII** | | | | | | | | | | | | | |
| France | 491 | 621 | 407 | 357 | 391 | 235 | 240 | 235 | 265 | 314 | 409 | 312 | |
| Ireland | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Netherlands | | | | | | | | | | | . | . | . |
| Spain | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Spain (Basque country) | - | - | - | - | - | - | - | - | - | - | . | . | . |
| UK(E&W) | 21 | 21 | 55 | 45 | 47 | 53 | 48 | 49 | 38 | 39 | 34 | 41 | 62 |
| UK(Scotland) | | | | | | | | | | | | | |
| Total (VI–VII) | 512 | 642 | 462 | 402 | 438 | 288 | 288 | 284 | 303 | 353 | 443 | 353 | 62 |
| **ICES Division VIII** | | | | | | | | | | | | | |
| France | 97 | 66 | 39 | 34 | 38 | 34 | 40 | 54 | 44 | 78 | 40 | 46 | + |
| Spain | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Spain (Basque country) | - | - | - | - | - | - | - | - | - | - | . | . | . |
| UK(E&W) | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| UK(Scotland) | | | | | | | | | | | | | |
| Total (VIII) | 97 | 66 | 39 | 34 | 38 | 34 | 40 | 54 | 44 | 78 | 40 | 46 | 0 |
| **ICES Division IX** | | | | | | | | | | | | | |

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Total (IX) | | | | | | | | | | | | | |
| **ICES Division X** | | | | | | | | | | | | | |
| Portugal | 24 | 34 | 23 | 56 | 81 | 80 | 115 | 116 | 124 | 80 | 104 | 128 | 129 |
| Total (X) | 24 | 34 | 23 | 56 | 81 | 80 | 115 | 116 | 124 | 80 | 104 | 128 | 129 |
| **Other** | | | | | | | | | | | . | . | . |
| France | - | - | - | - | - | - | - | - | - | - | . | . | 386 |
| UK(E&W) | - | - | - | - | - | - | - | + | + | - | . | . | . |
| **CECAF area** | | | | | | | | | | | . | . | . |
| Portugal | - | - | - | - | - | - | - | - | - | - | . | . | . |
| **TOTAL LANDINGS** | 675 | 782 | 554 | 523 | 593 | 427 | 469 | 485 | 504 | **536** | **615** | **551** | **593** |

**Table 10.1. (continued). Tope in the Northeast Atlantic. Reported species-specific landings (nearest tonne) for the period 1975–2012. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and limited for Northwest African waters.**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES Division IIIa–IV** | | | | | | | | | | | | | |
| Denmark | 8 | 4 | 5 | 5 | 5 | 8 | 6 | 4 | 4 | 3 | 2 | 4 | . |
| France | 11 | 11 | 6 | 6 | 3 | 3 | 6 | 6 | 6 | 7 | 9 | 7 | 4 |
| Sweden | . | . | . | . | . | + | + | + | . | . | . | . | . |
| UK(E&W) | 13 | 10 | 13 | 11 | 8 | 10 | 13 | 5 | 2 | 1 | 1 | 4 | 1 |
| UK(Scotland) | . | . | . | . | . | . | . | + | + | + | + | + | + |
| Total (IIIa–IV) | 32 | 25 | 24 | 22 | 16 | 21 | 25 | 14 | 12 | 11 | 12 | 15 | 6 |
| **ICES Division V–VII** | | | | | | | | | | | | | |
| France | 368 | 394 | 324 | 284 | 209 | 181 | 293 | 155 | 187 | 259 | 278 | 199 | 226 |
| Ireland | na | 4 | 1 | 6 | 4 | na | 7 | 3 | 4 | 3 | 3 | 1 | + |
| Netherlands | . | . | . | . | . | . | . | . | . | . | 2 | 18 | . |
| Spain | na | + | 242 | 3 | na | na | na | na | 60 | 69 | 44 | 12 | 3* |
| Spain (Basque country) | . | + | + | 3 | 15 | 10 | . | . | . | . | . | . | . |
| UK(E&W) | 98 | 72 | 60 | 55 | 65 | 65 | 74 | 44 | 26 | 22 | 15 | 13 | 15 |
| UK(Scotland) | | | | | | | | . | 7 | + | + | + | . |
| Total (VI–VII) | 466 | 470 | 627 | 351 | 293 | 256 | 374 | 202 | 284 | 352 | 342 | 242 | 241 |
| **ICES Division VIII** | | | | | | | | | | | | | |
| France | 71 | 58 | 49 | 60 | 16 | 29 | 40 | 28 | 35 | 74 | 57 | 39 | 39 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | na | 9 | 13 | 10 | na | na | na | na | 21 | 33 | 11 | 5 | 2* |
| Spain (Basque country) | . | 9 | 6 | 10 | 10 | 14 | 12 | 1 | 12 | 14 | 12 | 17 | . |
| UK(E&W) | | 1 | .. | 3 | 8 | 6 | 5 | . | . | + | .. | . | . |
| UK(Scotland) | . | .. | | . | . | . | . | . | + | | | . | . |
| Total (VIII) | 71 | 77 | 68 | 83 | 34 | 49 | 57 | 29 | 69 | 121 | 80 | 61 | 39 |
| **ICES Division IX** | | | | | | | | | | | | | |
| Spain | na | na | na | na | 76 | na | na | na | 96 | 85 | 88 | 89 | 12* |
| Total (IX) | | | | | | | | | | | | | |
| **ICES Division X** | | | | | | | | | | | | | |
| Portugal | 142 | 82 | 77 | 69 | 51 | 45 | 45 | 43 | 47 | 34 | 41 | 44 | 47 |
| Total (X) | 142 | 82 | 77 | 69 | 51 | 45 | 45 | 43 | 47 | 34 | 41 | 44 | 47 |
| **Other** | . | . | . | . | . | . | . | . | . | . | . | . | . |
| France | . | 2 | . | . | . | . | . | . | . | . | . | . | + |
| UK(E&W) | . | . | . | . | . | . | . | . | . | . | . | . | . |
| **CECAF area** | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Portugal | 2 | 1 | 2 | 98 | na | na | na | na | na | . | . | . | . |
| **TOTAL LANDINGS** | **713** | **656** | **798** | **622** | **394** | **371** | **502** | **288** | **412** | **518** | **475** | **361** | **333** |

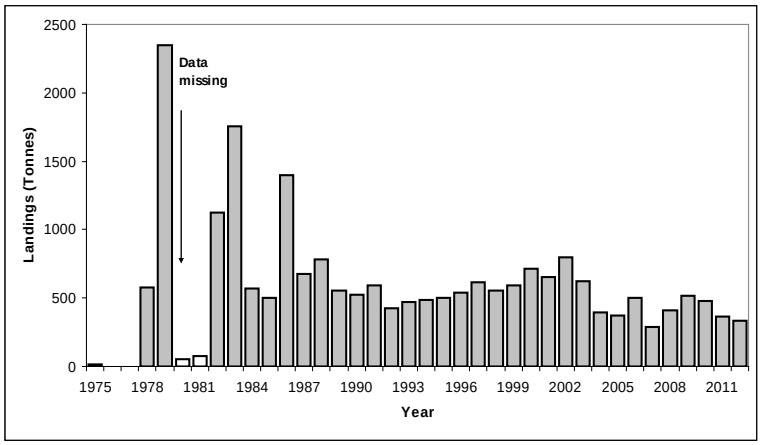



**Figure 10.1. Tope in the Northeast Atlantic. Annual landings 1975–2012. These data are considered underestimates as some tope are landed under generic landings categories, and no species-specific landings data are available for the Mediterranean Sea and northwest African waters. Not all data are available for recent years.**

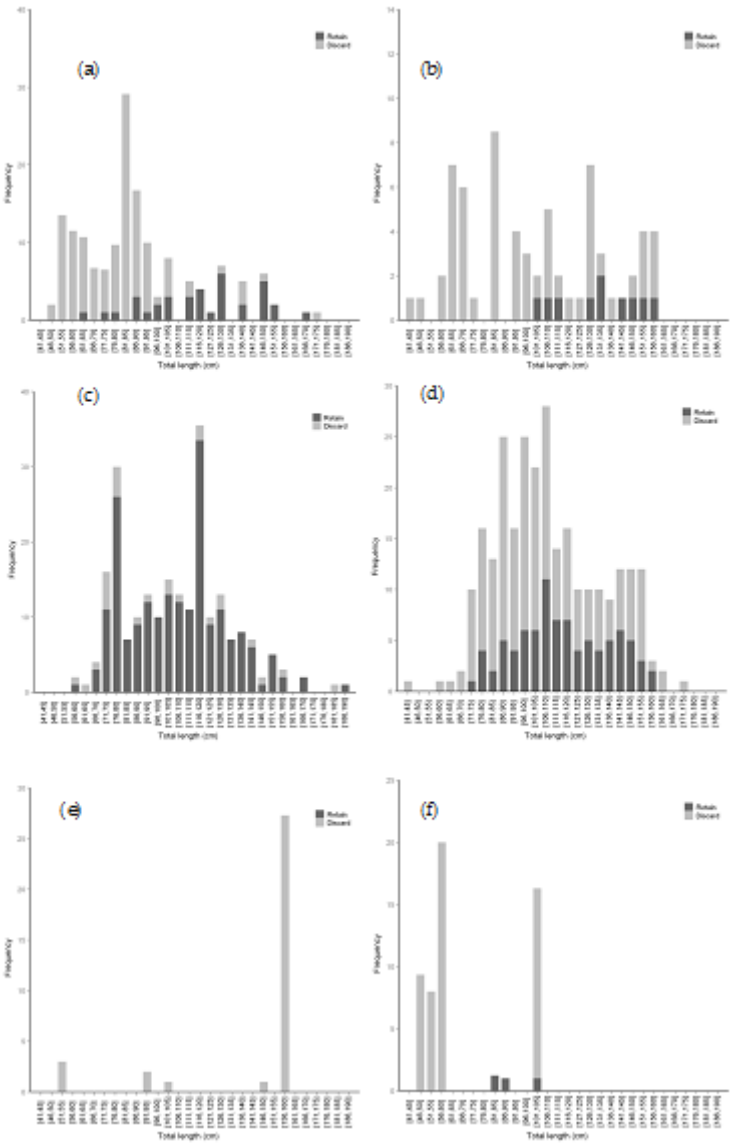



**Figure 10.2. Tope in the Northeast Atlantic. Length–frequency of discarded and retained tope *Galeorhinus galeus* by (a) otter trawl (2002–2007) and (b) otter trawl (2008–2011), (c) gillnet (2002–2007), (d) gillnet (2008–2011), (e) beam trawl (2002–2011) and (f) *Nephrops* trawl (2002–2011) across both ecoregions, as recorded in the Cefas observer programme.**

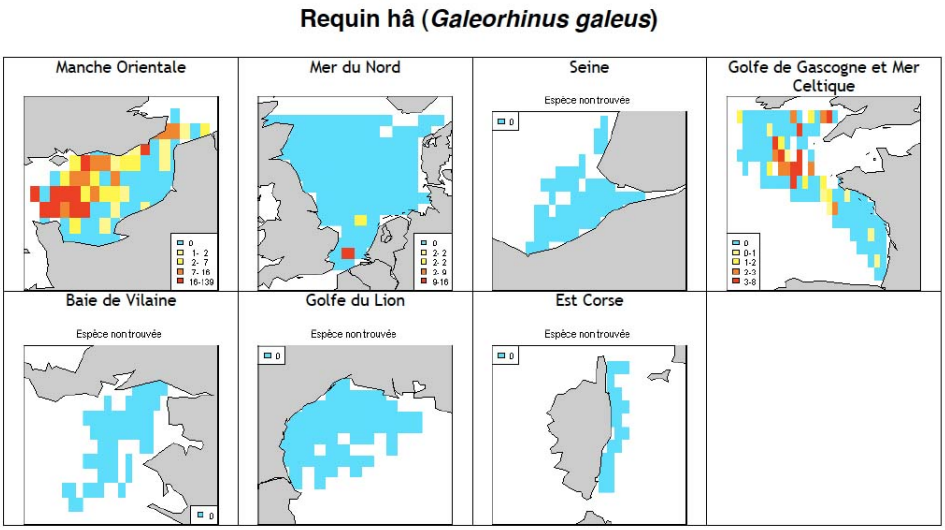



**Figure 10.3. Tope in the Northeast Atlantic mean densities/km² of tope from French scientific trawl cruises betwen 1983 and 2008 (from Trenkel *et al.*, 2009). Blue: never observed - Pale yellow: <25% - Yellow: 25-50% - Orange: 50-75% - red: >75%.**

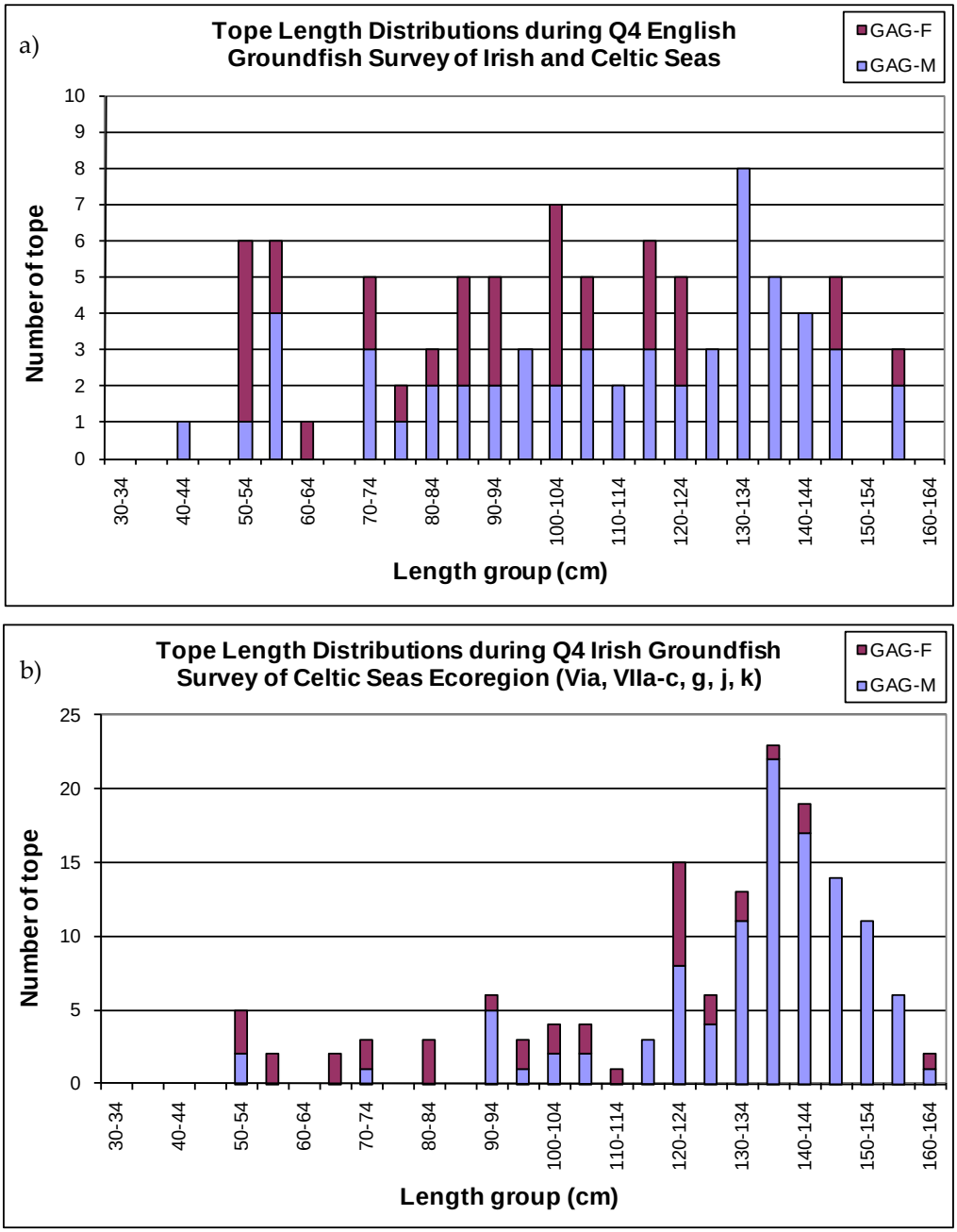
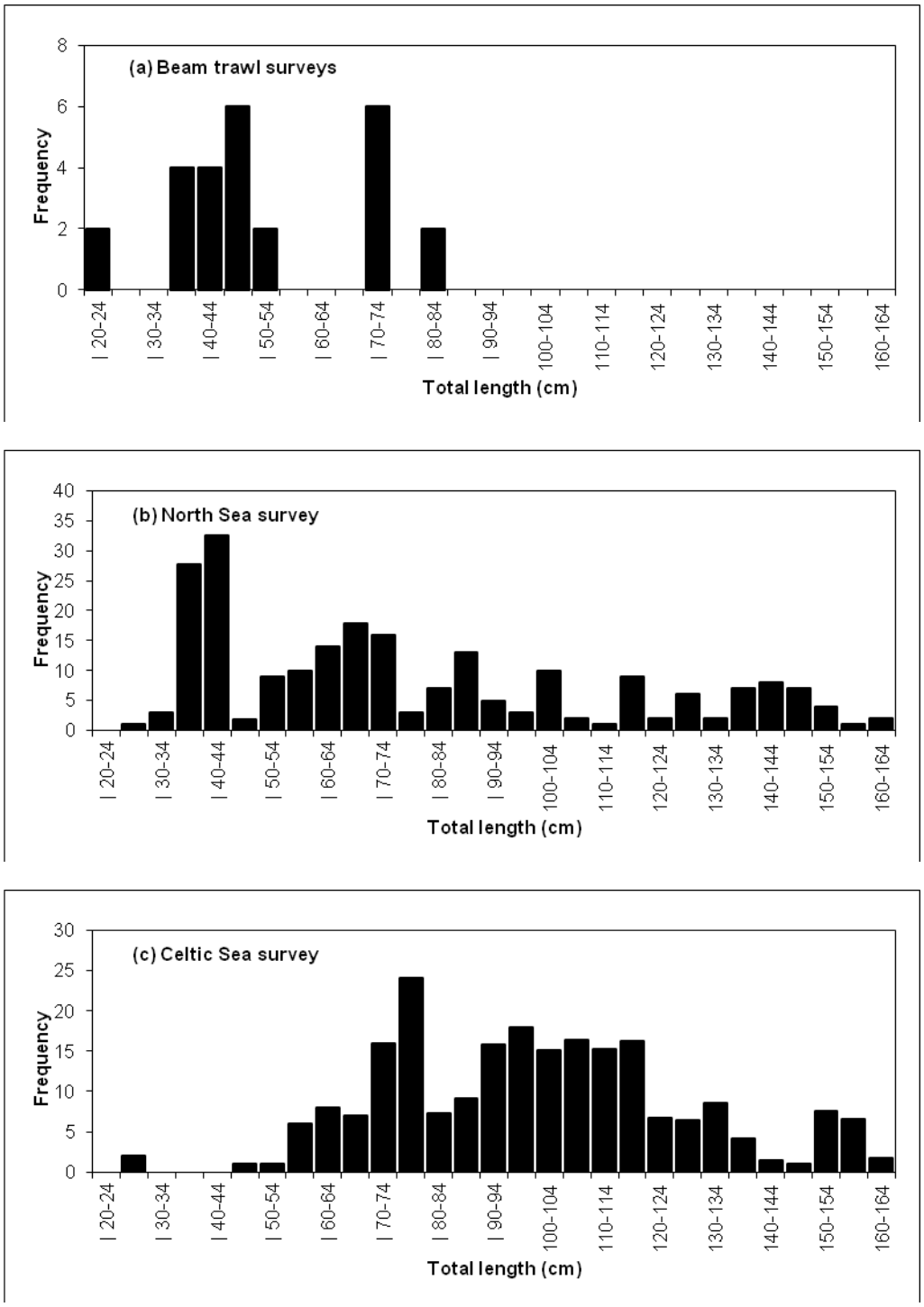



**Figure 10.4. Tope in the Northeast Atlantic Tope length distributions from a) English Groundfish Survey data, years 2004–2009, conducted in Q4 in Celtic and Irish Seas, and b) Irish Groundfish Survey data, years 2003–2009, conducted in Q4 in the Celtic Seas ecoregion (ICES Divisions VIa, VIIa–c, g, j, k).**


(a) Beam trawl surveys
Frequency
0
2
4
6
8
| 20-24
| 30-34
| 40-44
| 50-54
| 60-64
| 70-74
| 80-84
| 90-94
100-104
110-114
120-124
130-134
140-144
150-154
160-164
Total length (cm)
(b) North Sea survey
Frequency
0
5
10
15
20
25
30
35
40
Total length (cm)
(c) Celtic Sea survey
Frequency
0
5
10
15
20
25
30
Total length (cm)

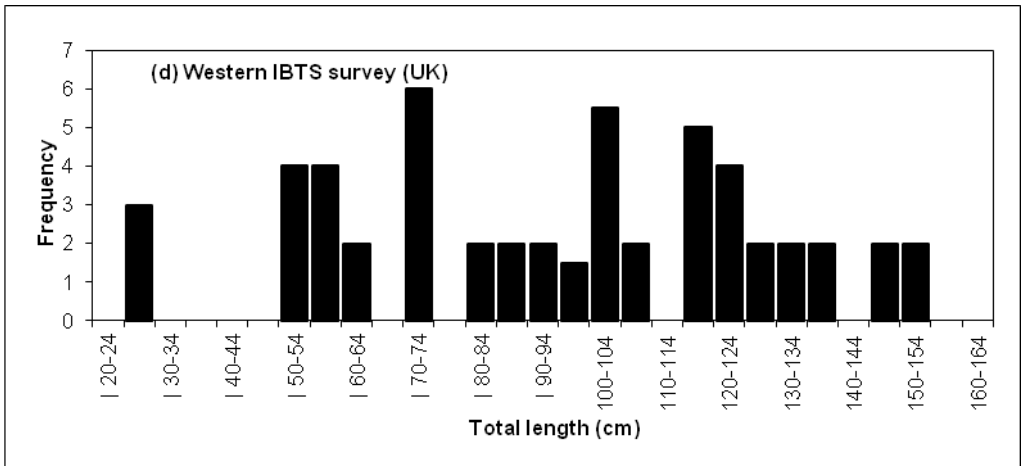



**Figure 10.5. Tope in the Northeast Atlantic. Length–frequency distributions of tope from beam trawl survey (a), North Sea Suvey (b), Celtic Sea survey (c) and western IBTS survey/UK (d); years 2004–2009.**

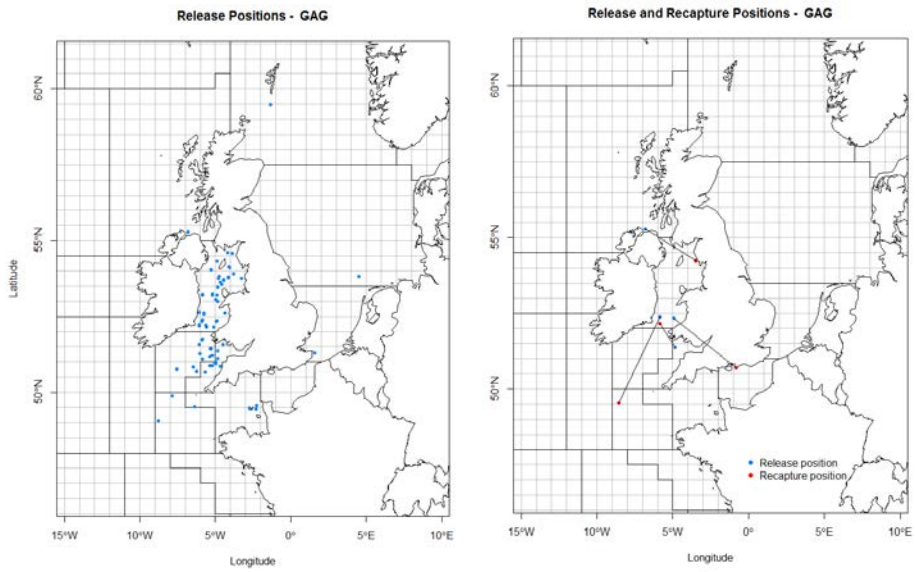



**Figure 10.6. Tope in the Northeast Atlantic. Locations of tope *Galeorhinus galeus* (i) released and (ii) release and recapture positions for recaptured fish (2000–2013). Source: Burt *et al.*, WD 2013**

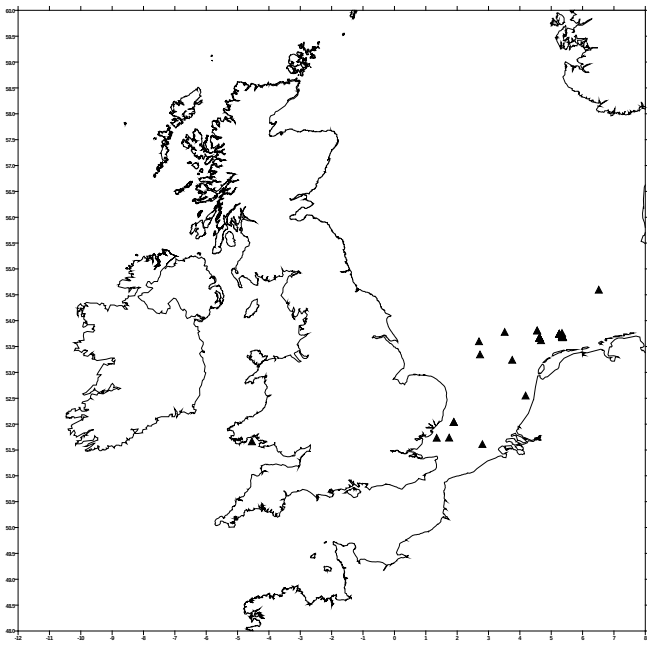


**Figure 10.7. Tope in the Northeast Atlantic. Sites where tope pups (24–45 cm total length) have been reported during UK surveys.**

# 11 Thresher sharks in the Northeast Atlantic and Mediterranean Sea

## 11.1 Stock distribution

Two species of thresher shark occur in the ICES areas: common thresher *Alopias vulpinus* and bigeye thresher *A. superciliosus.* Of these, *A. vulpinus* is the dominant species taken in the continental shelf fisheries of the ICES area. There is little information on the stock identity of these circumglobal sharks, and WGEF assumes there to be a single NE Atlantic and Mediterranean stock of *A. vulpinus*. This stock probably extends into the CECAF area. The presence of a nursery ground in the Alboran Sea provides the rationale for including the Mediterranean Sea within the stock area.

Further information on the stock identity is included in the stock annex 2009.

## 11.2 The fishery

### 11.2.1 History of the fishery

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

Both species occur in the Mediterranean Sea. There are no target fisheries but they are taken as a bycatch in various fisheries, including the Moroccan driftnet fishery in the southwest Mediterranean. They are caught by industrial and semi-industrial longline fisheries and by artisanal gillnet fisheries, and in France thresher sharks are caught incidentally mainly by the trawlers operating in the Gulf of Lions targeting small pelagics and are landed in two major harbours (Sète and Port La Nouvelle). Additional bycatch of these sharks will occur in the Straits of Gibraltar.

Further information on the stock identity is included in the stock annex 2009.

### 11.2.2 The fishery in 2012

No new information.

### 11.2.3 ICES Advice applicable

ICES has never provided advice for this stock.

### 11.2.4 Management applicable

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

Article 19 of EC Regulation No. 44/2012 prohibits the retention, transshipment or landing any part or whole carcass of bigeye thresher shark *Alopias superciliosus* in any fishery, and also prohibits any directed fishery for thresher sharks *Alopias* spp. in the ICCAT area.

## 11.3 Catch data

### 11.3.1 Landings

The landings of thresher sharks are reported irregularly and rather variably; from 3–193 t in the NE Atlantic and the Mediterranean Sea (ICCAT and national data; Tables 11.1–11.2; Figure 11.1). There are large discrepancies between national landings data presented to ICES and that reported to ICCAT (Figure 11.1). The main landing nations are Portugal, Spain and France, although the large quantities reported by Portugal to ICCAT in 2006 and 2007 need to be verified.

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

Small (2 t or less) irregular landings have been reported by Denmark, Ireland and the UK, since 2000. The countries with more consistent estimated landings are France, Portugal and Spain. The national reported landings of thresher sharks in French waters have typically ranged from 2–22 t, however in 2000 and 2001, reported landings increased to 107–112 t, remained at levels <10 t until 2006 and increased to levels between 27 and 41 t in recent years . However, the French landings reported to ICCAT are larger, at between 9–42 t since 2002. The values of the 2000 and 2001 landings are believed to be an overestimate (Poisson and Séret, 2009).

Portuguese estimated national landings began in 1986 at 7 t, they peaked two years later in 1988, then remained relatively stable ranging from 7–37 t annually, until 2005, when another surge increased this to 80 t (none were reported to ICCAT by Portugal). It is likely that those figures were from North and South Atlantic combined. No national landings have been reported to WGEF since, yet catches of 95, 82, 44, 43 and 15 t were reported to ICCAT by Portugal in 2006–2011. The Portuguese area off West Africa has nominal estimated landings between zero and at most two in 1998.

Spanish landings began in 1997 at 53 t, and after three years this fell to just one tonne, then to zero by 2001. However, from 2003 on landings increased again and in 2004 were an estimated 84 t, falling to 54 t in 2005, with no national landings reported to WGEF after this year, apart from 2 t from the Basque Country in 2009. Similarly, like Portugal, landings of 46 t in 2007, 73 t in 2008 and 78 t in 2009, have however been reported by Spain to ICCAT.

Consequently, the overall estimated landings as reported by national data to WGEF ranged from just 3 t, the lowest level, in 1984 to 143 t in 2005. However, landings reported to ICCAT are far greater, with the peak landings of 193 t in 1997, and the lowest level of 19 t in 2003. A distinctly better harmonization between these data is required.

In 2012, 33 t of thresher sharks were landed mostly by France from ICES Subarea VI, VII, VIII and X (Table 11.2).

### 11.3.2 Discards

No data available.

### 11.3.3 Quality of catch data

Thresher sharks have not routinely been reported at either a species-specific or generic level, although such data collection has improved in recent years.

The two species are recorded mixed or separately; however analysis of the available data seems to indicate that they are often mixed even when recorded under specific names. Also, some discrepancies are observed when different sources of data are compared (e.g. FAO, ICCAT, national data). Landings of thresher shark in coastal waters are most likely to represent *A. vulpinus*, but some of these landings may be reported as 'sharks nei'.

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

Following the publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Workshop on Stock Assessment of selected species of Elasmobranchs in the GFCM area, WGEF believes that collaboration should continue between ICES and the GFCM. This will encourage the sharing of information and aid the better understanding of elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

## 11.4 Commercial catch composition

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

## 11.5 Commercial catch-effort data

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

## 11.6 Fishery-independent surveys

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

Ifremer has implemented a small-scale pilot research programme (Alop project) in the Mediterranean Sea, in close collaboration with the fishing industry and especially with the trawler fishery targeting small pelagic fish in the Gulf of Lions.

The aims of the 'Alop' project were (1) to monitor the landings and to reconstruct the landing time-series of thresher sharks, (2) to collect basic biological parameters and (3) to study the feeding ecology (isotope, fatty acids, and contaminants) of the common thresher shark. Incentive and compensatory measures will be initiated to encourage fishers to release the individuals alive at sea after tagging.

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

## 11.7 Life-history information

Various aspects of the life history, including conversion factors, and nursery grounds for these species are included in the stock annex 2009.

Fernandez-Carvalho *et al.* (2011) provide the van Bertalanffy growth parameters for the bigeye thresher shark of the tropical Northeastern Altantic (Table 11.4) estimated on 117 specimens ranging from 176 to 407 cm TL.

Fernandez-Carvalho *et al.* (2012) provide maturity information on the bigeye thresher shark from the Atlantic. Significant differences were found in the size distribution of the species and the sex ratios between the North and South Atlantic. Sizes at first maturity (L50) were estimated at 206.09 cm FL for females and 159.74 cm FL for males.

The wet-fins to carcass mass ratio are scarce for the Atlantic specimens of *Alopias vulpinus*, a recent revision was made by Biery and Pauly (2012).

### 11.7.1 Habitat

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

Weng and Block (2004) studied diel vertical migration patterns of two bigeye thresher sharks (*A. superciliosus*) that were caught and tagged with pop-up satellite archival tags in the Gulf of Mexico and near Hawaii. Both showed strong diel movement patterns spending the majority of day in layers below the thermocline (300–500 m and 400–500 m) while night-time was spent mostly in the mixed layer or above the thermocline (10–50 m). Both sharks spent night-time in waters warmer than 20°C and eight or more hours during daytime in deep waters with ambient temperatures of less than 10°C.

Carlson and Gulak (2012) provide results from a tagging programme with archival tags deployed on bigeye thresher sharks. One shark exhibited a diurnal vertical diving behaviour, spending most of their time between 25 and 50 m depth in waters between 20 and 22°C. One shark dove down to 528 m. Deeper dives occurred more often during the day, and by night they tend to stay above the thermocline.

Cao *et al.* (2012) provide the following data for *Alopias superciliosus* and *Alopias vulpinus* around the Marshall Islands: optimum swimming depth 240–360 m and 160–240 m, water temperature 10–16°C and 18–20°C, salinity 34.5–34.7% and 34.5–34.8%, dissolved oxygen 3.0–4.0 ml/l and 1.0–1.5 ml/l respectively.

### 11.7.2 Nursery grounds

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

Further information on potential nursery areas is included in the stock annex 2009.

### 11.7.3 Diet

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

## 11.8 Exploratory assessment models

### 11.8.1 Previous studies

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

### 11.8.2 Stock assessment

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

## 11.9 Quality of assessments

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

## 11.10 Reference points

No reference points have been proposed for these stocks.

## 11.11 Conservation considerations

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

Ecological risk assessments were undertaken by ICCAT for eleven pelagic sharks (ICCAT, 2011). These analysis demonstrated that the bigeye thresher has the lowest productivity and highest vulnerability with a productivity rate of 0.010, and that the common thresher is 10th in rank with a productivity rate of 0.141 (Figure 11.3).

## 11.12 Management considerations

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

In 2009 The International Commission for the Conservation of Atlantic Tuna (ICCAT) recommend the following:

1 ) "CPCs (The Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities) shall prohibit, retaining on board, transhipping, landing, storing, selling, or offering for sale any part or whole carcass of bigeye thresher sharks (*Alopias superciliosus*) in any fishery with exception of a Mexican small-scale coastal fishery with a catch of less than 110 fish.

2 ) CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, bigeye thresher sharks when brought along side for taking on board the vessel;

3 ) CPCs should strongly endeavour to ensure that vessels flying their flag do not undertake a directed fishery for species of thresher sharks of the genus *Alopias* spp;

4 ) CPCs shall require the collection and submission of Task I and Task II data for *Alopias* spp other than *A. superciliosus* in accordance with ICCAT data reporting requirements. The number of discards and releases of *A. superciliosus* must be recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements;

5 ) CPCs shall, where possible, implement research on thresher sharks of the species *Alopias* spp in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate."

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

## 11.13 References


Biery, L., and Pauly, D. 2012. A global review of species-specific shark fin to body mass ratios and relevant legislations. *J. Fish. Biol*., 80 : 1643–1677.

Camhi, M.D. 2008. Conservation status of pelagic elasmobranchs. *In*: Sharks of the Open Ocean: Biology, Fisheries and Conservation (M.D.Camhi, E.K.Pikitch and E.A.Babcock, Eds). Blackwell Publishing, Oxford, UK. pp. 397–417.

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

Cao, D-M., Song, L-M., Zhang, Y., Lv, K-K., and Hu, Z-X. 2012. Environmental preferences of *Alopias superciliosus* and *Alopias vulpinus* in waters near the Marshall Islands. New Zealand Journal of Marine and Freshwater Research, 45(1) : 103–119.

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

EU. 2012. Council Regulation (EU) No 44/2012 of 17 January 2012 fixing for 2012 the fishing opportunities available in EU waters and, to EU vessels, in certain non- EU waters for certain fish stocks and groups of fish stocks which are subject to international negotiations or agreements. Official Journal of the European Union, L, 25–144.

Fernandez-Carvalho, J., Coelho, R., Erzini, K., and Nevs Santos, M. 2011. Age and growth of the bigeye thresher shark, *Alopias superciliosus,* from the pelagic longline fisheries in the tropical northeastern Atlantic Ocean, determined by vertebral band counts. Aquatic Living Resources, 24: 359–368.

Fernandez-Carvalho, J., Coelho, R., Amorim, S., and Santos, M. 2012. Maturity of the bigeye thresher (*Alopias superciliosus*) in the Atlantic Ocean. SCRS/2011/086.

Carlson, J.K., and Gulak, S.J.B. 2012. Habitat use and movements patterns of oceanic whitetip, bigeye thresher and dusky sharks based on archival satellite tags. SCRS/2011/099.

Holmes, B. H., Steinke, D., and Ward, R. D. 2009. Identification of shark and ray fins using DNA barcoding Fisheries Research, 95: 280–288.

ICCAT. Rec.09-07. Recommendation by ICCAT on the conservation of thresher sharks caught in association with fisheries in the ICCAT convention area.

ICCAT. 2011. Report for biennial period 2010-2011; Part I (2010). Vol. 2. SCRS. 285 p.

IUCN. 2006. 2006 IUCN Red List of Threatened Species. www.iucnredlist.org.

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.

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.

Nakano, H., Matsunaga, H., Okamoto, H., and Okazaki, M. 2003. Acoustic tracking of bigeye thresher shark *Alopias superciliosus* in the eastern Pacific Ocean. Marine Ecology Progress Series, 265: 255–261.

Poisson F. and Séret B. 2009. Pelagic sharks in the Atlantic and Mediterranean French fisheries: Analysis of catch statistics. ICCAT SCRS/2008/134. Collective Volume of Scientific Papers - ICCAT, 64(5): 1547–1567.

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

Weng, K. C., and Block, B. A. 2004. Diel vertical migration of the bigeye thresher shark (*Alopias superciliosus*), a species ossessing orbital retia mirabilia. Fishery Bulletin, 102(1): 221–229.

**Table 11.1. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Landings of thresher sharks by European countries from 1997 to 2011 (ICCAT data). Landings prior to 1997 are in combined sharks.**

| **Data source** | **ICCAT** | | | | **ICCAT** | | | **ICCAT** | **ICCAT** | **ICCAT** | | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nation | Spain | | | | Portugal | | | France | UK | Ireland | | |
| Year | *A. vul.* | *A. sup.* | *Alopias* spp. | Total | *A. vul.* | *Alopias* spp. | Total | *A. vul.* | *A. vul.* | *A. vul.* | *Alopias spp.* | |
| 1997 | 30 | 138 | 25 | 193 | | | | | | | | 193 |
| 1998 | 44 | 104 | 27 | 175 | | | | | | | | 175 |
| 1999 | na | na | 56 | 56 | 1 | | 1 | | | | | 57 |
| 2000 | 8 | 21 | 23 | 52 | | 2 | 2 | | | + | | 54 |
| 2001 | 21 | 35 | 62 | 118 | | 2 | 2 | | | | | 120 |
| 2002 | 11 | 38 | 25 | 74 | 22 | | 22 | | | | | 96 |
| 2003 | 8 | 18 | 1 | 27 | 18 | | 18 | | | | + | 45 |
| 2004 | 16 | 38 | 7 | 61 | 21 | | 21 | 23 | | | + | 105 |
| 2005 | na | na | na | ?[1] | na | | | 19 | | | | 19 |
| 2006 | na | na | na | ?[1] | 95 | | 95 [2] | | + | + | | 95 |
| 2007 | 14 | 32 | na | 46 | 79 | 3 | 81 | 37 | 1 | | | 165 |
| 2008 | na | na | 73 | 73 | 43 | | 43 | 10 | 1 | | | 127 |
| 2009 | 28 | 50 | na | 78 | 43 | | 43 | 32 | 1 | | | 154 |
| 2010 | na | na | na | | 14 | | 14 | 27 | 2 | | | 43 |
| 2011 | na | na | na | | | | | 41 | 1 | | | 42 |

**[1] Spain previously reported 159 t in 2004 and 105 t in 2005; clarification of these catches is required.**

**[2] These landings require verification.**

**Table 11.2. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Estimates of landings of thresher sharks (*Alopias* spp.) by country and ICES subarea.**

| | | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Azores | | | | | | | | | | | | | |
| Denmark | IV | | | | | | | | | | | | |
| France | VI–IX | 3 | 6 | 2 | 7 | 12 | 10 | 9 | 13 | 14 | 14 | 11 | 13 |
| Ireland | VI–VIII | | | | | | | | | | | | |
| Portugal | VII–IX | | | 7 | 11 | 103 | 13 | 14 | 31 | 13 | 12 | 16 | 7 |
| Portugal | W Africa | | | | + | + | + | + | 1 | + | + | | |
| Spain (Basque Country) | VIII | | | | | | | | | | | | |
| Spain | VII–IX | | | | | | | | | | | | |
| UK(E&W) | IV–VII | | | | | | | | | | | | |
| Total | | 3 | 6 | 9 | 18 | 115 | 23 | 23 | 45 | 27 | 26 | 27 | 20 |

| | | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | IV | | | | | | . | . | + | . | | | | | | | 0 | |
| France | VI,VII | 17 | 22 | 18 | 13 | 107 | 112 | 4 | 3 | 1 | 2 | 1 | 2 | 3 | 10 | 4 | 4 | 6 |
| France | VIII | | | | | | | | | 2 | 7 | 11 | 10 | 4 | 24 | 21 | 36 | 27 |
| Ireland | VI | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 |
| Ireland | VII | | | | | | . | . | + | + | | | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | VII–IX | 13 | 37 | 24 | 12 | 15 | 25 | 21 | 17 | 33 | 80 | | | | | | | |
| Portugal | W | + | 1 | 2 | + | | | | | | | | | | | | | |
| Spain (Basque | VIII | | | | | | | | | | | | | | 2 | 0 | | |
| Spain | VII–IX | | 53 | 54 | 36 | 1 | | | 3 | 84 | 54 | | | | | | | |
| UK(E&W) | IV | | | | | | | | | | | 0 | | 0 | 0 | 1 | 0 | 0 |
| UK(E&W) | VII | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | | 30 | 113 | 98 | 61 | 123 | 137 | 25 | 23 | 120 | 143 | 12 | 13 | 8 | 36 | 27 | 41 | 33 |

**Table 11.3. Productivity values ranked from lowest to highest for main pelagic sharks in the ICCAT zone (from ICCAT 2011 report).**

| *Species* | *Productivity (r)* | *Productivity rank* |
|---|---|---|
| BTH (*Alopias superciliosus*) | 0.010 | 1 |
| SMA (*Isurus oxyrinchus*) | 0.014 | 2 |
| LMA (*Isurus paucus*) | 0.014 | 3 |
| POR (*Lamna nasus*) | 0.053 | 4 |
| FAL (*Carcharhinus falciformis*) | 0.076 | 6 |
| OCS (*Carcharhinus longimanus*) | 0.087 | 7 |
| SPL (*Sphyrna lewini*) | 0.090 | 8 |
| SPZ (*Sphyrna zygaena*) | 0.124 | 9 |
| ALV (*Alopias vulpinus*) | 0.141 | 10 |
| PST (*Pteroplatytrygon violacea*) | 0.169 | 11 |
| BSH (*Prionace glauca*) | 0.301 | 12 |
| CRO (*Pseudocarcharias kamoharai*) | - | - |

**Table 11.4. Von Bertalanffy growth parameters for *Alopias superciliosus* from the tropical North-eastern Atlantic (from Fernandez-Carvalho *et al.*, 2011).**

| Sex | Model | Parameter | Estimate | SE | 95% CI | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Sexes combined | VBGF | $L_{inf}$ | 247 | 18.0 | 212 | 283 |
| | | $k$ | 0.09 | 0.02 | 0.05 | 0.13 |
| | $AIC$ = 860.4 | $L_0$ | 106 | 4.8 | 96 | 115 |
| | VBGF Fixed $L_0$ | $L_{inf}$ | 212 | 5.9 | 200 | 224 |
| | $AIC$ = 870.7 | $k$ | 0.17 | 0.01 | 0.14 | 0.20 |
| Males | VBGF | $L_{inf}$ | 206 | 10.1 | 186 | 227 |
| | | $k$ | 0.18 | 0.05 | 0.09 | 0.27 |
| | $AIC$ = 322.6 | $L_0$ | 93 | 9.5 | 73 | 112 |
| | VBGF Fixed $L_0$ | $L_{inf}$ | 201 | 6.4 | 188 | 214 |
| | $AIC$ = 321.3 | $k$ | 0.22 | 0.03 | 0.16 | 0.27 |
| Females | VBGF | $L_{inf}$ | 293 | 42.6 | 208 | 378 |
| | | $k$ | 0.06 | 0.02 | 0.02 | 0.10 |
| | $AIC$ = 537.2 | $L_0$ | 111 | 5.3 | 100 | 121 |
| | VBGF Fixed $L_0$ | $L_{inf}$ | 223 | 9.7 | 204 | 243 |
| | $AIC$ = 550.2 | $k$ | 0.15 | 0.02 | 0.11 | 0.18 |

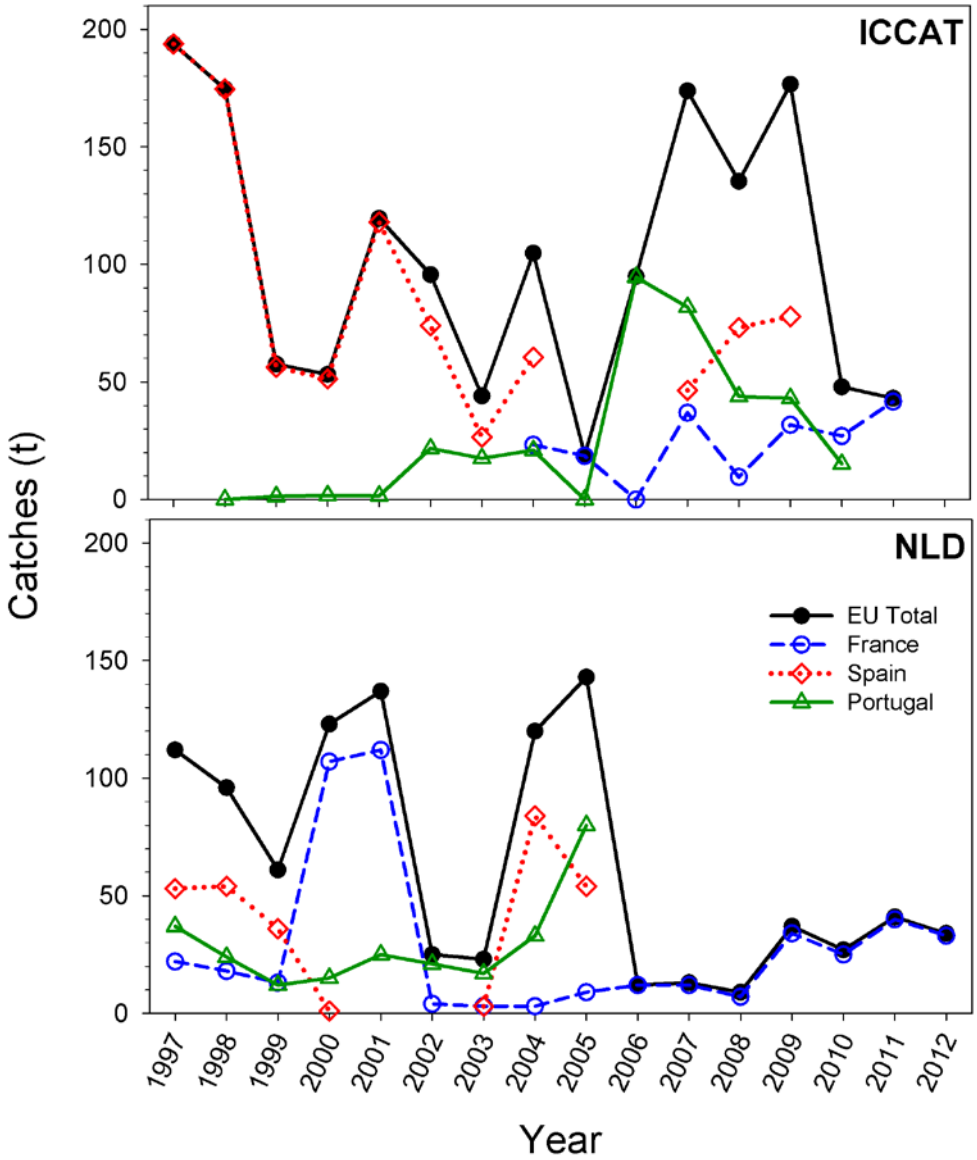



**Figure 11.1. Thresher sharks in the Northeast Atlantic and the Mediterranean Sea. Landings as reported by Spain, Portugal and France to ICCAT (1997–2011, ICCAT database, upper panel) and national landings data (NLD) reported by these countries to WGEF (lower panel).**

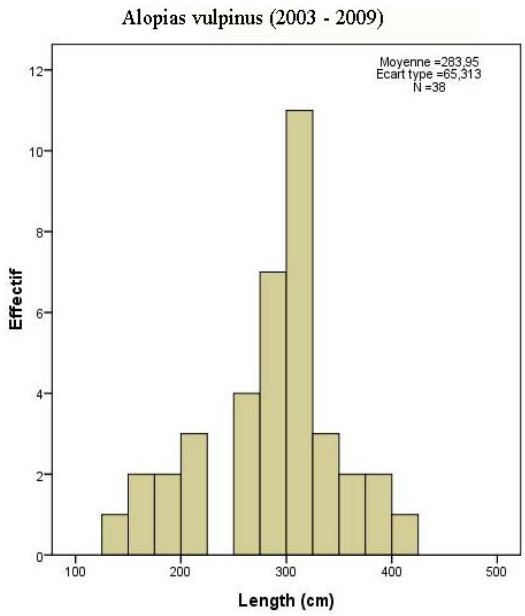



**Figure 11.2. Length–frequency distributions for *Alopias vulpinus* sampled in the Divisions VIIIabcd in the framework of the Data Collection Regulation programme by observers on board French vessels between 2003 and 2009 (Lengths are fork length over the body).**

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# 12 Other pelagic sharks in the Northeast Atlantic

## 12.1 Ecosystem description and stock boundaries

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

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

Many of these taxa, including many of the hammerhead sharks (*Sphyrna* spp.) and requiem sharks (*Carcharhinus* spp.) are mainly tropical to warm temperate species, and often coastal, pelagic species. There is limited information with which to examine the stock structure of these species, and the ICES area would only be the northern extremes of their NE Atlantic distribution range.

Other species, including *I. paucus, C. falciformis* and *C. longimanus* are truly oceanic, and are likely to have either North Atlantic or Atlantic stocks, although once again, data are lacking. Within the ICES area, these species are also found mostly in the southern parts of the ICES areas (e.g. off the Iberian Peninsula), though some may occasionally occur further north. Some of these species also occur in the Mediterranean Sea.

## 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 others are only sporadically recorded (e.g. white shark, tiger shark, pelagic stingray and devil ray). Some of these species are an important bycatch in high seas fisheries (e.g. silky shark and oceanic whitetip) and others are taken in continental shelf waters of the ICES area (e.g. various requiem sharks and hammerhead sharks).

### 12.2.2 The fishery in 2012

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 43/2009 prohibits Community vessels to fish for, to retain on board, to tranship and to land white shark (*Carcharodon carcharias*) in all Community and non-Community waters; and also prohibits third-country fishing vessels to fish for, to retain on board, to tranship and to land white shark in all Community waters.

## 12.3 Catch data

### 12.3.1 Landings

No reliable estimates of catch are available for all of these species, as many nations that land various other species of pelagic sharks will record them under generic landings categories. Species specific landings reported to ICES are given in Table 12.1 and amount to 765 t from 1999–2012. However, 98% (751 t) of these landings were made between 1999 and 2004. The main country reporting catch of these species during this period was Portugal, with 51 t of *Sphyrna* spp. and 331 t of *Carcharhinus* spp across all areas. During the same period France also reported 331 t of *Carcharhinus* spp, and Spain reported 2 t of *Sphyrna* spp. Post 2004, Portugal has only reported 10 t of *Sphyrna zygaena* (2007–2011), and Spain 4 t of pelagic stingray this year.

Since 1997, landings are also recorded in the ICCAT database (Table 12. 2), and these data provide the best catch estimates available, with a total of 28 614 t between 1997 and 2011. In the Northeast Atlantic, Spain and Portugal are the main countries reporting these species, with Portugal giving catches of 809 t and Spain 3562 t between 1997 and 2011. For Spain, the main catch is reported as *Sphyrna* spp., totalling 2431 t across the time-series. Other countries reporting catch to ICCAT are Senegal (23 420 t), France (518 t), Netherlands (37 t), the UK (12 t) and Chinese Taipei (4 t). Requiem sharks comprise the largest proportion of the catch at 69% (22 434 t), followed by hammerhead sharks at 30% (5950 t) and longfin mako sharks at 1% (173 t).

There are few catch data for the other pelagic species (e.g. tiger shark, devil ray and pelagic stingray) in national datasets, nor in the ICCAT database, except for some sporadic records of tiger sharks (45 t of which 37 t was made by the Netherlands in 2007, and the rest by Spain) in the ICCAT database between 1997 and 2011.

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). They 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%).

Available landings data from FAO FishStat (Atlantic, Northeast) are presented Table 12.4. These values are considered to be underestimates, as a consequence of the inconsistent reporting of catches; however this is the only database to report devil ray landings (17 t by Spain 2004–2011).

### 12.3.2 Discards

No data available. Some species are usually retained, although pelagic stingray is most often discarded.

### 12.3.3 Quality of catch 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). Species-specific identification in the field within some of these genera (e.g. *Carcharhinus* and *Sphyrna*) can be problematic.

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

## 12.4 Commercial catch composition

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

## 12.5 Commercial catch-effort data

No cpue data are available for these pelagic sharks in the ICES area. However Cramer and Adams, 1998; Cramer *et al*., 1998 and Cramer, 1999 provided catch rates for the Atlantic US longline fishery targeting tunas and swordfish; where cpue ranged from 2.7 individuals/1000 hooks in 1996 to 0.35 ind./1000 hooks in 1997.

## 12.6 Fishery-independent surveys

No fishery-independent data are available for these species.

## 12.7 Biological parameters

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

Little information is available on nursery or pupping grounds. Silky shark are thought to use the outer continental shelf as primary nursery ground (Springer, 1967; Yokota and Lessa, 2006), and young oceanic whitetip have been found offshore along the SE coast of the USA, suggesting offshore nurseries over the continental shelf (Seki *et al*., 1998). The scalloped hammerhead nurseries are usually in shallow coastal waters.

The overall biology of several species has been reviewed, including white shark (Bruce, 2008), silky shark (Bonfil, 2008), oceanic whitetip (Bonfil *et al*., 2008) and pelagic stingray (Neer, 2008).

Other biological information is available in Branstetter, 1987; 1990; Stevens and Lyle, 1989; Shungo *et al*., 2003 and Piercy *et al*., 2007.

The wet-fins to carcass mass ratio was estimated for *Carcharhinus longimanus*, *Carcharhinus falciformis*, *Prionace glauca*, *Sphyrna lewini*, *Sphyrna mokarran* and *Sphyrna zygaena* by Biery and Pauly (2012).

## 12.8 Stock assessment

### 12.8.1 Previous studies

No previous assessments have been made of these stocks in the NE Atlantic. Cortés *et al.* (2010) undertook a level 3 quantitative Ecological Risk Assessment (ERA) for eleven pelagic elasmobranchs (blue shark, shortfin mako, longfin mako, bigeye thresher, common thresher, oceanic whitetip, silky, porbeagle, scalloped and smooth hammerhead, and pelagic stingray). Of these species, silky shark were found to be high risk (along with shortfin mako and bigeye thresher sharks), and oceanic whitetip and longfin mako sharks were also considered to be highly vulnerable. McCully *et al*. (2012) undertook a level 2, semi-quantitative ERA for pelagic species in the Celtic Sea area, and of the 19 species considered (eight of which were elasmobranchs), porbeagle and shortfin mako sharks were found to be at the highest risk in longline and setnet fisheries, followed by common thresher shark. However, a comparable analysis examining the pelagic ecosystem for the whole Northeast Atlantic would be a useful exercise.

### 12.8.2 Stock assessment

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

## 12.9 Quality of the assessment

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

## 12.10 Reference points

No reference points have been proposed for these stocks.

## 12.11 Management considerations

Retaining on board, transhipping or landing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) and silky shark (*Carcharhinus falciformis*) taken in any fishery is prohibited in the ICCAT area by the EU regulation n° 44/2012.

There is a paucity of the fishery data on these species, and this hampers the provision of management advice. Some of the species have conservation status: for example white shark is listed on Appendix II of the Barcelona Convention, Appendix II of the Bern Convention, Appendices I/II of the CMS and Appendix I of CITES.

In 2013, *Carcharhinus longimanus*, *Sphyrna lewini*, *Sphyrna mokarran*, *Sphyran zygaena*, *Manta birostris and Manta alfredi* were listed on Appendix II of CITES (Conference of Parties 16, Bangkok). However, the implementation of this listing has been delayed by 18 months (14 September 2014) to enable Range States and importing States to address potential implementation issues.

The following species are also included in the Memorandum of Understanding for Sharks (MoU-Sharks) of the Convention of Migratory Species (CMS): *Carcharodon carcharias*, *Isurus paucus* and *Manta birostris*.

In 2012, a consortium of scientific institutions (AZTI, IEO, IRD and Ifremer) obtained a contact from the EC to review the fishery and biological data on major pelagic shark and ray species. The aim was to identify the gaps that could be filled up in the frame of the implementation of the EU shark action plan (EUPOA-Sharks) in order to improve the monitoring of major elasmobranch species caught by both artisanal and

industrial large pelagic fisheries on the high seas of the Atlantic, Indian and Pacific Oceans. It reviews and prioritises the gaps identified to develop a research programme to fill them in support for the formulation of scientific advice for management of sharks. Main gaps concern the fishery statistics often not broken down by species, the lack of size–frequency data and regional biological/ecological information. The group was informed about this consortium and that final report was given to the DG-Mare of the EU in May 2013 (DG-Mare, in press).

In 2013, the shark species group of ICCAT proposed the framework of a Shark Research and Data Collection Program (SRDCP) to fill up the gaps in our knowledge on pelagic sharks that are responsible for much of the uncertainty in stock assessments, and have caused constraints to the provision of scientific advice. The final report is available at ICCAT website (ICCAT, 2013).

## 12.12 References

Biery, L., and Pauly, D. 2012. A global review of species-specific shark fin to body mass ratios and relevant legislations. *J. Fish. Biol.*, 80 : 1643–1677.

Bonfil, R. 2008. The biology and ecology of the silky shark, *Carcharhinus falciformis*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M.D.Camhi, E.K.Pikitch and E.A.Babcock, Eds). Blackwell Publishing, Oxford, UK, 114–127.

Bonfil, R., Clarke, S. and Nakano, H. 2008. The biology and ecology of the oceanic whitetip shark, *Carcharhinus longimanus*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M.D.Camhi, E.K.Pikitch and E.A.Babcock, Eds). Blackwell Publishing, Oxford, UK, 128–139.

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

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

Bruce, B. D. 2008. The biology and ecology of the white shark, *Carcharodon carcharias*. In *'Sharks of the Open Ocean: Biology, Fisheries and Conservation'* (M.D.Camhi, E.K.Pikitch and E.A.Babcock, eds). Blackwell Publishing, Oxford, UK, 69–81.

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.

Cortés, E. Arocha, F. Beerkircher, L. Carvalho, F. Domingo, A. Heupel, M., Holtzhausen, H. Santos, M.N., Ribera, M. and Simpfendorfer C. 2010. Ecological Risk Assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. *Aquatic Living Resources*, 23: 25–34.

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 US 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.

DG-Mare. In press. Studies for Carrying out the Common Fisheries Policy (Reference: Mare/2010/11) LOT 2: Provision of scientific advice for the purpose of the implementation of the EUPOA sharks. Final report for the Directorate-General for Maritime Affairs and Fisheries. AZTI, IRD, Ifremer, IEO, 31st May 2013, 474 p.

Holmes B. H., Steinke D., Ward R. D. 2009. Identification of shark and ray fins using DNA barcoding Fisheries Research 95:280–288.Hueter, R. E. And. Simpfendorfer, C. 2008. Case Study: Trends in Blue Shark Abundance in the Western North Atlantic as Determined by a Fishery-Independent Survey. In: Sharks of the Open Ocean; M. D. Chami, E. K. Pikitch and E. Babcock (eds.) 236–241.

ICCAT. 2013. Report of the 2013 inter-sessional meeting of the shark species group. Mindelo, Cape Verde, April 8–12, 2013. 81 pp.

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.

McCully, S. R., Scott, F., Ellis, J. R. and Pilling, G. M. 2012. Productivity and susceptibility analysis: Application and suitability for data poor assessment of UK elasmobranchs. ICCAT SCRS/2012/079.

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

Neer, J.A. 2008. The biology and ecology of the pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832). In *'Sharks of the Open Ocean : Biology, Fisheries and Conservation'* (M.D.Camhi, E.K.Pikitch and E.A.Babcock, eds). Blackwell Publishing, Oxford, UK, 152–159.

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

Sebastian H., Haye P. A. and Shivji M. S. 2008. Characterization of the pelagic shark-fin trade in north-central Chile by genetic identification and trader surveys. Journal of Fish Biology 73, 2293–2304 Skomal, G.B. 1990. Age and growth of the blue shark, *Prionace glauca*, in the North Atlantic. Master's Thesis. University of Rhode Island, Kingston, RI. 82 pp.

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

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 shark 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. Yellow marked ref not in text.

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 Northeast Atlantic. Summary of landing data reported to WGEF of hammerhead and requiem sharks in the ICES Subareas from 1999 to 2011; reported landings post 2004 are limited.**

| Species | Country | ICES area | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hammerhead sharks (*Sphyrna* spp.) | Portugal | VIIIc | 1 | | | | | | | | | | | 0 | 0 | 0 |
| | | IX | 6 | 8 | 4 | 5 | 5 | | | | | | | 0 | 0 | 0 |
| | | IXa | | | | | | 18 | | | | | | 0 | 0 | 0 |
| | | X | 1 | | | | 2 | 1 | | | | | | | | |
| | Spain | IX a, b | | | | | | 2 | | | | | | 0 | 0 | 0 |
| Sphyrna zygaena | Portugal | X | | | | | | | | | 3 | 1 | 2 | 2 | 1 | 1 |
| Total Sphyrna | | | 8 | 8 | 4 | 5 | 7 | 21 | | | 3 | 1 | 2 | 2 | 1 | 1 |
| Requiem sharks (*Carcharhinus* spp.) | Portugal | VIb | | 1 | | 1 | | | | | | | | | | |
| | | IX | | 1 | | 7 | 129 | 2 | | | | | | | | |
| | | IXb | | | | | | 3 | | | | | | | | |
| | | X | 9 | 24 | 31 | 47 | 16 | 43 | | | | | | | | |

| Species | Country | ICES area | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | IX a, b | | | | | | 17 | | | | | | | | |
| | Spain | VIIIa | | | | | | | | | | | | | | |
| | France | | 9 | 26 | 31 | 55 | 145 | 65 | | | | | | | | |
| Total Requiem | | | 17 | 34 | 35 | 60 | 152 | 86 | | | | | | | | |
| Pelagic stingray | Spain | IXa | | | | | | | | | | | | | 4 | |
| Total pelagic sharks (all areas) | | | 34 | 68 | 70 | 120 | 304 | 155 | 0 | 0 | 3 | 1 | 2 | 2 | 5 | 1 |

**Table 12.2. Other pelagic sharks recorded in the ICCAT Task I Catch database for the Northeast Atlantic (1997-2011). Catches of <0.5 t are indicated by a +.**

| Country | Scientific Name | Species Code | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spain** | *Carcharhinidae* | RSK | | 158 | 60 | | 100 | 80 | 86 | 97 | | | | 28 | | | |
| | *Carcharhinus altimus* | CCA | | 1 | | | | | | | | | | | | | |
| | *Carcharhinus brachyurus* | BRO | | | | | | | | | | | | + | + | | |
| | *Carcharhinus falciformis* | FAL | | 10 | | | 1 | | | 4 | | | 59 | | 20 | | |
| | *Carcharhinus galapagensis* | CCG | | | | | | | | | | | | | 1 | | |
| | *Carcharhinus limbatus* | CCL | | | | | + | | | | | | | | | 5 | |
| | *Carcharhinus longimanus* | OCS | | 2 | | + | 4 | + | | | | | | | 18 | 56 | |
| | *Carcharhinus obscurus* | DUS | | + | | | | | | | | | | | | | |
| | *Carcharhinus plumbeus* | CCP | | | | | | | | | | | | | 4 | + | |
| | *Carcharhinus signatus* | CCS | | 2 | | | + | | | + | | | | | | 2 | |
| | *Galeocerdo cuvier* | TIG | 1 | 3 | | 1 | 1 | 1 | + | + | | | + | | 1 | | |
| | *Isurus paucus* | LMA | | 3 | | 4 | 16 | 24 | 24 | 28 | | | 16 | | 37 | 20 | |
| | *Sphyrna lewini* | SPL | | 3 | | | | | + | 2 | | | | | | | |
| | *Sphyrna mokarran* | SPK | | 1 | | | | | | | | | | | | | |

| Country | Scientific Name | Species Code | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Sphyrna spp* | SPN | 353 | 343 | | 312 | 249 | 363 | 231 | 364 | | | 103 | | 113 | | |
| | *Sphyrna zygaena* | SPZ | | 3 | | 1 | 4 | 1 | | 12 | | | 2 | | + | | |
| | *Sphyrnidae* | SPY | | | | | | | | | | | | 124 | | | |
| **France** | *Carcharhinidae* | RSK | | | | | | | | | | | | 507 | 2 | + | 3 |
| | *Carcharhinus albimarginatus* | ALS | | | | | | | | | | | | | | + | + |
| | *Carcharhinus brevipinna* | CCB | | | | | | | | | | | | | + | | |
| | *Carcharhinus leucas* | CCE | | | | | | | | | | | | | + | | |
| | *Carcharhinus limbatus* | CCL | | | | | | | | | | | | | + | | |
| | *Carcharhinus longimanus* | OCS | | | | | | | | | | | | | 1 | | |
| | *Carcharhinus obscurus* | DUS | | | | | | | | | | | | | 1 | + | + |
| | *Carcharias taurus* | CCT | | | | | | | | | | | | | + | 1 | 3 |
| | *Carcharodon carcharias* | WSH | | | | | | | | | | | | | | | + |
| | *Sphyrna lewini* | SPL | | | | | | | | | | | | | + | | |
| | *Sphyrna spp* | SPN | | | | | | | | | | | | | | | + |
| | *Sphyrnidae* | SPY | | | | | | | | | | | | | | | + |
| **Portugal** | *Carcharhinidae* | RSK | | | | | | | 155 | | | 18 | 5 | | | + | |

| Country | Scientific Name | Species Code | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Carcharhiniformes* | CVX | | | | | | | | | | | 483 | | | | |
| | *Carcharhinus falciformis* | FAL | | | | | | | | | | | | | + | + | 30 |
| | *Carcharhinus limbatus* | CCL | | | | | | | | | | | | | | | + |
| | *Carcharhinus longimanus* | OCS | | | | | | | | | | + | | 1 | 1 | 18 | |
| | *Carcharhinus plumbeus* | CCP | | | | | | | | | | | | | | + | |
| | *Isurus paucus* | LMA | | | | | | | | | | | | | | 1 | + |
| | *Sphyrna spp* | SPN | | | | + | + | | 6 | | | 17 | 6 | 5 | 10 | 42 | |
| | *Sphyrna zygaena* | SPZ | | | | | | | 1 | | | 4 | | | + | 6 | |
| **United Kingdom** | *Sphyrna lewini* | SPL | | | | | | | | | | | | | 12 | + | |
| **Netherlands** | *Galeocerdo cuvier* | TIG | | | | | | | | | | | 37 | | | | |
| **Maroc** | *Carcharhinus obscurus* | DUS | | | | | | | | | | | | | | | 6 |
| | *Carcharodon carcharias* | WSH | | | | | | | | | | | | | | | 92 |
| | *Sphyrna lewini* | SPL | | | | | | | | | | | | | | | 1 |
| | *Sphyrna zygaena* | SPZ | | | | | | | | | | | | | | | 153 |
| **Senegal** | *Carcharhinidae* | RSK | 239 | 827 | 972 | 1714 | 1806 | 1045 | 1387 | 1651 | 5401 | 1035 | 1221 | 1253 | 375 | 426 | 898 |
| | *Carcharhinus plumbeus* | CCP | | | | | | | | | | | + | | | | |

| Country | Scientific Name | Species Code | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Carcharias taurus* | CCT | | | | | | | | | | | | 49 | | | |
| | *Carcharodon carcharias* | WSH | | | | | | | | | | | | | | 18 | |
| | *Sphyrna spp* | SPN | 126 | 94 | 117 | 57 | 1464 | 36 | 71 | 168 | 318 | 173 | 154 | 110 | 101 | 56 | 51 |
| | *Sphyrna zygaena* | SPZ | | | | | | | | | 7 | | | | | | |
| **Chinese Taipei** | *Carcharhinus falciformis* | FAL | | | | | | | | | | | | 1 | 3 | | |
| ***Carcharhinus* spp. Total** | | | 239 | 1000 | 1032 | 1714 | 1910 | 1125 | 1629 | 1752 | 5401 | 1053 | 1768 | 1838 | 425 | 526 | 1032 |
| ***Sphyrma* spp. Total** | | | 479 | 443 | 117 | 370 | 1717 | 400 | 310 | 546 | 325 | 194 | 265 | 239 | 236 | 104 | 205 |
| **All species Total** | | | 720 | 1449 | 1149 | 2089 | 3644 | 1550 | 1963 | 2327 | 5726 | 1247 | 2087 | 2077 | 699 | 650 | 1237 |

**Table 12.3. Other pelagic sharks in the Northeast Atlantic. Sharks bycatches of the Spanish swordfish longline fisheries in the NE Atlantic. Data from Castro *et al.*, 2000 and Mejuto *et al.*, 2002.**

| Shark bycatches of the Spanish longline swordfish fishery | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NE Atlantic | *Carcharhinus* spp. | *Sphyrna* spp. | *Galeocerdo cuvier* | *Isurus paucus* | *Mobula* spp. | Total bycatches | % sharks | % blue shark |
| 1997 | 148 | 382 | 3 | 8 | | 28 000 | 99.4 | 87.5 |
| 1998 | 190 | 396 | 5 | 8 | 7 | 26 000 | 99.4 | 86.5 |
| 1999 | 99 | 240 | 4 | 18 | 1 | 25 000 | 98.6 | 87.2 |

**Table 12.4. Other pelagic sharks in the Northeast Atlantic. Reported landings (t) by country (Source FAO Fish-Stat) for Atlantic, Northeast fishing area.**

| FAO FISHSTAT (2012) | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Species** | | | | | | | | | | | | | | |
| **Portugal** | *Sphyrna zygaena* | | | 8 | 8 | 4 | 5 | 7 | 20 | 3 | 13 | 9 | 7 | 5 | 4 |
| **Spain** | *Mobula mobular* | | | | | | | | 1 | 3 | 3 | 2 | 1 | 3 | 4 |
| | *Sphyrna zygaena* | | | | | | | | 5 | 10 | < 0,5 | 3 | 2 | 1 | < 0,5 |
| | *Galeocerdo cuvier* | | | | | | | | 2 | 4 | 5 | 3 | 2 | - | < 0,5 |
| **TOTAL** | | 0 | 0 | | 8 | 4 | 5 | 7 | 28 | 20 | 21 | 17 | 12 | 9 | 8 |

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

| | Distribution Depth range | Max. TL cm | Egg development | Maturity size cm | Age at maturity (years) | Gestation period (months) | Litter size | Size at birth (cm) | Lifespan years | Growth | Trophic level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| White shark *Carcharodon carcharias* | Cosmopolitan 0–1280 m | 720 | Ovoviviparous+ oophagy | 372–402 | 8–10 | ? | 7–14 | 120–150 | 36 | L∞ = 544<br>K= 0.065<br>T0 = –4.40 | 4.42–4.53 |
| Longfin mako *Isurus paucus* | Cosmopolitan | 417 | Ovoviviparous | > 245 F | | | 2 | 97–120 | | | 4.5 |
| Silky shark *Carcharhinus falciformis* | Circumtropical 0–500 m | 350 | Viviparous | 210–220 M<br>225 F | 6–7<br>7–9 | 12 | 2–15 | 57–87 | 25 | L∞ = 291/315<br>K= 0.153 / 0.1<br>T0 = –2.2 / –3.1 | 4.4–4.52 |
| Spinner shark *Carcharhinus brevipinna* | Circumtropical 0–100 m | 300 | Viviparous | 176–212 | 7.8–7.9 | 10–12 | Up to 20 | 60–80 | | L∞ = 214 FL<br>K= 0.210<br>T0 = –1 .94 | 4.2–4.5 |
| Oceanic whitetip *Carcharhinus longimanus* | Cosmopolitan 0–180 m | 396 | Viviparous | 175–189 | 4–7 | 10–12 | 1–15 | 60–65 | 22 | L∞ = 245 / 285<br>K= 0.103 / 0.1<br>T0 = 2.7 / – 3.39 | 4.16–4.39 |
| Dusky shark *Carcharhinus obscurus* | Circumglobal | 420 | Viviaparous | 220–280 | 14–18 | 22–24 | 3–14 | 70–100 | 40 | L∞ = 349 / 373<br>K= 0.039/ 0.038<br>T0 = –7.04/ –6.28 | 4.42–4.61 |
| Sandbar shark *Carcharhinus plumbeus* | Circumglobal 0–1800 m | 250 | Viviparous | 130–183 | 13–16 | 12 | 1–14 | 56–75 | 32 | L∞ = 186 FL<br>K= 0.046<br>T0 = –6.45 | 4.23–4.49 |

| | Distribution Depth range | Max. TL cm | Egg development | Maturity size cm | Age at maturity (years) | Gestation period (months) | Litter size | Size at birth (cm) | Lifespan years | Growth | Trophic level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Night shark *Carcharhinus signatus* | Atlantic 0–600 m | 280 | Viviparous | 185–200 | 8–10 | ~12 | 4–12 | 60 | | L∞ = 256 / 265 K= 0.124 / 0.114 T0 = –2.54 / – 2.7 | 4.44–4.5 |
| Tiger shark *Galeocerdo cuvier* | Circumglobal 0–350 m | 740 | Ovivivipparous | 316–323 | 8–10 | 13–16 | 10–82 | 51–104 | 50 | L∞ = 388 / 440 K= 0.18 / 0.107 T0 = –1.13 / –2.35 | 4.54–4.63 |
| Scalloped hammerhead *Sphyrna lewini* | Cosmopolitan 0–512 m | 430 | Viviparous | 140–250 | 10–15 | 9–10 | 13–31 | 45–50 | 35 | L∞ = 320 / 321 K= 0.249 / 0.222 T0 = –0.41 / – 0.75 | 4.0–4.21 |
| Great hammerhead *Sphyrna mokarran* | Circumglobal 1–300 m | 610 | Viviparous | 250–292 | | 11 | 13–42 | 60–70 | | L∞ = 264 / 308 (FL) K= 0.16 / 0.11 T0 = -1.99 / -2.86 | 4.23–4.43 |
| Smooth hammerhead *Sphyrna zygaena* | Circumglobal 0–200 m | 500 | Viviparous | 210–265 | | 10–11 | 20–50 | 50–60 | | | 4.32–4.5 |
| Pelagic stingray *Pteroplatytrygon violacea* | Cosmopolitan 37–238 | 160 | Ovoviviparous | 35–40 DW | 2–3 | 2–4 | 4–9 | 15–25 DW | ~10 | L∞ = 116 DW K= 0.0180 | 4.36 |
| Devil ray *Mobula mobular* | NE Atl. + Med. epipelagic | 520 | Ovoviviparous | | | 25 | 1 | ≤ 166 DW | | | 3.71 |

# 13 Demersal elasmobranchs in the Barents Sea

## 13.1 Ecoregion and stock boundaries

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

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

All skate species occurring in the offshore areas are also found in the coastal areas of this ecoregion, with the exception of *A, hyperborea, D. oxyrinchus* and *D. linteus* (Williams *et al.*, 2008).

The species composition of skates caught in the Barents Sea differs from those recorded in the Norwegian Deep and northeastern Norwegian Sea (Skjaeraasen and Bergstad, 2000; 2001). Although *A. radiata* is the dominant species in both areas, the proportion of warmer-water species (*B. spinicauda*, *D. linteus*) is lower and the portion of cold-water species (*A. hyperborea*) is higher in the Barents Sea.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between the coastal and offshore areas. The adjacent Norwegian coastal area has been included within the Barents Sea ecoregion. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

The spatial distribution of chondrichthyan fishes in the Barents Sea, as observed in recent surveys, has been illustrated by described by Wienerroither *et al*. (2011; 2013)

## 13.2 The fishery

### 13.2.1 History of the fishery

Detailed data on catches of skates from the Barents Sea are only available from bycatch records and surveys from 1996–2001 and 1998–2001, respectively (provided by Dolgov *et al.*, 2004a; 2004b). Bottom-trawl fisheries mainly target cod *Gadus morhua* and haddock *Melanogrammus aeglefinus*, and longline fisheries target cod, blue catfish *Anarhichas denticulatus* and Greenland halibut *Reinhardtius hippoglossoides*. These are conducted through all seasons and have a skate bycatch, which is generally discarded. Dolgov *et al.*, 2004a estimated the total catch of skates taken by the Russian fishing fleet operating in the Barents Sea and adjacent waters in 1996–2001, and found that it ranged from 723–1891 t (average of 1250 t per year). *A. radiata* accounted for 90–95% of the total skate bycatch.

### 13.2.2 The fishery in 2012

No new information.

### 13.2.3 ICES advice applicable

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

### 13.2.4 Management applicable in 2012

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

Norway has a general ban on discarding. Since 2010 all dead or dying skates in the catches should be landed, whereas live specimens can be discarded.

## 13.3 Catch data

### 13.3.1 Landings

For ICES Subdivision I, landings data are limited and only available for all skate species combined (Table 13.1 and Figure 13.1). Landings from the most westerly parts of the Barents Sea ecoregion fall within Subarea II, and are described in Section 14. Russia and Norway are the main countries landing skates from the Barents Sea. Russian landings are not available for 2011 and 2012.

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

### 13.3.2 Discards

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

### 13.3.3 Quality of catch data

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

The Norwegian oceanic reference fleet (commercial vessels) collect biological data for the Institute of Marine Research (IMR) in Bergen, and some of these vessels are trawlers and longliners operating in the Barents Sea in various parts of the year. Personnel on board these vessels are obliged to measure the quantity of all fish species, including elasmobranchs. Data from 2008–2009 were analysed for species composition of elasmobranchs and reported to the WG (Vollen, 2010 WD). The results supported earlier findings of dominance of *A. radiata* (>95% of both weight and numbers) of catches in ICES Subdivision I (Table 13.2). It is concluded that most skates are discarded, as the yearly catch/vessel reported by the reference fleet is very high compared with corresponding numbers from the official Norwegian landings statistics. Future analysis of these data should include quantities and proportions of elasmobranchs in relation to commercial teleosts such as cod and haddock.

## 13.4 Commercial catch composition

### 13.4.1 Species and size composition

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

Vinnichenko *et al.* (2010 WD) reported that catches of skates in Russian trawl and longline bottom fisheries in 2009 (60–400 m depths) were dominated by *A. radiata* (90–95%). Other species occurring were *R. fyllae*, *A. hyperborea*, *B. spinicauda* and *D. batis* (complex). These findings were supported by data from the Norwegian Reference Fleet for 2008–2009 (Vollen, 2010 WD).

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

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian bottom trawl survey and the joint Russian–Norwegian surveys. These are presented in Section 13.6.4.

## 13.5 Commercial catch-effort data

Relative cpue data are available for *A. radiata*, *A. hyperborea*, *R. fyllae* and *D. batis* (complex) in trawl and longline fisheries, respectively. Total catches of skates in Russian fisheries in the Barents Sea and adjacent areas for the years 1996–2001 were summarized in ICES (2007).

Catch data from other nations are limited and analyses of more recent Russian data are required.

## 13.6 Fishery-independent surveys

### 13.6.1 Russian bottom-trawl survey (RU-BTr-Q4)

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

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

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. These are presented in Section 13.6.4.

### 13.6.2 Norwegian coastal survey (NOcoast-Aco-Q4)

The distribution and diversity of elasmobranch species in the northern Norwegian coastal areas were assessed by Williams (2007) and Williams *et al. (*2007 WD) and Wienerroither *et al.* (2011, 2013). The results were summarized in ICES (2007 and 2008). New data from this survey should be analysed and presented to the WGEF, as some of the issues regarding species misidentification have been solved.

### 13.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from deep trawl hauls (400–1400 m) along the continental slope (62–81°N) in 2003-2009. The area investigated covered the Norwegian Sea ecoregion, as well as the border between the Norwegian Sea and Barents Sea ecoregions. Results were summarized in ICES (2009), in the Norwegian Sea ecoregion (Section 14).

### 13.6.4 Joint Russian-Norwegian surveys (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea. The cruises run in February (BS-NoRu-Q1 (BTr)), in the southern Barents Sea northwards to the latitude of Bear Island, and August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)), practically covering the whole of the Barents Sea including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but data on elasmobranchs are missing for some years. The August–September survey started in 2003. All skate species are recorded during these surveys, and data on length distributions are collected, as well as some biological data on board of Russian vessels. As a consequence of problems with the species identification, species-specific data should only be used from the years 2006–2007 onwards (Norwegian data). Analyses of data from these surveys are not completed, but some data were presented from the 2009 surveys by Vinnichenko *et al.* (2010 WD).

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

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

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

In August–September 2009, *A. radiata* of 7-57 cm in length were recorded (Figure 13.6). In the length distribution, different size/age classes of *A. radiata* were well-

pronounced. The mean length of males was much greater and equalled 41.8 cm; of females 38.0 cm. The catches were dominated by males and the sex ratio was 1.2:1.

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

### 13.6.5 Quality of survey data

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

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

## 13.7 Life-history information

Length data for *A. radiata, A. hyperborea, R. fyllae, Dipturus* complex and *B. spinicauda* are available in Dolgov *et al.* (2004a, 2004b) and Vinnichenko *et al.* (2010 WD; see ICES, 2007, 2010). Some biological information is available in the literature (e.g. Berestovsky, 1994).

### 13.7.1 Ecologically important habitats

No information available.

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

## 13.8 Exploratory assessment models

No assessments have been conducted.

## 13.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated, although taxonomic irregularities need to be addressed first.

## 13.10 Reference points

No reference points have been proposed.

## 13.11 Conservation considerations

Listings other than "Least concern" on the International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species (IUCN, 2013):

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

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

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

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

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

## 13.12 Management considerations

There are no TACs for any of the demersal skates in this region. The elasmobranch fauna of the Barents Sea is little studied and comprises relatively few species. The most abundant demersal elasmobranch in the area is *A. radiata*, which is widespread and abundant in this and adjacent waters. Further and more extensive studies are required, particularly for some of the larger-bodied species (e.g. larger skates), which could be more vulnerable to overfishing.

## 13.13 Spatial information

There is no high resolution information available from this area.

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

## 13.14 References

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).

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 longline 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.

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

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

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

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 519 pp.

IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.1. http://www.iucnredlist.org>. Downloaded on 22 July 2013.

Sjøtun, K., Fredriksen, S., Heggøy, E., Husa,V., Langangen, A., Lindstrøm, E-A., Moy, F., Rueness, J. and Åsen, P. A. 2010. Cyanophyta, Rhodophyta, Chlorophyta, Ochrophyta – In: Kålås, J.A., Viken, Å., Henriksen, S. and Skjelseth, S. (eds.) 2010. The 2010 Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Norway.

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

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

Vinnichenko, V.I., Dolgov, A.V., Yurko, A.S., Zhivov, B.D. and Safronov, A.M. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2009. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Vollen, T. 2009. Distribution of chondrichthyan species in Norwegian deep-sea waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2009.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Wienerroither R., Johannesen E., Dolgov A., Byrkjedal I., Bjelland O, Drevetnyak K., Eriksen KB., Høines Å., Langhelle G., Langøy H., Prokhorova T., Prozorkevich D., Wenneck T. 2011. Atlas of the Barents Sea Fishes. IMR/PINRO Joint Report Series 1-2011. ISSN 1502-8828.

Wienerroither R., Johannesen E., Dolgov A., Byrkjedal I., Aglen A., Bjelland O., Drevetnyak K., Eriksen KB., Høines Å., Langhelle G., Langøy H., Murashko P., Prokhorova T., Prozorkevich, Smirnov O., Wenneck T. 2013. Atals of the Barents Sea Fishes based on the winter survey. IMR-PINRO Joint Report Series 2-2013. ISSN 1502-8828. 220 pp.

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

Williams, T., 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.

Williams, T., Helle, K., Aschan, M. 2008. The distribution of chondrichthyan along the north coast of Norway. ICES Journal of Marine Science 65(7) 1161–1174.

**Table 13.1. Demersal Elasmobranchs in the Barents Sea. Total landings of skates and rays from ICES Subdivision I, 1973–2012. Total landings (tonnes). "n.a." = no data available, "." = means zero catch, "+" = <50 tonnes.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | 1 | . | . | . | . | . | . | . | . | . | . |
| France | . | . | . | 81 | 49 | 44 | . | . | . | . | . | . | . | . |
| Germany | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | . | . | . | 1 | 3 | 4 | 8 | 2 | 2 | 2 | 1 | 10 | 11 | 3 |
| Portugal | . | . | 100 | 11 | 1 | . | . | + | . | . | . | . | . | . |
| USSR/Russian Fed. | n.a. | n.a. | n.a. | n.a. | n.a. | 1126 | 168 | 93 | 3 | 1 | n.a. | 563 | 619 | 2137 |
| Spain | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK(E&W) | 78 | 46 | 49 | 33 | 70 | 9 | 8 | 4 | + | 1 | . | + | + | + |
| UK(Scotland) | . | . | 1 | 2 | 2 | . | . | . | . | . | . | . | . | . |
| Total | 78 | 46 | 150 | 129 | 125 | 1183 | 184 | 99 | 5 | 4 | 1 | 573 | 630 | 2140 |
| | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** |
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| France | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Germany | . | . | . | . | . | . | . | 2 | . | . | . | . | . | . |
| Iceland | . | . | . | . | . | . | 1 | . | . | + | 1 | . | . | 4 |
| Norway | 14 | 7 | 4 | 1 | 5 | 24 | 29 | 72 | 9 | 27 | 3 | 13 | 21 | 12 |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| USSR/Russian Fed. | 2364 | 2051 | 1235 | 246 | n.a. | 399 | 390 | 369 | n.a. | n.a. | 399 | 790 | 568 | 502 |
| Spain | . | . | . | . | . | . | . | . | 7 | . | . | . | . | . |
| UK(E&W) | 2 | . | + | . | . | . | . | . | . | . | . | . | + | . |
| UK(Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Total | 2380 | 2058 | 1239 | 247 | 5 | 423 | 420 | 443 | 16 | 27 | 403 | 803 | 589 | 518 |
| | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | | |
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . | | |
| France | . | . | . | . | . | . | . | . | . | . | . | . | | |
| Germany | . | . | . | . | . | . | + | . | . | + | . | . | | |
| Iceland | . | . | . | 3 | 3 | . | . | . | . | . | . | . | | |
| Norway | 30 | 26 | 2 | 1 | 4 | 13 | 4 | 72 | 15 | 9 | 31 | 109 | | |
| Portugal | . | . | . | + | . | . | . | . | . | . | . | . | | |
| USSR/Russian Fed. | 218 | 173 | 38 | 69 | 37 | 48 | 24 | 6 | 2 | 1 | n.a. | n.a. | | |
| Spain | . | . | . | . | . | . | . | . | . | . | . | . | | |
| UK(E&W) | . | . | . | . | . | . | . | . | . | . | + | . | | |
| UK(Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | | |
| Total | 248 | 199 | 40 | 73 | 44 | 61 | 28 | 78 | 17 | 10 | 31 | 109 | | |

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

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

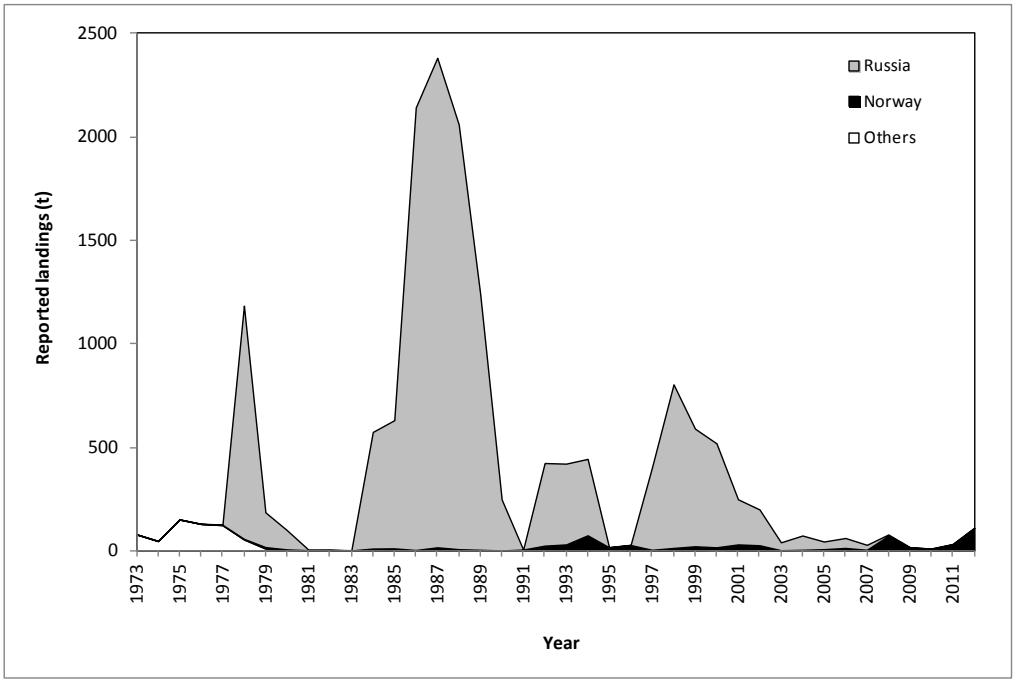



**Figure 13.1. Demersal elasmobranchs in the Barents Sea. Skates and rays from ICES Subdivision 1, 1973–2012. Total landings (tonnes).**

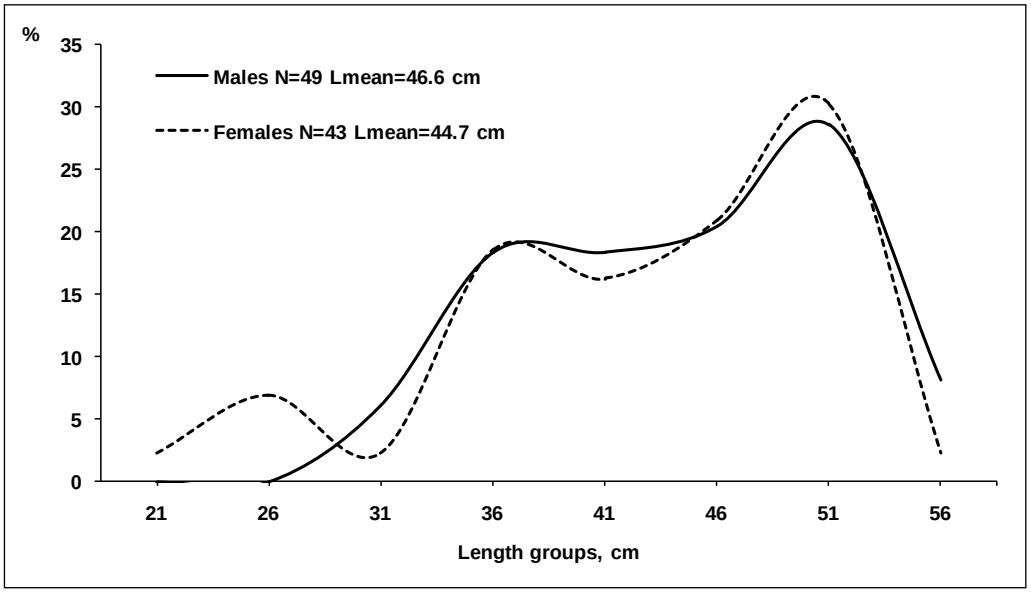



**Figure 13.2. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* from commercial bottom-trawl catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.,* 2010 WD).**

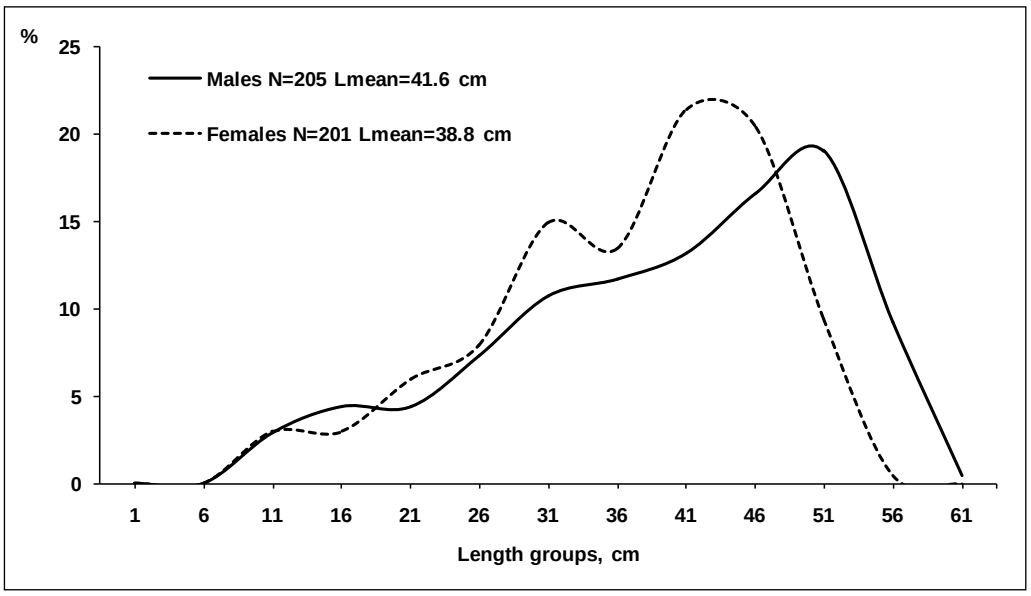



**Figure 13.3. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

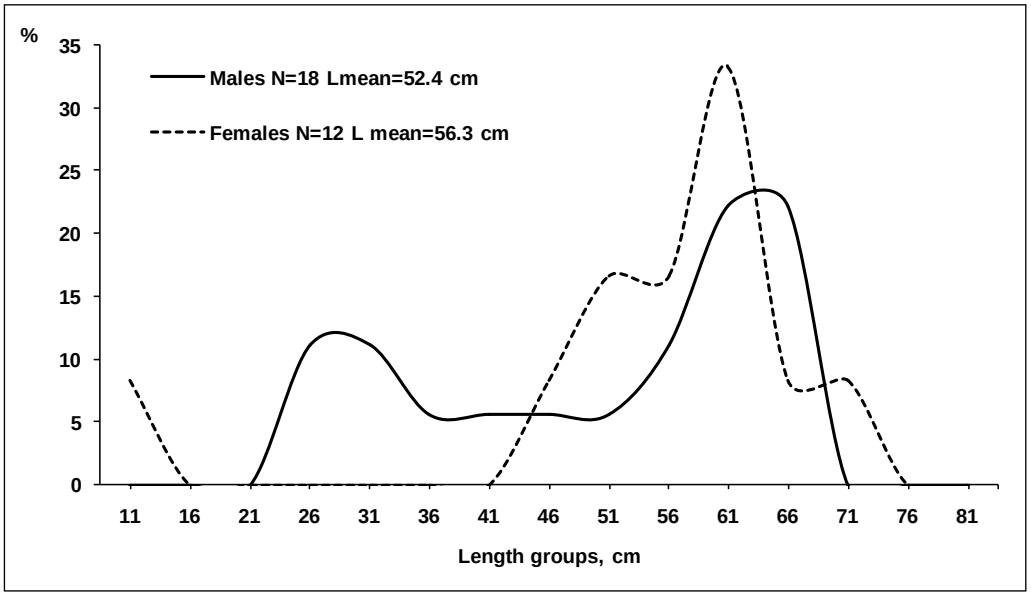



**Figure 13.4. Demersal elasmobranchs in the Barents Sea. Length composition of *A. hyperborea* in the Barents Sea (Area I) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

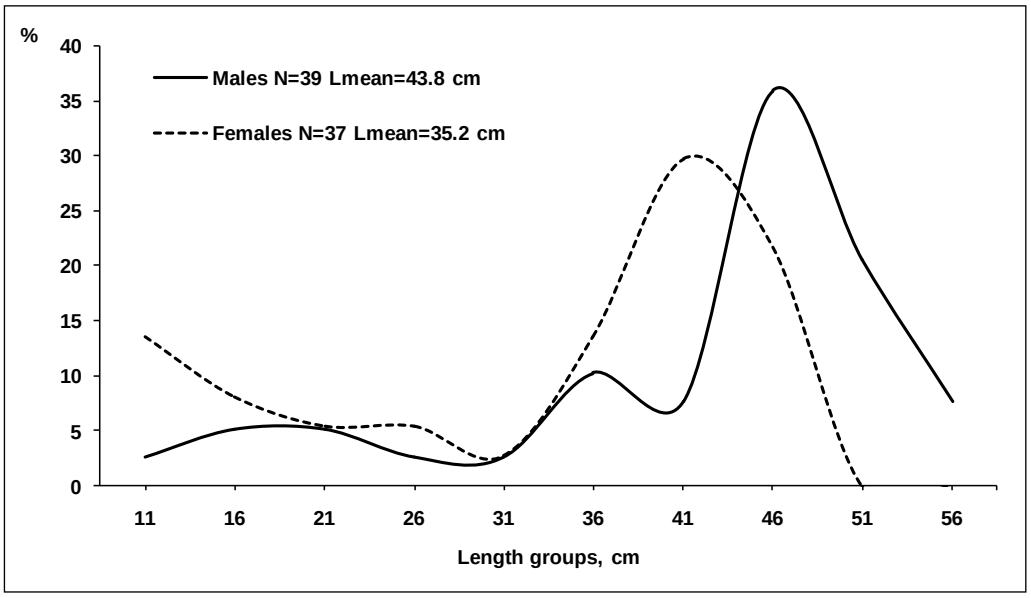



**Figure 13.5. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Area I) based on data of the joint Russian–Norwegian winter survey (February 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

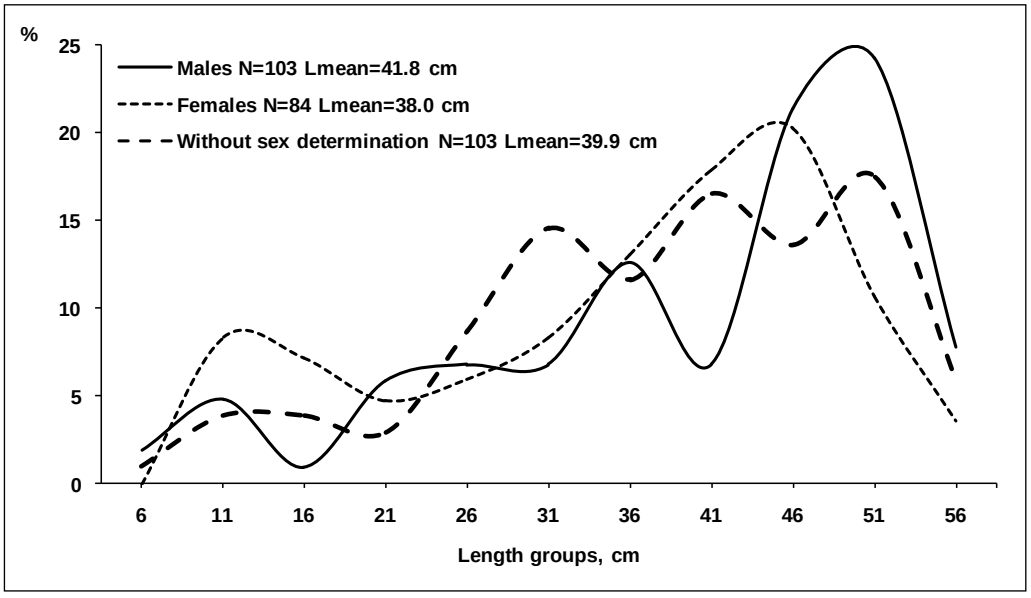



**Figure 13.6. Demersal elasmobranchs in the Barents Sea. Length composition of *A. radiata* in the Barents Sea (Subarea I) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

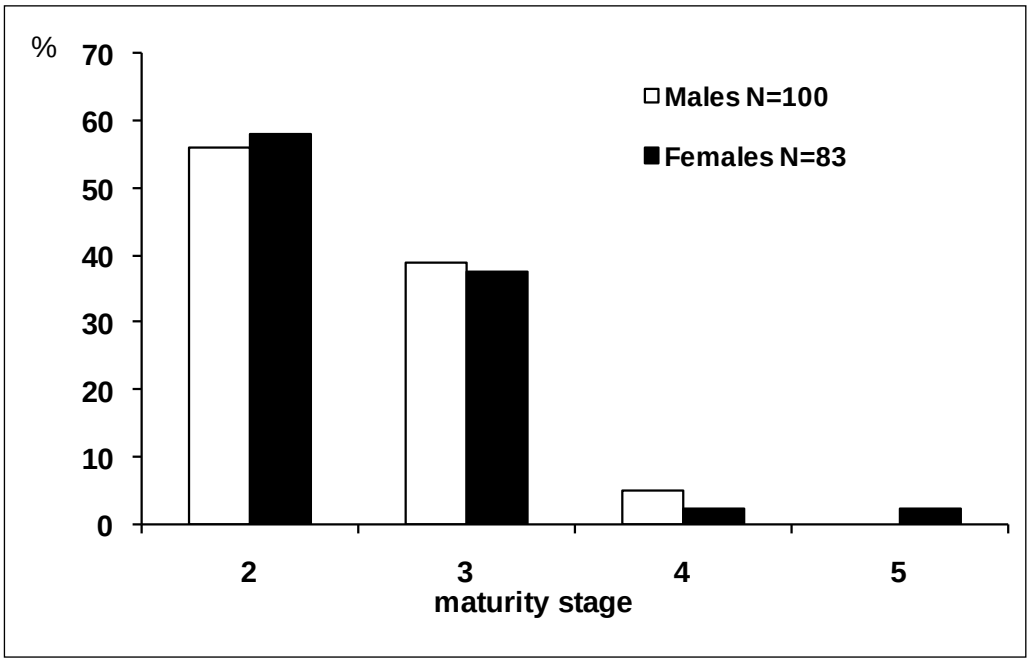



**Figure 13.7. Demersal elasmobranchs in the Barents Sea. Maturity of *A. radiata* in bottom trawl catches in the Barents Sea in 2009. (Source: Vinnichenko *et al.,* 2010 WD).**

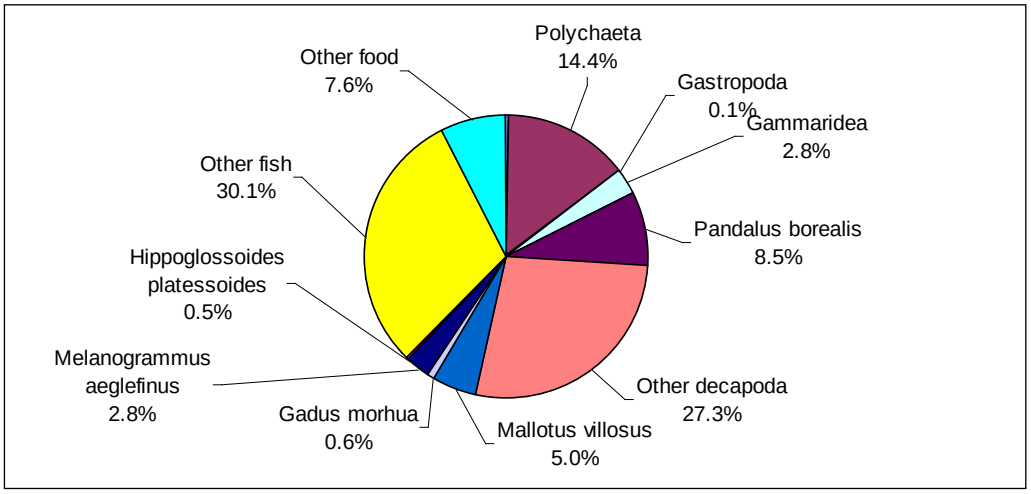



**Figure 13.8. Demersal elasmobranchs in the Barents Sea. Food composition of *A. radiata* in the Barents Sea (Area I) in 2009, % by weight (N=169, 27% empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).**

# 14 Demersal elasmobranchs in the Norwegian Sea

## 14.1 Ecoregion and stock boundaries

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

In deeper areas of the Norwegian Sea, *A. radiata* and *A. hyperborea* are the two most numerous species, but *B. spinicauda* and *R. fyllae* also occur regularly (Skjaeraasen and Bergstad, 2001; Vollen, 2009 WD). These species of skates are particularly abundant north of 70°N (Vollen, 2009 WD).

Sharks in the Norwegian Sea ecoregion include spurdog *Squalus acanthias* (see Section 2) and several deep-water species (see Section 5), such as velvet belly lantern shark *Etmopterus spinax,* blackmouth catshark *Galeus melastomus* and Greenland shark *Somniosus microcephalus* (Williams *et al.*, 2007 WD; Vollen, 2009 WD). Other species reported in Norwegian fisheries include lesser spotted dogfish *Scyliorhinus canicula* (see Section 15), porbeagle *Lamna nasus* (see section 6) and basking shark *Cetorhinus maximus* (see Section 7) (Vollen, 2010 WD).

Stock boundaries are not known for the species in this area, neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

## 14.2 The fishery

### 14.2.1 History of the fishery

There is no directed fishery on skates and rays in the Norwegian Sea, though they are caught in mixed fisheries targeting various teleost species. Landings data for skates are demonstrated in Table 14.1 and Figure 14.1 for the years 1973–2012.

### 14.2.2 The fishery in 2012

No new information.

### 14.2.3 ICES advice applicable

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

### 14.2.4 Management applicable

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

Norway has a general ban on discarding. Since 2010 all dead or dying skates in the catches should be landed, whereas live specimens can be discarded.

## 14.3 Catch data

### 14.3.1 Landings

For ICES Subdivision II, landings data are limited and, for skates, not species disaggregated (Table 14.1and Figure 14.1). This area covers all of the Norwegian Sea ecoregion, but also includes the most westerly parts of the Barents Sea ecoregion (Section 13).

Overall landings throughout time have been low, at about 200–300 t per year for all fishing countries, with moderate fluctuations. The peak in the late 1980s resulted from Russian fisheries landing over 1900 t of skates in 1987, subsequently dropping to low levels two years later. This peak was as a consequence of an experimental fishery, when skate bycatch was landed, whereas normally they are discarded (Dolgov, pers. comm., 2006). Russia and Norway are the main countries landing skates from the Norwegian Sea.

Norwegian landings of sharks were reported by species for 2012. Landings of blackmoth dogfish *Galeus melastomus* were 21 tonnes. Other sharks landed in this area include porbeagle, spurdog and velvet belly (*Etmopterus spinax*). These are reported in Sections 6, 2 and 5, respectively.

Landings data (usually not resolved to species level) have been provided by Norway, France, and Scotland in recent years. Russian landings are not available for 2011 and 2012.

### 14.3.2 Discard data

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

### 14.3.3 Quality of catch data

Catch data are not species disaggregated.

## 14.4 Commercial catch composition

### 14.4.1 Species and size composition

In 2009, Russian landings of skates were taken as bycatch during the longline and trawl demersal fisheries at 50–900 m depths in February–November. *A. radiata* made up the bulk of bycatch. *R. fyllae*, *A. hyperbora* and *B. spinicauda* were found in minor quantities (Vinnichenko *et al.*, 2010 WD).

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

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

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. These are presented in Section 14.6.4.

### 14.4.2 Quality of the data

Information on the species composition of commercial catches is required.

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

The data from the Coastal Reference Fleet demonstrated that *D. batis* (complex; possibly misidentified) and unidentified skates dominated the landed catches in this area (39% and 33% by weight, respectively). Discards were dominated by unidentified skates (32% by weight). As opposed to the Oceanic Reference Fleet, *A. radiata* was only sporadically recorded in this area.

## 14.5 Commercial catch-effort data

No information.

## 14.6 Fishery-independent surveys

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

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

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

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. These are presented in Section 14.6.4.

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

The distribution and diversity of elasmobranchs in northern Norwegian coastal areas was summarized by Williams (2007) and Williams *et al.* (2007 WD; 2008) based on survey data from 1992–2005. The southern portion of the coastal area studied was

incorporated within the Norwegian Sea ecoregion, and the Barents Sea was defined as the border between Norwegian Directorate of Fisheries Statistical Areas 04 and 05 (as illustrated in Fiskeridirektoratet, 2004).

Thirteen skate species and four species of sharks were recorded as inhabiting the coastal region (Table 14.2). Regularly occurring skates were *A. radiata, A. hyperborea, D. batis (complex)*, *D. nidarosiensis, D. oxyrinchus, Raja clavata, Rajella fyllae, L. fullonica*,. Occasional or single observations were made of *B. spinicauda*, *D. linteus*, *R. montagui*, *R. brachyura* and *L. circularis*. Four species of shark were identified: *E. spinax, G. melastomus* and *S. acanthias*, as well as one specimen of *S. microcephalus.*

No clear shifts in abundance over time were detected for any species. A more robust assessment is necessary to better identify temporal trends in abundances.

### 14.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen, 2009 WD reported on elasmobranch catches from 3185 deep trawl hauls (400–1400 m) at the continental slope (62–81°N), the Barents Sea and Skagerrak. Data were combined from multiple deep-water surveys during the period 2003–2009. Data from the Skagerrak are excluded in this section, whereas parts of the Barents Sea ecoregion are included. A total of nine species were recorded; six skates and three sharks. *A. radiata* and *A. hyperborea* were the dominating species north of 62°N (ICES Subdivision II), whereas *E. spinax* were most numerous in the Norwegian Deep (ICES Subdivision IIIa). *B. spinicauda* and *R. fyllae* also occurred frequently in the catches in all areas. Recordings of *R. clavata* were considered to be misidentification of other species. Results were reported in more detail in ICES, 2009.

### 14.6.4 Joint Russian-Norwegian survey (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea. The cruises run in February (BS-NoRu-Q1 (BTr)), in the southern Barents Sea northwards to the latitude of Bear Island, and August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)), practically covering the whole of the Barents Sea, including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but for some years data on elasmobranchs are missing. The August–September survey started in 2003. All skates are recorded during these surveys, and data on length distributions as well as some biological data (on board of Russian vessels) are collected. As a result of problems with the species identification, species-specific data should only be used from the years 2006–2007 onwards (for Norwegian data). Analyses of data from these surveys are not completed, but some data were presented from the 2009 surveys by Vinnichenko *et al.* (2010 WD).

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

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for both samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. Males prevailed in the samples (1.7:1). The most of males and females (over 70%) were immature, the rest of them were maturing and mature (Figure 14.6). Unlike the Barents Sea, in that area, there were no individuals which were close to the active stage. Prevailing prey were bottom decapods (crabs *Hyas* spp. and the northern shrimp (*Pandalus borealis*)) and fish (capelin

(*Mallotus villosus*) and Atlantic hookear scuplin (*Artediellus atlanticus*)), 47% and 31% by weight, respectively (Figure 14.7).

### 14.6.5 Quality of survey data

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

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

## 14.7 Life-history information

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

### 14.7.1 Ecologically important habitats

No information available.

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

## 14.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data.

## 14.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated, although taxonomic irregularities need to be addressed first.

## 14.10 Reference points

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

## 14.11 Conservation considerations

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

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

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

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

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

## 14.12 Management considerations

There are no TACs for any of the demersal skates in this region. The demersal elasmobranch fauna of the Norwegian Sea comprises several species that occur in the Barents Sea (Section 13) and/or the North Sea (Section 15). Further investigations are required, and could also offer valuable additional information for managing the neighbouring ecoregions.

## 14.13 Spatial information

There is no high resolution information available from this area.

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

## 14.14 References

BerestovskyY, E. G. 1994. Reproductive biology of skates in the Arctic seas. J. Vopr. Ichthyol., 34(2): 212–218 (in Russian).

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

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

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

IUCN. 2011. IUCN Red List of Threatened Species. Version 2011.1. http://www.iucnredlist.org>. Downloaded on 24 June 2011.

Sjøtun, K., Fredriksen, S., Heggøy, E., Husa,V., Langangen, A., Lindstrøm, E-A., Moy, F., Rueness, J. and Åsen, P. A. 2010. Cyanophyta, Rhodophyta, Chlorophyta, Ochrophyta – In: Kålås, J.A., Viken, Å., Henriksen, S. and Skjelseth, S. (eds.) 2010. The 2010 Norwegian Red List for Species. Norwegian Biodiversity Information Centre, Norway.

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 Northeastern Atlantic and Mediterranean, Volume 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.

Vinnichenko, V.I., Dolgov, A.V., Yurko, A.S., Zhivov, B.D. and Safronov, A.M. 2010. Russian research and fisheries of sharks and skates in the Northeast Atlantic in 2009. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

Vollen, T. 2009. Distribution of chondrichthyan species in Norwegian deep-sea waters. Working document for the ICES Elasmobranch Working Group (WGEF) 2009.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working document for the ICES Elasmobranch Working Group (WGEF) 2010.

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

Williams, T., Helle, K., Aschan, M. 2008. The distribution of chondrichthyan along the north coast of Norway. ICES Journal of Marine Science 65(7) 1161–1174.

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. Total landings (t) of skates and rays from ICES Subdivisions II, IIa and IIb from 1973–2012. Ireland (1 ton in 2007), Denmark (+ in 1994 and Sweden (+ in 1975) are not included in the landings table). "n.a." = no data available, "." = means zero catch, "+" = <50 tonnes.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | 1 | . | . | . | . | . | . | . | . | . | . | . |
| Estonia | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faroe Islands | . | . | . | 5 | 2 | 1 | 1 | . | . | . | . | . | . | 4 |
| France | . | . | 1 | 68 | 61 | 18 | 2 | 1 | 12 | 109 | 2 | 6 | 5 | 11 |
| Germany | + | 1 | 52 | 12 | 59 | 114 | 84 | 85 | 53 | 7 | 2 | 112 | 124 | 102 |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | 2 | . | . | . | . | . | . | . |
| Norway | 201 | 158 | 89 | 34 | 99 | 82 | 126 | 191 | 137 | 110 | 96 | 150 | 104 | 133 |
| Portugal | . | . | . | 34 | 39 | . | . | . | . | . | . | . | . | . |
| USSR/Russ. Fed. | . | . | . | . | . | 302 | 99 | 39 | . | . | . | 537 | 261 | 1633 |
| Spain | . | . | . | . | . | . | . | . | . | . | 28 | | 17 | 5 |
| UK – E, W & NI | 65 | 18 | 14 | 20 | 90 | 10 | 6 | 2 | + | + | . | 5 | 1 | 2 |
| UK - Scotland | 2 | 1 | . | + | 1 | + | . | . | . | . | . | . | + | + |
| Total | 268 | 178 | 157 | 173 | 351 | 527 | 320 | 318 | 202 | 226 | 128 | 810 | 512 | 189 |

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Estonia | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faroe Islands | . | 15 | . | 42 | . | 2 | . | . | . | . | . | . | . | . |
| France | 21 | 42 | 8 | 56 | 11 | 15 | 9 | 7 | 8 | 6 | 8 | 5 | . | 5 |
| Germany | 95 | 76 | 32 | 52 | . | + | . | . | . | . | . | . | . | 2 |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | 214 | 112 | 148 | 216 | 235 | 135 | 286 | 151 | 239 | 198 | 169 | 214 | 239 | 244 |
| Portugal | . | . | . | . | . | . | 22 | 11 | . | 10 | 28 | 46 | 10 | 6 |
| USSR/Russ. Fed. | 1921 | 1647 | 867 | 208 | n.a. | 181 | 112 | 257 | n.a. | n.a. | 77 | 139 | 247 | 400 |
| Spain | . | 9 | . | . | . | . | . | . | 3 | . | 3 | 15 | 6 | . |
| UK - E, W & NI | 4 | . | 2 | 1 | + | 1 | + | + | 1 | 4 | . | + | 1 | + |
| UK - Scotland | 2 | + | + | + | + | + | + | . | + | + | + | + | 1 | 1 |
| Total | 2257 | 1902 | 1057 | 575 | 246 | 334 | 429 | 426 | 251 | 218 | 285 | 419 | 504 | 658 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . |
| Estonia | . | 5 | . | . | 4 | . | . | . | . | . | . | n.a. |
| Faroe Islands | . | . | 2 | 12 | 15 | 13 | 9 | 13 | 4 | 3 | n.a. | . |
| France | 4 | 7 | 2 | 7 | 8 | . | 4 | 2 | 1 | 3 | + | 1 |
| Germany | . | 2 | 2 | 7 | 1 | . | . | . | . | 1 | . | . |
| Iceland | 4 | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | 233 | 118 | 111 | 135 | 133 | 146 | 189 | 259 | 257 | 250 | 197 | 123 |
| Portugal | 3 | . | 8 | 2 | 1 | 14 | 13 | 2 | . | . | . | . |
| USSR/Russ. Fed. | 113 | 38 | 6 | 50 | 20 | 16 | 20 | . | 8 | 2 | n.a. | n.a. |
| Spain | 7 | 11 | 32 | . | 2 | . | . | . | . | . | . | . |
| UK - E, W & NI | . | . | . | . | . | + | . | . | . | . | . | . |
| UK – Scotland | 1 | 3 | 3 | . | 2 | 4 | 1 | 1 | + | . | . | . |
| Total | 365 | 184 | 166 | 213 | 186 | 193 | 237 | 277 | 270 | 259 | 197 | 124 |

**Table 14.2. Catch data (number of individuals per species) for the Norwegian Sea ecoregion from the Annual Autumn Bottom-trawl Surveys of the North Norwegian Coast, from 1992 to 2005. (Source: adapted from Williams, 2007 WD)**

| Species | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Total catch | Total % of positive samples | Catch rate (No. per survey) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amblyraja radiata* | 7 | 44 | 23 | 15 | 8 | 41 | 9 | 16 | 9 | 6 | 10 | 10 | 19 | 9 | 226 | 11% | 17.4 |
| *Bathyraja spinicauda* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0% | 0.1 |
| *Rajella fyllae* | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | 6 | 4 | 0 | 20 | 1% | 1.5 |
| *Raja clavata* | 0 | 4 | 15 | 1 | 0 | 2 | 3 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 33 | 2% | 2.5 |
| *Dipturus batis* (complex) | 0 | 2 | 0 | 1 | 3 | 7 | 7 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 24 | 1% | 1.8 |
| *Leucoraja fullonica* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 9 | 3 | 0 | 0 | 1 | 20 | 1% | 1.5 |
| *Leucoraja circularis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 9 | 5 | 7 | 23 | 1% | 1.8 |
| *Raja montagui* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 5 | <1% | 0.4 |
| *Dipturus oxyrinchus* | 0 | 0 | 54 | 3 | 2 | 30 | 2 | 0 | 0 | 1 | 2 | 6 | 4 | 2 | 106 | 5% | 8.2 |
| *Dipturus nidarosiensis* | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 0 | 7 | <1% | 0.5 |
| *Amblyraja hyperborea* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 6 | <1% | 0.5 |
| *Raja brachyura* | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | <1% | 0.3 |
| *Dipturus linteus* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | <1% | 0.1 |
| *Galeus melastomus* | 0 | 24 | 1883 | 1197 | 105 | 1269 | 189 | 480 | 258 | 812 | 1196 | 275 | 640 | 48 | 8376 | 24% | 644.3 |
| *Etmopterus spinax* | 0 | 829 | 8453 | 473 | 1061 | 2733 | 584 | 3881 | 1485 | 1401 | 2417 | 785 | 2305 | 1369 | 27 776 | 33% | 2136.6 |
| *Squalus acanthias* | 0 | 21 | 51 | 26 | 20 | 5 | 106 | 168 | 12 | 68 | 43 | 21 | 104 | 17 | 662 | 8% | 50.9 |
| *Somniosus microcephalus* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | <1% | 0.1 |
| Number of samples | 17 | 163 | 106 | 77 | 74 | 96 | 78 | 81 | 76 | 56 | 78 | 65 | 77 | 63 | | | |

**Table 14.3. Demersal elasmobranchs in the Norwegian Sea. Species composition of elasmobranch catches in ICES Subdivision II by the Norwegian Oceanic and Coastal Reference Fleet. Data for the Oceanic Reference Fleet is Total catch of elasmobranchs as percentage of biomass and percentage of numbers. Data for the Coastal Reference Fleet is percentage in numbers of landed catch and discarded catch. (Source: Adapted from Vollen, 2010 WD)**

| | Oceanic Reference Fleet | | | Oceanic Reference Fleet | | | Coastal Reference Fleet | |
|---|---|---|---|---|---|---|---|---|
| | Total catch (% biomass) | | | Total catch (% numbers) | | | Landed | Discarded |
| Species | Lines | Nets | Trawls | Lines | Nets | Trawls | Nets | Nets |
| *Chimaera monstrosa* | 5,6 | 6,9 | 30,3 | 3,4 | 7,5 | 27,2 | 1,1 | 44,5 |
| *Amblyraja radiata* | 79,5 | 6,3 | 55,1 | 78,9 | 7,8 | 54,5 | | 1,8 |
| *Raja clavata* | | 74,5 | 9,4 | | 82,2 | 9,4 | 6,5 | 0,8 |
| *Amblyraja hyperborea* | 5,4 | | | 2,9 | | | 0,1 | |
| *Dipturus batis* (complex) | 0,2 | | | 0,1 | | | 38,7 | 0,4 |
| *Dipturus linteus* | 0,2 | | | 0,1 | | | | 2,0 |
| *Rajella fyllae* | 2,2 | 0,6 | 3,2 | 3,8 | 1,1 | 5,5 | 0,7 | 1,1 |
| *Dipturus oxyrinchus* | + | | 0,1 | + | | 0,1 | 0,7 | 7,4 |
| *Dipturus nidarosiensis* | | | | | | | | + |
| *Leucoraja fullonica* | 0,2 | 11,4 | 1,5 | 0,1 | 0,9 | 2,8 | | |
| *Bathyraja spinicauda* | 0,5 | | 0,4 | 0,2 | | 0,5 | | |
| *Skates indet* | 3,6 | | | 5,0 | | | 33,4 | 18,2 |
| *Squalus acanthias* | 0,2 | 0,3 | + | 0,1 | 0,4 | 0,1 | 7,9 | 7,3 |
| *Galeorhinus galeus* | | | | | | | | + |
| *Galeus melastomus* | 1,4 | | | 2,2 | | | 0,1 | 11,3 |
| *Scyliorhinus canicula* | | | | | | | | 0,3 |
| *Etmopterus spinax* | 1,0 | | | 3,3 | | | | 4,2 |
| *Cetorhinus maximus* | | | | | | | | 0,2 |
| *Lamna nasus* | | | | | | | 10,8 | 0,1 |
| *Somniosus microcephalus* | | | | | | | | 0,5 |
| Total chimaeras | 5,6 | 6,9 | 30,3 | 3,4 | 7,5 | 27,2 | 1,1 | 44,5 |
| Total skates | 91,8 | 92,8 | 69,7 | 91,0 | 92,1 | 72,7 | 80,1 | 31,7 |
| Total sharks | 2,6 | 0,3 | 0,0 | 5,6 | 0,4 | 0,1 | 18,8 | 23,8 |

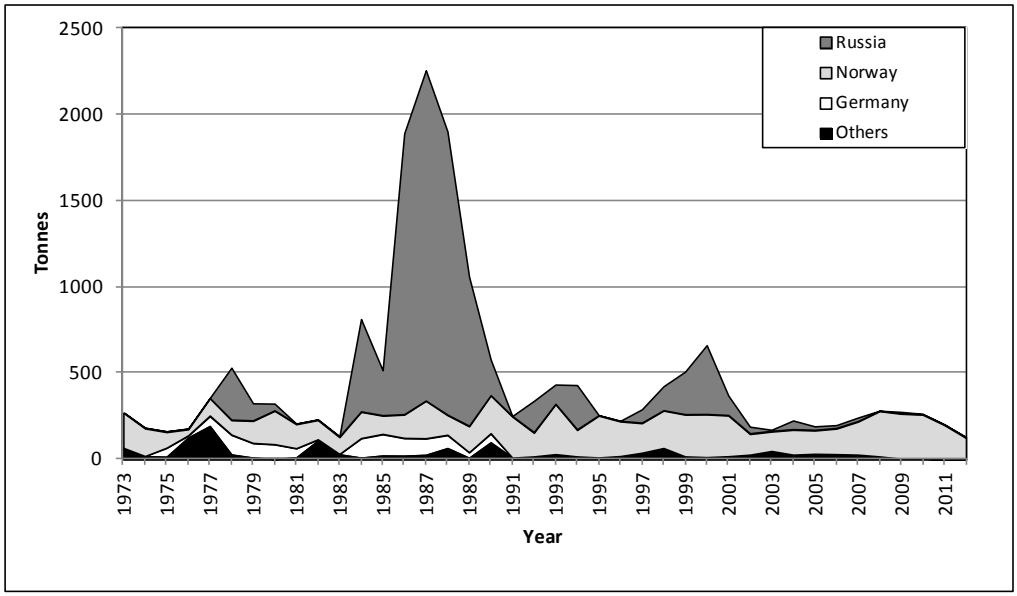



**Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates and rays from ICES Subdivisions II, IIa and IIb from 1973–2012.**

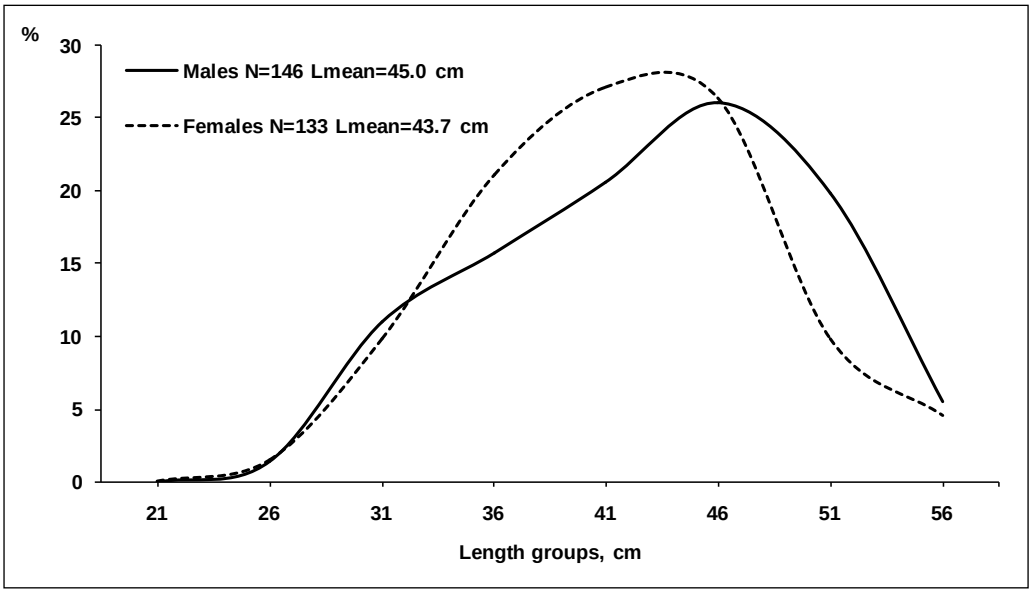



**Figure 14.2. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* from commercial bottom-trawl catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.*, 2010 WD).**

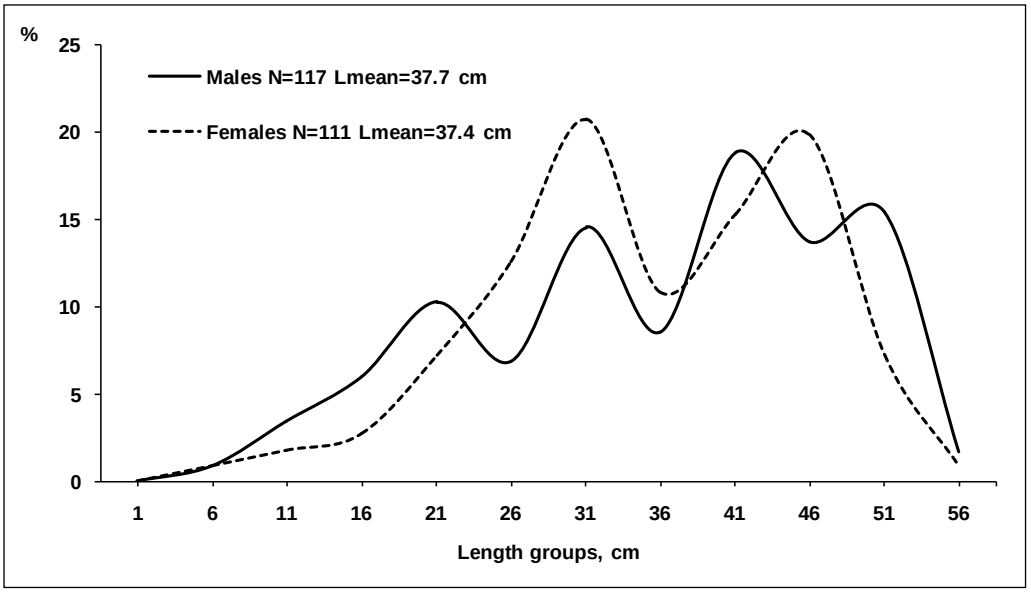



**Figure 14.3. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

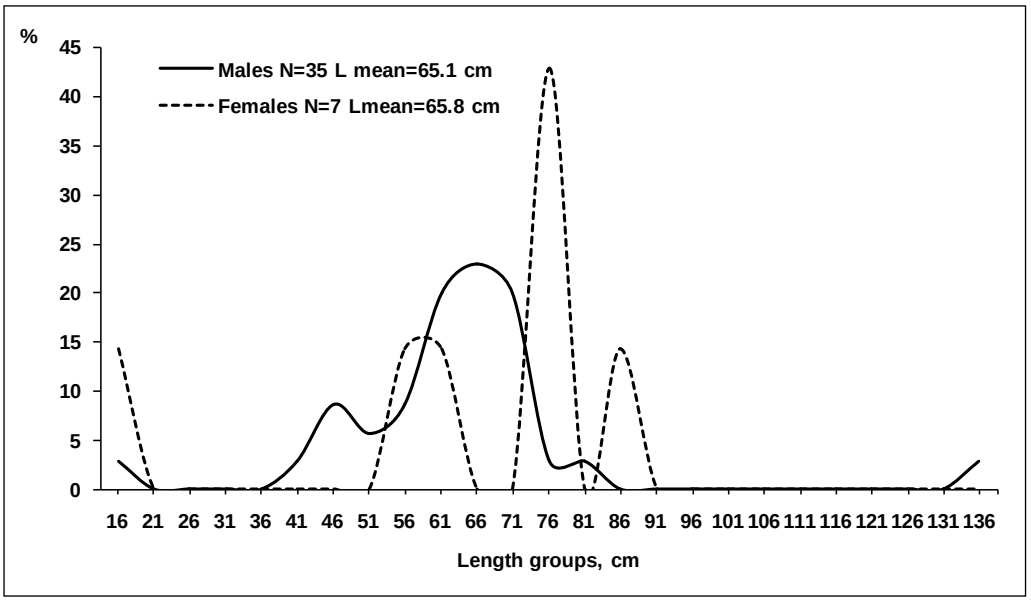



**Figure 14.4. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. hyperborea* in the Norwegian Sea (Subarea IIb) based on data of the Russian demersal survey (October–December 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

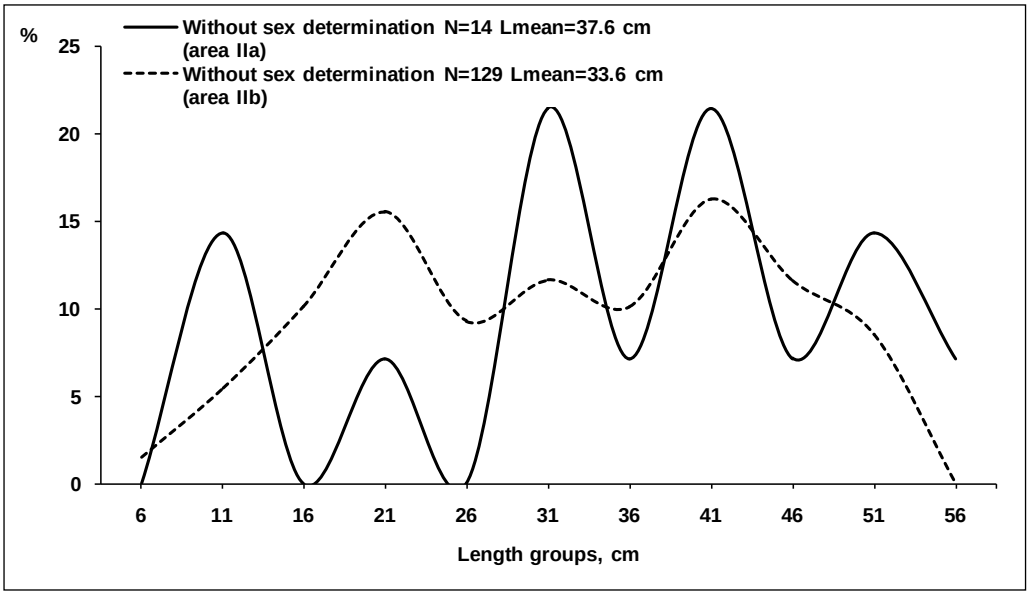



**Figure 14.5. Demersal elasmobranchs in the Norwegian Sea. Length composition of *A. radiata* in the Norwegian Sea (Area IIa and IIb) based on data of the joint Russian–Norwegian ecosystem survey (August–September 2009). (Source: Vinnichenko *et al.,* 2010 WD).**

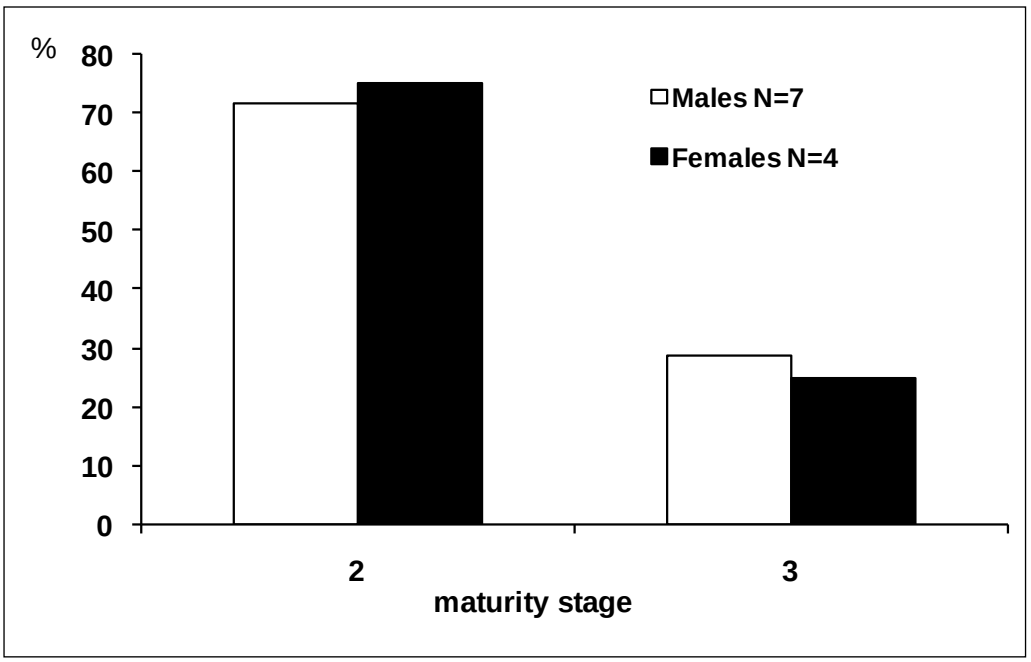



**Figure 14.6. Demersal elasmobranchs in the Norwegian Sea. Maturity of *A. radiata* in bottom-trawl catches in the Norwegian Sea in 2009. (Source: Vinnichenko *et al.,* 2010 WD).**

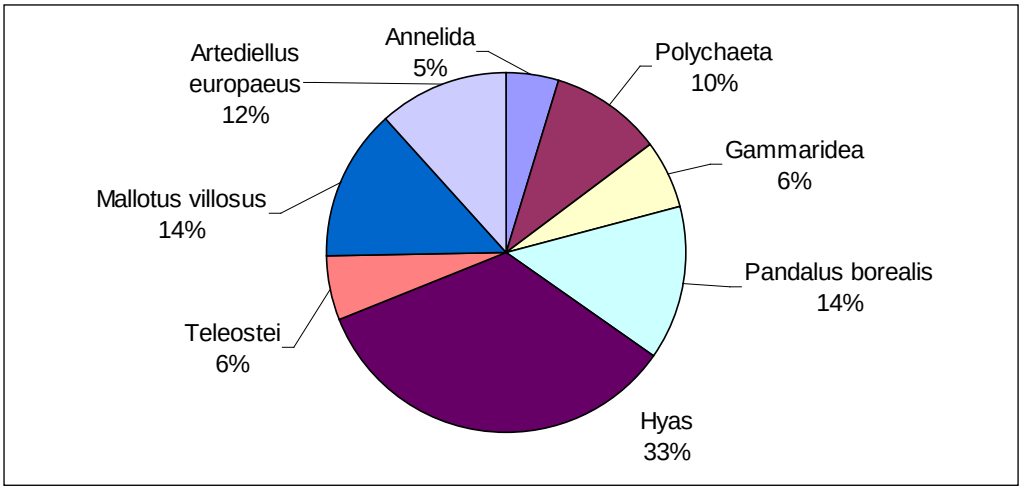



**Figure 14.7. Demersal elasmobranchs in the Norwegian Sea. Food composition of *A. radiata* in the Norwegian Sea in November 2009 (% by weight; N=11 stomachs, 9.0 % empty stomachs). (Source: Vinnichenko *et al.*, 2010 WD).**

# 15 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel

## 15.1 Ecoregion and stock boundaries

In the North Sea about ten skate and ray species occur as well as seven demersal shark species. Thornback ray *Raja clavata* is probably the most important ray for the commercial fisheries. Preliminary assessments for this species were presented in ICES, 2005 and ICES, 2007, based on research vessel surveys. WGEF is still concerned over the possibility of misidentifications of skates in some of the recent IBTS surveys, especially between *R. clavata* and starry ray (or thorny skate) *Amblyraja radiata*.

*R. clavata* in the Greater Thames Estuary (southern part of ICES Division IVc) are known to move into the eastern English Channel (VIId). For most other demersal species/stocks in the North Sea ecoregion the stock boundaries are not well known. The stocks of cuckoo ray *Leucoraja naevus*, spotted ray *R. montagui*, *R. clavata* and lesser-spotted dogfish *Scyliorhinus canicula* probably continue into the waters west of Scotland (and for *R. montagui* and lesser-spotted dogfish also into the eastern English Channel). The stock boundary of the common skate *Dipturus batis* complex is likely to continue to the west of Scotland and into the Norwegian Sea, but most specimens from this ecoregion are likely to be *Dipturus intermedia*, although the presence and extent of *Dipturus batis* (cf. *flossada*) in this region are unknown. Blonde ray *R. brachyura* has a patchy distribution in the southern and northwestern North Sea.

## 15.2 The fishery

### 15.2.1 History of the fishery

Demersal elasmobranchs are caught as a bycatch in the mixed demersal fisheries for roundfish and flatfish. A few inshore vessels target skates and rays with tanglenets and longlines. For a description of the demersal fisheries see the Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES, 2009b) and the report of the DELASS project (Heessen, 2003).

The 25% bycatch ratio brought in by the EC (see also Section 15.2.4) has restrained some fisheries and may have resulted in misreporting since 2007, both of area and species composition.

### 15.2.2 The fishery in 2012

Landings tables for the relevant species are provided in Tables 15.1–15.8. The landings generally peaked in the middle of the 1980s and declined steadily thereafter in the North Sea. A similar trend as observed for Area VIId although an increase was observed since 2005.

### 15.2.3 CES Advice applicable

In 2012 ICES provided advice on the overall exploitation (landings and discards) of the ray and skates species assemblage, and also on individual species for 2013 and 2014. Individual advice has been given for each of the main stocks, on the basis of ICES approach to data-limited stocks. However, ICES does not advice that individual TACs be established for each species at present because the catch statistics for individual species are not reliable. The advice states no targeted fishery for *R. undulata* and *D. batis* complex should be allowed, and measures should be taken to minimize

bycatch. A zero catch was advised for *S. squatina*. Furthermore, based on ICES approach to data-limited stocks, ICES advised that catches could be increased by a maximum of 20% for *R. clavata*, *R. montagui, L. naevus* and *S. canicula* and catches should be reduced by at least 20% for *R. brachyura* and *Raja microocellata*, For *A. radiata* ICES advises catches should be reduced by 36%. For the other species found in this region (*Dipturus linteus, Dipturus nidarosiensis, Dipturus oxyrhincus, Leucoraja circularis,* and *Leucoraja fullonica*) ICES advises that catches should be reduced by at least 20%.

In 2010 ICES provided advice for 2011 and 2012 for these stocks, stating that "No targeted fishery for *R. undulata* and *D. batis* complex should be permitted". Again, zero catch was advised for angel shark *Squatina squatina*. *Status quo* catch was advised for spotted ray *R. montagui*, starry ray *A. radiata*, cuckoo ray *L. naevus*, thornback ray *R. clavata* in Divisions IVc and VIId and lesser spotted dogfish *S. canicula*. For thornback ray *R. clavata* in Divisions IVa, b ICES stated "Reduce catch from recent level". No advice was given for blonde ray *R. brachyura*.

In 2008 ICES provided advice for 2009 and 2010 for skates and rays, stating that "Target fisheries for common skate *D. batis* and undulate ray *R. undulata* should not be permitted, and measures should be taken to minimize bycatch". Furthermore, no fisheries should be permitted for angel shark *Squatina squatina*. *Status quo* catch was advised for spotted ray *R. montagui*, starry ray *A. radiata*, cuckoo ray *L. naevus*, thornback ray *R. clavata* in division IVc and lesser-spotted dogfish *S. canicula*. No advice was given for blonde ray *R. brachyura*, and thornback ray *R. clavata* in Division IVa, b.

#### 15.2.3.1 State of the stocks

In the absence of defined reference points, the status of the stocks of demersal skates and rays and demersal sharks cannot be assessed. Therefore, a qualitative summary of the general status of the major species based on surveys and landings is given. It should be noted that this perception (from 2012) has not changed compared with previous reports of WGEF:

*D. batis complex*; is depleted. It was formerly widely distributed over much of the North Sea but is now found only rarely, and only in the northern North Sea. The distribution extends into the west of Scotland and the Norwegian Sea.

Thornback ray *R. clavata*; distribution area and abundance have decreased over the past century, with the stock concentrated in the southwestern North Sea where it is the main commercial skate species. Its distribution extends into the eastern Channel. Survey catch trends in Division IVc and VIId have been stable/increasing in recent years. The status of *R. clavata* in Divisions IVa, b is uncertain.

Spotted ray *R. montagui*; stable/increasing. The area occupied has fluctuated without trend. Abundance in the North Sea is increasing since 2000, in the eastern Channel a slight increase can be observed during recent years.

Starry ray *A. radiate*; stable. Survey catch rates increased from the early 1970s to the early 1990s and have decreased slightly since then.

Cuckoo ray *L. naevus*; stable. Since 1990 the area occupied has fluctuated without trend. Abundance has decreased since the early 1990s, but has been stable in recent years.

Blonde ray *R. brachyura*; uncertain. This species has a patchy occurrence in the North Sea. It is at the edge of its distributional range in this area.

Undulate ray *R. undulata*; uncertain, reason for concern. Mainly limited to Division VIId where it merges with Division VIIe. Occasional vagrants in Division IVc. The biology of the species gives rise to concern. It has a patchy and localized distribution (where it can be locally abundant), possibly forming discrete stocks which make this species sensitive to local depletion. Additionally, the species disappeared from the English beam trawl survey in Division VIId in 2006–2007 but was caught again in 2008 and 2009.

Lesser-spotted dogfish *S. canicula*; abundance increasing in IV and Division VIId, area occupied in IV is increasing.

Angel shark *S. squatina*; is extirpated in the North Sea. It may still occur in Division VIId.

### 15.2.4 Management applicable

In 1999 the EC first introduced a common TAC for "skates and rays". From 2008 onwards the EC has obliged member states to provide species-specific landings data for the major North Sea species: *R. clavata, R. montagui, R. brachyura*, *L. naevus, A. radiata* and *D. batis* complex. WGEF is of the opinion that this measure is ultimately expected to improve our understanding of the skate fisheries in the area.

The TAC for skates and rays for 2013 for the different parts of the area was: 1256 t for IIa and IV, 798 t for VIId and 52 t for IIIa. The TAC does not apply for *D. batis*, for *R. undulata* and for *R. clavata* from area IIIa. "When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid a safe release of the species".

| Year | TAC | Landings |
|---|---|---|
| 1999 | 6060 | 3997 |
| 2000 | 6060 | 3992 |
| 2001 | 4848 | 4011 |
| 2002 | 4848 | 3904 |
| 2003 | 4121 | 3797 |
| 2004 | 3503 | 3237 |
| 2005 | 3220 | 3030 |
| 2006 | 2737 | 2845 |
| 2007 | 2190 [1)] | 3141 |
| 2008 | 1643 [2)] | 3025 |
| 2009 | 2755 [3)] | 3192 |
| 2010 | 2342 [4)] | 2951 |
| 2011 | 2342 [4)] | 2672 |
| 2012 | 2340 [5)] | 2776 |
| 2013 | 2106 [6)] | |

**[1)] Considered as bycatch quota. These species shall not comprise more than 25% by live weight of the catch retained on board.**

**[2)] Catches of Cuckoo ray (*Leucoraja naevus*), Thornback ray (*Raja clavata*), Blonde ray (*Raja brachyura*), Spotted ray (*Raja montagui*), Starry ray (*Amblyraja radiata*) and Common skate (*Dipturus batis*) shall be reported separately.**

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

**[4] This includes a shared TAC of 1397 t for Areas IIa and IV; a TAC of 887 t for VIId and a TAC of 58 t for IIIa.**

**[5] This includes a shared TAC of 1395 t for Areas IIa and IV; a TAC of 887 t for VIId and a TAC of 58 t for IIIa.**

**[6] This includes a shared TAC of 1256 t for Areas IIa and IV; a TAC of 798 t for VIId and a TAC of 52 t for IIIa.**

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

Since 2009, Norway has a discards ban that applies to skates and sharks, as well as other fish, in the Norwegian Economic Zone. However, discarding of skates is likely to have continued, although the precise quantity is unknown.

## 15.3 Catch data

### 15.3.1 Landings

The landings tables for all skates and rays combined (Tables 15.1–15.4) were updated. Since 2008, EC member states are required to provide species-specific landings data for the main species of rays and skates (Tables 15.5–15.7). Landings data of lesser-spotted dogfish is presented in Table 15.8.

Figure 15.1 shows the total international landings of rays and skates from IIIa and IV combined, and VIId since 1973, plus the TAC for recent years. Data from 1973 onwards are WG estimates. Figure 15.2 shows the landings by country for the whole North Sea ecoregion.

### 15.3.2 Discard data

Information on discards in the different demersal fisheries is being collected by several countries.

Length–frequency distributions of discarded and retained elasmobranchs, covering the period from 1998–2006, were provided by UK (England) and illustrated in ICES, 2006, with updated information provided in Ellis *et al*. (2010a).

Silva *et al*. (2012) investigated the UK skate catches including from the North Sea, and using observer data, discussed discarding patterns. The discarding patterns found that in general, the main commercial skate species were retained from 27–34 cm total length, and 50% retention occurred at 49–51 cm. Nearly all skates were retained at >60 cm total length. *Amblyraja radiata* was generally discarded across the entire length range (12–69 cm).

### 15.3.3 Quality of the catch data

In 2008 the EC asked Member States to start reporting their landings of skates and rays by (major) species. Official species-specific landings should therefore be available for four years now; however compliance with this varies from 0–100% by region and country (see Section 15.4.1). The quality of the species-specific data is discussed in Section 15.4.2.

Several nations have market sampling and discard observer programmes that can also provide information on the species composition, although comparable information is lacking for earlier periods.

## 15.4 Commercial landings composition

### 15.4.1 Species and size composition

From 2008 onwards all countries are obliged to register species-specific landings. In the past, only France and Sweden provided landings data by species based on information from logbooks and auction. However, the accuracy of these data was doubtful. The landings for each country have been analysed to determine the percentage of landings that have been reported to species-specific level. It can be seen that this percentage varies between regions and countries (Tables 15.5–15.7). Belgium, France, the Netherlands, UK(E,W&NI) and UK(Scotland) demonstrate a consistent high level of species-specific declaration for Areas IV and VIId; in 2012 they declared 86%, 66.2%, 98.3%, 98.5% and 73.6% of their landings in Area IV up to species level respectively, and 87.4%, 82.1%, 81.8%, 98.2% and 100% of their landings in Area VIId up to species level respectively (Tables 15.6–15.7). Sweden mainly landed rays and skates from Area IIIa; 100% of the landings were declared up to species level. Denmark, Germany and Norway (Areas IIIa, IV) did not declare any landings to species level (Tables 15.5–15.6). However, the Norwegian Reference Fleet do provide some information on species composition, but this cannot be regarded as representative of the whole Norwegian fishery.

The species composition (percentage) for landings by the Dutch beam trawl fleet based on market sampling for 2000–2007 is presented in Table 15.9. Table 15.10 gives length compositions of these landings. Figures 15.3–15.4 show the length–frequency of sampled Dutch ray and shark (lesser-spotted dogfish) landings in 2012.

There are no specific effort data for North Sea skates.

### 15.4.2 Quality of data

The WG is of the opinion that analyses of data from market sampling and observer programmes can provide reliable data on the recent species composition of landings and discards.

From 2008 onwards improved species-specific landings are available. Such data can be compared with market sampling and observer programmes to determine whether species identification has occurred correctly. The market sampling programme of the Dutch beam trawl fishery from 2000–2007 demonstrates that *R. montagui* and *R. clavata* are the most common species landed, followed by *R. brachyura* (Table 15.9). Since the species-specific landings data were available (from 2008 onwards), it appears that the percentage of *R. brachyura* has decreased in the Dutch landings (Table 15.6; ICES, 2009a; ICES, 2010; ICES, 2011a; ICES, 2012) compared with 2000–2007. It is likely that misidentification has occurred (especially between *R. montagui* and *R. brachyura*). This probably affects most nations reporting these two species.

Landings of *Rostroraja alba* and *R. microocellata* as reported by France in ICES Area IV, *A. hyperborea* as reported by France in ICES Areas IV and VIId, and *D. oxyrinchus* as reported by the UK (England) in ICES Area VIId are likely the result of misidentification or incorrect use of species codes. Furthermore, landings of *L. circularis* reported by Belgium in ICES Area VIId are unlikely and could possibly have been *R. microocellata*, as both species are sometime known locally as 'sandy ray'. Very low landings (39 kg) of *Rostroraja alba* were reported by UK (England) in ICES Areas IV and VIId, but the accuracy of this species identification remains unclear.

These examples demonstrate that more robust protocols for ensuring correct identification are still needed, both at sea and in the market. The species-specific landings data also demonstrate that some nations still report a considerable proportion of unidentified ray and skate landings or do not report species-specific landing data at all.

In 1981 France reported exceptionally high landings for IV and VIId. This is likely to be caused by misreporting. Misreporting may also have taken place in 2007 as a consequence of limited quota and the 25% bycatch limitation.

## 15.5 Commercial catch-effort data

There are no effort data specifically for North Sea skates and rays.

## 15.6 Fishery-independent surveys

Time-series of the most relevant species, based on North Sea IBTS surveys for the years 1977–2012, are shown in Figure 15.5. In addition, stock summary sheets were made for these species for the years 1977–2011 (Figures 15.6–15.15). These summary sheets also provide information on the mean, maximum and minimum length per year. Data were extracted from the DATRAS database.

### 15.6.1 International Bottom Trawl Survey North Sea Q1 (IBTS-Q1) and Q3 (IBTS-Q3)

Fishery-independent data are available from the International Bottom Trawl Survey (IBTS), in winter and summer, and from different beam trawl surveys (in summer). An overview of North Sea elasmobranchs based on survey data was presented in Daan *et al.*, 2005. Distribution maps are provided in ICES, 2005 and ICES, 2006.

Daan *et al.*, 2005 also analysed the time-series of abundance for the major species caught for the period 1977–2004 (see Figure 12.3 of ICES, 2006). Lesser-spotted dogfish has increased markedly. *A. radiata* appears to have increased from the late seventies to the early eighties, followed by a decline. The same pattern also seems to apply to *L. naevus* and *R. montagui*. *D. batis* demonstrated an overall decline, supporting the findings of ICES, 2006. *R. clavata* has largely remained stable in recent years, with one outlier in 1991 owing to a single exceptionally large catch (confirmed record).

In 2007 two methods, the GAM method and SPANdex modelling methods, were undertaken to examine the changes in abundance and spatial variation in the more commonly occurring skate species in the North Sea. Both methods are explained briefly in Sections 15.8.1 and 15.8.2. A further detailed explanation on these analyses can be found in ICES, 2007.

### 15.6.2 Channel groundfish survey

Martin *et al.*, 2005 analysed data from the Channel Groundfish Survey (CGFS) and the Eastern Channel Beam Trawl Survey (UK (BTS-Q3)) for the years 1989–2004. Migratory patterns related to spawning and nursery areas are demonstrated. An apparent trend for lesser-spotted dogfish distribution to be increasing towards the Straits of Dover and into the North Sea was evident, whereas the SE English coast is an important habitat for *R. clavata*. Updated analyses for this survey were recently published by Martin *et al*. (2010, 2012). CGFS continued in 2012, where high indices were registered for *R. clavata* and *R. undulata*.

### 15.6.3 Beam trawl surveys

The UK (BTS-Q3) started in the late 1980s, although the survey grid was not standardized until 1993. The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in relatively shallow water. Lesser-spotted dogfish, *R. brachyura*, *R. clavata*, *R. montagui* and *R. undulata* are all sampled during this survey. For a description of the survey see Ellis *et al*., 2005, Parker-Humphreys, 2005 and Ellis (WD2010-16).

Catch rates ($n.h^{-1}$) for this survey were updated, with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least 16 times during the 19 year time-series (1993–2011; Figures 15.16–15.21). For lesser spotted dogfish mainly adults are being caught, whereas for the other species the catches mostly consist of juvenile fish, which is likely to be an effect of the shallow area covered in this survey and that the gear is less effective for larger elasmobranchs.

Although *R. brachyura* have generally increased over the period, catch rates for this species are low and variable. Catch rates for *R. montagui* have declined in recent years. Given that this survey generally catches juveniles of these species, it is unclear as to whether there are identification issues involved in these contrasting trends. *R. clavata* have broadly increased over the period, though the greatest catches and increase is from stations in IVc. Over the entire time-series, there have been a limited number of stations fished routinely in this division, although an increased number of sampling stations have been fished in recent years, and these data should be examined in future studies. Only small numbers of *R. undulata* are captured in this survey (VIId is the eastern part of their geographic range). The species was absent in 2006 and 2007 but was caught again in the following years.

Distribution plots for six selected ray species: *R. brachyura*, *L. naevus*, *L. microocellata*, *R. montagui*, *R. clavata*, *and R. undulata* based on international offshore BTS data of 1996, 2000, 2005 and 2010 are presented in Figures 15.22–15.25 (see also ICES, 2011b).

## 15.7 Life-history information

Elasmobranchs are not routinely aged, although techniques for ageing are available (e.g. Walker, 1999; Serra-Pereira *et al.,* 2005). Limited numbers of some species have been aged in special studies.

Some information on maturity-at-length exists and should be combined for different countries, to maximize the sample sizes. Updated length–weight and length-at-maturity conversion factors are available for nine skate species (McCully *et al*., 2012). Three of which have conversion factors specific to the North Sea ecoregion, with the lengths at maturity for both sexes of *L. naevus*, and female *R. clavata*, being significantly smaller in the North Sea than the Celtic Seas ecoregion.

Demographic modelling requires more accurate life-history parameters, in terms of age–length keys and fecundity. For example, recent studies of the numbers of egg-cases laid by captive female *R. clavata* were 38–66 eggs over the course of the egg-laying season (Ellis, unpublished), whereas other studies using oocyte counts and the proportion of females carrying eggs have suggested that the fecundity may be >100.

### 15.7.1 Ecologically important habitats

Ecologically important habitats for the demersal elasmobranchs would include (a) any oviposition (egg-laying) sites for oviparous species; (b) pupping grounds for

viviparous species; (c) nursery grounds; (d) habitats of the rarer species, as well as other sites where there can be large aggregations (e.g. for mating or feeding).

Little is known about the presence of egg-laying and pupping grounds.

Trawl surveys could usefully provide information on catches of (viable) skate egg-cases. This recommendation has therefore been put into the offshore and inshore manuals of the trawl surveys (ICES, 2011b). The Netherlands already collects data on viable elasmobranch egg cases.

Surveys may be able to provide information on the locations of nursery grounds and other juvenile habitats, and these should be further investigated to identify sites where there are large numbers of 0-groups and where these life-history stages are found on a regular basis.

Little is known about the habitats of the rarer elasmobranch species, and further investigations on these are required (e.g. Martin *et al*., 2010, 2012; Ellis *et al*., 2012).

### 15.7.2 Recruitment

No information is available on recruitment, although parts of the southern North Sea (e.g. the Thames area) are known to have large numbers of juveniles (Ellis *et al.*, 2005).

## 15.8 Exploratory assessment models

Given the lack of longer term species-specific data from commercial fleets and limited biological information the status of North Sea demersal elasmobranchs has been evaluated from analyses of survey data, including historical information.

### 15.8.1 GAM analyses of survey trends

The GAM analysis focused on the most abundant species caught in the IBTS-Q1 across this ecoregion: *R. clavata*, *L. naevus*, *A. radiata* and lesser-spotted dogfish. Only 'filtered' IBTS-Q1 data (see ICES, 2007) were used and, as haul and depth data were not available at the WG, the model effects were year and statistical rectangle only.

The results of the fitted GAMs differ per species. For *R. clavata* the fitted GAM demonstrates an increase through the 1980s, followed by a decline to the mid-1990s then a subsequent increase (Figure 15.26). Catch rates are estimated to be highest across a small number of statistical rectangles in the southwestern North Sea specifically those around the Thames estuary and the Wash. The fitted GAMs of the *L. naevus*, *A. radiata* and the lesser-spotted dogfish also demonstrate some fluctuations over the 25-year period (Figures 15.27–15.29). In recent years the fitted GAMs for the *A. radiata* decreased, for the lesser-spotted dogfish increased and for the *L. naevus* stabilized. The highest catch rates of these species are found in the central North Sea, the western North Sea and off the east coast of Scotland respectively and further around Orkney and Shetland.

Further exploration of these survey data (in terms of individual model fit, residual patterns, interaction terms, etc.) was not as thorough as would be ideal. However, general trends in estimated year effect appeared to be relatively robust to distributional assumptions although the actual magnitude of fluctuations in year effect and smoothness of the function were less so. Additionally, the consistency of spatial effects between years was not explored.

### 15.8.2 Estimation of abundance and spatial analysis–application of the SPANdex method

In 2007 the SPANdex approach was used to examine changes in abundance and distribution of four more common skate species in the North Sea (*A. radiata, L. naveus, R. clavata* and *R. montagui*).

Density surfaces (distribution based strata) were created using potential mapping in SPANS (Anon., 2003). Quarter 1 catch rate data from the North Sea IBTS survey (IBTS-Q1) employing a GOV demersal trawl, from 1980 to 2006 were used for the analysis.

The distribution maps of all four skate species (*A. radiata, L. naveus, R. clavata* and *R. montagui*) demonstrated that the species have been restricted to the consistent areas (Figures 15.30–15.33). The area occupied (AO) changes over time (Figure 15.34). Overall, it is clear from this study that AO may not reflect population changes and should therefore be used with caution when being used as metric for population status.

### 15.8.3 Previous assessments of *R. clavata*

Under the DELASS project (Heessen, 2003), various analyses of survey data were conducted (ICES, 2002). The high frequency of zero catches in combination with a few, in some cases, high catches were analysed statistically using a two-stage model approach. First, the probability of getting a catch with at least one *R. clavata* was made using a GLM with a binomial distribution and a logit link function. Non-zero catches were then modelled using a Gamma distribution and a log link function.

ICES, 2002 concluded that "The North Sea stock of thornback ray has steadily declined since the start of the 20th century. One hundred years ago, the distribution area of the stock included almost the whole North Sea. Today, survey data demonstrate a concentration in the southwest North Sea (from the Thames Estuary to the Wash), and this reduced distribution area is confirmed by the steep decrease in the probability of a catch including thornback ray estimated by statistical models. Apparently, there are still patches left in the North Sea with stable local populations. Whether these areas are self-sustaining and whether the number of patches will remain high enough for a sustained North Sea population is, however, unknown."

ICES, 2005 subsequently undertook GIS analyses of survey data, and these studies also suggested that the stock was concentrated in the southwestern North Sea (see Sections 10.5 and 10.8 of ICES, 2005) and the stock area had declined.

From comparisons of recent survey data with data for the early 1900s it can be seen that, in the first decade of the 20th century, *R. clavata* was widely distributed over the southern North Sea, with centres of abundance in the southwestern North Sea and in the German Bight, north of Helgoland. The area over which the species is distributed in recent years is much smaller than 100 years ago. The species has disappeared from the southeastern North Sea (German Bight), and catches in the Southern Bight have become limited to the western part only (see also ICES, 2002).

## 15.9 Quality of assessments

Analyses of survey data for *R. clavata* undertaken by ICES in 2002 and 2005 (ICES, 2002 and 2005) may have been compromised by misidentifications in submitted IBTS data, and so the extent of the decline in distribution reported in these reports may be exaggerated. The distribution of *R. clavata* in the southern North Sea has certainly

contracted to the southwestern North Sea, and they are now rare in the southeastern North Sea, where they previously occurred (as indicated by historical surveys). The perceived decline in catches in the northeastern North Sea may have been based, at least in part, on catches of *A. radiata*. Excluding questionable records from analyses still indicates that the area occupied by *R. clavata* has declined, with the stock concentrated in the southwestern North Sea, with catch trends in IVc more stable/increasing in recent times (ICES, 2007).

## 15.10 Reference points

No reference points have been proposed for *R. clavata* or other elasmobranch stocks in this ecoregion.

## 15.11 Conservation considerations

*Squatina squatina* is considered by IUCN as critically endangered, and considered as extirpated in the North Sea by WGEF. Also *Dipturus batis* complex is considered critically endangered by IUCN. OSPAR has listed *Squatina squatina*, *Dipturus batis*, *Raja montagui*, and *Raja clavata*.

In 2008 angel shark was added to the Wildlife and Countryside act in the United Kingdom, and is protected under legislation in inshore waters.

In Sweden a number of demersal and deep-water elasmobranchs are contained in the Swedish Red List: velvet belly *Etmopterus spinax*, Greenland shark *Somniosus microcephalus*, *D. batis*, *D. linteus*, *R. clavata,* and rabbit fish *Chimaera monstrosa*. In the updated Red List from 2010 *D. batis* is considered regionally extirpated. Furthermore, fishing for and landing of lesser-spotted dogfish, *R. clavata* and *D. batis* is prohibited since 2004 and rays and skates should be landed whole for easier identification since 2008. However, there is no good field identification guide for skates and rays occurring in Swedish waters which makes it likely that a lot of species-specific data are missing.

In Norway a number of demersal elasmobranchs are listed on the Norwegian Red List (2010) including various skates: *D. batis* (complex) is considered critically endangered and *B. spinicauda*, *D. nidarosiensis* and *L. fullonica* are considered near threatened.

## 15.12 Management considerations

Demersal elasmobranchs are usually caught in mixed fisheries for demersal teleosts, although some inshore longline and gillnet fisheries target *R. clavata* in seasonal fisheries in the southwestern North Sea. Up to 2008 they have traditionally been landed and reported in mixed categories such as "skates and rays" and "sharks". For assessment purposes species-specific landings data are essential. Some doubts exist as to the quality of the data provided. Particularly the distinction between *R. montagui* and *R. brachyura* may need to be improved. Further sampling of commercial catches to validate species-specific landings is therefore required.

Since a TAC was introduced for North Sea "skates and rays" in 1999 it has generally been higher than the landings (Figure 15.1), although landings have been at or above the TAC since 2006 and may have become restrictive for some fisheries. Since its introduction the TAC has gradually been reduced. In 2009–2013 there were three separate TACs for Areas IIa and IV combined, for IIIa and for VIId.

Since 2006, landings consistently exceed current TACs, and if fishers do not change, their practices must either lead to an increase of discarding and/or to misreporting. WGEF therefore stated in its 2008 Report that "the current TAC should not be reduced any further at this time".

Discard survivorship could be high for inshore trawlers in the SW North Sea, as tow duration tends to be relatively short and line fisheries should also have a high discard survival (Ellis *et al*., 2008a, b). Discard survival from gillnet catches will likely be affected by soak-time. Discard survival from offshore fleets is unknown. The survival of *S. canicula* is considered high (Revill *et al*., 2005).

From 2008 onwards, species-specific landings data for the major skate species have been required. Information on the catches of the next couple of years should demonstrate what effect the low TAC will have on the fisheries.

As a consequence of effort restrictions and high fuel prices, effort may divert to small inshore fisheries that may target skates. The main areas of *R. clavata* occur in the Thames estuary and the Wash in the southwestern North Sea.

The TAC for "skates and rays" should only apply to Areas IIIa, IV and VIId and not to IIa because only a part of IIa belongs to the present North Sea ecoregion.

Technical interactions of fisheries in this ecoregion are demonstrated in Table 15.11.

## 15.13 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., Silva, J.F., McCully, S.R., Evans, M. and Catchpole, T. 2010a. UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10.

Ellis, J.R., Burt, G.J. and Cox, L.P.N. 2008a. Thames ray tagging and survival. Cefas Fisheries Science Partnership 2007/2008, Programme 19, Final Report, 54 pp.

Ellis, J.R., Burt, G.J., Cox, L.P.N., Kulka, D.W, and Payne, A.I.L. 2008b. The status and management of thornback ray *Raja clavata* in the southwestern North Sea. ICES CM 2008/K:13, 45 pp.

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

Ellis, J.R., McCully, S.R. and Brown, M.J. 2012. An overview of the biology and status of undulate ray *Raja undulata*. Journal of Fish Biology, 80: 1057–1074.

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. 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 Elasmobranch Fishes. ICES CM 2007/ACFM:27.

ICES. 2008. Demersal Elasmobranchs in the North Sea (Subarea IV), Skagerrak (Division IIIa), and eastern English Channel (Division VIId). ICES Advice 2008, Book 6, Section 6.4.30, 201–205.

ICES. 2009a. Report of the Joint meeting between ICES Working Group on Elasmobranch Fishes (WGEF) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009.ACOM:16. 422 pp.

ICES. 2009b. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak-Combined Spring and Autumn (WGNSSK). ICES CM 2009\ACOM:10.

ICES. 2010. Report of the Working Group on Elasmobranch Fishes (WGEF), 22–29 June 2010, Horta, Portugal. ICES CM 2010/ACOM:19. 519 pp.

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

ICES. 2011b. Report of the Working Group on Beam Trawl Surveys (WGBEAM). ICES CM 2011/SSGESST:14.

ICES. 2012. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–26 June 2012, Lisbon, Portugal. ICES CM 2012/ACOM:19. 551 pp.

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.

Martin C.S., Vaz, S., Ellis, J.R., Coppin, F., Le Roy, D. and Carpentier, A. 2010. Spatio-temporal patterns of demersal elasmobranchs in trawl surveys in the eastern English Channel (1988–2008). Marine Ecology Progress Series, 417: 211–228.

Martin, C.S., Vaz, S., Ellis, J.R., Lauria, V., Coppin, F., and Carpentier, A. 2012. Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. Journal of Experimental Marine Biology and Ecology, 418/419: 91–103.

McCully, S. R., Scott, F., and Ellis, J. R. 2012. Lengths-at-maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES Journal of Marine Science, 69: 1812–1822.

Parker-Humphreys, M. 2005. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Eastern English Channel (ICES Division VIId) and the southern North Sea (ICES Division IVc) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 124, 92 pp.

Revill, A., Dulvy, N. K. and Holst, R. 2005. The survival of discarded lesser-spotted dogfish (*Scyliorhinus canicula*) in the western English Channel beam trawl fishery. Fisheries Research, 71: 121–124.

Serra-Pereira, B., Figueiredo, I., Bordalo-Machado, P., Farias, I., Moura, T., and Serrano Gordo, L. 2005. Age and growth of *Raja clavata* Linnaeus, 1758-evaluation of ageing precision using different types of caudal denticles. ICES CM 2005/N:17.

Silva, J. F., Ellis, J. R and Catchpole, T. L. 2012. Species composition of skates (Rajidae) in commercial fisheries around the British Isles and their discarding patterns. Journal of Fish Biology, 80(5): 1678-1703.

Walker, P. A. 1999. Fleeting images: Dynamics of North Sea Ray populations. PhD Thesis, University of Amsterdam, the Netherlands, 145 pp.

**Table 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division IIIa. "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 |
| Denmark | 11 | 41 | 56 | 22 | 36 | 129 | 65 | 26 | 8 | 5 | 12 | 12 | 44 | 16 |
| Germany | . | . | . | . | . | . | . | 1 | . | . | . | . | + | + |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | . | . | + | . | . | . | . | . |
| Norway | 208 | 123 | 154 | 159 | 163 | 85 | 94 | 51 | 13 | 23 | 33 | 24 | 25 | 28 |
| Sweden | 2 | 2 | 12 | 13 | 9 | 20 | 10 | 18 | 11 | 6 | 2 | 10 | 3 | 3 |
| UK (E, W_& NI) | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Total of submitted data | 221 | 166 | 222 | 194 | 208 | 234 | 169 | 95 | 32 | 34 | 47 | 45 | 72 | 47 |

**Table 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea IV. Note that "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 336 | 332 | 370 | 436 | 323 | 276 | 327 | 350 | 272 | 371 | 299 | 294 | 231 | 183 |
| Denmark | 45 | 93 | 65 | 34 | 33 | 25 | 23 | 26 | 27 | 23 | 29 | 30 | 38 | 20 |
| Faroe Islands | . | . | . | . | . | . | . | . | . | . | . | n.a. | n.a. | n.a. |
| France | 41 | 31 | 61 | 62 | 36 | 37 | 34 | 15 | 56 | 69 | 74 | 89 | 57 | 47 |
| Germany | 16 | 23 | 11 | 22 | 21 | 17 | 29 | 16 | 17 | 30 | 21 | 32 | 19 | 17 |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | n.a. | . |
| Ireland | . | . | . | . | . | . | . | . | 119 | . | . | . | . | . |
| Netherlands | 515 | 693 | 834 | 805 | 686 | 561 | 680 | 603 | 721 | 564 | 379 | 390 | 212 | 431 |
| Norway | 152 | 161 | 173 | 83 | 113 | 77 | 87 | 96 | 71 | 97 | 119 | 105 | 56 | 69 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | n.a. | n.a. |
| Sweden | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| UK (E, W_& NI) | 618 | 516 | 476 | 500 | 537 | 550 | 434 | 348 | 329 | 392 | 348 | 372 | 413 | 356 |
| UK (Scotland) | 965 | 860 | 822 | 853 | 741 | 512 | 404 | 374 | 331 | 343 | 311 | 289 | 358 | 305 |
| Total of submitted data | 2688 | 2709 | 2812 | 2794 | 2490 | 2055 | 2018 | 1801 | 1944 | 1889 | 1580 | 1602 | 1383 | 1429 |

**Table 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division VIId. "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 93 | 69 | 79 | 113 | 153 | 96 | 94 | 109 | 164 | 174 | 125 | 111 | 103 | 105 |
| France | 558 | 693 | 729 | 725 | 796 | 695 | 602 | 687 | 792 | 710 | 1270 | 1043 | 954 | 1010 |
| Germany | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| Ireland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | . | 13 | 21 | 13 | 10 | 11 | 12 | 14 |
| Spain | . | . | . | . | . | . | . | . | . | . | . | . | 0 | .* |
| UK (E, W_& NI) | 437 | 355 | 169 | 140 | 186 | 157 | 147 | 139 | 188 | 199 | 152 | 133 | 141 | 166 |
| UK (Scotland) | . | . | . | . | . | . | . | 2 | . | 6 | 8 | 5 | 6 | 4 |
| Total of submitted data | 1088 | 1117 | 977 | 978 | 1135 | 948 | 843 | 948 | 1165 | 1102 | 1564 | 1303 | 1217 | 1300 |

***includes Basque country landings.**

**Table 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in the North Seas ecoregion (IIIa, IV, VIId). "." indicates zero landings, "+" indicates landings <0.5 and "n.a." indicates not available.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 429 | 401 | 449 | 548 | 476 | 372 | 422 | 459 | 436 | 545 | 424 | 405 | 334 | 288 |
| Denmark | 56 | 134 | 121 | 56 | 69 | 154 | 88 | 52 | 35 | 28 | 41 | 42 | 81 | 36 |
| Faroe Islands | . | . | . | . | . | . | . | . | . | . | . | n.a. | n.a. | n.a. |
| France | 599 | 724 | 790 | 725 | 796 | 732 | 636 | 701 | 848 | 779 | 1344 | 1132 | 1011 | 1057 |
| Germany | 16 | 23 | 11 | 22 | 21 | 17 | 29 | 17 | 17 | 30 | 21 | 32 | 19 | 17 |
| Iceland | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Ireland | . | . | . | . | . | . | . | . | 119 | . | . | . | . | . |
| Netherlands | 515 | 693 | 834 | 805 | 686 | 561 | 680 | 615 | 742 | 577 | 389 | 401 | 224 | 446 |
| Norway | 360 | 284 | 327 | 242 | 276 | 162 | 181 | 120 | 84 | 120 | 152 | 129 | 81 | 97 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | n.a. | n.a. |
| Spain | . | . | . | . | . | . | . | . | . | . | . | . | . | .* |
| Sweden | 2 | 2 | 12 | 13 | 9 | 20 | 10 | 18 | 11 | 6 | 2 | 10 | 4 | 3 |
| UK (E&W and NI) | 1055 | 871 | 645 | 640 | 723 | 707 | 580 | 487 | 517 | 591 | 500 | 504 | 555 | 522 |
| UK (Scotland) | 965 | 860 | 822 | 853 | 741 | 512 | 404 | 375 | 331 | 349 | 320 | 295 | 365 | 310 |
| Total of submitted data | 3997 | 3992 | 4011 | 3904 | 3797 | 3237 | 3030 | 2845 | 3141 | 3025 | 3192 | 2951 | 2672 | 2776 |

***includes Basque country landings.**

**Table 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Division IIIa in 2012.**

| Area IIIa | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| BELGIUM | *Raja brachyura* | < 0.1 | 7.7% | 80.0% |
| | *Raja clavata* | < 0.1 | 1.9% | 20.0% |
| | Skates and rays | < 0.1 | 90.4% | |
| | Total: | 0.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 9.6% | |
| DENMARK | Skates and rays | 16.4 | 100.0% | |
| | Total: | 16.4 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0% | |
| NORWAY | Skates and rays | 28.0 | 100.0% | |
| | Total: | 28.0 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0% | |
| SWEDEN | *Dipturus batis* | 1.4 | 47.0% | 47.0% |
| | *Dipturus linteus* | 1.5 | 52.9% | 52.9% |
| | *Raja clavata* | < 0.1 | 0.2% | 0.2% |
| | Total: | 2.9 | 100.0% | |
| Percent of catch as species-specific landings: | | | 100% | |
| GERMANY | Skates and rays | 0.1 | 100.0% | |
| | Total: | 0.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0% | |

**Table 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Subarea IV in 2012.**

| Area IV | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| BELGIUM | *Raja brachyura* | 58.0 | 31.7% | 36.7% |
| | *Leucoraja naevus* | 1.0 | 0.6% | 0.6% |
| | *Leucoraja circularis* | 0.1 | 0.0% | 0.0% |
| | *Raja montagui* | 9.2 | 5.0% | 5.8% |
| | *Raja clavata* | 89.8 | 49.0% | 56.8% |
| | Skates and rays | 25.0 | 13.7% | |
| | Total: | 183.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 86% | |
| DENMARK | Rajidae | 19.9 | 100.0% | |
| | Total: | 19.9 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0% | |
| FRANCE | *Rostroraja alba* | 1.1 | 2.4% | 3.6% |
| | *Raja brachyura* | 0.4 | 0.9% | 1.4% |
| | *Raja clavata* | 28.4 | 61.1% | 92.3% |
| | *Leucoraja fullonica* | 0.0 | 0.1% | 0.1% |
| | *Amblyraja hyperborea* | 0.1 | 0.2% | 0.3% |
| | *Raja microocellata* | 0.0 | 0.0% | 0.0% |
| | *Raja montagui* | 0.2 | 0.4% | 0.6% |
| | *Leucoraja naevus* | 0.5 | 1.1% | 1.6% |
| | *Raja undulata* | 0.0 | 0.0% | 0.0% |
| | Skates and rays | 16.4 | 33.8% | |
| | Total: | 47.2 | 100.0% | |
| Percent of catch as species-specific landings: | | | 65.3% | |
| GERMANY | Skates and rays | 16.9 | 100.0% | |
| | Total: | 16.9 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0% | |
| NETHERLANDS | *Dipturus batis* | 2.4 | 0.6% | 0.6% |
| | *Leucoraja naevus* | 8.5 | 2.0% | 2.0% |
| | *Raja brachyura* | 58.4 | 13.5% | 13.8% |
| | *Raja clavata* | 175.1 | 40.6% | 41.3% |
| | *Raja montagui* | 179.7 | 41.6% | 42.4% |
| | Skates and rays | 7.4 | 1.7% | |
| | Total: | 431.5 | 100.0% | |
| Percent of catch as species-specific landings: | | | 98.3% | |

**Table 15.6. Continued.**

| Area IV | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| NORWAY | Skates and rays | 69.1 | 100.0% | |
| | Total: | 69.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 0.0% | |
| SWEDEN | *Dipturus batis* | <0.1 | 67.4% | 67.4% |
| | *Dipturus linteus* | <0.1 | 32.6% | 32.6% |
| | Total: | 0.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 100.0% | |
| UK (E,W and NI) | *Amblyraja radiata* | 0.1 | 0.0% | 0.0% |
| | *Dasyatis pastinaca* | 0.0 | 0.0% | 0.0% |
| | *Dipturus batis* | 0.2 | 0.1% | 0.1% |
| | *Leucoraja naevus* | 2.1 | 0.6% | 0.6% |
| | *Raja brachyura* | 14.3 | 4.0% | 4.1% |
| | *Raja clavata* | 316.2 | 88.9% | 90.2% |
| | *Raja microocellata* | 0.0 | 0.0% | 0.0% |
| | *Raja montagui* | 17.6 | 5.0% | 5.0% |
| | *Rostroraja alba* | 0.0 | 0.0% | 0.0% |
| | Skates and rays | 5.2 | 1.5% | |
| | Total: | 355.8 | 100.0% | |
| Percent of catch as species-specific landings: | | | 98.5% | |
| UK (Scotland) | *Dipturus batis* | 0.7 | 0.2% | 0.3% |
| | *Dipturus oxyrinchus* | 1.1 | 0.3% | 0.5% |
| | *Leucoraja circularis* | 2.0 | 0.6% | 0.9% |
| | *Leucoraja fullonica* | 3.2 | 1.0% | 1.4% |
| | *Leucoraja naevus* | 119.8 | 39.2% | 53.3% |
| | *Raja brachyura* | 0.0 | 0.0% | 0.0% |
| | *Raja clavata* | 39.9 | 13.1% | 17.8% |
| | *Raja montagui* | 58.1 | 19.0% | 25.8% |
| | Skates and rays | 80.7 | 26.4% | |
| | Total: | 305.4 | 100.0% | |
| Percent of catch as species-specific landings: | | | 73.6% | |

**Table 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Species-specific landings and species composition of skates (Rajidae) from ICES Division VIId in 2012.**

| Area VIId | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| BELGIUM | *Raja brachyura* | 25.0 | 23.8% | 27.2% |
| | *Leucoraja naevus* | 0.4 | 0.4% | 0.4% |
| | *Leucoraja circularis* | 2.7 | 2.6% | 3.0% |
| | *Raja montagui* | 1.2 | 1.1% | 1.3% |
| | *Raja clavata* | 62.6 | 59.6% | 68.2% |
| | Skates and rays | 13.2 | 12.6% | |
| | Total: | 105.1 | 100.0% | |
| Percent of catch as species-specific landings: | | | 87.4% | |
| FRANCE | *Rostroraja alba* | 8.9 | 0.9% | 1.1% |
| | *Raja brachyura* | 21.6 | 2.2% | 2.7% |
| | *Raja circularis* | 1.0 | 0.1% | 0.1% |
| | *Raja clavata* | 694.9 | 71.0% | 86.5% |
| | *Leucoraja fullonica* | 1.1 | 0.1% | 0.1% |
| | *Amblyraja hyperborea* | 0.7 | 0.1% | 0.1% |
| | *Raja microocellata* | 7.2 | 0.7% | 0.9% |
| | *Raja montagui* | 25.1 | 2.6% | 3.1% |
| | *Leucoraja naevus* | 38.5 | 3.9% | 4.8% |
| | *Dipturus oxyrinchus* | 0.5 | 0.0% | 0.1% |
| | *Raja undulata* | 3.9 | 0.4% | 0.5% |
| | Skates and rays | 219.5 | 21.7% | |
| | Total: | 1009.9 | 100.0% | |
| Percent of catch as species-specific landings: | | | 82.1% | |
| NETHERLANDS | *Raja brachyura* | 0.2 | 1.2% | 1.5% |
| | *Raja clavata* | 11.3 | 78.1% | 95.5% |
| | *Raja montagui* | 0.4 | 2.5% | 3.0% |
| | Skates and rays | 2.6 | 18.2% | |
| | Total: | 14.4 | 100.0% | |
| Percent of catch as species-specific landings: | | | 81.8% | |

**Table 15.7. Continued.**

| Area VIId | Species Categories | Weight (t) | % of national catch | % excluding generic categories |
|---|---|---|---|---|
| UK (E,W and NI) | *Amblyraja radiata* | 0.0 | 0.0% | 0.0% |
| | *Dipturus batis* | 0.2 | 0.1% | 0.1% |
| | *Dipturus oxyrinchus* | 0.1 | 0.1% | 0.1% |
| | *Leucoraja circularis* | 0.0 | 0.0% | 0.0% |
| | *Leucoraja naevus* | 0.0 | 0.0% | 0.0% |
| | *Raja brachyura* | 36.7 | 22.1% | 22.5% |
| | *Raja clavata* | 117.9 | 70.9% | 72.2% |
| | *Raja microocellata* | 2.3 | 1.4% | 1.4% |
| | *Raja montagui* | 6.0 | 3.6% | 3.7% |
| | *Rostroraja alba* | 0.0 | 0.0% | 0.0% |
| | Skates and rays | 3.0 | 1.8% | |
| | Total: | 166.2 | 100.0% | |
| Percent of catch as species-specific landings: | | | 98.2% | |
| UK (Scotland) | *Raja clavata* | 0.5 | 11.4% | 11.4% |
| | *Leucoraja fullonica* | 3.9 | 88.6% | 88.6% |
| | Total: | 4.3 | 100.0% | |
| Percent of catch as species-specific landings: | | | 100.0% | |

**Table 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings of *Scyliorhinus canicula* in IIIa, IV and VIId. "n.a." indicates not available.**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 186 | 330 | 235 | 244 | 225 | 238 | 262 | 266 | 336 | 313 | 291 | 309 | 310 |
| France | 1633 | 1811 | 1899 | 1777 | 1472 | 1614 | 1492 | 1459 | 1406 | 1751 | 1999 | 2013 | 1977 |
| Netherlands | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 37 | 37 | 47 | 35 |
| UK (E,W&NI) | n.a. | n.a. | n.a. | 13 | 57 | 92 | 118 | 94 | 102 | 116 | 128 | 176 | 179 |
| UK (Scotland) | . | . | 1 | 5 | 3 | 22 | 6 | 3 [1)] | 2 [1)] | 3 [1)] | 3 [1)] | . | 10 [1)] |

[1)] **Registered as spotted dogfish.**

**Table 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: quantification of species composition (%) for North Sea skates and rays in Dutch beam trawl fishery based on market sampling.**

| Year | *A. radiata* | *L. naevus* | *R. brachyura* | *R. clavata* | *R. montagui* |
|---|---|---|---|---|---|
| 2000 | 0.2 | 0.5 | 19.6 | 38.2 | 41.5 |
| 2001 | 0.2 | 0.5 | 13.8 | 37.7 | 47.8 |
| 2002 | | | 31.1 | 28.1 | 40.8 |
| 2003 | | | 26.9 | 27.0 | 46.1 |
| 2004 | | | 20.7 | 38.7 | 40.6 |
| 2005 | 0.2 | 0.2 | 29.8 | 23.3 | 46.5 |
| 2006 | | | 25.3 | 40.9 | 33.8 |
| 2007 | | | 28.9 | 33.6 | 37.4 |

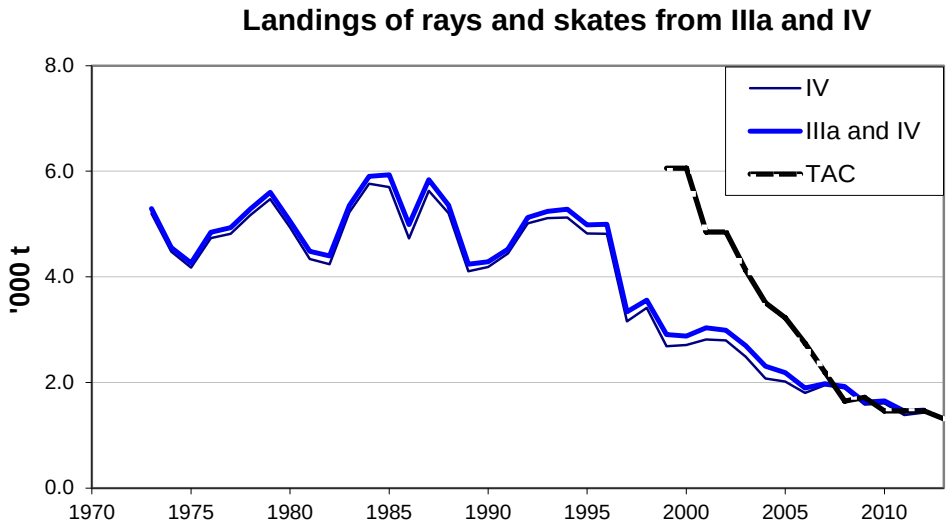
**Table 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: North Sea rays and skates. Length–frequency distributions (numbers in '000).**

Country: the Netherlands
Gear: beam trawl
Category: landings

| | *Raja clavata* | | | | | | *Raja montagui* | | | | | | *Raja brachyura* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| length | 2000 | 2001 | 2005 | 2006 | 2007 | 2008 | 2000 | 2001 | 2005 | 2006 | 2007 | 2008 | 2000 | 2001 | 2005 | 2006 | 2007 | 2008 |
| 25 | | | | | | | | | | | | | | | | | | |
| 30 | 0.6 | 1.9 | 3.0 | 0.3 | 1.0 | 0.5 | 3.5 | 0.5 | 0.9 | 0.5 | | 0.2 | | | | | | |
| 35 | 9.4 | 11.2 | 7.8 | 8.6 | 7.1 | 3.0 | 34.2 | 6.3 | 4.7 | 2.5 | 0.4 | 0.2 | 1.2 | 1.0 | 0.3 | 1.5 | | |
| 40 | 16.8 | 19.9 | 14.2 | 13.4 | 30.5 | 4.0 | 75.6 | 33.5 | 14.0 | 15.8 | 9.7 | 6.3 | 1.2 | 1.5 | 2.1 | 5.5 | 3.8 | |
| 45 | 17.5 | 20.3 | 11.2 | 26.2 | 27.2 | 8.5 | 85.9 | 60.3 | 36.9 | 52.5 | 32.2 | 16.1 | 1.2 | 3.3 | 6.0 | 3.9 | 7.2 | 0.1 |
| 50 | 23.0 | 36.4 | 18.2 | 40.0 | 36.0 | 15.2 | 58.3 | 72.5 | 47.6 | 59.6 | 52.6 | 45.4 | 2.7 | 5.6 | 7.7 | 3.5 | 3.8 | 0.6 |
| 55 | 16.0 | 35.3 | 12.9 | 26.6 | 30.9 | 17.7 | 42.7 | 54.6 | 49.9 | 34.6 | 50.8 | 58.9 | 3.1 | 4.9 | 9.6 | 7.7 | 5.1 | 0.7 |
| 60 | 12.1 | 22.8 | 14.7 | 20.0 | 19.1 | 16.6 | 26.1 | 42.4 | 44.2 | 25.3 | 40.5 | 71.7 | 0.6 | 5.3 | 6.8 | 7.5 | 5.1 | 0.8 |
| 65 | 5.3 | 15.3 | 5.7 | 16.7 | 17.5 | 14.9 | 10.4 | 16.1 | 13.7 | 4.7 | 12.4 | 26.1 | 1.0 | 3.6 | 8.0 | 7.6 | 6.1 | 0.7 |
| 70 | 5.3 | 5.2 | 6.2 | 11.8 | 12.3 | 14.6 | 2.0 | 2.3 | 0.9 | 1.1 | 0.5 | 1.2 | 1.6 | 2.1 | 6.1 | 4.5 | 5.9 | 0.5 |
| 75 | 4.7 | 5.5 | 5.2 | 8.1 | 6.9 | 9.8 | 0.3 | | 0.1 | | | | 1.8 | 2.7 | 3.1 | 5.4 | 6.8 | 0.8 |
| 80 | 3.7 | 3.5 | 2.2 | 3.7 | 5.4 | 5.0 | | | | | | | 1.6 | 1.9 | 4.2 | 5.1 | 8.2 | 0.5 |
| 85 | 3.4 | 2.3 | 1.8 | 1.9 | 1.8 | 2.9 | | | | | | | 1.1 | 1.5 | 3.1 | 2.3 | 6.0 | 0.5 |
| 90 | 1.2 | 0.6 | 0.7 | 0.9 | 1.0 | 0.9 | | | | | | | 0.5 | 1.9 | 2.4 | 2.0 | 2.8 | 0.4 |
| 95 | 0.8 | 0.3 | 0.1 | | 0.1 | 0.4 | | | | | | | 0.1 | 0.6 | 1.6 | 1.2 | 2.6 | 0.2 |
| 100 | | | | | | 0 | | | | | | | 0.1 | | 0.2 | 0.3 | 0.1 | 0.0 |
| 105 | | | | | | | | | | | | | | | 0.3 | | | 0.0 |
| 110 | 0.1 | | | | | | | | | | | | | | | | | |
| sum | 119.8 | 180.5 | 103.9 | 178.2 | 197 | 114.0 | 339.2 | 288.4 | 212.9 | 196.6 | 199.2 | 226.1 | 17.7 | 35.8 | 61.5 | 58.0 | 63.5 | 5.8 |

**Table 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Technical interactions of otter trawl (OT), beam trawl (BT), gillnet (GN), industrial (Ind). It is also recognized that there are interactions between skates and rays with cod fisheries in IVc and VIId.**

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



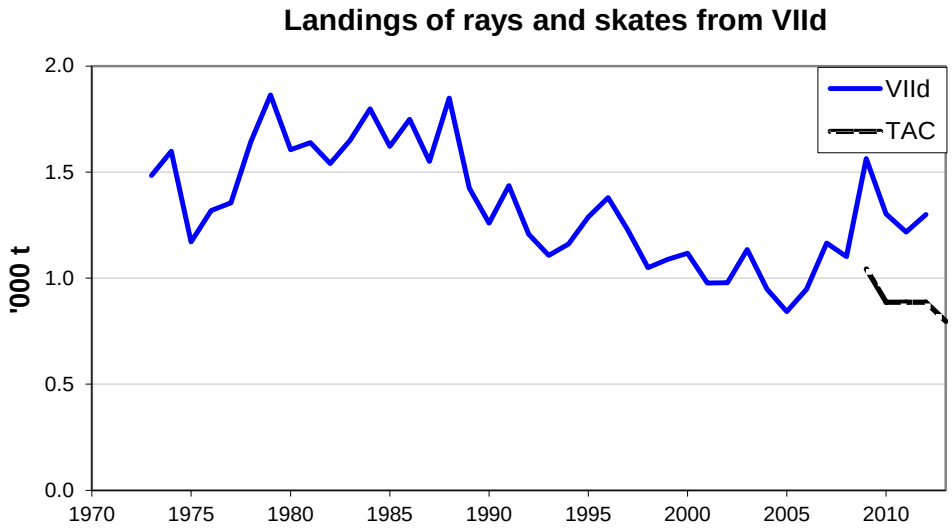




**Figure 15.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel: total international landings of rays and skates in IIIa and IV, and in VIId since 1973, based on WG estimates. TAC for both areas is added. It should be noted that the TAC for Areas IIIa and IV includes a shared TAC for Areas IIa and IV and a TAC for IIIa. The exceptional high value reported by France for 1991 has been omitted from these graphs.**

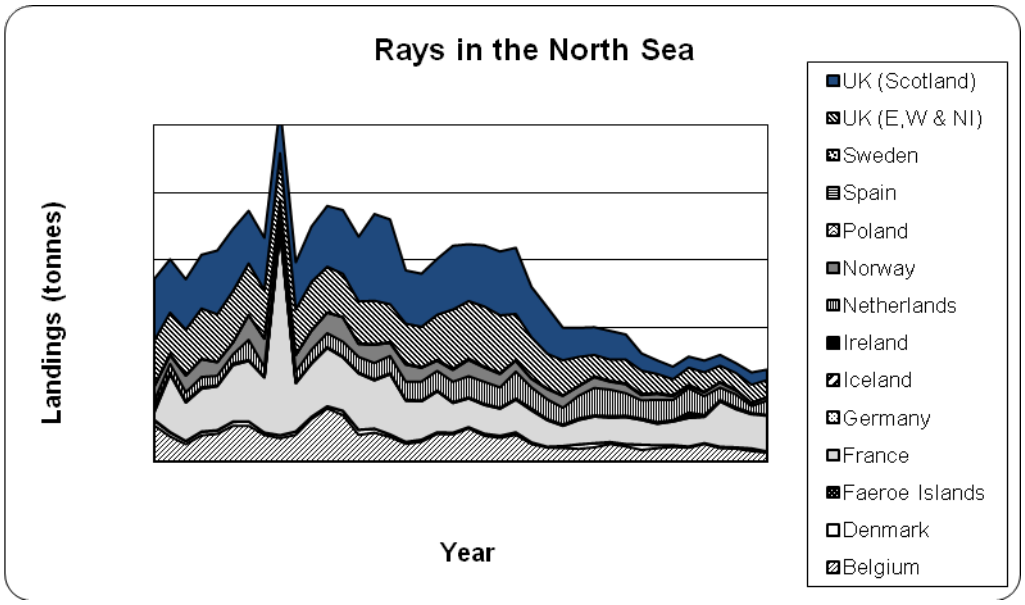



**Figure 15.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings (t) of rays and skates from Skagerrak (IIIa), the North Sea (IV) and the eastern Channel (VIId).**

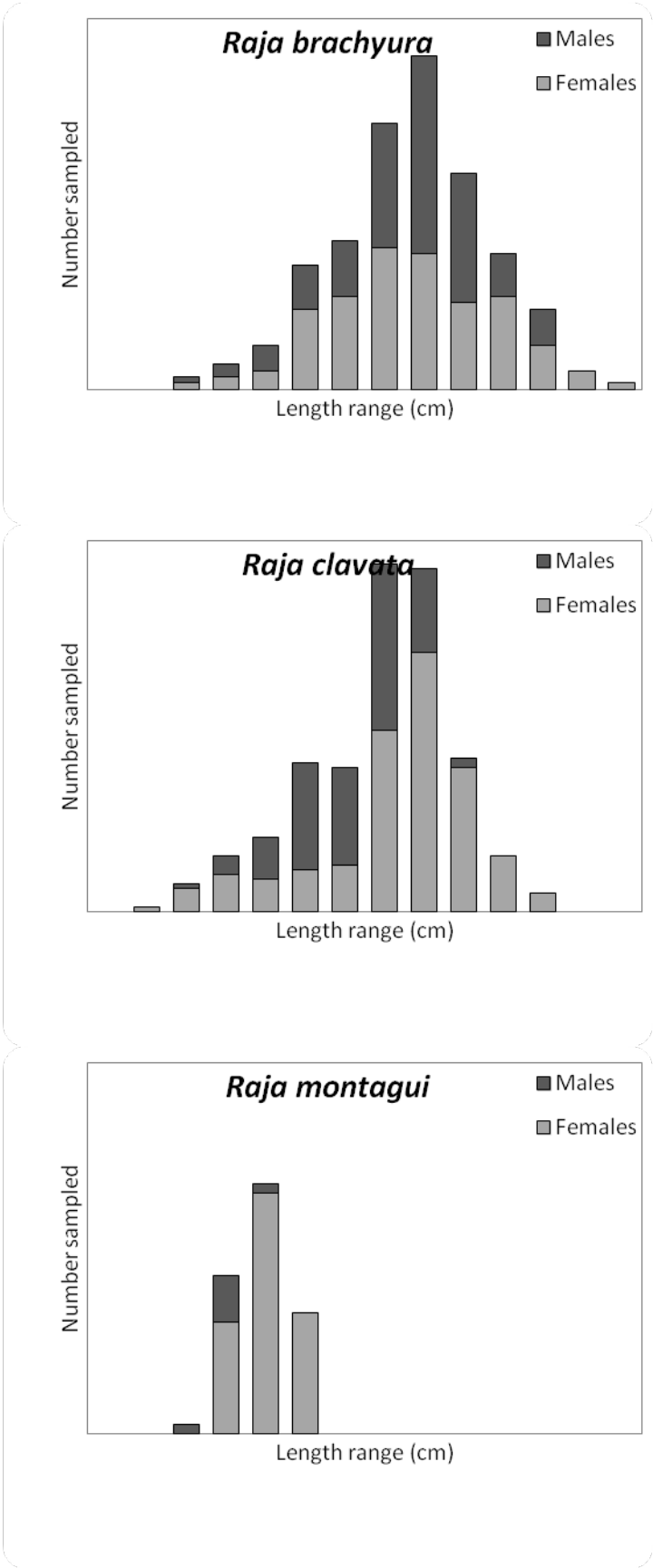



**Figure 15.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length–frequency distribution of the number of *R. brachyura*, *R. clavata* and *R. montagui* individuals measured during the market sampling programme of the Dutch beam trawl fleet in 2012.**

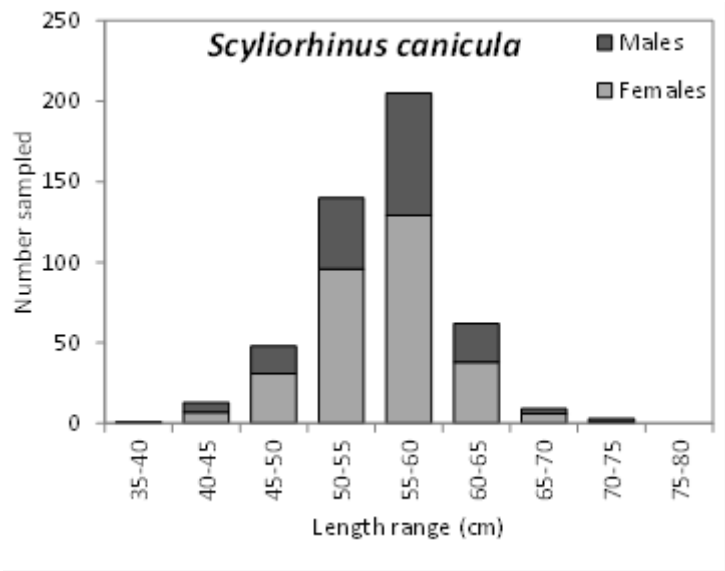



**Figure 15.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length–frequency distribution of the number of *S. canicula* individuals measured during a pilot market sampling programme of the Dutch beam trawl fleet in 2012.**

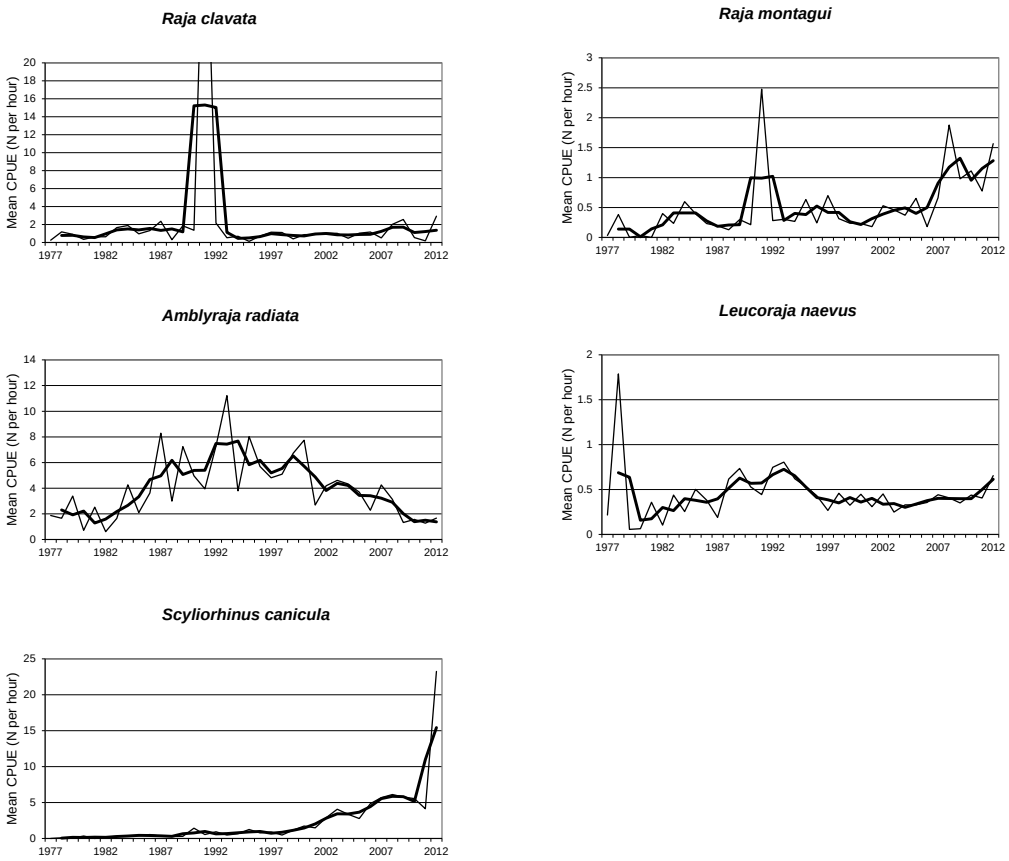


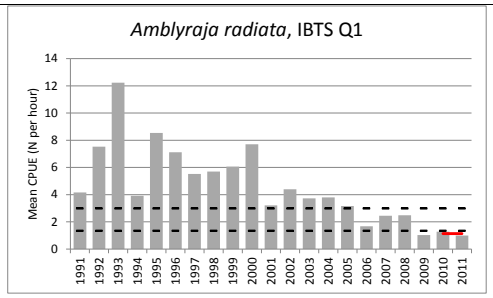

**Figure 15.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average catch (N per hour) and three year running mean during the North Sea IBTS-Q1 in the years 1977–2012 in roundfish Areas 1–7. Data extracted from the DATRAS database (selected for cpue per length per statrec) on 16th June 2013.**

***Amblyraja radiata***

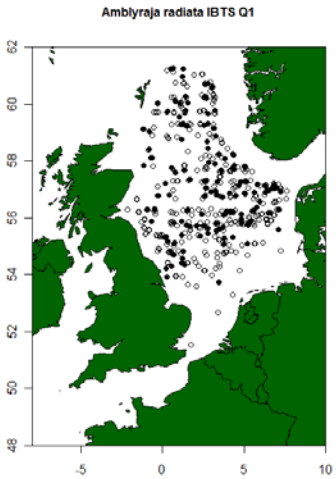
Survey acronym: IBTS Q1
Survey gear: GOV
ICES area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

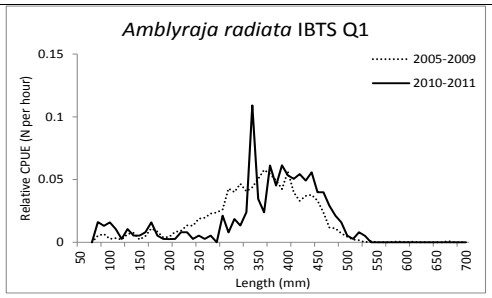
Comments:
- Taxonomic misidentification may occur for this species
- Not commercial species



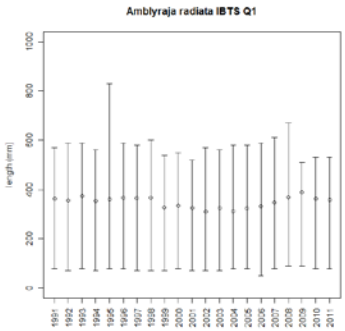

Mean CPUE of IV *Amblyraja radiata*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Amblyraja radiata*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Amblyraja radiata* for the periods 2005-2009, and 2010-2011.




Mean size (open circles) and observed size range of IV *Amblyraja radiata*.

Distribution: The stock is concentrated in areas IVa,b. Connectivity with area IIa. Within the survey *Amblyraja radiata* is found in the central North Sea. There is no evidence of changes in distribution.

Catch rates: The CPUE shows a decrease within the last few years. The mean CPUE for 2010-2011 is just below the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009). The reason for decline is unclear.

Size distribution: The largest individual reported within the period 1991-2011 was 83 cm, while the maximum size for this species is 61 cm (Ellis *et al*., 2005). This is possibly due to misidentification; this specimen could possibly have been *R. clavata*. There is no evidence of changes in the length frequency distribution. The observed mean length has remained stable in the last two decades, while there is a sligth decrease visbile in the observed Lmax in the last three years.

Exploitation: *Amblyraja radiata* is not a commercially exploited species. The status of exploitation is unknown.

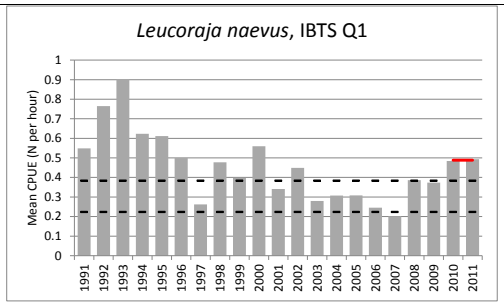
Overall status: The status of the stock is unknown.

**Figure 15.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Amblyraja radiata* based on data from IBTS Q1.**

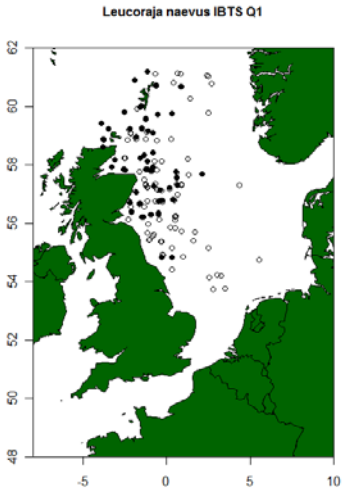
***Leucoraja naevus***

Survey acronym: IBTS Q1
Survey gear: GOV
ICES area: IV

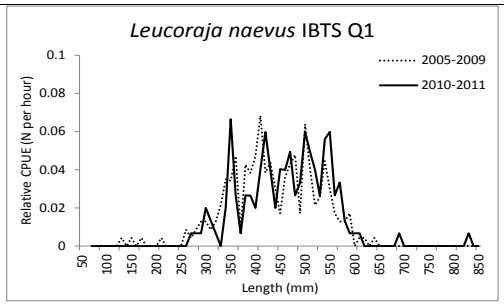
Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).



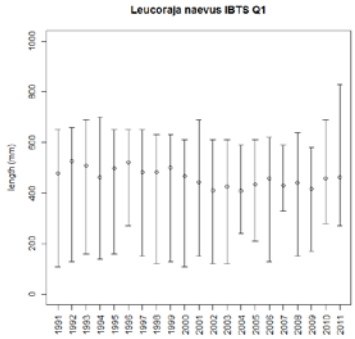

Mean CPUE of IV *Leucoraja naevus*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Leucoraja naevus*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Leucoraja naevus* for the periods 2005-2009, and 2010-2011.




Mean size (open circles) and observed size range of IV *Leucoraja naevus*.

Distribution: The stock is concentrated in areas IVa,b (may extend into VI). Within the survey *Leucoraja naevus* is found in the central western part of the North Sea. There is no evidence for changes in distribution.

Catch rates: The CPUE shows an increase within the last few years. The mean CPUE for 2010-2011 is above the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

Size distribution: The largest individual reported within the period 1991-2011 was 83 cm, while the maximum size for this species is 72 cm (Ellis *et al.*, 2005). There is no evidence of changes in the length frequency distribution. The observed mean length has remained stable over time.

Exploitation: The status of exploitation is unknown.

Overall status: The status of the stock is unknown.

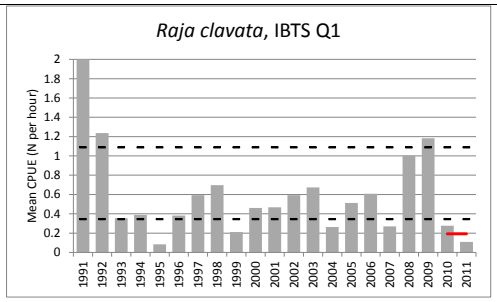
**Figure 15.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Leucoraja naevus* based on data from IBTS Q1.**

***Raja clavata***

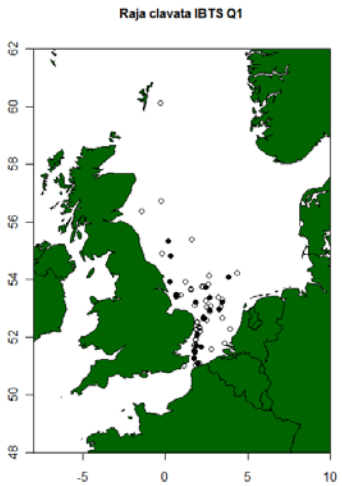
Survey acronym: IBTS Q1
Survey gear: GOV
ICES area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

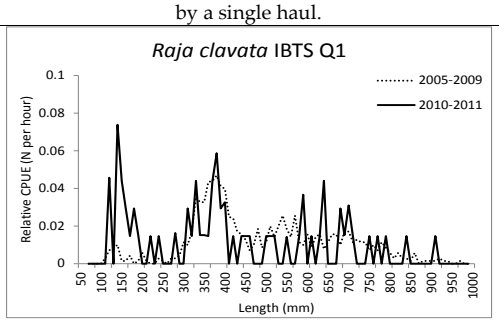
Comment: The English beamtrawl survey is considered to provide more accurate information on this species than the IBTS.



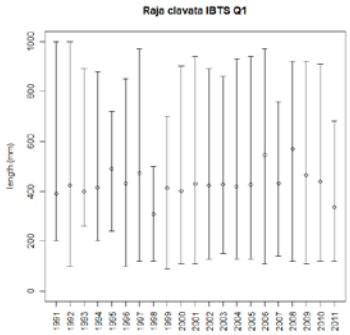

Mean CPUE of IV *Raja clavata*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011. Mean CPUE in 1991 was higher than the range given in this figure. This was caused by a single haul.




Distribution of *Raja clavata*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Raja clavata* for the periods 2005-2009, and 2010-2011.




Mean size (open circles) and observed size range of IV *Raja clavata*.

Distribution: The stock is concentrated in the southwestern North Sea. Its distribution extends to the eastern Channel. The survey does not show evidence for changes in distribution.

Catch rates: The CPUE shows a stable trend in recent years. The mean CPUE for 2010-2011 is outside the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

Size distribution: The largest individual reported within the period 1991-2011 was 100 cm. The maximum size for this species is 110 cm (Ellis *et al*., 2005), with very occassional larger specimens. The observed mean length and lmax fluctuates over time.

Exploitation: The status of exploitation rate is unknown.

Overall status: The status of the stock is unknown.

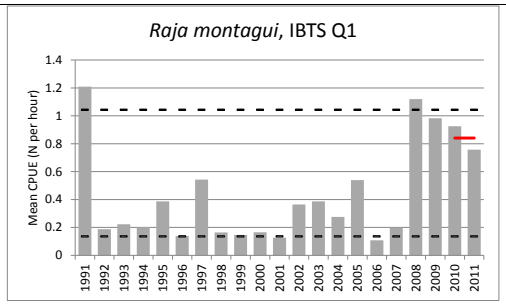
**Figure 15.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja clavata* based on data from IBTS Q1.**

***Raja montagui***

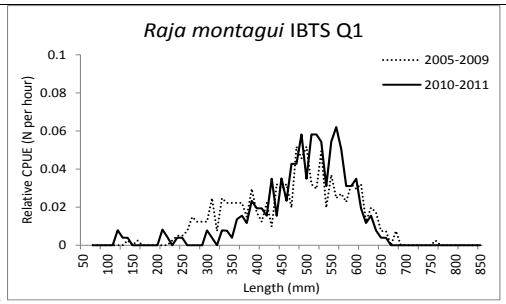
Survey acronym: IBTS Q1
Survey gear: GOV
ICES Area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

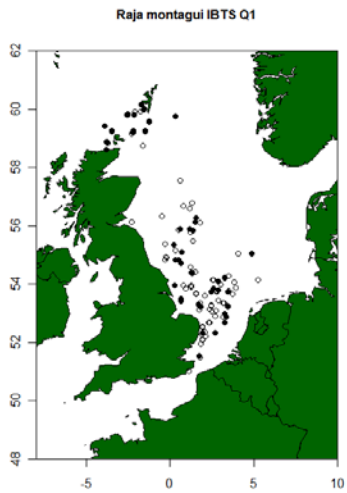
Comments:
- Taxonomic misidentification may occur for this species



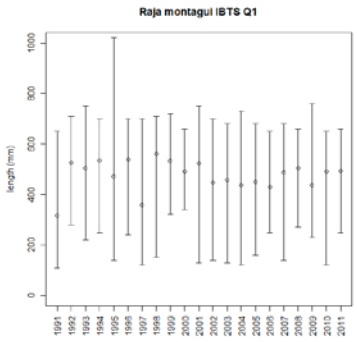

Mean CPUE of IV *Raja montagui.* Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Relative length distribution of IV *Raja montagui* for the periods 2005-2009, and 2010-2011.




Distribution of *Raja montagui*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Mean size (open circles) and observed size range of IV *Raja montagui*.

Distribution: Stock is concentrated in areas IVb,c. However, recent survey data shows that this species is also found in area IVa.

Catch rates: The CPUE has increased in recent years. The mean CPUE for 2010-2011 is within the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

Size distribution: Largest individual reported within the period 1991-2011 was 102 cm, while the maximum size for this species is 72 cm (Ellis *et al.*, 2005). This is possibly due to misidentification; this specimen could possibly have been *R. brachyura*. There is no evidence of changes in the length frequency distribution. The observed mean length shows a slight decrease over time.

Exploitation: The status of exploitation is unknown.

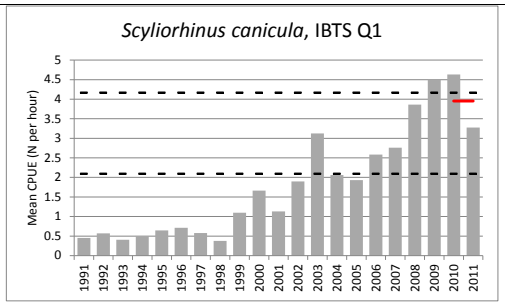
Overall status: The status of the stock is unknown.

**Figure 15.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja montagui* based on data from IBTS Q1.**

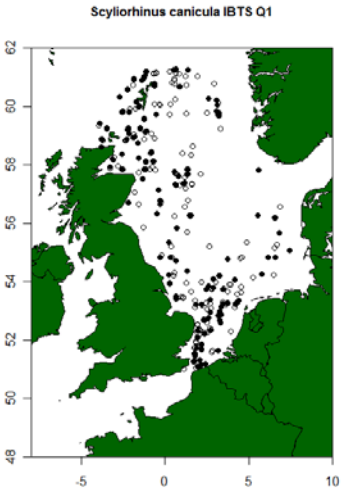
***Scyliorhinus canicula***

Survey acronym: IBTS Q1
Survey gear: GOV
ICES area: IV

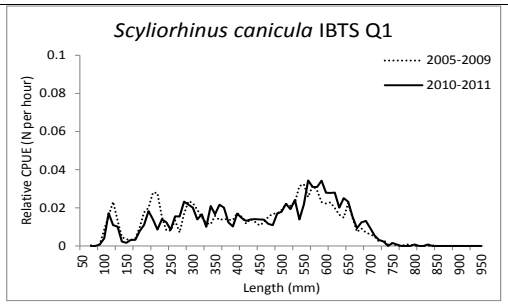
Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).



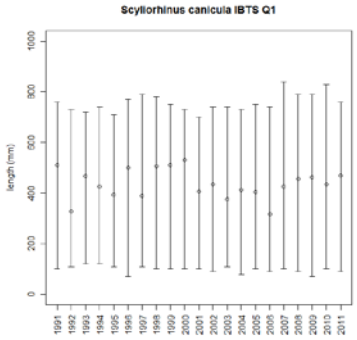

Mean CPUE of IV *Scyliorhinus canicula*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Scyliorhinus canicula*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Scyliorhinus canicula* for the periods 2005-2009, and 2010-2011.




Mean size and observed size range of IV *Scyliorhinus canicula*.

| | |
|---|---|
| Distribution: The stock is concentrated in the North Sea. Its distribution extends to the eastern Channel. The survey does not show evidence for changes in distribution. | ✓ |
| Catch rates: The CPUE is increasing. The mean CPUE for 2010-2011 is within the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009). | ↗ |
| Size distribution: The largest individual reported within the period 1991-2011 was 84 cm, maximum size for this species is 85 cm (Ellis *et al*., 2005). There is no evidence of changes in the length frequency distribution. The observed mean length and lmax fluctuates over time. | ? |
| Exploitation: Based on the survey trends it is considered that current exploitation is appropriate for the stock. | ✓ |
| Overall status: Based on the survey trends the state of the stock is considered increasing. | ✓ |

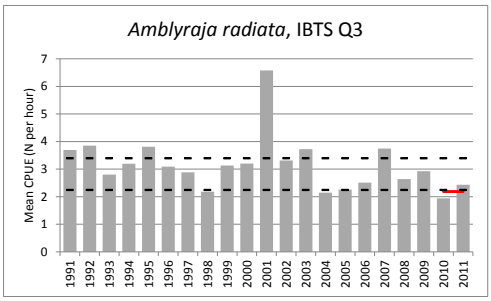
**Figure 15.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Scyliorhinus canicula* based on data from IBTS Q1.**

***Amblyraja radiata***

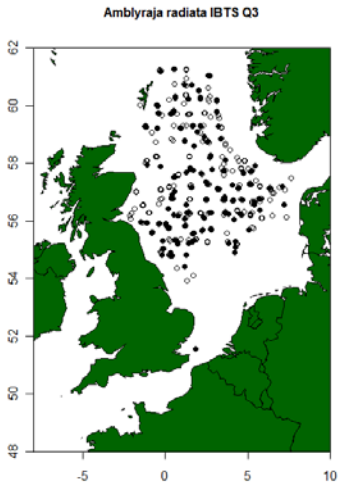
Survey acronym: IBTS Q3
Survey gear: GOV
ICES area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

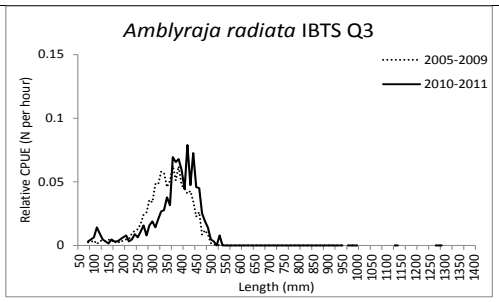
Comments:
- Taxonomic misidentification may occur for this species
- Not commercial species



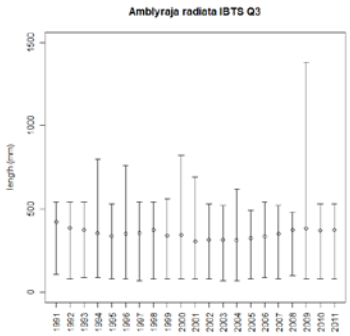

Mean CPUE of IV *Amblyraja radiata.* Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Amblyraja radiata*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Amblyraja radiata* for the periods 2005-2009, and 2010-2011.




Mean size (open circles) and observed size range of IV *Amblyraja radiata*.

Distribution: The stock is concentrated in areas IVa,b. Connectivity with area IIa. Within the survey *Amblyraja radiata* is found in the central North Sea. There is no evidence of changes in distribution.

Catch rates: The CPUE as remained stable within the last few years. The mean CPUE for 2010-2011 is just below the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009). The reason for decline is unclear.

Size distribution: The largest individual reported within the period 1991-2011 was 138 cm, while the maximum size for this species is 61 cm (Ellis *et al.*, 2005). This is possibly due to misidentification; this specimen could possibly have been *R. clavata*. There is no evidence for changes in the length frequency distribution. The observed mean length has remained stable in the last two decades.

Exploitation: *Amblyraja radiata* is not a commercially exploited species. The status of exploitation is unknown.

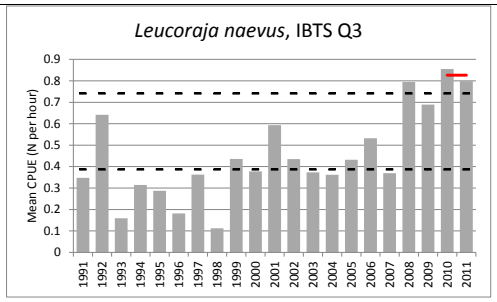
Overall status: The status of the stock is unknown.

**Figure 15.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Amblyraja radiata* based on data from IBTS Q3.**

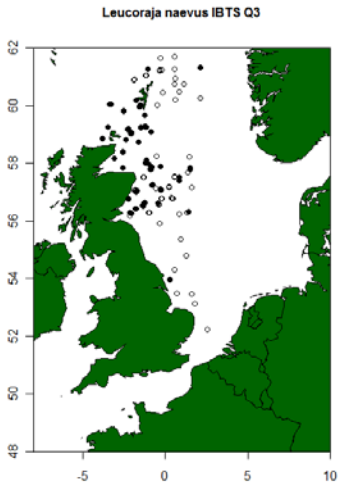
***Leucoraja naevus***

Survey acronym: IBTS Q3
Survey gear: GOV
ICES area: IV

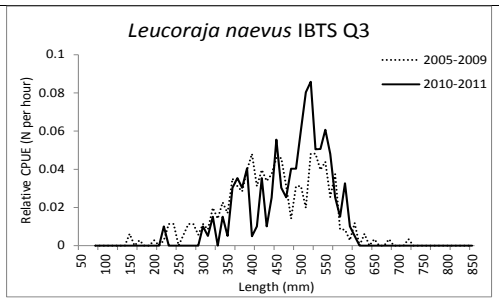
Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).



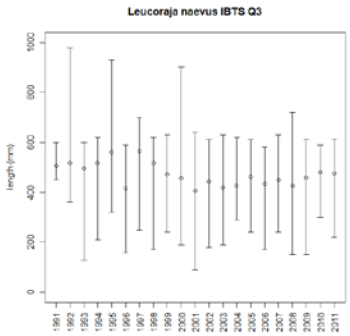

Mean CPUE of IV *Leucoraja naevus*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Leucoraja naevus*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Leucoraja naevus* for the periods 2005-2009, and 2010-2011.




Mean size (open circles) and observed size range of IV *Leucoraja naevus*.

Distribution: The stock is concentrated in areas IVa,b (may extend into VI). Within the survey *Leucoraja naevus* is found in the central western part of the North Sea. The distribution in the last two years appears to be less widely dispersed in comparison with the reference period.

Catch rates: The CPUE shows an increase within the last few years. The mean CPUE for 2010-2011 is above the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

Size distribution: The largest individual reported within the period 1991-2011 was 98 cm, while the maximum size for this species is 72 cm (Ellis *et al.*, 2005). This may be due to misidentification, it may be a measuring error, or a typo when inserting. There is no evidence for changes in the length frequency distribution. The observed mean length fluctuates over time.

Exploitation: The status of exploitation is unknown.

Overall status: The status of the stock is unknown.

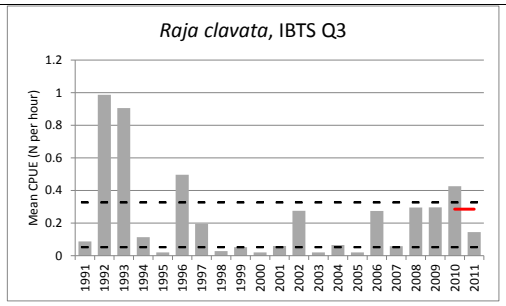
**Figure 15.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Leucoraja naevus* based on data from IBTS Q3.**

***Raja clavata***

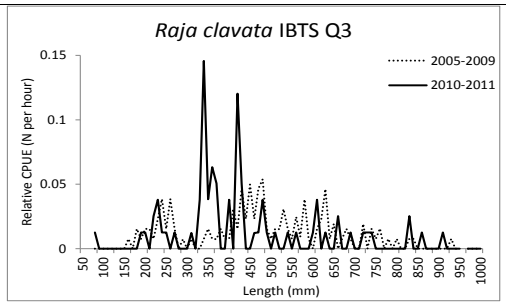
Survey acronym: IBTS Q3
Survey gear: GOV
ICES area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

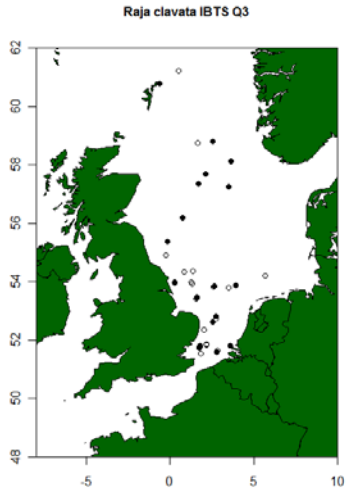
Comment: The English beamtrawl survey is considered to provide more accurate information on this species than the IBTS.



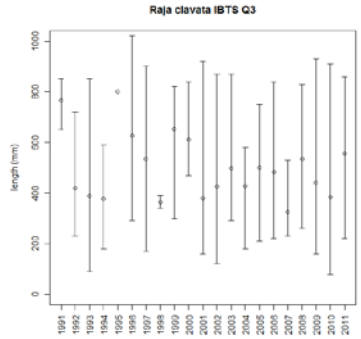

Mean CPUE of IV *Raja clavata*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Relative length distribution of IV *Raja clavata* for the periods 2005-2009, and 2010-2011.




Distribution of *Raja clavata*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Mean size (open circles) and observed size range of IV *Raja clavata*.

| | |
|---|---|
| Distribution: The stock is concentrated in the southwestern North Sea. Its distribution extends to the eastern Channel. There is no evidence of changes in distribution. | ✓ |
| Catch rates: The CPUE shows an increasing trend in recent years. The mean CPUE for 2010-2011 is within the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009). | → |
| Size distribution: The largest individual reported within the period 1991-2011 was 102 cm. The maximum size for this species is 110 cm (Ellis *et al.*, 2005), with very occassional larger specimens. The observed mean length and lmax fluctuates over time. | ? |
| Exploitation: The status of exploitation rate is unknown. | ? |
| Overall status: The status of the stock is unknown. | ? |

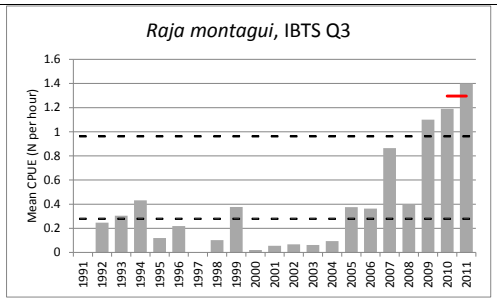
**Figure 15.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja clavata* based on data from IBTS Q3.**

***Raja montagui***

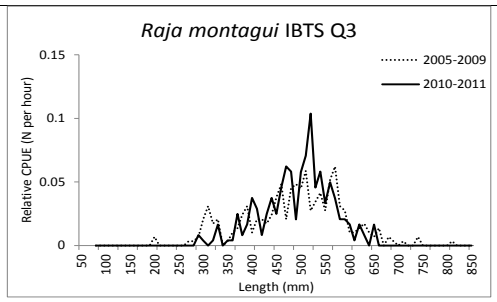
Survey acronym: IBTS Q3
Survey gear: GOV
ICES Area: IV

Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).

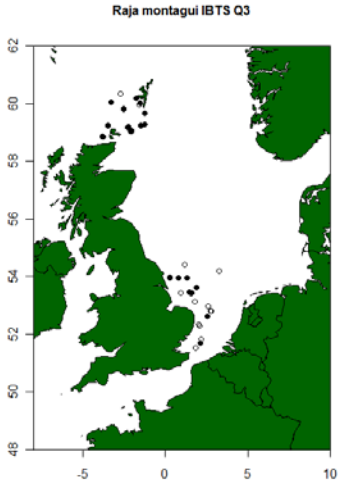
Comments:
- Taxonomic misidentification may occur for this species



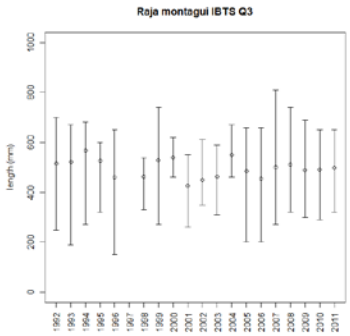

Mean CPUE of IV *Raja montagui*. Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Relative length distribution of IV *Raja montagui* for the periods 2005-2009, and 2010-2011.




Distribution of *Raja montagui*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Mean size (open circles) and observed size range of IV *Raja montagui*.

Distribution: Stock is concentrated in areas IVb,c. However, recent survey data shows that this species is also found in area IVa.

Catch rates: The CPUE has increased in recent years. The mean CPUE for 2010-2011 is above the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

Size distribution: Largest individual reported within the period 1991-2011 was 81 cm, while the maximum size for this species is 72 cm (Ellis *et al*., 2005). This is possibly due to misidentification; this specimen could possibly have been *R. brachyura*. There is no evidence of changes in the length frequency distribution. The observed mean length and lmax fluctuates over time.

Exploitation: The status of exploitation is unknown.

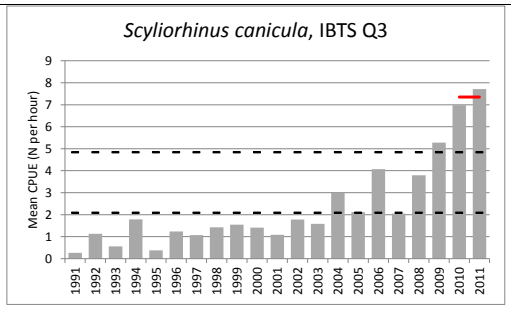
Overall status: The status of the stock is unknown.

**Figure 15.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja montagui* based on data from IBTS Q3.**

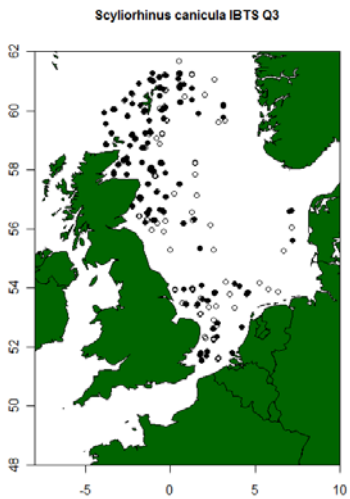
***Scyliorhinus canicula***

Survey acronym: IBTS Q3
Survey gear: GOV
ICES area: IV

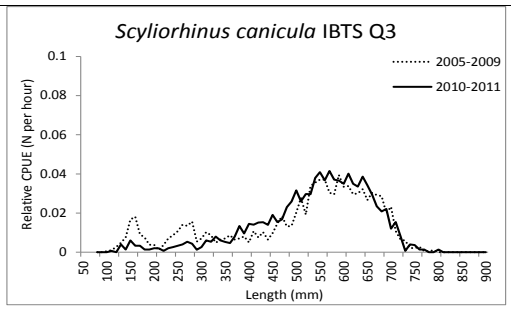
Survey data used: Stations in roundfish areas 1-7. Data extracted from DATRAS database on 22nd June 2012 (Selected for CPUE per length per haul).



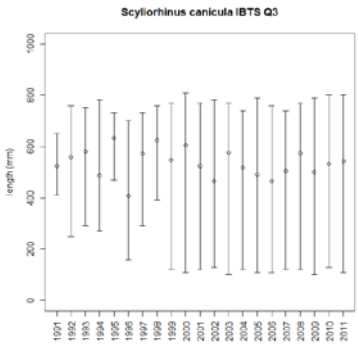

Mean CPUE of IV *Scyliorhinus canicula.* Dashed lines give mean annual cpue +/- stdev for 2005-2009, red line shows mean annual CPUE for 2010-2011.




Distribution of *Scyliorhinus canicula*. Closed circles give presence for 2010-2011, open circles give presence for 2005-2009.




Relative length distribution of IV *Scyliorhinus canicula* for the periods 2005-2009, and 2010-2011.




Mean size and observed size range of IV *Scyliorhinus canicula*.

Distribution: The stock is concentrated in the North Sea. Its distribution extends to the eastern Channel. The survey does not show evidence for changes in distribution.

Catch rates: The CPUE is increasing. The mean CPUE for 2010-2011 is above the range of the reference period (mean annual CPUE ± 1stdev over 2005-2009).

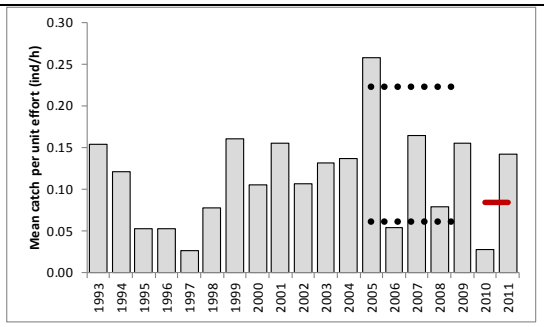
Size distribution: The largest individual reported within the period 1991-2011 was 81 cm, maximum size for this species is 85 cm (Ellis *et al*., 2005). There is no evidence of changes in the length frequency distribution. The observed mean length fluctuates over time.

Exploitation: Based on the survey trends it is considered that current exploitation is appropriate for the stock.

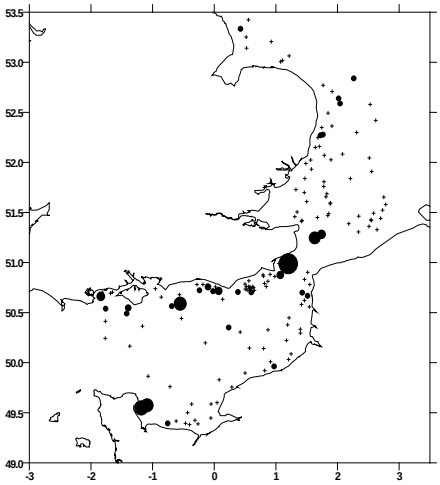
Overall status: Based on the survey trends the state of the stock is considered increasing.

**Figure 15.15. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Scyliorhinus canicula* based on data from IBTS Q3.**

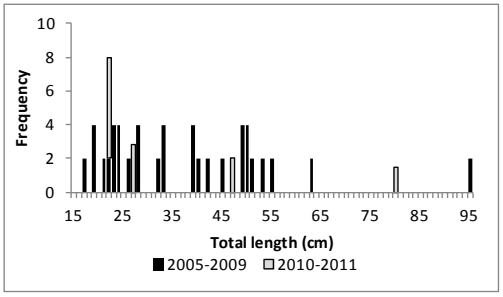
**Species:** ***Raja brachyura***
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Mean CPUE of IVc-VIId *Raja brachyura*. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.




Distribution and relative abundance of *Raja brachyura* in survey area (from Ellis, 2010)

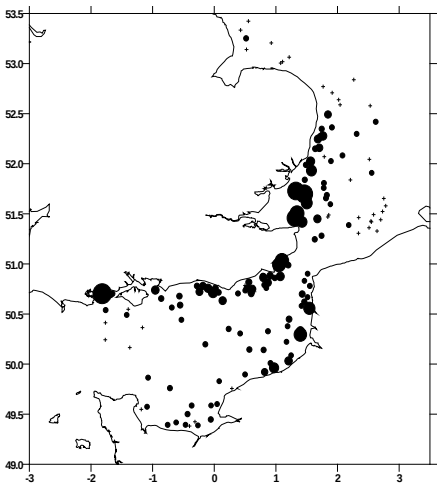



Length distribution of *Raja brachyura* in beam trawl survey for the periods 2005–2009 and 2010–2011

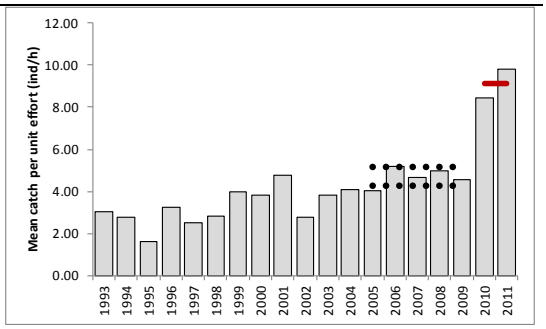
| | |
|---|---|
| Distribution: Captured in coastal waters of the survey area, but generally in low numbers. | ? |
| Catch rates: Mean annual catch rates are low and highly variable. | ? |
| Size distribution: Catches comprised mostly of immature fish, as larger, adult fish not sampled by gear. | ? |
| Overall status: Uncertain | ? |
| Exploitation: Unknown. | ? |

**Figure 15.16. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja brachyura* based on data from UK BTS Q3.**

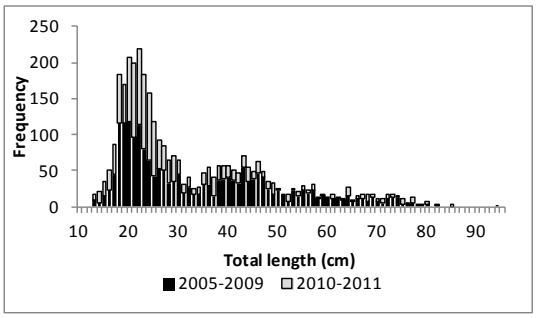
**Species:** ***Raja clavata***
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Distribution and relative abundance of *Raja clavata* in survey area (from Ellis, 2010)




Mean CPUE of IVc-VIId *Raja clavata*. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.

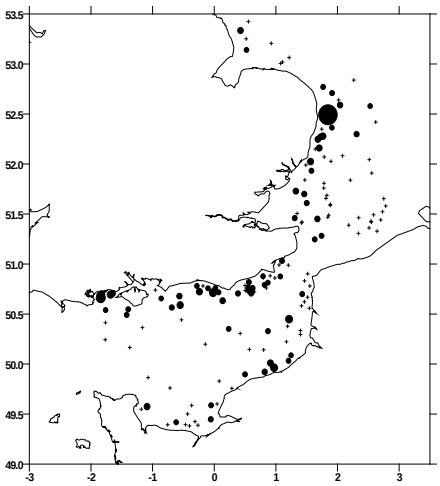



Length distribution of *Raja clavata* in beam trawl survey for the periods 2005–2009 and 2010–2011

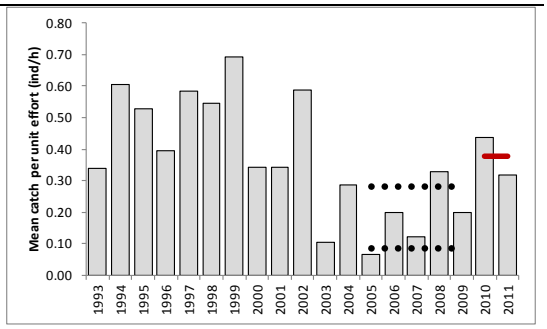
| | |
|---|---|
| Distribution: Abundant and widespread in survey area. Tagging studies have indicated mixing between southern North Sea and eastern English Channel. Degree of mixing between southern North Sea and other parts of the North Sea is unclear. | ✓ |
| Catch rates: Mean catch rates in the last two years are the highest in the time series, and the longer term trend is also increasing. | ↗ |
| Size distribution: Catches comprised mostly of immature fish. Although this survey gear is not designed to sample larger skates, these are present in the catches. | ? |
| Overall status: Catch rates increasing, and this remains one of the most abundant (and commercially important) skates in the area. This survey is considered to sample the main IVc/VIId stock more effectively than the IBTS, given that there are more stations in the main stock area, and that the gear is more effective at sampling smaller skates. | ✓ |
| Exploitation: It is considered that current exploitation is appropriate for the stock. | ✓ |

**Figure 15.17. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja clavata* based on data from UK BTS Q3.**

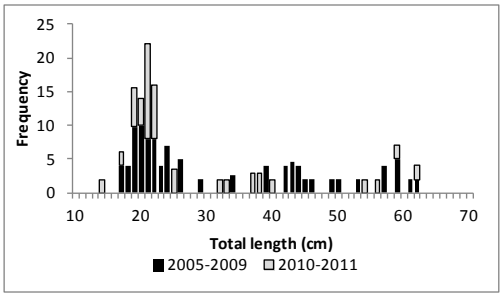
**Species:** ***Raja montagui***
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Distribution and relative abundance of *Raja montagui* in survey area (from Ellis, 2010)




Mean CPUE of IVc-VIId *Raja montagui*. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.

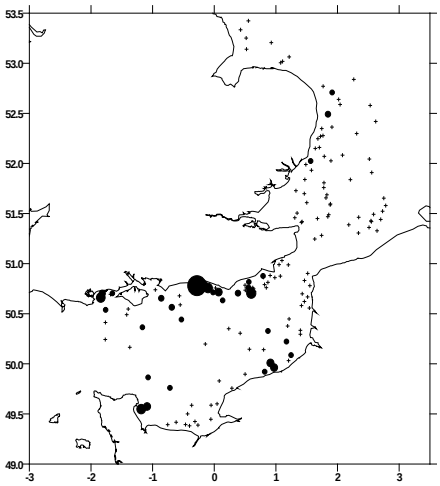



Length distribution of *Raja montagui* in beam trawl survey for the periods 2005–2009 and 2010–2011

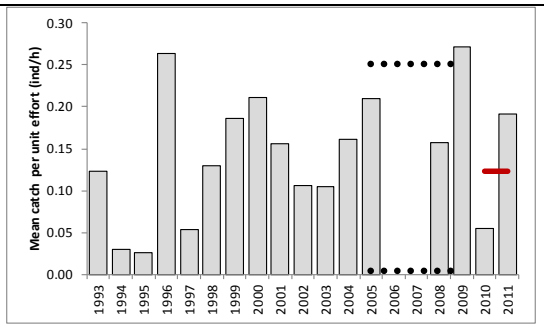
| | |
|---|---|
| Distribution: Captured in coastal waters of the survey area, albeit mostly juvenile specimens. | ✓ |
| Catch rates: Although recent catch rates are lower than at the very start of the time series, the mean annual catches from the last two years is greater than the preceding 5-year period. | ↗ |
| Size distribution: Catches comprised mostly of immature fish., although mature individuals of this small-bodied species also taken. Although the numbers of adults sampled are small, the overall size distributions observed do not give cause for concern.. | ? |
| Overall status: Catch rates increasing, and this remains one of the more abundant skates in the area. | ✓ |
| Exploitation: It is considered that current exploitation is appropriate for the stock. | ✓ |

**Figure 15.18. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja montagui* based on data from UK BTS Q3.**

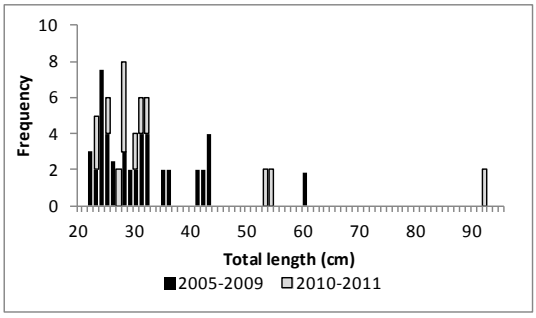
**Species:** ***Raja undulata***
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Distribution and relative abundance of *Raja undulata* in survey area (from Ellis, 2010)




Mean CPUE of *Raja undulata* in VIId. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.

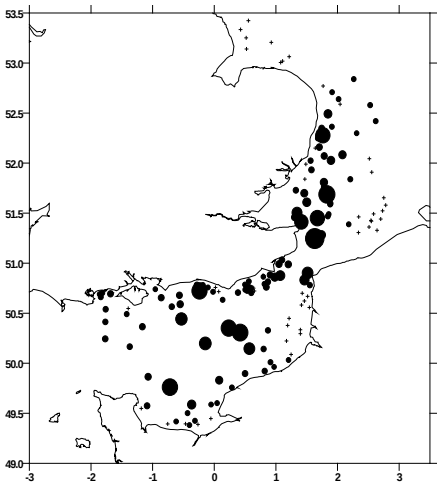



Length distribution of *Raja undulata* in beam trawl survey for the periods 2005–2009 and 2010–2011

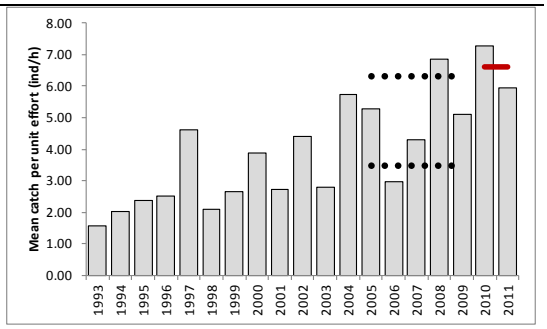
| | |
|---|---|
| Distribution: Patchily distributed in the survey area and mostly in inshore waters, although the catches are comprised mainly of juveniles. This stock extends into the western English Channel, and VIIe may comprise the main part of the stock. | ? |
| Catch rates: Mean annual catch rates are low and highly variable. Juveniles tend to be caught in coastal areas. Although adults are known to occur in the area (Ellis et al., 2012), the low density of stations to the west of the survey grid means that the main stock area is sampled poorly. Although absent in 2006–2007, they have been present each year since. | ? |
| Size distribution: Catches comprised mostly of immature fish, as larger, adult fish not sampled by gear. | ? |
| Overall status: Uncertain. This large-bodied skate species has a patchy distribution and data are limited. | ? |
| Exploitation: Unknown. Currently on the prohibited species list, although this measure has been controversial in areas of high local abundance. | ? |

**Figure 15.19. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for *Raja undulata* based on data from UK BTS Q3.**

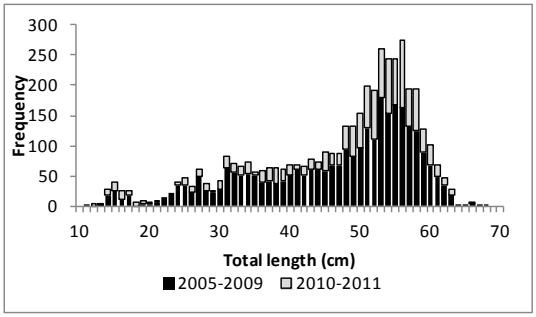
**Species: Lesser-spotted dogfish**
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Distribution and relative abundance of lesser-spotted dogfish in survey area (from Ellis, 2010)




Mean CPUE of IVc-VIId lesser-spotted dogfish. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.

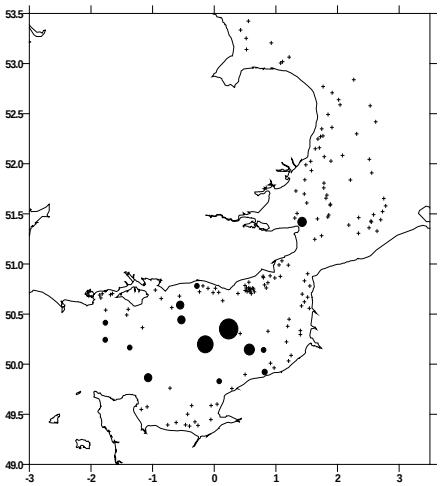



Length distribution of lesser-spotted dogfish in beam trawl survey for the periods 2005–2009 and 2010–2011

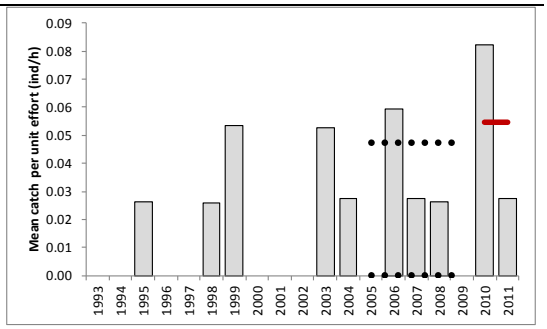
| | |
|---|---|
| Distribution: Abundant and widespread in survey area. | ✓ |
| Catch rates: Mean catch rates in the last two years are amongst the highest in the time series, and the longer term trend has increased consistently. | ↗ |
| Size distribution: Full length range sampled in survey. | ✓ |
| Overall status: Catch rates increasing and population appears healthy. | ✓ |
| Exploitation: It is considered that current exploitation is appropriate for the stock. | ✓ |

**Figure 15.20. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for Lesser-spotted dogfish based on data from UK BTS Q3.**

**Species: Greater-spotted dogfish**
Survey area: IVc, VIId
Survey acronym: UK (BTS-Q3)
Survey gear: 4 m Beam trawl with chain mat
Survey data used:




Distribution and relative abundance of greater-spotted dogfish in survey area (from Ellis, 2010)




Mean CPUE of VIId greater-spotted dogfish. Dashed lines give mean ± 1SD annual CPUE for 2005–2009, red line shows mean annual CPUE for 2010–2011.

Length distribution of greater-spotted dogfish not shown, due to small numbers

| | |
|---|---|
| Distribution: Only found occasionally in the southern North Sea, with most records from the deeper waters of the central English Channel and on the harder grounds in the 'narrows' (the area between Isle of Wight and Cherbourg Peninsula). | ? |
| Catch rates: Mean annual catch rates are low and highly variable. This species tends to occur on rocky grounds which are not sampled extensively in the survey. Whereas this species was not always captured each year during the first half of the survey time series, they are now usually reported. | ? |
| Size distribution: Data limited, as only a few individuals of this species are taken each year, and the gear does not sample the upper part of the expected length range. | ? |
| Overall status: Uncertain | ? |
| Exploitation: Unknown, but of minor economic importance | ? |

**Figure 15.21. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Stock summary sheet for Greater-spotted dogfish based on data from UK BTS Q3.**

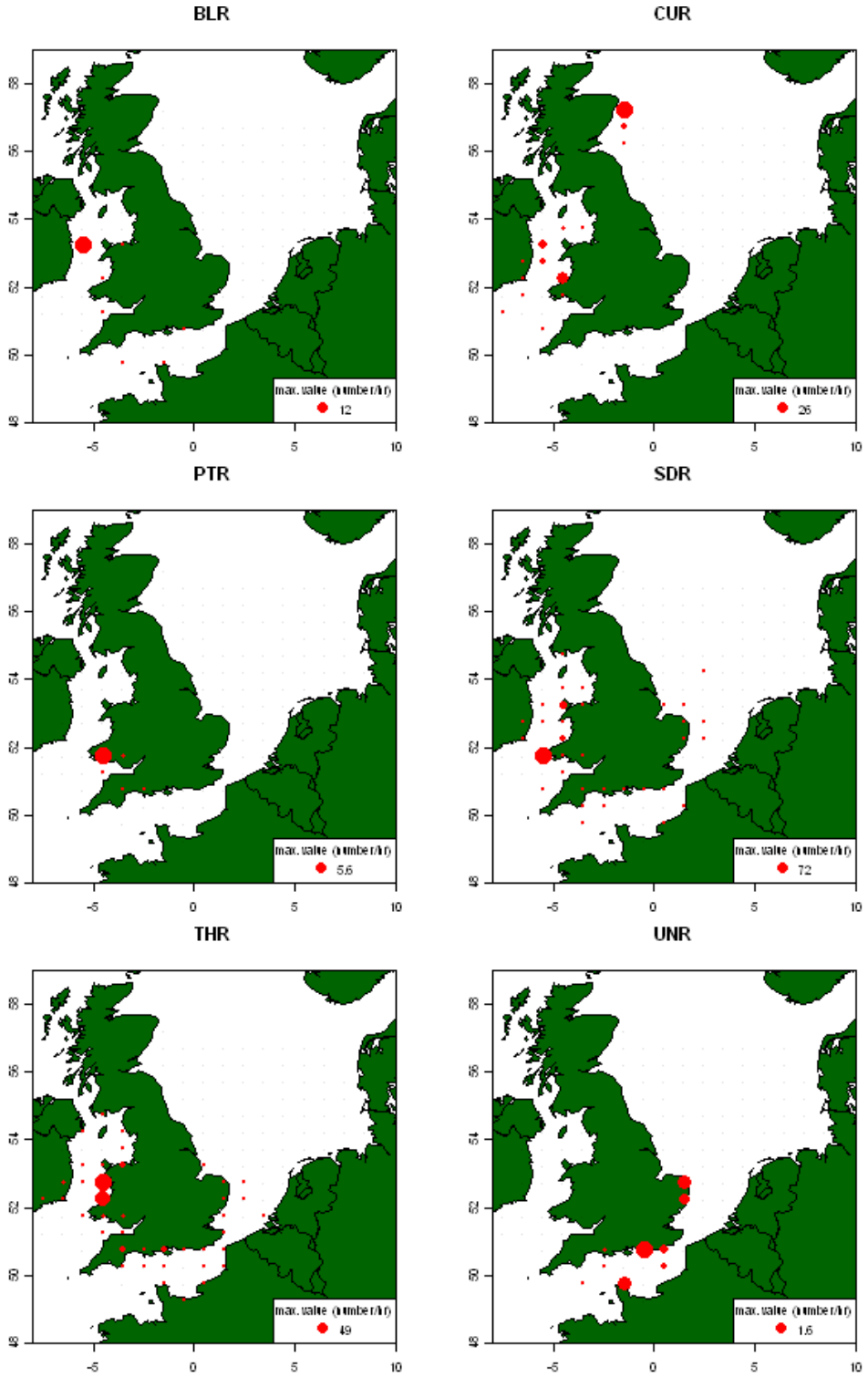



**Figure 15.22. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 1996 (Source: ICES, 2011b).**

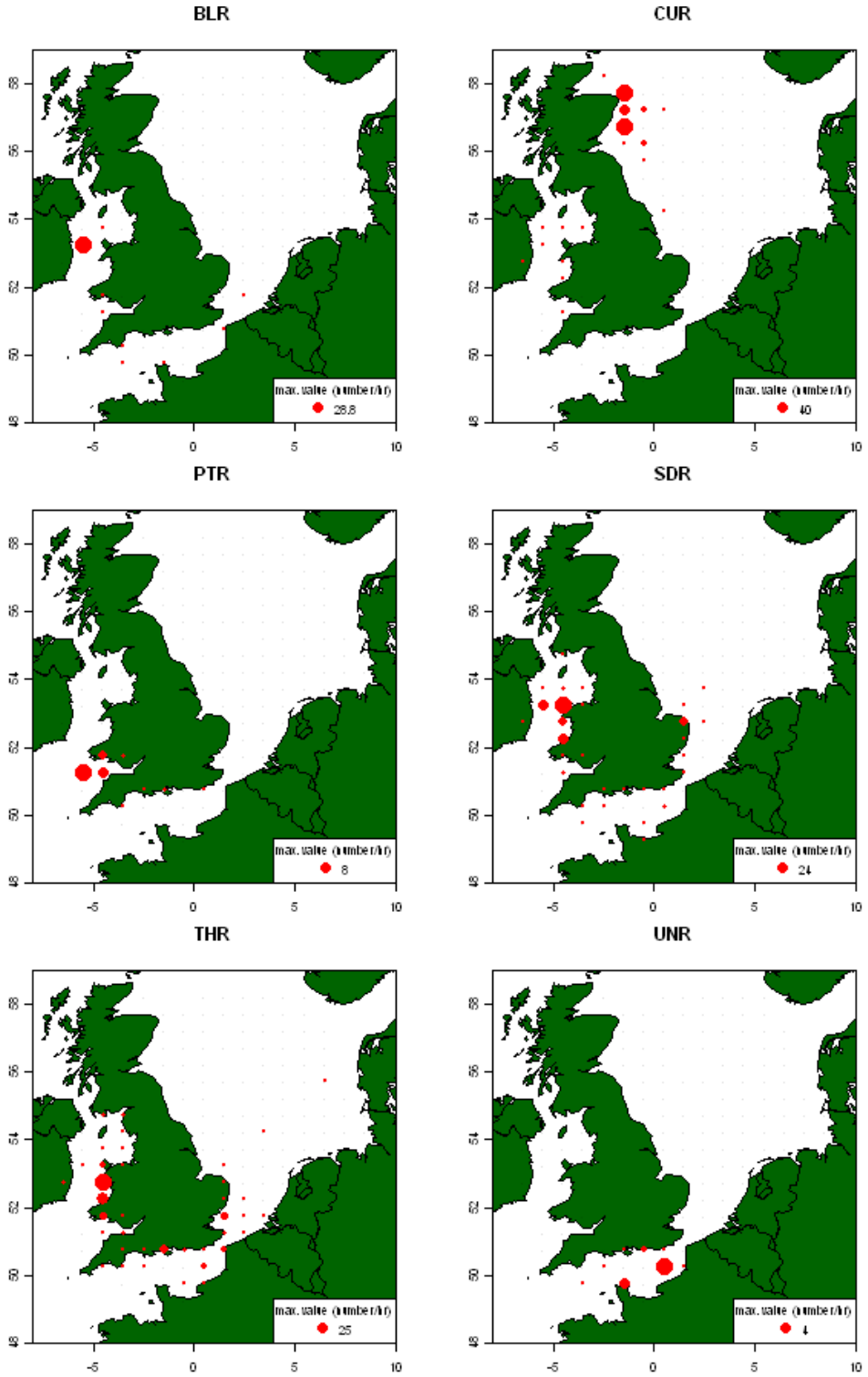



**Figure 15.23. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2000 (Source: ICES, 2011b).**

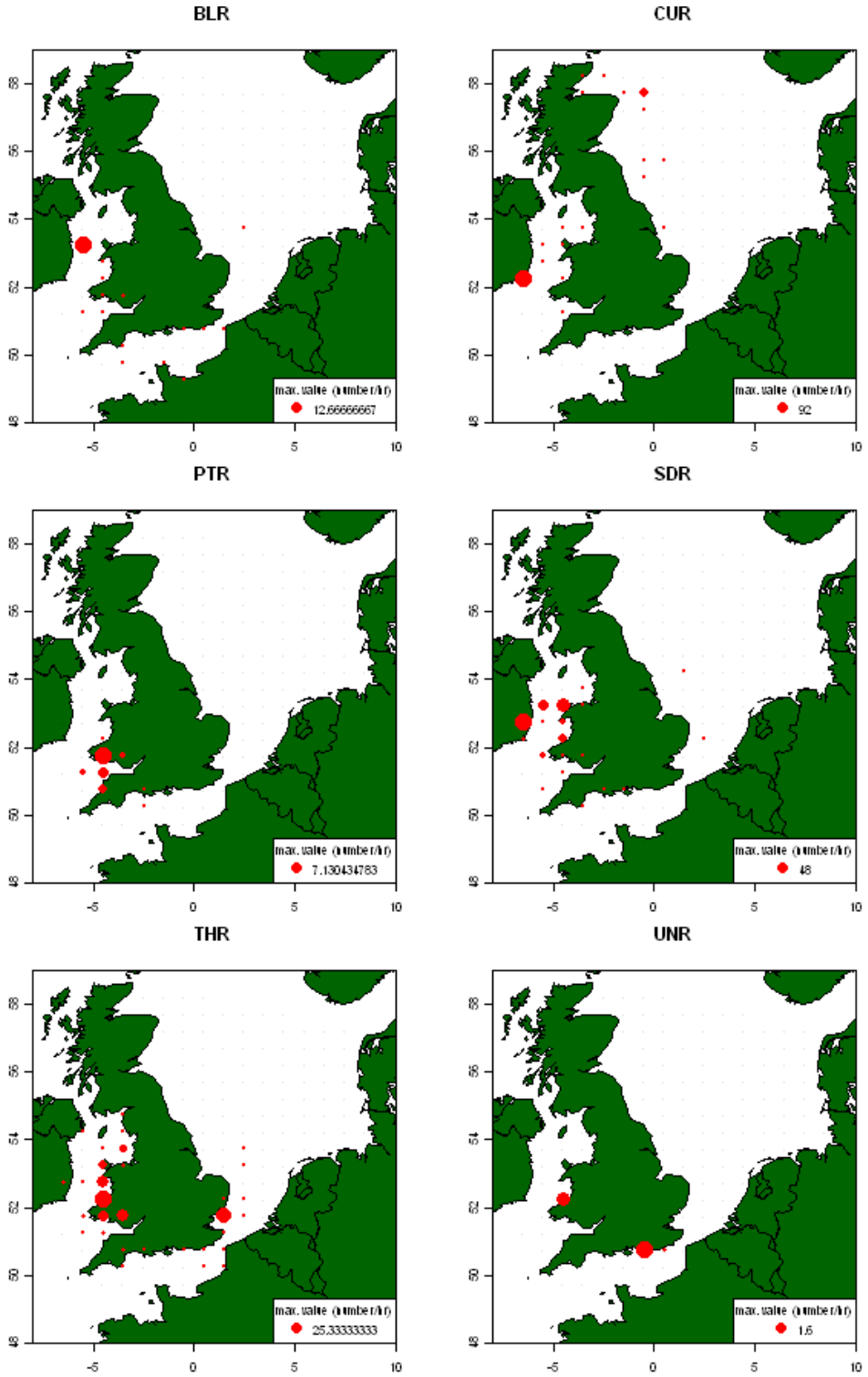



**Figure 15.24. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2005 (Source: ICES, 2011b).**

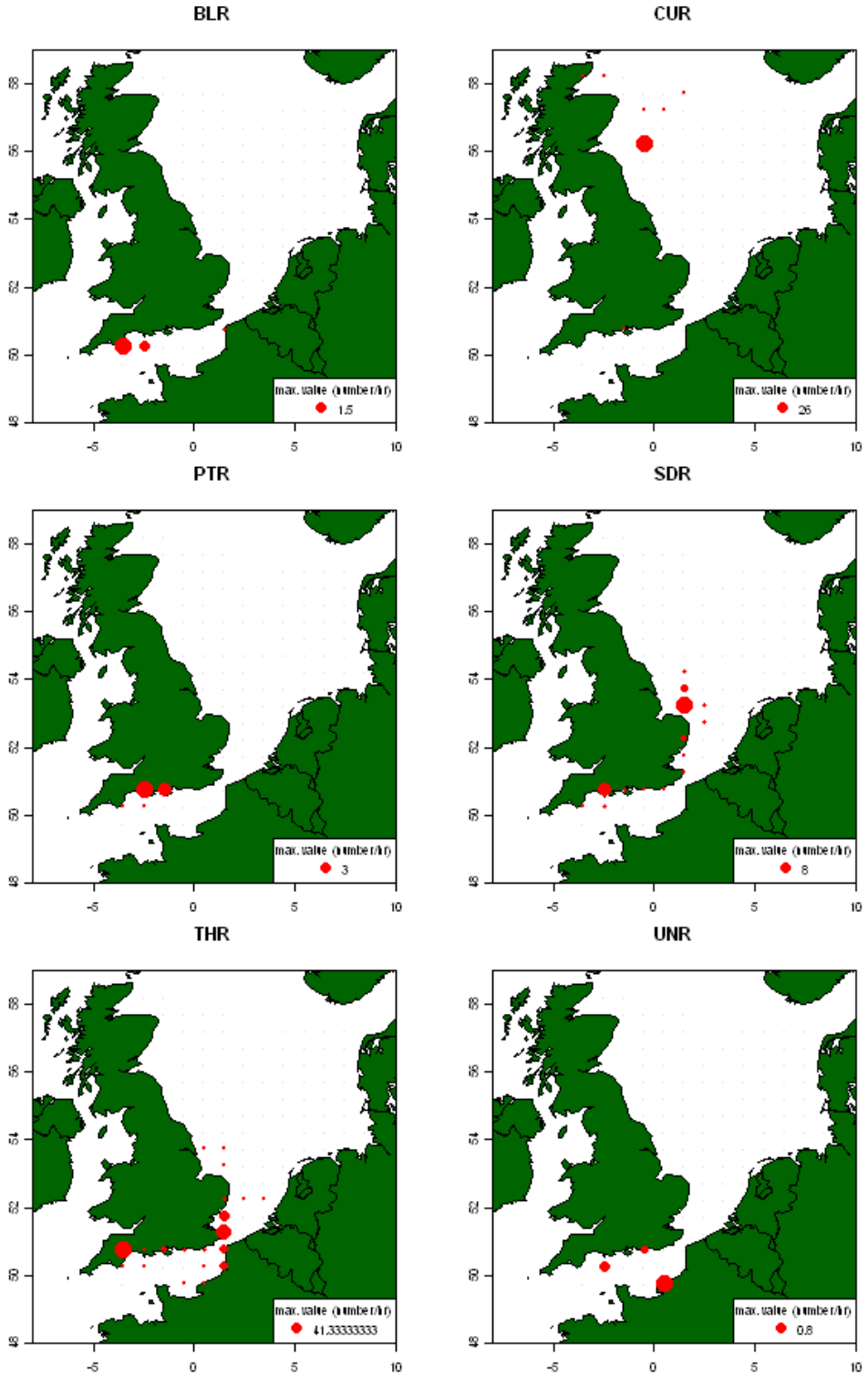



**Figure 15.25. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel: distribution plots for six selected ray species: *Raja brachyura* (BLR), *Leucoraja naevus* (CUR), *Raja microocellata* (PTR), *Raja montagui* (SDR), *Raja clavata* (THR), and *Raja undulata* (UNR) based on offshore BTS data of 2010 (Source: ICES, 2011b).**

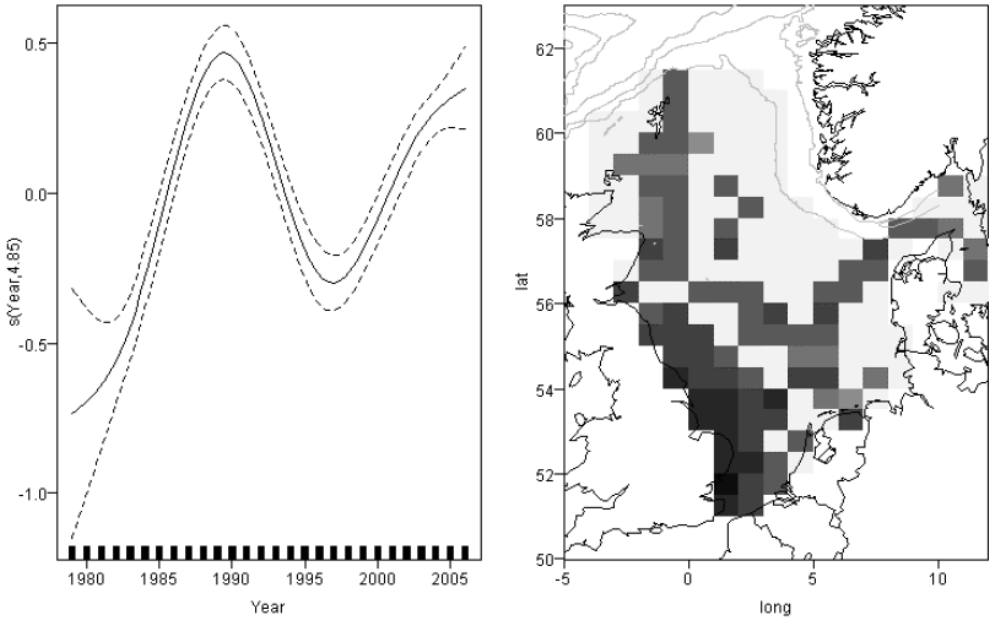



**Figure 15.26. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Thornback ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a log scale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007).**

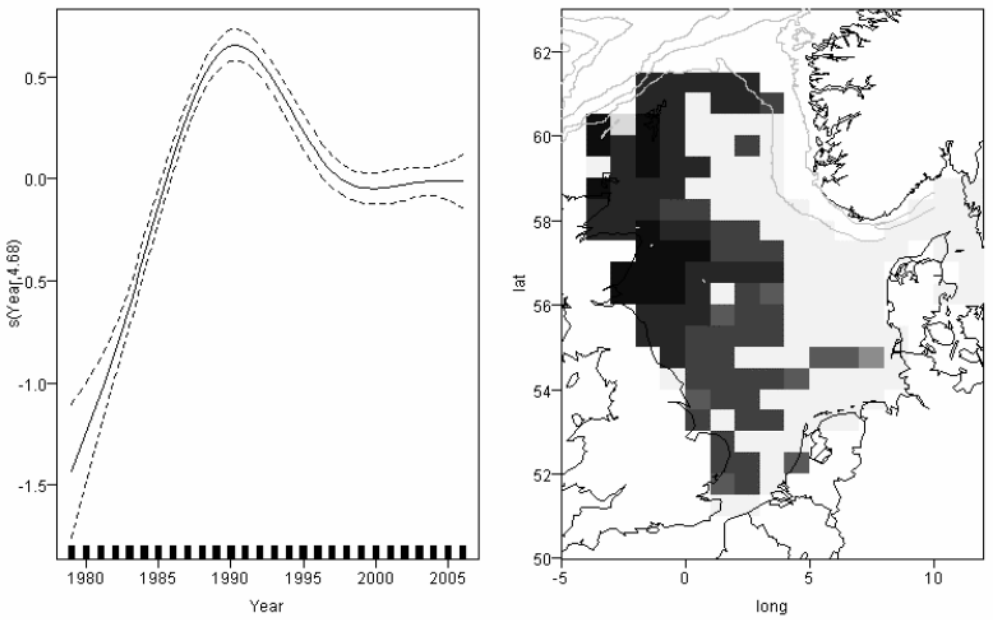



**Figure 15.27. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Cuckoo ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a logscale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007).**

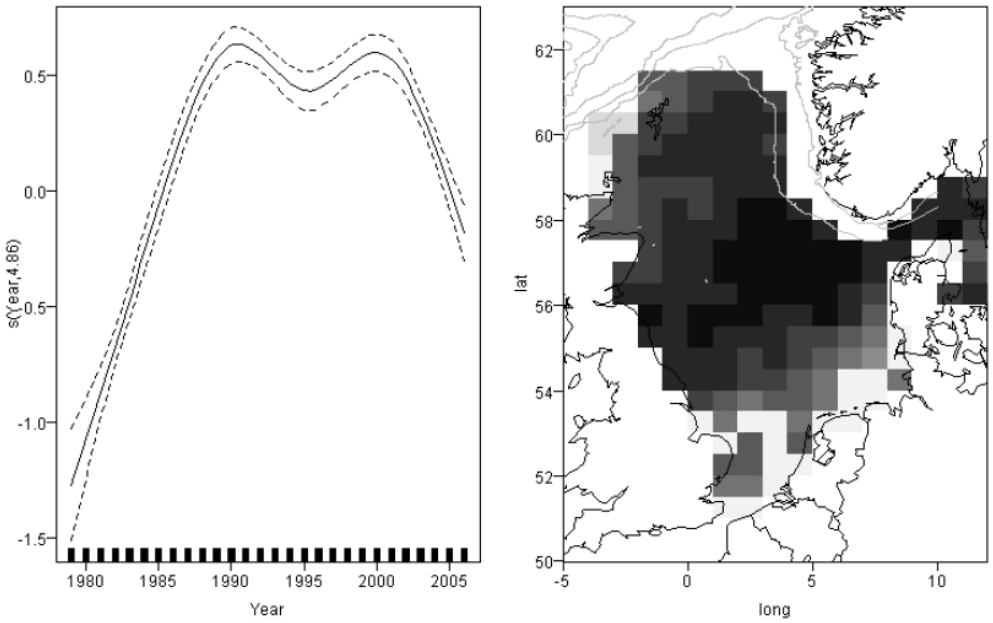



**Figure 15.28. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Starry ray in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a logscale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007).**

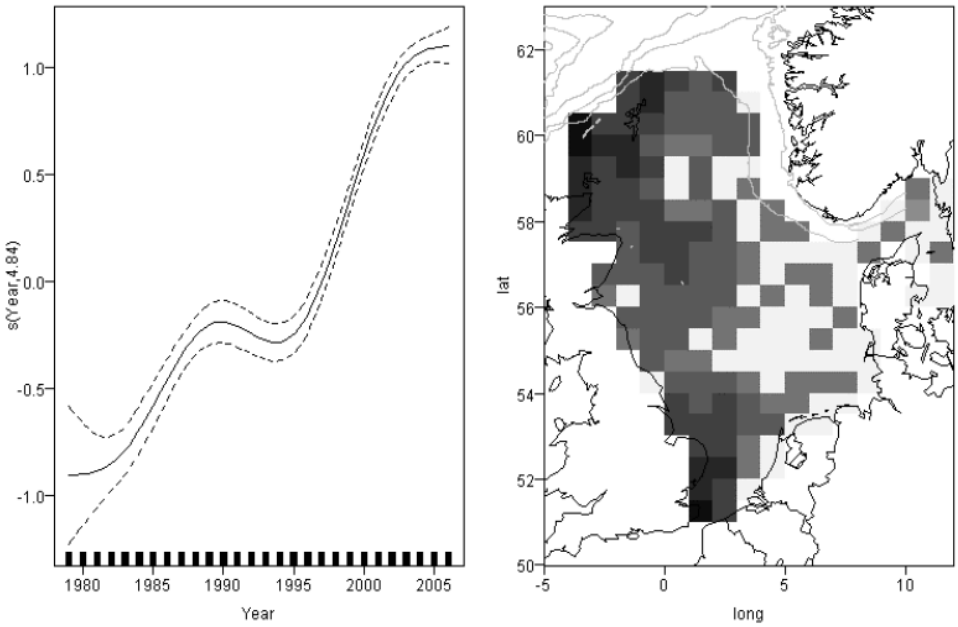



**Figure 15.29. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Lesser spotted dogfish in the North Sea. Results of GAM analysis of the 'filtered' IBTS-Q1 data. Estimated year effects and spatial effects are on a logscale. Statistical rectangles with zero catch rates are shaded very pale grey (Source: ICES, 2007).**

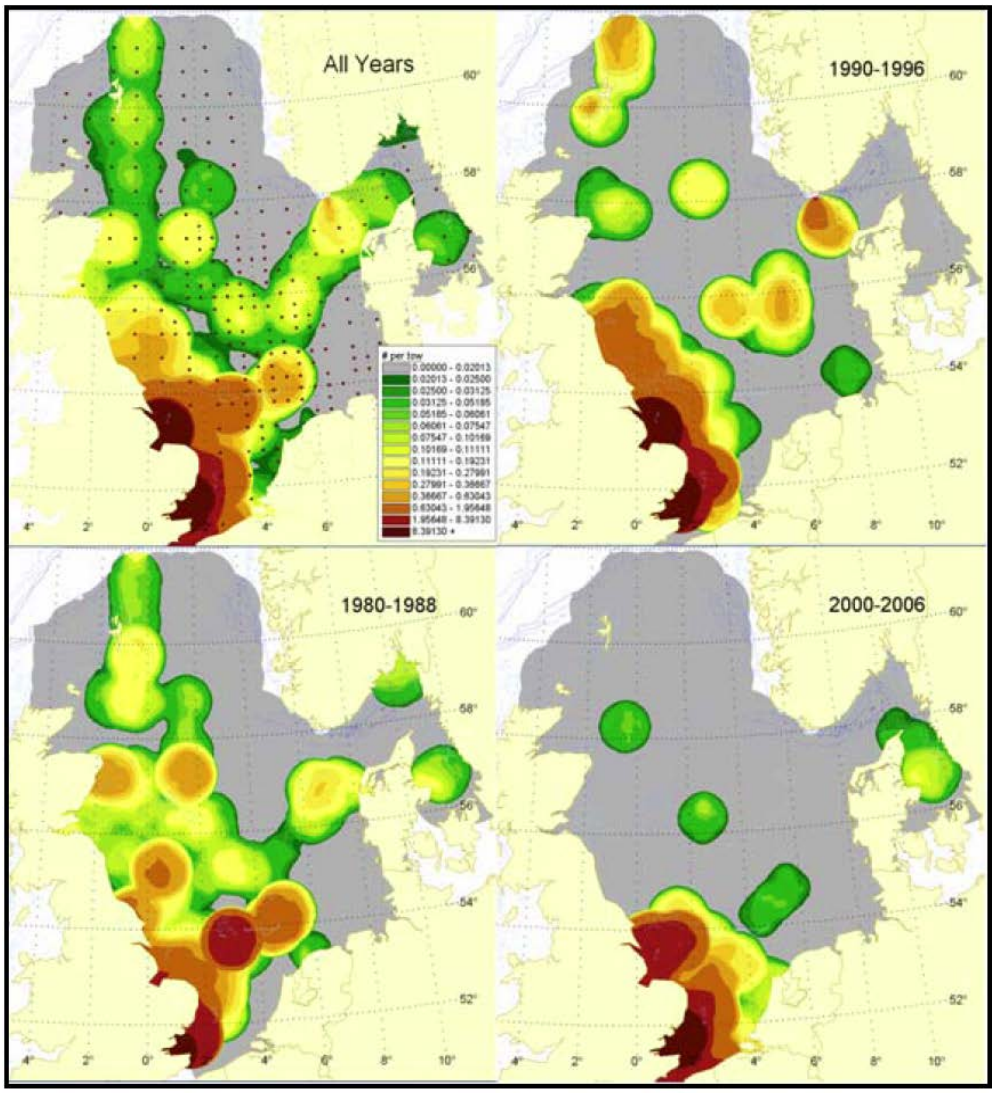



**Figure 15.30. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja clavata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007).**

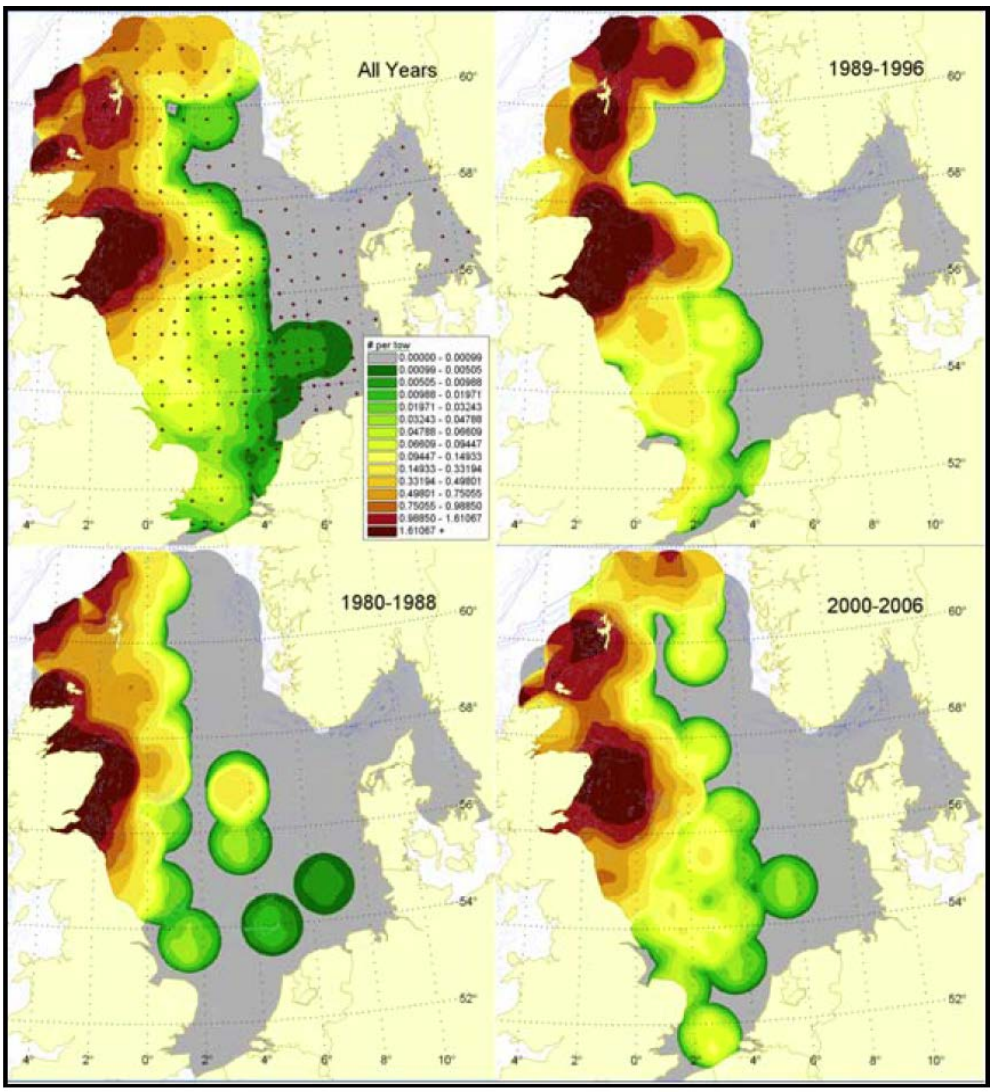



**Figure 15.31. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Leucoraja naevus* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007).**

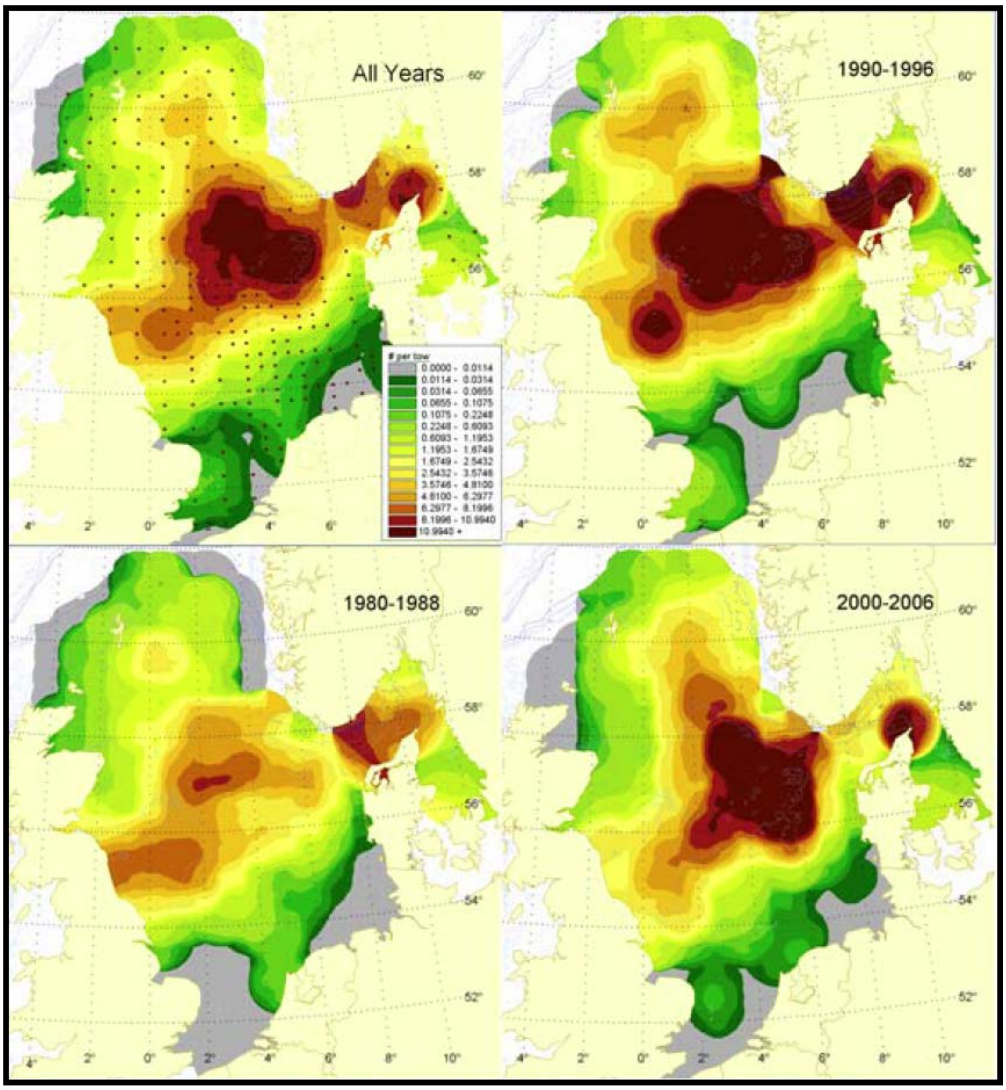



**Figure 15.32. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Amblyraja radiata* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007).**

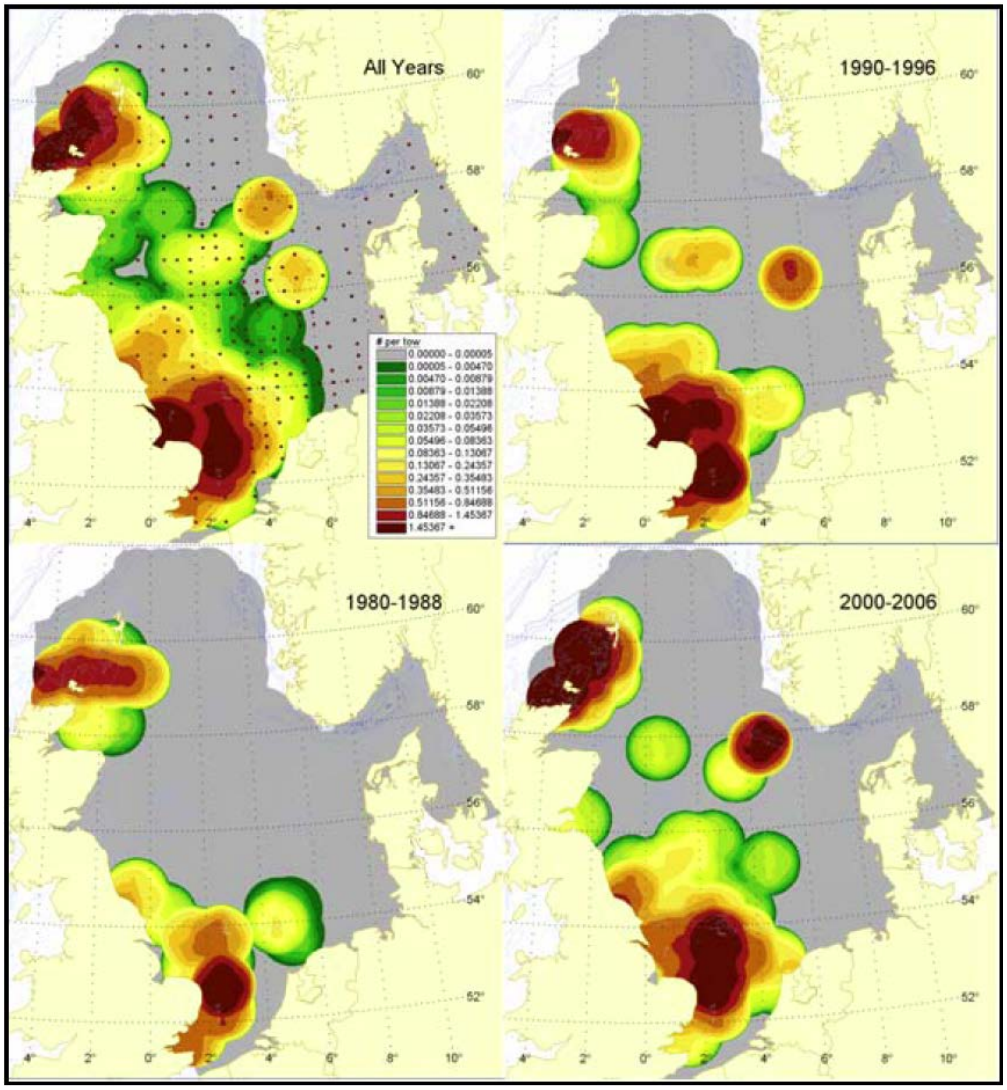



**Figure 15.33. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution of *Raja montagui* during four periods and averaged over the entire survey period (1980–2006). Density strata are expressed as mean number per tow. Points on "All Years" map are grid averaged survey location (Source: ICES, 2007).**

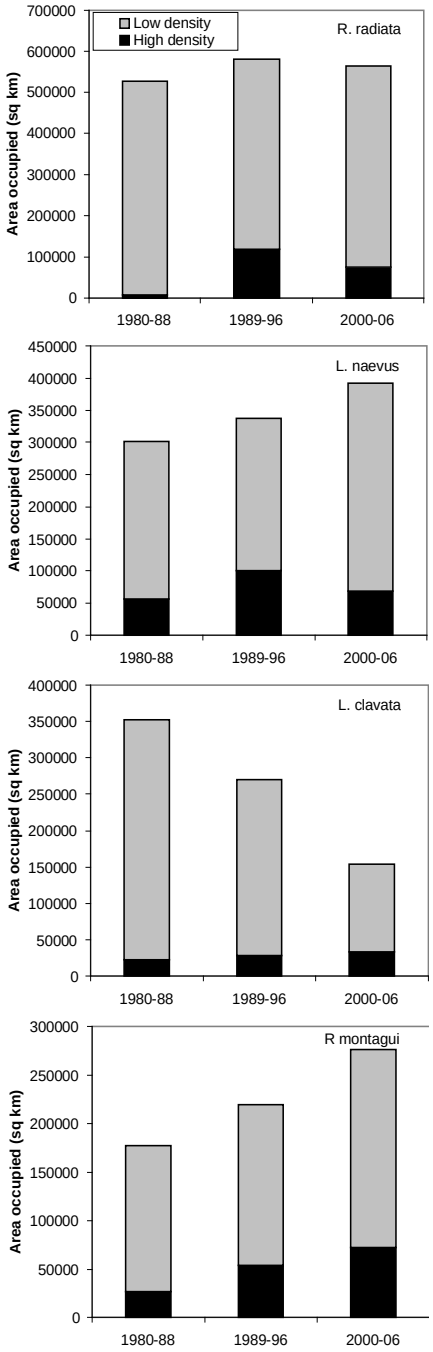



**Figure 15.34. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Area occupied during three periods illustrated in the distribution maps for *Amblyraja radiata, Leucoraja naevus, Raja clavata* and *R. montagui* (Source: ICES, 2007).**

# 16 Demersal elasmobranchs at Iceland and East Greenland

## 16.1 Ecoregion and stock boundaries

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species. The number of species decreases as the water temperature gets colder, and only a few elasmobranch species are common in Icelandic waters. Skates occurring in the area include spinytail skate *Bathyraja spinicauda*, deep-water ray *Rajella bathyphila*, round skate *Rajella fyllae*, Arctic skate *Amblyraja hyperborea*, starry ray (or thorny skate) *Amblyraja radiata* and roughskin skate *Malacoraja spinacidermis* with Jensen's skate *Amblyraja jenseni*, Norwegian skate *Dipturus nidarosienis* shagreen ray *Leucoraja fullonica*, common skate (*Dipturus batis* complex) and sailray *Dipturus linteus* also recorded off Iceland.

Dogfish and sharks in this ecoregion include spurdog *Squalus acanthias* (Section 2), Portuguese dogfish *Centroscymnus coelolepis* and leafscale gulper shark *Centrophorus squamosus* (Section 3), birdbeak dogfish *Deania calcea*, black dogfish *Centroscyllium fabricii*, Iceland catshark *Apristurus laurussonii*, smalleye catshark *Apristurus microps*, mouse catshark *Galeus murinus*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*, Greenland shark *Somniosus microcephalus* and velvet dogfish *Zameus squamulosus* (Section 5), porbeagle *Lamna nasus* (Section 6) and basking shark *Cetorhinus maximus* (Section 7).

Chimaeras (rabbitfish *Chimaera monstrosa*, spearnose chimaera *Rhinochimaera atlantica*, large-eyed rabbitfish *Hydrolagus mirabilis*, smalleyed rabbitfish *Hydrolagus affinis*, narrownose chimaera *Harriotta raleighana*) all occur in the area.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

## 16.2 The fishery

### 16.2.1 History of the fishery

Skates are a bycatch in demersal fisheries, being Iceland the main fishing nation operating in the region. Common skate is taken with a variety of fishing gears throughout the year, and catches peak in May and June. They used to be fairly common in Icelandic waters, but landings are now only about 10% of what was landed 50 years ago. A large part of the landed catch goes to local consumption as common skate is a traditional food in Iceland, particularly at Christmas time. Icelanders prepare the skate by salting or fermenting, as well as, the Greenland shark. The other part of the landed catch is processed and is mainly exported to Belgium where it is eaten fresh boiled.

*A. radiata* has always been a bycatch in a variety of fishing gears around Iceland but until recently were usually discarded. The increase in landings in recent years can therefore mostly be explained by increased retention. The landed catch has grown from virtually nothing in 1980 to more than 1000 t annually between 1995 and 2004. Thereafter, landings declined but have been increasing again to levels exceeding 1000 t in 2010 and 2011 and more than 2000 t in 2012. A relatively large share goes to local consumption.

### 16.2.2 The fishery in 2012

No new information.

### 16.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

### 16.2.4 Management applicable

There is no TAC for demersal skates in these areas.

## 16.3 Catch data

### 16.3.1 Landings

Reported landings of skates from Iceland (Subarea Va) and eastern Greenland (XIV) are given in Table 16.1. Icelandic national data for estimated landings of common skate the *D. batis* complex (1906–2012), starry ray *A. radiata* (1977–2012), sailray *D. linteus* (2000–2012) and shagreen ray *L. fullonica* (1993–2012) were updated in 2013. Table 16.1 contains national data from Iceland, data from the ICES database (ICES, 2011) and landings statistics from the Faroese national database (www.hagstova.fo). Database entries for all species were updated with national landings data provided by Iceland for the years 2003–2012.

Prior to 1992 all skates, with the exception of *A. radiata* and the *D. batis* complex, were reported as '*Raja* rays nei'. *A. radiata* and the *Dipturus batis* complex on average have accounted for about 98% of the yearly skate/ray landings since 1992, since when it is thought that all species are reported to species level. Only small quantities of *L. fullonica*, *D. linteus* and *B. spinicauda* have been reported. Fishers do not usually distinguish between *L. fullonica* and *D. linteus* in Icelandic waters. Therefore the landings of *D. linteus* are likely to be underestimated and landings of *L. fullonica* overestimated as it is, at least sometimes, *D. linteus*. *L. fullonica* generally is relatively rare in Icelandic waters. Landings of the *D. batis* complex could also sometimes be *D. Linteus.*

From 1973–2012, 13 countries have reported landings of skates, demersal sharks and chimaeras from Subareas Va (Iceland) and XIVa and XIVb (East Greenland). Iceland is the main nation fishing in these areas.

Reported skate landings peaked at 2500 t in 1951. Since then the landings of the *D. batis* complex have decreased but landings of *A. radiata* have increased in later years. Landings of *A. radiata* were under 1000 t since 2005 but increased to over 1000 t in 2011 again and were close to 2000 t in 2012 contributing the bulk of landings (Table 16.1, Figures 16.1 and 16.2). Overall, over 95% of the skate landings came from Subarea Va. The share taken by Iceland from this area increased from <50% in the 1970s to nearly 100% from 1999 to 2012.

Information on bycatch of elasmobranchs in East Greenland waters is unavailable but several species are probably taken and discarded in the fishery for cod, shrimp and Greenland halibut *Reinhardtius hippoglossoides*. Anecdotal information indicates that some Greenland sharks taken in the shrimp fishery are landed in Iceland, but the amount is not known.

### 16.3.2 Discards

No information regarding discards was available.

### 16.3.3 Quality of catch data

The major nation fishing skate in this area now provides species-specific information.

## 16.4 Commercial catch composition

### 16.4.1 Species and size composition

No information regarding the length distribution or sex ratio from commercial landings was available.

### 16.4.2 Quality of data

No data available.

## 16.5 Commercial catch-effort data

No data available.

## 16.6 Fishery-independent surveys

### 16.6.1 Availability of survey data

Since 1998, the Greenland surveys (GR-GHXIVB) have covered the area between 61º45'–67ºN at depths from 400–1500 m. The area between 63–64ºN north was not covered by the surveys, as the bottom topography was too steep and rough. The surveys are aimed at Greenland halibut, although all fish species are recorded. The surveys use an ALFREDO III trawl (wingspread of about 21 m, headline height of about 5.8 m, and a mesh size of 30 mm in the codend) on rock-hopper groundgear. These data were presented to WGEF in a working paper by Jørgensen (2006) and are summarized in Table 16.2.

Examination of Icelandic survey data is still to be undertaken.

## 16.7 Life-history information

No new information.

### 16.7.1 Ecologically important habitats

No information available. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

## 16.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data.

## 16.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated.

## 16.10 Reference points

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

## 16.11 Management considerations

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species (22 sharks, 15 skates and six chimaeras). Most of the landings of skates and rays are reported to species. The most abundant demersal elasmobranch in the southern parts of the area is *A. radiata*, which is widespread and abundant in this and adjacent waters.

As species, the *D. batis* complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas. Further investigation into the *D. batis* complex and other skates in Iceland and east Greenland is required, including from fishery-independent sources.

## 16.12 Spatial information

There is no high resolution spatial information available from this area. Numbers-at-length by species in national trawl surveys may be available but these data have not been available to WGEF.

## 16.13 References

ICES. 2011. Official catch statistics 1950–2010. EUROBASE/ICES database on catch statistics (Available at www.ices.dk).

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

### Electronic references

http://www.fisheries.is/main-species/cartilaginous-fishes/ Accessed 17th June 2013.

http://www.fisheries.is/main-species/cartilaginous-fishes/grey-skate/ Accessed 17th June 2013.

http://www.fisheries.is/main-species/cartilaginous-fishes/starry-ray/ Accessed 17th June 2013.

http://www.hagstova.fo Accessed 17th June 2013.

**Table 16.1. Demersal Elasmobranchs at Iceland and east Greenland. Reported landings of skates from Iceland (Subarea Va) and East Greenland (XIV) Data from Icelandic national data and ICES database (ICES, 2011). Faroese landings were extracted from Faroes national statistics website (www.hagstova.fo).**

| WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA VA AND XIV | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Country | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| *Dipturus batis* | Iceland | 364 | 275 | 188 | 333 | 442 | 424 | 403 | 196 | 229 | 245 | 185 | 178 | 120 |
| *Amblyraja radiata* | Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 12 | 46 | 15 |
| *Raja* rays nei | Belgium | 59 | 51 | 62 | 36 | 41 | 23 | 27 | 36 | 28 | 11 | 15 | 15 | 19 |
| | Faroe Islands | 80 | 56 | 43 | 35 | 75 | 27 | 37 | 21 | 25 | 23 | 73 | 24 | 21 |
| | Germany | 76 | 41 | 49 | 41 | 37 | 10 | 2 | 1 | 2 | 2 | 4 | 3 | 2 |
| | Norway | 1 | 0 | 63 | 4 | 2 | 3 | 2 | 3 | 6 | 1 | 10 | 3 | 5 |
| | UK - England & Wales | 385 | 187 | 195 | 106 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 5 | 8 | 14 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | 970 | 618 | 614 | 563 | 602 | 487 | 471 | 257 | 290 | 291 | 299 | 269 | 182 |
| WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA VA AND XIV | | | | | | | | | | | | | | |
| Species | Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| *Dipturus batis* | Iceland | 108 | 130 | 152 | 152 | 222 | 304 | 363 | 274 | 299 | 245 | 181 | 118 | 108 |
| *Amblyraja radiata* | Iceland | 44 | 125 | 39 | 100 | 163 | 286 | 317 | 294 | 1206 | 1749 | 1493 | 1430 | 1252 |
| *Leucoraja fullonica* | Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 24 | 19 | 16 | 12 |
| *Raja* rays nei | Belgium | 18 | 22 | 20 | 22 | 6 | 9 | 6 | 3 | 0 | 0 | 0 | 0 | 0 |
| | Faroe Islands | 0 | 8 | 2 | 2 | 16 | 5 | 2 | 3 | 4 | 9 | 2 | 2 | 7 |
| | Germany | 1 | 0 | 0 | 0 | 1 | 3 | 1 | 2 | 0 | 9 | 0 | 0 | 1 |
| | Norway | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 8 | 8 | 7 | 10 | 2 | 19 |
| | Portugal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | UK - Eng+Wales+N.Irl. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | | 4 | 0 | 0 | 1 |
| Total | | 171 | 285 | 213 | 276 | 408 | 607 | 715 | 588 | 1529 | 2047 | 1705 | 1569 | 1400 |

| WG ESTIMATES OF LANDINGS (T) OF ELASMOBRANCHS IN ICES AREA VA AND XIV | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| *Dipturus batis* | Iceland | 80 | 94 | 82 | 59 | 115 | 141 | 162 | 134 | 118 | 118 | 113 | 98 | 122 | 145 |
| | Norway | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amblyraja radiata* | Iceland | 996 | 1076 | 1211 | 1781 | 1456 | 969 | 625 | 512 | 473 | 609 | 710 | 950 | 1329 | 1865 |
| *Dipturus linteus* | Iceland | 0 | 0 | 0 | 0 | 10 | 8 | 20 | 0 | 0 | 10 | 8 | 12 | 9 | 9 |
| *Leucoraja fullonica* | Iceland | 21 | 27 | 37 | 32 | 17 | 23 | 16 | 16 | 17 | 4 | 33 | 19 | 17 | 21 |
| *Raja* rays nei | Faroe Islands | 5 | 0 | 2 | 2 | 0 | 8 | 9 | 16 | 7 | 11 | 6 | 5 | 14 | 5 |
| | Germany | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 10 | 0 | 0 | 0 | 0 |
| | Norway | 8 | 3 | 6 | 5 | 1 | 0 | 0 | 7 | 0 | 1 | 2 | 80 | 4 | 0 |
| | Portugal | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Russian Federation | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 3 | 0 | 0 | n.a. | n.a. | n.a. | n.a. |
| | Spain | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Eng+Wales+N.Irl. | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | 1112 | 1210 | 1340 | 1879 | 1615 | 1152 | 838 | 698 | 615 | 753 | 866 | 1159 | 1495 | 2045 |

**Table 16.2. Demersal Elasmobranchs at Iceland and east Greenland. Demersal elasmobranch species captured during groundfish surveys at east Greenland during 1998–2005. Total number, observed maximum weight (kg), depth range (m) and bottom temperature range ºC and most northern position (decimal degrees; adapted from Jørgensen, 2006).**

| Species | N | Max wt (kg) | Depth range (m) | Temp range (°C) | Maximum latitude |
|---|---|---|---|---|---|
| *Bathyraja spinicauda* | 82 | 61.5 | 548–1455 | 0.5–5.6 | 65.46ºN |
| *Rajella bathyphila* | 57 | 45.3 | 476–1493 | 0.3–4.1 | 65.44ºN |
| *Rajella fyllae* | 117 | 4.8 | 411–1449 | 0.8–5.9 | 65.46ºN |
| *Amblyraja hyperborea* | 12 | 23.4 | 520–1481 | 0.5–5.4 | 65.47ºN |
| *Amblyraja radiata* | 483 | 22.1 | 411–1281 | 0.8–6.6 | 66.21ºN |
| *Malacoraja spinacidermis* | 3 | 3.1 | 1282–1450 | 2.3–2.7 | 62.25ºN |
| *Apristurus laurussoni* | 3 | 0.7 | 836–1255 | 1.7–4.3 | 65.22ºN |
| *Centroscyllium fabricii* | 812 | 128 | 415–1492 | 0.6–5.1 | 65.40ºN |
| *Somniosus microcephalus* | 9 | 500 | 512–1112 | 1.4–4.9 | 65.35ºN |

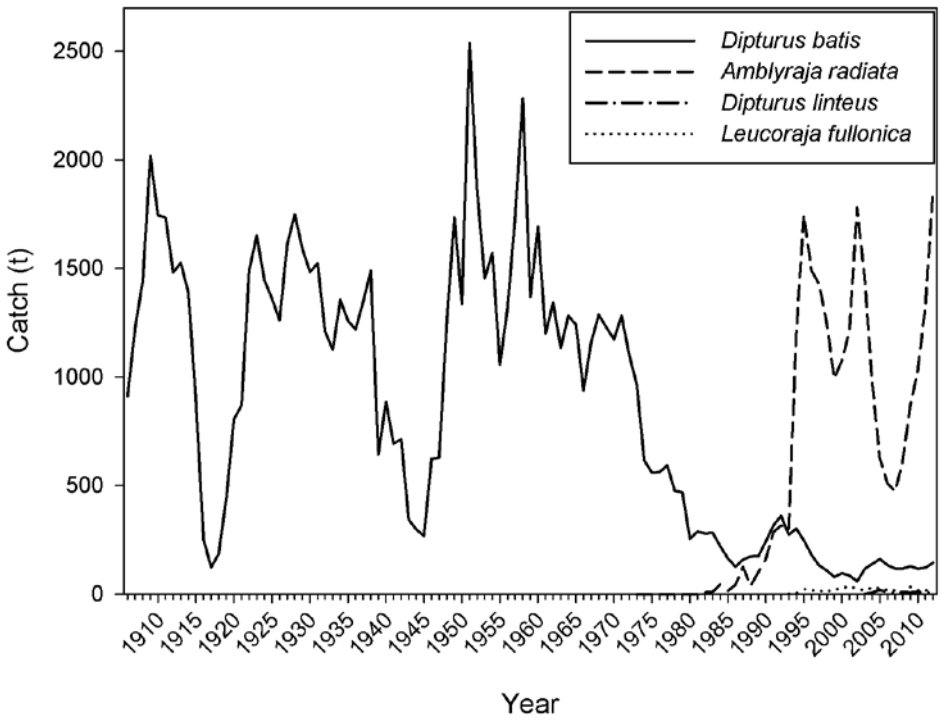



**Figure 16.1. Demersal Elasmobranchs at Iceland (Subarea Va). WG estimates of the most commonly reported rays and skates, 1906–2012. (ICES, 2011, national landings data and Faroese statistical database www.hagstova.fo).**

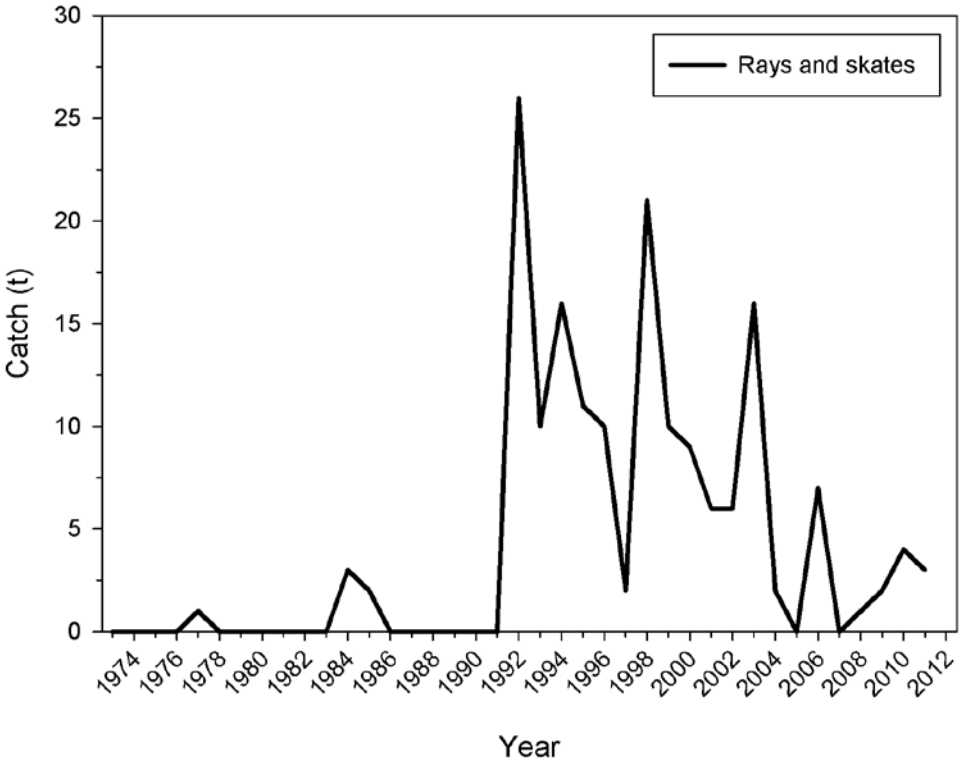



**Figure 16.2. Demersal Elasmobranchs at east Greenland (Subarea XIV). WG estimates of the most commonly reported rays and skates, 1973–2011 (ICES, 2011 and national landings data).**

# 17 Demersal elasmobranchs at the Faroe Islands

## 17.1 Ecoregion and stock boundaries

The elasmobranch fauna off the Faroe Islands (ICES Divisions Vb1, Vb2) is little studied in the scientific literature, though it is likely to be somewhat similar to that occurring in the northern North Sea and off NW Scotland and Iceland. Skates recorded in the area include common skate (the *Dipturus batis* complex), sailray *Dipturus linteus*, long-nosed skate *Dipturus oxyrinchus*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, cuckoo ray *Leucoraja naevus*, spotted ray *Raja montagui*, thornback ray *Raja. clavata*, round skate *Rajella fyllae*, Arctic skate *Amblyraja hyperborea*, starry ray (thorny skate) *Amblyraja radiata*, white skate *Rostroraja alba* and common stingray *Dasyatis pastinaca*. Demersal sharks include several deep-water species (Leafscale gulper shark *Centrophorus squamosus*, black dogfish *Centroscyllium fabricii*, birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*, Greenland shark *Somniosus microcephalus*, mouse catshark *Galeus murinus* and blackmouth catshark *Galeus melastomus*; see Section 5) and spurdog *Squalus acanthias* (Section 2). Chimaeras also occur in the area: rabbitfish *Chimaera monstrosa*, large-eyed rabbitfish *Hydrolagus mirabilis*, narrownose chimaera *Harriotta raleighana* and spearnose chimaera *Rhinochimaera atlantica*.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

## 17.2 The fishery

### 17.2.1 History of the fishery

Since 1973, ten countries have reported landings of demersal elasmobranchs from Division Vb, with the bulk of catches consisting of skates and rays. In earlier years, Scottish vessels landed the largest portion of catches, while since the 1980es the largest share is caught by Faroese vessels. These include trawlers and, to a lesser extent, longliners and gillnetters. Norwegian vessels fishing in this area are longliners targeting ling, tusk and cod. UK vessels include a small number of large Scottish trawlers that are occasionally able to obtain quotas to fish in Faroese waters targeting gadoids and deep-water species. French vessels fishing in this area are probably from the same fleet that prosecute the mixed deep-water and shelf fishery west of the UK. Demersal elasmobranchs likely represent a minor to moderate bycatch in these fisheries.

In 2007, a Russian longliner started fishing deep-water sharks in the Faroese Fishing Zone (FFZ) and on the Reykjanes Ridge. The total catch of the elasmobranchs in those and other NEA areas amounted to 483 t (Vinnichenko, 2008).

### 17.2.2 The fishery in 2012

In 2012 landings from ICES Division Vb were reported from France. Faroese landings were extracted from the Faroese national statistics database (www.hagstova.fo). Detailed info about the Russian fishery can be found in ICES (2010).

### 17.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

### 17.2.4 Management applicable

The majority of the area is managed by the Faroes through an effort based system which restricts fishing days for demersal gadoids. Some EU vessels have been able to gain access to the Faroes EEZ where they have been managed under individual quotas for the main target species.

## 17.3 Catch data

### 17.3.1 Landings

Landings of skates, mainly unidentified, are presented in Table 17.1. The French reported landings of the *D. batis* complex do not represent its entire catch as an unknown quantity is included in the category of unidentified rays. Total landings of skates combined are shown in Figure 17.1.

WGEF had noted a large decline in the Faroese landings in 2009 (ICES, 2012). However, updated landings data from ICES database in 2011 (ICES, 2011) and from official Faroese landing statistics (www.hagstova.fo) for 2009 and more recent years could not confirm a decline. Landings in 2012 are similar to previous years 2007–2011.

### 17.3.2 Discards

The amount of discarding of skates and demersal sharks from this area is unknown.

### 17.3.3 Quality of catch data

Species-specific information for commercial catches is lacking.

## 17.4 Commercial catch composition

### 17.4.1 Species and size composition

All skates in Division Vb, with the exception of French landings, were reported as '*Raja* rays nei' before 2008 (see Table 17.1). There was no available port sampling data to split these landings by species. It is likely that catches included the *D. batis* complex, *L. fullonica*, *R. clavata* and *A. rad*iata.

No information regarding size composition or sex ratio from commercial landings was available.

### 17.4.2 Quality of data

Information on the species and length composition is required.

## 17.5 Commercial catch–effort data

No information available to WGEF.

## 17.6 Fishery-independent surveys

No survey data from this area were available to the working group. Magnussen (2002) summarized the demersal fish assemblages from the Faroe Bank, based on the analysis of routine survey data collected by the RV Magnus Heinason since 1983.

Data on elasmobranchs taken in these surveys are summarized in Table 17.2. A more detailed analysis of the demersal elasmobranchs taken in Faroese surveys is still to be undertaken.

## 17.7 Life-history information

No new information.

### 17.7.1 Ecologically important habitats

No information available. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

## 17.8 Exploratory assessment models

No assessments have been conducted, as a consequence of insufficient data being available to WGEF.

## 17.9 Quality of assessments

No assessments have been conducted to date. Analyses of survey trends may allow the general status of the more frequent species to be evaluated.

## 17.10 Reference points

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

## 17.11 Management considerations

Total international reported landings of skates declined from 1973–2003 but increased to above the average of the time-series in 2004–2006. Since then, landings declined below the long-term average again. Without further information on the fisheries such as better differentiation of species, amounts of discards, sizes caught, it is not possible to provide information on the pattern of exploitation or on the status of stocks.

The elasmobranch fauna off the Faroe Islands is little studied in the scientific literature, though it is likely to be somewhat similar to that occurring in the northern North Sea and off Iceland. Further studies to describe the demersal elasmobranch fauna of this region and to conduct preliminary analyses of fishery-independent survey data are required.

As species, the *D. batis* complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas. Further investigation into the *D. batis* complex and other skates in the Faroe Islands is required, including from fishery-independent sources.

## 17.12 Spatial information

There is no high resolution spatial information available from this area. Numbers-at-length by species in national trawl surveys may be available but these data have not been available to WGEF.

## 17.13 References

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

ICES. 2011. Official catch statistics 1950–2010. EUROBASE / ICES database on catch statistics (Available at www.ices.dk).

ICES. 2012. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–26 June 2012, Lisbon, Portugal. ICES CM 2011/ACOM:19. 551 pp.

Magnussen, E. 2002. Demersal fish assemblages of the Faroe Bank: Species composition, distribution, biomass spectrum and diversity. Marine Ecology Progress Series 238: 211–225.

Vinnichenko, V.I. 2008. Russian deep-sea investigations and fisheries in the Northeast Atlantic in 2007. Working Document for the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources, ICES, 9 p.

## Electronic references

http://www.hagstova.fo Accessed 17th June 2013.

**Table 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates and rays from the Faroes area (Division Vb). Data were updated with ICES database landings data (ICES, 2011) for years 2000–2011 and also contain national landings data provided to the WG. Faroese landings were extracted from Faroese national statistics database available on www.hagstova.fo .**

| WG Estimates of Landings (t) of Rays in ICES Area Vb | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Country | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| *Raja* rays nei | Faroe Islands | 150 | 95 | 107 | 136 | 164 | 201 | 202 | 198 | 135 | 221 | 211 | 281 | 277 |
| | France | 0 | 0 | 30 | 57 | 159 | 7 | 3 | 0 | 4 | 2 | 0 | 0 | 0 |
| | Germany | 47 | 33 | 36 | 15 | 23 | 55 | 14 | 7 | 1 | 3 | 3 | 3 | 1 |
| | Netherlands | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Norway | 29 | 27 | 37 | 42 | 46 | 64 | 37 | 18 | 21 | 13 | 32 | 35 | 14 |
| | UK - Eng+Wales+N.Irl. | 62 | 33 | 45 | 50 | 10 | 5 | 4 | 2 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 322 | 205 | 205 | 226 | 164 | 99 | 104 | 66 | 11 | 32 | 20 | 1 | 1 |
| *Dipturus batis* | France | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucoraja naevus* | France | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Raja clavata* | France | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 6 | 23 | 38 |
| | **Total** | 610 | 393 | 461 | 527 | 566 | 436 | 375 | 291 | 172 | 272 | 272 | 343 | 331 |

**Table 17.1. Continued. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates and rays from the Faroes area (Division Vb). Data were updated with ICES database landings data (ICES, 2011) for years 2000–2011 and also contain national landings data provided to the WG. Faroese landings were extracted from Faroese national statistics database available on www.hagstova.fo .**

| WG Estimates of Landings (t) of Rays in ICES Area Vb | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Country** | **1986** | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** |
| *Raja* rays nei | Denmark | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Faroe Islands | 258 | 171 | 92 | 136 | 102 | 207 | 254 | 203 | 167 | 220 | 165 | 178 | 144 |
| | France | 1 | 6 | 5 | 8 | 5 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 |
| | Germany | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 |
| | Norway | 22 | 11 | 29 | 84 | 96 | 81 | 37 | 75 | 20 | 14 | 60 | 14 | 45 |
| | UK - Eng+Wales+N.Irl. | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 12 | 3 | 3 | 0 | 6 | 0 |
| | UK - Scotland | 0 | 1 | 0 | 1 | 2 | 0 | 5 | 1 | 5 | 4 | 4 | 5 | 7 |
| *Dipturus batis* | France | 5 | 6 | 7 | 13 | 12 | 5 | 1 | 0 | 0 | 1 | 2 | 3 | 0 |
| *Leucoraja naevus* | France | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dipturus oxyrinchus* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Raja clavata* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Raja montagui* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dasyatis pastinaca* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucoraja circularis* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucoraja fullonica* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 287 | 200 | 135 | 242 | 217 | 295 | 298 | 292 | 198 | 243 | 232 | 208 | 196 |

**Table 17.1. Continued. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division Vb). Data were updated with ICES database landings data (ICES, 2011) for years 2000–2011 and also contain national landings data provided to the WG. Faroese landings were extracted from Faroese national statistics database available on www.hagstova.fo .**

| WG Estimates of Landings (t) of Rays in ICES Area Vb | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| *Raja* rays nei | Faroe Islands | 175 | 0 | 76 | 25 | 98 | 272 | 274 | 238 | 185 | 179 | 150 | 177 | 182 | 198 |
| | France | 2 | 0 | 0 | 1 | 5 | 10 | 7 | 19 | 8 | 9 | 5 | 0 | 0 | 0 |
| | Germany | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Norway | 45 | 50 | 21 | 15 | 5 | 0 | 11 | 10 | 16 | 5 | 4 | 11 | 0 | 0 |
| | UK - Eng+Wales+N.Irl. | 0 | 23 | 2 | 0 | 2 | 15 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 6 | 12 | 25 | 12 | 6 | 5 | 25 | 2 | 2 | 2 | 4 | 3 | 0 | 0 |
| *Dipturus batis* | Norway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| | France | 4 | 2 | 2 | 2 | 3 | 5 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 |
| *Leucoraja naevus* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | UK - Scotland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| *Dipturus oxyrinchus* | France | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Raja clavata* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Raja montagui* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dasyatis pastinaca* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucoraja circularis* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucoraja fullonica* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rostroraja alba* | France | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | UK - Scotland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| | **Total** | 233 | 89 | 129 | 55 | 122 | 308 | 324 | 272 | 212 | 200 | 170 | 193 | 182 | 199 |

**Table 17.2. Demersal elasmobranchs at the Faroe Islands. Elasmobranchs taken on the Faroe Bank during bottom-trawl surveys (1983–1996) by depth band. Symbols indicate frequency of occurrence in hauls (***: 60–100% of hauls, **: 10–60% of hauls, *: 3–10% of hauls, + : <3% of hauls). Adapted from Magnussen, 2002.**

| Species | <100 m | 100–200 m | 200–300 m | 300–400 m | 400–500 m | >500 m | Total |
|---|---|---|---|---|---|---|---|
| *Galeus melastomus* | – | + | * | * | ** | ** | * |
| *Galeorhinus galeus* | – | + | – | – | – | * | + |
| *Squalus acanthias* | – | * | * | ** | * | ** | * |
| *Etmopterus spinax* | – | + | – | – | * | ** | * |
| *Centroscyllium fabricii* | – | – | – | – | * | – | + |
| *Amblyraja radiata* | – | – | – | – | – | ** | + |
| *Dipturus batis* | – | * | * | – | – | ** | * |
| *Leucoraja fullonica* | – | + | + | – | – | * | + |
| *Leucoraja circularis* | – | – | * | – | – | – | + |
| *Rajella fyllae* | – | + | – | – | – | – | + |
| *Dipturus linteus* | * | + | – | – | – | – | + |
| *Raja clavata* | – | + | – | – | – | – | + |
| *Chimaera monstrosa* | * | * | ** | *** | *** | *** | ** |

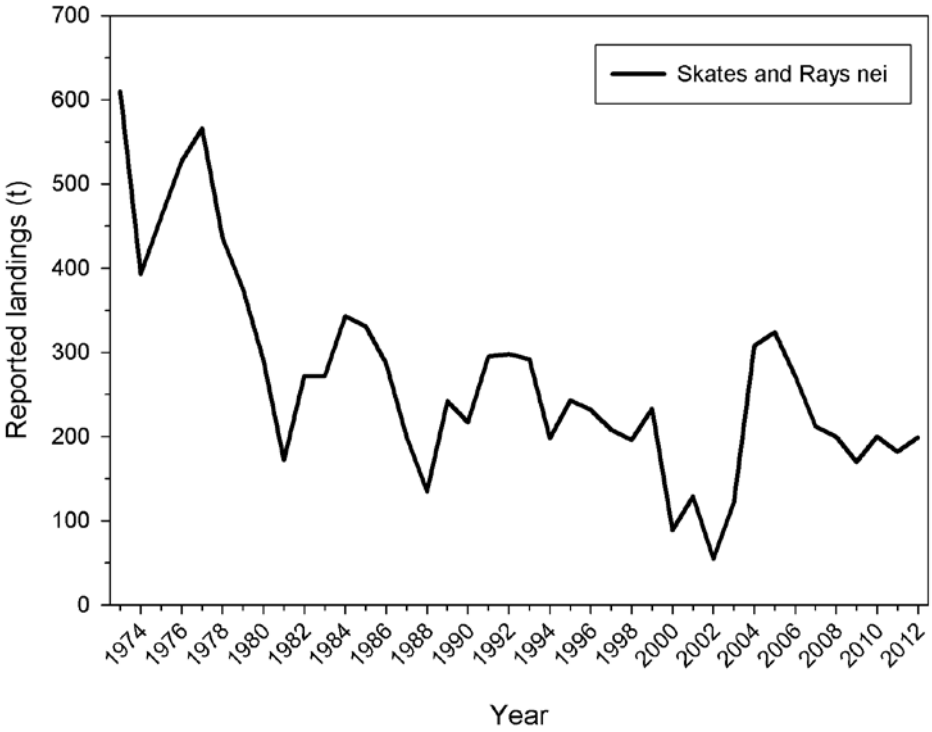



**Figure 17.1. Demersal elasmobranchs at the Faroe Islands (Subarea Vb). Reported landings of skates and rays from 1973–2012 based on ICES database (ICES, 2011), national landings data and Faroese national statistics database (www.hagstova.fo).**

# 18 Demersal elasmobranchs in the Celtic Seas (ICES Subareas VI and VII (Except Division VIId))

## 18.1 Ecoregion and stock boundaries

The Celtic Seas ecoregion covers west of Scotland (VIa), Rockall (VIb), Irish Sea (VIIa), Bristol Channel (VIIf), the western English Channel (VIIe), and the Celtic Sea and west of Ireland (VIIb–c, g–k). This ecoregion broadly equates with the area covered by the North Western Waters RAC (NWWRAC). The southwestern sector of ICES Division VIIk is contained in the oceanic Northeast Atlantic ecoregion.

Whereas some demersal elasmobranchs, such as spurdog (Section 2), tope (Section 10), smooth-hounds (Section 21) and lesser-spotted dogfish, are widespread throughout this region, there are some important regional differences in the distributions of other species, especially the skates (Rajidae) which were described in earlier reports (see ICES 2010a), and are summarized in Table 18.1.

The stock identity for many of these species is poorly known. Genetic studies have only been undertaken for a few species (e.g. Chevolot *et al.*, 2006). 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 these areas. Further studies to better understand stock structure are required, especially in the case of the offshore species, such as *Leucoraja naevus*, for which it is unclear as to the degree of connectivity of populations in the Celtic Sea, Irish Sea and off NW Scotland, as well as with adjacent ICES Divisions in other ecoregions (IVa, VIII). Further tagging studies could also be usefully undertaken to better understand the stock structure of species with patchy distributions, such as *Raja brachyura* and *R. undulata*. Preliminary results of skate tagging in the western English Channel have indicated high site fidelity for these species (Ellis *et al.*, 2011; Stéphan *et al.*, 2013 WD).

## 18.2 The fishery

### 18.2.1 History of the fishery

Most skate species in the Celtic Seas ecoregion are taken as a bycatch in mixed demersal fisheries, which are either directed at flatfish or gadoids. The main countries involved in these fisheries are Ireland, UK, France, Spain, with smaller catches by Belgium and Germany. The main gears used are otter trawl, beam trawl and bottom-set gillnets.

There are some localized, inshore fisheries targeting skates (e.g. *R. clavata*) using longline and tanglenets, and some trawl fisheries targeting various skate species in the southern Irish Sea (VIIa) and Bristol Channel (VIIf) at some times of year.

There is also a large recreational fishery for skates, rays and dogfish, particularly for those species close to shore, with some ports having locally important charter boat fisheries. Whereas many anglers return tope, smooth-hounds and greater-spotted dogfish, there is likely to be some retention of skates, although the levels of these catches are unknown.

### 18.2.2 The fishery in 2012

There is no new information relating specifically to elasmobranchs. TAC and quota regulations may have been restrictive for some fisheries, and the inclusion of com-

mon skate (*Dipturus batis*-complex) and undulate ray *R. undulata* on the prohibited species list has resulted in increased discarding of these species, especially in areas where they are locally common.

It has been suggested that the English gillnet fishery in the Celtic Sea has moved eastwards, due to increasing discarding of *Dipturus batis*-complex, although further studies are required to examine the spatial distribution of fishing activity.

Landings tables for the relevant species are provided in Tables 18.2–18.5.

### 18.2.3 ICES advice applicable

ICES provided advice for several species/stocks in this region in 2012 as summarized below:

**Angel shark**

"*ICES advises on the basis of the precautionary approach that there should be no catches of angel shark, and that it should remain a species prohibited from being fished. Measures should be taken to minimize bycatch*".

**Lesser-spotted dogfish**

"*Based on the ICES approach to data-limited stocks, ICES advises that current catches could be increased by a maximum of 20%. Because the data for catches of lesser-spotted dogfish are not fully documented, ICES is not in a position to quantify the result. ICES does not advise that an individual TAC be set for this stock, at present.*"

**Skates (Rajidae)**

"*ICES provides advice on the overall exploitation (landings and discards) of the ray and skates species assemblage, and also individual species …. ICES does not advise that species-specific TACs be established, at present. This is because a TAC is not considered the most effective means to regulate fishing mortality in these, mostly bycatch, species.*

*ICES advises that a suite of species- and fishery-specific measures be developed to manage the fisheries on the commercial species and achieve recovery of the depleted species. Such measures should be developed by management authorities involving all stakeholders; ICES could assist in this process.*

*Management measures should be framed in a mixed-fisheries context, considering the overall behaviour of demersal fleets, and the drivers for such behaviour. These species are mainly caught in mixed fisheries. When the TAC is exhausted, catches continue to take place, but are discarded. In order to achieve optimal harvesting of the commercial species, and to assist recovery of the depleted species, a suite of measures should be put in place.*

*Closure to fishing of spawning and/or nursery grounds, and measures to protect the spawning component of the population (e.g. maximum landing size) are powerful tools to protect rays and skates. In some cases, single-species TACs may be appropriate, but their effects should be carefully evaluated for each specific case before implementation.*

*Given that the European Community intends to introduce a ban on discards, minimum or maximum landing sizes should be carefully considered before they are introduced, because they could lead to increased discards.*

*ICES advises that white skate (Rostroraja alba) remains on the Prohibited Species List, as it appears to be depleted in the Celtic Sea ecoregion.*"

Species-specific advice was provided for the following stocks:

- Blonde ray (*Raja brachyura*) in Subarea VI (West of Scotland)
- Blonde ray (*Raja brachyura*) in Divisions VIIa, f, g (Irish and Celtic Sea)
- Blonde ray (*Raja brachyura*) in Division VIIe (Western English Channel)
- Thornback ray (*Raja clavata*) in Subarea VI (West of Scotland)
- Thornback ray (*Raja clavata*) in Divisions VIIa, f, g (Irish and Celtic Sea)
- Thornback ray (*Raja clavata*) in Division VIIe (Western English Channel)
- Small-eyed ray (*Raja microocellata*) in Divisions VIIf, g (Celtic Sea)
- Small-eyed ray (*Raja microocellata*) in Division VIIe (Western English Channel)
- Spotted ray (*Raja montagui*) in Subarea VI (West of Scotland)
- Spotted ray (*Raja montagui*) in Divisions VIIa, f, g (Irish and Celtic Sea)
- Undulate ray (*Raja undulata*) in Division VIIj (Great Sole Bank)
- Sandy ray (*Leucoraja circularis*) in the Celtic Sea ecoregion
- Shagreen ray (*Leucoraja fullonica*) in the Celtic Sea ecoregion
- Cuckoo ray (*Leucoraja naevus*) in the Celtic Sea ecoregion
- Common skate, *Dipturus batis* complex (flapper skate (*Dipturus cf. flossada*) and blue skate (*Dipturus cf. intermedia*)) in the Celtic Sea ecoregion
- Other ray and skate species in the Celtic Sea ecoregion

As species-specific landings data are not complete, it is not possible to quantify the current catch and so ICES did not advise that an individual TAC be set for individual stocks, at present. However, it was noted that, based on the ICES approach to data-limited stocks, that catches of *R. microocellata* (VIIf, g) and *Leucoraja naevus* (Celtic Sea ecoregion) should be decreased by at least 36%, *R. montagui* (VI) should be decreased by at least 23%, and catches of *R. brachyura* (VI), *R. brachyura* (Divisions VIIa, f, g), *Raja microocellata* (VIId, e) *Leucoraja circularis* (Celtic Sea ecoregion) and *Leucoraja fullonica* (Celtic Sea ecoregion) should all be decreased by 20%, compared to the last three years' average. ICES also advised that catches of *R. clavata* (both VI and Divisions VIIa, f, g) and *R. montagui* (VIIa, f, g) could be increased by a maximum of 20%. Based on the precautionary approach, ICES also advised that there should be no targeted fishery for *R. undulata*, *Dipturus* cf. *flossada* or *Dipturus* cf. *intermedia.*

In 2010, ICES was asked to comment on the listings of common skate and undulate ray as 'prohibited species' on EC TAC and quota regulations.

For undulate ray, ICES advised "*There is no basis in the current or previous ICES advice for the listing of undulate ray as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion fisheries legislation … In view of the poor knowledge and patchy distribution of these populations, ICES recommends a precautionary approach to the exploitation of these populations of undulate ray*".

For common skate ICES advised "*There is no basis in the current or previous ICES advice for the listing of the common skate (Dipturus batis) as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion*

*fisheries legislation. In the Celtic Seas ecoregion, ICES considers that stocks of the common skate complex is depleted, and that protective management measures are required. There should be no target fishing on the common skate, and there should be a TAC set at 0".*

### 18.2.4 Management applicable

A TAC for skates and rays in VI and VIIa–c, e–k was first established for 2009 and set at 15 748 t. Since then, the TAC has been reduced by approximately 15% (in 2010), 15% (in 2011), 13% (in 2012) and 10% (for 2013). The history of the regulations is as follows:

| Year | TAC for EC waters of VIa–b and VIIa–c, e–k | Other measures | Regulation |
|---|---|---|---|
| 2009 | 15 748 t | 1,2 | Council Regulation (EC) No 43/2009 of 16 January 2009 |
| 2010 | 13 387 t | 1,2,3 | Council Regulation (EU) No 23/2010 of 14 January 2010 |
| 2011 | 11 379 t | 1,2,3 | Council Regulation (EU) No 57/2011 of 18 January 2011 |
| 2012 | 9915 t | 1,2,3 | Council Regulation (EU) No 43/2012 of 17 January 2012 |
| 2013 | 8924 t | 1,2,3 | Council Regulation (EU) No 39/2013 of 21 January 2013 |

1 ) Catches of cuckoo ray (*L. naevus*), thornback ray (*R. clavata*), blonde ray (*R. brachyura*), spotted ray (*R. montagui*), small-eyed ray (*R. microocellata*) sandy ray (*L. circularis*), shagreen ray (*L. fullonica*) should be reported separately.

2 ) Does not apply to undulate ray (*R. undulata*), common skate (*D. batis*), Norwegian skate (*D. nidarosiensis*) and white skate (*Rostroraja alba*). Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

3 ) Of which up to 5% may be fished in EU waters of VIId. There are also mesh-size regulations for target fisheries, the EC action plan for the conservation and management of sharks (EC, 2009), and some local bylaws and initiatives, which were detailed in ICES (2010a).

### 18.2.5 Proposed management plans

A management plan for skates and rays in the Celtic Seas ecoregion was developed by the North-Western Waters Regional Advisory Council (NWWRAC). This would primarily manage skates and rays in the Irish Sea (VIIa) and Celtic Sea (VIIg) by means of voluntary closed areas that would protect spawning/juvenile fish during the spawning season. Proposals to manage skates with separate TACs and management for *Raja* spp. and *Leucoraja* spp. were not agreed. The plan has not yet been fully implemented with just one closed area currently in place. The plan has not yet been evaluated by ICES. In 2012 the NWWRAC submitted a special request to ICES for separate advice for the two species within the *Dipturus batis* complex. However it is not yet possible to provide advice on this basis.

Fishermen off North Devon have a voluntary seasonal closed area over what they consider to be a nursery ground.

## 18.3 Catch data

### 18.3.1 Landings

Landings data were supplied by all nations. Data for 2012 are considered provisional.

#### 18.3.1.1 Skates

Landings tables for skates (Rajidae) by country are provided in Table 18.2. Landings for the entire time-series available are shown in Figure 18.1(a–c). Where species-specific landings have been provided they have been included in the total for the relevant year. Although there are about 15 countries involved in the fisheries in this ecoregion, only six of these (Belgium, France, Ireland, UK (England and Wales), UK (Scotland) and Spain) have continually landed large amounts of skates.

Landings appear as a series of peaks and troughs, with lows of approximately 14 000 t in the mid-1970s and 1990s, and highs of just over 20 000 t in the early and late 1980s and late 1990s. Although landings have fluctuated over most of the time-series, there has been a steady decline in landings since 2000. Annual reported landings have been less than 10 000 t in recent years.

##### West of Scotland (VIa)

Recent reported landings in this division, at about 400 t in the last four years, are at their lowest point since 1973, with almost all countries declaring less than previous landings. In contrast, average landings in the early 1990s were about 3000 t.

##### Rockall (VIb)

Reported landings of skates from Rockall in the 1990s were about 500 t per year, but are now under 200 t. The increased landings in the mid-1990s were a result of new landings of 300–400 t per year by Spanish vessels. These no longer appear to take place with no Spanish landings reported in this area in recent years. It is not clear what proportion of these catches may have been taken from Hatton Bank (VIb1 and XIIb). One to three Russian longliners fished in this area in 2008–2009, mainly catching deep-water species, including sharks, but also catching 7 t of deep-water skate species.

##### Irish Sea (VIIa)

Reported landings of skates in the Irish Sea vary considerably, and ranged from over 1500 t in 1995 to ca. 5000 t in the late 1980s. Since 2006, annual landings have been <2000 t. This may be as a result of reduced fishing effort and effort changes because of the cod recovery programme in the area, where whitefish boats have switched to *Nephrops* fishing, with the latter thought to have a lower skate bycatch. Most landings are from Ireland, UK and Belgium.

##### Bristol Channel (VIIf)

Following an increase in reported skate landings in the mid-1970s, skate landings in VIIf have ranged from 1000–1600 t in recent years. Landings in this area are predominantly from three countries (UK, France and Belgium).

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

Annual reported skate landings from Divisions VIIb–c,j–k were in the general range of 500–1200 t from 1973–1995. Landings then increased during the period 1996–2003, with some annual landings of approximately 4000 t. Landings subsequently declined to approximately 1000 t per year, which is of a comparable magnitude to earlier landings. The level of misreporting in the period 1996–2003 is unknown.

Landings are consistently higher in the southern parts of this region (Divisions VIIe,g–h), and these have reduced from ca. 8000 t per year (from 1973–2000) to ca. 5000 t in recent years.

#### 18.3.1.2 Skate landing categories

Historically, most skate landings have been reported under a generic landing category, although some nations (e.g. France) have reported some species-specific landings data. Available species-specific data were examined in ICES (2010a) and species-specific data continue to be reported. Earlier reports have highlighted various issues regarding the quality of these data (ICES, 2010a, 2011, 2012), and this is discussed further in Section 18.4.3.

A recent study by Silva *et al*. (2012) examined the species-specific data recorded by the UK (England and Wales). Although there were some erroneous or potentially erroneous records, the regional species composition was broadly comparable to that recorded by scientific observers on commercial vessels, and data quality seemed to be improving. Comparable studies to critically evaluate other national data and identify potential errors are still required, so as to better identify where improved training and/or market sampling may improve data quality.

#### 18.3.1.3 Dogfish

Landings data for many demersal sharks are limited, and often included the use of generic landings categories. Nominal landings are provided for lesser-spotted dogfish (Table 18.3) and angel shark *Squatina squatina* (Table 18.4; Figure 18.2).

Landings tables for both lesser-spotted dogfish and greater-spotted dogfish are underestimates, as it has not been possible to disaggregate these species from the generic categories under which they are often declared, and the lack of consistency by which it is categorized. As a consequence of the lack of species-specific landings data for demersal sharks, and the absence of market sampling, it is not currently possible to differentiate the landings of demersal shark species in most areas. Although scyliorhinids are landed for human consumption in parts of the ICES area, fisheries in the Celtic Seas ecoregion also land them for use as bait in pot fisheries.

Angel shark (historically termed monkfish) *Squatina squatina* is increasingly rare, and this species was rarely reported in landings data prior to it being listed as a prohibited species. It is believed that the peak in UK landings in 1997 from VIIj–k were either misreported anglerfish (also called monkfish) or hake, as *S. squatina* is more of a coastal species. These figures have been removed from the landings data. French landings have declined from >20 t in 1978 to less than 1 t per year prior to the prohibition on landings.

### 18.3.2 Discards

#### 18.3.2.1 Discard–retention patterns

Discard information for skates taken in UK (English and Welsh) fleets were recently summarised (Silva *et al*., 2012), and comparable information for dogfishes are presented here for UK fisheries (Figure 18.3; Silva *et al*., 2013 WD). Discards data from other nations were not examined this year.

Although there may be widespread discarding of both skates (e.g. of small individuals and prohibited species, and if vessels have restrictive quota) and dogfishes, a proportion of these fish will survive in some fisheries.

#### 18.3.2.2 Discard survival

Lesser-spotted dogfish have high rates of discard survival from trawl fisheries (Revill *et al*., 2005; Rodríguez-Cabello *et al*., 2005), and the related greater-spotted dogfish will likely have a comparably high discard survival.

Recent studies in UK waters have examined the discard survival of various skates in a range of fisheries. Skate discard survival is approximately 55% in otter trawl fisheries (Enever *et al*., 2009), with this influenced by the other contents of the trawl. In other areas, it has also been observed that *R. clavata* caught by inshore trawlers (which tend to have a short tow duration, due to the increased amount of weed in the water in inshore areas) tend to be lively on capture and commercially caught fish tagged and released have good return rates (Ellis *et al*., 2008), indicating a higher discard survival from such fisheries.

Studies on beam trawlers indicate that survival of skates may be up to 50% when tow duration is <2 h, but is likely to increase with higher tow duration and will also be influenced by the quantity and type of other material in the net (Ellis *et al*., in press).

Inshore gillnet fisheries have a relatively high discard survival for skates when soak time is short (survival is >95% when soak times are ca. 24 h), but longer soak times (40–48 h) resulted in higher mortality rates (Ellis *et al*., in press). The soak times for offshore gillnet fisheries are generally greater, and so there is also an increased mortality, and also an increased incidence of scavenging by isopods (Bendall *et al*., 2012; Ellis *et al*., 2012a WD).

It should also be recognised that such studies are based on data collected by scientists at sea, with skates handled with due care and immediately after capture. Hence, the normal practices on commercial vessels, in terms of how the catches are processed and fish handled could result in reduced survival in comparison to results above.

### 18.3.3 Quality of catch data

Commercial catch data are either limited or of insufficient quality to be used for evaluating the stocks at the current time, although this situation is continually improving.

Historical skate landings were reported at the family level, and there have been improvements to species-specific landings data in recent years, although the current time-series is quite limited. Although many dogfish catches are reported to species, there is still widespread use of generic categories and uncertainty in overall landings.

Observer programmes to examine the catch and discards on commercial vessels continue to provide important information and further analyses of these data are re-

quired for most member states. The future use of discards data will need to be explored in conjunction with estimates of discard survival.

## 18.4 Commercial catch composition

### 18.4.1 Species composition

National species-specific landings data were available for Belgium, France, Ireland and the UK (Table 18.5).

Within the waters off NW Scotland (VIa), French skate landings were dominated by *L. naevus* (ca. 36%) and *R. clavata* (38%), with smaller quantities of *L. circularis, L. fullonica* and *Dipturus* spp. also reported. An increased quantity of *D. oxyrinchus* was reported, with this species accounting for 14.4% of identified skates. This increase in reported landings of *D. oxyrinchus* in this area needs further study, as it is unclear as to whether such landings may be misidentified *D. batis* complex. Indeed, recent studies have questioned the accuracy of landings data for larger, long-snouted skates (Iglesias *et al.*, 2010). Both Ireland and Scotland also reported primarily *L. naevus* and *R. clavata.*

Within the Irish Sea (VIIa), Belgian landings were dominated by *R. brachyura* (34.5%), *R. clavata* (52%) and *R. montagui* (<4%), and Irish landings also indicated a high proportion of these three species (*R. brachyura:* 82%, *R. montagui:* 7.4%, *R. clavata*: 7.8%). English landings were dominated more by *R. clavata* (80%), although *R. brachyura* (11%) and *R. montagui* (5%) were still important components. In contrast, French landings were dominated by *R. montagui* (ca. 69%), and so there may still be some confusion between *R. brachyura* and *R. montagui*.

Skate landings in the western English Channel were comprised mostly of *R. brachyura, R. clavata, R. montagui* and *L. naevus,* and this was evident in landings from Belgium, France and England. These species also dominated the landings in the Bristol Channel (VIIf), although *R. microocellata* was also an important component in UK landings and, to a lesser extent, French landings. The latter species was also thought to be an important component of Belgian landings, although they continue to report catches as *L. circularis* (both species are known by the common name 'sandy ray'). The relative proportion of *Raja* spp. typically decreases further offshore in VIIg,h, with Belgium, Ireland, France and the UK all reporting *L. naevus* as the main species.

### 18.4.2 Size composition

Market sampling data are available for skate species for recent years, as well as the data for the retained portions of the catch from discard observer trips. WGEF reiterate the need for sampling these species so that long-term trends in size frequency can be examined, and also that temporal and spatial differences in the species composition and sex ratio can also be studied for relevant metiers. Species identification is still considered to be an issue.

Although no new data were examined this year, length frequencies for the more common species were shown in ICES (2007; 2011), Johnston and Clarke (2011 WD) provided information on the length frequencies of some skate species taken in Irish fisheries, and UK (English and Welsh) data were recently shown (Silva *et al.*, 2012, 2013).

### 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 (e.g. Silva *et al*., 2012) and that the methods of raising the data are appropriate and can allow for seasonal, geographical and gear-related differences in the species composition of skate landings to be examined. While there are market sampling programmes in place in several countries, in some of these skates are treated as low-priority species, so these species are not sampled as effectively as they might be.

There are concerns that as certain species are added to the prohibited species list, these may be declared in generic categories or as morphologically similar species, rather than be declared to species level. Further studies to better understand landings of *Dipturus* spp. are required by those nations landing such taxa.

Although the quality of other species-specific appears to be improving, there are issues regarding:

- Belgian landings of *L. circularis* are thought to represent *R. microocellata*, and efforts should be made to ensure such data are reported accurately in future years;
- Data for *R. brachyura* and *R. montagui* may be confounded, and all nations could usefully make attempts to improve the data quality for these species;
- Scotland and France both report landings of *R. alba* (a prohibited species), although it is possible that these landings refer to *L. fullonica.* Efforts should be made to ensure such data for these species are checked and reported accurately in future years;
- UK reported landings of *A. hyperborea* and *A. radiata* from this ecoregion. Although the quantities are small, they are thought to represent other species.

## 18.5 Catch per unit of effort

### 18.5.1 Commercial cpue

There were no new commercial cpue data available. See ICES (2010a) for analyses of earlier data.

### 18.5.2 Recreational cpue

No new information available. Information from the Irish Central Fisheries Board has been used by WGEF to inform on the stock status of undulate ray and angel shark (see ICES 2010b for further information).

Updated information from the Inland Fisheries Ireland (IRI) National Marine Sport Fish Tagging Programme confirm the scarcity of angel shark, with only a single individual tagged between 2007 and 2011 (Roche and O'Reilly, 2013 WD), with only occasional specimens (estimated at three per year) caught by anglers in Tralee Bay. Effort data were, however, not available.

## 18.6 Fishery-independent surveys

Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance

of various demersal elasmobranchs, including some biological studies. Several fishery-independent surveys operate in the Celtic Seas ecoregion, as discussed below.

Updated analyses for one survey were provided this year. Individual stock sheets, providing the state of each stock based on survey trends in length and abundance can be found in the Supplementary Material, at the end of this Chapter, and will be updated next year.

It is noted that these surveys were not designed primarily to inform on the populations of demersal elasmobranchs, and so the gears used, timing of the surveys and distribution of sampling stations may not be optimal for informing on some species and/or life-history stages. **However, these surveys provide the longest time-series of species-specific information for demersal elasmobranchs for many parts of the ecoregion.**

### 18.6.1 Southern and Western International Bottom Trawl Surveys

UK (Scotland), UK (England and Wales), UK (Northern Ireland), Ireland, France and Spain undertake trawl surveys in the Celtic Seas ecoregion, as part of the internationally coordinated IBTS surveys for southern and western waters (see Figure 18.4). Although the trawls used in these surveys are not standardized (see Table 18.6), individual surveys can provide survey-specific metrics. Most surveys are in Q4, with some nations also conducting surveys in Q1. The manual for the SWIBTS was revised in 2010 to provide updated information on the various surveys (ICES, 2010a, 2012).

#### 18.6.1.1 French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4)

The French EVHOE survey has been carried out in Bay of Biscay since 1987 and in the Celtic Sea since 1995, when it came under the IBTS. Mahé and Poulard (2005) undertook preliminary analyses of these data, and reported that 26 species of elasmobranch had been recorded in the Bay of Biscay and 19 species in the Celtic Sea. Biseau (2012 WD) provided some updated analyses for this survey, as also presented below.

This survey has been used to provide information on the following species: Lesser-spotted dogfish, *L. naevus, L. fullonica* and *Dipturus batis*-complex in the Celtic Sea, as well as additional information for *R. montagui* and *R. clavata.*

#### 18.6.1.2 Irish Groundfish Survey (IGFS-WIBTS-Q4)

The Irish Groundfish Survey has taken place since 2003. The survey has a random stratified design, with four depth bands. Approximately 185 stations are trawled annually around the Irish coast, with the exception of the Irish Sea, which is covered by Northern Ireland surveys. 15 species of ray have been reported from this survey, along with regular catches of four species of dogfish and lesser amounts of pelagic and deep-water shark species.

Analyses of these data were presented in earlier reports (see ICES, 2010b, 2012) and provide fishery-independent data for the following species: *R. montagui, R. clavata, R. brachyura, L. naevus, S. canicula,* and the *D. batis* complex.

#### 18.6.1.3 Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4)

The annual Spanish Porcupine bottom trawl survey, which started in 2001, collects data on the distribution and relative abundance, and biological information of commercial fish in the Porcupine Bank Area (ICES Divisions VIIb,k). The primary target species for this survey are hake, anglerfish, white anglerfish, megrim, four-spot me-

grim, *Nephrops* and blue whiting. The survey has a random stratified design with two geographical strata (northern and southern) and three depth strata (170–300 m, 301–450 m, 451–800 m). Stations are allocated at random according to the strata surface. The gear used is a Porcupine baca 39/52 with 3 m vertical opening, 23 m wing spread and 134 m door spread, hauls last 30 minutes.

Lesser-spotted dogfish and *L. naevus* occur mainly on the shallower grounds close to the Irish shelf and on the central mound in the bank, with black-mouth dogfish and *L. circularis* occurring in deeper waters around the Porcupine Bank. Other elasmobranchs are also caught; including deep-water sharks (see Section 5).

This survey provides information for black-mouth dogfish, lesser-spotted dogfish, *L. naevus, L. circularis* and *D. batis* complex (see Supplementary Material 18.S1–S5; Fernández-Zapico *et al*., 2013 WD).

#### 18.6.1.4 UK (England and Wales) Western Groundfish Survey (EngW-WIBTS-Q4)

The UK (England and Wales) survey used a modified GOV trawl with ground gear A on fine grounds, and ground gear D on coarser grounds (2004–2011). Preliminary analyses of these data were presented at a previous meeting (ICES, 2010a) and biological data from this survey were used to inform on the length at maturity for several skate species (McCully *et al.*, 2012).

This survey has now been reduced in duration and switched to Q1 in 2013, in order to collect improved data on the maturity stages of teleost fish.

#### 18.6.1.5 UK (Northern Ireland) Groundfish Survey – October (NIGFS-WIBTS-Q4)

UK (Northern Ireland) has undertaken annual Q4 (and Q1, see below) trawl survey of the Irish Sea since 1992. The gear deployed is a commercial rock-hopper trawl fitted with a 20 mm liner in the codend and is towed for a set time period, (either 20 minutes or one hour) to allow comparison between tows and years. AFBI (NI) previously analysed available survey data from the northern VIIa (N) region (see NIEA, 2008; ICES, 2010a).

The absence of participation from UK (Northern Ireland) precluded further analyses of these survey data this year.

#### 18.6.1.6 UK (Northern Ireland) Groundfish Survey – March (NIGFS-WIBTS-Q1)

UK (Northern Ireland) has also undertaken Q1 groundfish surveys in the Irish Sea (see above for further information).

#### 18.6.1.7 Scottish West Coast Groundfish Survey Q4 (ScoGFS-WIBTS-Q4)

The Scottish Quarter 4 west coast groundfish survey, which began in 1990, covers a depth range of 20–500 m. The survey originally covered an area west of the British Isles, from 56–61°N and bounded by the 200 m depth-contour and the coast. Initially the survey area did not include the area of the Minch and the North Channel of the Irish Sea but gradually the spatial coverage has been altered until now it mimics the Quarter 1 survey.

The survey uses a GOV, which originally used ground gear C, now uses a variant of ground gear D. A change of research vessel took place in 1998, and haul duration was reduced from 60 to 30 minutes at this time.

No updated analyses of these data were undertaken this year, although information was given in ICES (2010a; Figure 18.5).

#### 18.6.1.8 Scottish West Coast Groundfish Survey Q1 (ScoGFS-WIBTS-Q1)

The UK (Scotland) Q1 west coast survey covers a similar area to the Q4 survey. No updated analyses of these data were undertaken this year, although information was provided during previous meetings (ICES, 2010a; Figure 18.5).

#### 18.6.1.9 Rockall survey (Rock-IBTS-Q3)

A Q3 survey of the Rockall Bank has also been conducted since 1991. During the period 1998–2004 this survey was conducted only in alternate years, with a deep-water survey along the shelf edge in VIa carried out in the intervening years. Since 2005, both surveys have been carried out annually.

The survey at Rockall has very low catch rates for all elasmobranchs. The most commonly caught demersal elasmobranchs in this survey are *R. clavata,* black-mouth dogfish and *D. batis*-complex, but the catch rates of even these are typically less than ten individuals per survey. The survey is therefore only useful as an indicator of whether a species is present in this part of Division VIb. Other demersal elasmobranchs which have occasionally been caught on this survey include *L. circularis, L. fullonica, R. montagui, D. oxyrinchus* and *Rajella fyllae*. There is little useful survey information from the deeper water of Division VIb.

### 18.6.2 Beam trawl surveys

Three beam trawl surveys operate in this ecoregion (Table 18.6), surveying the Irish Sea, Bristol Channel and western English Channel.

#### 18.6.2.1 UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3)

An annual survey with a 4 m beam trawl is undertaken in the Irish Sea and Bristol Channel each September (Parker-Humphreys, 2004a,b; Ellis *et al*., 2005). Updated information on this survey was provided last year (ICES, 2012). The primary target species for the survey are commercial flatfish (plaice and sole) and so most sampling effort occurs in coastal water. Preliminary studies of survey data indicate that the gear used may not sample larger skates effectively, although this gear should be suitable for sampling smaller skate species (e.g. *R. montagui* and *L. naevus*) and juveniles and sub-adults of the larger species.

Lesser-spotted dogfish, *R. brachyura, R. clavata, R. microocellata* (VIIf), *R. montagui* and *L. naevus* (VIIa) are all sampled during this survey. Biological data from this survey have been used to examine the length at maturity for several skate species (McCully *et al.,* 2012).

This survey has sampling stations around the Lleyn Peninsula and Cardigan Bay, and so is one of the few surveys that can provide information for greater-spotted dogfish, which is locally abundant in parts of the study area.

Catch rates (ind.h$^{-1}$) for this survey were summarized (see survey summary sheets), with analyses (a) omitting data collected prior to 1993, and (b) only including those fixed stations fished at least 16 times during the 19 year time-series (1993–2011).

#### 18.6.2.2 UK (England) beam trawl in Start Bay, VIIe (Eng-WEC-BTS-Q4)

A beam trawl survey is undertaken in and around the Great West Bay (between Start Point and Portland) during October, using 4 m beam trawl. This survey samples a fixed grid of stations. It has usually been undertaken on the commercial fishing vessel

*Carhelmar* (with twin beam trawls) although for a small number of years was undertaken on RV *Corsytes* (single beam trawl). Detailed analyses of the demersal elasmobranchs taken in this survey have been undertaken (Burt *et al.*, 2013), with summary data provided here (Figure 18.6).

This survey samples lesser-spotted dogfish, *R. brachyura, R. clavata, R. montagui* and, to a lesser extent, *R. microocellata* and *R. undulata.*

#### 18.6.2.3 UK (England) beam trawl in western English Channel (Eng-WEC_BTS-Q1)

There is also a beam trawl survey (using twin 4 m beam trawls) in the western English Channel during March. This survey has a random-stratified survey design. Information from this survey was used to examine the distribution of *R. undulata* (ICES, 2010a; Ellis *et al.*, 2012b). Detailed analyses of the demersal elasmobranchs taken in this survey are still required.

### 18.6.3 Other sources of survey data

#### 18.6.3.1 UK Portuguese high headline trawl 1Q (PHHT-Q1)

This Q1 survey with Portuguese high headline trawl (PHHT) was undertaken in the Celtic Sea (ICES Division VIIe–j) from 1982–2003, although the survey grid was most standardized from 1987–2002.

These data have been examined in previous years, and provide a useful perspective of the species present in the area at that time. For example, by providing additional information on the distribution of *D. batis* complex and *L. fullonica*.

#### 18.6.3.2 Additional Irish surveys

An annual survey to collect maturity data for commercially important fish took place during the spring-spawning season (2004–2009). Different areas were surveyed each year, so annual trends cannot be derived. An annual deep-water trawl survey to the west of Ireland (2006–2009) over the depth range 500–1800 m. This may provide limited data for certain skate species.

### 18.6.4 Temporal trends in catch rates

Given the very recent initiation of species-specific landings and discard observer programmes, the status of demersal elasmobranchs of this ecoregion is based primarily on the evaluation of fishery-independent trawl surveys. The available survey data have been used to evaluate the general status of the stocks in the absence of a more formal stock assessment.

#### 18.6.4.1 Blonde ray *Raja brachyura* in Subarea VI

*Raja brachyura* has a patchy distribution in Subarea VI. It is not encountered in sufficient numbers in surveys to derive trends. The stock likely extends to the northwestern North Sea (IVc) and may also continue along the west coast of Ireland.

#### 18.6.4.2 Blonde ray *Raja brachyura* in Divisions VIIa, f, g

*Raja brachyura* has a patchy distribution, and can be locally abundant in some parts of the Irish Sea and Bristol Channel. Mean catch rates in the Irish Sea and Bristol Channel (e.g. as observed in the UK beam trawl survey) are low and variable (see 18.S12). More detailed analyses of these data are required.

If ICES is to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered.

#### 18.6.4.3 Blonde ray *Raja brachyura* in Division VIIe

*Raja brachyura* has a patchy distribution in the western English Channel, and can be locally abundant on particular grounds. Mean catch rates in the Great West Bay are low and they are caught in a relatively low proportion of tows (Figure 18.6a). This may be due to blonde ray favouring particular grounds, for example they are commonly encountered around sand banks in the area.

If ICES is to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered.

#### 18.6.4.4 Thornback ray *Raja clavata* in Subarea VI

The Irish Groundfish survey shows a steady increasing trend in catches of thornback ray in VIa (see 18.S19).

Earlier analyses of the Scottish surveys of VIa suggested stable/increasing catch trends (Figure 18.5b), although updated analyses were not available.

#### 18.6.4.5 Thornback ray *Raja clavata* in Divisions VIIa, f, g

The French EVHOE survey generally indicated stable catch rates in the Celtic Sea (Mahé and Poulard, 2005), although updated analyses from this survey indicate a recent decrease in catch rates (see 18.S8). Nevertheless, it should also be recognised that this survey tends to sample offshore grounds, whereas *R. clavata* is a more inshore species.

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches reasonable numbers of *R. clavata* and they are observed very regularly, although the gear used (4 m beam trawl with chain mat) may have a lower catchability for the larger individuals. This survey shows increasing catch rates (see 18.S13).

The UK (England and Wales) westerly IBTS in the area is currently of too limited temporal coverage with which to examine annual trends in catches, although this survey has caught good numbers of *R. clavata* in Liverpool Bay and the Bristol Channel, where groundgear 'A' is used, and helps provide samples of larger individuals (e.g. for maturity sampling). The UK (Northern Ireland) survey of the Irish Sea has also indicated low but stable catches (see ICES, 2010a), although this survey uses a rock-hopper trawl, and so the catchability may be low.

#### 18.6.4.6 Thornback ray *Raja clavata* in Division VIIe

Preliminary analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) were provided (Figure 18.6b), which suggest stable catch rates.

#### 18.6.4.7 Small-eyed ray *Raja microocellata* in the Bristol Channel (Division VIIf,g)

Although occasional specimens of *R. microocellata* are caught in VIIa, the main concentration of this species is in VIIf, with larger individuals occurring slightly further offshore (VIIg). The youngest size class is not often taken in surveys, as 0-group fish tend to occur in very shallow water.

The UK (England and Wales) beam trawl survey in the Bristol Channel has previously indicated stable catch rates, although the recent mean catches were very lightly below the recent average (see 18.S14).

This species may also occur in some inshore areas of southern and southwestern Ireland, although data are limited for these areas.

#### 18.6.4.8 Small-eyed ray *Raja microocellata* in the English Channel (Divisions VIId,e)

There are also localized concentrations of *R. microocellata* in the English Channel, including around the Channel Islands (Ellis *et al.*, 2011) and Baie of Dournanenz, Brittany (Rousset, 1990), with small numbers taken elsewhere.

Preliminary analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) were provided (Figure 18.6c). The low catch rates are probably related to the patchy distribution of the species in this area.

If ICES are to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered.

#### 18.6.4.9 Spotted ray *Raja montagui* in Subarea VI

*R. montagui* is a widespread and small-bodied skate and is taken in reasonable numbers in a variety of surveys in the ecoregion.

Catches of *Raja montagui* in the Irish Groundfish survey in VIa are increasing, although from a lower level in 2008 (see 18.S20).

Earlier analyses of the Scottish surveys of VIa suggested stable/increasing catch trends (Figure 18.5c), although updated analyses were not available.

#### 18.6.4.10 Spotted ray *Raja montagui* in Divisions VIIa, e, f, g

The French EVHOE survey generally indicated stable catch rates in the Celtic Sea (see 18.S9).

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches reasonable numbers of *R. montagui* and they are observed very regularly, with mature individuals taken on the offshore stations on coarse grounds. This survey indicated above average catches in the last two years (see 18.S15).

Initial analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) were provided (Figure 18.6d), which suggests that recent catches have increased in relation to the preceding five years, although catch rates were greater at the start of the time-series.

Earlier analyses of the UK (Northern Ireland) survey of the Irish Sea also indicated stable/increasing catches, although this survey uses a rock-hopper trawl, and the catchability may be low.

#### 18.6.4.11 Cuckoo ray *Leucoraja naevus* in Subarea VI and Divisions VIIa–c, e–j

*L. naevus* is a widespread and small-bodied skate that is taken in reasonable numbers in a variety of surveys in the ecoregion, especially on offshore grounds.

The stock structure of this species is insufficiently known, which makes the interpretation of catch rates in the various surveys more problematic. As an offshore species

that is also abundant in the Bay of Biscay (VIII) and northern North Sea (IVa), it is possible that the stock or stocks extend out of the Celtic Seas ecoregion.

The Spanish survey on the Porcupine Bank indicated recent decreases in catches (both in terms of biomass and abundance), although catch rates in the last few years are comparable to those observed at the start of the time-series (see 18.S4).

The French EVHOE survey demonstrated peaks in relative abundance in 2001/2002 and 2007/2008, with the lowest catches in 2000. The relative abundance in the Celtic Sea/Biscay region has been stable in recent years (see 18.S6).

The UK (England and Wales) beam trawl survey in VIIa catches reasonable numbers of *L. naevus,* mostly on the offshore stations on coarse grounds. There is the indication of a slight decline from the start of the time-series, with the mean catch rates in the last row years lower than the average catches from the previous five years (see 18.S16).

The Irish Groundfish Survey mainly catches these in offshore areas. Trends in abundance are not very apparent, with fluctuating annual catches (see 18.S21).

Earlier analyses of UK (Scotland) survey data for VIa suggested stable/increasing catch trends (Figure 18.5a), although more recent data were not available.

That different surveys demonstrate slightly different trends in relative abundance for this species further highlights the need to better understand the stock structure of this species.

#### 18.6.4.12 Sandy ray *Leucoraja circularis* in the Celtic Seas and adjacent areas

*Leucoraja circularis* is a large-bodied offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division IVa) and parts of the Bay of Biscay (VIII).

Only the Spanish Porcupine Bank survey covers an important part of the main habitat of *L. circularis* and catches this species in any quantity. Peak catches were in 2003. Overall, the limited time-series has low and variable catch rates, with a stable trend in recent years (see 18.S3).

This species is taken only infrequently in other surveys, with some nominal records considered unreliable.

#### 18.6.4.13 Shagreen ray *L. fullonica* in the Celtic Seas and adjacent areas

*Leucoraja fullonica* is a large-bodied offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division IVa) and parts of the Bay of Biscay (VIII).

Although the UK PHHT Q1 survey seemed to catch *L. fullonica* regularly, albeit in small numbers, this survey has been discontinued. Recently initiated surveys by Ireland and UK (England and Wales) have only caught occasional specimens (see ICES, 2010a), which may reflect insufficient sampling of the main habitat, and possibly a gear effect.

The EVHOE survey suggests an overall declining trend in the numbers and biomass for this species over the time-series (see 18.S7), although this is driven by higher catch

rates at the start of the time-series. Recent catch rates from the last two years appear stable in relation to the five years prior to this.

#### 18.6.4.14 Common skate *Dipturus batis*–complex (flapper skate *Dipturus batis cf. flossada* and blue skate *Dipturus cf. intermedia*) in Subarea VI and Divisions VIIa–c, e–j

Recent studies have highlighted that common skate comprise two different species. Although the nomenclature is still to be ratified, the smaller species (the form described as *D. flossada* by Iglesias *et al*., 2010) will probably remain as *Dipturus batis* and the larger species will probably revert to *D. intermedia.*

*D. intermedia* is the main species in VIa (extending into IVa), although the southern limits of the distribution are unclear, with this species thought to be much less frequent in the Celtic Sea than *D. batis.*

*D. batis* is the main species on Rockall (VIb) and in the Celtic Sea (VIIe-j), with the two species overlapping around the coast of Ireland.

Given that much of the data refers to the species-complex, both species are currently treated together until improved species-specific data are available.

Preliminary analyses of data from the Spanish Porcupine Bank Survey indicate low but stable catch rates of '*D. batis*' (see 18.S5).

A preliminary examination of Scottish data (see ICES, 2010b, 2011) indicated some increase in the proportion of hauls in which *D. batis* complex were observed (Figure 18.5d), although it should be recognized that catch rates were low and with wide confidence intervals.

More detailed analyses of captures of '*D. batis*' from these and other surveys (e.g. the Irish western IBTS surveys are required). The EngW-WIBTS-Q4 survey caught more *Dipturus* cf. *flossada* in 2010 than in previous years (Ellis *et al.,* 2012a WD).

There was a declining catch trend in the EVHOE survey (see 18.S10). Although clarification is required as to whether the recent (2010/2011) drop in catches is due to reporting issues of the different species in the common skate complex, the longer term trend was also declining.

#### 18.6.4.15 Undulate ray *Raja undulata* in Division VIIj

There is thought to be a discrete stock of *R. undulata* in some of the bays of southwest Ireland, particularly Tralee Bay. Due to the shallow depth of these bays, existing surveys are unable to quantify the abundance or local distribution of this species. Limited tagging information (ICES, 2007) has shown movement from out of these bays, but dispersion and migration levels are unknown. Other survey methods should be considered to assess this stock.

#### 18.6.4.16 Undulate ray *Raja undulata* in Divisions VIId, e (English Channel)

There is thought to be a discrete stock of *R. undulata* in the English Channel (VIId,e), with the main part of the range extending from the Isle of Wight to the Normano-Breton Gulf. This stock is surveyed, in part, by three different beam trawl surveys: the Channel beam trawl survey (see Section 15), and surveys of Start Bay (Eng-WEC-BTS-Q4) and the western English Channel (Eng-WEC_BTS-Q1). Catch rates are generally low and variable (Figure 18.6e), partly due to the patchy distribution of this species.

If ICES are to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered.

#### 18.6.4.17 Lesser-spotted dogfish *Scyliorhinus canicula* in Subarea VI and Divisions VIIa-c, e-j (Celtic Sea and west of Scotland)

Lesser-spotted dogfish is abundant and widespread over most parts of the Celtic Seas ecoregion. Like many elasmobranchs it often aggregates by size and sex, and these aggregations can result in occasional large catches.

The Spanish Porcupine Bank survey demonstrates an increasing trend for *Scyliorhinus canicula* to the west of Ireland (see 18.S2), with the highest catch levels in the time-series occurring during the 2007 survey.

Although catches in the French EVHOE survey have declined slightly in recent years, this survey also indicates a general increase in the Celtic Sea (see 18.S11).

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches large numbers of lesser-spotted dogfish, and they are abundant throughout the survey grid, suggesting they occur over a range of habitats. This survey indicates increasing catches (see 18.S17).

Earlier analyses of the Scottish surveys of VIa suggested increasing catch trends (Figure 18.5d), although updated analyses were not available.

Other data, such as the UK (Northern Ireland) survey of the Irish Sea and the Irish Groundfish Survey also indicate increasing catch trends (see ICES, 2010a).

#### 18.6.4.18 Greater-spotted dogfish *Scyliorhinus stellaris* in the Celtic seas and adjacent areas

Greater-spotted dogfish is larger than lesser-spotted dogfish and also tends to have a more restricted, inshore distribution than lesser-spotted dogfish. The preferred habitats for this species include rocky, inshore grounds. Hence, most surveys will not sample effectively the main parts of their range, resulting in low catch rates.

The stock structure is little-known at the moment, although preliminary tagging studies have not observed any movements between the western English Channel and Irish Sea (Burt *et al.*, 2013 WD; Figure 18.7).

The UK (England and Wales) beam trawl survey in VIIa and VIIf catches small numbers of greater-spotted dogfish (although the catchability for the larger individuals may be low), and they are captured regularly around Anglesey, Lleyn Peninsula and in Cardigan Bay. This survey indicates that the most recent catches are above average (see 18.S18).

The UK (England and Wales) westerly IBTS survey also had stations along the west coast of Wales. Although they are captured regularly in this survey, catches comprised few individuals. These UK surveys have tagged and released a number of greater-spotted dogfish in recent years, which will hopefully provide further information to aid in stock identification.

#### 18.6.4.19 Angel shark *Squatina squatina* in the Celtic Seas and adjacent areas

One specimen of angel shark was captured in Cardigan Bay during the 2009 UK (England and Wales) beam trawl survey, confirming the continued presence of this species in the area. Angel shark also occurs in Tralee Bay, although once again rec-

ords are very infrequent. Dedicated inshore surveys with an appropriate survey gear would probably be necessary if the current status of this species is to be evaluated.

#### 18.6.4.20 White skate *Rostroraja alba* in the Celtic Seas and adjacent areas

*Rostroraja alba* was reportedly abundant in the English Channel in the 1800s (Ellis *et al*., 2010) are now very rare in the area, with only isolated individuals taken in some surveys, mostly in the south-west of this ecoregion (e.g. Fernández-Zapico *et al*., 2013 WD).

Given the rarity of this species, no surveys can currently inform on the exact status of the species, which may be considered near-extirpated.

#### 18.6.4.21 Other demersal elasmobranchs

Both long-nose skate *Dipturus oxyrinchus* and Norwegian skate *Dipturus nidarosiensis* also occur in the ecoregion, although the main habitats of these species are along the continental slope, at Rockall and around the Porcupine Bank (e.g. Fernández-Zapico *et al*., 2013 WD), and so only a part of the distribution may be sampled in some of surveys conducted within the ecoregion.

### 18.6.5 Quality of data

#### 18.6.5.1 Species identification in surveys

There are several identification problems with certain skate species that may lead to uncertainty in the quality of survey data. *Raja montagui* and *R. brachyura* may be confused, and the identification of neonatal specimens of *R. clavata*, *R. brachyura* and *R. montagui* can also be problematic.

Many recent surveys in the area have attempted to ensure that data collected for the common skate-complex are now differentiated, and whereas national delegates have confirmed which species have been caught, survey data can only be uploaded to DATRAS for the complex, as the two species do not have valid taxonomic codes as yet. Work to expedite the taxonomic problems was discussed intersessionally and will hopefully be resolved soon.

#### 18.6.5.2 Gear performance

There are several scientific trawl surveys in the ecoregion. Beam trawl surveys operate in VIIa,e,f, and this gear would appear to be a suitable sampling tool for lesser-spotted dogfish, juvenile smooth-hounds and smaller skates. However, this gear may not be appropriate to informing on larger skates.

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

#### 18.6.5.3 Degree of survey effort in relation to localized populations

Several demersal elasmobranch species that occur sporadically throughout much of the Celtic Seas ecoregion have certain sites where they are locally abundant. Localized depletions of the species at these sites could therefore have a major impact on the population as a whole. Hence, the status of such species may need to be monitored and assessed on a more localized scale.

In the case of *Raja microocellata*, which is locally abundant in the Bristol Channel (VIIf), there are many sampling stations in this area from the UK (England and Wales) beam trawl survey, and so WGEF should be able to monitor and evaluate their status.

However, some other species have more discrete areas in which they are abundant, and as such existing survey data may be limited. This is especially noteworthy for some of the more coastal species. More detailed studies of existing data are required to better inform on the status of:

- *Raja undulata* in Tralee Bay (VIIj) and the middle of the English Channel (VIId,e);
- *Scyliorhinus stellaris* off Anglesey and the Lleyn Peninsula (VIIa, see also Figure 18.7);
- *Squatina squatina* in Tralee Bay and Cardigan Bay;
- *Raja brachyura* in areas of high abundance.

In some instances, it may be that available survey data will not be appropriate to evaluate some of these species, and dedicated inshore surveys using an appropriate gear and census method may be required if these stocks are to be better evaluated.

## 18.7 Life-history information

Various published biological studies provide maturity and age data for skates in the Celtic Seas (e.g. Fahy, 1989; Gallagher, 2000; Gallagher *et al*., 2005). Recent studies have provided improved information on the length–weight relationships and lengths at maturity (McCully *et al*., 2012).

### 18.7.1 Ecologically important habitats

Ecologically important habitats for the demersal elasmobranchs would include (a) any oviposition (egg-laying) sites for oviparous species; (b) pupping grounds for viviparous species; (c) nursery grounds; (d) habitats of the rarer species, as well as other sites where there can be large aggregations (e.g. for mating or feeding).

Surveys may be able to provide information on the locations of nursery grounds and other juvenile habitats, and these should be further investigated to identify sites where there are large numbers of 0-groups and where these life-history stages are found on a regular basis.

Little is known about the habitats of the rarer elasmobranch species, and further investigations on these are required. Wearmouth and Sims (2009) undertook a tagging study of *Dipturus batis*, and tagging studies have recently been undertaken for this complex in the Celtic Sea (Bendall *et al*., 2012).

### 18.7.2 Recruitment

Juveniles of many species are found in most groundfish surveys and in discards, although usually in small numbers. Annual beam trawl surveys in September catch recently hatched thornback rays (ca. 10 cm total length). Although catches of 0-groups tend to be low and may not be accurate indicators of recruitment, a more critical examination of these data could usefully be undertaken. However for areas where elasmobranch catches are low, such as skates in VIIj, it will not be possible to estimate recruitment without dedicated surveys.

## 18.8 Exploratory assessment models

### 18.8.1 Previous assessments

Preliminary assessments of the Celtic Sea stock of *L. naevus* were made during the DELASS project, using GLM analyses of commercial cpue and EVHOE survey data, a surplus production model and catch curve analysis. The results of these exploratory assessments did not give consistent results. *L. naevus* had demonstrated signs of an increase in number, followed by a decrease in the 1990s (Heessen, 2003). Longer term cpue data and a better knowledge of the stock are required.

A GAM analysis of survey data was carried out by WGEF in 2007. This used Scottish Groundfish data for *R. clavata, L. naevus, R. montagui and S. canicula* in Divisions VIa, VIb and UK (English and Welsh) beam trawl survey for these species in VIIa/f. Summary plots were included in ICES (2010a) and in ICES advice, with more information on the results and a description of the methods used given in ICES (2007).

### 18.8.2 Stock status

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

| Species | Nominal stock Area | Perceived status |
|---|---|---|
| Blonde ray *Raja brachyura* | VIa | Uncertain. No trends are apparent from surveys. |
| | VIIa,f,g | Uncertain. No trends are apparent from surveys. Locally abundant off SE Ireland. |
| | VIIe | Uncertain. Locally abundant in parts of area. |
| Thornback ray *R. clavata* | VI | Survey catch rates stable/increasing. |
| | VIIa,f,g | Survey catch rates increasing. |
| | VIIe | Survey catch rates stable |
| Small-eyed ray *R. microocellata* | VIIf,g | Survey catch rates stable, but recent survey catches have fallen slightly |
| | VIId,e | Uncertain, relationship with populations in VIIf,g unclear. |
| Spotted ray *R. montagui* | VI | Survey catch rates stable/increasing. |
| | VIIa,e, f,g | Survey catch rates increasing. Survey catch rates in VIIe increasing in recent years, but this follows a period of decline. |
| Cuckoo ray *Leucoraja naevus* | VI-VII | Uncertain. The stock area is not known, and may merge with Subareas IV and VIII. Survey catches in VIa are increasing, whilst survey catches in VII appear stable (EVHOE survey) or have shown a decline |
| Sandy ray *L. circularis* | VI, VIIb,c,h–k | Uncertain. Survey catch rates in Division VIIj low and variable, and appear stable, although compraable data lacking for other parts of the range. |
| Shagreen ray *R. fullonica* | VI, VIIb,c,g–k | Uncertain. There is a poor signal from surveys for this species. |

| Species | Nominal stock Area | Perceived status |
|---|---|---|
| Common skate<br>*Dipturus batis* complex | VI–VII | Uncertain. Although common skate *D. batis* was previously considered depleted, on the basis of its loss from former habitat (e.g. Brander, 1981), this species has recently been confirmed to comprise two species. Longer-term data to determine the extents to which the two individual species have declined are lacking.<br>Blue skate *Dipturus batis* (*D.* cf. *flossada*) is known to occur in parts of VIb (Rockall Bank), Celtic Sea (VIIe–k) and it likely extends into Subarea VIII. It's northern limits are unclear.<br>Flapper skate *D.* cf. *intermedia* occurs in VIa, parts of VIb, and the northern North Sea (IVa). Smaller numbers are taken in the Celtic Sea (VIIe–k), although it's southerly and northerly limits are unknown.<br>The bathymeric ranges of both species are poorly known, as is their western distribution ranges, although unspecified *D. batis* have been reported from the mid-Atlantic ridge. |
| Undulate ray<br>*R. undulata* | VIIj | Uncertain. Locally common in discrete areas. |
| | VIId,e | Uncertain. Locally common in discrete areas. |
| Lesser-spotted dogfish<br>*Scyliorhinus canicula* | VI and VII | Survey catch rates increasing. |
| Greater-spotted dogfish<br>*S. stellaris* | VIIa,e,f | Locally common. Survey catches appear to be increasing in VIIa, but there is a poor signal in other areas due to low catches, as the rocky habitats of this coastal species are poorly sampled. |
| Angel shark<br>*Squatina squatina* | VI,VII | Rare in this ecoregion, and near extirpated from parts of its former range. |
| White skate<br>*Rostroraja alba* | VII | Considered to be near-extirpated from this ecoregion (which is the northern part of the geographical distribution). See Ellis *et al*. (2010) for further information. |
| Norwegian skate<br>*Dipturus nidarosiensis* | VI, VIIb,c,j,k | Uncertain. Stock area likely extends outside the ecoregion. |
| Long-nose skate<br>*Dipturus oxyrinchuss* | VI, VIIb,c,j,k | Uncertain. Stock area likely extends outside the ecoregion. |

## 18.9 Quality of assessments

Commercial data are insufficient for a full stock assessment, although data are improving.

Several updated analyses of temporal changes in relative abundance in fishery-independent surveys were carried out in 2012 and 2013. These surveys provide the most comprehensive time-series of species-specific information. For example the French and Scottish IBTS surveys and the UK (England and Wales) beam trawl surveys have been undertaken for 10–20 years. Several other surveys now operate in the area, but over a shorter time frame. There is also a wide spatial coverage of most parts of the ecoregion with otter trawl and/or beam trawl. Hence, fishery-independent trawl data are considered the most appropriate data for evaluating the general status of the more common demersal elasmobranchs.

However, it must be stressed that not all skates and rays are well sampled by these surveys, and even the most common species (spotted ray, thornback ray, cuckoo ray) may only occur in about 30% of hauls. There is also uncertainty regarding the mean catch rates, due to the large confidence intervals.

There are several other issues that influence the evaluation of stock status:

1 ) The stock identity for many species is not accurately known (although there have been some tagging studies and genetic studies to inform on some species, and the stocks of species with patchy distributions can be inferred from the spatial distributions observed from surveys). For inshore, oviparous species, assessments by ICES division or adjacent divisions may be appropriate, although for species occurring offshore, including *L. naevus*, a better delineation of stock boundaries is required;

2 ) Age and growth studies have only been undertaken for the more common skate species, although IBTS and beam trawl surveys continue to collect maturity information. Other aspects of their biology, including reproductive output, egg-case hatching success, and natural mortality (including predation on egg-cases) are poorly known;

3 ) The identification of skate species is considered to be reliable for recent surveys, although there are suspected to be occasional misidentifications;

4 ) Although fishery-independent surveys are informative for commonly occurring species on the inner continental shelf, these surveys are not well suited for species with localized, coastal distributions (e.g. *R. undulata*, angel shark), patchy distributions (e.g. *R. brachyura*) or outer shelf distributions (e.g. *L. fullonica*).

## 18.10 Reference points

No reference points have been proposed for these stocks.

## 18.11 Conservation considerations

Angel shark and *R. alba* are listed on the UK Wildlife and Countryside Act, which gives them legal protection in the inshore waters of England and Wales (out to 6 nm).

IUCN list angel shark, "*Dipturus batis*" and *Rostroraja alba* (NE Atlantic) as Critically Endangered, *Raja undulata* is listed as Endangered and *Leucoraja circularis* as Vulnerable.

Species listed by the IUCN as Near Threatened include *Dipturus oxyrinchus*, *Leucoraja fullonica*, *Raja brachyura*, *Raja clavata*, *Raja microocellata* and *Scyliorhinus stellaris*.

*Leucoraja naevus*, *Raja montagui*, *Rajella fyllae*, *Scyliorhinus canicula* and *Mustelus asterias* are all listed as Least Concern (Gibson *et al*., 2008).

## 18.12 Management considerations

A TAC was only introduced in 2009 for the main skate species in this region.

Technical interactions for fisheries in this ecoregion are shown in Table 18.7.

It has been difficult for WGEF to deal with some of the elasmobranchs in this region adequately. This is as a result of the long history of aggregated species landings, limited knowledge of the species composition of skates in commercial landings (including taxonomic confusion in some datasets), and a poor knowledge of stock structure.

Currently, fishery-independent trawl survey data provide the best time-series of species-specific information.

#### Commercial species

Thornback ray *Raja clavata* is one of the most important commercial species in the inshore fishing grounds of the Celtic Seas (e.g. eastern Irish Sea, Bristol Channel). It is thought to have been more abundant in the past, and more accurate longer term assessments of the status of this species are required. Preliminary analyses of recent survey data indicate that the relative abundance of this species in VIa and VIIa,f suggest it has been stable or increasing in recent years.

Cuckoo ray *Leucoraja naevus* is an important commercial species on offshore grounds in the Celtic Sea. Survey catch rates have decreased in some areas, but have shown more stability in other areas. Further studies to better define the stock structure are required to better interpret these contrasting abundance trends.

The relative abundance of lesser-spotted dogfish *Scyliorhinus canicula* and spotted ray *Raja montagui* in this ecoregion appear to be increasing in recent years.

Council Regulations (EC) No 43/2009 of 16 January 2009 and (EU) No 23/2010 of 14 January 2010 banned the retention on board of three species of skate and this has been a controversial issue for some fisheries with regards *R. undulata* (in VIIe) and *D. batis (D. cf. flossada)* in some offshore areas.

Currently, interpretation of the prohibited species list may not allow commercial vessels to land fish for scientific purposes (including tagged fish), which has impacted on some recent scientific research programmes on these species.

### Other species

Contemporary surveys occasionally record other skate species, although catch rates of these species are highly variable.

The near-absence of *R. alba* and angel shark in contemporary surveys, as noted by ICES (2006) is cause for concern.

There are anecdotal and historical reports suggesting that localized populations of white skate *Rostroraja alba* were targeted in fisheries in the western English Channel, Baie de Douarnenez (Brittany) and off the Isle of Man, and this species is now very rarely observed in the region. Further studies to determine whether viable populations of *R. alba* remain in this ecoregion are required.

Localized populations of angel shark in Start Bay (VIIe) and Cardigan Bay (VIIa) have declined severely and this species is now reported only infrequently in the area, though it was previously more common (Rogers and Ellis, 2000). Landings of this species have almost ceased, with only occasional individuals landed. Tagging studies from the Irish Central Fisheries Board demonstrate that these sharks can migrate further than previously thought. Although they are considered to be only abundant in Tralee Bay, and many tagged fish from this area have been returned from nearby areas along the west coast of Ireland, there have also been reported recaptures from the English Channel, France and Spain (Green, 2007). Landings of this species have almost ceased, with only occasional individuals landed. It is an inshore species, distinctive, and may have a relatively good discard survivorship. Given the concern over *S. squatina* in this and adjacent ecoregions, the ban on retaining this species will hopefully benefit their stock(s).

Historically, species such as *L. circularis, L. fullonica* and *D. oxyrinchus* may have been more widely distributed on the outer continental shelf seas. These species are now encountered only infrequently in some surveys on the continental shelf, though they are still present in deeper waters along the edge of the continental shelf. Hence studies to better examine the current status of these species in Subareas VI and VII should be undertaken. Future analyses should examine the long-term distribution and relative abundance of these species. In the first instance, data on the occurrences of these species should be collated from all surveys.

## 18.13 References


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

Biseau, A. 2012. Elasmobranch indices from French surveys. Working Document presented to the Working Group on Elasmobranch Fishes, 25 pp.

Brander, K. 1981. Disappearance of common skate *Raia batis* from the Irish Sea. Nature, 290: 48–49.

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document presented to the Working Group on Elasmobranch Fishes, 12 pp.

Burt G.J., Ellis J.R., Harley B.F. and Kupschus S. 2013. The FV Carhelmar beam trawl survey of the western English Channel (1989–2011): History of the survey, data availability and the distribution and relative abundance of fish and commercial shellfish. Science Series Technical Report, CEFAS Lowestoft, 151: 139 pp.

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.

EC. 2009. Communication from the Commission to the European Parliament and the council on a European Community action plan for the conservation and management of sharks. Com. 2009 (40). 5th February 2009. 16 pp.

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

Ellis, J.R., Burt, G.J., Cox, L.P.N., Kulka, D.W. and Payne, A.I.L. 2008. The status and management of thornback ray *Raja clavata* in the southwestern North Sea. ICES CM 2008/K:13, 45 pp.

Ellis, J.R., Silva, J.F., McCully, S.R., Evans, M. and Catchpole, T. 2010. UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10, 38 pp.

Ellis, J.R., Morel, G., Burt, G. and Bossy, S. 2011. Preliminary observations on the life history and movements of skates (Rajidae) around the Island of Jersey, western English Channel. Journal of the Marine Biological Association of the United Kingdom, 91: 1185–1192.

Ellis, J.R., Bendall, V.J. and McCully, S.R. 2012a. Notes on common skate (*Dipturus batis*-complex) in the Celtic Sea. Working Document presented to the Working Group on Elasmobranch Fishes, 13 pp.

Ellis, J.R., McCully, S.R. and Brown, M.J. 2012b. An overview of the biology and status of undulate ray *Raja undulata*. Journal of Fish Biology, 80: 1057–1074.

Ellis, J. R., McCully, S. R., Silva, J. F., Catchpole, T. L., Goldsmith, D., Bendall, V. and Burt G. In press. Assessing discard mortality of commercially caught skates (Rajidae) – validation of experimental results. Report to DEFRA.

Enever, R., Catchpole, T.L., Ellis, J.R. and Grant, A. 2009. The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research, 97: 72–76.

Fahy, E. 1989. Growth parameters of rays (Batoidei) in Irish waters, from material examined in commercial catches. ICES CM 1989/G:59, 11 pp.

Fernández-Zapico, O., Velasco, F., Baldó, F., Rodríguez-Cabello, C. and Ruiz-Pico, S. 2013. Results on main elasmobranch species captured during the 2001–2012 Porcupine Bank (NE Atlantic) bottom trawl surveys. Working Document presented to the Working Group on Elasmobranch Fishes, 26 pp.

Gallagher, M. J. 2000. The fisheries biology of commercial ray species from two geographically distinct regions. PhD. Thesis. Trinity College, University of Dublin. 240 pp.

Gallagher, M. J., Nolan, C.P. and Jeal, F. 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. Journal of Northwest Atlantic Fishery Science, 35: 47–66.

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

Green, P. 2007. CFB Marine Sportfish Tagging Programme 1970–2006. Working Document presented to the Working Group on Elasmobranch Fishes.

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

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 Working Group on Elasmobranch Fisheries (WGEF). Galway, Ireland.

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

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

ICES. 2012. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–26 June 2012, Lisbon, Portugal. ICES CM 2012/ACOM:19. 547 pp.

ICES. 2013. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 8–12 April 2013, Lisbon, Portugal. ICES CM 2013/SSGESST:10. 272 pp.

Iglesias, S.P., Toulhaut, L. and Sellos, D.Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 319–333.

Johnston, G. and Clarke, M. 2011. A comparison of the length frequencies of two ray species in the Irish sea, 2008–2010, with the length frequencies measured in 1997. Working Document to WGEF 2011, 4 pp.

Mahé, J. C. and Poulard, J.C. 2005. Spatial distribution and abundance trends of main elasmobranch species in the Bay of Biscay and the Celtic Sea from bottom-trawl surveys. ICES CM 2005/N:04, 27 pp.

McCully, S. R., Scott, F. and Ellis, J. R. 2012. Lengths at maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES Journal of Marine Science, 69: 1812–1822.

NIEA. 2008. Position statement on sharks, skates and rays in Northern Ireland waters. Report No. BDU 2/66, 198 pp.

Parker-Humphreys, M. 2004a. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Irish Sea (ICES Division VIIa) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 120, 68 pp.

Parker-Humphreys, M. 2004b. Distribution and relative abundance of demersal fishes from beam trawl surveys in the Bristol Channel (ICES Division VIIf) 1993–2001. Science Series Technical Report, Cefas, Lowestoft, 123, 69 pp.

Pawson, M., Nichols, V. 1994. Recapture patterns of rays tagged in the Bristol Channel and Irish Sea. In Proceedings of the Second European Shark and Ray Workshop. Tag and Release Schemes and Shark and Ray Management Plans, 15–16 February 1994 (Fowler, S.T. and Earll, R.C., Eds.), pp. 10–13.

Revill, A., Dulvy, N. K. and Holst, R. 2005. The survival of discarded lesser-spotted dogfish (*Scyliorhinus canicula*) in the western English Channel beam trawl fishery. Fisheries Research, 71: 121–124.

Roche, W. and O'Reilly, S. 2013. Note on recent Angel shark (*Squatina squatina*) angling and tagging activity in Ireland- 1970–2011. Working Document presented to the Working Group on Elasmobranch Fishes, 2 pp.

Rodríguez-Cabello, C., Fernández, A., Olaso, I. and Sánchez, F. 2005. Survival of small-spotted catshark (*Scyliorhinus canicula*, L.) discarded by trawlers in the Cantabrian Sea. Journal of the Marine Biological Association of the United Kingdom, 85: 1145–1150.

Rogers, S. and Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. ICES Journal of Marine Science, 57: 866–881.

Rousset, J. 1990. Catches and geographical distribution of selachians on the western coast of Brittany. Journal of the Marine Biological Association of the United Kingdom, 70: 255–260.

Silva, J.F., Ellis, J.R. and Catchpole, T.L. 2012. Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. Journal of Fish Biology, 80: 1678–1703.

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

Stéphan E., Hennache, C., Delamare, A., Legrand, V. and Leblanc, N. 2013. The French RECOAM project : study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay. Working Document presented to the Working Group on Elasmobranch Fishes, 8 pp.

Wearmouth, V.J. and Sims, D.W. 2009. Movement and behaviour patterns of the critically endangered common skate *Dipturus batis* revealed by electronic tagging. Journal of Experimental Marine Biology and Ecology, 380: 77–87.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J., & Tortonese, E. 1984. Fishes of the north-eastern Atlantic and the Mediterranean.

**Table 18.1. Demersal elasmobranchs in the Celtic Seas. Preliminary identification of the occurrence of the various species in the ecoregion by ICES division (Eastern English Channel (VIId) also included). Symbols: ● = Present, ○ = absent; ⦿ = occasional vagrants reported from the area, or distribution might extend to this division; ⊗ = no recent records but occurred in the past;? = uncertain). Adapted from Whitehead *et al.* (1984); Ellis *et al.* (2005); ICES (2007; Table 1.4) and FishBase.**

| Scientific name | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIh | VIIj | VIIk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Skates (Rajidae) occurring on the continental shelf and upper slope | | | | | | | | | | | | |
| *"Dipturus batis"*-complex | ● | ● | ● | ● | ● | ⦿ | ● | ● | ● | ● | ● | ● |
| *D. batis (cf. flossada)* | ⦿ | ● | ● | ● | ● | ⊗ | ● | ⦿ | ● | ● | ● | ● |
| *D. cf.intermedia* | ● | ⦿ | ⦿ | ⦿ | ? | ? | ? | ? | ⦿ | ⦿ | ⦿ | ⦿ |
| *D. oxyrinchus* | ● | ● | ○ | ● | ● | ○ | ○ | ○ | ⦿ | ● | ● | ● |
| *D. nidarosiensis* | ● | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ● |
| *Leucoraja circularis* | ● | ● | ○ | ● | ● | ○ | ○ | ○ | ⦿ | ● | ● | ● |
| *L. fullonica* | ● | ● | ⦿ | ● | ● | ○ | ⦿ | ⦿ | ● | ● | ● | ● |
| *L.naevus* | ● | ● | ● | ● | ● | ⦿ | ● | ● | ● | ● | ● | ● |
| *Raja brachyura* | ● | ⦿ | ● | ● | ⦿ | ● | ● | ● | ● | ● | ● | ○ |
| *R. clavata* | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ⦿ |
| *R. microocellata* | ⦿ | ○ | ⦿ | ● | ○ | ● | ● | ● | ● | ⦿ | ● | ○ |
| *R. montagui* | ● | ● | ● | ● | ⦿ | ● | ● | ● | ● | ● | ● | ⦿ |
| *R. undulata* | ○ | ○ | ⦿ | ● | ○ | ● | ● | ⦿ | ⦿ | ⦿ | ● | ○ |
| *Rajella fyllae* | ● | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ● | ● | ● |
| *Rostroraja alba* | ○ | ○ | ⊗ | ● | ? | ⊗ | ⊗ | ? | ? | ? | ? | ○ |
| Demersal sharks (Scyliorhinidae, Trikidae, Squatinidae) occurring on the continental shelf | | | | | | | | | | | | |
| *Galeus melastomus* | ● | ● | ⦿ | ● | ● | ○ | ⦿ | ⦿ | ● | ● | ● | ● |
| *Scyliorhinus canicula* | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| *S. stellaris* | ● | ⦿ | ● | ● | ? | ● | ● | ● | ● | ● | ● | ○ |
| *Mustelus* spp. | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| *Squatina squatina* | ● | ? | ● | ● | ○ | ⊗ | ● | ● | ● | ● | ● | ○ |
| Demersal rays (Torpediniformes and Myliobatiformes) occurring on the continental shelf | | | | | | | | | | | | |
| *Torpedo marmorata* | ? | ? | ? | ? | ○ | ⦿ | ● | ⦿ | ⦿ | ● | ? | ? |
| *Torpedo nobiliana* | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ |
| *Dasyatis pastinaca* | ⦿ | ⦿ | ⦿ | ⦿ | ○ | ● | ● | ⦿ | ⦿ | ● | ⦿ | ○ |
| *Myliobatis aquila* | ⦿ | ? | ⦿ | ⦿ | ○ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ⦿ | ○ |
| | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIh | VIIj | VIIk |

**Table 18.2. Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIa).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 13 | 10 | 3 | 4 | . | . | . | 2 | 1 | 2 | . | . | 2 | 1 | 3 | 2 | 3 | . | 2 | . |
| Denmark | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | + | . | + | + |
| Faroe Islands | 107 | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . |
| France | 736 | 907 | 777 | 918 | 653 | 839 | 730 | 583 | 2318 | 741 | 885 | 955 | 996 | 645 | 727 | 766 | 724 | 711 | 621 | 603 |
| Germany | . | 1 | . | . | 1 | 2 | 1 | . | . | . | . | . | 1 | . | . | . | . | . | . | . |
| Ireland | 281 | 336 | 458 | 425 | 342 | 242 | 268 | 343 | 474 | 537 | 806 | 836 | 574 | 440 | 367 | 690 | 630 | 150 | 200 | 350 |
| Netherlands | . | . | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | 116 | 105 | 70 | 77 | 96 | 226 | 81 | 253 | 119 | 146 | 217 | 99 | 67 | 44 | 93 | 144 | 264 | 71 | 38 | 82 |
| Poland | 64 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain | . | . | . | . | . | . | . | . | . | 19 | 11 | 8 | 4 | 12 | 14 | 8 | . | . | 43 | . |
| UK - (E,W&N.I.) | 264 | 266 | 264 | 334 | 338 | 292 | 209 | 89 | 93 | 99 | 104 | 141 | 47 | 47 | 54 | 87 | 67 | 57 | 77 | 72 |
| UK – Scotland | 1302 | 1142 | 1393 | 1792 | 1724 | 1660 | 1540 | 1577 | 1496 | 1617 | 1818 | 2016 | 2034 | 1802 | 2111 | 2137 | 2499 | 2007 | 2026 | 1605 |
| Total | 2883 | 2767 | 2965 | 3551 | 3154 | 3261 | 2829 | 2847 | 4501 | 3161 | 3841 | 4055 | 3726 | 2991 | 3370 | 3834 | 4187 | 2996 | 3007 | 2712 |
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Belgium | 1 | 2 | 7 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 8 | 9 | 4 | 4 | 0 | . | | 0 | 0 | 0 |
| Denmark | + | + | + | + | . | + | + | . | . | . | . | . | 0 | | . | . | . | 0 | 0 | 0 |
| Faroe Islands | . | . | . | . | . | . | . | . | . | . | . | . | | . | . | 0 | . | | | |
| France | 606 | 437 | 553 | 526 | 384 | 333 | NA | 321 | 278 | 212 | 183 | 149 | 181 | 174 | 194 | 245 | 97 | 65 | 50 | 97 |
| Germany | . | 2 | . | 1 | 4 | 16 | 7 | 1 | 1 | . | 3 | 0 | . | 0 | | | | | 0 | |
| Ireland | 331 | 265 | 504 | 681 | 596 | 488 | 388 | 274 | 238 | 311 | 364 | 363 | 186 | 176 | 119 | 109 | 81 | 111 | 88 | 103 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | | 0 | | 0 |
| Norway | 56 | 9 | 74 | 29 | 20 | 50 | 29 | 49 | 20 | 25 | 2 | 2 | 10 | 4 | 5 | 11 | 4 | 11 | 5 | 2 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | | | | |
| Spain | . | . | . | 47 | 58 | 69 | 34 | 2 | . | 9 | 27 | 14 | 14 | 0 | 0 | 4 | | | | 8 |
| Spain (Basque Country) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | 1 | |
| UK - (E,W&N.I.) | 70 | 101 | 138 | 101 | 69 | 157 | 67 | 108 | 65 | 114 | 159 | 66 | 26 | 18 | 5 | 1 | 4 | 1 | 1 | 0 |
| UK – Scotland | 1419 | 1429 | 1980 | 2606 | 1879 | 1460 | 1324 | 1316 | 1263 | 1136 | 1307 | 1012 | 623 | 369 | 426 | 297 | 240 | 224 | 194 | 206 |
| Total | 2483 | 2245 | 3256 | 3992 | 3012 | 2575 | 1853 | 2073 | 1869 | 1809 | 2053 | 1615 | 1043 | 744 | 750 | 667 | 427 | 412 | 341 | 416 |

**Table 18.2. (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIb).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faroe Islands | 2 | 95 | 43 | 43 | 24 | 15 | 61 | 44 | . | 23 | 22 | 18 | 2 | 6 | . | . | . | . | . | . |
| France | 125 | 423 | 39 | 44 | 10 | 20 | 1 | 0 | 4 | 8 | 10 | 6 | 6 | 4 | 1 | 2 | 0 | 3 | 13 | 0 |
| Germany | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | 1 | 1 | . | . | . |
| Ireland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | . | 22 | 123 | 45 | 60 | 145 | 217 | 222 | 117 | 147 | 332 | 364 | 164 | 231 | 200 | 132 | 279 | 203 | 248 | 234 |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Russian Federation | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain | . | . | . | . | . | . | . | . | 63 | . | . | 12 | 8 | 48 | 41 | 36 | . | . | 14 | . |
| UK - (E,W&N.I.) | 11 | . | . | 39 | 62 | 36 | 56 | . | 4 | . | 8 | 4 | 18 | 15 | 12 | 7 | 4 | 4 | 11 | 12 |
| UK – Scotland | 562 | 166 | 307 | 77 | 160 | 189 | 152 | 181 | 152 | 44 | 9 | 15 | 58 | 38 | 59 | 72 | 70 | 76 | 67 | 57 |
| Total | 700 | 706 | 512 | 248 | 316 | 405 | 487 | 447 | 340 | 222 | 381 | 419 | 256 | 342 | 313 | 250 | 354 | 286 | 353 | 303 |
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Estonia | . | . | . | . | . | . | . | . | 56 | 1 | . | . | . | . | . | . | . | | | |
| Faroe Islands | . | . | . | . | . | . | . | . | . | . | . | na | na | . | . | 3 | | | | |
| France | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 5 | 2 | 6 | 15 | 0 | 17 | 17 | 12 | 0 | 0 | 6 |
| Germany | 6 | 25 | 17 | 49 | 26 | 36 | 67 | 76 | 8 | 1 | 6 | 22 | 22 | 6 | 0 | | | 3 | 2 | |
| Ireland | 24 | 23 | 60 | 68 | 23 | 15 | 28 | 20 | 10 | 1 | 18 | 7 | 9 | 24 | 14 | 15 | 4 | 3 | 10 | 8 |
| Norway | 170 | 272 | 176 | 95 | 101 | 98 | 59 | 120 | 80 | 44 | 61 | 46 | 39 | 82 | 81 | 66 | 91 | 120 | 56 | 98 |
| Portugal | . | . | 56 | . | 25 | 26 | 24 | 29 | 17 | 31 | 18 | Na | 0 | 0 | | | | | | |
| Russian Federation | . | . | . | . | . | . | . | 5 | 8 | . | . | Na | na | | | | | | | |
| Spain | . | . | . | 328 | 410 | 483 | 322 | 347 | 158 | 36 | 46 | 0.5 | 0 | 0 | 0 | 0 | | | | 4 |
| UK - (E,W&N.I.) | 21 | 28 | 73 | 175 | 105 | 134 | 147 | 156 | 120 | 92 | 47 | 48 | 20 | 20 | 9 | 0 | 0 | 0 | 0 | 0 |
| UK – Scotland | 70 | 98 | 97 | 83 | 91 | 101 | 123 | 204 | 97 | 79 | 146 | 164 | 59 | 51 | 30 | 26 | 35 | 33 | 34 | 18 |
| Total | 295 | 446 | 479 | 798 | 781 | 893 | 770 | 964 | 559 | 290 | 344 | 294 | 164 | 183 | 151 | 127 | 143 | 159 | 102 | 134 |

**Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIIa).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 296 | 365 | 278 | 195 | 236 | 212 | 177 | 151 | 206 | 230 | 233 | 246 | 372 | 425 | 545 | 390 | 271 | 298 | 209 | 230 |
| France | 1516 | 426 | 337 | 491 | 827 | 967 | 560 | 593 | 1985 | 617 | 440 | 788 | 1194 | 1578 | 1318 | 1009 | 641 | 712 | 890 | 642 |
| Ireland | 822 | 916 | 838 | 936 | 858 | 796 | 813 | 725 | 851 | 803 | 781 | 1067 | 1946 | 1416 | 1644 | 1911 | 1808 | 1811 | 1400 | 1301 |
| Netherlands | 1 | 1 | 3 | 1 | 1 | . | 1 | + | + | + | + | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Norway | 4 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain | | | | | | | | | | | | | | | | | | | | |
| UK - (E,W&N.I.) | 1564 | 1533 | 1430 | 1163 | 1130 | 906 | 1045 | 1202 | 1113 | 1307 | 1133 | 1126 | 1103 | 976 | 1503 | 1435 | 1373 | 1378 | 1226 | 1150 |
| UK (Scotland) | 62 | 69 | 53 | 39 | 47 | 52 | 58 | 132 | 82 | 89 | 87 | 192 | 219 | 224 | 321 | 210 | 171 | 227 | 163 | 107 |
| Total | 4265 | 3310 | 2939 | 2825 | 3099 | 2933 | 2654 | 2803 | 4237 | 3046 | 2674 | 3419 | 4834 | 4619 | 5331 | 4955 | 4264 | 4426 | 3888 | 3430 |
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Belgium | 107 | 224 | 218 | 265 | 298 | 398 | 542 | 504 | 724 | 997 | 830 | 860 | 860 | 593 | 680 | 295 | 250 | 274 | 471 | 430 |
| France | 550 | 330 | 293 | 282 | 151 | 285 | NA | 163 | 343 | 349 | 322 | 183 | 192 | 114 | 51 | 14 | 7 | 9 | 16 | 5 |
| Ireland | 679 | 514 | 438 | 438 | 593 | 692 | 827 | 759 | 807 | 1032 | 1086 | 825 | 786 | 645 | 721 | 515 | 370 | 557 | 500 | 496 |
| Netherlands | n.a. | n.a. | n.a. | n.a. | n.a. | 4 | 4 | 6 | + | + | + | + | . | 0 | | | | | 0 | 0 |
| Norway | . | . | . | . | . | . | . | . | . | . | . | . | 0 | 0 | 0 | 0 | | | 0 | 0 |
| Spain | | | | | | | | | | | | | | | | 4 | | | | |
| UK - (E,W&N.I.) | 1003 | 748 | 606 | 789 | 824 | 1009 | 936 | 671 | 983 | 863 | 1184 | 533 | 1252 | 271 | 260 | 243 | 214 | 190 | 172 | 226 |
| UK (Scotland) | 96 | 86 | 42 | 55 | 80 | 52 | 33 | 86 | 80 | 68 | 67 | 38 | 30 | 65 | 13 | 1 | 2 | 9 | 1 | 2 |
| Total | 2435 | 1902 | 1597 | 1829 | 1946 | 2440 | 2342 | 2189 | 2937 | 3309 | 3489 | 2439 | 3120 | 1689 | 1724 | 1071 | 844 | 1038 | 1161 | 1160 |

**Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIIf).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 182 | 273 | 280 | 184 | 106 | 75 | 127 | 189 | 167 | 130 | 139 | 98 | 177 | 209 | 129 | 172 | 268 | 135 | 155 | 128 |
| Denmark | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| France | . | 242 | 426 | 569 | 720 | 680 | 873 | 896 | 856 | 837 | 648 | 377 | 306 | 330 | 247 | 464 | 366 | 326 | 607 | 663 |
| Germany | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Ireland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Norway | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain (b) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - (E,W&N.I.) | 504 | 401 | 468 | 437 | 452 | 436 | 444 | 494 | 508 | 529 | 480 | 558 | 648 | 697 | 784 | 761 | 710 | 666 | 627 | 705 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Total | 686 | 916 | 1174 | 1190 | 1278 | 1191 | 1444 | 1579 | 1531 | 1496 | 1267 | 1033 | 1131 | 1236 | 1160 | 1397 | 1344 | 1127 | 1389 | 1497 |
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Belgium | 96 | 117 | 108 | 89 | 116 | 121 | 103 | 90 | 91 | 117 | 134 | 210 | 208 | 138 | 206 | 184 | 193 | 143 | 175 | 185 |
| Denmark | . | . | . | . | . | . | . | . | . | . | . | . | . | | | | | | 0 | 0 |
| France | 565 | 468 | 394 | 432 | 485 | 464 | 453 | 538 | 642 | 526 | 536 | 478 | 429 | 305 | 424 | 399 | 366 | 517 | 297 | 325 |
| Germany | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | | | 0 | |
| Ireland | . | . | . | . | . | 1 | . | . | . | 1 | 1 | 15 | 8 | 6 | 2 | 4 | 3 | 2 | 1 | 1 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | | | | 0 | | 0 |
| Norway | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | 0 | 0 | | | 0 | 0 |
| Spain (b) | . | . | . | 8 | 10 | 12 | 1 | . | 3 | . | . | . | . | 0 | 0 | 0 | | | 0 | 0 |
| UK - (E,W&N.I.) | 638 | 630 | 589 | 676 | 664 | 624 | 560 | 613 | 691 | 920 | 766 | 609 | 631 | 653 | 620 | 639 | 546 | 680 | | 708 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | | | 0 | | 0 | 682 | 0 |
| Total | 1299 | 1215 | 1091 | 1205 | 1275 | 1222 | 1117 | 1241 | 1427 | 1564 | 1437 | 1312 | 1276 | 1101 | 1252 | 1226 | 1107 | 1342 | 1155 | 1219 |

**Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIIegh).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 259 | 238 | 209 | 529 | 308 | 208 | 206 | 254 | 318 | 271 | 182 | 215 | 211 | 311 | 224 | 227 | 355 | 242 | 97 | 183 |
| Denmark | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 2 | 1 | . | 1 |
| France | 5729 | 4095 | 6901 | 6602 | 6189 | 6095 | 6519 | 6796 | 7647 | 6765 | 7323 | 6561 | 6890 | 7771 | 7693 | 7986 | 7566 | 7734 | 7077 | 6477 |
| Germany | 18 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Ireland | 147 | 158 | 148 | 241 | 158 | 143 | 218 | 399 | 380 | 291 | 236 | 303 | 286 | 251 | 296 | 315 | 57 | 100 | 68 | . |
| Netherlands | . | . | 1 | 7 | 13 | 6 | . | . | . | . | 2 | na | na | na | na | na | na | na | na | na |
| Norway | . | . | . | . | . | . | . | . | . | . | 12 | . | . | 25 | . | . | 12 | 5 | . | . |
| Poland | 24 | 28 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain (b) | . | . | . | . | . | 45 | 0 | 0 | 77 | 30 | 29 | 24 | 2 | 62 | 75 | 49 | . | . | 21 | . |
| UK - (E,W&N.I.) | 432 | 466 | 572 | 556 | 566 | 615 | 564 | 528 | 606 | 637 | 700 | 832 | 936 | 939 | 1061 | 1307 | 865 | 1211 | 638 | 751 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Total | 6609 | 4985 | 7831 | 7935 | 7234 | 7112 | 7507 | 7977 | 9028 | 7994 | 8484 | 7935 | 8325 | 9359 | 9349 | 9885 | 8857 | 9293 | 7901 | 7412 |
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Belgium | 209 | 172 | 203 | 177 | 293 | 260 | 240 | 223 | 248 | 347 | 576 | 407 | 432 | 582 | 569 | 636 | 506 | 479 | 533 | 589 |
| Denmark | + | 0 | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | |
| France | 5873 | 5836 | 6029 | 6425 | 7093 | 6114 | 6098 | 5710 | 5603 | 5273 | 5588 | 4261 | 4517 | 3740 | 3741 | 3302 | 3719 | 3428 | 3193 | 2894 |
| Germany | . | . | . | . | . | . | . | . | . | + | . | 3 | . | | . | . | . | . | 0 | |
| Ireland | 120 | 106 | 162 | 349 | 479 | 446 | 408 | 203 | 481 | 729 | 838 | 844 | 334 | 315 | 285 | 214 | 198 | 174 | 316 | 315 |
| Netherlands | na | na | na | na | na | 9 | na | 7 | 7 | 11 | . | . | . | 1 | . | . | 1 | 2 | 1 | 1 |
| Norway | . | . | . | . | . | . | . | . | 11 | . | . | . | . | 0 | 0 | 0 | | | 0 | 0 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | |
| Spain (b) | . | . | . | 312 | 932 | 1178 | 2647 | 1706 | 1142 | 653 | 31 | 15 | 9 | 1 | 1 | 3 | . | . | | 109 |
| Spain (Basque Country) | | | | | | | | | | | | | | | | | 7 | 2 | 8 | |
| UK - (E,W&N.I.) | 735 | 869 | 997 | 953 | 1098 | 1167 | 796 | 932 | 880 | 775 | 804 | 811 | 1024 | 727 | 730 | 667 | 650 | 865 | 771 | 667 |
| UK (Scotland) | 1 | . | . | . | 2 | . | 2 | . | 2 | . | . | 149 | 3 | 1 | | 3 | 3 | 7 | 7 | 3 |
| Total | 6938 | 6983 | 7391 | 8216 | 9897 | 9173 | 10191 | 8781 | 8374 | 7788 | 7837 | 6490 | 6318 | 5366 | 5326 | 4826 | 5082 | 4957 | 4830 | 4576 |

**Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (VIIbcjk).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 907 | 725 | 292 | 480 | 239 | 219 | 188 | 340 | 1120 | 203 | 169 | 198 | 344 | 346 | 456 | 462 | 427 | 781 | 541 | 546 |
| Germany | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 266 | 321 | 314 | 320 | 265 | 268 | 239 | 269 | 336 | 271 | 325 | 296 | 220 | 226 | 419 | 332 | 633 | 350 | 400 | 619 |
| Netherlands | | | | | | | | | | | | | | | | | | | | 0 |
| Norway | | | | | | | | | | | | | | | | | | | 0 | 0 |
| Spain (b) | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 47 | 33 | 24 | 31 | 1 | 53 | 64 | 41 | 0 | 0 | 124 | 0 |
| UK - (E,W&N.I.) | 1 | + | + | 0 | + | 0 | 0 | + | 0 | + | 0 | 4 | 1 | 3 | 27 | 28 | 25 | 5 | 53 | 71 |
| UK (Scotland) | 0 | 0 | 0 | 0 | 0 | 1 | | 1 | 0 | 0 | 0 | 1 | + | 1 | + | 1 | 13 | 14 | 15 | 10 |
| Total | 1174 | 1046 | 606 | 800 | 504 | 491 | 427 | 610 | 1503 | 507 | 518 | 530 | 566 | 629 | 966 | 864 | 1098 | 1150 | 1133 | 1246 |
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 5 | 0 | 5 | 1 | na | 0 | 0 | 0 | . | | 0 | 0 | 0 |
| France | 298 | 224 | 297 | 375 | 599 | 500 | NA | 568 | 362 | 272 | 192 | 101 | 257 | 255 | 391 | 421 | 262 | 249 | 139 | 166 |
| Germany | 7 | 18 | 3 | 4 | 9 | 17 | 10 | 21 | 7 | + | 3 | 15 | 17 | 0 | | | | | 1 | 1 |
| Ireland | 602 | 625 | 735 | 757 | 811 | 741 | 740 | 653 | 383 | 354 | 435 | 511 | 465 | 473 | 417 | 384 | 362 | 285 | 217 | 246 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Norway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 4 | 0 | | | 0 | 6 |
| Spain (b) | 0 | 0 | 0 | 1341 | 1676 | 1978 | 2419 | 2573 | 1205 | 2939 | 1281 | 7 | 16 | 19 | 11 | 1 | | 0 | 0 | 184 |
| UK - (E,W&N.I.) | 88 | 201 | 361 | 469 | 468 | 376 | 352 | 597 | 545 | 373 | 350 | 364 | 269 | 176 | 172 | 83 | 90 | 94 | 99 | 72 |
| UK (Scotland) | 34 | 43 | 73 | 58 | 36 | 67 | 121 | 189 | 162 | 124 | 226 | 70 | 58 | 77 | 0 | 66 | 39 | 60 | 54 | 63 |
| Total | 1029 | 1111 | 1469 | 3004 | 3599 | 3679 | 3666 | 4606 | 2664 | 4067 | 2488 | 1068 | 1081 | 1016 | 995 | 954 | 753 | 687 | 510 | 738 |

| Celtic Seas Unspecified | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | | | | | | | | | | | | | 643 | 693 | 605 | 494 | 2 |
| Spain (Basque Country) | | | | | | | | | | | | | | 0.8 | 0.0 | 8 | |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 643 | 693 | 605 | 502 | 2 |

**Table 18.2 (continued). Demersal elasmobranchs in the Celtic Seas. Total landings of skates (Rajidae) in the Celtic Seas ecoregion (total landings).**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 750 | 886 | 770 | 912 | 650 | 495 | 510 | 596 | 692 | 633 | 554 | 559 | 762 | 946 | 901 | 791 | 897 | 675 | 463 |
| Denmark | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 1 | 2 | 1 | . |
| Estonia | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Faroe Islands | 109 | 95 | 43 | 43 | 24 | 15 | 61 | 44 | . | 23 | 22 | 18 | 3 | 6 | . | . | . | . | . |
| France | 9013 | 6818 | 8772 | 9104 | 8638 | 8820 | 8871 | 9208 | 13 930 | 9171 | 9475 | 8885 | 9736 | 10 674 | 10 442 | 10 689 | 9724 | 10 267 | 9749 |
| Germany | 18 | 1 | . | . | 1 | 2 | 1 | . | . | . | . | . | 1 | . | . | 1 | 1 | 0 | 0 |
| Ireland | 1516 | 1731 | 1758 | 1922 | 1623 | 1449 | 1538 | 1736 | 2041 | 1902 | 2148 | 2502 | 3026 | 2333 | 2726 | 3248 | 3128 | 2411 | 2068 |
| Netherlands | 1 | 1 | 4 | 9 | 14 | 6 | 1 | + | + | + | 2 | na | na | na | na | na | na | na | na |
| Norway | 120 | 127 | 193 | 122 | 156 | 371 | 298 | 475 | 236 | 293 | 561 | 463 | 231 | 300 | 293 | 276 | 555 | 279 | 286 |
| Poland | 88 | 28 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Russian Federation | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Spain | . | . | . | . | . | 48 | 0 | 0 | 187 | 82 | 64 | 75 | 15 | 175 | 194 | 134 | 0 | 0 | 202 |
| UK - (E,W&N.I.) | 2776 | 2666 | 2734 | 2529 | 2548 | 2285 | 2318 | 2313 | 2324 | 2572 | 2425 | 2665 | 2753 | 2677 | 3441 | 3625 | 3044 | 3321 | 2632 |
| UK – Scotland | 1926 | 1377 | 1753 | 1908 | 1931 | 1902 | 1750 | 1891 | 1730 | 1750 | 1914 | 2224 | 2311 | 2065 | 2491 | 2420 | 2753 | 2324 | 2271 |
| Total | 16 317 | 13 730 | 16 027 | 16 549 | 15 585 | 15 393 | 15 348 | 16 263 | 21 140 | 16 426 | 17 165 | 17 391 | 18 838 | 19 176 | 20 489 | 21 185 | 20 104 | 19 278 | 17 671 |
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Belgium | 413 | 515 | 536 | 532 | 709 | 781 | 913 | 824 | 1067 | 1467 | 1549 | 1485 | 1503 | 1316 | 1455 | 1115 | 949 | 896 | 1179 |
| Denmark | + | . | + | . | . | . | . | . | . | . | . | . | 0 | . | . | . | . | . | . |
| Estonia | . | . | . | . | . | . | . | . | 56 | 1 | . | . | . | . | . | . | . | 0 | 0 |
| Faroe Islands | . | . | . | . | . | . | . | . | . | . | . | . | na | . | . | 4 | . | . | . |
| France | 7896 | 7295 | 7566 | 8040 | 8712 | 7696 | 6551 | 7307 | 7233 | 6637 | 6823 | 5178 | 5591 | 4587 | 4818 | 4398 | 4463 | 4267 | 3695 |
| Germany | 13 | 45 | 20 | 54 | 39 | 69 | 84 | 98 | 16 | 2 | 12 | 40 | 39 | 7 | . | . | . | 4 | 3 |
| Ireland | 1756 | 1533 | 1898 | 2294 | 2502 | 2382 | 2390 | 1909 | 1919 | 2428 | 2742 | 2565 | 1787 | 1640 | 1557.940 | 1240.360 | 1018 | 1132 | 1133 |
| Netherlands | na | na | na | na | na | 13 | 4 | 13 | 7 | 11 | na | na | 0 | 1 | . | . | 1 | 2 | 1 |
| Norway | 226 | 281 | 250 | 124 | 121 | 148 | 88 | 169 | 111 | 69 | 63 | 48 | 49 | 101 | 90 | 77 | 95 | 131 | 62 |
| Poland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Portugal | . | . | 56 | . | 25 | 26 | 24 | 29 | 17 | 31 | 18 | na | 0 | . | . | . | . | . | . |
| Russian Federation | . | . | . | . | . | . | . | 5 | 8 | . | . | na | na | . | . | . | . | . | . |
| Spain | 0 | 0 | 0 | 2036 | 3086 | 3720 | 5423 | 4628 | 2508 | 3637 | 1385 | 37 | 39 | 20 | 12 | 655 | 700 | 607 | 503 |
| UK - (E,W&N.I.) | 2555 | 2577 | 2764 | 3163 | 3228 | 3467 | 2858 | 3077 | 3283 | 3137 | 3310 | 2431 | 3222 | 1865 | 1796 | 1633 | 1504 | 1830 | 1725 |
| UK – Scotland | 1620 | 1656 | 2192 | 2802 | 2088 | 1680 | 1603 | 1795 | 1604 | 1407 | 1746 | 1433 | 773 | 562 | 469 | 393 | 319 | 332 | 290 |
| Total | 14 479 | 13 902 | 15 282 | 19 044 | 20 510 | 19 981 | 19 938 | 19 854 | 17 830 | 18 828 | 17 648 | 13 217 | 13 004 | 10 099 | 10 198 | 9514 | 9047 | 9201 | 8590 |

**Table 18.3. Demersal elasmobranchs in the Celtic Seas. Nominal landings (tonnes) of lesser-spotted dogfish (*Scyliorhinus canicula*) in ICES Subareas VI and VII. These data are considered under-estimates, as this species is often reported under generic landings categories, and some landings (for bait in pot fisheries) may not be reported. 2012 data for Spain include landings from Basque country.**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | | | | | | | | 377 | 392 | 389 | | | 317 | 320 | 382 | 236 |
| France | 5395 | 5255 | 4509 | 4332 | 4353 | 4309 | 4182 | 4591 | 4568 | 46 | 4808 | 4922 | 4697 | 4361 | 4314 | 3937 | 3815 | 3881 | 3360 | 2456 | 2489 | 3850 | 1965 |
| Ireland | . | . | . | . | . | 1487 | 465 | 796 | 886 | 470 | 407 | 518 | 506 | 285 | 124 | 85 | 40 | 130 | 257 | 211 | 321 | 315 | 216 |
| Netherlands | | | | | | | | | | | | | | | | | | | | 7 | 1 | 4 | 0.6 |
| Spain | . | . | . | . | . | . | 51 | 73 | 22 | 67 | 77 | 46 | 50 | 20 | 21 | 41 | 13 | 17 | 4 | 0 | 21 | | 53 |
| Spain (Basque country) | | | | | | | | | | | | | | | | | | | 2 | 1 | 4 | 4 | |
| UK (E&W) | . | . | . | . | . | . | . | . | . | . | 11 | . | . | 88 | | 325 | 126 | 11 | 269 | 329 | 238 | 259 | 227 |
| UK (Scotland) | . | . | . | . | . | . | . | . | . | . | . | . | 37 | 8 | 33 | 55 | 42 | 40 | 6 | 15 | 12 | 9 | 7 |
| Total | 5395 | 5255 | 4509 | 4332 | 4353 | 5796 | 4698 | 5460 | 5476 | 583 | 5303 | 5486 | 5290 | 4762 | 4869 | 4835 | 4425 | 4079 | 3897 | 3336 | 3406 | 4824 | 2705 |

**Table 18.4. Demersal Elasmobranchs in the Celtic Seas. Landings of *Squatina squatina*. French landings from ICES and Bulletin de Statistiques des Peches Maritimes. UK data from ICES and DEFRA. Belgian data from ICES. UK landings for 1997 considered to be misreported fish.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 8 | 3 | 32 | 26 | 29 | 24 | 19 | 18.7 | 19.5 | 18 |
| UK (E,W &N.I.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 8 | 3 | 32 | 26 | 29 | 24 | 19 | 18.7 | 19.5 | 18 |

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 13 | 9 | 13 | 14 | 12 | 11 | 2 | 2 | 1 | 1 |
| UK (E,W &N.I.) | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 |
| Total | 13 | 9 | 13 | 14 | 12 | 11 | 4 | 3 | 2 | 1 |

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 1 | 1 | 2 | 1 | 2 | + | 1 | + | + | + |
| UK (E,W &N.I.) | 0 | 0 | 0 | 0 | (47) | 0 | 0 | 0 | 0 | 0 |
| Total | 1 | 1 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 0 |

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | | | | | | | | | . |
| France | + | + | 2 | + | 0.5 | + | 0.9 | 2.1 | 0 | 0 |
| UK (E,W &N.I.) | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0 | 0 |
| Total | 0 | 0 | 2 | 0.0 | 0.5 | 0.0 | 0.9 | 2.1 | 0 | 0 |

**Table 18.5. Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | Species composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | France | | Ireland | | Scotland | | UK (E,W&NI) | | France | | Ireland | | Scotland | | UK (E,W&NI) | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIa | *A. radiata* | | | | 0.0 | | | 0.0 | 0.0 | | | | 0.1 | | | 6.7 | 5.6 |
| | *A. hyperborea* | | 1.5 | | | | | | | | 1.6 | | | | | | |
| | *D. batis* | 0.1 | | | | 0.6 | 1.2 | | | 0.1 | | | | 0.4 | 0.8 | | |
| | *D. oxyrinchus* | 3.1 | 13.9 | 0.9 | | 2.8 | 4.5 | | | 6.2 | 14.4 | 1.5 | | 1.8 | 2.9 | | |
| | *L. circularis* | 1.1 | 0.7 | | | | 0.4 | | | 2.1 | 0.8 | | | | 0.3 | | |
| | *L. fullonica* | 1.6 | 2.6 | | | | | | | 3.1 | 2.8 | | | | | | |
| | *L. naevus* | 27.7 | 34.5 | 12.0 | 7.4 | 62.8 | 51.7 | 0.1 | 0.0 | 54.9 | 38.3 | 20.5 | 9.9 | 40.6 | 32.9 | 11.6 | 0.8 |
| | *R. brachyura* | | | 0.4 | 0.7 | 7.3 | 1.9 | 0.3 | 0.1 | | | 0.7 | 0.9 | 4.7 | 1.2 | 34.6 | 46.4 |
| | *R. clavata* | 15.9 | 36.9 | 43.4 | 64.6 | 45.9 | 62.8 | 0.3 | 0.1 | 31.4 | 40.5 | 74.0 | 86.5 | 29.7 | 39.9 | 47.1 | 47.2 |
| | *R. microocellata* | | | | | | | | | | | | | | | | |
| | *R. montagui* | 1.1 | 2.6 | 1.9 | 2.0 | 30.5 | 26.2 | | | 2.1 | 2.7 | 3.3 | 2.7 | 19.8 | 16.7 | | |
| | *Rostroraja alba* | | | | | 4.6 | 8.5 | | | | | | | 3.0 | 5.4 | | |
| | **VIa Total** | **50.4** | **91.3** | **58.6** | **74.7** | **154.4** | **157.2** | **0.7** | **0.3** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| VIb | *D. batis* | | | | | | 1.7 | | | | | | | | 10.2 | | |
| | *D. oxyrinchus* | | 2.1 | | | 15.2 | 4.0 | | | | 34.5 | | | 50.3 | 23.4 | | |
| | *L. circularis* | 0.1 | 2.3 | 4.1 | | | 0.3 | | | 94.3 | 38.1 | 45.4 | | | 1.5 | | |
| | *L. fullonica* | | 1.1 | 0.6 | 3.0 | | 0.7 | | | | 18.5 | 6.6 | 36.5 | | 3.9 | | |
| | *L. naevus* | | | 0.2 | 0.3 | 1.4 | 5.0 | | | | | 1.8 | 3.8 | 4.5 | 29.5 | | |
| | *R. brachyura* | | | | | 0.3 | | 0.1 | 0.3 | | | | | 1.1 | | 100.0 | 100.0 |
| | *R. clavata* | | 0.5 | 4.2 | 5.0 | 10.8 | 4.5 | | | | 9.0 | 46.2 | 59.7 | 35.7 | 26.5 | | |
| | *R. microocellata* | | | | | | | | | | | | | | | | |
| | *R. montagui* | 0.0 | | | | 0.6 | 0.7 | | | 5.7 | | | | 2.1 | 4.0 | | |
| | *Rostroraja alba* | | | | | 1.9 | 0.2 | | | | | | | 6.3 | 1.0 | | |
| | **VIb Total** | **0.1** | **6.0** | **9.1** | **8.3** | **30.2** | **17.1** | **0.1** | **0.3** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

**Table 18.5 (cont.). Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | | | Species composition (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Belgium | | France | | Ireland | | Scotland | | UK (E,W&NI) | | Belgium | | France | | Ireland | | Scotland | | UK (E,W&NI) | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIIa | *A. radiata* | | | | | 0.9 | | | | 0.7 | 1.2 | | | | | 0.2 | | | | 0.4 | 0.6 |
| | *D. batis* | | | | | 4.8 | | | | 0.1 | 0.2 | | | | | 1.0 | | | | 0.0 | 0.1 |
| | *L. fullonica* | | | 0.0 | 0.0 | | 0.1 | | | | | | | 0.0 | 0.0 | | 0.0 | | | | |
| | *L. naevus* | 36.8 | 35.9 | 1.5 | 0.3 | 9.5 | 12.9 | | | 5.1 | 7.4 | 9.1 | 8.7 | 9.8 | 5.9 | 2.0 | 2.7 | | | 3.0 | 3.4 |
| | *R. brachyura* | 182.3 | 142.9 | 0.0 | 0.1 | 362.3 | 388.6 | | | 23.6 | 23.8 | 45.1 | 34.5 | 0.1 | 1.3 | 78.4 | 82.1 | | | 14.2 | 10.8 |
| | *R. clavata* | 132.6 | 214.9 | 0.6 | 1.3 | 35.4 | 36.8 | 0.2 | | 129.3 | 176.8 | 32.8 | 51.9 | 3.7 | 23.9 | 7.7 | 7.8 | 89.2 | | 77.5 | 80.3 |
| | *R. microocellata* | 2.2 | 5.1 | 0.0 | 0.0 | 0.1 | 0.0 | | | | 0.0 | 0.5 | 1.2 | 0.0 | 0.1 | 0.0 | 0.0 | | | | 0.0 |
| | *R. montagui* | 50.0 | 15.3 | 13.5 | 3.7 | 49.3 | 35.0 | 0.0 | | 8.1 | 10.7 | 12.4 | 3.7 | 86.4 | 68.8 | 10.7 | 7.4 | 10.8 | | 4.9 | 4.8 |
| | *Rostroraja alba* | | | | | | | | 0.2 | | 0.0 | | | | | | | | 100.0 | | 0.0 |
| | **VIIa Total** | **403.9** | **414.0** | **15.6** | **5.3** | **462.3** | **473.4** | **0.3** | **0.2** | **166.8** | **220.1** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |
| VIIf | *A. radiata* | | 0.2 | | | | | | | 2.8 | 12.9 | | 0.1 | | | | | | | 0.4 | 1.8 |
| | *D. batis* | | | 0.2 | | | | | | | | | | 0.1 | | | | | | | |
| | *D. oxyrinchus* | | | 0.0 | 0.0 | | | | | | 0.0 | | | 0.0 | 0.0 | | | | | | 0.0 |
| | *L. circularis* | | | | 0.9 | | | | | 0.1 | 0.5 | | | | 0.3 | | | | | 0.0 | 0.1 |
| | *L. fullonica* | | | 4.3 | 4.8 | | | | | 2.7 | 2.7 | | | 1.5 | 1.5 | | | | | 0.4 | 0.4 |
| | *L. naevus* | 19.7 | 16.8 | 71.3 | 71.2 | 0.8 | 0.1 | | | 19.3 | 22.7 | 14.5 | 9.9 | 24.9 | 22.3 | 83.4 | 24.8 | | | 2.9 | 3.2 |
| | *R. brachyura* | 32.1 | 53.9 | 94.0 | 70.6 | 0.0 | 0.2 | 0.0 | | 227.8 | 218.2 | 23.7 | 32.0 | 32.8 | 22.1 | 4.1 | 49.6 | 100.0 | | 34.7 | 30.9 |
| | *R. clavata* | 40.1 | 42.3 | 8.7 | 7.2 | 0.0 | 0.0 | | | 215.5 | 255.0 | 29.5 | 25.1 | 3.0 | 2.3 | 4.1 | 12.6 | | | 32.9 | 36.1 |
| | *R. microocellata* | 30.7 | 36.1 | 10.1 | 13.3 | | | | | 164.2 | 175.4 | 22.6 | 21.4 | 3.5 | 4.2 | | | | | 25.0 | 24.8 |
| | *R. montagui* | 13.2 | 19.2 | 98.3 | 150.9 | 0.1 | 0.0 | | | 23.1 | 19.3 | 9.7 | 11.4 | 34.3 | 47.3 | 8.3 | 13.0 | | | 3.5 | 2.7 |
| | *Rostroraja alba* | | | 0.1 | | | | | | | | | | 0.0 | | | | | | | |
| | **VIIf Total** | **135.9** | **168.5** | **286.9** | **319.1** | **1.0** | **0.4** | **0.0** | | **655.6** | **706.7** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | | **100** | **100** |

**Table 18.5 (cont.). Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | Species composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | France | | Ireland | | Scotland | | UK (E,W&NI) | | France | | Ireland | | Scotland | | UK (E,W&NI) | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIIb | *A. radiata* | | | 0.2 | 0.6 | | | | | | | 0.2 | 0.6 | | | | |
| | *D. nidarosiensis* | | | | | | | | 0.0 | | | | | | | | 0.2 |
| | *D. oxyrinchus* | | 0.1 | 11.6 | | | | | | | 0.2 | 11.7 | | | | | |
| | *L. circularis* | 0.0 | 0.0 | | | | | | | 0.1 | 0.1 | | | | | | |
| | *L. fullonica* | 0.0 | 0.0 | | | | | 2.1 | 4.5 | 0.0 | 0.0 | | | | | 15.1 | 17.3 |
| | *L. naevus* | 34.4 | 36.0 | 9.1 | 12.5 | 1.4 | | 6.5 | 11.6 | 64.9 | 53.7 | 9.2 | 11.2 | 34.0 | | 45.8 | 44.8 |
| | *R. brachyura* | | 0.0 | 36.1 | 32.9 | | | | 0.0 | | 0.0 | 36.6 | 29.4 | | | | 0.2 |
| | *R. clavata* | 18.4 | 30.7 | 39.4 | 60.2 | 2.6 | 2.4 | 5.5 | 8.8 | 34.8 | 45.7 | 40.0 | 53.9 | 66.0 | 100.0 | 39.1 | 33.9 |
| | *R. microocellata* | | | | | | | | | | | | | | | | |
| | *R. montagui* | 0.1 | 0.2 | 2.2 | 5.6 | | | | 0.9 | 0.1 | 0.2 | 2.2 | 5.0 | | | | 3.6 |
| | **VIIb Total** | **52.9** | **67.1** | **98.5** | **111.8** | **4.0** | **2.4** | **14.1** | **25.9** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| VIIc | *D. batis* | 0.3 | | | | | | | | 2.4 | | | | | | | |
| | *D. oxyrinchus* | | | 0.0 | | | | | | | | 1.6 | | | | | |
| | *L. circularis* | 0.0 | 0.0 | | | | 0.1 | | | 0.3 | 0.4 | | | | 0.6 | | |
| | *L. fullonica* | 0.0 | 0.1 | | | | 0.1 | 0.7 | | 0.4 | 0.6 | | | | 0.5 | 19.6 | |
| | *L. naevus* | 9.6 | 6.8 | 1.6 | 1.5 | | | 2.7 | 0.5 | 77.0 | 66.4 | 61.5 | 26.0 | | | 80.4 | 37.5 |
| | *R. asterias* | | 0.0 | | | | | | | | 0.2 | | | | | | |
| | *R. brachyura* | | | 0.2 | 0.1 | | 9.0 | | 0.3 | | | 6.2 | 1.3 | | 63.7 | | 27.0 |
| | *R. clavata* | 2.3 | 3.2 | 0.8 | 4.1 | 13.5 | 5.0 | | 0.3 | 18.3 | 30.8 | 30.7 | 72.7 | 100.0 | 35.2 | | 25.1 |
| | *R. microocellata* | | | | | | | | | | | | | | | | |
| | *R. montagui* | 0.2 | 0.2 | | | | | | 0.1 | 1.7 | 1.7 | | | | | | 10.5 |
| | **VIIc Total** | **12.5** | **10.3** | **2.6** | **5.6** | **13.5** | **14.1** | **3.3** | **1.2** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

**Table 18.5 (cont.). Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | | | Species composition (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Belgium** | | **France** | | **Ireland** | | **Scotland** | | **UK (E,W&NI)** | | **Belgium** | | **France** | | **Ireland** | | **Scotland** | | **UK (E,W&NI)** | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIIe | *A. radiata* | | 0.0 | 0.0 | | | | | | 0.2 | 0.5 | | 0.1 | 0.0 | | | | | | 0.1 | 0.1 |
| | *A. hyperborea* | | | | | | | | | | 0.0 | | | | | | | | | | 0.0 |
| | *D. batis* | | | 0.7 | | | | | | 0.1 | 0.3 | | | 0.1 | | | | | | 0.0 | 0.1 |
| | *D. oxyrinchus* | | | 0.0 | 0.2 | | | | | | 0.0 | | | 0.0 | 0.0 | | | | | | 0.0 |
| | *L. circularis* | | 0.4 | | 1.2 | | | | | 0.4 | 0.3 | | 4.0 | | 0.2 | | | | | 0.1 | 0.1 |
| | *L. fullonica* | | | 2.1 | 2.5 | | | | | 3.4 | 1.3 | | | 0.2 | 0.3 | | | | | 0.7 | 0.3 |
| | *L. naevus* | 0.9 | 0.7 | 275.3 | 184.5 | | | | | 79.8 | 75.8 | 9.4 | 6.1 | 30.8 | 24.8 | | | | | 17.4 | 16.6 |
| | *R. alba* | | | | 1.9 | | | | | | | | | | 0.3 | | | | | | |
| | *R. asterias* | | | | 0.0 | | | | | | | | | | 0.0 | | | | | | |
| | *R. brachyura* | 3.5 | 4.3 | 210.9 | 144.2 | | 0.4 | | | 204.6 | 175.4 | 37.4 | 39.2 | 23.6 | 19.4 | | 100.0 | | | 44.6 | 38.5 |
| | *R. clavata* | 3.3 | 4.4 | 96.9 | 107.3 | | | | | 98.0 | 127.4 | 35.1 | 39.5 | 10.8 | 14.4 | | | | | 21.4 | 27.9 |
| | *R. microocellata* | 0.4 | | 15.3 | 15.1 | | | | | 24.9 | 30.6 | 4.6 | | 1.7 | 2.0 | | | | | 5.4 | 6.7 |
| | *R. montagui* | 1.3 | 1.2 | 278.4 | 284.9 | | | | | 46.8 | 44.7 | 13.5 | 11.0 | 31.2 | 38.3 | | | | | 10.2 | 9.8 |
| | *R. undulata* | | | 1.7 | 1.3 | | | | | | 0.0 | | | 0.2 | 0.2 | | | | | | 0.0 |
| | *Rajella fyllae* | | | | 0.0 | | | | | | | | | | 0.0 | | | | | | |
| | *Rostroraja alba* | | | 12.3 | | | | | | | 0.0 | | | 1.4 | | | | | | | 0.0 |
| | **VIIe Total** | **9.3** | **11.1** | **893.7** | **739.7** | | **0.4** | | | **458.2** | **456.2** | **100.0** | **100.0** | **100.0** | **100.0** | | **100.0** | | | **100.0** | **100.0** |

**Table 18.5 (cont.). Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | | | Species composition (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Belgium** | | **France** | | **Ireland** | | **Scotland** | | **UK (E,W&NI)** | | **Belgium** | | **France** | | **Ireland** | | **Scotland** | | **UK (E,W&NI)** | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIIg | *A. radiata* | | | | | 0.6 | 1.2 | | | | | | | | | 0.4 | 0.6 | | | | |
| | *D. batis* | | | 0.0 | | | 0.1 | | | | | | | 0.0 | | | 0.1 | | | | |
| | *D. oxyrinchus* | | | 0.0 | 0.2 | | 0.7 | | | 0.2 | 0.0 | | | 0.0 | 0.0 | | 0.4 | | | 0.1 | 0.0 |
| | *L. circularis* | | | | 11.1 | 0.0 | | | | 0.2 | 0.0 | | | | 1.4 | 0.0 | | | | 0.2 | 0.0 |
| | *L. fullonica* | | | 16.2 | 13.5 | 1.5 | 0.6 | 0.2 | | 8.6 | 10.2 | | | 2.3 | 1.7 | 1.0 | 0.3 | 28.4 | | 8.3 | 8.9 |
| | *L. naevus* | 41.3 | 33.3 | 80.2 | 90.9 | 23.4 | 35.9 | 0.1 | 0.0 | 21.1 | 18.5 | 10.3 | 6.2 | 11.4 | 11.5 | 16.4 | 19.0 | 16.9 | 3.7 | 20.3 | 16.0 |
| | *R. brachyura* | 101.3 | 208.2 | 43.7 | 13.2 | 20.0 | 32.6 | 0.3 | 0.5 | 19.1 | 17.4 | 25.3 | 38.7 | 6.2 | 1.7 | 14.1 | 17.2 | 40.8 | 63.3 | 18.4 | 15.1 |
| | *R. clavata* | 128.5 | 183.3 | 92.4 | 85.9 | 84.4 | 101.2 | 0.1 | 0.2 | 30.0 | 33.9 | 32.2 | 34.1 | 13.2 | 10.9 | 59.3 | 53.4 | 13.8 | 32.9 | 29.0 | 29.4 |
| | *R. microocellata* | 73.0 | 79.5 | 7.7 | 2.1 | 0.0 | | | | 21.6 | 28.8 | 18.3 | 14.8 | 1.1 | 0.3 | 0.0 | | | | 20.9 | 25.0 |
| | *R. montagui* | 55.3 | 34.0 | 451.8 | 573.0 | 12.5 | 17.0 | | | 2.8 | 6.4 | 13.9 | 6.3 | 64.5 | 72.5 | 8.8 | 9.0 | | | 2.7 | 5.6 |
| | *Rajella fyllae* | | | | | | 0.1 | | | | | | | | | | 0.1 | | | | |
| | *Rostroraja alba* | | | 8.1 | | | | | | | | | | 1.2 | | | | | | | |
| | **VIIg Total** | **399.5** | **538.2** | **700.2** | **789.9** | **142.4** | **189.4** | **0.6** | **0.8** | **103.6** | **115.2** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| VIIh | *A. radiata* | | | | 0.1 | | | | | | | | | | 0.0 | | | | | | |
| | *D. batis* | | | 0.1 | | | | | | | | | | 0.0 | | | | | | | |
| | *D. oxyrinchus* | | | 0.1 | 3.5 | | | | | 0.1 | 0.0 | | | 0.0 | 0.3 | | | | | 0.0 | 0.0 |
| | *L. circularis* | | 0.0 | | 14.1 | | | | | 0.0 | 0.1 | | 11.1 | | 1.1 | | | | | 0.0 | 0.1 |
| | *L. fullonica* | | | 114.7 | 112.7 | 3.6 | 3.1 | 0.1 | 0.0 | 57.3 | 20.1 | | | 7.5 | 8.6 | 11.7 | 29.5 | 2.1 | 19.5 | 30.0 | 22.8 |
| | *L. naevus* | 0.0 | 0.1 | 1318.4 | 1089.4 | 27.1 | 7.2 | 4.5 | 0.2 | 117.4 | 62.0 | 100.0 | 48.5 | 86.1 | 82.8 | 86.9 | 69.6 | 97.9 | 80.5 | 61.6 | 70.5 |
| | *R. asterias* | | | | 0.7 | | | | | | | | | | 0.0 | | | | | | |
| | *R. brachyura* | | 0.0 | 7.4 | 20.3 | 0.0 | 0.1 | | | 3.8 | 1.3 | | 18.7 | 0.5 | 1.5 | 0.1 | 0.9 | | | 2.0 | 1.5 |
| | *R. clavata* | | 0.0 | 16.7 | 8.8 | 0.4 | | | | 2.8 | 1.6 | | 21.6 | 1.1 | 0.7 | 1.1 | | | | 1.5 | 1.8 |
| | *R. microocellata* | | | 10.3 | 0.1 | | | | | 3.8 | 1.5 | | | 0.7 | 0.0 | | | | | 2.0 | 1.7 |
| | *R. montagui* | | | 63.1 | 66.5 | 0.0 | | | | 5.5 | 1.4 | | | 4.1 | 5.0 | 0.1 | | | | 2.9 | 1.6 |
| | *Rostroraja alba* | | | 0.6 | | | | | | | 0.0 | | | 0.0 | | | | | | | 0.0 |
| | **VIIh Total** | **0.0** | **0.2** | **1531.4** | **1316.1** | **31.1** | **10.4** | **4.6** | **0.2** | **190.6** | **88.1** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

**Table 18.5 (cont.). Demersal elasmobranchs in the Celtic Seas. Species composition of skates (Rajidae), as reported in national landing statistics. Note: Belgian records of 'sandy ray' are assumed to refer to small-eyed ray; Scottish records of *Rostroraja alba* may refer to *L. fullonica*.**

| | | Landings (t) | | | | | | | | Species composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | France | | Ireland | | Scotland | | UK (E,W&NI) | | France | | Ireland | | Scotland | | UK (E,W&NI) | |
| **Div** | **Scientific name** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| VIIj | *A. radiata* | | | | 0.0 | | | | | | | | 0.0 | | | | |
| | *D. batis* | 0.2 | | | | | | | | 0.3 | | | | | | | |
| | *D. oxyrinchus* | 3.3 | 2.5 | | 0.4 | | | | | 4.8 | 3.0 | | 0.3 | | | | |
| | *L. circularis* | 6.3 | 8.9 | 0.1 | 0.1 | | 0.9 | | 0.3 | 9.3 | 10.7 | 0.1 | 0.1 | | 2.1 | | 0.8 |
| | *L. fullonica* | 3.1 | 5.1 | 2.1 | 2.1 | 3.5 | 3.8 | 11.6 | 15.3 | 4.6 | 6.1 | 2.3 | 1.9 | 9.9 | 8.6 | 14.3 | 34.0 |
| | *L. naevus* | 43.0 | 56.8 | 29.8 | 32.8 | 13.5 | 11.3 | 52.5 | 21.1 | 63.0 | 68.2 | 33.2 | 29.2 | 38.5 | 25.4 | 64.6 | 46.7 |
| | *R. brachyura* | 0.0 | 1.4 | 8.5 | 11.2 | | | 0.0 | | 0.0 | 1.6 | 9.5 | 9.9 | | | 0.0 | |
| | *R. clavata* | 10.7 | 6.7 | 38.6 | 48.2 | 18.0 | 28.4 | 14.2 | 6.3 | 15.6 | 8.1 | 43.1 | 42.9 | 51.5 | 63.6 | 17.5 | 13.9 |
| | *R. microocellata* | | 0.0 | | | | | 0.1 | | | 0.0 | | | | | 0.1 | |
| | *R. montagui* | 1.6 | 2.0 | 10.7 | 17.4 | | 0.1 | 2.9 | 2.1 | 2.3 | 2.4 | 11.9 | 15.5 | | 0.3 | 3.5 | 4.6 |
| | **VIIj Total** | **68.3** | **83.3** | **89.7** | **112.2** | **35.0** | **44.6** | **81.3** | **45.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| VIIk | *D. batis* | 0.0 | | | | | | | | 0.1 | | | | | | | |
| | *D. oxyrinchus* | 0.2 | 0.0 | | | | | | | 17.4 | 0.4 | | | | | | |
| | *L. circularis* | 0.0 | 0.0 | | | | 0.8 | | | 0.1 | 0.2 | | | | 39.3 | | |
| | *L. fullonica* | 0.6 | 0.1 | | | | | | 0.1 | 45.7 | 4.4 | | | | | | 100.0 |
| | *L. naevus* | 0.3 | 1.9 | 0.3 | 0.3 | | | | | 20.4 | 76.5 | 42.5 | 44.2 | | | | |
| | *R. brachyura* | | 0.2 | | 0.3 | | | | | | 6.2 | | 49.8 | | | | |
| | *R. clavata* | 0.1 | 0.3 | 0.4 | 0.0 | 1.5 | 1.3 | | | 5.2 | 12.4 | 57.5 | 6.0 | 100.0 | 60.7 | | |
| | *R. microocellata* | | 0.0 | | | | | | | | | | | | | | |
| | *R. montagui* | 0.1 | 0.0 | | | | | | | 11.1 | 0.0 | 0.0 | | | | | |
| | **VIIk Total** | **1.3** | **2.5** | **0.6** | **0.6** | **1.5** | **2.1** | | **0.1** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | | **100.0** |

**Table 18.6a. Demersal elasmobranchs in the Celtic Seas. Summary details of fishery-independent surveys using otter trawls in the Celtic Seas ecoregion. Adapted from ICES (2009, 2010a).**

| Country | Ireland | UK (Scot) | UK (Scot) | UK (Scot) | UK (NI) | UK (NI) | UK (Eng&Wal) | UK (Eng&Wal) | France | Spain |
|---|---|---|---|---|---|---|---|---|---|---|
| Acronym | IGFS-WIBTS-Q4 | ScoGFS-WIBTS-Q1 | ScoGFS-WIBTS-Q4 | Rock-IBTS-Q3 | NIGFS-WIBTS-Q1 | NIGFS-WIBTS-Q4 | EngW-WIBTS-Q4 | PHHT-Q1 | EVHOE-WIBTS-Q4 | SpPGFS-WIBTS-Q4 |
| Laboratory | MI | MSS | MSS | MSS | AFBI | AFBI | Cefas | Cefas | Ifremer | IEO |
| Research vessel | Celtic Explorer | Scotia | Scotia | Scotia | Corystes | Corystes | Endeavour | Cirolana/Endeavour | Thalassa | Vizconde de Eza |
| Gear type | 36/47 GOV | 36/47 GOV | 36/47 GOV | | Rock-hopper otter trawl | Rock-hopper otter trawl | 36/47 GOV [34/45 GOV] | PHHT | 36/47 GOV | BACA 40/52 |
| Depth range | 20–600 | 20–400 | 20–400 | | 20–120 | 20–120 | 20–150 | | 30–400 | 150–800 |
| Trawl speed (knots) | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 3.5 |
| Groundrope | Groundgears A&D | Bobbins | Bobbins | Bobbins | Rubber discs | Rubber discs | Groundgears A&D | Rock-hopper | Groundgear A | Synthetic wrapped wire core (double coat) |
| Survey area | VIA, VII | VI | VI | VIb | VIIA | VIIA | VIIA,E–H | VII | VIIF–J, VIII | VIIC |
| Station grid | Semi-random depth stratified | Semi-random, 1–2 tows per rectangle | Semi-random, 1–2 tows per rectangle | | Fixed stations in strata | Fixed stations in strata | Fixed stations in strata | Fixed stations | Stratified random | Random stratified across 5 strata |
| Quarter | 4 | 1 | 4 | 4 | 1 | 4 | 4 | 1 (4) | 4 | 3–4 |
| Time coverage | 2003– | 1992– | 1992– | | 1992– | 1992– | 2003–2011 | 1988–2003 | 1997– | 2001– |
| Coordination | IBTSWG | IBTSWG | IBTSWG | IBTSWG | IBTSWG | IBTSWG | IBTSWG | - | IBTSWG | IBTSWG |

**Table 18.6b. Demersal elasmobranchs in the Celtic Seas. Summary details of fishery-independent trawl surveys (WIBTS) in the Celtic Seas ecoregion. Adapted from ICES (2009, 2010a).**

| COUNTRY | UK (ENG&WAL) | UK (ENG&WAL) | UK (ENG&WAL) |
|---|---|---|---|
| Acronym | EngW-BTS-Q3 | Eng-WEC-BTS-Q4 | Eng-WEC-BTS-Q1 |
| Laboratory | Cefas | Cefas | Cefas |
| Research vessel | Endeavour [1] | FV Carhelmar | Endeavour |
| Gear type | 4 m BT | 4 m BT (twin) | 4 m BT (twin) |
| Depth range | 10–135 | | |
| Trawl speed (knots) | 4 | 4 | 4 |
| Survey area | VIIAF | VIIE (part) | VIIE |
| Station grid | Fixed | Fixed | Stratified random |
| Quarter | 3 | 4 | 1 |
| Initiated (for quarter) | 1988 [2] | 1988 [2] | 2006 |
| Coordination | WGBEAM | WGBEAM | |

**[1] Endeavour used in recent years only. RV Corystes used previously.**

**[2] Grid standardized since 1993.**

**Table 18.7. Demersal elasmobranchs in the Celtic Seas. Technical interactions.**

| Stock interaction table | Anglerfish budegassa VIIb-k, VIIIabd | Anglerfish piscatorius VIIb-k, VIIIabd | Cod VIIe-k | Haddock VIIb-k | Hake Northern | Herring Celtic Sea and Division VIIj | Herring VIa(S) and VIIbc | Horse Mackerel Western | Mackerel North East Atlantic | Megrim VII | Nephrops Area L: VIIbcjk | Nephrops Area M: VIIfgh+VIIa | Nephrops VIIIa,b | Plaice VIIbc | Plaice VIIe | Plaice VIIfg | Plaice VIIhjk | Sole VIIbc | Sole VIIe | Sole VIIfg | Sole VIIhjk | Sprat VIIde | Whiting VIIe-k | Seabass | Skates and rays | Pelagic and migratory sharks | Demersal sharks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anglerfish budegassa VIIb-k, VIIIabd | | H | L | L | M | 0 | 0 | 0 | 0 | M | M | L | M | L | L | L | L | L | L | L | L | | L | | H | L | H |
| Anglerfish piscatorius VIIb-k, VIIIabd | T | | L | L | M | 0 | 0 | 0 | 0 | M | M | M | M | L | L | L | L | L | L | L | L | | L | | H | L | H |
| Cod VIIe-k | T | T | | H | L | 0 | 0 | 0 | 0 | L | L | M | 0 | 0 | L | M | L | 0 | L | L | L | 0 | H/M | | H | L | H |
| Haddock VIIb-k | T | T | T | | L | 0 | 0 | 0 | 0 | L | M | M | 0 | L | L | L | L | L | L | L | L | 0 | H | 0 | H | L | H |
| Hake Northern | T | T | T | | | 0 | 0 | 0 | 0 | M | M | L | M | L | | 0 | L | L | | 0 | L | | L | | H | L | H |
| Herring Celtic Sea and Division VIIj | N | N | N | N | N | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | I | 0 |
| Herring VIa(S) and VIIbc | N | N | N | N | N | N | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | L | 0 |
| Horse Mackerel Western | N | N | N | N | N | N | N | | H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | L | 0 |
| Mackerel North East Atlantic | N | N | N | N | N | N | N | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | L | 0 |
| Megrim VII | T, BT | T, BT | T | | T | N | N | N | N | | H | M | M | L | | | L | L | | L | L | | L | | H | 0 | H |
| Nephrops Area L: VIIbcjk | NT | NT | NT | NT | NT | N | N | N | N | NT | | 0 | 0 | L | 0 | 0 | L | L | 0 | 0 | L | 0 | M | | M | 0 | M |
| Nephrops Area M: VIIfgh+VIIa | NT | NT | NT | NT | NT | N | N | N | N | NT | N | | 0 | 0 | 0 | 0 | L | 0 | 0 | L | L | 0 | M | | M | 0 | M |
| Nephrops VIIIa,b | NT | NT | N | N | NT | N | N | N | N | NT | N | N | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | L | 0 | M |
| Plaice VIIbc | | | N | | | N | N | N | N | | NT | N | N | | 0 | 0 | 0 | L | 0 | 0 | 0 | 0 | L | 0 | H | 0 | M |
| Plaice VIIe | OT, BT | OT, BT | OT, BT | N | | N | N | N | N | | N | N | N | N | | 0 | 0 | 0 | H | 0 | 0 | 0 | L | | H | 0 | M |
| Plaice VIIfg | OT, BT | OT, BT | OT, BT | OT, BT | N | N | N | N | N | | N | N | N | N | N | | 0 | 0 | 0 | H | 0 | 0 | L | | H | 0 | M |
| Plaice VIIhjk | | | BT, OT | | | N | N | N | N | | NT | N | N | N | N | N | | 0 | 0 | 0 | L | 0 | L | 0 | H | 0 | M |
| Sole VIIbc | | | N | | | N | N | N | N | | N | N | N | | N | N | N | | 0 | 0 | 0 | 0 | L | 0 | H | 0 | M |
| Sole VIIe | BT, OT | BT, OT | BT, OT | N | | N | N | N | N | | N | N | N | N | BT, OT | N | N | N | | 0 | 0 | 0 | L | | H | 0 | M |
| Sole VIIfg | BT, OT | BT, OT | BT, OT | BT, OT | N | N | N | N | N | BT | N | NT | N | N | N | BT, OT | N | N | N | | 0 | 0 | L | | H | 0 | M |
| Sole VIIhjk | | | BT, OT | | | N | N | N | N | | N | N | N | N | N | N | T, BT | N | N | N | | 0 | L | 0 | H | 0 | M |
| Sprat VIIde | N | N | N | N | | | | N | N | | N | N | N | N | N | N | N | N | N | N | N | | 0 | | | | |
| Whiting VIIe-k | T | T | T | T | | N | N | N | N | | NT | NT | N | N | N | BT, OT | | N | N | BT, OT | | | | 0 | H | L | H |
| Seabass | | | | | | N | N | N | N | | | | | | | | | | | | | | 0 | | L | L | L |
| Skates and rays | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | N | N | N | BT, OT | NT | NT | NT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | BT,OT | GN | | L | H |
| Pelagic and migratory sharks | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | N | N | N | BT, OT | | | | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | BT, OT | BT, OT | N | BT,OT | T, GN | GN, BT | | 0 |
| Demersal sharks | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | N | N | N | BT, OT | NT | NT | NT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | BT, OT | N | BT,OT | GN | BT,OT | N | |

H; the stocks are taken together in most fisheries where they are taken and their fisheries linkage is therefore high; M: the stocks are taken together in some but not all important fisheries and their fisheries linkage is therefore medium; L: the stocks

T: Trawl; BT: Beam trawl; OT: Otter trawl; NT: Nephrops trawl; GN: Gillnet; N: none

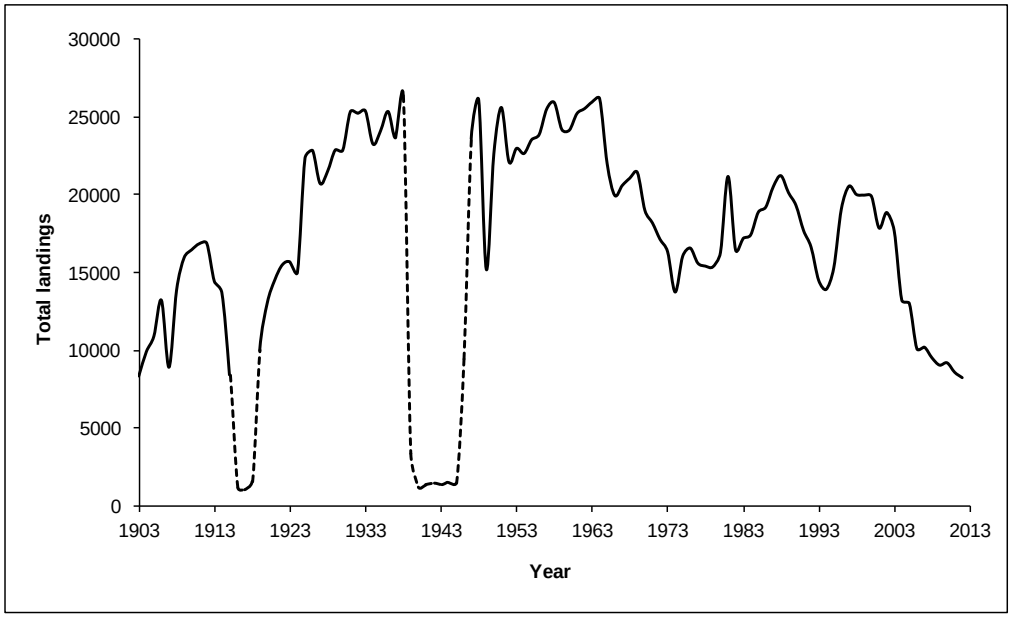



**Figure 18.1a. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas (ICES Subareas VI and VII (including VIId)), from 1903–2012 (Source: ICES).**

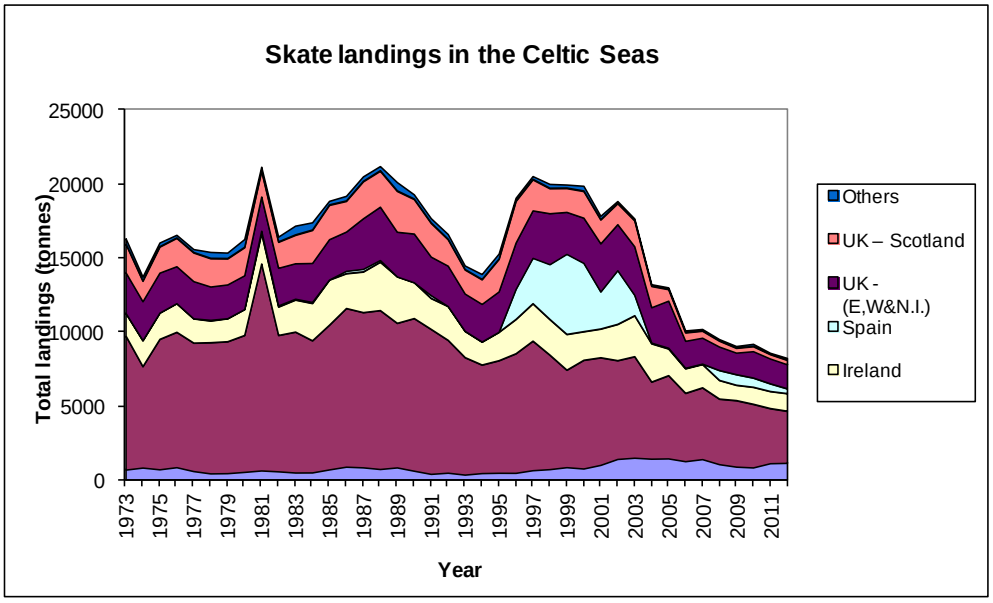



**Figure 18.1b. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2012 (Source: ICES).**

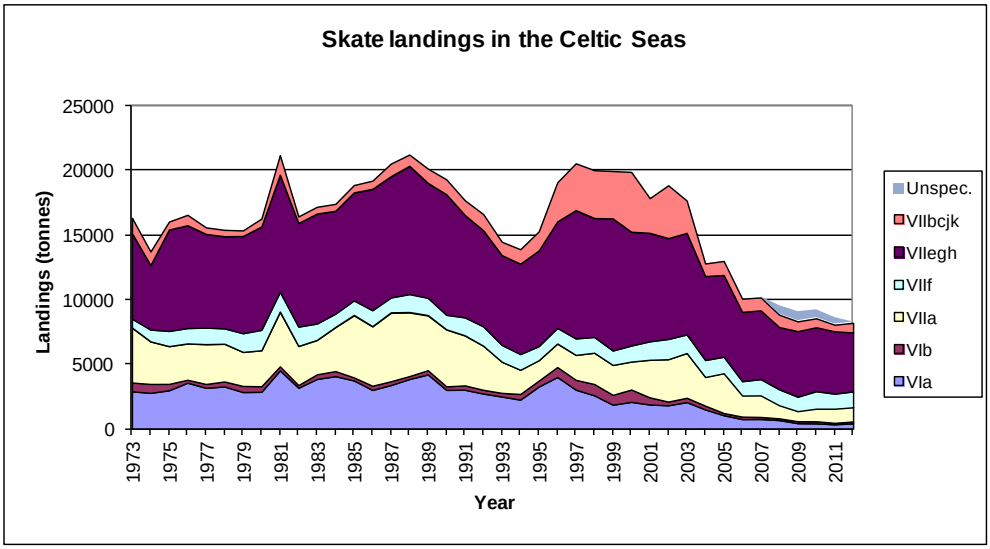



**Figure 18.1c. Demersal elasmobranchs in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by ICES Division in the Celtic Seas from 1973–2012 (Source: ICES).**

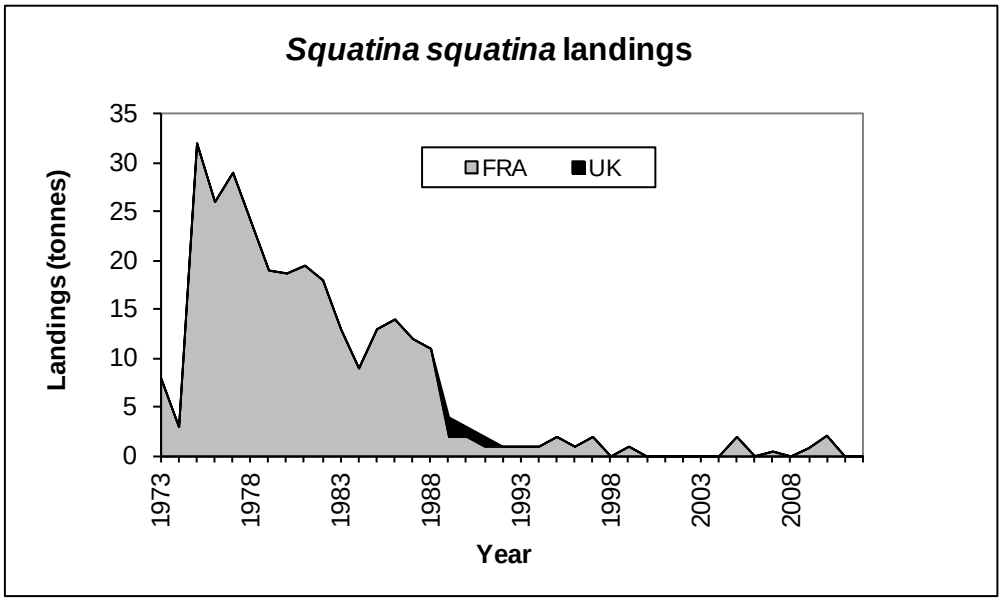



**Figure 18.2. Demersal elasmobranchs in the Celtic Seas. Total landings of *Squatina squatina* (1973–2012). Angel shark is now on a prohibited species list and only nominal landings are reported in 2009–2011. (Source: ICES and Bulletin de Statistiques des Peches Maritimes).**

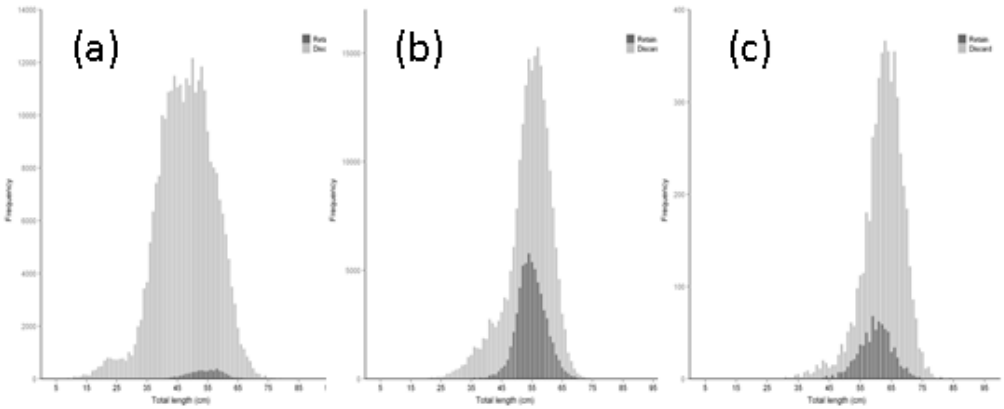



**Figure 18.3a. Demersal elasmobranchs in the Celtic Seas. Discard and retention patterns for lesser-spotted dogfish *Scyliorhinus canicula* caught in (a) beam trawl, (b) otter trawl and (c) gillnet in the Celtic Seas ecoregion by UK (English) vessels, as observed in the Cefas discard observer programme (Source: Silva *et al.*, 2012WD).**

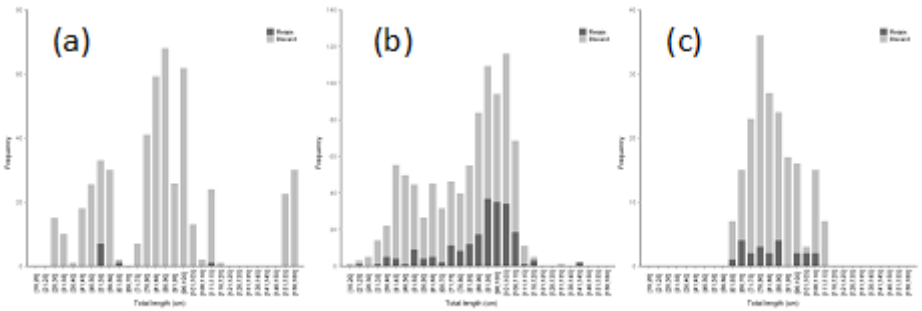



**Figure 18.3b. Demersal elasmobranchs in the Celtic Seas. Length frequency of discarded and retained greater-spotted dogfish *Scyliorhinus stellaris* by (a) beam trawl, (b) otter trawl and (c) gillnet in the Celtic Seas ecoregion by UK (English) vessels, as observed in the Cefas discard observer programme (Source: Silva *et al.*, 2012WD).**

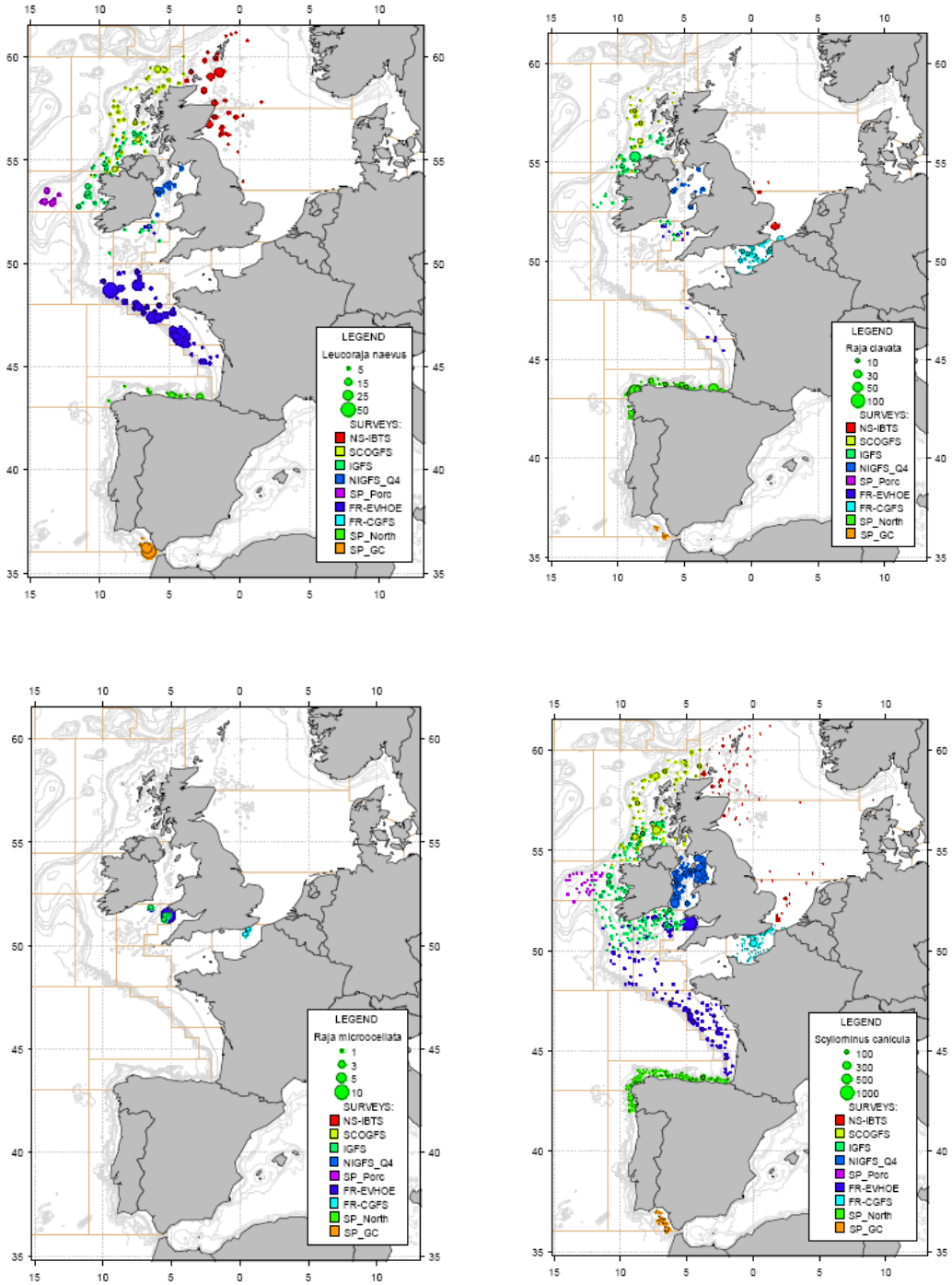



**Figure 18.4. Demersal elasmobranchs in the Celtic Seas. Catches, in numbers per hour, of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, small-eyed ray *Raja microocellata* and lesser-spotted dogfish *Scyliorhinus canicula* in Q4 IBTS surveys in the Southern and Western Areas in 2011. The catchability of the different gears used in these surveys is not constant; therefore these maps do not reflect proportional abundance in all the areas but within each survey (Source: ICES, 2013).**

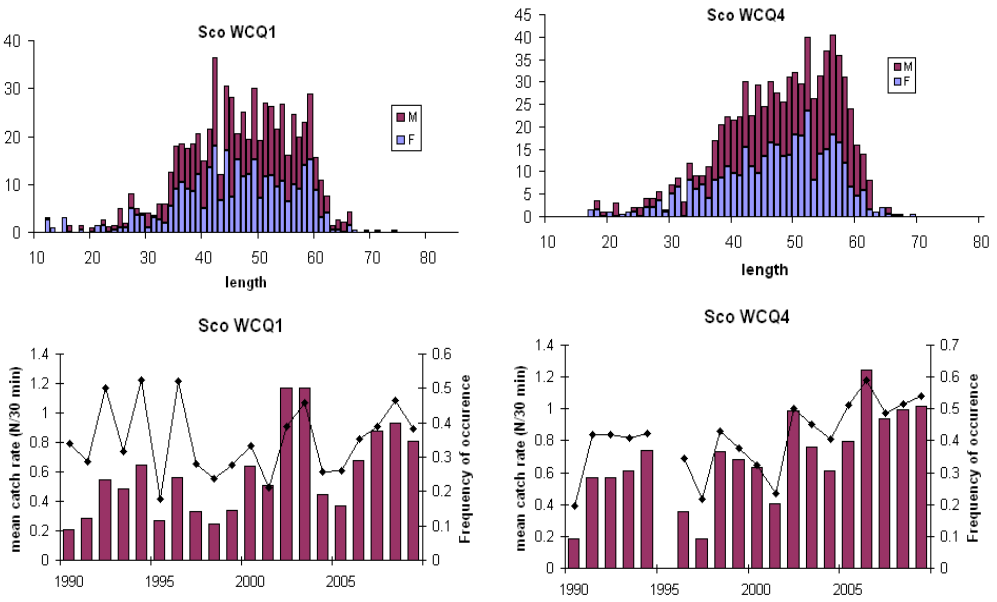



**Figure 18.5a. Demersal elasmobranchs in the Celtic Seas. Length–frequency distributions of *L. naevus* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

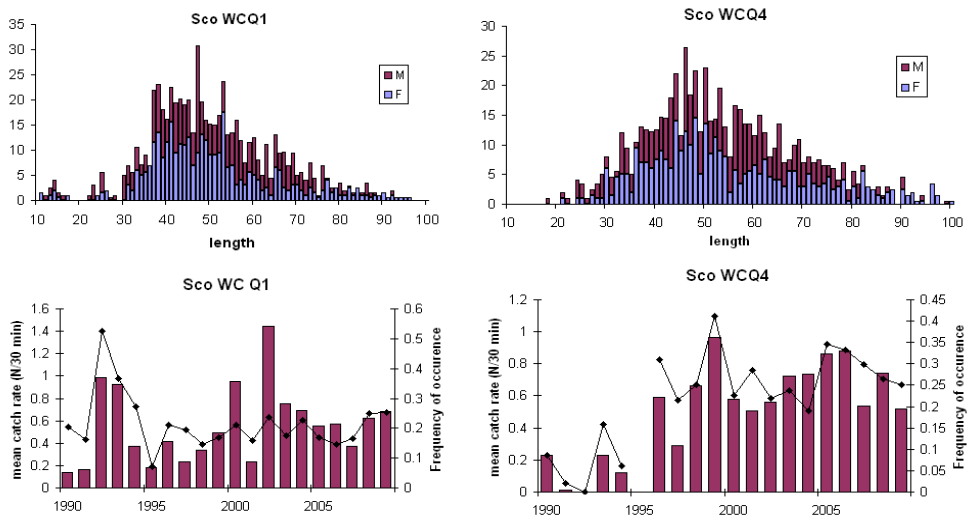



**Figure 18.5b. Demersal elasmobranchs in the Celtic Seas. Length–frequency distributions of *R. clavata* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

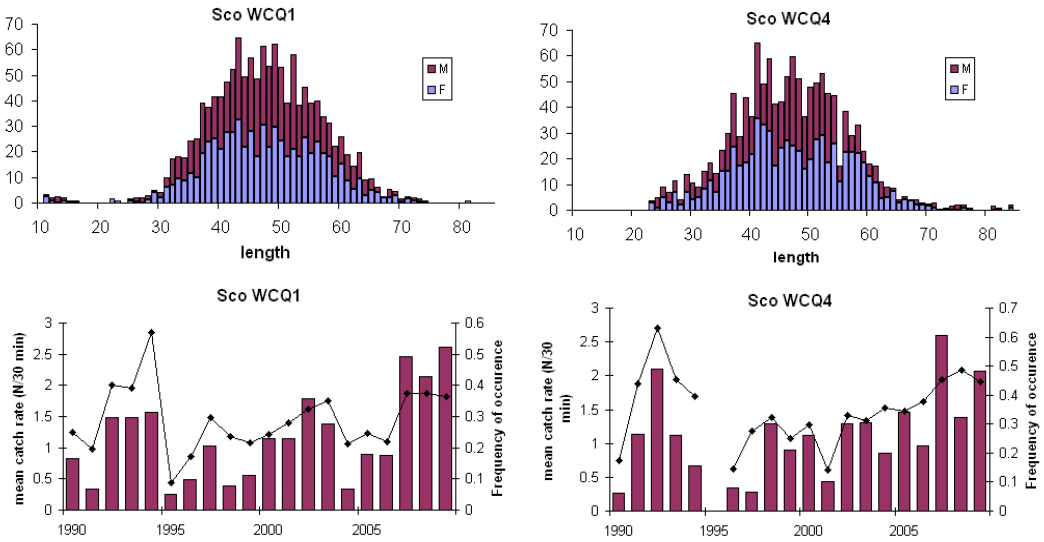



**Figure 18.5c. Demersal elasmobranchs in the Celtic Seas. Length–frequency distributions of *R. montagui* from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

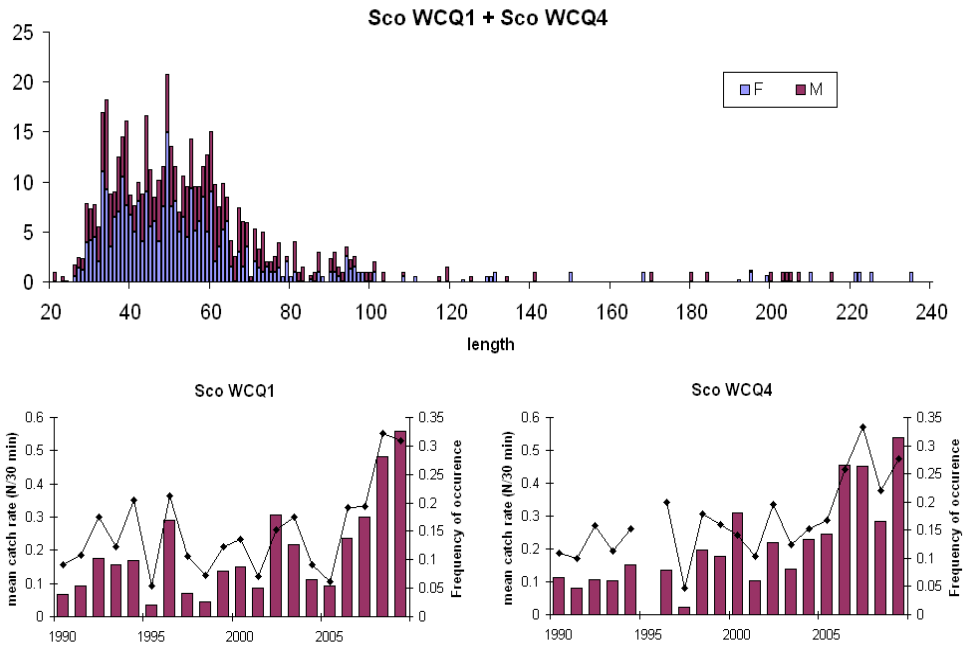



**Figure 18.5d. Demersal elasmobranchs in the Celtic Seas. Combined length–frequency distributions of *'D. batis'* from the Scottish west coast surveys in Q1 and Q4 (upper plot). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

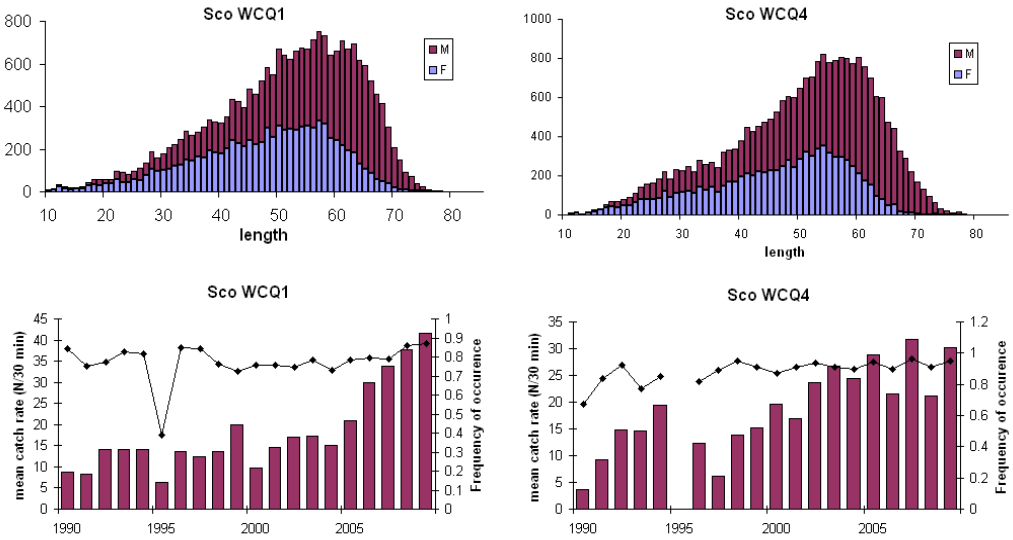



**Figure 18.5e. Demersal elasmobranchs in the Celtic Seas. Length–frequency distributions of lesser-spotted dogfish from the Scottish west coast surveys in Q 1 and Q4 (upper plots). Lower plots show frequency of occurrence (line) and average catch rate (bars) in number 30 min$^{-1}$.**

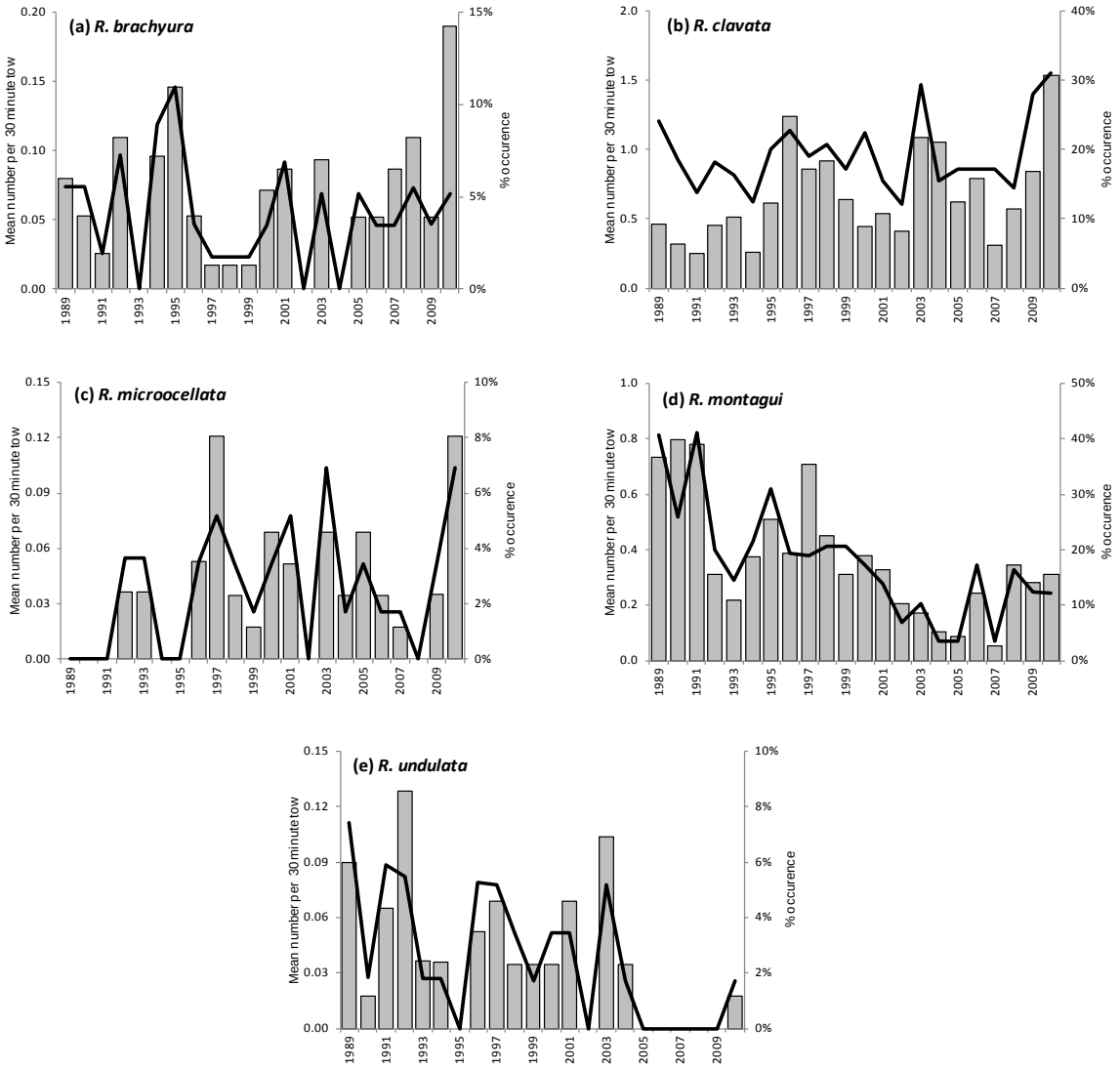



**Figure 18.6. Demersal elasmobranchs in the Celtic Seas. Trends in the mean relative abundance (numbers per 30 minute tow, grey columns) and frequency of occurrence (solid line) for five skate species caught in the Great West Bay (western English Channel) during the Carhelmar survey (1989–2010). Adapted from Burt *et al*. (2012)**

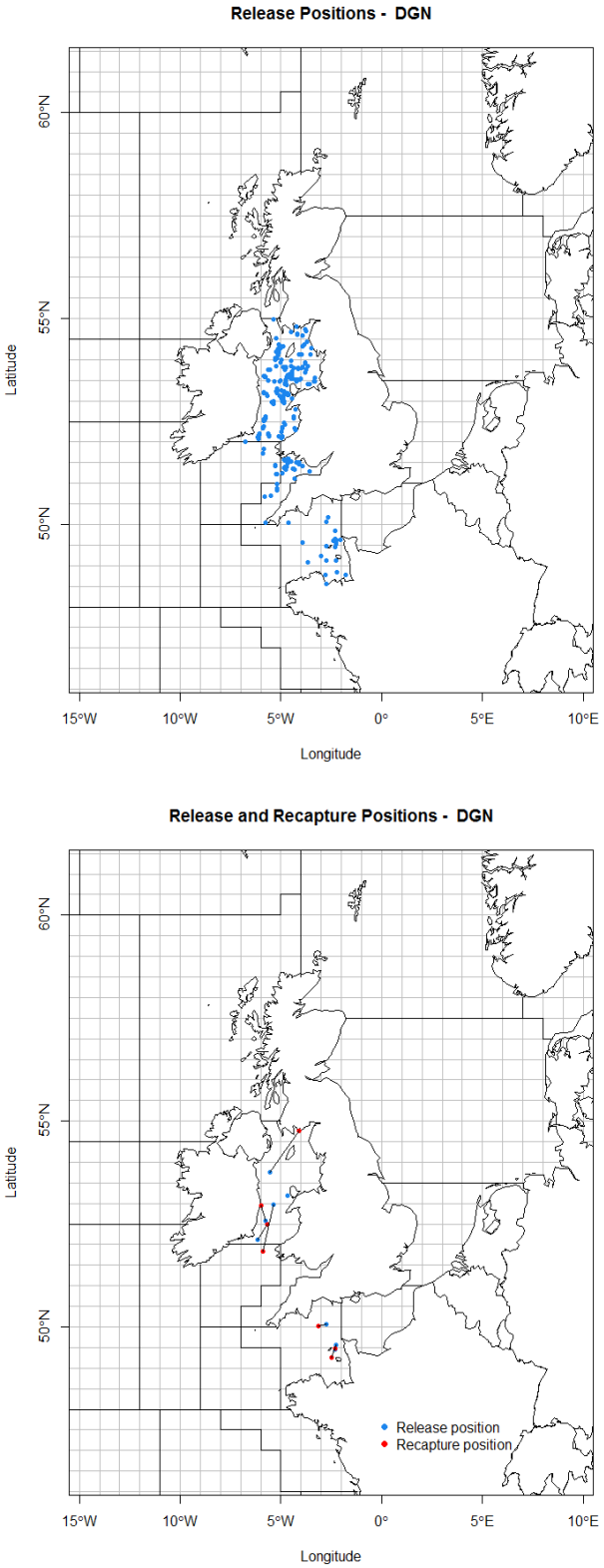
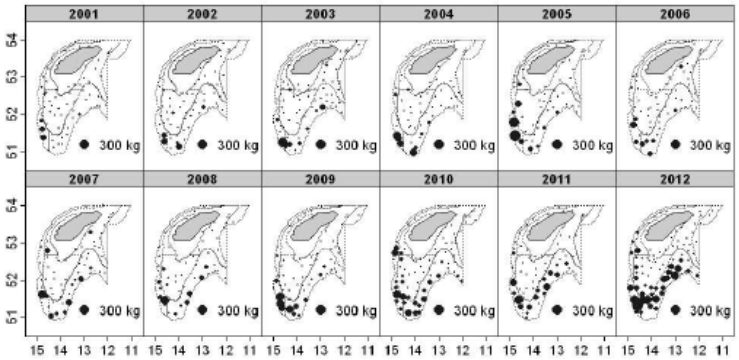
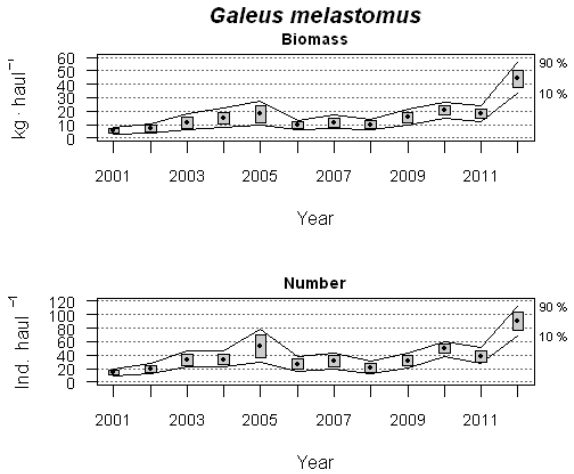
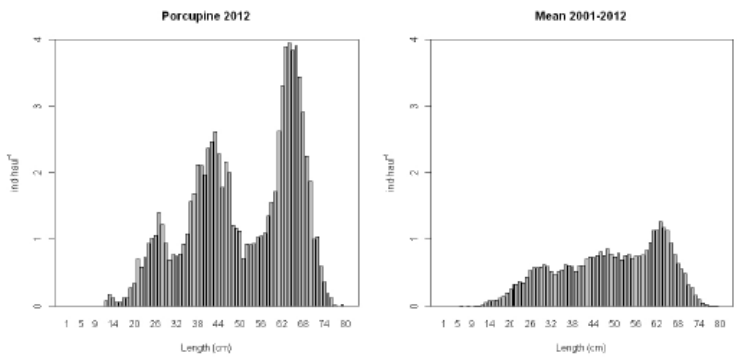


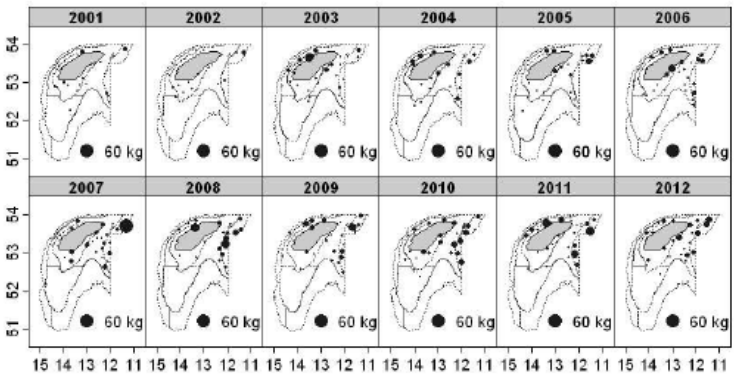
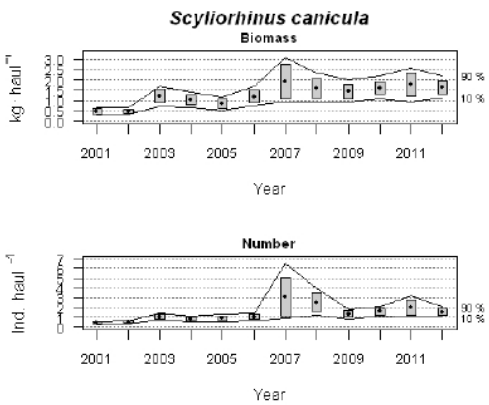
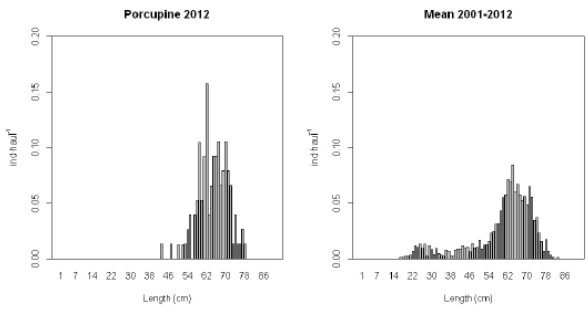

**Figure 18.7. Demersal elasmobranchs in the Celtic Seas. Release and recapture positions of greater-spotted dogfish (Source: Burt *et al.*, 2013 WD)**

## 18.14 Supplementary material–Survey Summary Sheets

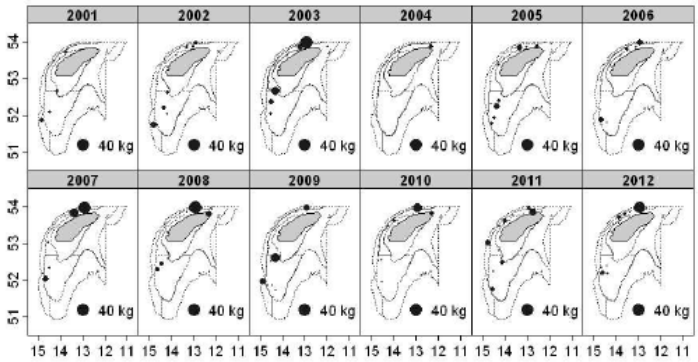
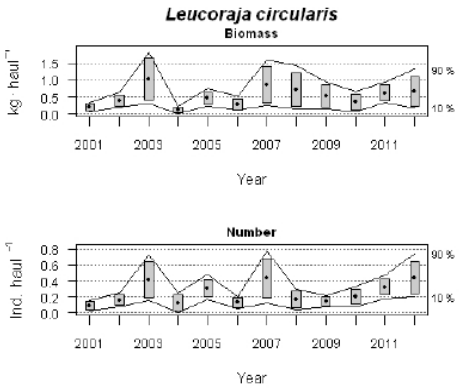
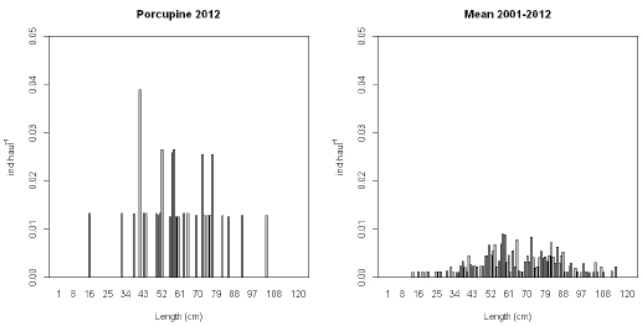
The following pages provide a short summary on the state of the main demersal elasmobranch stocks within the Celtic Seas ecoregions. Different survey indices are used to illustrate changes in distribution, catch rate and size, and provide qualitative information on the status of the stocks.

| **18.S1: Black-mouth dogfish *Galeus melastomus*** | Survey: SpPGFS-WIBTS-Q4 |
|---|---|
|   | Geographical distribution of black-mouth dogfish *G. melastomus* catches (kg·haul$^{-1}$) (2001–2012). |
|   | Temporal changes in black-mouth dogfish biomass index and abundance during Porcupine survey time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) |
|   | Stratified length distributions of black-mouth dogfish *G. melastomus* in 2012 Porcupine survey, and mean values over the entire time-series (2001–2012). |

| | |
|---|---|
| Distribution: Widely distributed along outer continental shelf/upper slope. Stock units unclear. Slight increase in distribution across survey area in 2012, although the survey area only covers a small part of species range. Found mainly in the southern part of the survey area. Highest biomass in the deeper parts (450–800 m) of the southern sector. | ✓ |
| Catch rates: cpue increased in 2012. | ↗ |
| Size distribution: Length range recorded in 2012 (12–79 cm) similar to longer term data. | ✓ |
| Overall status: Survey information suggests broadly stable abundance and size composition. | ✓ |
| Exploitation: Survey index for this stock is within the expected range and there are no other biological indications of over-exploitation. It is considered that current exploitation is appropriate for the stock. | ✓ |

| **18.S2: Lesser-spotted dogfish *Scyliorhinus canicula*** | Survey: SpPGFS-WIBTS-Q4 |
|---|---|
|  | Geographical distribution of lesser-spotted dogfish *S. canicula* catches (kg·haul$^{-1}$) in Porcupine survey time-series (2001–2012). |
|  | Temporal changes in lesser-spotted dogfish *Scyliorhinus canicula* biomass index (kg·haul$^{-1}$) during Porcupine survey time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). |
|  | Stratified length distribution of lesser-spotted dogfish *S. canicula* in 2012 in Porcupine survey, and mean values over the entire time-series (2001–2012). |

| | |
|---|---|
| Distribution: Widely distributed along continental shelf. Stock units unclear. No changes in distribution observed in survey area, which only covers part of species range. Found mainly along Irish shelf and northwest of the bank at about 300 m. | ✓ |
| Catch rates: The biomass and abundance have shown an increasing trend in recent years. | ↗ |
| Size distribution: Length range recorded in 2012 (43–78 cm) similar to longer term data. Individuals <40 cm were recorded in the 2011 survey, in contrast with the lack of smaller fish in the previous two years. Individuals <55 cm are caught infrequently in this area. | ✓ |
| Overall status: Survey information suggests an increasing abundance and broadly stable distribution and size composition. | ✓ |
| Exploitation: Survey index for this stock is within the expected range and there are no other biological indications of over-exploitation. It is considered that current exploitation is appropriate for the stock. | ✓ |

| **18.S3: Sandy ray *Leucoraja circularis*** | Survey: SpPGFS-WIBTS-Q4 |
|---|---|
|  | Geographical distribution of sandy ray *Leucoraja circularis* catches (kg·haul⁻¹) in Porcupine survey time-series (2001–2012). |
|  | Temporal changes in sandy ray *Leucoraja circularis* biomass index (kg.haul⁻¹) during Porcupine survey time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000). |
|  | Stratified length distribution of sandy ray *Leucoraja circularis* in 2012 in Porcupine survey, and mean values over the entire time-series (2001–2012). |

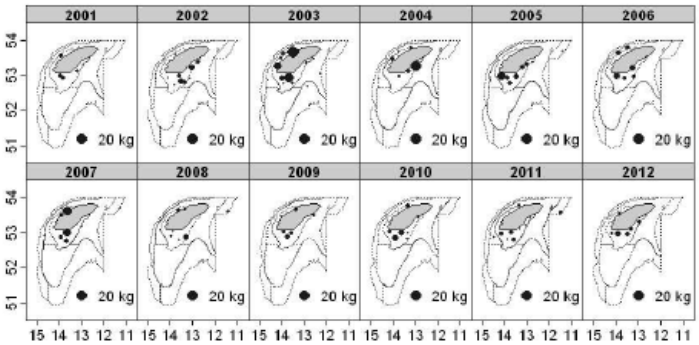
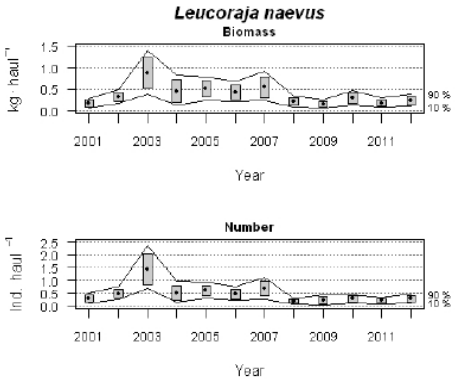
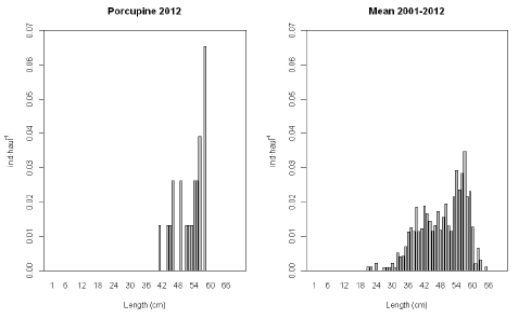
Distribution: Widely distributed along outer continental shelf and upper slope. Stock units unclear. In 2012 *L. circularis* occurred across the northern and western Porcupine area. This is one of the few surveys in the ecoregion that catches this species regularly, and the status of the stock over wider areas is unknown.

Catch rates: Both indices of biomass and abundance appear stable over the time-series, albeit with peaks in 2003 and 2007. Although there seems to be a slight increase in numbers, biomass appears more stable

Size distribution: Length range recorded in 2012 was 16–104 cm. The presence of some small specimens in the 2011 and 2012 surveys is noted, as individuals <32 cm are caught infrequently.

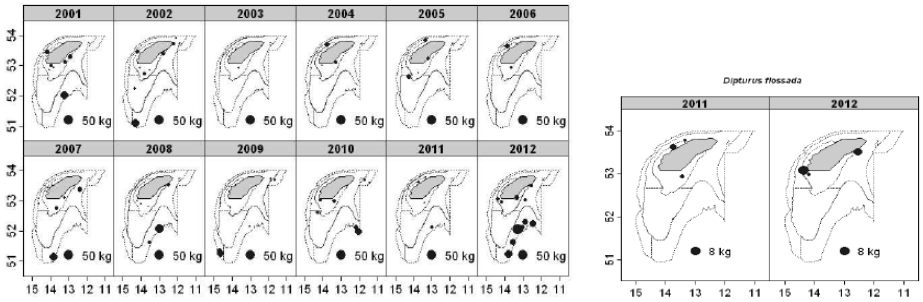
Overall status: Survey information suggests a low but stable abundance and broadly stable distribution and size composition. However, this survey only covers part of stock range.

Exploitation: Although survey data for this stock are within the expected range on the Porcupine Bank, there is a lack of data for this species elsewhere in the stock range.

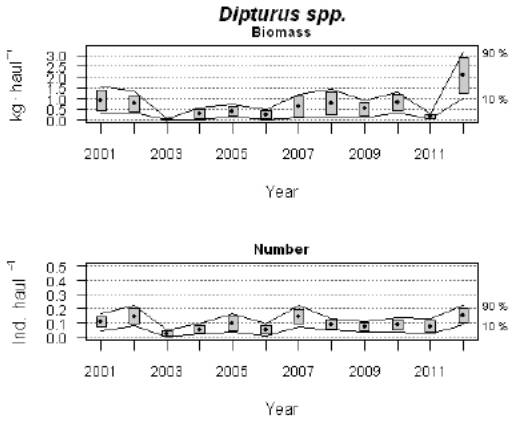
| **18.S4: Cuckoo ray *Leucoraja naevus*** | Survey: SpPGFS-WIBTS-Q4 |
|---|---|
|   | Geographical distribution of cuckoo ray *Leucoraja naevus* catches (kg·haul$^{-1}$) in Porcupine survey time-series (2001–2011). |
|   | Temporal changes in cuckoo ray *Leucoraja naevus* biomass index (kg.haul$^{-1}$) during Porcupine survey time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000). |
|   | Stratified length distributions of cuckoo ray *Leucoraja naevus* in 2012 in Porcupine survey, and mean values over the entire time-series (2001–2012). |

| | |
|---|---|
| Distribution: Widely distributed along continental shelf and upper slope. Stock units unclear. In this survey it is found mainly around the central mound of the Porcupine Bank. | ✓ |
| Catch rates: Although both indices of biomass and abundance have been stable in recent years (2008–2012), catches were greater in the preceding period (2003–2007). | ↘ |
| Size distribution: The observed length range of *L. naevus* (41–58 cm) was narrowe4 than seen in previous years and, as in 2012, the absence of specimens <37 cm was in contrast to earlier surveys | ? |
| Overall status: Survey information suggests a declining catch rate, although the connectivity between *L. naevus* on the Porcupine Bank and elsewhere in the ecoregion is unclear. | ✗ |
| Exploitation: Although levels of exploitation are unknown for this stock, survey catch rates have declined and so current levels of exploitation may be too high. | ? |

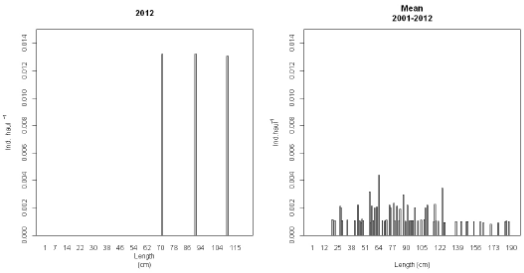
| **18.S5: Common skate *Dipturus batis* complex** | Survey: SpPGFS-WIBTS-Q4 |
|---|---|




Geographical distribution of *Dipturus* spp. (kg·haul$^{-1}$) in Porcupine survey time-series (2001–2012), and occurrence of *D. batis* cf. *flossada*.




Temporal changes in common skate biomass (kg.haul$^{-1}$) during Porcupine survey time-series (2001–2012). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).




Stratified length distributions of *Dipturus* cf. *flossada* in 2012 Porcupine survey, and mean values of *Dipturus* spp. over the entire time-series (2001–2012).

Distribution: Earlier surveys recorded this species complex as *Dipturus batis.* In 2012 all captured individuals were observed to be of the *D.* cf. *flossada* form. Distribution of the two species in the complex unclear, as both may occur to the west of Ireland. In the survey area, common skate was found mainly around the mound in the centre of the bank, over a 190–740 m depth range. The *D.* cf. *flossada* recorded in 2011 were in waters 230–320 m deep.

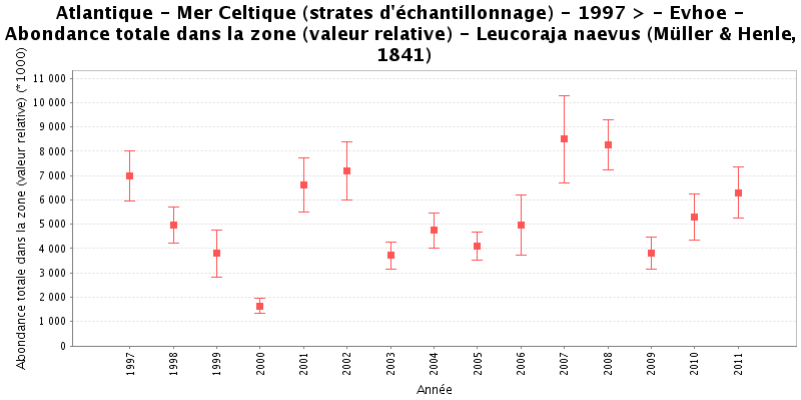
Catch rates: Both indices of biomass and abundance appear stable but low. No data to determine whether this species was more abundant on the Porcupine Bank prior to the survey. Peaks in biomass index often due to captures of small numbers of large specimens.

Size distribution: The length distribution of *Dipturus* cf. *flossada* captured in 2012 was 70–110 cm, within the wider length range reported for *Dipturus* spp. over the longer time frame (20–177 cm).

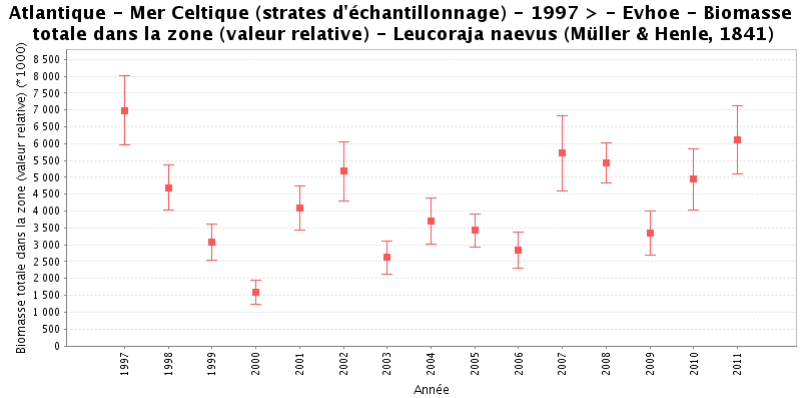
Overall status: Survey catches are low and confirm that *D.* cf. *flossada* occurs in the area. The largest fish recorded prior to 2011 (177 cm) probably represent *D.* cf. *intermedia*.

Exploitation: Although levels of exploitation are unknown for this stock, survey catch rates have declined and so current levels of exploitation may be too high.

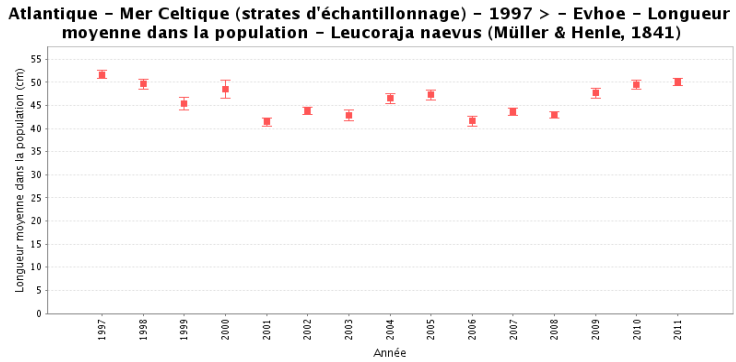
| 18.S6: Cuckoo ray *Leucoraja naevus* | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)




Temporal trends in relative abundance (biomass)




Temporal trends in mean length

Distribution: Widely distributed on the offshore grounds of the Celtic Sea. Stock units unclear and degree of connectivity with ICES regions to the north and south unclear. Spatial data were shown in Mahé and Poulard (2005).

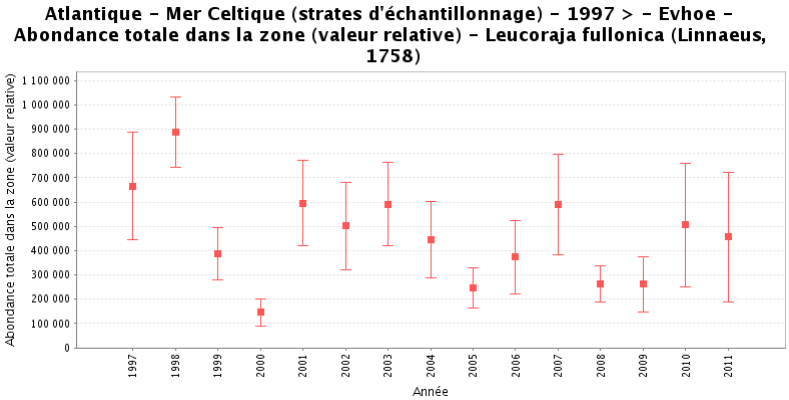
Catch rates: Indices of biomass and abundance appear stable.

Size distribution: Mean length stable.

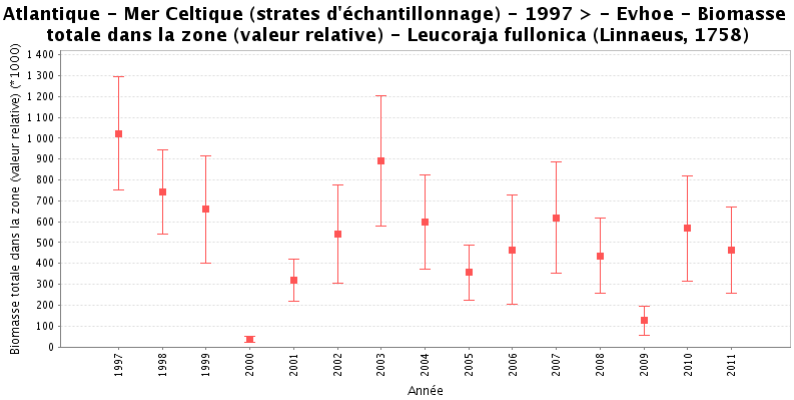
Overall status: Survey data appear stable, but further studies of these data are required.

Exploitation: One of the main skate species taken in commercial fisheries in the Celtic Sea.

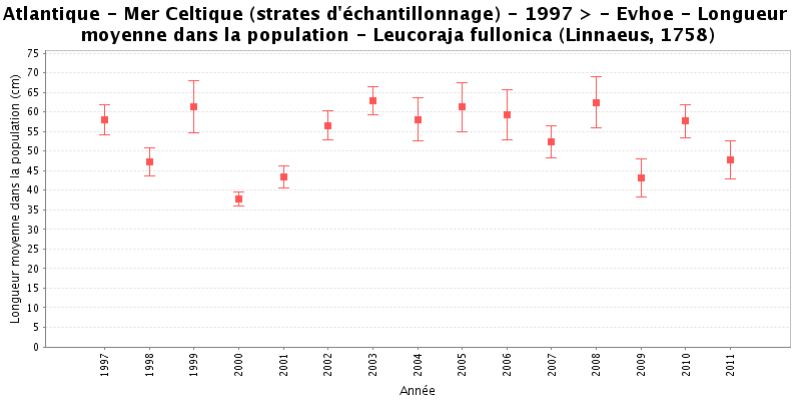
| 18.S7: *Leucoraja fullonica* | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)




Temporal trends in relative abundance (biomass)




Temporal trends in mean length

Distribution: Widely distributed on the offshore grounds of the Celtic Sea. Stock units unclear and degree of connectivity with ICES regions to the north and south unknown.

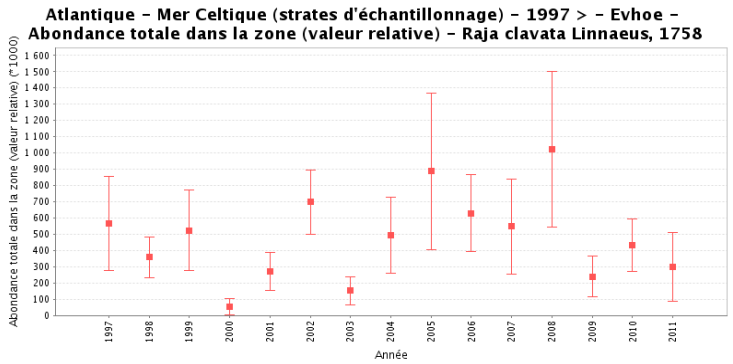
Catch rates: Overall declining trend in the numbers and biomass caught over the time-series, and this is driven by higher catch at the start of the time-series. Recent catch rates low but stable.

Size distribution: Further studies on the size distribution required.

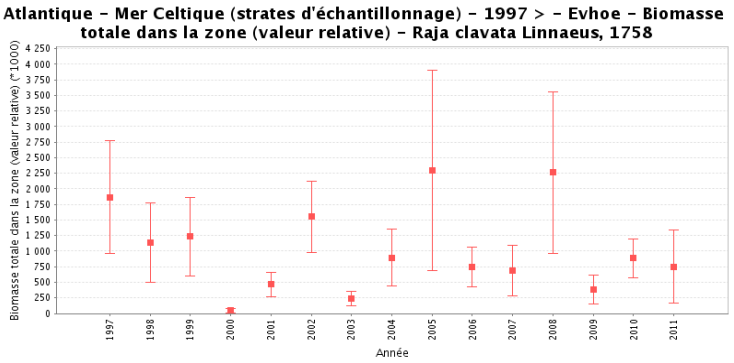
Overall status: This large-bodied skate is usually caught in small numbers, and is more common in deeper waters, Further studies to better evaluate the stock are required.

Exploitation: Although levels of exploitation are unknown for this stock, survey catch rates have declined and so current levels of exploitation may be too high.

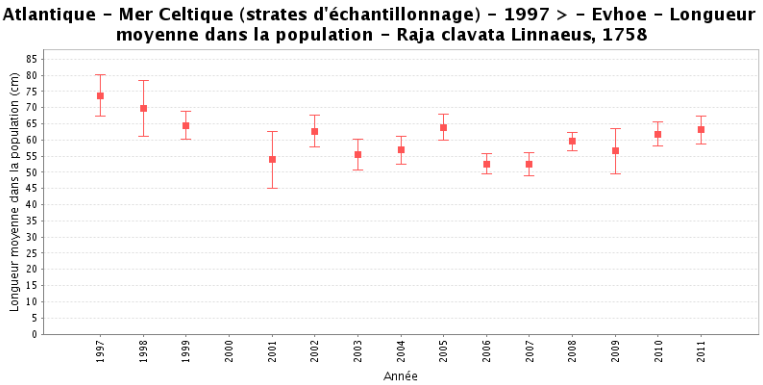
| **18.S8: *Raja clavata*** | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)




Temporal trends in relative abundance (biomass)




Temporal trends in mean length

Distribution: Widely distributed in the Celtic Sea. Stock units unclear and degree of connectivity with other ICES regions to the north and south unknown. No updated distributional area presented this year, but spatial data were shown in Mahé and Poulard (2005).

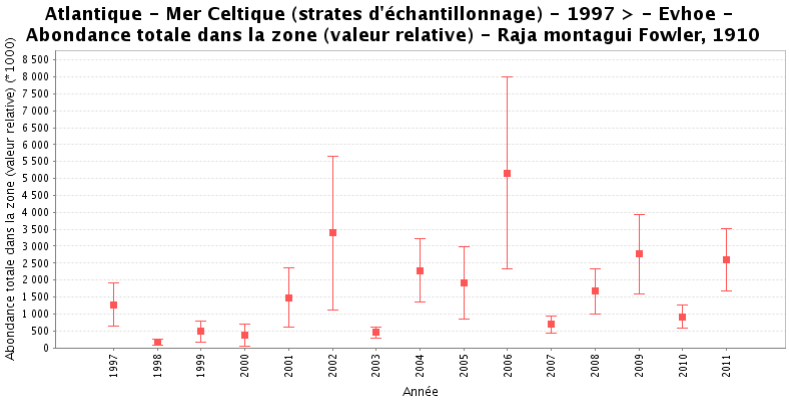
Catch rates: Indices of abundance from the two most recent years suggest a recent decline in relation to catches made in the five years preceding, although low catch rates have been observed earlier in the time-series.

Size distribution: The mean size has declined over the longer time-series, but the most recent two years show a slight increase over the preceding five years.

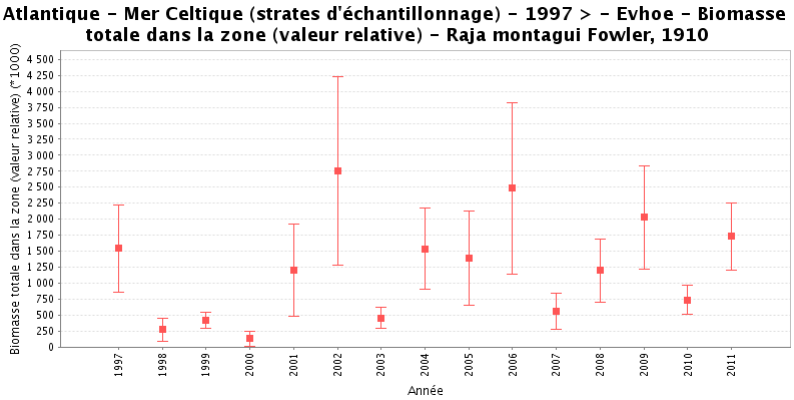
Overall status: Uncertain. This survey does not sample some of the main habitats of this inshore species, and data from beam trawl surveys may provide a better indication of status.

Exploitation:

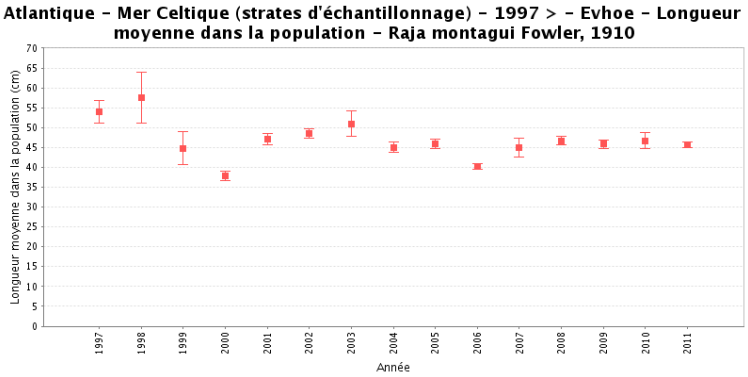
| **18.S9: *Raja montagui*** | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)




Temporal trends in relative abundance (biomass)




Temporal trends in mean length

Distribution: Widely distributed on the offshore grounds of the Celtic Sea. Stock units unclear and degree of connectivity with ICES regions to the north and south unclear.

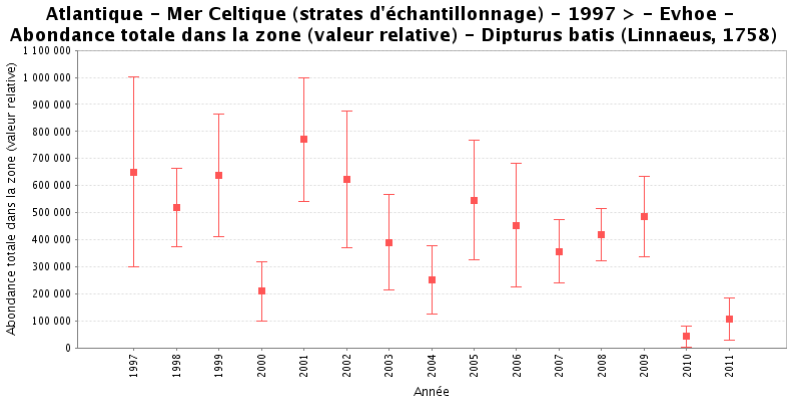
Catch rates: Recent indices of abundance and biomass appear stable.

Size distribution: Mean size has been stable for most of the time-series.

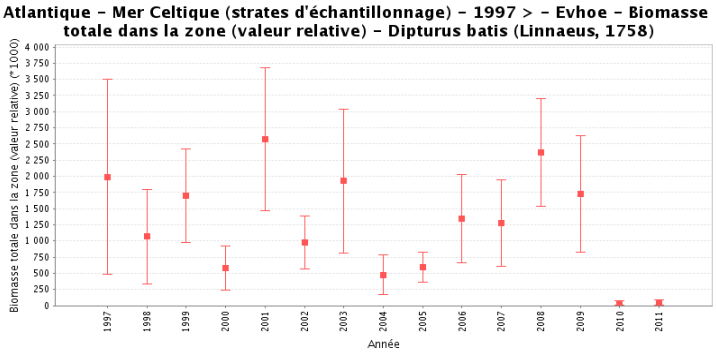
Overall status: No causes of concern at the present time.

Exploitation: It is considered that current levels of exploitation are appropriate for the stock.

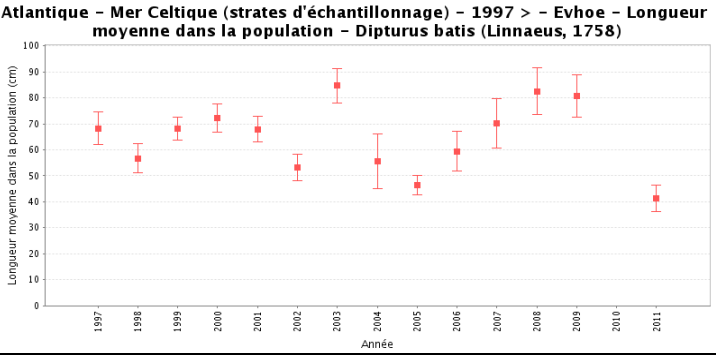
| **18.S10: *Dipturus batis*** | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)



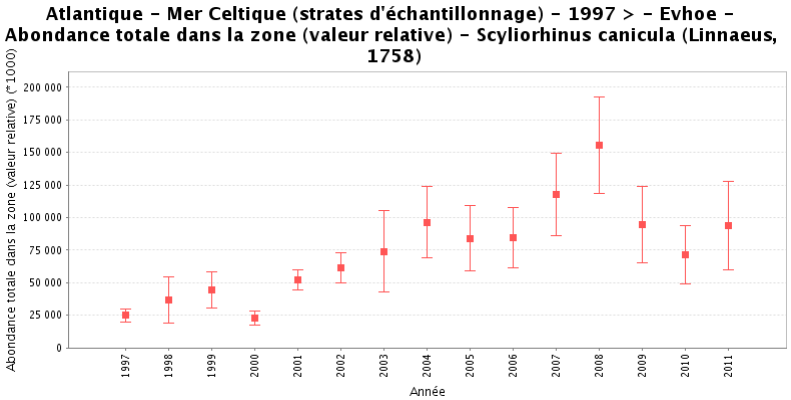

Temporal trends in relative abundance (biomass)



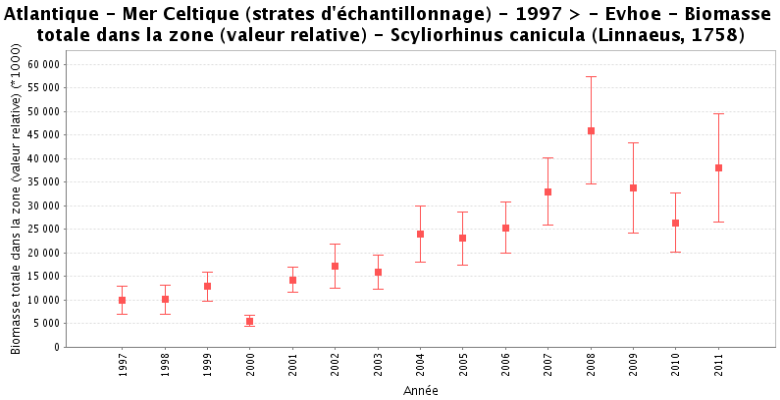

Temporal trends in mean length

| | |
|---|---|
| Distribution: Widely distributed on the offshore grounds of the Celtic Sea and upper continental slope. Stock units unclear and degree of connectivity with other ICES regions to the north and south unknown. It may not be possible to allocate historical survey data to *D.* cf. *flossada* or *D.* cf. *intermedia*. | ? |
| Catch rates: Catch rates have declined over the time-series. | ↘ |
| Size distribution: Mean size smaller in recent years. | ✕ |
| Overall status: This large-bodied skate is usually caught in small numbers. Decreasing catch rates are cause for concern. | ✕ |
| Exploitation: Although levels of exploitation are unknown for this stock, survey catch rates have declined and so current levels of exploitation may be too high. | ? |

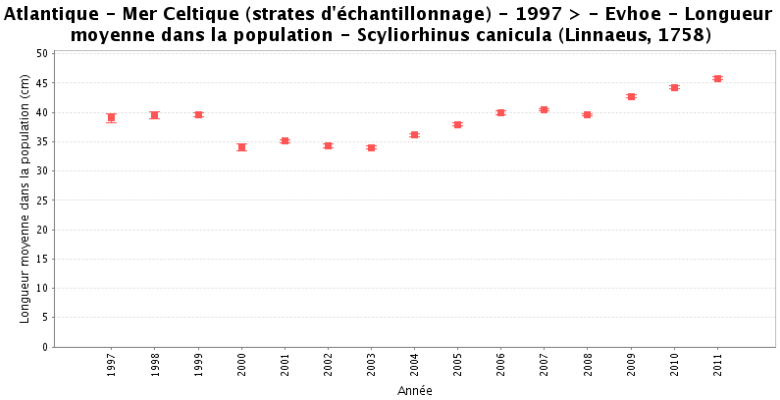
| **18.S11:** ***Scyliorhinus canicula*** | Survey: EVHOE-WIBTS-Q4 | ICES Division: VIIf–j |
|---|---|---|




Temporal trends in relative abundance (numbers)




Temporal trends in relative abundance (biomass)




Temporal trends in mean length

| | |
|---|---|
| Distribution: Widely distributed in the Celtic Sea. Stock units unclear and degree of connectivity with other ICES regions to the north and south unclear. No updated distributional area presented this year, but spatial data were shown in Mahé and Poulard (2005). | ✓ |
| Catch rates: Catch rates increasing in survey. | ↗ |
| Size distribution: Mean size increasing. | ✓ |
| Overall status: No concern over stock status. | ✓ |
| Exploitation: It is considered that current exploitation is appropriate for the stock. | ✓ |

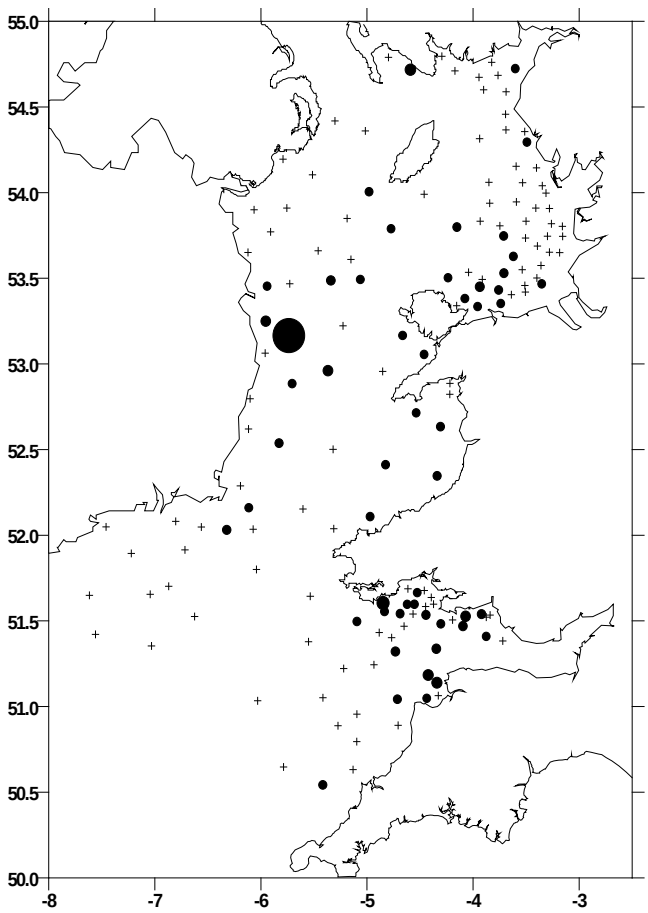
**18.S12:** *Raja brachyura*

Survey area: VIIaf

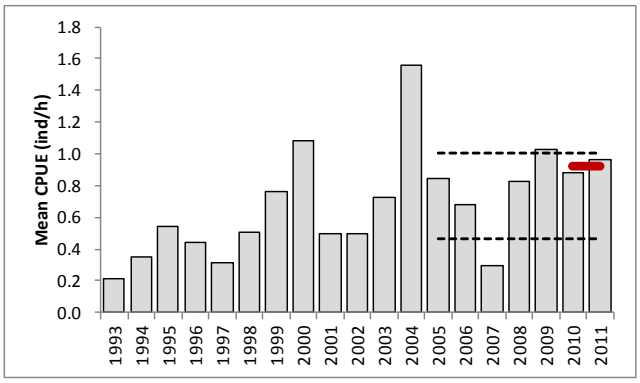
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

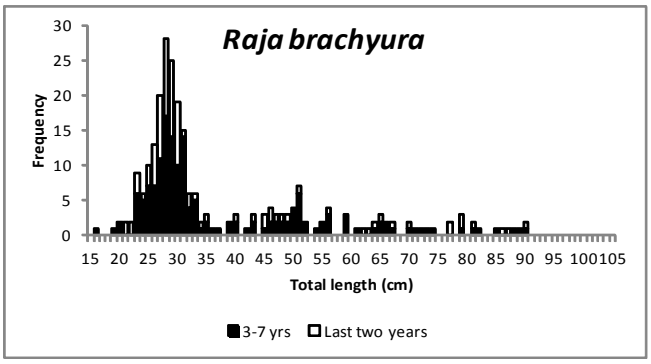
Survey data used:




Distribution and relative abundance of *Raja brachyura* in survey area (from Ellis, 2010)




Mean cpue of *Raja brachyura.* Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja brachyura* in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Patchily distributed in survey area, and caught most regularly in the Bristol Channel and off the east coast of Ireland. Known to occur around sandbanks, and such habitats are not always sampled in trawl surveys.

Catch rates: Catch rates increasing.

Size distribution: Larger individuals only encountered infrequently, which may be related to a low gear selectivity for larger fish in the survey gear and that adults may occur around sandbanks.

Overall status: Although there are no signs of decreasing catch rates, the adult population is not sampled effectively, and further studies are required to better understand this relatively large-bodied skate

Exploitation: Given the large size, patchy distribution and limited biological knowledge of the species, further studies are required to determine whether current levels of exploitation are appropriate.

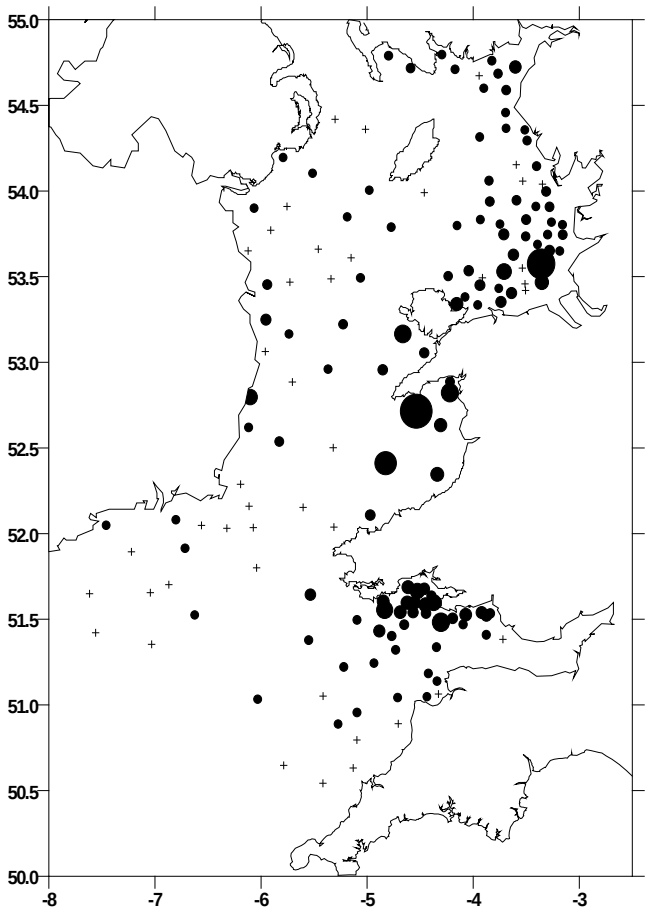
**18.S13: *Raja clavata***

Survey area: VIIaf

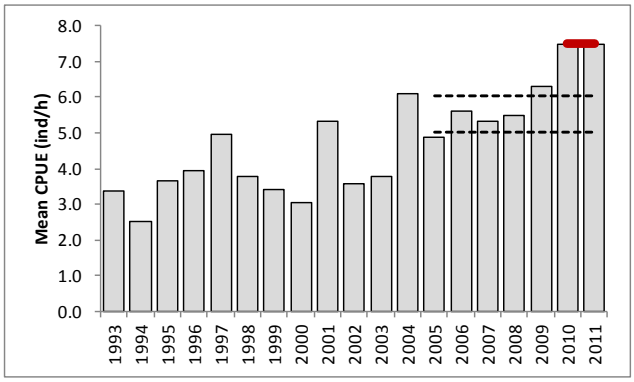
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

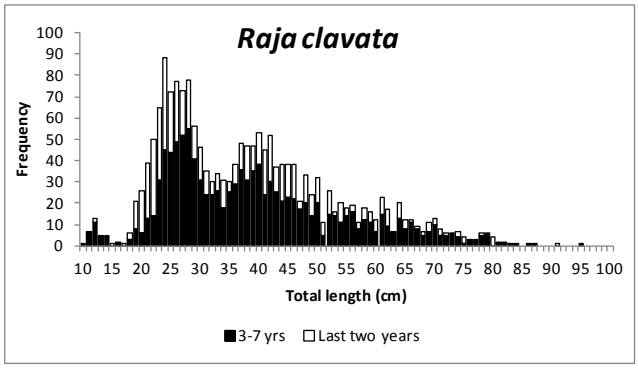
Survey data used




Distribution and relative abundance of *Raja clavata* in survey area (from Ellis, 2010)




Mean cpue of VIIaf *Raja clavata.* Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja clavata* in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Widespread in survey area, especially in Solway Firth, Liverpool Bay, Cardigan Bay and Bristol Channel.

Catch rates: Catch rates increasing.

Size distribution: Larger individuals only encountered infrequently, which may be related to a low gear selectivity for larger fish.

Overall status: Although there are no indications of recent declines in the health of the stock, this is one of the main commercial species.

Exploitation: It is considered that current exploitation is appropriate for the stock.

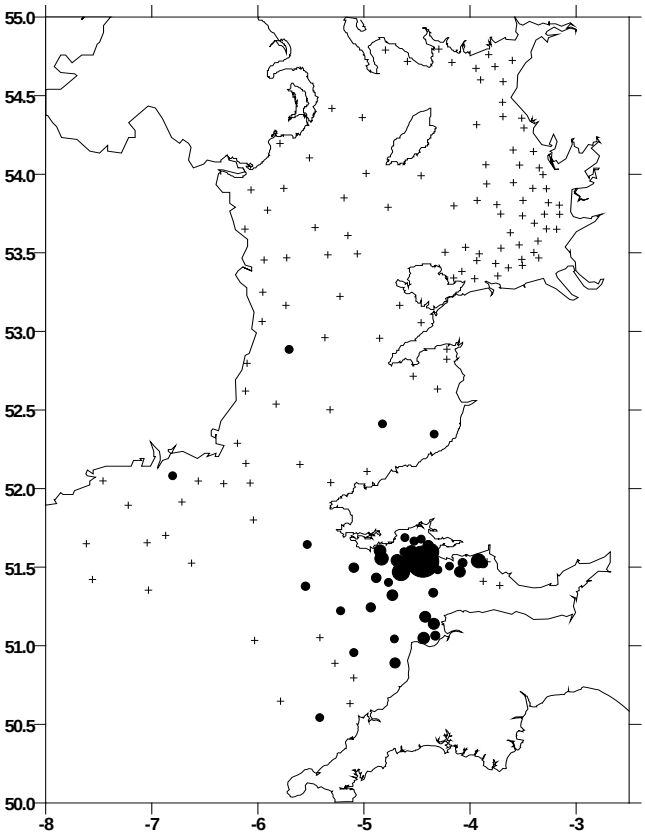
**18.S14: *Raja microocellata***

Survey area: VIIf

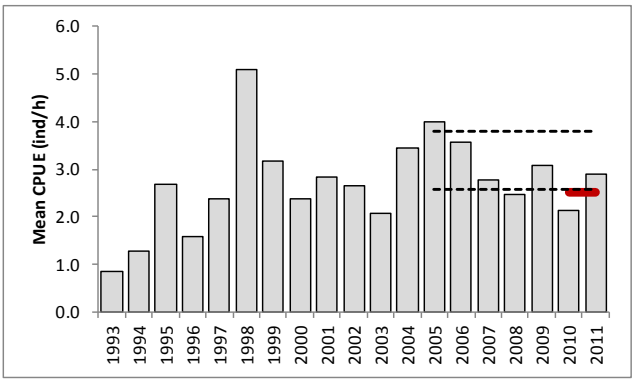
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

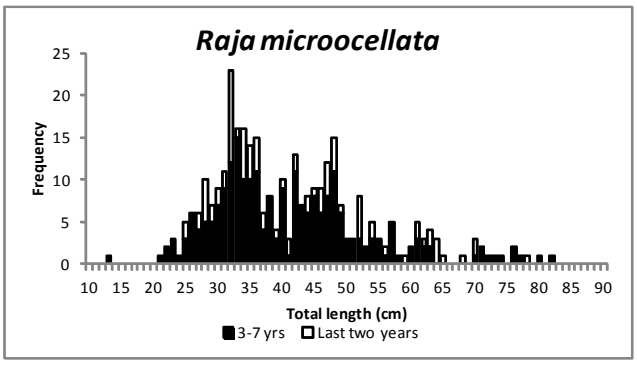
Survey data used: Stations in Bristol Channel only




Distribution and relative abundance of *Raja microocellata* in survey area (from Ellis, 2010)




Mean cpue of VIIf *Raja microocellata.* Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja microocellata* in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Stock concentrated in Bristol Channel, larger individuals also occur in Celtic Sea (VIIg), occasional specimens in VIIa. Connectivity with VIIe and VIII unknown. No evidence of change in distribution.

Catch rates: Most recent catches slightly below preceding 5-year average, although longer term trend has been increasing.

Size distribution: 0-groups in very shallow water and not sampled in survey. Largest individual reported 89 cm (c.f. $L_{MAX.}$ of 91 cm). Slight decrease in mean size, but this is partly influenced by numbers of juveniles. Slight decreasing trend in the maximum size observed.

Overall status: Mean cpue for 2010/2011 is marginally below the preceding five year period.

Exploitation: The survey index for this stock is just below expected range, but there are no other biological indications of overexploitation. It is unclear as to whether current exploitation is appropriate for the stock.

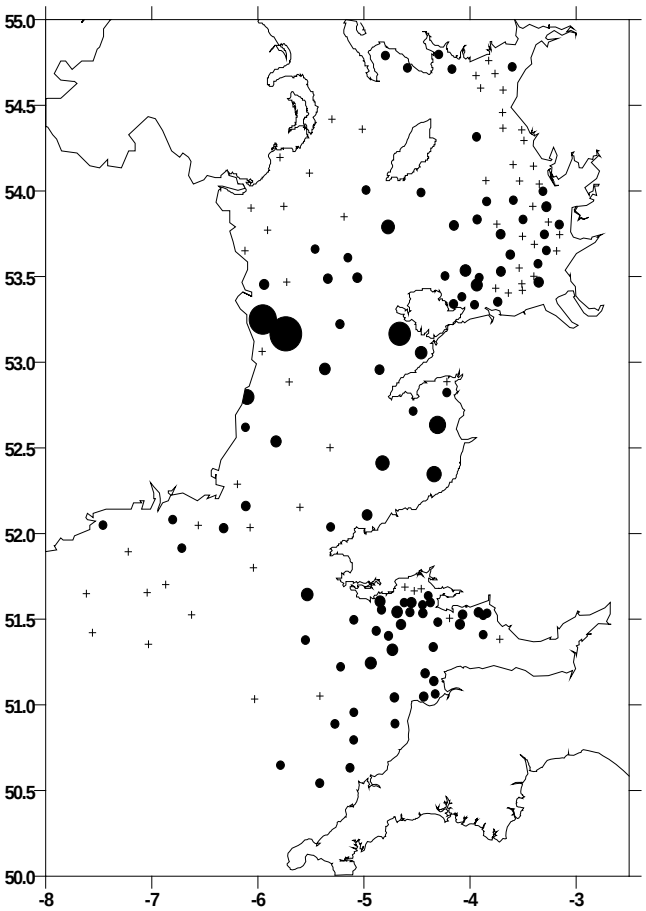
**18.S15: *Raja montagui***

Survey area: VIIaf

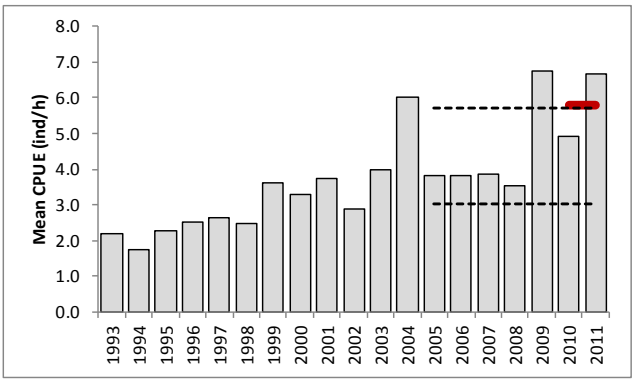
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

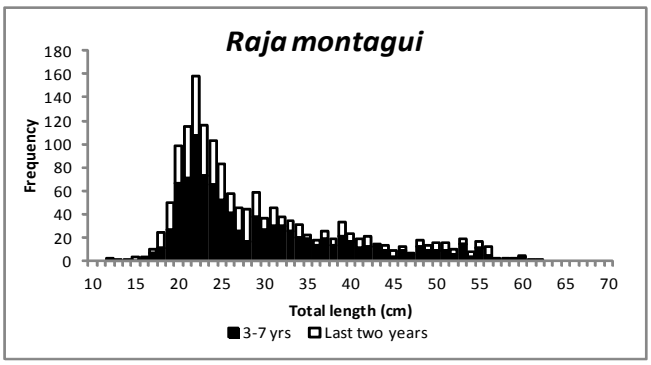
Survey data used:




Distribution and relative abundance of *Raja montagui* in survey area (from Ellis, 2010)




Mean cpue of VIIaf *Raja montagui*. Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja montagui* in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Widespread in survey area, especially in St George's Channel, central Irish Sea and Bristol Channel. Juveniles also occur in inshore waters.

Catch rates: Increasing, with recent catch rates amongst the highest in the time-series.

Size distribution: Expected size range seen in the survey.

Overall status: No causes for concern.

Exploitation: It is considered that current exploitation is appropriate for the stock.

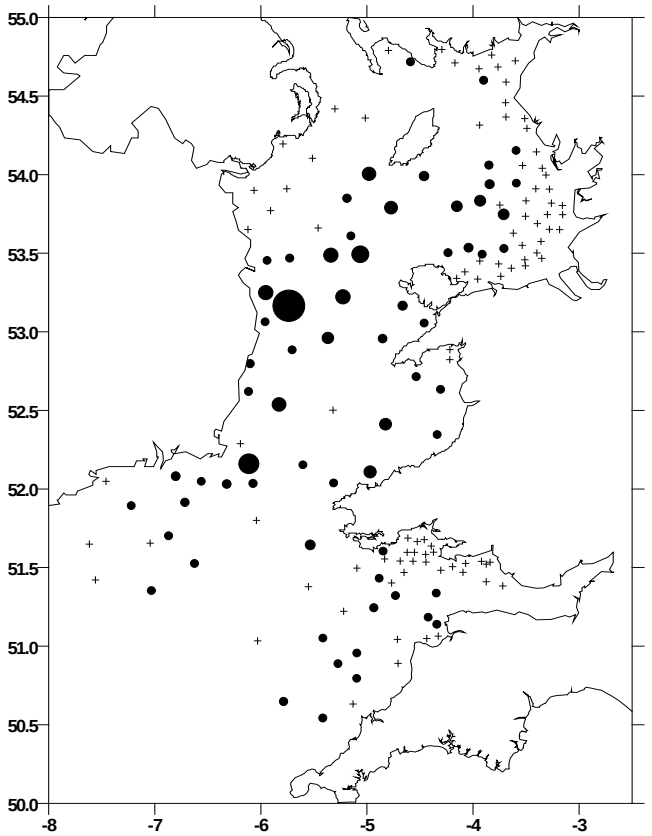
**18.S16: *Leucoraja naevus***

Survey area: VIIa

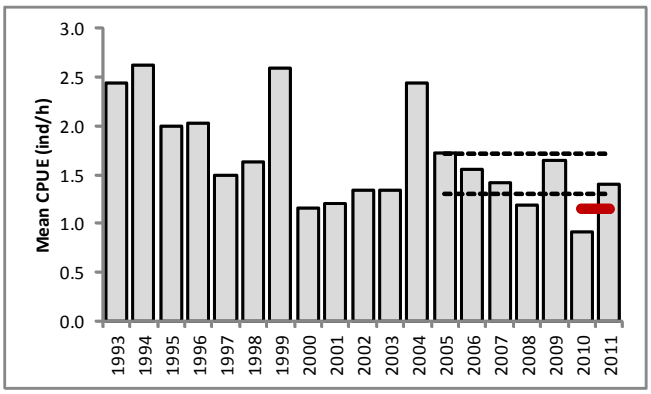
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

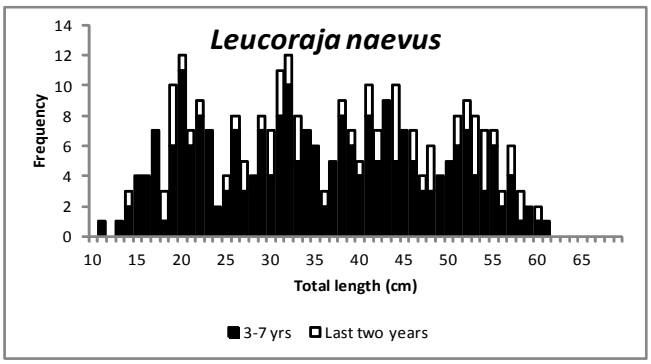
Survey data used: Stations in Irish Sea only




Distribution and relative abundance of *Leucoraja naevus* in survey area (from Ellis, 2010)




Mean cpue of VIIa *Leucoraja naevus*. Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of *Leucoraja naevus* in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Widespread in deeper waters of survey area, especially in St George's Channel. Degree of connectivity with Celtic Sea and NW Scotland unclear.

Catch rates: Mean catch rate from last two years had decreased from preceding five years.

Size distribution: Length range encountered does not appear to have changed for this small-bodied species.

Overall status: Although recent catch rates appear to have declined, recent catch rates are similar to that observed from 2000–2003. This small-bodied species is not as commercially valuable as larger species (e.g. *R. brachyura* and *R. clavata*).

Exploitation: Recent catch rates have shown a decline, but there are no other biological indications of overexploitation. It is unclear as to whether current exploitation is appropriate for the stock.

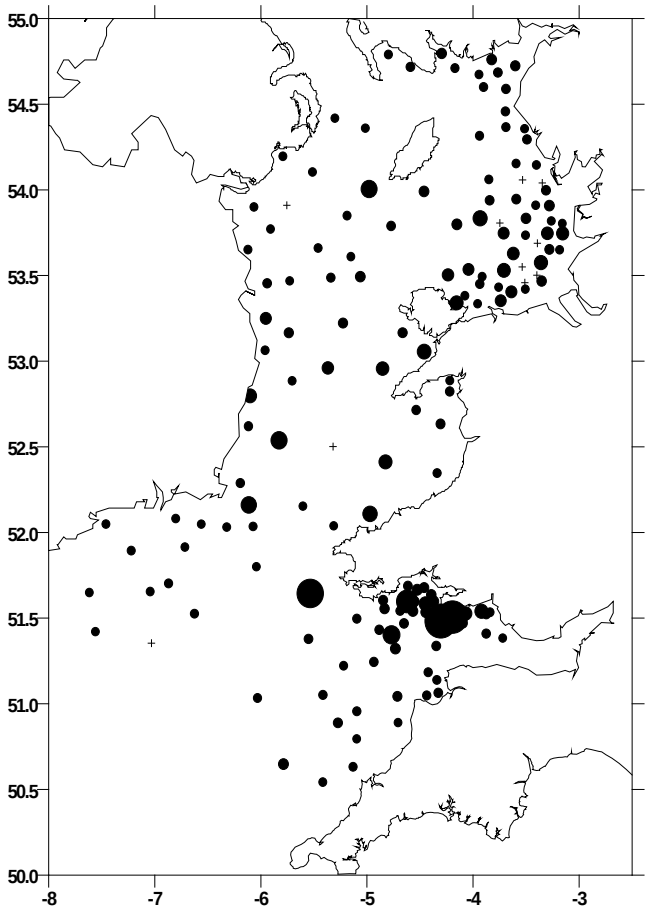
**18.S17: Lesser-spotted dogfish**

Survey area: VIIaf

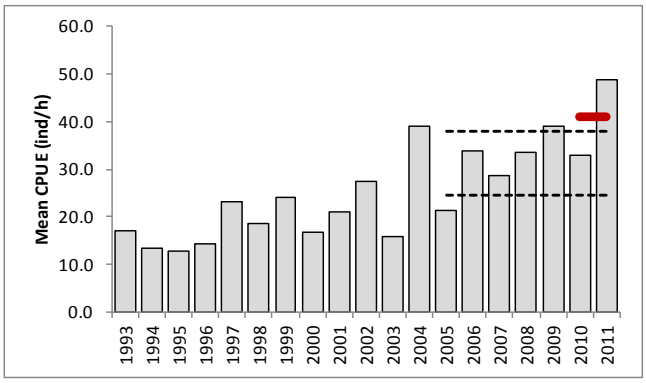
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

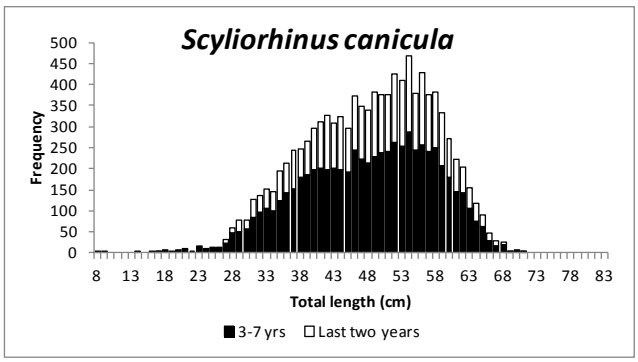
Survey data used:




Distribution and relative abundance of lesser-spotted dogfish in survey area (from Ellis, 2010)




Mean cpue of VIIaf lesser-spotted dogfish. Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of lesser-spotted dogfish in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Abundant, widespread and the most abundant elasmobranch taken in the survey area. Occurs on a variety of habitat types, ranging from muddy to rocky grounds.

Catch rates: Increasing.

Size distribution: Although smaller size classes are caught infrequently (which may be due to a low gear selectivity and/or that they occur on grounds not sampled during the survey), there are no indications of changes in the length–frequency.

Overall status: Stock status appears healthy.

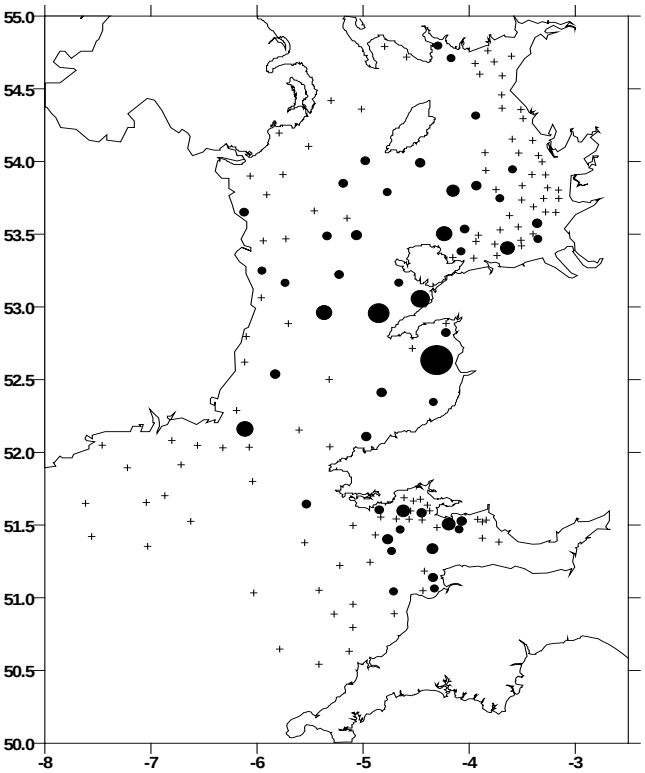
Exploitation: It is considered that current exploitation is appropriate for the stock.

**18.S18: Greater-spotted dogfish**

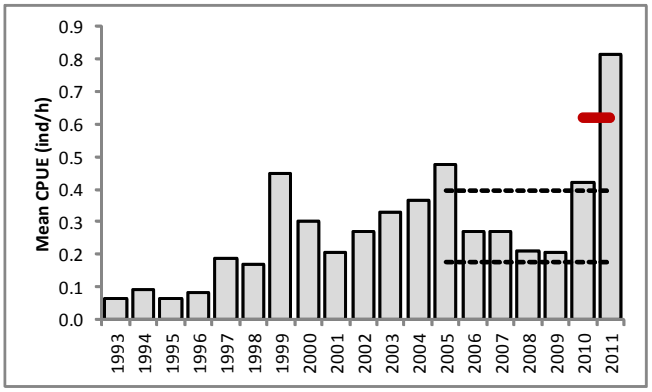
Survey area: VIIaf

Survey acronym: UK (E&W) VIIAF BTS

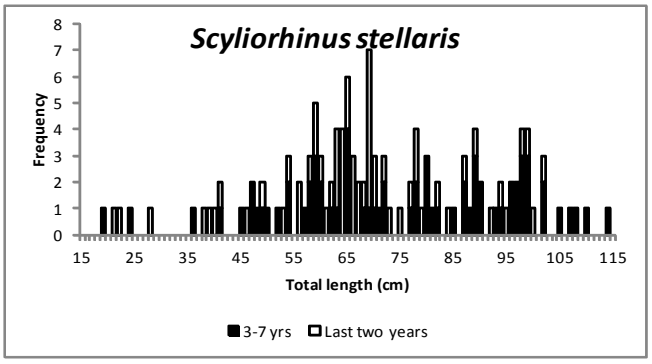
Survey gear: 4 m Beam trawl with chain mat




Distribution and relative abundance of greater-spotted dogfish in survey area (from Ellis, 2010)




Mean cpue of VIIaf greater spotted dogfish. Dashed lines give mean annual cpue for 2005–2009; red line shows mean annual cpue for 2010–2011.




Length distribution of greater-spotted dogfish in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Taken in small numbers across the survey area, but mostly taken on inshore, rocky areas in the Bristol Channel and around the Llyn Peninsula. The movements of this species are poorly known, although several individuals have been tagged and released in UK surveys. Further analyses of these data are required.

Catch rates: Although catch rates are low, there is an increasing trend, with 2011 catches the highest on record.

Size distribution: Larger fish poorly sampled by the gear, so these data may not be useful informing on the size distribution of the overall stock.

Overall status: Although the large size of this species, combined with an inshore distribution on rocky grounds, means that they are not sampled effectively in current surveys, stock status appears healthy.

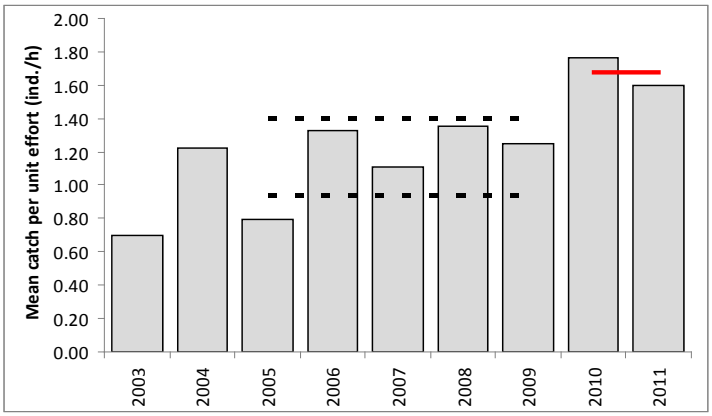
Exploitation: It is considered that current exploitation is appropriate for the stock.

**18.S19: *Raja clavata***

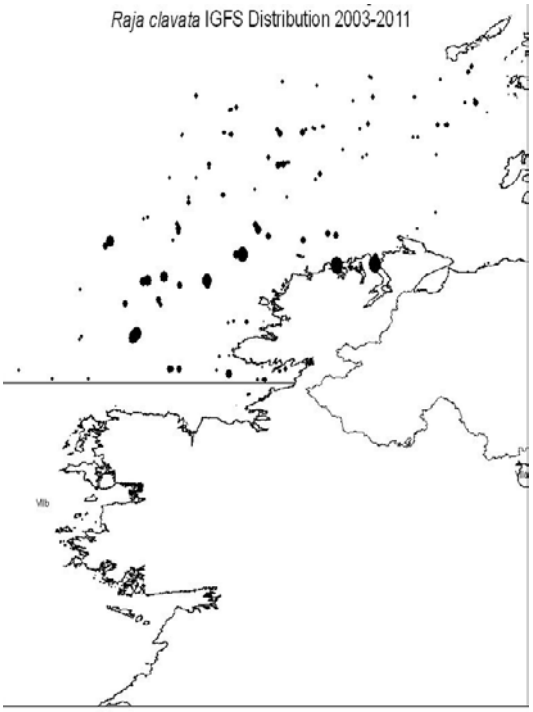
Survey area: VIa

Survey acronym: Irish Groundfish Survey (IGFS-WIBTS-Q4)

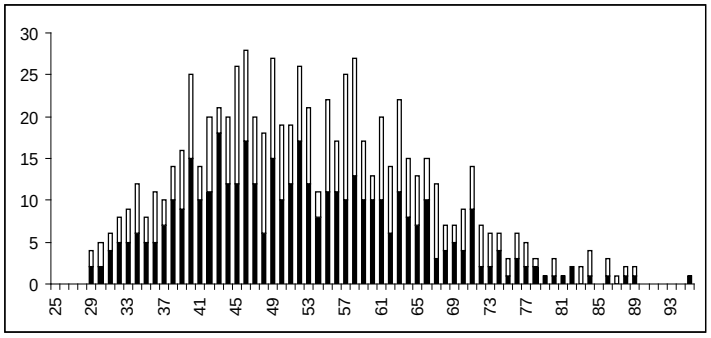
Survey gear: GOV




Mean cpue of VIIaf *Raja clavata.* Dashed lines give mean annual cpue for 2005–2009 +/- 1sd; red line shows mean annual cpue for 2010–2011.




Distribution and relative abundance of *Raja clavata* in survey area, 2003–2011.




Length distribution of *Raja clavata* in Irish Groundfish Survey for the periods 2005–2009 (black bars)) and 2010–2011 (white)

Distribution: Widespread in survey area, particularly west of Donegal.

Catch rates: Catch rates increasing.

Size distribution: Large and small individuals caught by survey. No apparent change in size distribution.

Overall status: Although there are no indications of recent declines in the health of the stock, this is one of the main commercial species.

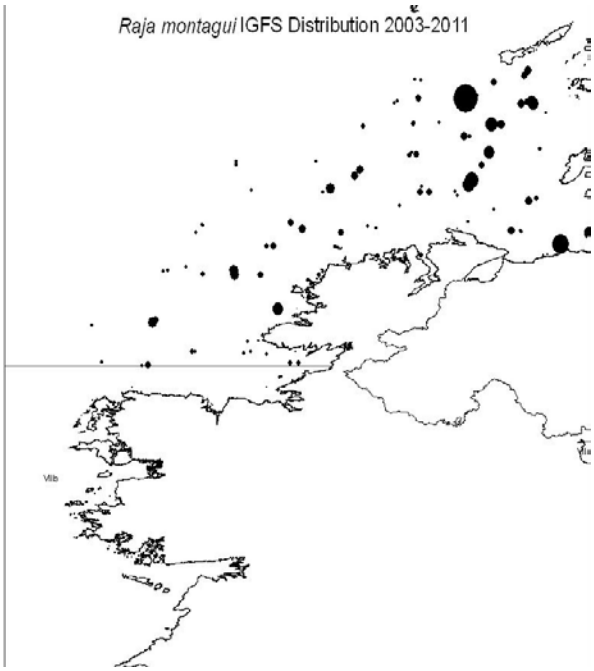
Exploitation: It is considered that current exploitation is appropriate for the stock.

**18.S20: *Raja montagui***

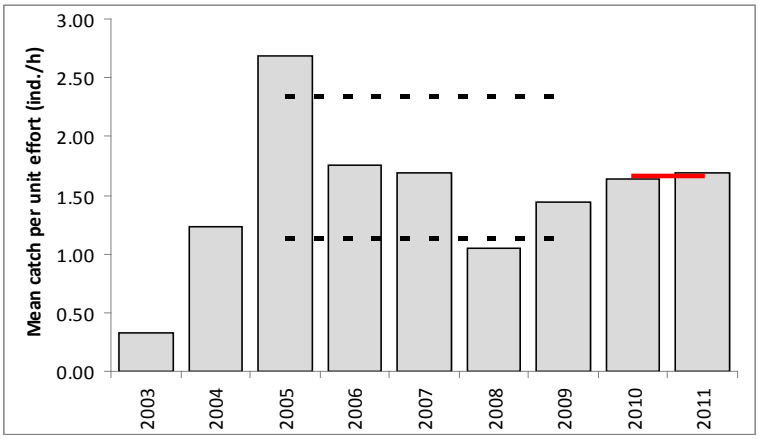
Survey area: VIa

Survey acronym: Irish Groundfish Survey (IGFS-WIBTS-Q4)

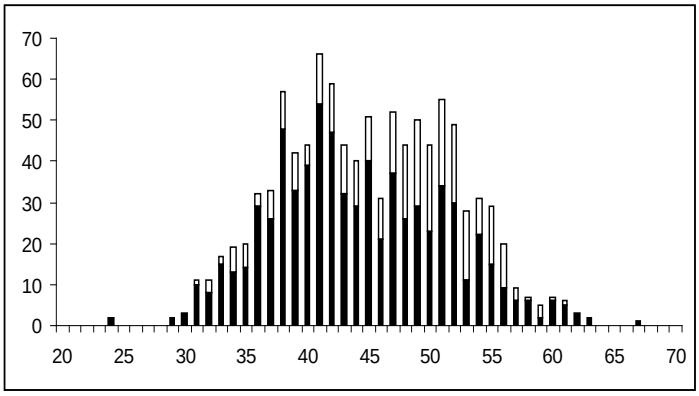
Survey gear: GOV




Distribution and relative abundance of *Raja montagui* in survey area, IGFS, 2003–2011.




Mean cpue of VIIaf *Raja montagui.* Dashed lines give mean annual cpue for 2005–2009 +/- 1sd; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja montagui* in Irish Groundfish Survey for the periods 2005–2009 (black bars)) and 2010–2011 (white)

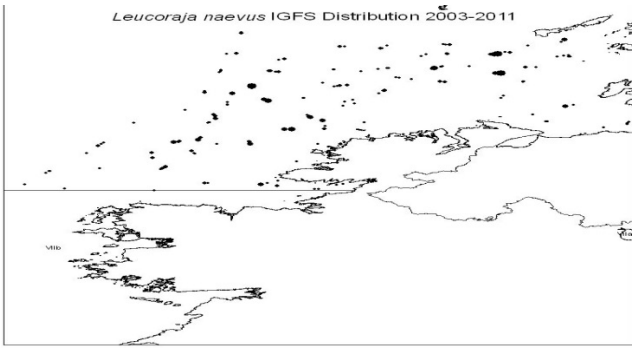
| | |
|---|---|
| Distribution: Widespread in survey area, especially to the west of Scotland. Distribution may extend into Irish Sea/. | ✓ |
| Catch rates: Catch rates are increasing, although from a previous decline. | ↗ |
| Size distribution: Expected size range seen in the survey, with no changes over time period. | ✓ |
| Overall status: No causes for concern. | ✓ |
| Exploitation: It is considered that current exploitation is appropriate for the stock. | ✓ |

**18.S21: *Leucoraja naevus***

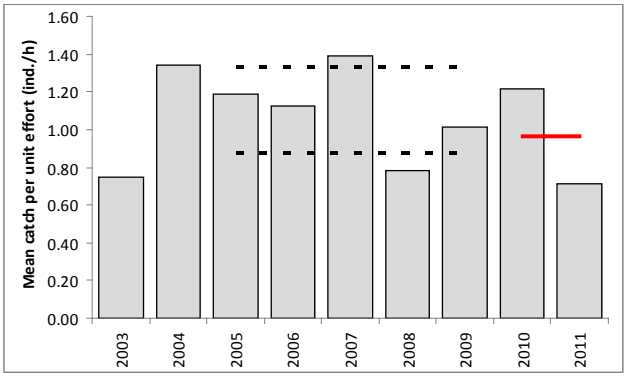
Survey area: VIa

Survey acronym: Irish Groundfish Survey (IGFS-WIBTS-Q4)

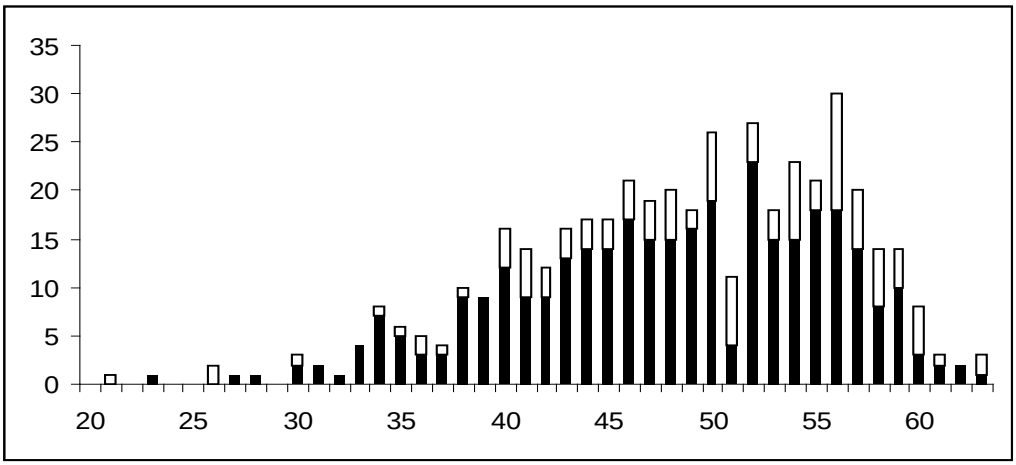
Survey gear: GOV




Distribution and relative abundance of *Leucoraja naevus* in survey area, IGFS 2003–2011.




Mean cpue of VIIa *Leucoraja naevus*. Dashed lines give mean annual cpue for 2005–2009 +/- 1sd; red line shows mean annual cpue for 2010–2011.




Length distribution of *Raja montagui* in Irish Groundfish Survey for the periods 2005–2009 (black bars)) and 2010–2011 (white)

Distribution: Widespread in deeper waters of survey area. Degree of connectivity the North Sea unknown.

Catch rates: Current catch rates are lower than in previous years, but no trend apparent.

Size distribution: The survey appears to be catching less small individuals than previously, although overall catch numbers are low.

Overall status: Although recent catch rates appear to have declined, recent catch rates are similar to that observed from 2000–2003. This small-bodied species is not as commercially valuable as larger species (e.g. *R. brachyura* and *R. clavata*). Levels of discarding vary between nations.

Exploitation: Recent catch rates have shown a decline, but there are no other biological indications of overexploitation. It is unclear as to whether current exploitation is appropriate for the stock.

# 19 Demersal elasmobranchs in the Bay of Biscay and Iberian Waters (ICES Subarea VIII and Division IXa)

## 19.1 Ecoregion and stock boundaries

The Cantabrian Sea (ICES Division VIIIc) is the southern part of the Bay of Biscay (ICES Divisions VIIIa, b, d). In contrast to the more northerly Bay of Biscay, which has a wider continental shelf with flat and soft bottoms more suitable for trawlers, the Cantabrian Sea has a narrow continental shelf with some remarkable bathymetric features (canyons, marginal shelves, etc.).

The Portuguese continental shelf (ICES Division IXa) is also generally narrow, except for the area located between the Minho River and the Nazaré Canyon, and in the Gulf of Cadiz, where it is about 50 km wide, particularly to the east. The slope is mainly steep with a rough bottom, with canyons and cliffs.

Like described for other ecoregions in earlier reports (ICES, 2010), regional differences are found in the distribution of most demersal species occurring in the Bay of Biscay and Iberian waters ecoregion. This is particularly evident for some skates and rays, which have a well-defined patchy distribution and limited and low mobility (Carrier *et al*., 2004). The geographical distribution of the main elasmobranch species in the ecoregion is fairly well known, but their stock structure is still to define. Trying to describe the distribution of each species and to identify self-containing stocks, WGEF decided to consider two stock units for demersal elasmobranch species in Bay of Biscay and Iberian Waters: Subarea VIII and Division IXa. The main commercial species and stock units are:

### Skates and rays

Thornback ray *(Raja clavata)* and Cuckoo ray (*Leucoraja naevus*): As biological and fisheries data are most accurate and comprehensive for the Iberian waters the same areas should be used in preliminary assessments of these species. A study held in the centre off Portugal (IXa) indicates a spatial overlap between these two species. Both occur in areas deeper than 100 m depth, in seabed grounds composed of soft sediment, between mud and fine sand (Serra-Pereira, *et al*., in press). *R. clavata* also occurs in other types of habitats, from rocky to sandy bottoms.

Other less common skates and rays in the area include blonde ray (*Raja brachyura*), smalleyed ray (*R. microocellata*), brown ray (*R. miraletus*), spotted ray (*R. montagui*), undulate ray (*R. undulata*), shagreen ray (*Leucoraja fullonica*), common skate (*Dipturus batis* complex), long-nose skate (*D. oxyrinchus*), sandy ray (*Leucoraja circularis*) and white skate (*Rostroraja alba*). *R. undulata* and *R. microocellata* co-occur in the same areas, preferably shallower than 40 m depth and over sandy bottoms. *R. clavata* and *R. brachyura* co-occur in areas with rocks surrounded by sand, at depths deeper than 100 m. Juveniles of *R. brachyura*, *R. montagui* and *R. clavata* are also known to co-occur at depths shallower than 100 m depth (Serra-Pereira, *et al*., in press). A tagging survey of undulate ray (*R. undulata*) carried out in the Bay of Biscay in 2012-2013 shows that migrations are mostly limited to 30 km, independently of time at liberty (Delamare *et al*., 2013 WD). This result confirms that several local stocks are likely to exist in western European waters giving support to separate Subarea VIII from Division IXa for a stock assessment of this species.

#### Lesser spotted dogfish

The lesser-spotted dogfish (*S. canicula*) is considered to be best assessed as local populations within the ICES division and subarea mentioned above, as a consequence tagging surveys carried out in VIIIc and IXa.

According to the tagging surveys carried out since 1993, lesser spotted dogfish is a philopatric species. The maximum distance registered for recaptured fishes was <20 km (Rodriguez-Cabello *et al*., 2004, 2007). This suggests that the migratory movements between subarea VIII and Division IXa might occur near the border boundaries.

## 19.2 The fishery

### 19.2.1 History of the fishery

In order to facilitate the reading of this section, the structure adopted for describing the history of the fishery is divided according to the three main countries fishing in this ecoregion: Spain, Portugal (mainland) and France.

#### Spain

The Spanish demersal fishery along the Cantabrian Sea (VIIIc) and Bay of Biscay (VIIIa,b,d) takes several species of skates and rays using a different gears, but most of the landings derived as bycatch of trawl fisheries targeting other demersal species such as hake, anglerfish and megrim. Although a wide number of skates and rays and demersal sharks can be found in the landings, historically, the most common are *L. naevus* and *R. clavata* and *S. canicula*. The fact that some elasmobranchs have a low commercial value and are taken as by-catches means that traditionally these species are landed together in the same commercial category, especially by artisanal gillnetters.

Along the Cantabrian sea and Galicia coast (VIIIc and IXa) there is also a artisanal fishery (gillnetters) operating in bays or shallow waters, but the "*modus operandi*" of this fleet limits the achievement of reliable information about the landings of elasmobranch by species for this fishery (mainly coastal species).

#### Mainland Portugal

Off mainland Portugal (IXa), skates and rays are captured by trawlers and mainly by the artisanal polyvalent fleet, which accounts for the highest landing records (75% of the annual skate and ray landings). The artisanal fleet primarily uses trammel nets but other types of fishing gears, such as longlines and gillnets, are also used. The skates and rays species composition in landings varies between areas in Division IXa, but the main species landed is thornback ray (*R. clavata*). Other species are also caught, including blonde ray (*R. brachyura*), cuckoo ray (*L. naevus*), spotted ray (*R. montagui*), undulate ray (*R. undulata*), smalleyed ray (*R. microocellata)*, brown skate (*R. miraletus*), longnosed skate (*D. oxyrinchus*), white skate (*R. alba*) and sandy ray (*L. circularis*).

*Scyliorhinus canicula* is caught by both coastal trawlers and artisanal fishing fleet, which operates with different fishing gears. This species is landed in the major ports of Division IXa. The greater-spotted dogfish (*S. stellaris)* is rarely caught by the Portuguese fishing fleets.

### France

Skates and rays and *S. canicula* (in less importance) are traditional food resources in France, where directed fisheries for skates and rays were known to occur since the 1800´s. In the 1960´s, skates and rays were primarily taken as bycatch of bottom trawl fisheries operating off the northern part of the Bay of Biscay, the southern Celtic Sea and the English Channel. By this time *R. clavata* was seasonally targeted by fisheries, being the dominant skates and rays species landed in France. After the 1980´s *L. naevus* became the dominant species. However the landings of the two species have declined since 1986.

Other skates and rays are also landed, including *L. circularis*, *L. fullonica*, *R. microocellata, D. batis* complex and *D. oxyrinchus*. *Rostroraja alba* is rarely caught by the French fleets.

## 19.2.2 The fishery in 2012

### Spain

The preliminary results from the ongoing DCF pilot study in the Basque Country waters (VIIIc), which main aim is to describe and characterise the coastal artisanal fishery, shows that although the coastal artisanal fleet targets demersal teleost species (mainly hake, monkfish and mackerel), several skates and rays species, particularly *R. clavata*, *R. montagui*, *L. naevus*, *L. fullonica, L. circularis* and *R. undulata* are also caught.

The coastal artisanal fleet consists of 55 small vessels using gillnets and trammel nets in different periods of the year. Vessels have a mean average length of 12.7 m and 82.4 kW average engine power. In 2009 and 2010, skates and rays contributed to 6% of the total landings, being mostly landed as "wings."

Also in the Cantabrian Sea (VIIIc) most of skates and rays landings are by-catches of otter trawl (47%) and gillnet gears (43%), and the remaining are derived from longlines and other gears.

### Mainland Portugal

Most of the skates and rays landings from the Portuguese continental coast (IXa) are obtained from the polyvalent fleet segment, operating between 10 and 150 m deep, but mostly shallower than 100 m. This segment includes vessels of different sizes, ranging from 5 to 27 m overall length. These vessels are characteristically licensed to operate with more than one fishing gear (trammel nets, gillnets, longlines, trawl, traps and pots). Therefore, no information of the fishing gear employed is available for individual hauls during each fishing trip, which hampers the determination of the fishing effort by métier category.

To circumvent this deficiency and to develop an estimator for fishing effort, different data sources are under analysis by IPMA, including data from interviews undertaken under the ongoing DCF pilot study in the Portuguese waters (IXa). The preliminary results (Maia *et al*., 2013 WD) show that, in the northern region the two most frequent species caught are *R. clavata* and *R. undulata.* The latter species is mainly caught by vessels operating in more inshore waters. In the central region *R. clavata* is the most representative species followed by *R. brachyura* and *L. naevus*. The latter species is mainly landed by polyvalent trawlers and longliners, operating further off coast.

### 19.2.3 ICES Advice applicable

ICES in 2012 provided advice for 2013 and 2014 for several species/stocks in this region as summarized below:

#### Skates and rays in Subareas VIII and IX

*ICES provides advice on the overall exploitation (landings and discards) of the skate and rays species assemblage, and also individual species. ICES does not advise that general or species-specific TACs be established for each species, at present. This is because a TAC is not considered the most effective means to regulate fishing mortality in these bycatch species.*

*ICES advises that a suite of species- and fishery-specific measures be developed to manage the commercial fisheries and achieve recovery of the depleted species. Such measures should be developed by management authorities involving all stakeholders; ICES could assist in this process. Management measures should be framed in a mixed-fisheries context, considering the overall behaviour of demersal fleets, and the drivers for such behaviour. When the TAC is exhausted, catches may continue to take place, but are discarded. In order to achieve optimal harvesting of the commercial species, and to assist recovery of the depleted species, a suite of measures should be put in place.*

*Closure to fishing of spawning and/or nursery grounds, and measures to protect the spawning component of the population (e.g. maximum landing size) are powerful tools to manage skates and rays. In some cases, single-species TACs may be appropriate, especially for easily identified species and/or discrete stocks in limited distribution areas.*

*Given that the European Community intends to introduce a ban on discards, minimum or maximum landing sizes should be carefully considered before they are introduced, because they could lead to increased discards. Size limits may best be applied in target fisheries, if discard (escape) survival can be shown to be high.*

Species-specific advice was provided for the following stocks:

- Thornback ray (*Raja clavata*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)
- Cuckoo ray (*Leucoraja naevus*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)
- Spotted ray (*Raja montagui*) in Subarea VIII (Bay of Biscay and Cantabrian Sea)
- Spotted ray (*Raja montagui*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)
- Cuckoo ray (*Leucoraja naevus*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)
- Thornback ray (*Raja clavata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)
- Blonde ray (*Raja brachyura*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz)
- Common skate (*Dipturus batis*) complex (flapper skate *Dipturus* cf. *flossada* and blue skate *Dipturus cf. intermedia*) in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)
- Other skates and rays in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters)

*As species-specific landings data are not complete, it is not possible to quantify the current catch and so ICES did not advise that an individual TAC be set for individual stocks, at present.* ICES recommended *landings of skates and rays to be less than 4200 t for the main species and no target fishery on R. undulata and Dipturus batis complex. ICES* also *advise that white skate (R. alba) should remain on the Prohibited species list, as it appears to be depleted in this area.*

*Additionally, it was noted that, based on the ICES approach to data-limited stocks, catches of L. naevus* (VIII) should increase *by at least* 6%, *R. clavata* (VIII) *should not increase*, and *R. montagui* (VIII and IXa), *L. naevus* (IXa), *R. clavata* (IXa), *R. brachyura* (IXa), and other Rajidae (VIII and IXa) should be decreased by at least 20%, *compared to the last three years' average.*

*In 2010, ICES was asked to comment on the listings of common skate and undulate ray as 'prohibited species' on EC TAC and quota regulations.*

*For undulate ray, ICES advised "There is no basis in the current or previous ICES advice for the listing of undulate ray as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion fisheries legislation … In view of the poor knowledge and patchy distribution of these populations, ICES recommends a precautionary approach to the exploitation of these populations of undulate ray".*

*For common skate ICES advised "There is no basis in the current or previous ICES advice for the listing of the common skate (Dipturus batis) as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia ecoregion fisheries legislation. In the Celtic Seas ecoregion, ICES considers that stocks of the common skate complex is depleted, and that protective management measures are required. There should be no target fishing on the common skate, and there should be a TAC set at 0.*

#### Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIa,b,d (Bay of Biscay)

*Based on ICES approach to data-limited stocks, ICES advises that catches could be increased by a maximum of 20%. Because the data for catches of lesser-spotted dogfish are not fully documented (due to the historical use of generic landings categories), ICES is not in a position to quantify the result. ICES does not advise that an individual TAC be set for this stock.*

#### Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIc and IXa

*Based on ICES approach to data-limited stocks, ICES advises that catches should be decreased by 9%. Because the data for catches of lesser-spotted dogfish are not fully documented (due to the historical use of generic landings categories), ICES is not in a position to quantify the result. ICES does not advise that an individual TAC be set for this stock.* Regarding *S. canicula,* ICES recommended *landings less than 1.7 thousand t.*

### 19.2.4 Management applicable

EC Council Regulation 43/2012 established a TAC of 4222 t in 2012 for Rajidae in Subareas VIII and IX.

| RAJIDAE | TAC | Landings |
|---|---|---|
| Divisions VIII and IX | 2012 | 2012 |
| Belgium | 9 | 4 |
| France | 1601 | 1227 |
| Portugal | 1298 | 1170 |
| Spain | 1305 | 996 |
| UK | 9 | 5 |
| UE | **4222** | **3402** |

This Regulation indicates that catches of *L. naevus* and *R. clavata* shall be reported separately. Council Regulation (EC) No 43/2009 also states that "angel shark in all EC waters may not be retained on board" and that catches "shall be promptly released unharmed to the extent practicable". This is also applied to *R. undulata*, *D. batis* complex and *R. alba*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

#### Portuguese legislation

In 29-12-2011 the Portuguese Administration adopted a national legislation (Portaria no 315/2011) that prohibits, along the whole continental Portuguese EEZ, during the whole month of May the catch, the maintenance on board and the landing of any skate species belonging to the Rajidae family. In addition, in each fishing trip a maximum of 5% bycatch, in weight, of those species is allowed to be maintained on board and to be landed.

## 19.3 Catch data

### 19.3.1 Landings

Landings for the period 1996–2012 are given in Table 19.1a–e. In 2012, the landings of the Basque Country (Spain) in 2012, are included in the Spanish reported landings.

#### Skates and rays VIII

Historically the 71% of landings in this area were assigned to France while 28% are from Spain and Basque Country fisheries combined. Since 1973, landings of skates and rays show no clear pattern (Figure 19.1), although there was a remarkable peak at the earlier years of the time-series (1973–1974) and also from 1982–1991.

From 2008 to 2011, landings in Subarea VIII remain above 2000 t.y$^{-1}$, but in 2012 decreased to 1950 t. This decrease may be associated to a slight decrease in Spanish landings. In 2012 the Divisions with the highest landings were VIIIa-b (68%), mostly from France (1150 t), which was similar to 2011. In Division VIIIc (28%) landings, mainly from Spain and Basque Country, reached 544 t in 2012, also similar to previous years. Finally Division VIIId (4%) reached 80 t in 2012 following the same trend of the historical series.

#### Skates and rays IXa

The two main countries reporting landings from this area are Portugal (84%) and Spain (16%). Mean landings from Portugal since the 1990s were around 1500 tonnes

per year; however in 2012 landings decreased to 1172 t. In the same Division, landings of Spain increased to 549 t in 2011 but decreased again in 2012 to 283 t. The combined landings in 2012 in this subarea are the lowest recorded since 1979, and probably reflect the Portuguese legislation adopted which was mentioned above.

In 2012, the most important species in official landings, by decreasing order are *R. clavata, R. brachyura, L. naevus* and *R. montagui* (see Section 19.4.2 for more detailed information).

#### Lesser-spotted dogfish in VIII

Landings of *S. canicula* reported to the WG are shown in Table 19.2. France and Spain landings originate mainly from Divisions VIIIa, b. In 2012, Spanish fleet landed 850 t in Subarea VIII, 53% from VIIIab and 46% from VIIIc (Tables 19.2a-b). In Divisions VIIIa,b,d landings of the French fleet declined from a peak of 1168 t in 2004 to 870 t in 2012. In Division VIIIc (Table 19.2c) only Spanish landings are significant, showing an increase since 2008 and especially in 2012, reaching 396 t.

In contrast, due to the reduced effort of the trawler fleet in VIIId compared to other Divisions, landings are historically not significant.

Total landings of *S. canicula* in the Bay of Biscay and Iberian waters average at around 2250 $t.y^{-1}$ since 2009 (Table 19.2e).

#### Lesser-spotted dogfish in IXa

According to the time-series, most of the landings of *S. canicula* in IXa originate from the Portuguese fleet (Table 19.2d). From 1996 to 2004, Portuguese landings ranged between 600 and 700 $t.y^{-1}$. Since lowest numbers in 2008, Portuguese and Spanish landings have increased to 544 t and 143 t in 2012 respectively (Figure 19.2).

Total landings of lesser-spotted dogfish in the Bay of Biscay and Iberian waters average at around 2250 $t.y^{-1}$ since 2009 (Table 19.2e).

#### Other demersal sharks in VIII

Information on historical landings of other elasmobranch species such as *Mustelus* spp. (smooth hounds) and *Squatina squatina* (angel shark) are scarce. Of these species, only *Mustelus* spp. are landed in significant quantities in Subarea VIII, mainly by French and Spanish fleets (See section 21 for more detailed information).

*S. squatina* landings in Subarea VIII have always been very low, and a revision of historical French data indicated that the total landing in 1996 was 3.2 t (Table 19.3).

Landings of *Galeus melastomus* (blackmouth catshark) are mentioned in Table 19.4a. In Subarea VIII only Spain reported landings and total landings have been historically very low and never exceeded 7 $t.y^{-1}$.

#### Other demersal sharks in IXa

In Division IXa, landings of *G. melastomus* are mainly from the Portuguese fleet. Before 2010, landings were around 30 t but after they decreased significantly (Table 19.4b).

### 19.3.2 Discards

Information on historical series of discards of main demersal elasmobranchs by the Basque OTB (Bottom Otter Trawler) fleet in Divisions VIIIa, b, c, d since 2003 were

also updated in this section (Table 19.5). Additionally, an estimate of Spanish elasmobranch discards in VIII and IXa since 2003 is presented in Tables 19.6 to 19.7b).

#### Basque OTB fleet in VIII

Skates and rays: In Subarea VIII, only smaller skates are usually discarded. Since 2009 there is species-specific information of skate discards. This information indicates that in 2011 *L. naevus* was the most discarded species (18 ton, 17% of catches), while 3,4 t (13% of catches) of *R. clavata* were discarded (Table 19.5).

*S. canicula*: Although this species is the most important elasmobranch species landed by the Basque and Spanish fleets in VIII and IXa, estimated discards have always been much higher than landings at the beginning of the time-series.

*G. melastomus* is landed in "small" amounts, however discards exceeded landings in 2004, 2005, 2009 and 2010 with exceptionally high discards of 226 t in 2004. However, this number seems to be unreliable and might be due to an overestimation of subsamples as this species is very scarce in the catches.

#### Spanish fleet in IXa and VIIIc

Information on results of the Spanish discard sampling programme for the main elasmobranch species in VIIIc and IXa were updated. In 2012, *G. melastomus* and *S. canicula* are the most important discarded species, accounting for 1433 t and 753 t. Data on *G. melastomus* in VIIIc and IXa indicate that all the individuals are discarded because there are not reported in landings in these subdivisions.

*L. naevus* also reveal important discard figures in some years (Table 19.6). Discards of skates such as *R. clavata* (29.6 t), *L. naevus* (5.6 t), *R. brachyura* (5.5 t) and *R. montagui* (4.1 t) were recorded in 2012.

#### Portuguese OTB fleet in IXa

Information on discards of elasmobranchs produced by the Portuguese bottom otter trawl fleet operating in the ICES Division IXa has been collected by the Portuguese on board sampling programme (EU DCR/NP) between 2004 and 2012.

Two fisheries were analyzed: i) the crustacean bottom otter trawl fishery (OTB_CRU) and ii) the demersal bottom otter trawl fish fishery (OTB_DEF). In both fisheries the annual frequency of elasmobranchs ranged from 0% to 57% in crustacean fishery (Table 19.7a) and between 0% and 42% in demersal fish fishery (Table 19.7b). For both fisheries, the total discarded weight in metric tons, the mean length in cm and the sex ratio was estimated for the main discarded species.

In the crustacean bottom otter trawl fishery the most frequent discarded demersal species were *G. melastomus* and *S. canicula*. For this fishery, the estimated total discarded weight for *G. melastomus* was from 263 t (CV=39%) in 2004 and 45 t (CV=93%) in 2012, and for *S. canicula* was from 30 t (CV=29%) in 2012 and 49 t (CV=40%) in 2012 (Prista and Fernandes, 2013 WD). The discarded *G. melastomus* measured, in average, 23.5±10.6 cm and presented a sex ratio of 1.1:1, and *S. canicula* measured, in average, 28.5±11.7 cm, and presented a sex ratio of 1.4:1.

In the demersal bottom otter trawl fish fishery the most frequent discarded species was *S. canicula*, for which the total discarded weight was estimated in 111 t (CV=24%) in 2011 (Prista and Fernandes, 2013 WD). The average discarded length of *S. canicula* was 34.0±7.8 cm, and the sex ratio was 1.3:1. Total discarding estimates were not available for the remaining period, due to low frequency of occurrence.

#### Deep-water longline Portuguese fleet

Information on *G. melastomus* discards in the deep-water longline Portuguese fleet targeting black scabbardfish in the ICES Division IXa has also been collected under the Portuguese on board sampling programme (EU DCR/NP), between 2005 and 2012 (Table 19.7c). In 2012 its frequency in the discards was 56%.

## 19.4 Commercial catch compositions

### 19.4.1 Species and size composition

#### Subarea VIII

Length–frequency distributions of *R. clavata*; *and L. naevus* from commercial Basque trawlers in VIIIa ,b ,d are presented in Figures 19.3a-c.

#### Divison IXa

Under a Pilot sampling Programm (EU DCR/NP) length–frequency distributions of *R. clavata*; *R. brachyura, R. montagui, L. naevus* and *R. microocellata* in the two main Portuguese (ICES IXa) landing ports (Peniche and Matosinhos) are presented in Figures 19.4 and 19.5.

### 19.4.2 Quality of the catch data

Most of the countries involved in the fisheries in Subarea VIII and Divisions IX have provided the specific composition of landings (Tables 19.8-19.9). However there are still landings reported as Rajidae or, *Raja* spp.

For Portugal data provided for the period 2010-2012 four commercial designations appear on official landing statistics (thornback ray, blonde ray, spotted ray and cuckoo ray). However, under the Portuguese DCF sampling programme identification problems were detected and the proportion estimates by species are presented in Table 19.10. More robust estimators are being developed and next year new landings estimates by skate species for the period 2008–2013 will be presented.

Spanish landings data of *S. canicula* and Rajidae in 2007 have been updated this year.

A revision of *S. canicula* landed by Belgium since 1997 has been presented and updated in the national landing tables.

The difficulty on the identification of smooth hounds at a species level, causes misreporting and part of the landings is still recorded as *Mustelus* spp.

From 2011 to 2013 there is a DCF pilot study (coordinated between AZTI-Tecnalia and IPMA). The main objective of the Basque Country pilot study is to characterize the main fishing parameter of this fishery (fishing gear, métier, effort and LPUE) and to identify the skates and rays species present in the landings as well as the biometric relationships as "wing weight/total weight" and total length/wing width" in order to precise the live weight of the landed skates and rays.

The main objective of the Portuguese DCF pilot study is to establish sampling statistical procedures as well as to define estimators necessary to calculate the inputs for stock assessment purposes. It is important to note that the procedures have been developed taking into consideration the spatial distribution of each skate species, which determine differences on species composition between landings ports. Despite the differences in the fishing regimes among vessels from the Portuguese polyvalent

fleet, it is observed that fishing regimes tend to be similar between vessels with the same technical characteristics and/or the fishing licenses assigned to each vessel.

## 19.5 Commercial catch–effort data

### 19.5.1 Spanish data (VIII)

A nominal LPUE and effort-series for the Basque Country's OTB and Bottom Pair trawl (PTB) in Subarea VIII until 2011 is presented in the Tables 19.11a and 19.11b. The data was not updated for 2012. The LPUE data are referred to the main elasmobranch species landed by the fleets: *S. canicula*, Rajidae and *Mustelus* spp. The OTB LPUEs for *L. naevus* and *R. clavata* from 2002 to 2011 are presented in Figure 19.6.

Since 1994, *S. canicula* annual landings averaged 300 t. Since the beginning of the series there was a continuous increase from 20 kg/day in 1994 and 211 kg/day in 2011. In Rajidae the highest LPUE (201 kg/day) was reached in 1998 but since then a decrease occurred till 2004. From this year onwards, the LPUE recovers slightly to reach 96 kg/day in 2009 but decreases in 2011 to 85 kg/day.

The trend for *L. naevus* shows a constant LPUE between 50–68 kg/days except for the lowest peaks in 2004 and 2010. Landings per effort of *R. clavata* in this area are smaller than those recorded for *L. naevus*, oscillating between 8 and 18 kg/days, and showing a slight increase since 2002 (Figure 19.6).

The trend of LPUE of *Mustelus* spp. was low and very stable from 1998 to 2011 (on average 10 kg/day) but in 2009 the LPUE increased strongly due to the increase of landings.

Elasmobranch landings and LPUE in PTB have been historically much lower than in OTB. The overall trend of this LPUE doesn't demonstrate any significant change compared with the analysis carried out in 2010, except for *S. canicula* that in 2011 in Subarea VIII shows the highest LPUE of the series.

### 19.5.2 Portuguese data (IXa)

Fishery data collected under the Portuguese Pilot Sampling Programme on skates in ICES Subarea IXa (EU DCR/NP) were used to estimate annual LPUE and their standard deviations. The estimates were determined for *R. clavata*, *R. microocellata*, *R. montagui*, *R. undulata* and *R. brachyura* for 2008, 2010 and 2011 by métier (Figure 19.7). LPUE was not determined for species with minor occurrence on the sampled trips.

Under the Pilot sampling programme the effort data collected was analysed in order to select the more adequate fishing effort unit (e.g. fishing day, soaking time, size and gear units). Fishing day was the selected unit of fishing effort. The sampling design current used under the Pilot Programme will allow collecting detailed information on the fishing operations which in turn will reduce the variability on the fishing effort data.

Figure 19.7 presents, for each species, the annual estimates of LPUE as well as their standard deviations for the polyvalent fleet by fishing gear at Peniche landing port. For all the species there are no significant differences on the LPUE estimates between years. However it is worth noting that both the species composition and the LPUE estimates varied among métier categories. The results obtained under the Pilot Sampling Program are now under analysis and the sampling design will be updated,

particular by increasing the sampling effort in some of the métier categories with the greatest variance, as is the case of trawl.

### 19.5.3 Quality of the catch data

It is still necessary to standardize the historical time-series of effort and LPUE by species, of trawler fleets and also to provide reliable effort and LPUE data from the artisanal fleets (gill and trammel netters) fishing for coastal skates. It is advisable to continue the on going studies for the correct determination of biological cycles and reproductive aspects for the main skate and ray species caught in Iberian waters.

## 19.6 Fishery-independent surveys

### 19.6.1 Availability of survey data

For some skates and rays species (e.g. *R. undulata, R. brachyura* and *R. microocellata*) the existing survey data may be limited, as a result of more shallow distribution. More detailed studies of existing data are required to better inform on their status. In some instances, it may be required to have dedicated inshore surveys using an appropriate gear and census method in order to have these stocks better evaluated.

The Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters has covered this area annually since 1983 (except in 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranch. Survey design is randomly stratified with number of hauls allocated proportionally to strata area. An update of the results on four of the most important elasmobranch species sampled in the IEO Q4-IBTS survey on the Northern Iberian shelf (VIIIc and IXa North) is presented in a Working Document (Ruiz-Pico *et al*., 2013 WD).

The aim of the ITSASTEKA survey carried out in the coastal waters of the Basque Country by AZTI-Tecnalia (ICES Divisions VIIIc) is the characterization of the demersal ecosystem, to obtain reliable data on the distribution and abundance of commercial fish, cephalopods and benthic invertebrates in this area. The ITSASTEKA survey covers a total of 7.21 km$^2$ in 23 fishing hauls. Results of biomass index and length–frequencies of the main elasmobranchs sampled in the third year of the ITSASTEKA survey carried out in summer of 2012 is presented in section 19.6.3.

Length–frequencies and abundance indices of *L. naevus* and *S. canicul*a are provided from the French EVHOE Survey in Subarea VIII.

The Portuguese groundfish surveys have been conducted along the Portuguese continental waters, along a surveyed area extending from latitude 41°20'N to 36°30'N (ICES Division IXa) and from 20 to 500 m depth. The main objective of the autumn survey (PtGFS-WIBTS-Q4) is to monitor the abundance and distribution of hake and horse mackerel recruitment, while the winter survey (PtGFS-WIBTS-Q1) aims to monitor the abundance and distribution of hake in the spawning season. Additionally, these surveys estimate (i) abundance indices and biomass of the most important commercial species, (ii) biological parameters, e.g. maturity, ages, sex-ratio, weight, food habits, and (iii) biodiversity indicators. The surveys are carried with the Portuguese RV "Noruega", which is a stern trawler of 47.5 m length, 1500 horse power and 495 GRT. In the autumn surveys the fishing gear used is a bottom trawl (type Norwegian Campell 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 weighting 650 kg. In the winter surveys the fishing gear used is a bottom trawl net (CAR) type FGAV019, without rollers in the groundrope. The mean horizontal opening between the wings is 25 m, the mean vertical opening is 2.5 m and the codend mesh size is 20 mm. The trawl doors used are the same as those used in the NCT gear. In autumns 1996, 1999, 2003 and 2004, the Portuguese RV "Noruega" was unavailable and RV "Capricórnio" was used. R/V "Capricórnio", which is a stern trawler of 46.5 m length, 1200 horse power (880 KW) and 494 GRT. The fishing gear, in the latter R/V, is a bottom trawl (CAR, FGAV019), the same used in winter surveys. Sampling design was progressively modified in order to improve the precision of the abundance and biomass estimates. A sampling scheme implemented in the winter series is a mixture of a fixed sampling scheme with trawl positions distributed over a fixed grid with 5′ per 5′ miles and random trawl positions. The new sampling scheme allows performing future calculations with the former strata and also allows performing spatial analysis using geostatistic methods. The 500–750 m depth stratum was removed due to small trawlable and low relevance for the survey purposes. The autumn groundfish survey plan, from 1990 to 2005, comprised a stratified sampling design followed a fixed grid of 97 sampling stations spread throughout the shelf between 19 and 708 m. After 2006, a new sampling design was implemented, with a mixture of a fixed sampling scheme with trawl positions distributed over a 66 fixed grid positions with 5′ per 5′ miles and 30 random trawl positions. The tow duration is 30 min, with a trawl speed of 3.5 knots, during daylight. The winter groundfish survey plan comprises 75 fishing stations, 66 at fixed (grid) positions and nine at random; the tow duration is 60 min, with a trawl speed of 3.5 knots, during daylight. More detailed information will be deal in section 19.6.5.

Abundance indices and mean size of Rajidae species from the Spanish IBTS-GC-Q1-Q4 (ARSA) bottom trawl surveys in the Gulf of Cadiz (IXa South) have been included in this section for first time (Gil *et al*., 2009). The ARSA bottom trawl surveys were routinely carried out by the IEO in spring and autumn in Spanish waters of the Gulf of Cádiz since 1993. Twenty-nine surveys from 1993 to 2009 (16 in March and 13 in November) were analysed. The surveyed area corresponds to the continental shelf and upper-middle slope from latitudes 6°20′W to 7°20′W and from 15 m to 800 m depth, covering an area of 5456 km2. The gear employed had a stretched mesh of 40 mm in the codend and was covered internally with a 20 mm mesh. Mean vertical and horizontal openings were 1.8 m and 21 m, respectively. Sampling design followed a random-stratified scheme with five depth strata (A: 15–30 m, B: 31–100 m, C: 101–200 m, D: 201–500 m and E: 501–800 m). All Rajidae species captured were weighted and counted. Also individuals were sexed ad their sizes were taken as total length (TL) to the nearest cm.

### 19.6.2 Spanish IEO Q4–IBTS survey in VIIIc and IXa

The result of this survey demonstrates relatively high abundances of *S. canicula*, *R. clavata* and *L. naevus* in Division VIIIc since 2000. In Division IXa, only *S. canicula* is relatively abundant, being present in all the years of the series. *L. naevus* does not appear in the surveyed area and *R. clavata* is scarce but mainly occurring since 2001. The length frequency distributions do not present remarkable changes in both ICES divisions covered by the survey (Ruiz-Pico *et al*., 2013 WD). Ruiz-Pico *et al*. (2013 WD) includes historical series of abundance and distribution of two additional elasmo-

branchs (*Galeus spp.* and *R. montagui*). Figures of biomass index and length–frequencies of these species are not presented.

#### Lesser–spotted dogfish

The differences in biomass terms between Divisions VIIIc and IXa from 2006 to 2012 were smaller than in the previous period due to the marked increase in IXa. The percentage of *S. canicula* in the total fish catch rate ranged from 1.7% (2.15 kg·haul$^{-1}$) in 1983 to 6.6% in 2011 (6.58 kg·haul$^{-1}$).

In Division VIIIc a slight increase was found, continuing with the high trend of the last six years. *S. canicula* length ranged from 11 to 68 cm in 2012. In Division IXa *S. canicula* catch rate increased from 2.12 kg·haul$^{-1}$ in 2011 to 7.98 kg·haul$^{-1}$ in 2012 (Figures 19.8–19.10).

#### *Raja clavata*

At Divisions VIIIc and IXa, *R. clavata* is the most abundant skate species. In 2012, catch rate was around 4 kg·haul$^{-1}$ (taking into account only the standard hauls), which was the highest value of the overall time-series. The major increase was registered in IXa, particularly taking in consideration the low values reported previously. This species was widespread in the surveyed area, being found at depths between 46 and 320 m. In 2012, the length of individuals ranged from 13 to 97 cm, being consistent with the former data (Figures 19.11-19.13).

#### *Leucoraja naevus*

In 2012, no records of *L. naevus* were registered at Division IXa, while at Division VIIIc the stratified biomass decreased, reaching values similar to low values reported in 2003 and 2008 (Figures 19.14-19.16). In 2012, this species occurs at depths from 127 to 296 m. The lowest catch rates occurred at same locations as those registered in previous years, mainly in the central and eastern areas of the Cantabrian Sea. The length of specimens ranged from 22 to 63 cm.

### 19.6.3 Basque Country (Spain) ITSASTEKA survey (VIIIc)

In the ITSASTEKA survey, among the 89 different species of fish and cephalopods caught, only two demersal sharks (*G. melastomus and S. canicula)* and four skates (*L. naevus, R. clavata, R. undulata* and, *R. montagui*) were identified. In 2012, despite the small number of shark and skate species caught, catch rates (kg/km$^2$) reached 12.9% of total biomass of fish and cephalopods (4% in 2011).

*S. canicula* and *R. clavata* were the second and fifth species by abundance in the survey (Table 19.12). *S. canicula* was found in almost all trawling stations except in shallower bottoms, being less abundant below 250 m. Younger and larger individuals were found at the same depths (Figure 19.17a). *R. clavata* was found in 20 trawling stations, at depths <135 m in fine sand and muddy grounds (see length–frequency distribution in Figure 19.17b). In some stations, biomass indices reached 147 kg/30 min.

*L. naevus* was the skate species less abundant, only found in three trawling stations always at depths <135 m and with much lower biomass indices than *R. clavata*.

### 19.6.4 French EVHOE Survey (VIII)

Biomass of *R. clavata* shows two peaks, in 2001 and 2008, and *L. naevus* fluctuates along the series, with high values in 2002, 2007 and 2008 (Figure 19.18a). The mean length of the *L. naevus* is quite stable since 1987, ranging between 42 and 50 cm. *R. clavata* mean length varied from 45 to 73 cm with no clear pattern along the time series.

The abundance of *S. canicula* increased from 1997 to 2008 and slightly decreased afterwards although maintaining values higher than those at the beginning of the series (Figure 19.18b).*S. canicula* mean length varied between 35 and 43 cm, and shows an important increase since 2003 (Figure 19.18b).

### 19.6.5 Portuguese survey (IXa)

#### *Raja clavata*

In ICES Division IXa the species occurs along the coast at depths ranging from 18 m till 700 m (Figure 19.19). The reference period adopted for the analysis was from 2005 to 2008 during which the fishing gear used on the survey is considered more adequate for the estimation of skate abundance. The results showed no difference on the mean biomass estimate between years (Figure 19.20). The temporal analysis of the mean length for the surveys held between 1991 and 2010 did not show any difference between years (Figure 19.21).

#### *Raja brachyura*

In ICES Division IXa the species occurs along the coast at depths ranging from 10 m to 700 m (Figure 19.22.). The reference period adopted for the analysis was from 2005 to 2008 during which the fishing gear used on the survey is considered more adequate for the estimation of skate abundance. The results showed no difference on the mean biomass estimate between years (Figure 19.23). The temporal analysis of the mean length for the surveys held between 1991 and 2010 did not show any difference between years (Figure 19.24).

#### *Raja montagui*

In ICES Division IXa the species occurs along the coast at depths ranging from 18 m to 700 m (Figure 19.25). The reference period adopted for the analysis was from 2005 to 2008 during which the fishing gear used on the survey is considered more adequate for the estimation of skate abundance. The results showed no difference on the mean biomass estimate between years (Figure 19.26). The temporal analysis of the mean length for the surveys held between 1991 and 2010 did not show any difference between years (Figure 19.27).

#### *Leucoraja naevus*

In ICES Division IXa the species occurs along the coast at depths ranging from 30 m to 700 m (Figure 19.28). The reference period adopted for the analysis was from 2005 to 2008 during which the fishing gear used on the survey is considered more adequate for the estimation of skate abundance. The results showed no difference on the mean biomass estimate between years (Figure 19.29). The temporal analysis of the mean length for the surveys held between 1991 and 2010 did not show any difference between years (Figure 19.30).

### 19.6.6 Spanish (IBTS-GC-Q1-Q4 (ARSA) bottom trawl survey in the Gulf of Cadiz (IXa South)

In ARSA surveys, 21 different skates and rays species were caught. The most abundant species were: *L. naevus, R. clavata, T. marmorata* and Iberian Pygmy Skate (*Neoraja iberica*). *R. clavata* was the most important species in terms of biomass (Figure 19.31). Only *T. marmorata* presented higher yields in autumn than spring suggesting a seasonal pattern in abundance and biomass.

No significant yield differences of *L. naevus* were found between seasons and depth strata. Mean length was relatively stable in the last years (Figure 19.32a). In autumn, bigger individuals occur at shallow waters.

*R. clavata* showed significant yield differences between depth strata with no clear trend on the mean length (Figure 19.32b). Bigger individuals occur at shallow waters in autumn.

## 19.7 Life-history information

Studies on biological aspects, e.g. age and growth, reproduction, diet and morphometry, of the most frequently landed species in ICES Division IXa, such as *Raja clavata*, *R. brachyura*, *R. undulata*, *L. naevus* and *R. montagui* caught in Portuguese Iberian waters are available. Table 19.13 compiles the main biological information collected. Data available for *R. undulata* was updated by Serra-Pereira *et al*. (2013 WD).

### 19.7.1 Ecologically important habitats

No new information of trawl surveys could usefully provide information on catches of (viable) skate egg-cases, and IBTSWG should be asked to consider this.

### 19.7.2 Recruitment

No information was provided to the WGEF 2013.

## 19.8 Exploratory assessment models

No new information is available to WGEF 2013.

## 19.9 Exploratory analyses

Further analyses of survey data (see above) and catch rates were undertaken.

#### Divisions VIIIa, b, d

##### Lesser spotted dogfish

According to the historical commercial LPUE series, the abundance of *S. canicula* in Divisons VIIIa, b and d has been increasing since 1994. Updated information of LPUE from trawler fleets indicate that the LPUE for *S. canicula* in Subarea VIII has been increasing from 1994 to 2011. The high levels of discards in 2011 could suggest high abundance of small individuals in Subarea VIII. Despite misreporting, Spain historical landings-series indicates a stable trend since 1996 (2000-2500 $t.y^{-1}$).

The French EVHOE survey indicates a clear increase in total biomass since 1997.

#### Rajidae

Except for a decrease in 2010, there is slight increase of commercial LPUE of *L. naevus* and *R. clavata* from 2005 to 2011, perhaps indicating stable abundance of these species. Commercial landings of skates and rays reveal a strong increase in Subarea VIII since 2009. The historical series seems to be stable at around 4000 t.year$^{-1}$.

French EVHOE survey also indicates an increase of total biomass for *L. naevus* and no trend for *R. clavata.*

#### Other elasmobranchs

*Mustelus* spp. landings are discussed in Section 21.

Since 1996 landings of *S. squatina* are negligible.

### Division VIIIc

#### Lesser spotted dogfish

*S. canicula* is a bycatch from many fisheries in this Division. Due to the lack of reported data in 2007; the interpretation of LPUE trends from this series is not reliable, however it is observed that landings increased since 2009 and the maximum peak in last eleven years was reached in 2011.

The IBTS survey after a peak of biomass in 2007, *S. canicula* showed a relative stable trend of biomass (Figure 19.9).

#### Rajidae

In spite of the saw-tooth shape (peaks in 2001, 2003 and 2007) of the series the trend since 1996 shows an increase in landings. The historical time-series of abundance from surveys in VIIIc show a stable trend in biomass of *R. clavata* since 2000. The low number of *L. naevus* specimens caught in the survey, is reflected on the high variability of biomass estimates.

#### Other elasmobranchs

No information is available for other elasmobranchs for this division.

### Divisions IXa

#### Lesser–spotted dogfish

In Division IXa, *S. canicula* is essentially a bycatch from other fisheries, so the landings could be related to changes in effort along the Portuguese coast. Landings, which might not reflect the actual catches, in this division have been reduced until 2008, but since this year onwards a strong recovery is observed (Figure 19.9).

The IEO Q4-IBTS survey in northern IXa showed an increase in the abundance index since 2006, and similarly the Portuguese Winter Groundfish Survey (PtGFS-WIBTS-Q1) in Southern IXa indicates that *S. canicula* is relatively abundant, being present in all the years of the series.

#### Rajidae

After a period in which landings have been between 1500–2000 t.y$^{-1}$, from 2009 onwards an important increase has been recorded. According to the IBTS survey in northern IXa (IEO Q4-IBTS) and Winter Groundfish Survey in Southern IXa (PtGFS-

WIBTS-Q1), *R. clavata* is the most frequent skate and ray species in this Division. *L. naevus, R. brachyura and R. montagui* also occur in surveys (Figures 19.12, 9.15, 19.20, 19.23, 19.26, 19.29).

The work developed by IPMA (ex-IPIMAR) under the Marine Strategy Framework Descriptor 3 to assess stock status of the most important commercial species in ICES IXa was based on PtGFS-WIBTS-Q1 and PtGFS-WIBTS-Q4 surveys (Azevedo *et al.*, 2012). The application of indicators for the criteria defined for descriptor D3 (EU, 2010) followed the approach proposed by ICES WG from MSFD D3 in the study case Bay of Biscay and Iberian Waters (ICES, 2012). In the case of skates and since no analytical assessment is available, secondary indicators were adopted for the criteria which were based on historical data available from surveys.

**Criterion 3.1** Level of the fishing pressure: the indicator adopted consisted on the ratio between catch and biomass as a proxy of F.

**Criterion 3.3** Population structure by size: the indicator adopted consisted on the annual estimate of the mean size length based on survey data.

The evaluation of the status was carried out by comparing the mean value estimate of each indicator at recent years with historical mean as proposed by ICES (2012) as:

$$m = \frac{mean_rec - mean_historic}{s.d.mean_historic}$$

Assuming a normal distribution adopting reference points based on that the GES assigned were:

| | Criterion 3.1<br>Level of the fishing pressure | | | Criterion 3.3<br>Population structure | | |
|---|---|---|---|---|---|---|
| Indicator | m | | | | | |
| | m≤0 | 0<m≤1.6 | m>1.6 | m≥0 | -1.6≤m<0 | m<-1.6 |
| GES | Low | Moderate | High | Low | Moderate | High |

***Raja clavata***

The estimate of fishing pressure indicates that the level is low, as well as the estimate for population structure (Table 19.14).

***Raja brachyura***

The estimate of fishing pressure indicates that the level is low (Table 19.14). Due to small sample size the criterion for population structure was not estimated.

***Raja montagui***

The estimate of fishing pressure indicates that the level is moderate, and the estimate for population structure is low (Table 19.14).

***Leucoraja naevus***

The estimate of fishing pressure indicates that the level is moderate (Table 19.14). Due to small sample size the criterion for population structure was not estimated.

***Galeus melastomus***

In the work developed by IPMA (ex-IPIMAR), under the Marine Strategy Framework Descriptor 1, the conservation status of *G. melastomus* was evaluated. For this, data

from the PtGFS-WIBTS-Q1 collected between 2005 and 2009 was compared with the period considered of reference, 2000–2002. The mean abundance by haul of each year was divided by the mean abundance of the reference period. Results show that the variations observed are not significant and that the conservation status is maintained along the years (Figure 19.33).

#### *Scyliorhinus canicula*

The work developed by IPMA (ex-IPIMAR), under the Marine Strategy Framework Descriptor D1, the conservation status of *S. canicula* was evaluated. For this, data from the PtGFS-WIBTS-Q1 collected between 2005 and 2009 was compared with the period considered as the reference period, 1997–2001. The mean abundance by haul of each year was divided by the mean abundance of the reference period. Results show that the variations observed are not significant and that the conservation status has been maintained along the years (Figure 19.34).

#### Other elasmobranchs

Despite low peaks in 2006 and 2008 *Mustelus* spp. exhibit a slight increase since 2000.

## 19.10 Quality of assessments

No analytic stock assessments have been conducted either for Divisions VIIIa, b, d and IXa.

In recent years LPUE data for *S. canicula, L. naevus and R. clavata* are available for Divisions VIIIa, b, d: Since 2008 LPUE were available for *R. clavata*, *R. microocellata*, *R. montagui*, *R. undulata* and *R. brachyura* in Division IXa.

In the last four years, a lot of effort has been made by the countries involved in the demersal elasmobranch fisheries on this ecoregion to provide species-specific landings of skates and rays. As a result of this improvement in the data, 19 different species have been identified (plus a general category "Rajidae.") from catches of Subareas VIII and IX. A summary of the information available of the species-specific landings of skates and rays by country is shown in Table 19.5.

Like surveys in other ecoregions, surveys in VIII and IXa were not specifically designed for elasmobranchs, producing a high frequency of zero-catch data. The fishing gear used in surveys is not the most appropriate to catch elasmobranchs, especially for species with patchy distributions. The survey effort in coastal areas is very scarce and does not cover a wide range of depths. Nevertheless, for some species, it is possible to estimate some valuable abundance data and by that get trends on abundance. An effort has been done to overcome these data limitations in order to standardize the fishery-independent abundance indexes, using as an example the estimates for *R. clavata* data from the autumn survey (PtGFS-WIBTS-Q4) in IXa (Figueiredo and Serra-Pereira, 2013 WD). To deal with the large amount of zero-catches a generalized linear mixed model (GLMM) was fitted to the data, assuming a Tweedie distribution for the observations. One of the main purposes of applying a GLMM was to incorporate, in the model, variables that could account for the differences between years, namely the difference between stations, depths, survey methodology, etc. Some decisions/assumptions had to be taken in order to proceed with the analysis of the data, including the determination of a subset of the available data which is better represents the geographical distribution of the species. Since, this methodology was proven to be adequate to model the abundance series of *R. clavata*, for 2014, standardized

fishery-independent abundance indexes will be presented for the remaining species, in this division.

## 19.11 Reference points

No reference points have been proposed for the stocks in this ecoregion.

## 19.12 Conservation considerations

The Council Regulation (EC) No 43/2009 of 16 January 2009 which bans the retention on board of three species of skates (see 19.2.4 Management applicable) has been a controversial issue in the affected countries. Despite an official answer from the EU Commission confirming this position, the fishing industry asked this measure to be reconsidered and other scientific studies to be conducted in order to assess the English Channel and Bay of Biscay and Iberia stock(s).

Spanish artisanal fishers operating in coastal waters of VIIIc and IXa and the French fisheries Ministry expressed surprise at this measure in 2009, as there is not enough information or evidence of declines in the populations of *R. undulata* in these subareas. In this sense, due to the coastal and shallow distribution of this species, there are not enough data from catches Most of the catches of this species came from small artisanal vessels operating in bays or shallow waters. Although Spanish trawler fleets historically land the largest proportion of skates from the Cantabrian Sea and Bay of Biscay waters, they do not catch *R. undulata*, because trawling is banned in waters shallower than 100 m.

In order to answer this controversial management decision, from this year, Portugal and Spain (Basque Country) are developing a triennial pilot project, funded by the DCF, to study the fisheries catching skates and rays in the areas of the continental coast in ICES Subarea VIII and Division IXa. The main objective of the study is to improve the quality of knowledge of the fisheries landing skates, filling the gaps in existing basic issues, such as fishery information, biology and economic importance. The data being collected will contribute to the future stock assessment of skates and rays from the Iberian ecoregion, and ensure the sustainability of the fisheries involved. The pilot study shares the same concept, goal, work plan and data analysis but is adapted to the particular "*modus operandi*" of the different fleets existing in the Subarea VIII and Division IXa.

IUCN list angel shark, *D. batis* complex and *R. alb*a (NE Atlantic) as Critically Endangered, *R. undulata* and the guitarfish *Rhinobatos cemiculus* and *Rhinobatos rhinobatos* are listed as Endangered, and *L. circularis* as Vulnerable. Sawfish (*Pristis pectinata* and *P. pristis*) are also listed as Critically Endangered, and the southernmost part of IXa is the northernmost part of the purported range of these species.

Species listed by the IUCN as Near Threatened include *D. oxyrinchus, L. fullonica, R. brachyura, R. clavata, R. microocellata* and *S. stellaris. L. naevus, R. miraletus, R. montagui, S. canicula* and *M. asterias* are all listed as Least Concern (Gibson *et al*., 2008).

## 19.13 Management considerations

EC Council Regulation 43/2012 established a TAC of 4222 t in 2012 for Rajidae of Subareas VIII and IX. The TAC for 2013 is 3800 t.

Records of *S. squatina* in the ecoregion have been practically disappeared since 1996. A more intensive sampling of small artisanal fleets fishing in sand or mud bottoms in

coastal waters could provide better information on the status and distribution of this species in the area.

In 29-12-2011 the Portuguese Administration adopted a national legislation (Portaria no 315/2011) that prohibits, along the whole continental Portuguese EEZ, during the whole month of May the catch, the maintenance on board and the landing of any skate species belonging to the Rajidae family. In addition, in each fishing trip a maximum of 5% bycatch, in weight, of those species is allowed to be maintained on board and to be landed.

## 19.14 References

Azevedo M., Silva A., Gaspar M., Silva C., Murta A., Moura T., Santos M.N., Stratoudakis Y., Prista N., Martins M.M., Soares E., Figueiredo I., Moreno A., Pereira J., Serra-Pereira, B., Faria I., Lagarto N. and Chaves C. 2012. Estado Ambiental das populações de peixes e moluscos explorados comercialmente na ZEE continental portuguesa: Descritor 3 da Directiva Quadro da Estratégia marinha (DQEM).

Carrier JC, Musick JA, Heithaus M.R. 2004. Biology of sharks and their relatives. CRC Press, Florida, USA.

Coelho, R. and Erzini, K. 2002. Age and growth of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal). Journal of the Marine Biological Association of the United Kingdom, 82: 987-990.

Coelho, R. and Erzini, K. 2006. Reproductive aspects of the undulate ray, *Raja undulata*, from the south coast of Portugal Fisheries Research, 81: 80-85

Delamare, Aline, Hennache Cédric, Éric Stéphan , Biais Gérard. 2013. Bay of Biscay undulate ray (*Raja undulata*) abundance assessment by mark-recapture method. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Farias I. 2005. Estudo da Biologia de *Leucoraja naevus* (Müller and Heule, 1841) e *Raja brachyura* Lafont, 1873, na Costa Portuguesa. Tese de Licenciatura. Faculdade de Ciências da Universidade de Lisboa, Janeiro 2005.

Figueiredo, I. and Serra-Pereira, B. 2013. Modelling *Raja clavata* abundance from Portuguese IBTS data (1990–2011) using GLMM with Tweedie distribution. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

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

Gil, J., Canoura, J. Vila, Y., Sobrino, I and Baro, J. 2009. Information about batoid species catched from ARSA bottom trawl surveys in the Spanish Gulf of Cadiz waters. 13th European Elasmobranch Association. Conference Hosted by Societat d´Història Natural de les Balears. ParcBit Auditorium 19th–22nd November.

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

ICES. 2012. Report of the Working Group on Elasmobranch Fishes (WGEF), 19–26 June 2012, Lisbon, Portugal. ICES CM 2012/ACOM:19. 547 pp.

Maia, C., Erzini, K., Serra-Pereira, B. and Figueiredo, I. 2012. Reproductive biology of cuckoo ray *Leucoraja naevus*. Journal of Fish Biology 81: 1285–1296.

Maia, C., Serra-Pereira, B. and Figueiredo, I. 2013. Skates and rays estimates of landings by species from the Portuguese vessels operating in ICES Division IXa. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Neves, A., Borges, M. d. F. and Gordo, L. S. 2008. Ontogenetic dietary shift and feeding strategy of *Raja undulata* Lacepède, 1802 (Chondrichthyes: Rajidae) on the Portuguese continental shelf. Scientia Marina, 72: 311-318.

Pina-Rodrigues, M.T. 2012. Age, growth and maturity of two skate species (Raja brachyura and Raja montagui) from the continental Portuguese coast. (Master thesis) Gent University. (49pp)

Prista, N. and Fernandes, A.C. 2013. Discards of elasmobranchs by the Portuguese bottom otter trawl and deep-water set longline fisheries operating in ICES Division XIa (2004–2012). Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Rodríguez-Cabello, C., Sánchez, F., Fernández, A., Olaso, I. 2004. Is the lesser spotted dogfish (*Scyliorhinus canicula*) from the Cantabrian Sea, a unique stock? Fisheries Research 69, 57–71.

Rodríguez-Cabello, C., Sánchez, F., Olaso, I. 2007. Distribution patterns and sexual segregations of *Scyliorhinus canicula* (L.) in the Cantabrian Sea. Journal of Fish Biology 70, 1568–1586.

Ruiz-Pico, S., Velasco, F., Rodríguez-Cabello., Punzón, A. Serrano, A., Fernández-Zapico O, Blanco. M. 2012. Results on main elasmobranch species captured in the bottom-trawl surveys on the Northern Spanish Shelf. Working Document for the Working Group on Elasmobranch Fishes (WGEF), 2012, Lisbon, 17–21 June 2013, 18 pp.

Serra-Pereira B. 2005. Aspectos da Biologia de *Raja clavata* Linnaeus, 1758 e *Raja montagui* Fowler, 1910, na Costa Portuguesa. Tese de Licenciatura. Faculdade de Ciências da Universidade de Lisboa, Janeiro 2005.

Serra-Pereira, B., Figueiredo, I., Farias, I., Moura, T. and Gordo, L. S. 2008. Description of dermal denticles from the caudal region of *Raja clavata* and their use for the estimation of age and growth. ICES Journal of Marine Science, 65: 1701-1709.

Serra-Pereira, B., Figueiredo, I. and Gordo, L. 2011. Maturation, fecundity, and spawning strategy of the thornback ray, *Raja clavata*: do reproductive characteristics vary regionally? Marine Biology, 158: 2187-2197.

Serra-Pereira, B., Maia, C. and Figueiredo, I. 2013. Remarks on the reproduction strategy of *Raja undulata* from mainland Portugal. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Serra-Pereira, B., Erzini, K., Maia, C. and Figueiredo, I. In press. Identification of potential Essential Fish Habitats for skates based on fisher's knowledge. Environmental Management.

**Table 19.1a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of skates and rays by division and country (Source: ICES). Total landings (t) of Rajidae in Divisions VIIIab.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 12 | 6 | 11 | 11 | 6 | 11 | 14 | 11 | 8 | 12 | 14 | | | 11 | 4 | 7 | 4 |
| France | 1535 | 1733 | 1503 | 1479 | 1206 | 1091 | 1106 | 1037 | 1170 | 1797 | 1296 | 1505 | 1395 | 1615 | 1393 | 1147 | 1150 |
| Netherlands | | | | | | 1 | | | | | | | 0 | 0 | | 0 | |
| Spain | 872 | 906 | 724 | 677 | 146 | 76 | 323 | 27 | 20 | 9 | 12 | 15 | 17 | 16 | 26 | 24 | 168 |
| Spain (Basque Country) | * | * | * | * | 297 | 337 | * | 252 | 242 | 278 | 218 | 199 | 283 | 224 | 100 | 154 | * |
| UK (E&W) | 22 | 76 | 13 | 7 | 2 | 3 | 4 | 4 | | 8 | 40 | | | 0 | 0 | 0 | 5 |
| UK (Scotland) | | | | | | | | | | 1 | | 3 | 2 | 0 | | 0 | |
| Total | 2442 | 2721 | 2251 | 2174 | 1657 | 1518 | 1447 | 1331 | 1440 | 2106 | 1581 | 1722 | 1697 | 1867 | 1524 | 1332 | 1327 |

*** Included in Spanish landings.**

**Table 19.1b. Total landings (t) of Rajidae in Division VIIID.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | | | | | | | | | 0 | |
| France | 46 | 50 | 60 | 52 | 43 | 66 | 64 | 73 | 63 | 97 | 61 | 58 | 89 | 68 | 70 | 57 | 76 |
| Spain | 89 | 92 | 74 | 2 | 1 | 1 | 9 | 5 | 40 | 21 | 23 | 20 | 17 | 16 | 32 | 0 | 3 |
| Spain (Basque Country) | * | * | * | * | | 2 | * | | 1 | | 1 | 2 | 0 | | 0 | | * |
| UK (E&W) | | | | | | | | | | | 3 | | | 0 | 0 | 0 | 0 |
| UK (Scotland) | | | | | | | | | | | | 1 | 0 | 0 | | | |
| Total | 135 | 143 | 134 | 54 | 44 | 69 | 73 | 78 | 104 | 118 | 87 | 81 | 107 | 84 | 102 | 57 | 80 |

*** Included in Spanish landings.**

**** Included in Area VIIIab.**

**Table 19.1c. Total landings (t) of Rajidae in Division VIIIc.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | | | | | | | | | | |
| France | 0 | 0 | 1 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| Netherlands | | | | | | | | | | | | | | | | | |
| Portugal | 11 | 7 | 10 | 4 | 4 | 5 | | | 264 | | | | | | | | |
| Spain | 0 | 321 | 345 | 226 | 424 | 978 | 352 | 1004 | 511 | 546 | 430 | 862 | 488 | 489 | 514 | 628 | 543 |
| Spain (Basque Country) | * | * | * | * | 5 | 16 | * | 21 | 21 | 20 | 14 | 9 | 23 | 22 | 21 | 25 | * |
| UK (E&W) | | | | | | | | | | | | | | | | | |
| UK (Scotland) | | | | | | | | | | | | | | | | | |
| Total | 11 | 328 | 356 | 231 | 434 | 999 | 352 | 1025 | 796 | 567 | 444 | 872 | 511 | 512 | 536 | 653 | 544 |

*** Included in Spanish landings.**

**Table 19.1d. Total landings (t) of Rajidae in Division IXa.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | | | | | | | | | | | | | | | | | |
| Portugal | 1534 | 1512 | 1485 | 1420 | 1528 | 1591 | 1521 | 1598 | 1614 | 1303 | 1544 | 1443 | 1580 | 1473 | 1469 | 1490 | 1170 |
| Spain | 58 | 143 | 197 | 276 | 285 | 416 | 339 | 342 | 325 | 300 | 364 | 354 | 376 | 342 | 457 | 549 | 283 |
| Total | 1592 | 1655 | 1682 | 1696 | 1813 | 2007 | 1860 | 1940 | 1939 | 1602 | 1908 | 1797 | 1956 | 1815 | 1926 | 2039 | 1452 |

**Table 19.1e. Combined Landings (t) of Rajidae in Biscay and Iberian Waters.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 12 | 6 | 11 | 11 | 6 | 11 | 14 | 11 | 8 | 12 | 14 | 0 | 0 | 11 | 4 | 7 | 4 |
| France | 1581 | 1784 | 1564 | 1532 | 1250 | 1157 | 1170 | 1110 | 1233 | 1894 | 1357 | 1564 | 1484 | 1684 | 1464 | 1204 | 1227 |
| Netherlands | | | | | | 1 | | | | | | | | 0 | | | 0 |
| Portugal | 1545 | 1519 | 1495 | 1424 | 1532 | 1596 | 1521 | 1598 | 1878 | 1303 | 1544 | 1443 | 1580 | 1473 | 1469 | 1490 | 1170 |
| Spain | 1019 | 1462 | 1340 | 1181 | 855 | 1471 | 1022 | 1378 | 895 | 876 | 829 | 1250 | 897 | 864 | 1029 | 1201 | 996 |
| Spain (Basque Country) | | | | | 302 | 354 | | 273 | 264 | 298 | 233 | 210 | 306 | 246 | 121 | 178 | * |
| UK (E&W) | 22 | 76 | 13 | 7 | 2 | 3 | 4 | 4 | | 8 | 43 | | | 0 | 0 | 0 | 5 |
| UK (Scotland) | | | | | | | | | | 1 | 0 | 4 | 2 | 0 | | | 0 |
| Total | 4179 | 4846 | 4423 | 4155 | 3947 | 4593 | 3732 | 4374 | 4279 | 4393 | 4020 | 4471 | 4270 | 4279 | 4087 | 4081 | 3402 |

*** Included in Spanish landings.**

**Table 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of Lesser-spotted dogfish by division and country (Source: ICES).**

**Table 19.2a. Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Divisions VIIIab.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | 3 | 8 | 7 | 9 | 11 | 10 | 8 | 9 | 10 | 13 | 13 | 18 | 24 | 28 | 28 | 32 |
| France | 606 | 691 | 811 | 405 | 768 | 839 | 748 | 1030 | 1168 | 1024 | 1112 | 1198 | 743 | 1115 | 1075 | 781 | 862 |
| Spain | 0 | 0 | 63 | 0 | 7 | 7 | 28 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 35 | 57 | 443 |
| Spain (Basque Country) | 223 | 270 | 336 | 254 | 247 | 277 | 353 | 318 | 254 | 335 | 318 | 247 | 383 | 415 | 270 | 285 | * |
| UK (E&W) | | | | | | | | 2 | | 3 | | | | | | | 5 |
| Total | 829 | 964 | 1218 | 667 | 1032 | 1135 | 1139 | 1359 | 1431 | 1373 | 1444 | 1458 | 1145 | 1554 | 1408 | 1151 | 1342 |

*** Included in Spanish landings.**

**Table 19.2c. Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Division VIIId.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 4 | 3 | 5 | 2 | 5 | 7 | 5 | 7 | 6 | 13 | 6 | 8 | 3 | 10 | 11 | 7 | 8 |
| Spain | | | 97 | | 78 | | | | | | | 1 | 2 | | | | 11 |
| Spain (Basque Country) | | | | | | 0 | 1 | | 1 | | 2 | 2 | 0 | | 0 | 0 | * |
| UK (E&W) | | | | | | | | | | | | | | | | | 0 |
| Total | 4 | 3 | 102 | 2 | 83 | 7 | 6 | 7 | 7 | 13 | 8 | 11 | 5 | 10 | 11 | 7 | 19 |

*** Included in Spanish landings.**

**Table 19.2c. Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Area VIIIc.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 0 | 0 | 1 | 1 | 1 | 4 | 3 | 4 | 5 | 1 | 0 | 1 | 1 | 1 | | 0 | 0 |
| Spain | 417 | 458 | 375,6 | 448 | 167 | 187,6 | 65 | 114 | 88 | 143 | 168 | 150 | 149 | 132 | 181 | 180 | 396 |
| Spain (Basque Country) | 11 | 8 | 8 | 9 | 5 | 10 | 52 | 65 | 63 | 66 | 73 | 59 | 47 | 30 | 56 | 121 | * |
| Total | 428 | 466 | 385 | 458 | 173 | 201 | 120 | 183 | 157 | 211 | 241 | 210 | 198 | 162 | 237 | 301 | 396 |

*** Included in Spanish landings.**

**Table 19.2d. Lesser-Spotted Dogfish (*Scyliorhinus canicula*) landings (t) in Division IXa.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 3 | 6 | 19 | 34 | 30 | 39 | 39 | 69 | 86 | 88 | 92 | 118 | 76 | 67 | 99 | 130 | 143 |
| Portugal | 667 | 691 | 689 | 882 | 757 | 734 | 673 | 658 | 677 | 385 | 185 | 157 | 120 | 450 | 444 | 551 | 544 |
| Total | 670 | 697 | 708 | 916 | 787 | 773 | 712 | 727 | 763 | 472 | 276 | 275 | 196 | 518 | 543 | 681 | 687 |

**Table 19.2e. Combined Landings (t) of Lesser-Spotted Dogfish (*Scyliorhinus canicula*) in Biscay and Iberian Water**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | 3 | 8 | 7 | 9 | 11 | 10 | 8 | 9 | 10 | 13 | 13 | 18 | 24 | 28 | 28 | 32 |
| France | 610 | 694 | 817 | 408 | 774 | 850 | 756 | 1041 | 1179 | 1038 | 1118 | 1207 | 747 | 1126 | 1086 | 788 | 870 |
| Spain | 420 | 464 | 555 | 482 | 283 | 234 | 132 | 184 | 174 | 231 | 262 | 269 | 228 | 199 | 315 | 367 | 993 |
| Spain (Basque Country) | 234 | 278 | 344 | 263 | 253 | 287 | 405 | 384 | 318 | 401 | 392 | 308 | 431 | 445 | 325 | 406 | * |
| UK (E&W) | | | | | | | | 2 | | 3 | | | | | | | 5 |
| Portugal | 667 | 691 | 689 | 882 | 757 | 734 | 673 | 658 | 677 | 385 | 185 | 157 | 120 | 450 | 444 | 551 | 544 |
| Total | 1931 | 2130 | 2413 | 2042 | 2075 | 2116 | 1976 | 2276 | 2357 | 2068 | 1969 | 1955 | 1544 | 2244 | 2198 | 2140 | 2444 |

*** Included in Spanish landings.**

**Table 19.3. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of angel shark by subarea and country (Source: ICES). Angel shark (*Squatina squatina*) - ICES Subarea VIII.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 0.4 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | | 0.1 | 0.1 | 0.04 | 0.02 | 0.9 | | | |
| UK (E&W) | | | | | | | | | | | | | | | | 0.6 | |
| Total | 0.4 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.04 | 0.02 | 0.9 | 0 | 0.6 | 0 |

**Table 19.4a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Nominal landings (tonnes) of blackmouth catshark (*Galeus melastomus*) by subarea and country (Source: ICES). Blackmouth catshark (*Galeus melastomus*) - ICES Subarea VIII.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | | | | | | | | | | | | 1 | 2 | | | | |
| Spain | | | | | | | 4 | 3 | 6 | 2 | 3 | 1 | 1 | 1 | 1 | 4 | 6 |
| Spain (Basque Country) | 4 | 3 | 6 | 2 | 3 | 1 | 1 | 1 | 1 | 4 | 4 | 6 | 4 | 4 | 3 | 0 | * |
| France | | | | | | | | | | | | | | | | | 0 |
| Total | 4 | 3 | 6 | 2 | 3 | 1 | 5 | 4 | 7 | 6 | 7 | 8 | 7 | 5 | 4 | 4 | 6 |

*** Included in Spanish landings.**

**Table 19.4b. Blackmouth catshark (*Galeus melastomus*) - ICES Subdivision IXa.**

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 17 | 17 | 16 | 20 | 37 | 29 | 35 | 29 | 57 | 38 | 35 | 24 | 26 | 15 | 7 | 2 | 2 |
| Spain | | | | | | | | | | | | | 25 | | | | 2 |
| Total | 17 | 17 | 16 | 20 | 37 | 29 | 35 | 29 | 57 | 38 | 35 | 24 | 51 | 15 | 7 | 2 | 4 |

**Table 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Elasmobranch discard estimates of OTB (Bottom otter trawl) in Subarea VIII.**

| | *S. canicula* | *G. melastomus* | *R. spp.* | *L.naevus* | *R. clavata* |
|---|---|---|---|---|---|
| | **estimated** | **estimated** | **estimated** | **estimated** | **estimated** |
| **Subarea VIII** | **discard (t)** | **discard (t)** | **discard (t)** | **discard (t)** | **discard (t)** |
| 2003 | 348 | 0 | 76 | | |
| 2004 | 654 | 227 | 64 | | |
| 2005 | 275 | 5 | 13 | | |
| 2006 | 173 | 1 | 10 | | |
| 2007 | 417 | N.A. | N.A. | | |
| 2008 | 641 | 23 | 24 | | |
| 2009 | 1092 | 0 | | 6 | |
| 2010 | 688 | 34 | 0 | 7 | 1 |
| 2011 | 1054 | 7 | 0 | 18 | 3 |
| 2012 | 905 | | 1 | 8 | 0 |

**Table 19.6. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters discard estimations from the Spanish discard sampling programme in VIII and IXa Divisions. Weight discarded (tons) of demersal elasmobranchs (Bold) and CV of estimations (Italics) by fishing ground.**

| Divisions (VIIIc–IXa) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| *Galeus melastomus* | 589 | 244 | 527 | 553 | 1063 | 226 | 904 | 1272 | 730.7 | 1433 |
| | 31.4 | 54.8 | 36.0 | 60.7 | 36.7 | 28.5 | 62.8 | 51.1 | 34.8 | 40.5 |
| *Leucoraja naevus* | 73.0 | 188 | 6.5 | 63.5 | 19.7 | 2.7 | 14.5 | 9.6 | 2.2 | 5.6 |
| | 56.4 | 57.6 | 69.3 | 51.7 | 63.9 | 52.0 | 79.3 | 70.2 | 40.3 | 40.5 |
| *Mustelus asterias* | 0.0 | 28.1 | 18.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| | - | 99.7 | 95.7 | - | - | - | - | - | - | 99.5 |
| *Raja brachyura* | 0.1 | 90.8 | 1.2 | 11.6 | 31.6 | 2.1 | 10.4 | 6.0 | 34.1 | 5.5 |
| | 99.8 | 50.6 | 63.9 | 92.7 | 59.2 | 47.8 | 43.8 | 54.8 | 68.5 | 65.1 |
| *Raja clavata* | 0.0 | 1.0 | 9.9 | 54.5 | 10.9 | 5.5 | 36.0 | 32.4 | 50.6 | 29.6 |
| | - | 57.7 | 54.6 | 75.6 | 45.5 | 76.2 | 47.9 | 43.1 | 50.7 | 28.9 |
| *Raja montagui* | 26.0 | 1.3 | 0.2 | 0.7 | 0.4 | 1.2 | 1.6 | 0.0 | 1.4 | 4.1 |
| | 66.1 | 69.8 | 99.6 | 75.8 | 99.8 | 94.0 | 70.3 | - | 47.5 | 63.8 |
| *Scyliorhinus canicula* | 1933 | 799 | 397 | 1723 | 954 | 300 | 954 | 635 | 720.8 | 753.3 |
| | 36.9 | 38.6 | 34.2 | 63.8 | 23.3 | 32.7 | 40.1 | 21.5 | 26.5 | 26.3 |

**Table 19.7a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Frequency of occurrence (%) of demersal elasmobranchs in the discards of the hauls sampled on board the Portuguese fisheries by gear type: crustacean bottom otter trawl - OTB_CRU; demersal fish bottom otter trawl - OTB_DEF; deep-water set longline fishery that targets black scabbardfish LLS_DWS (2004–2012). "---" indicates no occurrence. (Prista and Fernandes, 2012 WD).**

| Fleet | Species | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| OTB_CRU | *R. miraletus* | --- | 1 | --- | --- | --- | --- | --- | --- | --- |
| | *R. clavata* | 1 | 4 | --- | 1 | 3 | 1 | 3 | 4 | --- |
| | *R. brachyura* | 1 | --- | --- | --- | 2 | --- | --- | 2 | --- |
| | *L. circularis* | 2 | 3 | --- | --- | --- | --- | --- | --- | --- |
| | *R. montagui* | --- | --- | --- | --- | --- | 2 | 1 | --- | --- |
| | *L. naevus* | 2 | --- | --- | --- | --- | 1 | 1 | --- | --- |
| | *R. oxyrinchus* | --- | 1 | --- | 3 | --- | --- | --- | --- | 1 |
| | *G. melastomus* | 57 | 51 | 50 | 38 | 38 | 25 | 24 | 27 | 46 |
| | *Raja spp.* | 4 | 7 | 7 | 1 | 2 | 1 | 1 | 2 | 1 |
| | *S. canicula* | 23 | 19 | 7 | 26 | 12 | 23 | 31 | 48 | 19 |
| OTB_DEF | *R. miraletus* | 4 | 1 | 4 | 2 | --- | 1 | 3 | --- | --- |
| | *R. clavata* | 8 | 3 | 5 | 10 | 5 | 5 | 6 | 12 | 3 |
| | *R. microocellata* | --- | 1 | --- | --- | --- | --- | --- | --- | --- |
| | *R. brachyura* | 4 | 1 | 3 | 1 | --- | --- | 1 | --- | --- |
| | *R. montagui* | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | --- |
| | *L. naevus* | 1 | 1 | 3 | 2 | 2 | --- | --- | --- | --- |
| | *R. oxyrinchus* | --- | --- | --- | --- | --- | --- | 1 | --- | --- |
| | *R. undulata* | --- | --- | --- | 1 | --- | 1 | --- | --- | --- |
| | *G. melastomus* | 8 | 2 | 4 | 3 | 2 | 1 | 2 | --- | --- |
| | *Raja spp.* | 2 | 1 | 1 | --- | --- | --- | 2 | --- | 2 |
| | *S. canicula* | 22 | 21 | 20 | 19 | 27 | 18 | 21 | 42 | 23 |
| LLS_DWS | *G. melastomus* | --- | --- | --- | --- | 75 | 17 | 33 | 50 | 56 |
| | *Raja spp.* | --- | 33 | 20 | --- | --- | --- | --- | --- | --- |

**Table 19.7b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters Volume (in metric tons) and CVs (%, in brackets) of demersal elasmobranchs discarded in the Portuguese crustacean bottom otter trawl (OTB_CRU) and demersal fish bottom otter trawl (OTB_DEF) fisheries (2004–2012). "---" = no occurrence, "(a)" = low frequency of occurrence; "(b)" provisional data based on paper logbook records. (Prista and Fernandes, 2012 WD).**

| | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 (b) |
|---|---|---|---|---|---|---|---|---|---|---|
| OTB_CRU | *G. melastomus* | 263 (39%) | 150 (21%) | 123 (14%) | 22 (59%) | 17 (27%) | (a) | (a) | (a) | 45 (93%) |
| | *S. canicula* | (a) | (a) | (a) | (a) | (a) | (a) | 30 (29%) | 49 (40%) | (a) |
| OTB_DEF | *S. canicula* | (a) | (a) | (a) | (a) | (a) | (a) | (a) | 111 (24%) | (a) |

**Table 19.7c. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length–frequency of discards (in cm) of elasmobranch taxa sampled on board the Portuguese crustacean bottom otter trawl (OTB_CRU), demersal fish bottom otter trawl (OTB_DEF) and deep-water set longline fishery that targets black scabbardfish (LLS_DWS) fisheries (2004-2012) (Prista and Fernandes, 2012 WD).**

| OTB_CRU | N | MEAN | SD | RANGE | % SEXED | FEM:MAL |
|---|---|---|---|---|---|---|
| *R. miraletus* | 1 | 12 | --- | 12-12 | 0 | --- |
| *R. clavata* | 22 | 21.6 | 8.9 | 12-44 | 9 | 1:00 |
| *R. brachyura* | 3 | 18.3 | 7.6 | 13-27 | 0 | --- |
| *L. circularis* | 9 | 20.6 | 6.8 | 12-32 | 0 | --- |
| *R. montagui* | 3 | 33 | 11.5 | 24-46 | 0 | --- |
| *L. naevus* | 6 | 13.3 | 2.6 | 9-16 | 0 | --- |
| *R. oxyrinchus* | 4 | 22.2 | 3.8 | 19-26 | 25 | 1:00 |
| *G. melastomus* | 1944 | 23.5 | 10.6 | 5-86 | 7 | 1.1:1 |
| *Raja spp.* | 20 | 20.9 | 8.6 | 9-34 | 0 | --- |
| *S. canicula* | 409 | 28.5 | 11.7 | 4-58 | 4 | 1.4:1 |
| *Torpedo spp.* | 2 | 37 | 2.8 | 35-39 | 50 | 1:00 |
| *Torpedo nobiliana* | 1 | 29 | --- | 29-29 | 0 | --- |
| *Torpedo marmorata* | 1 | 65 | --- | 65-65 | 0 | --- |
| *Torpedo torpedo* | 3 | 26 | 1 | 25-27 | 0 | --- |
| **OTB_DEF** | **n** | **Mean** | **SD** | **Range** | **% sexed** | **fem:mal** |
| *R. miraletus* | 24 | 31.1 | 7.5 | 12-42 | 0 | --- |
| *R. clavata* | 87 | 31.1 | 8.5 | 17-55 | 0 | --- |
| *R. microocellata* | 1 | 23 | --- | 23-23 | 0 | --- |
| *R. brachyura* | 19 | 35.8 | 10.6 | 20-60 | 0 | --- |
| *R. montagui* | 19 | 32.3 | 8.3 | 13-50 | 0 | --- |
| *L. naevus* | 15 | 38 | 10 | 19-51 | 0 | --- |
| *R. oxyrinchus* | 1 | 46 | --- | 46-46 | 0 | --- |
| *R. undulata* | 2 | 18 | 5.7 | 14-22 | 0 | --- |
| *G. melastomus* | 114 | 29.1 | 9.2 | 15-45 | 0 | --- |
| *Raja spp.* | 8 | 33.2 | 5.8 | 25-44 | 0 | --- |
| *S. canicula* | 612 | 34 | 7.8 | 8-54 | 3 | 1.3:1 |
| **LLS_DWS** | **n** | **Mean** | **SD** | **Range** | **% sexed** | **fem:mal** |
| *G. melastomus* | 63 | 66.7 | 4.1 | 56-74 | 92 | 57:01:00 |

**Table 19.8. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. 2012 Species-specific landings as a percent of total landings in each ICES subdivision, by country.**

| Species | IXa* | VIIIa | VIIIb | VIIIc | VIIId | VIIIe |
|---|---|---|---|---|---|---|
| *Dipturus batis spp* | | <1% | | | | |
| *Dipturus oxyrinchus* | | <1% | <1% | | <1% | |
| *Leucoraja naevus* | 5.2% | 72.0% | 24.4% | 38.8% | 85.4% | 3.8% |
| *Raja alba* | | <1% | <1% | | <1% | <1% |
| *Raja asterias* | | <1% | | | | |
| *Raja brachyura* | 33.7% | <1% | <1% | | <1% | 82.9% |
| *Raja circularis* | <1% | 1.5% | <1% | | 3.0% | |
| *Raja clavata* | 52.3% | 8.5% | 51.9% | 43.7% | 8.1% | |
| *Raja microocellata* | | <1% | 6.8% | | <1% | |
| *Raja montagui* | 5.0% | 8.3% | <1% | <1% | <1% | 12.7% |
| *Raja radiata* | | <1% | | | | |
| *Raja undulata* | | <1% | 1.6% | | <1% | |
| *Leucoraja fullonica* | | 2.5% | <1% | | 2.9% | |
| *Raja* spp | 3.8% | 6.1% | 12.5% | 16.9% | <1% | <1% |
| | 100% | 100% | 100% | 100% | 100% | 100% |

*** Based on official landings.**

**Table 19.9. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Species-specific landings (skates and rays in t) by country in Subarea VIII, and Division XIa, all gears combined. These data are included in the Tables 19.1a to 19.1c. * (Data could include landings of *R. brachyura*). **consider by WGEF to be misidentified.**

| Country | year | Subarea | *T. marmorata* | *D. Batis* | *D. oxyrinchus* | *I. circularis* | *L. fullonica* | *L. naevus* | *R. clavata* | *R. microocellata* | *R. montagui* * | *R. undulata* | *D. pastinaca* | *M. aquila* | *R. asterias*** | *R. brachyura* | *R. miraletus* | *R. alba* | *A. radiata*** | *R. alba* | *Raja spp.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 1999 | VIII | 24 | 1 | 0 | 17 | 0 | 319 | 75 | 0 | 46 | 0 | 0 | 2 | | | | | | | 0 |
| France | 2000 | VIII | 9 | 5 | 1 | 55 | 3 | 749 | 68 | 0 | 53 | 1 | 1 | 0 | | | | | | | 1 |
| France | 2001 | VIII | 3 | 4 | 0 | 47 | 7 | 637 | 37 | 1 | 62 | 2 | 1 | 0 | | | | | | | 1 |
| France | 2002 | VIII | 5 | 13 | 16 | 51 | 5 | 614 | 39 | 1 | 47 | 0 | 0 | 0 | | | | | | | 0 |
| France | 2003 | VIII | | 4 | 1 | 44 | 4 | 654 | 49 | 2 | 58 | 0 | | | 0 | | | | | | |
| France | 2004 | VIII | | 4 | 0 | 46 | 4 | 749 | 97 | 0 | 67 | 0 | | | 0 | | | | | | 201 |
| France | 2005 | VIII | | 4 | 1 | 61 | 5 | 946 | 104 | 0 | 54 | 0 | | | 0 | | | | | | 598 |
| France | 2006 | VIII | | 4 | 2 | 36 | 4 | 668 | 139 | 0 | 61 | 0 | 2 | 1 | 0 | | | 0 | | | 607 |
| France | 2007 | VIII | | 2 | 1 | 30 | 3 | 582 | 74 | | 30 | | 1 | | | | | | | | 841 |
| France | 2008 | VIII | | 5 | 3 | 56 | 5 | 775 | 82 | | 41 | 0 | 2 | 0 | | | | | | | 502 |
| France | 2009 | VIII | 26 | 1 | 1 | 20 | 45 | 1096 | 177 | 3 | 64 | 2 | 3 | 1 | 0 | 3 | | 4 | 0 | | 237 |
| France | 2010 | VIII | 22 | 0 | 0 | 26 | 36 | 975 | 165 | 2 | 81 | | | 1 | | 2 | | | 1 | 0 | 173 |
| France | 2011 | VIII | | | | 16 | 32 | 875 | 107 | | 65 | 0 | | | | 20 | | | | | 69 |
| France | 2012 | VIII | 19 | | 0 | 18 | 28 | 818 | 171 | 12 | 84 | | 2 | 1 | 0 | 8 | | | 0 | | 64 |
| Belgium | 2002 | VIIIa,b | | | | | | 15 | 6 | | 0 | | | | | | | | | | |
| Belgium | 2009 | VIIIa,b | | | | | | 7 | 2 | | 0 | | | | | 0 | | | | | 2 |
| Belgium | 2010 | VIIIa,b | | | | | | 3 | | 1 | 0 | | | | | 0 | | | | | 1 |

| Country | year | Subarea | *T. marmorata* | *D. Batis* | *D. oxyrinchus* | *I. circularis* | *L. fullonica* | *L. naevus* | *R. clavata* | *R. microocellata* | *R. montagui* * | *R. undulata* | *D. pastinaca* | *M. aquila* | *R. asterias*** | *R. brachyura* | *R. miraletus* | *R. alba* | *A. radiata*** | *R. alba* | *Raja spp.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 2011 | VIIIa,b | | | | 0 | | 4 | | | 0 | | | | | 0 | | | | | 0 |
| Belgium | 2012 | VIIIa,b | | | | 0 | | 2 | 2 | | 0 | | | | | 0 | | | | | 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 | | 7 | 202 | 46 | 0 | 6 | 0 | | | 0 | | | | | | |
| Spain (Basque Country)* | 2005 | VIII | | 3 | 0 | | 8 | 229 | 52 | 0 | 7 | 0 | | | 0 | | | | | | |
| Spain (Basque Country)* | 2006 | VIII | | 3 | 0 | | 6 | 179 | 41 | | 5 | 0 | | | 0 | | | | | | |
| Spain (Basque Country)* | 2007 | VIII | | 2 | 0 | | 5 | 161 | 37 | | 5 | 0 | | | 0 | | | | | | |
| Spain (Basque Country) | 2008 | VIII | | 4 | 0 | | 8 | 236 | 52 | | 7 | 0 | | | 0 | | | | | | |
| Spain (Basque Country) | 2009 | VIII | | | | | 0 | 194 | 48 | | | | | | | | | | | | |
| Spain (Basque Country) | 2010 | VIII | | | | | | 88 | 33 | | | | | | | | | | | | |
| Spain (Basque Country) | 2011 | VIII | | | | | | 135 | 36 | | | | | | | | | | | | |
| Spain | 2011 | VIII | | | | | | 2 | | | 4 | | | | | | | | | | 516 |
| Spain | 2011 | IXa | | | | | | | | | | 0 | | | | | | | | | 526 |
| Spain | 2012 | VIII | 0 | | 0 | 6 | 0 | 160 | 269 | 0 | 21 | | 0 | | | 0 | | | | | 268 |
| Spain | 2012 | IXa | 1 | | 0 | 0 | 0 | 12 | 193 | 0 | 3 | | 0 | | | 0 | | | | | 97 |
| Portugal | 2002 | IXa | | | | | | 13 | 2 | | | | | | | | | | | | 1505 |
| Portugal | 2003 | IXa | | | | | | 18 | 351 | 78 | 56 | 126 | | | | 578 | 2 | | | | |

| Country | year | Subarea | *T. marmorata* | *D. Batis* | *D. oxyrinchus* | *I. circularis* | *L. fullonica* | *L. naevus* | *R. clavata* | *R. microocellata* | *R. montagui* * | *R. undulata* | *D. pastinaca* | *M. aquila* | *R. asterias*** | *R. brachyura* | *R. miraletus* | *R. alba* | *A. radiata*** | *R. alba* | *Raja spp.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 2004 | IXa | | | | | | 113 | 516 | 95 | 82 | 108 | | | | 532 | 17 | 5 | | | |
| Portugal** | 2005 | IXa | | | | | | 43 | 480 | 88 | 76 | 100 | | | | 495 | 16 | 5 | | | |
| Portugal** | 2006 | IXa | | | | | | 51 | 569 | 105 | 90 | 119 | | | | 586 | 19 | 6 | | | |
| Portugal** | 2007 | IXa | | | | | | 79 | 472 | 35 | 119 | 277 | | | | 459 | | | | | 3 |
| Portugal | 2008 | IXa | | | | 33 | | 19 | 418 | | 155 | 52 | | | | 340 | | | | | 557 |
| Portugal | 2009 | IXa | | | 19 | 2 | | 66 | 562 | 51 | 96 | 220 | | | | 244 | 4 | 11 | | | 3 |
| Portugal*** | 2010 | IXa | | | | 40 | | 9 | 813 | | 93 | | | | | 379 | | | | | 190 |
| Portugal*** | 2011 | IXa | | | | | | 68 | 817 | | 79 | | | | | 379 | | | | | 148 |
| Portugal*** | 2012 | IXa | | | | | | 58 | 586 | | 56 | | | | | 379 | | | | | 90 |
| UK (E & W) | 2008 | VIII | | | | | | 1 | | 1 | | | | | | 2 | | | | | 175 |
| UK (E & W) | 2009 | VIII | | | | | 0 | | 0 | | 0 | | | | | 0 | | | | | 0 |
| UK (E & W) | 2010 | VIII | | | | | 0 | 0 | | 0 | 0 | | | | | | | | | | 0 |
| UK (E & W) | 2011 | VIII | | | | | | 0 | | | 0 | | | | | | | | | | |
| UK (E & W) | 2012 | VIII | | | | 0 | 0 | | 2 | | | | | | | | | | | | |
| UK (Scotland) | 2009 | VIII | | | | | | | | | 0.3 | | | | | | | | | | |

*** landings from 2004 to 2007 are based on the average species proportion of 2000–2003 ** landings from 2005 to 2008 are based in the species proportion of 2004; ***Based on official landings.**

**Table 19.10. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Relative landed weight (%) for skate species (*Raja miraletus*, *Rostroraja alba*, *Raja clavata*, *Raja microocellata*, *Raja brachyura*, *Leucoraja circularis*, *Raja montagui*, *Leucoraja naevus*, *Dipturus oxyrinchus*, *Raja undulata* and Rajidae), per fishing segment (Portuguese polyvalent and trawl fleets) for 2009 and 2011.**

| | Polyvalent | | | Trawl | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 |
| *R. miraletus* | 0% | 1% | 0% | 2% | 3% | 0% | 1% | 1% | 0% |
| *Rostroraja alba* | 2% | 0% | 2% | 0% | 0% | 1% | 1% | 0% | 2% |
| *R. clavata* | 41% | 50% | 39% | 47% | 48% | 68% | 42% | 49% | 46% |
| *R. microocellata* | 5% | 3% | 6% | 0% | 0% | 0% | 4% | 2% | 5% |
| *R. brachyura* | 29% | 26% | 29% | 21% | 18% | 8% | 27% | 24% | 24% |
| *L. circularis* | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| *R. montagui* | 5% | 4% | 6% | 19% | 11% | 12% | 8% | 6% | 7% |
| *Leucoraja naevus* | 3% | 4% | 1% | 6% | 13% | 8% | 3% | 6% | 3% |
| *Dipturus oxyrinchus* | 0% | 0% | 1% | 3% | 0% | 0% | 1% | 0% | 1% |
| *R. undulata* | 16% | 13% | 15% | 3% | 7% | 2% | 12% | 11% | 12% |
| N samples | 116 | 124 | 226 | 34 | 27 | 26 | 150 | 151 | 252 |
| Sampled weight (kg) | 4759 | 7027 | 11 007 | 2570 | 684 | 1501 | 7329 | 7711 | 12 509 |

**Table 19.11a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Effective effort (fishing days = trips*(days/trip)), landings (t), and LPUE (landings in kg/day) of main elasmobranchs caught by the Basque Country OTB (Bottom otter trawl) in Subarea VIII.**

| OTB (Bottom otter trawl) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Scyliorhinus canicula* | | *Rajidae* spp | | smooth hounds | |
| | effort | Landings | LPUE | Landings | LPUE | Landings | LPUE |
| | (days) | (t) | (kg/days) | (t) | (kg/days) | (t) | (kg/days) |
| 1994 | 5619 | 115 | 20 | 180 | 32 | 34 | 6 |
| 1995 | 4474 | 203 | 45 | 505 | 113 | 25 | 6 |
| 1996 | 4378 | 212 | 49 | 477 | 109 | 35 | 8 |
| 1997 | 4286 | 247 | 58 | 554 | 129 | 38 | 9 |
| 1998 | 3002 | 308 | 103 | 604 | 201 | 28 | 9 |
| 1999 | 2337 | 237 | 101 | 367 | 157 | 27 | 11 |
| 2000 | 2227 | 228 | 102 | 273 | 123 | 28 | 13 |
| 2001 | 2707 | 239 | 88 | 301 | 111 | 33 | 12 |
| 2002 | 3617 | 389 | 107 | 281 | 78 | 50 | 14 |
| 2003 | 3363 | 368 | 109 | 239 | 71 | 40 | 12 |
| 2004 | 4232 | 299 | 71 | 191 | 45 | 35 | 8 |
| 2005 | 3697 | 396 | 107 | 248 | 67 | 41 | 11 |
| 2006 | 2979 | 383 | 128 | 205 | 69 | 47 | 16 |
| 2007 | 2780 | 309 | 111 | 199 | 71 | 32 | 11 |
| 2008 | 2967 | 400 | 135 | 255 | 86 | 71 | 24 |
| 2009 | 2274 | 434 | 191 | 219 | 96 | 154 | 68 |
| 2010 | 1844 | 325 | 177 | 100 | 66 | 30 | 16 |
| 2011 | 1733 | 366 | 211 | 148 | 85 | 39 | 23 |

**Table 19.11b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Effective effort (fishing days = trips*(days/trip)), landings (t), and LPUE (landings in kg/day) of main elasmobranchs caught by the Basque Country PTB (Bottom Pair trawl) in Subarea VIII.**

| PTB (Bottom Pair trawl) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Scyliorhinus canicula* | | *Rajidae* spp | | smooth hounds | |
| | effort | Landings | LPUE | Landings | LPUE | Landings | LPUE |
| | (days) | (t) | (kg/day) | (t) | (kg/day) | (t) | (kg/day) |
| 1994 | 362 | 1 | 3 | 0 | 0 | 0 | 1 |
| 1995 | 959 | 0 | 0 | 1 | 1 | 2 | 2 |
| 1996 | 1332 | 1 | 1 | 5 | 4 | 8 | 6 |
| 1997 | 1290 | 2 | 2 | 5 | 4 | 9 | 7 |
| 1998 | 1482 | 3 | 2 | 9 | 6 | 18 | 12 |
| 1999 | 1787 | 6 | 3 | 8 | 4 | 12 | 7 |
| 2000 | 1214 | 3 | 2 | 8 | 6 | 22 | 18 |
| 2001 | 3402 | 7 | 2 | 14 | 4 | 13 | 4 |
| 2002 | 4045 | 5 | 1 | 16 | 4 | 20 | 5 |
| 2003 | 3845 | 9 | 2 | 15 | 4 | 13 | 3 |
| 2004 | 3944 | 14 | 4 | 12 | 3 | 10 | 3 |
| 2005 | 3421 | 4 | 1 | 5 | 1 | 11 | 3 |
| 2006 | 3228 | 7 | 2 | 9 | 3 | 14 | 4 |
| 2007 | 2724 | 15 | 6 | 4 | 2 | 10 | 4 |
| 2008 | 2342 | 8 | 3 | 5 | 2 | 9 | 4 |
| 2009 | 1771 | 10 | 5 | 2 | 1 | 11 | 6 |
| 2010 | 2255 | 10 | 4 | 1 | 1 | 8 | 3 |
| 2011 | 2283 | 37 | 16 | 7 | 3 | 6 | 3 |

**Table 19.12. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Distribution of elasmobranch biomass (kg/ 30 min) by depth and type of substratum in the ITSASTEKA survey in 2012.**

| DEPTH (M) | SUBSTRATE | *G. MELASTOMUS* | *L. NAEVUS* | *L. FULLONICA* | *R. CLAVATA* | *R. MONTAGUI* | *R. UNDULATA* | *S. CANICULA* | *M. ASTERIAS* |
|---|---|---|---|---|---|---|---|---|---|
| 28 | --- | | | | | | 12 | | |
| 31 | fine sand | | | 18 | 14 | 2 | | | |
| 45 | medium sand | | | | 49 | 21 | 44 | 2 | |
| 49 | fine sand | | | | 24 | 3 | | 7 | |
| 50 | coarse sand | | | | | | | 2 | |
| 52 | fine sand | | 2 | | 84 | 30 | | 23 | |
| 66 | fine sand | | | | 24 | 6 | | 13 | |
| 71 | fine sand | | | | 147 | 71 | | 156 | |
| 88 | fine sand | | | | 47 | 29 | | 100 | |
| 90 | mud | | | | | 2 | | 55 | |
| 95 | coarse sand | | | | 6 | 2 | | 11 | |
| 99 | mud | | | | 5 | 13 | | 126 | |
| 100 | mud | | | | 16 | 20 | | 50 | |
| 116 | fine sand | | 4 | | 10 | | | 209 | |
| 120 | mud | | | | 0 | | | 49 | |
| 123 | mud | | | | 12 | 4 | | 48 | |
| 128 | mud | | | | 27 | | | 55 | |
| 130 | mud | | | | 9 | 3 | | 71 | |
| 132 | mud | | | | 2 | | | 46 | |
| 135 | mud | | | | 1 | 1 | | 37 | |
| 135 | fine sand | | 5 | | 52 | 8 | | 78 | |
| 160 | fine sand | | | | | | | 286 | |
| 169 | medium sand | 0 | | | | | | 35 | |
| 173 | fine sand | | | | | | | 79 | 7 |
| 173 | medium sand | | | | 1 | | | 107 | |
| 182 | fine sand | | | | 3 | | | 161 | |
| 199 | fine sand | | | | | | | 91 | 0 |
| 258 | mud | 1 | | | | | | 6 | |
| 360 | mud | 19 | | | | | | 9 | |

**Table 19.13. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Life-history information): Table 2. Biological parameter estimates available for skate species inhabiting Portuguese Iberian waters. Growth models: VBR – von Bertalanffy Growth Model; GG – Gompertz Growth Model.**

| Species | TL range (cm) | L50 (cm) F | L50 (cm) M | I50 (years) F | I50 (years) M | Fecundity | Reproductive period | Growth model | Growth parameters estimates | | | | | | Period | Region | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | L∞ (cm) | k (year-1) | t0 (years) | Lmax (cm) | Imax (years) | I∞ longevity (years) | | | |
| *R. undulata* | 19.4-88.2 | 76.2 | 73.6 | 8.98 | 7.66 | - | - | VBG | 110.2 | 0.11 | -1.58 | 88.2 | 13 | - | 1999–2001 | Algarve | [1], [2] |
| | 23.7-90.5 | 83.8 | 78.1 | 9 | 8 | - | Feb–May | VBG | 113.7 | 0.15 | -0.01 | 90.5 | 12 | 23.6 | 2003–2006 | Centre | [3] |
| | 32.0-83.2 | - | - | - | - | - | - | VBG | 119.3 | 0.12 | -0.41 | 83.2 | 9 | 28.9 | 1999–2001 | Algarve | [3] |
| | 23.5-95.9 | 86.2 ±2.6 | 76.8 ±2.4 | 8.7 ±0.3 | 8.7 ±0.3 | 69.8 ±3.4 | Dec–Jun | - | - | - | - | - | - | - | 2003–2013 | North /Centre | [4] |
| *R. clavata* | 14.3-91.3 | - | - | - | - | | - | VBG | 128.0 | 0.112 | -0.62 | 91.3 | 10 | - | 2003–2007 | All | [5] |
| | 12.5-105.0 | 78.4 | 67.6 | 7.5 | 5.8 | 136 | May–Jan | | - | - | - | - | - | - | 2003–2008 | All | [6] |
| *R. brachyura* | 37.4-106.1 | 97.9 | 88.8 | - | - | - | Mar–jul | VBG | 110.51 | 0.12 | 0.26 | 106.1 | - | - | 2003–2004 | All | [7] |
| | 37.6-108.8 | 96.6 | 88.6 | - | - | | Mar–Jul | | - | - | - | - | - | - | 2003–2012 | North /Centre | [8] |
| *R. montagui* | 25.2-76.1 | 59.4 | 50.4 | - | - | - | Apr–Jun | VBG | 75.9 | 0.23 | 0.16 | 76.1 | 7 | - | 2003–2004 | All | [9] |

| Species | TL range (cm) | L50 (cm) F | L50 (cm) M | I50 (years) F | I50 (years) M | Fecundity | Reproductive period | Growth model | Growth parameters estimates | | | | | | Period | Region | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 36.8-70.2 | 56.7 | 48.0 | - | - | | Apr-Jul | - | - | - | - | - | - | - | 2003-2012 | All | [10] |
| *L. naevus* | 12.7-71.8 | 55.6 | 56.5 | - | - | | - | VBG | 79.2 | 0.24 | 0.12 | 71.8 | - | - | 2003-2004 | All | [7] |
| | 13.3-71.8 | 56.5 | 56.0 | - | - | 63 | Jan-May | | - | - | - | - | - | - | 2003-2010 | All | [9] |

**[1] Coelho and Erzini, 2002; [2] Coelho and Erzini, 2006; [3] Moura *et al.*, 2008; [4] Serra-Pereira *et al.*, 2013 WD; [5] Serra-Pereira *et al.*, 2008; [6] Serra-Pereira *et al.*, 2011; [7] Farias, 2005; [8] Serra-Pereira, 2005; [9] Maia *et al.*, 2012; [10] Pina Rodrigues, 2012.**

**Table 19.14. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. GES classification for the level of fishing pressure and population structure of skate species in ICES Division IXa, using criteria 3.1 Level of fishing pressure and 3.3. Population structure (Source: Azevedo et al., 2012).**

| | 3.1. Level of fishing pressure | | 3.3. Population structure | |
|---|---|---|---|---|
| | Indicator | GES | Indicator | GES |
| *Raja clavata* | -0.03 | Low | 0.47 | Low |
| *Raja brachyura* | -0.05 | Low | NA | NA |
| *Raja montagui* | 0.20 | Moderate | 0.61 | Low |
| *Leucoraja naevus* | 0.36 | Moderate | NA | NA |

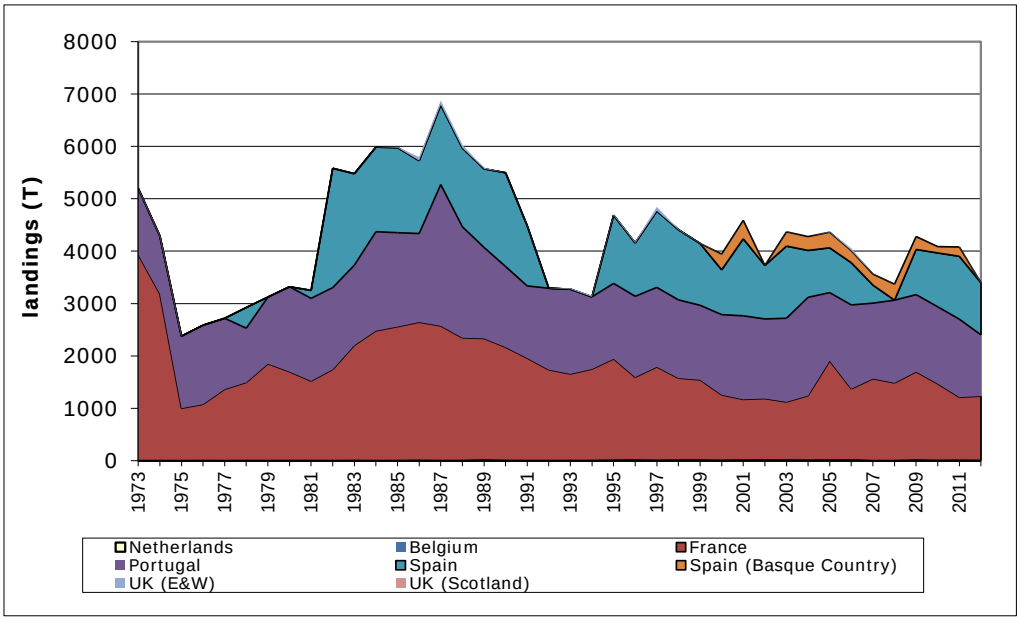



**Figure 19.1. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of *Rajidae* in Subarea VIII and Division IXa.**

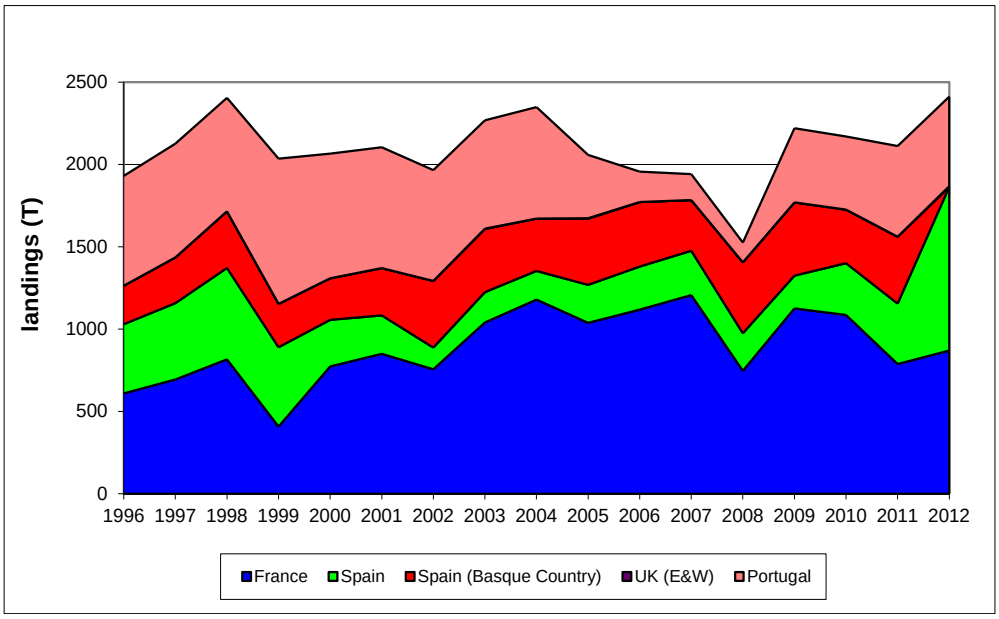



**Figure 19.2. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Historical trend landings of Lesser-spotted dogfish in Subarea VIII and Division IXa. (Spanish landings data in 2007 and 2008 come from FishStat.**

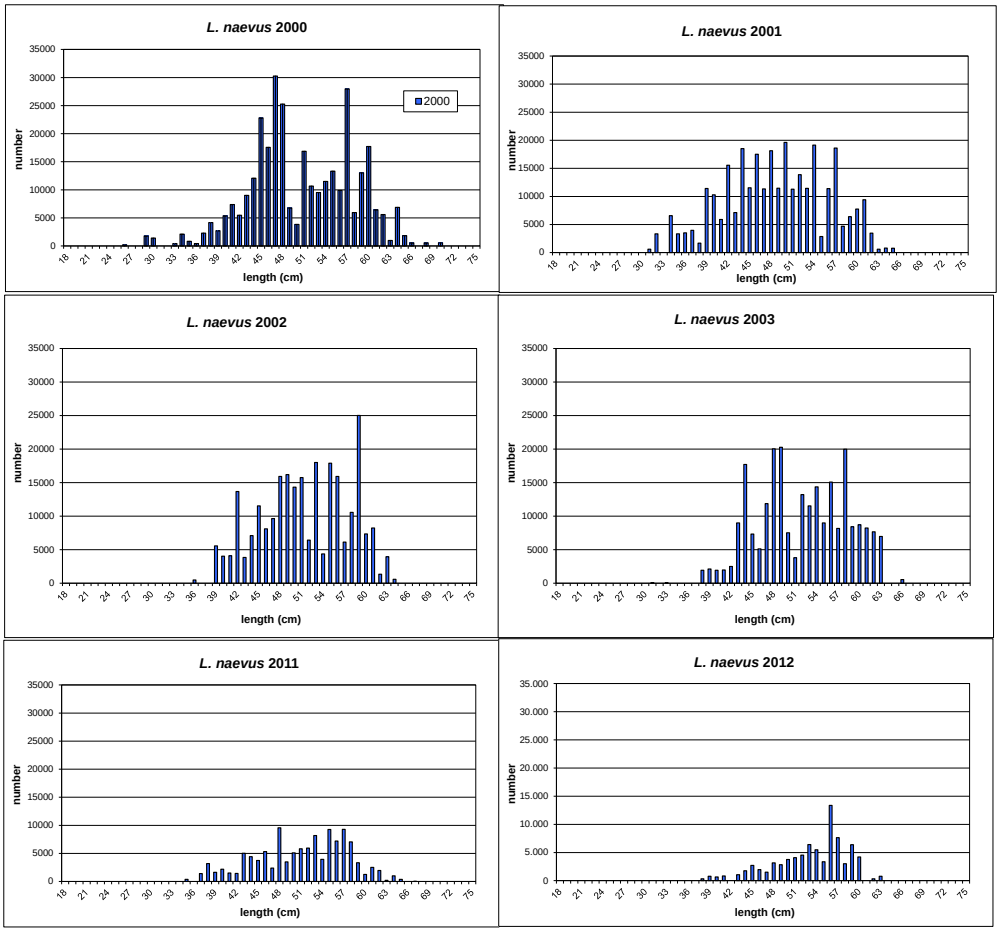



**Figure 19.3a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies of *L. naevus* of the OTB Basque fleet in Subarea VIII from the period 2000–2003 and 2011–2012.**

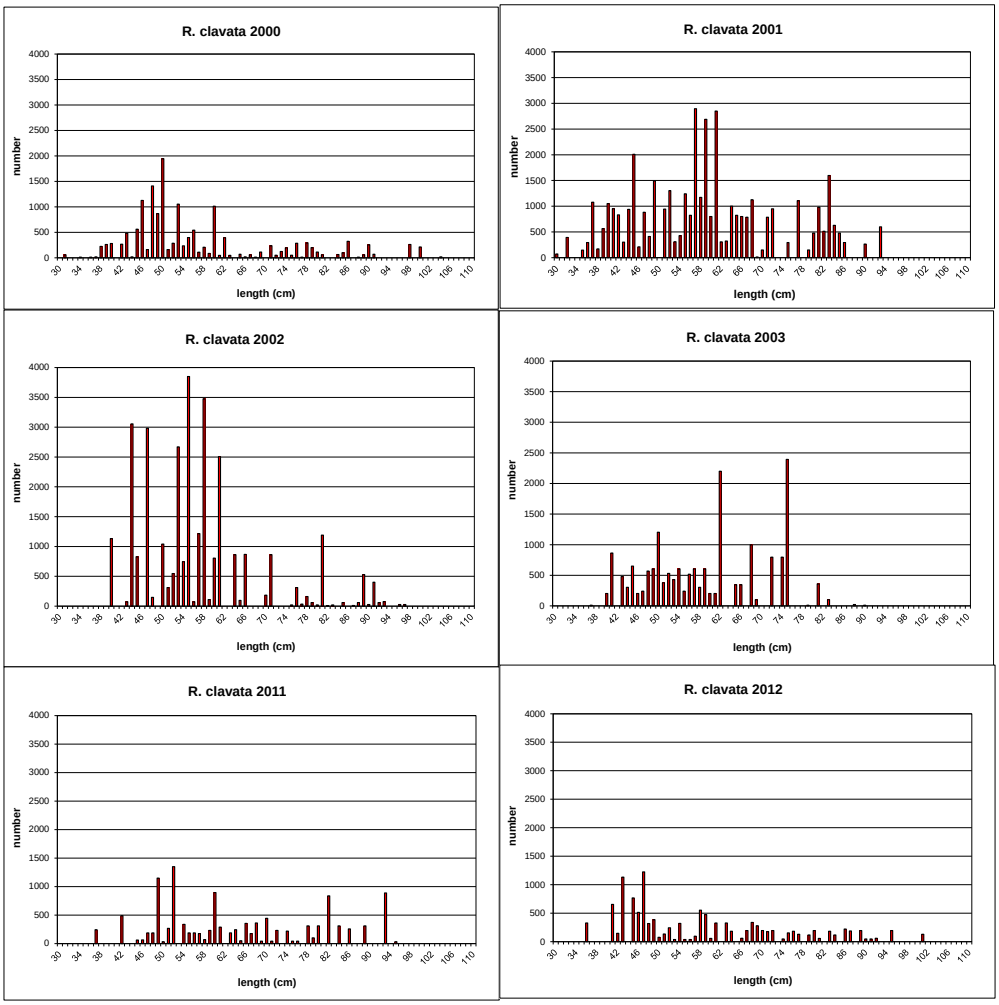



**Figure 19.3b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies of *R. clavata* of the OTB Basque fleet in Subarea VIII from the period 2000–2003 and 2011–2012.**

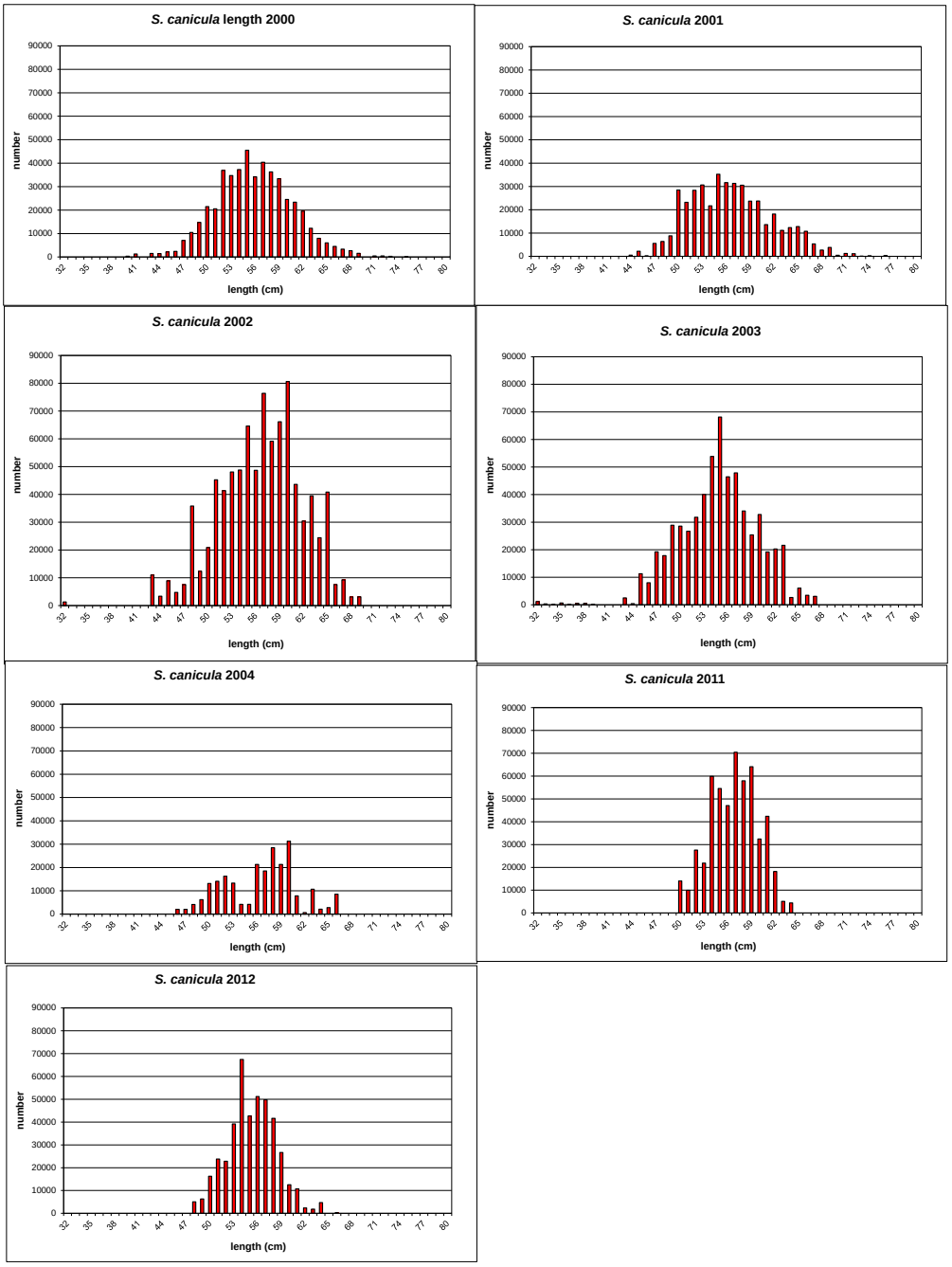



**Figure 19.3c. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Length frequencies of *S. canicula* of the OTB Basque fleet in Subarea VIII from the period 2000–2004 and 2011–2012.**

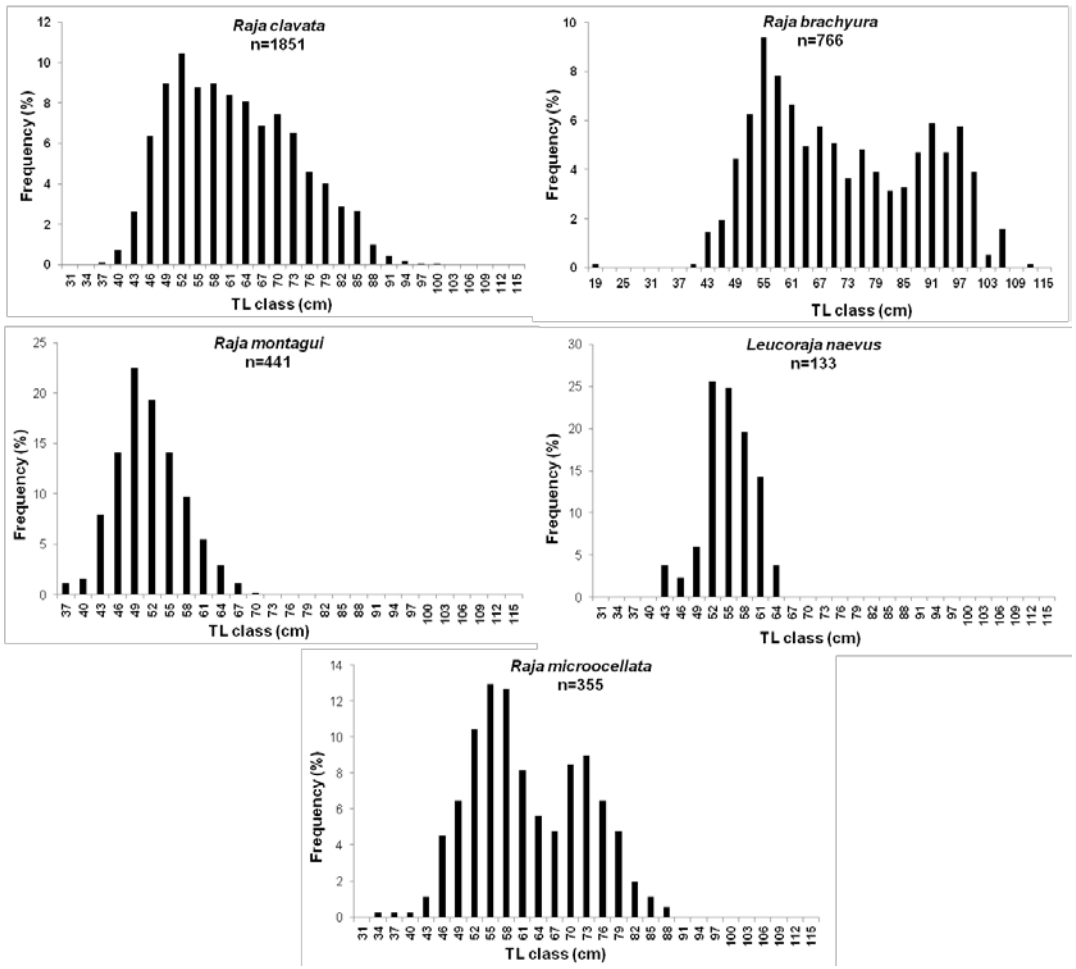



**Figure 19.4. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters length–frequency distribution of *Raja clavata*, *Raja brachyura*, *Raja montagui*, *Leucoraja naevus* and *Raja microocellata* in Peniche landing port (3 cm length class; total number of sampled specimens for each species is indicated; number of sampled trips: 148).**

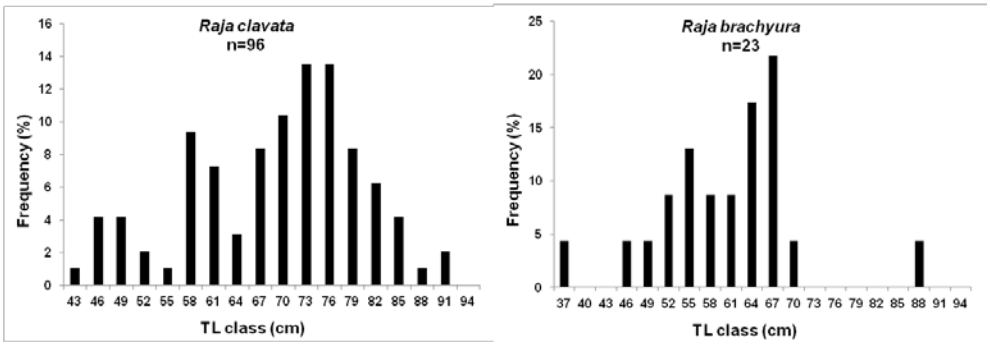
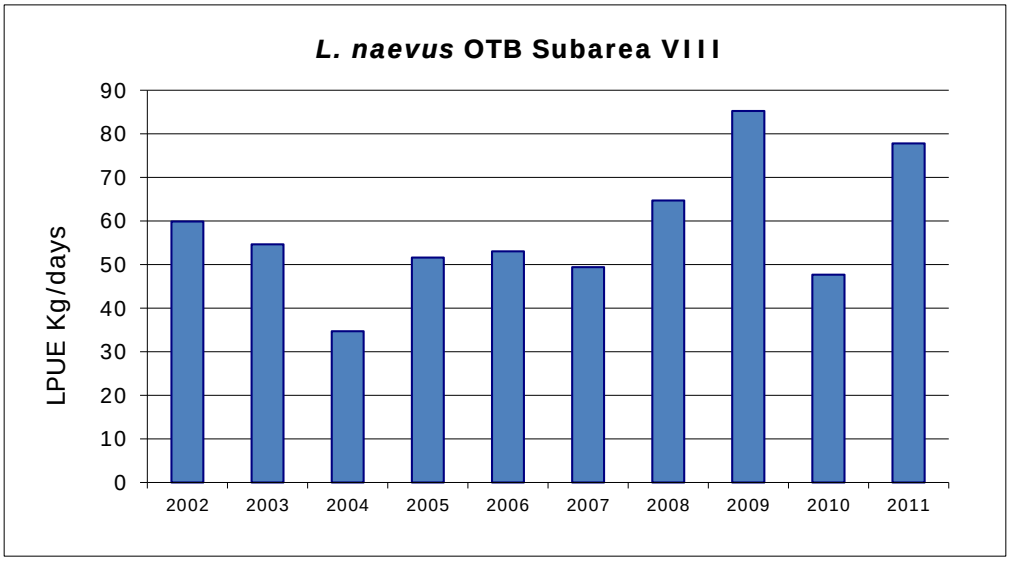



**Figure 19.5. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters length–frequency distribution of *Raja clavata* and *Raja brachyura* in Matosinhos (north of Portugal mainland) landing port (3 cm length class; total number of sampled specimens for each species is indicated; number of sampled trips: 29).**



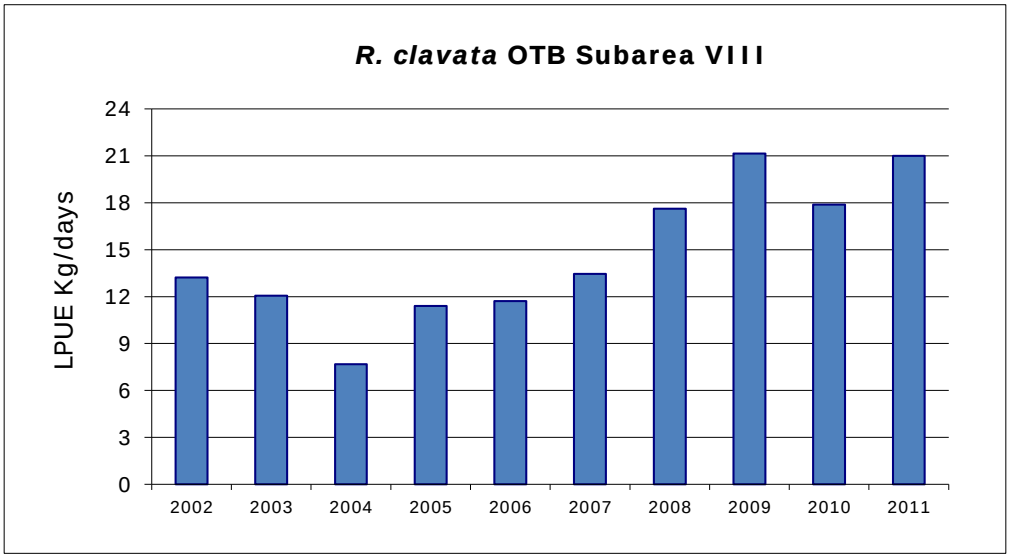




**Figure 19.6. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *L. naevus* and *R. clavata* nominal LPUE of OTB Basque fleet in Subarea VIII from 2002 to 2011.**

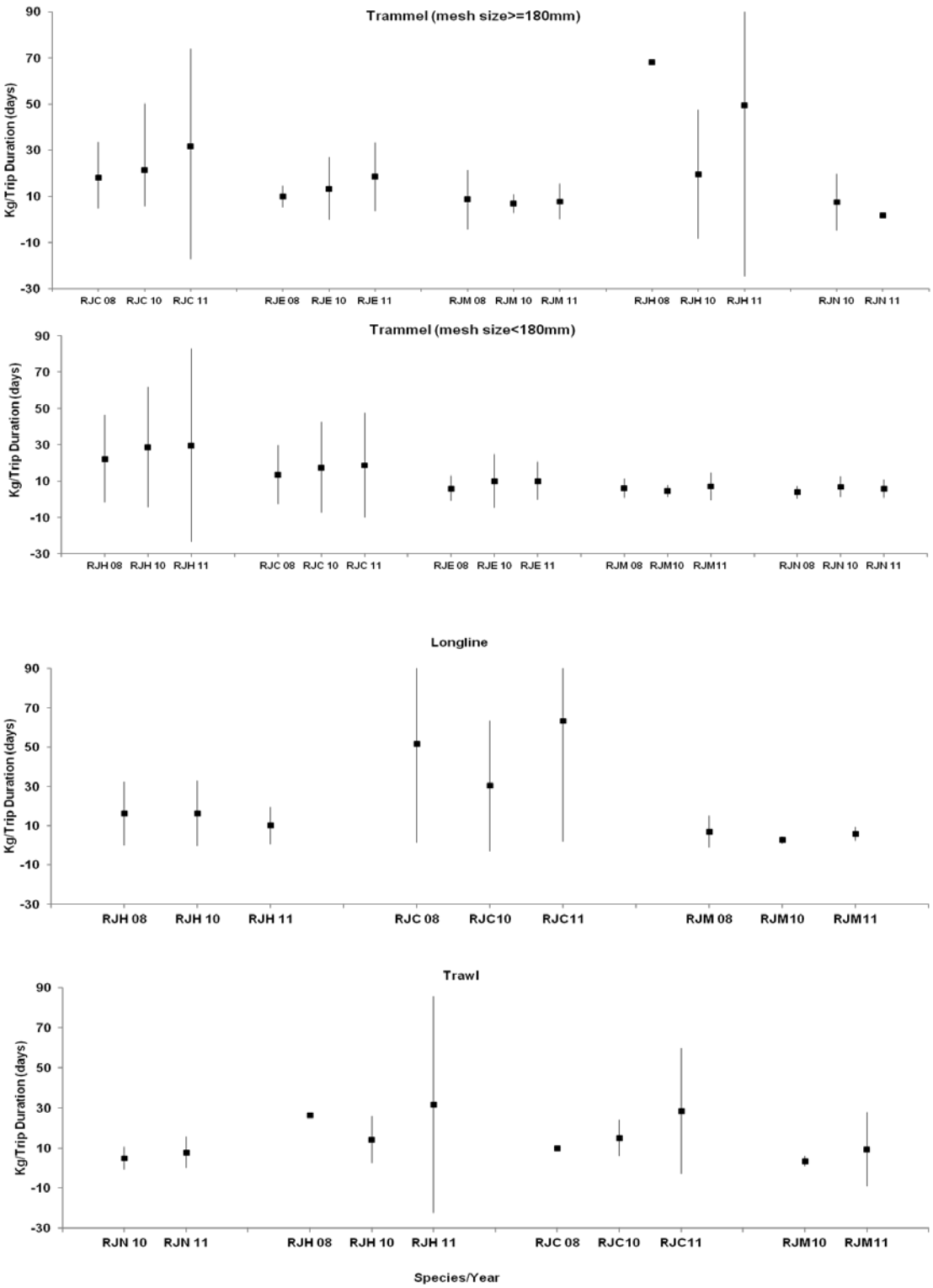



**Figure 19.7. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Lpue (kg/fishing day) by species and by fishing method for 2008, 2010 and 2011: *Raja clavata* (RJC), *Raja microocellata* (RJE), *Raja montagui* (RJM), *Raja undulata* (RJU) and *Raja brachyura* (RJH).**

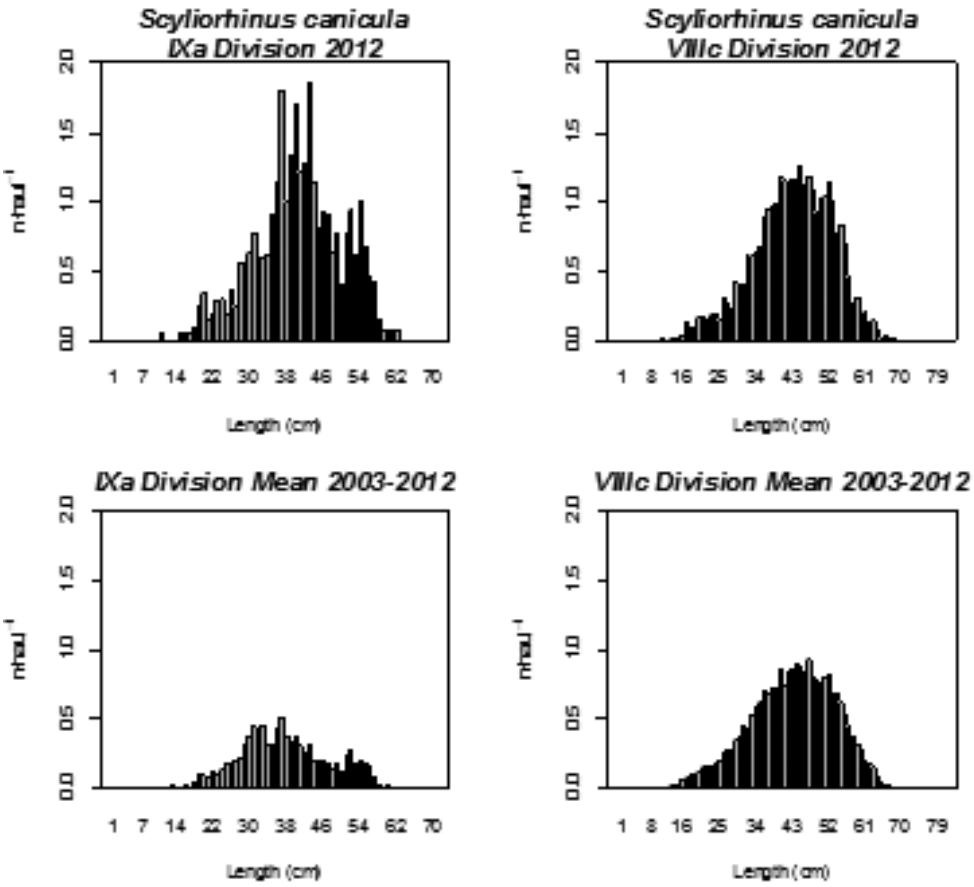



**Figure 19.8. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *Scyliorhinus canicula* in 2011 in the two ICES divisions covered by the North Spanish Shelf bottom trawl survey, and mean values for the last decade in both areas (2000–2010).**

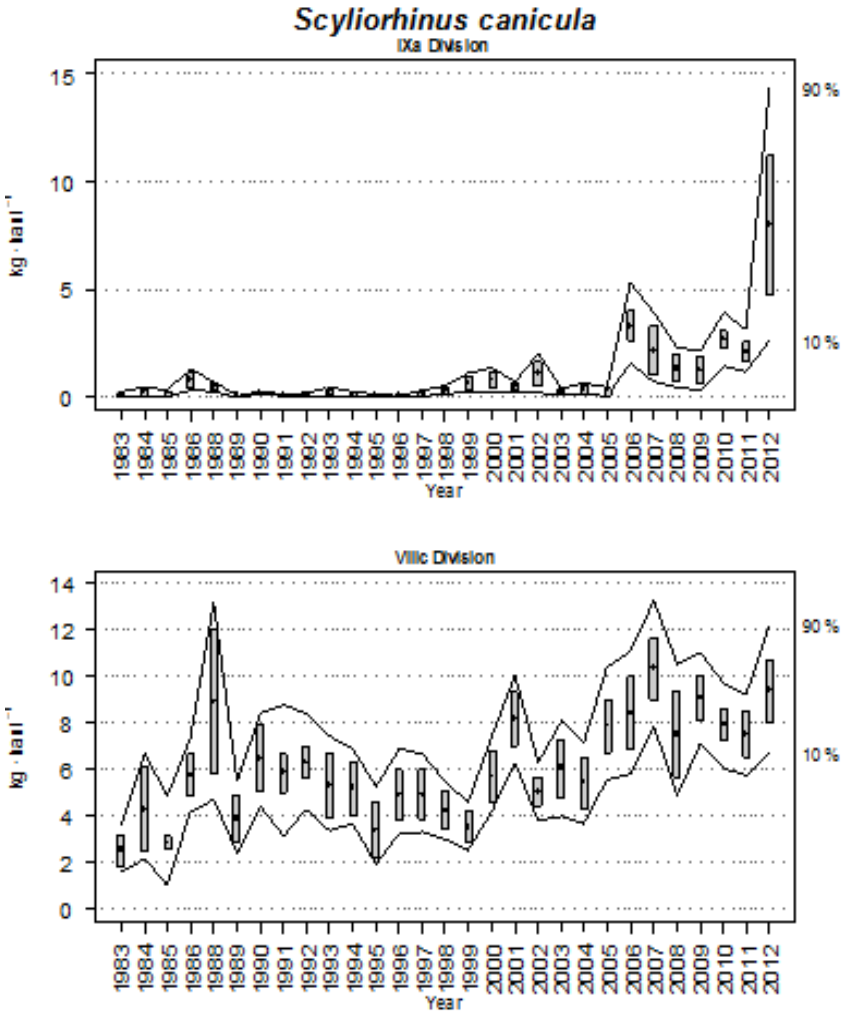



**Figure 19.9. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Scyliorhinus canicula* biomass index during the North Spanish shelf bottom trawl survey time-series (1983–2011 but in 1987) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**

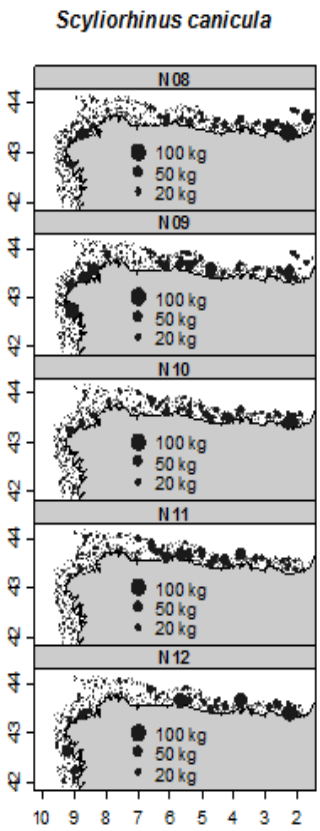



**Figure 19.10. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of lesser-spotted dogfish (*S. canicula*), catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2011).**

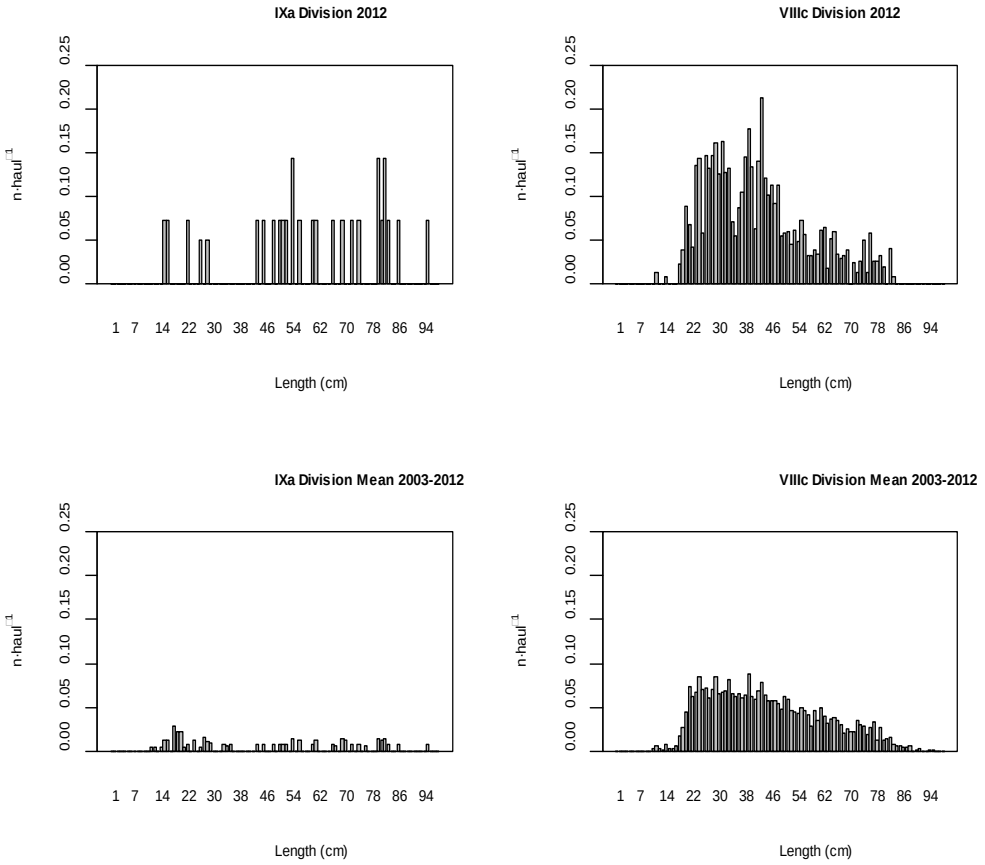



**Figure 19.11. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distribution of thorny ray (*R. clavata*), in ICES Divisions IXa and VIIIc, during 2011 and mean values during the last decade (2000–2012).**

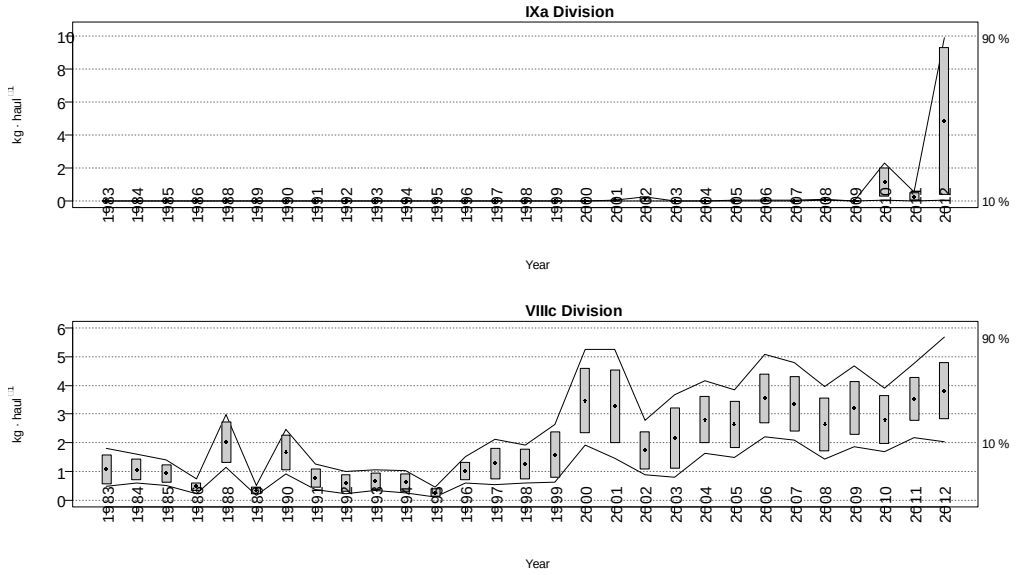



**Figure 19.12. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in thorny ray (*Raja clavata*) biomass indices, in ICES Division IXa and VIIIc, during North Spanish Coast Survey time-series (1983–2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**

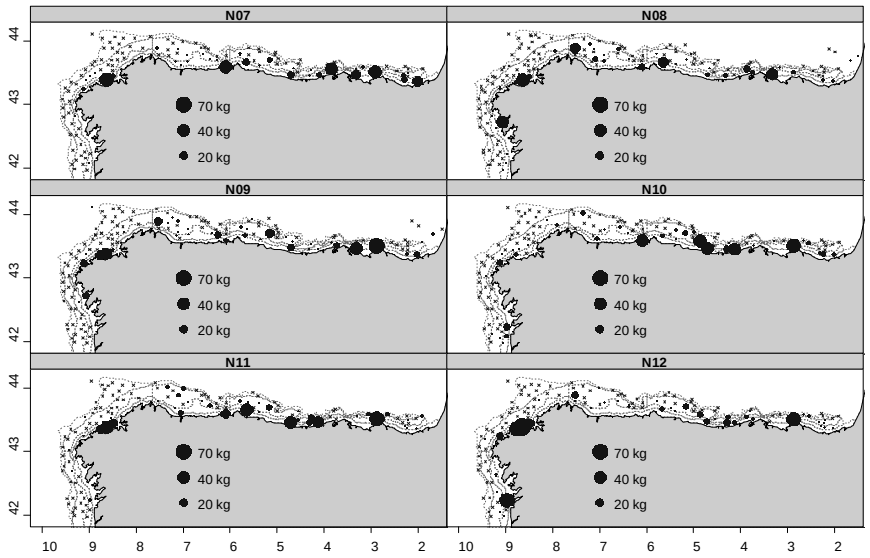



**Figure 19.13. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of thornback ray (*R. clavata*) catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2011).**

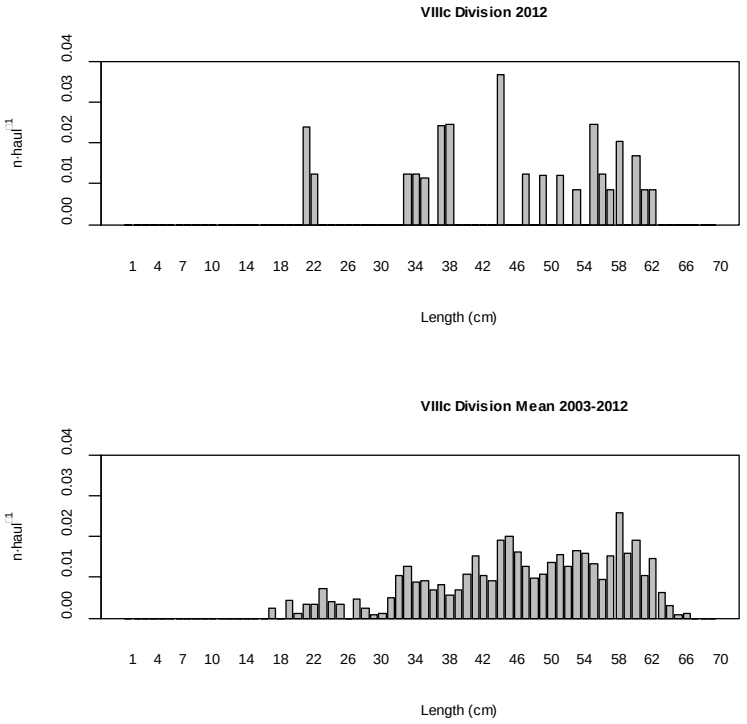



**Figure 19.14. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Stratified length distributions of *L. naevus* in 2011 in VIIIc ICES Division covered by North Spanish shelf bottom trawl survey, and mean values for the last decade (2000–2011).**

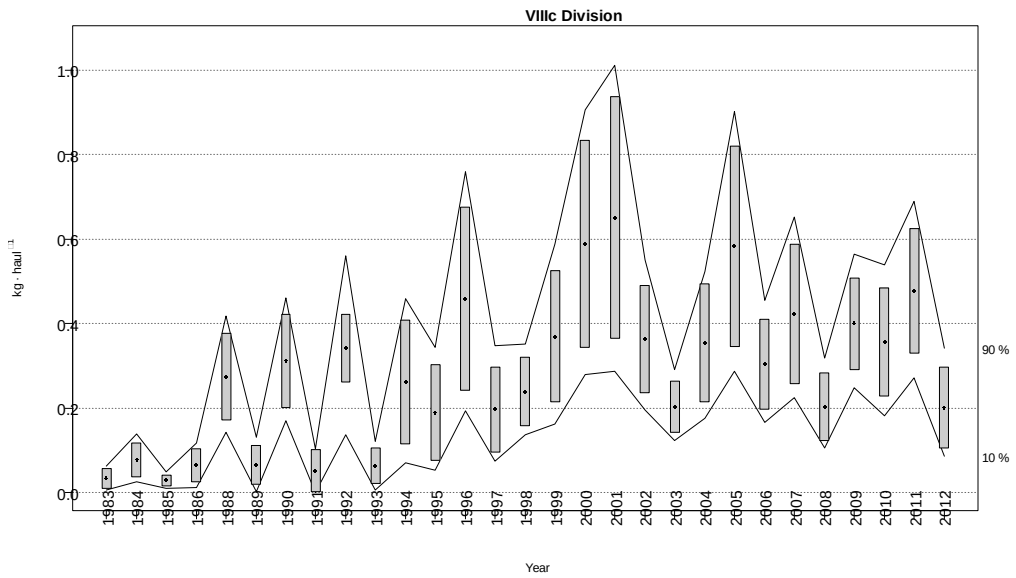



**Figure 19.15. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Changes in *Leucoraja naevus* biomass index during North Spanish shelf bottom trawl survey time-series (1983–1986, 1988–2011) in the two ICES divisions covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).**

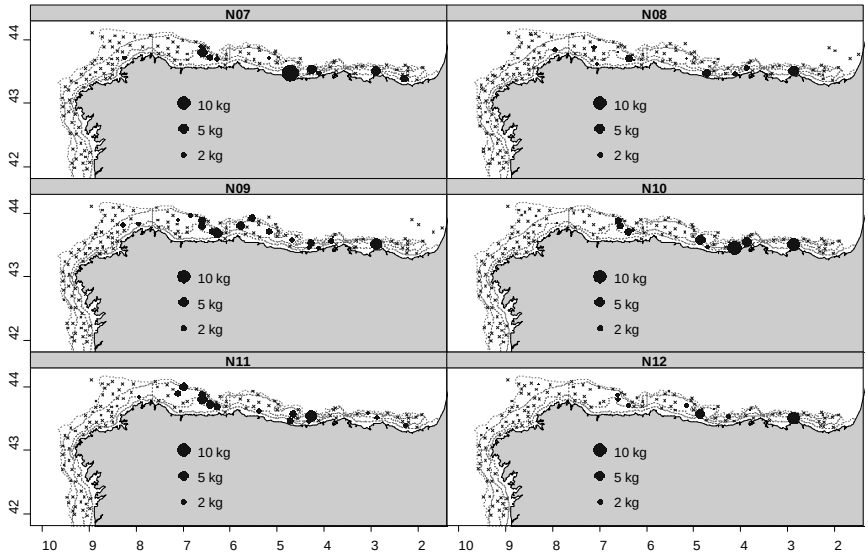



**Figure 19.16. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Geographic distribution of cuckoo ray (*L. naevus*) catches (kg/30 min haul) in North Spanish Shelf groundfish surveys (2004–2011).**

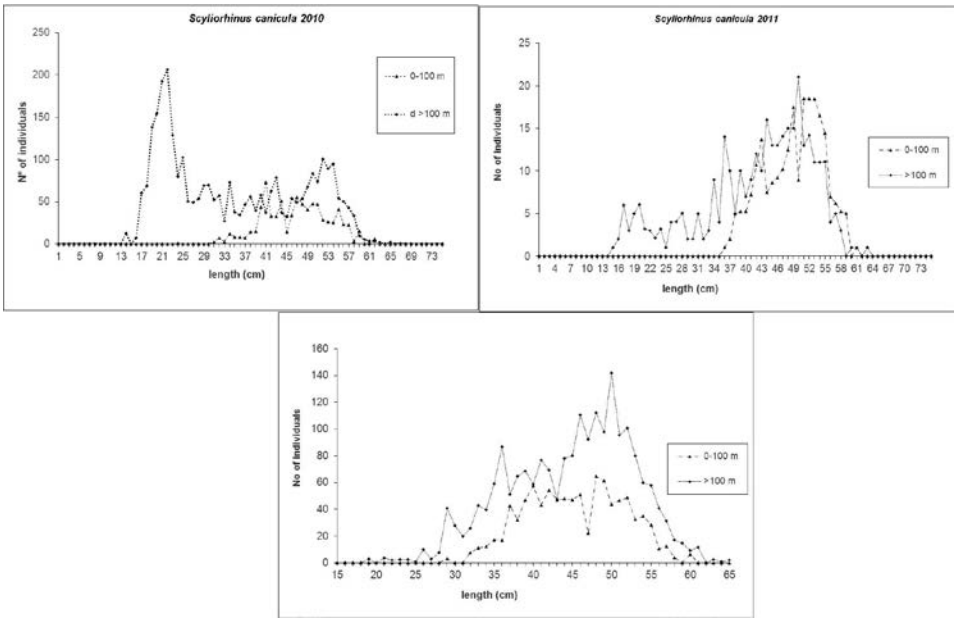



**Figure 19.17a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters length distribution of *S. canicula* by depth in the ITSASTEKA survey (Eastern VIIIc) in 2010 and 2011.**

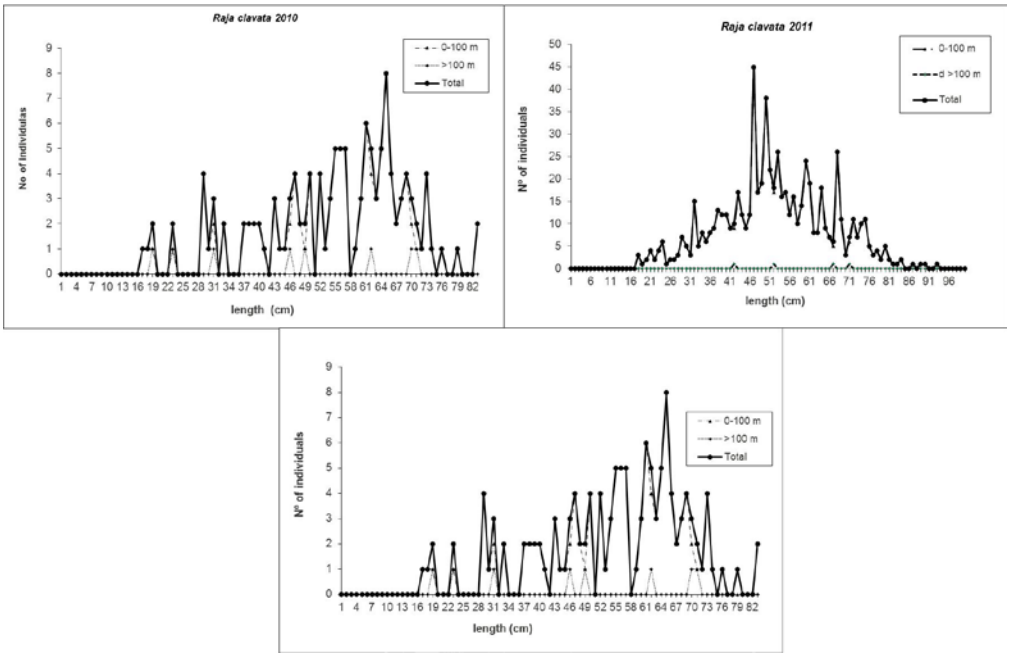
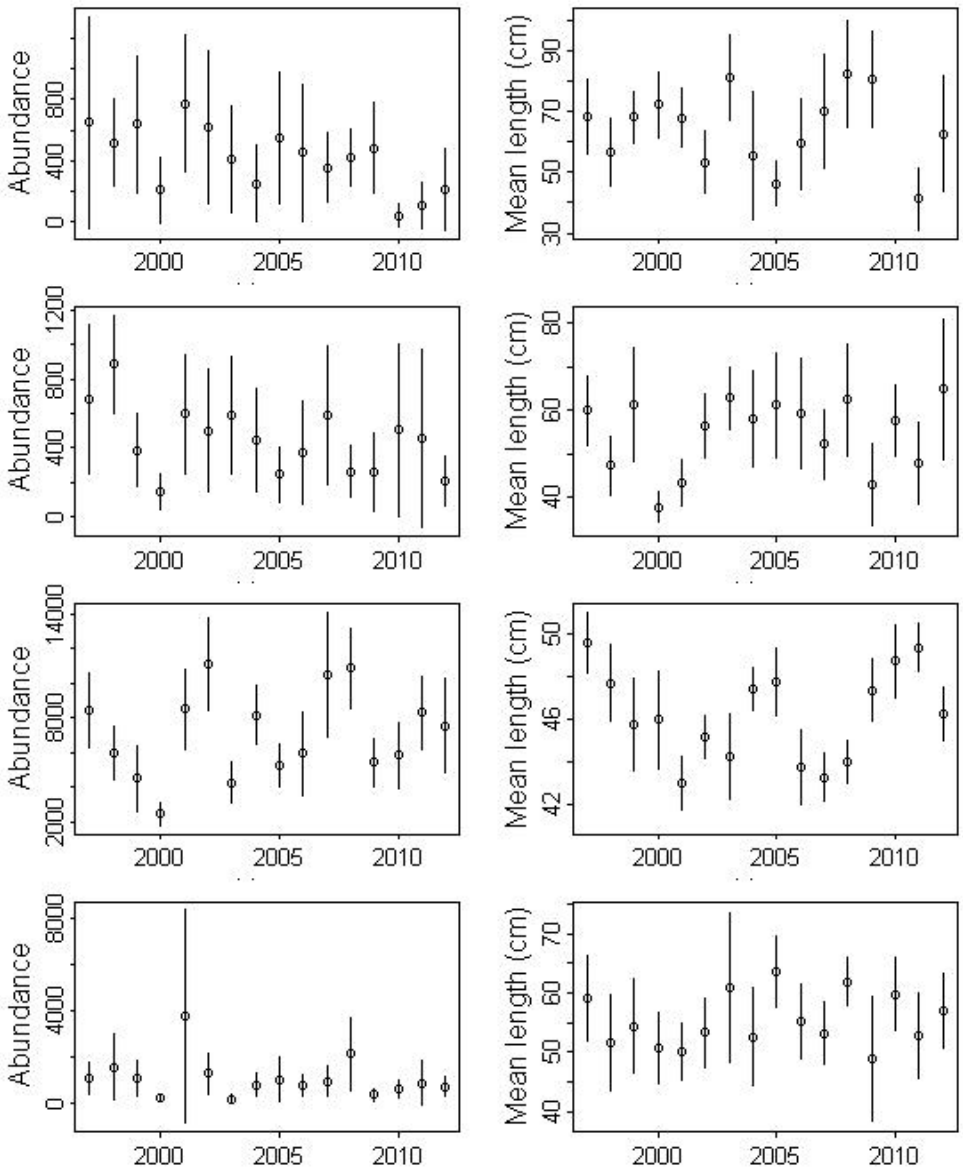
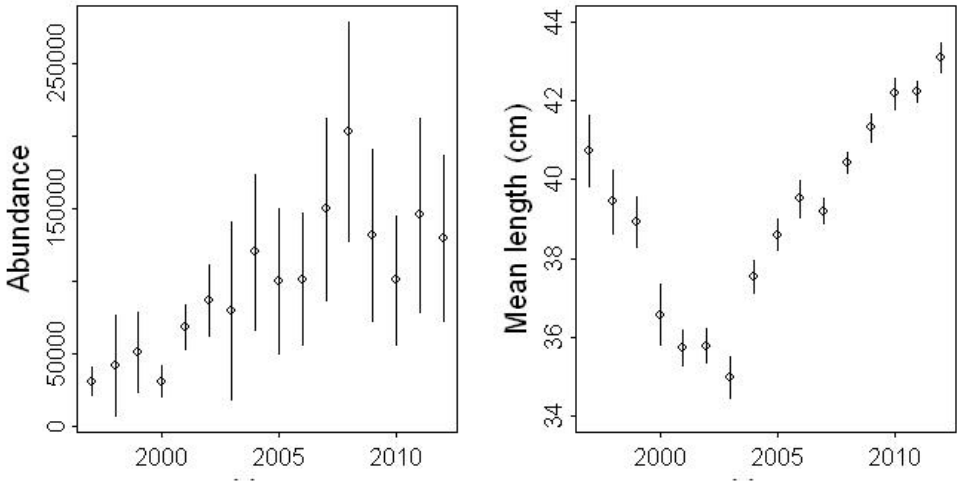



**Figure 19.17b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters length distribution of *R. clavata* by depth in the ITSASTEKA survey (Eastern VIIIc) in 2010 and 2011.**




**Figures 19.18a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. French EVHOE Survey indices in VIIg,h,j and VIIIabd. Left Relative swept area abundance, right mean length. From top to bottom : *D. batis, L. fullonica, L. neavus, R. clavata,* 1997–2012.**




**Figures 19.18b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. French EVHOE Survey indices in VIIg,h,j and VIIIabd. Relative swept area abundance (left) and mean length (right), *S. canicula* (top), 1997–2012.**

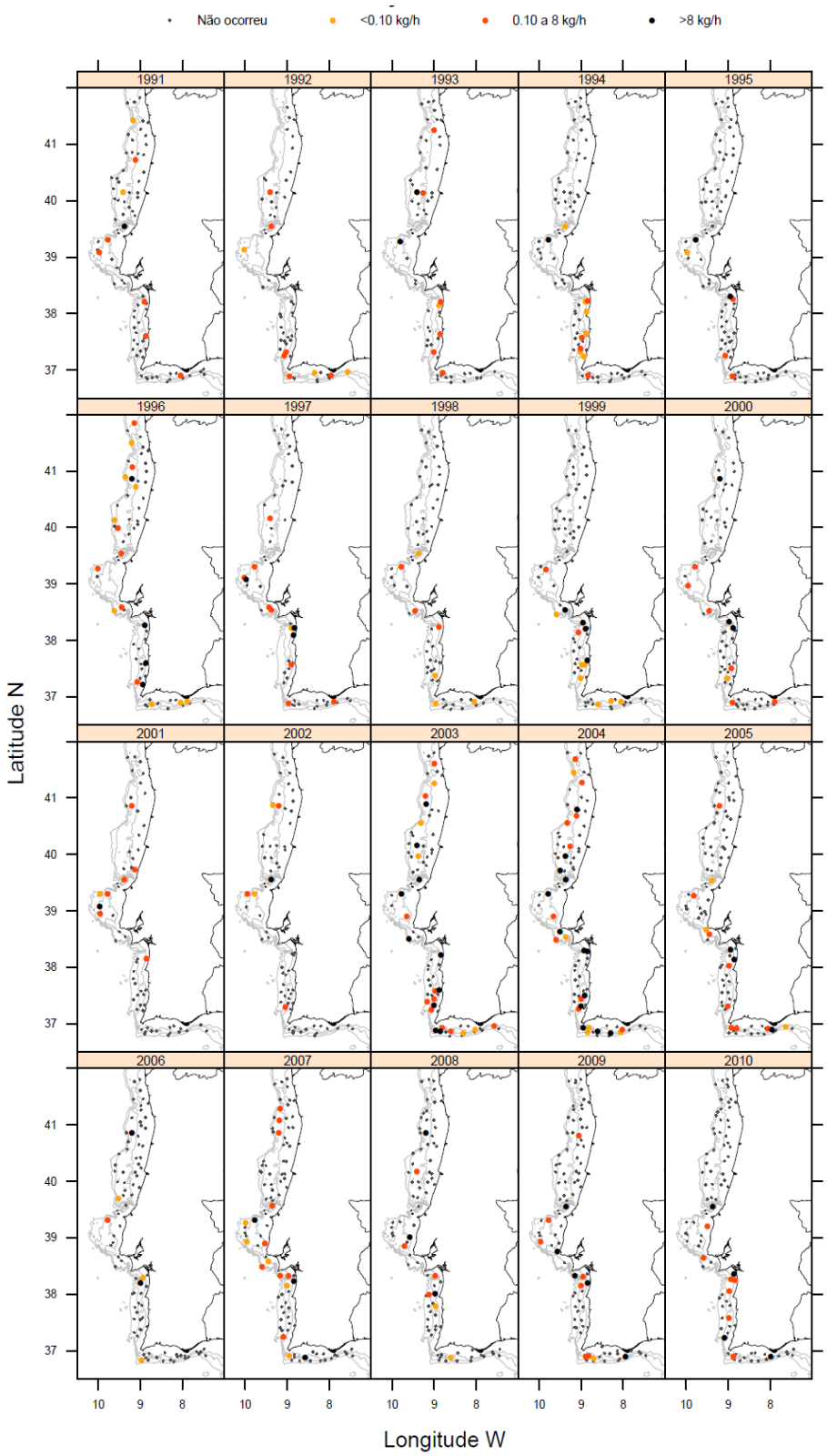



**Figure 19.19. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja clavata* biomass indices distribution on PtGFS-WIBTS-Q4 surveys, for 1991–2010.**

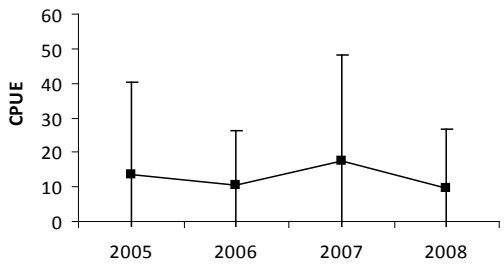



**Figure 19.20. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja clavata* biomass indices (kg/h) on PtGFS-WIBTS-Q1 surveys, during 2005–2008.**

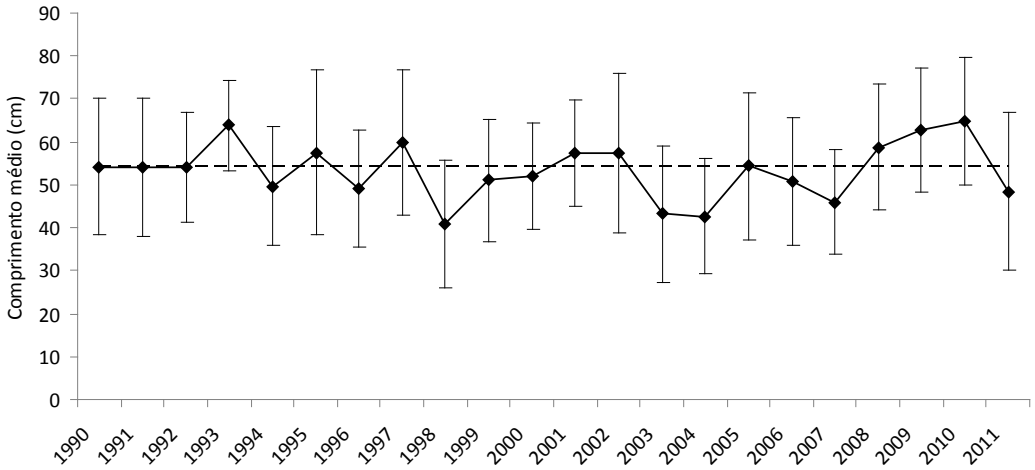



**Figure 19.21. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja clavata* mean length on PtGFS-WIBTS-Q4 surveys, during 1991–2010.**

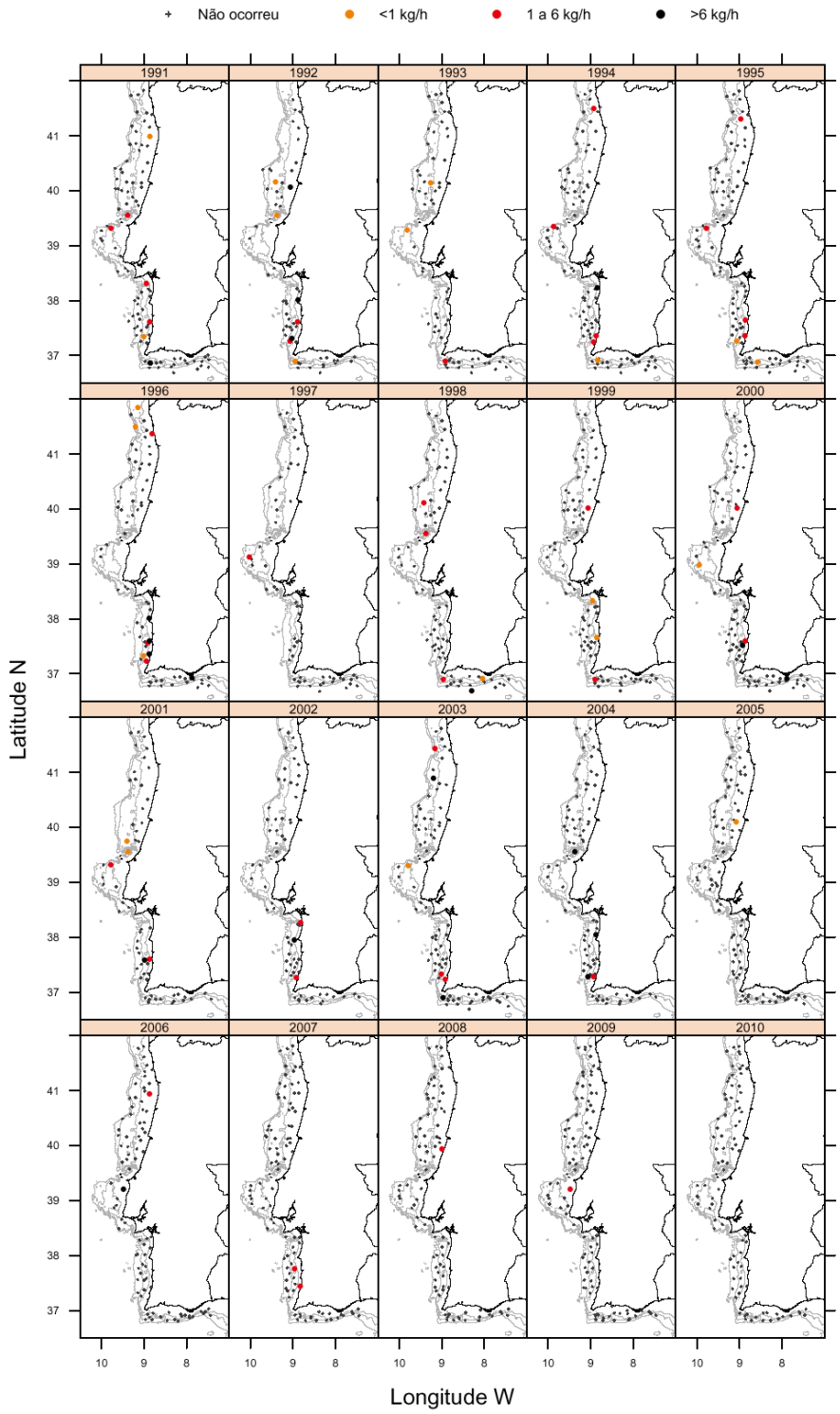



**Figure 19.22. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja brachyura* biomass indices distribution on PtGFS-WIBTS-Q4 surveys, for 1991–2010.**

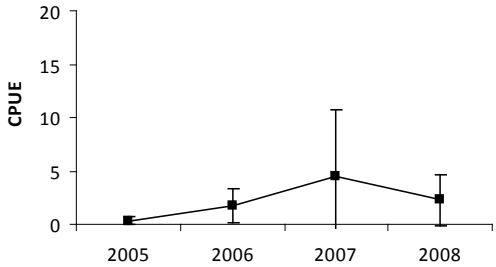



**Figure 19.23. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja brachyura* biomass indices (kg/h) on PtGFS-WIBTS-Q1 surveys, during 2005–2008.**

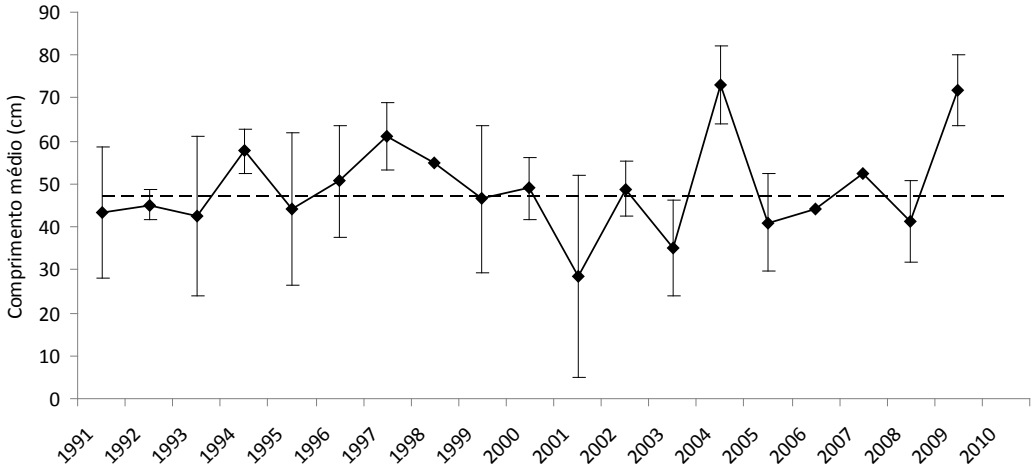



**Figure 19.24. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja brachyura* mean length on PtGFS-WIBTS-Q4 surveys, during 1991–2010.**

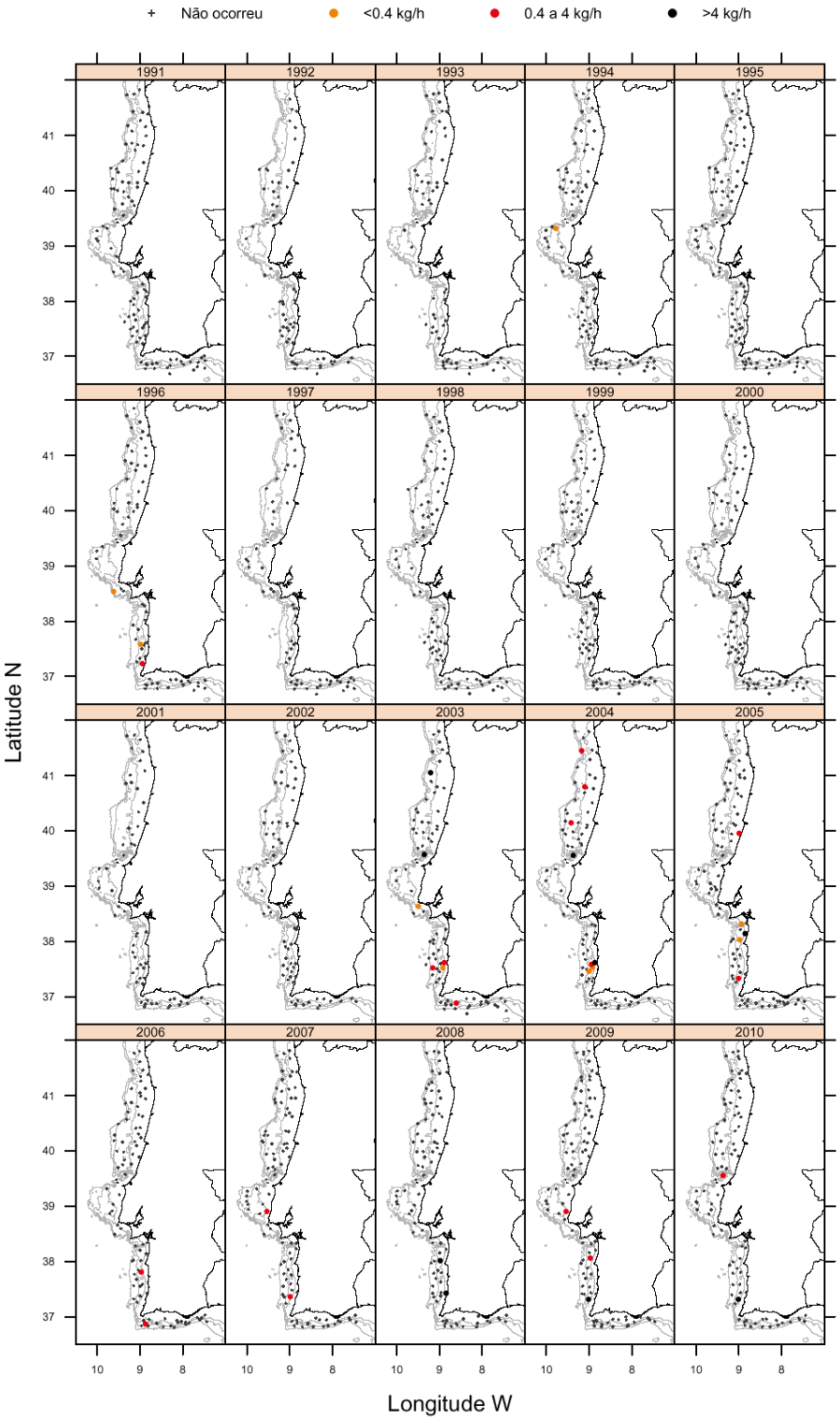



**Figure 19.25. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja montagui* biomass indices distribution on PtGFS-WIBTS-Q4 surveys, for 1991–2010.**

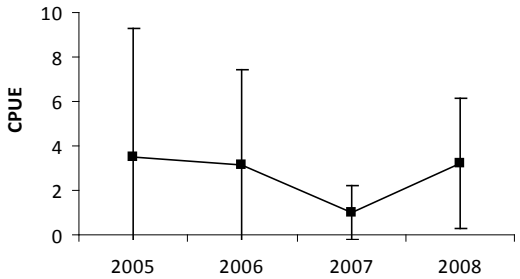



**Figure 19.26. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja montagui* biomass indices (kg/h) on PtGFS-WIBTS-Q1 surveys, during 2005–2008.**

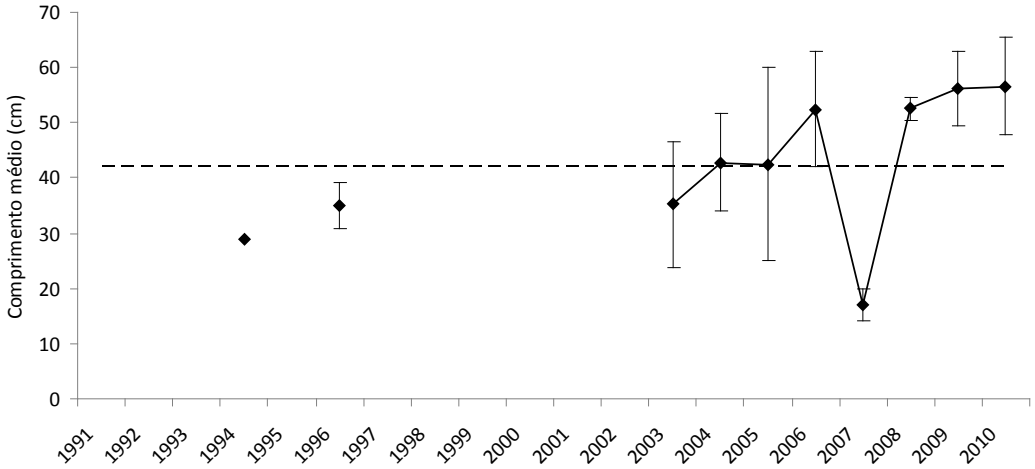



**Figure 19.27. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Raja montagui* mean length on PtGFS-WIBTS-Q4 surveys, during 1991–2010.**

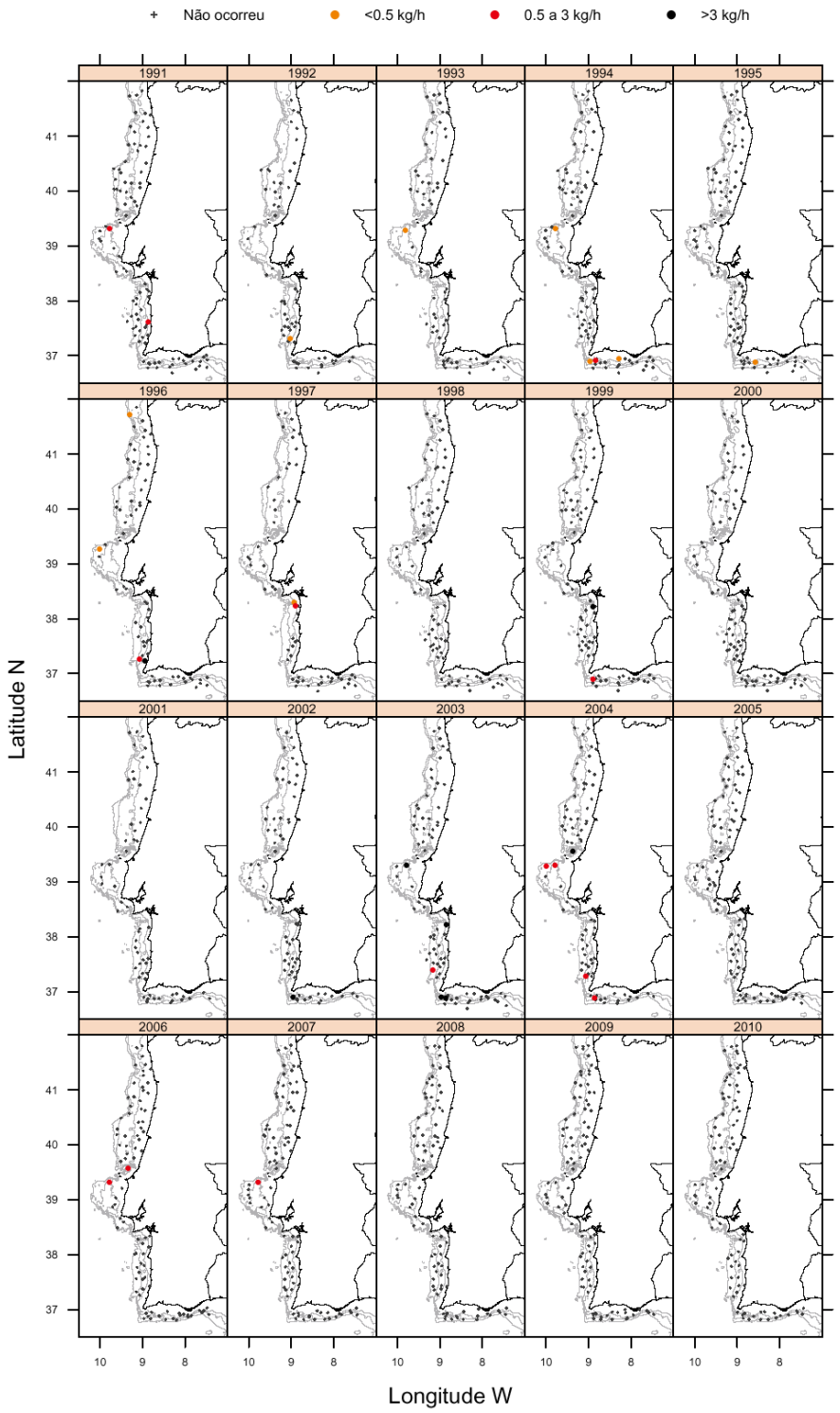



**Figure 19.28. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* biomass indices distribution on PtGFS-WIBTS-Q4 surveys, for 1991–2010.**

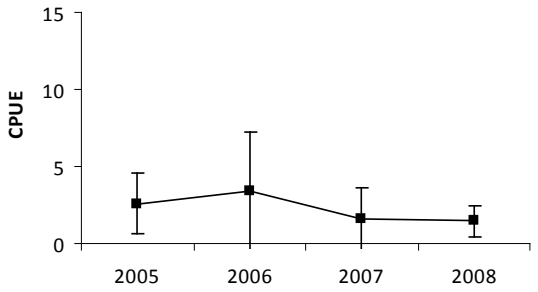



**Figure 19.29. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* biomass indices (kg/h) on PtGFS-WIBTS-Q1 surveys, during 2005–2008.**

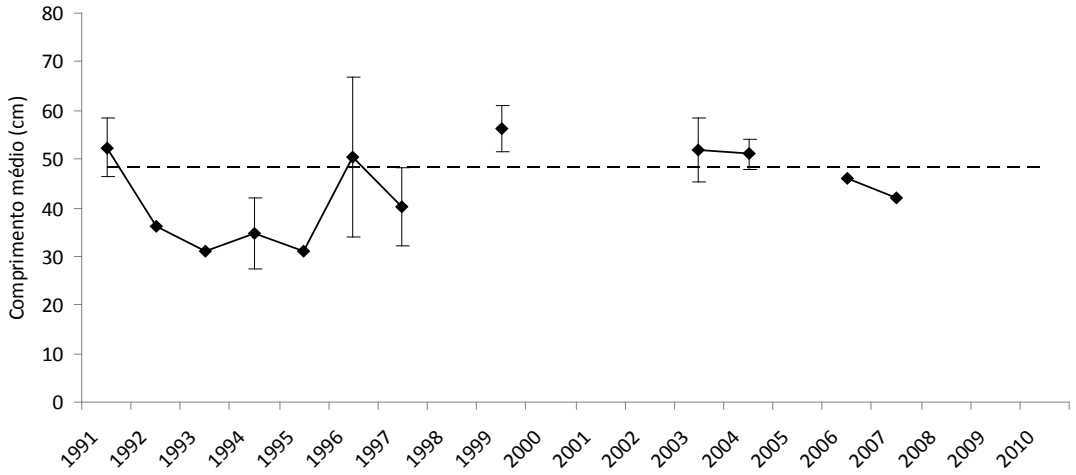



**Figure 19.30. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* mean length on PtGFS-WIBTS-Q4 surveys, during 1991–2010.**

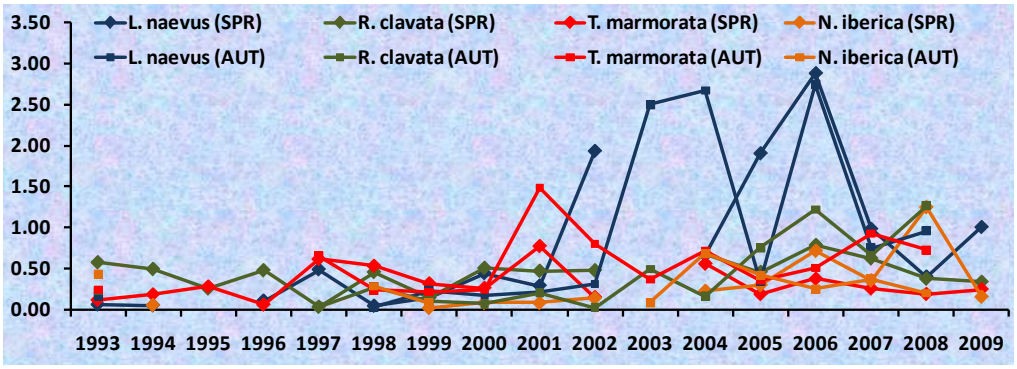



**Figure 19.31. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Trend of the yield, expressed as number of individuals standardized to 1 h of trawling.**

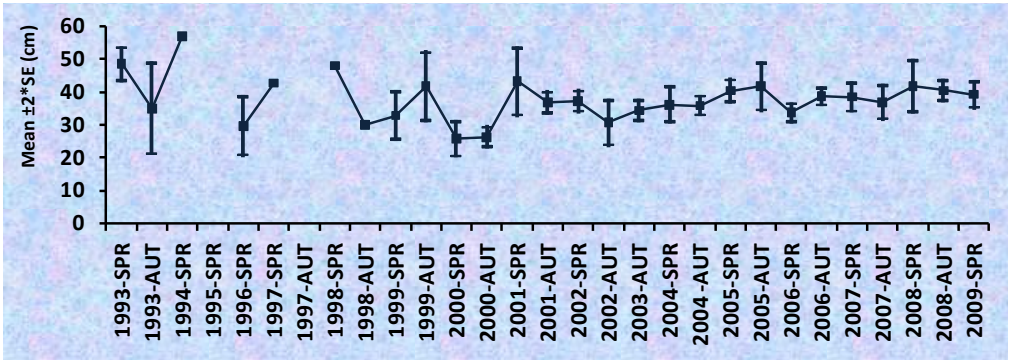



**Figure 19.32a. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Trend of the mean size for *L. naevus* in Gulf of Cadiz (IXa South) (1993–2009).**

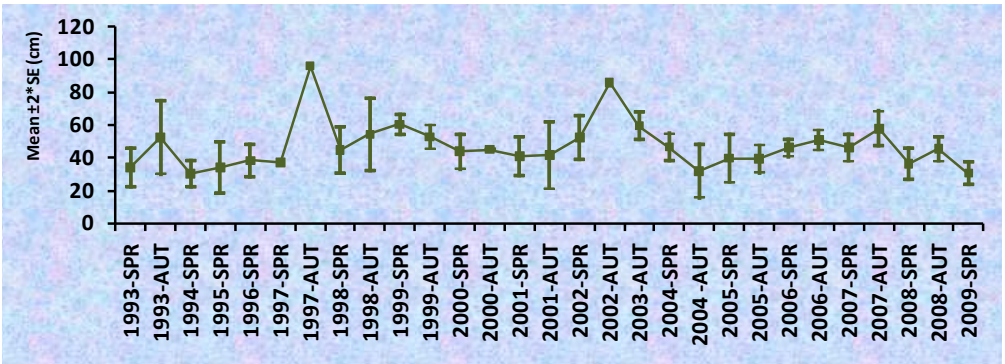



**Figure 19.32b. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Trend of the mean size for *R. clavata* in Gulf of Cadiz (IXa South) (1993–2009).**

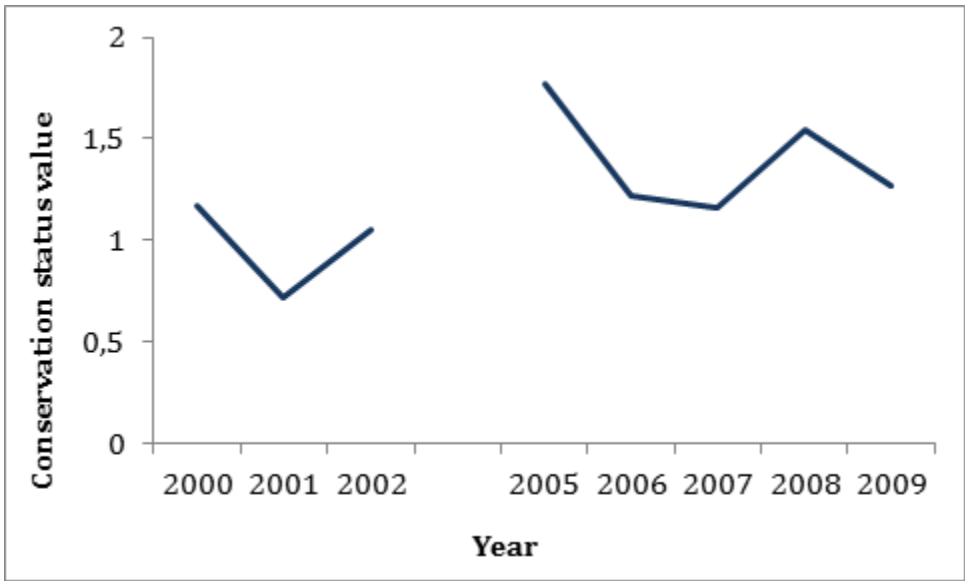



**Figure 19.33. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Conservation status of *G. melastomus* in PT-CTS (UWTV (FU 28–29) (IXa).**

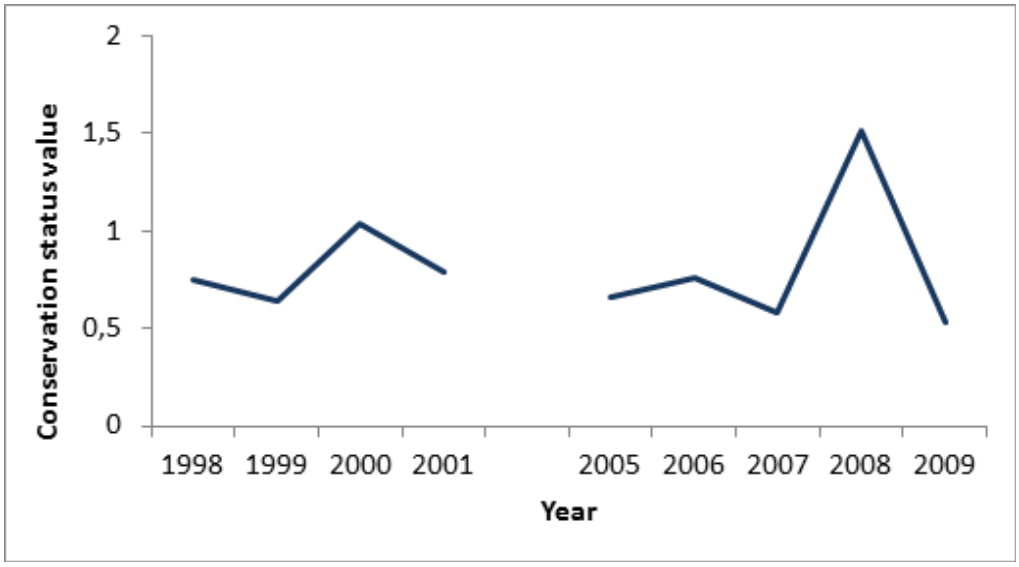


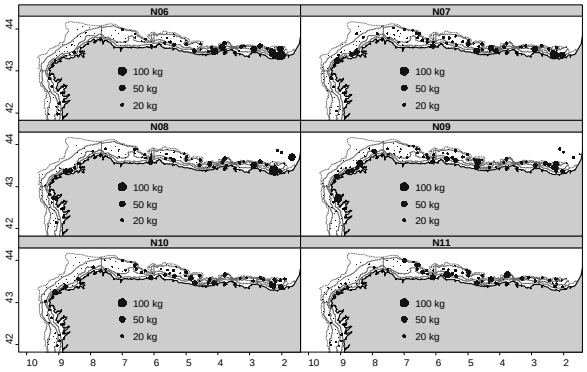

**Figure 19.34. Demersal elasmobranchs in the Bay of Biscay and Iberian Waters. Conservation status of *S. canicula* in PT-CTS (UWTV (FU 28–29) (IXa).**

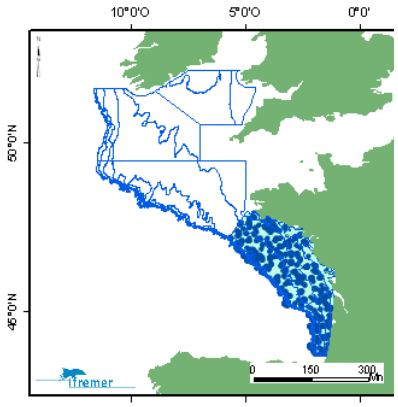
## 19.15 Appendix B–supplementary information

The following pages provide a short summary on the state of the main demersal elasmobranch stocks in the Bay of Biscay and Iberian Waters ecoregions. Different survey indices are used to illustrate changes in distribution, catch rate and size, and provide qualitative information on the status of the stocks.

***Scyliorhinus canicula* in the Bay of Biscay and Iberian Waters (ICES Subarea VIII)**

Distribution of abundance

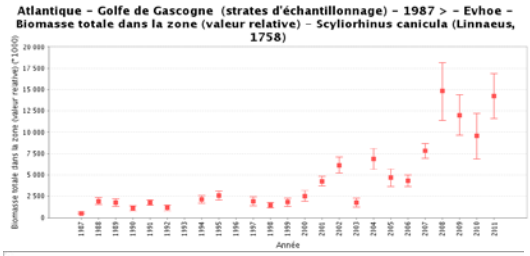


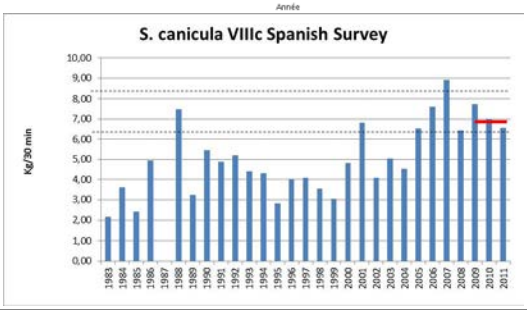




Spanish IEO Q4-IBTS Survey indices – IXa – VIIc Distribution and relative abundance (kg/30 min haul)

French EVHOE Survey indices – VIIIa, b, d Distribution and relative abundance

Survey Abundance Indices



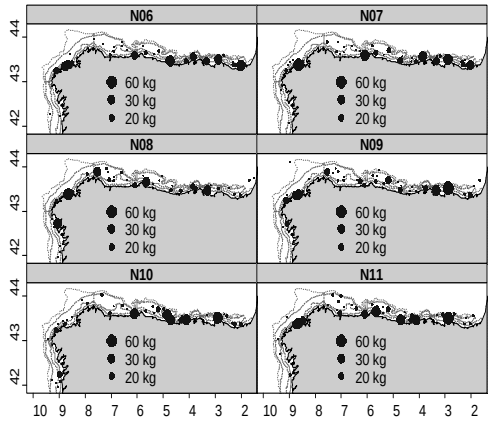

Left: French EVHOE Survey indices – VIIIa, b, d. Total biomass (weight) since 1987.

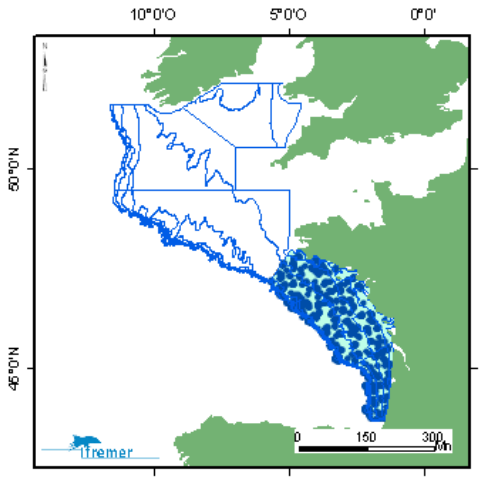
Right: Spanish IEO Q4-IBTS Survey indices – VIIc Distribution and relative abundance (kg/30 min haul) . Dashed lines give mean annual cpue +/- stdev for 2005–2009, red line shows mean annual cpue for 2010–2011.

| | |
|---|---|
| Distribution:. There is no evidence of changes in distribution. | ✓ |
| Catch rates: Lpue clearly increase since the beginning of the series . The mean cpue for 2010–2011 is above the range of the reference period (mean annual cpue ± 1stdev over 2007–2009). | ✓ |
| Size distribution: Surveys indicate a decrease of the mean length and a slight increase of proportion of small individuals. Commercial sizes indicate no changes | ? |
| Exploitation: *S. canicula* is a commercially exploited species. The survey index for this stock indicates a clear increase of abundance. | ✓ |
| Overall status: The trend of cpue for 2010–2011 is above the expected range of the reference period (mean annual cpue ± 1stdev over 2007–2009) and landings equal to the average series. The mortality is decreasing since 2004. The state of the stock is increasing. | ✓ |

***Raja clavata* in the Bay of Biscay and Iberian Waters (ICES Subarea VIII)**

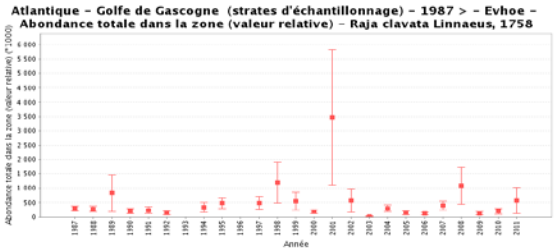
Distribution of abundance

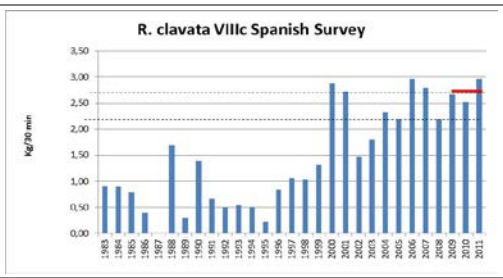



| Spanish IEO Q4-IBTS Survey indices – VIIIc Distribution and relative abundance (kg/30 min haul) | French EVHOE Survey indices – VIIIa, b, d Distribution and relative abundance |
|---|---|

Survey Abundance Indices



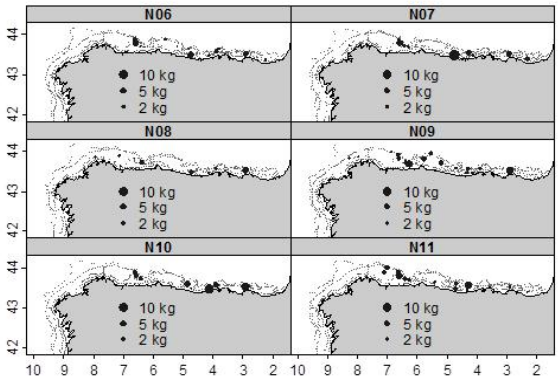

Spanish IEO Q4-IBTS Survey –VIIIc . Biomass index (Kg/haul).

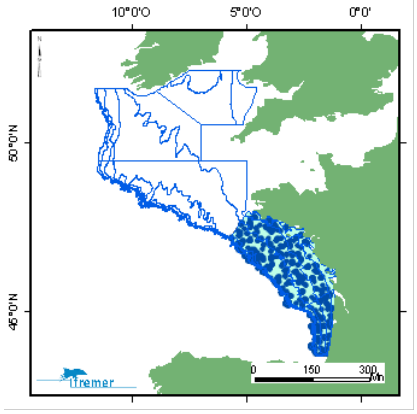
Right: Spanish IEO Q4-IBTS Survey indices – VIIc Distribution and relative abundance (kg/30 min haul) . Dashed lines give mean annual cpue +/- stdev for 2005–2009, red line shows mean annual cpue for 2010–2011.

| | |
|---|---|
| Distribution: There is no evidence of changes in distribution. Maximum cpue is stable in the VIIIb | ✓ |
| Catch rates: The LPUE trend is not clear due to the value of 2010. The mean LPUE for 2010–2011 is the upper value of the reference period (mean annual cpue ± 1stdev over 2007–2009). $F_{proxy}$ decreases clearly. | ✓ |
| Size distribution: Surveys indicate a stable status of the mean length and proportion of sizes. Commercial length sizes show no clear trend, indicating no changes. | ✓ |
| Exploitation: *S. canicula* is a commercially exploited species. The survey index for this stock in VIIIc indicates a clear increase of abundance and in VIIIa, b, d does not show any clear trend. | ✓ |
| Overall status: The trend of LPUE for 2010–2011 is between the expected range of the reference period (mean annual cpue ± 1stdev over 2007–2009) and landings are above the average series. The mortality is decreasing since 2004.The state of the stock is regarded to be increasing. | ✓ |

***Leucoraja naevus* in the Bay of Biscay and Iberian Waters (ICES Subarea VIII)**

Distribution of abundance

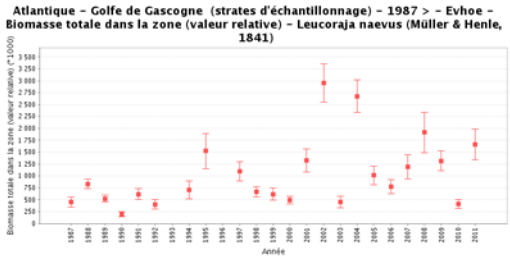


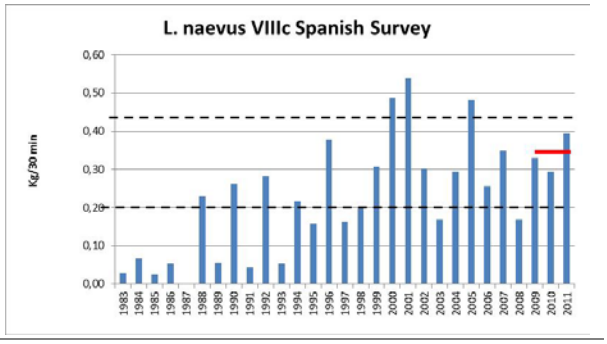




Spanish IEO Q4-IBTS Survey indices – VIIIc and IXa Distribution and relative abundance (kg/30 min haul)

French EVHOE Survey indices – VIIIa, b, d Distribution and relative abundance

Survey Abundance Indices



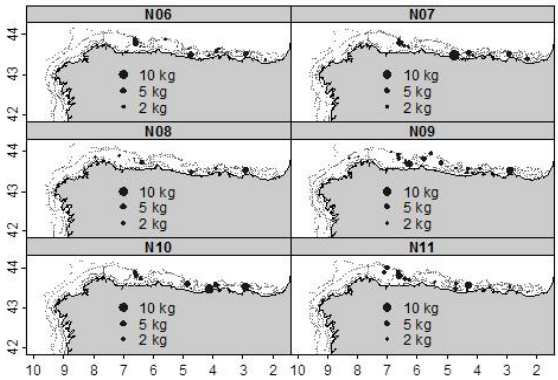

French EVHOE Survey indices – VIIIa, b, d. Total biomass (weight) since 1987(relative value *1000)

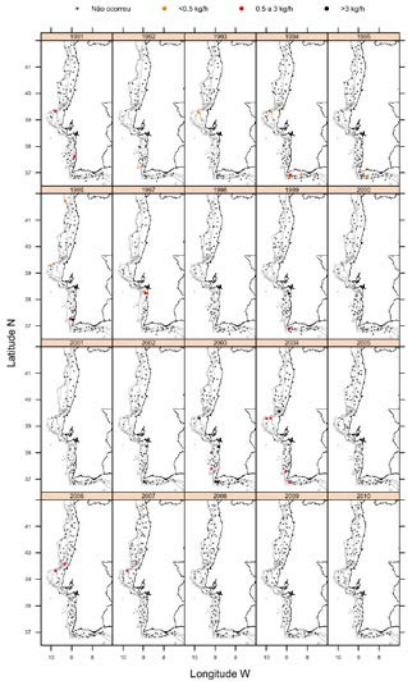
Right: Spanish IEO Q4-IBTS Survey indices – VIIc Distribution and relative abundance (kg/30 min haul) . Dashed lines give mean annual cpue +/- stdev for 2005–2009, red line shows mean annual cpue for 2010–2011.

| | |
|---|---|
| Distribution: There is no evidence of changes in distribution. Maximum cpue is stable in the VIIIb | ✓ |
| Catch rates: The LPUE trend is not clear due to the value of 2010. The mean LPUE for 2010–2011 is in the range of the reference period (mean annual cpue ± 1stdev over 2007–2009). $F_{proxy}$ decreases clearly. | ✓ |
| Size distribution: Surveys and commercial plots indicates a stable status of the mean length and proportion of sizes. | ✓ |
| Exploitation: *L. naevus* is a commercially exploited species. The survey index for this stock indicates an increase of abundance, more clear in VIIIc. | ✓ |
| Overall status: Although the LPUE in 2010 was low, the trend of LPUE for 2010–2011 is between the expected range of the reference period (mean annual cpue ± 1stdev over 2005–2009). Landings in last four years are above the average series. The mortality is decreasing since 2004. The state of the stock is regarded to be increasing. | ✓ |

***Leucoraja naevus*** **in the Bay of Biscay and Iberian Waters (ICES Subarea IXa)**

Distribution of abundance

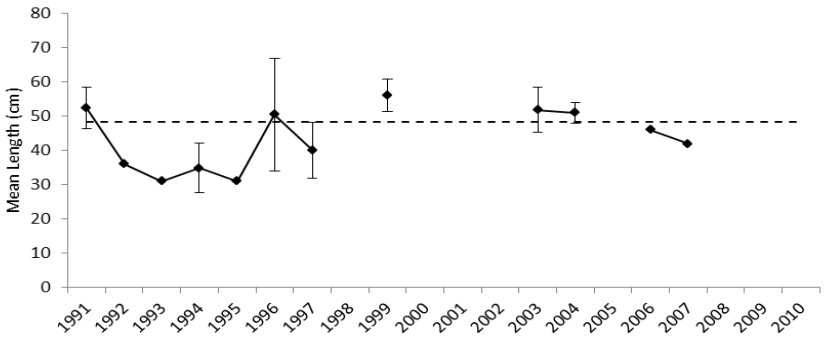



Spanish IEO Q4-IBTS Survey indices – VIIIc and IXa Distribution and relative abundance (kg/30 min haul)

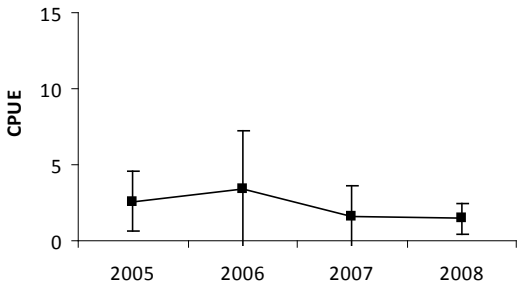
PtGFS-WIBTS-Q4 Survey indices in IXa. Distribution and relative biomass

Mean Length



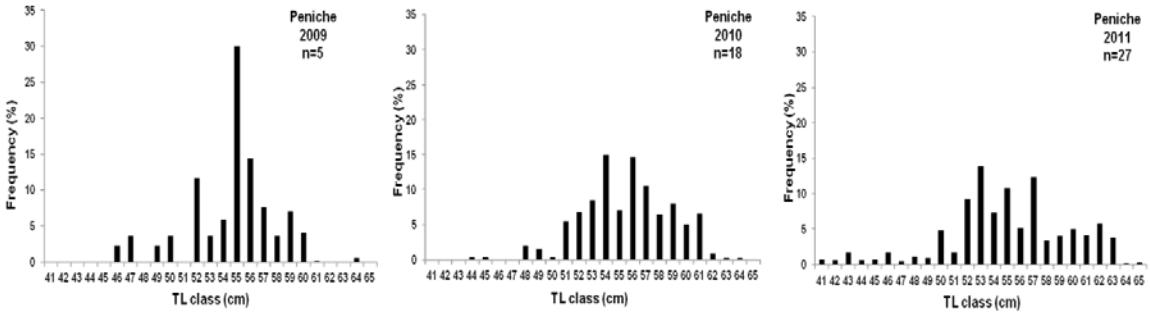

Portuguese PtGFS-WIBTS-Q4 Survey main length, during 1991–2010.

Survey Abundance Indices




Portuguese PtGFS-WIBTS-Q1 Survey indices in IXa. Distribution and relative biomass

Size composition

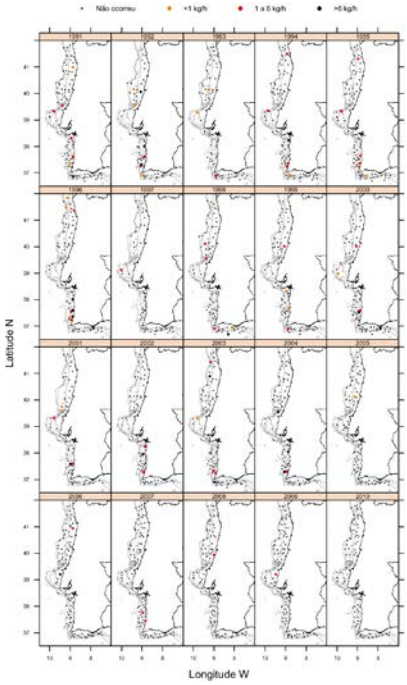



Portuguese length frequencies from the Polyvalent fleet operating in Peniche fishing area (2009–2011). The number of sampled fishing trips is indicated.

| | |
|---|---|
| Distribution: Not frequent in surveys, however based on the survey data available, no trend on the spatial distribution is evident. | |
| Catch rates: Lpue indicates a slight increase trend, cpue from the survey does not show any trend. | |
| Size distribution: Commercial length–frequency distribution indicates no changes for the period 2009–2011. Survey mean length have varied at the beginning of the time-series but in more recent years is stable. | |
| Exploitation: *L. naevus* despite being commercially exploited, the landed weight is less important than for other species. Lpue for different métiers have been increasing from 2008, 2010–2011. The decrease in landings together with the slight increase in LPUE indicates that fishing mortality rate has decreased. | |
| Overall status: This is a small bodied species and a fast growing species with a high intrinsic rebound potential The frequency of occurrence of *L. naevus* in surveys is low, so the perception of the stock is based on the LPUE trends derived from the dedicated DCF project for skates and rays in Division IXa. For all métiers the index of abundance shows a similar increasing trend. Furthermore the decrease in landings together with the slight increase in LPUE indicates that fishing mortality rate has decreased. The state of the stock is regarded to be increasing. | |

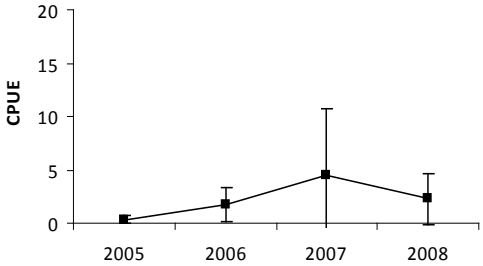
***Raja brachyura*** **in the Bay of Biscay and Iberian Waters (ICES Subarea IXa)**

Distribution of abundance



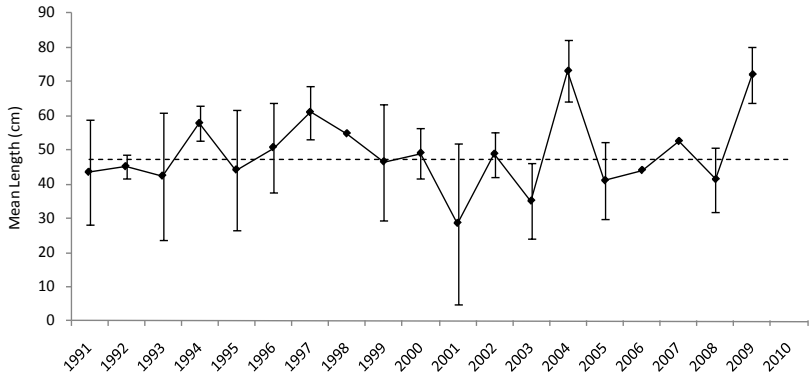

Portuguese PtGFS-WIBTS-Q4 Survey indices in IXa. Distribution and relative biomass

Survey Abundance Indices



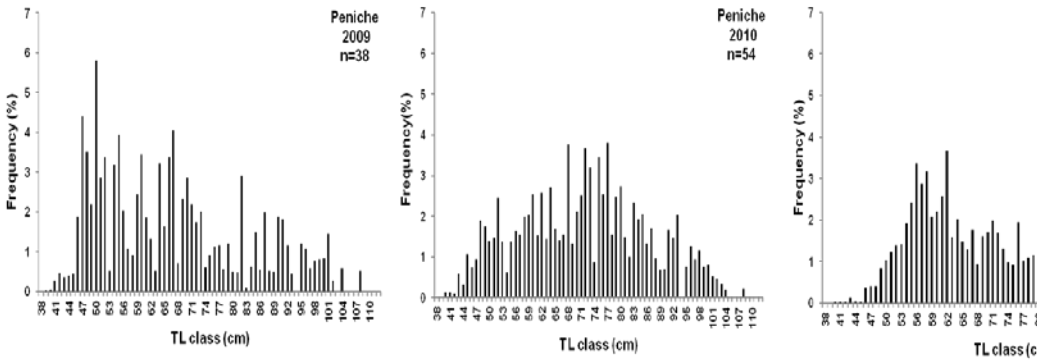

Portuguese PtGFS-WIBTS-Q1 Survey indices in IXa. Distribution and relative biomass

Mean Length




Portuguese PtGFS-WIBTS-Q4 Survey main length, during 1991–2010.

Size composition

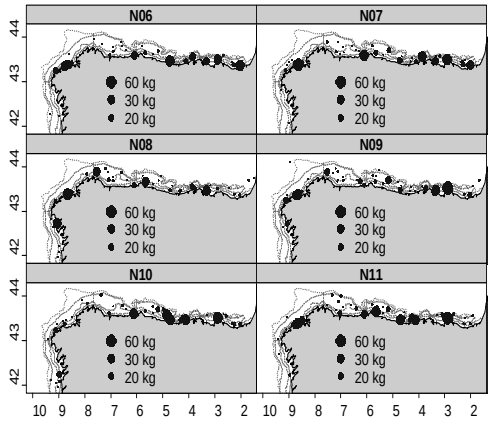


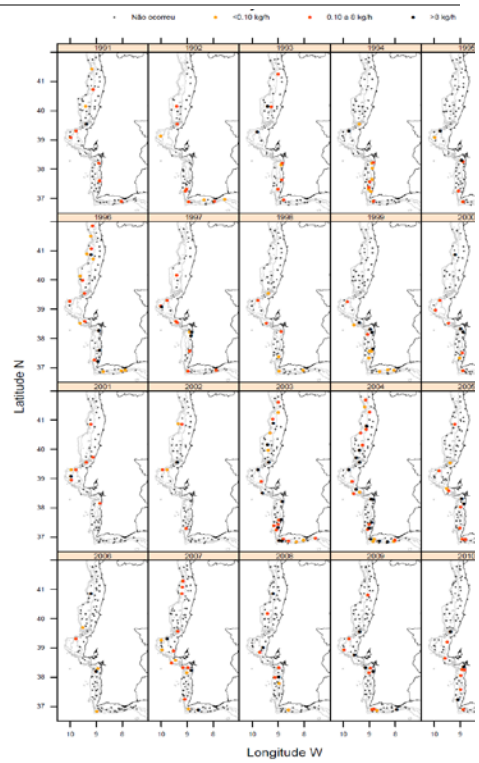

Portuguese length frequencies from the Polyvalent fleet operating in Peniche fishing area (2009–2011). The number of sampled fishing trips is indicated.

| | |
|---|---|
| Distribution: Not frequent in surveys however based on the data survey data available no trend on the spatial distribution is evident. | |
| Catch rates: Both LPUE and cpue from the survey show a slight increasing trend. | |
| Size distribution: Commercial length–frequency distribution indicates a slightly change for the period 2009–2011, with increase of larger specimens. This is further supported by the increase in the mean length in the surveys for more recent years. | |
| Exploitation: *R. brachyura* is the second most abundant commercially exploited species. Lpue for different métiers has slightly increased from 2008, 2010–2011. The decrease in landings together with the increase in LPUE indicates that fishing mortality rate has decreased. | |
| Overall status: Despite the low frequency of occurrence of the species in the surveys, there are no indications of reductions in the area of occurrence. The perception of the stock is based on the LPUE trends derived from the dedicated DCF project for skates and rays in Division IXa. For all métiers, the index of abundance shows an increasing trend, particularly in the metiers with the highest catch rates (those using trammelnets). The increase in LPUE together with the decrease in landings indicates that fishing mortality rate has decreased. The state of the stock is regarded to be increasing. | |

***Raja clavata*** **in the Bay of Biscay and Iberian Waters (ICES Division IXa)**

Distribution of abundance

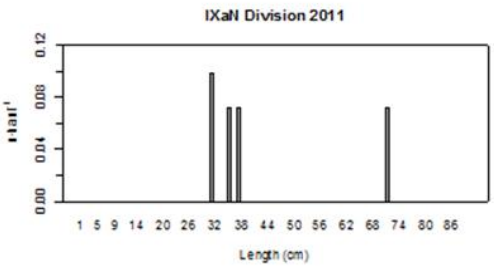


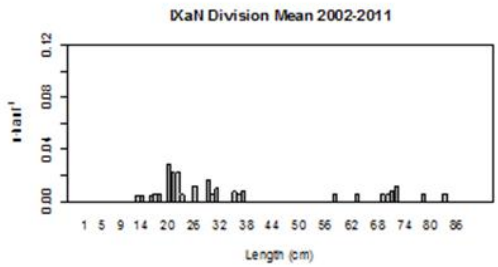




Spanish IEO Q4-IBTS Survey indices-IXa–VIIIc Distribution and relative abundance of *Raja clavata* (kg/30 min haul)

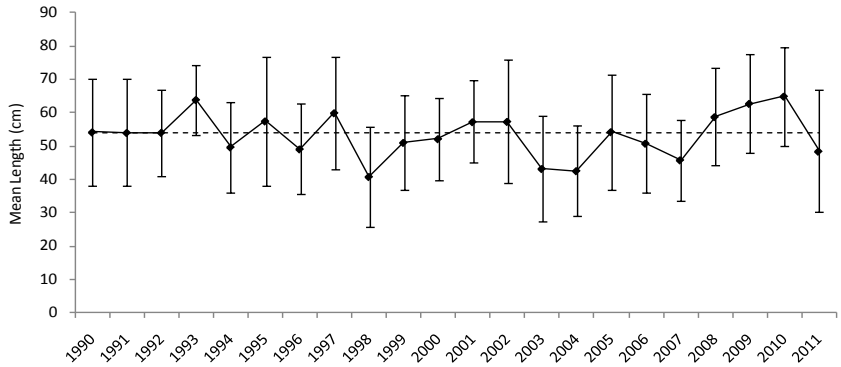
PtGFS-WIBTS-Q4 Survey indices in IXa. Distribution and relative biomass

Size composition



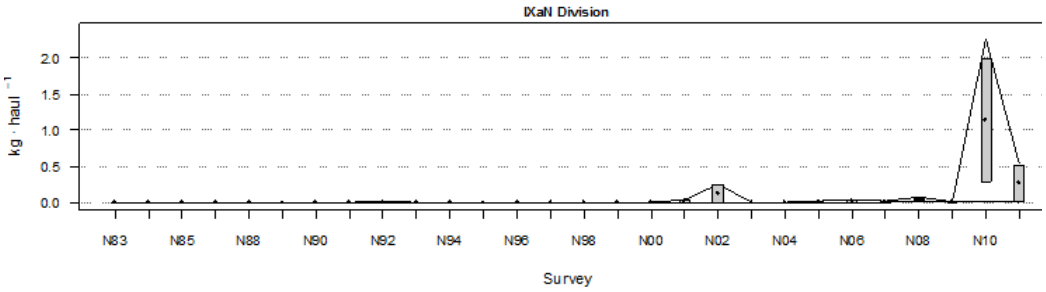




Spanish IEO Q4-IBTS Survey I–IXa-VIIIc Stratified length distribution during 2011 and mean values during the last decade (2000–2011).

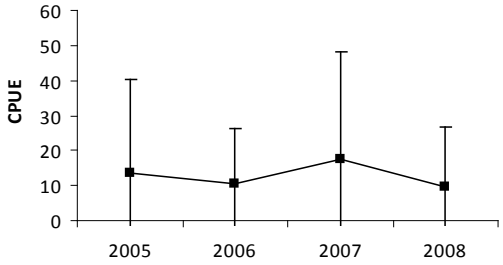



Portuguese PtGFS-WIBTS-Q4 Survey main length, during 1991–2010.

Survey Abundance Indices

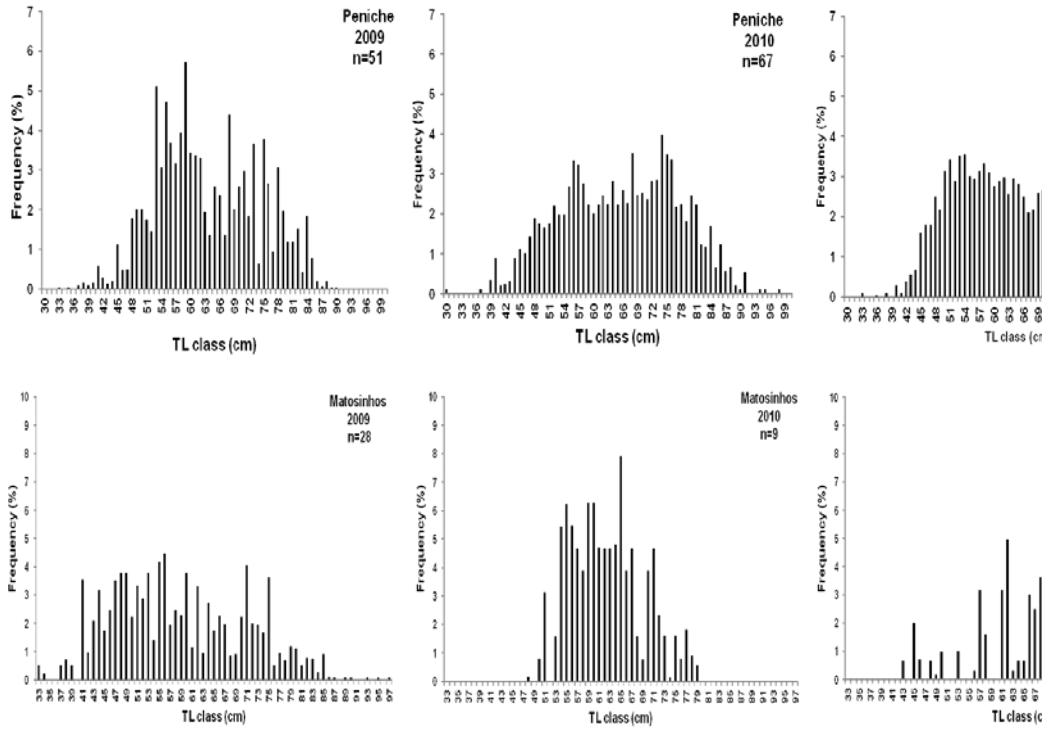



Spanish IEO Q4-IBTS Survey – IXa . Biomass index (Kg/haul).




Portuguese PtGFS-WIBTS-Q1 Survey indices in IXa. Distribution and relative biomass

Size composition



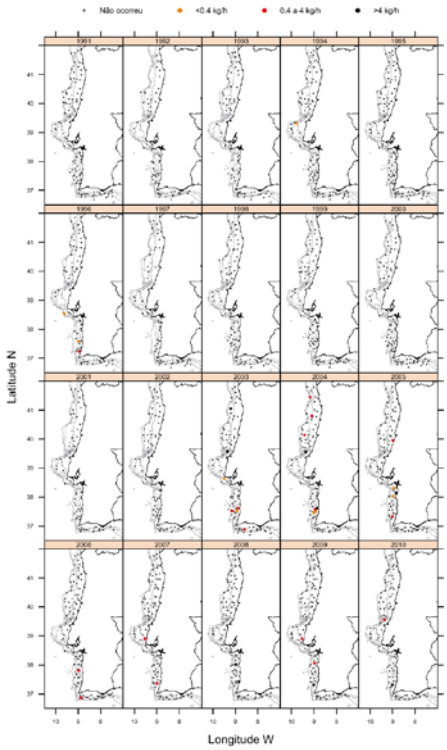

Portuguese length frequencies from the Polyvalent fleet operating in Peniche and Matosinhos fishing areas (2009–2011). The number of sampled fishing trips is indicated.

| | |
|---|---|
| Distribution: There is no evidence of changes in distribution based on the data survey data available. | |
| Catch rates: Lpue indicates a slightly increase trend, cpue from the survey does not show any trend. | |
| Size distribution: Commercial length–frequency distribution indicates no changes for the period 2009–2011. Survey data suggests a slight increase in the last years. | |
| Exploitation: *R. clavata* is the most abundant commercially exploited species. Lpue for different métiers show an increase from 2008, 2010–2011. The increase in landings together with the increase in LPUE indicates that fishing mortality rate may be stable or decreasing. | |

Overall status: Despite the low frequency of occurrence of the species in the surveys, there are no indications of reductions in the area of occurrence. The perception of the stock is based on the LPUE trends derived from the dedicated DCF project for skates and rays in Division IXa. For all métiers, the index of abundance shows an increasing trend. This increase in LPUE together with the increase in landings indicates that fishing mortality rate is stable or decreased. The state of the stock is regarded to be increasing.

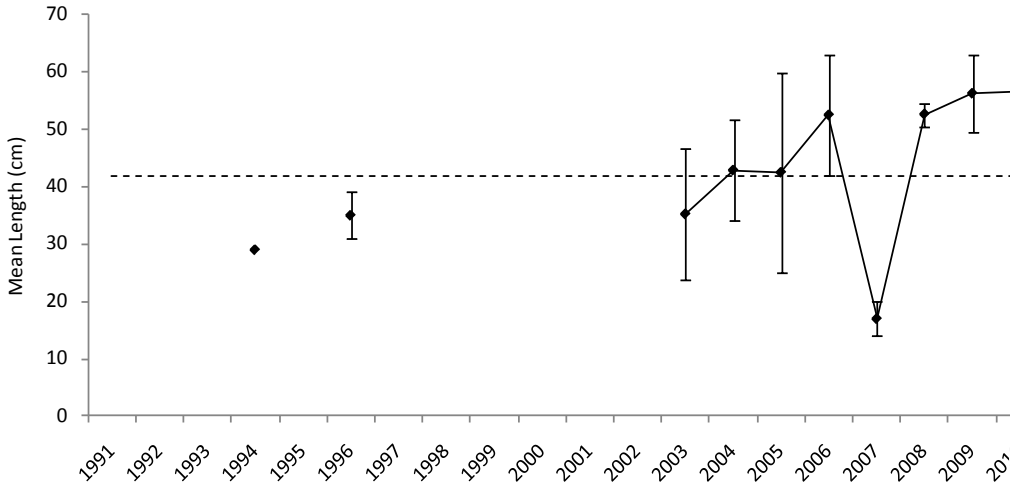
***Raja montagui* in the Bay of Biscay and Iberian Waters (ICES Subarea IXa)**

Distribution of abundance



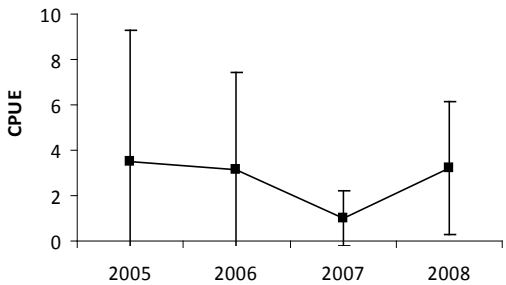

PtGFS-WIBTS-Q4 Survey indices in IXa. Distribution and relative biomass

Mean Length



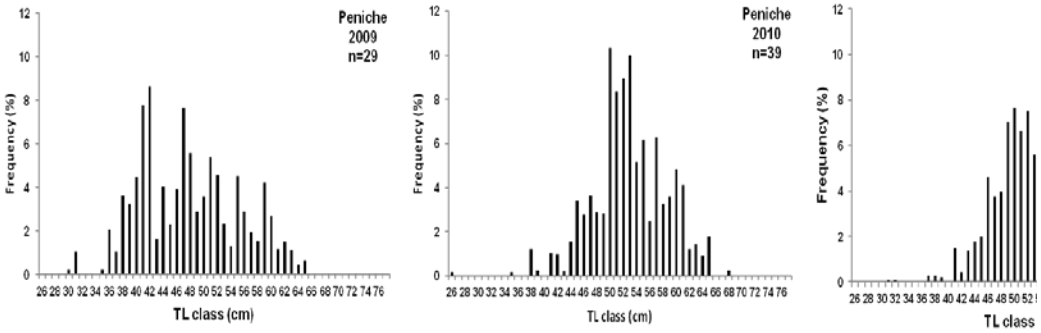

Portuguese PtGFS-WIBTS-Q4 Survey main length, during 1991–2010

Survey Abundance Indices




Portuguese PtGFS-WIBTS-Q1 Survey indices in IXa. Distribution and relative biomass

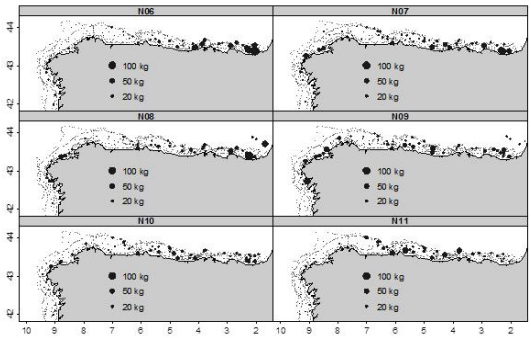
Size composition




| | |
|---|---|
| Portuguese length frequencies from the Polyvalent fleet operating in Peniche fishing area (2009–2011). The number of sampled fishing trips is indicated. | |
| Lpue (Kg/Fishing days) estimates for different gear categories in Subarea IXa for 2008, 2010 and 2011. Gear: TN>=180-Trammelnets with mesh size >=180 mm; TN<180 trammelnets with mesh size <180 mm; LL-Longline; T-Trawl. | |
| Distribution: Not frequent in surveys however based on the data survey data available no trend on the spatial distribution is evident. | |
| Catch rates: Both LPUE and cpue from the survey show a stable trend. | |
| Size distribution: Commercial length–frequency distribution indicates no changes for the period 2009–2011. Survey data suggests an increase in the mean length. | |
| Exploitation: *R. montagui* despite being commercially exploited the landed weight is less important than for other species. Lpue for different métiers have been increasing from 2008, 2010–2011. The decrease in landings together with the stability in LPUE indicates that fishing mortality rate has decreased. | |
| Overall status: This is a small bodied species and a fast growing species with a high intrinsic rebound potential. The frequency occurrence of the species in the surveys is low so the perception of the stock is based on the LPUE trends derived from the dedicated DCF project for skates and rays in Division IXa. For all métiers the index of abundance shows a similar stable trend. Furthermore the decrease in landings together with the stability in LPUE indicates that fishing mortality rate has decreased. The state of the stock is regarded to be increasing. | |

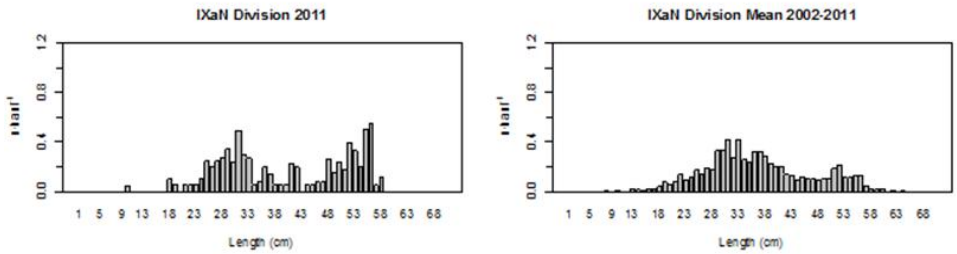
***Scyliorhinus canicula* IXa in the Bay of Biscay and Iberian Waters (ICES Subarea IXa)**

Distribution of abundance



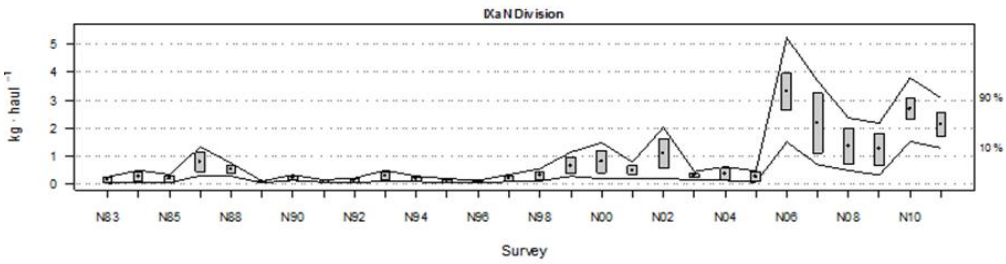

Spanish IEO Q4-IBTS Survey indices-VIIIc and IXa. Distribution and relative abundance (kg/30 min haul)

Size composition




Spanish IEO Q4-IBTS Survey-IXa – VIIIc Stratified length distribution during 2011 and mean values during the last decade (2000–2011).

Survey Abundance Indices




Spanish IEO Q4-IBTS Survey-IXa . Biomass index (Kg/haul).

Distribution: There is no evidence of changes in distribution.

Catch rates: According the Spanish surveys LPUE is increasing in last years

Size distribution: Not enough information. In 2011 medium size individuals are less represented in the survey.

Exploitation: Landings have been reduced compared with the first years of the series although it seems to be recovered since 2009. It is a bycatch species in this area, especially in Portuguese waters.

Overall status: There are no indications of reductions in the area of occurrence, together with an increase in abundance in last years, suggest that the state of the stock is regarded to be increasing.

# 20 Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge

## 20.1 Ecoregion and stock boundaries

The Mid-Atlantic Ridge (MAR; ICES Subareas X, XII, XIV) is an extensive and diverse area, which includes several types of ecosystem, including abyssal plains, seamounts, active underwater volcanoes, chemosynthetic ecosystems and islands.

For most species dealt with in this section the stock boundaries are not well known. The main species of elasmobranch observed in this ecoregion are deep-water species (*Centrophorus* spp., *Centroscymnus* spp., *Deania* spp., *Etmopterus* spp., *Hexanchus griseus, Galeus murinus, Somniosus microcephalus, Pseudotriakis microdon*, *Scymnodon obscurus*, *Centroscyllium fabricii* and various deep-water skates; see Sections 3 and 5), particularly whenever the gear fishes deeper than 600 m. Many of these are discarded as a consequence of their low commercial value (ICES, 2005; Pinho and Canha, 2011). In the Azores area, kitefin shark *Dalatias licha* and tope *Galeorhinus galeus* are the most important commercial elasmobranchs (see Sections 4 and 10 respectively).

Of the skates, the most abundant species in Subarea X is thornback ray *Raja clavata*. Other species also observed include *Dipturus batis* complex, *D. oxyrinchus*, *Leucoraja fullonica*, *Rajella bathyphila*, *Raja brachyura*, *Raja maderensis* and *Rostroraja alba* (Pinho, 2005; 2013b). Other species of batoid, such as Bigelow's ray *Rajella bigelowi*, stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana* are also observed in this ecoregion. These species are generally discarded if caught in commercial fisheries (Pinho and Canha, 2011). Some of the scarcer elasmobranchs observed on MAR include *Bathyraja pallida* and *Bathyraja richardsoni* (ICES, 2005).

Stock boundaries are not known for the species in this area, neither are the potential movements of species that also occur on the continental shelf of mainland Europe. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

## 20.2 The fishery

### 20.2.1 History the fishery

In the context of this report, this area is mainly a natural deep-water environment exploited by small-scale fisheries in the Azorean islands EEZ and industrial deep-sea fisheries in international waters. The fisheries from these areas have already been described in ICES reports (ICES, 2005). Landings from the Azorean fleets have been reported to ICES. Landings from MAR remain very small and variable, or even absent, and few vessels find the MAR fisheries profitable at present.

Demersal elasmobranchs are caught in the Azores EEZ by a multispecies demersal fishery, using handlines and bottom longlines, and by the black scabbardfish fishery using bottom longlines (ICES, 2005). The most commercially important elasmobranchs caught and landed from these fisheries are *Raja clavata* and *G. galeus* (Pinho, 2005; 2013a; ICES, 2005).

### 20.2.2 The fishery in 2011 and 2012

An expansion of the longline fishery to the more offshore seamounts has been observed on the last years as a result of intensive fishing or overexploitation of im-

portant commercial demersal/deep-water stocks. A shifting from this fishery to the new black scabbard fish has been observed during the last three years.

The landings of the demersal/deep-water sharks were very low due to the quota restrictions (WD Pinho, 2013a). There are no target fisheries, but discards of these species are expected to increase, particularly from the longliners, because of quota and local area restrictions to fishing being introduced on Subdivision Xa2 (Azores EEZ).

### 20.2.3 ICES advice applicable

ACOM has not previously provided advice for these stocks.

### 20.2.4 Management applicable

NEAFC has adopted management measures for the MAR areas under its regulatory area. These include effort limitations, area and gear restrictions (http://www.neafc.org/measures). Those recommendations that are relevant to elasmobranchs in this region include:

- Recommendation III (2006): Since 2006 NEAFC has prohibited fisheries with gillnets, entanglingnets and trammelnets in depths below 200 m and introduced measures to remove and dispose of unmarked or illegal fixed gear and retrieve lost gear to minimize ghost fishing;
- Recommendations IX (2007) and IX (2008): Bottom fishing (Bottom trawling and fishing with static gear, including bottom-set gillnets and longlines) was forbidden in some areas of Hatton Bank and Rockall Bank;
- Recommendation XVI (2008): The access to the new bottom fishing areas (considered as other areas not mapped as actual existing bottom fishing areas) was limited;
- Recommendation VII (2009) and REC VI (2010): Since 2009 effort was limited and set at 65% of the highest level put into deep-sea fishing in previous years for the relevant species;
- Recommendation XIV (2009): During 2009 five areas (including three seamounts), on the Mid-Atlantic Ridge in the high seas in the Northeast Atlantic, were closed temporarily to bottom fisheries (fishing gears which is likely to contact the seabed) under its policy for area management;
- Recommendation VI (2011): As an interim measure, no directed fishery for basking shark shall be undertaken in the Convention Area in 2011;
- Recommendation VII (2010). Directed fishing of spurdog (*Squalus acanthias*) is prohibited in the Regulatory Area by vessels flying its flag. Any incidental catches of this stock shall be promptly released unharmed to the extent possible.

Deep-water sharks are subject to management in Community waters and in certain non-Community waters for stocks of deep-sea species (EC no 2270/2004 article 1).

In 1998, the Azorean government implemented local management actions in order to reduce effort on shallow areas of the islands, including a licence threshold based on the requirement of the minimum value of sales and the creation of a box of three miles around the islands areas, with fishing restrictions by gear (only handlines are permitted) and vessel type. During 2009 additional measures were implemented,

including area restriction (temporary closure of the Condor Bank) and gear restriction by vessel type (licence and gear configuration).

Under the Common Fisheries Policy of the EU a box of 100 miles was created around the Azorean EEZ where the Azorean fleets are permitted to fish for deep-sea species (Regulation EC 1954/2003). TACs for deep-water sharks are in place for ICES Areas V, VI, VII, VIII, IX, X and XII (EC Reg. no 1539/2008).

## 20.3 Catch data

### 20.3.1 Catch data

The catches reported from each country and subarea are given in Tables 20.1–20.3. Historical total landings of skates reported for Areas X and XII are presented in Figure 20.1.

Landings data from this ecoregion are also collated by NEAFC, and further studies to ensure that these data are consistent with ICES estimates are required.

### 20.3.2 Discards

Information on discards from observers in the longline fishery from 2004 to 2010, as reported to the WGDEEP (Pinho and Canha, 2011) shows that for some species, such as deep-water sharks, the discards may be important. Actually, for species such as *Etmopterus* sp and *Centrophorus* sp all fishes are discarded. Other species frequently caught and discarded are *Dalatias licha*, *Deania* sp. and *Hexancus griseus*. These changes are probably due to the management measures introduced, particularly the TAC/quotas, minimum size and fishing area restrictions that changed the fleet behaviour on targeting, expanding the fishing areas to more offshore seamounts and deeper strata. Fisheries occurring outside the ICES area to the south of the Azores EEZ may be exploiting the same stocks as considered here.

### 20.3.3 Quality of catch data

Species-specific landings data are not currently available for skates landed in this region. For demersal sharks misidentification is known to occur. Misidentified species, grouped as not specified elasmobranchs in the landings increased during the last two years.

## 20.4 Commercial catch composition

### 20.4.1 Species and size composition

In the Azores there is no systematic fishery/landing sampling programme for these species because they have very low priority on the port sampling programme. Landings statistics on rays and skates from Azorean fisheries are reported under generic categories. Since 2004, length samples of *Raja clavata* have been collected, however few individuals were sampled.

### 20.4.2 Quality of data

Only limited data are available.

## 20.5 Commercial catch–effort data

No new information.

## 20.6 Fishery-independent surveys

Since 1995 the Department of Oceanography and Fisheries (DOP) has carried out an annual spring demersal bottom longline survey around the Azores. An overview of the elasmobranch species occurring in the Azores (ICES Subarea X), their fisheries and available information on species distributions by depth were described by Pinho (2005; 2013a,b WD). This survey is not specifically designed to catch elasmobranchs, and so does not provide quantitative information for several of these species.

*Raja clavata* is one of the demersal elasmobranch species most commonly reported from the Azorean spring bottom longline (ICES, 2006). Relevant biological information available from surveys on this species was updated. An annual abundance index for this species is presented in Figure 20.2. The length–frequency of samples is illustrated in Figure 20.3. The absence of records of the youngest size classes in this survey can to attribute to gear effect. Relative abundance for other species is available from this survey.

Information on elasmobranchs recorded on MAR is available from the literature (Hareide and Garnes, 2001) and was summarized in ICES, 2005. Some information on deep-water sharks was presented during the 2009 meeting (Vinnichenko and Fomin, 2009 WD), and this is detailed in Sections 3 and 5.

## 20.7 Life-history information

No new information.

## 20.8 Exploratory assessment methods

No assessments have been conducted, as a consequence of insufficient data.

## 20.9 Quality of assessments

No assessments have been conducted, as a consequence of insufficient data. Analyses of survey trends may allow the general status of the more frequent species to be evaluated in future.

## 20.10 Reference points

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

## 20.11 Management considerations

WGEF considers that the elasmobranch fauna of Mid-Atlantic Ridge in ICES Subareas X and XII is poorly understood. The species of demersal elasmobranchs are probably little exploited compared with continental Europe. The ecoregion is considered to be a sensitive area. Consequently, commercial fisheries taking demersal elasmobranchs in this area should not be allowed to proceed unless studies are conducted that can demonstrate what sustainable exploitation levels should be.

## 20.12 References

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

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

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

Pinho, M. R. 2013a. Update of the Azorean elasmobranchs fishery data (ICES Area X). ICES Working Document WGEF 2013.

Pinho, M. R. 2013b. Updating elasmobranchs survey data from the Azores (ICES X). ICES Working Document WGEF 2013.

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

Pinho, M. R. And Canha, A. 2011. Elasmobranch discards from the Azores longline fishery (ICES Subdivision Xa2). ICES Working Document WGDEEP 2011.

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

**Table 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea X.**

| ICES SUBAREA X | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1996 |
| Azores | Rajidae | 48 | 29 | 35 | 52 | 43 | 32 | 55 | 62 | 71 | 99 | 117 | 71 |
| France | Rajidae | | | | | | | 1 | | | | | |
| Spain | Rajidae | | | | | | | . | | | | | |
| Azores | Bluntnose six-gill shark | + | 1 | 1 | 1 | + | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Azores | Sharks | + | + | 4 | 12 | + | n.a. | 138 | 256 | 328 | n.a. | n.a. | 328 |
| Total | | 48 | 30 | 40 | 65 | 43 | 32 | 194 | 318 | 399 | 99 | 117 | 399 |

| ICES SUBAREA X | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Azores | Rajidae | 99 | 117 | 103 | 83 | 68 | 70 | 89 | 72 | 47 | 62 | 71 | 72 |
| France | Rajidae | | | | | 2 | . | . | . | . | - | - | . |
| Spain | Rajidae | | | | 24 | 29 | - | - | - | . | - | - | |
| Azores | Bluntnose six-gill shark | n.a. | n.a. | n.a. | n.a. | n.a. | 7 | 2 | 1 | 1 | 1 | 1 | . |
| Azores | Sharks | n.a. | n.a. | 6 | 18 | 22 | n.a. | n.a. | n.a. | 3 | | 11 | 18 |
| Total | | 99 | 117 | 109 | 125 | 121 | 77 | 91 | 73 | 51 | 63 | 82 | 91 |

| ICES SUBAREA X | | | | | |
|---|---|---|---|---|---|
| Country | Species | 2009 | 2010 | 2011 | 2012 |
| Azores | Rajidae | 60 | 68 | 90.7 | 103 |
| France | Rajidae | . | . | . | |
| Spain | Rajidae | | | . | |
| Azores | Bluntnose six-gill shark | . | 0.6 | . | 0 |
| Azores | Sharks | 10 | 6.3 | 1.6 | 31 |
| Total | | 71 | 75 | 92 | 134 |

**Table 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XII.**

| ICES SUBAREA XII | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| UK | Rays and skates | 1 | 1 | 6 | 1 | . | | | 0 | 0 |
| UK | Sharks | - | 6.7 | - | - | 113 | | | 0 | 0 |
| Total | | 1 | 7 | 6 | 0.8 | 113 | 0 | 0 | 0 | 0 |

| ICES SUBAREA XII | | | | |
|---|---|---|---|---|
| Country | Species | 2010 | 2011 | 2012 |
| UK | Rays and skates | | . | . |
| Norway | Rajidae | | . | . |
| Total | | 0 | 0 | 0 |

**Table 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Landings of demersal elasmobranchs (t) from ICES Subarea XIV.**

| ICES SUBAREA XIV | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | Species | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| UK | Rays and skates | + | + | - | - | - | | | 0 | 0 |
| Norway | Rajidae | | | | | | 6 | 0 | 1 | 0 |
| Total | | 0.3 | 0.4 | - | - | - | 6 | 0 | 1 | 0 |

| ICES SUBAREA XIV | | | | |
|---|---|---|---|---|
| Country | Species | 2010 | 2011 | 2012 |
| France | Rays and skates | | | 0,484 |
| Germany | Rays and skates | 0,02 | 0 | 0 |
| UK | Rays and skates | + | . | |
| Norway | Rajidae | | . | |
| Total | | 0.02 | 0 | 0,484 |

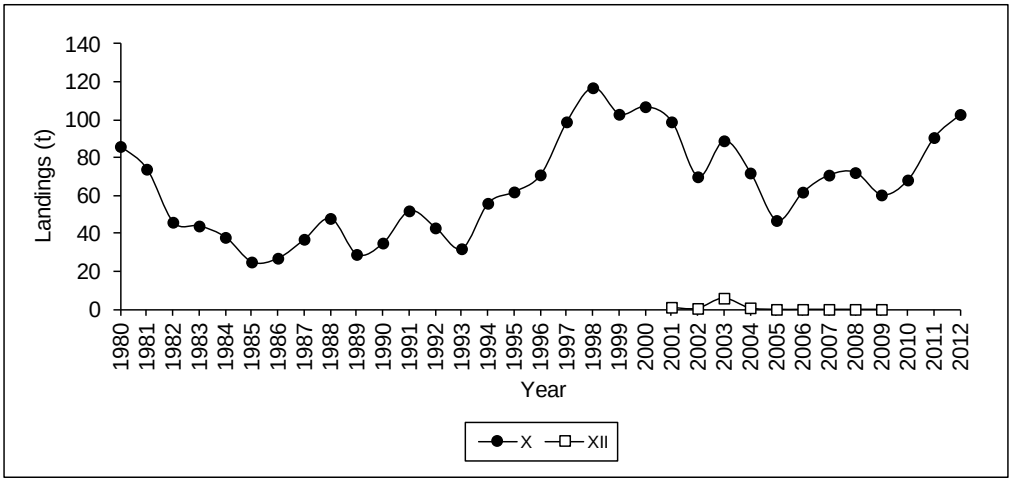



**Figure 20.1. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Historical landings of rays from Azores (Ices Subarea X) and MAR (ICES Subarea XII).**

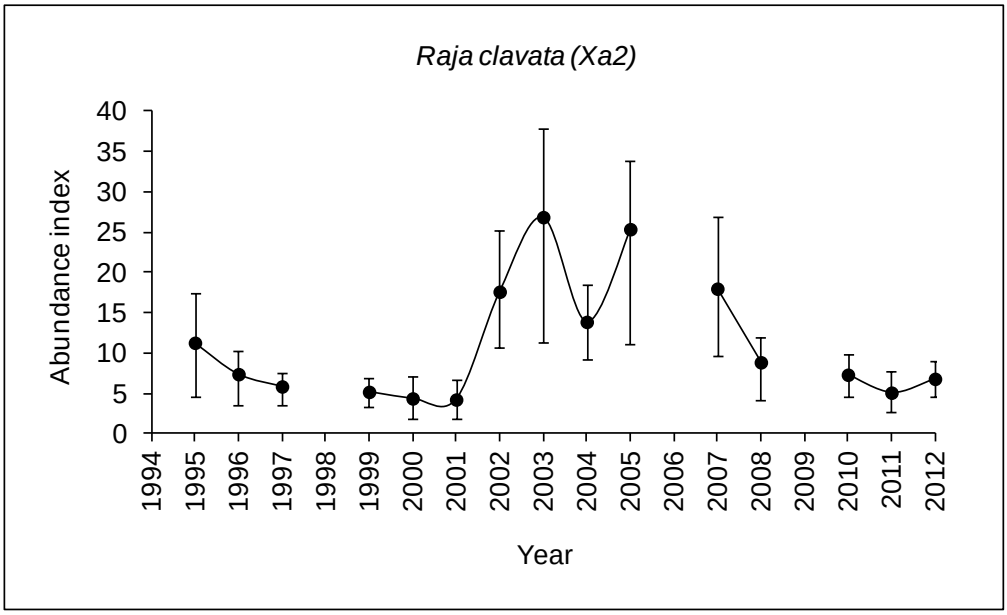



**Figure 20.2. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Survey annual abundance, in number, of *Raja clavata* from the Azores (ICES X).**

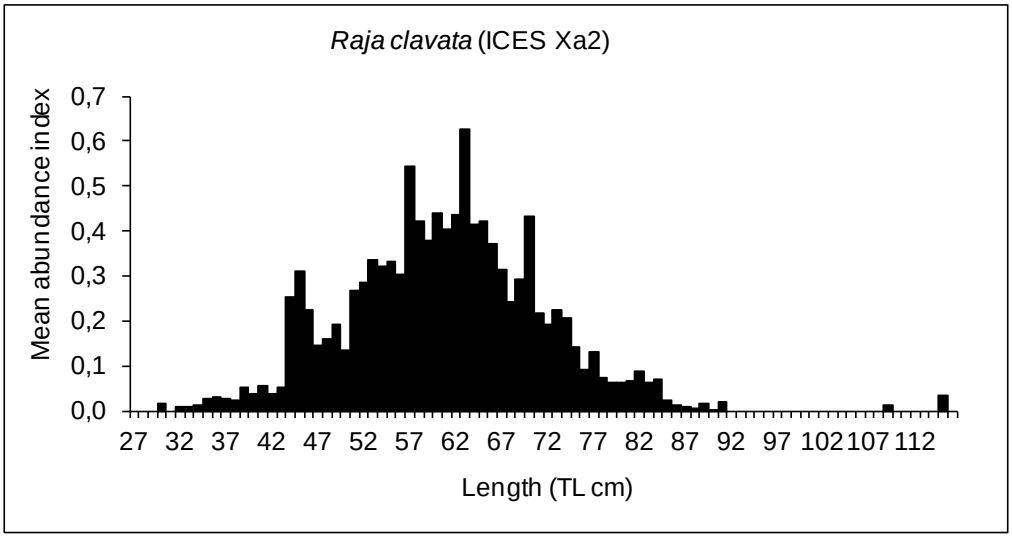



**Figure 20.3. Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge. Length frequency of *Raja clavata* caught at the Azorean demersal spring bottom longline surveys during the period 1995–2012.**

# 21 Smooth-hounds in the Northeast Atlantic

## 21.1 Stock distribution

Three species of smooth-hound (Triakidae) occur in the ICES area. The most frequent species in the northern part of the area is starry smooth-hound *Mustelus asterias.* Common smooth-hound *Mustelus mustelus* may also occur in northern European seas, although separating these two species on the presence or absence of spots is unreliable (Compagno, 1984; Farrell *et al*., 2009), and information and data referring to *M. mustelus* likely refers to *M. asterias*.

A third species, black-spotted smooth-hound *Mustelus punctulatus,* occurs in the Mediterranean Sea (Quignard, 1972) and off NW Africa and may occur in the southernmost part of ICES Division IXa.

*M. asterias* appears to be the dominant smooth-hound in northern European waters.

Given the problems in separating *M. asterias* and *M. mustelus* and that data for these two species are confounded, data in this chapter are generally combined at genus level.

In the absence of dedicated scientific studies on stock units, WGEF considers there to be a single management unit of *Mustelus asterias* in the continental shelf waters of the ICES area, comprising ICES Subareas IV, VI–IX. This stock may extend to the northern part of the CECAF area and possibly the Mediterranean Sea.

Improved studies to better understand the stock unit(s) are required. There are several programmes that tag and release *M. asterias* in the North Sea and Celtic Seas ecoregions, and analyses of these data are required. Additionally, tagging studies from the southern parts of the ICES area could be usefully undertaken.

## 21.2 The fishery

### 21.2.1 History of the fishery

Smooth-hounds are taken as a seasonal bycatch in trawl, gillnet and longline fisheries. Though they are discarded in some fisheries, other fisheries land this bycatch, depending on market demands.

Smooth-hounds are also a relatively important species for recreational sea anglers and charter boat fishing in several areas, with anglers and angling clubs often having catch-and-release protocols.

### 21.2.2 The fishery in 2012

There were no major changes to the fishery noted in 2012. Information from the fishing industry suggests that the increased landings of smooth-hounds are partly to supply market demand for 'dogfish' given the current restrictions on spurdog.

### 21.2.3 ICES Advice applicable

ICES first provided advice for this stock in 2012. Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 4%. Because the data for catches of smooth-hounds are not fully documented and considered highly unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result.

### 21.2.4 Management applicable

EC Council Regulations 850/98 for the `conservation of fishery resources through technical measures for the protection of juveniles of marine organisms' details the minimum mesh sizes that can be used to target fish. Although other dogfish (*Squalus acanthias* and *Scyl;iorhinus* spp.) could be targeted in fixed nets of 120–219 mm and >220 mm mesh size (in regions 1 and 2), *Mustelus* spp. would be classed under 'all other marine organisms', and so can only be targeted in fixed nets of >220 mm. This has been queried by some fishermen.

## 21.3 Catch data

### 21.3.1 Landings

No accurate estimates of catch are available, as many nations that land smooth-hounds report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). Preliminary values of landings are given in Table 21.1 and Figure 21.1.

### 21.3.2 Discards

Although some discards information is available from various nations, data are limited for most nations and fisheries. Preliminary analyses have indicated that juveniles are typically discarded (Figure 21.2), although the survival of these discards has not yet been evaluated (Silva *et al*., 2013 WD).

Smooth-hounds taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and sub-adults (<70 cm), and most these were nearly all discarded. Gillnet catches were comprised primarily of fish in the 60–110 cm length range, with fish <55 cm usually discarded. Otter trawl catches covered a broad length range, and smooth-hounds <50 cm were typically discarded. The absence of full retention at length in these gears may be due to various factors, such as catch quality and local market value, influencing the discarding behaviour of fishers. Silva *et al.* (2013 WD) noted that a greater proportion of smooth-hounds were retained since landings of spurdog had become restrictive.

### 21.3.3 Quality of catch data

Catch data are of poor quality, as much of the landings data have been reported under generic landings categories, especially historically. Most nations have made efforts to improve the recording of species in recent years.

The availability and quality of catch data for off NW Africa and the Mediterranean needs to be investigated.

Better estimates of discarding are required, with information on discard survival also needed, as a proportion of discarded smooth-hounds may survive.

Biological data are not collected under the Data Collection Regulations, although some generic biological data are available (see Section 21.7).

## 21.4 Commercial catch composition

Studies to better understand both the species, size and sex composition are required. Given the potential for sexual and sex-based segregation of *Mustelus* spp., appropri-

ate monitoring would be required to understand the catch composition over appropriate spatial and temporal scales.

## 21.5 Commercial catch-effort data

No data available.

## 21.6 Fishery-independent information

### 21.6.1 Availability of survey data

Several fishery-independent surveys operate in the stock area. Larger individuals are not sampled effectively in beam trawl surveys (because of low gear selectivity). They are often caught in GOV trawl and other otter trawl surveys in the area. For further details of trawl surveys in the stock area, see Section 15 (North Sea ecoregion), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia). Summary details from the most recent IBTS are shown in Figure 21.3 and in the Supplementary Information of this section.

Analyses of survey data need to be undertaken with care, as smooth-hounds are relatively large-bodied species (maximum size of *M. mustelus* is about 165 cm total length) and adults are strong swimmers. Hence, larger individuals may not be sampled effectively in IBTS surveys. Given their aggregating nature, some surveys may have a large number of zero hauls and a few hauls with relatively large numbers.

Although two species of smooth-hound have been reported in most surveys, the discrimination of these species has usually been based on the presence or absence of spots, which is not a reliable characteristic. WGEF consider that survey data for these two species should be combined in any analyses, and that starry smooth-hound *Mustelus asterias* is by far the more common of the two species in the Celtic Seas and North Sea ecoregions.

### 21.6.2 Temporal trends in relative abundance

In the Celtic Sea, the UK PHHT survey demonstrated a peak in the relative abundance of *Mustelus* spp. in 2000. Although this peak was not apparent in the French survey in 2000, this species has also increased in recent years, peaking in 2004 (ICES 2007).

The UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea has also indicated an increase in mean catch rates (ICES, 2010c). The UK(England and Wales) and Irish groundfish survey also catch reasonable numbers of smooth-hounds (see ICES, 2010c, S21.1), and these data should be analysed when more of a time-series has been established. Larger smooth-hounds, including mature fish, are also taken in these surveys.

The UK(England and Wales) beam trawl survey has also indicated that smooth-hounds are increasing in relative abundance, and are also being observed in an increasing proportion of hauls (ICES, 2011; S21.2). The individuals taken in this survey are generally juveniles, and the small proportion of mature fish is due to a low catchability.

Although smooth-hounds are not subject to routine biological sampling in any of the surveys, the EngW-WIBTS-Q4 survey tags and releases smooth-hounds, and the individual weights and maturity (of male fish) are recorded prior to release (See Section 21.7.6).

## 21.7 Life-history information

There have been several biological investigations of *Mustelus* spp. in European seas, including from the NE Atlantic and Mediterranean Sea.

### 21.7.1 Reproductive biology

Studies in the Celtic Seas ecoregion have indicated that the total length (and age) at 50% maturity for male and female *M. asterias* are 78 cm (4–5 years) and 87 cm (six years), respectively (Farrell *et al*., 2010b).

Estimates of fecundity range from 8–27 (ovarian fecundity) and 6–18 (embryonic fecundity), with a gestation period of about twelve months (Farrell *et al*., 2010b), and there may also be a resting period of a year between pregnancies, giving a 2-year reproductive period.

In the Mediterranean Sea, *Mustelus asterias* reach maturity at about 75 cm (males) and 96 cm (females), with estimates of fecundity ranging from 10–45 (ovarian fecunddity) and 10–35 (uterine fecundity), with fecundity increasing with length (Capape, 1983).

Studies on *Mustelus mustelus* in the Mediterranean have found that females matured at 107.5–123 cm total length (50% maturity at 117.2 cm) and that males matured at 88–112 cm (50% maturity at 97.1 cm) (Saidi *et al*., 2008). This study also found that embryonic fecundity ranged from 4–18 embryos, with fecundity increasing with length. Further south, off Senegal, the lengths at first (and 100%) maturities for *M. mustelus* were found to be 82 cm (95 cm), for males, and 95 cm (104 cm) for females (Capape *et al*., 2006). This study reported litters of 4–21.

### 21.7.2 Age and growth

Farrell *et al*. (2010a) studied the age and growth of *M. asterias* in the Celtic Seas ecoregion. Growth parameters for males (n = 106) were L sub( infinity ) = 103.7 cm total length, L sub(0) = 38.1 cm STL, k = 0.195 year super(–1)). Growth parameters for females (n = 114) were (L sub( infinity ) = 123.5 cm STL, L sub(0) = 34.9 cm STL, k = 0.146 year super(–1)). Estimates of longevity were 13 years (males) and 18.3 years (females).

Age and growth of *M. mustelus* has been studied in South African waters, with males and females estimated to mature at 6–9 and 12–15 years, respectively (Goosen and Smale, 1997). The maximum age reported in this study was 24 years.

The length–weight relationship of *Mustelus* spp. caught during the Cefas tagging programme, 2000–2010 is illustrated in Figure 21.4.

### 21.7.3 Habitat

The distribution of *Mustelus* spp. around the British Isles has been described, with more detailed studies on the habitat utilization only examined in the English Channel (Martin *et al*., 2010, 2012).

### 21.7.4 Pupping and nursery areas

Pups of *M. mustelus* are born at a size of 34–42 cm in the Mediterranean (Saidi *et al*., 2008) and 36 to 45 cm off Senegal (Capape *et al*., 2006). Pups are taken in trawl surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas. Most of the records for pups recorded in UK beam

trawl surveys are from the southern North Sea (IVc), parts of the English Channel and Bristol Channel (VIIf) (Ellis *et al*., 2005).

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.

Studies on other species of smooth-hound have shown high site fidelity of immature individuals on nursery grounds (Espinoza *et al*., 2011).

### 21.7.5 Diet

*Mustelus* spp. are primarily carcinophagous, predating on a variety of crustaceans, including hermit crabs (Paguridae), stomatopods, brachyuran crabs, squat lobsters and shrimps, with teleosts also consumed by larger individuals (Ellis *et al*., 1996; Morte *et al*., 1997; Jardas *et al*., 2007; Santic *et al*., 2007; Saidi *et al*., 2009; Lipej *et al*., 2011). In some rocky areas they can be important predators of small edible crab *Cancer pagurus.*

### 21.7.6 Movements and migrations

Although the movements and migrations of smooth-hounds are not fully known, there have been relatively high numbers of *Mustelus* spp. tagged and released during various other elasmobranch research programmes in the UK (Burt *et al*., 2013 WD), Figure 21.5.

A Dutch angler-led programme has tagged 746 smoothhounds since 2011, with 15 returns so far (Figure 21.6).

Further analyses of these and other data are still required.

## 21.8 Exploratory assessment models

### 21.8.1 Previous studies

No previous assessments of NE Atlantic smooth-hounds have been made. However, there have been assessment methods developed for the Australian species *Mustelus antarcticus* (e.g. Xiao and Walker, 2000; Pribac *et al*., 2005) which may be applied to European species when relevant data are available.

### 21.8.2 Data exploration and preliminary modelling

Although no modelling or quantitative stock assessments have been undertaken, trends in relative abundance have been used to inform on current status (see Section 21.6).

### 21.8.3 Stock assessment

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

## 21.9 Quality of the assessment

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

Scientific trawl surveys provide the longest time-series of species-specific data.

## 21.10 Reference points

No reference points have been proposed for this stock.

## 21.11 Conservation considerations

The IUCN Red List Assessments do not identify smooth-hounds as high conservation importance, listing them as Least Concern (*M. asterias* and *M. mustelus*) and Data Deficient (*M. punctulatus*).

## 21.12 Management considerations

Smooth-hounds appear to be increasing in relative abundance in trawl surveys, and also in commercial landings data. Given the potential expansion in fisheries for smooth-hounds (which may reflect an increased abundance and that fishing opportunities for *S. acanthias* are limited), further work to examine this stock is required.

It should be noted that smooth-hounds taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and sub-adults (<70 cm), and these were nearly all discarded, as were smooth-hounds <50 cm in the otter trawl fishery (Figure 21.2. Discard mortality is not known, and nor is the proportion of recruits that may survive to maturity and marketable size. Further study on the mortality and survivor rates of juveniles in these fisheries are needed to evaluate impacts on recruitment.

Smooth-hounds are also an important target species in some areas for recreational fisheries; though there are insufficient data to examine the relative economic importance of these fisheries, or the degree of mortality.

Other species of smooth-hound are targeted elsewhere in the world, including Australia/New Zealand and South America. Although smooth-hounds are generally quite productive stocks (at least for elasmobranchs), evidence from these fisheries suggests that various management controls can be used for their appropriate management.

## 21.13 References

Burt, G. J., Silva, J. F., McCully, S. R., Bendall, V.A. and Ellis, J. R. 2013. Summary results from opportunistic tagging programmes for smooth-hound *Mustelus* spp., greater-spotted dogfish *Scyliorhinus stellaris* and tope *Galeorhinus galeus* around the British Isles. Working Document to the Working Group on Elasmobranch Fishes, Lisbon, Portugal, 17–21 June 2013. 12 pp.

Capape, C. 1983. New data on the biological of the reproduction of *Mustelus asterias* Cloquet, 1821 (Pisces, Pleurotremata, Triakidae) from Tunisian coasts. Vie Et Milieu, 33: 143–152.

Capape, C., Diatta, Y., Diop, M., Vergne, Y. and Guelorget, O. 2006. Reproductive biology of the smoothhound, *Mustelus mustelus* (Chondrichthyes: Triakidae) from the coast of Senegal (eastern tropical Atlantic). Cybium, 30: 273–282.

Espinoza, M., Farrugia, T. J. and Lowe, C. G. 2011. Habitat use, movements and site fidelity of the gray smooth-hound shark (*Mustelus californicus* Gill 1863) in a newly restored southern California estuary. Journal of Experimental Marine Biology and Ecology, 401: 63–74.

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

Farrell, E. D., Clarke, M. W. and Mariani, S. 2009. A simple genetic identification method for northeast Atlantic smoothhound sharks (*Mustelus* spp.). ICES Journal of Marine Science, 66: 561–565.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010a. Age and growth estimates for the starry smoothhound (*Mustelus asterias*) in the northeast Atlantic Ocean. ICES Journal of Marine Science, 67: 931–939.

Farrell, E. D., Mariani, S. and Clarke, M. W. 2010b. Reproductive biology of the starry smoothhound shark *Mustelus asterias*: Geographic variation and implications for sustainable exploitation. Journal of Fish Biology, 77: 1505–1525.

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

Goosen, A. and Smale, M. J. 1997. A preliminary study of age and growth of the smoothhound shark *Mustelus mustelus* (Triakidae). South African Journal of Marine Science, 18: 85–91.

Jardas, I., Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet of the smooth-hound, *Mustelus mustelus* (chondrichthyes: Triakidae), in the eastern Adriatic Sea. Cybium, 31: 459–464.

Lipej, L., Mavric, B., Resek, S., Chérif, M. and Capapé, C. 2011. Food and feeding habits of the blackspotted smooth-hound, *Mustelus punctulatus* (Elasmobranchii: Carcharhiniformes: Triakidae), from the northern Adriatic. Acta Ichthyologica et Piscatoria, 41: 171–177.

Martin C.S., Vaz, S., Ellis, J.R., Coppin, F., Le Roy, D. and Carpentier, A. 2010. Spatio-temporal patterns of demersal elasmobranchs in trawl surveys in the eastern English Channel (1988–2008). Marine Ecology Progress Series, 417: 211–228.

Martin, C.S., Vaz, S., Ellis, J.R., Lauria, V., Coppin, F., and Carpentier, A. 2012. Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. Journal of Experimental Marine Biology and Ecology, 418/419: 91–103.

Morte, S., Redon, M. J. and Sanz-Brau, A. 1997. Feeding habits of juvenile *Mustelus mustelus* (Carcharhiniformes, Triakidae) in the western Mediterranean. Cahiers de Biologie Marine, 38: 103–107.

Pribac, F., Punt, A. E. Taylor, B. L. and Walker, T. I. 2005. Using length, age and tagging data in a stock assessment of a length selective fishery for gummy shark (*Mustelus antarcticus*). Journal of Northwest Atlantic Fishery Science, 35: 267–290.

Quignard, J. P. 1972. Note sur les especes mediterraneenes du genre *Mustelus* (Selachii, Galeoidea, Triakidae) Rev. Trav. Inst. Peches Marit., Nantes, 36(1): 15–29.

Saidi, B., Bradai, M. N. and Bouain, A. 2008. Reproductive biology of the smooth-hound shark *Mustelus mustelus* (L.) in the Gulf of Gabes (south-central Mediterranean Sea). Journal of Fish Biology, 72: 1343–1354.

Saidi, B., Enajjar, S., Bradai, M. N. and Bouain, A. 2009. Diet composition of smooth-hound shark, *Mustelus mustelus* (Linnaeus, 1758), in the Gulf of Gabes, southern Tunisia. Journal of Applied Ichthyology, 25: 113–118.

Santic, M., Nerlovic, V. and Pallaoro, A. 2007. Diet composition of blackspotted smooth-hound, *Mustelus punctulatus* (Risso, 1826), in the eastern Adriatic Sea. Journal of Applied ichthyology, 23: 279–281.

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

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 21.1. Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1978–2011. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for northwestern African waters.**

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | . | . | . | . | . | . | . | . | . | . | . | . | . |
| France | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 222 | 218 | 66 | 143 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | |
| UK -E, W & NI | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - Scotland | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 222 | 218 | 66 | 143 |

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | | | | | | |
| France | 64 | 117 | 126 | 93 | 90 | 102 | 138 | 145 | 228 | 187 | 197 | 64 | 117 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK -E, W & NI | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - Scotland | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | 64 | 117 | 126 | 93 | 90 | 102 | 138 | 145 | 228 | 187 | 197 | 64 | 117 |

**Table 21.1 (continued). Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1978–2011. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for northwestern African waters.**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | | | | | | | 8 |
| France | . | 306 | 377 | 585 | 589 | 682 | 767 | 714 | 908 | 522 | 926 | 969 | 706 | 2695 |
| Netherlands | . | . | . | . | . | . | . | . | . | . | . | 8 | 3 | |
| Portugal | . | . | . | . | . | . | . | . | . | . | . | . | 35 | 32 |
| UK -E, W & NI | . | 14 | . | . | . | . | . | . | . | 115 | 132 | 161 | 919 | |
| UK - Scotland | . | . | . | . | . | . | . | . | . | . | 1 | . | | |
| | 0 | 320 | 377 | 585 | 589 | 682 | 767 | 714 | 908 | 637 | 1059 | 1138 | 1664 | 2728 |

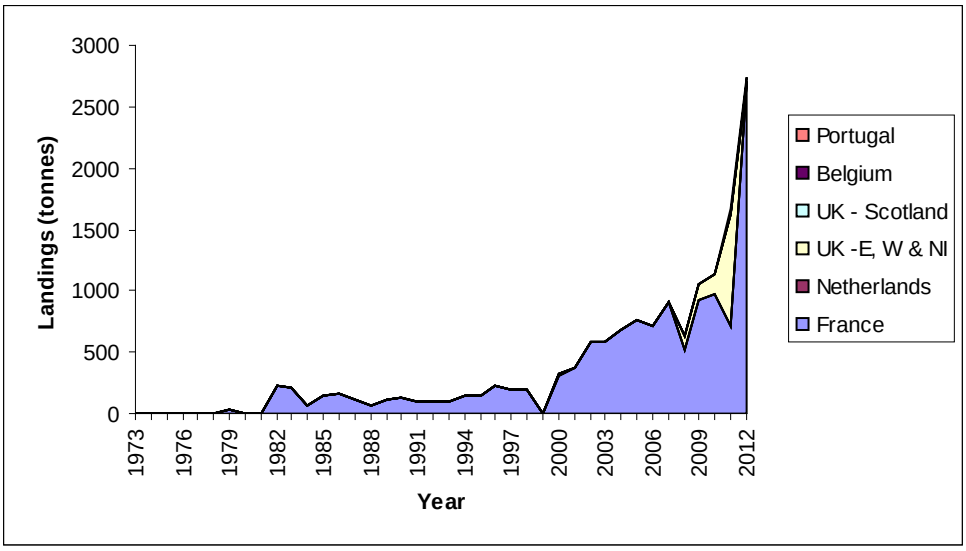



**Figure 21.1. Smooth-hound in the Northeast Atlantic. Working group estimates of *Mustelus* spp. landings by country, 1973–2012.**

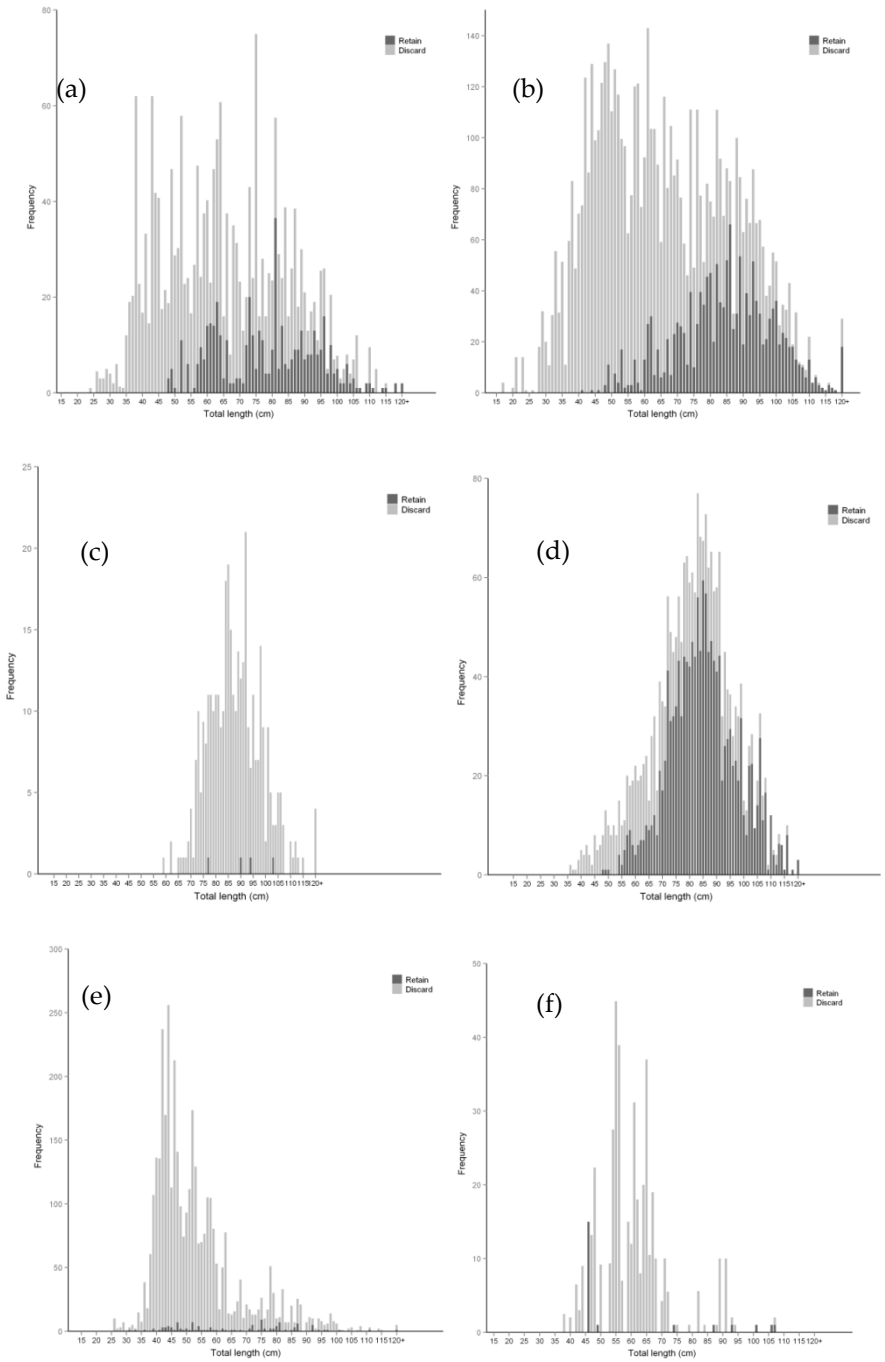



**Figure 21.2. Smooth-hounds in the Northeast Atlantic. Length–frequency of discarded and retained smooth-hounds *Mustelus* spp. by (a) otter trawl (2002–2005), (b) otter trawl (2006–2011), (c) gillnet (2002–2005), (d) gillnet (2006–2011), (e) beam trawl (2002–2011) and (f) *Nephrops* trawl (2002–2011), as recorded in the Cefas observer programme. Data aggregated across ecoregions (Source: Silva *et al.*, 2013 WD).**

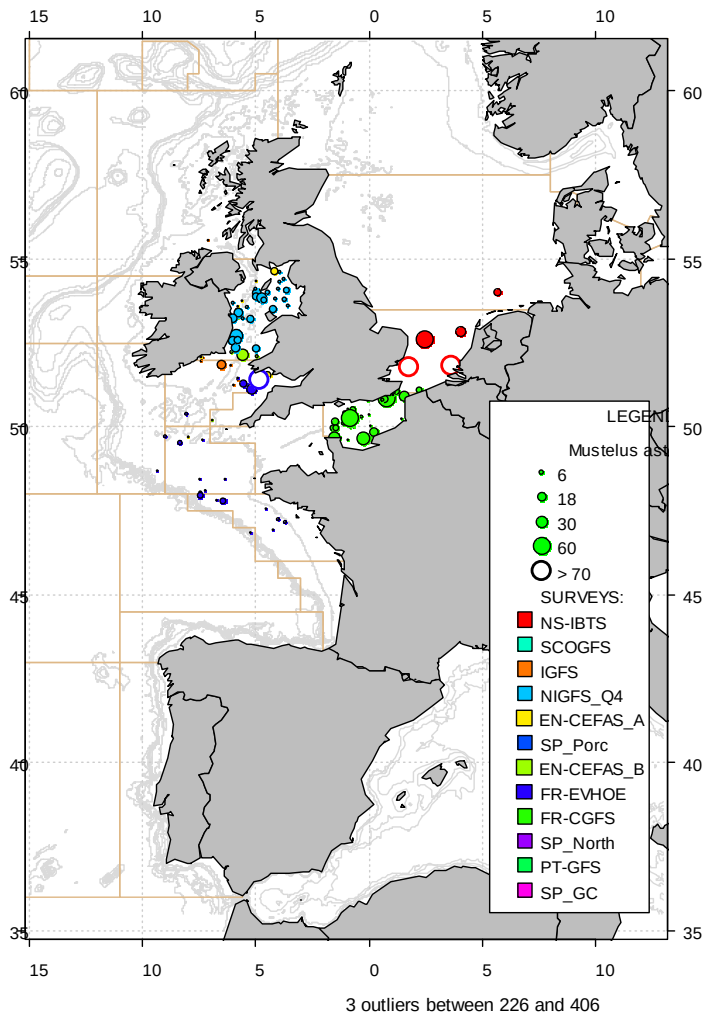



**Figure 21.3a. Smooth-hounds in the Northeast Atlantic. Captures of *Mustelus asterias* as reported in the 2011 IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey. (From ICES, 2012).**

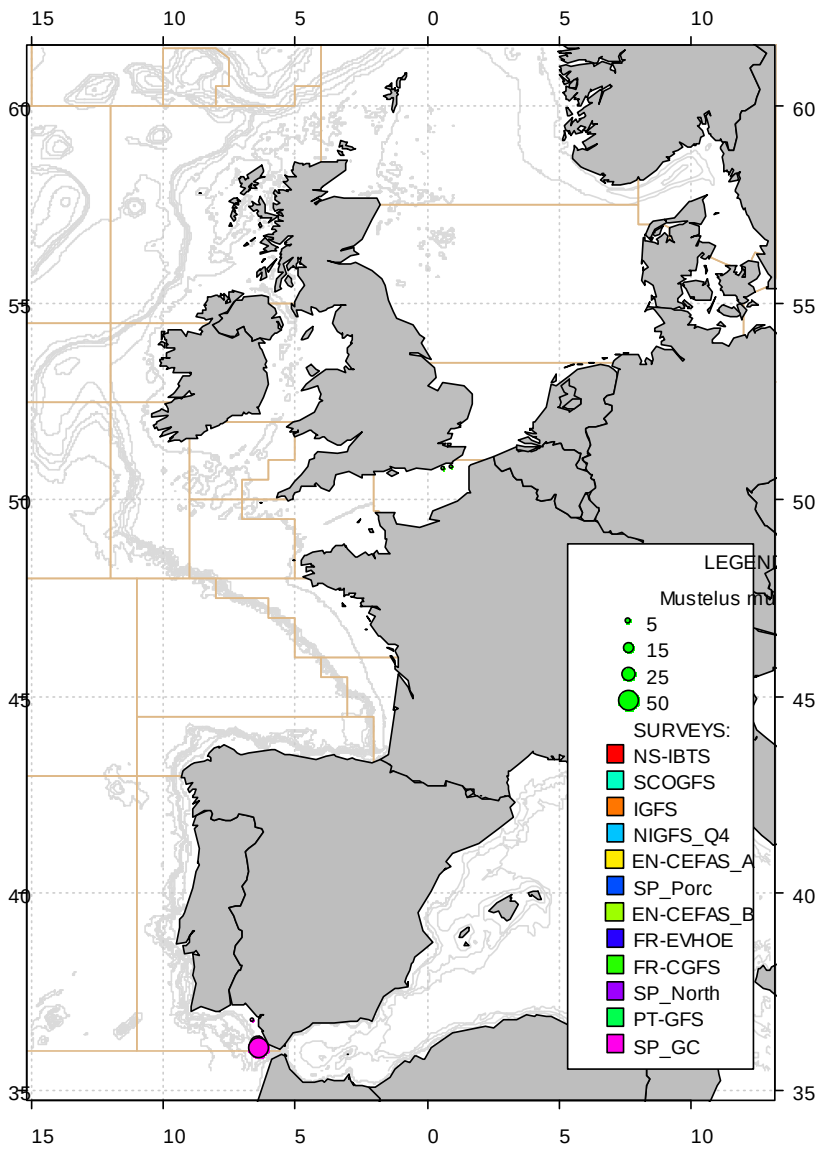



**Figure 21.3b. Smooth-hounds in the Northeast Atlantic. Captures of *Mustelus mustelus* as reported in the 2011 IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey. (From ICES, 2012).**

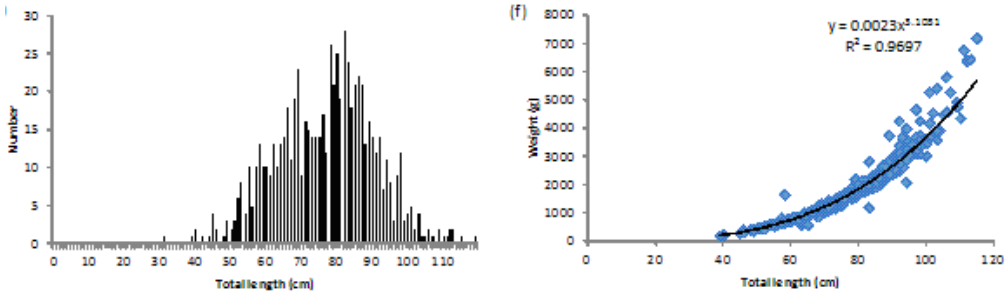



**Figure 21.4. Smoothhounds in the Northeast Atlantic. Length–frequency distributions of *Mustelus* spp. (n = 715), and the length–weight relationships for (*Mustelus* spp. (n = 508) tagged during the Cefas programme. Source: Burt *et al.*, 2013 WD.**

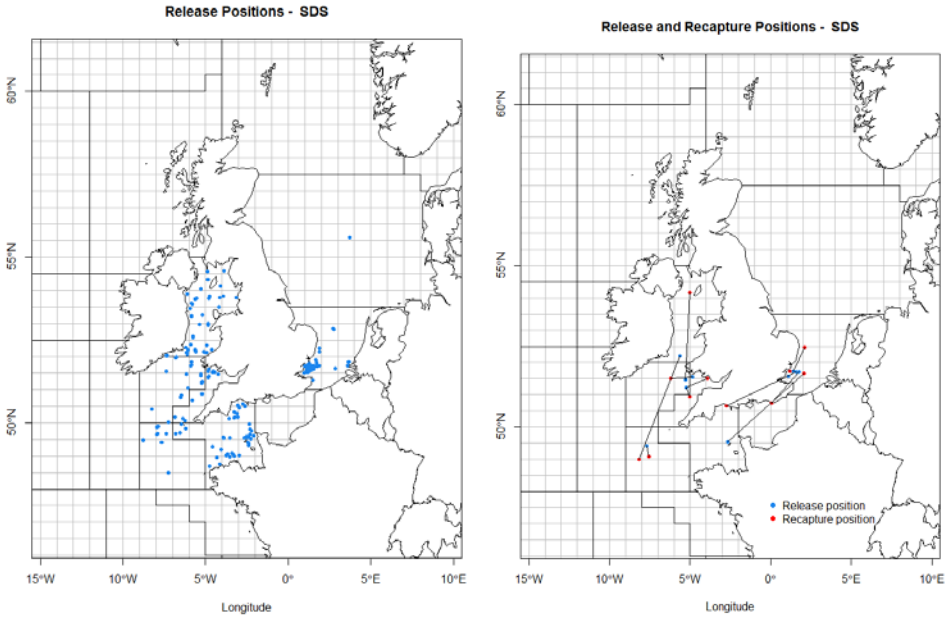



**Figure 21.5. Smooth-hounds in the Northeast Atlantic. Locations of smooth-hound, *Mustelus* spp. (i) released and (ii) release and recapture positions for recaptured fish (2000–2013). Source: Burt *et al.*, WD 2013.**

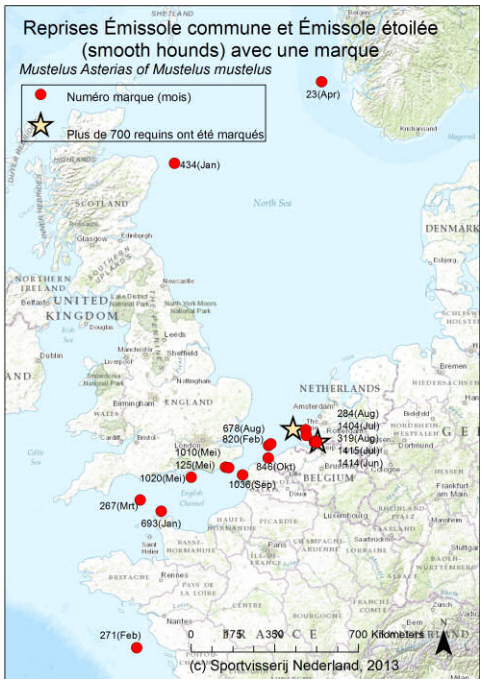



**Figure 21.6. Smooth-hounds in the Northeast Atlantic. Recapture positions of smooth-hounds from Dutch sport fishing tagging programme. Source: Niels Breve, Sportvisserij Nederland, *pers comm.)***

## Supplementary material: *Mustelus* survey summary sheets

S21.1

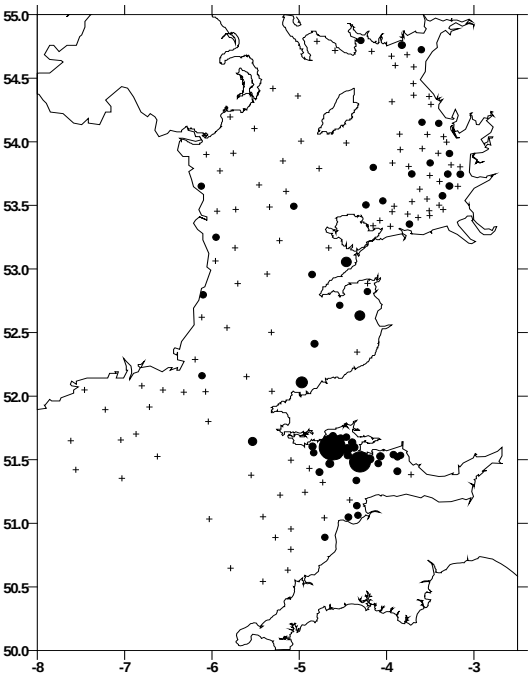
**Species: Smooth-hounds**

Survey area: VIIaf

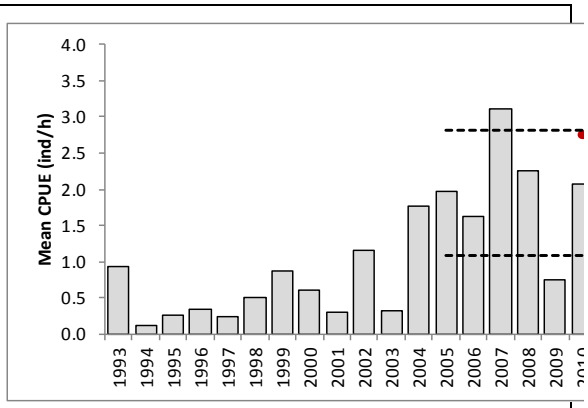
Survey acronym: UK (E&W) VIIAF BTS

Survey gear: 4 m Beam trawl with chain mat

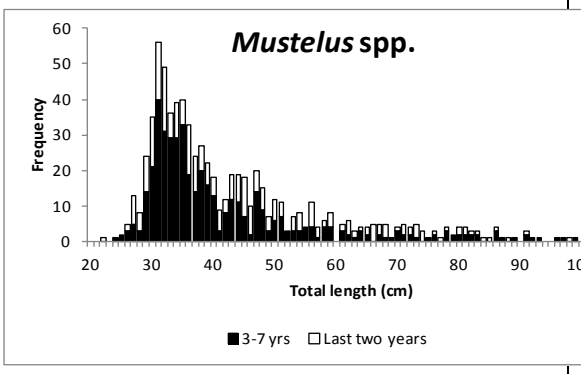
Survey data used:




Distribution and relative abundance of smooth-hounds in survey area (from Ellis, 2010).




Mean cpue of VIIaf smooth-hounds. Dashed lines give mean annual cpue for 2005–2009, red line shows mean annual cpue for 2010–2011.




Length distribution of smooth-hounds in beam trawl survey for the periods 2005–2009 and 2010–2011.

Distribution: Most abundant in the Bristol Channel and St George's Channel, although occasionally recorded in the northern parts of the Irish Sea.

Catch rates: Increasing.

Size distribution: Larger fish poorly sampled by the gear, so these data will not inform on the size distribution of the overall stock. In contrast, juveniles (including neonatal specimens with fresh umbilical scars) are captured, which may help with the identification of potential nursery grounds.

Overall status: Although the large size of this species means that adults are not sampled effectively in current surveys, stock status appears healthy.

Exploitation: It is considered that the current levels of exploitation are appropriate for the stock.

S21.2

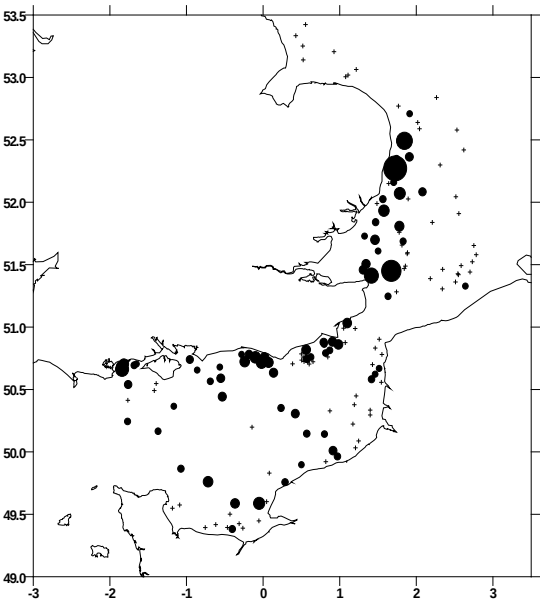
**Species: Smooth-hounds**

Survey area: IVc, VIId

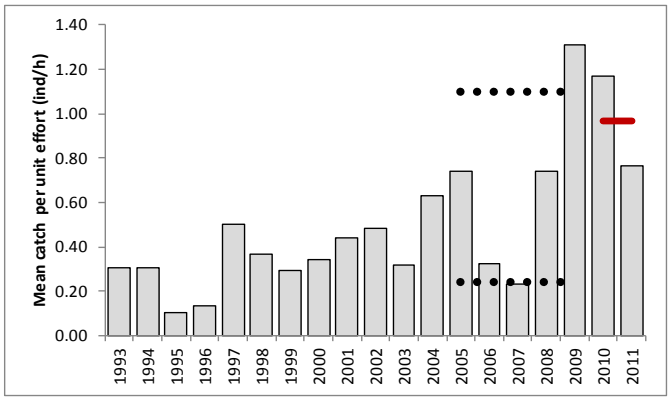
Survey acronym: UK (BTS-Q3)

Survey gear: 4 m Beam trawl with chain mat

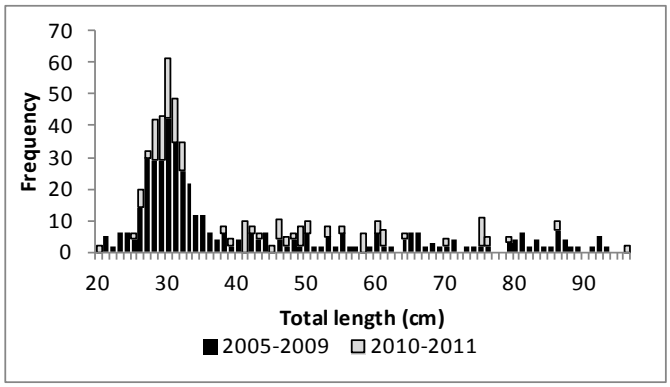
Survey data used:




Distribution and relative abundance of smooth-hounds in survey area (from Ellis, 2010)




Mean cpue of IVc–VIId smooth-hounds. Dashed lines give mean ± 1SD annual cpue for 2005–2009, red line shows mean annual cpue for 2010–2011.




Length distribution of smooth-hounds in beam trawl survey for the periods 2005–2009 and 2010–2011

Distribution: Widespread in coastal waters of the survey area, although these catches are comprised mostly of juveniles. Adults, which may occur in deeper waters, are better sampled in otter trawl surveys.

Catch rates: Mean catch rates in the last two years are amongst the highest in the time series, and the longer term trend has increased consistently.

Size distribution: Catches comprised mostly of immature fish, and although the survey may inform on younger age classes, the data for adult fish will be more limited (although these may be sampled by the French Channel GFS).

Overall status: Catch rates increasing and population appears healthy.

Exploitation: It is considered that current exploitation is appropriate for the stock.

# 22 Terms of Reference

## 22.1 Tor g; Review options for fine-scale taxonomic or geographical units for the provision of advice for demersal elasmobranchs

WGEF was requested to "Review options for fine-scale taxonomic or geographical units for the provision of advice for demersal elasmobranchs".

As discussed above, spatial management is a potentially valuable element for effective management of skate stocks, and also for other demersal elasmobranchs. However, assessments for elasmobranchs skates should, wherever possible, be based on biologically meaningful stock units. Data to delineate stocks are limited for many species (Pawson and Ellis, 2005), and in some circumstances advice may refer to 'management units'.

WGEF have considered the range of demersal elasmobranchs for which advice is required, as summarised below (Table 22.1), with this based on earlier work of members of the group (see Section 5.2 of CEC, 2003).

**Table 22.1a. Proposed stock/management units for angel shark, starry smooth-hound, starry ray and common skate complex in the ICES area.**

| FAMILY / STOCK | STOCK NAME | RATIONALE |
|---|---|---|
| Squatinidae | Angel shark *Squatina squatina* | |
| agn-nea | Angel shark (*Squatina squatina*) in the Northeast Atlantic | Stock structure is unknown, and it has been suggested that this species should be managed on the smallest possible spatial scale (CEC, 2003). Given the rarity of this species in the ICES area, advice is provided for the entire area, with information for specific locations of occurrence given where possible. |
| Triakidae | Starry smooth-hound *Mustelus asterias* | |
| trk-nea | Starry smooth-hound (*Mustelus asterias*) in the Northeast Atlantic | *Mustelus asterias* is thought to comprise a single Northeast Atlantic stock (CEC, 2003), and recent tagging studies would also support this (see Section 21). |
| Rajidae | Starry ray *Amblyraja radiate* | |
| rjr-234 | Starry ray (*Amblyraja radiata*) in Subareas II, IV and Division IIIa (Norwegian Sea, North Sea, Skagerrak and Kattegat) | This species occurs in the North Sea, Skagerrak and north to the Barents Sea. Studies in the wider North Atlantic have indicated clines in certain life history parameters, which may indicate different stocks. Given this species is largely a discarded bycatch in the North Sea, this is deemed the most appropriate management unit for advice. |
| Rajidae | Common skate *Dipturus batis*-complex | |
| rjb-34 | Common skate complex (*Dipturus batis* cf. *flossada* and *Dipturus* cf. *intermedia*) in Subarea IV and Division IIIa (North Sea, Skagerrak and Kattegat) | This large bodied skate is now known to comprise two species. The taxonomic revision has not been finalised, and so the two species are referred to as *Dipturus batis* complex. The likely outcome of the revision is that the more common species will be termed *Dipturus batis* (the form sometimes referred to as *D. flossada*) and flapper skate *D. intermedia.* The distribution of the two species within the common skate complex is highly uncertain, as much of the data collected over the last 100 years are confounded, and as there can be identification issues with other members of the genus. Furthermore, the northern, southern and western boundaries of the population range are also uncertain.<br>In the absence of information on stock units, ICES may only be able to provide advice for the species by management area (ecoregion). |
| rjb-celt | Common skate complex (*Dipturus batis* cf. *flossada* and *Dipturus* cf. *intermedia*) in Subarea VI and Divisions VIIa–c, e–j | |
| rjb-8 | Common skate complex (*Dipturus batis* cf. *flossada* and *Dipturus* cf. *intermedia*) in Subarea VIII (Bay of Biscay) | |

**Table 22.1b. Proposed stock/management units for catsharks (Scyliorhinidae) in the ICES area.**

| FAMILY/ STOCK | STOCK NAME | |
|---|---|---|
| Scyliorhinidae | Lesser-spotted dogfish *Scyliorhinus canicula* | |
| syc-347d | Lesser-spotted dogfish (*Scyliorhinus canicula*) in the Subarea IV and Division VIId (North Sea and eastern English Channel) | Available data led DELASS to assume that separate stocks occurred in separate ICES Divisions and that immigration and emigration from adjacent populations would be either insignificant or on a par (Heessen, 2003; CEC, 2003).<br>CEC (2003) considered that *S. canicula* populations would best be managed as local populations. Hence, analyses of existing trawl surveys across the various ecoregions may form the basis of the most pragmatic management units.<br>Advice should be given for at the the ecoregion level at the present time. |
| syc-celt | Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea VI and Divisions VIIa–c, e–j (Celtic Sea and west of Scotland) | |
| syc-bisc | Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIa,b,d (Bay of Biscay) | |
| syc-8c9a | Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions VIIIc and IXa (Atlantic Iberian waters) | |
| Scyliorhinidae Greater-spotted dogfish *Scyliorhinus stellaris* | | |
| syt-celt | Greater-spotted dogfish (*Scyliorhinus stellaris*) in the Celtic Seas and adjacent areas | Stock units unclear. Given that few surveys sample this species effectively (due to it occurring on rocky, inshore grounds), trends in relative abundance are only available for a few areas (e.g. VIIa).<br>Hence, management advice is only provided for the Celtic Seas ecoregion. This species is less common in other ecoregions, and so advice cannot be provided at the present time. |
| Scyliorhinidae | Black-mouth dogfish *Galeus melastomus* | |
| sho-celt | Black-mouth dogfish (*Galeus melastomus*) in the Celtic Seas | Stock units unclear. In the absence of other information, the management units and advice may be provided at ICES ecoregion level (as per *S. canicula*) |
| sho-bisc | Black-mouth dogfish (*Galeus melastomus*) in the Bay of Biscay and Atlantic Iberian waters | |

**Table 22.1c. Proposed stock/management units for skates of the genus *Leucoraja* in the ICES area.**

| Rajidae | Cuckoo ray *Leucoraja naevus* | |
|---|---|---|
| rjn-34 | Cuckoo ray (*Leucoraja naevus*) in Subarea IV and Division IIIa (North Sea, Skagerrak and Kattegat) | Stock units are unclear for this widely-distributed offshore species. Earlier studies have reported differences in the parasites and life history parameters between North Sea and Celtic Sea populations (e.g. Pawson and Ellis, 2005; McCully *et al.*, 2012).<br>Recent analyses of commercial catch data (Figure 22.1) indicate that the northern Bay of Biscay may be confluent with the Celtic Sea, and further studies on this are required. Until further data on stock identity are available, WGEF suggest that this species is managed in the following management units (i) North Sea, (ii) Celtic Seas, (iii) Bay of Biscay and (iv) western Iberia IXa. |
| rjn-celt | Cuckoo ray (*Leucoraja naevus*) in Subarea VI and Divisions VIIa–c, e–j, | |
| rjn-bisc | Cuckoo ray (*Leucoraja naevus*) in Subarea VIII (Bay of Biscay and Cantabrian Sea) | |
| rjn-pore | Cuckoo ray (*Leucoraja naevus*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) | |
| **Rajidae** | **Sandy ray *Leucoraja circularis*** | |
| rji-celt | Sandy ray (*Leucoraja circularis*) in the Celtic Seas and adjacent areas | This little-known species has an offshore distribution, and stock units are unknown. In the absence of other information, advice is provided for the species in the Celtic Seas ecoregion (the area for which most data are available), although the distribution extends to the northern North Sea and south to Biscay. |
| **Rajidae** | **Shagreen ray *Leucoraja fullonica*** | |
| rjf-celt | Shagreen ray (*Leucoraja fullonica*) in the Celtic Seas and adjacent areas | This little-known species has an offshore distribution, and stock units are unknown. In the absence of other information, advice is provided for the species in the Celtic Seas ecoregion (the area for which most data are available), although the distribution extends to the northern North Sea and south to Biscay. |

**Table 22.1d. Proposed stock/management units for blonde ray *Raja brachyura* and small-eyed ray *Raja microocellata* in the ICES area.**

| Rajidae | Blonde ray *Raja brachyura* | |
|---|---|---|
| rjh-4c7d | Blonde ray (*Raja brachyura*) in Divisions IVc and VIId (Southern North Sea and eastern English Channel) | This species is locally abundant in parts of the ICES area and the combination of the observed distribution and perceived habitat preference for sandy substrates in coastal waters are used to suggest the nominal stock units / management units.<br>Although data are often limited for this species, WGEF currently consider the following five units:<br>Southern North Sea (IVc) and eastern English Channel (VIId)<br>Scotland (IVa and VIa)<br>Irish Sea and Bristol Channel (VIIa,f,g)<br>Western English Channel (VIIe)<br>Western Iberia (IXa)<br>Issues that still need to be better resolved include (i) whether the western Channel population is discrete, or confluent with VIId or VIIa,f-g, (ii) the status of this species on the grounds west of Ireland (VIIb,j), and (iii) the status of this species in Subarea VIII. |
| rjh-4a6a | Blonde ray (*Raja brachyura*) in the northwestern North Sea (IVa) and west of Scotland (Subarea VI) | |
| rjh-7afg | Blonde ray (*Raja brachyura*) in Divisions VIIa, f, g | |
| rjh-7e | Blonde ray (*Raja brachyura*) in Divisions VIIe | |
| rjh-pore | Blonde ray (*Raja brachyura*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) | |
| Rajidae | Small-eyed ray *Raja microocellata* | |
| rje-7de | Small-eyed ray (*Raja microocellata*) in English Channel (Divisions VIId,e) | This species is locally abundant in parts of the western English Channel (Channel Islands and Brittany), with larger juveniles also taken elsewhere in the Channel The combination of the observed distribution and perceived habitat preference for sandy substrates in coastal waters are used to suggest this possible stock unit and management unit. |
| rje-7ag | Small-eyed ray (*Raja microocellata*) in Bristol Channel (Division VIIf,g) | This species is locally abundant in the Bristol Channel (VIIf) and larger individuals range into the northern Celtic Sea (VIIg). The combination of the observed distribution and perceived habitat preference for sandy substrates in coastal waters are used to suggest this possible stock unit and management unit. |

**Table 22.1e. Proposed stock/management units for thornback ray *Raja clavata* and spotted ray *Raja montagui* in the ICES area.**

| Rajidae | Thornback ray *Raja clavata* | |
|---|---|---|
| rjc-347d | Thornback ray (*Raja clavata*) in Subarea IV and in Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat, and eastern English Channel) | This species is locally abundant in several parts of the ICES area and the combination of the observed distribution and knowledge from tagging studies are used to suggest the nominal stock units / management units. WGEF currently consider the following six units:<br>North Sea, Skagerrak, Kattegat, and English Channel (Subarea IV and in Divisions IIIa and VIId)<br>West of Scotland (VIa) and west of Ireland (VIIb,j)<br>Irish Sea and Bristol Channel (VIIa,f,g)<br>Western English Channel (VIIe)<br>Bay of Biscay (VIII)<br>Western Iberia (IXa).<br>Issues that still need to be better resolved include (i) whether the western Channel population is discrete or would it be better related to VIId or VIIa,f-g, (ii) status of this species in the various Divisions of sub-area VIII. |
| rjc-67bj | Thornback ray (*Raja clavata*) in Subarea VI | |
| rjc-7afg | Thornback ray (*Raja clavata*) in Divisions VIIa, f, g | |
| rjc-7e | Thornback ray (*Raja clavata*) in Division VIIe | |
| rjc-bisc | Thornback ray (*Raja clavata*) in Subarea VIII (Bay of Biscay and Cantabrian Sea) | |
| rjc-pore | Thornback ray (*Raja clavata*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) | |
| Rajidae | Spotted ray *Raja montagui* | |
| rjm-347d | Spotted ray (*Raja montagui*) in Subarea IV and in Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat, and eastern English Channel) | This species is locally abundant in several parts of the ICES area and the combination of the observed distribution and knowledge from tagging studies are used to suggest the nominal stock units / management units. WGEF currently consider the following five units:<br>North Sea, Skagerrak, Kattegat, and eastern English Channel (Subarea IV and in Divisions IIIa and VIId)<br>West of Scotland (VIa) and west of Ireland (VIIb,j)<br>Irish Sea, Bristol Channel and Celtic Sea (VIIa,e,f–h)<br>Bay of Biscay (VIII)<br>Western Iberia (IXa). |
| rjm-67bj | Spotted ray (*Raja montagui*) in Subarea VI and Divisions VIIbj | |
| rjm-7aefg | Spotted ray (*Raja montagui*) in Divisions VIIa, e, f-h | |
| rjm-bisc | Spotted ray (*Raja montagui*) in Subarea VIII (Bay of Biscay and Cantabrian Sea) | |
| rjm-pore | Spotted ray (*Raja montagui*) in Division IXa (west of Galicia, Portugal, and Gulf of Cadiz) | |

**Table 22.1f. Proposed stock/management units for undulate ray *Raja undulata*, white skate *Rostroraja alba* and other skates in the ICES area.**

| Rajidae | Undulate ray *Raja undulata* | |
|---|---|---|
| rju-7de | Undulate ray (*Raja undulata*) in Divisions VIId, e (English Channel) | The observed distribution of this species indicates a preference for coastal waters (mostly <50 m water depth), often in close association with bays and outer estuaries (Ellis *et al.*, 2012).<br>Given its patchy distribution, the species is presumed to have discrete stocks, which would also form appropriate management units.<br>Data to inform on some of these stocks are very limited, although given that this species can be locally abundant, advice should be provided for small management units where possible. |
| rju-7j | Undulate ray (*Raja undulata*) in Division VIIj (southwest Ireland) | |
| rju-8ab | Undulate ray (*Raja undulata*) in Division VIIIa,b (Bay of Biscay) | |
| rju-8c | Undulate ray (*Raja undulata*) in Divisions VIIIc (Cantabrian Sea) | |
| rju-9a | Undulate ray (*Raja undulata*) in Divisions IXa (Galicia and Portugal) | |
| **Rajidae** | **White skate *Rostroraja alba*** | |
| rja-nea | White skate (*Rostroraja alba*) in the Northeast Atlantic | Stock structure is unknown. Given the rarity of this species in the ICES area, advice should be provided at species-level for the entire area, with information for specific locations of occurrence given where possible. |
| **Rajidae** | **Other skates** | |
| raj-347d | Other ray and skate species in Subarea IV and in Divisions IIIa and VIId (North Sea, Skagerrak, Kattegat, and eastern English Channel) | ICES may only be able to provide qualitative advice for the other skate species in these ecoregions, which include species such as Norwegian skate *Dipturus oxyrinchus*, long-nosed skate *D. oxyrinchus* and round skate *Rajella fyllae.* |
| raj-celt | Other ray and skate species in Subarea VI and Divisions VIIa–c, e–j | |
| raj-89a | Other skates and rays in Subarea VIII and Division IXa (Bay of Biscay and Atlantic Iberian waters) | ICES may only be able to provide qualitative advice for the other skate species in this ecoregion, which include species such as Norwegian skate *Dipturus oxyrinchus*, long-nose skate *D. oxyrinchus,* Iberian pygmy skate *Neoraja iberica* and brown ray *Raja miraletus.* |
| raj-mar | Rays and skates (mainly thornback ray *Raja clavata*) in ICES Subareas X, XII, and XIV (Azores and Mid-Atlantic Ridge) | ICES may be able to provide advice for the main species in the area, *Raja clavata*, with information on other species reported from the area (e.g. *Dipturus batis*-complex, long-nosed skate *D. oxyrinchus*, shagreen ray *Leucoraja fullonica*, blonde ray *Raja brachyura* and *Raja maderensis*) very limited. |

### 22.1.1 References

CEC. 2003. Commission staff working paper. Report of *ad hoc* working group elasmobranch fisheries. Brussels, 22–25 July 2003. Commission of the European Communities, Brussels, 5.12.2003 SEC(2003)1427, 207 pp.

Ellis, J. R., McCully, S. R. and Brown, M. J. 2012. An overview of the biology and status of undulate ray *Raja undulata*. Journal of Fish Biology, 80: 1057–1074.

Heessen, H. J. L. Ed. 2003. Development of Elasmobranch Assessments – DELASS. DG Fish Study Contract 99/055, Final Report.

McCully, S. R., Scott F. and Ellis J. R. 2012. Length at maturity and conversion factors for skates (Rajidae) around the British Isles, with a critique of earlier studies. ICES Journal of Marine Science, 69: 1812–1822.

Pawson, M. G. and Ellis, J. R. 2005. Stock identity of elasmobranchs in the North-east Atlantic in relation to assessment and management. Journal of Northwest Atlantic Fishery Science, 35: 173–193.

Tétard, A. 2013. Distribution of elasmobranchs from the French program of observations at sea aboard fishing vessels (ObsMer). Working Document presented to the Working Group on Elasmobranch Fishes, 24 pp.

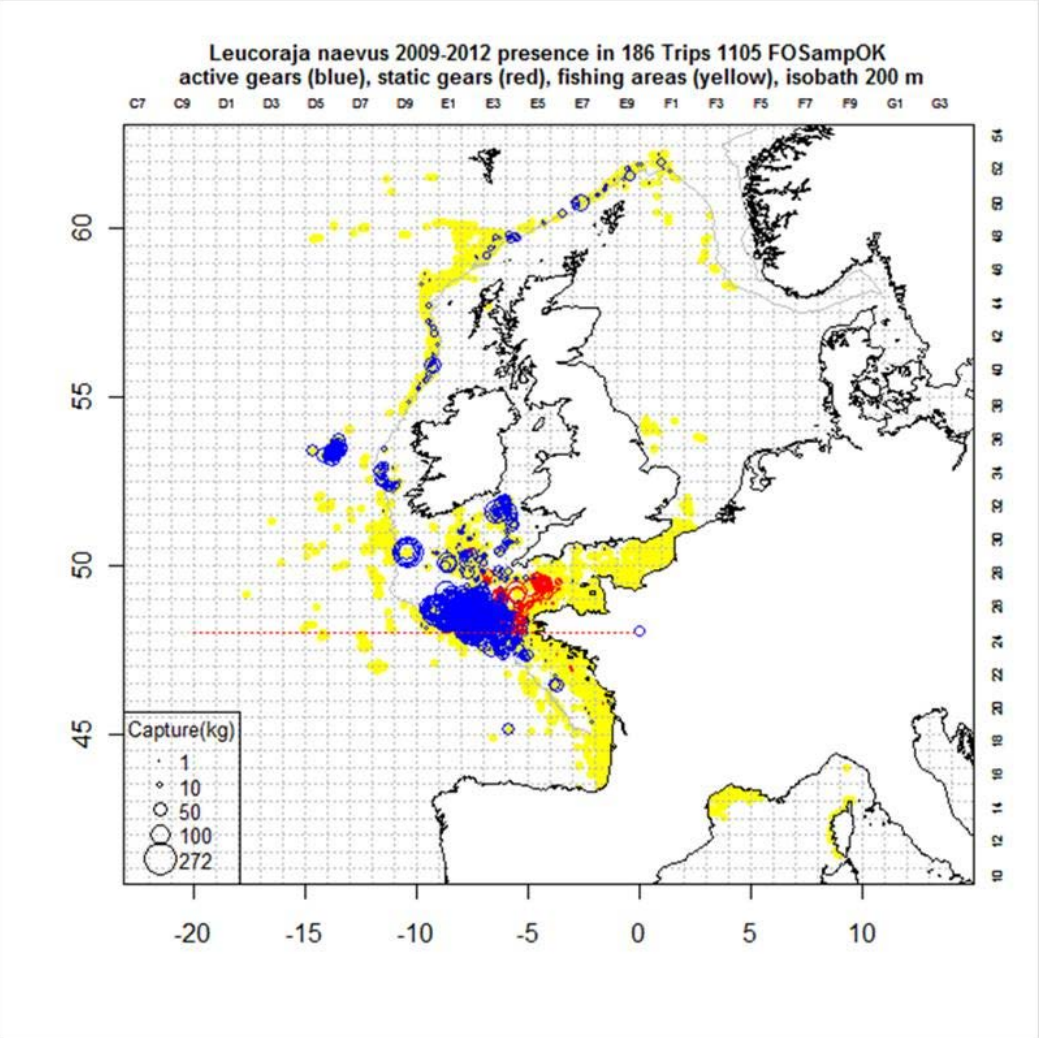



**Figure 22.1. Distribution of cuckoo ray *Leucoraja naevus* as observed in the French observer programme (Source: Tétard, 2013 WD).**

## 22.2 Tor h; Determine additional data requirements for certain statistical and model techniques for 2014 stock assessment cycle

### 22.2.1 Statistical and model techniques

The type of statistical and modelling techniques used to conduct a stock assessment is strictly dependent on the type, quantity and quality of data available. ICES recognise six main categories of stocks, ranging from those with an analytical assessment available to stocks where only scarce landings information exists. The application of the ICES framework to each of these categories and the biological information used in the categorisation is discussed in the General context of ICES advice and it is also applicable to elasmobranchs.

#### Trends from surveys and cpue

Within WGEF, analytical stock assessment models are used currently in the assessments of two species only; porbeagle and spurdog, the former conducted in association with ICCAT. For the other species, WGEF followed the latest ICES guidelines on the assessment of data-poor stocks (ICES 2012).

Most of the stocks are assessed by ICES using survey trends although surveys in the ICES area are not specifically designed for elasmobranchs, which results on a high frequency of zero-catch data for most species. Nevertheless, for some species of elasmobranchs, it is possible to obtain valuable abundance data from the surveys. To overcome these data limitations and to deal with the large amount of zero-catches, and to standardize the fishery-independent abundance indexes for each stock unit, generalized linear mixed models (GLMM) have been suggested, particularly by assuming a Tweedie distribution for the observations (Figueiredo and Serra-Pereira, 2013 WD). One of the main purposes of applying a GLMM is to incorporate in the model random variables (e.g. stations, depths, survey methodology, etc.), which could account for the differences between years or within each year.

A working document was presented, in which the abundance of *Raja clavata* from IXa (mainland Portugal - autumn IBTS) was modelled taking into consideration the geographical distribution of the species, together with the area covered by the survey (Figueiredo and Serra-Pereira, 2013 WD). The results obtained are considered as a promising tool for future standardisation of cpue of several elasmobranchs species (Figueiredo and Serra-Pereira, 2013 WD).

Research on assessment and monitoring methods has primarily focused on fisheries with long multivariate datasets. Less research exists on methods applicable to data-limited fisheries. The capabilities of (seasonal) autoregressive integrated moving average ((S)ARIMA) models to fit, forecast, and monitor the landings-per-unit of effort (lpue) of the cuckoo ray *Leucoraja naevus* caught off Peniche (Portugal) under a statistical process control framework were examined (Prista *et al.*, 2013 WD). Daily landings and vessel trips were compiled into a monthly time-series of lpue. The time-series was further divided into a fitting period (2006–2010) and a forecasting/monitoring period (2011–2012). The adjustment of SARIMA model gave a good fit to the lpue data and adequately modelled the correlation in the time-series data. Overall, even if not being assessment models, SARIMA models proved good capabilities to fit and forecast the *L. naevus* lpue data, detecting major events that took place in the fishery. The SARIMA statistical process control methods will be worth further investigation within efforts to improve monitoring coverage of WGEF species as they

provide an objective and statistically sound means of analyzing routinely collected data.

#### Stocks with catch data only

When only reliable time-series of catch data are available, DCAC (Depletion-Corrected Average Catch) can be applied to deriving MSY reference point. DCAC (available in the NOAA toolbox http://nft.nefsc.noaa.gov/DCAC.html), is a "simple formula for estimating sustainable yields in data-poor situations" as stated in the original article on this model (MacCall, 2009). The formula is an extension of the potential yield formula, and it provides useful estimates of sustainable yield for data-poor fisheries on long-lived species. Over an extended period, e.g. a decade or more, the catch is divided into a sustainable yield component and an unsustainable "windfall" component associated with a one-time reduction in stock biomass. The size of the windfall is expressed as being equivalent to a number of years of sustainable production, in the form of a "windfall ratio". The DCAC is calculated as the sum of catches divided by the sum of the number of years in the catch series and the windfall ratio. Over a period of time, the windfall, i.e. the unsustainable part of the catch, corresponds to the stock biomass depletion. The input information to DCAC is:

- $\Sigma C$, the cumulated catches over the considered time-series;
- n, the number of years;
- $\Delta$ the relative reduction in biomass during the period;
- M the natural mortality, which should not exceed 0.2;
- c the assumed ratio of FMSY to M.

The input values are expected to be approximate, and based on the estimates of their imprecision, the uncertainty can be integrated by Monte Carlo exploration of DCAC values. It must however be kept in mind that the input values and, moreover, their variance are guess estimates in data-poor situations.

#### Estimation of total mortality

To estimate the impact of the fisheries on a given stock and to assess its stock status in respect to MSY, an estimate of the total mortality (Z) exerted on the stock is required. Although many elasmobranch species are not caught in sufficient amounts to allow for analytical methods to be applied, a selection of species with high level of landings and/or discards could be identified for each ecoregion.

This should be done for a restricted set of species and stock units for which data are sufficient to develop an analytical assessment model. For these species, all available data on length distribution of the catches and surveys and biological parameters (i.e. growth, natural mortality, fecundity, discard survival, etc.) should be collated and used for developing length-based stock assessment model.

Age data can be then derived from length data using statistical slicing methodology (Kell and Kell, 2011; Scott *et al.*, 2011). Pseudocohorts analysis can be then used to derive a first estimation of total mortality. More data demanding methods as VPA models can also be used when in the future sufficient long time-series of length data will be available (a rule of thumb is to have a minimum of five years). An intersessional work should be organised prior to the next WGEF to define the list of species, assemble available data and run preliminary models.

Total mortality (Z) can be also estimated using a mean length approach derived by Gedamke and Hoenig (2006) which does not require equilibrium conditions. The

fundamental concept is based on the same premise as the Beverton and Holt mortality estimator (1957):

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c}$$

having the same minimal data requirements and therefore potential for widespread use. The only information required to obtain an estimate of Z is the von Bertalanffy growth parameters K and $L_{inf}$ (growth rate and length at infinite, respectively), the so-called length of first capture (smallest size at which animals are fully vulnerable to the fishery and to the sampling gear; Lc) and a time-series of the mean length ( $\bar{L}$ ) of the individuals above Lc. The methodology and a practical application are described in detail in Gedamke and Hoenig (2006) and have been already used for elasmobranchs (Gedamke *et al*., 2008).

#### Data requirements

*DCAC*

WGEF considered the use of DCAC for elasmobranchs and identified that a major problem, which is common to most elasmobranch stocks, is the lack of long time-series of catch data. The use of DCAC for aggregated species (e.g. demersal rays) was discussed but it was not considered relevant owing to the large range of different life histories rays species living in a given ecosystem.

Data requirement for the application of DCAC are (i.) review the historical catch composition data of elasmobranch to derive time-series of catch by species and (ii.) improved reporting of catches (landings and discards), including species under 0 TACs, by species in the future.

#### Mortality rates

For the estimation of *Z* using the method from Gedamke and Hoeing (2006) or any of other methods described above, the data requirements are length distributions of the catch (landings and discards) or length distributions derived from surveys, and stock specific biological parameters. The collection of such data has been improved in recent years owing to the DCF and national programs (including data collected by the industry and on-board observation) and therefore this methodology might be applied for several stocks of elasmobranch in the future.

#### Cpue and total catches

A method has been recently developed to assess cpues and total catch using on-board observations and VMS data using a spatial "nested grid" (see Section 3 Deep-water sharks: Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (IV–XIV)). It has the potential to provide trends of cpues and total catch of these species. Data requirement to apply the "nested grid" method include, raw, i.e. haul-by-haul, on-board observation data and VMS coverage of the relevant fleet. This is available for offshore fleet such as the French deep-sea fishing fleet, VMS data are more problematic for coastal fleets were a proportion of vessels have an overall length less than 15 m. Data processing is a time-consuming process that cannot be accomplished during the WGEF meeting. So it is required that length distribution of the catch and of the surveys, cpue and catch trends need to be prepared well in advance the 2014 WGEF meeting.

### 22.2.2 References

Beverton, R.J.H. and Holt, S.J. 1957. On the dynamics of exploited fish populations. U.K. Ministry of Agriculture, Fisheries, Food, and Fishery Investigations Series II, Vol. XIX.

Figueiredo, I. and Serra-Pereira, B. 2013. Modelling *Raja clavata* abundance from Portuguese IBTS data (1990–2011) using GLMM with Tweedie distribution. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013.

Gedamke T. and Hoenig, J.M. 2006 Estimation of mortality from mean length data in non-equilibrium situations, with application to monkfish (*Lophius americanus*). Trans Amer Fish Soc 135:476–487.

Gedamke, T., Hoenig, J.M., Dupaul, W.D. and Musick, J.A. 2008. Total mortality rates of the barndoor skate, *Dipturus laevis*, from the Gulf of Maine and Georges Bank, United States, 1963–2005. Fisheries Research, 89: 17–25 DOI: 10.1016/j.fishres.2007.08.014.

ICES. 2012. ICES implementation of advice for data-limited stocks in 2012 in its 2012 advice. ICES CM 2012/ACOM 68. 42pp.

Kell, L. and Kell, A. 2011. A comparison of age slicing and statistical age estimation for Mediterranean Swordfish (*Xiphias gladius*). Collect. Vol. Sci. Pap. ICCAT, 66(4): 1522–1534.

MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. ICES Journal of Marine Science 66(10), 2267–2271.

Prista, N., Serra-Pereira, B., Figueiredo, I. 2013. Using SARIMA models for monitoring landings-per-unit effort of cuckoo ray *Leucoraja naevus*: a methodological proposal. Working Document presented at the Working Group on Elasmobranch Fishes (WGEF) meeting, 17–21th June, 2013. WD16.

Scott. F, Osio. C, and Cardinale, M. 2011. Comparison of age slicing methods. Luxembourg: Publications Office of the European Union EUR – Scientific and Technical Research series – ISSN 1831-9424.

## 22.3 Tor I; Consider the application of the Marine Strategy Framework Directive indicators for elasmobranchs

### 22.3.1 Background MSFD

On 17th June 2008 the EU signed up to the Directive establishing a framework for community action in the field of environmental policy (Marine Strategy Framework Directive) with the aim to establish a framework within which member states shall take the necessary measures to achieve or maintain good environmental status (GES) in the marine environment by the year 2020 at the latest (EU-COM, 2008). And which would "*…contribute to coherence between different policies and foster the integration of environmental concerns into other policies, such as the Common Fisheries Policy…*"

In 2010 the Commission published a decision paper on "General conditions of application of the criteria for good environmental status as well as criteria for good environmental status relevant to the descriptors of Annex I to Directive 2008/56/EC (EU-COM, 2010)". The application of the indicators belonging to these criteria as a means of assessing the good environmental status of elasmobranch stocks are the subject of this term of reference.

In 2011 the WGEF gave an overview of MSFD and the elements of WGEF work that may help determine the status for MSFD descriptors and determining 'Good Environmental Status' (ICES, 2011). In the present report this term of reference will take the work a step further by looking at the indicators in more detail and also gives an update of the progress made in each of the member countries.

The issues addressed are:

- Relevance of indicators for elasmobranch species;
- Definition of good environmental status (GES);
- Progress per country.

### 22.3.2 Relevance of indicators for elasmobranch species

#### Background

In the 2008 document, eleven descriptors for determining Good Environmental Status were defined (EU-COM, 2008). Of the eleven descriptors two are especially relevant for elasmobranchs:

Descriptor 1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

Descriptor 3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

Descriptors 4 and 6 also have indicators which could be complementary to the above.

Descriptor 4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

Descriptor 6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

#### Relevance of indicators

Each of the descriptors has a number of indicators which can be quantified. The application of the indicators to elasmobranchs was discussed by the group. In Tables 22.1 to 22.4 there is an overview of the indicators and their relevance for elasmobranchs for the descriptors 1, 3, 4 and 6 as determined by expert judgement from the WGEF.

**Table 22.1. Descriptor 1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.**

| Level | Criterion | Indicator | Appropriate | Data available |
|---|---|---|---|---|
| Species | 1.1 Species distribution | 1.1.1 Distributional range<br>1.1.2 Distributional pattern within the latter, where appropriate<br>1.1.3 area covered by the species (for sessile/benthic species) | Very important as range contractions and extirpations have been observed | Survey data provide the best time series of species-specific information. However, existing surveys were not designed to sample elasmobranchs, and so there can be limitations to surveys, in terms of gear catchability and distribution of survey stations. Additionally, these data may be limited for the rarer species.<br>Data from observer programmes are also important. |
| | 1.2 Population size | 1.2.1 Population abundance and/or biomass, as appropriate | Appropriate but existing data only for main commercial species (D1) | Current surveys not generally designed for elasmobranchs neither the gear used These data may be limited for the rarer species and for depths sampled. |
| | 1.3 Population condition | 1.3.1 Population demographic characteristics<br>1.3.2 population genetic structure, where appropriate | 1.3.1 Important but given long generation times of elasmobranchs needs long time series exception is occurrence of large individuals as females > males and fecundity increases with size.<br>1.3.2 potentially important, but see 1.3.1 for comment on generation times. | 1.3.1 Difficult to collect enough information to identify short-term variance<br>1.3.2 Little knowledge of genetics |

| Level | Criterion | Indicator | Appropriate | Data available |
|---|---|---|---|---|
| Habitat | 1.4 Habitat distribution | 1.4.1 Distributional range<br>1.4.2 Distributional pattern | Some habitats important for elasmobranchs, e.g. for reproduction; but this indicator is for habitats per se | Little knowledge of direct association species and habitats. |
| | 1.5 Habitat extent | 1.5.1 Habitat area<br>1.5.2 Habitat volume, where relevant | | |
| | 1.6 Habitat condition | 1.6.1 Condition of the typical species and communities<br>1.6.2 Relative abundance and/or biomass, as appropriate<br>1.6.3 Physical, hydrological and chemical conditions | | |
| Ecosystem | 1.7 | 1.7.1 Composition and relative proportions of ecosystem components (habitats and species) | Elasmobranchs are an important part of fish assemblages and as such will be included within analyses of survey data. | See comments for 1.1 and 1.2 |

General comment: Criteria 1.1 and 1.2 are the most important for elasmobranch species, 1.3 less relevant. Importance of habitats for life cycle of demersal elasmobranchs could be addressed in Descriptor 6, rather than 1.4 above.

**Table 2.2. Descriptor 3: Populations of commercially exploited and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. Secondary indicators are shaded and are meant to be applied only if the primary indicators cannot be quantified.**

| Criterion | Indicator | Appropriate | Data available |
|---|---|---|---|
| 3.1. Level of pressure of the fishing activity | 3.1.1 Fishing mortality (F) | Very important | Data limited for species taken in mixed fisheries |
| | 3.1.2 Ratio between catch and biomass index | Proxies for F should be considered | Some work done by ICES, but not specifically for elasmobranchs |
| 3.2. Reproductive capacity of the stock | 3.2.1 Spawning–Stock Biomass (SSB) | Very important | Data limited for species taken in mixed fisheries |
| | 3.2.2 Biomass indices | Very important - cpue possible | Scientific surveys can provide proxies for main commercially important demersal elasmobranch species.<br>Commercial catch and effort data, including landings, may be used. |
| 3.3. Population age and size distribution | 3.3.1 Proportion of fish larger than the mean size at sexual maturation | A high absolute abundance of large mature elasmobranchs is an important goal. Assessing this through proportional indicators is not informative as patchy distribution and catches can lead to bias for all proportional indicators.<br>Looking at juveniles and adults separately may be more informative. | Existence of artefacts in survey data precludes meaningful conclusions.<br>Dedicated research will be needed. |
| | 3.3.2 Mean maximum length across all species found in research vessel surveys | Not appropriate | |
| | 3.3.3 95 percentile of the fish length distribution found in research vessel survey | See 3.3.1 | |

| Criterion | Indicator | Appropriate | Data available |
|---|---|---|---|
| | 3.3.4 Size of first sexual maturation which may reflect the extent of undesirable effects of genetic effects of exploitation | Important but given long generation times of elasmobranchs needs long time-series. It is also noted that females may attain a larger size than males, and fecundity increases with size. | Difficult to collect enough information to identify short-term variance |

General comments: The indicators for population age and size distribution (3.3.1-3.3.4) were not considered to be informative for elasmobranchs at the present time, given the lack of data. This is particularly true for lesser-known species. For species with patchy distributions, a chance catch of large numbers of juvenile or adult fish would lead to high variability in metrics based on the proportions of large fish.

**Table 2.3. Descriptor 4: all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.**

| Criterion | Indicator |
|---|---|
| 4.1. Productivity (production per unit biomass) of key species or trophic groups | 4.1.1 Performance of key predator species using their production per unit biomass (productivity) |
| 4.2. Proportion of selected species at the top of foodwebs | 4.2.1 Large fish (by weight) |
| 4.3. Abundance/distribution of key trophic groups/species | 4.3.1. Abundance trends of functionally important selected groups/species |

General comments: Descriptor 4 still needs some work. It is necessary to identify changes in population status potentially affecting foodweb structure. Detailed indicators need to be further specified, taking account their importance to the food webs, on the basis of suitable groups/species in a region, sub-region or subdivision, including where appropriate:

- groups with fast turnover rates (e.g. phytoplankton, zooplankton, jellyfish, bivalve molluscs, short-living pelagic fish) that will respond quickly to ecosystem change and are useful as early warning indicators;
- groups/species that are targeted by human activities or that are indirectly affected by them (in particular, by-catch and discards);
- habitat-defining groups/species;
- groups/species at the top of the foodweb;
- long-distance anadromous and catadromous migrating species;
- groups/species that are tightly linked to specific groups/species at another trophic level.

General comments: Indicators for descriptor 4 are still under development and offer possibilities for fine-tuning for the specific requirements for elasmobranchs.

**Table 2.4. Descriptor 6: sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.**

| CRITERION | INDICATOR |
|---|---|
| 6.1. Physical damage, having regard to substrate characteristics | 6.1.1 Type, abundance, biomass and areal extent of relevant biogenic substrate |
| | 6.1.2 Extent of the seabed significantly affected by human activities for the different substrate types |
| 6.2. Condition of benthic community | 6.2.1 Presence of particularly sensitive and/or tolerant species |
| | 6.2.2 Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species |
| | 6.2.3 Proportion of biomass or number of individuals in the macrobenthos above some specified length/size |
| | 6.2.4 Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community |

General comments: integrity of sea-floor habitats is important for the demersal elasmobranch species for feeding and reproductive purposes. Indicators to ensure this can be modified from the above.

### 22.3.3 Definition of Good Environmental Status (GES)

Each descriptor has a suite of indicators which taken together can determine GES for that particular descriptor. However, this is, in practice, not that straightforward. Issues are:

- Reference points: which baseline to use; can we identify historical reference point (ICES 2012) or should trend-based targets be identified (Probst *et al*., 2013; Greestreet *et al*., 2012). If an historical reference point is used, then how should the relevant period be selected.
- Data sources: There is a rationale for taking available data, e.g. IBTS, and use it for as many species as practical, BUT should species of interest/concern be identified *a priori* and then relevant data collected to support the development of quantitative indicators. Given that WGEF has found discrepancies in DATRAS data often due to erroneous species identification these data, although valuable, need appropriate quality control or interpretation.
- Geographical resolution and coherence between countries: member states have an individual reporting obligation , but the stocks of most of the species will almost certainly cross country borders. Some level of international coordination is necessary.
- The sum of indicators which point to GES does not necessarily lead to ecosystem health. See also Greenstreet *et al*. (2012). It might be sensible in this case to invest time in the fine-tuning of indicator 1.7. Also there is room for fine-tuning in descriptor 4 (see chapter 22.5.3 Relevance of indicators). In this respect, coordination with OSPAR is recommended. OSPAR is currently researching a 'broader monitoring and assessment framework for biodiversity which follows an ecosystem approach' and which 'will provide a basis for biodiversity targets and indicators' and

which will be especially relevant for MSFD (http://www.ospar.org/html_documents/ospar/html/ospar_towards_ges_nea.pdf).

- The criteria for species selection should be defined. The use of PSA for the identification and ranking of vulnerable species could function as a first step to listing the species (see Tor j included in this section). This should be explored and again international coordination is required.

### 22.3.4 Progress per country

The member countries provided information on the status of the implementation of MSFD for elasmobranchs.

#### Overview

The country information provided has been summarised in Table 2.5 for certain parameters.

**Table 2.5. Overview of country information. Not all countries were able to provide information for the WGEF meeting. This table represents work in progress.**

| Country | Descriptor | Species selected | Indicators used | GES defined | Results for elasmobranchs |
|---|---|---|---|---|---|
| Belgium | 1, 3, 4 & 6 | Yes | Own suite of indicators | Yes if all indicators are 'met' | No |
| Denmark | | | | | |
| France | | | | | |
| Germany | 1 | No | Not yet | No | No |
| Ireland | 1 | Yes | 1.1, 1.2, 1.3 | No – trends only | Yes |
| | 3 | | 3.1, 3.2 | GES using MSY ref points | Yes |
| Netherlands | 1 | In progress | In progress | Recovery in accordance with CPOA Sharks | Not yet |
| Spain | 1, 3, 4 & 6 | Yes | Yes | Yes | Yes |
| Portugal - mainland | 1 | Yes | 1.2.1 | GES historical | Yes |
| | 3 | Yes | 3.1, 3.3 | GES historical | Yes |
| Sweden | 1 | No | 1.1.1, 1.1.2, 1.2.1, 1.6.1 | High level definition but not specified | |
| | 3 | Yes | Not yet | High level definition but not specified | |

| COUNTRY | DESCRIPTOR | SPECIES SELECTED | INDICATORS USED | GES DEFINED | RESULTS FOR ELASMOBRANCHS |
|---|---|---|---|---|---|
| UK | 1,4 | In part | Under development | In part | In part. Proposed metrics are applicable to those fish species sampled adequately in international and national bottom trawl groundfish surveys |

The species selected per descriptor, per country is presented in Table 2.6.

**Table 2.6. Species selected per descriptor per country.**

| SPECIES | DESCRIPTOR 1 | DESCRIPTOR 3 | DESCRIPTOR 4 | DESCRIPTOR 6 |
|---|---|---|---|---|
| Spurdog (*Squalus acanthias*) | Ireland | Ireland | | |
| Lesser spotted dogfish (*Scyliorhinus canicula*) | Ireland, Belgium, Spain, Portugal | Ireland, Belgium, Sweden, Spain | Belgium | Belgium |
| Blackmouth catshark (*Galeus melastomus*) | Spain, Portugal | Spain | | |
| Basking shark | | Sweden | | |
| Thornback ray (*Raja clavata*) | Ireland, Belgium, Spain | Ireland, Belgium, Spain, Portugal | Belgium | Belgium |
| Blonde ray (*Raja brachyura*) | | Portugal | | |
| Cuckoo ray (*Raja naevus*) | Ireland, Spain | Ireland, Portugal | | |
| Spotted ray (*Raja montagui*) | | Portugal | | |
| Portuguese dogfish (*Centroscymnus coelolepsis*) | Ireland | Ireland | | |
| Leafscale gulper (*Centrophorus squamosus*) | Ireland | Ireland | | |

## Detailed information per country

### Belgium

Two documents were consulted for the compilation of this overview: the description of MSFD-indicators that were selected in Belgium with national definitions of Good Environmental Status for these (Belgische Staat, 2012a) and the Initial Assessment for the Belgian Marine Waters (Belgische Staat, 2012b).

Neither of these documents detailed methodologies, data sources, responsible persons/ institutes, etc. but several national scientific institutes are involved (ILVO – Institute for Agricultural and Fisheries Research is responsible for the monitoring and evaluation of fish). No updates presenting results that were obtained or trends that were observed since the initial assessment are available yet.

Descriptors 1 (Biodiversity), 4 (Marine foodwebs) and 6 (Integrity of the seafloor) are treated together by the Belgian State. **GES** is reached when (selection of goals with relevance to elasmobranchs; from Belgische Staat, 2012a):

- The distribution and the state of the populations of fish species are in accordance with the Initial Assessment,
- Rare species that are subject of existing legislation and treaties are protected as prescribed in this legislation and treaties,
- The diversity within ecosystem components (fish are considered a component) is maintained,
- Viable populations of slowly reproducing species and all top predators are kept at safe levels in all habitat types.

Additionally there are goals directed at protecting individual habitats and habitat diversity of which elasmobranch species could also benefit.

However, only one of the withheld indicators is directly elasmobranch-related: positive trend in the number of thornback ray *Raja clavata*.

The initial assessment (Belgische Staat, 2012b) described lesser-spotted dogfish and thornback ray as the only two elasmobranch species that are currently still regularly observed in Belgian waters, based on findings of beam trawl surveys carried out in these waters. No information on the current number of thornback rays was presented in this assessment.

No information on species that are nationally protected or prohibited to keep on board or land at the auctions, which includes undulate ray (*Raja undulata*), white skate (*Rostroraja alba*, VII and VIII), Norwegian skate (*Dipturus nidarosiensis*, VII), blue skate (*Dipturus batis*), angel shark (*Squatina squatina*), basking shark (*Cetorhinus maximus*), porbeagle (*Lamna nasus*) and spurdog (*Squalus acanthias*) is mentioned in the reports, so it is not clear how or whether it will be monitored that these were really not landed at the fish auctions.

#### Ireland

Elasmobranch assessment for the Irish MSFD:

Ireland assessed the status of commercial and non-commercial elasmobranchs present in the Irish Assessment area under the biodiversity descriptor 1 and the commercial fish and shellfish descriptor 3. Under descriptor 1, a trend assessment was conducted on the distributional range and pattern (criteria 1.1), the abundance (criteria 1.2) and the population condition (criteria 1.3) of each species. Commercial stocks were assessed under descriptor 3 using MSY reference points for fishing mortality under criteria 3.1 ($F_{MSY}$) and reproductive capacity under criteria 3.2 ($B_{MSYtrigger}$) where available.

*Methodology*

Species selection

The following six elasmobranch species have been included in the Irish national assessment: Spurdog, lesser-spotted dogfish, thornback ray, cuckoo ray and the two deep-water sharks, Portuguese dogfish and leafscale gulper shark.

D1 assessment – criteria 1.1 (distributional range and pattern), criteria 1.2 (abundance) and criteria 1.3 (population condition):

Data used to calculate indicators for criteria 1.1, 1.2 and 1.3 were based on the Irish groundfish survey (IGFS) from 2005 to 2011. The IGFS is part of the international bottom trawl survey, which is coordinated by ICES. Survey strategy and sampling methodology can be found in MI, 2012a. For the two deep-water species, Portuguese dogfish and leafscale gulper shark, data were used from the Irish Deep-water survey (IDWS) as described in MI, 2012a.

Indicators for criteria 1.1 population distribution and distributional pattern were applied as follows:

Annual mean values and the range of catch depth and latitude were examined for temporal trends.

Percentage (%) occurrence was calculated as the number of hauls at which a species is found every year divided by the total number of hauls carried out during that year. Percentage occurrence is a measure of how widely a species is distributed and was used to detect changes in distributional pattern. An indicator for criteria 1.2 population abundance was calculated as the cpue of numbers per species per hour. The description of trends for criteria 1.3 population condition was based on the following indicators: Proportion of fish larger than the mean size of first sexual maturation (3.3.1) and 95% percentile of the fish length distribution observed in research vessel surveys (3.3.3). Both indicators are based on length–frequency data from the IGFS and are applied with the same methodology as described in ICES 2012.

Trends reporting only:

It was not possible to carry out a GES assessment based on criteria 1.1 population distribution, 1.2 population abundance and criteria 1.3 population condition. This is due to the short time-series of relevant monitoring programmes which do not cover an adequate time period at sustainable exploitation levels and do not allow the setting of meaningful reference levels. Instead, trends of the above criteria were reported based on available time-series without linking them to GES. Significant increasing or decreasing trends were detected with an intersection union test as described in Trenkel and Rochet (2009). For the two deep-water species, no trend analysis could be carried out due to a termination of the time-series in 2009. Instead, a description of their abundance, distribution and population condition was provided based on the four years of deep-water survey data.

Status reporting and GES assessment for commercial species:

For commercial species, ICES fisheries assessments and advice (MI, 2012b) were used for GES assessment under descriptor 3. Under criteria 3.1, *Level of pressure of the fishing activity*, the primary indicator *fishing mortality* (3.1.1) was used where available. Under criteria 3.2 *reproductive capacity of the stock,* the primary indicator *Spawning–stock biomass* (3.2.1) was applied, where available. GES was evaluated by assessing fishing pressure and reproductive capacity against MSY reference points.

The following table shows the elasmobranch species included in the Irish assessment and the criteria that were used to describe their status and trends:

| Species/Stock | Distributional range and pattern | Population condition | Abundance | Fishing mortality |
|---|---|---|---|---|
| **Spurdog** | Trends in lat, depth and % occurrence based on IGFS catches | Trends in % above size at first maturity and length at 95% based IGFS catches | SSB | y |
| **Lesser spotted dogfish** | Trends in lat, depth and % occurrence based on IGFS catches | Trends in % above size at first maturity and length at 95% based IGFS catches | SSB | |
| **thornback ray** | Trends in lat, depth and % occurrence based on IGFS catches | Trends in % above size at first maturity and length at 95% based IGFS catches | Trends of cpue based on IBTS catches as reported in ICES advice 2012 | |
| **cuckoo ray** | Trends in lat, depth and % occurrence based on IGFS catches | Trends in % above size at first maturity and length at 95% based IGFS catches | Trends of cpue based on IBTS catches as reported in ICES advice 2012 | |
| **Portuguese dogfish** | Description of depth and area distribution based on IDWS catches | Description of maturity and length distribution based on IDWS catches | SSB | |
| **Leafscale gulper shark** | Description of depth and area distribution based on IDWS catches | Description of maturity and length distribution based on IDWS catches | SSB | |

***Results***

Figures 22.2 and 22.3 show the distributional range and pattern for thornback ray in the survey area and the output of the union intersection test for area as examples of the trend assessment for descriptor 1 biodiversity.

The following Table summarises the results of the trend assessment under D1 and the GES assessment under D3.

| SPECIES/STOCK | DISTRIBUTIONAL RANGE AND PATTERN | | | POPULATION CONDITION | | ABUNDANCE | FISHING MORTALITY |
|---|---|---|---|---|---|---|---|
| | Latitudinal range | Depth range | % occurrence | % > size mature | Length at 95% | | |
| **Spurdog** | → | → | → | → | → | ✗ | ✓ |
| **Lesser spotted dogfish** | → | → | ↗( in VII) | → | → | ↗ | ↘ |
| **Thornback ray** | → | → | → | → | → | ↗ | ? |
| **Cuckoo ray** | → | → | → | → | → | ↘ | ? |
| **Portuguese dogfish** | Description only | Description only | Description only | Description only | Description only | ✗ | ? |
| **Leafscale gulper shark** | Description only | Description only | Description only | Description only | Description only | ✗ | ? |

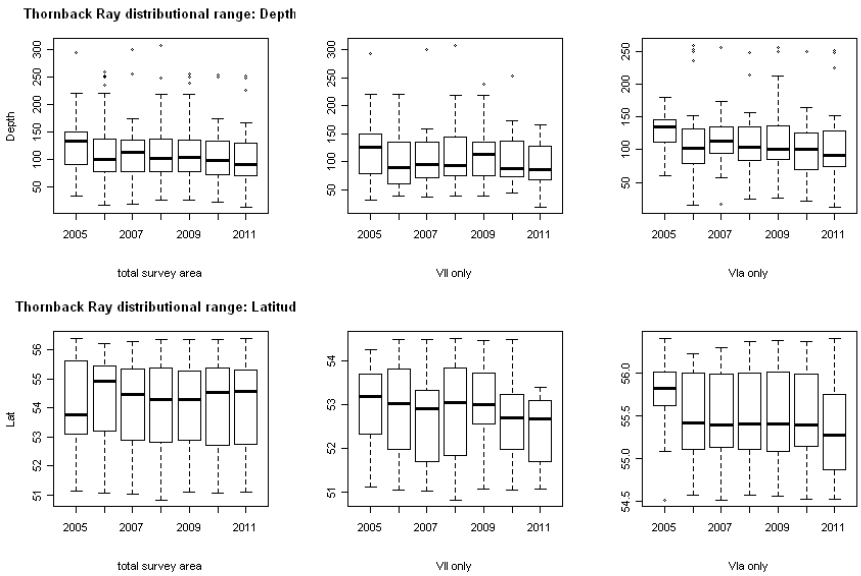



**Figure 22.2. Boxplots of depth and latitude of thornback ray sampled on the IGFS, 2005 to 2011.**

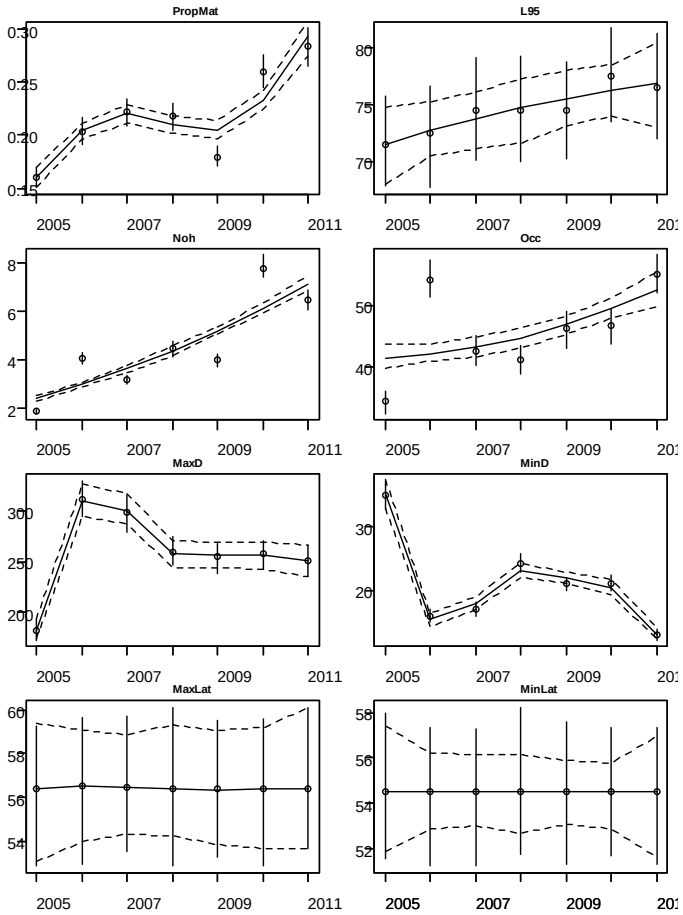



**Figure 22.3. Output of the union intersection test for thornback ray in VIa sampled on the IGFS, 2005 to 2011.**

### Germany

In forthcoming MSFD evaluations, indicators of abundance, distribution and population structure of sharks and rays/skates in the North Sea will be incorporated in MSFD descriptor D1 - biodiversity.

In the German initial evaluation in 2012 however, elasmobranchs are factually not specifically addressed as the German initial MSFD evaluation contrary to EU 477/2010 does not address descriptors or indices. Accordingly, corresponding descriptors and indices as discussed on EU level are not reflected in the German evaluation as of yet.

### Netherlands

The Netherlands are conducting a detailed research project into elasmobranch management in the MSFD; the final report will be presented in July 2014.

At present the Netherlands has reported the following targets and indicators for sharks and rays.

Targets:

- Improve population size, condition and distribution of vulnerable fish species as far as its decline has been caused by humans.

This includes fish species with a long negative trend in population size and fish species with a low reproductive capacity (sharks and rays)

- Fishing mortality ≤$F_{MSY}$ for commercially exploited (shell)fish stocks.

  For declining shark and ray stocks fished by the EU fleet, the target is recovery in accordance with the EU shark action plan.

Indicators:

- Aggregated indicators for population size, condition and distribution for sharks and rays.
- Netherlands specifically seeks to integrate national indicators with existing OSPAR and other indicators.

#### Portugal mainland

The work developed by IPMA (ex IPIMAR) under the Marine Strategy Framework Descriptor 3 to assess stock status of the most important commercial species in ICES IXa was based on PtGFS-WIBTS-Q1 and PtGFS-WIBTS-Q4 surveys (Azevedo *et al.*, 2012). The application of indicators for the criteria defined for descriptor D3 (EU-COM, 2010) followed the approach proposed by ICES WG from MSFD D3 in the study case Bay of Biscay and Iberian Waters (ICES, 2012). In the case of skates and since there is no analytical assessment are available, secondary indicators were adopted for the criteria which were based on historical data available from surveys.

**Criterion 3.1** Level of the fishing pressure: the indicator adopted consisted on the ratio between catch and biomass as a proxy of F.

**Criterion 3.3.** Population structure by size: the indicator adopted consisted on the annual estimate of the mean size length based on survey data.

The evaluation of the status was carried out by comparing the mean value estimate of each indicator at recent years with historical mean as proposed by ICES (2012) as:

$$m = \frac{mean_rec - mean_historic}{s.d.mean_historic}$$

Assuming a normal distribution adopting reference points based on that the GES assigned were:

| | Criterion 3.1 Level of the fishing pressure | | | Criterion 3.3 Population structure | | |
|---|---|---|---|---|---|---|
| Indicator | m | | | | | |
| | $m \leq 0$ | $0 < m \leq 1.6$ | $m > 1.6$ | $m \geq 0$ | $-1.6 \leq m < 0$ | $m < -1.6$ |
| GES | Low | Moderate | High | Low | Moderate | High |

For the MSFD D3 analysis the data used consist on survey data from 1991–2010 excluding the years 1996, 1999, 2003 and 2004 during which another fishing gear and commercial data for years between 2003–2010 (for which the commercial landings per species were available after the sampling programme at Portuguese landing port under DCF has been initiated).

**Spain**

In Spain all descriptors have been addressed and the indicators have been quantified. Data used was from demersal fisheries surveys. The most commonly caught elasmobranchs have been considered in these assessments: e.g. *Scyliorhinus canicula*, *Raja clavata*, *Raja montagui*, *Raja naevus* and *Galeus melastomus*.

**Sweden**

Swedish reporting of elasmobranchs for the Marine Strategy Framework Directive:

This review relies on the Swedish Initial Assessment and on the national documentation of indicators for Good Environmental Status (GES) reported to the European Commission.

Initial Assessment (IA)

The Swedish IA for fish species relied on existing reports and no new analyses were performed. The elasmobranchs were not considered specifically, but only as a part of the fish fauna in the ICES Area IIIa (i.e. Skagerrak and Kattegat). Thus, the information on elasmobranchs refers to Skagerrak and Kattegat within the subregion "greater North Sea" (region NE Atlantic). Elasmobranchs were not considered relevant for the Baltic Sea region as they are very rare or absent in this area.

Sharks and rays have generally decreased in the catches and it has been reported that species such as *Etmopterus spinax* and *Dipturus batis* complex are no longer caught by the IBTS (Svedäng *et al*., 2004), although WGEF noted that updated analyses of IBTS data are needed to examine the current status.

From the latest ICES advice at the time of IA reporting (i.e. 2012), three species of elasmobranchs were identified:

- *Squalus acanthias*: NE Atlantic, F is around $F_{MSY}$ but the biomass is estimated to be low and the advice is no fishing and reduces bycatch.
- *Cetorhinus maximus*: NE Atlantic, F is not known, the biomass is estimated to be low and the advice is no fishing.
- *Lamna nasus*: NE Atlantic, F is not known, the biomass is estimated to be low; the advice is no fishing.

The Swedish National red list (2010) reports 27 marine fish species in IIIa. *Dipturus batis* complex is mentioned as nationally extinct. *Squalus acanthias*, *Lamna nasus* and *Cetorhinus maximus* are reported as critically endangered, whereas *Raja clavata* was reported as endangered. It is also reported that of the 27 red listed fish species, 13 are commercial today, eight have been commercial in the past and four species are present as unwanted bycatch. The elasmobranchs are, however, not detailed further in the Swedish IA.

The three last paragraphs above sums up, how elasmobranchs were reported in the Swedish IA.

Reported indicators for GES (Good Environmental Status)

Elasmobranchs are not considered specifically in the Swedish report of indicators.

Under Descriptor 1 (Biodiversity), there are several indicators under development, which may in the future include elasmobranchs. For a selection of key fish species (which are not yet identified), the spatial distribution range (D1.1.1) and the distribution pattern within that range (D1.1.2) together with abundance and/or biomass

(D1.2.1) should be evaluated. Further, conservation status of sensitive fish species (D1.3.1) should come to include some elasmobranchs, but there are still concerns on how to translate conservation status into a functional indicator. The large fish indicator and the Mean Maximum Length (MML) indicator (D1.6.1) reflect how fish individuals and fish species will change towards smaller body size with increasing fishery.

Sweden will evaluate Elasmobranch species included in the DCF (Data Collection Regulation; European Commission (EU) decision 2010/93/EU) under Descriptor 3 (commercial species). For the Skagerrak-Kattegat area, DCF only identifies *Cetorhinus maximus* and *Scyliorhinus canicula* to the level of species, but also include Rajidae and shark-like selachii as groups. It is not considered meaningful to evaluate fishing mortality (D3.1) and reproductive capacity of the stock (D3.2) for groups of species, and currently it is not known how this issue will be resolved.

More information on the Swedish reporting of the IA and Indicators for GES can be found in the documents below.

- God havsmiljö 2020: Marin strategi för Nordsjön och Östersjön. Del 1: Inledande bedömning av miljötillstånd och socioekonomisk analys. Havs- och vattenmyndighetens rapport 2012:19. 334pp.
- God havsmiljö 2020: Marin strategi för Nordsjön och Östersjön. Del 2: God miljöstatus och miljökvalitetsnormer. Havs- och vattenmyndighetens rapport 2012:20. 159pp.

#### UK

The UK approach to MSFD (especially descriptors 1 and 4) is largely driven by available data, with scientific trawl surveys deemed the most appropriate source for providing good spatial, temporal and species-specific data with which to examine longer-term change in a cost-effective manner (see Greenstreet *et al.*, 2012).

Such trawl survey data can inform on the distributional range (in terms of occurrence across ICES rectangles and/or depth bands; bathymetric range), distributional pattern within range (i.e. patchiness), population abundance (i.e. catch rates in terms of relative abundance and biomass) and population condition (e.g. proportion of mature fish). Trawl survey data may also be used to inform on the large fish indicator (LFI), which may inform on ecosystem structure (1.7) as well as food web structure (descriptor 4).

This approach will be applied to all fishes sampled adequately in existing surveys, and so the more common elasmobranchs, such as lesser-spotted dogfish, thornback and spotted rays and starry smooth-hounds will be included, whilst rarer species will not be included, at least in the short term.

## Summary

### Relevance of indicators for elasmobranch species

Indicators on biodiversity (1.1 and 1.2) and healthy stocks (3.1 and 3.2) are especially applicable for elasmobranchs. Developing indicators in descriptor 4 would be advisable. Some elasmobranch species are apex predators and populations of larger apex predators are not surveyed appropriately in the ICES area. This is especially true for deep-water and pelagic sharks. Such surveys could usefully be undertaken, but would not necessarily need to be annual. In descriptor 6 is habitat requirements of

elasmobranchs should be taken into consideration. This is especially important for reproduction (e.g. egg-laying of oviparous).

### Definition of good environmental status (GES)

Definition of GES from a suite of indicators is not straightforward. There are a number of issues which should be addressed.

- What are the reference points, and which baseline should be used? Can we identify historical reference point (ICES, 2012) or should trend-based targets be identified (Probst *et al*., 2013; Greestreet *et al*., 2012). If an historical reference point then how to choose the relevant period.
- Data source and methodology: take available data, e.g. IBTS, and use it for all species OR identify species first and then find data for quantification of indicator. Use of survey data for elasmobranchs should be done with care because the sur. Given that WGEF has found discrepancies in DETRAS data often due to erroneous species identification these data, although valuable, need appropriate quality control or interpretation.
- Geographical resolution and coherence between countries: Member States have an individual reporting obligation, but the stocks of most of the species will almost certainly cross country borders. Some level of international coordination is necessary.
- The sum of indicators which point to GES does not necessarily lead to ecosystem health (see also Greenstreet *et al*., 2012). It might be sensible in this case to invest time in the fine-tuning of indicator 1.7. Also there is room for fine-tuning in descriptor 4. Coordination with OSPAR is recommended. OSPAR is currently researching a 'broader monitoring and assessment framework for biodiversity which follows an ecosystem approach' and which 'will provide a basis for biodiversity targets and indicators' and which will be especially relevant for MSFD (http://www.ospar.org/html_documents/ospar/html/ospar_towards_ges_nea.pdf).
- The criteria for species selection should be defined. The use of PSA for the identification and ranking of vulnerable species could function as a first step to listing the species (see Tor j included in this section). This should be explored and again international coordination is required.

### GES progress per country

Elasmobranchs are included in general MSFD assessments in Spain. Portugal has developed GES methodology according to ICES guidance, and applied this to elasmobranchs for both descriptors 1 and 3. Ireland has also looked directly at GES for descriptors 1 and 3 for elasmobranchs including trend analysis for D1 and an estimate of GES for D3. Other countries are beginning to apply the concept of MSFD descriptors and indicators as part of shark management plans, or implementation of the CPOA for sharks, as is the case in the Netherlands.

### 22.3.5 References

Azevedo M., Silva A., Gaspar M., Silva C., Murta A., Moura T., Santos M.N., Stratoudakis Y., Prista N., Martins M.M., Soares E., Figueiredo I., Moreno A., Pereira J., Serra-Pereira, B., Faria I., Lagarto N. and Chaves C. 2012. Estado Ambiental das populações de peixes e moluscos explorados comercialmente na ZEE continental portuguesa: Descritor 3 da Directiva Quadro da Estratégia marinha (DQEM).

Belgische Staat. 2012a. Omschrijving van Goede Milieutoestand en vaststelling van Milieudoelen voor de Belgische mariene wateren. (Description of Good Environmental Status and determination of Environmental Goals for the Belgian Marine Waters.) Kaderrichtlijn Mariene Strategie – Art 9 & 10. BMM, Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Brussel, België, 34 pp.

Belgische Staat. 2012b. Initiële Beoordeling voor de Belgische mariene wateren. (Initial assessment for the Belgian Marine Waters.) Kaderrichtlijn Mariene Strategie – Art 8 lid 1a & 1b. BMM, Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Brussel, België, 81 pp.

EU-COM. 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). 22 pp.

EU-COM. 2010. Commission decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956) (2010/477/EU). 11 pp.

Greenstreet, S.P.R., Rossberg, A.G., Fox, C.J., Le Quesne, W.J.F., Blasdale, T., Boulcott, P., Mitchall, I. Millar, C. and Moffat, C.F. 2012. Demersal fish biodiversity: species-level indicators and trends-based targets for the Marine Strategy Framework Directive. ICES Journal of Marine Science. 69(10): 1789–1801.

IBTS western manual on survey methodology and design: http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=74.

ICES. 2011. Marine Strategy Framework Directive - Descriptor 3+ , ICES CM 2011/ACOM:62. 169 pp.

ICES. 2012. Marine Strategy Framework Directive - Descriptor 3+, ICES CM 2012/ACOM:62. 173 pp.

IGFS annual species distribution maps can be found at: http://www.marine.ie/home/publicationsdata/data/WebMapServices/IrishGroundFishSurveyViewer.htm.

MI. 2012a. Commercial fish species reported within the "Atlas of Irish Groundfish Trawl Surveys – 2012". http://oar.marine.ie/handle/10793/792.

MI. 2012b. The Stock Book 2012: Annual Review of Fish Stocks in 2012 with Management Advice for 2013 http://oar.marine.ie/handle/10793/841.

Probst, W.N., Kloppmann, M. and Kraus, G. 2013. Indicator-based status assessment of commercial fish species in the North Sea according to the EU Marine Strategy Framework Directive (MSFD). ICES Journal of Marine Science. 70(3): 694–706.

Svedäng, H., Hagberg, J., Börjesson, P., Svensson, A. and Vitale, F. 2004. Bottenfisk i Västerhavet. Fyra studier av beståndens status, utveckling och lekområden vid den svenska västkusten (Demersal fish the Kattegat-Skagerrak. Four studies on stock status, development and spawning areas along the Swedish west coast). Finfo 2004:6. 42 p. (in Swedish).

Trenkel, V.M., Rochet, M.-J. 2009 Intersection-union tests for characterising recent changes in smoothed indicator time series. Environmental Indicators, 9, 732–739.

## 22.4 Tor j; Initiate the necessary planning for a future PSA for elasmobranchs in the ICES area

### 22.4.1 Introduction

National and European wide shark conservation plans aim to manage elasmobranch stocks sustainably. However there has been very limited success towards such targets, as a result of uncertainties and data deficiency hampering traditional robust assessment methods and thus effective management. With ICES (through the WKLIFE expert group) exploring and diversifying into data deficient assessment methods as tools to substantiate management advice, WGEF felt that an exploratory Productivity and Susceptibility Assessment (PSA) on one or more of its data deficient stocks (category 5 or 6), would aid in informing on the suitability of this methodology for future qualitative assessment and advice.

PSAs have already been trialled and in some cases, successfully employed in management for elasmobranch species around the world. For example, Cortés *et al*. (2010) and Simpfendorfer *et al*. (2008) used PSAs to examine the vulnerability of pelagic elasmobranchs taken in a pelagic longline fishery in the Atlantic Ocean, while Arrizabalaga *et al*. (2009) performed a PSA for bycatch species caught in ICCAT fisheries. The approach was also tested in the Indian Ocean for purse seiners and longline fleets (Murua *et al*., 2009), and the deep-water mixed trawl fishery to the west of the UK (Watling *et al*., 2011), with a species-specific application in the same area conducted for orange roughy (*Hoplostethus atlanticus*) by Dransfeld *et al*. (2013). Despite the number of applications, PSAs as a methodology are still in their infancy with respect to development. It has been identified in this (and previous applications) that no 'one size fits all' approach works, however some level of standardisation would aid in extending this methodology across the ICES community and allow some parity.

The primary aim of PSAs is to prioritise species of concern in particular fisheries, for more detailed assessment, precautionary management (where necessary) and potentially further investment in studies. With the Celtic Seas demersal elasmobranch stock being categorised as a category 7 (now a category 6 within the new system) stock (ICES, 2012a,b), this was an ideal candidate stock on which to trial a PSA (McCully *et al*., 2013). Of approximately 25 species of demersal elasmobranch in the Celtic Seas ecoregion, nine skate species were examined independently by WGEF in 2012, for species-specific advice based on other data deficient methods (such as survey trends), for some no advice was possible, five were classified in the new system as category 3, four in category 5, and 'other' skates and rays were classified into category 6.

Two demersal fisheries were investigated (otter trawl and gillnet) and relative vulnerabilities for 21 species of elasmobranchs were estimated. After a review of existing approaches and worldwide applications to date, the approach was developed and modified from the Patrick *et al*. (2009; 2010) methodology (and subsequently NOAA toolbox application). Several productivity and susceptibility parameters were included or modified to make the PSA more applicable to our candidate species. The input parameters for this preliminary assessment were provided inter-sessionally by a range of five experts from four countries to introduce objectivity, while quantifying the range in perceptions of each stock, data quality, and the confidence allocated to each score.

A complimentary preliminary assessment was also completed for bycatch species taken in the deep-water black scabbardfish longline fishery from Portugal mainland

(Moura *et al*., 2013). Again, the methodology followed was based on Patrick *et al*. (2010), but these parameters were, for most of the cases, considered inadequate to apply to deep-water species due to the insufficient knowledge about their biology, distribution patterns and stock structure.

### 22.4.2 Preliminary Results

Preliminary results of vulnerability scores and rankings within both fisheries of the Celtic Seas demersal elasmobranch stock were presented (McCully *et al*., 2013), but are not shown here fully. Further inter-sessional work (including refinements to the expert scores and the methods, and accounting for confidence) will be advanced further before the results are analysed with a view to aiding assessment and advice in 2014.

However, in general, the demersal skates falling under the 'skates and rays' quota seemed to group at a more productive and more susceptible level than those demersal elasmobranchs such as *Dipturus batis* complex, *Rostroraja alba*, *Squatina squatina* and *Squalus acanthias*, which all currently have a zero TAC/prohibited status.

Results from the Portuguese longline fishery showed that, in general, deep-water sharks were more vulnerable to this fishery than teleosts (Moura *et al*., 2013).

### 22.4.3 Discussion of PSA in future applications

The group liked the PSA approach, in terms of its ability to prioritise species of concern at a smaller regional scale of fisheries. Given the data classification of 24 WGEF advice stocks as category 5 (Data poor) or 6 (Negligible landings stocks and stocks caught in minor amounts as bycatch), and the PSA being a recommended option within both of these classifications, this approach is potentially of real value to WGEF in benefiting stocks for which otherwise no advice could historically be given.

The group identified the utility of this approach in aiding the MSFD implementation and identification of candidate indicator species which itself, falls under WGEF 2013, Tor i (Application of the Marine Strategy Framework Directive indicators for elasmobranchs).

The group also identified the utility of this approach as a baseline for trying to address the special request from the EU to ICES (Opinion on exploring management measures other than TACs for skates and rays) in future applications. The PSA can be used to identify the most vulnerable species that management measures need to be aimed to, and also in evaluating the potential effects of different technical management scenarios at a regional level.

The PSA can also be instrumental in facilitating the movement of these data-limited stocks, up into their 'target stock categories'. This assessment can identify what data are required (but currently may be unavailable) to make this move achievable. Similarly, this potential application of the method, fits in with WGEF 2013, Tor h (Determine the additional data requirements for certain statistical and model techniques for the 2014 stock assessment cycle). Part of this requirement, is likely to include better delineation of stock discrimination of the most vulnerable species, which in turn feeds into a further WGEF 2013 Tor g (Review options for fine-scale taxonomic or geographical units for the provision of advice for demersal elasmobranchs).

It would be beneficial to extend the assessment to other areas and metiers eventually, but not before the methodology has been refined, and a standardised 'protocol' has been drafted for the methodology. A list of data needs is required, even for the most

basic and qualitative application. For the most basic application, where expert judgement is heavily relied upon, the data requirements include: some life history information (maximum age, size, age at maturity, fecundity) and growth parameters (*r* and *K*) for the productivity parameters. For the susceptibility parameters, some knowledge of the distribution and fishery, catchability, post capture mortality, migrations and aggregating nature are desirable. However, the advantage of this approach is the ability to judge the assigned score, as the category groupings are broad-scale, allow for personal confidence (or lack of) to be accounted for, and also where knowledge is lacking completely, this parameter can be excluded from the analysis altogether.

Prior to extending this method to other species and areas, some refinements to the approach shall be made, to include (but not limited to), spatially mapping the distribution of the most vulnerable species and their overlap with the fisheries being assessed (with a view to informing on spatial management or technical measures); investigating management scenarios and rescoring assessment to evaluate 'knock-on' effects to other species; include target species and non-target teleosts; evaluate the impact of existing (or proposed) spatial closures (e.g. MPAs) by rescoring the assessment and mapping effort relocation; and evaluation of confidence scores in expert opinion.

However, it is clear that a 'one size fits all' approach is not appropriate for all species and areas, so where data are not available, that parameter can be excluded or down weighted in the assessment. A common methodology needs to be employed in each application of the assessment, to allow parity and further applications by ICES.

There was agreement that given the large amount of potential applications and value of PSAs to the group, that this should be developed collaboratively and importantly, in association with industry. Their involvement would be key, especially in discussions around potential regional management or technical measures and a workshop or meeting with the RAC's would facilitate this.

Inter-sessionally, refinements shall be made to the PSA, and comments sought from WKLIFE3 on how best to improve this application in time for next year's advice.

### 22.4.4 References

Arrizabalaga, H., de Bruyn, P., Diaz, G.A., Murua, H., Chavance, P., Delgado de Molina, A., Gaertner, D., Ariz, J. and Ruiz, J. 2009. Ecological risk assessment for species caught in ICCAT fisheries. ICCAT SCRS/2009/058.

Cortés, E., Arocha, F., Beerkircher, L., Carvalho, F., Domingo, A., Heupel, M., Holtzhausen, H., Santos, M. N., Ribera, M. and Simpfendorfer, C. 2010. Ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Aquatic Living Resources, 23, 25–34.

Dransfeld, L., Hareide, N. R., Gerritsen, H. and Lorance, P. 2013. Assessing the risk of vulnerable species exposure to deep-water trawl fisheries- The case of orange roughy *Hoplostethus* atlanticus (Collett, 1889) to the west of Ireland and Britain. Working document to the ICES Working Group on the Biology and Assessment of Deep-sea Fisheries Resources, Copenhagen, 14–20 March, 2013.

ICES. 2012a. Report of the Workshop on the Development of Assessments based on LIFE history traits and Exploitation Characteristics (WKLIFE), 13–17 February 2012, Lisbon, Portugal . ICES CM 2012/ACOM:36. 140 pp.

ICES. 2012b. Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make

Recommendations on Target Categories for Data-limited Stocks (WKLIFE II), 20–22 November 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:79. 46 pp.

McCully, S. R., Scott, F., Seret, B., Johnston, G., Diez, G. and Ellis, J.R. 2013. Productivity and Susceptibility Analysis: application and suitability for data poor assessment of Celtic Sea skate complex. Working Document for the ICES Working Group on Elasmobranch Fishes, Lisbon, 17–21 June 2013.

Moura, T., Prista, N. and Figueiredo, I. 2013. Productivity-susceptibility analysis of the by-catch species taken in the deepwater longline fishery from Portugal mainland. Working Document for the ICES Working Group on Elasmobranch Fishes, Lisbon, 17–21 June 2013.

Murua H., Arrizabalaga H., Huang J.J.H.-W., Romanov E., Bach P., Bruyn P.d., Chavance P., Molina A.D.d., Pianed R., Ariz J., Ruiz J. 2009. Ecological Risk Assessment (ERA) for species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC): a first attempt. IOTC-2009-WP-20, 9 pp.

Patrick W.S., Spencer P., Link J., Cope J., Field J., Kobayashi D., Lawson P., Gedamke T., Cortés E., Ormseth O., Bigelow K., Overholtz W. 2010. Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. Fish Bull. 108, 305–322.

Patrick, W. S., P. Spencer, O. Ormseth, J. Cope, J. Field, D. Kobayashi, T. Gedamke, E. Cortés, K. Bigelow, W. Overholtz, J. Link, and P. Lawson. 2009. Use of productivity and susceptibility indices to determine stock vulnerability, with example applications to six U.S. fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-101, 90 p.

Simpfendorfer, C., Cortés, E., Heupel, M., Brooks, E., Babcock, E., Baum, J., McAuley, R., Dudley, S., Stevens, J.D., Fordham, S. and Soldo, A. 2008. An integrated approach to determining the risk of over-exploitation for data-poor pelagic Atlantic sharks. ICCAT SCRS/2008/140, 15 pp.

Watling, L., Haedrich, R. L., Devine, J., Drazen, J., Dunn, M. R., Gianni, M., Baker, K., *et al*. 2011. Can ecosystem-based deep-sea fishing be sustained? Report of a Workshop held 31 August–3 September 2010. Neuville-Bosc, France (http://digitalcommons.library.umaine.edu/sms_facpub/145/).

# 23 Landings from within the NEAFC Regulatory Area

## 23.1 Background

At a meeting between ICES and the North East Atlantic Fisheries Commission (ICES 2013), NEAFC requested that ICES provided landings information at a resolution that would show catches from within the NEAFC regulatory area. This should be provided by relevant Expert Groups, and the landings information should be presented in the advice for the relevant stocks. This was agreed by ICES.

This year is not part of the WGEF advice cycle. However, as a first step to providing this information, WGEF requested landings information from member countries that would show if catches took place within the NEAFC regulatory area. Only three countries (Ireland, Norway and Spain), provided landings information to this level. In addition, two countries (Belgium and Denmark) declared that they had no elasmobranch fisheries within the NEAFC regulatory area.

### 23.1.1 NEAFC landings

**Table 23.1. WGEF declared landings of elasmobranchs from within the NEAFC regulatory area.**

| SKATES AND RAYS | LANDINGS IN TONNES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IIa1 | IIb1 | Vb1a | VIb1 | VIIc1 | VIIj1 | VIIk1 | VIIId1 | VIIIe1 | IXb1 | Xa1 | XIIa1 | Total |
| Ireland | . | . | . | 2.53 | . | 0.76 | . | . | . | . | . | . | . |
| Norway | . | . | . | 6.00 | . | . | . | . | . | . | . | . | . |
| Spain | . | . | . | 4.00 | . | 0.15 | . | 0.23 | 0.46 | 24.46 | 0.24 | 0.09 | . |
| | . | . | . | 12.53 | . | 0.91 | . | 0.23 | 0.46 | 24.46 | 0.24 | 0.09 | 38.92 |
| *Scyliorhinus canicula* | Landings in tonnes | | | | | | | | | | | | |
| | IIa1 | IIb1 | Vb1a | VIb1 | VIIc1 | VIIj1 | VIIk1 | VIIId1 | VIIIe1 | IXb1 | Xa1 | XIIa1 | Total |
| Spain | . | . | . | . | . | . | . | . | . | 4.94 | 0.52 | . | . |
| | . | . | . | . | . | . | . | . | . | 4.94 | 0.52 | . | 5.46 |
| *Mustelus* spp. | Landings in tonnes | | | | | | | | | | | | |
| | IIa1 | IIb1 | Vb1a | VIb1 | VIIc1 | VIIj1 | VIIk1 | VIIId1 | VIIIe1 | IXb1 | Xa1 | XIIa1 | Total |
| Spain | . | . | . | . | . | . | . | 0.0 | 0.2 | . | . | . | . |
| | . | . | . | . | . | . | . | 0.0 | 0.2 | . | . | . | . |
| Catsharks, nursehounds *nei* | Landings in tonnes | | | | | | | | | | | | |
| | IIa1 | IIb1 | Vb1a | VIb1 | VIIc1 | VIIj1 | VIIk1 | VIIId1 | VIIIe1 | IXb1 | Xa1 | XIIa1 | Total |
| Spain | . | . | . | . | . | . | . | . | 0.02 | 0.12 | . | . | . |
| | . | . | . | . | . | . | . | . | 0.02 | 0.12 | . | . | 0.14 |

These figures are clearly an underestimate of the total elasmobranch landings from within the NEAF Regulatory area. Nevertheless, they illustrate that the proportion of landings from within the NEAFC regulatory area of these species are low in comparison to the total landings from the relevant ICES Division. For instance, of 20 tonnes of skates and rays declared within ICES Subdivision VIIj by Spain, only 4 tonnes was from the NEAFC area. Similarly, of 8 tonnes of skates and rays landed by Ireland from Subdivision VI, only 2.5 tonnes was from the NEAFC area. Further landings information can be found within the relevant ecoregion chapters.

### 23.1.2 Future information

Countries supplying data in 2014 will again be requested to supply data at a spatial resolution that will allow landings to be discriminated in this way. In particular, those countries that have relatively deep-water fisheries will be asked to provide landings information of any shark species that may have been caught. It is hoped that these information will be made available with more advanced notice.

## 23.2 References

ICES 2013. Report of Meeting between NEAFC and ICES on deep sea species. Copenhagen, 28 February–1 March 2013.

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## Annex 2: Terms of Reference

2012/2/ACOM19 The **Working Group on Elasmobranch Fishes** (WGEF), co-chaired by Ivone Figueiredo, Portugal and Jim Ellis, UK, will meet at Lisbon, Portugal, 17–26 June 2014 (to be confirmed) to:

a ) Update the description of elasmobranch fisheries for deep-water, pelagic and demersal species in the ICES area and compile landings, effort and discard statistics by ICES subarea and division, and catch data by NEAFC area;

b ) Evaluate the stock status of skates (Rajidae) in the ICES area and NE Atlantic spurdog for the provision of advice;

c ) Develop stock annexes for skates (Rajidae) in the Celtic Seas, in the Biscay and Iberian ecoregion and in the North Sea;

d ) Collate data and undertaking exploratory assessment for those species that will be assessed in 2015;

Conduct further studies using PSA to guide future management.

# Annex 3: Response to the EC on special management measures for skates and rays

## Summary

At the 2013 meeting of the WGEF this request from the European Commission was discussed extensively. In short, current scientific resources provide some broad insights, but they are not sufficient to answer this request as it is formulated. Given regional differences in skate assemblages and fisheries, management measures would best be developed on a case-by-case basis and also with the participation of the fishing industry. ICES could, upon request, put together a team of scientists who would outline a scientific study that would take into account: (1) specific spatial and temporal closure options and/or other technical measures, (2) mixed fisheries issues, (3) impacts of fleet behaviour, (4) stakeholder input, (5) the biology and behaviour of the relevant skates and rays in the area, and (6) the scientific information required to inform such a request.

WGEF drafted a short literature review during their annual meeting in response to this request. It demonstrates the scope of the issues involved and it consolidates the available scientific knowledge on the subject.

### Information from the WGEF leadership and Anne on answering this request

1 ) Is this proposed request reasonable (i.e. is it answerable now or would a little re-drafting of the request provide more targeted information)?

This is a reasonable request, scientifically; however, specific regional case studies would be needed to answer this request. The WGEF document highlighted a few options that are available to managers. Perhaps one or two of these are taken forward in the first instance.

2 ) Is the information available to answer this request today, or are further studies required?

There is some information and data to draw on, see WGEF document, although some data collation may be required. A specific study would be required to answer this request, and in some instances, improved data collection may also be required, and this could be prioritized by ICES.

3 ) Can this request be answered during the WGEF annual meeting, by correspondence, or does it require a special in-person meeting?

No, this request cannot be answered at the annual WG meeting; however, WGEF did consider the proposed request at their 2013 annual meeting. Answering this request would benefit most from developing such a request in collaboration with the RACs. Perhaps ICES could host a joint ICES-NWWRAC meeting to develop management measures for a particular case study.

3.1 ) If it requires an in-person meeting, how many experts would be needed to attend and for how many days would the meeting last?

Unknown at this time until more information is available from the Commission.

4 ) Timeline—when could the experts submit a report to ICES for review and advice drafting (RG/ADG)?

Unknown at this time until more information is available from the Commission.

## Potential management measures other than TACs for skates and rays

### Background

ICES was asked to provide advice on "*Exploring alternative and/or complementary management measures such as closed areas/seasons or effort restrictions which may better protect demersal elasmobranchs. In particular ICES is asked to comment on the functioning of the current voluntary closure in the Irish Sea and provide any recommendations on its operation.*"

At present, fisheries for skates (Rajidae) are managed under a common TAC, although the skate complex comprises species that may have different vulnerabilities to exploitation. There are also prohibitions on fishing for, retaining and landing some species, including the most severely depleted species.

Although there are some seasonal target (trawl, gillnet or longline) fisheries for skates in some areas, many skates are taken as an important bycatch in mixed demersal fisheries. TACs alone, therefore, may not adequately protect these species, as restrictive quota may lead to high discarding in some fisheries. A proportion of these discards will not survive, with this proportion varying between fisheries.

In 2012, ICES advice for skates stated "*Management measures such as closed areas/seasons or effort restrictions may better protect demersal elasmobranchs. In particular, measures to protect spawning/nursery grounds would be beneficial. ICES could provide advice on such measures". Furthermore, for some individual skate stocks, ICES stated that "ICES does not advise that an individual TAC be set for this stock, at present. Additional measures should be identified that can regulate exploitation of this stock. Such measures may include seasonal and/or area closures, technical measures, and tailored measures for target fisheries. Such measures should be developed by stakeholder consultations, considering the overall mixed fisheries context*".

### Management options

ICES WGEF consider that technical measures are suitable alternative and/or complementary management measures for skates, especially for those species occurring in shelf seas and coastal waters.

WGEF considers that the selection of the most effective and pragmatic measures should be addressed for stocks/regions of concern. These should be developed for specific fisheries/regions in close cooperation with fishers, Regional Advisory Councils and other stakeholders, especially to discuss and evaluate the viability of potential measures and subsequent uptake and compliance of any measures.

WGEF discussed options for management in an earlier report (ICES, 2003), and these are elaborated on below.

### Output controls

Output controls can take the form of single or multispecies TACs, and the latter is the main measure currently in place for skates.

Advice on adjusting catch levels can be based on information on trends in stock size. However, there is only a limited time period for species-specific landings data, and there are also concerns about the accuracy of some of these data. Hence, it has not been possible for ICES to advise on options for species-specific TACs for the main species in the skate complex.

Although some parts of the ICES area have a relatively low diversity of skate species (e.g. *R. clavata* is the main species in Division IVc, with lower numbers of *R. brachyura*, and *R. montagui*), other areas may have a much greater range of species (see Section 18).

If species-specific catch options were to become available, and so allowing for a move away from the single skate complex TAC, then there would be potential issues in terms of reallocation and relative stability.

### Input controls

Input controls include such measures as effort controls, licensing schemes and restrictions on effective effort by particular gear types. Advice on effort controls could be given for assemblages of species.

Measures to regulate effective effort include restrictions on number of hooks, soak time, gillnet length, or hours trawled, and some of these measures can be used to regulate effort, and also to improve the survival of discarded fish.

For example, some inshore areas of the UK have local bylaws relating to the soak time of gillnets. The survival of skates is thought to be relatively high when the soak time is <24 h, but decreases slightly when up to 48 h. Such measures may be developed in inshore areas where soak times are generally short. In contrast, the soak time for gillnets on offshore fishing grounds can be higher, but the economic consequences of reducing soak times or the ability to enforce such regulations are unclear.

Similarly, the survival of skates may be reduced in relation to haul duration (although the catch composition and weight may be the main factors influencing skate mortality). Once again, inshore vessels often have reduced haul durations and so discarded skates are likely to be in better condition.

Hence, local measures to facilitate the survivorship of skates could be developed with the fishing industry, thereby allowing those skates not landed (including juveniles, prohibited species or when quota is restrictive) to have a high chance of surviving.

Ideally, advice based on effort should be based on quantitative relationships between effort and fishing mortality, and requires that there are datasets of effort available. Although there are now better estimates of fishing effort for some gears, accurate data may not be available for all gears and areas.

### Technical measures

Technical measures can include mesh size regulations, landing sizes, closed areas, gear restrictions and spatial restrictions.

- Spatially managed areas: There has been increased interest in spatial management for elasmobranchs (Bonfil, 1999; Stevens, 2002; Walker, 2004), and there are some examples of spatial regulations in other parts of the world (e.g. Carrier and Pratt, 1998).

Data from fishery-independent surveys and observer programmes on commercial vessels, together with derived data from methods such as habitat preference/ suitability modelling could be used to identify ecologically-important skate habitats, which could include grounds important for vulnerable species and/or particular life-history stages (e.g. egg cases or juveniles, spawning females, mating grounds). If human activities on such grounds impact on the feature(s) of interest, then methods of mitigating or reducing impact could be developed.

Spatial planning and management may include a range of options, ranging from seasonal closures and gear restrictions to no-take zones. Close collaboration with the fishing industry, a good knowledge of fleet behaviour and consequences of such restrictions are vital if such approaches are to be effective both for the stocks of concern and other ecosystem components. A technical measure that has been demonstrated to significantly reduce fishing mortality can then be appropriately implemented in the right place at the right time to achieve maximum conservation benefits and minimise potential knock-on impacts to the fishing industry.

- Mesh-size regulations: If the objective is to protect the juveniles and/or spawning stock, then mesh size regulations could be beneficial. Whereas this may be appropriate in some gillnet fisheries, such regulations for trawl fisheries may impact more on the selectivity and catches of the main target species. In such circumstances, other technical measures (e.g. grids such as Turtle Excluding Devices, or alterations to ground gears and use of tickler chains) may have some merit, but would require further collaborative studies prior to implementation.

The use of square mesh panels and other modifications to reduce the amount of abrasive material in the catch (e.g. rocks or echinoderms) that may compromise discard survival could also be considered in some instances.

- Minimum Landing Size: Such a measure can be used to protect juveniles, although such a measure would only be beneficial if it reduced fishing effort on nursery grounds or if discard survival is high. Given the differences in the sizes of skates (whether $L_{birth}$, $L_{mat}$ or $L_{max}$), there would need to be further studies to identify whether a generic skate MLS or species-specific MLS would be most appropriate.
- Maximum Landing Length (MLL): Such a measure could be used to protect adults (e.g. mature females) and/or the larger-bodied species. Once again, such a measure would be most beneficial if it reduced fishing effort on particular grounds or if discard survival is high. For some elasmobranch species, females attain a larger size than males, mature at a greater length, and larger females likely produce more (and possibly larger) young.

Several studies have indicated that protecting the biomass of spawners is a useful management measure (Cortés, 1999; Simpfendorfer, 1999; Prince, 2005), although this would depend on whether it resulted in available quota being redirected to other life-history stages.

- Prohibited listing: Inclusion of the most vulnerable species on the 'Prohibited species list' is an important option for the conservation of the most threatened species, for example *Rostroraja alba*.

However, other species may be locally and/or seasonally abundant and able to withstand some exploitation, and the prohibiting the landing of such species may be controversial. For example, in 2010 *Raja undulata* was placed on the prohibited species list. This had not been recommended by ICES. Following a request from commercial fishers, the European Commission asked ICES to give advice on this listing. ICES reiterated that *R. undulata* would be better managed under local management measures and that there was no justification for placing it on the prohibited species list. However, to-date, there has been no change in the listing of this species. WGEF

made other comments on 'Prohibited Species' in an earlier report (see Section 1.8 of ICES, 2010).

### Proposed management plans

In 2011 as a result of the potential consequences of skates and rays being classified as a data-limited stock by ICES, the Irish Fishing Industry proposed work on a Long-Term Management Plan for Skates and Rays. This work progressed through the North-Western Waters Regional Advisory Council (NWWRAC) which had established a Focus Group on Skates and Rays.

Initial discussions included options for managing skates by genus or species, instead of at the family level, with separate TACs and management for *Raja* spp., *Leucoraja* spp. and *Dipturus* spp. Such an approach may have allowed more targeted and bespoke management measures for some of the various species. This plan also aimed to have separate management for *Dipturus batis* (cf. *flossada*) and *Dipturus* cf. *intermedia*, and ICES had advised on the provision of separate advice for these species. This plan was not evaluated by ICES.

Subsequently, at a meeting of the Focus Group in September 2012, the Irish Fishing Industry put forward a proposal for a pilot closure of a number of areas where it is known that skates and rays occur in high abundance, or are spawning/nursery grounds. It is widely acknowledged that the protection of juveniles is a useful tool in stock recovery. Protecting areas where spawning females are found is also considered a useful tool to protect the SSB.

Initially two closed areas, one in the Irish Sea and another in the Celtic Sea, were proposed. The proposals came from a combination of fishers' knowledge and results from IBTS and beam trawl surveys in the relevant areas. The proposed areas would be closed to any fishing activity that would catch skates or rays from the 1st April to the 30th June each year. This time was chosen based on the perceived spawning times of skate species in the Celtic Seas ecoregion. The closure in the Celtic Sea was eventually rejected by the NWWRAC, due to concerns over the potential impact on existing fisheries activity. The Irish Sea closure would be closed on a voluntary basis as a first step in 2013, with a review of the effectiveness of the closure later in the year. However, adherence levels with the first proposed voluntary closure are currently unknown and should be evaluated before the next closed season in 2014.

The co-ordinates of the Irish Sea Closure are provided below:

| | |
|---|---|
| 53°11.50'N, 05°57.00'W | 53°11.50'N, 05°38.50'W |
| 52°58.00'N, 05°38.50'W | 52°48.00'N, 05°51.50'W |
| 52°36.00'N, 05°58.50'W | 52°36.00'N, 06°00.00'W |
| 52°38.50'N, 06°00.00'W | 53°11.50'N, 05°57.00'W |

ICES has not evaluated this plan, although individual WGEF scientists contributed to drafts of the plan. WGEF recommend that any future plans continue to have stakeholder input, as without their input and consensus, any voluntary closure may not be effective.

Future spatial/temporal closures will also require a monitoring component to review the effectiveness of these measures over an appropriate time frame.

## Summary

Management measures should be framed in a mixed-fisheries context, considering the overall behaviour of demersal fleets, and the drivers for such behaviour. When the TAC is exhausted, catches may continue to take place, but they are discarded. In order to achieve optimal harvesting of the commercial species, and to assist recovery of depleted species, a suite of measures should be put in place.

Skate and ray focus groups have been initiated at various points, for example in the UK in conjunction with SeaFish and also under the NWWRAC. Such groups can help bring together fishers, producer organisations, processors, fishery scientists and managers and other groups, which can lead to improved communication between stakeholders and facilitate the discussion of management options. Hence enabling 'skate and ray focus groups' within the various RACs should be considered.

An appropriate knowledge of the spatial ecology of skates is requited in order to inform on options for regional management. Some skate species have been subject to conventional and/or electronic tagging programmes (e.g. *Raja clavata* in the southern North Sea, *Dipturus intermedia* in Subarea VI (west of Scotland)), or are sampled in trawl surveys and other programmes. Such data can be used to inform on spatial management. However, current scientific understanding of some other species (e.g. *R. brachyura* and *R. undulata*) is more limited. Furthermore, those species that have more discrete distributions or high habitat specificity (in terms of bathymetry, substrate and sea bed topography) and may be more suitable candidates for spatial management than species that are more wide-ranging and occur on a broad range of habitat types.

Many elasmobranchs are known to aggregate, and such aggregation may be 'behavioural' (i.e. they aggregate (which may be by sex and/or size) in large numbers anywhere within their overall range) or 'geographical' (i.e. they aggregate on discrete grounds at certain times of the year to, for example, mate, spawn, feed or overwinter). These have different implications for management options, with spatial management more effective for the latter.

## Options for future case studies

WGEF discussed several options across the ICES area that may be usefully considered as case studies to better evaluate specific, regional management options for skates.

### Undulate ray *Raja undulata*

There have been several field studies to better understand the dynamics of *R. undulata* since the prohibition on landing this species (Ellis *et al*., 2012; Delamare *et al*., 2013 WD; Stéphan *et al*., 2013 WD; Serra-Pereira *et al*., 2013 WD; Leblanc *et al*., 2013 WD). Although this species has a patchy distribution (which may confer a risk of localised depletion), historical information from the 1800s suggests this may have been the case for a long time. The use of pop-off electronic tags to better understand the movements and connectivity of this species in 'hot spots' across 6–7 sites in its European range (southwest Ireland; Isle of Wight; Normano-Breton Gulf; Bay of Biscay; Galicia and parts of Portugal) could usefully be undertaken.

### Thornback ray *Raja clavata* in the southern North Sea

This stock is possibly one of the best known skate stocks in European seas and forms an important target species for local inshore fisheries and bycatch for larger vessels

operating in Division IVc. Hence, this stock could provide a useful case study for the development of a regional management plan.

#### Skates in the Nomano–Breton Gulf

Several little-known skate species are locally important in the Normano-Breton Gulf, including *R. brachyura, R. microocellata* and *R. undulata.* This area is fished primarily by France, England and the Channel Islands.

#### Skate fisheries in the Irish Sea and Bristol Channel

Targeted fisheries for skates and rays in the Irish Sea and Bristol Channel tend to be seasonal. There are known spawning and nursery areas, although fishers' information can refine these. A combination of seasonal and spatial management can be used to protect juvenile and spawning stocks. Current studies through the MYFISH project on skate and ray populations and habitats in the Irish Sea may provide further information and management options for these stocks. Existing management plans should be regularly evaluated to ensure there continuing effectiveness.

#### Blonde ray (*Raja brachyura*) in Iberian and adjacent waters

Blonde ray is a frequent but patchily distributed species in the coastal areas off western Galicia, Portugal and Gulf of Cadiz, and it appears to concentrate on specific habitats. The implementation of a tagging programme, using inshore commercial vessels, would provide a useful opportunity to better understand the spatial dynamics of this species in relation to habitat type and help identify the most practical management units for this species in Iberian waters, and potential connectivity with other areas, such as the Bay of Biscay.

#### Common skate west of Scotland

Flapper skate *Dipturus intermedia* can still be found locally abundant in this area where the species forms an important basis for 'catch-and-release' recreational fisheries. A recent electronic tagging programme has been completed and there is wider information on the distribution of the species from IBTS and other surveys. Hence, this area could be a useful case study for the development of a regional management plan.

## References

Bonfil, R. 1999. Marine protected areas as a shark fisheries management tool. *In*: Proceedings of the 5th Indo-Pacific Fish Conference, Nouméa, 1997 (eds B. Séret and J-Y. Sire). Societe Francaise d'Ichtyologie, Paris, pp. 217–230.

Carrier, J. C. and Pratt, H. L. 1998. Habitat management and closure of a nurse shark breeding and nursery ground. Fisheries Research 39, 209–213.

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 J. A. Musick). American Fisheries Society Symposium 23, 115–136.

Delamare, A., Hennache, C., Stéphan, E. and Biais, G. 2013. Bay of Biscay undulate ray (*Raja undulata*) abundance estimate by mark-recapture. Working Document presented to the Working Group on Elasmobranch Fishes, 11 pp.

Ellis, J. R., McCully, S. R. and Brown, M. J. 2012. An overview of the biology and status of undulate ray *Raja undulata*. Journal of Fish Biology, 80: 1057–1074.

ICES. 2003. Report of the Working Group on Elasmobranch Fishes. Vigo, Spain, 28 April–2 May 2003. ICES CM 2003/G:09; 151 pp.

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

Leblanc, N., Tetard, A. and Legrand, V. 2013. RAIMOUEST: the French fishery of rays in the Western English Channel (VIIe). Working Document presented to the Working Group on Elasmobranch Fishes, 9 pp.

Prince, J. D. 2005. Gauntlet fisheries for elasmobranchs – the secret of sustainable shark fisheries. Journal of Northwest Atlantic Fishery Science 35, 407–416.

Serra-Pereira, B., Maia, C. and Figueiredo, I. 2013. Remarks on the reproduction strategy of *Raja undulata* from mainland Portugal. Working Document presented to the Working Group on Elasmobranch Fishes, 2 pp.

Simpfendorfer, C. A. 1999. Demographic analysis of the dusky shark fishery in southwestern Australia. *In*: Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals (ed J. A. Musick). American Fisheries Society Symposium 23, 149–160.

Stéphan, E., Hennache, C., Delamare, A., Legrand, V. and Leblanc, N. 2013. The French RECOAM project : study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay. Working Document presented to the Working Group on Elasmobranch Fishes, 8 pp.

Stevens, J. D. 2002. The role of protected areas in elasmobranch fisheries management and conservation. *In*: Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997 (eds S. L. Fowler, T. M. Reed and F. A. Dipper). IUCN SSC Shark Specialist Group, IUCN, Cambridge, 258 pp.

Walker, T. I. 2004. Elasmobranch fisheries management techniques. *In*: Elasmobranch Fisheries Management Techniques (eds J. A. Musick and R. Bonfil). APEC Fisheries Working Group, pp. 285–321.

## ICES request form

| REQUEST FROM (ORGANISATION) | EUROPEAN UNION (EUROPEAN COMMISSION, DG MARE, UNIT C2) |
|---|---|
| Contact within organisation:<br>Name/ Email/ Telephone | Gilles Doignon, gilles.doignon@ec.europa.eu, Tel: +32 229 99368 |
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| Request announced | 21 May 2013 |
| Request received | 21 May 2013 |
| Answer deadline client | 31 July 2013 |
| Request code (client) | |
| Request code (ICES) | |
| Request | Opinion on exploring management measures other than TACs for skates and rays.<br>Background<br>Fisheries on skates and rays are currently managed under a common TAC, although this complex comprises species that may have different vulnerabilities to exploitation. TAC advice is based on the status of the main commercial species.<br>Demersal elasmobranchs are caught in mixed target and non-target fisheries. TACs alone, therefore, may not adequately protect these species as restrictive TACs may lead to high discarding.<br>At present, fisheries on rays and skates are managed by means of a generic, multispecies TAC, along with prohibitions and certain extra obligations for severely depleted species.<br>On the basis of the explained above, ICES is asked to provide advice on:<br>Exploring alternative and/or complementary management measures such as closed areas/seasons or effort restrictions which may better protect demersal elasmobranchs.<br>In particular ICES is asked to comment on the functioning of the current voluntary closure in the Irish Sea and provide any recommendations on its operation. |
| Planning ICES | |
| Request (budget) accepted | Date: |
| ICES contact person<br>Name/ Email/ Telephone | |
| WG(s) involved | |
| Preparation timing | |
| Review group | |
| Advice drafting group | |
| ACOM WebEx | |
| Release date | |

**Grey cells to be filled in by ICES.**

# Annex 4: Special Advice request (EC)

## Opinion on modification to the list of deep-sea sharks

### Background

During the last negotiations for fixing the fishing opportunities for EU vessels for certain deep-sea fish stocks for 2013 and 2014, some Member States' delegates asked for a revision to the list of species of deep–sea sharks (Annex of Council Regulation (EU) No 1262/2012). In particular the request referred that black-mouth catshark (*Galeus melastomus*) be excluded from the list and low fin gulper shark (*Centrophorus lusitanicus*) be included in the list. The rationale behind the former case responds to consider the species as only demersal and not illustrative of deep-sea habitats. The latter regards to landings in ICES area IX, where the landings of other morphologically very similar species such as gulper shark (*Centrophorus squamosus*) may have been underreported due to misidentification among both species.

Concerning deep-sea sharks, the main commercial species are considered depleted and no directed fishing should take place. The Council agreed to fix TAC equal to zero since 2012, and, therefore, the content of the list of species of deep-sea sharks is deemed to be essential.

On the basis of the explained above, and taking into account the general principle of the vulnerability to fishing of most deep sea species, ICES is asked to provide advice on the appropriateness to amend the list of deep-sea sharks, considering:

- To exclude blackmouth catshark (*Galeus melastomus*);
- To include lowfin gulper shark (*Centrophorus lusitanicus*).

### ICES WGEF response

ICES WGEF's expert opinion is that there is sufficient scientific information to warrant:

- Exclusion of the blackmouth catshark (*Galeus melastomus*) from the list of deep-sea sharks;
- Inclusion of <u>all</u> species belonging to the genus *Centrophorus* (including the lowfin gulper shark, *Centrophorus lusitanicus*) on the list of deep-sea sharks, by listing gulper sharks *Centrophorus* spp.

This is for the following reasons, respectively to each case;

#### *Galeus melastomus*

*G. melostomus* is biologically different from other species on the deep-water sharks list. The species is oviparous and hence has a higher reproductive potential than the mainly viviparous deep-water species. It is also relatively fast growing, early maturing and is not thought to live longer than ten years (Moore *et al.*, 2013). It is thus much less vulnerable to exploitation than the other deep-water sharks on the list. Furthermore while the species is found in deep-water (to depths of 1000 m), its core depth distribution is less than 600 m and in many areas it occurs in abundance in waters that are not considered to be deep-water habitat (<400 m). It is a species that straddles the continental shelf and upper continental slope ecosystem and there is evidence that it breeding areas extend to shelf habitats at depths of 150–250 m (Hen-

dry *et al*., 2013). Together these factors lead WGEF to the conclusion that *G. melastomus* is not biologically or ecologically comparable to the other deep-water sharks on the list and hence its removal can be scientifically justified. Hence, *G. melastomus* should be removed from the list of deep-water sharks.

#### *Centrophorus squamosus*

The genus *Centrophorus* (13 species worldwide) are all deep-water continental slope, mid-oceanic ridge and seamount species. There is uncertainty around the status of *C. lusitanicus* as a species, with what appears to be two distinct species with the same scientific name, one in the Atlantic and one in the Pacific and Indian oceans (White and Darmadi, 2010; White *et al*., 2006). While there is taxonomic uncertainty regarding the species within the genus *Centrophorus*, all species within the genus are thought to be long-lived (>25 years) and ages of up to 70 years were estimated for *C. squamosus* (Clarke *et al*., 2002). All species in the genus are believed to have slow growth rates and very low fecundity (Girard and Du Buit, 1999; Guallart *et al*., 2006) and complete their life-cycle in deep-water environments. The core depth range of the *Centrophorus* species in the North Atlantic is below 400 m. In these respects all species of the family Centrophoridae that occur in EU waters should be included on the list of deep-water sharks. Therefore *C. lustianicus* and any other species of the genus *Centrophorus* should be included on the list of deep-water sharks.

### References

Clarke, M. W., Connolly, P. L. and Bracken, J. J. 2002. Age estimation of the exploited deep-water shark *Centrophorus squamosus* from the continental slopes of the Rockall Trough and Porcupine Bank. Journal of Fish Biology 60(3), 501–514.

Henry, L.A., Navas, J. M., Henige, S. J., Wicks, L. C., Vad, J. and Roberts, J. M. 2013. Cold-water coral reef habitats benefit recreationally valuable sharks. Biological Conservation 161, 67–70.

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

Guallart, J., Serena, F., Mancusi, C., Casper, B. M., Burgess, G. H., Ebert, D. A., Clarke, M. and Stenberg, C. 2006. *Centrophorus granulosus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2

Moore, D. M, Neat F. C. and McCarthy I. D. 2013. Population biology and ageing of the deep water sharks *Galeus melastomus*, *Centroselachus crepidater* and *Apristurus aphyodes* from the Rockall Trough, north-east Atlantic. *Journal of the Marine Biological Association of the United Kingdom*. doi:10.1017/S0025315413000374.

White, W. T. and Dharmadi. 2010. Aspects of maturation and reproduction in hexanchiform and squaliform sharks. Journal of Fish Biology, 76: 1362–1378.

White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi. 2006. Economically important sharks and rays of Indonesia. Australian Centre for International Agricultural Research, Canberra.

## Annex 5: Working documents presented to WGEF 2013

The following working documents were presented to the WGEF 2013.

# Bay of Biscay undulate ray (*Raja undulata*) abundance estimate by mark-recapture

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## Summary

This working document presents the results of a tagging operation that suggests that the undulate ray population is closed in the central part of the Bay of Biscay regarding emigration or immigration. This was the first step of the RaieBECA project, which the second step aims at carrying out a recapture survey to estimate the abundance of this population. The methodology that could be implemented for this survey is presented, considering the conditions that are necessary to use the Lincoln-Petersen estimator. The quality of the results that may be provided by this survey is discussed. The conclusion is that there is no guarantee to get a robust population abundance estimate but, nevertheless an interest to plan a future tagging-recapture project well designed. If all the partners of the project agree on its interest, this survey could be planned in autumn 2013.

## Introduction

Before 2009, undulate ray (*Raja undulata*), "raie brunette" in French, was not namely identified in French commercial landings of the Bay of Biscay auction halls. Moreover, elasmobranch species were not reported individually in the logbooks. Limited information was consequently available on catches and abundance of that species in the Bay of Biscay. However, a socioeconomical study carried out for a limited part of the Bay of Biscay (*Hennache, 2012*) estimates that landings of undulate ray in the three French auction halls of the Région Poitou-Charentes (La Rochelle area) was 60 to 100 t per year in 2007 and 2008, i.e. the two years preceding the undulate ray landing ban.

Because the French fishermen get more and more undulate ray in their gears since the landing ban and, consequently, because the lack of evidence that the species is an endangered one in the Bay of Biscay, a project was launched to estimate the abundance of undulate ray local stock in the center part of the Bay of Biscay by mark-recapture. This project, named RaieBECA (Raie Brunette Etude Centre Atlantique), is a partnership between fishermen, the regional technical organization CREAA, the interregional organization AGLIA, NGO APECS and Ifremer. This project was carried out in close relation with a second project

named RECOAM, run by APECS in Atlantic and English Channel coastal waters and focused on biology (length at maturity in particular), stocks structure (genetic study) and spatial behavior also by tagging (*Stéphan et al., 2013*).

The project was planned in two steps. In a first one, the aim was to confirm by tagging that the undulate ray population is closed in the central part of the Bay of Biscay regarding emigration or immigration, forming one of the discrete stocks that the patchy distribution may let suppose to exist in the western European coastal waters (*Ellis & al., 2012*). If tagged fish reports confirm that there is no exchange with other areas, then a recapture survey could be planned in a second step in autumn 2013.

This working document presents the results of the first step on the population structure in the center part of Bay of Biscay and the recapture survey methodology that could be implemented.

# RaieBECA methodology

## Survival experiment

An experiment to evaluate the short term survival rate of undulate ray after tagging with Petersen disks was carried out by CREAA (*Hennache, 2013*).
From the 15th to the 25th November 2011, 68 undulate rays were caught and placed in two raceway tanks of 15m$^3$ each, with sea water (Figure 1). 32 of them were tagged and all of them were kept in the tanks at least one month up to 22nd December. The study was carried out without any major problem, the fish being fed with squid, except that the water salinity and the temperature decreased quite dramatically in the last days of the study, owing to hydrological conditions at the coastal experimental site at the start of winter (Figure 2).

**Figure 1:** Raceway tanks (*Hennache, 2013*)

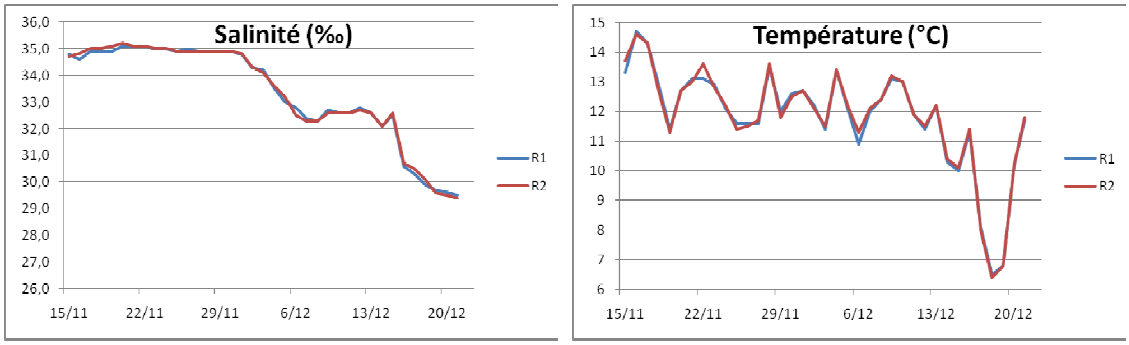



**Figure 2:** Salinity and temperature within the two tanks (R1 & R2) (*Hennache, 2013*)

## Tagging

Considering the possible number of rays that could be tagged during the project RaieBECA, 2000 Petersen disk tags were bought (Figure 3). In addition, the project RECOAM acquired and deployed 1000 tags. The same tags and procedure were used in the two projects and a common database was built. Lastly, at the end of the survival experiment, the set of untagged rays were tagged and 56 rays were released in the wild and therefore contribute to the tag-recapture project. These 56 rays were tagged using identical Pertersen disks provided by Cefas.

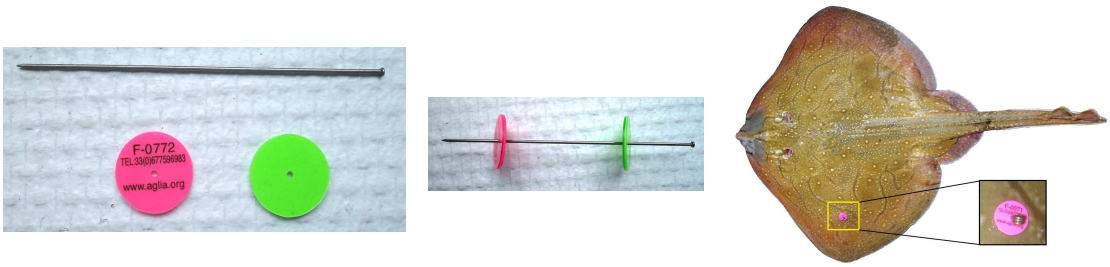



**Figure 3:** Used Petersen disk and tagged undulate ray, © *CREAA*

The tagging was done by three ways:

1. Scientific observers deployed by RaieBECA for the specific purposes of tagging undulate rays and collect biological data on this species on board of commercial fishing vessels, in real commercial conditions, i.e., fishermen carry out usual fishing operations and do not target undulate ray.
2. Scientific observers from RaieBECA and RECOAM on board on commercial fishing vessels and fishermen get back a compensation to fish in areas known for their high undulate ray abundance. The purpose is to tag as many individuals as possible.
3. Commercial fishermen are trained to do the tagging on their own. That's a cheap way to tag a large number of individuals.

**Fishermen reports**

Because the project is a fisheries-science partnership and also because undulate ray landing is banned, no reward was planned in case of tagged fish recapture. Fishermen were informed by the press, their professional organizations and a poster (Annex 1) that, in case of a tagged undulate ray recapture, they only have to note the tag number and the catching position and to report them before releasing the ray with its tag.

For that purpose, a telephone number (APECS) and an internet site (AGLIA) are engraved on the tags (Figure 3). Commercial fishermen may also transmit the information to their relevant fishing industry organization. These data are stored in the project database.

## Planned recapture survey

To assess the population abundance of undulate ray, 10 to 15 trips on commercial fishing vessels are planned in autumn 2013. The following methodology is proposed:

1. The study area will be divided in 3 sub-areas according to tagging results: Pertuis Breton sound and Vendée Southern coast, Pertuis d'Antioche sound and North-West Oléron Island, Gironde mouth (Figure 4).
2. One or several vessels will be chartered to carry out fishing targeting undulate ray.
3. In each sub-area, the fishing positions will be decided on board by the skipper, based upon his empirical knowledge of locations where undulate rays are more abundant, as for a commercial trip.
4. In order to obtain a higher precision of estimated abundance in the most important sub-areas, the number of trips by sub-area will be proportional to the abundance in each sub-area. The abundance by sub-area will be estimated by the product of the catch rate and the sub-area surface.
5. Small mesh (<100 mm stretched mesh) gillnet allows catching a larger size range, from 21 to 94 cm, than large mesh gillnet or long-line, which targets only large individuals, from 48 to 97 cm (Figure 5). Large mesh gillnet are all gillnets>100 mm stretched mesh, however length distribution data presented in figure 5 were collected from large fish (i.e. turbot) gillnet with 270 mm stretched mesh size. The dome shape selectivity curves of these gears affect the probability to catch fish on each side of theirs length catch distributions. Lower number of large rays are caught in the small mesh gillnet which is then poorly appropriate to the recapture survey. The large mesh gillnet and longline selectivity seem quite similar however longlines seem to catch a large size range with a higher proportion of individuals of 50-70 cm and above *ca* 85 cm. Hooks and baits might indeed be suitable for adult undulate rays of all size including the larger/older individuals. As a consequence this gear appears

the most appropriate to catching mature fish, including the larger adults and priority should be given to trips on longliners for sampling mature fish. Large mesh gillnetters would be used only if no longliner is available for the survey.

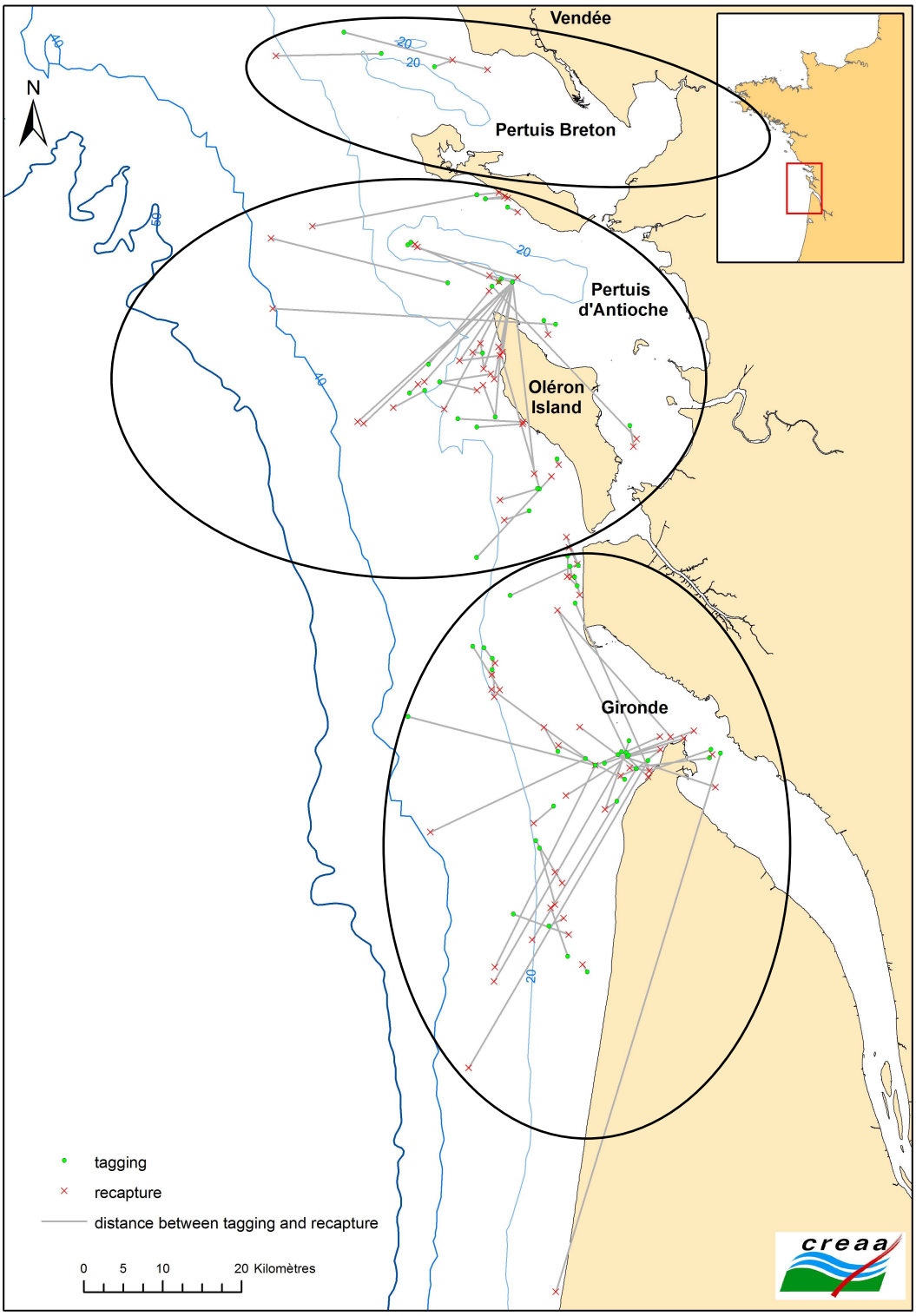



**Figure 4:** Undulate ray marks-recaptures positions in the center of the Bay of Biscay (preliminary results in May 2013) with the 3 sub-areas which are designed for the study according to tagging results.

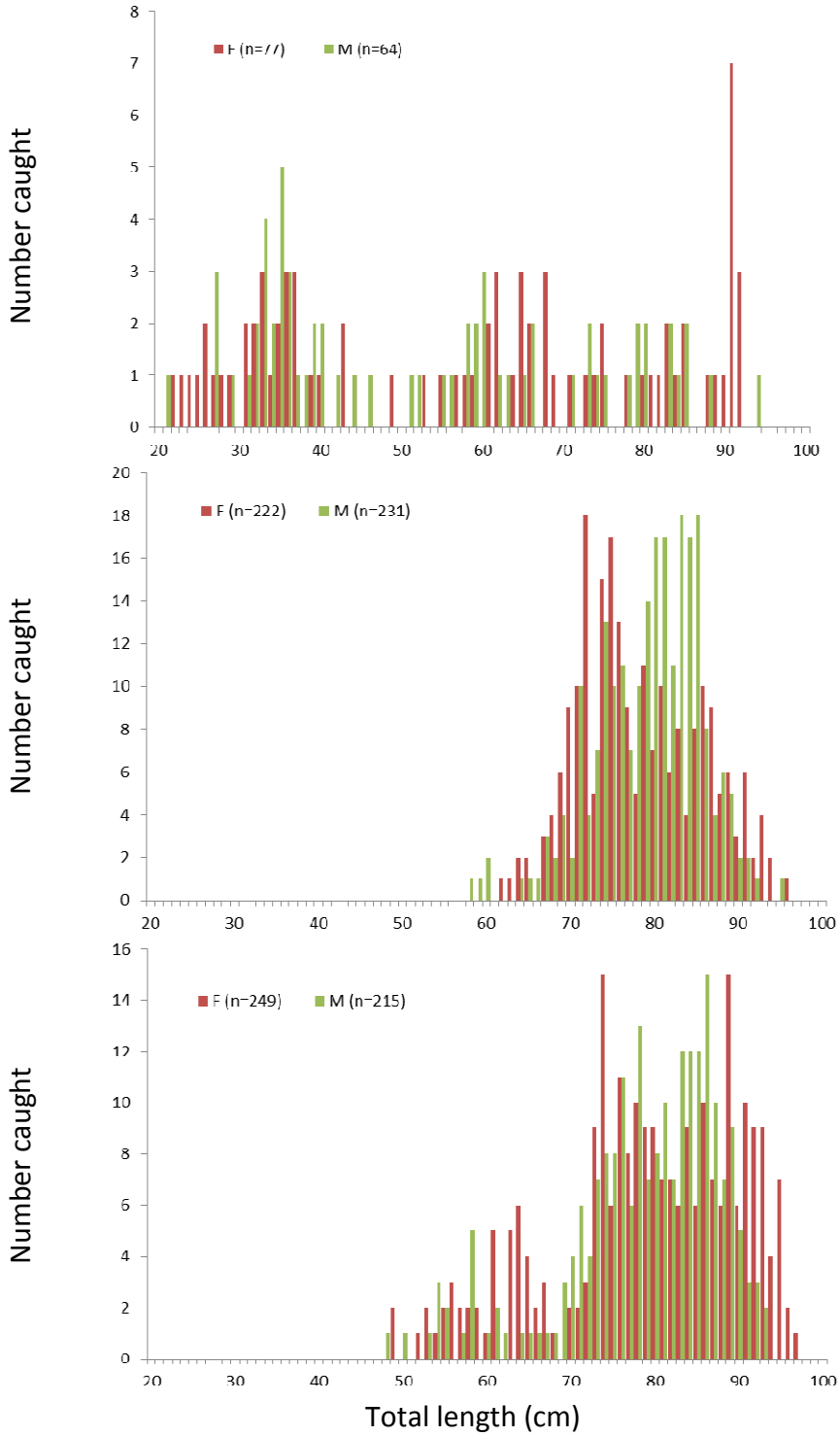



**Figure 5:** Length distribution per sex (F= female / M= male) of undulate rays in the central Bay of Biscay caught by small mesh size nets (a), large mesh size nets (b) and long-lines (c) (data collected by RaieBECA and RECOAM scientific observers from May 2012 to May 2013).

### Capture-recapture model

The RaieBECA project aims to carry out an abundance estimation if tagging confirms that undulate ray forms a sufficiently separated dynamic population in the central part of the Bay of Biscay regarding emigration or immigration.

Such a condition is necessary to estimate abundance using the Lincoln-Petersen estimator but not sufficient. The complete set of conditions is (*Pine et al., 2003*):

1. the population is closed to additions (recruitment or immigration) or deletions (deaths or emigration),
2. capture probability is equal among all animals in each sample,
3. marks are not lost or overlooked.

## Preliminary results

The survival study showed that 30/32 (94 %) of the tagged fish survive after one month in captivity (*Hennache, 2013*). On the 36 untagged rays, 2 died during transport, 4 the next day, 1 two days later and 1 after one week. The remaining 28 survived to the experiment. In the latter a hook was found in the stomach so no death was ascribed to captivity. As no reason for death ascribable to any wound or rearing condition was found, the death of 2/34 tagged rays was ascribed to tagging itself. Then, this experiment confirmed that some mortality is induced by the tagging with Petersen disks. This mortality is low but not negligible and, consequently, its level must be taken into account to carry out an abundance estimate by mark-recapture.

Out of the 3100 available Petersen disks, including 100 provided by Cefas, 1700 have been used to tag undulate rays from April 2012 to the end of May 2013 in the central part of the Bay of Biscay:

- 56 from the survival experiment (3.2 %),
- 45 by a fishing guide, i.e. the skipper of recreational fishing guided trips, (2,6 %),
- 591 by professional fishermen (34.8 %),
- 1008 by scientific observers (59.3 %), whose 478 from RECOAM project.

The tagged rays measured 20 to 100 cm at tagging time (*Stéphan et al., 2013*).

98 recaptures have been recorded, it means 6 % of tagged rays. The distances between tagging and recapture are rarely longer than 30 km, about two third of them being less than 10 km (Figure 4). Furthermore, no relation has been observed between the distances from a tagging to recapture positions and the durations of the trips (Figure 6). The lengths of these recaptured fishes are quite well distributed between 48 and 95 cm (only 2 ray less long than 48 cm), the sex-ratio is equilibrated between males (46%) and females (54%).

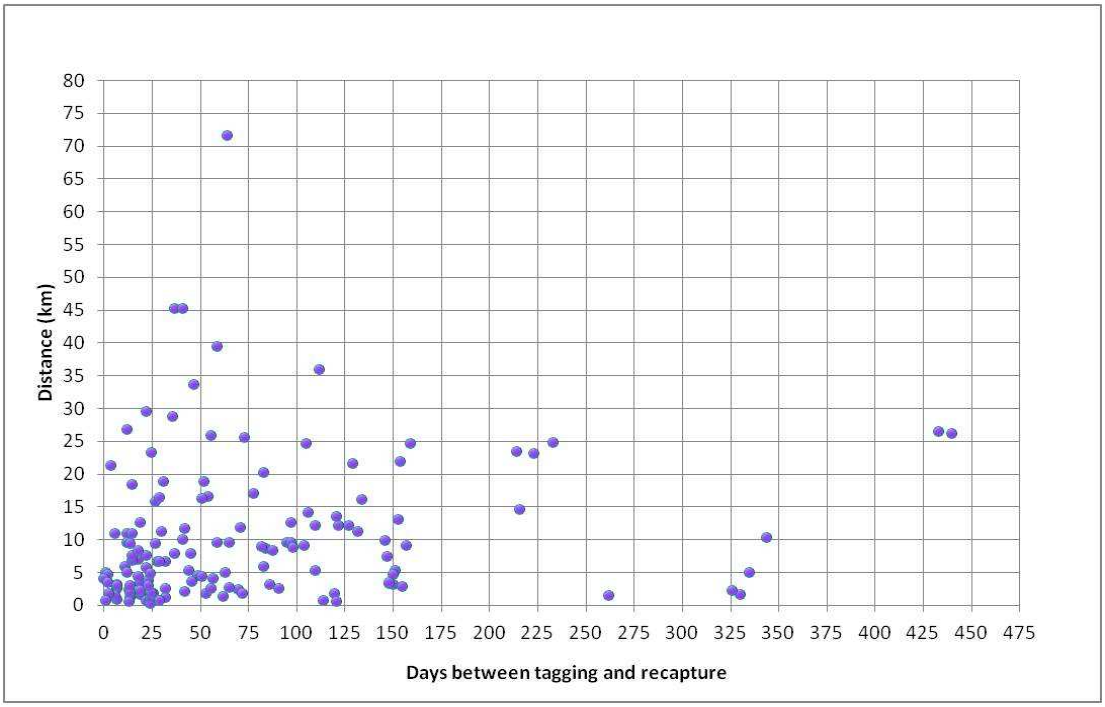



**Figure 6:** Distance from tagging to recapture plotted against time between these two events

According to these observations, the undulate ray population is closed in the central part of the Bay of Biscay regarding emigration or immigration.

## Conclusion and discussion

The recaptures of tagged fish shows that, at size larger than size-at-tagging, undulate rays from the study area do not seem to migrate far away. Migrations are mostly limited to less than 30 km and there is even little exchange between the three sub-areas depicted on Figure 4.

In neighboring areas further north and south of the area in figure 4, undulate ray abundance may be lower. On-board observations carried out under the Data Collection Framework (DCF) suggest two main areas where undulates ray are caught: the Normano-Breton Gulf and the central Bay of Biscay (*Tétard., 2013*). Collection of stranded egg capsules carried routinely by APECS since 2008 also suggest a higher abundance of undulate ray in the central Bay of Biscay. Therefore exchanges between the study area and other area occupied by *R. undulata* seem limited and the undulate ray population in the centre of the Bay of Biscay may form an unit which have a low rate of migration or immigration.
On-going field work and data collection including the likely recapture of more individuals from this study and addition tagging carried out further North and south, by fishers organisation of Pays de la Loire and Aquitaine, might allow to evaluate further this in the near future.
Regarding recruitment that can also affect population abundance and then that may contribute to a violation of the close population conditions to use a Lincoln-Petersen estimator, it is not really an issue because the number of tagged fishes is low below 60 cm. Consequently, the recapture operation must be carried out

using the long-line which is the more suitable gear to catch the larger fishes. With this gear, the mark-recapture abundance estimate must be limited to the fishes longer than 70 cm if one wants to avoid the effect of selectivity that causes a violation of equality of the capture probability among fishes of different lengths.

According to available growth-model parameters (*Moura et al., 2007*), undulate ray grows from 60 to 70 cm in about 2 years. Then, rays reaching 70 cm during the year might have a probability to be tagged not much different from the one of older fish.

Consequently, when the tag-recapture abundance estimate is limited to fishes longer than 70cm, the problems of recruitment as well as the one of the equality of the capture probability among fishes of different lengths are overcome. An abundance estimate by sub-area within which fishes are moving should also limit the spatial effect on capture probabilities among fishes.

Mortality is limited to natural mortality because of the ban of landings when the fishes are not tagged. When fish are tagged, a 6 % immediate mortality has been shown by the rearing experiment. However this value must be considered as indicative only, given the limited number of fishes on which it was estimated. Further, mortality of tagged fish in captivity, where e.g. food is provided without limitation, may not represent conditions that prevail in the wild. The effects of natural and tagging mortalities are likely low compared to the uncertainty of a mark-recapture abundance estimate based on a limited number of tagged fishes. However, they will be simulated by using a range of possible natural mortalities values from the literature to assess the sensitivity of the abundance estimate to this parameter of the dynamic of the population.

The last condition for applying the Lincoln-Petersen estimator, i.e. marks are not lost or overlooked, is violated without any doubt because some fishermen reported that some individuals had been re-caught with an injury corresponding to the usual place of Petersen disk or with only one of the two plastic disks forming the tag. To estimate the loss percentage, fishes have been tagged both a spaghetti and a Petersen disk since May 2013 in the RECOAM project. Because this problem was only realized lately, double tagging started recently and there is a concern that data to assess the proportion of lost tag will be limited. In that case, a range of likely rate, according to a fishermen survey, might be a solution but it may be an important weakness of the future abundance estimate.

Finally, considering all these issues, estimating the total abundance (number of individuals) of undulate ray in the Central Bay of Biscay by combining tagging with a recapture operation appears to require some methodological work. Results may be uncertain primarily depending upon the total number of tagged and untagged fish recaptured (the higher the total number the more accurate the abundance estimate).

*Acknowledgements*:
The RaieBECA project is funded by the Regional Councils of Aquitaine, Poitou-Charentes, Pays de la Loire and Bretagne, by FFP (France Filière Pêche) in 2013, and was part of the Interreg IVb MAIA project in 2012. We are grateful to Cefas colleagues for provision of 100 Petersen disks that allowed to start the survival experiment early on in 2011. Fishers who contributed to tagging and who took observers on-board their vessels are kindly acknowledged. The authors are also largely indebted to Pascal Lorance for his help to improve this WD but they remain fully responsible for all the defaults that this text may still contain.

## References

Ellis, J. R., McCully S. R. and Brown M. J. , 2012. An overview of the biology and status of undulate ray Raja undulata in the north-east Atlantic Ocean. Journal of Fish Biology 2012, doi:10.1111/j.1095-8649.2011.03211.x. Available at ww.wileyonlinelibrary.com.

Hennache, C., 2012. Évaluation de l'impact socio-économique de l'interdiction de pêche de la raie brunette (*Raja undulata*) en Poitou-Charentes et caractérisation de la pêcherie. 16p.

Hennache, C., 2013. Etude du taux de survie de raies brunettes marquée à l'aide de disque de Petersen. 7p.

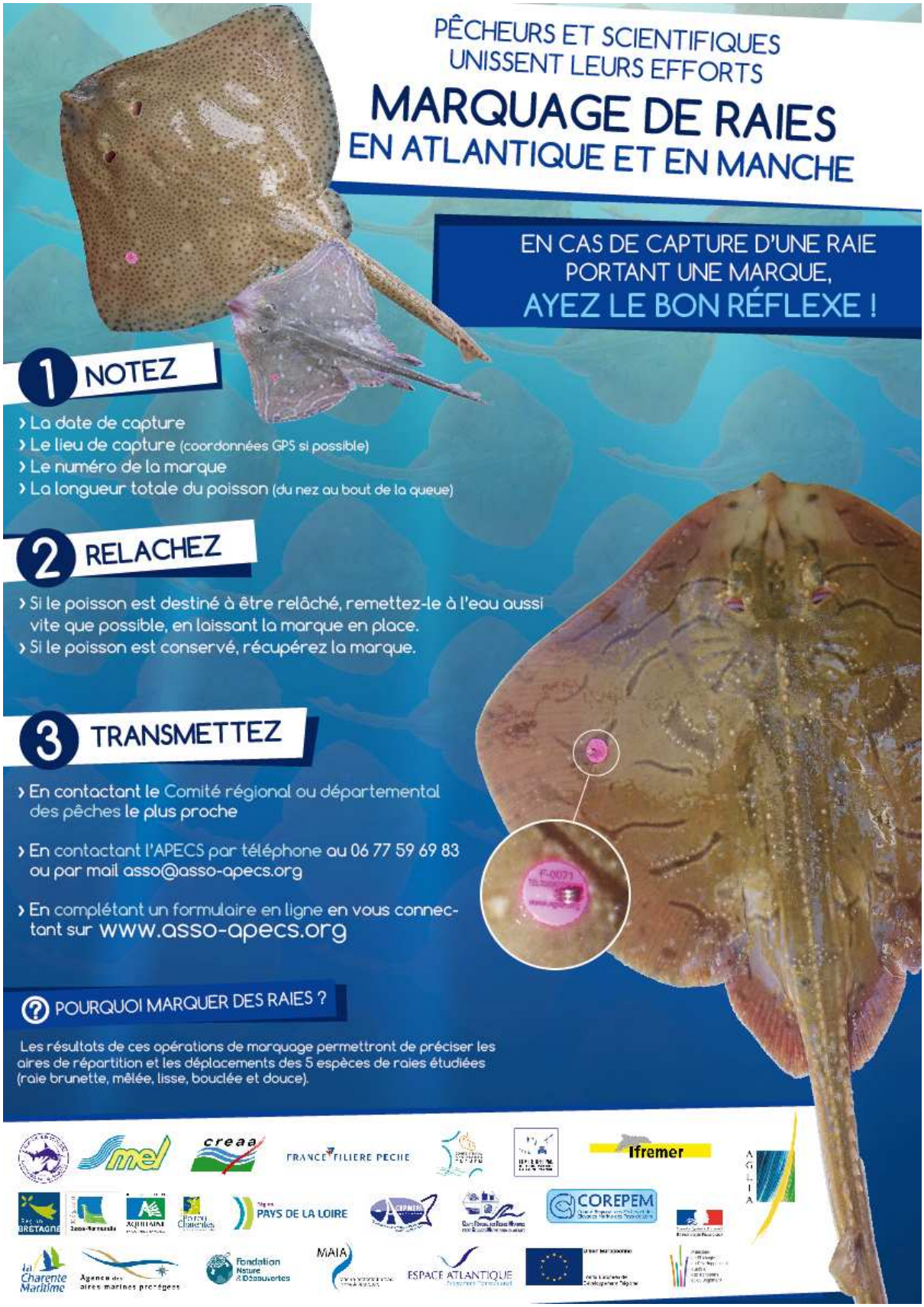
Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Coelho, R., Erzini, K., Neves, A. and Gordo, L. S., 2007. The use of caudal thorns for ageing Raja undulata from the Portuguese continental shelf, with comments on its reproductive cycle. Marine and Freshwater Research 58, 983–992. Available at http://www.publish.csiro.au/?paper=MF07042

Pine, W. E., Pollock K. H., Hightower J. E., Kwak T. J. and Rice J. A., 2003. A review of tagging methods for estimating fish population size and components of mortality. Fisheries, vol. 28 n°10 : 10-23.

Stéphan, E., Hennache C., Delamare A., Legrand V., and Leblanc N., 2013. The French RECOAM project : study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay. Working paper presented at the 2013 WGEF, Lisbon, 17-21 June 2013, 8 p.

Tétard, A. 2013. Distribution of Elasmobranches from the French program of observations at sea aboard fishing vessels (ObsMer). Working document to WGEF 17-21 June 2013. 24pp.

**Annex 1**


PÊCHEURS ET SCIENTIFIQUES
UNISSENT LEURS EFFORTS
MARQUAGE DE RAIES
EN ATLANTIQUE ET EN MANCHE
EN CAS DE CAPTURE D'UNE RAIE
PORTANT UNE MARQUE,
AYEZ LE BON RÉFLEXE !
1 NOTEZ
› La date de capture
› Le lieu de capture (coordonnées GPS si possible)
› Le numéro de la marque
› La longueur totale du poisson (du nez au bout de la queue)
2 RELACHEZ
› Si le poisson est destiné à être relâché, remettez-le à l'eau aussi vite que possible, en laissant la marque en place.
› Si le poisson est conservé, récupérez la marque.
3 TRANSMETTEZ
› En contactant le Comité régional ou départemental des pêches le plus proche
› En contactant l'APECS par téléphone au 06 77 59 69 83 ou par mail asso@asso-apecs.org
› En complétant un formulaire en ligne en vous connectant sur www.asso-apecs.org
POURQUOI MARQUER DES RAIES ?
Les résultats de ces opérations de marquage permettront de préciser les aires de répartition et les déplacements des 5 espèces de raies étudiées (raie brunette, mêlée, lisse, bouclée et douce).
creaa
FRANCE FILIERE PECHE
Ifremer
PAYS DE LA LOIRE
COREPEM
Fondation Nature & Découvertes
MAIA
ESPACE ATLANTIQUE

# The French RECOAM project : study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay.

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*Correspondence: eric.stephan@asso-apecs.org*

## Introduction

In the Celtic seas and the Biscay/Iberian ecoregions, most of skates species are little known. It's particularly the case for species that seems to have patchy coastal distribution which are not well sampled by the scientific fishery-independent surveys. Information on the mixing between skates of different areas and the populations structures but also on biology and possible movements between ecologically important grounds are needed for management purposes.

The RECOAM project was set up to contribute to a better knowledge of five skate species, undulate ray (*Raja undulata*), blonde ray (*Raja brachyura*), small-eyed ray (*Raja microocellata*), thornback ray (*Raja clavata*) and spotted ray (*Raja montagui*), working in two areas of the French waters of particular interest, one in the western English Channel and one in the Bay of Biscay. These two areas were chosen because skates are regularly caught and because they are concerned by marine protected areas creation projects. Furthermore, the undulate ray (*Raja undulata*) can be locally common in these two coastal areas and the fishermen, who feel that the European Commission regulation introduced in 2009 is poorly adapted to their local situation, agreed to take part to a study that could improve scientific knowledge and give the possibility to re-evaluate the status of this species.

The aims of the project are to :

- evaluate the length at maturity for each area which is a fundamental parameter given its importance in the assessment models,
- enhance the understanding of skates movements which could contribute to identify important grounds in their life cycles,
- precise the stocks structure which is essential for abundance assesment

To achieve them, biological, tagging and genetic studies were initiated in 2012 and will continue until 2014.

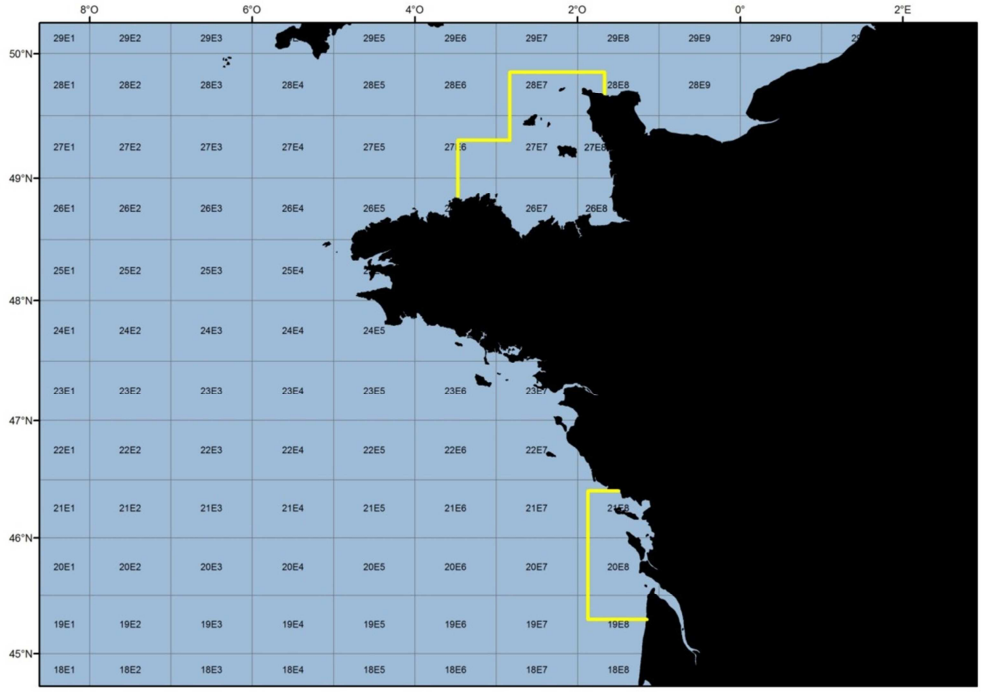


**Figure 1 : Map of the 2 study areas in the Bay of Biscay and in the western English Channel**

## Methods

Cost compensated fishing trips targeting skates are done with volunteer coastal fishing vessels, mainly gillnetters and demersal longliners. Because undulate ray (*Raja undulata*) fishing is prohibited under the European Commission TAC regulation, special authorizations are delivered by the French authorities to each boat involved in the project. Areas fished are determined based on fishermen knowledge and experience and gear deployment are of commercial duration for longline and are shorter for gillnets when possible (24h instead of the standard 30-48h). Data on each gear deployment are recorded.

When a skate is caught, species and sexe are determined, total length ($L_T$) and width ($D_W$) are measured to the centimeter below. For males, the inner side of the right clasper is measured to the half centimeter below.

The sexual maturity stage is determined using anatomical criteria according to the scale defined by ICES (ICES 2010). It's done systematically for males, and because internal examination is necessary for females, this data is only collected for dead females and for a fixed number of sacrificed individuals which are landed for later analysis. In the case of undulate ray (*Raja undulata*), a landing possibility is lead down on the fishing authorization delivered by the French authorities.

For the genetic study, a non-lethal tissue sample is taken on the bottom edge of the pectoral or dorsal fin[1]. A one centimeter notch is sufficient. Each sample is placed in a tube filled with alcohol and correctly labelled.
Skates are finally tagged on the left pectoral fin using a numbered Petersen disc (16mm diameter) and released. Individuals who remain very weak (no movement of the pectorals or body and small movements of the spiracles) even after having spent time in a stabilizing tank are not tagged. Smaller skates (below 30 cm) are not tagged as this would require the tag to be fitted very loosely to leave space for growth (i.e. thickening of the wing) which could generate an important risk of the tag snagging.

**Figure 2 : Tissue sampling and Petersen disc used**

The database is also updated by data collected by scientific observers in the frame of two other regional projects set up in the French waters, the project RaieBECA in the Bay of Biscay (Delamare et al. 2013) and the project Raimouest in the Normand-breton Gulf (Leblanc et al. 2013). The scientific observers have been trained and the same protocol is implemented. For the Bay of Biscay study area, the database is also updated by tagging data from fishermen self-tagging operations designed in the frame of the project RaieBECA.
Partnerships are also established with some professional fishing guides in the Bay of Biscay who also contribute to the tissue sampling and tagging.

To enhance the recovery of information on recaptured tagged skates, information posters were widely distributed on the English Channel and Atlantic French coasts and a media campaign was executed. Recapture data can be supplied by telephone or via an online form (http://www.asso-apecs.org/Signalez-la-capture-d-une-raie.html).

## Planned data analysis

The proportion of mature rays will be plotted against length and a sigmoid function will be fitted. The equation used to fit the curve to the data is as follows :

$$P_{Li}=1/1+e^{-b(Li-L50)}$$

where $P_{Li}$ is the proportion of mature rays at length $L_i$, b is the steepness of the curve and $L_{50}$ is the length at which 50% of the rays are mature ($P_{Li}$=0,5).

For each recaptured skate with information on date and location, the days at liberty and distances (km) between tagging and recapture sites will be calculated. Days at liberty, distance data and recapture location information will then be analyzed by release area, sexe

[1] *Within the RECOAM project, the genetic study will not be led on the thornback ray (R. clavata) because the work has already undergone in NE Atlantic (Chevolot et al. 2006). The samples will nevertheless be collected in order to prepare for a possible prolongation of this study.*

and size based on the total length at tagging in order to investigate movement's patterns. These data will also help to support or refute hypotheses on population structure and stock identity.

Tissue samples will be used to analyze the genetic polymorphism in order to investigate the population structure. This molecular detection of population structure will be done in collaboration with a specialized laboratory.

## Project progress

The 15th of May 2013, 6 fishing operations were done in Atlantic and 4 in the English Channel. Data were also collected during 45 and 7 observers boarding in the frame of the projects RaieBECA and Raimouest respectively. For the Atlantic study area, data from the fishermen self-tagging operations and from a professional fishing guide are also included in the database.

A total of 2002 skates were caught in the Atlantic study area, 1805 undulate ray (90.2%), 174 small-eyed ray (8.7%) and 23 thornback ray (1.1%). Undulate ray (20-100cm $L_T$) were caught in the whole area whereas small-eyed (26-93cm $L_T$) and thornback (40-93cm $L_T$) were caught mainly north and south of the mouth of the Gironde.

In the English Channel study area, 418 skates were caught, 283 undulate (67.7%), 113 blonde ray (27%), 14 spotted ray (3.3%), 7 thornback and 1 small-eyed ray (Table 1).

Data collected (maturity stage, tissue sample) and number of skates tagged and released are summarized by area, species and sexe in table 1.

### *Length at maturity*

To date, the length at maturity was calculated only for males undulate ray for the Atlantic study area. Maturity was recorded for 431 male of which 191 were mature. First maturity was 74 cm $L_T$, with 50% maturity reached at 80 cm $L_T$ (Figure 3). The largest immature fish was 89 cm $L_T$.

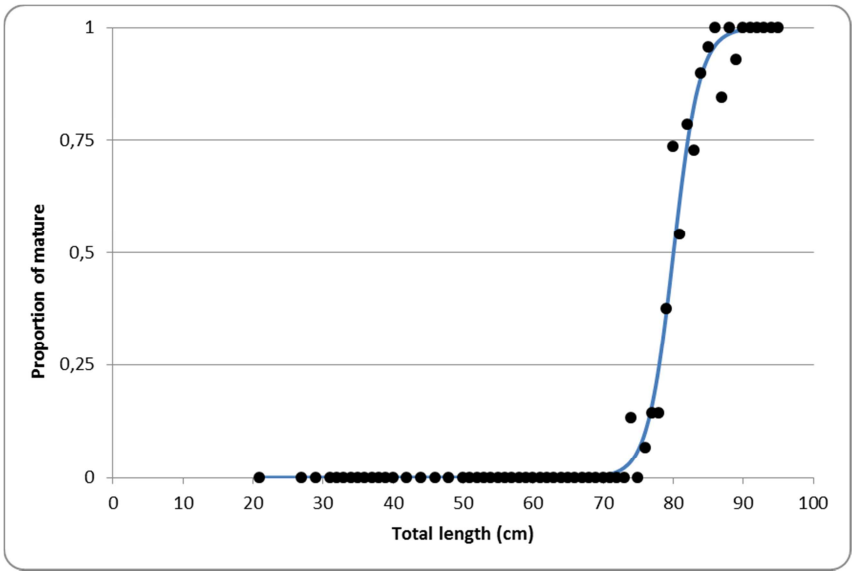


**Figure 3 : Proportion of mature fish at length for male undulate ray (*Raja undulata*) in the Bay of Biscay**

**Table 1 : Summary table of the data collected for each species in the two study areas**

| Area | Species | Femelle | | | | Male | | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Maturity stage | Tagged | Tissue sample | n | Maturity stage | Tagged | Tissue sample | n | Tagged | Tissue sample | n | Tagged | Tissue sample |
| Central Bay of Biscay | *Raja undulata* | 967 | 24 | 897 | 294 | 805 | 434 | 771 | 217 | 33 | 32 | 0 | 1805 | 1700 | 511 |
| | *Raja microocellata* | 89 | 16 | 20 | 34 | 60 | 60 | 17 | 23 | 25 | 0 | 0 | 174 | 37 | 57 |
| | *Raja clavata* | 13 | 3 | 1 | 5 | 10 | 10 | 7 | 5 | 0 | 0 | 0 | 23 | 8 | 10 |
| Western English Channel | *Raja undulata* | 109 | 8 | 85 | 95 | 174 | 165 | 139 | 154 | 0 | 0 | 0 | 283 | 224 | 249 |
| | *Raja brachyura* | 49 | 1 | 28 | 46 | 64 | 63 | 33 | 62 | 0 | 0 | 0 | 113 | 61 | 108 |
| | *Raja clavata* | 4 | 0 | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 7 | 4 | 4 |
| | *Raja montagui* | 5 | 0 | 3 | 5 | 9 | 9 | 6 | 9 | 0 | 0 | 0 | 14 | 9 | 14 |
| | *Raja microocellata* | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

**Table 2 : Number of tagged and released skates and recapture rates by area and species**

| | | Central Bay of Biscay | | | | Western English Channel | | |
|---|---|---|---|---|---|---|---|---|
| Specie | | F | M | unknown | Total | F | M | Total |
| Undulate ray | Released | 897 | 771 | 32 | ***1700*** | 85 | 139 | ***224*** |
| | Recaptured | | | | ***94*** | | | ***5*** |
| | % recaptured | | | | ***5.5*** | | | ***2.2*** |
| Small eyed ray | Released | 20 | 17 | | ***37*** | 1 | | ***1*** |
| | Recaptured | | | | ***1*** | | | ***0*** |
| | % recaptured | | | | ***2.7*** | | | ***0.0*** |
| Blonde ray | Released | | | | | 28 | 33 | ***61*** |
| | Recaptured | | | | | | | ***1*** |
| | % recaptured | | | | | | | ***1.6*** |
| Thornback ray | Released | 1 | 7 | | ***8*** | 3 | 1 | ***4*** |
| | Recaptured | | | | ***1*** | | | ***0*** |
| | % recaptured | | | | ***12.5*** | | | ***0.0*** |
| Spotted ray | Released | | | | | 3 | 6 | ***9*** |
| | Recaptured | | | | | | | ***0*** |
| | % recaptured | | | | | | | ***0.0*** |

***Movements***

1745 skates were tagged and released in Atlantic, 1700 undulate ray (97.4%) (Figure 4 and 6a), 37 small-eyed ray (2.1%) and 8 thornback ray. Of these skates, 96 (5.5%) were recaptured during the time frame considered (Table 2), most close to the tagged and released area. Only one undulate ray was taken outside of the study area after 64 days, about 72 kilometers south of the released position, along the Gironde coast.

In the western English Channel, 298 skates were tagged, 224 undulate ray (75.2%) (Figure 5 and 6b), 61 blonde ray (20.5%), 9 spotted ray (3%) and 4 thornback and 1 small-eyed ray. To date, 6 were recaptured (2%), all in the study area (Table 2).

Table 3 give information on the number of the days at liberty, distance travelled and speed for undulate ray in the two study areas. The detailed movement's patterns analysis will be done when more recapture data will be available.

**Table 3 : Preliminary results on movements of undulate ray**

| | Central Bay of Biscay | Western English Channel |
|---|---|---|
| Maximum time at liberty (days) | 440 | 82 |
| Mean time at liberty (days) | 87 | 40 |
| Maximum distance (km) | 72 | 34 |
| Mean distance (km) | 11 | 18 |
| Maximum speed (km/day) | 5.30 | 1.26 |
| Mean speed (km/day) | 0.36 | 0.58 |

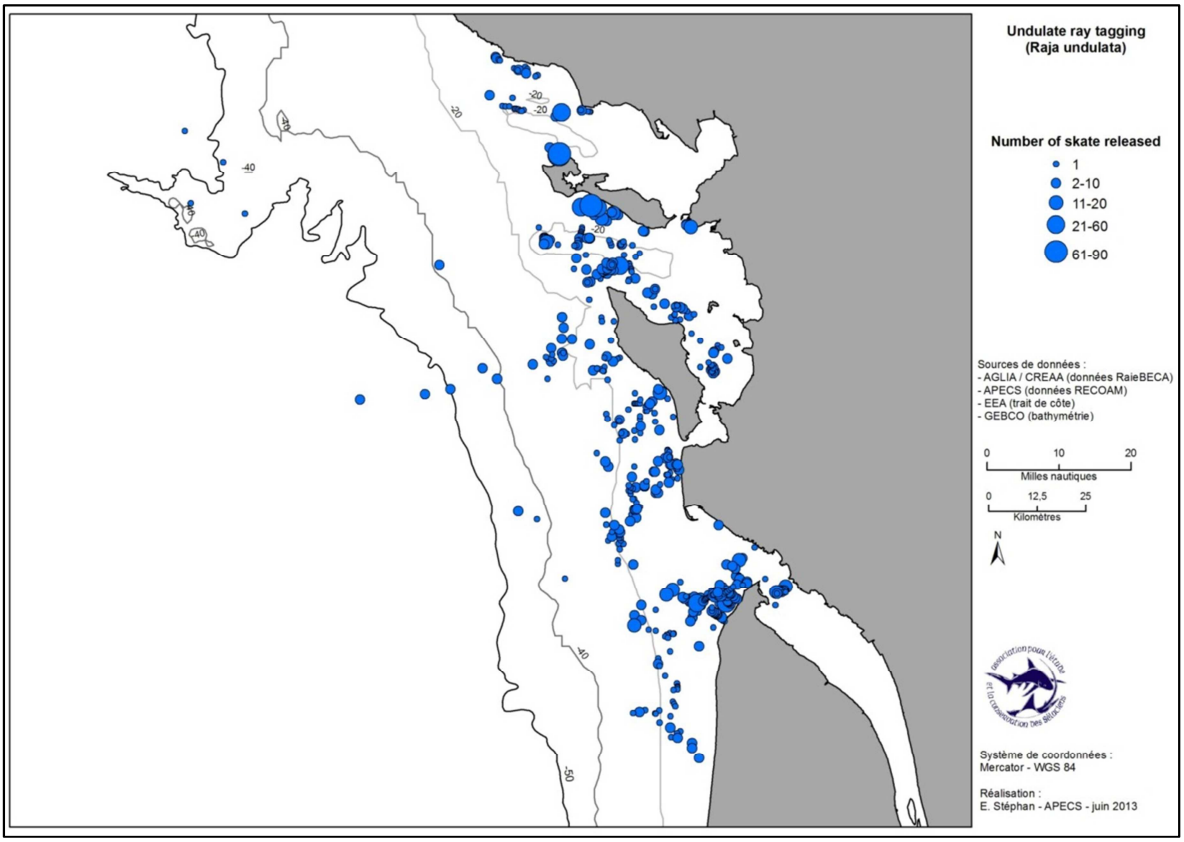


**Figure 4 : Released positions of undulate ray tagged in the central Bay of Biscay**

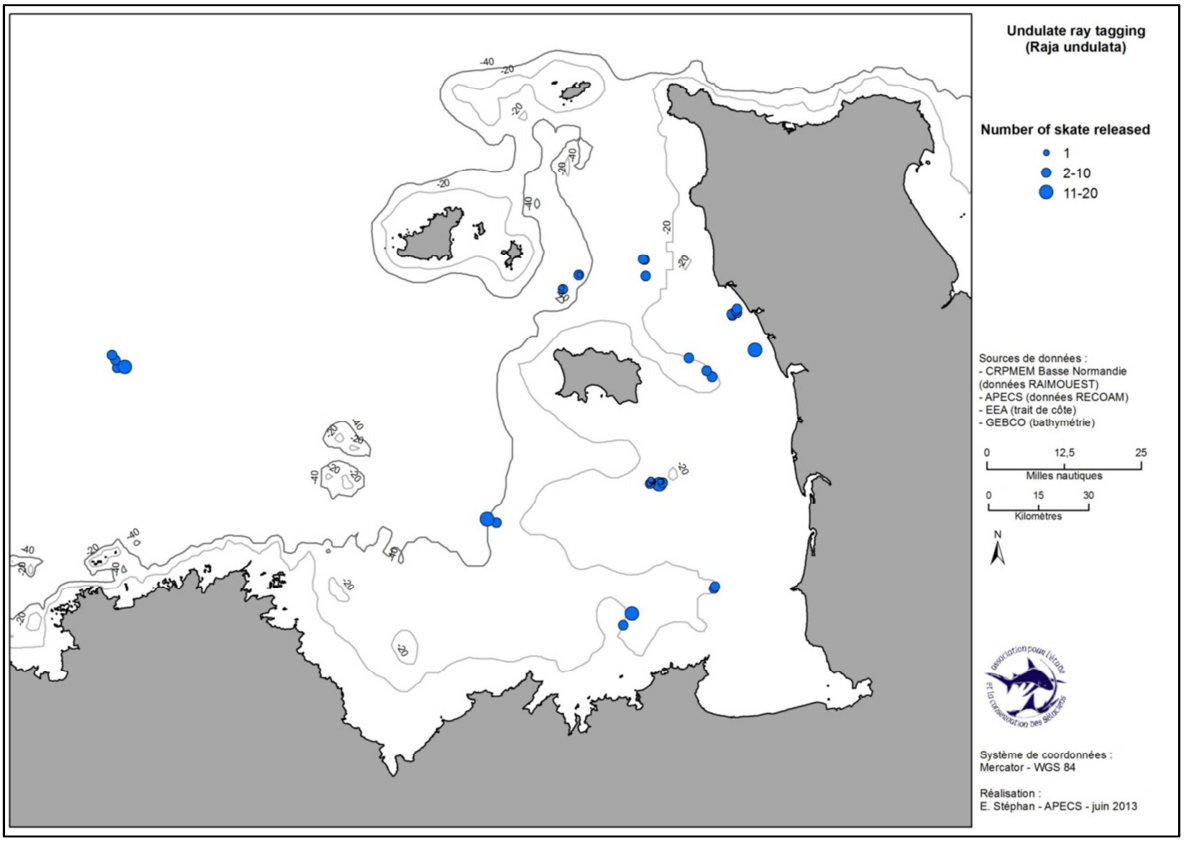


**Figure 5 : Released positions of undulate ray tagged in the western English Channel**

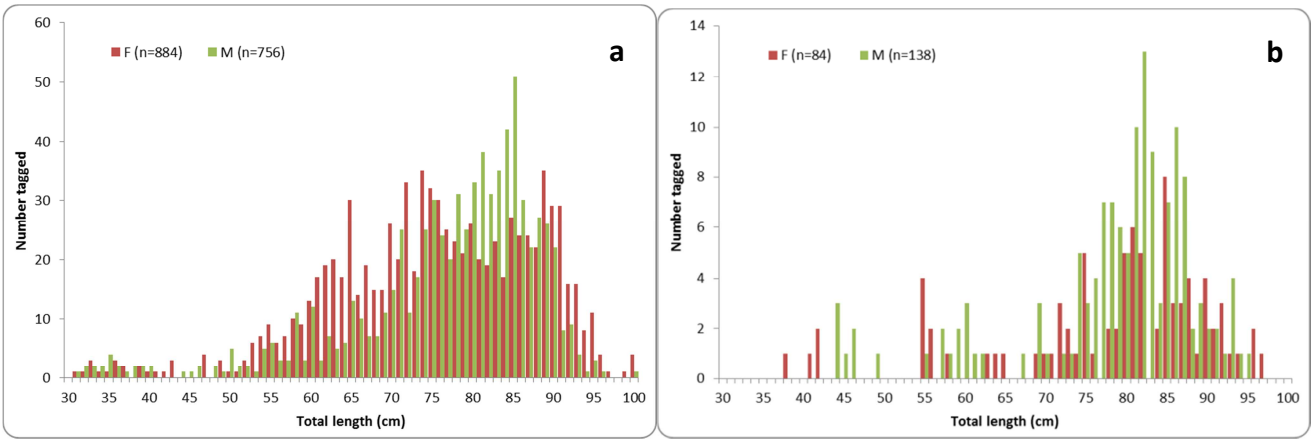


**Figure 6 : Length-frequency distribution of undulate ray tagged in the central Bay of Biscay (a) and in the western English Channel (b)**

***Population structure***

The number of tissue samples collected for the genetic study is summarized in table 4. Additional samples will be collected in the two study areas during the next fishing operations and samples from other areas are also required to begin the genetic analysis at least at the scale of the French waters, maybe more if samples from other European areas are available.

**Table 4 : Number of tissue samples collected for each species**

| Area | *R. undulata* | *R. microocellata* | *R. brachyura* | *R. clavata* | *R. montagui* |
|---|---|---|---|---|---|
| Eastern English Channel | 1 | | 2 | 22 | |
| Western English Channel | 249 | 1 | 108 | 4 | 14 |
| Iroise Sea | 7 | | | | |
| South Brittany | 21 | | | | |
| Central Bay of Biscay | 511 | 57 | | 10 | |
| Maroc | 5 | | | | |

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Additional thanks to the members of the scientific committee of the project, Alain Biseau, Gérard Biais and Alain Tétard from IFREMER and Samuel Iglésias from the Station de biologie marine de Concarneau, Muséum National d'Histoire Naturelle.

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## References

ICES (2010) Report of the Workshop on Sexual Maturity Staging of Elasmobranches (WKMSEL), 11-15 October 2010, Valetta, Malta. ICES CM 2010/ACOM : 48. 32 pp

Delamare A., Hennache C., Stéphan E., Biais G., 2013. Bay of Biscay undulate ray (*Raja undulata*) abundance assessment by mark-recapture method. Working paper presented at the 2013 WGEF, Lisbon, 17-21 June 2013, 13 p.

Leblanc. N, Tétard A., Legrand V., 2013. RAIMOUEST : Rays in the western English Channel (VIIe). Working paper presented at the 2013 WGEF, Lisbon, 17-21 June 2013, 5 p.

# Remarks on the reproduction strategy of *Raja undulata* from mainland Portugal

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Regarding the urgent need for information about *Raja undulata* as a protected species (Gibson *et al.,* 2008) and the need to obtain knowledge about its reproductive dynamics and reproductive potential, a publication is in preparation (Serra-Pereira *et al*.) to address that, in the particular case of mainland Portugal. In this paper, an update of the reproductive parameters available for the species was compiled. In addition, information was gathered about occurrence areas and spawning sites of the species, mainly in the north and central regions. As a final output of that work, an estimate of the intrinsic growth rate of *R. undulata* was obtained, based on the estimated biological parameters, allowing determining the level of sensibility compared to others species. Table 1 resumes all the main results obtained.

Table 1. Summary of biological information published for *Raja undulata* from mainland Portugal.

| **References** | | [1], [2] | [3] | [3] | [4] | [5] |
|---|---|---|---|---|---|---|
| **Period** | | 1999-2001 | 1999-2001 | 2003-2006 | 2001-2008 | 2003-2013 |
| **Region** | | Algarve | Algarve | Centre | North/Centre | North/Centre |
| **Depth range (m)** | | - | - | - | - | 4 to 128 (mostly 30-40) |
| **Spawning depth range (m)** | | - | - | - | - | 10 to 55 (mostly < 30) |
| **TL range** (cm) | | 19.4-88.2 | 32.0-83.2 | 23.7-90.5 | 48.0-95.9 | 23.5-95.9 |
| **L50** (cm) | F | 76.2 | - | 83.8 | - | 86.2±2.6 |
| | **M** | 73.6 | - | 78.1 | - | 76.8±2.4 |
| **I50** (years) | F | 8.98 | - | 9 | - | 8.7±0.3 |
| | **M** | 7.66 | - | 8 | - | 7.6±0.4 |
| **M50 (cm)** | | - | - | - | - | 95.7±15.3 |
| **Reproductive period** | | Dec-Feb | - | Feb-May | - | Dec-Jun |
| **Fecundity** (eggs per female) | | - | - | - | - | 69.8±3.4 |
| **Fecundity/batch** (eggs per female) | | - | - | - | - | 15 |
| **Number of batches** | | - | - | - | - | 3.6 |
| **Size-at-birth** (cm) | | - | - | - | - | 13.5 |
| $L_{max}$ (cm) | | 88.2 | 83.2 | 90.5 | - | 95.9 |
| $L_\infty$ (cm) | | 110.2 | 119.3 | 113.7 | - | - |
| **k** ($year^{-1}$) | | 0.11 | 0.12 | 0.15 | - | - |
| $t_0$ (years) | | -1.58 | -0.41 | -0.01 | - | - |
| $I_{max}$ (years) | | 13 | 9 | 12 | - | 12.6 |
| $I_\infty$ (years) | | - | 28.9 | 23.6 | - | - |
| **TW ~ $aTL^b$** | **a** | - | - | - | $1.92*10^{-5}$ | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **b** | - | - | - | 2.86 | - |
| **r'** | | - | - | - | - | 0.49 |
| **M** | (Jensen, 1996) | - | - | - | - | 0.24 |
| | (Pauly, 1980) | - | - | - | - | 0.27 |

(*TL*: total length; *L50*: size-at-maturity; *I50*: age-at-maturity; *M50*: size-at-maternity; Fecundity; $L_\infty$: asymptotic length; *k*: growth rate; $t_0$: size ate age-0; $L_{max}$: maximum observed length; $I_{max}$: maximum observed age; $\mathbf{I_\infty}$: maximum theoretical age; $TW \sim aTL^b$: weight-length relationship; *r'*: potential population increase; M: natural mortality)

[1] Coelho and Erzini, 2002; [2] Coelho and Erzini, 2006; [3] Moura *et al*., 2008; [4] Serra-Pereira et al. 2010; [5] Serra-Pereira et al. *In preparation*.

## References


Coelho, R. and Erzini, K. 2002. Age and growth of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal). Journal of the Marine Biological Association of the United Kingdom 82: 987-990.

Coelho, R. and Erzini, K. 2006. Reproductive aspects of the undulate ray, *Raja undulata*, from the south coast of Portugal. Fisheries Research 81: 80-85. doi:10.1016/j.fishres.2006.05.017

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

Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Coelho, R., Erzini, K., Neves, A. and Gordo, L. S. 2007. The use of caudal thorns for ageing *Raja undulata* from the Portuguese continental shelf, with comments on its reproductive cycle. Marine and Freshwater Research 58: 983-992.

Jensen, A.L. 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Canadian Journal of Fisheries and Aquatic Sciences 53: 820–822.

Pauly, D. 1980. On the interrelationship between natural mortality, growth parameters, and mean environmental temperatures in 175 fish stocks. Journal du Conseil 39: 175–192.

Serra-Pereira, B., Farias, I., Moura, T., Gordo, L. S., Santos, M., and Figueiredo, I. 2010. Morphometric ratios of six commercially landed species of skate from the Portuguese continental shelf, and their utility for identification. ICES Journal of Marine Science 67: 1596-1603.

Serra-Pereira, B., Erzini, K. and Figueiredo, I. *In preparation*. Remarks on the reproduction strategy of *Raja undulata* from mainland Portugal.

# RAIMOUEST: the French fishery of rays in the Western English Channel (VIIe).

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## 1. CONTEXT AND OBJECTIVES

Limited knowledge on biology and lack of data on fisheries for most of the ray species lead to significant issues when trying to understand and assess the status of stocks, and establish management measures for sustainable fisheries.

In the Western English Channel (ICES Division VIIe), the principal concerns are for the blonde ray (*Raja Brachyura),* the small-eye ray (*Raja microocellata*) and the undulate ray (*Raja undulata*) for which stock status are considered uncertain by ICES. This situation is problematic for fishermen because, classified as 'data-limited stocks', a precautionary margin of −20% is applied to the ICES advice (ICES 2012). This is true for e.g. *R. brachyura* and *R. microocellata* where the stock status relative to candidate reference points for stock size or exploitation are unknown (ICES 2012). The situation is more problematic for *R. undulata* which has been listed as prohibited species by European Union since 2009 despite a recommendation from ICES asking only not to target this species (ICES said: "precautionary approach to the exploitation of these populations and no target fishery").

The landing ban of *R. undulata* has raised misunderstanding for French fishermen's, particularly for those fishing in the normano-breton gulf where this species is abundant. Indeed, *R. undulata* is the main ray species caught in this area and catches are considered stable over time by fishers. This ban generates discards and the majority of the fleet is affected. This situation is even more incomprehensible since ICES stated that "there was no basis in the current or previous ICES advice for the listing of *R. undulata* as a prohibited species".

The lack of data resulting in a poorly known stock status could be explained by two points. Before 2009, R. *undulata* was underrepresented in landings and sales notes because of confusion in the species name (it was confused with the cuckoo ray *Leucoraja naevus*) or registration at higher taxonomic level, i.e. miscellaneous rays and skates. Since 2010, there are no data on landings and sales at auctions because of the ban on landing this species. Also, there is a lack of scientific fishery-independent survey in ICES Division VIIe.

In this context, the RAIMOUEST project has been established as a professional and scientist partnership in order to improve fisheries data on the main ray species caught in the normano-breton gulf (*Raja undulata*, *Raja brachyura*, *Raja microocellata*, *Raja clavata* and *Raja montagui*). The objectives were the identification of fisheries for rays, production of stocks status indicators (catch, landings, Catch Per Unit Effort indices, length distribution, abundance indices of adults and recruits) and the geo-localization of potential areas for spatial protection measures. The aim of RAIMOUEST project is thus to re-evaluate the perception of the state of these stocks, and subsequently, to

propose appropriate and concerted management measures for sustainable exploitation of these resources.

Furthermore RAIMOUEST contributes to the RECOAM project carried out by APECS[1] in Atlantic and English Channel coastal waters on the main ray species (Stéphan *et al*., 2013). This project focuses on biology (length at maturity in particular), stocks structure (genetic study) and spatial behaviour by tagging.

# 2. MATERIAL AND METHODS

## 2.1. Study area

The study is carried out in the normano-breton gulf (Southeast of ICES Division VIIe) with an extension to the North Coast of the Cotentin (in ICES Division VIId) which corresponds to a sector where *Raja undulata* is very abundant in coastal waters (fig. 1).

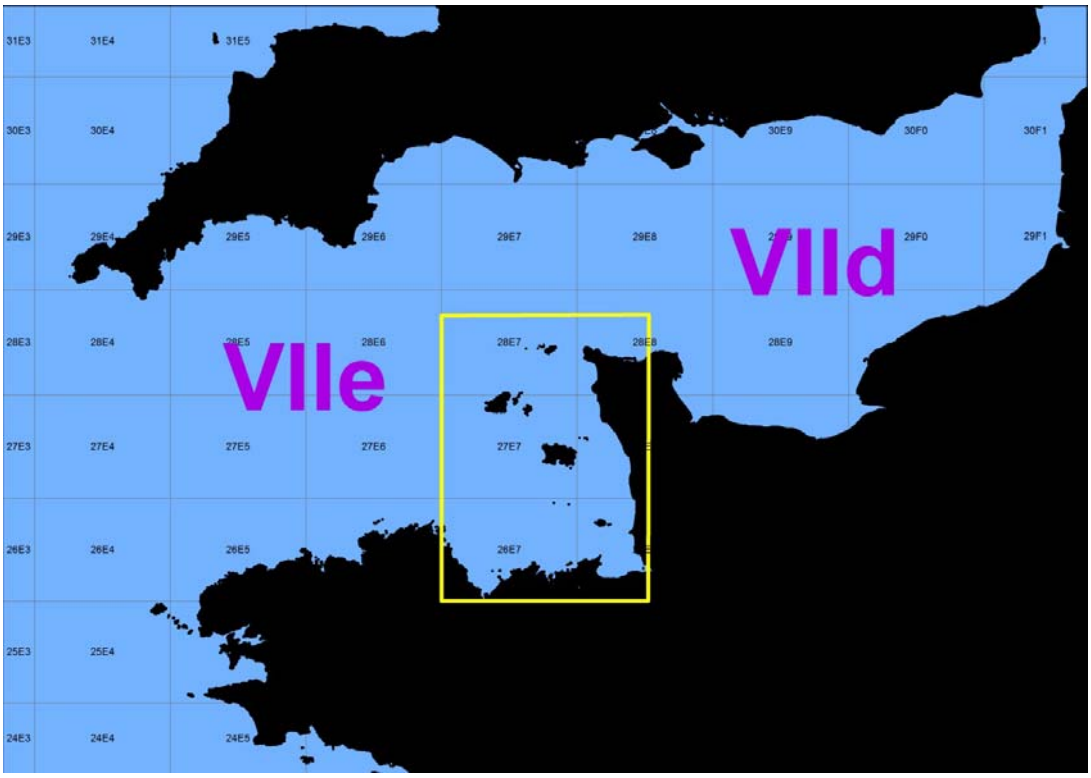



*Figure 1: Map of the study area in the western English Channel*

## 2.2. Data sources

In the RAIMOUEST project, data come from (i.) fishery-dependent data from the SIH[2] database held at Ifremer and (ii.) local enquiries and sampling at sea aboard professional fishing vessels carried out by the Regional Fishing Committee of Lower Normandy (Comité Régional des Pêches Maritimes de Basse Normandie - CRPM-BN).

[1] Association pour l'étude et la conservation des sélaciens (http://www.asso-apecs.org/)

[2] Système d'Information Halieutique (http://sih.ifremer.fr/)

### 2.2.1. SIH data

The SIH network is based on several key actions for the collection of data. Landings and effort data (logbook), sales at auctions, sampling at sea aboard professional fishing vessels (ObsMer) will be used in this study.

ObsMer (for "Observations en Mer") is the French observation at sea program in application of the Data Collection Framework (EC, 2008). This collection is mandatory for all EC Members States. Ifremer is involved as French technical support, producing methodology, data storage, tools and participating to the exploitation of data. The different steps of the data collection are quality controlled. The quality insurance comprises a sampling plan stratified by fisheries, observer's manual and various documentations to standardize the collection (http://sih.ifremer.fr/Acquisition-des-donnees/Echantillonnage-des-captures-a-bord-des-navires-de-peche), software for data entry in the national database, validation tools and output format for exploitation (http://wwz.ifremer.fr/cost/Cost-Project).

ObsMer data includes the characteristics of the fishing operations (gear, location, fishing effort) and sampling of the catches (species and weight exhaustively; number of individuals, length size and sex from sampling). Data are available at a national level from 2003 onwards, but the sampling effort is more intensive since 2009. A meta-analysis of these data demonstrated the importance of Rays in the normano-breton gulf (Tétard A. *et al*., 2013).

The location of the sampling (all métiers) in the normano-breton gulf in 2012 is presented figure 2. Each point corresponds to a fishing operation, each colour to a trip (colours are recycled).

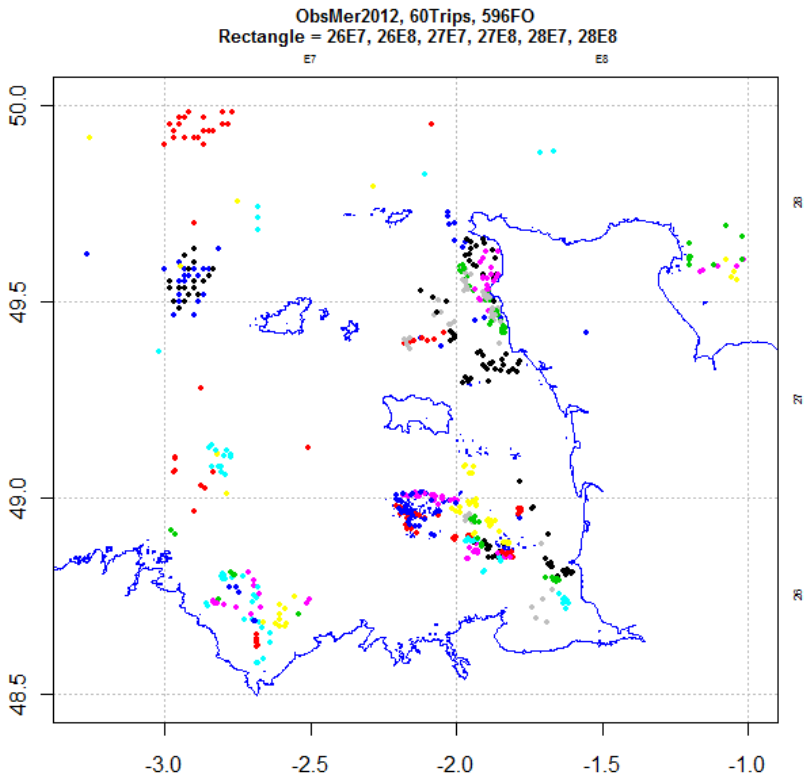



*Figure 2 : Fishing operation sampling in the normano-breton gulf in 2012 through ObsMer*

### 2.2.2. Data collection through RAIMOUEST

#### *Inquiries*

Vessels from Basse-Normandie, Brittany and Jersey identified as catching or having caught rays in the normano-breton gulf will be inquired in order to characterize:

- ray species caught,

- fishing strategy, season and target species associated to catches of rays,

- rays fishing areas by month and métier as well as the proportion of each ray species in the total catch of ray by area,

- seasonality and spatial distribution of mating, spawning and nursery area,

- annual ray landings by species and contribution to the annual total sales in weight and values,

- changes in fishing strategy and economic impact induced by the landing ban of *R. undulata.*

#### *Sampling at sea aboard professional fishing vessels*

24 additional sampling at sea aboard professional fishing vessels are scheduled, with the objective of increasing the observed proportion of fishing activities that catch rays. This additional sampling was carried under ObsMer protocol and could be used to supplement ObsMer data. It started in September 2012 and will run until December 2013.

#### *Experimental fishing*

In response to *R. undulata* landing ban, areas where this species is most abundant have no longer been fished and fishing methods targeting this species have been abandoned. In order to collect data on these areas and fishing activities, experimental fishing trips targeting *R. undulata* will be carried out.

## 2.3. RAIMOUEST plan of analyzes

### 2.3.1. Ray fisheries

A description of the socio economic status of ray fisheries in the normano-breton gulf was carried out with a particular focus on the contribution of *R.* undulata and *R.* brachyura to these fisheries.

#### *Fleet Characteristics*

Description of the ray fisheries fleet (number and average vessels characteristics for each métier) and its evolution using SIH and CRPBN fleet database.

#### *Fishing strategies*

Description of ray fishing strategies per métier including seasonality, targeted or bycatch fishery, proportion of rays in the catch and mean contributions to sales revenues in total and by species, target species associated to catch of rays will be assessed using inquiries.

#### *Fishing area mapping*

The fishing activity in number of vessels per métier will be mapped at the resolution of 1x1 nautical mille square represented by vessels frequentation map using inquiries. The proportion of ray species in the ray catch will be mapped per métier at the same resolution.

#### *Impact induced by the ban of* R. undulata *landings*

The vessels impacted (ray fishery abandoned or decreased) will be identified and the loss of revenues for these vessels will be estimated using inquiries data.

Discards of *R. undulata* since the ban will be estimated using inquiries and ObsMer data.

#### 2.3.2. Stocks status indicators

The R-package COST was developed as a common "open source" tool (COST) for assessing the accuracy of the biological data and parameters estimates collected for stock assessment purposes within the framework of the Data Collection Framework.

All available on-board observations from both the standard DCF sampling and RAIMOUEST were used to derive stock status indicators. It allows to raise observed discards and catches to the total fishing activities and to estimate length distribution per strata (time, space and technical).

Several raising methods (by trips, by fishing operations, by an auxiliary variable, by fishing days) can be used and the results be compared.

#### 2.3.3. Experimental fishing

To consider the bias resulting from the disappearance of the fishing activities targeting R. undulata since 2009 and the sharp reduction of other fishing activities catching rays, CPUEs will be assessed using experimental fishing data.

#### 2.3.4. Research of potential areas for spatial protection measures

The mating, spawning and nursery area identified by inquiries or by on-board observations will be mapped and could be used to propose management measures.

# 3. PRELIMINARY RESULTS

## 3.1. Ray fisheries

61 % of the currently active fleet from Lower Normandy (coastline from Granville to Cherbourg) catches or have caught rays in the normano-breton gulf. The distribution of the Lower Normandy's vessels is presented figure 3. Vessels from each port along the coast are concerned. All the fishermen who have ever been inquired yet indicated that *R. undulata* is the main ray species caught in this area (approximately 75 % of the ray catch) and *R. brachyura* the second (approximately 20 % of the ray catch). The rays are caught by both active gear (trawling in particular and dredging) and by passive gear (large mesh gillnet or long-line).

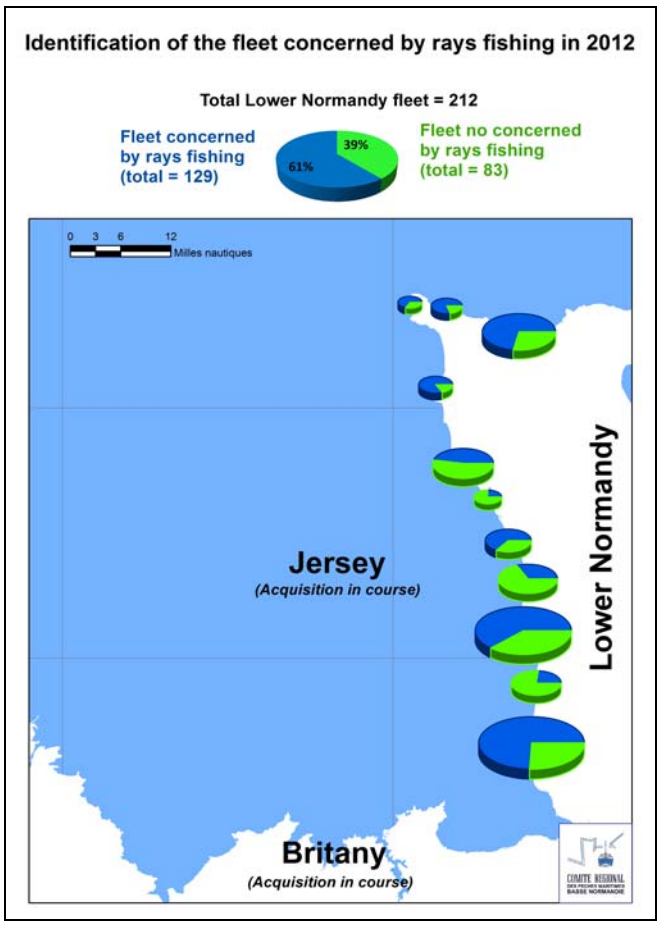



*Figure 3 : Identification of the fleet concerned by rays fishing in the normano-breton gulf in 2012*

## 3.2. Stock status indicators

### *Landings*

The French total landings of rays in ICES Division VIIe are more or less stable from 2000 to 2005 and decrease after (Fig. 4). Years 2009 and 2010 mark a decreasing step certainly in relation with the *R. undulata* ban.

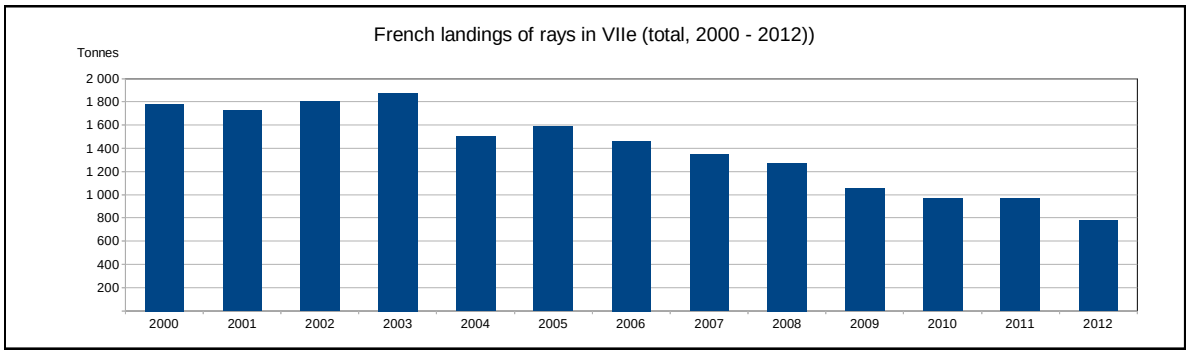



*Figure 4 : Total French landings of rays in ICES Division VIIe from 2000 to 2012.*

The situation of the main species (fig.5) shows a very important various group (RAJ) from 2000 to 2008, it decreases sharply in 2009 with the *R. undulata* ban and the enforcement to distinguish the ray species in the log book and auction sales. This confirms that *R. undulata*, one of the main species, was present in the landings before 2009 but not recorded at a taxonomic level. The decrease of 300 tonnes in the landings from 2008 to 2010 can be analysed as the loss of *R. undulata* despite of changing of fishing practise. Confusions between French common name of *R. undulata* and *L. naevus* have also certainly contributed to mask the reality of the landings of *R. undulata*. Confusions between *R. brachyura* and *R. montagui* are also noticed.

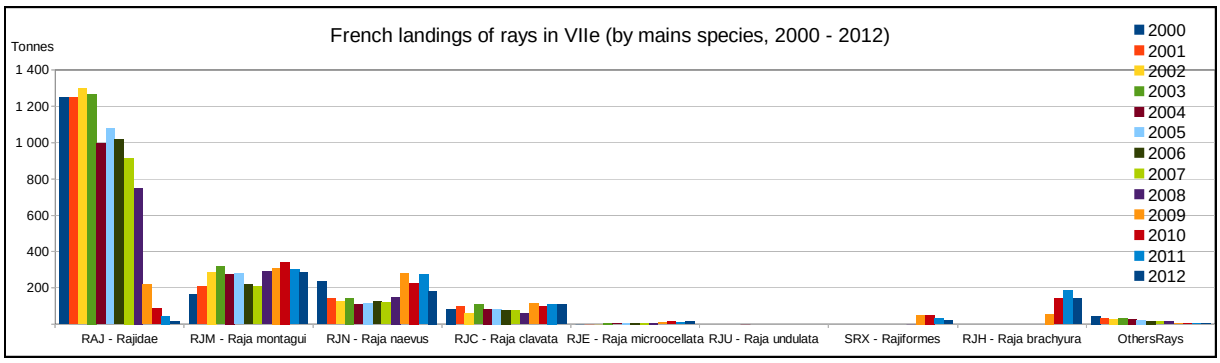



*Figure 5 : French landings of the main rays in ICES Division VIIe from 2000 to 2012*

## Discards estimate

Preliminary results concerning *R.undulata* in ICES Division VIIe using ObsMer sampling in 2012 are presented in table 1. For this area and period 162 trips are available, 42 trips caught *R. undulata* with a total catch of 1.6 tonnes. The distribution of these catches is 61.0 % for bottom otter trawling, 29.7 % for netting and 9.3 % for beam trawling.

We choose to raise the data by fishing days, which seems the more accurate method after exploratory analysis. The estimation of discards is around 750 tonnes and the main contributing métiers are bottom trawling (98 %), beam trawling (1 %) and netting (0.4 %). The very low contribution of the netting is a cause of concern. For this métier, the CVs are very high and contribution is much less important than in the samplings.

| time | space | technical | value | cv | inf | sup |
|---|---|---|---|---|---|---|
| 2012 - 1 | VIIe | FPO CRU | 0 | NaN | | |
| 2012 - 1 | VIIe | GNS DEF | | NaN | | |
| 2012 - 1 | VIIe | GNS SPF | NA | NA | NA | NA |
| 2012 - 1 | VIIe | GTR CEP | NA | NA | NA | NA |
| 2012 - 1 | VIIe | GTR CRU | | NaN | | |
| 2012 - 1 | VIIe | GTR DEF | 523 | 10.47 | | 11 258 |
| 2012 - 1 | VIIe | LLS DEF | | NaN | | |
| 2012 - 1 | VIIe | OTB DEF | 339 809 | .16 | 234 692 | 444 926 |
| 2012 - 1 | VIIe | PTM DEF | | NaN | | |
| 2012 - 1 | VIIe | TBB DEF | 6 057 | .17 | 4 002 | 8 112 |
| 2012 - 1 | VIIe | all | 346 389 | | | |
| 2012 - 2 | VIIe | FPO CEP | NA | NA | NA | NA |
| 2012 - 2 | VIIe | FPO CRU | | NaN | | |
| 2012 - 2 | VIIe | GNS DEF | 447 | 7.78 | | 7 272 |
| 2012 - 2 | VIIe | GTR CRU | | NaN | | |
| 2012 - 2 | VIIe | GTR DEF | 1 578 | 14.19 | | 45 470 |
| 2012 - 2 | VIIe | LLS DEF | | NaN | | |
| 2012 - 2 | VIIe | MIS DES | NA | NA | NA | NA |
| 2012 - 2 | VIIe | OTB CEP | NA | NA | NA | NA |
| 2012 - 2 | VIIe | OTB DEF | 681 | .66 | | 1 565 |
| 2012 - 2 | VIIe | OTT CEP | NA | NA | NA | NA |
| 2012 - 2 | VIIe | all | 2 707 | | | |
| 2012 - 3 | VIIe | FPO CRU | | NaN | | |
| 2012 - 3 | VIIe | GNS CRU | 17 | 45.04 | | 1 526 |
| 2012 - 3 | VIIe | GNS DEF | 0 | NaN | | |
| 2012 - 3 | VIIe | GTR CRU | | NaN | | |
| 2012 - 3 | VIIe | GTR DEF | 24 | 20.69 | | 983 |
| 2012 - 3 | VIIe | LLS DEF | | NaN | | |
| 2012 - 3 | VIIe | MIS DES | NA | NA | NA | NA |
| 2012 - 3 | VIIe | OTB CEP | NA | NA | NA | NA |
| 2012 - 3 | VIIe | OTB DEF | 122 552 | .21 | 71 790 | 173 313 |
| 2012 - 3 | VIIe | OTM SPF | | NaN | | |
| 2012 - 3 | VIIe | OTT CEP | NA | NA | NA | NA |
| 2012 - 3 | VIIe | SDN DEF | NA | NA | NA | NA |
| 2012 - 3 | VIIe | TBB DEF | 4 535 | .72 | | 10 968 |
| 2012 - 3 | VIIe | all | 127 128 | | | |
| 2012 - 4 | VIIe | FPO CRU | 0 | NaN | | |
| 2012 - 4 | VIIe | GNS CRU | 0 | NaN | | |
| 2012 - 4 | VIIe | GNS DEF | | NaN | | |
| 2012 - 4 | VIIe | GNS SPF | NA | NA | NA | NA |
| 2012 - 4 | VIIe | GTR CRU | 134 | .00 | 134 | 134 |

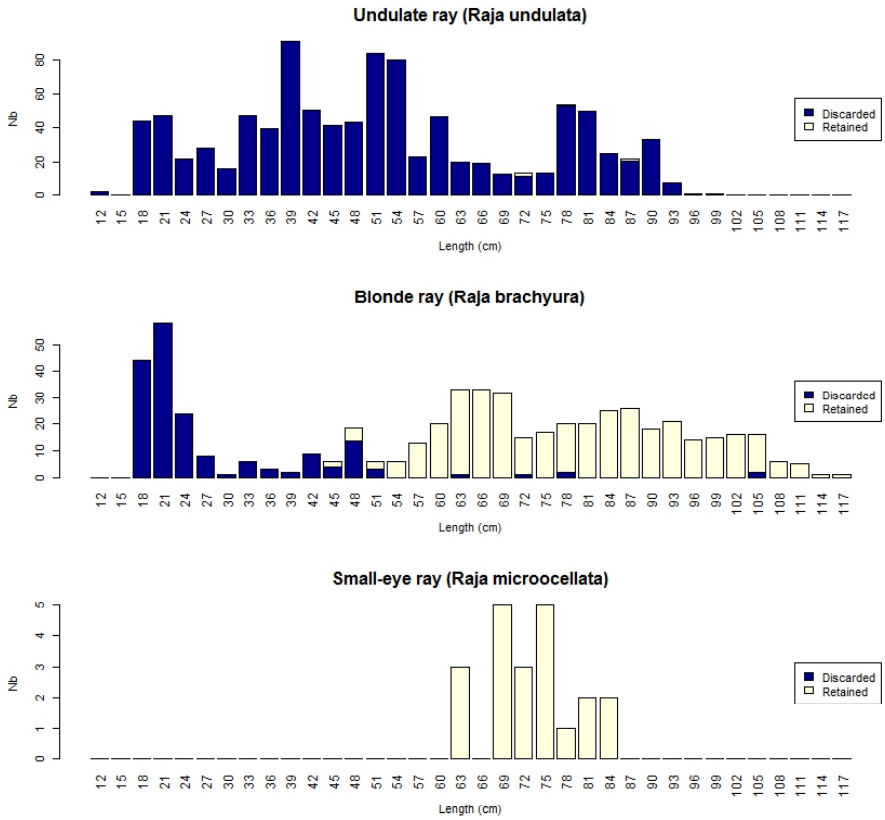
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2012 - 4 | VIIe | GTR | DEF | 0 | NaN | | | |
| 2012 - 4 | VIIe | LLS | DEF | | NaN | | | |
| 2012 - 4 | VIIe | OTB | CEP | NA | NA | NA | NA | |
| 2012 - 4 | VIIe | OTB | DEF | 274 018 | .44 | 36 954 | 511 081 | |
| 2012 - 4 | VIIe | OTT | DEF | | NaN | | | |
| 2012 - 4 | VIIe | SDN | DEF | NA | NA | NA | NA | |
| 2012 - 4 | VIIe | | all | 274 152 | | | | |
| 2012 - Tot | VIIe | FPO | CEP | NA | | | | |
| 2012 - Tot | VIIe | FPO | CRU | 0 | | | | |
| 2012 - Tot | VIIe | GNS | CRU | 17 | | | | |
| 2012 - Tot | VIIe | GNS | DEF | 447 | | | | |
| 2012 - Tot | VIIe | GNS | SPF | NA | | | | |
| 2012 - Tot | VIIe | GTR | CEP | NA | | | | |
| 2012 - Tot | VIIe | GTR | CRU | 134 | | | | |
| 2012 - Tot | VIIe | GTR | DEF | 2 125 | | | | |
| 2012 - Tot | VIIe | LLS | DEF | 0 | | | | |
| 2012 - Tot | VIIe | MIS | DES | NA | | | | |
| 2012 - Tot | VIIe | OTB | CEP | NA | | | | |
| 2012 - Tot | VIIe | OTB | DEF | 737 060 | | | | |
| 2012 - Tot | VIIe | OTM | SPF | 0 | | | | |
| 2012 - Tot | VIIe | OTT | CEP | NA | | | | |
| 2012 - Tot | VIIe | OTT | DEF | 0 | | | | |
| 2012 - Tot | VIIe | PTM | DEF | 0 | | | | |
| 2012 - Tot | VIIe | SDN | DEF | NA | | | | |
| 2012 - Tot | VIIe | TBB | DEF | 10 592 | | | | |
| 2012 - Tot | VIIe | | all | 750 375 | | | | |

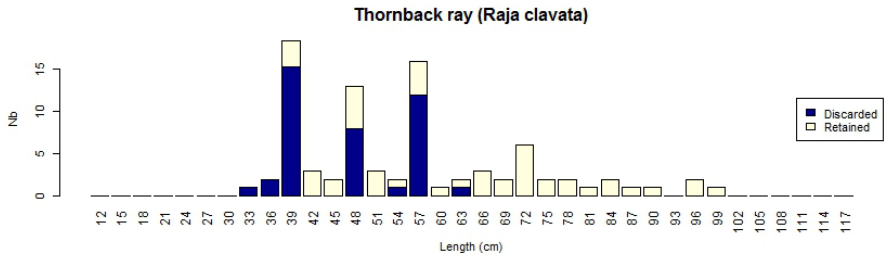
*Table 1: Estimation of R. undulata discards in 2012 from COST-analysis. Values (Kg) are presented by season and by metier with the corresponding coefficient of variation (cv), inferior and superior limits. Total estimations were added.*

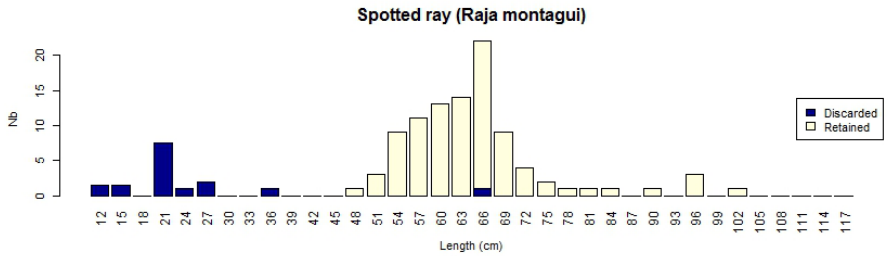
We tried another estimation using the raising by trips. The estimation of discards is 379 tonnes that seems less realistic, trawling represents 87 % and netting 13 %, which is more in agreement with the distribution in the sampling data.

More work is necessary to improve the evaluation; a solution may be to evaluate separately and with different raising methods, active gears and static gears.

## *Length structure raised to sampled trips*



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## *References*

- EC, 2008. Council Regulation (EC) No 199/2008 of 25 February 2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy

- E. Stéphan, C. Hennache, A. Delamarre, V. Legrand, N. Leblanc, 2013. The French RECOAM project: study of the biology and ecology of five skate (Rajidae) species present in the coastal waters of the western English Channel and central Bay of Biscay. Working paper presented at the 2013 WGEF, Lisbon, 17-21 June 2013, 8 p.

- Tétard, A. et al., 2013. Distribution of Elasmobranches from the French program of observations at sea aboard fishing vessels (ObsMer). Working document to WGEF 17-21 June 2013. 24pp.