# ICES WGDEEP REPORT 2011

ICES ADVISORY COMMITTEE

ICES CM 2011/ACOM:17

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

2-8 March 2011

Copenhagen, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2011. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 2–8 March 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:17. 889 pp.

# Contents

# 1 Executive summary

WGDEEP, meeting in 2011 under the Co-Chairmanship of Tom Blasdale and Phil Large, adopted a number of new working protocols in an attempt to address the problems encountered in 2010 (extremely long working hours and not all outputs reviewed in full plenary) and the general and stock-specific issues raised in last year's RGDEEP technical review. The overall aim is to build a framework for the meeting in 2012 which is an advisory year (advice is not required in 2011). Firm deadlines were set for the provision of data and Working Documents and normal hours were worked on Sunday including plenaries. The salient points raised by the Review Group were raised and addressed where there was agreement and time available.

The ToRs are described in Section 2.4 and in addition to the usual ToRs for assessment Working Groups where no advice is required, they included ToRs to:

- Evaluate methodologies for developing MSY targets for data poor and deep-water stocks and propose targets for the stocks assessed by WGDEEP.
- Evaluate the need of fisheries independent data and propose solution for the near future based on WGNEACS work, in collaboration with WGDEC and WGEF (EU Request).
- Assess the progress on the benchmark preparation for WKDEEP 2012.
- Upload fisheries data to the INTERCATCH database.

Despite the revised protocols introduced, the Group again encountered problems with excessive workload and long working hours. This was exacerbated by the fact that Members were not present from UK (Scotland), Denmark and the Faroes. WGDEEP has recommended that ICES should take steps to ensure that WG participation includes all countries with deep-water fisheries and surveys (see Section 15-Recommendations).

The issue that gave the most difficulty was drafting the advice in response to the EU Request on surveys. This was front-loaded in the meeting in preparation for attendance on the third day of the meeting by Jan Lindemann (European Commission). A useful presentation in Jan's presence was given by the ex-Chair of ICES WGNEACS-Leonie Dransfield, however given the wide geographical scale of the deep-water stocks/ecosystems addressed by ICES (three WG Chairs participated in related plenaries-Francis Neat (WGDEC), Graham Johnston (WGEF) and Elvar Hallfredsson (WGNEACS)) and the urgent need for fisheries-independent surveys and ecosystem monitoring for most stocks/areas, addressing this ToR took almost three full days and work continued by correspondence after the meeting. Notwithstanding, the ICES deadline for this work was met.

A summary of survey data requirements was compiled and included as a table in the WG report and draft advice. For most deep-water stocks fished by EU fleets, there are no adequate surveys that currently provide data to be used in stock assessments at a spatial scale corresponding to the distribution area of these stocks. Surveys have been proposed by the ICES Working Group for Northeast Atlantic Continental Slope Survey (WGNEACS for the central Northeast Atlantic (ICES Subareas VI and VII and Divisions Vb and XIIb) and the Iberian Shelf/Bay of Biscay (Subareas VIII and IX; ICES, 2010). If fully implemented, these surveys would meet near-future (and long-term) requirements for stock assessment and provide a baseline for ecosystem monitoring.

However, some additional data cannot be collected during the WGNEACS coordinated surveys and will require separate surveys, namely the spatial extension of the Azores longline survey (Subarea X) to cover offshore seamounts. This survey is expected to provide improved abundance indices for red sea bream, bluemouth, and deep-water sharks. The additional resources required to meet this objective are currently being considered.

The Group made good progress on addressing most of the remaining ToRs including those mentioned above.

The MSY guidelines recently issued for data-poor stocks by WKFRAME were reviewed and likely suitable methods to be considered and addressed intersessionally were suggested and recorded on a stock by stock basis (see under Management Considerations for each stock).

Regarding future Benchmark meetings, the Group recommended that there be no benchmark meetings for deep-water stocks in 2011 or 2012. Stock Coordinators expressed the view that there were no stocks ready for benchmarking at the present time. Also a postponement will allow the methodologies currently under trial/development in the EU FW7 DEEPFISHMAN project to be reviewed and, if appropriate, assimilated into stock assessments. Next year WGDEEP will discuss and make recommendations for stocks to be benchmarked in 2013.

The INTERCATCH Workshop (Chair: Henrik Kjems-Nielsen), held at ICES two days preceding WGDEEP, went well despite being attended by only ten members. During the workshop and the WGDEEP meeting a total of 19 fleets were defined for 21 of the 29 stocks. A major problem for some Stock Coordinators was the difficulty to exactly define the fleets/fisheries/métiers because gear information it is not always reported. A further problem is that for some stocks historical data are grouped by ICES Subarea. Notwithstanding, landings data for 2010 were uploaded for eleven stocks.

A total of 27 Working Documents were received by WGDEEP including the following exploratory assessments of:

- Ling in Va using Gadget, by Gudmunder Thordarson;
- Roundnose grenadier in Vb, VI, VII and XIIb using Bayesian surplus production methods, by Beatriz Roel, Lionel Pawlowski and Phil Large (funded by the EU DEEPFISHMAN project);
- Blue ling in Vb, VI and VII using stock reduction in FLR, by Finlay Scott and Phil Large (again funded by the DEEPFISHMAN project);
- Joint assessment between Spain and Morocco of red sea bream in the Strait of Gibraltar by Belcaidi *et al.*;
- Greater silver smelt in the Faroese area (Division Vb) by Lise Ofstad and Petur Steingrund.

Where there was consensus within the Group, Working Documents are appended to the Report and incorporated in the Report text (see Annex 2).

The Group considered the WACCU (Workshop on Methods to Evaluate and Estimate the Accuracy of Fisheries Data used for Assessment) scorecards and PGCCDBS data template but did not make progress on their completion due to lack of time.

Due to the diversity and number of stocks, the Group envisages that nine days will be needed to complete the advisory workload required at next year's meeting Furthermore, work during the meeting should be restricted to assessment/advisory ToRs with other requests being dealt with as far as possible intersessionally. The Group recommends that the meeting in 2012 should be held towards the end of March to facilitate the provision of data from the Icelandic spring survey.

# 2 Introduction

WGDEEP met at ICES Headquarters in Copenhagen, Denmark on 2–8 March 2011. The group was co-chaired by Tom Blasdale and Phil Large from the UK. Eighteen participants from eight countries contributed to the report. The full participants list is in Annex 1.

The Terms of Reference are given below:

2010/2/ACOM17 The **Working Group on the Biology and Assessment of Deep-sea Fisheries Resources** (WGDEEP), chaired by Tom Blasdale, UK and Phil Large, UK, will meet at ICES Headquarters, 2–8 March 2011 to:

a ) Address generic ToRs for Fish Stock Assessment Working Groups (see table below).

b ) Evaluate methodologies for developing MSY targets for data poor and deep-water stocks and propose targets for the stocks assessed by WGDEEP.

c ) Evaluate the need of fisheries independent data and propose solution for the near future based on WGNEACS work, in collaboration with WGDEC and WGEF

d ) Complete the development of Stock Annexes for all the stocks assessed by WGDEEP.

e ) Continue work on exploratory assessments for deep-water species.

f ) Assess the progress on the benchmark preparation for WKDEEP 2012.

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

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

WGDEEP members will meet two days before the WGDEEP meeting for an InterCatch workshop (28 February–1 March, 2011).

WGDEEP will report by 14 March 2011 for the attention of ACOM.

| Advice doc. (Fish Stock) | Stock/Assessmnet Unit Name | Stock Coord. | Assess. Cood. | Advice |
|---|---|---|---|---|
| alf-comb | Alfonsinos/Golden eye perch (*Beryx* spp.) | Portugal (Azores) | UK (England and Wales) | Same advice as last year |
| arg-icel | Greater silver smelt in Subdivision Va | Norway | UK (England and Wales) | Same advice as last year |
| arg-rest | Greater silver smelt in other areas (Subdivisions I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, and XIV) | Norway | UK (England and Wales) | Same advice as last year |
| bli-5a14 | Blue ling in Subdivisions Va and XIV | UK (England and Wales) | UK (England and Wales) | Same advice as last year |
| bli-5b67 | Blue ling in Subdivisions Vb, VI, and VII | UK (England and Wales) | UK (England and Wales) | Same advice as last year |

| | | | | |
|---|---|---|---|---|
| bli-rest | Blue ling in other areas (Subdivisions I, II, IIIa, IVa, VIII, IX, and XII) | UK (England and Wales) | UK (England and Wales) | Same advice as last year |
| bsf-89 | Black scabbardfish (*Aphanopus carbo*) in Divisions VIII and IX | Portugal | UK (England and Wales) | Same advice as last year |
| bsf-nort | Black scabbardfish (*Aphanopus carbo*) in in Subareas VI, VII, and Divisions Vb, XIIb | Portugal | UK (England and Wales) | Same advice as last year |
| bsf-rest | Black scabbardfish (*Aphanopus carbo*) in all the other areas | Portugal | UK (England and Wales) | Same advice as last year |
| gfb-comb | Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic | Spain (AZTI) | UK (England and Wales) | Same advice as last year |
| lin-arct | Ling (*Molva molva*) in Divisions I and II | Norway | UK (England and Wales) | Same advice as last year |
| lin-icel | Ling (*Molva molva*) in Subdivision Va | Norway | UK (England and Wales) | Same advice as last year |
| in-faro | Ling (*Molva molva*) in Subarea Vb | Norway | UK (England and Wales) | Same advice as last year |
| lin-rest | Ling (*Molva molva*) in Divisions IIIa and IVa, and in Subareas VI, VII, VIII, IX, XII, and XIV | Norway | UK (England and Wales) | Same advice as last year |
| ory-comb (ory-scrk; ory-vii; ory-rest) | Orange roughy (*Hoplostethus atlanticus*) in Notheast Atlantic | Ireland | UK (England and Wales) | Same advice as last year |
| rng-1012; | Roundnose grenadier (*Coryphaenoides rupenstris*) in in Mid-Atlantic Ridge (Xb, XIIc, Va1, XIIa1, XIVb1) | France | UK (England and Wales) | Same advice as last year |
| rng-nsea | Roundnose grenadier (*Coryphaenoides rupenstris*) in Division IIIa | France | UK (England and Wales) | Same advice as last year |
| rng-675b | Roundnose grenadier (*Coryphaenoides rupenstris*) in Subareas VI and VII, and Divisions Vb and XIIb | France | UK (England and Wales) | Same advice as last year |
| rng-rest | Roundnose grenadier (*Coryphaenoides rupenstris*) in Northeast Atlantic | France | UK (England and Wales) | Same advice as last year |
| sbr-comb (sbr-ix; sbr-x; sbr678) | Red (=blackspot) sea bream in Northeast Atlantic | Spain (IEO) | UK (England and Wales) | Same advice as last year |
| usk-arct | Tusk in Subareas I and II (Arctic) | Norway | UK (England and Wales) | Same advice as last year |
| usk-icel | Tusk in the Iceland Grounds (Fishing Area Va) | Norway | UK (England and Wales) | Same advice as last year |
| usk-mar | Tusk in Division XIIb (Mid Atlantic Ridge) | Norway | UK (England and Wales) | Same advice as last year |
| usk-rest | Tusk in Divisions IIIa, Iva, Vb, VI, VII, VIII, IX and XIIa (other areas) | Norway | UK (England and Wales) | Same advice as last year |
| usk-rock | Tusk in Division Vb (Rockall) | Norway | UK (England and Wales) | Same advice as last year |
| oth-comb | Other deep-sea species combined | Ireland | UK (England and Wales) | Same advice as last year |

# 3 Overview

## 3.1 Data availability

### 3.1.1 Discards

Only Spain supplied discard data to the Working Group in 2011 (see Section 3.4 for details). Discarding is known to be high in some deep-water fisheries and it is imperative that such data are collected and made available to the Working Group.

### 3.1.2 Fishing effort

#### Logbook data

Fishing effort time-series were reported for:

- Icelandic trawlers and longliners harvesting blue ling, ling, tusk and greater argentine in Division Va;
- Norwegian longliners from a reference fleet harvesting ling and tusk, mainly in Subareas I and II;
- Portuguese (mainland) longliners harvesting black scabbardfish in Subareas VIII and IX;
- Azorean longliners harvesting red (blackspot) sea bream and alfonsinos in Division Xa.

### 3.1.3 Research surveys

#### Faroe Islands

The Faroese groundfish surveys for cod, haddock and saithe is a fixed station trawl survey conducted annually on the Faroe Plateau. The spring survey (conducted in February–March) began in 1994 and covers 100 stations; while the autumn survey (conducted in August) began in 1996 covering 200 stations. The surveys also yield useful information on many other species. It needs to be kept in mind that the spring surveys are restricted to depths shallower than 500 m, so it only covers a part of the distribution area of deep-water species. The autumn survey was expanded in 2000 to cover depths to 1200 m.

#### Greenland

Greenland has conducted stratified random bottom-trawl surveys in ICES XIVb since 1998 (except 2001) covering depths between 400 and 1500 m. The survey is aimed at Greenland halibut but estimates of biomass and abundance and length frequencies on roundnose and roughhead grenadier are also available. Information on sex, length and weight on the very few tusk, ling, smoothheads, argentines and different species of elasmobranchs have also been recorded. The utility of this survey for assessment purposes cannot yet be evaluated.

#### Iceland

The Icelandic groundfish survey, which has been conducted annually since 1985, yields information on the variation in time of the fishable biomass of many exploited stocks in Division Va, and also useful information on many other species. More than 500 stations are fished annually, but the survey depth is restricted to the shelf and slope shallower than 500 m. Therefore the survey area only covers part of the distribution area of ling and blue ling as their distribution extends into greater depths. Another annual deep-water groundfish survey has been carried out all around Iceland since 1996. Although the main target species in this survey are Greenland halibut (*Reinhardtius hippoglossoides*) and deep-water redfish (*Sebastes mentella*), data for all species are collected. These data include length distributions and number of all species caught as well as weight, sex and maturity stages of selected ones.

#### Ireland

The Marine Institute ran ten deep-water surveys along the northeastern shelf edge between 1992 and 1999, five each by trawl and longline. This survey programme was an important source of information on the distribution and abundance of deep-water fish during the early development of the commercial fishery, and provided samples of deep-water fish for biological analysis. The surveys have also produced catch per unit of effort (cpue) and discarding information.

In 2006 the Marine Institute recommenced its deep-water survey programme with a slope survey covering the continental slope in Area VIa and the northern Porcupine Bank in Area VIIc. Overall, 27 hauls were carried out at four depths, 500 m, 750 m, 1000 m and 1500 meters. The survey attempted to standardize gear, sampling strategy and protocols with the Scottish survey as much as possible. As part of this standardization and intercomparison, RV Celtic Explorer carried out eight comparative tows with the Scottish research vessel, RV Scotia. The objective of the survey was to collect abundance data and biological information on the main deep-water fish species, including weight, length and maturity, and also to collect benthic invertebrates and bottom sediment samples. CTD transects, grab sampling, and cetacean studies were also carried out. It is envisaged that this survey will provide a time-series for cpue for the main deep-water species in the survey area in future.

#### Portugal (Azores)

Since 1995, a longline survey has been conducted annually by the Department of Oceanography and Fisheries at the University of the Azores (DOP), during spring, covering the main areas of distribution of demersal species (the coast of the islands, and the main fishing banks and seamounts), with the primary objective of estimating fish abundance for stock assessment (Pinho, 2003).

The survey has supplied information needed to estimate the relative abundance of commercially important deep-water species, from ICES Area X, based on the common assumption that catch rate (cpue) is proportional to species abundance, cpue=q.N, where q is catchability, which is assumed constant, and N is the abundance.

Bottom longline was adopted as a sampling survey technology in the Azores because the seabed is very rough, which does not permit use of other gears (e.g. trawl), and also due to a combination of behavioural and physiological factors of the demersal species (e.g. deep-water species are difficult to detect acoustically, particularly those living near the seabed, and mark recapture studies are ineffective for some of the species because they die when brought to surface).

#### Spain

From 2001 a new bottom-trawl survey started in the Porcupine bank to estimate abundance indices of commercial species and the distribution patterns of the demersal and benthic species in the area. Porcupine 2005 survey was organized by the IEO and counted with the collaboration on board the cruise of scientists from the Marine Institute of Ireland and from AZTI. The area covered in Porcupine 2005 survey is the Porcupine bank extending from longitude 12°W to 15°W and from latitude 51°N to 54°N, covering depths between 150 and 800 m. The cruise was carried out between September and October on board RV "Vizconde de Eza. Trawling time was set to 30 minutes between the end of wire shutting and starting to pull it back and towing speed was set to 3.5 kn.

#### UK (Scotland)

A deep-water trawl survey of the continental slope to the west of Scotland has been carried out biennially in September by FRS, The Marine Laboratory since 1998. In 2005, it was combined with the Rockall Haddock survey, upgrading both to annual status. A TV sled survey for deep-water *Nephrops* burrows is carried out at night at selected sites on Rockall and the slope, and TV drop frame deployments are also carried out as part of collaboration with JNCC (Joint Nature Conservation Committee) to map habitat in these areas. The survey contains stations extending from the Wyville–Thomson Ridge in the north to south of the Hebridean Terrace, although coverage has varied from year to year. Fishing is stratified by depth and currently ranges from 400–1900 m.

### 3.1.4 Abundance indices

Due to the sparsity of survey data currently available, the WGDEEP has relied heavily on cpue to reflect changes in stock abundance. Although new deep-water surveys are expected to provide abundance indicators in the long term, the WG will still have to rely on commercial cpue trends in the coming years.

WG members have adopted different strategies to standardize fishing effort and cpue. Sumarised below.

#### Cpue from logline fisheries in the Azores

GLM was used as the standardization method to adjust the cpue trends of several species from the Azores bottom longline fishery, namely of blackspot sea bream, alfonsino, golden eye perch, bluemouth rockfish and greater forkbeard. Factors for year, month, boat class and target species effects were used to adjust the nominal catch per unit of effort. Once the effects of the month, boat class and target species are removed, the remaining year effect was assumed to be proportional to abundance. Trips with zero catches were not included in the calculations. The analyses were conducted for cpue in biomass (kg of fish per 1000 hooks) and for cpue in number (number of fish per 1000 hooks).

GLMs are convenient as they make use of accepted methods to select variables in models, and also because the coefficients derived from these analyses can be directly used to standardize fishing effort and catch rates. However, GLMs are subject to a number of limitations. First, fisheries data are generally unbalanced (e.g. not all vessels are present over all time-series). Second, the underlying functional form is linear, by construction. However, the linkage between cpue and stock abundance could be of a more complex nature, e.g. including non-linear effects. Hinton and Maunder (2004) reviewed non-linear modelling alternatives which have been or could be used in relation to cpue analyses. These include non-linear models such as General Additive Models (Bigelow *et al.*, 1999), neural networks (Warner and Misra, 1996), regression trees (Watters and Deriso, 2000), and also habitat-based models (Bigelow *et al.*, 2002; Maunder *et al.*, 2002).

#### Cpue from the French trawl fishery to the west of the British Isles

Several problems have been seen previously in the French time-series of cpues.

In the 1990s, i.e. the first decade of the mixed fishery targeting roundnose grenadier, black scabbardfish and sikis sharks, cpues were shown to vary of over three different French sub-fleets. Only the cpue for a sub-fleet of large high-sea trawlers prosecuting a pure deep-water activity was considered as a reliable indicator of stocks abundance (Lorance and Dupouy, 2001). Due to disruption of the time-series of French catch statistics database, such cpue could not be updated in the 2000s.

In 2006, a working document showed that several factors affected the French cpues. In particular the fishery have been exploiting new fishing grounds in the 2000s and the cpues in these new grounds were higher than in grounds fished since the early 1990s, driving an increase in global cpues. The cpue per small areas showed different trends (Figure 3.1.2; Biseau, 2006WD). In addition, due to changes in the national fishery statistics system, the effort data before and after 1999, were not fully consistent.

Use of total cpue for all the French fleet is problematic because the composition of the fleet has varied over time with changing proportions of large high-sea trawlers (more than 45 m overall length and 1400 kw power) and medium size high-sea trawlers (28–40 m overall length, less than 1000 kw).

Nevertheless, for each of roundnose grenadier, black scabbardfish and orange roughy, four time-series of cpue have been computed:

1 ) total annual catch divided by total effort;
2 ) total annual catch in a reference area divided by total effort in the same area;
3 ) the same as (2) by a reference fleet;
4 ) the same as (2) for the reference fleet considering only directed effort (i.e. effort from sub-trip where the species makes at least 10% of the total catch).

The reference area was defined based upon the working paper from Biseau (2006) as represented in Figure 3.1.1.

#### Cpue from Norwegian longline fisheries

This procedure was adopted to derive catch rates for a reference Norwegian fleet harvesting blue ling, ling and tusk. This reference fleet, which comprises four vessels, has been used to provide abundance indices, in the form of catch rates, since 2001. Data from the reference fleet were combined with logbook data for the entire high seas longliners fleet, which were available over the period 2000–2006 (see WGDEEP06 WD3 for full details). A similar approach has been undertaken to identify a reference Faroese fleet in relation to the ling and tusk assessments.

### 3.1.5 Stock structure

This Report presents the status and advice of deep-sea species by individual stock component. The identification of stock structure has been based upon the best available knowledge to date (see the species-specific chapters for more details). However, it has to be stressed that overall, the scientific basis underlying the identity of deep-sea stocks is currently weak. In most of the cases, the identification of stock is based on either theoretical considerations on the mixing of populations in relation to the hydrological and geological characteristics of fishing grounds, or comparison of trends in catch rates, or consistency with management units. Therefore, the WG considers that the stock definitions proposed in this report are only preliminary. There are currently genetic studies ongoing to improve the knowledge of the stock structure of a number of species. The WG recommends that increased research effort be devoted to clarify the stock identity of the different deep-sea species investigated by ICES.

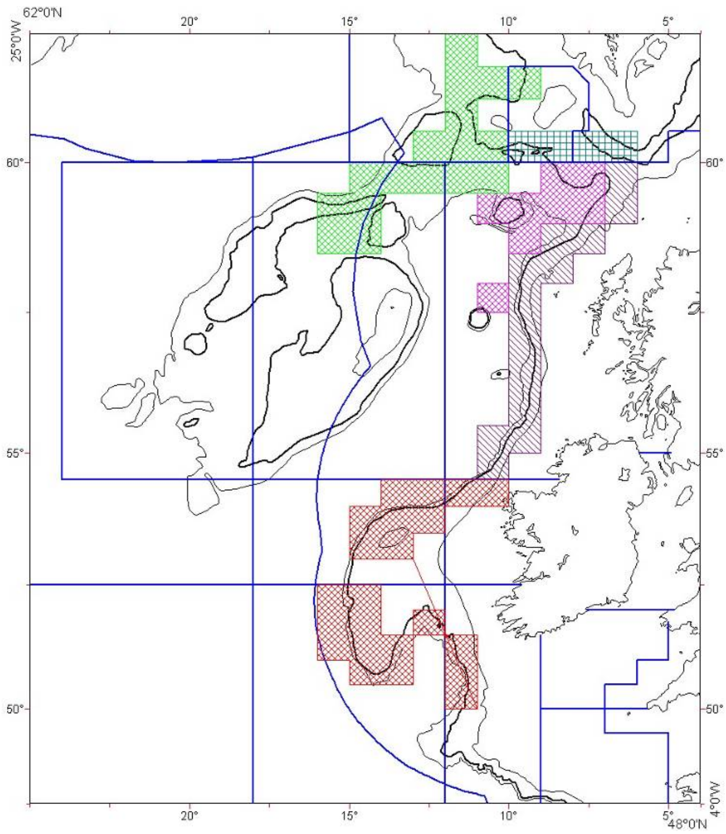


**Figure 3.1.1. Areas used to compute cpue of French vessels (green: New grounds in Vb and VI; dark green: reference area in Vb; pink: others in VI; purple: continentalslope in VI; red reference in VII).**

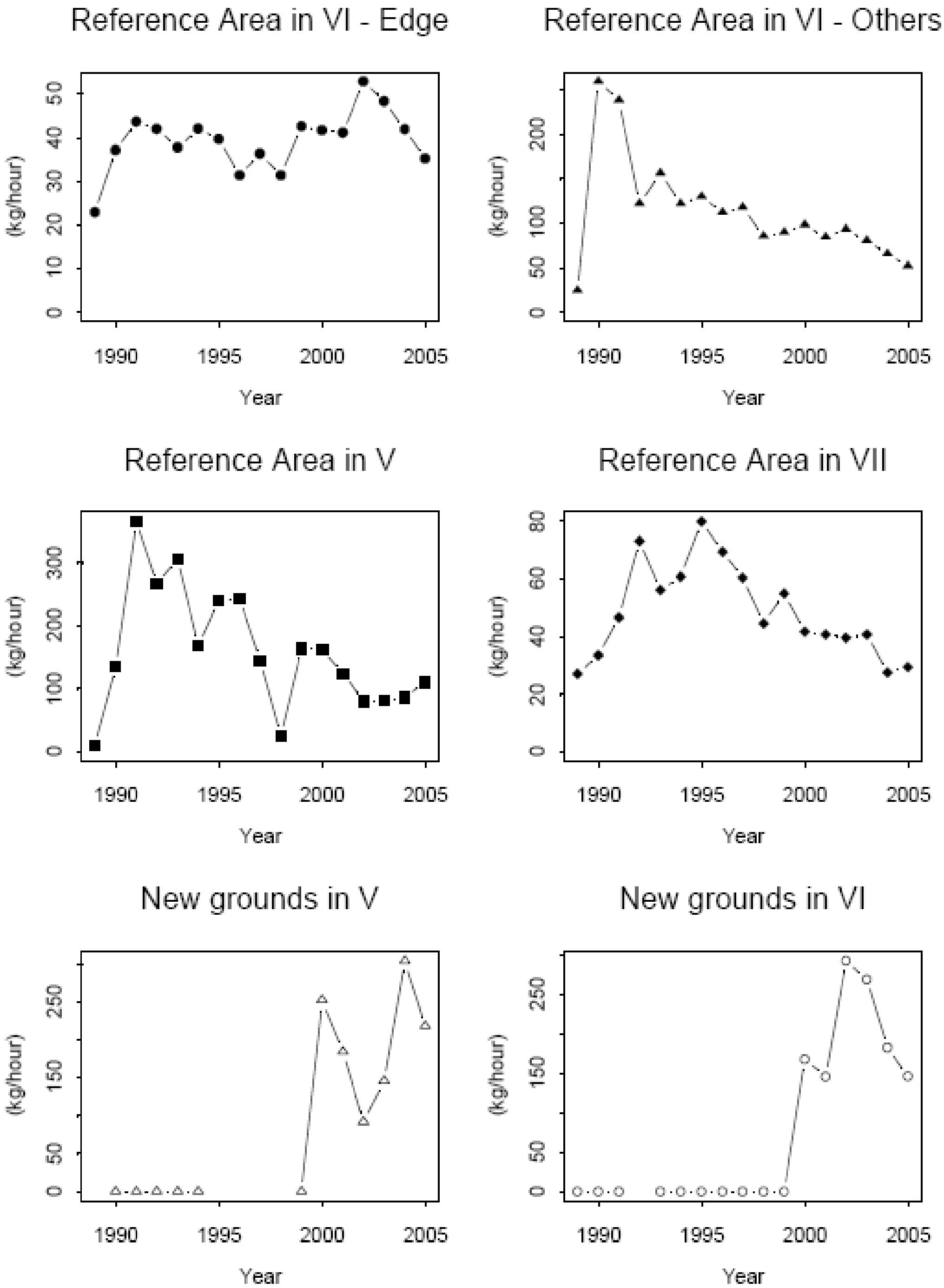


**Figure 3.1.2. Cpues of roundnose grenadier in different parts of Division Vb and Subareas VI and VII. Reference areas were exploited since the begining of the fishery in the late 1980s, new grounds have not been intensively exploited by French trawlers before the 2000s (see Figure 3.1.1 for a map).**

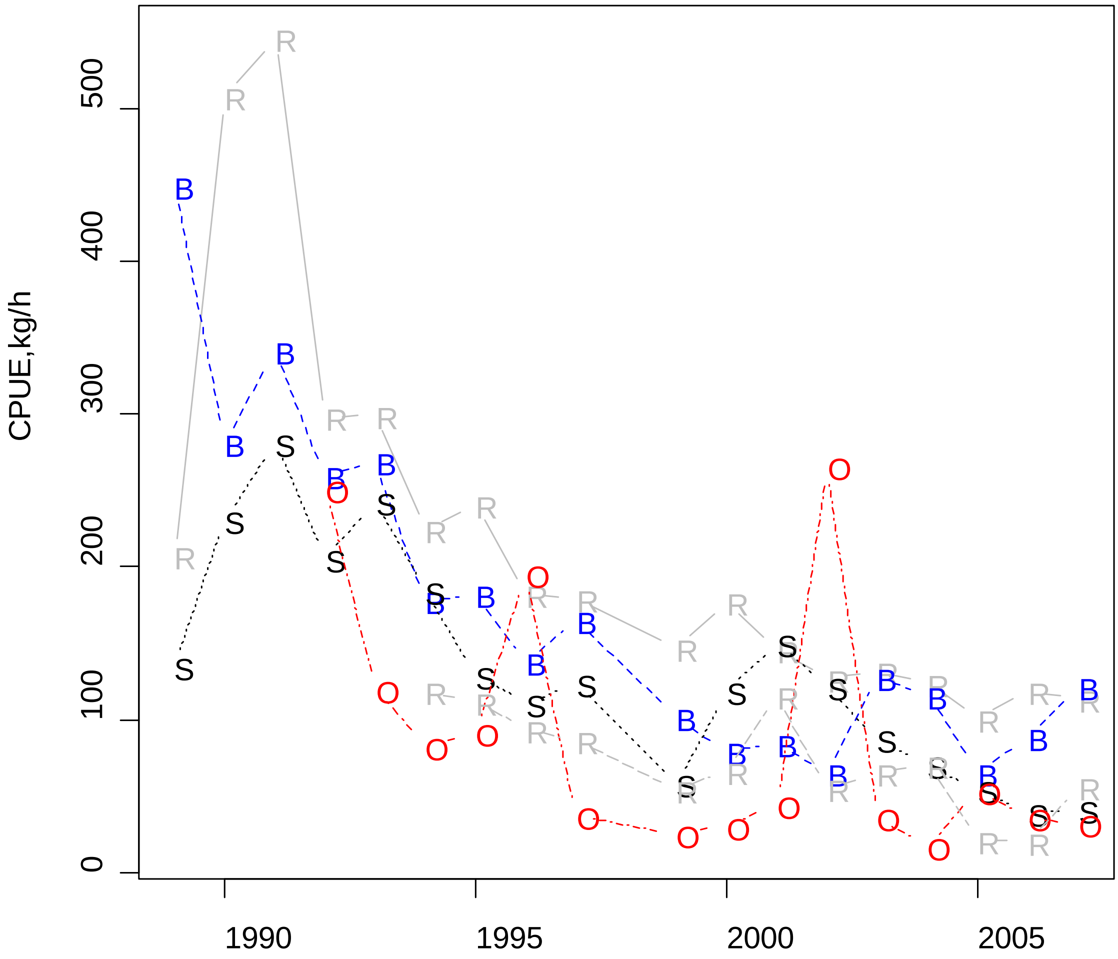


**Figure 3.1.3. Directed cpue from the reference fleet (a fleet of large high-sea trawlers doing a pure deep-water fishing). R: roundnose grenadier, B: blue ling; S: black scabbardfish; O: orange roughy.**

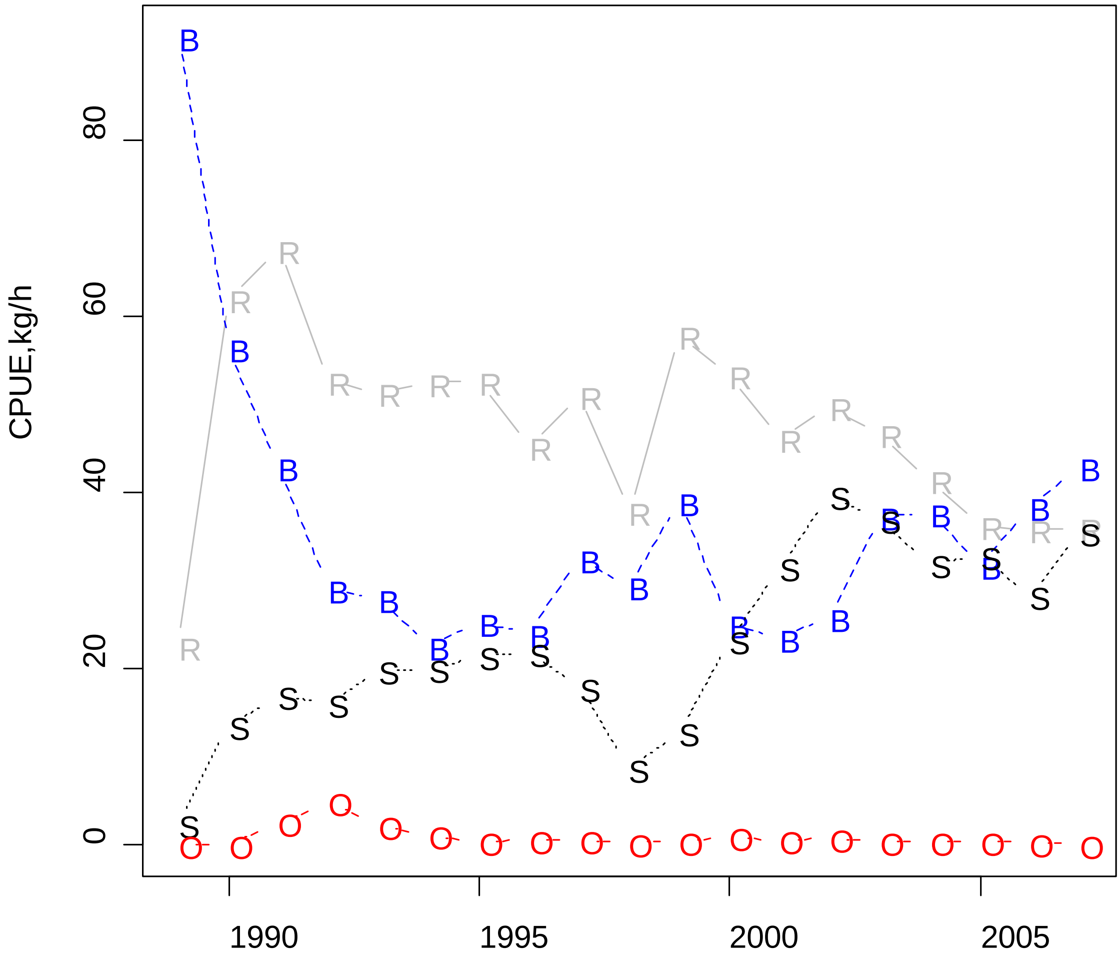


**Figure 3.1.4. Total cpue for all French vessels in the reference area. R: roundnose grenadier, B: blue ling; S: black scabbardfish; O: orange roughy.**

## 3.2 Methods and software

This section summarizes the methods and software used by the Working Group historically and any new methods and software used in 2010. (separated into methods agreed for benchmarked stocks and those that are exploratory).

### 3.2.1 Historical

#### 3.2.1.1 Methods

##### Catch curve analysis

The group were aware of the assumption of constant recruitment implied when constructing catch curves within years. Lack of historical data frequently required this course of action rather than the preferred option of analysing individual year classes by cohort.

#### Depletion models

A catch and effort data analysis package (CEDA) was used to apply modified Delury constant recruitment models when sufficient data were available. The Working Group recognized that depletion models in general assume that data are from a single-stock (i.e. there is no immigration or emigration) and that this approach should not be applied to components of stocks or fisheries. Notwithstanding these assumptions, and the lack of knowledge regarding the stock structure of deep-water species, the group still felt these methods were worth trying as an investigative tool. The general procedure adopted was to use sensitivity analysis to evaluate the effect on results (residual plots, goodness-of-fit, parameter estimates, principally carrying capacity, catchability and current population size) of a range of assumptions for stock size in the first year as a proportion of carrying capacity and error models. Indexed recruitment depletion models could not be attempted because of a lack of recruit data.

#### Production models

ASPIC and CEDA was also used to fit dynamic (i.e. non-equilibrium) production models. Again sensitivity analysis of outputs was used to evaluate the effect of error models and ratio of initial to virgin biomass and time-lag. For some of the stocks assessed, available time-series data of cpue comprise a gradual decline across the period studied. The Working Group was aware that the results from production models in these circumstances (the so called 'one way trip') can be unreliable.

Attempts have been made to apply a Bayesian approach to a Schaefer model using WINBUGS free software. There are uncertainties about the key population parameters for deep-water fish species and a Bayesian approach is a natural way to portray those uncertainties and to express the risks that are associated with alternative management measures. It is becoming commonly accepted that Bayesian methods can produce less biased estimates when compared with frequentist approaches based on maximum likelihood estimators (Nielsen and Lewi, 2002).

#### VPA analysis

The Lowesoft VPA package has been used to carry out Shepherd/Laurec analyses to detect trends in catchability, and separable VPA and extended survivors analysis (XSA) to produce estimates of stock, where possible.

#### Stock reduction models

Stock reduction analysis is a developed form of a delay-difference model (Quinn and Deriso, 1999). The method uses biologically meaningful parameters and information for time delays as a result of growth and recruitment to predict the basic biomass dynamics of the populations without requiring information on age structure. Thus it can be considered to be a conceptual hybrid between dynamic surplus production and full age based models (Hilborn and Walters, 1992). A full description of the general approach can be found in Kimura and Tagart; 1982, Kimura *et al.*, 1984; Kimura, 1985; 1988.

The stock reduction model used is part of programme suite (PMOD) developed by Francis, 1992; 1993 and Francis *et al.*, 1995. Simple deterministic and enhanced stochastic models are included, but given the paucity of the available data it was decided to use the former. The method requires time-series data of annual catches, one or more abundance index and a range of biological parameters. A Beverton–Holt stock–recruitment relationship with a steepness of 0.75 was used throughout (Francis, 1993).

The method provides an estimate of virgin biomass (B0) and current biomass from which a depletion ratio can be calculated. The stock reduction model developed by Francis also provides an estimate of the annual mean catch that can be taken, consistent with a 10% probability of spawning-stock biomass falling below 20% of virgin SSB. In New Zealand and Australian fishery this catch is termed the maximum constant yield (MCY). Given that age of recruitment and age of maturity are reasonably similar for some species e.g. blue ling, 20% of virgin SSB can be considered to be broadly equivalent to 20% of virgin exploitable biomass. It should be possible, therefore, to estimate a sustainable constant catch broadly consistent with a high probability of maintaining exploitable biomass above the limit reference level for deep-water stocks in the ICES area.

#### Catch Survey Analysis (CSA)

CSA (Mesnil, 2003) is an assessment method that aims to estimate absolute stock abundance given a time-series of catches and relative abundance indices, typically from research surveys. This is done by filtering measurement error in the latter through a simple two-stage population dynamics model known as the Collie-Sissenwine, 1983 model. The population dynamics are described by the following model:

$$N_{y+1} = (N_y + R_y)e^{-M} - C_y e^{-M(1-\tau)} \qquad [1]$$

where:

y : time-step, typically annual. Years may be defined either on a calendar basis or as the interval between regular surveys. The year range is [1, Y].

Ny : population size, in number, of fully recruited animals at start of year y;

Ry : population size, in number, of recruits at start of year y;

Cy : catch in number during year y (known);

M : instantaneous rate of natural mortality (equal for both stages, assumed);

τ : fraction of the year when the catch is taken, e.g. 0 if the fishing season is early in the year, or 0.5 if the catch is taken midway through the year or, by resemblance with Pope's (1972) cohort approximation, evenly over the year.

Estimating the time-series of Ny and Ry given the catches is the basic task of any assessment but, as with other methods, this requires additional information in the form of relative indices ny and ry of abundance for each stage, typically from surveys, which are assumed to be proportional to absolute population sizes Ny and Ry. The indices are deemed to be measured with some (lognormal) observation error:

$$n_y = q_n N_y \exp(\eta_y); y = 1, Y \qquad [2]$$

$$r_y = q_r R_y \exp(\delta_y); y = 1, Y-1 \qquad [3]$$

where:

qn and qr : catchability coefficients of fully recruited and recruits, respectively, in the survey, supposed to be constant with time;

$\eta$ and $\delta$ : normally distributed random variables.

A constraint must be imposed whereby the survey catchability of the recruits is some fraction s of that of the fully recruited:

$$s = q_r / q_n \qquad [4]$$

#### Gadget

Gadget is a shorthand for {G}lobally applicable {A}rea {D}isaggregated {G}eneral {E}cosystem {T}oolbox which is a statistical model of marine ecosystems. Gadget is a simulation model designed as a multispecies-multiarea model but can also be used as a single-species model. The model operates as an age and length based cohort model, where all the selection curves depend on the length of the fish and information on age is not a prerequisite but can be utilized if available.

#### 3.2.1.2 Software

Assessment software used at recent Working Groups includes CEDA (Catch Effort data analysis, produced by MRAG Ltd, 27 Campden Street, London W8 7EP, UK.) ASPIC, PMOD (stock reduction programme), the Lowestoft VPA package, Winbugs (version 1.4 http://www.mrc-bsu.cam.ac.uk/bugs/winbugs) and CSA. The software and a detailed description of the Gadget model can be found at www.hafro.is/gadget.

### 3.2.2 New assessment methodologies/software used in 2011

#### 3.2.2.1 Exploratory assessments

WGDEEP is not required to provide advice in 2011 so all assessments carried out were of an exploratory nature.

#### Bayesian surplus production model (based on Schaefer biomass dynamic model) applied to roundnose grenadier in Vb,VI,VII and XIIb

A surplus production model has been evaluated in the EU DEEPFISHMAN Project to assess the stock through a Bayesian implementation of the Schaefer surplus production model. The method used to compute the posterior distribution is the Markov Chain Monte Carlo (MCMC). To improve the MCMC performance, the original model is reparameterized by $Q = qK$, resulting in the following equation for the biomass dynamics:

$$B_y = B_{y-1} + r \cdot B_{y-1} \cdot \left(1 - B_{y-1}^{m-1}\right) - \frac{C_{y-1}}{K} \qquad (1)$$

The biomass index (cpue) is modelled as

$$CPUE_y = Q\ B_y \qquad (2)$$

Where $B_y$ corresponds to the ratio of biomass in year $y$ over $K$, $r$ is the intrinsic growth rate, $K$ the carrying capacity, $q$ is catchability and $Cy$ the catch in year $y$. This model is a function available from the FLR FLBayes package.

A base case was run with the following prior distributions:

| | |
|---|---|
| Mean Ln(Q) | 0 |
| Variance Ln(Q) | 100 |
| Mean r | -1.859 |
| variance r | 0.015 |
| Mean ln(K) | 11.513 |
| variance ln(K) | 1 |
| sigma shape | 2 |
| sigma rate | 1 |

A model run using a less informative prior for *K*, i.e. with mean *K* =ln(1E5), variance of *K* = 5 was also carried out to test the sensitivity to this prior.

#### Multiyear catch curve applied to roundnose grenadier in Vb,VI,VII and XIIb

The general approach is described above in Section 3.2.1.1.

The multiyear catch curve model was carried out to estimate total annual mortality Zt taking account of interannual variations in recruitment. The data used are proportions-at-age in numbers by year and total catch (landings) in numbers by year.

In the multiyear catch curves the population dynamics in numbers are modelled as:

$N_{a,t} = N_{a-1, t-1} \exp(-Z_{t-1}) \quad a_r < a < A+ \qquad (1)$

$N_{A+,t} = (N_{A+-1, t-1} + N_{A+,t-1}) \exp(-Z_{t-1}) \quad a = A+ \qquad (2)$

where $N_{a,t}$ are population numbers-at-age *a* in year *t*, A+ is an age plus group and $Z_t$ are annual total mortality rates. Recruitment-at-age $a_r$ is assumed to vary randomly over time following a lognormal distribution.

$N_{1,t} = R_t \quad R_t \sim \text{logN}(\mu_R, \sigma_R) \qquad (3)$

where $\mu_R$ are the mean recruitment and $\sigma_R$ the standard deviation. For ease of interpretation the coefficient of variation (CVR) instead of $\sigma_R$ was calculated making use of the fact that var(ln(*x*))□ln(CV(*x*)2 +1). Recruitment is treated as a random effect In model fitting.

The initial state vector at the beginning of year t=1 is calculated assuming constant historical total mortality $Z_0 = M + F_0$

$N_{a,1} = \exp((1-a) Z_0) \mu_R \quad a_r < a < A+ \qquad (4)$

The initial numbers in the plus group $N_{A+,1}$ are estimated as a separate model parameter.

The observation model has two parts, the first one for numbers-at-age $Y_{a,t}$ typically from on-board or harbour sampling, assumed to follow a multinomial distribution.

$Y_{a,t} \sim \text{Multinom}(p_{a,t}, m_t) \quad a_r$ □ a □A+ $\qquad (5)$

where $p_{a,t}$ are proportions-at-age and $m_t$ is the effective sample size in year *t*. It has been shown that due to the clustered nature of individuals, the sample size in trawl surveys or harbour sampling programmes does not correspond to the number of individuals measured but is rather much smaller (Pennington and Vølstad, 1994). The result is that the oberved variability is much larger than would be expected given the number of measurements. Therefore after some trials the effective sample size was set to 50 for all years.

The second observation model is for the total catch (in numbers) which is assumed to follow a Gamma distribution with parameters $\alpha$ and $\beta$

$$Ct \sim \text{Gamma}(\alpha,\beta) \quad (6)$$
$$E[Ct]= (Zt-M)/Zt\ (1-\exp(-Zt))\ \Sigma Na,t \quad (7)$$

The coefficient of variation (CV) of the Gamma distribution is related to the $\alpha$ parameter as CVc=1/sqrt($\alpha$ ) and $\beta = \alpha$ /E[Ct]. As CVs are easier to handle, the model is parameterized in terms of CVc.

Not all model parameters **θ**={Z1,..., ZT, M, F0, μR, σR, NA+,1, CVR, CVc} can be estimated and some need to be fixed. The fixed parameters where set as follows:

- o fishing mortality before the dataseries F0=0.001
- o natural mortality M=0.1
- o coefficient of variation of recruitement (CVR= 0.1)
- o coefficient of variation of landings or catch (CVc=0.05) to allow for some misreporting

Large-scale fishing for roundnose grenadier to the west of the British Isles started in the early 1990s (Pawlowski and Lorance, 2009). Hence for the landings dataset which starts in 1990 assuming fishing mortality $F_0$ was very low previously seems justified, the assumption is less justified.

For roundnose grenadier recruitment age is *ar*=26 and the age plus group A+=46.

Estimation of free model parameters **θ** was carried out by maximum likelihood based on the observation vector $\boldsymbol{y}$ = *(C1,..., CT, Yar,T,,..., YA+,T)* which has conditional density $f_\theta$ (**y u**) where $\boldsymbol{u}$ = (*R1,..., Rn*) is the vector of the latent random recruitment variable with marginal density *h(**u**)*. The marginal likelihood function is obtained by integrating out **u** from the joint density fθ (**y u**)hθ (**u**)

$$L(\boldsymbol{\theta})= f_\theta\ (\mathbf{y}\ \mathbf{u})h_\theta\ (\mathbf{u})d\mathbf{u} \quad (8)$$

The joint penalized loglikelihood is $PL(\Theta)=\log(f_\theta\ (y\ \mathbf{u}))$□og($h_\theta$ (**u**)).

The integral in (8) is evaluated using the Laplace approximation as implemented in the random effects module of AD Model builder and described in Skaug and Fournier (2006). AD Model builder automatically calculates standard deviations of estimates based on the observed Fisher Information matrix.

For the analysis the datasets were restricted to the fully recruited age classes to avoid fitting catch curves to the ascending limb of the size distribution created by gear selectivity. Further, a plus group was created for ages 46 and above, called 46+

#### Stock reduction in FLR applied to blue ling in Vb, VI and VII

The general approach is described above in Section 3.2.1.1.

This year an exploratory assessment was carried out under the EU DEEPFISHMAN Project using *FLaspm*, a package for the statistical computing environment R (R Development Core Team, 2010). The package is open source and is currently hosted at GoogleCode (the source code is freely available at http://code.google.com/p/deepfishman/. *FLaspm* is part of the FLR project (Kell *et al.*,

2007) and requires that the package *FLCore* is also installed (v >2.3). The stock reduction model used in this analysis implements the model described in Francis (1992) and is capable of fitting multiple indices simultaneously. The method requires time-series data of annual catches, one or more abundance index and a range of biological parameters. The effect of these biological parameters on results is investigated using sensitivity analysis. A Beverton and Holt stock and recruitment relationship with a steepness of 0.75 was used throughout.

| Parameter | Symbol | Value |
|---|---|---|
| Maximum age | Amax | 30 |
| Natural mortality | m | 0.15 |
| Steepness of Beverton Holt stock recruitment relationship | h | 0.75 |
| Age of first selectivity | Asel | 7 |
| Age of maturity | Amat | 7 |
| von Bertalanffy growth parameters | Linf<br>k<br>t0 | 125 cm<br>0.152<br>1.552 |
| Length weight parameters | a<br>b | 2e-6<br>3.15 |

The effect of varying M was investigated using sensitivity analysis

#### Gadget applied to ling in Va

The general approach is briefly described above in Section 3.2.1.1.

Ling is a rather long-lived species, reaching 20 years of age in Icelandic waters, so it takes a cohort a long time to pass through the fishery. Consequently simulation time needs to be long but data before 1985 are limited i.e. before the Icelandic groundfish survey started. The simulation started at 1982 but apart from data of total catch there are very few data pre-1985.

10 cm length groups were used and the year was subdivided into four time-steps. The age range was 0–20 years with the oldest age treated as a plus group. Length of recruitment was estimated and mean growth was assumed to follow a von Bertalanffy function. M was assumed to be 0.2.

The commercial catch was modelled as three fleets, each with its own selection pattern described by a logistic function.

The survey was modelled as a fleet with constant effort and a nonparametric selection pattern was estimated for each length group

Optimization was started with simulation annealing to make the results less sensitive to the starting values then changed to Hooke and Jeeves when the optimum was approached.

#### Pseudocohort analysis of red (blackspot) in the Straits of Gibraltar

A pseudocohort (Spain + Morocco) was performed from 2005–2007 length distribution available information. The exercise was carried out (LCA, YpR and VPA) using VIT assessment software. Two pseudocohorts (Spain and Morocco) were produced as an average of 2005–2007 length distribution data.

A Kolmogorov-Smirnoff test was applied for the comparison between Spain and Morocco pseudocohorts. A total pseudocohort (Spain + Morocco) constituted the data file source for a Length Cohort Analysis (LCA).

The software VIT (Lleonart and Salat, 1997) was designed to analyse exploited marine populations based on catch data, structured by ages or sizes, from one or several gears. The main assumption is that of steady state because the program works with pseudo-cohorts, therefore it is not suitable for historical series.

The exercise includes too a Yield-per-recruit (YpR) model from the assessment estimates. Besides, lengths were transformed into ages by the slicing technique and consequently, a VPA was also attempted.

#### *Ad hoc* methods

Where *ad hoc* methods have been used these are described in the relevant species assessment sections.

#### Intercatch

An Intercatch Workshop (Chair: Henrik Kjems-Nielsen) held on 28th February and 1st March was attended by ten WGDEEP members  During the workshop and the WGDEEP meeting a total of 19 fleets were defined for 21 of the 29 stocks. A major problem for some SCs was the difficultly to exactly define the fleets/fisheries/métiers for the landings because gear information it is not always reported. A further problem is that for some stocks historical data are grouped by subarea. Notwithstanding, landings data for 2010 were uploaded for eleven stocks. Progress stock-by-stock is summarized in Table 3.2.1.

### 3.2.3 Implementation of the ICES MSY concept and an historical summary of Biological Reference Points and Harvest Control Rules previously explored by WGDEEP

#### 3.2.3.1 Implementation of the ICES MSY concept

WGDEEP assimilated the guidance from WKFRAME2 on the implementation of the ICES MSY concept for stocks where there is no analytical assessment. WGDEEP agreed with the view put forwarded by WKFRAME2 that *in situations where no analytical assessment is available or for stocks with a poor data situation, calling this MSY advice is potentially misleading. In these circumstances, the advised exploitation rates are compatible with sustainable exploitation (SE) and not a narrowly defined MSY. It is also important to stress that for these stocks, the approach is considered adaptive, where provisional targets are used and long-term targets are periodically updated.*

For each stock, WGDEEP suggested likely methods to be considered for trialling by Stock Coordinators (SCs) intersessionally in preparation for use at WGDEEP in 2012 (Table 3.2.2). The methods identified should not be viewed as prescriptive. It was recognized that SCs may use other methods if considered appropriate.

### 3.2.4 Biological reference points

No new information was available. Below is presented a historical review of previous progress.

In 2005, WGDEEP reviewed the biological reference points (BRPs) used in the WG since 1998. These were proposed for data poor situation by ICES SGPA and NAFO in 1997 and are as follows:

Ulim = 0.2 * Umax (may be a smoothed abundance index)
Upa = 0.5 * Umax

Where U is the index of exploitable biomass.

Flim = F35 %SPR
Fpa = M

Historically, WGDEEP has applied these BRPs to all stocks, but the F reference points have not been used because reliable estimates of F have not been available. In 2005, the WG proposed that that the F reference points should remain unchanged but the biomass reference points should be adjusted to take into account differences in life history characteristics between species (e.g growth rate, age-of-maturity, etc.). The WG grouped the different species into two categories, one including slow-growing late-maturing species (category 1: orange roughy, roundnose grenadier, deep-water squalids), and another one including relatively quick-growing early maturing species (category 2: all other species).

It was suggested that the current 50% and 20% thresholds might be reasonable to define the PA BRPs of category 2 species. As for category 1 species, the WG was of the opinion that thresholds should reflect the specific vulnerability of these species to exploitation and their capacity to recover. To quantify these thresholds, two different options were suggested in 2005:

1 ) The thresholds should be higher than those suggested for category 2 species (respectively 50% and 20% of the virgin biomass for $U_{pa}$ and $U_{lim}$), and their values should be decided by managers;
2 ) The thresholds should be set provisionally at 75% and 50% of the virgin biomass for $U_{pa}$ and $U_{lim}$ respectively, to accommodate the PA approach in a data poor context.

The WG could not agree on which option to choose and to date no guidance from managers or ICES (from ISGMAS, for example) was available.

At the 2006 WG, the WG again could not agree a way forward and decided to request advice from ACFM on this issue. The WG recognized that it is desirable that BRPs based on SSB and F levels, instead of cpue levels, should be introduced as more reliable stock assessments become available.

In recent years ACFM in their advice has not specified biological reference points for deep-water species because of concerns that $U_{max}$ (usually the initial value of an abundance index) may not represent virgin biomass when fishing has taken place previously.

The WG consider that this is a valid comment for some species, however for others, where abundance indices commence at the start of the fishery, orange roughy for example; the reference points used previously by WGDEEP remain useable.

Biological indicators such as trends in mean length, ratio of mature/immature continue to provide a valuable insight of the state of stocks.

In the longer term, the WG considers, in line with other ICES assessment WGs, that ICES should develop an MSY-based positive target strategy, rather than current risk avoidance strategies. Experience from around the world suggests that strategies building in positive targets can control fishing mortality more effectively. However, it is recognized that the current level of information available on deep-water species does not allow the calculation of MSY-based BRPs in the short term. When data become available in the longer term, MSY-based BRPs should be calculated and used as benchmarks in substitution to the current $U_{pa}$ and $U_{lim}$.

The EU Project DEEPFISHMAN, which will develop a monitoring, assessment and management framework for deep-water stocks in the NE Atlantic, has a dedicated work package to develop suitable BRPs for deep-water species. The project commenced in April 2009 and completes in March 2012.

### 3.2.5 Harvest control rules

No new information was available. Below is presented a historical review of previous progress.

In the short term, both for category 1 and 2 species (as defined in Section 3.2.4), ICES advice could in principle be provided in a similar way to that given for other stocks for which stock assessments are routinely carried out. For example:

If $U < U_{lim}$, fishery should cease;
If $U_{lim} < U < U_{pa}$, exploitation should be reduced until $U > U_{pa}$;
If $U > U_{pa}$, exploitation should be set so that U remains above $U_{pa.}$

The main difference in advice between species belonging to categories 1 and 2 would be the recovery time. For category 2 species, multi-annual HCR may be contemplated, so the recovery time of stocks should be allowed to exceed one year. For category 1 species, multi-annual plans for stock recovery should not be contemplated.

The above HCRs can also be applied to mixed-species fishery. From a biological point of view, and more precisely for the sake of biodiversity preservation, the WG suggests that the poorest or the most vulnerable stock should be a reasonable candidate to set the HCR. However, the WG was of the opinion that the decision weight allocated to each stock should be left to managers. In the longer term, HCR should be elaborated on the newly calculated BRPs, as described above. In addition, HCR should accommodate pertinent environmental issues in a quantitative way.

The EU Project DEEPFISHMAN has a dedicated work-package to develop suitable HCRs for deep-water species.

**Table 3.2.1. Summary of progress in Intercatch for WGDEEP stocks.**

| Table of Use and Acceptance of InterCatch | | | | |
|---|---|---|---|---|
| Stock code for each stock of the expert group | InterCatch used as the: 'Only tool' 'In parallel with another tool' 'Partly used' 'Not used' | If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section. | Discrepancy between output from InterCatch and the so far used tool: Non or insignificant Small and acceptable significant and not acceptable Comparison not made | Acceptance test. InterCatch has been fully tested with at full dataset, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in future. |
| alf-comb | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| arg-icel | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| arg-rest | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bli-5a14 | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bli-5b67 | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bli-rest | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bsf-soth | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bsf-89 | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| bsf-rest | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| gfb-comb | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| lin-faro | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| lin-icel | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |

Table of Use and Acceptance of InterCatch

| Stock code for each stock of the expert group | InterCatch used as the: 'Only tool' 'In parallel with another tool' 'Partly used' 'Not used' | If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section. | Discrepancy between output from InterCatch and the so far used tool: Non or insignificant Small and acceptable significant and not acceptable Comparison not made | Acceptance test. InterCatch has been fully tested with at full dataset, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in future. |
|---|---|---|---|---|
| lin-arct | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| lin-rest | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| ory-scrk | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| ory-vii | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| ory-rest | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| rng-soth | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| rng-nsea | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| rng-1012 | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| rng-rest | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| sbr-ix | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| sbr-x | Partly used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| sbr-678 | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| tusk-5a14 | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |

| Table of Use and Acceptance of InterCatch | | | | |
|---|---|---|---|---|
| **Stock code for each stock of the expert group** | **InterCatch used as the: 'Only tool' 'In parallel with another tool' 'Partly used' 'Not used'** | **If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section.** | **Discrepancy between output from InterCatch and the so far used tool: Non or insignificant Small and acceptable significant and not acceptable Comparison not made** | **Acceptance test. InterCatch has been fully tested with at full dataset, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in future.** |
| tusk-arct | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| tusk-mar | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| tusk-rock | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |
| tusk-rest | Not used | Not enough time to prepare and import data | Comparison not made | InterCatch has not been properly tested |

**Table 3.2.2. MSY method(s) suggested for intersessional investigation in preparation for WGDEEP in 2012 (see text).**

| Stock | Analytical | Length/ age | Standardized cpue/Survey | Landings | MSY method |
|---|---|---|---|---|---|
| Ling Va | Yes | Yes | Yes | Yes | Gadget: estimates of uncertainty from bootstrapping of gadget and simulation studies |
| Ling Vb | No? | Yes | Yes | Yes | To be identified |
| Ling I,II | No | Yes | Yes? | Yes | Proxy F, CUSUM |
| Ling other areas | No | No | No | Yes | F Proxy, CUSUM |
| Blue ling Va,XIV | No | Yes | Yes | Yes | Gadget |
| Blue ling Vb,VI,VII | Historical | Yes-length | Yes | Yes, but TAC limited | CUSUM, catch curve, YPR<br>Gadget, stock reduction |
| Blue ling other areas | No | No | No | Yes | CUSUM, PSA |
| Tusk I,II | No | Yes | No | Yes | F Proxy, CUSUM |
| Tusk Va, XIV | Yes | Yes | Yes | Yes | Gadget: estimates of uncertainty from bootstrapping of gadget and simulation studies |
| Tusk MAR | No | No | No | Yes | To be identified |
| Tusk VIb | No | Yes | No | Yes | F Proxy, CUSUM |
| Tusk other areas | No | No | No | yes | To be identified |
| Greater silver smelt Va | No | Yes | No | Yes | Conflicting information in data. Not identified. |
| Greater silver smelt other areas | No | Yes | Yes | Yes | Not identified. |

| Stock | Analytical | Length/ age | Standardized cpue/Survey | Landings | MSY method |
|---|---|---|---|---|---|
| Orange roughy VI | Historical exploratory assessment | Historical | Historical | Historical | PSA |
| Orange roughy VII | Historical exploratory assessment | Historical | Historical | Historical | PSA |
| Orange roughy other areas | Historical exploratory assessment | Historical | Historical | Historical | PSA |
| Roundnose grenadier Vb,VI,VII,XIIb | Yes? | Yes | Yes | Yes | Bayesian Production Model |
| Roundnose grenadier IIIa | No | No | Yes | Yes | CUSUM, PSA, F proxy |
| Roundnose grenadier Xb,XIIc, Va1,XIIa1,XIVb1 | No | No | Yes | Yes | To be identified |
| Roundnose grenadier other areas | No | No | No | Yes | Catches insignificant |
| Black scabbardfish Vb,VI,VII,XIIb | No | No | Yes | Yes | PSA, Cusum,Fproxy |
| Black scabbardfish VIII,IX | No | Yes | Yes | Yes | Cusum |
| Black scabbardfish other areas | No | No | No | Yes | PSA |
| Greater forkbeard in all areas | No | Yes | Yes | Yes | F proxy, CUSUM |
| Beryx spp. in all areas | No | Yes | Yes | Yes | YPR |
| Red (blackspot) sea bream IX | Yes | Yes | No | Yes | YPR,catch curves, F proxy |
| Red (blackspot) sea bream X | No | Yes | Yes | Yes | Catch curves, Fproxy catch/survey cpue,CUSUM |
| Red (blackspot) sea bream V,VII,VIII | No | No | No | Yes | To be identified. Stock is below any possible candidate Btrigger |

# 4 Area overviews

## 4.1 Stocks and fisheries of Greenland and Iceland Seas

This section gives a very broad and general overview of the ecosystem, fishery, fleet and species composition of the commercially landed species as well as management measures in the Icelandic Exclusive Economic Zone and in Greenland waters in the ICES area. The Icelandic zone covers a number of different ICES statistical regions. These include parts of IIa2, Va1, Va2, Vb1b, XIIa4, XIVa and XIVb2. Although the Icelandic EEZ covers quite a number of different areas, in practice, the Icelandic landings of different species are generally reported as catches/landings in Va.

The information presented here is based to a large extent on the information presented in the NWWG and WGRED reports.

### 4.1.1 Fisheries overview

**Iceland**

Since the mid-seventies stocks in Division Va have mainly been exploited by Icelandic vessels. However, vessels of other nationalities have also operated in the pelagic fishery on capelin, herring and blue whiting and few trawlers and longliners targeting deep-sea redfish, tusk, ling and blue ling have been operating in the region.

Fisheries in Icelandic waters are characterized by the most sophisticated technological equipment available in this field. This applies to navigational techniques and fish-detection instruments as well as the development of more effective fishing gears. The most significant development in recent years is the increasing size of pelagic trawls and with increasing engine power the ability to fish deeper with them. There have also been substantial improvements with respect to technological aspects of other gears such as bottom trawl, longline and handline. Each fishery uses a variety of gears and some vessels frequently shift from one gear to another within each year. The most common demersal fishing gear are otter trawls, longlines, seines, gillnets and jiggers whereas the pelagic fisheries use pelagic trawls and purse-seines. At present there are approximately 1400 Icelandic vessels operating in the fisheries. The definition of types of vessels may be very complicated as some vessels are operating both as large factory fishing for demersal species and as large purse-seiners and pelagic trawlers fishing for pelagic fish during different times of the year.

Demersal fisheries take place all around Iceland including a variety of gears and boats of all sizes. The most important fleets targeting them are:

- Large and small trawlers using demersal trawl. This fleet is the most important one fishing cod, haddock, saithe, redfish as well as a number of other species. This fleet is operating year around, mostly outside 12 nautical miles from the shore.
- Boats (<300 GRT) using gillnet. These boats are mostly targeting cod but haddock and a number of other species are included. This fleet is mostly operating close to the shore.
- Boats using longlines. These boats are both small boats (<10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but a number of deep-sea species are also caught, some of them in directed fisheries.

- Boats using jiggers. These are small boats (<10 GRT). Cod is the most important target species of this fleet with saithe following as the second most important species.
- Boats using Danish seine. (20–300 GRT). The most important species for this fleet are cod and haddock but this fleet is the most important fleet fishing for a variety of flatfish like plaice, dab, lemon sole and witch.

**Greenland**

There is no directed fishery for any of the species dealt with in this Working Group in ICES XIV. A number of the species are, however, taken as very small bycatches in the fishery for Greenland halibut in XIVb. Roundnose grenadier is the only species for which catches have been reported though the years.

In East Greenland the cod fishery has been closed north of 62°N since 2008 in order to protect cod spawning grounds. The Greenland offshore shrimp fleet consist of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland landing around 135 000 and 12 500 t, respectively. The shrimp fleet is close to or above 80 BT and 75% of the fleet process the shrimps onboard. They use shrimp trawls with a minimum mesh size of 44 mm and a mandatory sorting grid (22 mm) to avoid bycatch of juvenile fish. The three most economically interesting species, redfish, cod and Greenland halibut are only found in relatively small proportions of the bycatch.

The longliners are operating on the East coast with Greenland halibut and cod as targeted species. Bycatches for the longliners fishing for Greenland halibut are roundnose grenadier, roughhead grenadier, tusk and Atlantic halibut, and Greenland shark (Gordon *et al*., 2003). Some segments of the longline fleet target Atlantic halibut.

On the East coast an offshore pelagic fleet conducted a fishery on capelin (106 000 t landed in 2003 by EU, Norway and Iceland). The capelin fishery was considered a rather clean fishery, without any significant bycatches. Since 2004 this fishery has ceased due to the low capelin biomass. Also the pelagic redfish fishery is a clean fishery conducted in the Irminger Sea and extending south of Greenland into the NAFO area.

### 4.1.2 Trends in fisheries

**Iceland**

Tusk, ling and blue ling remain the most important "deep-sea species" in Icelandic waters. In recent years, about 120 vessels were engaged in these fisheries with registered catches from less than 100 kg to nearly 1000 tonnes. In 2007 about 7000 tonnes of deep-water species were caught in bottom-trawl, whereof 4100 were greater silver smelt. There has been an increase in the landings of ling, tusk and blue ling in the last five years up 2008 (Figure 4.1.1; note this figure could not be updated by WGDEEP in 2011), the increase in the two former stocks as a consequence of increases in quota (a TAC is not set for blue ling). The longline fishery for blue ling seems to have changed from almost a pure bycatch fishery to a more targeted fishery (Figure 4.1.3). This trend is against ICES advice (ACOM May 2008 and 2010 which states that *"There should be no directed fisheries for blue ling in Areas Va and XIV and measures should be implemented to minimize bycatches in mixed fisheries. Blue ling is susceptible to sequential depletion of spawning aggregations and therefore closed areas to protect spawning aggregations should be maintained and expanded where appropriate."*

Table 4.1.1 gives the catches of the Icelandic fleet of the most important deep-sea species taken by different gears in 2007 to 2010 and Table 4.1.2 gives the total landings of deep-sea species from Subdivision Va since 2000.

**Greenland**

There is no directed fishery for the stocks covered by WGDEEP in Greenland waters.

### 4.1.3 Technical interactions

**Iceland**

The ling, blue ling and tusk in Icelandic waters constitute only a minor portion of total demersal removals from the Icelandic Ecosystem (Figure 4.1.2). These three species are to some extent bycatch in fisheries targeting other species; both in the longline (Figure 4.1.3) and the bottom-trawl (Figure 4.1.4) fisheries. As stated above, this may be changing in the longline fishery for blue ling, but also for ling and tusk. Greater silver smelt on the other hand is targeted in the trawl fishery (Figure 4.1.4).

The geographical distribution of bottom-trawl catches of ling and blue ling overlap to a large extent with those that are the main target species, among other being Greenland halibut, *Sebastes sp*., saithe and cod (Figure 4.1.5).

However some limited targeted longline fishing for ling and in particular tusk takes place. For the latter species, there are indications that the fishery in the southwest of the Icelandic fishing area on the Reykjanes is directed at tusk, with relatively little catch of other species (Figure 4.1.6).

**Greenland**

As stated above there are no directed fisheries for the stocks covered by WGDEEP in Greenland waters. However tusk is caught as a bycatch in the longline fishery targetting cod off the east coast.

### 4.1.4 Ecosystem considerations

**Iceland**

Iceland is located at the junction of the Mid-Atlantic Ridge (MAR) and the Greenland-Scotland Ridge, just south of the Arctic Circle and this is reflected in the topography around the country. Generally hard bottom is found in shallower areas while softer sediments dominate in the troughs and outside the continental slope. The shelf around Iceland is narrowest off the south coast and is cut by submarine canyons around the country.

The Polar Front lies west and north of Iceland and separates the cold and southward flowing waters of Polar origin from the northward flowing waters of Atlantic origin. South and east of Iceland the North Atlantic Current flows towards the Norwegian Sea. The Irminger Current is a branch of the North Atlantic Current and flows northwards over and along the Reykjanes Ridge and along the western shelf break. In the Denmark Strait it divides into a branch that flows northeastwards and eastwards to the waters north of Iceland and another branch that flows southwestwards along the East Greenland Current. In the Iceland Sea north of Iceland a branch of the cold East Greenland Current flows over the Kolbeinsey Ridge and continues to the southeast along the northeastern shelf brake as the East Icelandic Current, which is part of a cyclonic gyre in the Iceland Sea., and continues into the Norwegian Sea along the Atlantic water flowing eastwards over the Iceland-Faroes Ridge (Stefansson, 1962; Valdimarsson and Malmberg, 1999).

The Icelandic Shelf is a high (150–300 gC/m2-yr) productivity ecosystem according to SeaWiFS global primary productivity estimates. Productivity is higher in the southwest regions than to the northeast and higher on the shelf areas than in the oceanic regions (Gudmundsson, 1998). In terms of numbers of individuals, copepods dominate the mesozooplankton of Icelandic waters with *Calanus finmarchicus* being the most abundant species, often comprising between 60–80% of net-caught zooplankton in the uppermost 50 m (Astthorsson and Vilhjalmsson, 2002; Astthorsson *et al.*, 2007).

The underlying features which appear to determine the structures of benthic communities around Iceland are water masses and sediment types. Accordingly, the distribution of benthic communities is closely related to existing water masses and, on a smaller scale, with bottom topography (Weisshappel and Svavarsson, 1998). Survey measurements indicate that shrimp biomass in Icelandic waters, both in inshore and offshore waters, has been declining in recent years. Consequently the shrimp fishery has been reduced and is now banned in most inshore areas. The decline in the inshore shrimp biomass is in part considered to be environmentally driven, both due to increasing water temperature north of Iceland and due to increasing biomass of younger cod, haddock and whiting.

Based on information from fishermen, eleven coral areas were known to exist close to the shelf break off northwest and southeast Iceland in around 1970. Since then more coral areas have been found, reflecting the development of the bottom-trawling fisheries extending into deeper waters in the 1970s and 1980s. At present considerably large coral areas exist on the Reykjanes Ridge and off southeast Iceland. Other known coral areas are small (Steingrímsson and Einarsson, 2004). Since January 1st 2006, five areas, covering 80 $km^2$ have been closed to all fishing except those targeting pelagic fish.

The database of the BIOICE programme provides information on the distribution of soft corals, based on sampling at 579 locations within the territorial waters of Iceland. The results show that gorgonian corals occur all around Iceland. They were relatively uncommon on the shelf (<500 m depth) but are generally found in relatively high numbers in deep waters (>500 m) off the south, west and north coasts of Iceland. Similar patterns were observed in the distribution of pennatulaceans off Iceland. Pennatulaceans are relatively rare in waters shallower than 500 m but more common in deep waters, especially off south Iceland (Guijarro *et al.*, 2006).

Icelandic waters are comparatively rich in species and contain over 25 commercially exploited stocks of fish and marine invertebrates. Main species include cod, haddock, saithe, redfish, Greenland halibut and various other flatfish, wolffish, tusk, ling, herring, capelin and blue whiting. Most fish species spawn in the warm Atlantic water off the south and southwest coasts. Fish larvae and 0-groups drift west and then north from the spawning grounds to nursery areas on the shelf off northwest, north and east Iceland, where they grow in a mixture of Atlantic and Arctic water.

Capelin is important in the diet of cod as well as a number of other fish stocks, marine mammals and seabirds. Unlike other commercial stocks, adult capelin undertake extensive feeding migrations north into the cold waters of the Denmark Strait and Iceland Sea during summer. Capelin abundance has been oscillating on roughly a decadal period since the 1970s, producing a yield of up to 1600 Kt at the most recent peak. In recent years the stock size of capelin has decreased from about 2000 Kt in 1996/97 to about 1000 Kt in 2006/07 (NWWG 2007). Herring was very abundant in the early 1960s, collapsed and then has increased since 1970 to a historically high level in the last decade. The abundance of demersal species has been trending downward irregularly since the 1950s, with aggregate catches dropping from over 800 Kt to under 500 Kt in the early 2000s.

A number of species of sharks and skates are known to be taken in the Icelandic fisheries, but information on catches is incomplete, and the status of these species is not known. Information on status and trends of non-commercial species is collected in extensive bottom-trawl surveys conducted in early spring and autumn, but information on catches in fisheries is not available.

The seabird community in Icelandic waters is composed of relatively few but abundant species, accounting for roughly ¼ of total number and biomass of seabirds within the ICES area. Auks and petrel are most important groups comprising almost $^3/_5$ and $^1/_4$ of abundance and biomass in the area, respectively. The estimated annual food consumption is of the order of 1.5 million tonnes.

At least 12 species of cetaceans occur regularly in Icelandic waters, and an additional ten species have been recorded more sporadically. In the continental shelf area minke whales (*Balaenoptera acutorostrata*) probably have the largest biomass. According to a 2001 sightings survey, 67 000 minke whales were estimated in the Central North Atlantic stock region, with 44 000 animals in Icelandic coastal waters (NAMMCO 2004). Two species of seals, common seal (*Phoca vitulina*) and grey seal (*Halicoerus grypus*) breed in Icelandic waters, while five northern vagrant species of pinnipeds are found in the area.

*Ecosystem considerations*

After 1996 a rise in both temperature and salinity were observed in the Atlantic water south and west of Iceland. Temperature and salinity have remained at similar high levels since, and west of Iceland amounts to an increase of temperature of about 1˚C and salinity by one unit. Off central N-Iceland similar changes have been observed although with higher interannual variability. This period has been characterized by an increase of temperature and salinity in the winter north of Iceland, in the last ten years, on average by about 1.5˚C and 1.5 salinity units.

It appears that these changes have had considerable effects on the fish fauna of the Icelandic ecosystem. Species which are at or near their northern distribution limit in Icelandic waters have increased in abundance in recent years. The most obvious examples of increased abundance of such species in the mixed water area north of Iceland are haddock, whiting, monkfish, ling, tusk, greater silver smelt, blue ling lemon sole and witch. The semi-pelagic blue whiting has lately been found and fished in E-Icelandic water in far larger quantities than ever before.

On the other hand, cold-water species like Greenland halibut and northern shrimp have become scarcer. Capelin have both shifted their larval drift and nursery areas far to the west to the colder waters off E-Greenland. The arrival of adults on the overwintering grounds on the outer shelf off N-Iceland has been delayed and migration routes to the spawning grounds off S- and W-Iceland have been located farther off N- and E-Iceland and not reached as far west along the south coast as was the rule in most earlier years. The change in availability of capelin on the traditional grounds may have had an effect on the growth rate of various predators, as is reflected in low weight of cod in recent years.

**Greenland**

The marine ecosystem around Greenland is located from arctic regions to subarctic regions. The water masses in East Greenland are composed of the polar East Greenland Current and the warm and saline Irminger Current. As the currents rounds Cape Farewell at Southernmost Greenland the Irminger water subducts the polar water and mixes extensively and forms the relatively warm West Greenland Current. The Irminger Current play a key role in the transport of larval and juvenile fish from spawning grounds south and west of Iceland to nursery areas, not only off N- and E-Iceland but also across to E- and then W-Greenland. In recent years spawning cod has been observed on the banks of East Greenland. Eggs and larvae from these cod are also being transported with the current to West Greenland.

Depending of the relative strength of the two East Greenland currents, The Polar Current and the Irminger Current, the marine environment experiences extensive variability with respect to temperature and speed of the West Greenland Current. The general effects of such changes have been increased bio-production during warm periods as compared to cold ones, and resulted in extensive distribution and productivity changes of many commercial stocks. Historically, cod is the most prominent example of such a change.

In recent years temperature have increased significant in Greenland water to about 2°C above the average for the historic average, with historic high temperatures registered in 2005 (50 years time-series). Recently increased growth rates for some fish stocks as indicated from the surveys might be a response of the stock to such favourable environmental conditions. As has been observed with the Icelandic cod stock, an important interaction between cod and shrimp exists. In recent years more southerly distributed species such as monk fish, lemon sole, saithe and whiting has been observed on surveys in offshore West and East Greenland and inshore West Greenland.

### 4.1.5 Management measures

**Iceland**

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations.

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry.

In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The quotas represent shares in the national TAC for each species, and most of the Icelandic fleets operate under this system.

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. Since 1998 a mesh size of 135 is allowed in the codend in all trawl fisheries not using a "Polish cover". A quick closure system has been in force since 1976 with the objective to protect juvenile fish. Fishing is prohibited for at least two weeks in areas where the number of small fish in the catches has been observed by inspectors to exceed a certain percentage. If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for a longer time forcing the fleet to operate in other areas. Such permanent closure took place at several places along the south–southeast area for tusk in 2003 (Figure 4.1.5). Inspectors from the Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2005, 85 such closures took place.

In addition to allocating quotas on each species, there are other measures in place to protect fish stocks. Based on knowledge of the biology of various stocks, many areas have been closed temporarily or permanently aiming to protect juveniles. Figure 4.1.7 shows map of such legislation that was in force in 2004. Some of them are temporarily, but others have been closed for fishery for decades.

**Greenland**

Management of the inshore fleets is regulated by licences, TACs and closed areas for the Atlantic cod, snow crab, scallops, salmon and shrimp. The fisheries for Greenland cod and lumpfish are unregulated.

Demersal and pelagic offshore fishing is managed by TAC, minimum landing sizes, gear specifications and irregularly closed areas.

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**Table 4.1.1. Overview of the Icelandic deep-sea landings (in tonnes) in Icelandic waters (Va) in 2007 to 2010 by gear type.**

| Species | Fishing Gear | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| **Ling** | Bottom-trawl | 1395 | 1509 | 1540 | 1535 |
| | Danish seine | 238 | 290 | 428 | 404 |
| | Gillnet | 633 | 476 | 723 | 363 |
| | Lobster trawl | 243 | 416 | 653 | 981 |
| | Longline | 4042 | 5002 | 6229 | 6529 |
| | Other gears | 49 | 35 | 39 | 55 |
| | Total | 6600 | 7736 | 9613 | 9867 |
| **Blue ling** | Bottom-trawl | 1483 | 2081 | 2079 | 1900 |
| | Danish seine | 44 | 54 | 63 | 92 |
| | Gillnet | 22 | 28 | 136 | 91 |
| | Lobster trawl | 55 | 29 | 166 | 283 |
| | Longline | 375 | 1454 | 1679 | 3978 |
| | Other gears | 17 | 7 | 9 | 33 |
| | Total | 1995 | 3653 | 4132 | 6377 |
| **Tusk** | Bottom-trawl | 95 | 114 | 107 | 92 |
| | Gillnet | 38 | 43 | 72 | 52 |
| | Hook | 9 | 5 | 8 | 5 |
| | Lobster trawl | 9 | 12 | 8 | 5 |
| | Longline | 4833 | 6756 | 6755 | 6760 |
| | Other gears | 2 | 2 | 3 | 3 |
| | Total | 5986 | 6932 | 6954 | 6917 |
| **Greater silver smelt** | Bottom-trawl | 4108 | 8774 | 10825 | 16 429 |
| | Pelagic trawl | 108 | 4 | 4 | 185 |
| | Total | 4226 | 8778 | 10829 | 16 428 |

**Table 4.1.2. Total landings of deep-sea species (other than blue ling, tusk, ling and greater silver smelt) in ICES Subdivision Va.**

| Species | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | | | | | | | | 0 | 0 | 0 | 0 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | 18 | 8 | 13 | 0 | 0 | 19 | 23 | 1 | 0 | 15 | 109 |
| BLUEMOUTH (*Helicolenus dactylopterus*) | | | | | | | | 0 | 0 | 0 | 0 |
| GREATER FORKBEARD (*Phycis blennoides*) | | | | | | 0 | 0 | 1 | 3 | 2 | 1 |
| MORIDAE | | | | | | | 0 | 0 | 0 | 0 | 0 |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | 68 | 19 | 10 | + | | 9 | 2 | 0 | 4 | 1 | 1 |
| RABBITFISH (*Chimaerids*) | 5 | | | | | | 1 | 1 | 1 | 2 | 7 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | 2 | 1 | 4 | 33 | 3 | 5 | 7 | 2 | 0 | 5 | 23 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 54 | 40 | 60 | 57 | 181 | 76 | 62 | 16 | 29 | 46 | 59 |
| RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*) | | | | | | | | 0 | 0 | 0 | 0 |
| SHARKS, VARIOUS | 45 | 57 | | | | 54 | 0 | 2 | 43 | 0 | 43 |
| WRECKFISH (*Polyprion americanus*) | | | | | | | | 0 | 0 | 0 | |

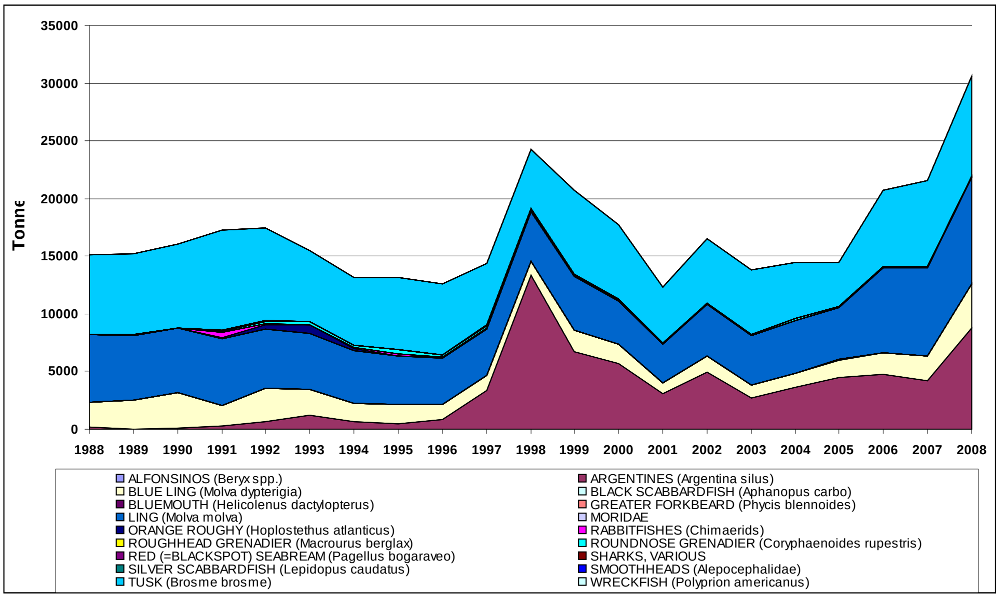



**Figure 4.1.1. Fishery of deep-sea species in Subdivision Va 1988–2008, by species.**

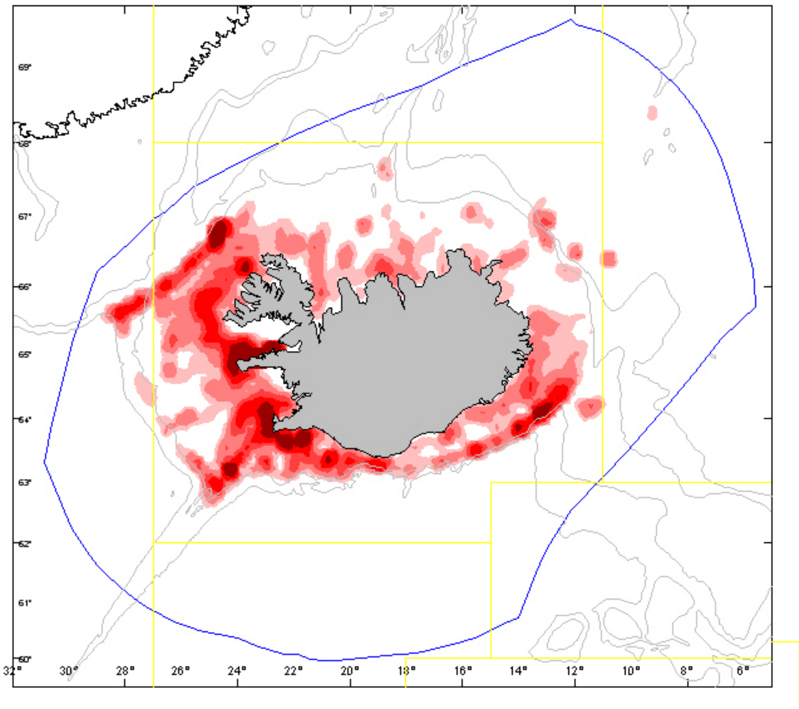


**Figure 4.1.2. The spatial distribution of the total removal of all species by the Icelandic demersal fishing fleet in the Icelandic EEZ in 2007. The EEZ is shown as a blue line, regular thin lines show major ICES areas and contour lines indicate 500 and 1000 m depth.**

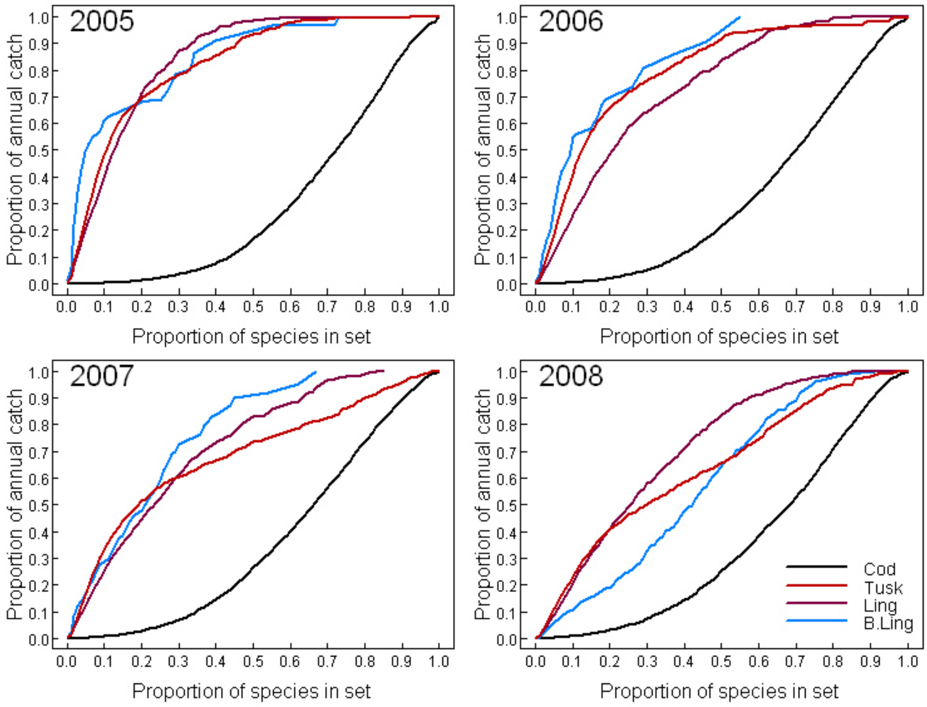



**Figure 4.1.3. Cumulative plot for longline in 2005–2008. An example describes this probably best. Looking at the figure for 2005 above it can be seen from the solid line that 50% of the catch of ling comes from sets where tusk is less than 15% of the total catch whereas only unsignificant % of the catch of cod sets where it is less than 15% of the total catch in each set. Over 90% of ling catches are caught where ling is less than about 30% of total catches in given set. For comparison, only around 15% of cod is caught in sets where cod is less than 50% of the total catch.**

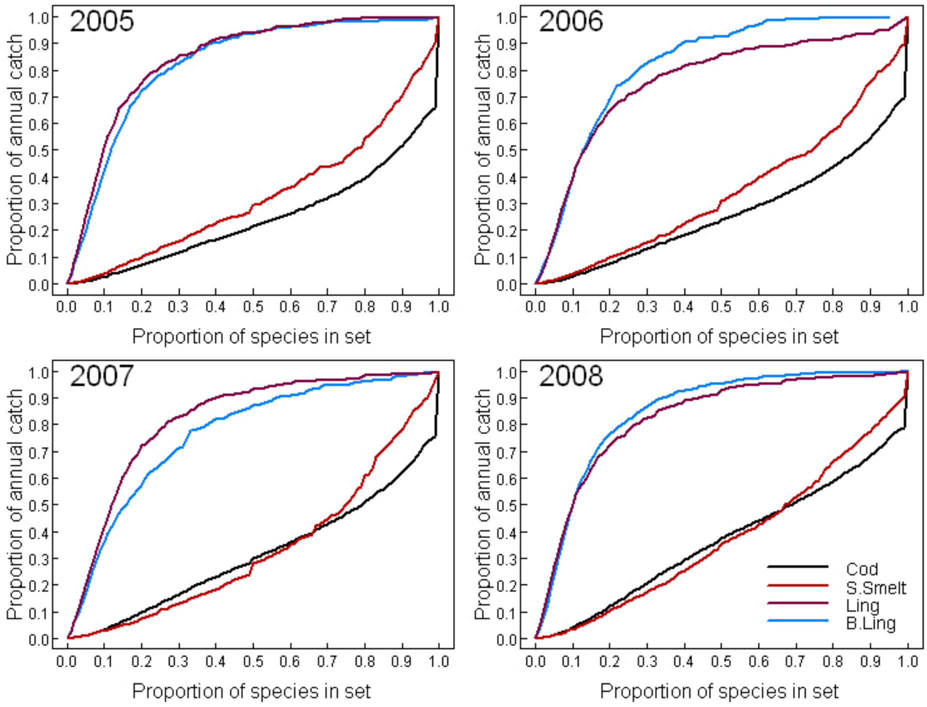



**Figure 4.1.4. Cumulative plot for bottom trawl in 2005–2008. See Figure 5.1.2 for details.**

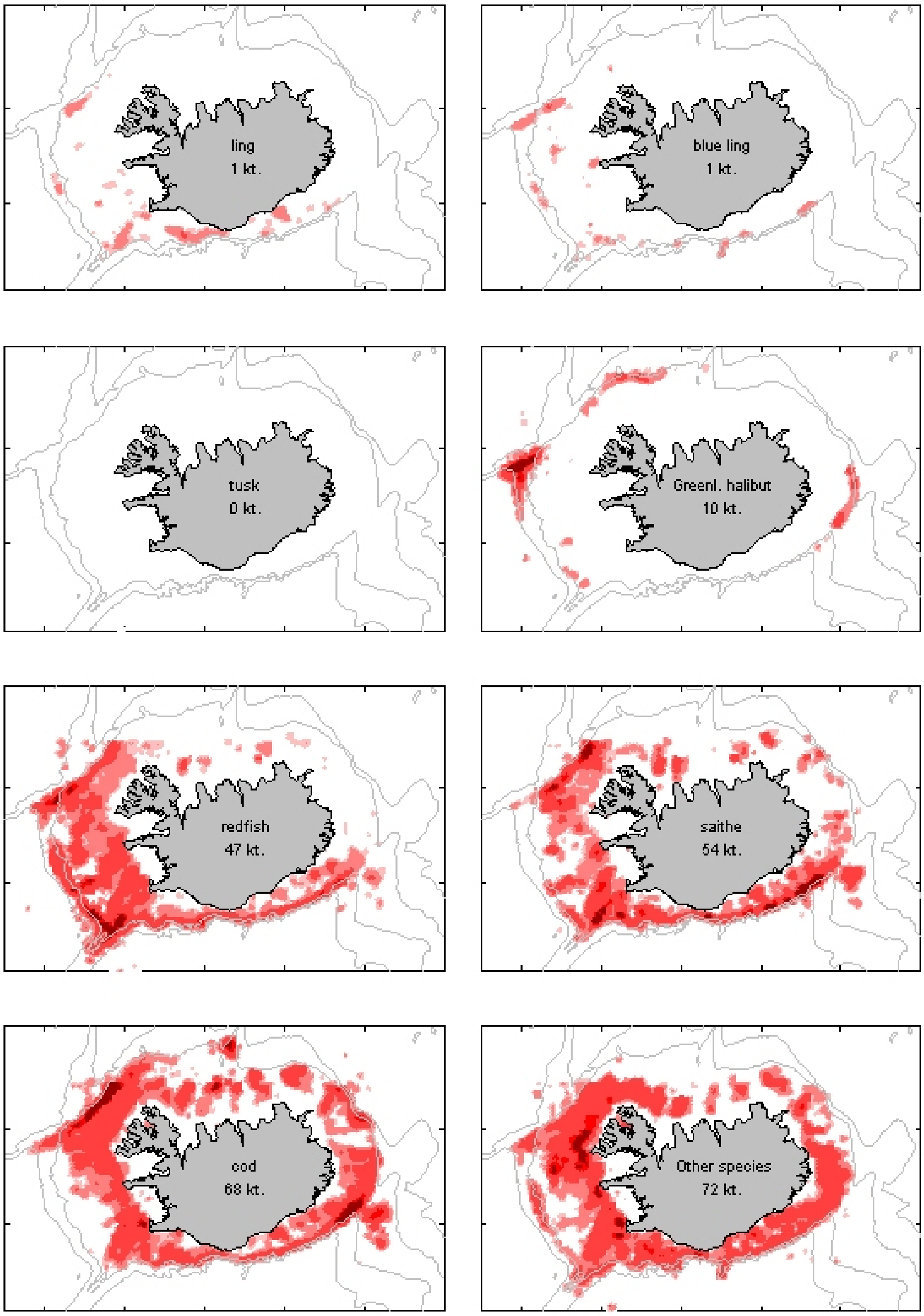



**Figure 4.1.5. Spatial distribution of the removal of various species by the bottom trawling in 2007. The densities scale is comparable among the figures. The total catch by species is shown in units of thousand tonnes (kilotonnes). The grey lines correspond to 500 and 1000 meter depth contours.**

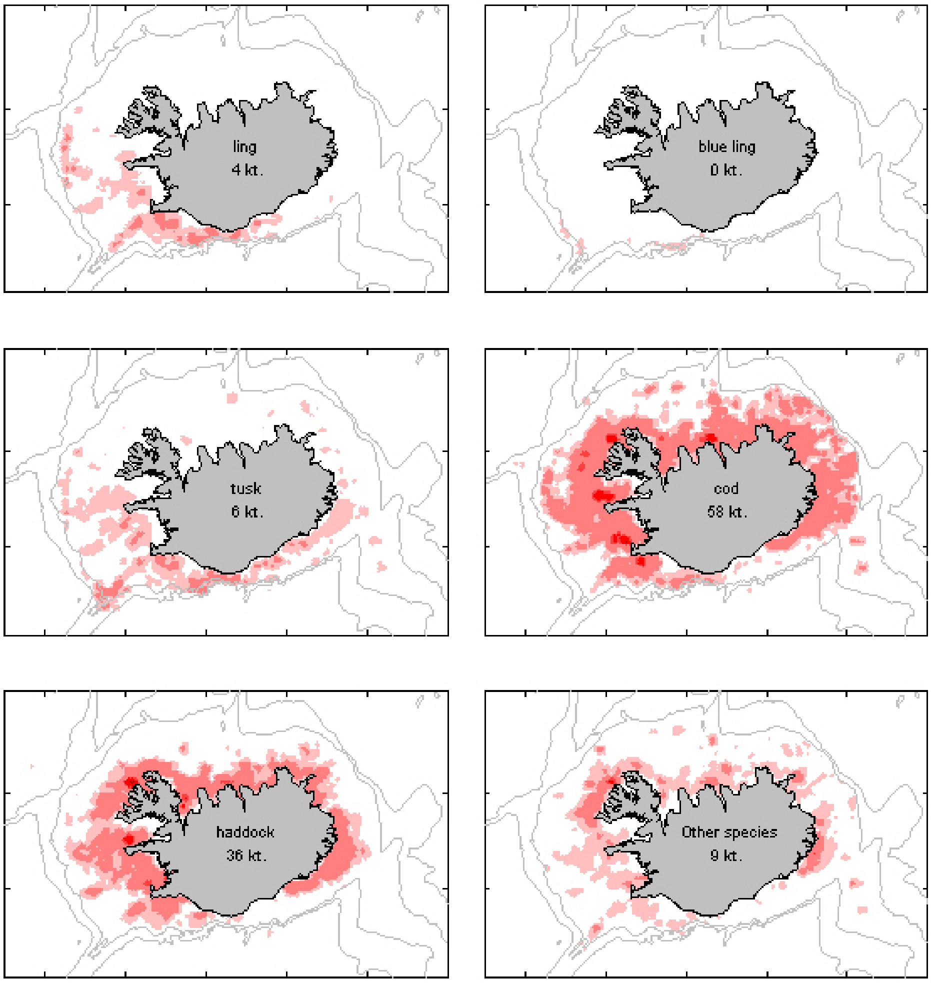



**Figure 4.1.6. Spatial distribution of the removal of various species by the longlining in 2007. The densities scale is comparable among the figures. The total catch by species is shown in units of thousand tonnes (kilotonnes). The grey lines correspond to 500 and 1000 meter depth contours.**

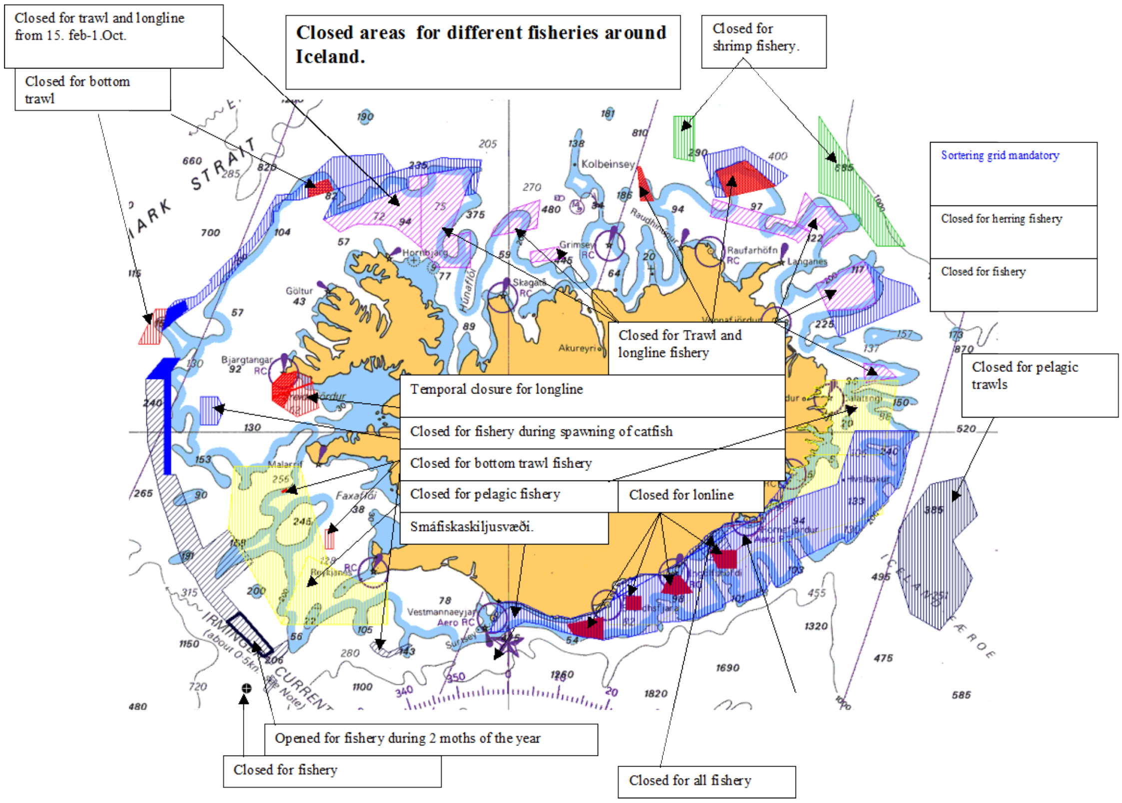



**Figure 4.1.7. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type.**

## 4.2 Stocks and fisheries of the Barents Sea and Norwegian Sea

### 4.2.1 Fisheries overviews I and II

In Subareas I and II three species, ling (*Molva molva*), tusk (*Brosme brosme*) and Greater silver smelt (*Argentina silus*) make up almost 99 per cent of the landed catches (Table 4.2.1 and Figure 4.2.1). Ling and tusk are mainly caught by longliners and a small proportion is caught in gillnets. Greater silver smelt are caught by bottom and mid-water trawls. Minor catches of other species, which are mainly taken as bycatches, include roughhead grenadier (*Macrourus berglax*), greater forkbeard (*Phycis blennoides*), roundnose grenadier (*Coryphaenoides rupestris*), rabbitfish (Chimaerids) and blue ling (*Molva dypterygia*). Norway lands by far the largest amount of the three species. The Faroes, France, Germany, Russia, Scotland, Ireland and England and Wales report small bycatch landings of ling, blue ling and tusk. Occasional landings of these species in the directed fishery for greater silver smelt were reported by the Netherlands and as bycatches by Germany, Russia, Scotland and the Faroes.

#### Longline fisheries

The longline fishery for ling (*Molva molva*) and tusk (*Brosme brosme*) has for many years been the most targeted deep-sea fishery in Norway (e.g. Bergstad and Hareide, 1996). The number of fishing vessels over 21 m targeting ling, tusk and blue ling has declined from 72 in 2000 to 35 in 2010 (Table 4.2.2). The number of vessels declined during this period mainly as a consequence of changes in the laws concerning quotas for catching cod.

#### Trawl fisheries

*Argentina silus* has been targeted in trawl fisheries off mid-Norway (Division IIa) since the late 1970s, especially in the southern southeast area off the coast of Norway. Recently the fishery has changed to be dominated by semi-pelagic trawlers operating further north but still along the coast of Norway. This fishery has continued, as previously described (ICES, 2008), but the effort directed at *A. silus* varies and is highly correlated with market demand. In Division IIa landings declined from approximately 10 000–11 000 t in the mid 1980s to about half that level in the early 1990s. During the period 2004–2006 there was a large increase in landings resulting in a 2007 Norwegian TAC set to 12 000 t. Landings in 2010 have decreased to a level below the TAC.

In the late 1990s there used to be a minor trawl fishery in mid-Norway (IIa) targeting roundnosed grenadier *Coryphaenoides rupestris* and *Argentina silus*. Details on this fishery were given in the report of the EC FAIR project (Gordon, 1999). This fishery is no longer executed.

#### Gillnet fisheries

There is a targeted gillnet fishery for ling (*Molva molva*) on the upper slope off mid-Norway (Area IIa). This fishery started in 1979 as a targeted fishery for blue ling. The catches of blue ling declined throughout the following decade to the extent that the fishery has since the 1990s become almost entirely focused on ling.

### 4.2.2 Trends in fisheries

Landing statistics for Subareas I and II for the period 1988–2010 are given in Table 4.2.1.

#### Tusk, ling and blue ling

There was a steady decline in the landings of tusk during the period 1988 through 2005 and the landed catches have declined from almost 20 000 tons at the end of the 1980s to about 7000 t in 2005. During the last years the reported catches have increased significantly compared to the level in 2005. Preliminary landings for 2010 are about 12 700 t which equates to a 55% increase from the 2005 level. Landings of ling have remained stable at between 7000 and 8000 t, but from 2006 landings started to increase and in 2010 landings were around 10 500 t. Blue ling landings declined markedly from 1988 through 1993, and the catches have been at a low level since (Figure 4.2.2).

#### Greater silver smelt

During the period 1988–2000 there was a slight downwards trend in the landed catches. From 2000 through 2006 there was a 3.4 times increase in the landed catches to about 22 000 t. Preliminary data demonstrate that catches have declined to about 12 000 t in 2010 (Figure 4.2.2) and to a level below the TAC set for this area.

### 4.2.3 Ecosystem considerations

The ICES Subareas I and II are mainly represented by the Norwegian Sea and the Barents Sea. The underwater ridge between Scotland and Greenland is the main southern barrier for this area with average depth of 1600 m containing two deep basins of 3000–4000 m. The current systems in the Norwegian Sea is mainly dependent on the bottom topography; the warm Atlantic water transported into the Norwegian Sea resulting in relatively high temperatures in this area until it meets the cold and less salt water from the north. This creates distinct fronts which are closely related to bottom topography. The topography and large variations in depth gives a variated bottom fauna with large concentrations of coral reefs.

Along the coast of northern Norway and in the Norwegian Sea a large number of coral reefs have recently been discovered. These are *Lophelia* reefs that represent an important natural resource with a high associated biodiversity and great abundance of fish. To protect the coral reefs from destruction by fishing activities the fishers have been urged to be careful when fishing close to the reefs. Five areas have also been closed to fisheries using towed gears, but longliners can fish in these areas.

Cold-water corals are particularly abundant along the Norwegian Continental shelf, between 200–400 m depths. Fosså *et al*., 2000 estimated that between 1500–2000 km$^2$ of the Norwegian EEZ is covered by this habitat. Recent surveys using ROVs and manned submersibles have also found dense populations of gorgonian corals *Paragorgia arborea* and *Primnoa resedaeformis* associated with *Lophelia pertusa* (ICES, 2006). These reefs represent an important natural resource with a high associated biodiversity and a high abundance of fish. However, it was estimated that between 30 and 50% of the Norwegian reef areas have been impacted by trawling (Fosså *et al*., 2000). A number of areas have been closed to towed fishing gears although longlining is still permitted. While such static gear has a smaller impact than trawling, increased intensity of such activity has the potential, over time, to cause significant damage through localized physical destruction of the coral structure from anchors and snagged gear.

A number of seamounts occur in these areas. Two are listed in the WGDEC 2006 Report, Eistla and Gjalp, both with summit depths below the daytime depth of the deep-scattering layer, but at depths shallower than 2000 m. Little is known about the fauna of these seamouts or the level of fishing activity, but such habitats are known generally to be areas where there are often higher levels of productivity with associated dense aggregations of fish.

### 4.2.4 Management measures

There is no regulation of the Norwegian fishery for ling, tusk and blue ling in Subareas I and II.

The total TAC for greater silver smelt in subarea I and II in 2010 was 12 111 t. The Norwegian greater silver smelt fishery has since 2007 been regulated by a Norwegian TAC. In addition, the EU sets TACs and quotas applicable to EC vessels fishing in community waters and international waters of Subarea I and II.

**Table 4.2.1. Overview of landings in Subareas I and II. * Preliminary data.**

| Species | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | | | | | | | | | | | | | | | | | | |
| ARGENTINES (*Argentina silus*) | 11 351 | 8390 | 9120 | 7741 | 8234 | 7913 | 6807 | 6775 | 6604 | 4463 | 8261 | 7163 | 6293 | 14 369 | 7407 | 8917 | 16 162 | 17 093 |
| BLUE LING (*Molva dypterigia*) | 3537 | 2058 | 1412 | 1479 | 1039 | 1020 | 422 | 364 | 267 | 292 | 279 | 292 | 252 | 209 | 150 | 148 | 175 | 198 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | | | | | | | | | | | | | | | | | | |
| BLUEMOUTH (*Helicolenus dactylopterus*) | | | | | | | | | | | | | | | | | | |
| GREATER FORKBEARD (*Phycis blennoides*) | | | 23 | 39 | 33 | 1 | | | | | | | | 8 | 318 | 155 | 75 | 51 |
| LING (*Molva molva*) | 6126 | 7368 | 7628 | 7793 | 6521 | 7093 | 6322 | 5954 | 6346 | 5409 | 9200 | 7651 | 5964 | 4957 | 7132 | 6157 | 6560 | 6313 |
| MORIDAE | | | | | | | | | | | | | | | | | | |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | | | | | | | | | | | | | | | | | | |
| RABBITFISH (*Chimaerids*) | | | | | | | | | | | | 1 | 6 | 5 | 15 | 57 | 21 | 66 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | | | 589 | 829 | 424 | 136 | | | | 17 | 55 | | 48 | 94 | 29 | 77 | 79 | 77 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | | 22 | 49 | 72 | 52 | 15 | 15 | 7 | 2 | 106 | 100 | 46 | | 2 | 12 | 4 | 27 | 13 |
| RED (=BLACKSPOT) SEA BREAM (*Pagellus bogaraveo*) | | | | | | | | | | | | | | | | | | |
| SHARKS, VARIOUS | 37 | 15 | | | | | | | | | | | 1 | | | | | |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | | | | | | | | | | | | | | | | | | |
| SMOOTHHEADS (*Alepocephalidae*) | | | | | | | | | | | | | | | | | | |
| TUSK (*Brosme brosme*) | 14 403 | 19 350 | 18 628 | 18 306 | 15 974 | 17 585 | 12 566 | 11 617 | 12 795 | 9426 | 15 353 | 17 183 | 14 008 | 12 061 | 12 191 | 7940 | 7426 | 7050 |
| WRECKFISH (*Polyprion americanus*) | | | | | | | | | | | | | | | | | | |

**Table 4.2.1. Overview of landings in Subareas I and II, continued.**

| Species | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | | | | | |
| ARGENTINES (*Argentina silus*) | 21 685 | 13 273 | 11 876 | 11 929 | 11 843 |
| BLUE LING (*Molva dypterigia*) | 202 | 262 | 333 | 285 | 426 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | | | | | |
| BLUEMOUTH (*Helicolenus dactylopterus*) | | | | | |
| GREATER FORKBEARD (*Phycis blennoides*) | 49 | 47 | 117 | 76 | 128 |
| LING (*Molva molva*) | 8845 | 10 338 | 11 339 | 8400 | 10 476 |
| MORIDAE | | | | | |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | | | | | |
| RABBITFISH (*Chimaerids*) | 28 | 63 | 80 | 88 | 197 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | 78 | 50 | 55 | 53 | 45 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 8 | 12 | 9 | 9 | 21 |
| RED (=BLACKSPOT) SEA BREAM (*Pagellus bogaraveo*) | | | | | |
| SHARKS, VARIOUS | | | 1 | | |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | | | | | |
| SMOOTHHEADS (*Alepocephalidae*) | | | | | |
| TUSK (*Brosme brosme*) | 9988 | 10 744 | 11 883 | 9629 | 12 655 |
| WRECKFISH (*Polyprion americanus*) | | | | | |

**Table 4.2.2. Number of vessels exceeding 21 m in the Norwegian longliner fleet during the period 1995–2010.**

| Year | Number of longliners |
|---|---|
| 1995 | 65 |
| 1996 | 66 |
| 1997 | 65 |
| 1998 | 67 |
| 1999 | 71 |
| 2000 | 72 |
| 2001 | 65 |
| 2002 | 58 |
| 2003 | 52 |
| 2004 | 43 |
| 2005 | 39 |
| 2006 | 35 |
| 2007 | 38 |
| 2008 | 36 |
| 2009 | 34 |
| 2010 | 35 |

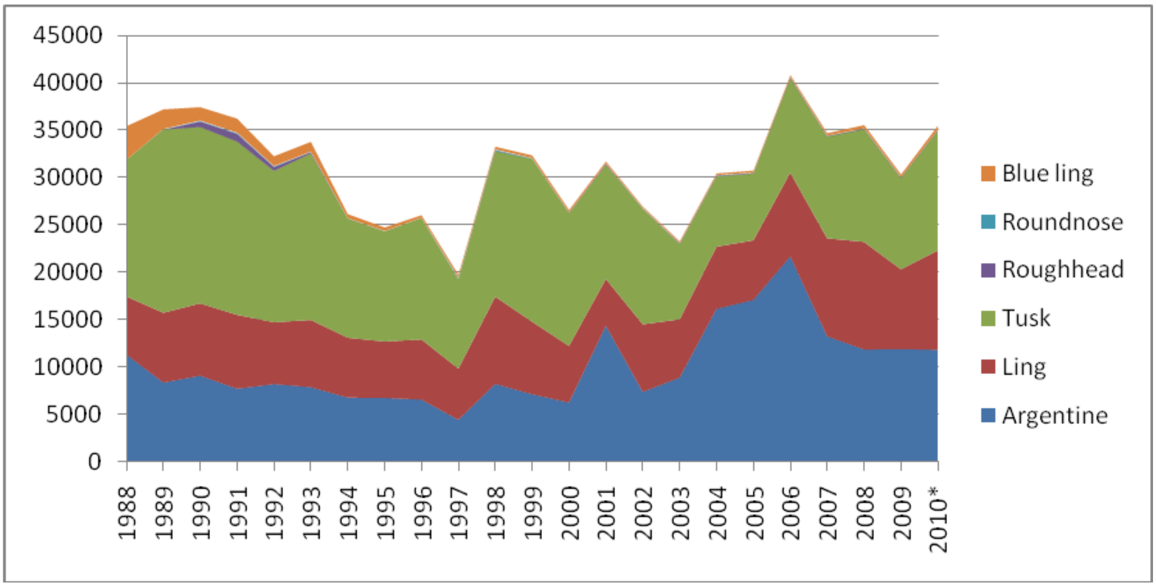



**Figure 4.2.1. Trends in the landings in Subareas I and II. Landings of roundnose and roughhead grenadier are insignificant in Subareas I and II. * Preliminary data.**

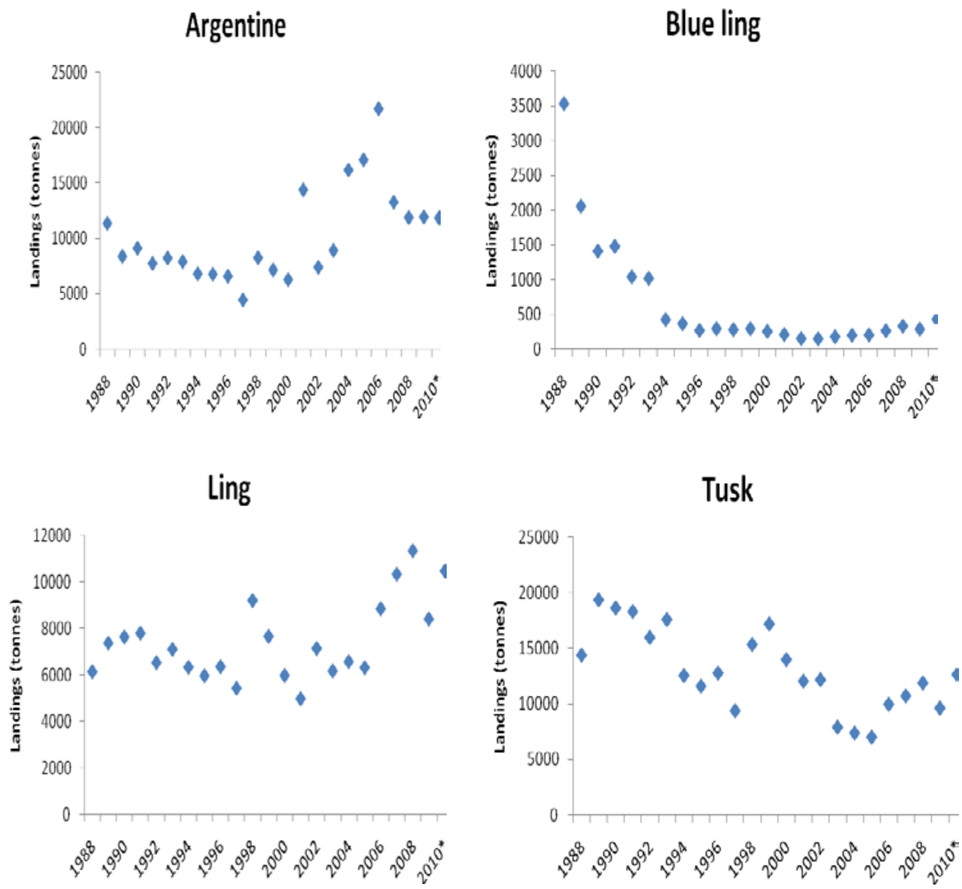



**Figure 4.2.2. Trends in the landings of argentines, tusk, ling and blue ling in Subareas I and II. Landings axex are in different scales. * Preliminary data.**

## 4.3 Stock and fisheries of the Faroes

This section could not be updated in 2011.

## 4.4 Stocks and fisheries of the Celtic Seas

### 4.4.1 Fisheries overview

Deep-water trawl fisheries are conducted in ICES Subareas VI and VII, principally by French, Irish Spanish and Scottish vessels until 2010, French vessels have operated a mixed deep-water fishery mainly targeting roundnose grenadier, black scabbardfish, blue ling and siki sharks on the continental slope and offshore banks of Subareas VI and VII. In the 1990s about 45 vessels from this fleet each landed more than 50 t of deep-water species (defined as species from Annex 1 of EC regulation 2347/2002) but this decreased in the 2000s to 18 t in 2007 and in 2008 (data for 2009–2010 are not available). Blue ling was the main target species from the early 1970s to the late 1980s; then fishing for roundnose grenadier, black scabbardfish and siki sharks developed. Some vessels from the same fleet also conducted a targeted fishery for orange roughy mainly in 1991–1992 in Division VIa and until mid-2000s in Subarea VII. Since 2003, the management (mainly TACs) has modified the fishing strategy of this fleet pushing it towards a more mixed activity between deep-water and shelf fishing. In 2003 and 2008 respectively, deep-water species made up 75% or more of the total landings in 39% and 25% of fishing days respectively.

The Irish deep-water fishery was based on the flat grounds and targeted orange roughy, black scabbard, roundnose grenadier and siki sharks. A number of Scottish vessels target monkfish (*Lophius spp)* on the continental slope of Subarea VIa and on the Rockall Bank. This fishery has a bycatch of deep-water species including ling, blue ling and siki sharks and a small number of these vessels occasionally fish in deeper water targeting roundnose grenadier, black scabbardfish and siki sharks. Spanish trawlers targeting hake in Subarea VII and VI (on Porcupine, Rockall and Great Sole Banks) have a bycatch of deep-water species including ling, blue ling, greater forkbeard and bluemouth redfish.

A fleet of 29 Spanish bottom freezer trawlers fish in the international waters of the Hatton Bank (ICES XIIb and VIb1). The presence of the majority of the vessels in this area is discontinuous. Vessels conduct fishing trips of variable duration. Fishing operations are conducted in a depth range of 800–1600 m, mainly at depths >1000 m or deeper. Roundnose grenadier and Baird's smoothhead (3000–13 000 t per year in 1997–2005) are the most important species in the catches. Black scabbardfish (1000 t in 2002, then decreasing) and blue ling (1200 t in 2002, 300 t in 2009) are also caught in significant amounts. Historical data on the catch and effort of this fleet have been problematic, and the Working Group considered that there was misreporting of species. For example, quantities of roughhead grenadier up to 5000 t per year were reported while this species is not known to occur. Significant improvement of the data available to the Working Group has been made in recent years and some inconsistencies have been resolved. However, effort data, and catch and effort data by ICES rectangle have not been available.

A fleet of UK registered gillnetters have, until recently, operated in Areas VI and VII targeting hake, monkfish and deep-water sharks, this fishery was stopped or seriously reduced as a result of regulation of deep-water gillnetting (see below, management measures).

UK registered longliners target hake with a bycatch of ling and blue ling.

There is a UK trap fishery for deep-water red crab *Chaceon affinis* in *S*ubarea VI and VII.

### 4.4.2 Trends in fisheries

Total landings with time of deep-water species from Sub-areas VI and VII are given in Table 4.4.1. The large decrease in 2003 was the result of the introduction of EU TACs for deep-water species. There are concerns that the actual reduction in landings for countries to comply with their application of the regulation may have been slower and newspapers reported the existence of fish landed illegally in the years considered, e.g. the following citation "*There is not one guy I know that can hold up their hand and say they haven't landed black fish. They are not doing this because they want to do it. They are doing this because they have to do it. Fishing is the lifeblood of the northeast [UK]. If you take it away, then the whole fabric of the community will crumble. The impact of the European quotas isn't a disaster waiting to happen, it's happening while I am talking to you* (Sunday Herald, 23 November 2003)" from Delaney *et al*. (2007).

Landings in 2009 and 2010 should be considered preliminary and Figure and Table 4.4.1 will be revised in 2012.

### 4.4.3 Technical interactions

Although a few of the French trawlers working in Subareas VI and VII are dedicated to deep-water fishing, the majority also fish on the continental shelf targeting saithe with a bycatch of other demersal species (megrim, monkfish). Landings of ling from this fleet also come mainly from fishing activity on the shelf or shelf break between 200 and 400 m. Vessels can move rapidly between fisheries and often target both deep-water and shelf species in the course of a single trip. None of the Scottish vessels fishing deep-water stocks is dedicated to deep-water trawling and vessels move between traditional fisheries for gadoid species on the shelf and in the North Sea, slope fisheries for monkfish and megrim, and genuine deep-water fisheries according to the availability of fishing opportunities. The Scottish bottom-trawl fishery targeting monkfish and megrim extends to depths of 800 m or more and has a bycatch deep-water species.

Although considered as deep-water species by WGDEEP, the depth range of ling, tusk and greater forkbeard in Subareas VI and VII extends onto the continental shelf and large quantities of these species are caught by a number of fleets and a variety of gears. Juveniles of some of the species considered by this WG are distributed in relatively shallow water and so are caught and discarded by other fisheries. This particularly applies to bluemouth redfish, which is discarded in large quantities by vessels fishing on the continental shelf in Division VIa and on the Rockall Bank in Sub-area VII, and to greater forkbeard in Subarea VII. Before the collapse of the stock red sea bream also occurred on the shelf and juveniles were coastal in summer (Lorance, 2010).

As a consequence of regulations banning deep-water gillnetting below 600 m, interactions of the UK gillnet fishery with deep-water species are small.

The Spanish fleet fishing on the Hatton Bank is not exclusive to this area and also works on a variety of grounds in the NE and NW Atlantic.

### 4.4.4 Ecosystem considerations

The Rockall Trough lies in Subarea VI to the west of Scotland and Ireland and is bounded to the north by the Wyville Ridge at a depth of about 500 m. This is a major faunal barrier and there is little similarity between the fish assemblages on either side of the ridge (Bergstad *et al.*, 1999; Gordon, 2001). To the west and northwest, the Rockall Trough is separated from the Icelandic basin by the Rockall Plateau and a chain of northern banks including the Rosemary, Bill Bailey and Hatton. To the west of Ireland the slope on the western edge of the Porcupine Bank is steep, while to the south, the Porcupine Seabight has more gentle slopes. The fish populations have been relatively well described in this region compared with other deep-water areas (e.g. Gordon and Duncan, 1985a, b; Gordon, 1986; Gordon and Bergstad, 1992). At depths between about 400 and 1500 m there may be between 40 and 50 demersal species present depending on gear type. Maximum species diversity occurs between 1000–1500 m before declining markedly with depth.

Some deep-water species are slow growing, long-lived, late maturing and have low fecundity. Orange roughy is so far the most extreme example of the slow growing species. Some other deep-water species such as greater forkbeard and black scabbardfish are much faster growing and blue ling is considered to have a typical gadoid life history. Therefore, deep-water species display a wide diversity of life-history characteristics.

Fishing has a stronger impact on species with low population productivity (Jennings *et al.*, 1998; Jennings *et al.*, 1999), making them particularly vulnerable to overexploitation. This applies to both the target and non-target species. A large proportion of deep-water trawl catches (upwards of 50%) can consist of unpalatable species and numerous small species, including juveniles of the target species, which are usually discarded (Allain *et al*., 2003). The main species in the discards of the trawl fishery in by far the Baird's smoothhead (*Alepocephalus bairdii*) however, a large number of other non-marketable bentho-pelagic species are discarded. The survival of these discards is unknown, but considered to be virtually zero because of fragility of these species and the effects of pressure changes during retrieval (Gordon, 2001). Therefore such fisheries tend to deplete the whole fish community biomass. Depletion of dominant species can induce major changes to fish communities through removal of key predatory or forage species. A study of the impacts of deep-water fishing to the west of Britain using historical survey data found some evidence of changes in size spectra and a decline in species diversity between pre- and post-exploitation data, but the scarce and unbalanced nature of the time-series hampered firm conclusions (Basson *et al*., 2001). A presence/absence analyses indicated a very likely decline in the abundance of the Portuguese dogfish since the 1980s, which was consistent with stock assessments of this species. Deep-water sharks, which demonstrate a greater diversity on the slope compared with continental shelf at temperate latitudes, are important predators and their removal through targeted fisheries and bycatch in trawl fisheries for other species such as roundnose grenadier is likely to have a major impact on the ecosystem. Although at a worldwide scale there are more shark species in shallow waters than at slope depths. In the Northeast Atlantic and the Mediterranean the species richness of demersal sharks is higher along the slope (35 deep-water speciesvs.22 occurring on the shelf). In contrast, ray species are more numerous on the shelf. Rays are caught in small numbers by deep-waters fisheries. As rather rare species they may be severely impacted by fishing but this is difficult to assess because as rare species, they would require high sampling intensity. Lastly, chimaeras (five species) form a third group of *Chondrichthyans*, whose life-history and populations dynamics are poorly known and which occur only in deep water.

The DEEPFISH project carried out trophic web modelling using Ecopath with Ecosym (EwE). The model reflected well the reported declining trend in biomass for most fish species since the onset of fishing. The model was used to make predictions on the future of the fishery if fishing is sustained at the 2009 levels to 2020. The model suggests that current TACs should lead to recovery of some species (roundnose grenadier, deep-water sharks), while for others the TAC would need to be lowered further still (black scabbardfish). For other species (blue ling, orange roughy) results were unreliable. In order to demonstrate the benefits of taking an ecosystem view of the fishery, the model was used to investigate interactions between fish and fisheries in the model area. The hypothetical removal of the blue whiting fishery from 2007 to 2020 revealed the importance of this species in the diet of many demersal fish species and the importance of interactions between the blue whiting and demersal fisheries (Howell *et al*., 2009).

The effects of fishing on the benthic habitat relate to the physical disturbance by the gear used. This includes the removal of physical features, reduction in complexity of habitat structure and resuspension of sediment. Benthic fauna in deep waters are understood to be diverse but of low productivity. Little information is available on the effects of trawling on deep-sea soft sediment habitats. Cryer *et al*., 2002 used a suite of multivariate analyses to infer that trawling probably changes benthic community structure and reduces biodiversity over broad spatial scales on the continental slope in a similar fashion to coastal systems. More attention has been paid to biogenic habitat that occurs along the slope, mainly the cold-water corals, which, in the Northeast Atlantic include the azooxanthellate scleractinarian corals *Lophelia pertusa*, *Madrepora oculata*, *Solenosmilia variabilis*, *Desmophyllum cristagalli,* and *Enallopsammia rostrata*. The main reef building species is *L. pertusa*. The other coral species often occur in association with *L. pertusa* and none has been found forming reefs without *L. pertusa* being present.

No exhaustive description of the distribution of *L. pertusa* exists, but it is found on the continental slopes off Norway, Iceland, Faroes, the UK, France, Spain and Portugal as well as the Mid-Atlantic Ridge (ICES, 2003; 2004 and 2005; Rogers, 1999). The extent of individual reefs varies. Some biogenic seamounts are reported to be up to 200 m high and several km long (Rogers, 1999; Freiwald *et al.*, 1999). A dense and diverse range of megafauna are associated with *Lophelia* reefs. This includes fixed (anthipatarians, gorgonians, sponges) and mobile invertebrates (echinoderms, crustaceans). The species richness of macrofauna associated to coral reefs has been found to be up to three times higher than on surrounding sedimentary seabed (Mortensen *et al.*, 1995). Several species of deep-water fish occur associated with corals, some in more abundance than in surrounding non-coral areas, but the functional links between fish and coral are still to be fully elucidated. However, it is accepted that structurally complex habitats such as corals, offer a greater diversity of food and physical shelter to fish and other macrofauna.

Other deep-water biogenic habitats with structures that stand proud of the seabed include sponge and xenophyophore fields, seafans and seapens (octocorals). Any long-lived sessile organisms that stand proud of the seabed will be highly vulnerable to destruction by towed demersal fishing gear. There are a number of documented reports of damage to *Lophelia* reefs in various parts of the Northeast Atlantic by trawl gear where trawl scars and coral rubble have been observed (e.g. Hall- Spencer, *et al.*, 2002). Damage can also be caused on a smaller scale by static gears such as gillnets and longlines (Grehan *et al*., 2003). The degree of this damage depends on fishing effort (ICES, 2007b). The recovery rates for damaged coral are likely to be extremely slow (Risk, 2002).

In Divisions VI, VII and XIIb there are a number of known areas of cold-water corals. These include the shelf break to the west and north of Scotland, Rockall Bank, Hatton Bank and the Porcupine Bank. The best known site is the Darwin Mounds, located at 1000 m to the south of the Wyville Thompson Ridge. Some of these areas have been heavily impacted by deep-water trawling activities (Hall-Spencer, 2002; Grehan *et al.*, 2003). In 2005, WGDEC recommended a number of areas on Rockall that would be appropriate to closure to protect cold-water corals from trawling activity. The choice of these sites was based on examination of scientific and anecdotal fishers' records of coral occurrence and VMS data indicating where fishing activity occurred.

Seamounts are widely recognized to be areas of high productivity where dense aggregations of fish can occur. The special hydrographic conditions and good availability of hard bottom are favourable for sessile suspension-feeders, which often dominate the community on seamounts (Genin *et al*., 1986). Within ICES Area VI there are three documented seamounts; Rosemary, Anton Dohrn and Hebrides Terrace. The first two of these have summits above the daytime depth of the deep scattering layer. These seamounts have been exploited since the 1990s, probably by vessels fishing for the orange roughy. As physical structure, seamounts per se are not threatened by fishing. Threats and impacts are most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself (OSPAR Commission, 2010).

As a consequence of the reduction in TACs, the number of vessels and the level of fishing have decreased. Because the quotas are restrictive, the incentive to explore new fishing ground is minimized and trawlers fish repeatedly on the same trawl tracks, where the available quotas can be fished without risk to the fishing gears.

Some fleet also operate mainly on sedimentary bottom such as the slope to the west of Scotland (eastern side of the Rockall Trough).

### 4.4.5 Management measures

Under Council Regulation (EC) No 2347/2002, Member States must ensure that fishing activities which lead to catches and retention on board of more than 10 t each calendar year of deep-sea species by vessels flying their flag and registered in their territory are subject to a deep-sea fishing permit. Member states are obliged to calculate the aggregate power and the aggregate volume of their vessels, which, in any one of the years 1998, 1999 or 2000, landed more than 10 t of any mixture of the deep-sea species. The aggregate volume of vessels holding deep-sea fishing permits may not exceed this figure.

Council Regulation (EC) No 27/2005 obliged Member States to ensure that, for 2005, the fishing effort levels, measured in kilowatt days absent from port, by vessels holding deep-sea fishing permits did not exceed 90% of the average annual fishing effort deployed by that Member State's vessels in 2003 on trips when deep-sea fishing permits were held and deep-sea species were caught. For 2006 this limit was further reduced to 80% of 2003 levels.

Council Regulation (EC) No 51/2006 banned the use of gillnets by Community vessels at depths greater than 200 m in ICES Divisions VIa,b and VIIb,c,j,k. In 2006 a derogation was introduced allowing the setting of gillnets with mesh sizes between 120 and 150 mm down to depths of 600 m. In 2008, this measure was extended to cover Subareas III and IV.

Landings of the main deep-water species caught in Subareas VI and VII are managed by EU TACs since 2003 for black scabbardfish, argentine, tusk, blue ling, ling, roundnose grenadier, orange roughy and blackspot sea bream (EC regulation n° 2340/20024 of the council of 16 December 2002). In 2005, TACs were introduced for deep-water sharks and greater forkbeard (EC regulation n° 2270/2004 of the council of 22 December 2004). TACs are revised every second year. They were reduced at each revision (for 2005/2006, 2007/2008 and 2009/2010). Zero TACs are currently set for orange roughy and for deep-sea sharks from 2010.

From 2009, EU-TACs for blue ling and greater silver smelt in Subareas, II, IV, V, VI and VII are set within the annual TAC regulation because the TAC level depends upon annual negotiation between Norway and EU.

From 2009, in order to protect the spawning aggregations of blue ling in the ICES Subarea VIa, some areas have been defined were fishing for blue ling is strongly limited (vessels should not keep more than 6 t of blue ling per trip) from 1st of March to May 31.

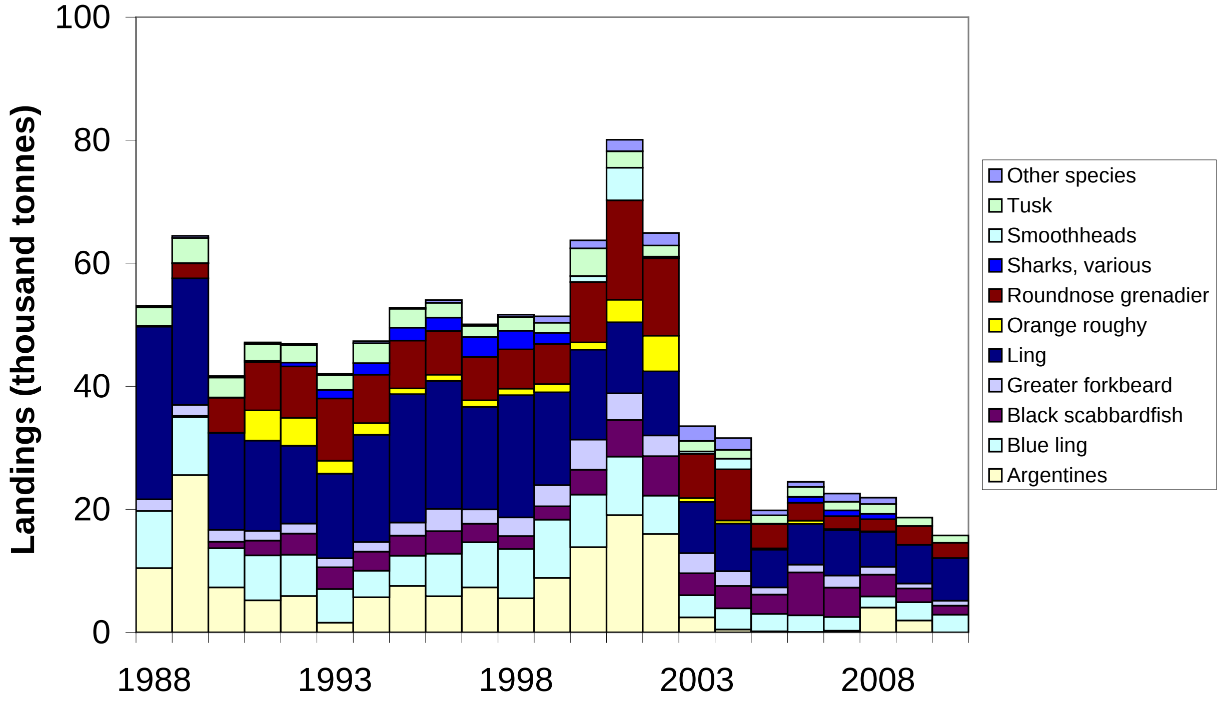



**Figure 4.4.1. Landings of deep-water species from Subareas VI and VII.**

**Table 4.4.1. Deep-sea landings in Division VI and VII.**

| Species | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alfonsinos | | 12 | 8 | | 3 | 1 | 5 | 3 | 178 | 25 | 81 | 75 | 133 | 186 | 94 | 82 | 62 | 15 | 0 | 64 | 22 | ?? | ?? |
| Argentines | 10 438 | 25 559 | 7294 | 5197 | 5906 | 1577 | 5707 | 7546 | 5863 | 7301 | 5555 | 8856 | 13 863 | 19 050 | 15 985 | 2444 | 480 | 178 | 55 | 257 | 4035 | 1932 | ?? |
| Blue ling | 9285 | 9434 | 6396 | 7319 | 6697 | 5471 | 4309 | 4892 | 6928 | 7361 | 8004 | 9472 | 8525 | 9534 | 6252 | 3605 | 3437 | 2839 | 2705 | 2257 | 1820 | 2974 | 2866 |
| Black scabbardfish | 0 | 184.3 | 1034 | 2401 | 3436 | 3530 | 3098 | 3275 | 3678 | 2996 | 2100 | 2178 | 4038 | 5932 | 6407 | 3571 | 3623 | 3112 | 6971 | 4761 | 3527 | 2241 | 1488 |
| Bluemouth | | 127 | 100 | 128 | 159 | 152 | 117 | 71 | 87 | 88 | 145 | 354 | 332 | 279 | 196 | 397 | 433 | 43 | 35 | 338 | 105 | ?? | ?? |
| Deep-water cardinal fish | | | | | | 30 | 217 | 91 | 45 | 49 | 115 | 258 | 287 | 385 | 974 | 1075 | 869 | 684 | 330 | 226 | 23 | ?? | ?? |
| Greater forkbeard | 1898 | 1815 | 1921 | 1574 | 1640 | 1462 | 1571 | 2138 | 3590 | 2335 | 3040 | 3430 | 4919 | 4349 | 3352 | 3257 | 2400 | 1176 | 1298 | 1974 | 1271 | 796 | 772 |
| Ling | 28 092 | 20 545 | 15 766 | 14 684 | 12 671 | 13 763 | 17 439 | 20 856 | 20 838 | 16 668 | 19 863 | 15 087 | 14 613 | 11 528 | 10 435 | 8321 | 7762 | 6154 | 6605 | 7366 | 5665 | 6280 | 6948 |
| Moridae | | | | 1 | 25 | | | | | | | 20 | 146 | 190 | 158 | 327 | 71 | 0 | 3 | 64 | 481 | ?? | ?? |
| Orange roughy | | 8 | 17 | 4908 | 4523 | 2097 | 1901 | 947 | 995 | 1039 | 1071 | 1337 | 1158 | 3692 | 5788 | 622 | 490 | 206 | 521 | 185 | 94 | ?? | ?? |
| Rabbitfish | | | | | | | 2 | | | | | 236 | 355 | 722 | 573 | 474 | 433 | 6 | 24 | 391 | 353 | ?? | ?? |
| Roughhead grenadier | | | | | | 18 | 5 | 4 | 13 | 12 | 10 | 34 | 10 | 44 | 19 | 12 | 13 | 2 | 75 | 39 | 6 | ?? | ?? |
| Roundnose grenadier | 32 | 2440 | 5730 | 7793 | 8338 | 10 121 | 7860 | 7767 | 7095 | 7070 | 6364 | 6538 | 9815 | 16 127 | 12 596 | 7185 | 8297 | 3940 | 2901 | 2078 | 1990 | 3071 | 2468 |
| Blackspot sea bream | 252 | 189 | 134 | 123 | 40 | 22 | 10 | 11 | 29 | 56 | 17 | 23 | 20 | 51 | 25 | 38 | 31 | 36 | 54 | 135 | 56 | ?? | ?? |
| Sharks, various | 85 | 40 | 43 | 254 | 639 | 1392 | 1864 | 2099 | 2176 | 3240 | 3023 | 1791 | 8 | | 1 | | | | 956 | 948 | 849 | ?? | 0 |
| Silver scabbardfish | | | | | | 2 | | | | | | 18 | 15 | | 1 | | | | 342 | 67 | 0 | ?? | ?? |
| Smoothheads | | | | 31 | 17 | | | | | | | | 978 | 5305 | 260 | 393 | 1765 | 45 | 3 | 0 | 3 | ?? | ?? |
| Tusk | 3002 | 4086 | 3216 | 2719 | 2817 | 2378 | 3233 | 3085 | 2417 | 1832 | 2240 | 1647 | 4504 | 2688 | 1794 | 1719 | 1411 | 1386 | 1601 | 1398 | 1594 | 1350 | 1217 |
| Wreckfish | 7 | | 2 | 10 | 15 | | | | 83 | | 12 | 14 | 14 | 17 | 9 | 2 | 2 | | | 2 | 3 | ?? | ?? |

## 4.5 North Sea (IIIa and IV)

### 4.5.1 Fisheries overview

### 4.5.2 Trends in fisheries

An overview of total landings is shown in Figure 4.5.1 and Table 4.5.1. At present, the main fisheries currently targeting deep-sea species in the IIIa and IV are the following:

- Bycatches of ling and tusk are taken in the U.K. demersal trawl fisheries.
- Fisheries for deep-sea shrimp (*Pandalus borealis*) carried out by Denmark, Norway and Sweden in Skagerrak (IIIa) and in the Norwegian Deep in the eastern part of the northern North Sea (IVa). The gears (trawls) used in these fisheries are small meshed (mesh size 35–45 mm). Bycatches of deep-sea fish species, such as anglerfish, tusk, ling and witch flounder, are also landed. Also bycatches of roundnose grenadier in this fishery have occasionally been landed for reduction, depending on the quantities. Introduction of sorting grids in recent years has probably reduced the amounts of some of this by-catch. Further information on the shrimp fisheries and their bycatches is found in the Reports of NIPAG (NAFO-ICES *Pandalus* Assessment Group).
- Bottom-trawl fisheries by Denmark and Norway and UK mainly in the northern and northeastern North Sea directed at mixed demersal species including ling, tusk and anglerfish and *Nephrops*.
- Minor fisheries in Skagerrak (IIIa) by Denmark and Sweden targeting witch flounder. These are mainly trawl fisheries, but also Danish seine has been used. Further information is found in ICES WGNEW Report (ICES 2010b).
- A Danish trawl fishery directed for roundnose grenadier in the deeper parts of Skagerrak was carried out by very few vessels from the 1980s up to 2006.
- Previously directed mid-water trawl fisheries for greater silver smelt in IVa were conducted, mainly from Norway. Today this species is caught only as bycatch in this area.

Table 4.5.2 gives an overview of the 2009 landings by country for the area.

#### The fishery for roundnose grenadier in Skagerrak

As mentioned above, minor catches of roundnose grenadier are taken as bycatch by shrimp (*Pandalus*) trawlers in IIIa (Skagerrak) and occasionally landed (mainly for reduction). However, from the late 1980s until 2006 a Danish directed fishery for roundnose grenadier was conducted in the deeper part of Skagerrak at depths of 400–650 m. The geographical area of exploitation was very small, constituting only few ICES rectangles. This fishery for roundnose grenadier began in 1987 as an exploratory fishery, following exploratory efforts by Denmark and Norway for new fish resources in the 1980s. However, in Norway and Sweden directed fisheries for this species never developed.

During most of the period up to 2002, the Danish directed fishery has mainly been conducted by the same single vessel accounting for more than 80% of the total landings. The gear (trawl) used was characterised by a mesh size <70 mm in the codend, most often 55 mm. Vessel sizes were around 30 m. Due to the prevailing market conditions the majority of the catch was landed for oil and meal. Almost all catches were landed in ports of Hirtshals and Skagen. In 2006 the economic value of the landings was around €225 000.

The development of this fishery during the recent decade has been remarkable considering the small area. From a level of around 2000 t up to 2002, taken by a mainly a single vessel, total landings increased to nearly 12 000 t in 2005. Landings decreased, however, in 2006 to around 2300 tons due to catch restrictions following a revised EU Norway agreement aimed at this fishery. A total of only 2–3 vessels participated significantly in the fishery during the period of peak catches, 2002–2005. Since 2007 there has been no directed fishery for roundnose grenadier in Division IIIa, not because of the catch restrictions introduced in 2006 or signs of stock decline, but because the remaining single fisher retired without any successors.

### 4.5.3 Technical interactions

The mixed demersal trawl fisheries are directed at roundfish species (cod, saithe, ling and tusk). A considerable part of these fisheries are carried out in the Norwegian Deep within the Norwegian EEZ. Anglerfish and *Nephrops* also constitute a significant part of the catches from this area.

The fishery for *Pandalus* is classified as a small mesh fishery and the bycatch landings are restricted by the general 10% (by weight) regulation. Apart from the bycatch of the deep-sea species mentioned above, bycatches of cod, ling and saithe are common in this fishery.

The above mentioned directed fishery for roundnose grenadier exploited the aggregations of this species in the deepest part of Skagerrak, and the reported bycatch in this fishery was rather insignificant, consisting of greater silversmelt, rabbitfish, blue ling and lantern shark.

### 4.5.4 Ecosystem considerations

The deep waters of Division IIIa and Subarea IV are small and geographically isolated from other deep-sea areas. It is likely that the deep-water fauna in this region, such as roundnose grenadier, constitute separate stocks to those in the North Atlantic (Bergstad, 1990; Bergstad and Gordon, 1994; Mauchline *et al*., 1994; Bergstad *et al*., 2003), and could therefore be particularly vulnerable to localized population depletion through heavy exploitation, see Section 10.3. There are a number sites in the northeast Skagerrak where the cold-water coral, *Lophelia pertusa* are known from and recent observations have suggested that some have been destroyed or severely damaged by trawling activities in relatively recent times (Lundälv and Jonsson, 2003). This damage was thought likely to be caused by trawling for *Pandalus borealis*.

### 4.5.5 Management measures

#### Management of fisheries in IIIa

ICES Subdivision IIIa is shared between the EU and Norway. However, according to the trilateral treaty between Denmark, Norway and Sweden (Skagerrak Treaty) fishing vessels from each of the three countries may operate freely in each country's waters. The Skagerrak treaty of 1966 expires in summer 2012. Normally, bilateral EU–Norway agreements on the shares of TACs for the exploited fish stocks are the basis for further national management of the fisheries in IIIa. The special case of the management of the Danish fishery for roundnose grenadier in IIIa and the development of this fishery in 2006 and 2007 is described in Section 10.3.

### Management of fisheries in IV

The North Sea is shared between the EU and Norway, and consequently fisheries in the EU zone are managed according to EU regulations, while the fisheries in the Norwegian zone IV are managed according to Norwegian regulations following the EU–Norway negotiations.

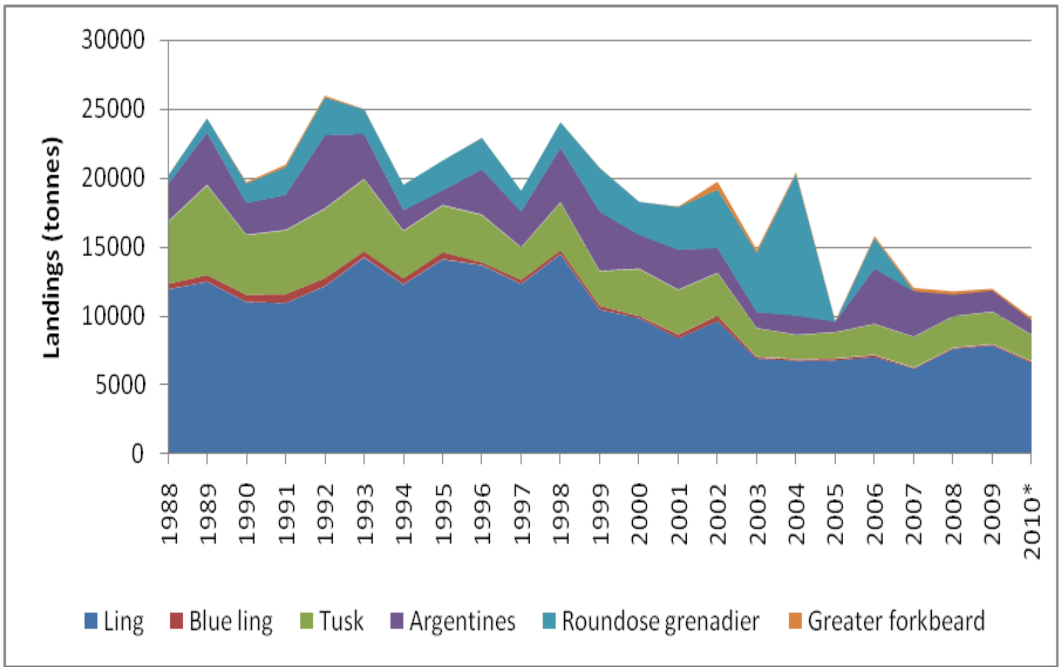



**Figure 4.5.1. Overview of deep-sea species landings, over 1988–2010 (tonnes).**

**Table 4.5.1. Landings of Deep-sea species in Division III and IV, 1997–2010.**

| Species | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | | | | | | | | | | | 0 | 0 | 0 |
| ARGENTINES (*Argentina silus*) | 2598 | 3982 | 4319 | 2471 | 2925 | 1811 | 1166 | 1105 | 1021 | 4018 | 3343 | 1571 | 1572 |
| BLUE LING (*Molva dypterigia*) | 291 | 292 | 271 | 144 | 276 | 386 | 120 | 94 | 115 | 138 | 63 | 83 | 81 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | 2 | 9 | 7 | 5 | 12 | 24 | 4 | 4 | 2 | 13 | 1 | 0 | 4 |
| BLUEMOUTH (*Helicolenus dactylopterus*) | 1 | | 8 | | | | | 2 | 0 | | 0 | 0 | 0 |
| GREATER FORKBEARD (*Phycis blennoides*) | 7 | 12 | 31 | 11 | 26 | 585 | 233 | 142 | 88 | 142 | 239 | 245 | 146 |
| LING (*Molva molva*) | 12 325 | 14 472 | 10 472 | 9858 | 8396 | 9642 | 6928 | 6770 | 6653 | 6918 | 6060 | 7512 | 7702 |
| MORIDAE | | | | | | | | | | 0 | 0 | 0 | 0 |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | | | | | | | | | 0 | 0 | 14 | 0 | 0 |
| RABBITFISH (*Chimaerids*) | 38 | 56 | 45 | 33 | 20 | 24 | 25 | 40 | 168 | 14 | 18 | 21 | 7 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | 5 | 1 | | 4 | 10 | 3 | 2 | 1 | 38 | | 0 | 0 | 0 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 1533 | 1854 | 3187 | 2406 | 3121 | 4258 | 4319 | 10 267 | 11 942 | 2272 | 26 | 1 | 2 |
| RED (=BLACKSPOT) SEA BREAM (*Pagellus bogaraveo*) | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SHARKS, VARIOUS | 32 | 359 | 201 | 36 | 62 | | | | 16 | 22 | 22 | 56 | 10 |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | | | | | | | | | | | 0 | 0 | 0 |
| SMOOTHHEADS (*Alepocephalidae*) | | | | | | | | | | | 0 | 0 | 0 |
| TUSK (*Brosme brosme*) | 2341 | 3474 | 2498 | 3411 | 3204 | 3082 | 2056 | 1733 | 1839 | 2204 | 2199 | 2251 | 2282 |
| WRECKFISH (*Polyprion americanus*) | | | | | | | | | | | 0 | 0 | 0 |

**Table 4.5.1. Continued.**

| Species | 2010 |
|---|---|
| ALFONSINOS (*Beryx* spp.) | |
| ARGENTINES (*Argentina silus*) | 1081 |
| BLUE LING (*Molva dypterigia*) | 124 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | |
| BLUEMOUTH (*Helicolenus dactylopterus*) | |
| GREATER FORKBEARD (*Phycis blennoides*) | 182 |
| LING (*Molva molva*) | 6609 |
| MORIDAE | |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | |
| RABBITFISH (*Chimaerids*) | 22 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 8 |
| RED (=BLACKSPOT) SEA BREAM (*Pagellus bogaraveo*) | |
| SHARKS, VARIOUS | 1 |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | |
| SMOOTHHEADS (*Alepocephalidae*) | |
| TUSK (*Brosme brosme*) | 2282 |
| WRECKFISH (*Polyprion americanus*) | |

**Table 4.5.2. Landings (t) by country, division and species in 2010 for Division IIIa and Subarea IV.**

| Country | Division | Greater Silver smelt | Blue Ling | Ling | Roundnose Grenadier | Tusk | Witch Flounder | Lantern sharks | Rabbitfish | Sharks | Greater forkbeard | Others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DK | III a | 0 | 0 | 58 | 1 | 1 | 537 | 0 | 1 | | | |
| | IV a | 47 | 1 | 433 | 0 | 36 | 173 | 4 | 0 | | | |
| | IV b | 0 | 0 | 55 | 0 | 1 | 76 | 0 | 0 | | | |
| | IV c | | | 0 | | | | 0 | 0 | | | |
| UK-E+W | | | | | | | | | | | | |
| | IVa | | | 27 | | 8 | | | | | | |
| | IVb | | | 25 | | | | | | | | 0 |
| | IVc | | | | | | | | | | | |
| UK-Scot | | | | | | | | | | | | |
| | IVa | | 21 | 2008 | + | 76 | | | | 1 | 1 | + |
| | IVb | | | 18 | | 1 | | | | | + | + |
| | IVc | | | | | | | | | | | |
| FRO | | | | | | | | | | | | |
| | IVa | | | + | | + | | | | | | |
| | IVb | | | | | | | | | | | |
| | IVc | | | | | | | | | | | |
| NOR | | | | | | | | | | | | |
| | IIIa | 0 | 0 | 64 | 0 | 17 | | | 0 | | | |
| | IVa | 1032 | 101 | 3836 | 0 | 1734 | | | 21 | | 181 | |
| | IVb | 2 | | 50 | | 13 | | | 0 | | | |
| | IVc | | | | | | | | | | | |
| FRA | | | | | | | | | | | | |
| | IVa | | 1 | 43 | 6 | 3 | | | 0 | | 3 | |
| | IVb | | | | 0 | 1 | | | 0 | | 1 | |
| | IVc | | | 0 | | | | | | | | |
| | | 1081 | 124 | 6609 | 8 | 1889 | 786 | 4 | 22 | 1 | 182 | |

## 4.6 Stocks and fisheries of the South European Atlantic Shelf

### 4.6.1 Fisheries overview

In ICES Subarea VIII there are two main Spanish fishing fleets defining the fisheries:

- The trawl fishery targets species such as hake, megrim, anglerfish, and *Nephrops* but also has variable bycatch of deep-water species. These include *Molva spp.*, *Phycis phycis*, *Phycis blennoides*, *Conger conger*, *Helicolenus dactylopterus*, *Polyprion americanus*, *Beryx* spp and *Pagellus bogaraveo*.
- Longline fishery mainly targets deep-water species such as conger, greater forkbeard, deep-water sharks and ling.

The French trawler fishery mainly targets demersal and pelagic species on the shelf with a small bycatch of deep-water species such as bluemouth and greater forkbeard. To the north of Subarea VIII, a small handline fishery targeting mainly bass and pollack (*Pollachius pollachius*) has a bycatch of red (blackspot) seabream. Until 2009, some landings of orange roughy caught to the north of Subarea VIII have occurred, from artisanal trawlers targeting this species. This activity was stopped in 2010 due to 0 quota.

In ICES Subarea IX there is a main directed Portuguese longline fishery for black scabbard fish (*Aphanopus carbo*) with a bycatch of the deep-water sharks, and also a Spanish longline (Voracera) fishery for *Pagellus bogaraveo*. There is also a bottom-trawl fishery at the southern part of the Portuguese continental coastal, targeting crustaceans, some on deeper grounds such as *Nephrops norvegicus* and *Aristeus antennatus*. Typical bycatch species of this fishery are: bluemouth (*Helicolenus dactylopterus*), greater forkbeard, conger eel (*Conger conger*), blackmouth dogfish (*Galeus melastomus*), kitefin shark (*Dalatias licha*), and gulper shark (*Centrophorus squamosus*).

There has been a small expansion of UK (England and Wales) gillnet fisheries into Subareas VIII and IX. In Subarea VIII landings are on a small scale.

### 4.6.2 Trends in fisheries

Although since 1988 from six to seventeen deep species are usually landed in Areas VIII and IX, the catches of *Aphanopus carbo* (46%) *Lepidopus caudatus* (20%) *Pagellus bogaraveo* (11%), *Molva molva* (10%), *Phycis blennoides* (5%), *Polyprion americanus* (4%), *Beryx* spp (1%), *Helicolenus dactylopterus* (1%) and *Argentina sphiraena* (1%) represent on average the 97% of total subareas' landings.

Since 1988 an average of 7144 t of these species has been landed from these subareas, but in 1995 an important peak of 12 678 t is observed due to an increase of *L. caudatus* landings in Subarea IX (Table 4.6.1).

#### Black scabbardfish (*Aphanopus carbo*) and silver scabbardfish (*Lepidopus caudatus*)

*Aphanopus carb*o and *Lepidopus caudatus* are the main species landed in both subareas combined, but most of *A. carbo* and *L. caudatus* landings come from Subarea IX. Landings of black scabbard fish never has been lower than 2400 t/year, and in 1993 reached its highest value (4524 t). Since this year the trend indicates a decrease until 2000 and after this year the average landings have been 2977 t/year.

The trend of silver scabbard fish landings is very variable over the period 1988–2006. Landings of this species have been always lower than those of black scabbardfish, except in 1995 when 5672 t were landed. In 2000 only 16 t were recorded. Landings in 2010 were 829 t (Figure 4.6.1).

#### Red Seabream (*Pagellus bogaraveo*) and Ling (*Molva molva*)

Since the collapse of the Bay of Biscay stock in the early 1980s, the main landings of red seabream since 1988 come from Subarea IX. On the European Atlantic Shelf from 1988 to 1998 the annual landings range from between 666 to 1175 t (average 958 t). From 1999 to 2010 the annual landings average 627 t.

Almost the 100% of total landings of ling come from Subarea VIII. The series shows a continuous decrease of catches from 1991 to 1994. Since this year a clear increase is observed reaching a peak in 1998 (1799 t). However since 1998 landings have decreased strongly (Figure 4.6.1).

**Geater forkbeard (*Phycis blennoides*), Wreckfish (*Polyprion americanus*) and Alfonsinos (*Beryx* spp.)**

Since 1998, 97% of greater forkbeard landings on the southern European Atlantic shelf are from Subarea VIII. The landings in the combined areas show a clear increase from 1988 to 1998, and although the peak in 1998 has been never reached again, the average of landings from 1999 onwards has been 384 t/year.

Wreckfish landings do not show a persistent trend and have been variable between around 100 and 500 t annually.

The most important landings of Alfonsinos in Subareas VIII and IX have been recorded since 1995. From 1995 to 2004 an increasing landings trend is observed but since then landings have decreased to only 38 t in 2010 (Table 4.6.1).

**Deep–water red crab (*Chaceon* spp.)**

The fishery of this species started in 2006 and disappeared from landings in 2008. In these two years 388 t were landed from these Subareas. The main bycatch of this new fishery in 2006 was deep-water sharks.

### 4.6.3 Technical interactions

An update of the information of gear interaction of Spanish fleet fishing deep-water species during the period 2005–2010 is shown in Table 4.6.2.

### 4.6.4 Ecosystem considerations

Deep-water conditions are more conducive to net loss, and there is strong evidence of net dumping and significant levels of ghost fishing in the deep-water northeast Atlantic fishery for monkfish. There is a need to evaluate the scale of this problem in Subareas VIII and IX.

In Subarea VIII there are historical records of impacts on deep-water ecosystems, in particular corals (Joubin, 1922).

### 4.6.5 Management measures

In 2009 and 2010 TACs for most deep-water species are set at lower levels than previous years, and a TAC 0 has been adopted in 2010 for some species such as orange roughy in Subareas I, II, III, IV, V, VIII, IX, X, XI, XII and XIV and deep-water sharks in V, VI, VII, VIII, IX and X). The ban on deep-water gillnetting in depths greater than 600 m does not apply to Subareas VIII and IX. There are no TACs or quotas for deep-water crab in Subareas VIII and IX.

**Table 4.6.1. Overview of landings in Subareas VIII and IX.**

| Species | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | | | 1 | | 1 | | 2 | 82 | 88 | 135 | 269 | 201 | 167 | 229 | 237 | 109 | 280 |
| ARGENTINES (*Argentina silus*) | | | | | | | | | | | | | | | 346 | 80 | 23 |
| BLUE LING (*Molva dypterigia*) | | | | | | | | | | 14 | 33 | 4 | 4 | 6 | 29 | 22 | 22 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | 2602 | 3473 | 3274 | 3979 | 4398 | 4524 | 3434 | 4272 | 3689 | 3555 | 3152 | 2752 | 2404 | 2767 | 2725 | 2664 | 2502 |
| BLUEMOUTH (*Helicolenus dactylopterus*) | | 2 | 5 | 12 | 11 | 8 | 4 | | | 1 | 3 | 29 | 33 | 34 | 18 | 124 | 135 |
| DEEP WATER CARDINAL FISH (*Epigonus telescopus*) | | | | | | | | | | | | 3 | 5 | 4 | 8 | 5 | 10 |
| GREATER FORKBEARD (*Phycis blennoides*) | 81 | 145 | 234 | 130 | 179 | 395 | 320 | 384 | 456 | 361 | 665 | 377 | 411 | 494 | 489 | 422 | 482 |
| LING (*Molva molva*) | 1028 | 1221 | 1372 | 1139 | 802 | 510 | 85 | 845 | 1041 | 1034 | 1799 | 451 | 331 | 577 | 439 | 450 | 527 |
| MORIDAE | | | | | | | | 83 | 52 | 88 | | | 26 | 20 | 8 | 12 | 11 |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | 0 | 0 | 0 | 0 | 83 | 68 | 31 | 7 | 22 | 24 | 15 | 40 | 52 | 20 | 20 | 31 | 43 |
| RABBITFISHES (*Chimaerids*) | | | | | | | | | | | | 2 | 2 | 7 | 6 | 2 | 6 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | | | | | | | | | | | | | | | | | |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | | | 5 | 1 | 12 | 18 | 5 | | 1 | | 20 | 16 | 5 | 7 | 3 | 2 | 2 |
| RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*) | 826 | 948 | 906 | 666 | 921 | 1175 | 1135 | 939 | 1001 | 1036 | 981 | 647 | 691 | 553 | 489 | 560 | 574 |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | 2666 | 1385 | 584 | 808 | 1374 | 2397 | 1054 | 5672 | 1237 | 1725 | 966 | 3069 | 16 | 706 | 1832 | 1681 | 854 |
| SMOOTHHEADS (*Alepocephalidae*) | | | | | | | | | | 7 | | | | | | | |
| TUSK (*Brosme brosme*) | 1 | | | | | | | | | | 1 | | | | | | |
| WRECKFISH (*Polyprion americanus*) | 198 | 284 | 163 | 194 | 270 | 350 | 410 | 394 | 294 | 222 | 238 | 144 | 123 | 167 | 156 | 243 | 141 |
| DEEP WATER RED CRAB (*Chaceon* spp)* | | | | | | | | | | | | | | | | | |
| LESSER SILVER SMELT (*Argentina sphiraena*)** | | | | | | | | | | | | | | | | 131 | 189 |

*** new species included in the WG2007**

**** new species included in the WG2008**

***** preliminary**

**Table 4.6.1 Continuation. Overview of landings in Subareas VIII and IX.**

| Species | 2005 | 2006 | 2007 | 2008 | 2009 | 2010*** |
|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | 191 | 94 | 71 | 101 | 65 | 38 |
| ARGENTINES (*Argentina silus*) | 202 | | 1 | 11 | 1 | 0 |
| BLUE LING (*Molva dypterigia*) | 61 | 351 | 36 | 56 | 16 | 4 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | 2770 | 2726 | 3480 | 3644 | 3612 | 3462 |
| BLUEMOUTH (*Helicolenus dactylopterus*) | 206 | 279 | 356 | 345 | 240 | 120 |
| DEEP WATER CARDINAL FISH (*Epigonus telescopus*) | 9 | 11 | 6 | 320 | 134 | 1 |
| GREATER FORKBEARD (*Phycis blennoides*) | 337 | 316 | 166 | 562 | 206 | 69 |
| LING (*Molva molva*) | 487 | 355 | 321 | 296 | 328 | 124 |
| MORIDAE | 15 | 9 | 18 | 9 | 6 | 3 |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | 27 | 43 | 1 | 9 | 17 | 0 |
| RABBITFISHES (*Chimaerids*) | 5 | 10 | 3 | 3 | 1 | 0 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | | 3 | 0 | 0 | 0 | 0 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 7 | 28 | 11 | 5 | 2 | 0 |
| RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*) | 584 | 656 | 718 | 751 | 809 | 490 |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | 526 | 620 | 654 | 846 | 931 | 829 |
| SMOOTHHEADS (*Alepocephalidae*) | | | | 0 | 0 | 0 |
| TUSK (*Brosme brosme*) | | 1 | 0 | 0 | 0 | 4 |
| WRECKFISH (*Polyprion americanus*) | 196 | 333 | 504 | 317 | 313 | 110 |
| DEEP WATER RED CRAB (*Chaceon* spp)* | | 305 | 83 | 0 | 0 | 0 |
| LESSER SILVER SMELT (*Argentina sphiraena*)** | 223 | 264 | 180 | 244 | 153 | 103 |

*** new species included in the WG2007**

**** new species included in the WG2008**

***** preliminary**

**Table 4.6.2. Quantitative description of fishing gears and landings (t) interaction of Spanish fleets in Subareas VIII and IX.**

| LANDINGS | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Gear | VIII | IX | VIII | IX | VIII | IX | VIII | IX | VIII | IX | VIII | IX |
| *Molva molva* | Longliners | 47 | 0 | 48 | 0 | 32 | 0 | 34 | 0 | 0 | 0 | 0 | 0 |
| | Gillnets | 16 | 0 | 8 | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 16 |
| | Bottom-trawl | 12 | 0 | 17 | 0 | 8 | 1 | 8 | 0 | 1 | 0 | 0 | 4 |
| | Others | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aphanopus carbo* | Longliners | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Gillnets | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Bottom-trawl | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Others | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pagellus bogaraveo* | Longliners | 44 | 334 | 28 | 369 | 83 | 404 | 20 | 439 | 16 | 594 | 0 | 0 |
| | Gillnets | 6 | 0 | 7 | 0 | 17 | 2 | 4 | 1 | 7 | 0 | 379 | 0 |
| | Bottom-trawl | 16 | 2 | 21 | 4 | 47 | 1 | 15 | 3 | 1 | 0 | 0 | 0 |
| | Others | 24 | 29 | 1 | 66 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| *Phycis* spp | Longliners | 148 | 0 | 80 | 1 | 294 | 3 | 20 | 14 | 20 | 5 | 2 | 1 |
| | Gillnets | 8 | 0 | 21 | 1 | 41 | 4 | 3 | 29 | 1 | 4 | 1 | 8 |
| | Bottom-trawl | 97 | 39 | 84 | 28 | 113 | 55 | 56 | 0 | 58 | 53 | 0 | 15 |
| | Others | 0 | 18 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Beryx* spp | Longliners | 21 | 0 | 26 | 3 | 47 | 1 | 4 | 0 | 4 | 5 | 0 | 0 |
| | Gillnets | 35 | 0 | 13 | 0 | 9 | 1 | 1 | 0 | 1 | 5 | 0 | 0 |
| | Bottom-trawl | 19 | 0 | 7 | 2 | 3 | 4 | 5 | 1 | 3 | 0 | 0 | 0 |
| | Others | 62 | 6 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polyprion americanus* | Longliners | 15 | 0 | 2 | 1 | 42 | 6 | 2 | 3 | 1 | 5 | 0 | 0 |
| | Gillnets | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 4 | 1 | 0 |
| | Bottom-trawl | 0 | 1 | 0 | 3 | 0 | 5 | 1 | 0 | 0 | 1 | 0 | 0 |
| | Others | 0 | 5 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| *Lepidopus caudatus* | Longliners | 0 | 449 | 0 | 563 | 0 | 645 | 0 | 842 | 0 | 894 | 0 | 0 |
| | Gillnets | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 785 | 0 |
| | Bottom-trawl | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 4 | 0 | 0 |
| | Others | 0 | 59 | 0 | 51 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 0 |
| *Argentina sphyraena* | Longliners | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Gillnets | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Bottom-trawl | 32 | 0 | 261 | 3 | 184 | 1 | 237 | 1 | 0 | 0 | 0 | 103 |
| | Others | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

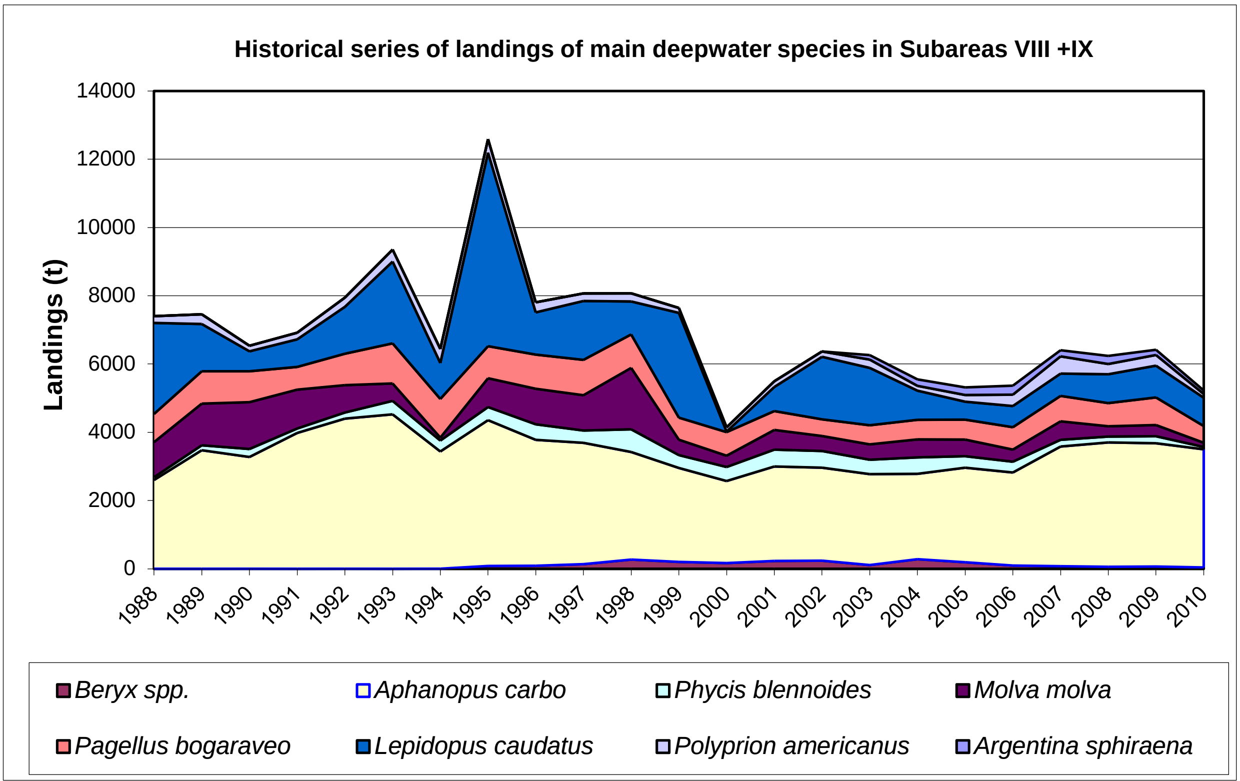



**Figure 4.6.1. Historical series of the eight main species landed in combined Subareas VIII and IX since 1988.**

## 4.7 Stocks and fisheries of the Oceanic northeast Atlantic

### 4.7.1 Fisheries overview

The Mid-Atlantic Ridge (MAR) is the spreading zone between the Eurasian and American plate. The ridge is continually being formed as the two plates spread at a rate of about 2 cm/year. In the ICES area it extends over 1500 nm from the Iceland to the Azores, crossing the Azores archipelago between the Western and central islands groups. It is characterised by a rough bottom topography comprising underwater mountain chains, a central rift valley, recent volcanic terrain, fracture zones and seamounts. In these areas two different types of fisheries occur. Industrial oceanic fisheries in the central region and northern parts of the MAR. There is an artisanal fishery inside the Azorean EZZ and this is targeted at stocks which may extend south of the ICES Area.

This Section deals with fisheries on the MAR and the Azores.

#### Azores EEZ

The Azores deep-water fishery is a multispecies and multigear fishery. The dynamic of the fishery seems to be dominated by the main target species *Pagellus bogaraveo*. However, other commercially important species are also caught and the target species change seasonally according to abundance, species vulnerability and market.

The fishery is clearly a typical small-scale one, where small vessels (<12 m; 90% of the total fleet) predominate, using mainly traditional bottom longline and several types of handlines. The ecosystem is a seamount type with fishing operations occurring in all available areas, from the islands coasts to the seamounts within the Azorean EEZ.

The fishery takes place at depths up to 1000 m, catching species from different assemblages, with a mode in the 200–600 m strata which is the intermediate strata where the most commercially important species occur.

#### Mid-Atlantic Ridge

The northern MAR is a huge area located between Iceland and Azores. There are more than 40 seamounts of commercial importance (Table 4.7.1).

The deep-water fishery on the MAR started in 1973, when dense concentrations of roundnose grenadier (*Coryphaenoides rupestris)* were discovered. Later aggregations of alfonsino *(Beryx splendens)*, orange roughy *(Hoplostethus atlanticus)*, cardinal fish *(Epigonus telescopus)*, tusk (*Brosme brosme*), 'giant' redfish (*Sebastes marinus)* and blue ling (*Molva dypterygia)* were found. Trawl and longline fisheries were conducted in Subareas XII, X, XIV and V (Figure 4.7.1) by Russian, Icelandic, Faroese, Polish, Latvian and Spanish vessels.

### 4.7.2 Trends in fisheries

#### Azores EEZ

Since the mid-1990s the landings of deep-water species show a decreasing tendency (Figure 4.7.2 and Table 4.7.2), reflecting the change in the fleet behaviour towards targeting blackspot seabream.

Since 2000, the use of bottom longlines in the coastal areas has significantly been reduced, as a result of the interdiction by the local authorities of the use of longlines in the coastal areas on a range of 3 miles from the islands coast. As a consequence, the smaller boats that operate in this area have changed their gears to several types of handlines, which may have increased the pressure on some species. The deep-water bottom longline is at present mostly a seamount fishery.

Also in one other fleet component, the medium size boats, ranging from 12 to 16 m, a change from bottom longline to handlines has been observed during the last 5 or 6 years. All these changes in the fishing pattern of the fleet may explain the changes in the landings of some species that were more vulnerable to the use of bottom longlines.

#### Mid-Atlantic Ridge

The greatest annual catch of roundnose grenadier (almost 30 000 t) on the MAR was taken by the Soviet Union in 1975, fluctuating in subsequent years between 2800 to 22 800 t. The fishery for grenadier declined after the dissolution of the Soviet Union in 1992. In the last 15 years, there has been a sporadic fishery (Figure 4.7.1) by vessels from Russia (annual catch estimated at 200–3200 t), Poland (500–6700 t), Latvia (700–4300 t) and Lithuania (catch data not available). Grenadier has also been taken as by-catch in the Faroese orange roughy fishery and the Spanish blue ling fishery. During the entire fishing period to 2009, the catch of roundnose grenadier from the northern MAR amounted to more than 232 000 t, mostly from ICES Subarea XII.

The deep-water fisheries off Iceland tend to be on the continental slopes although a short-lived fishery on spawning blue ling (*Molva dypterygia*) was reported on a "small steep hill" at the base of the slope near the Westman Islands. The fishery began in 1979, peaked at 8000 t in 1980 and subsequently declined rapidly. French trawlers found a small seamount in southerly areas of the Reykjanes Ridge and were fishing for blue ling there in 1993 with 390 t of catch. The maximum Icelandic catch in that area was around 3000 t, also in 1993. Catches declined sharply to 300 and 117 t for next two years and no fishery was reported later (Figure 4.7.1). A Fishery on the seamount was resumed by Spanish trawlers in the 2000s with biggest catch about 1000 t.

Orange roughy occurs in restricted areas of the MAR, where it can be abundant on the tops and the slopes of narrow underwater peaks. These are generally difficult to fish, although in 1991 a single trawler made some noteworthy catches of orange roughy off the south coast of Iceland. In 1992 the Faroe Islands began a series of exploratory cruises for orange roughy beginning in their own waters and later extending into international waters. Exploitable concentrations were found in late 1994 and early 1995. Several vessels began a commercial fishery but only one vessel managed to maintain a viable fishery. Most of the fishery took place on five banks. In the northern area (ICES Subarea XII) catches peaked in 1995–1998 (570–802 t), and since then have generally been less than 300 t (Figure 4.7.1). Catches from 6 to 470 t per annum were also made in ICES Subarea X in 1996–1998, 2000–2001, 2004–2009. Black scabbard fish was the main bycatch species (313 t for both subareas in 2009).

In 1983–1987, dives with a Soviet submersible discovered aggregations of tusk and northern wolffish (*Anarhichas denticulatus)* on the northern MAR seamounts, and a bottom longline fishery subsequently developed. Catches of tusk were taken on 20 seamounts in the area between 51–57°N. The highest catch rates were on a seamount named Hekate, with 813 kg per 1000 hooks.

In 1996 a small fleet of Norwegian longliners began a fishery for 'giant' redfish and tusk on the Reykjanes Ridge. The fishery was mainly conducted close to the summits of seamounts and a new type of vertical longline was developed for the fishery. The fishery continued in 1997 but experienced an 84% decrease in cpue. Norway carried out two exploratory longline surveys in 1996 and 1997. The fishery in that area was resumed in 2005–2007 and 2009 by Russian longliners.

Spain carried out five limited exploratory trawl surveys to seamounts on the MAR between 1997–2000 and a longline survey in 2004, but except for sporadic fisheries in the northern area (Division XIVb) there has been a decline in interest.

The first commercial catches of alfonsino in this area were taken by pelagic trawling on the Spectre seamount in 1977 and this and other seamounts were exploited in 1978 and 1979. No commercial fishing took place during the 1980s but nine exploratory and research cruises yielded about 1000 t of mixed deep-water species, mostly alfonsino, but also commercial catches of cardinal fish, orange roughy, black scabbardfish and silver roughy (*Hoplostethus mediterrraneus).* A joint Russian–Norwegian survey in 1993 used a bottom trawl to survey three seamounts and a catch of 280 t, mainly alfonsino and cardinal fish, was taken from two of them. Orange roughy, black scabbard fish and wreckfish *(Polyprion americanus)* were also of commercial importance. Commercial fishing yielded more than 2800 t over the next seven years (Figure 4.7.2). In recent years there have been no indications of a fishery for alfonsino. Since the discovery of the seamounts in the North Azores area, Soviet and Russian, vessels have taken about 6000 t, mainly of alfonsino. Vessels from the Faroe Islands and the UK have also taken small catches of this species in the area.

In 2010 Spain started a new targeted bottom fishery of roughhead grenadier (*Macrourus berglax)* in the Division XIVb with a bycatch of roundnose grenadier, blackscabbard fish and other species. The total catch amounted to approximately 1000 t. However the reliability of the information needs to be validated.

Deep-water fisheries in the MAR have declined to very low levels in the recent years in Subareas X and XII due to many reasons, including the implementation of a range of management measures (WD Bergstad and Høines, 2011). (Figure 4.7.3).

### 4.7.3 Technical interactions

#### Azores EEZ

The fishery is multi-species and so technological interactions are observed. In the past the bycatch of this fishery was considered insignificant, according to a pilot study conducted in 2004 (ICES, 2006). However, reported discards from observers in the longline fishery during 2007 and 2008 suggest that for some species the discards may be important. Commercial value species like red blackspot seabream and wreckfish, among others, are also discarded. These changes may be 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.

#### Mid-Atlantic Ridge

The possible interactions between local fishing grounds (e.g. seamounts) and the status of the stocks at a larger scale are unknown. In particular, seamount aggregating species such alfonsinos and orange roughy are sensitive to sequential local depletion. However, no data were available to assess such effects. Little is understood about the stock structure of these species and it is possible that the industrial fleets fishing on the MAR may be fishing the same stocks that are exploited by the Azorean fishery.

The separation of fishing activities and catch on the MAR and Hatton Bank have been problematic as both these areas are parts of ICES Subarea XII. The Spanish fishery on the Hatton Bank is not known to operate on the MAR. However, this fishery is operated by large high-sea freezer trawlers that also fish in the Northwest Atlantic (NAFO area) and could therefore do some fishing also on the northern MAR. The Spanish fishery produces only small landings of aggregating seamount species (orange roughy, alfonsinos) and target mainly roundnose grenadier. Therefore it is unlikely to interact with fisheries in the southern MAR and other fisheries for roundnose grenadier. Landings of non-aggregating species (mainly roundnose grenadier) on the northern ridge have been small over recent years.

### 4.7.4 Ecosystem considerations

#### Azores EEZ

The Azores is considered a "seamount ecosystem area" because of its high seamount density. The Azores, as for most of the volcanic islands, does not have a coastal platform and is surrounded by extended areas of great depths, punctuated by some seamounts where fisheries occur. The average depth in the Azores EEZ is 3000 m, and only 0.8% (7715 $km^2$) has depths <600 m while 6.8% is between 600 and 1500 m. The deep-water fishery in the Azores is mostly a seamount fishery where only bottom longlines and handlines are used.

#### Mid-Atlantic Ridge

Most of Divisions XIIa, XIIc, Xb, XIVb1 and Va are covered in abyssal plain with an average depth of ca. 4000 m which currently remains largely unexploited. The major topographic feature is the northern part of the MAR, located between Iceland and the Azores. Numerous seamounts of variable height occur all along this ridge along with isolated seamounts in other areas such as Altair and Antialtair. The physical structure of seamounts often amplify water currents and create unique hard substrata environments that are densely populated by filter-feeding epifauna such as sponges, bivalves, brittle stars, sea lilies and a variety of corals such as the reef-building cold-water coral *Lophelia pertusa*. This benthic habitat supports elevated levels of biomass in the form of aggregations of fish such as orange roughy, alfonsinos, etc. and a number of seamounts have been targeted by commercial fleets. Such habitats are however highly susceptible to damage by mobile bottom fishing gear and the fish stocks can be rapidly depleted due to the life-history traits of the species which are slow growing and longer-living than non-seamount species.

The MAR is isolated from the continental slope except for the relatively continuous shallower connections via the Greenland and Scotland ridges, and some seamount chains, e.g. the New England seamounts provide other linkages to the continents. Along with much of the general biology, the intraspecific status of species inhabiting the MAR is unclear. Based on geographical patterns it is probable that MAR stocks are isolated from the others in the North Atlantic and endemism, especially among benthic species, may be high and therefore they may be particularly vulnerable.

### 4.7.5 Management of fisheries

#### Azores EEZ

The only known deep-water fisheries in ICES Subdivision Xa are those from the Azores. Fisheries management is based on regulations issued by the European Community, by the Portuguese government and by the Azores regional government. Under the EC Common Fisheries Policy (CFP), TACs were introduced for some species, e.g. blackspot seabream, black scabbardfish, and deep-water sharks, in 2003 (EC. Reg. 2340/2002) and revised/maintained thereafter. Specific access requirements and conditions applicable to fishing for deep-water stocks were also established (EC. Reg. 2347/2002).

Fishing with trawl gears is forbidden in the Azores region. A box of 100 miles limiting deep-water fishing to vessels registered in the Azores was created in 2003 under the management of fishing effort of the CFP for deep-water species (EC Reg. 1954/2003). Some technical measures were also introduced by the Azores regional government since 1998 (including fishing restrictions by area, vessel type and gear, fishing licences based on landing thresholds and minimum lengths).

In order to reduce effort on traditional stocks, fishermen are encouraged by local authorities to exploit the deeper strata (>700 m), but the poor response of the market has been limiting the expansion of the fishery.

#### Mid-Atlantic Ridge

EC vessels fishing on the MAR are covered by Community TACs. There is NEAFC regulation of fishing effort in the fisheries for deep-water species and closed areas to protect vulnerable habitats.

**Table 4.7.2. Overview of landings in Subareas X (a1,a2,b), XII (c, a1) (does not include information from XIIb, Western Hatton Bank) and XIVb1.**

| SPECIES | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFONSINOS (*Beryx* spp.) | 631 | 550 | 983 | 229 | 175 | 229 | 199 | 243 | 172 | 139 | 157 | 192 | 211 | 250 | 312 | 56 |
| ARGENTINES (*Argentina silus*) | | 1 | | | 2 | | | | | 4 | | | | | | |
| BLUE LING (*Molva dypterigia*) | 602 | 814 | 438 | 451 | 1363 | 607 | 675 | 1270 | 1069 | 644 | 35 | 65 | 1 | | | 47 |
| BLACK SCABBARDFISH (*Aphanopus carbo*) | 304 | 455 | 203 | 253 | 224 | 357 | 134 | 1062 | 502 | 384 | 198 | 73 | | 80 | 162 | 160 |
| BLUEMOUTH (*Helicolenus dactylopterus*) | 589 | 483 | 410 | 381 | 340 | 452 | 301 | 280 | 338 | 282 | 190 | 209 | 275 | 281 | 267 | 213 |
| DEEP WATER CARDINAL FISH (*Epigonus telescopus*) | | | | | | 3 | | 14 | 16 | 21 | 4 | 10 | 7 | 7 | 7 | 5 |
| GREATER FORKBEARD (*Phycis blennoides*) | 75 | 47 | 32 | 39 | 41 | 100 | 91 | 63 | 56 | 46 | 1 | 134 | 201 | 18 | 26 | 14 |
| LING (*Molva molva*) | 50 | 2 | 9 | 2 | 2 | 7 | 59 | 8 | 19 | | 2 | | | | 1 | |
| MORIDAE | | | | | | 1 | 88 | 113 | 140 | 91 | 69 | 127 | 86 | 53 | 68 | 54 |
| ORANGE ROUGHY (*Hoplostethus atlanticus*) | 676 | 1289 | 814 | 806 | 441 | 447 | 839 | 28 | 201 | 711 | 324 | 104 | 20 | 108 | 26 | |
| RABBITFISHES (*Chimaerids*) | | | 32 | 42 | 115 | 48 | 79 | 98 | 81 | 128 | 193 | | | | 22 | 407 |
| ROUGHHEAD GRENADIER (*Macrourus berglax*) | | | | | 3 | 7 | 10 | 7 | 2 | 28 | 8 | 8 | | | 6 | 407 |
| ROUNDNOSE GRENADIER (*Coryphaenoides rupestris*) | 644 | 1739 | 8622 | 11979 | 9696 | 8602 | 7926 | 11 468 | 10 805 | 10 748 | 513 | 86 | 2 | 13 | 5 | 302 |
| RED (=BLACKSPOT) SEABREAM (*Pagellus bogaraveo*) | 1096 | 1036 | 1012 | 1114 | 1222 | 947 | 1034 | 1193 | 1068 | 1075 | 1383 | 958 | 1070 | 1089 | 1042 | 687 |
| SHARKS, VARIOUS | 1385 | 1264 | 891 | 1051 | 50 | 1069 | 1208 | 35 | 25 | 6 | 14 | 104 | 63 | 12 | 1 | 7 |
| SILVER SCABBARDFISH (*Lepidopus caudatus*) | 789 | 815 | 1115 | 1186 | 86 | 28 | 14 | 10 | 25 | 29 | 31 | 35 | 55 | 63 | 64 | 68 |
| SMOOTHHEADS (*Alepocephalidae*) | | 230 | 3692 | 4643 | 6549 | 4146 | 3592 | 12538 | 6883 | 4368 | 6872 | | | | | |
| TUSK (*Brosme brosme*) | 18 | 158 | 30 | 1 | 1 | 5 | 52 | 27 | 83 | 16 | 66.26 | 64 | 19 | | 2 | 107 |
| WRECKFISH (*Polyprion americanus*) | 240 | 240 | 177 | 139 | 133 | 268 | 229 | 283 | 270 | 189 | 279 | 497 | 664 | 513 | 382 | 238 |

**Table 4.7.1. Summary data on seamount fisheries on the MAR.**

| Main species | Discovery Year | Discovery Country | No. of commercial seamounts | Maximum catch/yr ('000 t) |
|---|---|---|---|---|
| *Coryphaenoides rupestris* | 1973 | USSR | 34 | 29.9 |
| *Beryx splendens* | 1977 | USSR | 4 | 1.1 |
| *Hoplostethus atlanticus* | 1979 | USSR | 5 | 0.8 |
| *Molva dypterigia* | 1979 | Iceland | 1 | 8.0 |
| *Epigonus telescopus* | 1981 | USSR | 1 | 0.1 |
| *Aphanopus carbo* | 1981 | USSR | 2 | 1.1 |
| *Brosme brosme* | 1984 | USSR | 15 | 0.3 |
| *Sebastes marinus* | 1996 | Norway | 10 | 1.0 |

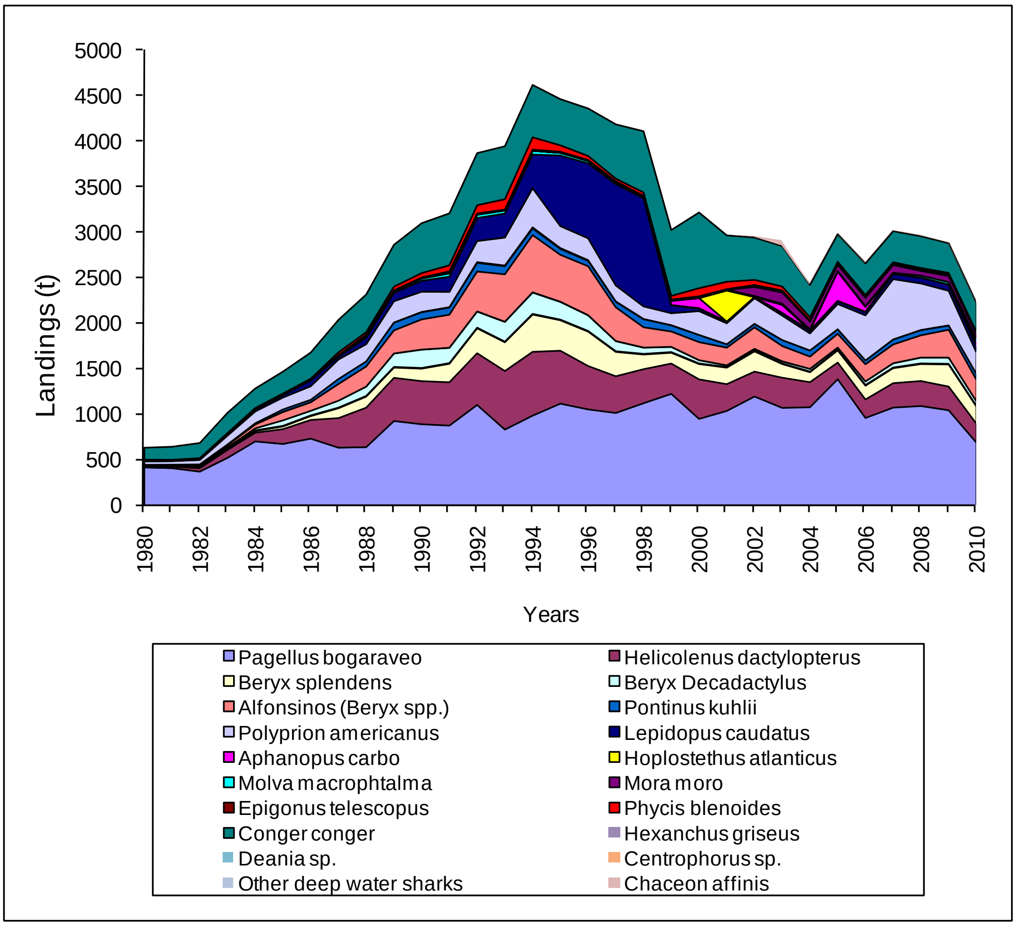



**Figure 4.7.2. Annual landings of major deep-water species in Azores from hook and line fishery (1980–2009).**

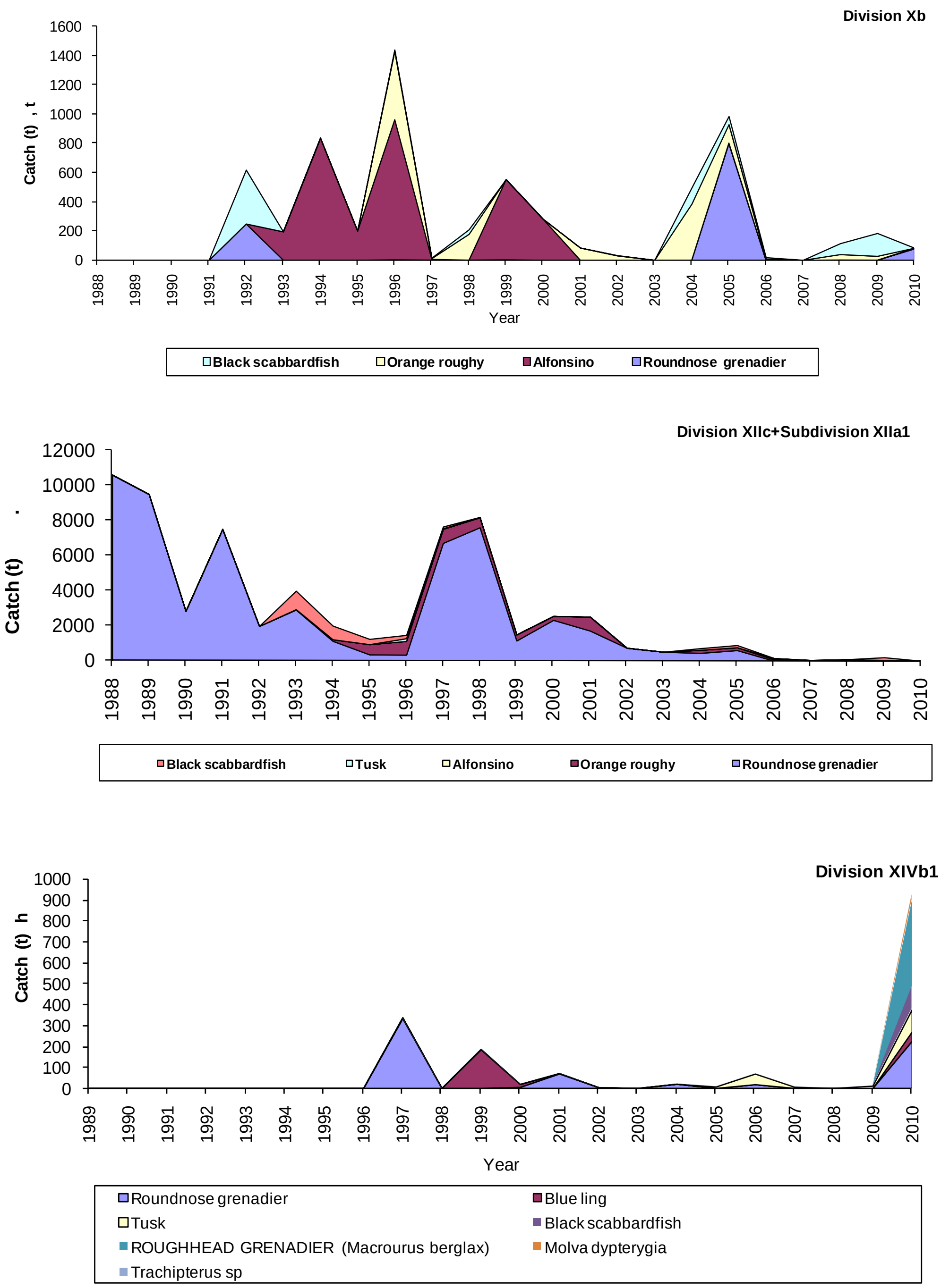



**Figure 4.7.1. Annual catch of major deep-water species on MAR in 1988–2009.**

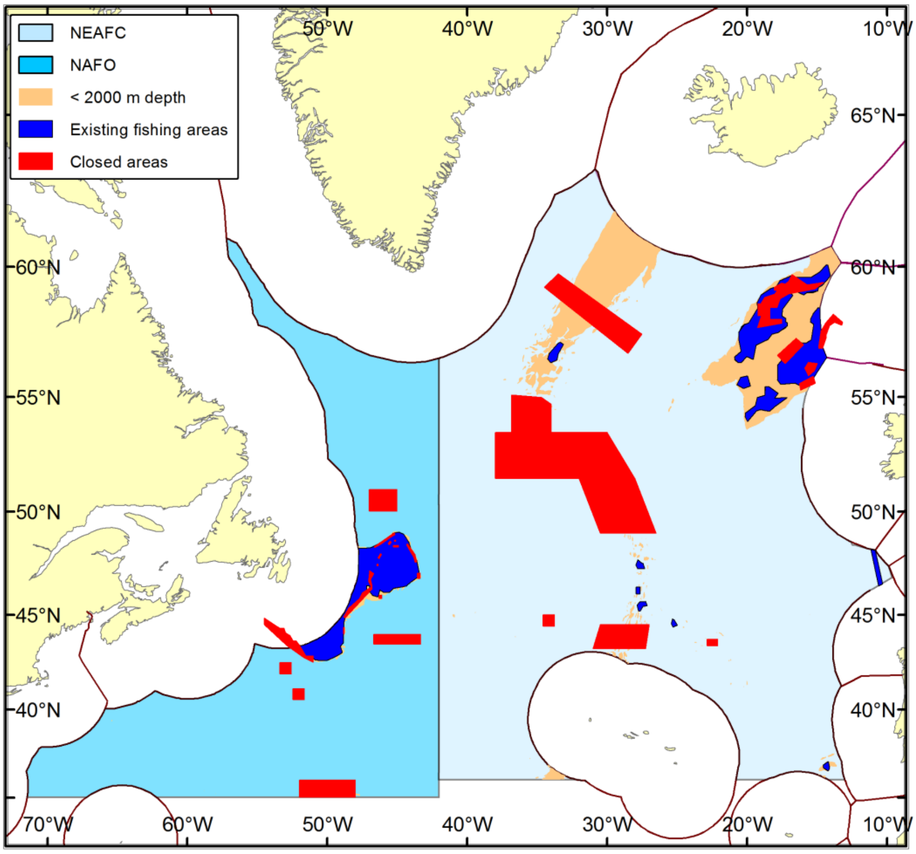



**Figure 4.7.3. RFMO regulatory areas of Mid Atlantic Ridge, and closures introduced by NEAFC and NAFO (red) (from WD Bergstad and Høines, 2011).**

# 5 Ling (*Molva molva*) in the Northeast Atlantic

## 5.1 Stock description and management units

WGDEEP 2006 indicated: 'There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e. stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Va), the Norwegian Coast (II), and the Faroes and Faroe Bank (Vb) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas IV, VI, VII and VIII) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in future'.

WGDEEP 2007 examined available evidence on stock discrimination and concluded that available information is not sufficient to suggest changes to current ICES interpretation of stock structure.

## 5.2 Ling (*Molva Molva*) in Subareas I and II

### 5.2.1 The fishery

Ling has been fished in these subareas for centuries, and the historical development is described in, e.g. Bergstad and Hareide (1996). In particular, the post-World War II increase in catch, because of a series of technical advances, is well documented. Currently the major fisheries in Subareas I and II are the Norwegian longline and gillnet fisheries, but there are also bycatches taken by other gears, i.e. trawls and handlines. Around 50% of the Norwegian landings are taken by longlines and 45% by gillnets, partly in the directed ling fisheries and partly as bycatch in fisheries for other groundfish. Other nations catch ling as bycatch in their trawl fisheries.

### 5.2.2 Landings trends

Landing statistics by nation in the period 1988–2010 are in Tables 5.3.1a–d. During the period 2000–2005 the landings varied between 5000 and 7000 t, which are slightly lower than catches as in the preceding decade. In 2007 and 2008 the landings increased to over 10 000 t. Preliminary landings for 2010 are 10 447 t. Total international landings in Areas I and II are given in Figure 5.3.1. Norwegian legislation enacted since 2000 for regulating the cod fishery caused a continuous reduction in the number of longliners in the fishery for tusk, ling and blue ling and by 2010 there were only 35 vessels above 21 m in the fishery.

### 5.2.3 ICES Advice

**Advice for 2011:** Constrain catches to 8000 t until such time there is sufficient scientific information to prove the fishery is sustainable.

### 5.2.4 Management

There is no quota set for the Norwegian fishery for ling but the vessels participating in the directed fishery for ling and tusk in Subareas I and II are required to have a specific licence. The quota for the EU for bycatch species such as ling and tusk in

Norwegian waters of Areas I and II is in 2011 set to 5000 t. There is no minimum landing size in the Norwegian EEZ.

The quota for ling only in EU and international waters was set at 36 t in 2011.

### 5.2.5 Data available

#### 5.2.5.1 Landings and discards

Landings were available for all relevant fleets. New discard data were not available.

#### 5.2.5.2 Length compositions

Average length from 1988 to 2009 is presented in Helle and Pennington WD21, 2011.

During this period the mean length has varied around 86 cm without any clear trend.

#### 5.2.5.3 Age compositions

No new age compositions were available.

#### 5.2.5.4 Weight-at-age

No new data were presented.

#### 5.2.5.5 Maturity and natural mortality

No new data were presented.

#### 5.2.5.6 Catch, effort and research vessel data

Cpue data for Norwegian longliners are presented in Figure 7.3.2. No research vessel data are available.

An analysis based on these data is in Helle and Pennington, WD21, 2011.

### 5.2.6 Data analyses

No analytical assessments were done.

The only source of information on abundance trends was the nominal cpue series from the Norwegian longliners presented by Helle and Pennington (WD21, 2011) Figure 5.3.2). The number of longliners has declined in recent years (Table 5.3.2), from 72 to 35 in the period 2000–2010. The numbers of fishing days per vessel have remained relatively stable during the last few years. (Table 5.3.2). The number of hooks set per day have had a slight increase over the period 2000–2009 in Subareas I and II (Figure 5.3.3)(Helle and Pennington, WD21, 2011). A standardized series will be developed in preparation for WGDEEP 2012.

In Table 5.3.3 are estimates of cpue based on the Norwegian official logbooks.

#### Comments on the assessment

The series starting in 2000 shows a clear upward trend during the period 2001–2009.

### 5.2.7 Management considerations

**No management advice is required this year.**

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g. $F_{proxy}$, CUSUM.

**Table 5.3.1a. Ling I. WG estimates of landings.**

| Year | Norway | Iceland | Scotland | Faroes | Total |
|---|---|---|---|---|---|
| 1996 | 136 | | | | 136 |
| 1997 | 31 | | | | 31 |
| 1998 | 123 | | | | 123 |
| 1999 | 64 | | | | 64 |
| 2000 | 68 | 1 | | | 69 |
| 2001 | 65 | 1 | | | 66 |
| 2002 | 182 | | 24 | | 206 |
| 2003 | 89 | | | | 89 |
| 2004 | 323 | | | 22 | 345 |
| 2005 | 107 | | | | 107 |
| 2006 | 58 | | | | 58 |
| 2007 | 96 | | | | 96 |
| 2008 | 55 | | | | 55 |
| 2009 | 236 | | | | 236 |
| 2010* | 58 | | | | 58 |

***Preliminary.**

**Table 5.3.1b. Ling IIa. WG estimates of landings.**

| Year | Faroes | France | Germany | Norway | E & W | Scotland | Russia | Ireland | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 3 | 29 | 10 | 6070 | 4 | 3 | | | 6119 |
| 1989 | 2 | 19 | 11 | 7326 | 10 | - | | | 7368 |
| 1990 | 14 | 20 | 17 | 7549 | 25 | 3 | | | 7628 |
| 1991 | 17 | 12 | 5 | 7755 | 4 | + | | | 7793 |
| 1992 | 3 | 9 | 6 | 6495 | 8 | + | | | 6521 |
| 1993 | - | 9 | 13 | 7032 | 39 | - | | | 7093 |
| 1994 | 101 | n/a | 9 | 6169 | 30 | - | | | 6309 |
| 1995 | 14 | 6 | 8 | 5921 | 3 | 2 | | | 5954 |
| 1996 | 0 | 2 | 17 | 6059 | 2 | 3 | | | 6083 |
| 1997 | 0 | 15 | 7 | 5343 | 6 | 2 | | | 5373 |
| 1998 | | 13 | 6 | 9049 | 3 | 1 | | | 9072 |
| 1999 | | 12 | 7 | 7557 | 2 | 4 | | | 7581 |
| 2000 | | 9 | 39 | 5836 | 5 | 2 | | | 5891 |
| 2001 | 6 | 9 | 34 | 4805 | 1 | 3 | | | 4858 |
| 2002 | 1 | 4 | 21 | 6886 | 1 | 4 | | | 6917 |
| 2003 | 7 | 3 | 43 | 6001 | | 8 | | | 6062 |
| 2004 | 15 | 0 | 3 | 6114 | | 1 | 5 | | 6138 |
| 2005 | 6 | 5 | 6 | 6085 | 2 | | 2 | | 6106 |
| 2006 | 9 | 8 | 6 | 8685 | 6 | 1 | 11 | | 8726 |
| 2007 | 18 | 6 | 7 | 9970 | 1 | 0 | 55 | 1 | 10 058 |
| 2008 | 22 | 4 | 7 | 11 040 | 1 | 1 | 29 | 0 | 11 104 |
| 2009 | 10 | 2 | 7 | 8189 | 0 | 19 | 17 | | 8244 |
| 2010* | 10 | 0 | | 10231 | 0 | 2 | 47 | | 10 290 |

***Preliminary.**

**Table 5.3.1c. Ling IIb. WG estimates of landings.**

| Year | Norway | E & W | Faroes | Total |
|---|---|---|---|---|
| 1988 | | 7 | | 7 |
| 1989 | | - | | |
| 1990 | | - | | |
| 1991 | | - | | |
| 1992 | | - | | |
| 1993 | | - | | |
| 1994 | | 13 | | 13 |
| 1995 | | - | | |
| 1996 | 127 | - | | 127 |
| 1997 | 5 | - | | 5 |
| 1998 | 5 | + | | 5 |
| 1999 | 6 | | | 6 |
| 2000 | 4 | - | | 4 |
| 2001 | 33 | 0 | | 33 |
| 2002 | 9 | 0 | | 9 |
| 2003 | 6 | 0 | | 6 |
| 2004 | 77 | | | 77 |
| 2005 | 93 | | | 93 |
| 2006 | 64 | | | 64 |
| 2007 | 180 | | 0 | 180 |
| 2008 | 162 | 0 | 0 | 161 |
| 2009 | 84 | | | 84 |
| 2010* | 128 | | | 128 |

***Preliminary.**

**Table 5.3.1d. Ling I and II. Total landings by subarea or division.**

| Year | I | IIa | IIb | All areas |
|---|---|---|---|---|
| 1988 | | 6119 | 7 | 6126 |
| 1989 | | 7368 | | 7368 |
| 1990 | | 7628 | | 7628 |
| 1991 | | 7793 | | 7793 |
| 1992 | | 6521 | | 6521 |
| 1993 | | 7093 | | 7093 |
| 1994 | | 6309 | 13 | 6322 |
| 1995 | | 5954 | | 5954 |
| 1996 | 136 | 6083 | 127 | 6346 |
| 1997 | 31 | 5373 | 5 | 5409 |
| 1998 | 123 | 9072 | 5 | 9200 |
| 1999 | 64 | 7581 | 6 | 7651 |
| 2000 | 69 | 5891 | 4 | 5964 |
| 2001 | 66 | 4858 | 33 | 4957 |
| 2002 | 206 | 6917 | 9 | 7132 |
| 2003 | 89 | 6062 | 6 | 6157 |
| 2004 | 345 | 6138 | 77 | 6560 |
| 2005 | 107 | 6106 | 93 | 6306 |
| 2006 | 58 | 8726 | 64 | 8848 |
| 2007 | 96 | 10 058 | 180 | 10 334 |
| 2008 | 80 | 11 104 | 161 | 11 345 |
| 2009 | 236 | 8086 | 84 | 8406 |
| 2010* | 58 | 10290 | 128 | 10 476 |

*** Preliminary**

**Table 5.3.2. Summary statistics for the Norwegian longliner fleet during the period 1995–2008 (vessels exceeding 21 m). This list only includes vessels that landed 8 t or more of ling, blue ling and tusk in a given year.**

| Year | Number of longliners |
|---|---|
| 1995 | 65 |
| 1996 | 66 |
| 1997 | 65 |
| 1998 | 67 |
| 1999 | 71 |
| 2000 | 72 |
| 2001 | 65 |
| 2002 | 58 |
| 2003 | 52 |
| 2004 | 43 |
| 2005 | 39 |
| 2006 | 35 |
| 2007 | 38 |
| 2008 | 36 |
| 2009 | 34 |
| 2010 | 35 |

**Table 5.3.3. Estimated mean cpue ([kg/hook]x1000) in IIa (based on logbook data) along with the standard error (se) and the number of catches sampled (n).**

| Ling | Area | I | IIA |
|---|---|---|---|
| 2000 | cpue | | 23,9 |
| | n | | 1064 |
| | se | | 0,7 |
| 2001 | cpue | | 21,9 |
| | n | | 1352 |
| | se | | 0,6 |
| 2002 | cpue | | 24,2 |
| | n | | 1345 |
| | se | | 0,5 |
| 2003 | cpue | 1,7 | 29,1 |
| | n | 3 | 925 |
| | se | 12,7 | 0,7 |
| 2004 | cpue | | 37,3 |
| | n | | 630 |
| | se | | 0,9 |
| 2005 | cpue | | 49,8 |
| | n | | 775 |
| | se | | 1,1 |
| 2006 | cpue | | 42,3 |
| | n | | 928 |
| | se | | 0,9 |
| 2007 | cpue | | 40 |
| | n | | 1334 |
| | se | | 0,6 |
| 2008 | cpue | | 47,6 |
| | n | | 859 |
| | se | | 0,93 |
| 2009 | cpue | | 52.6 |
| | n | | 889 |
| | se | | 1.38 |

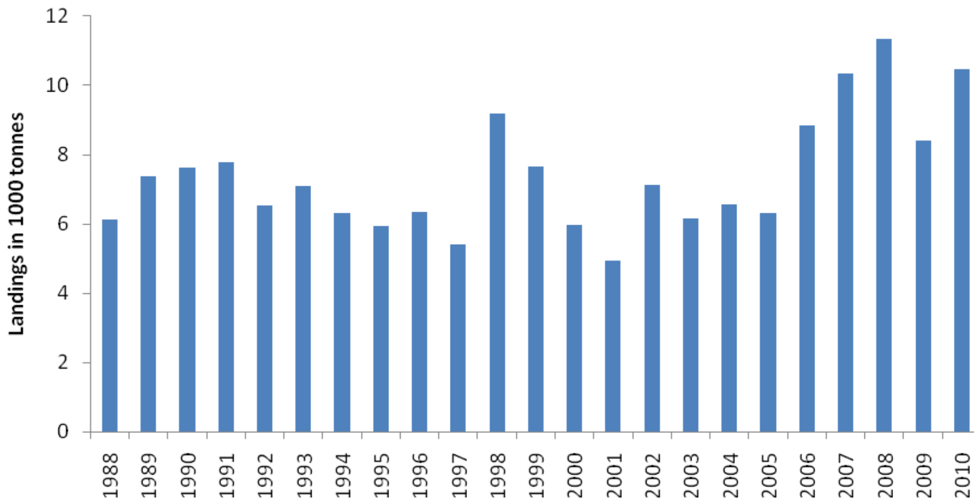
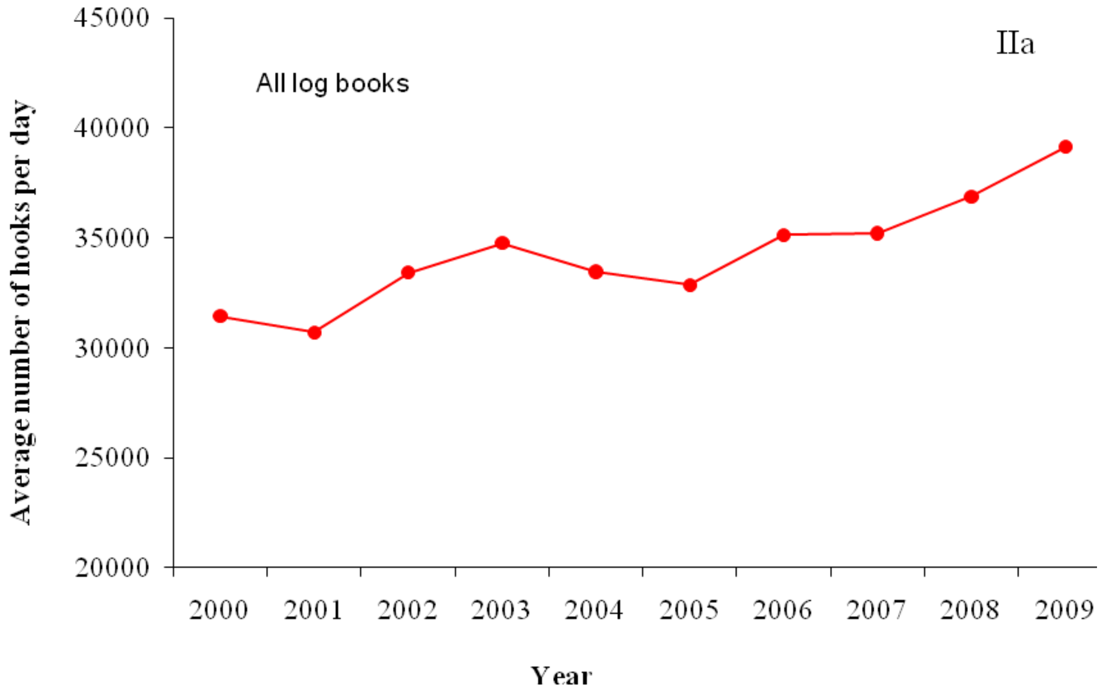



**Figure 5.3.1. Total international landings of ling in Subareas I and II.**



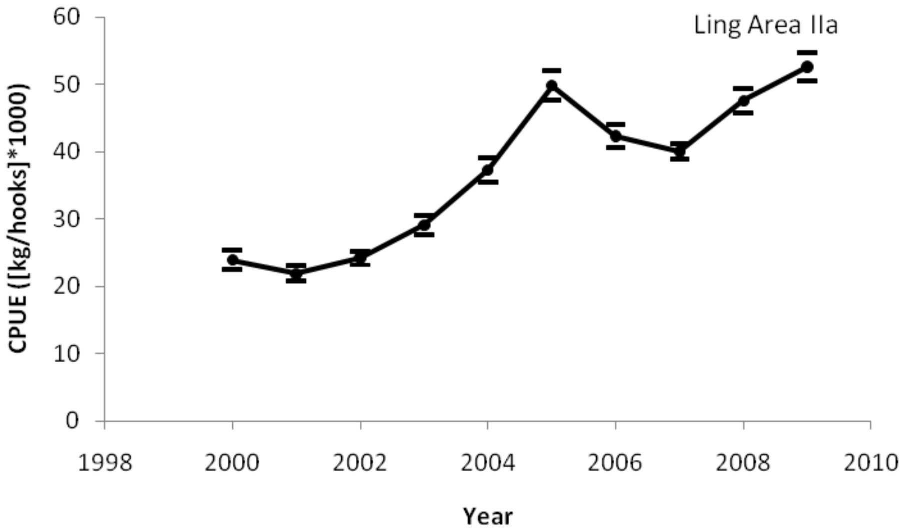




**Figure 5.3.2. Ling in IIa. Estimates of cpue (kg/1000 hooks) based on skipper's logbooks 2000–2009. The bars denote the 95% confidence interval.**

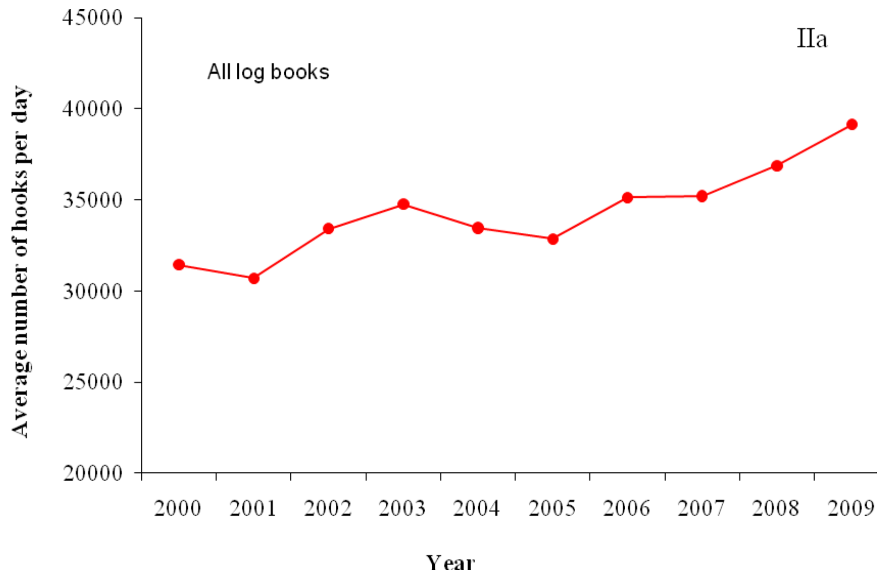



**Figure 5.3.3. Average number of hooks the Norwegian longliner fleet used per day in ICES Sub-area IIa for the years 2000–2009 in the fishery for tusk, ling and blue ling.**

## 5.3 Ling (*Molva Molva*) in Division Va

### 5.3.1 The fishery

The fishery for ling in Va has not changed substantially in recent years. Around 150 longliners annually report catches of ling, around 70 gillnetters and a similar number of trawlers (Table 5.4.1). Most of ling in Va is caught on longlines and the proportion caught by that gear has increased since 2000 to around 65% in 2010. At the same time the proportion caught by gillnets has decreased from 20–30% in 2000–2001 to 4–8% in 2008–2010. Catches in trawls have varied less and have been at around 20% of Icelandic catches of ling in Va (Table 5.4.2).

A minor change in the ling fishery in Va is that the longline fishery has changed from a bycatch fishery in 2000–2005 to more of a mixed fishery since then. This change is most likely a result of increased abundance of ling in Va in recent years.

Most of the ling caught in Va by Icelandic longliners is caught at depths less than 300 m and less than 500 m by trawlers (Figure 5.4.1). The main fishing grounds for ling in Va as observed from logbooks are on the south, southwestern and western part of the Icelandic shelf (Figure 5.4.2). The main trend in the spatial distribution of ling catches in Va according to logbook entries is the decreased proportion of catches caught in the southeast and increased catches on the western part of the shelf. Around 40% of ling catches are caught on the southwestern part of the shelf (Figure 5.4.3).

### 5.3.2 Landings trends

Since 2001 catches have increased substantially year on year and in 2010 amounted to 11 030 t (preliminary) (Figure 5.4.4). Of that, Icelandic vessels caught 9867 t or 89% of the total catches (Table 5.4.3).

### 5.3.3 ICES Advice

The latest advice is from ICES in May 2010. ICES advises that catches in 2011 should not exceed 7500 t until such time there is sufficient scientific information to prove the fishery is sustainable.

### 5.3.4 Management

The Icelandic Ministry of Fisheries and Agriculture is responsible for management of the Icelandic fisheries and implementation of legislation. The Ministry issues regulations for commercial fishing for each fishing year (1 September–31 August), including an allocation of the TAC for each stock subject to such limitations. Ling in Va has been managed by TAC since the 2001/02 fishing year.

Landings have exceeded both the advice given by MRI and the set TAC in all fishing years except 2001/2002 (Table 5.4.4). The reasons for the implementation errors are transfers of quota share between fishing years, conversion of TAC from one species to another and catches by Norway and the Faroe Islands by bilateral agreement. The level of those catches is known in advance but not taken into consideration by the Ministry when allocating TAC to Icelandic vessels. There is no minimum landing size for ling in Va.

### 5.3.5 Data available

#### 5.3.5.1 Landings and discards

Landings by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard. Discarding is banned by law in the Icelandic demersal fishery. Based on limited data, discard rates in the Icelandic longline fishery for ling are estimated very low (<1% in either numbers or weight) (WD-02). Measures in the management system such as converting quota share from one species to another are used by the fleet to a large extent and this is thought to discourage discarding in mixed fisheries. A description of the management system is given in the area overview.

#### 5.3.5.2 Length compositions

An overview of available length measurements is given in Table 5.4.5. Most of the measurements are from longlines. The number of available length measurements has been increasing in recent years in line with increased landings.

Length distributions from the Icelandic longline fleet are presented in Figure 5.4.5. Mean length decreased from 2000 to 2008 from around 91 cm to 79 cm. This may be the result of increased recruitment in recent years rather than increased fishing effort. However mean length increased slightly in 2009 and 2010 in the longline fishery to around 83–86 cm.

#### 5.3.5.3 Age compositions

A limited number of otoliths collected in 2010 (Table 5.4.6) were aged and a considerable difference in growth rates was observed between the older data and the 2010 data (WD-07). The plan is to explore the differences in growth rates in greater detail in the coming year by re-ageing previously aged material and having an otolith exchange with the Faroe Islands where ling is routinely aged.

#### 5.3.5.4 Weight-at-age

No data available.

#### 5.3.5.5 Maturity and natural mortality

No new data available (See stock annex for current estimates).

No information is available on natural mortality of ling in Va.

#### 5.3.5.6 Catch, effort and research vessel data

##### Catch per unit of effort and effort data from the commercial fleets

Figures 5.4.6 and 5.4.7 show nominal catch per unit effort (cpue) and effort in the Icelandic longline fishery. Cpue is calculated using all longline data where catches of the species were registered, with no standardization attempted. The cpue estimates of ling in Va have not been considered representative of stock abundance, however they do show the same trend as the survey data. Ling commercial cpue has been relatively stable over the time period since 1991, with the highest observed values in the last three years (Figures 5.4.6 and 5.4.7).

#### Icelandic survey data

Figure 5.4.8 shows both a recruitment index and the trends in biomass. Survey length distributions are shown in Figures 5.4.9 (abundance) and 5.4.10 (biomass). Ling in both the spring and autumn surveys are mainly found in the deeper waters south and west off Iceland. Both the total biomass index and the index of the fishable biomass (>40 cm) in the March survey declined by half from the late 1980s to 1989, but gradually decreased until 1995 (Figures 5.4.8a and b). In the years 1995 to 2003 these indices were half of the mean from 1985–1989. In 2003 to 2007, the indices increased sharply and to their highest observed value in 2007 or about 2 times higher than that observed in the late 1980s. The indices then fell sharply again in 2008 and 2009 and are at present at a similar level as in the late 1980s. The index of the large ling (90 cm and larger) shows similar trend as the total biomass index (Figure 5.4.8c). The recruitment index of ling, defined here as ling smaller than 40 cm, also showed a similar increase in 2003 to 2007 and has since then decreased by around 25% from its record high in 2007 (Figure 5.4.8d). The consistently high indices in the spring survey in 2007 suggest that it may have been an outlier because of unexplained changes in catchability rather than actual change in stock size.

The shorter autumn survey shows that biomass indices were low from 1996 to 2000, but have increased since then (Figures 5.4.8a, b, c). There is a consistency between the two survey series except the autumn survey biomass indices are still increasing in most recent years. Also there is an inconsistency in the recruitment indices (<40 cm), where the autumn survey shows much lower recruitment, in absolute terms, compared with the spring survey (Figure 5.4.8d). This discrepancy is likely a result of much lower catchability of small ling (due to different gears) in the autumn survey, where ling less than 40 cm has rarely been caught.

**Changes in spatial distribution as observed in surveys:** According to the spring survey most of the increase in recent years in ling abundance is in the western area, however an increase can be seen in most areas (Figure 5.4.11). A similar pattern is observed in the autumn survey.

### 5.3.6 Data analyses

No age-based assessments were possible due to lack of age-structured data, however a Gadget model of ling in Va was presented at the meeting.

#### Exploratory stock assessment on Ling in Va using Gadget

An exploratory stock assessment of ling in Va using the Gadget model was presented at the meeting. Gadget (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see [www.hafro.is/gadget](www.hafro.is/gadget)) is an age- and length based cohort model, where all the selection curves depend on the length of the fish and information on age is not a prerequisite but can be utilized if available. The commercial catch is modelled as three fleets with a fixed selection pattern described by a logistic function and total catch in tonnes specified for each time period (A detailed description of Gadget is given in WD-07 and in the stock annex for tusk in Va).

*Data used and model settings*

Model settings used in the exploratory Gadget model for ling in Va are described in more detail in Working Document 7; "*Ling in Va, exploratory Gadget stock assessment*" (WD7). Two alternative runs were presented based on different assumptions of growth. One using growth information from otoliths aged before 1999 and another as inferred from new ageing from 2010 (See 5.3.5.3)

*Results*

The model does capture the trends in the available data irrespective of the growth assumptions (Figure 5.4.13). The two different assumptions of growth do not have great impact on the estimates. Fishing mortality is estimated slightly higher assuming the faster growth regime in the 2010 data (Figure 5.4.14).

*Analysis of trends*

The decrease in mean length from commercial catches since 2000 is likely the result of increased abundance of smaller fish (as observed in the spring survey, rather than being a result of increasing targeting of smaller fish (Figure 5.4.5). The increase in 2009–2010 may therefore be the result of growth rather than change in the fishery.

Due to the above mentioned problems with the cpue series and the overall consistency in the survey indices, the Working Group has concluded that the fishery-independent data are the best indicator of stock trends of ling. Although the spring survey may not cover the full distributional depth range of ling in Icelandic waters, it has in the past been used as the basis of the ICES advice, since it covers longer historical time span than the autumn survey.

The relative changes in relative fishing mortality ($F_{proxy}$ = Yield/Survey biomass) for ling in Va (Figure 5.4.15) indicate that $F_{proxy}$ increased in the period from 1985 until 2000, but may have declined from 2001 to 2002 and remained fairly constant until 2008 (2007 survey year an outlier). However in 2009 the $F_{proxy}$ seems to have increased sharply again to a similar level as it was highest in the late 1990s early 2000s.

### 5.3.7 Comments on the assessment

WGDEEP-2011 agreed that the exploratory Gadget assessment presented at the meeting was promising and the estimates from the model and projections could very well become the basis for advice in the near future. However before that can happen the issue with the ageing (see 5.3.5.3) has to be resolved.

Both the Icelandic March and October survey-series suggest that ling abundance increased considerably in the period 2001–2007. The spring survey indicates a considerable drop in biomass since 2007 to a level similar to that observed in the late 1980s. It should be noted that the 2007 survey indices may be an artefact of changed catchability in that year.

#### 5.3.7.1 Management considerations

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, eg estimates of uncertainty of the input data of the GADGET model and simulation studies of various scenarios taking into account stochastic elements.

**Table 5.4.1. Ling in Va. Number of Icelandic boats participating in the ling fishery in Va.**

| Year | Longliners | Gillnetters | Trawlers |
|---|---|---|---|
| 2000 | 159 | 88 | 67 |
| 2001 | 144 | 113 | 57 |
| 2002 | 128 | 92 | 55 |
| 2003 | 136 | 73 | 53 |
| 2004 | 142 | 66 | 68 |
| 2005 | 151 | 60 | 72 |
| 2006 | 167 | 51 | 81 |
| 2007 | 155 | 58 | 77 |
| 2008 | 138 | 42 | 77 |
| 2009 | 141 | 46 | 67 |
| 2010 | 156 | 50 | 68 |

**Table 5.4.2. Percentage of ling catches by gear type of the Icelandic fleet.**

| Gear | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Longlines | 48.0 | 38.0 | 45.0 | 61.7 | 54.0 | 45.2 | 59.5 | 61.3 | 64.7 | 64.8 | 66.2 |
| Gillnets | 21.9 | 36.9 | 22.9 | 12.7 | 14.6 | 11.7 | 10.0 | 9.5 | 6.2 | 7.5 | 4.0 |
| Trawls | 22.7 | 17.2 | 23.3 | 16.2 | 17.6 | 25.1 | 19.8 | 21.2 | 19.5 | 16.0 | 15.6 |
| Other | 7.4 | 7.9 | 8.8 | 9.4 | 13.8 | 18.1 | 10.8 | 8.0 | 9.7 | 11.7 | 14.2 |

**Table 5.4.3. Ling in Va. Nominal landings in Source STATLANT database.**

| Year | Belgium | Faroe | France | Germany | Iceland | Norway | UK | Total |
|---|---|---|---|---|---|---|---|---|
| 1973 | 1080 | 984 | 0 | 586 | 3564 | 418 | 829 | 7461 |
| 1974 | 681 | 890 | 0 | 486 | 3868 | 318 | 532 | 6775 |
| 1975 | 736 | 732 | 23 | 375 | 3748 | 522 | 562 | 6698 |
| 1976 | 431 | 498 | 0 | 404 | 4538 | 502 | 268 | 6641 |
| 1977 | 442 | 613 | 0 | 254 | 3433 | 506 | 0 | 5248 |
| 1978 | 541 | 534 | 0 | 0 | 3439 | 484 | 0 | 4998 |
| 1979 | 508 | 536 | 0 | 0 | 3759 | 399 | 0 | 5202 |
| 1980 | 445 | 607 | 0 | 0 | 3149 | 423 | 0 | 4624 |
| 1981 | 196 | 489 | 0 | 0 | 3348 | 415 | 0 | 4448 |
| 1982 | 116 | 524 | 0 | 0 | 3733 | 612 | 0 | 4985 |
| 1983 | 128 | 644 | 0 | 0 | 4256 | 115 | 0 | 5143 |
| 1984 | 103 | 450 | 0 | 0 | 3304 | 21 | 0 | 3878 |
| 1985 | 59 | 384 | 0 | 0 | 2980 | 17 | 0 | 3440 |
| 1986 | 88 | 556 | 0 | 0 | 2946 | 4 | 0 | 3594 |
| 1987 | 157 | 657 | 0 | 0 | 4161 | 6 | 0 | 4981 |
| 1988 | 134 | 619 | 0 | 0 | 5098 | 10 | 0 | 5861 |
| 1989 | 95 | 614 | 0 | 0 | 4896 | 5 | 0 | 5610 |
| 1990 | 42 | 399 | 0 | 0 | 5153 | 0 | 0 | 5594 |
| 1991 | 69 | 530 | 0 | 0 | 5206 | 0 | 0 | 5805 |
| 1992 | 34 | 526 | 0 | 0 | 4556 | 0 | 0 | 5116 |
| 1993 | 20 | 501 | 0 | 0 | 4333 | 0 | 0 | 4854 |
| 1994 | 3 | 548 | 0 | 0 | 4049 | 0 | 0 | 4600 |
| 1995 | 0 | 463 | 0 | 0 | 3729 | 0 | 0 | 4192 |
| 1996 | 0 | 358 | 0 | 0 | 3670 | 20 | 0 | 4048 |
| 1997 | 0 | 299 | 0 | 0 | 3634 | 0 | 0 | 3933 |
| 1998 | 0 | 699 | 0 | 0 | 3603 | 0 | 0 | 4302 |
| 1999 | 0 | 500 | 0 | 0 | 3973 | 120 | 1 | 4594 |
| 2000 | 0 | 0 | 0 | 0 | 3196 | 67 | 3 | 3266 |
| 2001 | 0 | 362 | 0 | 2 | 2852 | 116 | 1 | 3333 |
| 2002 | 0 | 1629 | 0 | 0 | 2779 | 45 | 0 | 4453 |
| 2003 | 0 | 565 | 0 | 2 | 3855 | 108 | 5 | 4535 |
| 2004 | 0 | 739 | 0 | 1 | 3721 | 139 | 0 | 4600 |
| 2005 | 0 | 682 | 0 | 1 | 4311 | 180 | 20 | 5194 |
| 2006 | 0 | 960 | 0 | 1 | 6283 | 158 | 0 | 7402 |
| 2007 | 0 | 807 | 0 | 0 | 6592 | 185 | 0 | 7584 |
| 2008 | 0 | 1366 | 0 | 0 | 7736 | 176 | 0 | 9278 |
| 2009 | 0 | 1157 | 0 | 0 | 9613 | 172 | 0 | 10 942 |
| 2010 | 0 | 1095 | 0 | 0 | 9867 | 168 | 0 | 11 130 |

**Table 5.4.4. Ling in Va. Advice given by MRI, set national TAC by the Ministry of Fisheries and Agriculture and landings by fishing year (1 September–31 August). Landings for 2008/09 are preliminary.**

| Fishing year | MRI-advice | National-TAC | Landings |
|---|---|---|---|
| 1999/00 | | | 3961 |
| 2000/01 | | | 3451 |
| 2001/02 | 3000 | 3000 | 2968 |
| 2002/03 | 3000 | 3000 | 3715 |
| 2003/04 | 3000 | 3000 | 4608 |
| 2004/05 | 4000 | 4000 | 5238 |
| 2005/06 | 4500 | 5000 | 6961 |
| 2006/07 | 5000 | 5000 | 7617 |
| 2007/08 | 6000 | 7000 | 8560 |
| 2008/09 | 6000 | 7000 | 10 489 |
| 2009/10 | 6000 | 7000 | 11 046 |
| 2010/2011 | 7500 | 7500 | |

**Table 5.4.5. Ling in Va. Number of available length measurements from Icelandic commercial catches.**

| Year | Longlines | Gillnets | D. Seine | Trawls | Lobster Tr. | Total |
|---|---|---|---|---|---|---|
| 2000 | 1624 | 566 | 0 | 383 | 0 | 2573 |
| 2001 | 1661 | 493 | 0 | 37 | 0 | 2191 |
| 2002 | 1504 | 366 | 0 | 221 | 0 | 2091 |
| 2003 | 2404 | 300 | 0 | 137 | 143 | 2984 |
| 2004 | 2640 | 348 | 46 | 141 | 0 | 3175 |
| 2005 | 2323 | 31 | 101 | 349 | 150 | 2954 |
| 2006 | 3354 | 645 | 0 | 1157 | 401 | 5557 |
| 2007 | 3531 | 0 | 76 | 400 | 0 | 4007 |
| 2008 | 5847 | 357 | 15 | 819 | 150 | 7188 |
| 2009 | 8445 | 410 | 0 | 366 | 450 | 9671 |
| 2010 | 7322 | 57 | 0 | 2345 | 0 | 9724 |

**Table 5.4.6. Ling in Va. Number of available otoliths from Icelandic commercial catches.**

| Year | Longlines | Gillnets | D. Seine | Trawls | Lobster Tr. | Total |
|---|---|---|---|---|---|---|
| 2000 | 650 | 200 | 0 | 150 | 0 | 1000 |
| 2001 | 550 | 193 | 0 | 37 | 0 | 780 |
| 2002 | 519 | 166 | 0 | 150 | 0 | 835 |
| 2003 | 900 | 100 | 0 | 100 | 50 | 1150 |
| 2004 | 750 | 100 | 46 | 100 | 0 | 996 |
| 2005 | 750 | 0 | 0 | 181 | 50 | 981 |
| 2006 | 1137 | 288 | 0 | 450 | 100 | 1975 |
| 2007 | 1250 | 0 | 50 | 100 | 0 | 1400 |
| 2008 | 1950 | 150 | 0 | 315 | 50 | 2465 |
| 2009 | 2350 | 150 | 0 | 200 | 150 | 2850 |
| 2010 | 2498 | 50 | 0 | 850 | 0 | 3398 |

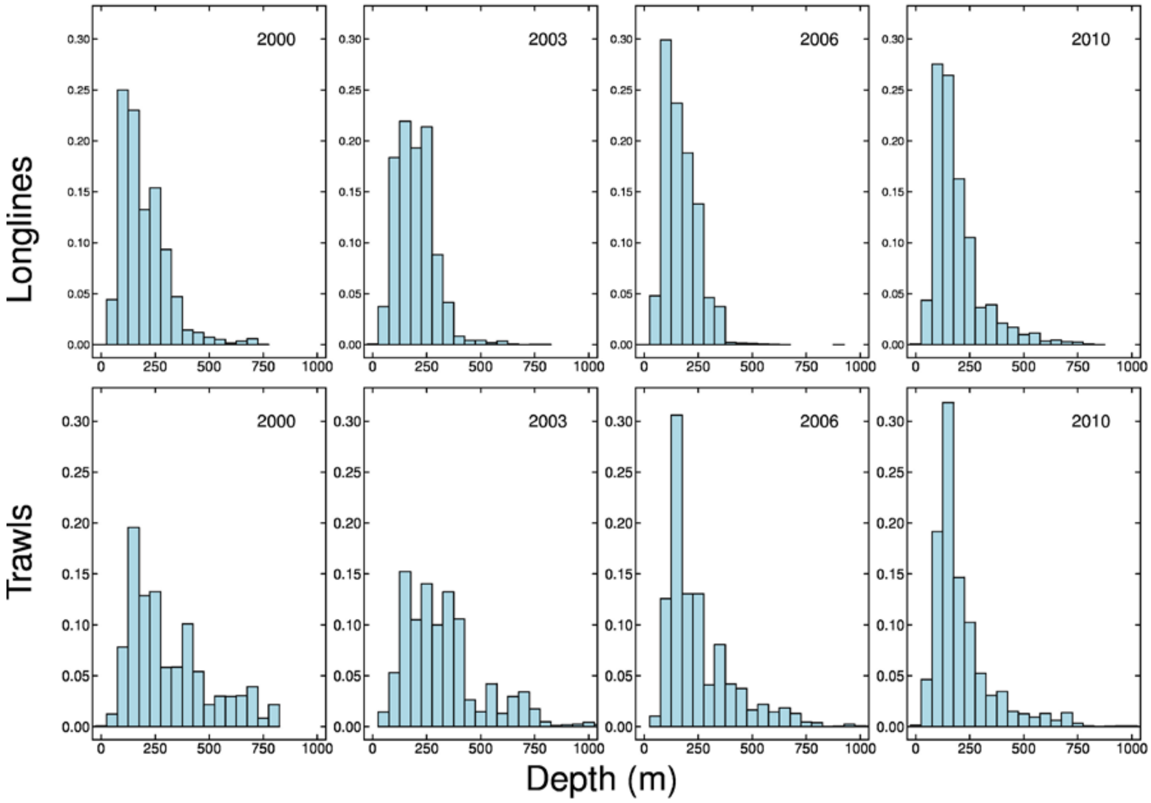



**Figure 5.4.1. Ling in Va. Depth distribution of ling catches from longlines and trawls from Icelandic logbooks.**

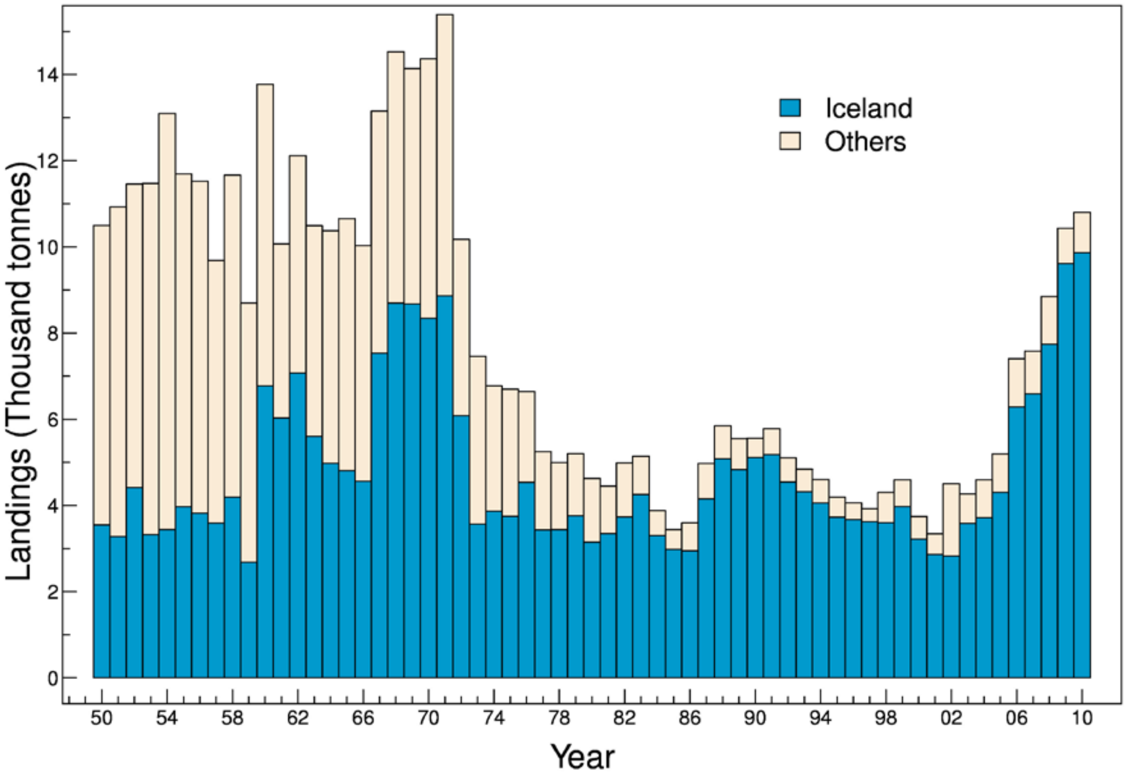



**Figure 5.4.4. Ling in Va. Nominal landings.**

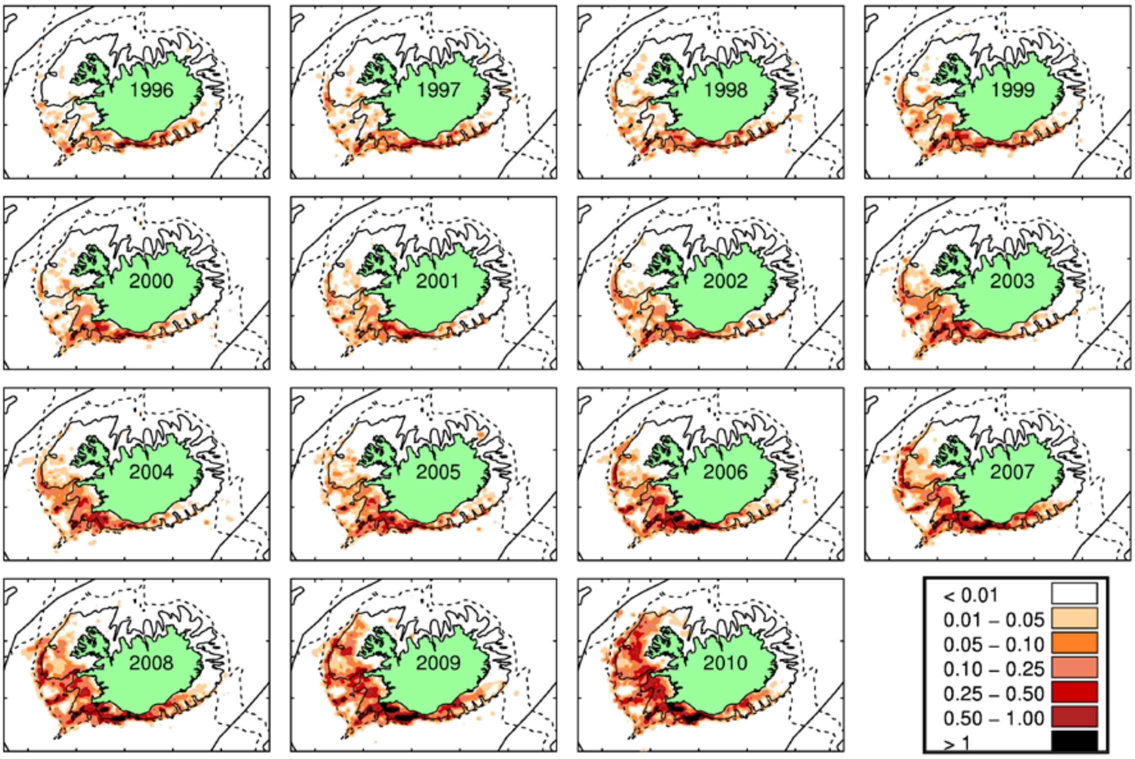



**Figure 5.4.2. Ling in Va. Geographical distribution (tonnes/square mile) of the Icelandic ling fishery in 1996–2010 as reported in logbooks by the Icelandic fleet. All gears combined.**

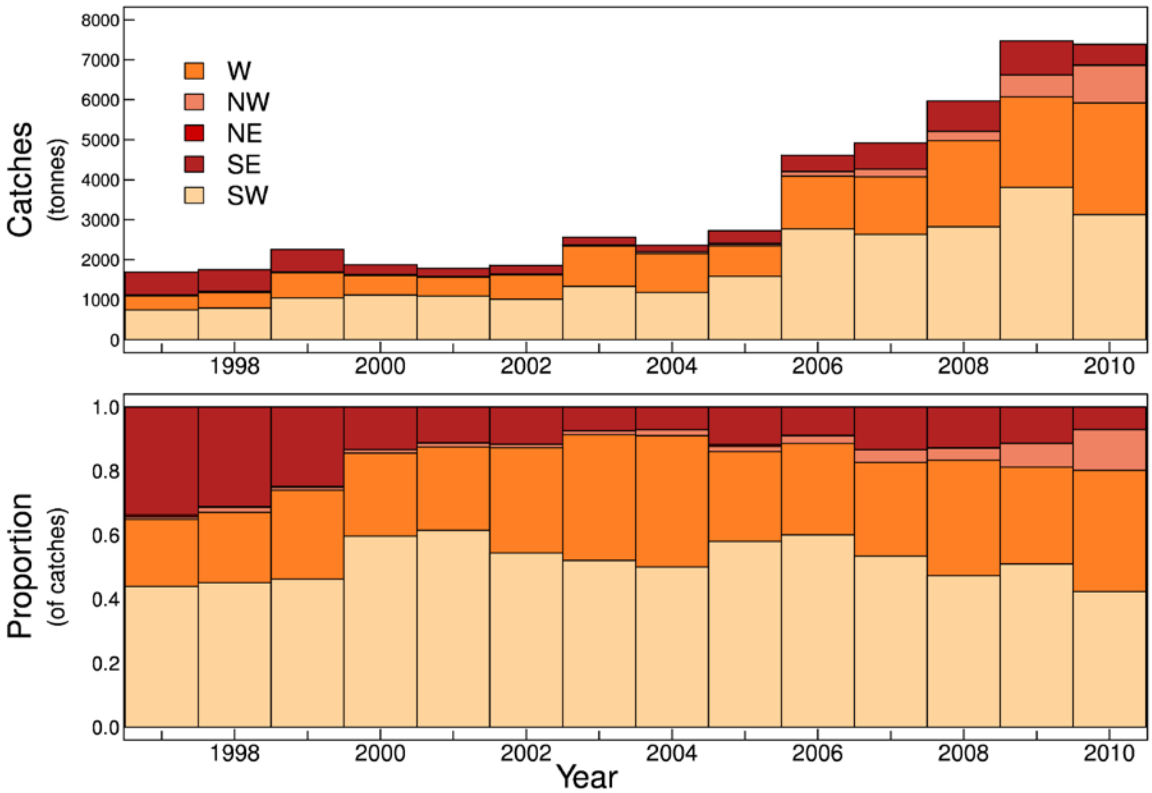



**Figure 5.4.3. Ling in Va. Changes in spatial distribution of ling catches as recorded in Icelandic logbooks.**

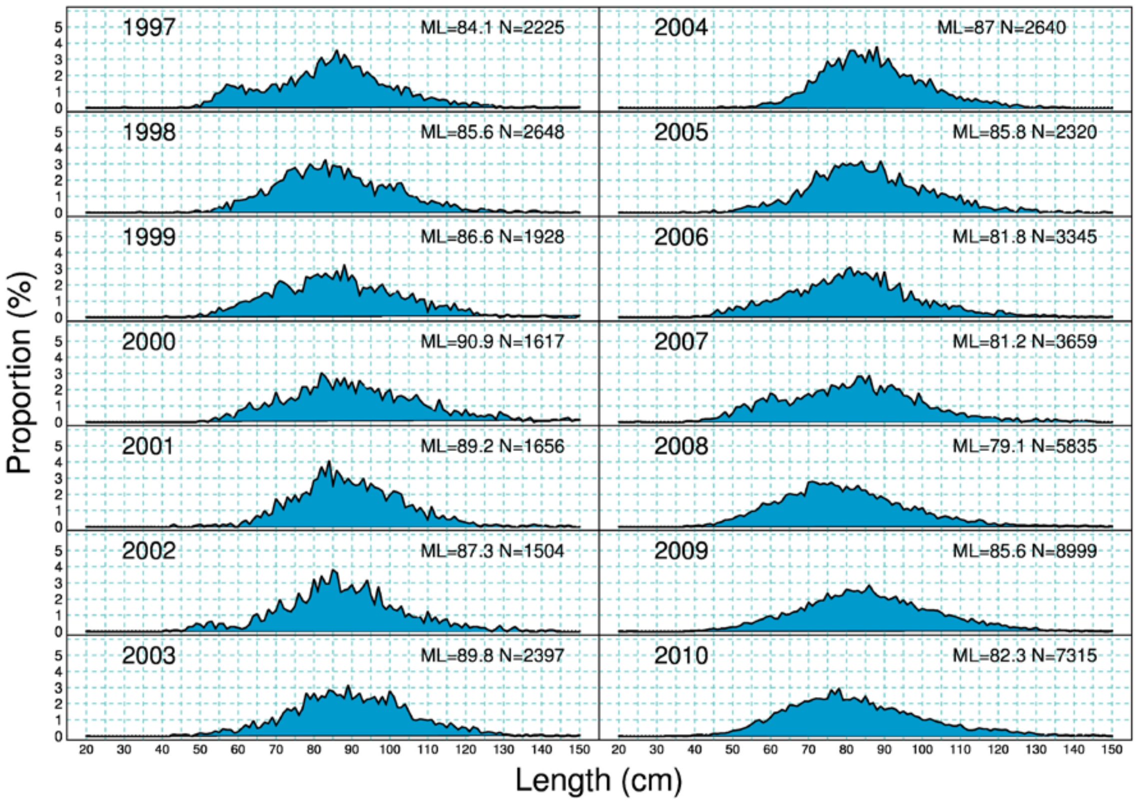



**Figure 5.4.5. Ling Va. Length distributions from the Icelandic longline fleet.**

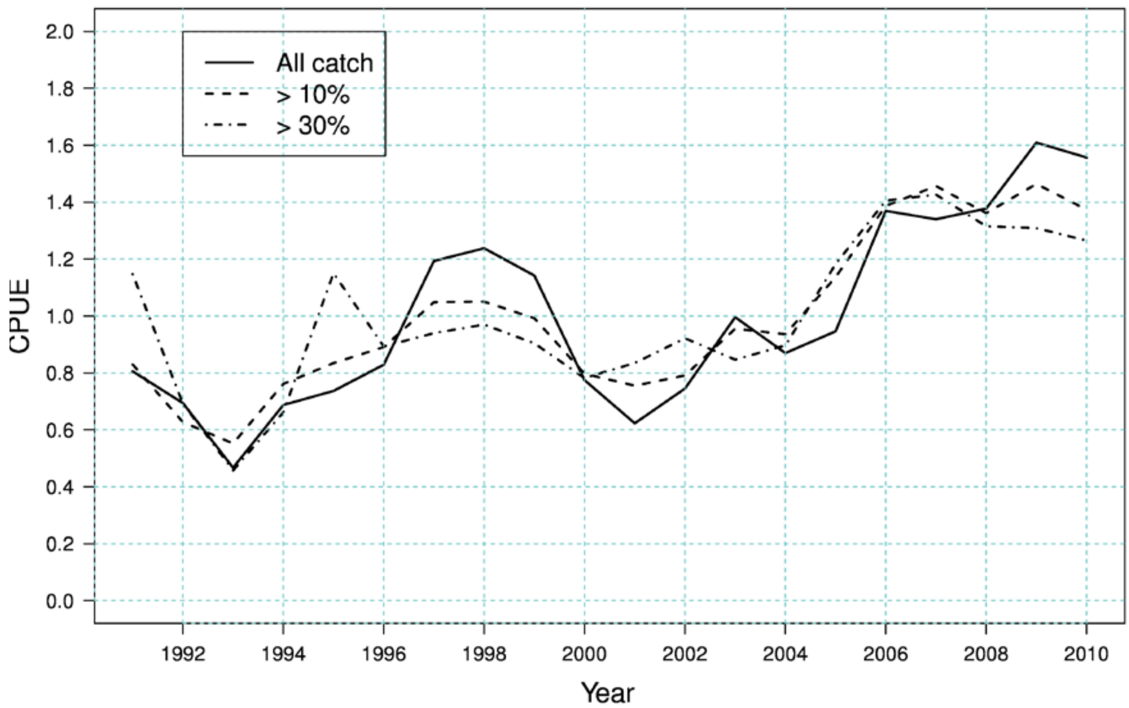



**Figure 5.4.6. Ling in Va. Index of raw cpue (sum(yield)/sum(effort)) of ling from the Icelandic longline fishery based on logbooks 1991–2010. The criteria for the calculations were all sets where ling was reported in the logbooks and where ling composed at least 10% and 30% of the total catch in each set.**

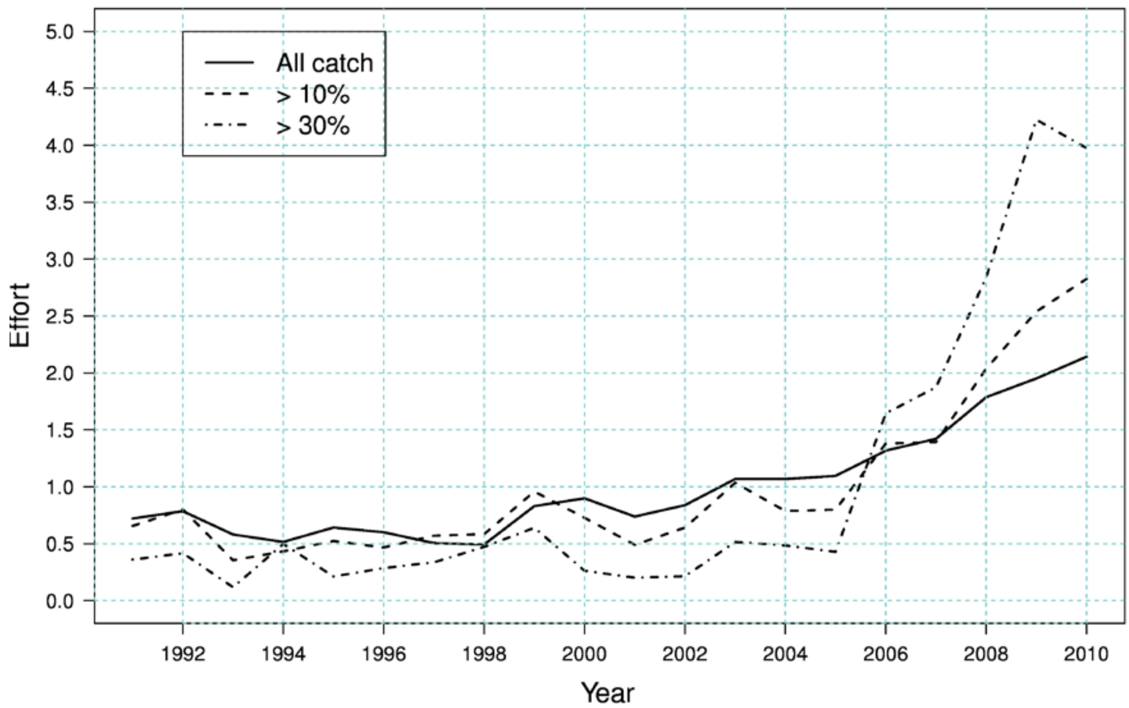



**Figure 5.4.7. Ling in Va. Index of raw effort of ling from the Icelandic longline fishery based on logbooks 1991–2010. The criteria for the calculations were all sets where ling was reported in the logbooks and where ling composed at least 10% and 30% of the total catch in each set.**

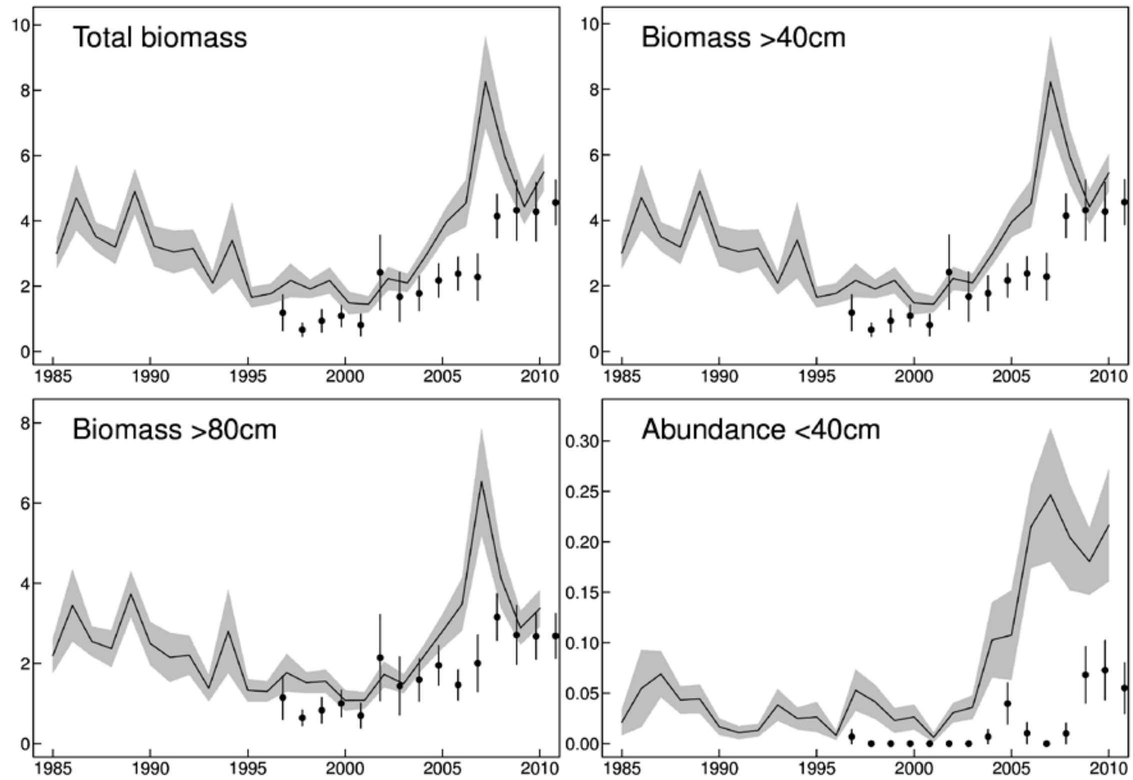



**Figure 5.4.8. Ling in Va. Ling in Va. Shown are a) total biomass indices, b) biomass indices larger than 40 cm, c) biomass indices larger than 80 cm and d) abundance indices smaller than 40 cm. The lines with shades show the Spring Survey indices from 1985 (SMB) and the points with the vertical line show the Autumn Survey (SMH) from 1997. The shades and vertical line indicate +/- 1 standard error.**

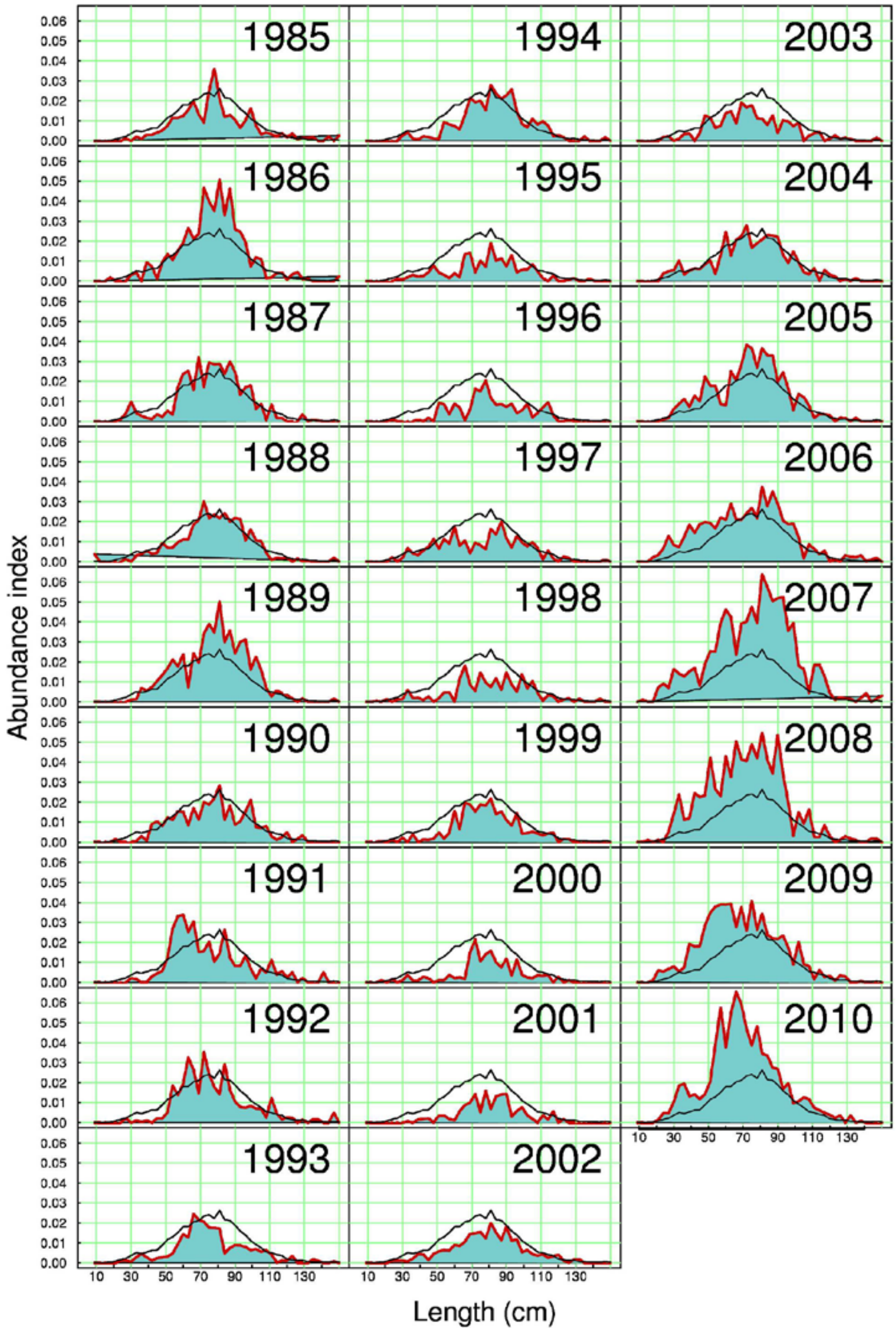



**Figure 5.4.9. Ling in Va. Abundance indices by length (3 cm grouping) of from the spring survey 1985 to 2010. Black line is the average over the whole period.**

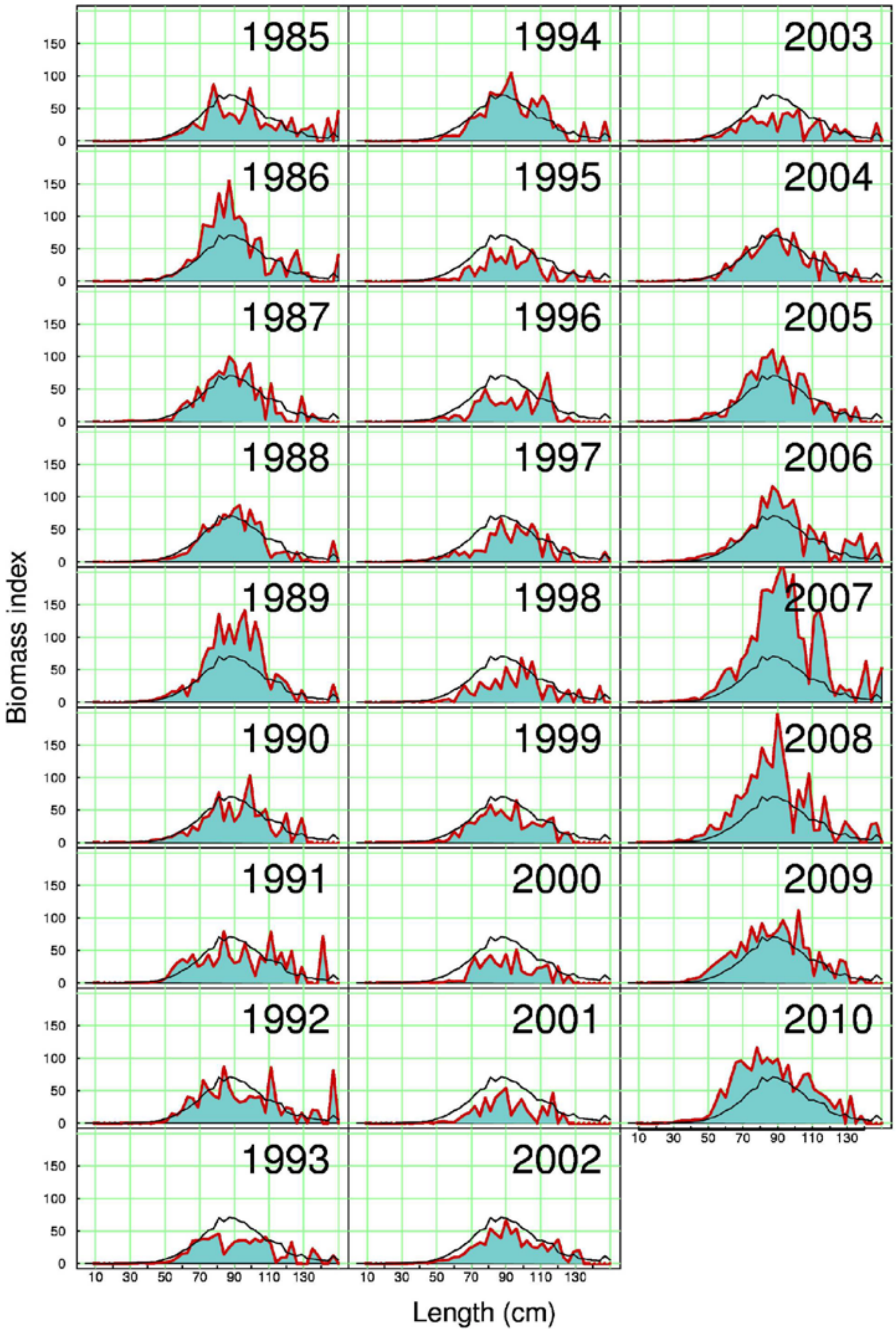



**Figure 5.4.10. Ling in Va. Biomass indices by length (3 cm grouping) of from the spring survey 1985 to 2010. Black line is the average over the whole period.**

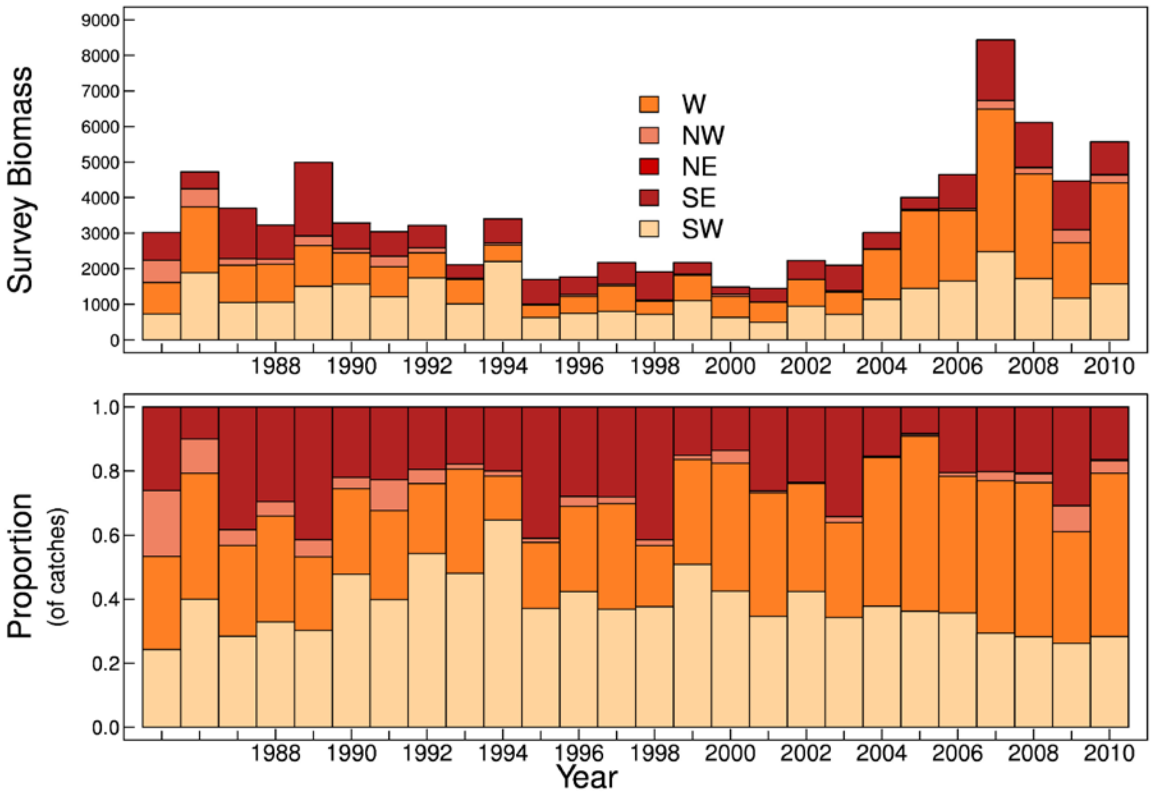



**Figure 5.4.11. Ling in Va. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportion of total (lower figure).**

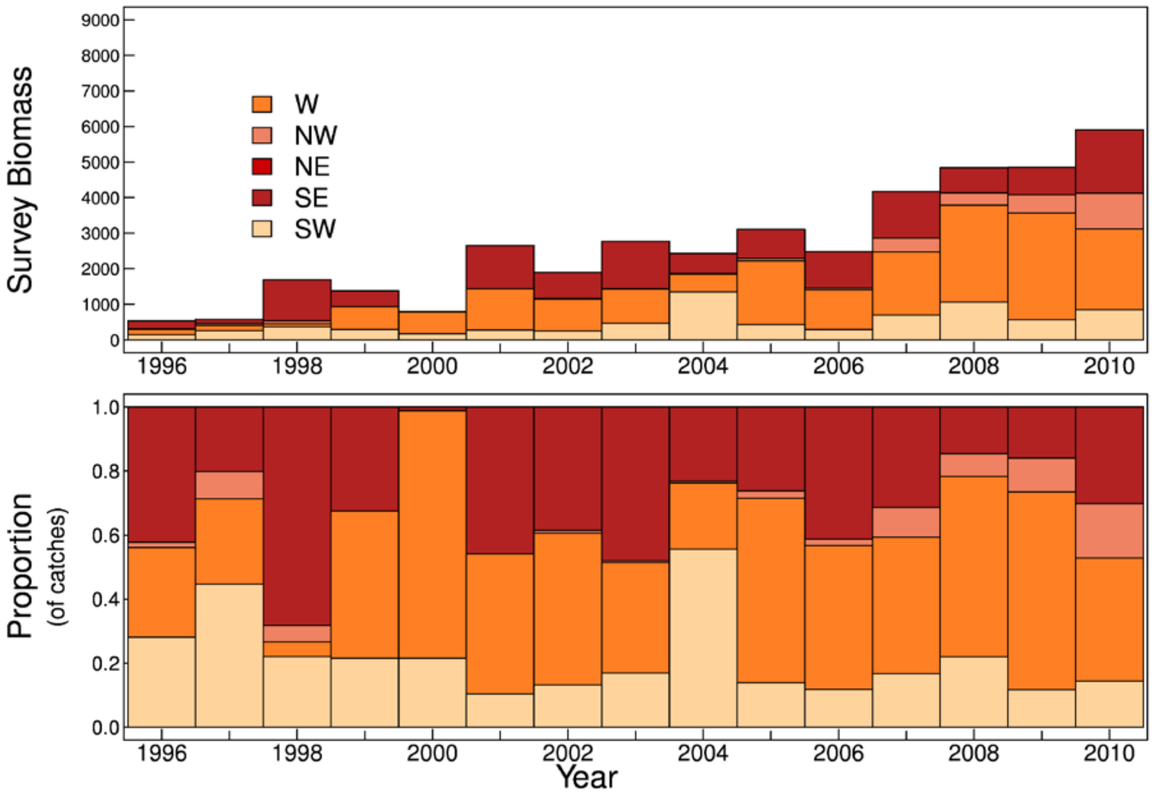



**Figure 5.4.12. Ling in Va. Estimated survey biomass in the autumn survey by year from different parts of the continental shelf (upper figure) and as proportion of total (lower figure).**


**Figure 5.4.15. Ling in Va. .Estimates of trends in relative fishing mortality (Yield/Survey Biomass [>39 cm]).**

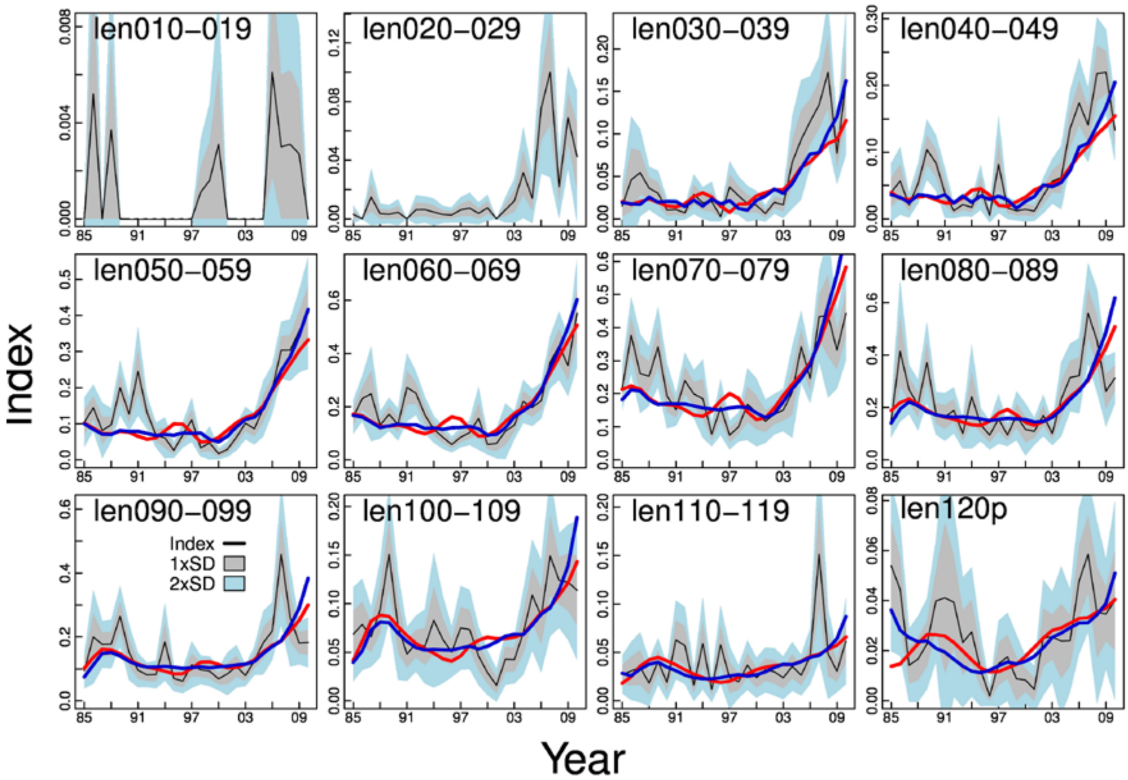



**Figure 5.4.13. Ling in Va. 10 cm aggregated survey indices (black line and shaded area) from the Icelandic Spring (March) survey and the fit from Gadget, using different growth data, from aged otoliths before 1999 (red line) and from 2010 (blue line).**

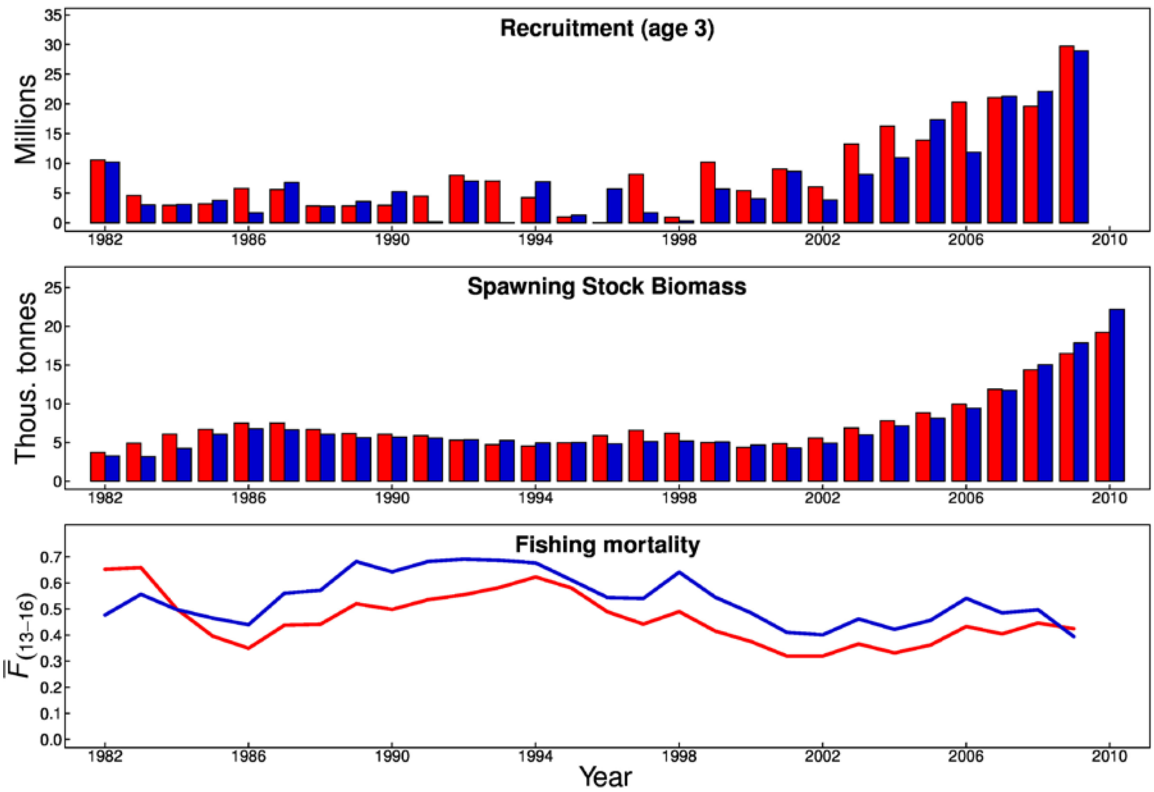



**Figure 5.4.14. Ling in Va. Estimates of recruitment, SSB and fishing mortality from the Gadget model, using different growth data, from aged otoliths before 1999 (red bars and line) and from 2010 (blue bars and line).**

# 5.4 Ling (*Molva Molva*) in Areas IIIa, IV, VI, VII, VIII, IX, X, XII, XIV

## 5.4.1 The fishery

Significant fisheries for ling have been conducted in Subareas III and IV at least since the 1870s, pioneered by Swedish longliners. Since the mid-1900s and currently, the major targeted ling fishery in IVa is by Norwegian longliners conducted around Shetland and in the Norwegian Deep. There is little activity in IIIa. Of the total Norwegian 2010 landings, 83% were taken by longlines, 8% by gillnets, and the remainder by trawls. The bulk of the landings from other countries were taken by trawls as bycatches in other fisheries, and the landings from the UK (Scotland) are the most substantial. The comparatively low landings from the central and southern North Sea (IVb,c), are only bycatches from various other fisheries.

The major directed ling fishery in VI is the Norwegian longline fishery. Trawl fisheries by the UK (Scotland) and France primarily take ling as bycatch.

When Areas III–IV and VI–XIV are pooled over the period 1988–2010, 40% of the landings were in Area IV, 29% in Area VI, and 26% in Area VI.

In Subarea VII the Divisions b, c, and g–k provide most of the landings of ling. Norwegian landings, and some Irish and Spanish landings are from targeted longline fisheries, whereas other landings are primarily bycatches in trawl fisheries. Data split by gear type were not available for all countries, but the bulk of the total landings (at least 60–70%) were taken by trawls in these areas.

In Subareas VIII and IX, XII and XIV all landings are bycatches in various fisheries.

### 5.4.1.1 Landings trends

Landing statistics by nation in the period 1988–2010 are in Tables 5.5.1 and 5.5.2 and Figures 5.5.1 and 5.5.2.

There was a decline in landings from 1988 to 2003, afterwards the landings have been stable. When Subareas III–IV are pooled, the total landings averaged around 32 000 t in 1988–1998 and then declined to an average of around 15 000 t in 2003–2010. The decline has been simultaneous in the main Subareas IV, VI and VII, but Subarea VII has had a greater reduction in landings than in Subareas IV and VI.

### 5.4.1.2 ICES Advice

**Advice for 2011:** Constrain catches to recent average (2003–2008) and a reduction in catches should be considered in order to be consistent with the MSY.

### 5.4.1.3 Management

Since 2003, the EU has set TACs for EU vessels fishing in community waters and waters not under the control of Third Countries. Between 2003 and 2007, ling was covered by the biennial regulations for deep-water species; however, from 2008 it has been included in annual TAC regulation covering other species.

EU TACs for ling in 2011 are:

| | |
|---|---|
| Subarea IIIa and EU waters of IIIc,d: | 92 t; |
| EU waters of Subarea IV: | 2428 t; |
| Subarea VI, VII, VIII, IX, X, XII, XIV: | 7804 t. |

There is no species-specific regulation in the Norwegian EEZ, but a TAC is negotiated for Norwegian vessels fishing in EU waters. The quota of ling for Norway in the EU zone was for 2010, 6140 t. The quota for the EU in Norwegian waters in Area IV was 850 t.

### 5.4.2 Data available

#### 5.4.2.1 Landings and discards

Landings were available for all relevant fleets. Within the Norwegian EEZ and for Norwegian vessels fishing elsewhere discarding is prohibited and so there is no information on discarding. Discard data from some fleets have been reported previously to WGDEEP.

#### 5.4.2.2 Length compositions

Average fish length from 1988 to 2009 is presented in Helle and Pennington WD 2011.

In this period the mean length has varied around 88 cm without any clear trend. Russian investigations in Subdivision VIb1 showed that fish length varied from 49 to 143 cm, mainly 80–120 cm (Figure 5.5.3; Vinnichenko *et al.*, WD 2010).

#### 5.4.2.3 Age compositions

No new age compositions were available.

#### 5.4.2.4 Weight-at-age

No new data were presented.

#### 5.4.2.5 Maturity and natural mortality

Russian investigations in Subdivision VIb1 showed that the bulk of catches was made up of mature fish. Males were the most abundant (58%). Most of them were either in the condition of post-spawning recovery or spawned a part of reproductive stock (maturity stage 6–4). Gonads of mature females were in the condition of post-spawning recovery (Figure 5.5.4; Vinnichenko *et al.*, WD 2010).

#### 5.4.2.6 Catch, effort and research vessel data

Catch and effort data for Norwegian longliners were updated for the period 2000 up to 2009 (Table 5.5.3, Figure 5.5.5). Trends from Danish trawlers are presented (Figure 5.5.6). No research vessel data were available.

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 tonnes in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. An analysis based on these data is in Helle and Pennington, WD, 2011.

A nominal cpue series for Danish trawlers fishing in IIIa and IV was available for the period 1992–2010 (Figure 5.5.6).

The historical series of cpues (kg/day) of the Basque Country OTB fleet in Subareas VI, VII and VIII since 1996 varies with no apparent trend since 2001 (Figure 5.5.7).

### 5.4.3 Data analyses

No analytical assessments attempted this year.

A source of information on abundance trends was the cpue series from the Norwegian longliners presented by Helle and Pennington (WD, 2011). The number of longliners has declined in recent years, from 72 to 35 in the period 2000–2010. The number of fishing days with ling catch has remained relatively stable in Division IVa. In Division VIa the number of fishing days has varied from 23 in 2005 to six days in 2009 with an average of 13 days (Helle and Pennington WD, 2011). The number of hooks set per day have remained stable in Subarea VIa, while there has been a slight increase in Subareas IVa and VIb (Figure 5.5.8).

In Table 5.5.3 are estimates of cpue together with its standard error based on the Norwegian official logbooks and the same results are shown in Figure 5.5.8.

There was an overall increase in cpue in Areas IVa and VIb, while there is no apparent trend in Area VIa.

A standardised series will be developed in preparation for WGDEEP 2012.

### 5.4.4 Comments on the assessment

The abundance indices should be interpreted with caution because the series have not been standardised.

The cpue series of the main fleet landing ling (Norwegian longliners) suggests that the abundance has increased or remained stable in all areas.

The Danish series from trawlers extending back to 1992 for Areas IIIa and IV display variation without any apparent trends until the three last years for which there has been a slight increase (Figure 5.5.6).

The historical series of cpues (kg/day) of the Basque Country OTB fleet in Subareas VI, VII and VIII since 1996 varied with no apparent trend since 2001 (Figure 5.5.7).

### 5.4.5 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, eg $F_{proxy}$, CUSUM.

**Table 5.5.1. Ling IIIa, IVa, VI, VII, VIII, IX, XII and XIV. WG estimates of landings.**

**LING III**

| Year | Belgium | Denmark | Germany | Norway | Sweden | E & W | Total |
|---|---|---|---|---|---|---|---|
| 1988 | 2 | 165 | - | 135 | 29 | - | 331 |
| 1989 | 1 | 246 | - | 140 | 35 | - | 422 |
| 1990 | 4 | 375 | 3 | 131 | 30 | - | 543 |
| 1991 | 1 | 278 | - | 161 | 44 | - | 484 |
| 1992 | 4 | 325 | - | 120 | 100 | - | 549 |
| 1993 | 3 | 343 | - | 150 | 131 | 15 | 642 |
| 1994 | 2 | 239 | + | 116 | 112 | - | 469 |
| 1995 | 4 | 212 | - | 113 | 83 | - | 412 |
| 1996 | | 212 | 1 | 124 | 65 | - | 402 |
| 1997 | | 159 | + | 105 | 47 | - | 311 |
| 1998 | | 103 | - | 111 | - | - | 214 |
| 1999 | | 101 | - | 115 | - | - | 216 |
| 2000 | | 101 | + | 96 | 31 | | 228 |
| 2001 | | 125 | + | 102 | 35 | | 262 |
| 2002 | | 157 | 1 | 68 | 37 | | 263 |
| 2003 | | 156 | | 73 | 32 | | 261 |
| 2004 | | 130 | 1 | 70 | 31 | | 232 |
| 2005 | | 106 | 1 | 72 | 31 | | 210 |
| 2006 | | 95 | 2 | 62 | 29 | | 188 |
| 2007 | | 82 | 3 | 68 | 21 | | 174 |
| 2008 | | 59 | 1 | 88 | 20 | | 168 |
| 2009 | | 65 | 1 | 62 | 21 | | 149 |
| 2010* | | 58 | | 64 | | | 122 |

***Preliminary.**

**Table 5.5.1. (continued).**

**LING IVa**

| Year | Belgium | Denmark | Faroes | France | Germany | Neth. | Norway | Sweden1) | E&W | N.I. | Scot. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 3 | 408 | 13 | 1143 | 262 | 4 | 6473 | 5 | 55 | 1 | 2856 | 11 223 |
| 1989 | 1 | 578 | 3 | 751 | 217 | 16 | 7239 | 29 | 136 | 14 | 2693 | 11 677 |
| 1990 | 1 | 610 | 9 | 655 | 241 | - | 6290 | 13 | 213 | - | 1995 | 10 027 |
| 1991 | 4 | 609 | 6 | 847 | 223 | - | 5799 | 24 | 197 | + | 2260 | 9969 |
| 1992 | 9 | 623 | 2 | 414 | 200 | - | 5945 | 28 | 330 | 4 | 3208 | 10 763 |
| 1993 | 9 | 630 | 14 | 395 | 726 | - | 6522 | 13 | 363 | - | 4138 | 12 810 |
| 1994 | 20 | 530 | 25 | n/a | 770 | - | 5355 | 3 | 148 | + | 4645 | 11 496 |
| 1995 | 17 | 407 | 51 | 290 | 425 | - | 6148 | 5 | 181 | | 5517 | 13 041 |
| 1996 | 8 | 514 | 25 | 241 | 448 | | 6622 | 4 | 193 | | 4650 | 12 705 |
| 1997 | 3 | 643 | 6 | 206 | 320 | | 4715 | 5 | 242 | | 5175 | 11 315 |
| 1998 | 8 | 558 | 19 | 175 | 176 | | 7069 | - | 125 | | 5501 | 13 631 |
| 1999 | 16 | 596 | n.a. | 293 | 141 | | 5077 | | 240 | | 3447 | 9810 |
| 2000 | 20 | 538 | 2 | 147 | 103 | | 4780 | 7 | 74 | | 3576 | 9246 |
| 2001 | | 702 | | 128 | 54 | | 3613 | 6 | 61 | | 3290 | 7854 |
| 2002 | 6 | 578 | 24 | 117 | | | 4509 | | 59 | | 3779 | 9072 |
| 2003 | 4 | 779 | 6 | 121 | 62 | | 3122 | 5 | 23 | | 2311 | 6433 |
| 2004 | | 575 | 11 | 64 | 34 | | 3753 | 2 | 15 | | 1852 | 6306 |
| 2005 | | 698 | 18 | 47 | 55 | | 4078 | 4 | 12 | | 1537 | 6449 |
| 2006 | | 637 | 2 | 73 | 51 | | 4443 | 3 | 55 | | 1455 | 6719 |
| 2007 | | 412 | - | 100 | 60 | | 4109 | 3 | 31 | | 1143 | 5858 |
| 2008 | | 446 | 1 | 182 | 52 | | 4726 | 12 | 20 | | 1820 | 7259 |
| 2009 | | 427 | 7 | 90 | 27 | | 4613 | 7 | 19 | | 2218 | 7412 |
| 2010* | | 433 | | 43 | | | 3836 | | 27 | | 2008 | 6347 |

***Preliminary. (1) Includes IVb 1988–1993.**

**Table 5.5.1. (continued).**

**LING IVbc**

| Year | Belgium | Denmark | France | Sweden | Norway | E & W | Scotland | Germany | Netherlands | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | | | 100 | 173 | 106 | - | | 379 |
| 1989 | | | | | 43 | 236 | 108 | - | | 387 |
| 1990 | | | | | 59 | 268 | 128 | - | | 455 |
| 1991 | | | | | 51 | 274 | 165 | - | | 490 |
| 1992 | | 261 | | | 56 | 392 | 133 | - | | 842 |
| 1993 | | 263 | | | 26 | 412 | 96 | - | | 797 |
| 1994 | | 177 | | | 42 | 40 | 64 | - | | 323 |
| 1995 | | 161 | | | 39 | 301 | 135 | 23 | | 659 |
| 1996 | | 131 | | | 100 | 187 | 106 | 45 | | 569 |
| 1997 | 33 | 166 | 1 | 9 | 57 | 215 | 170 | 48 | | 699 |
| 1998 | 47 | 164 | 5 | | 129 | 128 | 136 | 18 | | 627 |
| 1999 | 35 | 138 | - | | 51 | 106 | 106 | 10 | | 446 |
| 2000 | 59 | 101 | 0 | 8 | 45 | 77 | 90 | 4 | | 384 |
| 2001 | 46 | 81 | 1 | 3 | 23 | 62 | 60 | 6 | 2 | 284 |
| 2002 | 38 | 91 | | 4 | 61 | 58 | 43 | 12 | 2 | 309 |
| 2003 | 28 | 0 | | 3 | 83 | 40 | 65 | 14 | 1 | 234 |
| 2004 | 48 | 71 | | 1 | 54 | 23 | 24 | 19 | 1 | 241 |
| 2005 | 28 | 56 | | 5 | 20 | 17 | 10 | 13 | | 149 |
| 2006 | 26 | 53 | | 8 | 16 | 20 | 8 | 13 | | 144 |
| 2007 | 28 | 42 | 1 | 5 | 48 | 20 | 5 | 10 | | 159 |
| 2008 | 15 | 40 | 2 | 5 | 87 | 25 | 15 | 11 | | 200 |
| 2009 | 19 | 38 | 2 | 13 | 58 | 29 | 137 | 17 | 1 | **314** |
| 2010* | | 55 | 1 | | 50 | 25 | 10 | | | **141** |

***Preliminary.**

**Table 5.5.1. (continued).**

**LING VIa**

| Year | Belgium | Denmark | Faroes | France [1] | Germany | Ireland | Norway | Spain[2] | E&W | IOM | N.I. | Scot. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 4 | + | - | 5381 | 6 | 196 | 3392 | 3575 | 1075 | - | 53 | 874 | 14 556 |
| 1989 | 6 | 1 | 6 | 3417 | 11 | 138 | 3858 | | 307 | + | 6 | 881 | 8631 |
| 1990 | - | + | 8 | 2568 | 1 | 41 | 3263 | | 111 | - | 2 | 736 | 6730 |
| 1991 | 3 | + | 3 | 1777 | 2 | 57 | 2029 | | 260 | - | 10 | 654 | 4795 |
| 1992 | - | 1 | - | 1297 | 2 | 38 | 2305 | | 259 | + | 6 | 680 | 4588 |
| 1993 | + | + | - | 1513 | 92 | 171 | 1937 | | 442 | - | 13 | 1133 | 5301 |
| 1994 | 1 | 1 | | 1713 | 134 | 133 | 2034 | 1027 | 551 | - | 10 | 1126 | 6730 |
| 1995 | - | 2 | 0 | 1970 | 130 | 108 | 3156 | 927 | 560 | n/a | | 1994 | 8847 |
| 1996 | | | 0 | 1762 | 370 | 106 | 2809 | 1064 | 269 | | | 2197 | 8577 |
| 1997 | | | 0 | 1631 | 135 | 113 | 2229 | 37 | 151 | | | 2450 | 6746 |
| 1998 | | | | 1531 | 9 | 72 | 2910 | 292 | 154 | | | 2394 | 7362 |
| 1999 | | | | 941 | 4 | 73 | 2997 | 468 | 152 | | | 2264 | 6899 |
| 2000 | + | + | | 737 | 3 | 75 | 2956 | 708 | 143 | | | 2287 | 6909 |
| 2001 | | | | 774 | 3 | 70 | 1869 | 142 | 106 | | | 2179 | 5143 |
| 2002 | | | | 402 | 1 | 44 | 973 | 190 | 65 | | | 2452 | 4127 |
| 2003 | | | | 315 | 1 | 88 | 1477 | 0 | 108 | | | 1257 | 3246 |
| 2004 | | | | 252 | 1 | 96 | 791 | 2 | 8 | | | 1619 | 2769 |
| 2005 | | | 18 | 423 | | 89 | 1389 | 0 | 1 | | | 1108 | 3028 |
| 2006 | | | 5 | 499 | 2 | 121 | 998 | 0 | 137 | | | 811 | 2573 |
| 2007 | | | 88 | 626 | 2 | 45 | 1544 | 0 | 33 | | | 782 | 3120 |
| 2008 | | | 21 | 1004 | 2 | 49 | 1265 | 0 | 1 | | | 608 | 2950 |
| 2009 | | | 30 | 418 | | 85 | 828 | 116 | 1 | | | 846 | **2324** |
| 2010* | | | 23 | 475 | | 164 | 989 | 3 | 0 | | | 1377 | **3031** |

***Preliminary. [1] Includes VIb until 1996 [2] Includes minor landings from VIb.**

**Table 5.5.1. (continued).**

**LING VIb**

| Year | Faroes | France [2] | Germany | Ireland | Norway | Spain [3] | E & W | N.I. | Scotland | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 196 | | - | - | 1253 | | 93 | - | 223 | | 1765 |
| 1989 | 17 | | - | - | 3616 | | 26 | - | 84 | | 3743 |
| 1990 | 3 | | - | 26 | 1315 | | 10 | + | 151 | | 1505 |
| 1991 | - | | - | 31 | 2489 | | 29 | 2 | 111 | | 2662 |
| 1992 | 35 | | + | 23 | 1713 | | 28 | 2 | 90 | | 1891 |
| 1993 | 4 | | + | 60 | 1179 | | 43 | 4 | 232 | | 1522 |
| 1994 | 104 | | - | 44 | 2116 | | 52 | 4 | 220 | | 2540 |
| 1995 | 66 | | + | 57 | 1308 | | 84 | | 123 | | 1638 |
| 1996 | 0 | | 124 | 70 | 679 | | 150 | | 101 | | 1124 |
| 1997 | 0 | | 46 | 29 | 504 | | 103 | | 132 | | 814 |
| 1998 | | 1 | 10 | 44 | 944 | | 71 | | 324 | | 1394 |
| 1999 | | 26 | 25 | 41 | 498 | | 86 | | 499 | | 1175 |
| 2000 | + | 18 | 31 | 19 | 1172 | | 157 | | 475 | 7 | 1879 |
| 2001 | + | 16 | 3 | 18 | 328 | | 116 | | 307 | | 788 |
| 2002 | | 2 | 2 | 2 | 289 | | 65 | | 173 | | 533 |
| 2003 | | 2 | 3 | 25 | 485 | | 34 | | 111 | | 660 |
| 2004 | + | 9 | 3 | 6 | 717 | | 6 | | 141 | 182 | 1064 |
| 2005 | | 31 | 4 | 17 | 628 | | 9 | | 97 | 356 | 1142 |
| 2006 | 30 | 4 | 3 | 48 | 1171 | | 19 | | 130 | 6 | 1411 |
| 2007 | 4 | 10 | 35 | 54 | 971 | | 7 | | 183 | 50 | 1314 |
| 2008* | 69 | 6 | 20 | 47 | 1021 | | 1 | | 135 | 214 | 1513 |
| 2009 | 249 | 5 | 6 | 39 | 1859 | | 3 | | 439 | 35 | **2635** |
| 2010* | 215 | 2 | | 34 | 2042 | | 0 | | 394 | | **2687** |

***Preliminary. [1] Includes XII. [2] Until 1966 included in VIa. [3] Included in Ling VIa.**

**LING VII**

| Year | France | Total |
|---|---|---|
| 1988 | 5057 | 5057 |
| 1989 | 5261 | 5261 |
| 1990 | 4575 | 4575 |
| 1991 | 3977 | 3977 |
| 1992 | 2552 | 2552 |
| 1993 | 2294 | 2294 |
| 1994 | 2185 | 2185 |
| 1995 | -1 | |
| 1996 | -1 | |
| 1997 | -1 | |
| 1998 | -1 | |
| 1999 | -1 | |

***Preliminary.**

**Table 5.5.1. (continued).**

**LING VIIa**

| Year | Belgium | France | Ireland | E & W | IOM | N.I. | Scotland | Total |
|---|---|---|---|---|---|---|---|---|
| 1988 | 14 | -1 | 100 | 49 | - | 38 | 10 | 211 |
| 1989 | 10 | -1 | 138 | 112 | 1 | 43 | 7 | 311 |
| 1990 | 11 | -1 | 8 | 63 | 1 | 59 | 27 | 169 |
| 1991 | 4 | -1 | 10 | 31 | 2 | 60 | 18 | 125 |
| 1992 | 4 | -1 | 7 | 43 | 1 | 40 | 10 | 105 |
| 1993 | 10 | -1 | 51 | 81 | 2 | 60 | 15 | 219 |
| 1994 | 8 | -1 | 136 | 46 | 2 | 76 | 16 | 284 |
| 1995 | 12 | 9 | 143 | 106 | 1 | -2 | 34 | 305 |
| 1996 | 11 | 6 | 147 | 29 | - | -2 | 17 | 210 |
| 1997 | 8 | 6 | 179 | 59 | 2 | -2 | 10 | 264 |
| 1998 | 7 | 7 | 89 | 69 | 1 | -2 | 25 | 198 |
| 1999 | 7 | 3 | 32 | 29 | | -2 | 13 | 84 |
| 2000 | 3 | 2 | 18 | 25 | | | 25 | 73 |
| 2001 | 6 | 3 | 33 | 20 | | | 31 | 87 |
| 2002 | 7 | 6 | 91 | 15 | | | 7 | 119 |
| 2003 | 4 | 4 | 75 | 18 | | | 11 | 112 |
| 2004 | 3 | 2 | 47 | 11 | | | 34 | 97 |
| 2005 | 4 | 2 | 28 | 12 | | | 15 | 61 |
| 2006 | 2 | 1 | 50 | 8 | | | 27 | 88 |
| 2007 | 2 | 0 | 32 | 1 | | | 8 | 43 |
| 2008 | 1 | 0 | 13 | 1 | | | 0 | **15** |
| 2009 | 1 | 36 | 9 | 2 | | | 0 | **48** |
| 2010* | | 28 | 15 | 1 | | | 0 | **44** |

**Preliminary. (1) French catches in VII not split into divisions, see Ling VII. (2) Included with UK (EW).**

**Table 5.5.1. (continued).**

**LING VII b, c**

| Year | France (1) | Germany | Ireland | Norway | Spain (3) | E & W | N.I. | Scotland | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | -1 | - | 50 | 57 | | 750 | - | 8 | 865 |
| 1989 | -1 | + | 43 | 368 | | 161 | - | 5 | 577 |
| 1990 | -1 | - | 51 | 463 | | 133 | - | 31 | 678 |
| 1991 | -1 | - | 62 | 326 | | 294 | 8 | 59 | 749 |
| 1992 | -1 | - | 44 | 610 | | 485 | 4 | 143 | 1286 |
| 1993 | -1 | 97 | 224 | 145 | | 550 | 9 | 409 | 1434 |
| 1994 | -1 | 98 | 225 | 306 | | 530 | 2 | 434 | 1595 |
| 1995 | 78 | 161 | 465 | 295 | | 630 | -2 | 315 | 1944 |
| 1996 | 57 | 234 | 283 | 168 | | 1117 | -2 | 342 | 2201 |
| 1997 | 65 | 252 | 184 | 418 | | 635 | -2 | 226 | 1780 |
| 1998 | 32 | 1 | 190 | 89 | | 393 | | 329 | 1034 |
| 1999 | 51 | 4 | 377 | 288 | | 488 | | 159 | 1366 |
| 2000 | 123 | 21 | 401 | 170 | | 327 | | 140 | 1182 |
| 2001 | 80 | 2 | 413 | 515 | | 94 | | 122 | 1226 |
| 2002 | 132 | 0 | 315 | 207 | | 151 | | 159 | 964 |
| 2003 | 128 | 0 | 270 | | | 74 | | 52 | 524 |
| 2004 | 133 | 12 | 255 | 163 | | 27 | | 50 | 640 |
| 2005 | 145 | 11 | 208 | | | 17 | | 48 | 429 |
| 2006 | 173 | 1 | 311 | 147 | | 13 | | 23 | 668 |
| 2007 | 173 | 5 | 62 | 27 | | 71 | | 20 | 358 |
| 2008 | 122 | 16 | 44 | 0 | | 14 | | 63 | **259** |
| 2009 | 42 | | 71 | 0 | | 17 | | 1 | **131** |
| 2010* | 34 | | 82 | 0 | | 6 | | 131 | **253** |

***Preliminary. (1) See Ling VII. (2) Included with UK (EW). (3) Included with VIIg–k.**

**Table 5.5.1. (continued).**

**LING VIId, e**

| Year | Belgium | Denmark | France (1) | Ireland | E & W | Scotland | Ch. Islands | Netherlands | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 36 | + | -1 | - | 743 | - | | | 779 |
| 1989 | 52 | - | -1 | - | 644 | 4 | | | 700 |
| 1990 | 31 | - | -1 | 22 | 743 | 3 | | | 799 |
| 1991 | 7 | - | -1 | 25 | 647 | 1 | | | 680 |
| 1992 | 10 | + | -1 | 16 | 493 | + | | | 519 |
| 1993 | 15 | - | -1 | - | 421 | + | | | 436 |
| 1994 | 14 | + | -1 | - | 437 | 0 | | | 451 |
| 1995 | 10 | - | 885 | 2 | 492 | 0 | | | 1389 |
| 1996 | 15 | | 960 | | 499 | 3 | | | 1477 |
| 1997 | 12 | | 1049 | 1 | 372 | 1 | 37 | | 1472 |
| 1998 | 10 | | 953 | | 510 | 1 | 26 | | 1500 |
| 1999 | 7 | | 545 | - | 507 | 1 | | | 1060 |
| 2000 | 5 | | 454 | 1 | 372 | | 14 | | 846 |
| 2001 | 6 | | 402 | | 399 | | | | 807 |
| 2002 | 7 | | 498 | | 386 | 0 | | | 891 |
| 2003 | 5 | | 531 | 1 | 250 | 0 | | | 787 |
| 2004 | 13 | | 573 | 1 | 214 | | | | 801 |
| 2005 | 11 | | 539 | | 236 | | | | 786 |
| 2006 | 9 | | 470 | | 208 | | | | 687 |
| 2007 | 15 | | 428 | 0 | 267 | | | | 710 |
| 2008* | 5 | | 348 | | 214 | 2 | | | **569** |
| 2009 | 6 | | 186 | | 170 | | | 1 | **363** |
| 2010* | | | 144 | | 137 | | | | **281** |

***Preliminary.**

**Table 5.5.1. (continued).**

**LING VIIf**

| Year | Belgium | France [1] | Ireland | E & W | Scotland | Total |
|---|---|---|---|---|---|---|
| 1988 | 77 | -1 | - | 367 | - | 444 |
| 1989 | 42 | -1 | - | 265 | 3 | 310 |
| 1990 | 23 | -1 | 3 | 207 | - | 233 |
| 1991 | 34 | -1 | 5 | 259 | 4 | 302 |
| 1992 | 9 | -1 | 1 | 127 | - | 137 |
| 1993 | 8 | -1 | - | 215 | + | 223 |
| 1994 | 21 | -1 | - | 379 | - | 400 |
| 1995 | 36 | 110 | - | 456 | 0 | 602 |
| 1996 | 40 | 121 | - | 238 | 0 | 399 |
| 1997 | 30 | 204 | - | 313 | | 547 |
| 1998 | 29 | 204 | - | 328 | | 561 |
| 1999 | 16 | 108 | - | 188 | | 312 |
| 2000 | 15 | 91 | 1 | 111 | | 218 |
| 2001 | 14 | 114 | - | 92 | | 220 |
| 2002 | 16 | 139 | 3 | 295 | | 453 |
| 2003 | 15 | 79 | 1 | 81 | | 176 |
| 2004 | 18 | 73 | 5 | 65 | | 161 |
| 2005 | 36 | 59 | 7 | 82 | | 184 |
| 2006 | 10 | 42 | 14 | 64 | | 130 |
| 2007 | 16 | 52 | 2 | 55 | | 125 |
| 2008 | 32 | 88 | 4 | 63 | | 187 |
| 2009 | 10 | 69 | 1 | 26 | | 106 |
| 2010* | | 48 | | 17 | | 65 |

***Preliminary. [1] See Ling VII.**

**Table 5.5.1. (continued).**

**LING VIIg–k**

| Year | Belgium | Denmark | France | Germany | Ireland | Norway | Spain (2) | E&W | IOM | N.I. | Scot. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 35 | 1 | -1 | - | 286 | - | 2652 | 1439 | - | - | 2 | 4415 |
| 1989 | 23 | - | -1 | - | 301 | 163 | | 518 | - | + | 7 | 1012 |
| 1990 | 20 | + | -1 | - | 356 | 260 | | 434 | + | - | 7 | 1077 |
| 1991 | 10 | + | -1 | - | 454 | - | | 830 | - | - | 100 | 1394 |
| 1992 | 10 | - | -1 | - | 323 | - | | 1130 | - | + | 130 | 1593 |
| 1993 | 9 | + | -1 | 35 | 374 | | | 1551 | - | 1 | 364 | 2334 |
| 1994 | 19 | - | -1 | 10 | 620 | | 184 | 2143 | - | 1 | 277 | 3254 |
| 1995 | 33 | - | 1597 | 40 | 766 | - | 195 | 3046 | | -3 | 454 | 6131 |
| 1996 | 45 | - | 1626 | 169 | 771 | | 583 | 3209 | | | 447 | 6850 |
| 1997 | 37 | - | 1574 | 156 | 674 | | 33 | 2112 | | | 459 | 5045 |
| 1998 | 18 | - | 1362 | 88 | 877 | | 1669 | 3465 | | | 335 | 7814 |
| 1999 | - | - | 1220 | 49 | 554 | | 455 | 1619 | | | 292 | 4189 |
| 2000 | 17 | | 1062 | 12 | 624 | | 639 | 921 | | | 303 | 3578 |
| 2001 | 16 | | 1154 | 4 | 727 | 24 | 559 | 591 | | | 285 | 3360 |
| 2002 | 16 | | 1025 | 2 | 951 | | 568 | 862 | | | 102 | 3526 |
| 2003 | 12 | | 1240 | 5 | 808 | | 455 | 382 | | | 38 | 2940 |
| 2004 | 14 | | 982 | | 686 | | 405 | 335 | | | 5 | 2427 |
| 2005 | 15 | | 771 | 12 | 539 | | 399 | 313 | | | 4 | 2053 |
| 2006 | 10 | | 676 | | 935 | | 504 | 264 | | | 18 | 2407 |
| 2007 | 11 | | 661 | 1 | 430 | | 423 | 217 | | | 6 | 1749 |
| 2008 | 11 | | 622 | 8 | 352 | | 391 | 130 | | | 27 | **1541** |
| 2009 | 7 | | 183 | 6 | 270 | | 51 | 142 | | | 14 | **673** |
| 2010* | | | 108 | | 311 | | 23 | 134 | | | 14 | **590** |

***Preliminary. (1) See Ling VII. (2) Includes VIIb, c. (3) Included in UK (EW).**

**Table 5.5.1. (continued).**

**LING VIII**

| Year | Belgium | France | Germany | Spain | E & W | Scot. | Total |
|---|---|---|---|---|---|---|---|
| 1988 | | 1018 | | | 10 | | 1028 |
| 1989 | | 1214 | | | 7 | | 1221 |
| 1990 | | 1371 | | | 1 | | 1372 |
| 1991 | | 1127 | | | 12 | | 1139 |
| 1992 | | 801 | | | 1 | | 802 |
| 1993 | | 508 | | | 2 | | 510 |
| 1994 | | n/a | | 77 | 8 | | 85 |
| 1995 | | 693 | | 106 | 46 | | 845 |
| 1996 | | 825 | 23 | 170 | 23 | | 1041 |
| 1997 | 1 | 705 | + | 290 | 38 | | 1034 |
| 1998 | 5 | 1220 | - | 543 | 29 | | 1797 |
| 1999 | 22 | 234 | - | 188 | 8 | | 452 |
| 2000 | 1 | 227 | | 106 | 5 | | 339 |
| 2001 | | 245 | | 341 | 6 | 2 | 594 |
| 2002 | | 316 | | 141 | 10 | 0 | 467 |
| 2003 | | 333 | | 67 | 36 | | 436 |
| 2004 | | 385 | | 54 | 53 | | 492 |
| 2005 | | 339 | | 92 | 19 | | 450 |
| 2006 | | 324 | | 29 | 45 | | 398 |
| 2007 | | 282 | | 20 | 10 | | 312 |
| 2008 | | 294 | | 36 | 15 | 3 | 345 |
| 2009 | | 150 | | 29 | 7 | | **186** |
| 2010* | | 92 | | 20 | 11 | | **123** |

**LING IX**

| Year | Spain | Total |
|---|---|---|
| 1997 | 0 | 0 |
| 1998 | 2 | 2 |
| 1999 | 1 | 1 |
| 2000 | 1 | 1 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | 1 | 1 |

**Table 5.5.1. (continued).**

**LING XII**

| Year | Faroes | France | Norway | E & W | Scotland | Germany | Ireland | Total |
|---|---|---|---|---|---|---|---|---|
| 1988 | | | | - | | | | 0 |
| 1989 | | | | - | | | | 0 |
| 1990 | | | | 3 | | | | 3 |
| 1991 | | | | 10 | | | | 10 |
| 1992 | | | | - | | | | 0 |
| 1993 | | | | - | | | | 0 |
| 1994 | | | | 5 | | | | 5 |
| 1995 | 5 | | | 45 | | | | 50 |
| 1996 | - | | 2 | | | | | 2 |
| 1997 | - | | + | 9 | | | | 9 |
| 1998 | - | 1 | - | 1 | | | | 2 |
| 1999 | - | 0 | - | - | + | 2 | | 2 |
| 2000 | | 1 | - | | 6 | | | 7 |
| 2001 | | 0 | 29 | 2 | 24 | | 4 | 59 |
| 2002 | | 0 | 4 | 4 | 0 | | | 8 |
| 2003 | | | 17 | 2 | 0 | | | 19 |
| 2004 | | | | | | | | |
| 2005 | | | | 1 | | | | 1 |
| 2006 | 1 | | | | | | | 1 |
| 2007 | | | | | | | | 0 |
| 2008 | | | | | | | | 0 |
| 2009 | | 0 | 1 | | | | | 1 |
| 2010* | | | | | | | | 0 |

**Table 5.5.1. (continued).**

**LING XIV**

| Year | Faroes | Germany | Iceland | Norway | E & W | Scotland | russia | Total |
|---|---|---|---|---|---|---|---|---|
| 1988 | | 3 | - | - | - | - | | 3 |
| 1989 | | 1 | - | - | - | - | | 1 |
| 1990 | | 1 | - | 2 | 6 | - | | 9 |
| 1991 | | + | - | + | 1 | - | | 1 |
| 1992 | | 9 | - | 7 | 1 | - | | 17 |
| 1993 | | - | + | 1 | 8 | - | | 9 |
| 1994 | | + | - | 4 | 1 | 1 | | 6 |
| 1995 | - | - | | 14 | 3 | 0 | | 17 |
| 1996 | - | | | 0 | | | | 0 |
| 1997 | 1 | | | 60 | | | | 61 |
| 1998 | - | | | 6 | | | | 6 |
| 1999 | - | | | 1 | | | | 1 |
| 2000 | | | 26 | - | | | | 26 |
| 2001 | 1 | | | 35 | | | | 36 |
| 2002 | 3 | | | 20 | | | | 23 |
| 2003 | | | | 83 | | | | 83 |
| 2004 | | | | 10 | | | | 10 |
| 2005 | | | | | | | | 0 |
| 2006 | | | | | | | | 0 |
| 2007 | | | | 5 | | | | 5 |
| 2008 | | | | | 1 | | 1 | 2 |
| 2009 | + | 3 | | | | | | 3 |
| 2010* | | | | | | | | 0 |

***Preliminary.**

**Table 5.5.2. Ling. Total landings by subarea or division.**

| Year | III | IVa | IVbc | VIa | VIb | VII | VIIa | VIIbc | VIIde | VIIf | VIIg-k | VIII | IX | XII | XIV | All areas |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 331 | 11 223 | 379 | 14 556 | 1765 | 5057 | 211 | 865 | 779 | 444 | 4415 | 1028 | | 0 | 3 | 41 056 |
| 1989 | 422 | 11 677 | 387 | 8631 | 3743 | 5261 | 311 | 577 | 700 | 310 | 1012 | 1221 | | 0 | 1 | 34 253 |
| 1990 | 543 | 10 027 | 455 | 6730 | 1505 | 4575 | 169 | 678 | 799 | 233 | 1077 | 1372 | | 3 | 9 | 28 175 |
| 1991 | 484 | 9969 | 490 | 4795 | 2662 | 3977 | 125 | 749 | 680 | 302 | 1394 | 1139 | | 10 | 1 | 26 777 |
| 1992 | 549 | 10 763 | 842 | 4588 | 1891 | 2552 | 105 | 1286 | 519 | 137 | 1593 | 802 | | 0 | 17 | 25 644 |
| 1993 | 642 | 12 810 | 797 | 5301 | 1522 | 2294 | 219 | 1434 | 436 | 223 | 2334 | 510 | | 0 | 9 | 28 531 |
| 1994 | 469 | 11 496 | 323 | 6730 | 2540 | 2185 | 284 | 1595 | 451 | 400 | 3254 | 85 | | 5 | 6 | 29 823 |
| 1995 | 412 | 13 041 | 659 | 8847 | 1638 | | 305 | 1944 | 1389 | 602 | 6131 | 845 | | 50 | 17 | 35 880 |
| 1996 | 402 | 12 705 | 569 | 8577 | 1124 | | 210 | 2201 | 1477 | 399 | 6850 | 1041 | | 2 | 0 | 35 557 |
| 1997 | 311 | 11 315 | 699 | 6746 | 814 | | 264 | 1780 | 1472 | 547 | 5045 | 1034 | 0 | 9 | 61 | 30 097 |
| 1998 | 214 | 13 631 | 627 | 7362 | 1394 | | 198 | 1034 | 1500 | 561 | 7814 | 1797 | 2 | 2 | 6 | 36 142 |
| 1999 | 216 | 9810 | 446 | 6899 | 1175 | | 84 | 1366 | 1060 | 312 | 4189 | 452 | 1 | 2 | 1 | 26 013 |
| 2000 | 228 | 9246 | 384 | 6909 | 1879 | | 73 | 1182 | 846 | 218 | 3578 | 339 | 1 | 7 | 26 | 24 916 |
| 2001 | 262 | 7854 | 284 | 5143 | 788 | | 87 | 1226 | 807 | 220 | 3360 | 594 | 0 | 59 | 36 | 20 720 |
| 2002 | 263 | 9072 | 309 | 4127 | 533 | | 119 | 964 | 891 | 453 | 3526 | 467 | 0 | 8 | 23 | 20 756 |
| 2003 | 261 | 6433 | 234 | 3246 | 660 | | 112 | 524 | 787 | 176 | 2940 | 436 | | 19 | 83 | 15 912 |
| 2004 | 232 | 6306 | 241 | 2769 | 1064 | | 97 | 640 | 801 | 161 | 2427 | 492 | | 0 | 10 | 15 240 |
| 2005 | 210 | 6449 | 149 | 3028 | 1142 | | 61 | 429 | 786 | 184 | 2053 | 450 | | 1 | 0 | 14 942 |
| 2006 | 188 | 6719 | 144 | 2573 | 1411 | | 88 | 668 | 687 | 130 | 2407 | 398 | | 1 | 0 | 15 414 |
| 2007 | 174 | 5858 | 159 | 3119 | 1314 | | 43 | 358 | 710 | 125 | 1749 | 312 | | 0 | 5 | 13 927 |
| 2008 | 168 | 7259 | 200 | 2950 | 1551 | | 15 | 259 | 569 | 187 | 1541 | 345 | | 0 | 1 | 15 045 |
| 2009 | 149 | 7424 | 314 | 2324 | 2635 | | 48 | 131 | 363 | 106 | 673 | 186 | | 1 | 3 | 14 357 |
| 2010 | 122 | 6347 | 141 | 3031 | 2667 | | 44 | 253 | 281 | 65 | 590 | 123 | | 0 | 0 | 13 664 |

***Preliminary.**

**Table 5.5.3. Estimated mean cpue ([kg/hook]x1000) in IIIa–IV and VI–XIV based on logbook data. Standard error (se) and number of catches sampled (n) is also given. Official logbook data.**

| Ling | Area | IIIA | IVA | IVB | VIA | VIB | VIIC | XIVA |
|---|---|---|---|---|---|---|---|---|
| 2000 | cpue | 4,53 | 56,5 | 8,3 | 101 | 45,4 | 82,9 | 3,75 |
| | n | 3 | 669 | 25 | 421 | 211 | 78 | 6 |
| | se | 13,3 | 0,9 | 4,6 | 1,1 | 1,6 | 2,6 | 9,4 |
| 2001 | cpue | | 48,1 | 2,4 | 85,9 | 33,5 | 78,4 | |
| | n | | 729 | 12 | 424 | 127 | 37 | |
| | se | | 0,8 | 6,0 | 1,0 | 1,8 | 3,4 | |
| 2002 | cpue | | 55,5 | 1,4 | 77,8 | 37,6 | | |
| | n | | 618 | 3 | 177 | 149 | | |
| | se | | 0,7 | 11,0 | 1,4 | 2,2 | 0,0 | |
| 2003 | cpue | 2,4 | 57,2 | 2,9 | 76,4 | 67,9 | | |
| | n | 25 | 505 | 29 | 296 | 85 | | |
| | se | 4,4 | 1,0 | 4,1 | 1,3 | 2,4 | | |
| 2004 | cpue | | 78,5 | | 102 | 71,9 | 122 | |
| | n | | 439 | | 308 | 110 | 28 | |
| | se | | 1,1 | | 1,3 | 2,3 | 4,5 | |
| 2005 | cpue | | 85,1 | | 117 | 68,8 | 66,4 | |
| | n | | 328 | | 369 | 137 | 7 | |
| | se | | 1,7 | | 1,6 | 2,6 | 11,6 | |
| 2006 | cpue | | 92,5 | | 94,5 | 90,4 | | |
| | n | | 672 | | 248 | 138 | | |
| | se | | 1,0 | | 1,7 | 2,2 | | |
| 2007 | cpue | 6,52 | 76,6 | 5,18 | 107 | 89,2 | 79,2 | |
| | n | 8 | 586 | 56 | 248 | 145 | 14 | |
| | se | 7,7 | 0,9 | 2,9 | 1,4 | 1,8 | 5,9 | |
| 2008 | cpue | 7,39 | 83,8 | 3,91 | 72,4 | 147 | | 23,3 |
| | n | 15 | 391 | 9 | 131 | 35 | | 1 |
| | se | 7,02 | 1,37 | 9,06 | 2,38 | 4,6 | | |
| 2009 | cpue | 7.37 | 97 | 7.61 | 97.7 | 113 | | |
| | n | 11 | 680 | 6 | 98 | 31 | | |
| | se | 10.4 | 1.57 | 14.1 | 4.14 | 7.37 | | |

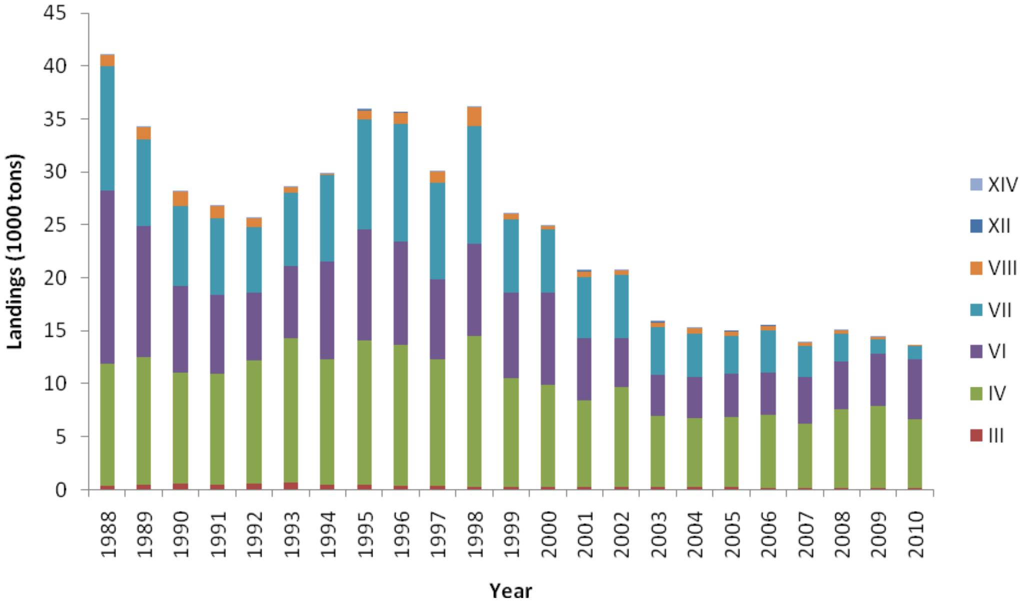



**Figure 5.5.1. International landings. Ling in other areas.**

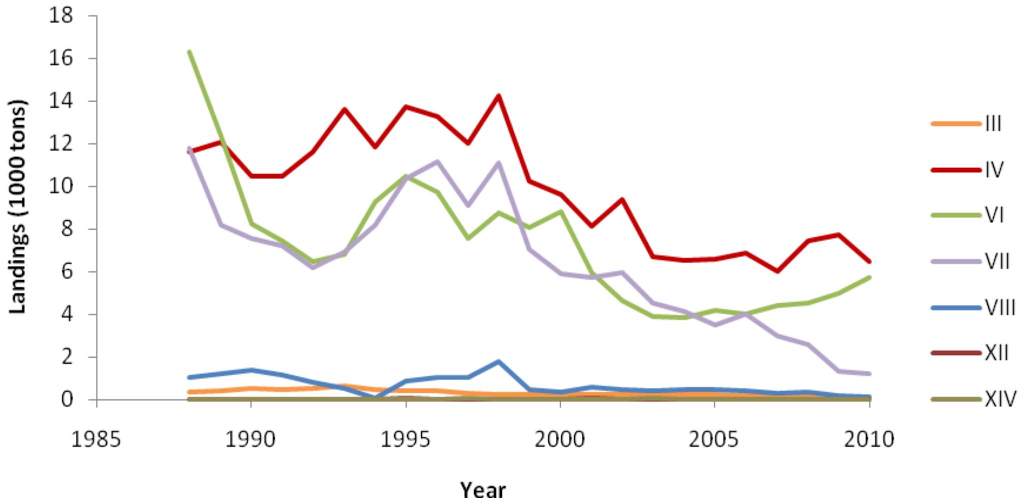



**Figure 5.5.2. International landings. Ling in other areas.**

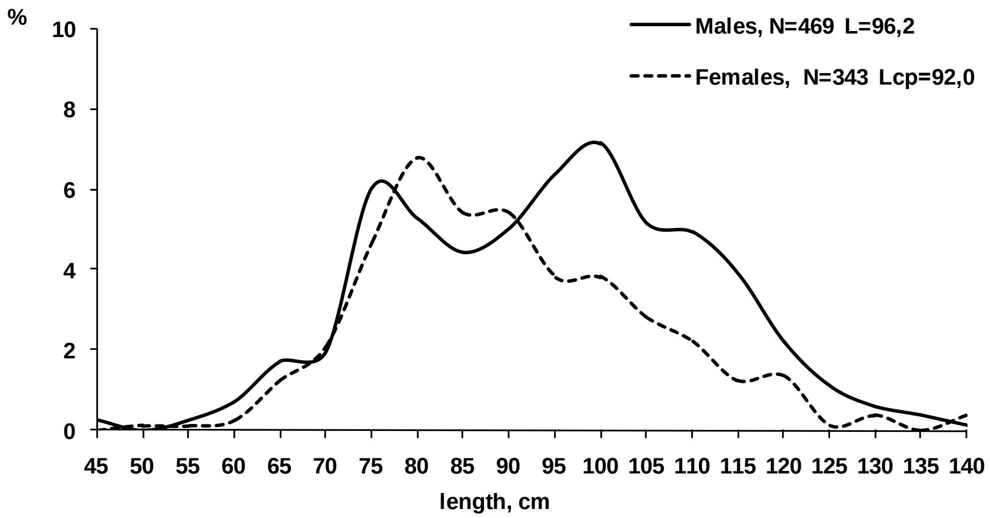



**Figure 5.5.3. Length composition of ling on Rockall Bank in July 2009 (Vinnichenko *et al.*, WD 2010).**

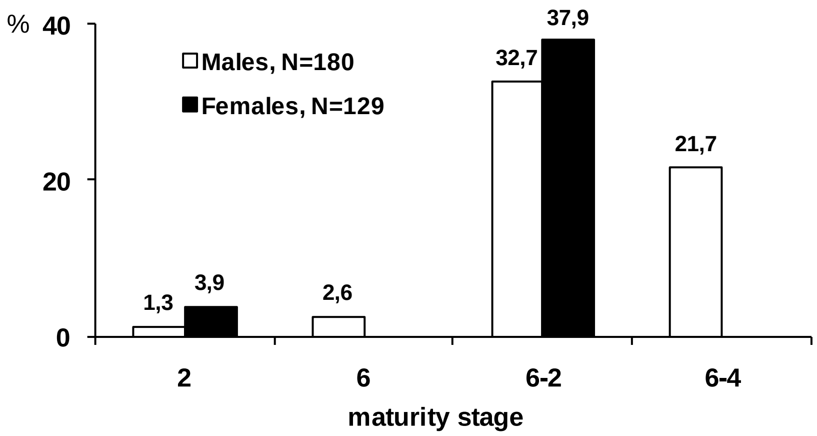



**Figure 5.5.4. Maturity of ling on Rockall Bank in July 2009 (Vinnichenko *et al.*, WD 2010).**

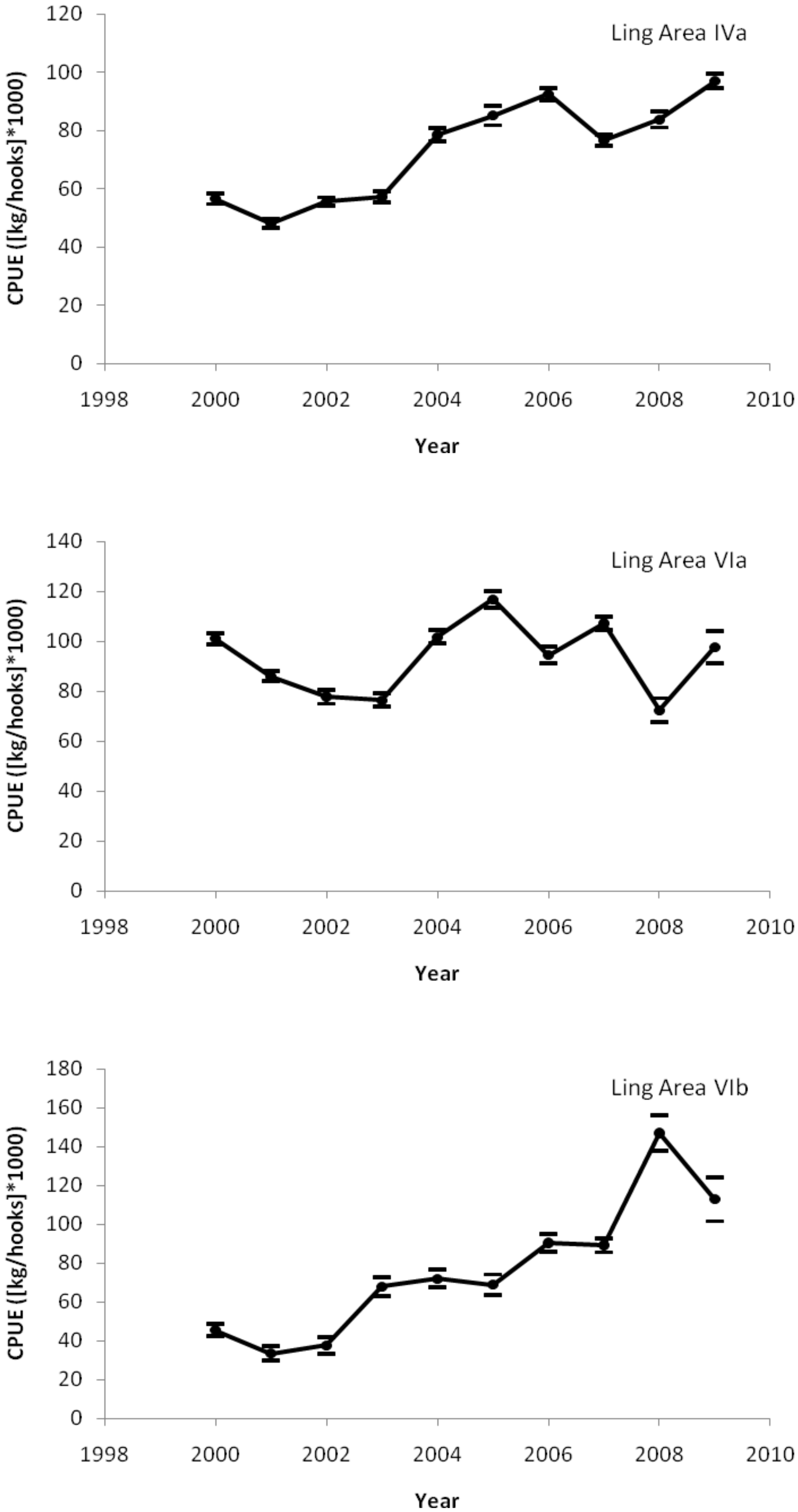



**Figure 5.5.5. Estimates of cpue (kg/1000 hooks) of ling based on skipper's logbooks in Areas IVa, VIa and VIb for the period 2000–2009. The bars denote the 95% confidence interval.**

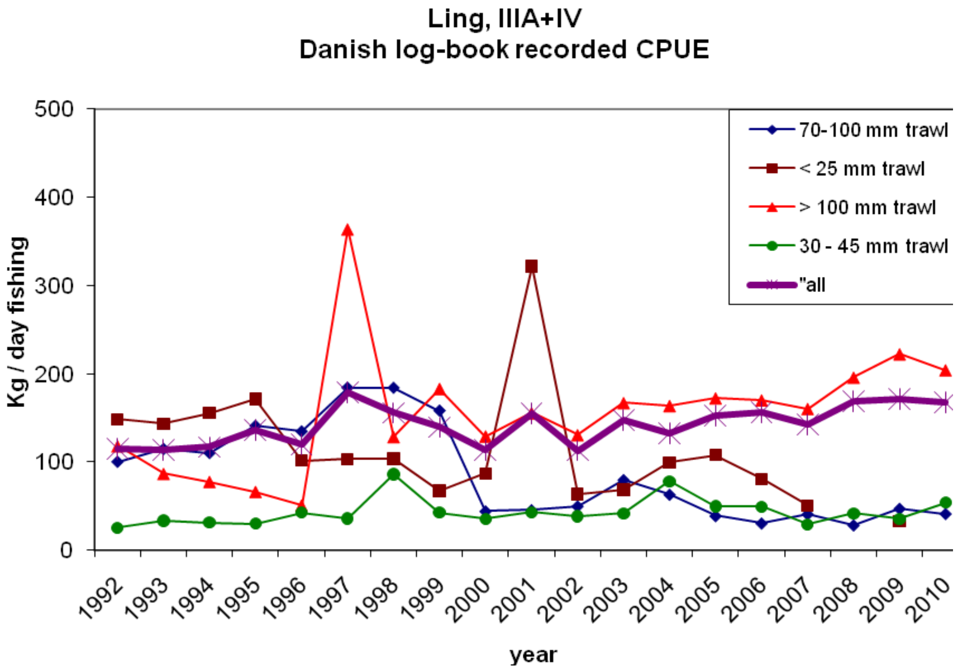



**Figure 5.5.6. Cpue of ling for Danish trawlers in Subareas IIIa and IV. Based on logbook data.**

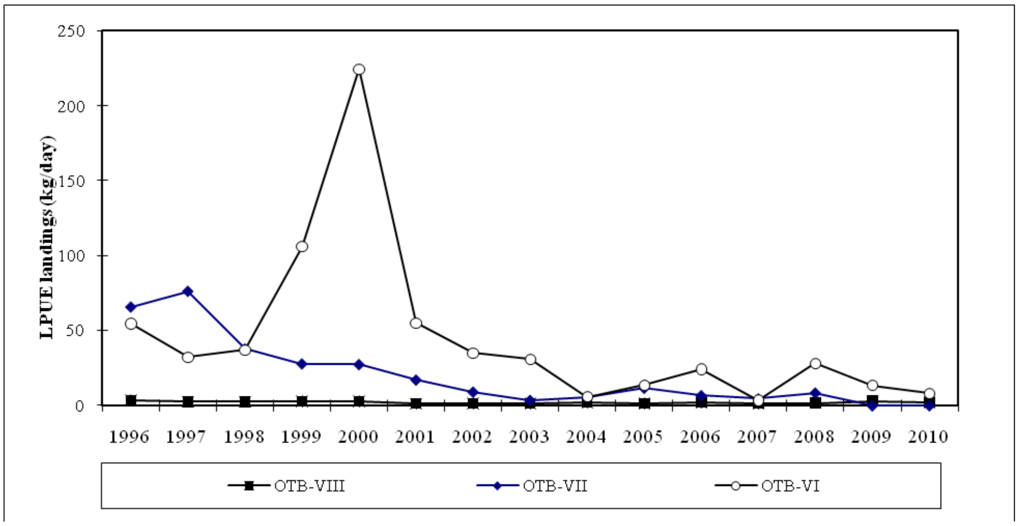



**Figure 5.5.7. Historical series of lpues (kg/day) of the Basque Country OTB fleet in Subareas VI, VII and VIII since 1996.**

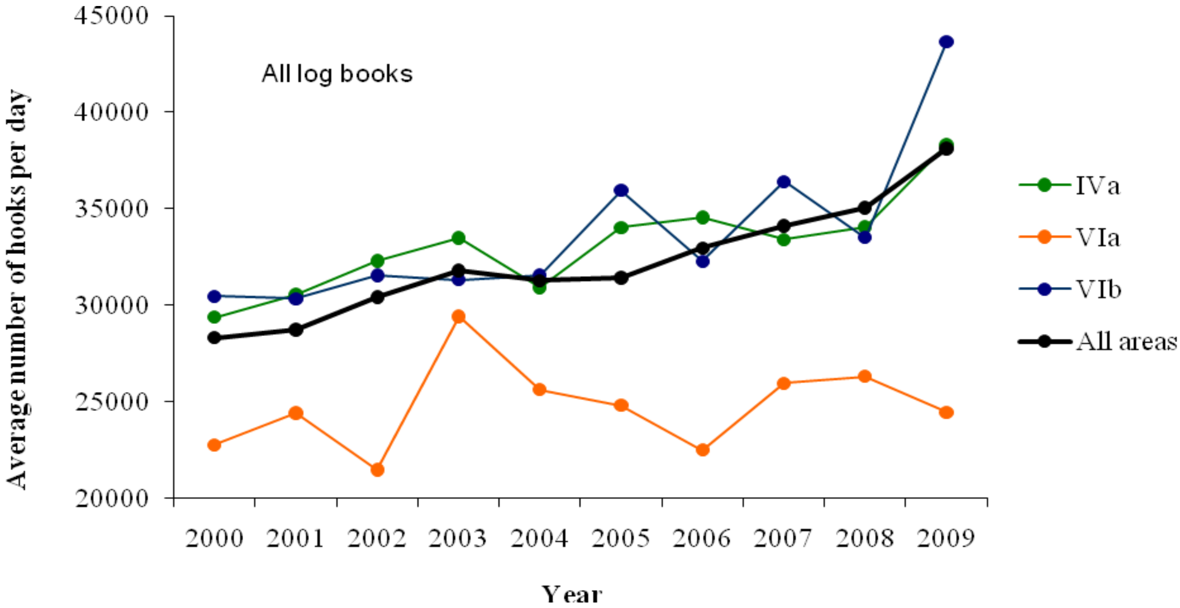



**Figure 5.5.8. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000–2009 in the fishery for tusk, ling and blue ling.**

# 6 Blue Ling (*Molva dypterygia*) in the Northeast Atlantic

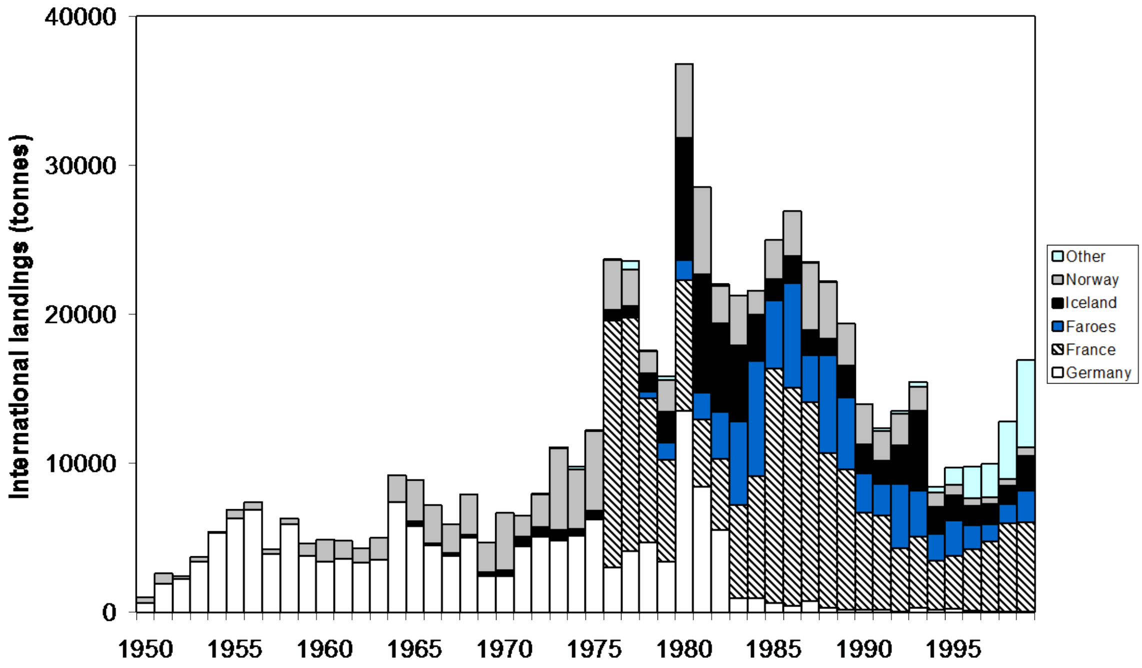
## 6.1 Stock description and management units

Biological investigations in the early 1980s suggested that at least two adult stock components were found within the Area, a northern stock in Subarea XIV and Division Va with a small component in Vb, and a southern stock in Subarea VI and adjacent waters in Division Vb. However, the observation of spawning aggregations in each of these areas and elsewhere suggest further stock separation. This is supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larval data from early studies also suggest the existence of many spawning grounds. The conclusion is that stock structure is uncertain within the areas under consideration.

However, as in previous years, on the basis of similar trends in the cpue series from Division Vb and Subareas VI and VII, blue ling from these areas has been treated for assessment purposes as a single southern stock. Blue ling in Va and XIV has been treated as a single northern stock. All remaining areas are grouped together as “other areas.

Historical total international landings shown that blue ling have been exploited for long (Figure 6.1.1). Landings from Norway from the 1950s and 1960s might have been from Subareas I and II. German landings from the 1960s were mainly reported in Statlant from ICES Division Va and Vb, landings in the 1960s might have come from the same area.

Blue ling is known to form spawning aggregation. From 1970 to 1990, the bulk of the fishery for blue ling was seasonal fisheries targeting these aggregations which were subject to sequential depletion. Known spawning areas are shown in Figure 6.1.2. In Iceland, the depletion of the spawning aggregation in a few years was documented (Magnússon and Magnússon, 1995) and blue ling is an aggregating species at spawning time. To prevent depletion of adult populations temporal closures have been set both in the Icelandic and EU EEZs.




**Figue 6.1.1. Total international landings of blue ling in the Northeast Atlantic 1950–1999.**

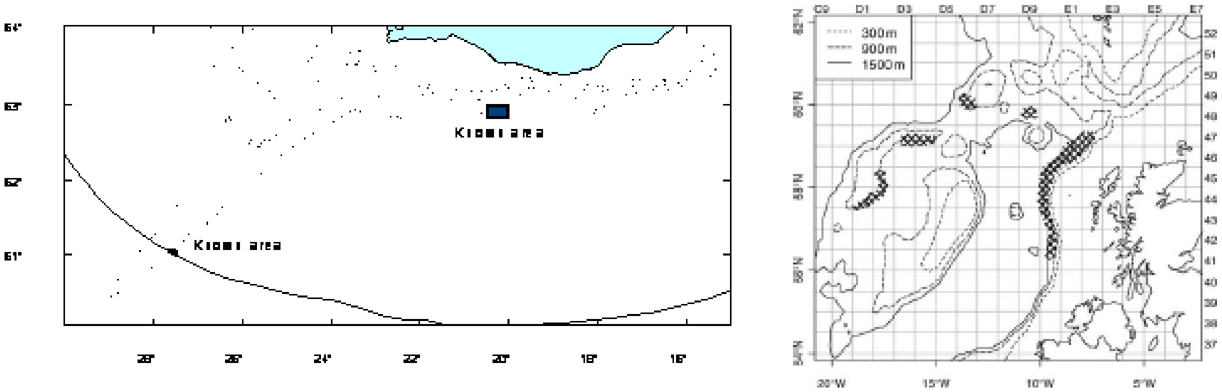



**Figure 6.1.2. Known spawning areas of blue ling in Icelandic water (a) and to the West of Scotland (b, from Large *et al.*, 2010).**

## 6.2 Blue Ling (*Molva* Dypterygia) In Division Va and Subarea XIV

### 6.2.1 The fishery

The change in geographical distribution of the Icelandic blue ling fisheries from 1996, to 2010 (Figure 6.2.1 and 6.2.5) indicates that there has been an expansion of the fishery of blue ling to northwestern waters. This increase is likely to be the result of increased availability of blue ling in the northwestern area, rather than of an increase in effort or reporting.

Before 2008 the majority of the catches of blue ling in Va were by trawlers, as bycatch in fisheries targeting cod, haddock and other demersal species. 50% of the bottom-trawl catches in 2007 were taken within the depth range of 300–700 and 50% of the longline catches was taken at depths greater than 400 m. After 2008 there has been a substantial change in the fishery for blue ling in Va as longliners started targeting blue ling (Figure 6.2.1.b). Subsequently the proportion of catches taken by longliners increased from 7–20% in 2001–2007 to around 60% in 2010 (Table 6.2.3).

Historically the fisheries in Subarea XIV have been relatively small.

## 6.2.2 Landings trends

The preliminary total landings in Va 2010 were 6900 t of which the Icelandic fleet caught 6377 t. (Table 6.2.1a and Figure 6.2.3). Catches of blue ling in Va have increased more than by 370% since 2006, the main part of this increases can be attributed to increased targeting of blue ling by the longline fleet (Table 6.2.3).

Total international landings from XIV (Table 6.2.1b) have been highly variable over the years, ranging from a few tonnes in some years to around 3700 t in 1993 and 950 t in 2003. Most of the landings in 2003 were taken by Spanish trawlers (390 t), but there is no further information available on this fishery. These larger landings are very occasional and in most years total international landings have been between 50 and 200 t. Preliminary landings in 2010 were 34 t.

## 6.2.3 ICES Advice

The latest Advice is from ICES in May 2010 states: No direct fishery and minimum bycatch. Area closures to protect spawning aggregations should be maintained and expanded as appropriate.

## 6.2.4 Management

The Icelandic fishery is not regulated by a national TAC or ITQs. The only restrictions on the Icelandic fleet regarding the blue ling fishery was the introduction of closed areas in 2003 to protect known spawning locations of blue ling, which are in effect.

EU has in recent years had TAC of redfish in Va and small TAC of bycatch in that fishery which includes blue ling. No EU vessels fished for redfish in Va in 2010.

## 6.2.5 Data available

### 6.2.5.1 Landings and discards

Landings data are given in Tables 6.2.1 and 6.2.2. Discarding is banned in the Icelandic fishery. There is no available information on discarding of blue ling in Va and XIV. Being a relatively valuable species and not subjected to TAC constraints nor minimum landing size there should be little incentive to discard blue ling in Va.

### 6.2.5.2 Length compositions

Length distributions from the Icelandic trawl and longline catches for the period 1997–2010 are shown in Figure 6.2.4. Mean length from trawls has varied from about 75 cm to 85 cm in the period without any obvious trend.. Detailed overview of the sampling from catches and surveys was given in WGDEEP 2007 Report. The sampling intensity in 2010 was similar as in recent years.

### 6.2.5.3 Age compositions

No new data were available. Existing data are not presented due to the difficulties in the ageing of this species.

#### 6.2.5.4 Weight-at-age

No new data were available. Existing data are not presented because of difficulty in ageing.

#### 6.2.5.5 Maturity and natural mortality

Length at 50% maturity is estimated at roughly 77 cm and the range for 10–90% maturity is 65–90cm.

No information is available on natural mortality (M).

#### 6.2.5.6 Catch, effort and survey data data

Effort and nominal cpue data from the Icelandic trawl and longline fleet are given in Figure 6.2.10. Cpue and effort have increased significantly in recent years for the longline fleet but cpue from trawling has remained at low levels while effort has been increasing. Due to changes in the fishery and technical innovations cpue is not considered a reliable index of biomass abundance of blue ling in Va and therefore no attempt has been made to standardize the series.

Time-series stratified abundance and biomass indices from the spring and autumn trawl surveys are shown in Figure 6.2.6 (For details see the stock annex for tusk in Va and XIV). Indices of total biomass from the spring survey are all either at their highest observed level or close to it. The biomass indices from the autumn survey peaked in 2009 but decreased slightly in 2010. The recruitment indices from both surveys have fallen drastically from 2007–2008 and are now close to their historical lowest level.

### 6.2.6 Data analyses

Length distribution data from the spring trawl survey (Figure 6.2.7) are very different from those in the commercially fishery, comprising a greater proportion of younger fish and a small proportion of larger fish (stock abundance for blue ling in Va peaks at depths at around 700 to 900 m). Therefore the length distributions from the autumn survey may better reflect the length distribution of the stock (Figure 6.2.8). In most years the length distribution in the autumn survey peaks between 70–80 cm, close to what is observed in the commercial trawl catches (Figure 6.2.4).

As stated above cpue indices from commercial catches are not considered a reliable index of stock abundance. Therefore the rapid increase in cpue from longlines should not be viewed as an increase in stock biomass but rather as the result of increased interest by the longline fleet and its expansion into deeper waters (Figure 6.2.2). This can be clearly seen in the effort indices for longlines.

The spring survey covers only the shallower part of the depth distributional range of blue ling and shows high inter annual variance (Figure 6.2.6). It is thus unknown to what extent the spring indices reflect actual changes total ling biomass, given that is does not cover the depths were largest abundance of blue ling occur. It is however not driven by isolated large catches at a few survey stations. It decreased by 90% from 1985–1995. It remained very low until 2003, but in six last surveys (2004–2010) the index has increased from being 20% of the 1985 value to be similar to what it was in the 1980s. However, given the above, the recent increase observed in the spring survey should be treated with caution. Figure 6.2.6d, which shows the abundance of under 40 cm fish may provide an indication of abundance of prerecruits.

The shorter autumn survey, which is more likely to reflect the true biomass dynamics than the spring survey does indicate that there has been some increase in the blue ling biomass since 2007. A large increase or more than 200% in the recruitment index was observed in 2008 but in the 2010 autumn survey it had decreased again to its lowest observed value (Figure 6.2.6).

Relative fishing mortality ($F_{proxy}$ = Yield/Survey biomass) derived from the autumn survey (+40 cm) indicates that fishing mortality may have increased by more than 50% between 2005–2006 and 2009 and by160% in 2010 (Figure 6.2.11).

This year no analytical assessments were attempted.

### 6.2.7 Comments on the assessment

There is a need for looking in greater detail of the available data on blue ling in Va and XIV. Among the things that should be scrutinized is to what extent the spring survey may be indicative of trends of blue ling, the information (or the lack thereof) contained in the commercial logbook data and the changes in the longline fishery and its expansion into new areas.

### 6.2.8 Management considerations

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, e.g. GADGET, CUSUM.

**Table 6.2.1. Blue ling: Landing in ICES Division Va.**

| Year | Faroe | Germany | Iceland | Norway | UK | Total |
|---|---|---|---|---|---|---|
| 1973 | 74 | 1678 | 548 | 6 | 61 | 2367 |
| 1974 | 34 | 1959 | 331 | 140 | 32 | 2496 |
| 1975 | 69 | 1418 | 434 | 366 | 89 | 2376 |
| 1976 | 29 | 1222 | 624 | 135 | 28 | 2038 |
| 1977 | 39 | 1253 | 700 | 317 | 0 | 2309 |
| 1978 | 38 | 0 | 1237 | 156 | 0 | 1431 |
| 1979 | 85 | 0 | 2019 | 98 | 0 | 2202 |
| 1980 | 183 | 0 | 8133 | 83 | 0 | 8399 |
| 1981 | 220 | 0 | 7952 | 229 | 0 | 8401 |
| 1982 | 224 | 0 | 5945 | 64 | 0 | 6233 |
| 1983 | 1195 | 0 | 5117 | 402 | 0 | 6714 |
| 1984 | 353 | 0 | 3122 | 31 | 0 | 3506 |
| 1985 | 59 | 0 | 1407 | 7 | 0 | 1473 |
| 1986 | 69 | 0 | 1774 | 8 | 0 | 1851 |
| 1987 | 75 | 0 | 1693 | 8 | 0 | 1776 |
| 1988 | 271 | 0 | 1093 | 7 | 0 | 1371 |
| 1989 | 403 | 0 | 2124 | 5 | 0 | 2532 |
| 1990 | 1029 | 0 | 1992 | 0 | 0 | 3021 |
| 1991 | 241 | 0 | 1582 | 0 | 0 | 1823 |
| 1992 | 321 | 0 | 2584 | 0 | 0 | 2905 |
| 1993 | 40 | 0 | 2193 | 0 | 0 | 2233 |
| 1994 | 89 | 1 | 1542 | 0 | 0 | 1632 |
| 1995 | 113 | 3 | 1519 | 0 | 0 | 1635 |
| 1996 | 36 | 3 | 1284 | 0 | 0 | 1323 |
| 1997 | 25 | 0 | 1319 | 0 | 0 | 1344 |
| 1998 | 59 | 9 | 1086 | 0 | 0 | 1154 |
| 1999 | 31 | 8 | 1525 | 8 | 11 | 1583 |
| 2000 | 0 | 7 | 1605 | 25 | 8 | 1645 |
| 2001 | 95 | 12 | 752 | 49 | 23 | 931 |
| 2002 | 28 | 4 | 1256 | 74 | 10 | 1372 |
| 2003 | 16 | 16 | 1098 | 6 | 24 | 1160 |
| 2004 | 38 | 9 | 1083 | 49 | 20 | 1199 |
| 2005 | 24 | 25 | 1497 | 20 | 26 | 1592 |
| 2006 | 63 | 22 | 1734 | 27 | 9 | 1855 |
| 2007 | 78 | 0 | 1999 | 4 | 10 | 2091 |
| 2008 | 101 | 0 | 3653 | 4 | | 3758 |
| 2009 | 87 | 0 | 4132 | 4 | 0 | 4233 |
| 2010[1)] | 515 | 0 | 6377 | 8 | 0 | 6900 |

[1)] **Provisional figures.**

**Table 6.2.2. Blue ling: Landing in ICES Division XIV.Source: STATLANT database.**

| Year | Faroe | Germany | Greenland | Iceland | Norway | Russia | Spain | UK | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 50 | 0 | 10 | 0 | 0 | 0 | 0 | 60 |
| 1974 | 0 | 90 | 0 | 6 | 0 | 0 | 0 | 0 | 96 |
| 1975 | 0 | 285 | 0 | 90 | 3 | 0 | 0 | 0 | 378 |
| 1976 | 0 | 65 | 0 | 21 | 0 | 0 | 0 | 13 | 99 |
| 1977 | 0 | 491 | 0 | 0 | 0 | 0 | 0 | 6 | 497 |
| 1978 | 0 | 933 | 0 | 0 | 4 | 0 | 0 | 0 | 937 |
| 1979 | 0 | 1026 | 0 | 0 | 0 | 0 | 0 | 0 | 1026 |
| 1980 | 0 | 746 | 0 | 0 | 0 | 0 | 0 | 0 | 746 |
| 1981 | 0 | 1206 | 0 | 0 | 0 | 0 | 0 | 0 | 1206 |
| 1982 | 0 | 1946 | 0 | 0 | 0 | 0 | 0 | 0 | 1946 |
| 1983 | 0 | 621 | 0 | 0 | 0 | 0 | 0 | 0 | 621 |
| 1984 | 0 | 537 | 0 | 0 | 0 | 0 | 0 | 0 | 537 |
| 1985 | 0 | 315 | 0 | 0 | 0 | 0 | 0 | 0 | 315 |
| 1986 | 214 | 149 | 0 | 0 | 0 | 0 | 0 | 0 | 363 |
| 1987 | 0 | 199 | 0 | 0 | 0 | 0 | 0 | 0 | 199 |
| 1988 | 21 | 218 | 3 | 0 | 0 | 0 | 0 | 0 | 242 |
| 1989 | 13 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 71 |
| 1990 | 0 | 64 | 5 | 0 | 0 | 0 | 0 | 10 | 79 |
| 1991 | 0 | 105 | 5 | 0 | 0 | 0 | 0 | 45 | 155 |
| 1992 | 0 | 27 | 2 | 0 | 50 | 0 | 0 | 32 | 111 |
| 1993 | 0 | 16 | 0 | 3124 | 103 | 0 | 0 | 22 | 3265 |
| 1994 | 1 | 15 | 0 | 300 | 11 | 0 | 0 | 57 | 384 |
| 1995 | 0 | 5 | 0 | 117 | 0 | 0 | 0 | 19 | 141 |
| 1996 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 2 | 14 |
| 1997 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 4 |
| 1998 | 48 | 1 | 0 | 0 | 1 | 0 | 0 | 6 | 56 |
| 1999 | 0 | 0 | 0 | 0 | 1 | 0 | 66 | 7 | 74 |
| 2000 | 0 | 1 | 0 | 4 | 0 | 0 | 889 | 2 | 896 |
| 2001 | 1 | 0 | 0 | 11 | 61 | 0 | 1631 | 6 | 1710 |
| 2002 | 0 | 0 | 0 | 11 | 1 | 0 | 0 | 0 | 12 |
| 2003 | 0 | 0 | 0 | 0 | 36 | 0 | 670 | 5 | 711 |
| 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 7 | 8 |
| 2005 | 2 | 0 | 0 | 0 | 1 | 0 | 176 | 8 | 187 |
| 2006 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 4 |
| 2007 | 19 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 20 |
| 2008 | 0.5 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 41 |
| 2009 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 4 | 7 |
| 2010[1)] | 1 | 0 | 0 | 0 | 8 | 0 | 25 |  | 34 |

[1)] **Provisional figures.**

**Table 6.2.3. Blue ling. Catches by gear type and numbers of boats participating in the blue ling fishery in Va.**

| Year | Longline | Trawl | Other gear | Total landings | No Trawlers | No. Longliners |
|---|---|---|---|---|---|---|
| | (tonnes) | (tonnes) | (tonnes) | (tonnes) | | |
| 2000 | 804 | 797 | 25 | 1626 | 27 | 15 |
| 2001 | 129 | 576 | 51 | 756 | 29 | 16 |
| 2002 | 255 | 980 | 22 | 1257 | 33 | 14 |
| 2003 | 197 | 879 | 22 | 1098 | 41 | 13 |
| 2004 | 145 | 891 | 44 | 1080 | 40 | 11 |
| 2005 | 102 | 1260 | 143 | 1505 | 58 | 13 |
| 2006 | 151 | 1461 | 121 | 1733 | 58 | 17 |
| 2007 | 373 | 1537 | 81 | 1991 | 54 | 16 |
| 2008 | 1453 | 2111 | 88 | 3652 | 68 | 29 |
| 2009 | 1678 | 2245 | 208 | 4131 | 66 | 28 |
| 2010 | 3977 | 2184 | 213 | 6374 | 64 | 46 |

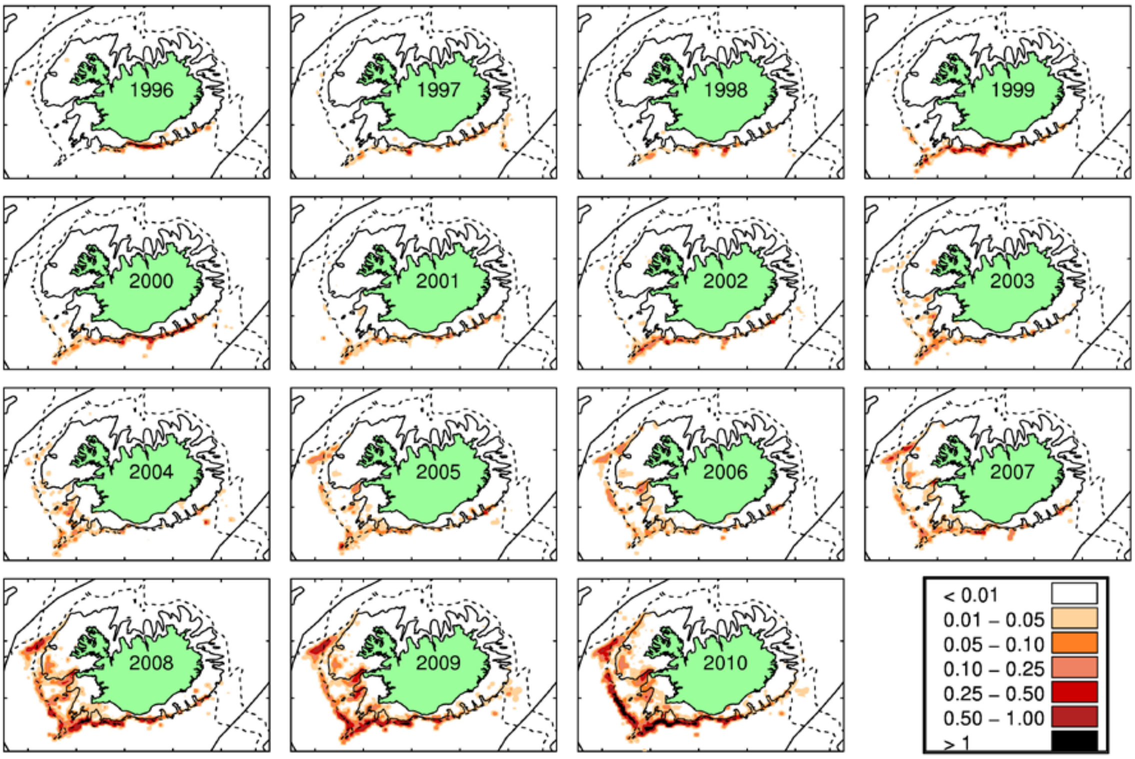



**Figure 6.2.1a. Geographical distribution (tonnes/square mile) of the Icelandic blue ling fishery in 1996–2009 as reported in the logbooks. All gear types combined.**

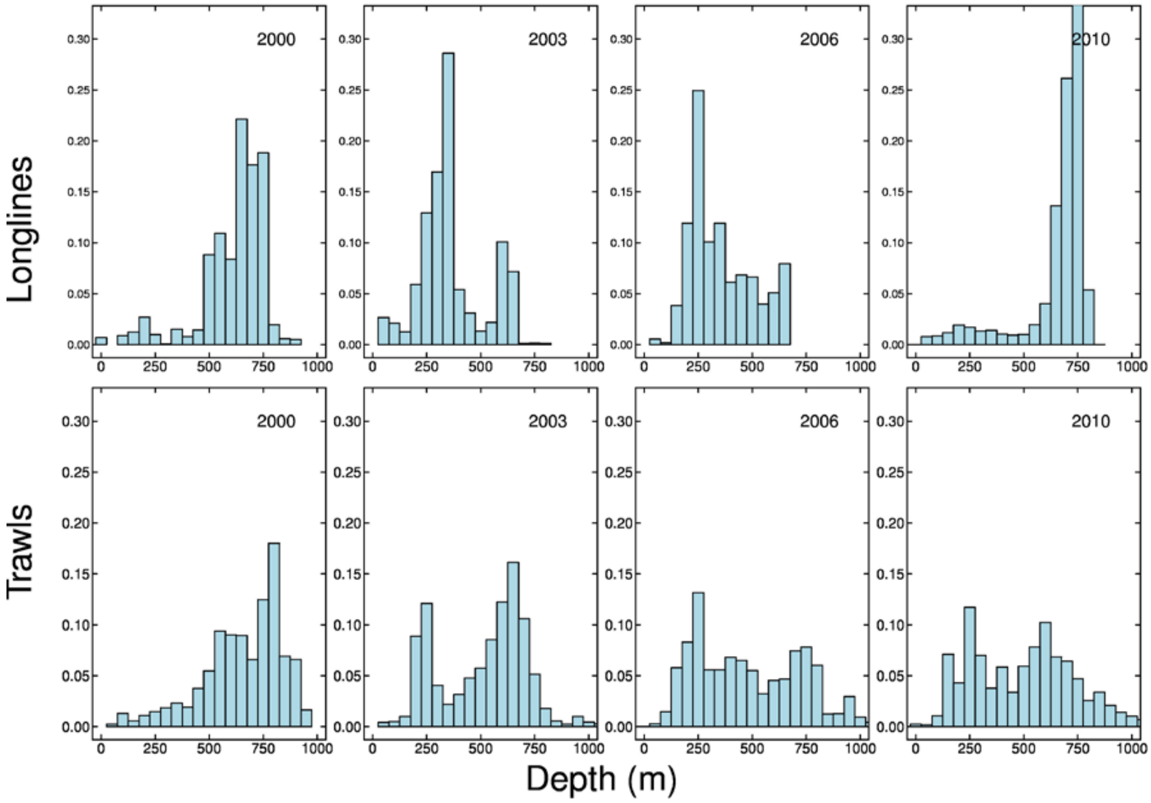



**Figure 6.2.2. Blue ling in Va and XIV. Depth distribution of longline and trawl catches in Va.**

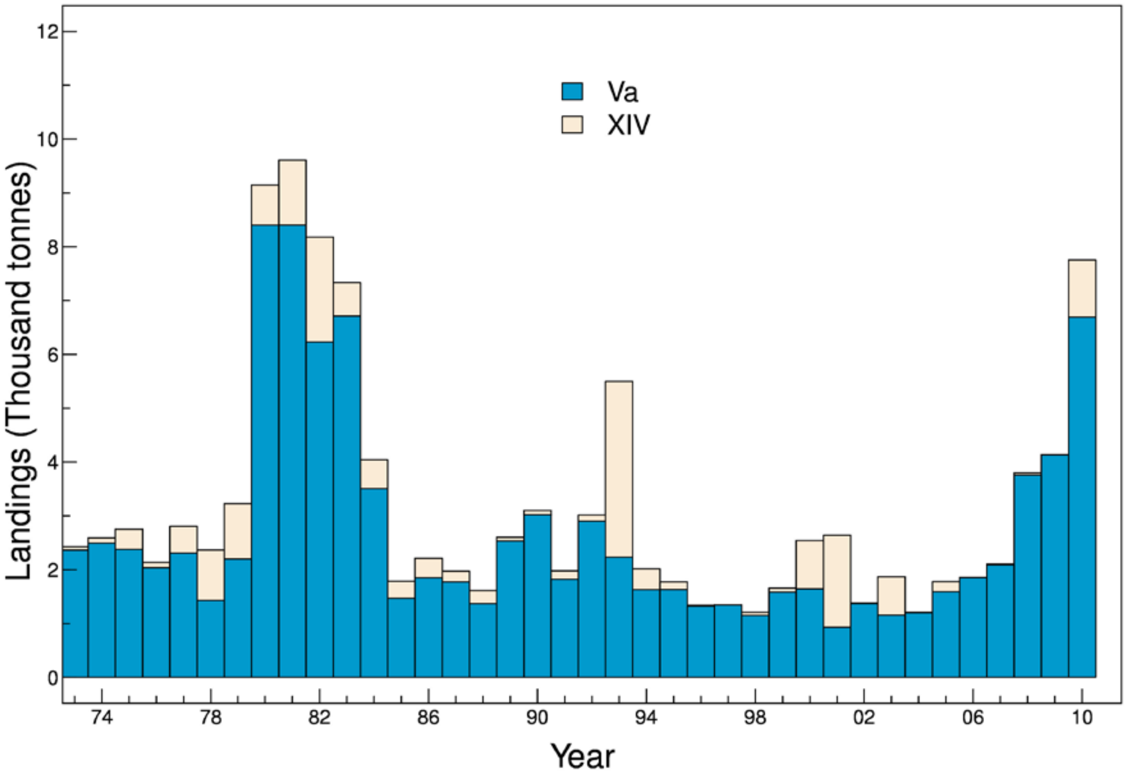



**Figure 6.2.3. Blue ling in Va and XIV. Estimated total landings.**

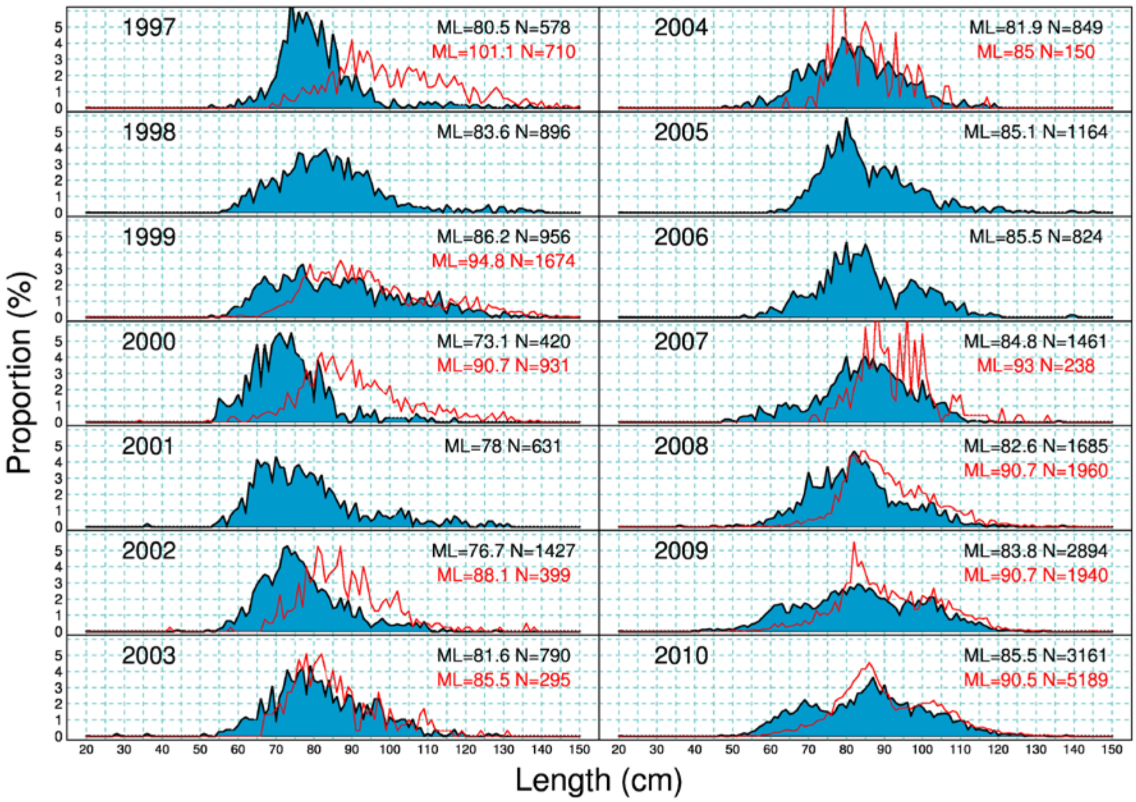
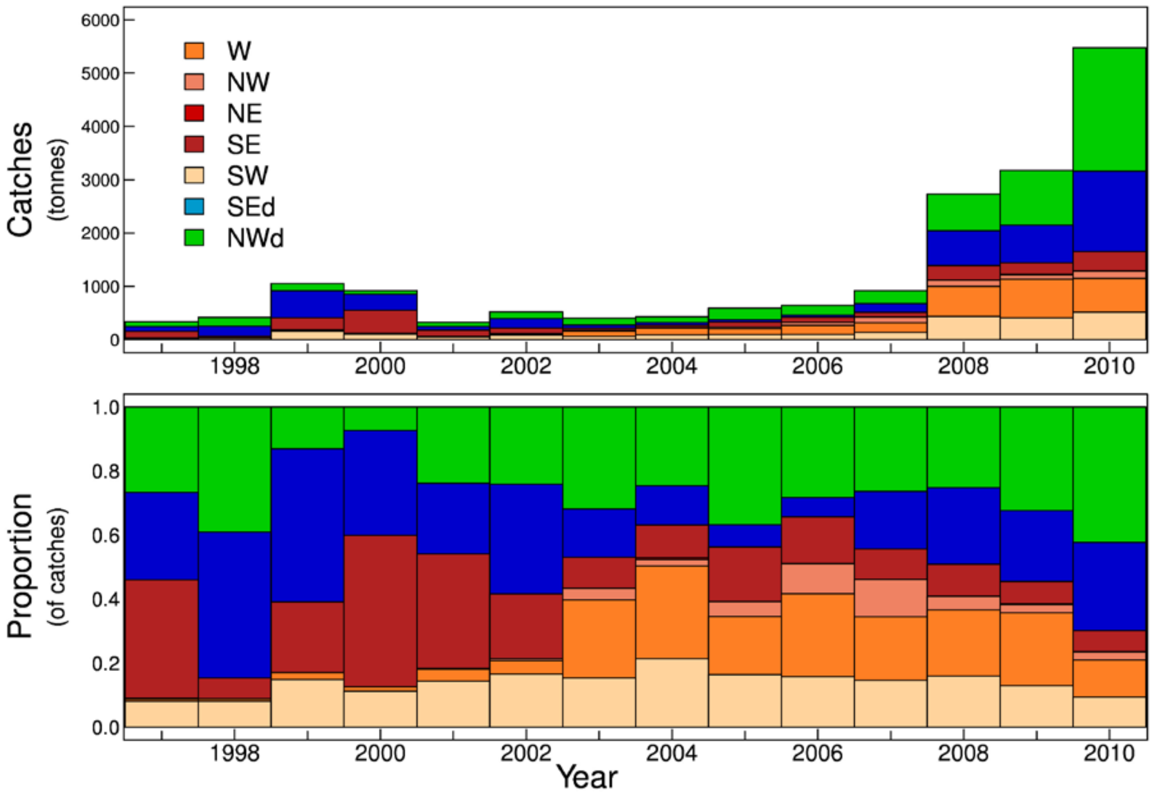



**Figure 6.2.4. Length distribution of blue ling from trawls (blue area) and longlines (red lines) of the Icelandic fleet in Va 1997–2010. The number of measured fish (N) and mean length (ML) is also given.**



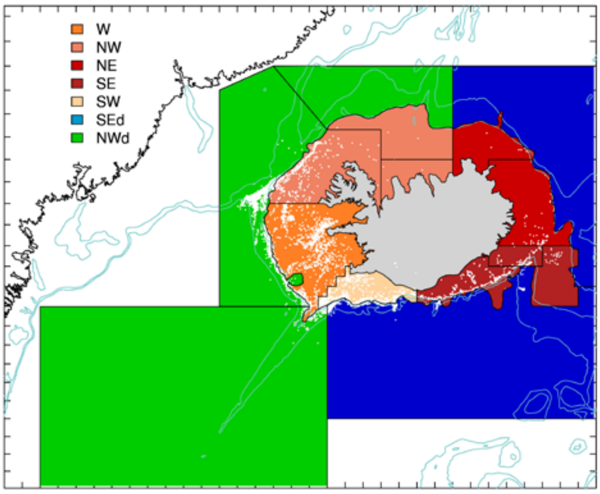




**Figure 6.2.5. Blue ling in Va and XIV. Spatial distribution of reported catches in Va in tonnes and as annual proportions. The inserted map shows the area division and locations of operations (hauls, lines) as white points.**

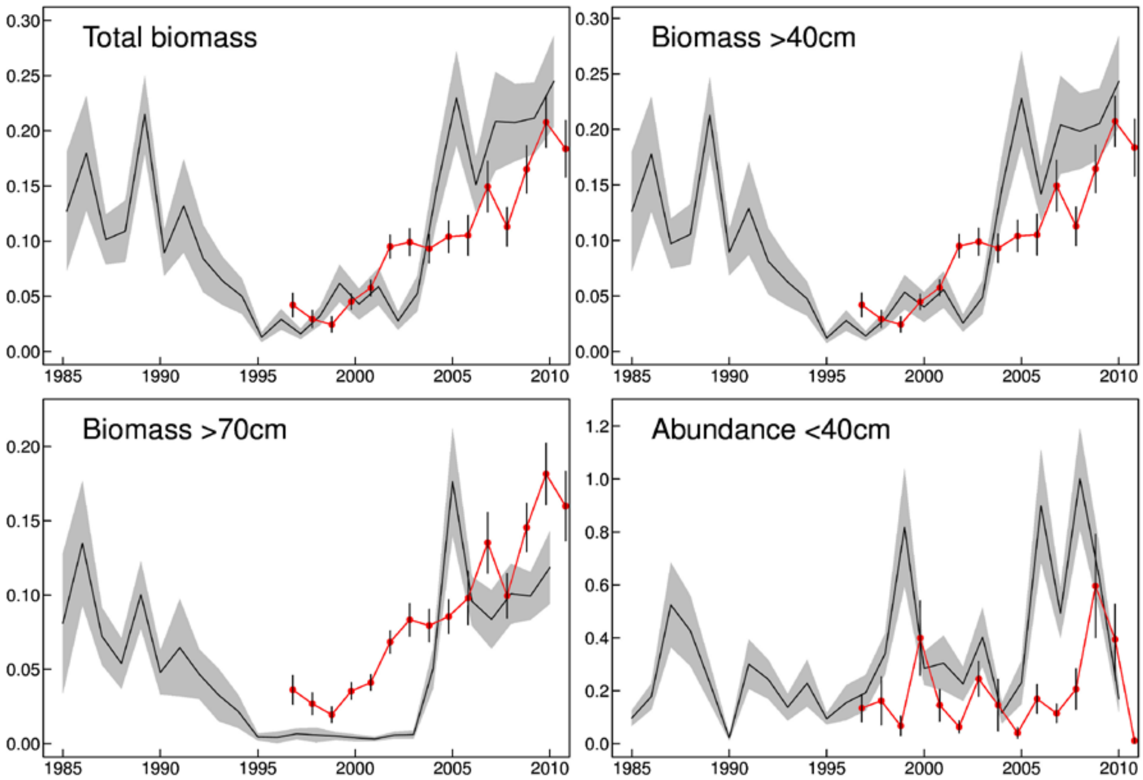



**Figure 6.2.6. Blue ling in Va and XIV. Abundance indices for blue ling in Icelandic groundfish survey in March 1985–2008 (SMB, line, shaded area) and October 1996–2008 (SMH, red lines and points, vertical lines). a) Total biomass index, b) Biomass of 40 cm and larger, c) Biomass 70 cm and larger, d) Abundance of <40 cm. The shaded area and the vertical bar show ±1 standard error of the estimate.**

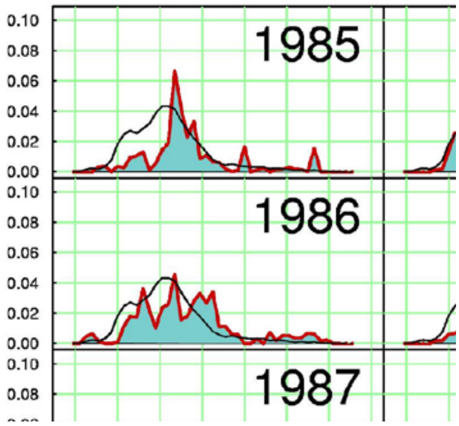



**Figure 6.2.7. Blue ling in Va and XIV. Length distributions of blue ling in the Icelandic groundfish survey in March 1985–2010.**

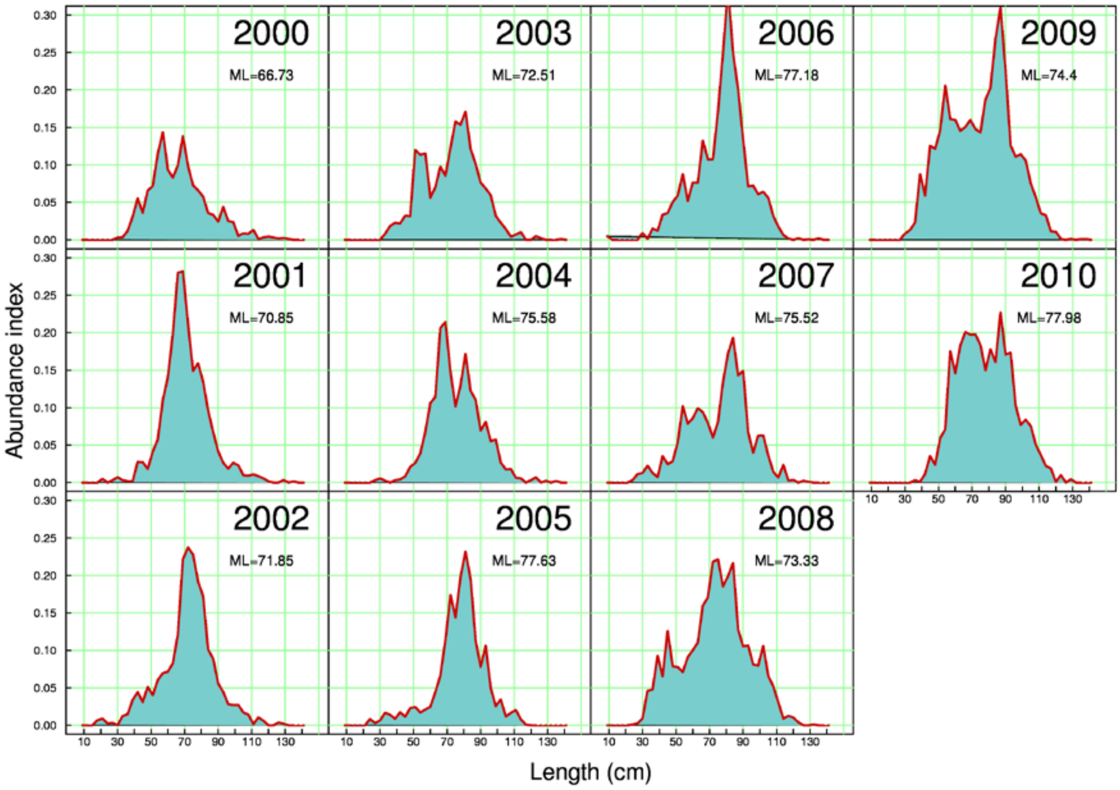



**Figure 6.2.8. Blue ling in Va and XIV. Length distributions of blue ling in the Icelandic ground-fish survey in October 2000–2009.**

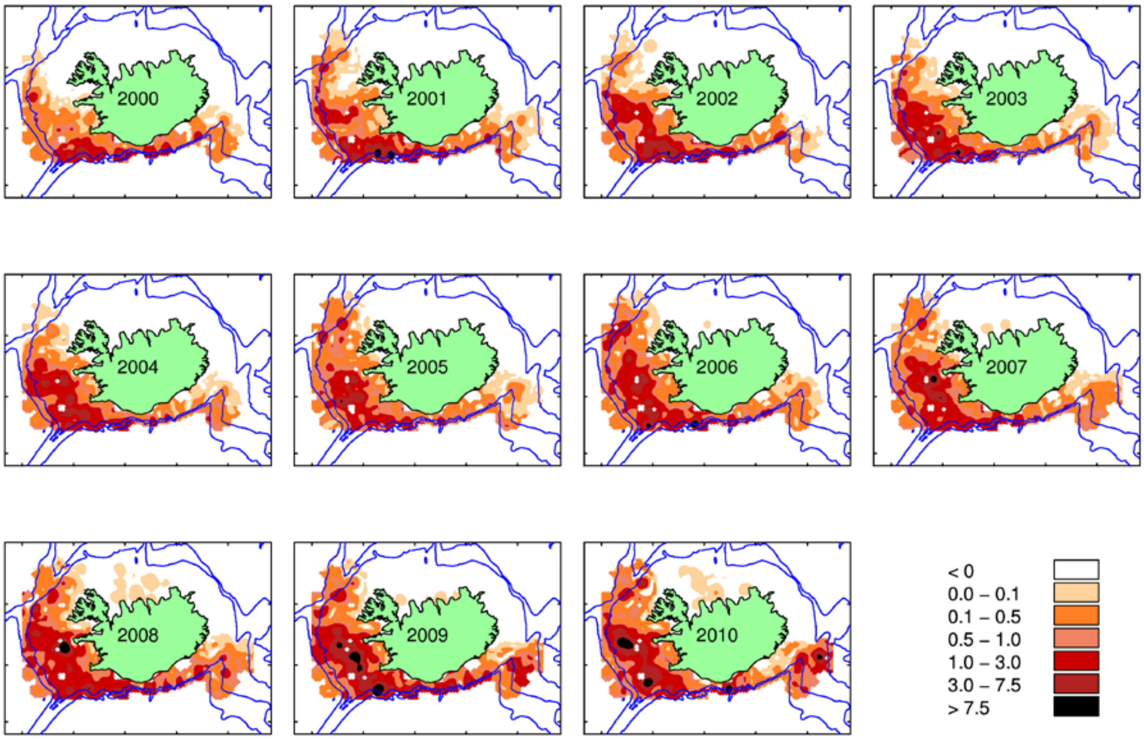



**Figure 6.2.9. Blue ling in Va and XIV. Distribution of blue ling in the groundfish survey in October 1999–2010.**

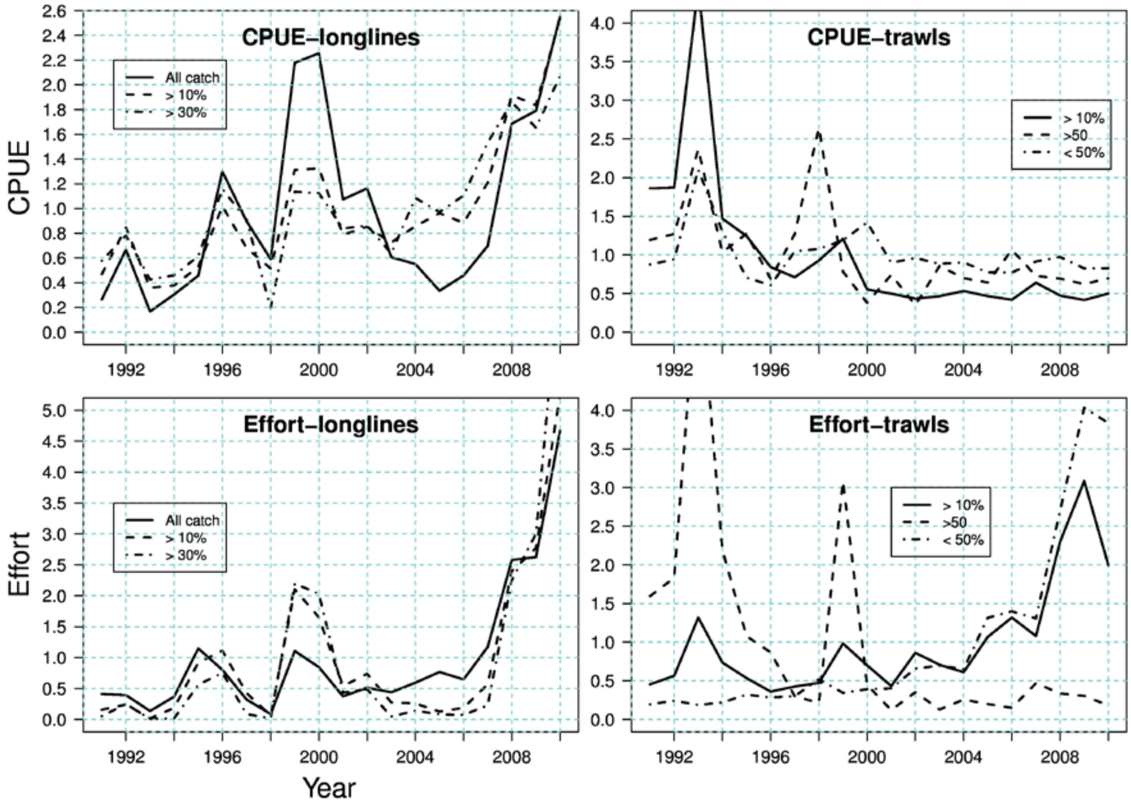



**Figure 6.2.10. Blue ling in Va and XIV. Index of raw cpue (sum(yield)/sum(effort)) of blue from the Icelandic longline and bottom-trawl fishery based on logbooks 1991–2010.**


**Figure 6.2.11. Blue ling in Va and XIV. Changes in relative fishing mortality ($F_{proxy}$ = Yield/Survey biomass).**

## 6.3 Blue Ling (*Molva Dypterygia*) in Division Vb and Subareas VI and VII

### 6.3.1 The fishery

The main fisheries are those by Faroese trawlers in Vb and French trawlers in VI and, to a lesser extent, Vb. Total international landings from Subarea VII are very small and are bycatches in other fisheries.

Landings by Faroese trawlers are mostly taken in the spawning season. Historically, this was also the case for French trawlers fishing in Vb and VI. However, in recent years blue ling has been taken mainly as a bycatch in French trawl fisheries for roundnose grenadier, black scabbardfish and deep-water sharks.

### 6.3.2 Landings trends

Total international landings from Division Vb (Table 6.3.0a–f and Figure 6.3.1) peaked in the late 1970s at around 21 000 t, stabilized in the 1980s at around 5000–10 000 t and have since declined to a stable low level of around 3000 t with a reduction in 2010 to around 1700 t.

The landings from Subarea VI peaked at about 18 000 t in 1973 and fluctuated throughout the 1980s within the range of 5000–10 000 t and have since gradually declined to around 2900 t in 2010.

Landings from Subarea VII are comparatively small and are mostly less than 500 t per annum and have mostly declined in recent years to <100 t.

The overall trend in total international landings for all areas combined demonstrates a series of peaks in the 1970s and 1980s, then a strong decline until a smaller peak in the late 1990s and a gradual decline thereafter. It should be noted that EU TACs were introduced in 2003 and these may have had a limiting factor on landings by EU Member States.

#### 6.3.2.1 ICES Advice

The latest Advice is from ICES in 2010 is: No direct fishery and effort should be made to limit bycatch in the mixed fishery. A reduction in catches should be considered in order to be consistent with the MSY (see Section 1.2.4 of ICES Advisory Report), namely:

- - Current closed areas to protect spawning aggregations should be maintained, and new closed areas should be identified and implemented where appropriate;
- - Closed areas should be identified and implemented to protect identified spawning aggregations in international waters in Divisions Vb and VIb.

#### 6.3.2.2 Management

Prior to 2009, EU deep-water TACs were been set on a biennial basis; however from 2009 onwards, annual TACs will be applied for the components of this stock in Vb and in VI and VII. From 2009 the EU TAC includes quota for Norway and the Faroe Islands. The Faroe Island set a quota for some EU countries.

The table below provides the EU TAC the TAC allocated to EU vessel in Faroese waters and the ICES estimate of international landings in recent years.

| | | | Quota included in EU TAC | | | EU quota in Vb (1) Faroese waters | international Landings Vb, VI, VII |
|---|---|---|---|---|---|---|---|
| | Area | EU TAC | EU | Norway | Faroe | | |
| 2006 | VI, VII | 3687 | | | | | 5648 |
| 2007 | VI, VII | 2510 | | | | | 5645 |
| 2008 | VI, VII | 2009 | | | | | 3929 |
| 2009 | Vb, VI, VII | 2300 | 2009 | 150 | 150 | 3065 | 4110 |
| 2010 | Vb, VI, VII | 2032 | 1732 | 150 | 150 | ? | 4550 |
| 2011 | Vb, VI, VII | 2032 | 1715 | 150 | ? | ? | |

**(1) TAC for ling and blue ling, against which a maximum bycatch of 1080 tonnes in 2009 of roundnose grenadier and black scabbard fish can be counted.**

In 2009, protection areas were introduced for spawning aggregations of blue ling on the edge of the Scottish continental shelf and at the edge of Rosemary Bank (both in VIa). Entry/exit regulations apply and vessels cannot retain >6 t of blue ling from these areas per trip. On retaining 6 t vessels must exit and cannot re-enter these areas before landing. These vessels cannot discard any quantity of blue ling.

From 2009 onwards, Member State Observer Sampling Plans, developed in accordance with EC Regulation 2347/2002, were to be revised to include a sampling protocol for sex and maturity of sampled blue ling (based on sampling advice provided by ICES in 2009).

There is minimum landing size of 70 cm for blue ling landings in Faroese waters.

## 6.3.3 Data availability

### 6.3.3.1 Landings and discards

Landings data are given in Table 6.3.0a–f. Landings data at the level of ICES statistical rectangles were provided by UK (Scotland), UK (England and Wales) and Ireland and these have been aggregated by quarter and plotted to display the geographical distribution of the fishery in Figure 6.3.2. The figures presented are for 2008 and 2009 but plots back to 2001 are presented in ICES 2009. Landings per rectangle from France in 2009 and 2010 are only partially available and reflect not more than half the actual landings in both years. Total French landings for 2009 and 2010 were extracted from sales in auction market; these data do not include the fishing location.

Information collected under the French deep-water sampling programme indicates there are no discards of this species in the French trawl fishery. However, the French industry has reported low levels of discarding towards the end of 2009 when quotas were exhausted.

The only other discard data available are from the Spanish Observer Programme for trawlers fishing in VIb. There are official records of blue ling catches in Division VIb for the period 2004–2009. During this time and in this division, observers have covered between 8% (2009) and 30% (2008) of the total number of fleet fishing days. It is reported that discards for this species are negligible, in the range of 0–0.5% of the catch.

### 6.3.3.2 Length compositions

Length composition data of blue ling from Faroese trawlers in Division Vb are presented in Figure 6.3.3. Further details can be found in WGDEEP10 WD Information on the mean length in annual landings was not available.

Time-series (1984–2010, excluding 1985 and 1986) of the length composition of French trawl landings of blue ling in VIa are given in Figure 6.3.4. The trends in annual and quarterly mean length in Division VIa are shown in Figure 6.3.5.

Mean lengths of blue ling from the Norwegian reference fleet in Divisions Vb, VIa, VIb are given in Table 6.3.1.

### 6.3.3.3 Age compositions

Preliminary age estimates were made from French sampling of landings in 2009 and 2010 according to the DCF (n = 754 and 613 in 2009 and 2010). There are also some existing historical data for some years and ICES areas.

### 6.3.3.4 Weight-at-age

No new data.

### 6.3.3.5 Maturity and natural mortality

No new data.

#### 6.3.3.6 Catch, effort and RV data

The time-series of cpue (kg/h) in the Faroese survey was not updated (Figure 6.3.6) but the time-series of number caught was (Figure 6.3.7). The time-series from the Scottish survey was not updated as the survey was not carried out in 2010.

The time-series of cpue in the Faroese fleet was not updated (Figure 6.3.6, Table 6.3.2).

The standardized lpue from haul-by-haul data provided by the French industry skipper tallybooks (see stock annex) was updated (Figure 6.3.8–6.3.10).

Effort to standardize the time-series of EC logbook are ongoing preliminary results were presented but still need significant work to interpret properly the trends.

### 6.3.4 Data analyses

The trend in international landings for this stock (Figure 6.3.1) shows a number of short-lived peaks in the 1970s. These may reflect the sequential location and fishing down of spawning aggregations as was reported to the south of Iceland (Magnússon and Magnússon, 1995) but may also be the consequence of the poor quality of landings data before the 1980s. After 1990 a part of the fishing effort of the French fleet was redirected to deeper-water species (roundnose grenadier, black scabbardfish and deep-water sharks). Subsequently for this fleet, the landings trends might represent a combination of the fishing strategy of the fleet moving deeper or shallower and fish abundance. This does not apply to Norwegian landings, which are bycatch in the ling and tusk longline fishery and the factors affecting Faroese landings are not known.

The unstandardized index of abundance from French trawler logbook data, used as a basis for Advice in 2008, is no longer used because it does not address changes in the fishery form a targeted to a bycatch fishery. The reference fleet used to calculate this index has been decommissioned.

French trawl abundance data, based on haul-by-haul data from fisher tallybooks, is available for years 2000–2010 (Figures 6.3.9 and 6.3.10), and indicates that abundance in recent years from 2007 has increased.

A similar increase in abundance in recent years is also evident from Scottish and Irish trawl surveys to the west of Britain (Figures 6.3.11 and 6.3.12). These data must also be treated with caution because the areas surveyed are small in relation to the area of the entire of the stock and the numbers of blue ling captured are small.

Abundance data from French tallybooks and the Irish and Scottish surveys are consistent in that they all suggest evidence of some increase in abundance in recent years.

Mean length in French trawl landings from VIb (Figure 6.3.5) shows a strong decline until the mid-1990s and stability thereafter, and an increase in the three last years. This is consistent with the fishing down of stock until 1990. Oscillations thereafter might results from recruitment pulses. It is worth noting that the increase in the abundance indices from 2007, correspond to a drop in mean length in that year followed by an increasing mean length in 2008–2010.

#### Data exploration

Cpue from the French trawl fishery to the west of the British Isles. The following paragraph deals with Landings per Unit of Effort (lpue).

Several problems have been seen previously in the French time-series of lpues. In the 1990s, i.e. the first decade of the mixed fishery targeting roundnose grenadier, black scabbardfish and sikis sharks, lpues were shown to vary of over three different French sub-fleets. Only the lpue for a sub-fleet of large offshore trawlers prosecuting a pure deep-water activity was considered as a reliable indicator of stocks abundance (Lorance and Dupouy, 2001). Due to disruption of the time-series of French catch statistics database, such lpue could not be updated in the 2000s. Thereafter, the fleet has undergone several changes and the vessels use to compute this lpue time-series are now all decommissioned.

In 2006, a working document showed that several factors affected the French lpues (Biseau, 2006WD). In particular the fishery have been exploiting new fishing grounds in the 2000s and the lpues in these new grounds were higher than in grounds fished since the early 1990s, driving an increase in global lpues. In addition, due to changes in the national fishery statistics system, the effort data before and after 1999 were not fully consistent.

In an attempt to overcome these problems, a standardized lpue index based upon, EC logbook data are being developed using GAM modelling. Preliminary results are presented here.

The GAM models have the form:

log(E[landings]) = s(haul duration) + month + vessel.id+ rectangle + year :Area

where E[] denotes expected value, s() indicates a smooth non-linear function (cubic regression spline), vessel.id the vessel identity and year:area an interaction term. The dependent variable was landings and not lpue, which allows including haul duration as explanatory variable and have a non-proportional relationship between landings and fishing time. The fit was done assuming a gamma distribution of the dependent variable with a log-link function using the mgcv package in R (Wood, 2006).

The modelling was restricted to EC logbook records where deep-water species made up more than 30¨% of the total landings and blue ling made less than 50% of all deep-water species. Deep-water species were defined as black scabbardfish, roundnose grenadier, orange roughy, blue ling, forkbeards, alfonsinos, greater silver smelt and all deep-water sharks, in agreement with EU regulation 2347/2002. Alfonsinos and greater silver smelt were caught in insignificant quantities or not at all; other species were reported in significant quantities in the data used. Vessels having landed less than five tonnes all years combined were excluded.

The same small area as used for the haul-by-haul data were used with the logbook data (Figure 6.3.8). From 1985 to 2009 (French logbook data for 2009 was incomplete and 2010 more incomplete). The diagnostic plot of the model was correct (Figure 6.3.13). There was much more data in one of the small area (edge 6) than in all the other. In the first years of the time-series (1985–1989) the number of sub-trips taken into account was very small compared to the following years (Figure 6.3.14a). The landings were also smaller but to a lesser extent (Figure 6.3.14b). This comes from landings for several days having been reported in a single logbook record. As a consequence, there are sub-trips of duration up to 250 hours (eleven days) in the data, but there is much more data for sub-trips of less than one day duration (Figure 6.3.14c) and these trends are derived from other areas (mainly edge 6).

In all small areas except edge 6, the confidence intervals of the predicted lpue are large and include 0. This may be further improved be refining the model or selecting different subsets of the data. There is an abrupt decline at the start of the series, in particular in edge 6, which is unlikely to represent similarly fast change in fish abundance and might result from a change in fishing strategy. Nevertheless, there is no doubt that in the early 1990s the blue ling stock was low and the decreasing catch of this species during the 1980s was a factor for the fleet moving to the deeper-water species (roundnose grenadier, black scabbardfish, orange roughy and deep-water sharks). The results presented here are preliminary and should not be over-interpreted. For example, the decreasing trends in 1985–1995, estimated for new5 and new6 should not be taken into account because there were no data in these areas (Figure 6.3.15). Constructing a single index representing the trend in the stock, based on this time-series requires further analysis, which was not carried out for this working group, data analysis need to be continued in this aim to select the best model and explore to which extent an lpue based on logbook could be rely upon for this stock. Lastly, this time-series may be unable to track recent trends because the effect of the regulation is difficult to introduce in the model. In particular, logbook data, unlike the tallybook used in recent years, do not include fishing depth and vessels might fish deeper or shallower depending on which species they target. The rectangle effect in the modelling of the logbook data cannot account for this as some ICES rectangles along the slope encompass depth from 200 to 2000 m. Therefore this time-series should be used primarily to assess the amplitude of the change in abundance in the 1980s and the trajectory of the stock abundance in the 1990s.

In order to estimate the fishing mortality that would generate the current observed mean length in the population, the following simple simulation was carried out. Although age estimation of adult fish in blue ling has been reported to be difficult, available growth parameters from different authors are fairly consistent (Ehrich and Reinsch, 1985; Magnussen, 2007; Moguedet, 1988; Thomas, 1987). These growth parameters were used to calculate the mean length in a simulated stock with a natural mortality $M$=0.17 and a fishing mortality $F$ in the range 0–0.5 (i.e. $Z$ in the range 0.17–0.67). Growth parameters for males and females were used considering that they should represent upper and lower limits of the likely values for the total stock. Relative numbers-at-age were calculated as in a yield-per-recruit model with constant recruitment and the range of $Z$ explored. Individuals were all assumed to have the mean length of their age group and the mean length of the population was calculated for each fishing mortality level.

The current mean length (mean 2005–2010=90 cm) of the landings is obtained with Fs lower than 0.2 for 7 out of the 10 sets of growth parameters and with higher fishing mortalities (up to 0.5) using the 3 other sets (Figure 6.3.16). The overall mean F across the 10 sets of growth parameter suggests an F in the order of 0.2.

This approach should be considered preliminary. Further development is needed.

The only other data analysis attempted this year was a catch curve analysis of age data from French landings in 2009. The size of aged fish ranged from 70 to 133 cm and estimated ages ranged from 7 to 20 years. The catch curve was made across ages 10 to 20, as younger ages reflecting partial recruitment from age 7 to 10.The curve (Figure 6.3.17) indicates a total mortality (Z) of 0.26. M was assumed to be 0.15 (see stock annex). The catch curve results suggest, therefore, that F in 2009 may be below the level of M.

This approach should be considered preliminary as age estimates for blue ling are not validated, and no routine age estimation has been carried out in previous years. The age composition, observed in a single year, may also represent a biased view of the stock dynamic due to assumptions made for constant recruitment and fishing mortality.

#### Exploratory Stock Reduction Analysis (SRA) using $FL_{aspm}$

The biomass in 1966 was assumed to be virgin and was estimated by the deterministic model for a range of different values of natural mortality (M). The model was run using all three indices simultaneously. The fitted indices for the original value of M can be seen in Figure 6.3.17.

The corresponding estimated values of exploitable virgin biomass and exploitable biomass in 2009 can be seen in Table 6.3.4. They are clearly affected by the value of M, particularly the estimated virgin biomass.

The estimated exploitable biomass and fishing mortality trajectories for the different values of M can be seen in Figure 6.3.18. For the value of M accepted for this stock, the maximum fishing mortality observed was 0.43 in 2001.

### 6.3.5 Comments on assessment

Management advice for deep-water species is not required this year.

$FL_{aspm}$ is currently a beta version developed in the EU funded DEEPFISHMAN project. Testing of the software has so far been limited and consequently the results generated should be treated with caution. However, it is possible to reproduce Francis' New Zealand orange roughy assessment (Francis, 1992) giving confidence that the model has been implemented correctly. It is possible to use the software to estimate a probability distribution of the virgin biomass. However, the tools to perform this analysis are still in development and therefore not used here. Future developments may include the calculation of confidence intervals, estimates of MCY, and better evaluation of the uncertainty of the estimated parameter values.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, e.g. CUSUM, catch curve, yield-per-recruit GADGET and stock reduction.

### 6.3.6 Management considerations

**Table 6.3.0a. Landings of blue ling in Subdivision Vb1.**

| Year | Faroes | France(2) | Germany(2) | Norway(3) | E & W(2) | Scotland (1) | Ireland | Russia (2) | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1966 | | 839 | | 430 | | | | | 1269 |
| 1967 | | | 1006 | 238 | | | | | 1244 |
| 1968 | | | 1838 | 823 | | | | | 2661 |
| 1969 | | | 303 | 798 | | | | | 1101 |
| 1970 | | | 348 | 2718 | | | | | 3066 |
| 1971 | | | 1367 | 557 | | | | | 1924 |
| 1972 | | | 2730 | 1203 | | | | | 3933 |
| 1973 | 51 | 80 | 3009 | 4003 | 4 | | | | 7147 |
| 1974 | 43 | 390 | 1808 | 1554 | 3 | | | | 3798 |
| 1975 | 17 | 2147 | 1528 | 2492 | 1 | | | | 6185 |
| 1976 | 42 | 10475 | 896 | 1482 | | | | | 12 895 |
| 1977 | 23 | 6977 | 870 | 858 | 4 | | | 12500 | 21 232 |
| 1978 | 423 | 3369 | 744 | 237 | 35 | | | | 4808 |
| 1979 | 1072 | 2683 | 691 | 331 | | | | | 4777 |
| 1980 | 1187 | 2427 | 5905 | 304 | | 1 | | | 9824 |
| 1981 | 1481 | 371 | 2867 | 167 | | | | | 4886 |
| 1982 | 2761 | 843 | 2538 | 121 | | | | | 6263 |
| 1983 | 3933 | 668 | 222 | 256 | | | | | 5079 |
| 1984 | 6453 | 515 | 214 | 105 | | | | | 7287 |
| 1985 | 4038 | 1193 | 217 | 140 | | | | | 5588 |
| 1986 | 4830 | 2578 | 197 | 94 | | | | | 7699 |
| 1987 | 3361 | 3246 | 152 | 81 | | | | | 6840 |
| 1988 | 3487 | 3036 | 49 | 94 | | | | | 6666 |
| 1989 | 2468 | 1802 | 51 | 228 | | | | | 4549 |
| 1990 | 946 | 3073 | 71 | 450 | | | | | 4540 |
| 1991 | 1573 | 1013 | 36 | 196 | 1 | | | | 2819 |
| 1992 | 1918 | 407 | 21 | 390 | 4 | | | | 2740 |
| 1993 | 2088 | 192 | 24 | 218 | 19 | | | | 2541 |
| 1994 | 1065 | 147 | 3 | 173 | | | | | 1388 |
| 1995 | 1606 | 588 | 2 | 38 | 4 | | | | 2238 |
| 1996 | 1100 | 301 | 3 | 82 | | | | | 1486 |
| 1997 | 778 | 1656 | | 65 | 11 | | | | 2510 |
| 1998 | 1026 | 1411 | 0 | 24 | 1 | | | | 2462 |
| 1999 | 1730 | 1067 | 4 | 38 | 4 | | | | 2843 |
| 2000 | 1677 | 575 | 1 | 163 | 33 | | | 1 | 2450 |
| 2001 | 1407 | 430 | 4 | 130 | 11 | | 2 | | 1984 |
| 2002 | 1003 | 578 | | 274 | 8 | | | | 1863 |
| 2003 | 2465 | 1133 | | 12 | 1 | | | | 3611 |
| 2004 | 751 | 1132 | | 20 | | | | 13 | 1916 |
| 2005 | 1028 | 781 | | 15 | 1 | | | | 1825 |
| 2006 | 1276 | 839 | | 21 | 1 | | | 16 | 2153 |

| Year | Faroes | France(2) | Germany(2) | Norway(3) | E & W(2) | Scotland (1) | Ireland | Russia (2) | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | 1220 | 1166 | | 212 | 8 | | | 36 | 2642 |
| 2008 | 642 | 865 | | 35 | | | | 110 | 1652 |
| 2009 | 523 | (4) | | | | | | 0 | 523 |
| 2010* | 830 | (4) | | | | | | 1 | 831 |

***Preliminary. (1) Included in Vb2. (2) Includes Vb2 (3) includes Vb2 up to 1974 (4) included in VIa**

**Table 6.3.0b. Landings of Blue ling in Subdivision Vb2.**

| Year | Faroes | Norway | Scotland (1) | E & W | Total |
|---|---|---|---|---|---|
| 1966 | | | | | 0 |
| 1967 | | | | | 0 |
| 1968 | | | | | 0 |
| 1969 | | | | | 0 |
| 1970 | | | | | 0 |
| 1971 | | | | | 0 |
| 1972 | | | | | 0 |
| 1973 | | | | | 0 |
| 1974 | | | | | 0 |
| 1975 | 1 | | | | 1 |
| 1976 | 6 | 37 | | | 43 |
| 1977 | | 86 | | | 86 |
| 1978 | 7 | 83 | | | 90 |
| 1979 | 14 | 87 | | | 101 |
| 1980 | 36 | 159 | | | 195 |
| 1981 | 48 | 93 | | | 141 |
| 1982 | 128 | 66 | | | 194 |
| 1983 | 463 | 182 | | | 645 |
| 1984 | 757 | 50 | | | 807 |
| 1985 | 396 | 70 | | | 466 |
| 1986 | 81 | 41 | | | 122 |
| 1987 | 209 | 90 | | | 299 |
| 1988 | 2788 | 72 | | | 2860 |
| 1989 | 622 | 95 | | | 717 |
| 1990 | 68 | 191 | | | 259 |
| 1991 | 71 | 51 | 21 | | 143 |
| 1992 | 1705 | 256 | 1 | | 1962 |
| 1993 | 182 | 22 | 91 | | 295 |
| 1994 | 239 | 16 | 1 | | 256 |
| 1995 | 162 | 36 | 4 | | 202 |
| 1996 | 42 | 62 | 12 | | 116 |
| 1997 | 229 | 48 | 11 | | 288 |
| 1998 | 64 | 29 | 29 | | 122 |
| 1999 | 15 | 49 | 24 | | 88 |
| 2000 | 0 | 37 | 37 | | 74 |
| 2001 | 0 | 69 | 63 | | 132 |
| 2002 | | 21 | 140 | | 161 |
| 2003 | | 84 | 120 | | 204 |
| 2004 | 710 | 6 | 68 | | 784 |
| 2005 | 609 | 14 | 68 | | 691 |
| 2006 | 647 | 34 | 16 | | 697 |

| Year | Faroes | Norway | Scotland (1) | E & W | Total |
|---|---|---|---|---|---|
| 2007 | 632 | 6 | 16 | | 654 |
| 2008 | 317 | 0 | 91 | | 408 |
| 2009 | 444 | 8 | 161 | | 613 |
| 2010* | 629 | 0 | 224 | | 853 |

***Preliminary.**

**Table 6.3.0c. Landings of Blue ling in DivisionVIa.**

| Year | Faroes | France | Germany | Ireland | Norway | Spain (2) | E & W | Scotland | Lithuania(1) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1966 | | | | | 20 | | | | | 20 |
| 1967 | | | 37 | | 35 | | | | | 72 |
| 1968 | | | | | 126 | | | | | 126 |
| 1969 | | | 6 | | 112 | | | | | 118 |
| 1970 | | | | | 176 | | | | | 176 |
| 1971 | | | | | 15 | | | | | 15 |
| 1972 | | 696 | | | 14 | | | | | 710 |
| 1973 | | 18 000 | | | 25 | | | | | 18 025 |
| 1974 | 33 | 15 000 | 1218 | | 371 | | 164 | | | 16 786 |
| 1975 | | 5000 | 2941 | | 20 | | 8 | | | 7969 |
| 1976 | | 5462 | 818 | | 10 | | 1 | | | 6291 |
| 1977 | | 7940 | 470 | | 16 | | 556 | | | 8982 |
| 1978 | | 5495 | 2498 | | 19 | | 21 | | | 8033 |
| 1979 | | 3064 | 993 | | 2 | | 279 | | | 4338 |
| 1980 | | 2124 | 773 | | 10 | | | | | 2907 |
| 1981 | | 3338 | 335 | | 11 | | | 1 | | 3685 |
| 1982 | | 3430 | 79 | | 16 | | 99 | | | 3624 |
| 1983 | | 5233 | 11 | | 118 | | 13 | | | 5375 |
| 1984 | | 3653 | 183 | | 45 | | 5 | | | 3886 |
| 1985 | 56 | 5670 | 5 | | 75 | | 2 | | | 5808 |
| 1986 | | 8254 | 7 | | 47 | | 2 | 1 | | 8311 |
| 1987 | | 9389 | 45 | | 51 | | 1 | | | 9486 |
| 1988 | 14 | 6645 | 2 | | 29 | | 2 | 1 | | 6693 |
| 1989 | 6 | 7797 | 2 | | 143 | | | | | 7948 |
| 1990 | | 6114 | 44 | | 54 | | | 1 | | 6213 |
| 1991 | 8 | 6165 | 18 | | 63 | | 1 | 35 | | 6290 |
| 1992 | 4 | 7742 | 4 | | 129 | | | 24 | | 7903 |
| 1993 | | 6793 | 48 | 3 | 27 | | 13 | 42 | | 6926 |
| 1994 | | 3363 | 24 | 73 | 90 | 433 | 1 | 91 | | 4075 |
| 1995 | 0 | 3073 | | 11 | 96 | 392 | 34 | 738 | | 4344 |
| 1996 | 0 | 4116 | 4 | | 50 | 681 | 9 | 1407 | | 6267 |
| 1997 | 0 | 4053 | | 1 | 29 | 190 | 789 | 1021 | | 6083 |
| 1998 | 0 | 4735 | 3 | 1 | 21 | 142 | 11 | 1416 | | 6329 |
| 1999 | 0 | 3731 | | 10 | 55 | 119 | 5 | 1105 | | 5025 |
| 2000 | | 4544 | 94 | 9 | 102 | 108 | 24 | 1300 | | 6181 |
| 2001 | | 2877 | 6 | 52 | 117 | 797 | 116 | 2136 | | 6101 |
| 2002 | | 2172 | | 62 | 61 | 285 | 16 | 2027 | | 4623 |
| 2003 | 7 | 2010 | | 2 | 106 | 3 | 3 | 428 | | 2559 |
| 2004 | 10 | 2264 | | 1 | 24 | 4 | 1 | 482 | | 2786 |
| 2005 | 17 | 2019 | | 2 | 33 | 88 | | 390 | 29 | 2578 |
| 2006 | 13 | 1794 | | 1 | 49 | 87 | 3 | 433 | | 2380 |

| Year | Faroes | France | Germany | Ireland | Norway | Spain (2) | E & W | Scotland | Lithuania(1) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 13 | 1814 | | | 31 | 47 | | 113 | 1 | 2019 |
| 2008 | 14 | 1574 | | | 73 | 10 | | 112 | | 1783 |
| 2009 | 11 | 2537(4) | | | 74 | 165 | | 178 | | 2965 |
| 2010* | 39 | 2453(4) | | | 1 | 223 | | 134 | | 2850 |

***Preliminary. (1) Includes VIb for all countries up to (and including) 1974, (2) Includes VIb, (4) all French landings in 2009–2010.**

**Table 6.3.0d. Landings of blue ling in DivisionVIb.**

| Year | Poland | Russia | Faroes | France | Germany | Norway | E & W | Scotland | Iceland | Ireland | Estonia | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | | | 1 | | | 37 | | | | | | 38 |
| 1976 | | | 13 | | | 6 | | | | | | 19 |
| 1977 | | | 6 | 36 | | 7 | | | | | | 49 |
| 1978 | | | 3 | 58 | | 8 | | | | | | 69 |
| 1979 | | | 4 | 652 | 187 | 28 | | | | | | 871 |
| 1980 | | | | 3827 | 5526 | 8 | | | | | | 9361 |
| 1981 | | | | 534 | 3944 | 5 | | | | | | 4483 |
| 1982 | | | | 263 | 554 | 13 | | 1 | | | | 831 |
| 1983 | | | | 243 | 38 | 50 | | 2 | | | | 333 |
| 1984 | | | 133 | 3281 | | 43 | | | | | | 3457 |
| 1985 | | | 11 | 7263 | 31 | 38 | | | | | | 7343 |
| 1986 | | | 1845 | 2928 | 39 | 66 | 7 | 1 | | | | 4886 |
| 1987 | | | 350 | 10 | 356 | 76 | 3 | 10 | | | | 805 |
| 1988 | | | 2000 | 499 | 37 | 42 | 9 | 14 | | | | 2601 |
| 1989 | | | 1292 | 61 | 22 | 217 | | 16 | | | | 1608 |
| 1990 | | | 360 | 703 | | 127 | | 2 | | | | 1192 |
| 1991 | | | 111 | 2482 | 6 | 102 | 5 | 15 | | | | 2721 |
| 1992 | | | 231 | 348 | 2 | 50 | 2 | 14 | | | | 647 |
| 1993 | | | 51 | 373 | 109 | 50 | 66 | 57 | | | | 706 |
| 1994 | | | 5 | 89 | 104 | 33 | 3 | 25 | | | | 259 |
| 1995 | | | 1 | 305 | 189 | 12 | 11 | 38 | | | | 556 |
| 1996 | | | 0 | 87 | 92 | 7 | 37 | 74 | | | | 297 |
| 1997 | | | 138 | 331 | | 6 | 65 | 562 | 1 | | | 1103 |
| 1998 | | | 76 | 469 | | 13 | 190 | 287 | 122 | 11 | | 1168 |
| 1999 | | | 204 | 654 | | 9 | 168 | 2411 | 610 | 4 | | 4060 |
| 2000 | | | | 514 | | 184 | 500 | 966 | | 7 | | 2171 |
| 2001 | | | 238 | 210 | 1 | 256 | 337 | 1803 | | 4 | 85 | 2934 |
| 2002 | | 3 | 79 | 345 | | 273 | 141 | 497 | | 1 | | 1339 |
| 2003 | 4 | 2 | | 510 | | 102 | 14 | 113 | | | 5 | 750 |
| 2004 | 1 | 5 | 4 | 514 | | 2 | 10 | 96 | | | 3 | 635 |
| 2005 | | 15 | 1 | 235 | | 1 | 9 | 80 | | | | 341 |
| 2006 | | | 3 | 313 | | 2 | 4 | 29 | | | | 351 |
| 2007 | | 1 | 15 | 109 | | 4 | 7 | 30 | | | | 166 |
| 2008 | | 12 | 2 | 29 | | 2 | 2 | 9 | | 0 | | 56 |
| 2009 | | 1 | | ([1]) | | 1 | | 7 | | 0 | | 9 |
| 2010* | | 0 | | ([1]) | | 15 | | 1 | | 0 | | 16 |

**([1]) included in VIa.**

**Table 6.3.0e. Landings of blue ling in Subarea VII.**

| Year | France | Germany | Spain (1) | Norway | E & W | Scotland | Ireland | Total |
|---|---|---|---|---|---|---|---|---|
| 1988 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 22 |
| 1989 | 291 | 0 | 0 | 2 | 0 | 0 | 0 | 293 |
| 1990 | 223 | 0 | 0 | 0 | 0 | 0 | 0 | 223 |
| 1991 | 211 | 0 | 0 | 0 | 0 | 1 | 0 | 212 |
| 1992 | 397 | 0 | 0 | 3 | 0 | 6 | 0 | 406 |
| 1993 | 273 | 0 | 0 | 2 | 16 | 30 | 0 | 321 |
| 1994 | 298 | 0 | 4 | 1 | 9 | 26 | 1 | 339 |
| 1995 | 155 | 0 | 13 | 0 | 43 | 16 | 3 | 230 |
| 1996 | 189 | 0 | 21 | 1 | 57 | 97 | 0 | 365 |
| 1997 | 179 | 8 | 0 | 2 | 170 | 15 | 9 | 383 |
| 1998 | 252 | 0 | 22 | 1 | 283 | 30 | 10 | 598 |
| 1999 | 116 | 2 | 59 | 1 | 168 | 18 | 27 | 391 |
| 2000 | 91 | 2 | 65 | 5 | 31 | 17 | 75 | 286 |
| 2001 | 84 | 2 | 64 | 5 | 29 | 17 | 494 | 695 |
| 2002 | 45 | 0 | 42 | 0 | 76 | 55 | 272 | 490 |
| 2003 | 27 | 1 | 42 | 0 | 8 | 16 | 28 | 122 |
| 2004 | 23 | 1 | 15 | 0 | 4 | 1 | 17 | 61 |
| 2005 | 36 | 0 | 25 | 0 | 1 | 0 | 10 | 72 |
| 2006 | 30 | 0 | 31 | 0 | 2 | 0 | 4 | 67 |
| 2007 | 121 | 0 | 38 | 0 | 2 | 1 | 2 | 164 |
| 2008 | 24 | 0 | 6 | 0 | 0 | 0 | 0 | 30 |
| 2009 | (2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010* | (2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Preliminary. (1) Reported as VII, (2) included in VIa.**

**Table 6.3.0f. Blue ling landings in Division Vb and Subareas VI and VII.**

| Year | Vb | VI | VII | Total |
|---|---|---|---|---|
| 1966 | 1269 | 20 | | 1289 |
| 1967 | 1244 | 72 | | 1316 |
| 1968 | 2661 | 126 | | 2787 |
| 1969 | 1101 | 118 | | 1219 |
| 1970 | 3066 | 176 | | 3242 |
| 1971 | 1924 | 15 | | 1939 |
| 1972 | 3933 | 710 | | 4643 |
| 1973 | 7147 | 18 025 | | 25 172 |
| 1974 | 3798 | 16 786 | | 20 584 |
| 1975 | 6186 | 8007 | | 14 193 |
| 1976 | 12 938 | 6310 | | 19 248 |
| 1977 | 21 318 | 9031 | | 30 349 |
| 1978 | 4898 | 8102 | | 13 000 |
| 1979 | 4878 | 5209 | | 10 087 |
| 1980 | 10 019 | 12 268 | | 22 287 |
| 1981 | 5027 | 8168 | | 13 195 |
| 1982 | 6457 | 4455 | | 10 912 |
| 1983 | 5724 | 5708 | | 11 432 |
| 1984 | 8094 | 7343 | | 15 437 |
| 1985 | 6054 | 13 151 | | 19 205 |
| 1986 | 7821 | 13 197 | | 21 018 |
| 1987 | 7139 | 10 291 | | 17 430 |
| 1988 | 9526 | 9294 | 22 | 18 842 |
| 1989 | 5266 | 9556 | 293 | 15 115 |
| 1990 | 4799 | 7405 | 223 | 12 427 |
| 1991 | 2962 | 9011 | 212 | 12 185 |
| 1992 | 4702 | 8550 | 406 | 13 658 |
| 1993 | 2836 | 7632 | 321 | 10 789 |
| 1994 | 1644 | 4334 | 339 | 6317 |
| 1995 | 2440 | 4900 | 230 | 7570 |
| 1996 | 1602 | 6564 | 365 | 8531 |
| 1997 | 2798 | 7186 | 383 | 10 367 |
| 1998 | 2584 | 7497 | 598 | 10 679 |
| 1999 | 2931 | 9085 | 391 | 12 407 |
| 2000 | 2524 | 8352 | 286 | 11 162 |
| 2001 | 2116 | 9035 | 695 | 11 846 |
| 2002 | 2024 | 5962 | 490 | 8476 |
| 2003 | 3815 | 3309 | 122 | 7246 |
| 2004 | 2700 | 3421 | 61 | 6182 |
| 2005 | 2516 | 2919 | 72 | 5507 |
| 2006 | 2850 | 2731 | 67 | 5648 |

| | | | | |
|---|---|---|---|---|
| 2007 | 3296 | 2185 | 164 | 5645 |
| 2008 | 2060 | 1839 | 30 | 3929 |
| 2009 | 1136 | 2974 | 0 | 4110 |
| 2010* | 1684 | 2866 | 0 | 4550 |

***Provisional.**

**Table 6.3.1. Unweighted estimates of the mean length in catches of blue ling by the Norwegian longline reference fleet during 2003–2007, along with standard errors (se) and number of fish measured.**

| Blue ling | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ICES Area | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Vb | Mean | | 96,35 | 107,79 | 104,5 | 109,25 | 94,92 | 94,53 |
| | se | | 1,32 | 3,81 | 5,2 | 3,29 | 7,68 | 3,72 |
| | N | | 103 | 14 | 15 | 8 | 12 | 19 |
| VIa | Mean | 83,6 | | | | 91,49 | | 99,61 |
| | se | 1,88 | | | | 0,57 | | 2,53 |
| | N | 40 | | | | 263 | | 41 |
| VIb | Mean | 91,26 | | | | 96,86 | | 103,53 |
| | se | 0,16 | | | | 1,55 | | 3,93 |
| | N | 5743 | | | | 36 | | 17 |

**Table 6.3.2. Blue ling catch, effort and cpue in the Faroese trawl surveys in Vb for cod haddock and saithe.**

| | Spring survey | | | Summer survey | | |
|---|---|---|---|---|---|---|
| | Catch (kg) | Effort (h) | cpue (kg/h) | Catch (kg) | Effort (h) | cpue (kg/h) |
| 1994 | 83 | 91 | 0.91 | | | |
| 1995 | 82 | 91 | 0.90 | | | |
| 1996 | 122 | 100 | 1.22 | 710 | 200 | 3.55 |
| 1997 | 199 | 98 | 2.03 | 237 | 200 | 1.18 |
| 1998 | 79 | 99 | 0.80 | 477 | 201 | 2.37 |
| 1999 | 8 | 100 | 0.08 | 287 | 199 | 1.44 |
| 2000 | 45 | 100 | 0.45 | 203 | 200 | 1.02 |
| 2001 | 70 | 100 | 0.70 | 350 | 200 | 1.75 |
| 2002 | 36 | 100 | 0.36 | 119 | 199 | 0.60 |
| 2003 | 119 | 100 | 1.19 | 156 | 200 | 0.78 |
| 2004 | 105 | 100 | 1.05 | 825 | 200 | 4.13 |
| 2005 | 95 | 100 | 0.95 | 846 | 200 | 4.23 |
| 2006 | 110 | 100 | 1.10 | 330 | 200 | 1.65 |
| 2007 | 115 | 100 | 1.15 | 253 | 199 | 1.27 |
| 2008 | 43 | 99 | 0.43 | 175 | 200 | 0.88 |
| 2009 | 238 | 100 | 2.38 | 455 | 200 | 2.27 |

**Table 6.3.3. Summary of GAM model statistics.**

Approximate significance of smooth terms:

| | edf | Ref.d.f. | F | p-value |
|---|---|---|---|---|
| s(haul duration) | 6.687 | 6.687 | 1524 | <2e-16 *** |

R-sq.(adj) = 0.484
Deviance explained = 53.8%
REML score = 2.7183e+05
Scale est. = 0.88572
n = 37296

Family: Tweedie(2) (equivallent to gamma)
Link function: log

Formula:
Zvar ~ s(DURE, bs = "cr") + factor(Vessel.id) + factor(Month) + factor(rectangle) + year:area

Parametric Terms

| | d.f. | F | p-value |
|---|---|---|---|
| factor(Vessel.id) | 70 | 62.73 | <2e-16 |
| factor(Month) | 11 | 986.44 | <2e-16 |
| factor(rectangle) | 48 | 26.24 | <2e-16 |
| year:area | 103 | 18.82 | <2e-16 |

**Table 6.1.4. Estimated values of exploitable virgin biomass from $FL_{aspm}$ in 1966 and 2009 for a range of values of M.**

| Natural mortality | Estimated exploitable virgin biomass in 1966 (t) | Estimated exploitable biomass in 2009 (t) |
|---|---|---|
| 0.05 | 445,493 | 146,705 |
| 0.10 | 304,182 | 70,640 |
| 0.15 | 242,825 | 49,472 |
| 0.20 | 205,236 | 50,296 |
| 0.25 | 187,492 | 91,537 |
| 0.30 | 169,623 | 99,105 |

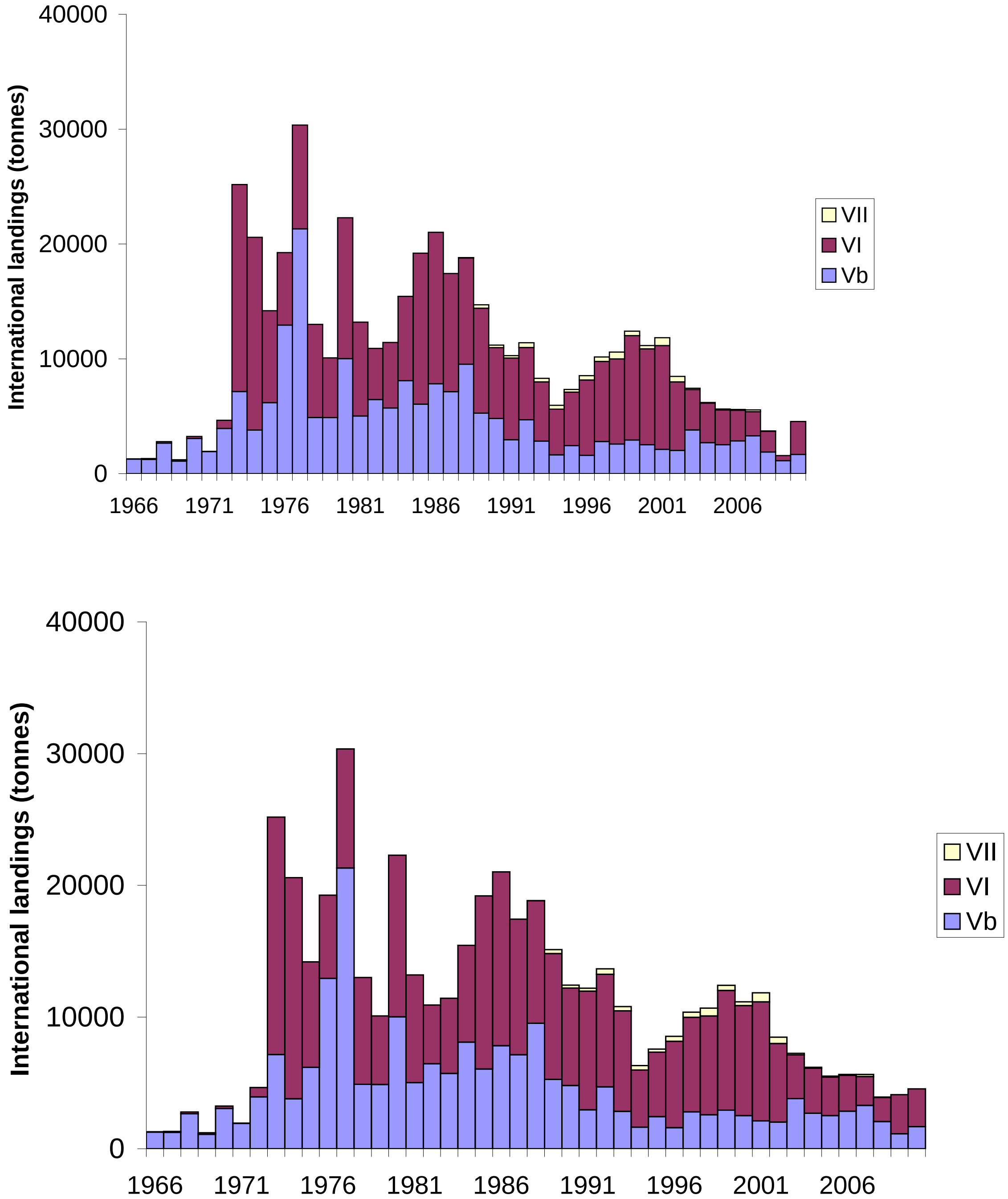



**Figure 6.3.1. Trends in total international landings for southern blue ling (Vb, VI, VII).**

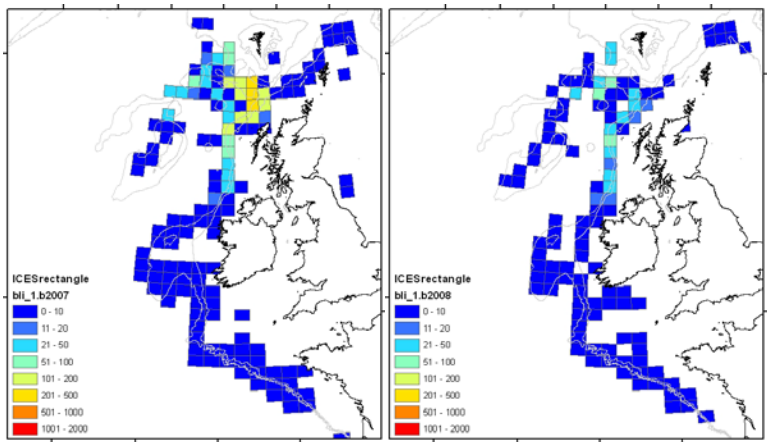



**Figure 6.3.2. Geographical distribution of landings France, (UK) Scotland, UK (England and Wales) and Ireland at the level of ICES statistical rectangles. The figures presented are for 2007 and 2008 but plots back to 2001 are presented under TOR g).**

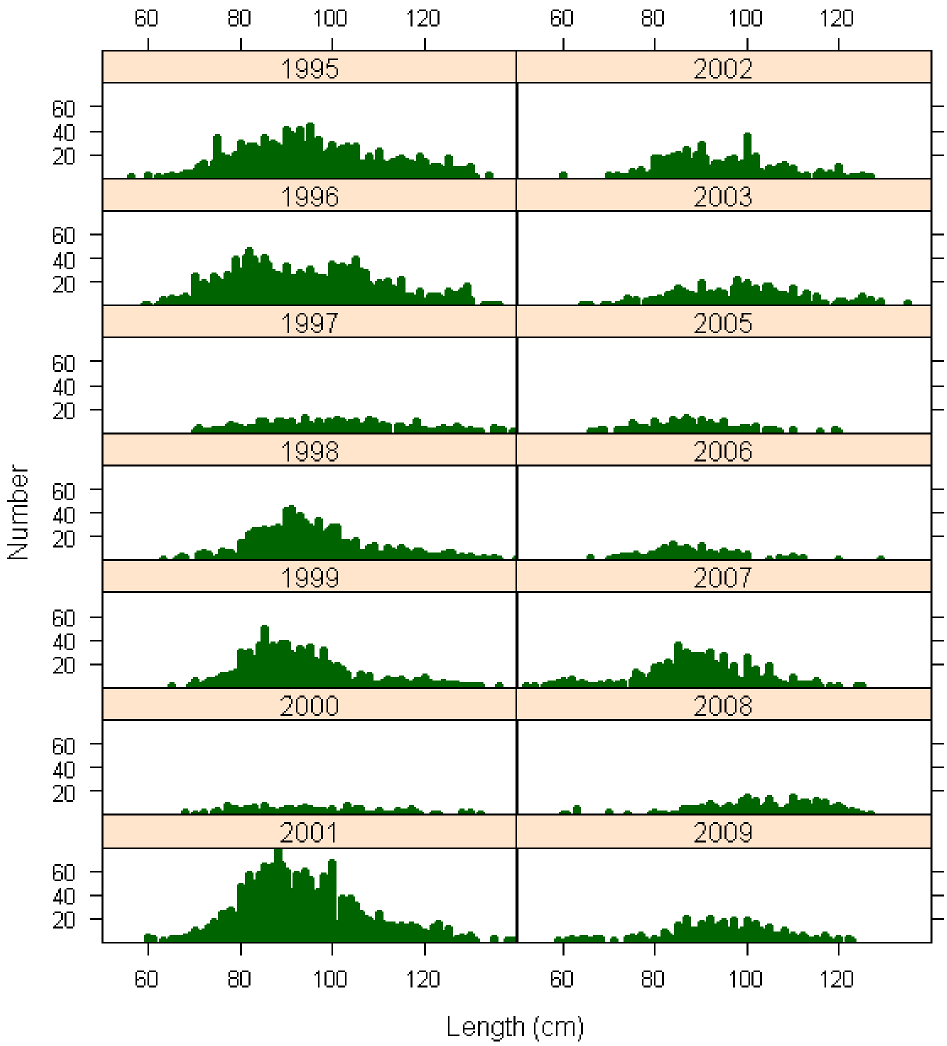



**Figure 6.3.3. Blue ling in Vb (Faroes). Length distribution in the landings from Faroese otterboard trawlers >1000 HP (No length sampling was carried out in 2004).**

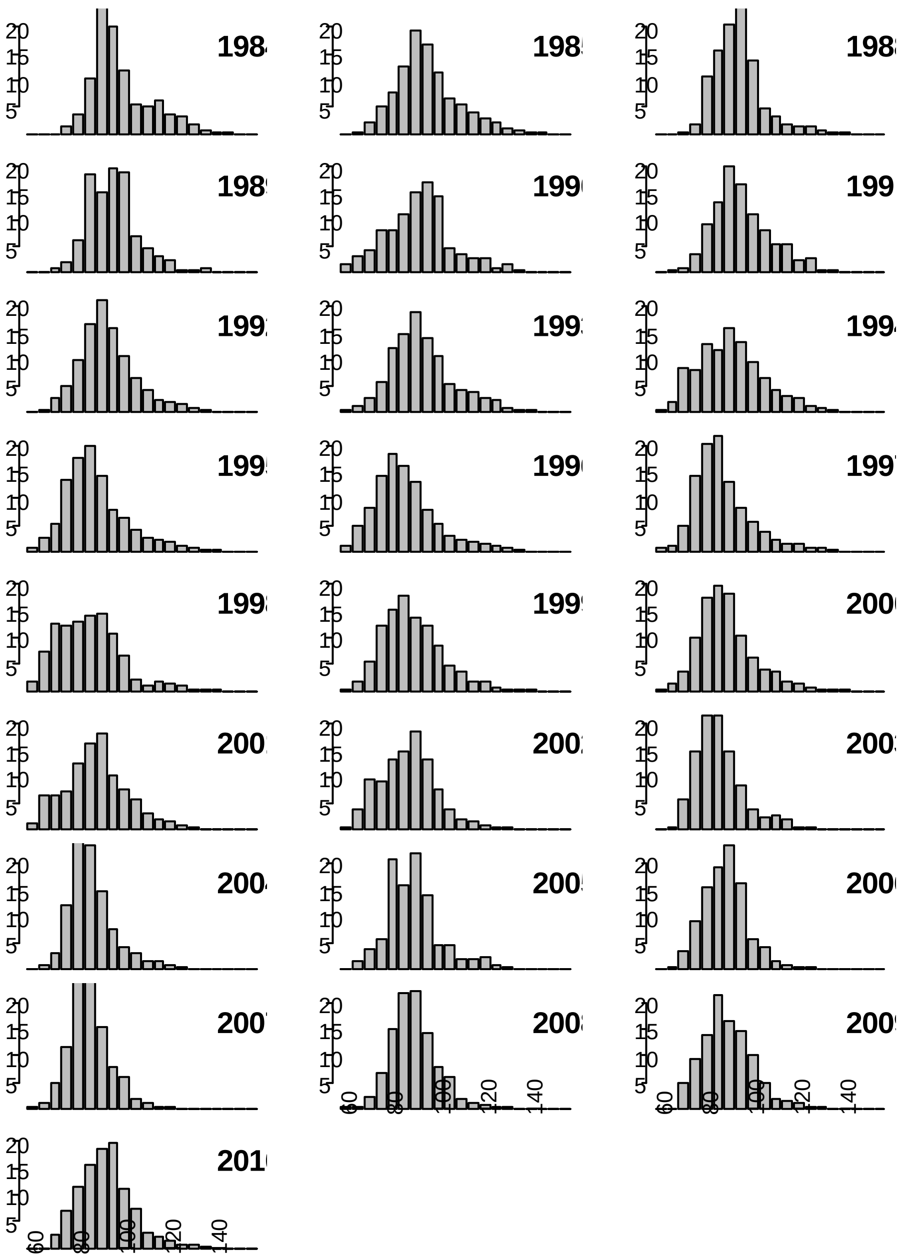


**Figure 6.3.4. Length distribution1984–2010 of the landings of blue ling from French otter fishing in VIa. (for legibility, small numbers below 60 cm, occurring in a few years only, were cut off).**

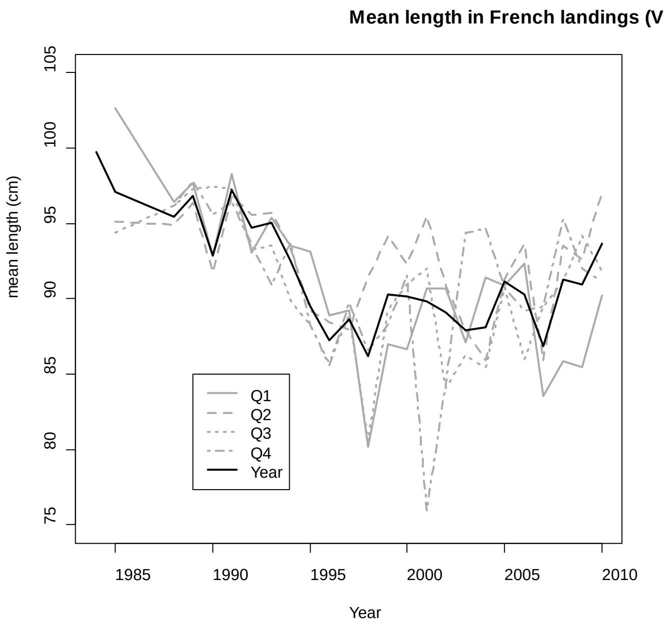



**Figure 6.3.5. Mean length in French trawl landings from VIa.**

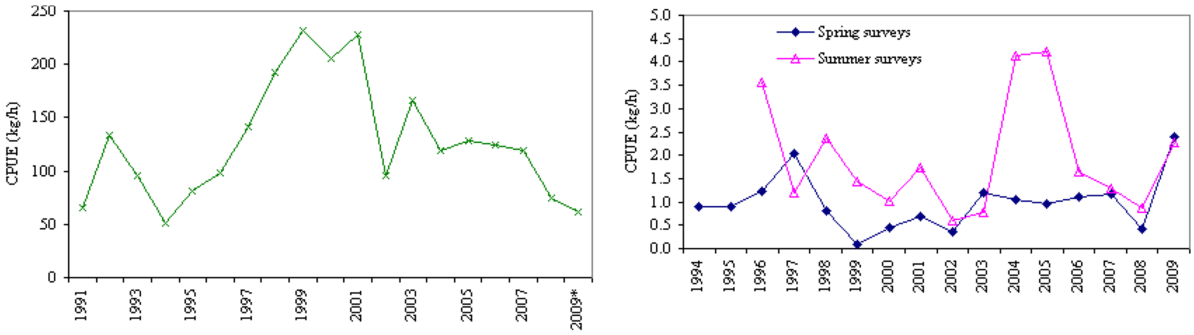



**Figure 6.3.6. Blue ling in Vb, (left) cpue from Faroese otterboard trawlers >1000 HP in the bank area west of the Faroes (DB-DG, 9–14) and (right) cpue series the annual Faroese spring and summer surveys for cod, haddock and saithe in Vb (note that survey are carried out on the Faroe Plateau, less than 500 m depth, data for 2009 are provisional).**

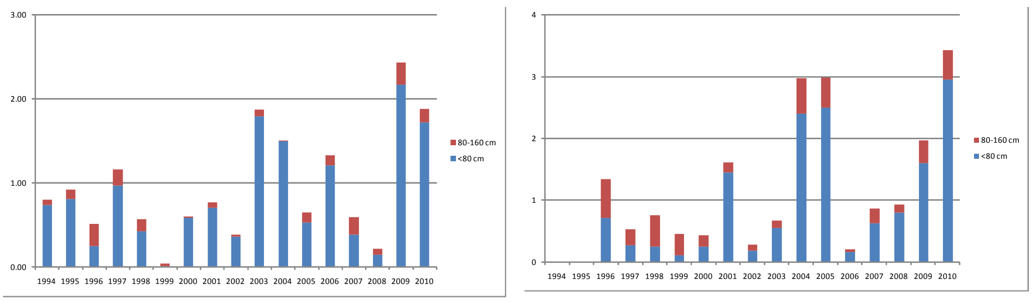



**Figure 6.3.7. Number of small (<80 cm) and adult (>80 cm) blue ling caught in the spring (left) and summer (right) Faroese surveys.**

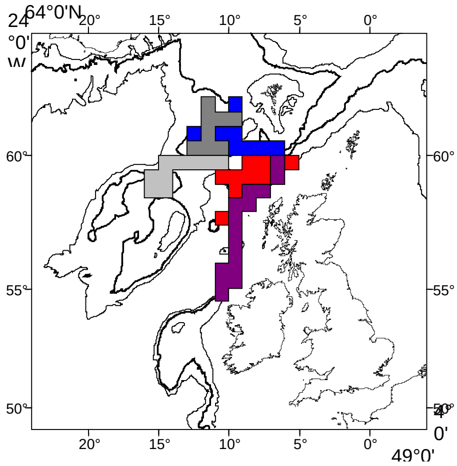


**Figure 6.3.8. Areas used to calculate French lpues for blue ling: .dark grey: new grounds in Vb (new5); light grey: new grounds in VI (new6); red: others in VI (other6); purple: edge in VI (edge6); blue: reference grounds in Vb (ref5). Depth contours are 200, 1000 and 2000 m.**

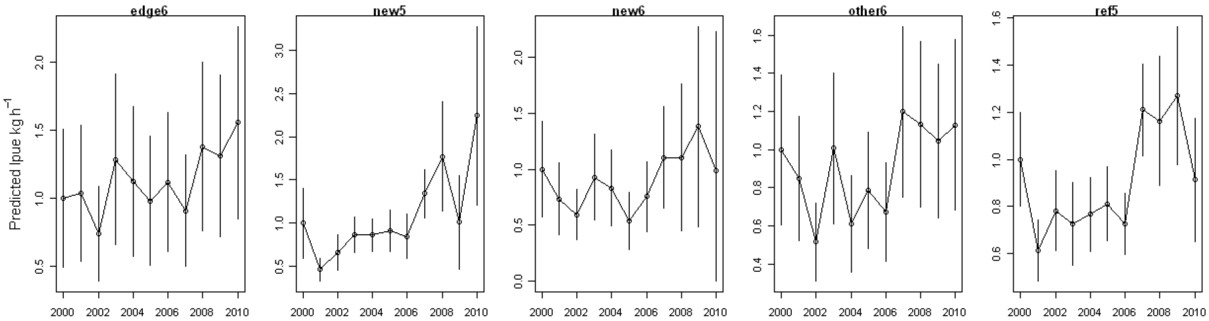



**Figure 6. 3..9. Trends in standardized relative lpue of blue ling by area since 2000 (from French trawl tallyook data), see stock annex for method.**

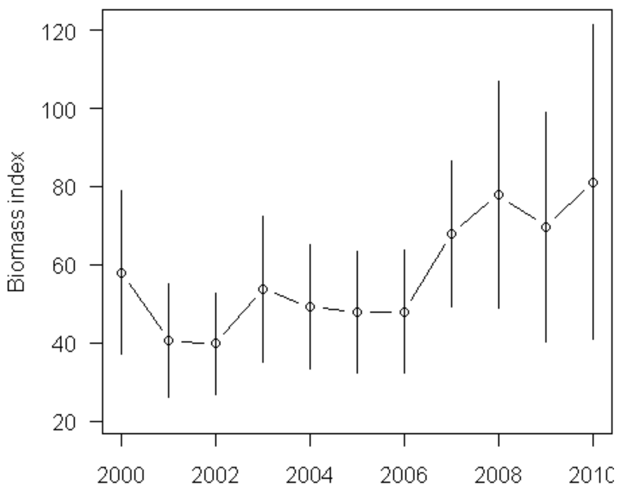



**Figure 6. 3.10. Trends in annual mean lpue of blue ling by area, from French trawl tallybook data, (See stock annex for method).**

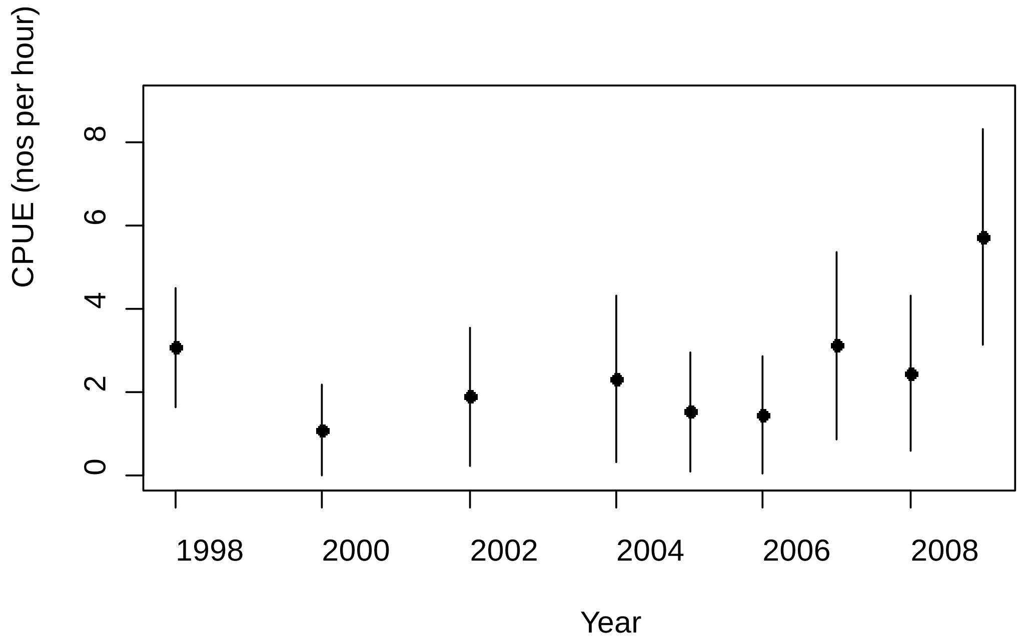



**Figure 6.3.11. Scottish Deep-water Survey; trend in annual mean cpue (± 1 s.e.).**

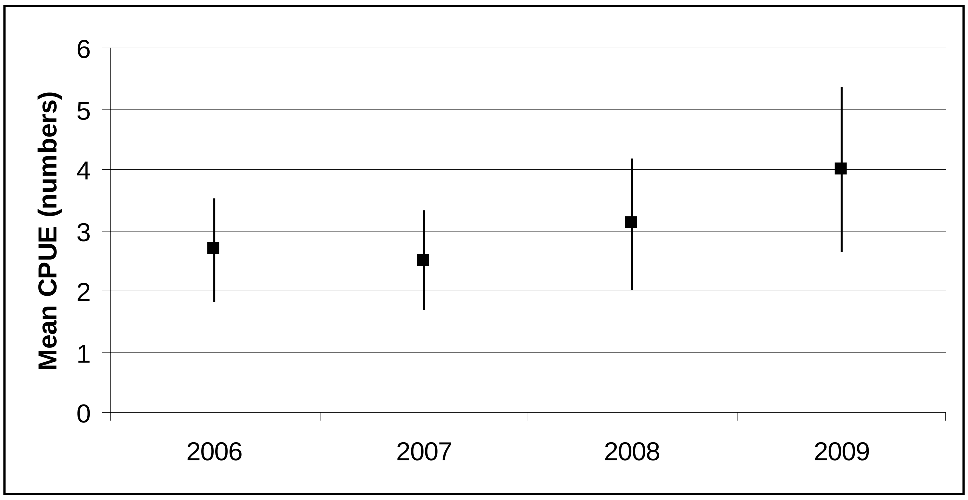



**Figure 6.3.12. Irish Deep-water Survey; trend in annual mean cpue (± 1 s.e.).**

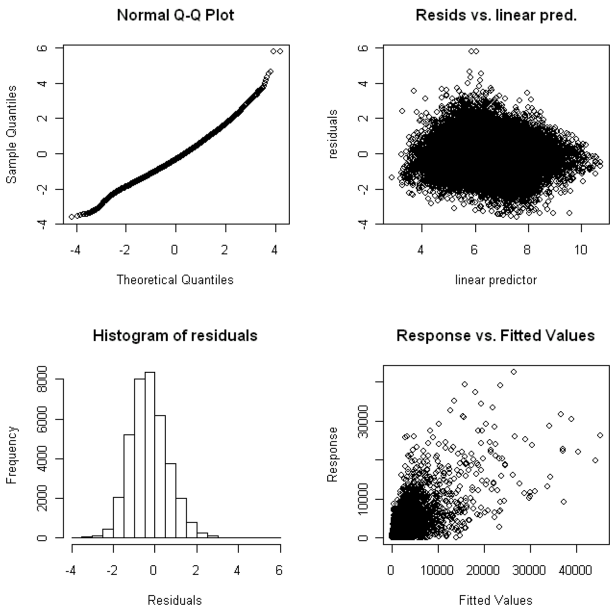



**Figure 6.3.13. Diagnostic plot of the GAM model of blue ling catch per fishing subtrip in the logbook data.**

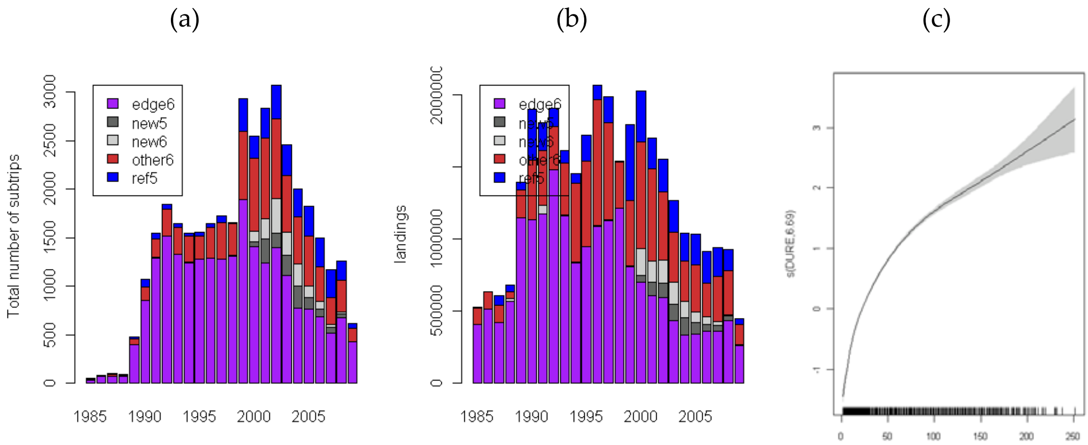



**Figure 6.3.14. Standardized logbook cpue index (a)number of logbook records and (b) total landings (kgs) in modelled subtrips (same small areas as for the tallybook index) and (c) effect of the subtrip duration variable (ticks along the x-axis depict the distribution of data, long subtrips of several days correspond to logbook record in the 1980s, subtrip duration in hours).**

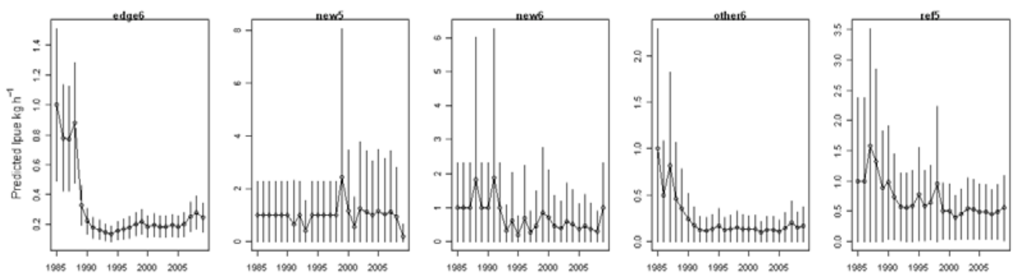



**Figure 6.3.15. Predicted lpue trends in the five small areas (note that the number of fishing subtrip was small in 1985–1989 and that there was no fishing in some areas and years).**

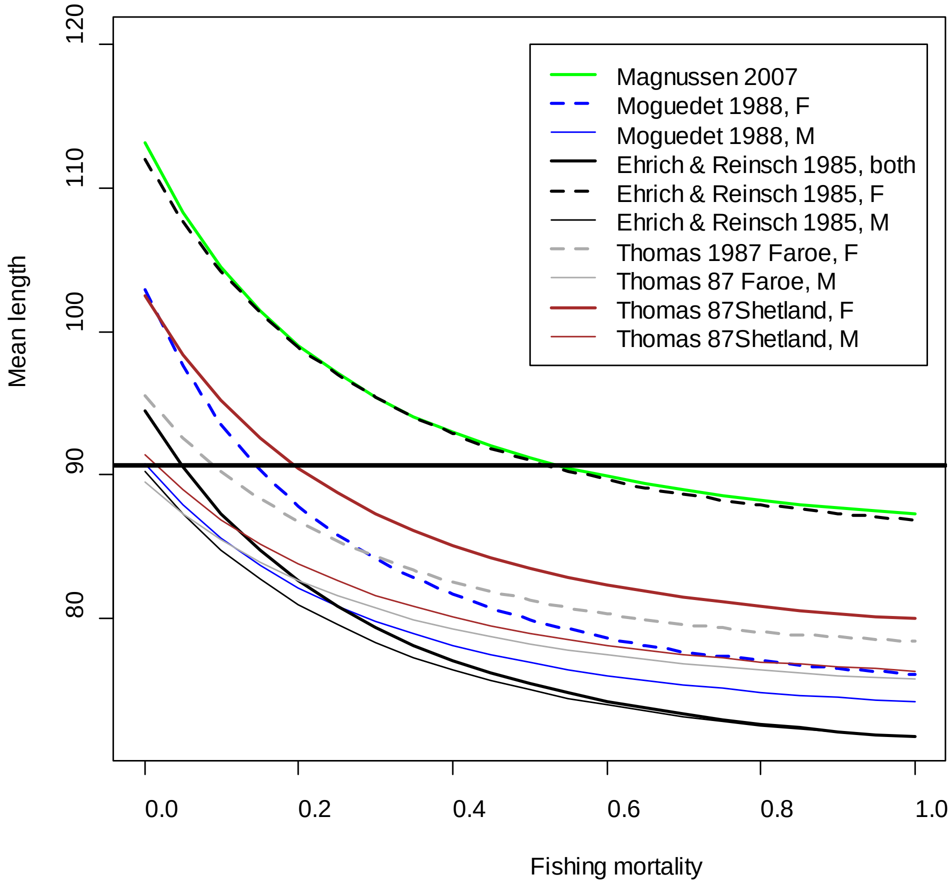



**Figure 6.3.16. Mean length of a blue ling stock based upon a range of estimations of growth parameters and current mean length in the landings (horizontal line: 90.7 cm, overall mean length of the landings accross years 2007–2010).**

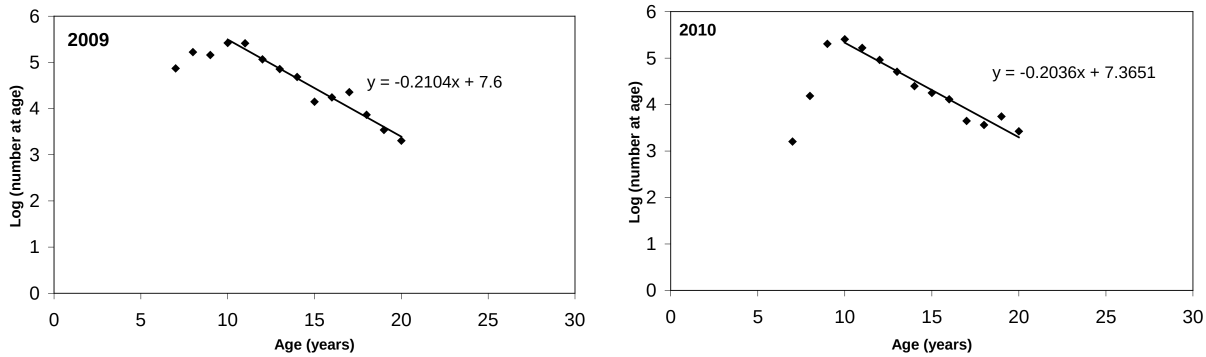



**Figure 6.3.17. Catch curve of blue ling, from age estimation on a sample on 754 and 613 fish sampled at from French Auction Market in 2009 and 2010 respectively (sampling carried out under DCF).**

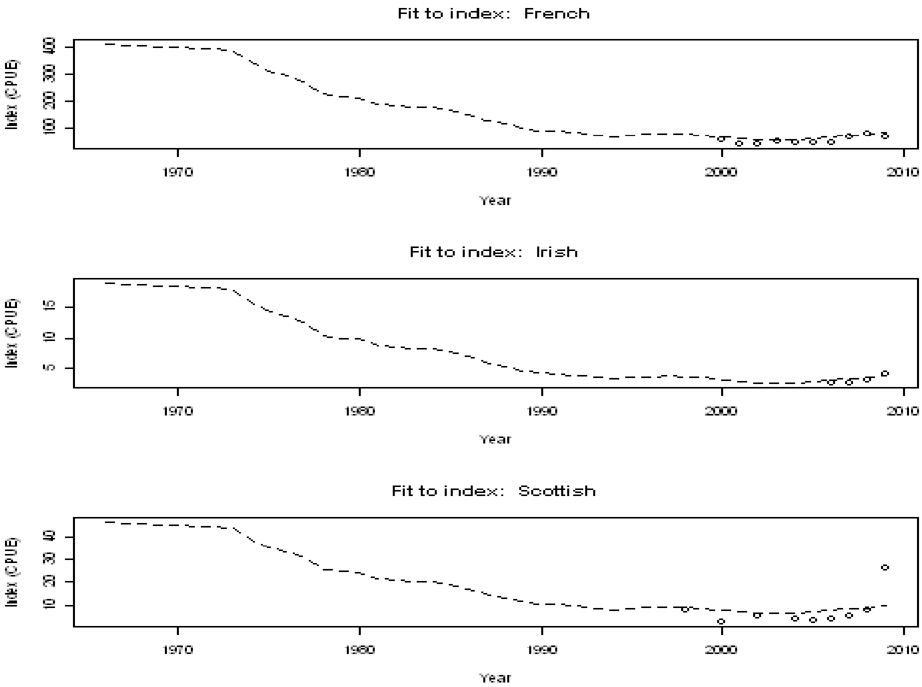



**Figure 6.3.18. Fitted indices from original assessment (M = 0.15).**

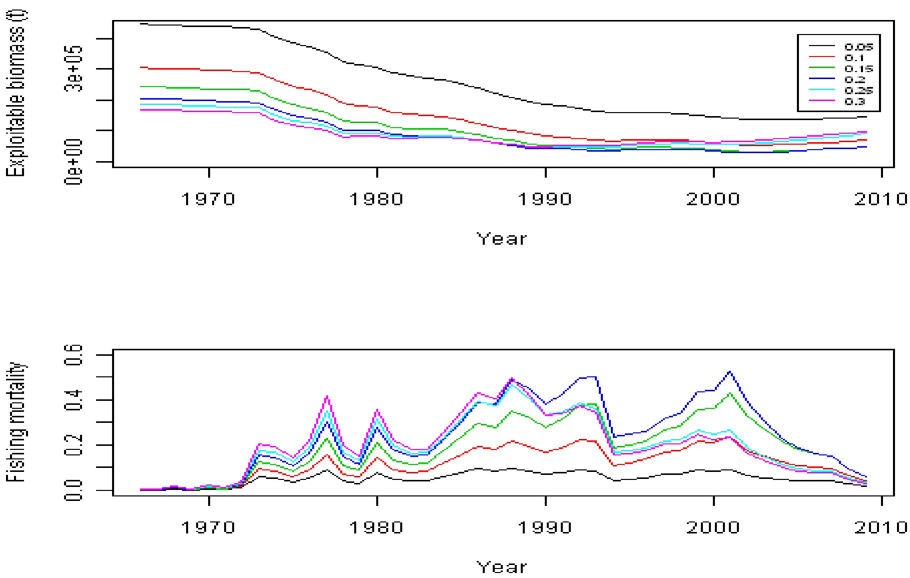



**Figure 6.3.19. Estimated trajectory of exploitable biomass and fishing mortality for different values of M.**

## 6.4 Blue ling (*Molva Dypterygia*) in I, II, IIIa, IV, VIII, IX, X, XII

### 6.4.1 The fishery

Blue ling has been an important bycatch in trawl fisheries for mixed deep-water species on Hatton Bank (Division XIIb). There is also a small bycatch in Norwegian longline fisheries. In other areas blue ling is taken in small quantities. Small reported landings in Subareas VIII, IX and X are now ascribed to the closely related Spanish ling (*Molva macropthalma*) and blue ling is not known to occur to any significant level in these subareas.

### 6.4.2 Landings trends

Landings data are demonstrated in Table 6.4.0a–f and Figures 6.4.1–3. During all the time-series, around 90% or more of the total landings were taken in Subareas II, IV and XII combined. For all these areas a decline has been seen since 1993 and for each area the landings have been below 500 tonnes in recent years. Then, landings of blue ling from other areas are currently at a low level. Historical landings trends in this assessment unit are described in the stock annex.

### 6.4.3 ICES Advice

Last year Advice from ICES in action for 2011 and 2012 is:

"*No direct fisheries, and a reduction in catches should be considered*."

### 6.4.4 Management

A 2011 TAC for EU vessels in international waters of XIIb was set to 815 tonnes. TACs for vessels in EU waters and international waters of Vb, VI and VII were set to 2032 tonnes; of this a quota for Norwegian vessels was set to 150 tonnes to be fished in IIa, Vb, VI and VII.

### 6.4.5 Data availability

#### 6.4.5.1 Landings and discards

Landings data are demonstrated in Table 6.4.1.

#### 6.4.5.2 Length compositions

No length data are available.

#### 6.4.5.3 Age compositions

No age data are available.

#### 6.4.5.4 Weight-at-age

No weight-at-age data are available.

#### 6.4.5.5 Maturity and natural mortality

No data were available.

#### 6.4.5.6 Catch, effort and research vessel data

No data are available.

### 6.4.6 Data analyses

No data analytical assessments were carried out.

The assessment for this stock is based on landing trends. The landings are now less than a 25% level of the mean landings from the years 1988–1993. Since 2004 the landings have been stable at a low level.

The increase in landings from Area IIIa in 2004 (2.5 times increase from 2003 to 2004) comes from increased Danish landings from the roundnose grenadier fishery. After 2005, landings from Division IIa have fallen to an insignificant level and should not be seen as an increase of the stock.

### 6.4.7 Comments on assessment

Not applicable.

### 6.4.8 Management considerations

Management advice for deep-water stocks is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g. CUSUM and PSA.

**Table 6.4.0a. Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes) in Subarea I. (* preliminary).**

| Year | Iceland | Norway | Germany | Total |
|---|---|---|---|---|
| 1988 | | | | |
| 1989 | | | | |
| 1990 | | | | |
| 1991 | | | | |
| 1992 | | | | |
| 1993 | | | | |
| 1994 | | 3 | | 3 |
| 1995 | | 5 | | 5 |
| 1996 | | | | 0 |
| 1997 | | 1 | | 1 |
| 1998 | | 1 | | 1 |
| 1999 | | | | 0 |
| 2000 | | 1 | | 1 |
| 2000 | | 3 | | 3 |
| 2001 | | 1 | | 1 |
| 2002 | | 1 | | 1 |
| 2003 | | | | 0 |
| 2004 | | 1 | | 1 |
| 2005 | | 1 | | 1 |
| 2006 | | | | 0 |
| 2007 | | | | 0 |
| 2008 | | | | 0 |
| 2009 | | 1 | | 1 |
| 2010* | | 1 | | 1 |

**Table 6.4.0b. Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes) in Divisions IIa and b. (* preliminary).**

| Year | Faroes | France | Germany | Greenland | Norway | E & W | Scotland | Sweden | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 77 | 37 | 5 | | 3416 | 2 | | | | 3537 |
| 1989 | 126 | 42 | 5 | | 1883 | 2 | | | | 2058 |
| 1990 | 228 | 48 | 4 | | 1128 | 4 | | | | 1412 |
| 1991 | 47 | 23 | 1 | | 1408 | | | | | 1479 |
| 1992 | 28 | 19 | | 3 | 987 | 2 | | | | 1039 |
| 1993 | | 12 | 2 | 3 | 1003 | | | | | 1020 |
| 1994 | | 9 | 2 | | 399 | 9 | | | | 419 |
| 1995 | 0 | 12 | 2 | 2 | 342 | 1 | | | | 359 |
| 1996 | 0 | 8 | 1 | | 254 | 2 | 2 | | | 267 |
| 1997 | 0 | 10 | 1 | | 280 | | | | | 291 |
| 1998 | 0 | 3 | | | 272 | | 3 | | | 278 |
| 1999 | 0 | 1 | 1 | | 287 | | 2 | | | 291 |
| 2000 | | 2 | 4 | | 240 | 1 | 2 | | | 249 |
| 2001 | 8 | 7 | | | 190 | 1 | 2 | | | 208 |
| 2002 | 1 | 1 | | | 129 | 1 | 17 | | | 149 |
| 2003 | 30 | | | | 115 | | 1 | 1 | | 147 |
| 2004 | 28 | 1 | | | 144 | | | | 1 | 174 |
| 2005 | 47 | 3 | | | 144 | 1 | | | 2 | 197 |
| 2006 | 49 | 4 | | | 149 | | | | | 202 |
| 2007 | 102 | 3 | | | 154 | | 3 | | | 262 |
| 2008 | 105 | 9 | | | 208 | | 11 | | | 329 |
| 2009 | 56 | 1 | | | 219 | | 9 | | | 285 |
| 2010* | 183 | 4 | | | 234 | | 4 | | | 425 |

**Table 6.4.0c. Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes) in Subarea III. (* preliminary).**

| Year | Denmark | Norway | Sweden | Total |
|---|---|---|---|---|
| 1988 | 10 | 11 | 1 | 22 |
| 1989 | 7 | 15 | 1 | 23 |
| 1990 | 8 | 12 | 1 | 21 |
| 1991 | 9 | 9 | 3 | 21 |
| 1992 | 29 | 8 | 1 | 38 |
| 1993 | 16 | 6 | 1 | 23 |
| 1994 | 14 | 4 | | 18 |
| 1995 | 16 | 4 | | 20 |
| 1996 | 9 | 3 | | 12 |
| 1997 | 14 | 5 | 2 | 21 |
| 1998 | 4 | 2 | | 6 |
| 1999 | 5 | 1 | | 6 |
| 2000 | 13 | 1 | | 14 |
| 2001 | 20 | 4 | | 24 |
| 2002 | 8 | 1 | | 9 |
| 2003 | 18 | 1 | | 19 |
| 2004 | 18 | 1 | | 19 |
| 2005 | 48 | 1 | | 49 |
| 2006 | 42 | | | 42 |
| 2007 | | | | 0 |
| 2008 | | 2 | | 2 |
| 2009 | | + | | 0 |
| 2010* | | + | | 0 |

**Table 6.4.0d. Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes) in Division IVa. (* preliminary).**

| Year | Denmark | Faroes | France (IV) | Germany | Norway | E & W | Scotland | Ireland | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 1 | 13 | 223 | 6 | 116 | 2 | 2 | | 363 |
| 1989 | 1 | | 244 | 4 | 196 | 12 | | | 457 |
| 1990 | | | 321 | 8 | 162 | 4 | | | 495 |
| 1991 | 1 | 31 | 369 | 7 | 178 | 2 | 32 | | 620 |
| 1992 | 1 | | 236 | 9 | 263 | 8 | 36 | | 553 |
| 1993 | 2 | 101 | 76 | 2 | 186 | 1 | 44 | | 412 |
| 1994 | | | 144 | 3 | 241 | 14 | 19 | | 421 |
| 1995 | | 2 | 73 | | 201 | 8 | 193 | | 477 |
| 1996 | | 0 | 52 | 4 | 67 | 4 | 52 | | 179 |
| 1997 | | 0 | 36 | | 61 | 0 | 172 | | 269 |
| 1998 | | 1 | 31 | | 55 | 2 | 191 | | 280 |
| 1999 | 2 | | 21 | | 94 | 25 | 120 | 2 | 264 |
| 2000 | 2 | | 15 | 1 | 53 | 10 | 46 | 2 | 129 |
| 2001 | 7 | | 9 | | 75 | 7 | 145 | 9 | 252 |
| 2002 | 6 | | 11 | | 58 | 4 | 292 | 5 | 376 |
| 2003 | 8 | | 8 | | 49 | 2 | 25 | | 92 |
| 2004 | 7 | | 17 | | 45 | | 14 | | 83 |
| 2005 | 6 | | 7 | | 51 | | 2 | | 66 |
| 2006 | 6 | | 6 | | 82 | | | | 94 |
| 2007 | 5 | | 2 | | 55 | | | | 62 |
| 2008 | 2 | | 9 | | 63 | | + | | 74 |
| 2009 | 1 | | 12 | | 69 | | 7 | | 89 |
| 2010* | 1 | | 1 | | 101 | | 21 | | 124 |

**Table 6.4.0e. Blue ling (*Molva dypterygia*). Working Group estimates of landings (tonnes) in Subarea XII. (* preliminary).**

| Year | Faroes | France | Germany | Spain | E & W | Scotland | Norway | Iceland | Poland | Lithuania | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | 263 | | | | | | | | | | 263 |
| 1989 | | 70 | | | | | | | | | | 70 |
| 1990 | | 5 | | | | | | | | | | 5 |
| 1991 | | 1147 | | | | | | | | | | 1147 |
| 1992 | | 971 | | | | | | | | | | 971 |
| 1993 | 654 | 2591 | 90 | | | | | | | | | 3335 |
| 1994 | 382 | 345 | 25 | | | | | | | | | 752 |
| 1995 | 514 | 47 | | | 12 | | | | | | | 573 |
| 1996 | 445 | 60 | | 264 | | 19 | | | | | | 788 |
| 1997 | 1 | 1 | | 411 | 4 | | | | | | | 417 |
| 1998 | 36 | 26 | | 375 | 1 | | | | | | | 438 |
| 1999 | 156 | 17 | | 943 | 8 | 43 | | 186 | | | | 1353 |
| 2000 | 89 | 23 | | 406 | 18 | 23 | 21 | 14 | | | | 594 |
| 2001 | 6 | 26 | | 415 | 32 | 91 | 103 | 2 | | | | 675 |
| 2002 | 19 | | | 1234 | 8 | | 9 | | | | | 1270 |
| 2003 | | 7 | | 1096 | | 2 | 40 | | 12 | 37 | | 1194 |
| 2004 | | 27 | | 861 | | | | | | | 7 | 895 |
| 2005 | | 10 | | 657 | | | | | | 8 | | 675 |
| 2006 | | 61 | | 436 | | | | | | | 4 | 501 |
| 2007 | 1 | | | 353 | | | | | | | | 354 |
| 2008 | | | | 564 | | | | | | | | 564 |
| 2009 | | + | | 312 | | | | | | | + | 312 |
| 2010* | | | | 92 | | | | | | | | 92 |

**Table 6.4.0f. Blue ling (*Molva dypterygia*). Total landings by Subarea/Division (From 2010 landings from Areas VIII, IX and X given in previous reports are now considered to represent *Molva macropthalma*). (* preliminary data).**

| Year | I | II | III | IV | XII | Total |
|---|---|---|---|---|---|---|
| 1988 | | 3537 | 22 | 363 | 263 | 4185 |
| 1989 | | 2058 | 23 | 459 | 70 | 2610 |
| 1990 | | 1412 | 21 | 501 | 5 | 1939 |
| 1991 | | 1479 | 21 | 627 | 1147 | 3274 |
| 1992 | | 1039 | 38 | 554 | 971 | 2602 |
| 1993 | | 1020 | 23 | 415 | 3335 | 4793 |
| 1994 | 3 | 419 | 18 | 424 | 752 | 1616 |
| 1995 | 5 | 359 | 20 | 483 | 573 | 1440 |
| 1996 | 0 | 267 | 12 | 190 | 788 | 1257 |
| 1997 | 1 | 291 | 21 | 270 | 417 | 1000 |
| 1998 | 1 | 278 | 6 | 286 | 438 | 1009 |
| 1999 | 0 | 291 | 6 | 265 | 1353 | 1915 |
| 2000 | 1 | 249 | 14 | 130 | 594 | 988 |
| 2001 | 3 | 208 | 24 | 252 | 675 | 1162 |
| 2002 | 1 | 149 | 9 | 377 | 1270 | 1806 |
| 2003 | 1 | 147 | 19 | 101 | 1194 | 1462 |
| 2004 | 0 | 174 | 19 | 83 | 895 | 1171 |
| 2005 | 1 | 171 | 49 | 70 | 675 | 966 |
| 2006 | 0 | 202 | 42 | 94 | 501 | 839 |
| 2007 | 0 | 263 | 0 | 62 | 354 | 679 |
| 2008 | 0 | 329 | 2 | 74 | 564 | 969 |
| 2009 | 1 | 285 | 0 | 89 | 312 | 687 |
| 2010* | 1 | 425 | 0 | 124 | 92 | 642 |

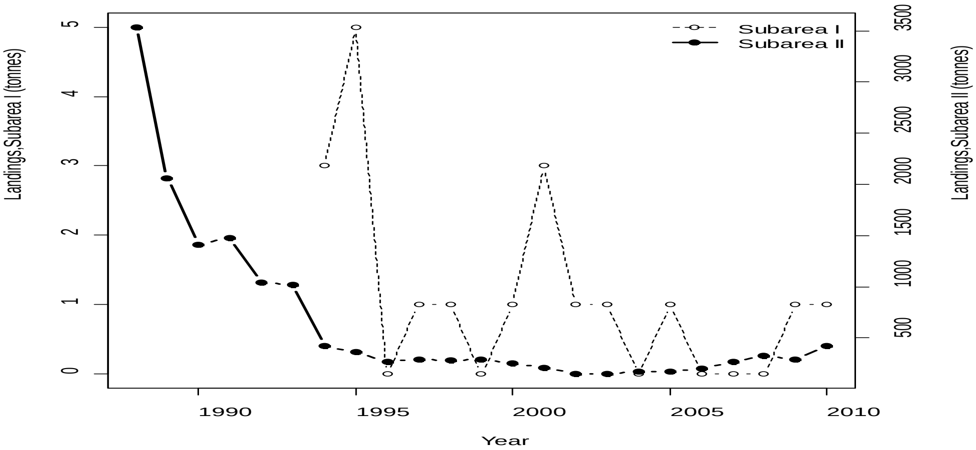



**Figure 6.4.1. Landings of blue ling in Subareas I and II.**

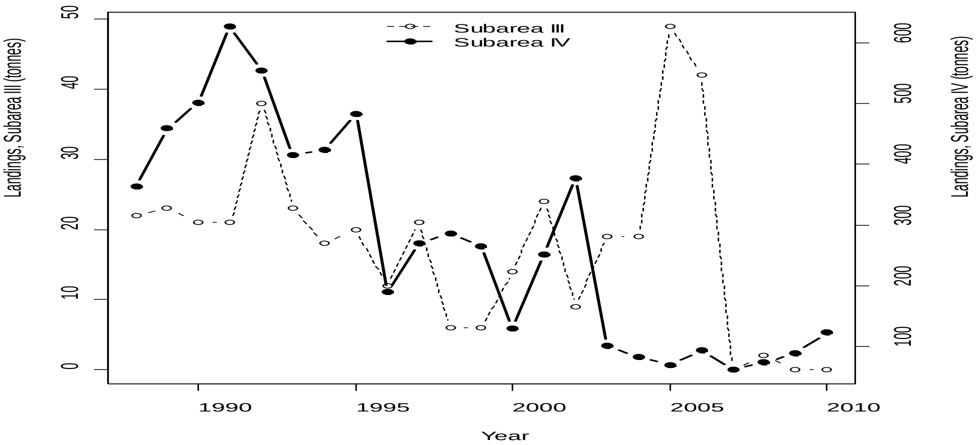



**Figure 6.4.2. Landings of blue ling in Subareas III and IV.**

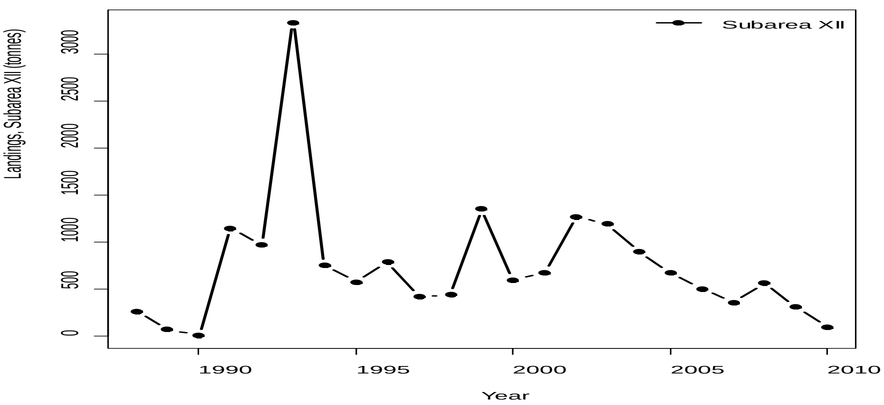



**Figure 6.4.3. Landings of blue ling in Subarea XII.**

# 7 Tusk (*Brosme brosme*) in the Northeast Atlantic

## 7.1 Stock description and management units

In 2007, WGDEEP examined the available evidence of stock discrimination in this species. Based on the genetic investigation, the Group suggests the following stock units:

- Tusk in Va and XIV;
- Tusk on the Mid-Atlantic Ridge;
- Tusk on Rockall (VIb);
- Tusk in I, II.

all other areas (IVa,Vb, VIa, VII,…) be assessed as one combined stock, until further evidence of multiple stocks become available in these areas purposes.

## 7.2 Tusk (*Brosme brosme*) in Division Va and Subarea XIV

### 7.2.1 The fishery

Tusk in Va is caught in a mixed longline fishery, conducted in order of importance by Icelandic, Faroese and Norwegian boats. Between 150 and 240 Icelandic longliners report catches of tusk, but much fewer gillnetters and trawlers (Table 7.2.1). Most of tusk in Va is caught on longlines accounting for around 97% of total tusk catches in tonnes and this has been relatively stable since 1992 (Table 7.2.2).

A minor change in the tusk fishery in Va is that the longline fishery has changed from a bycatch fishery in 2000–2005 to a more mixed fishery since then. This change is most likely a result of increased abundance of tusk in Va in recent years.

Most of the tusk caught in Va by Icelandic longliners is caught at depths less than 300 m and by trawlers at less than 600 m (Figure 7.2.1). The main fishing grounds for tusk in Va, as observed from logbooks, are on the south, southwestern and western part of the Icelandic shelf (Figure 7.2.2).

The main trend in the spatial distribution of tusk catches in Va according to logbook entries is the decreased proportion of catches caught in the southeast and the increased catches on the western part of the shelf. Around 50 to 60% of tusk is caught on the south and western part of the shelf (Figure 7.2.3).

Tusk in XIV is caught mainly as a bycatch by longliners and trawlers. The main area where tusk is caught in XIV is 63°–66°N and 32°–40°W, well away from the Icelandic EEZ.

#### 7.2.1.1 Landings trends

The total annual landings from ICES Division Va were around 9000 t in 2010 (Table 7.2.3). Since 2000, the annual landings have gradually increased. The catch of the Icelandic fleet since in 2008 has been at its highest observed levels, having increased by more than 50% since 2004. The foreign catch (mostly from the Faroe Islands, but also from Norway) of tusk in Icelandic waters has always been considerable. Until 1990, between 40–70% of the total annual catch from ICES Division Va was caught by foreign vessels but has since then been between 15–25%, mainly from the Faroe Islands.

Landings in XIV have always been low compared to Va, rarely exceeding 100 t. (Table 7.2.7).

#### 7.2.1.2 ICES Advice

The latest Advice from ICES in May 2010 states: *ICES advises that catches should be less than 6000 t.*

#### 7.2.1.3 Management

The Icelandic Ministry of Fisheries and Agriculture is responsible for management of the Icelandic fisheries and implementation of legislation. Tusk was included in the ITQ system in the 2001/2002 quota year and as such subjected to TAC limitations. In the beginning the TAC was set as recommended by MRI but has often been set higher than advice. One reason is that no formal harvest rule exists for this stock. The landings, by quota year, have always exceeded the advised and set TAC by 30–40% (Table 7.2.4).

The reasons for the large difference between annual landings and both advised and set TACs are threefold: The first reason is that it is possible to transfer unfished quota between fishing years. Second it is possible to convert quota shares in one species to another, and finally the national TAC is only allocated to Icelandic vessels. All foreign catches are outside the quota system. The tusk advice given by MRI and ICES for each quota year is, however, for all catches, including foreign catches.

There are bilateral agreements between Iceland, Norway and the Faroe Islands relating to a fishery of vessels in restricted areas within the Icelandic EEZ. Faroese vessels are allowed to fish 5600 t of demersal fish species in Icelandic waters which includes a maximum 1200 t of cod and 40 t of Atlantic halibut. The rest of the Faroese demersal fishery in Icelandic waters is mainly directed at tusk, ling, and blue ling. Further description of the Icelandic management system can be found in the Stock Annex.

### 7.2.2 Data available

#### 7.2.2.1 Landings and discards

Landings by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard. Discarding is banned by law in the Icelandic demersal fishery. Based on limited data, discard rates in the Icelandic longline fishery for tusk are estimated very low (<1% in either numbers or weight) (Thordarson WD-02). Measures in the management system such as converting quota share from one species to another are used by the fleet to a large extent and this is thought to discourage discards in mixed fisheries. A description of the management system is given in the Stock Annex for tusk in Va and XIV.

Landings for tusk in XIV are obtained from the STATLANT database. No information is available on discards in XIV.

#### 7.2.2.2 Length compositions

An overview of available length measurements from Va is given in Table 7.2.5. Most of the measurements are from longlines. The number of available length measurements increased in 2007–2009 in line with increased landings, but decreased considerably in 2010.

Length distributions from the longline fishery are shown in Figure 7.2.4. Mean length has slightly increased in recent years, from 50.5 cm in 2002 to 55 cm in 2010.

No length composition data from commercial catches in XIV are available.

#### 7.2.2.3 Age compositions

Table 7.2.6 gives an overview of otolith sampling intensity by gear types in 2000 to 2010 in Va. In 2010 considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1985, 1995, 2008–2010. The ages are used as input data for the Gadget assessment. It is expected that the effort in ageing of tusk will continue.

No data are available from XIV.

#### 7.2.2.4 Weight-at-age

Weight-at-age data from Va are limited to 1985, 1995, 2008–2010.

No data are available from XIV.

#### 7.2.2.5 Maturity and natural mortality

No new data are available for Va.

No data are available for XIV.

#### 7.2.2.6 Catch, effort and research vessel data

##### Catch per unit of effort and effort data from the commercial fleets

Figures 7.2.5 and 7.2.6 show catch per unit of effort (cpue) and effort in the Icelandic longline fishery. The cpue is calculated using all longline data where catches of the species were registered, with no standardization attempted. The cpue estimates of tusk in Va are not considered representative of stock abundance.

Cpue estimations have not been attempted on available data from XIV.

##### Icelandic survey data (Va)

**Indices:** The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the tusk fishery. Detailed description of the spring groundfish survey is given in the Stock Annex for tusk in Va.

Figure 7.2.7 shows both a recruitment index and the trends in biomass. Survey length distributions are shown in Figure 7.2.8 (abundance).

In addition, an autumn survey was commenced in 1996 and expanded in 2000. A detailed description of the autumn groundfish survey is given in the Stock Annex for tusk in Va. Figure 7.2.7 shows both a recruitment index and the trends in various biomass indices, all of which have been increasing in recent years.

**Changes in spatial distribution as observed in surveys**: According to the spring survey most of the increase in tusk abundance in recent years is in the western area, however an increase can be seen in most areas (Figure 7.2.9). A similar pattern is observed in the autumn survey.

##### German survey data (XIV)

**Indices:** The German groundfish survey was started in 1982 and is conducted in the autumn. It is primarily designed for cod but covers the entire groundfish fauna down to 400 m. The survey is designed as a stratified random survey; the hauls are allocated to strata off West and East Greenland both according to the area and the mean historical cod abundance at equal weights. Towing time is 30 min at 4.5 kn.

(Ratz, H.-J. 1999: Structures and changes of the demersal fish assemblage off Greenland, 1982–1996. NAFO Sci. Coun. Studies,32:1–15).

Data from the 2010 German survey in XIV were not available at the meeting. The trend in the German survey catches, presented at the WGDEEP-2010, is similar to those observed in surveys in Va.

### 7.2.3 Data analyses

The following discussion applies to tusk in Va. Catches of tusk in XIV are low compared to catches in Va and are unlikely to affect any of the conclusions following this paragraph. Additionally the limited survey trends available show similar trends as in Va.

Mean length in the commercial catches decreased between 2000 and 2002 possibly because of increased recruitment. Since 2002, mean length has increased again and in 2010 was at its highest in the time-series available (2000–2009) (Figure 7.2.4.).

Available cpue data are not considered representative of stock trends, however in recent years the trend is similar to that observed in the spring survey.

The indices of total biomass and of fishable biomass (40 cm and larger) of tusk increased gradually from 2001, when it was below 50% of the 1985 value, to 2007, but have decreased slightly since then (Figure 7.2.7 a, b). In 2007–2009, the biomass indices were around 70% of the mean in 1985–1989. The recruitment index (tusk less than 30 cm) peaked in 2006 but has since then decreased rapidly and was in 2010 at a similar level as in the late 1990s and early 2000s (Figure 7.2.7d).

#### Stock assessment on Tusk in Va using Gadget

At WGDEEP in 2009 an exploratory stock assessment of tusk in Va using the Gadget model (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see www.hafro.is/gadget) was presented and subsequently tusk in Va was benchmarked in 2010. At the Benchmark Meeting for Deep-sea Species in 2010 (WKDEEP) the Group concluded that the results of the Gadget model for tusk in Va were indicative of trends. The Gadget setup presented at WKDEEP-2010 was preliminary and has been improved vastly since then. WGDEEP-2010, followed by RGDEEP-2010 and ADGDEEP-2010, proposed that advice should be based on the estimates and projections from Gadget. Following this recommendation ACOM decided that the ICES advice for tusk in Va and XIV should be based on Gadget.

At the meeting improvements to the settings of the model were presented (Thordarson WD-03 and Thordarson WD-04). These improvements were:

- Re-iterative weighting of likelihood components following the procedure described by Taylor *et al*. (2007). This replaces the *ad hoc* weighing of likelihood components used in 2010.
- Inclusion of the Iceland–Faroe ridge in the survey-series. Considerable part of the tusk caught in the Icelandic Spring survey is caught in this area; however the area was not covered in 1996 to 2004. In line with other stocks in Va that use the survey in their assessment, the Ridge is now included. The trend in the series is very similar (Figure 7.2.10).
- Additional ageing material, from commercial catches (1984, 1995, 2008–2010) and from surveys (1985, 1995, 2009–2010).

- Extension of the survey length-distribution from 20 cm down to 10 cm. This results in a more realistic estimation of the survey selection curve.
- Reducing the number of survey likelihood components from 5 to 3.

These improvements, though quite substantial, did not alter the perception of stock trends in any significant way (Figure 7.2.15).

#### Data used and model settings

Data used for tuning are given in the stock annex.

Model settings used in the Gadget model for tusk in Va are described in more detail in the Stock Annex and in Thordarson WD-03 and WD-04.

#### Diagnostics

**Likelihood profiles plot:** The model converged. Following the comments from the review group in 2010 that basically means that the likelihood profile plots are not very informative.

**Observed and predicted proportions by fleets:** Overall the fit of the predicted proportional length distributions is close to the observed distributions (Figures 7.2.11 and 7.2.12). In general for the commercial catch distributions the fit is better at the end of the time-series (Figure 7.2.12). The reason for this is there is little data at the beginning of the time-series and the model may be constrained by the initial values.

**Model fit and residuals:** In Figure 7.2.13 the length disaggregated indices are plotted against the predicted numbers in the stock. The correlation between observed and predicted is good for the first three length groups (20–29, 30–39 and 40–49) which are the main length groups of tusk caught in the spring survey. In the larger length groups the fit gets progressively worse. The residuals show fairly substantial positive and negative blocks however in a length based assessment such as this it is to be expected because of the auto-correlation between adjacent length groups. Another point worth noting is that the contrast (rapid increase and subsequent decrease) in the survey indices indicates that the index may not be linearly related to stock abundance.

**Retrospective analysis:** Due to time constraints an analytical retrospective analysis was not presented at the meeting.

#### Results

The results are presented in Table 7.2.8 and Figure 7.2.15. As stated above the perception of the stock does not change markedly from last year. The most notable difference is that recruitment is now estimated to have peaked in 2007 and decreased since then, contrary to a rather constant recruitment from 2003 estimated at WGDEEP-2010. SSB is estimated at its highest observed level and fishing mortality close to its lowest value since 1980. Estimates of selection curves are similar to the estimates from WGDEEP-2010 (Figure 7.2.14).

#### Projections

Two different forward projections were evaluated for 2011 to 2014 assuming fishing mortalities of 0.2 ($F_{0.1}$) and 0.38 ($F_{max}$). Fishing at $F_{0.1}$=0.2 results in catches of 5900 t in 2011 and then an increase in catches to around 6400 t in 2012–2014. In the period SSB will increase from 8300 t in 2010 to 10 500 t in 2014. Fishing at $F_{max}$=0.38 results in catches of 8300 t in 2011 and peaking at 10 600 t in 2012 and then rapidly declining catches to 7700 t in 2014. Between 2011 to 2014 SSB will decrease to 6600 t (Figure 7.2.17).

$F_{max}$ and $F_{0.1}$ were calculated by following one year class of million fish for 29 years through the fisheries calculating total yield from the year class as function of fishing mortality of fully recruited fish. From the plot of yield vs. fishing mortality $F_{max}$ and $F_{0.1}$ were estimated (Figure 7.2.16). In the model, the selection of the fisheries is length-based so only the largest individuals of recruiting year classes are caught reducing mean weight of the survivors more as fishing mortality is increased. This is to be contrasted with age based yield-per-recruit where the same weights-at-age are assumed in the landings independent of the fishing mortality, even when the catch weights are much higher than the mean weight in the stock.

### 7.2.4 Comments on the assessment

In line with the recommendations of WKROUND-2010 and WKDEEP-2010 the group stresses the need for flexibility on ICES' part when it comes to updating model settings for assessments such as the tusk assessment which are based on complicated statistical theory and are computationally intensive.

All the signs from commercial catch data and surveys indicate that tusk in Va is in a good state. This is confirmed in the Gadget assessment.

Work in relation to the ICES MSY-framework. In theory this should be fairly straightforward but there are various caveats and pitfalls that need to be explored before trying to apply the MSY-framework to tusk in Va and XIV. These include:

- Estimation of uncertainty, presumably by bootstrapping;
- Given an estimation of uncertainty, stochastic simulation of various scenarios of fishing mortality, recruitment alternatives (low recruitment for many years for example), implementation errors, etc.

Estimation of Yield Per Recruit based reference points in Gadget is in a fundamental way different from the standard approach adopted by ICES (see end of previous section). Since they do take account of variance in growth and are based on length-based selection they should be more conservative than the standard ICES approach. However there remains a need for sensitivity analysis in the form of estimating uncertainty and stochastic elements.

### 7.2.5 Management considerations

No advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WKFRAME, e.g. estimates of uncertainty of the input data of the GADGET model and simulation studies of various scenarios taking into account stochastic elements.

**Table 7.2.1. Tusk in Va. Number of Icelandic boats participating in the fishery.**

| Year | Longliners | Gillnetters | Trawlers |
|---|---|---|---|
| 2000 | 236 | 20 | 13 |
| 2001 | 226 | 33 | 7 |
| 2002 | 192 | 18 | 10 |
| 2003 | 200 | 8 | 9 |
| 2004 | 190 | 5 | 10 |
| 2005 | 231 | 7 | 17 |
| 2006 | 228 | 11 | 12 |
| 2007 | 205 | 8 | 17 |
| 2008 | 170 | 16 | 30 |
| 2009 | 157 | 20 | 38 |
| 2010 | 165 | 24 | 34 |

**Table 7.2.2. Tusk in Va Annual landings (tonnes) of tusk of the Icelandic flees in 1992–2009.**

| Year | Catches | | | | Proportional catches | | |
|---|---|---|---|---|---|---|---|
| | Longline | Trawl | Other gear | Catches | Longline | Trawl | Other gear |
| 1992 | 6121 | 132 | 195 | 6448 | 94.9% | 2.0% | 3.0% |
| 1993 | 4299 | 118 | 314 | 4732 | 90.8% | 2.5% | 6.6% |
| 1994 | 4124 | 105 | 384 | 4614 | 89.4% | 2.3% | 8.3% |
| 1995 | 4830 | 109 | 289 | 5227 | 92.4% | 2.1% | 5.5% |
| 1996 | 4934 | 101 | 182 | 5217 | 94.6% | 1.9% | 3.5% |
| 1997 | 4639 | 77 | 128 | 4843 | 95.8% | 1.6% | 2.6% |
| 1998 | 3942 | 77 | 101 | 4119 | 95.7% | 1.9% | 2.5% |
| 1999 | 5588 | 94 | 93 | 5775 | 96.8% | 1.6% | 1.6% |
| 2000 | 4585 | 95 | 60 | 4741 | 96.7% | 2.0% | 1.3% |
| 2001 | 3263 | 74 | 88 | 3425 | 95.3% | 2.2% | 2.6% |
| 2002 | 3729 | 75 | 130 | 3935 | 94.8% | 1.9% | 3.3% |
| 2003 | 3917 | 55 | 57 | 4030 | 97.2% | 1.4% | 1.4% |
| 2004 | 2996 | 84 | 43 | 3124 | 95.9% | 2.7% | 1.4% |
| 2005 | 3358 | 135 | 40 | 3533 | 95.0% | 3.8% | 1.1% |
| 2006 | 4902 | 91 | 60 | 5053 | 97.0% | 1.8% | 1.2% |
| 2007 | 5829 | 95 | 60 | 5984 | 97.4% | 1.6% | 1.0% |
| 2008 | 6755 | 114 | 64 | 6933 | 97.4% | 1.6% | 0.9% |
| 2009 | 6755 | 108 | 93 | 6955 | 97.1% | 1.6% | 1.3% |
| 2010 | 6760 | 93 | 66 | 6919 | 97.7% | 1.3% | 1.0% |

**Table 7.2.3. Tusk in Va. Nominal landings in 1973–2009.**

| Year | Faroe | Germany | Iceland | Norway | UK | Total |
|---|---|---|---|---|---|---|
| 1973 | 3363 | 576 | 2366 | 911 | 391 | 7607 |
| 1974 | 3172 | 375 | 1857 | 893 | 230 | 6527 |
| 1975 | 2445 | 384 | 1673 | 975 | 254 | 5731 |
| 1976 | 2397 | 334 | 2935 | 1352 | 94 | 7112 |
| 1977 | 2818 | 212 | 3122 | 1796 | 0 | 7948 |
| 1978 | 2168 | 0 | 3352 | 812 | 0 | 6332 |
| 1979 | 2050 | 0 | 3558 | 845 | 0 | 6453 |
| 1980 | 2873 | 0 | 3089 | 928 | 0 | 6890 |
| 1981 | 2624 | 0 | 2827 | 1025 | 0 | 6476 |
| 1982 | 2410 | 0 | 2804 | 666 | 0 | 5880 |
| 1983 | 4046 | 0 | 3469 | 772 | 0 | 8287 |
| 1984 | 2008 | 0 | 3430 | 254 | 0 | 5692 |
| 1985 | 1885 | 0 | 3068 | 111 | 0 | 5064 |
| 1986 | 2811 | 0 | 2549 | 21 | 0 | 5381 |
| 1987 | 2638 | 0 | 2984 | 19 | 0 | 5641 |
| 1988 | 3757 | 0 | 3078 | 20 | 0 | 6855 |
| 1989 | 3908 | 0 | 3131 | 10 | 0 | 7049 |
| 1990 | 2475 | 0 | 4813 | 0 | 0 | 7288 |
| 1991 | 2286 | 0 | 6439 | 0 | 0 | 8725 |
| 1992 | 1567 | 0 | 6437 | 0 | 0 | 8004 |
| 1993 | 1329 | 0 | 4746 | 0 | 0 | 6075 |
| 1994 | 1212 | 0 | 4612 | 0 | 0 | 5824 |
| 1995 | 979 | 1 | 5245 | 0 | 0 | 6225 |
| 1996 | 872 | 1 | 5226 | 3 | 0 | 6102 |
| 1997 | 575 | 0 | 4819 | 0 | 0 | 5394 |
| 1998 | 1052 | 1 | 4118 | 0 | 0 | 5171 |
| 1999 | 1035 | 2 | 5794 | 391 | 2 | 7224 |
| 2000 | 1154 | 0 | 4714 | 374 | 2 | 6244 |
| 2001 | 1125 | 1 | 3392 | 285 | 5 | 4808 |
| 2002 | 1269 | 0 | 3840 | 372 | 2 | 5483 |
| 2003 | 1163 | 1 | 4028 | 373 | 2 | 5567 |
| 2004 | 1478 | 1 | 3126 | 214 | 2 | 4821 |
| 2005 | 1157 | 3 | 3539 | 303 | 41 | 5043 |
| 2006 | 1239 | 2 | 5054 | 299 | 2 | 6596 |
| 2007 | 1250 | 0 | 5984 | 300 | 1 | 7535 |
| 2008 | 959 | 0 | 6932 | 284 | 0 | 8175 |
| 2009 | 997 | 0 | 6955 | 300 | 0 | 8252 |
| 2010 | 1794 | 0 | 6919 | 263 | 0 | 8976 |

**Table 7.2.4. Tusk in Va. TAC recommended by the Marine Research Institute, national TAC, total landings (in tonnes) and difference between total landings and recommended and national TAC in the quota years 2001/2002–2009/2010.**

| Fishing year | MRI advice | National TAC | Landings |
|---|---|---|---|
| 2001/02 | | 4500 | 4876 |
| 2002/03 | 3500 | 3500 | 5046 |
| 2003/04 | 3500 | 3500 | 4958 |
| 2004/05 | 3500 | 3500 | 4901 |
| 2005/06 | 3500 | 3500 | 5928 |
| 2006/07 | 5000 | 5000 | 7942 |
| 2007/08 | 5000 | 5500 | 7279 |
| 2008/09 | 5000 | 5500 | 8162 |
| 2009/10 | 5000 | 5500 | 8382 |
| 2010/11 | 6000 | 6000 | |

**Table 7.2.5. Tusk in Va. Number of available length measurements from Icelandic commercial catches.**

| Year | Longlines | Gillnets | Lobster T | Trawls | Total |
|---|---|---|---|---|---|
| 2000 | 2995 | 0 | 0 | 0 | 2995 |
| 2001 | 3097 | 0 | 151 | 0 | 3248 |
| 2002 | 2843 | 0 | 0 | 0 | 2843 |
| 2003 | 8444 | 0 | 0 | 0 | 8444 |
| 2004 | 3844 | 0 | 0 | 150 | 3994 |
| 2005 | 5785 | 0 | 0 | 21 | 5806 |
| 2006 | 4861 | 0 | 0 | 472 | 5333 |
| 2007 | 11 841 | 167 | 0 | 150 | 12 158 |
| 2008 | 20 963 | 0 | 0 | 0 | 20 963 |
| 2009 | 21 151 | 0 | 0 | 0 | 21 151 |
| 2010 | 8862 | 0 | 0 | 0 | 8862 |

**Table 7.2.6. Tusk in Va. Number of available otoliths from Icelandic commercial catches.**

| Year | Longlines | Gillnets | Lobster T | Trawls | Total |
|---|---|---|---|---|---|
| 2000 | 849 | 0 | 0 | 0 | 849 |
| 2001 | 849 | 0 | 50 | 0 | 899 |
| 2002 | 851 | 0 | 0 | 0 | 851 |
| 2003 | 900 | 0 | 0 | 0 | 900 |
| 2004 | 500 | 0 | 0 | 50 | 550 |
| 2005 | 600 | 0 | 0 | 0 | 600 |
| 2006 | 750 | 0 | 0 | 150 | 900 |
| 2007 | 1050 | 67 | 0 | 50 | 1167 |
| 2008 | 1600 | 0 | 0 | 0 | 1600 |
| 2009 | 1250 | 0 | 0 | 0 | 1250 |
| 2010 | 1449 | 0 | 0 | 0 | 1449 |

**Table 7.2.7. Tusk in XIV. Nominal landings by nations.**

| Year | Faroe | Germany | Iceland | Norway | Russia | Spain | UK | Total |
|---|---|---|---|---|---|---|---|---|
| 1973 | 16 | 9 | 0 | 0 | 0 | 0 | 2 | 27 |
| 1974 | 259 | 2 | 15 | 0 | 0 | 0 | 1 | 277 |
| 1975 | 29 | 17 | 13 | 138 | 0 | 0 | 0 | 197 |
| 1976 | 0 | 5 | 89 | 47 | 0 | 0 | 1 | 142 |
| 1977 | 167 | 16 | 0 | 40 | 0 | 0 | 1 | 224 |
| 1978 | 0 | 47 | 0 | 38 | 0 | 0 | 0 | 85 |
| 1979 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 27 |
| 1980 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 13 |
| 1981 | 110 | 10 | 0 | 0 | 0 | 0 | 0 | 120 |
| 1982 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 |
| 1983 | 74 | 11 | 0 | 0 | 0 | 0 | 0 | 85 |
| 1984 | 0 | 5 | 0 | 58 | 0 | 0 | 0 | 63 |
| 1985 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 |
| 1986 | 33 | 2 | 0 | 0 | 0 | 0 | 0 | 35 |
| 1987 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 15 |
| 1988 | 19 | 2 | 0 | 0 | 0 | 0 | 0 | 21 |
| 1989 | 13 | 1 | 0 | 0 | 0 | 0 | 0 | 14 |
| 1990 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 9 |
| 1991 | 0 | 2 | 0 | 68 | 0 | 0 | 1 | 71 |
| 1992 | 0 | 0 | 3 | 120 | 0 | 0 | 0 | 123 |
| 1993 | 0 | 0 | 1 | 39 | 0 | 0 | 0 | 40 |
| 1994 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 16 |
| 1995 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 30 |
| 1996 | 0 | 0 | 0 | 157 | 0 | 0 | 0 | 157 |
| 1997 | 0 | 0 | 10 | 9 | 0 | 0 | 0 | 19 |
| 1998 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 12 |
| 1999 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| 2000 | 0 | 0 | 11 | 11 | 0 | 3 | 0 | 25 |
| 2001 | 3 | 0 | 20 | 69 | 0 | 0 | 0 | 92 |
| 2002 | 4 | 0 | 86 | 30 | 0 | 0 | 0 | 120 |
| 2003 | 0 | 0 | 2 | 88 | 0 | 0 | 0 | 90 |
| 2004 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 40 |
| 2005 | 7 | 0 | 0 | 41 | 8 | 0 | 0 | 56 |
| 2006 | 3 | 0 | 0 | 19 | 51 | 0 | 0 | 73 |
| 2007 | 0 | 0 | 0 | 40 | 6 | 0 | 0 | 46 |
| 2008 | 0.2 | 0 | 0 | 7 | 0 | 0 | 0 | 7.2 |
| 2009 | 0 | 0 | 0 | 5 | 11 | 0 | 0 | 16 |
| 2010 | 7 | 0 | 0 | 5 | 0 | 0 | 0 | 12 |

**Russian catches were taken in Subdivision XIVb1 (Mid-Atlantic Ridge).**

**Table 7.2.8. Tusk in Va and XIV. Estimates of biomass, harvestable biomass, spawning–stock biomass (SSB) in thous. tonnes and recruitment (millions) and fishing mortality from Gadget.**

| Year | Biomass | Harvestable biomass | SSB | Recruitment | Catch | Fbar (7–13) |
|---|---|---|---|---|---|---|
| 1980 | 29.626 | 7.695 | 1.956 | 14.378 | 6.890 | 0.571 |
| 1981 | 29.292 | 10.323 | 2.806 | 15.934 | 6.476 | 0.413 |
| 1982 | 29.706 | 13.942 | 3.882 | 19.246 | 5.880 | 0.417 |
| 1983 | 28.984 | 15.571 | 4.583 | 16.394 | 8.287 | 0.434 |
| 1984 | 28.033 | 14.334 | 4.762 | 14.499 | 5.692 | 0.323 |
| 1985 | 28.738 | 14.561 | 5.096 | 10.385 | 5.065 | 0.293 |
| 1986 | 29.330 | 16.034 | 5.382 | 7.273 | 5.381 | 0.237 |
| 1987 | 30.218 | 18.232 | 5.964 | 16.503 | 5.645 | 0.296 |
| 1988 | 29.493 | 18.327 | 6.072 | 12.301 | 6.865 | 0.265 |
| 1989 | 29.801 | 17.988 | 6.129 | 14.994 | 7.077 | 0.358 |
| 1990 | 28.904 | 15.750 | 5.470 | 19.834 | 7.292 | 0.435 |
| 1991 | 27.723 | 13.507 | 4.608 | 17.947 | 8.733 | 0.552 |
| 1992 | 26.061 | 11.113 | 3.747 | 16.146 | 8.010 | 0.569 |
| 1993 | 25.054 | 9.950 | 3.352 | 13.022 | 6.059 | 0.417 |
| 1994 | 25.855 | 11.311 | 3.708 | 11.225 | 5.828 | 0.402 |
| 1995 | 25.607 | 12.730 | 4.127 | 11.726 | 6.231 | 0.388 |
| 1996 | 24.751 | 13.537 | 4.450 | 4.702 | 6.241 | 0.353 |
| 1997 | 24.178 | 13.948 | 4.682 | 11.667 | 5.759 | 0.350 |
| 1998 | 23.778 | 13.712 | 4.663 | 16.659 | 5.146 | 0.396 |
| 1999 | 23.240 | 12.406 | 4.262 | 18.026 | 7.290 | 0.518 |
| 2000 | 22.401 | 9.786 | 3.469 | 15.036 | 6.240 | 0.567 |
| 2001 | 22.450 | 8.207 | 2.923 | 16.341 | 4.526 | 0.337 |
| 2002 | 25.463 | 10.040 | 3.367 | 18.286 | 5.249 | 0.414 |
| 2003 | 27.331 | 11.494 | 3.760 | 19.555 | 5.315 | 0.370 |
| 2004 | 29.598 | 12.981 | 4.331 | 19.658 | 4.655 | 0.244 |
| 2005 | 33.727 | 15.812 | 5.386 | 21.254 | 4.820 | 0.255 |
| 2006 | 37.507 | 18.427 | 6.306 | 23.522 | 6.602 | 0.286 |
| 2007 | 40.324 | 20.303 | 6.934 | 24.686 | 7.594 | 0.293 |
| 2008 | 42.499 | 21.861 | 7.456 | 21.077 | 8.175 | 0.334 |
| 2009 | 42.720 | 22.521 | 7.647 | 14.795 | 8.253 | 0.276 |
| 2010 | 43.355 | 24.707 | 8.272 | 10.538 | 8.976 | |

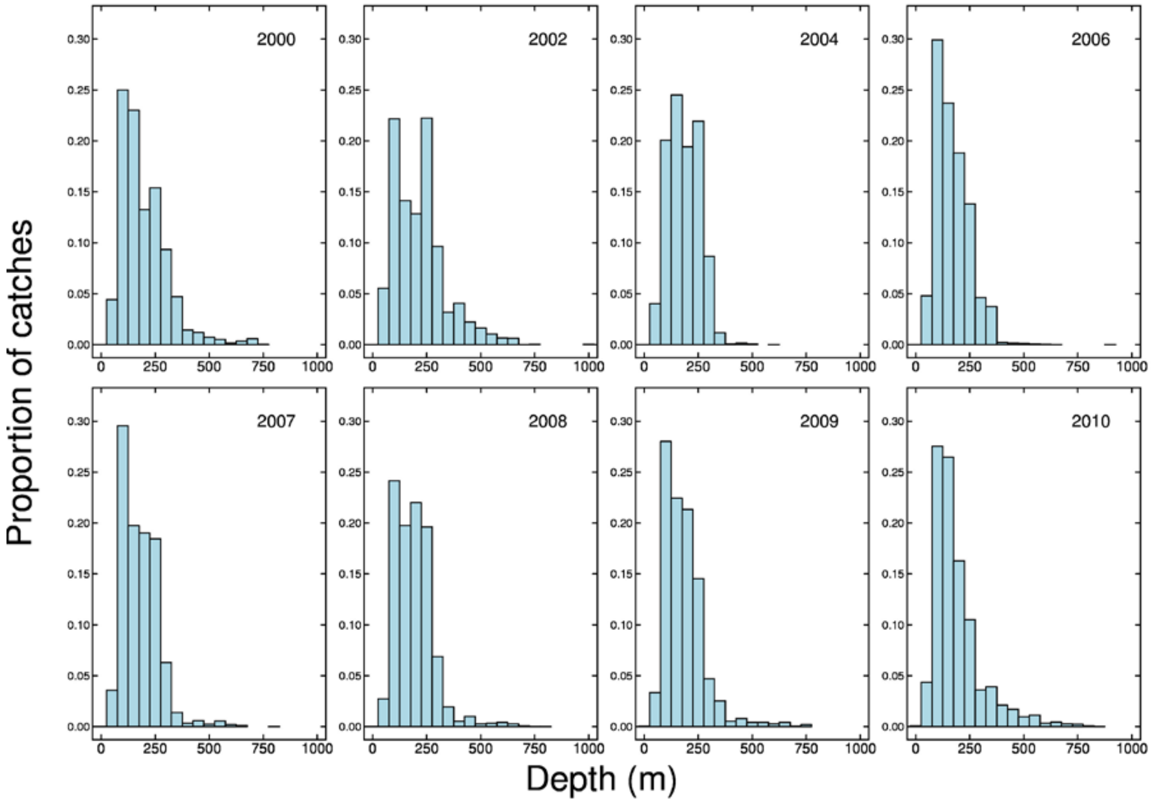



**Figure 7.2.1. Tusk in Va and XIV. Depth distribution of longline catches in Va.**

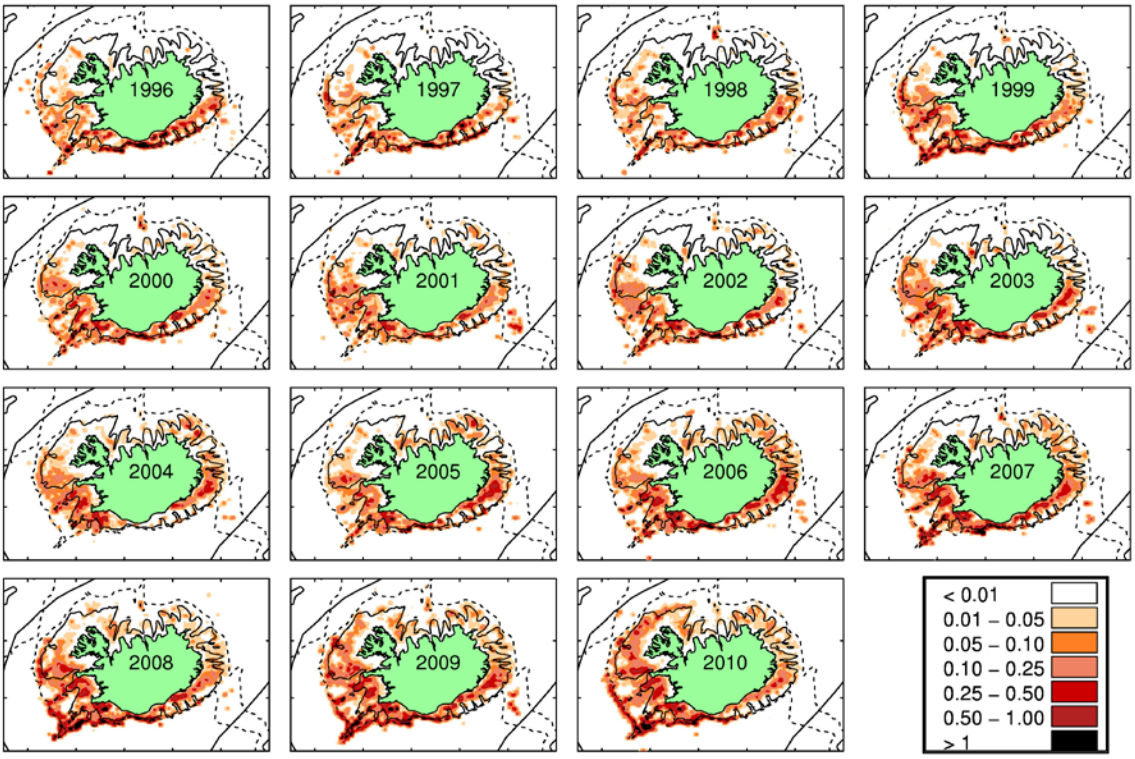



**Figure 7.2.2. Tusk in Va and XIV. Geographical distribution (tonnes/square mile) of the Icelandic fishery in 1996–2010 as reported in logbooks. All gears combined.**

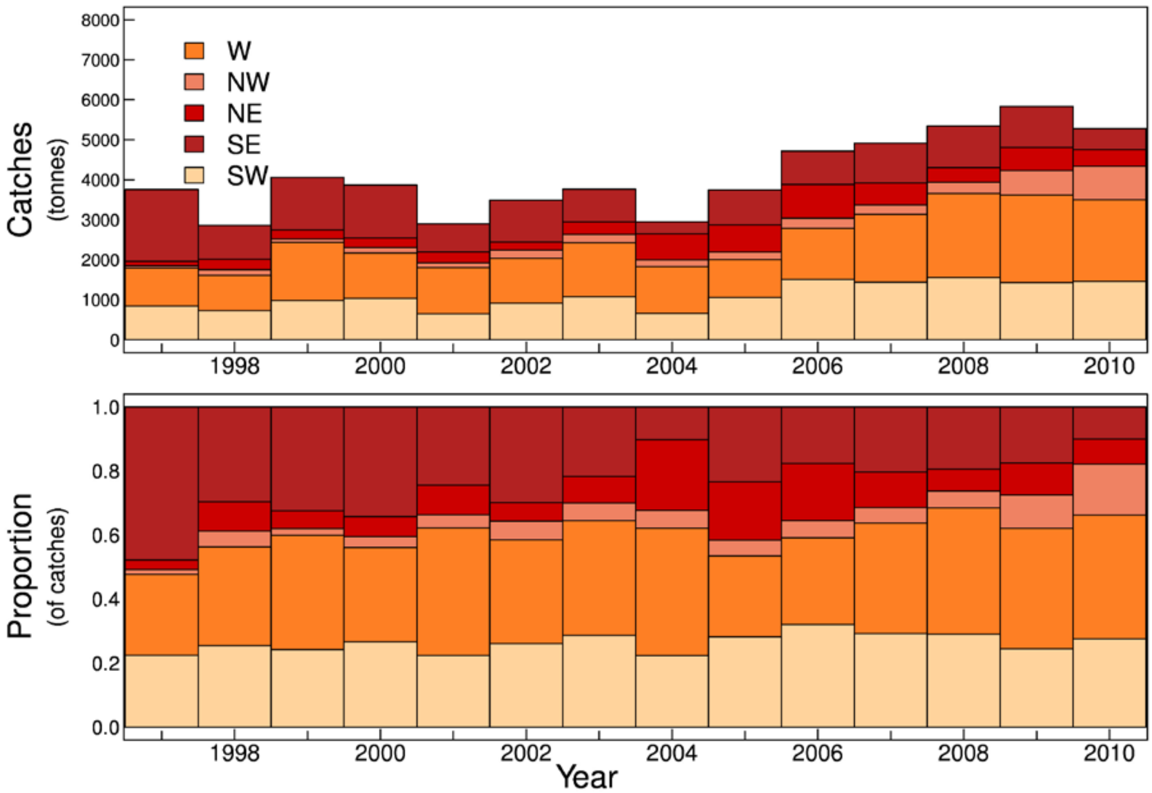



**Figure 7.2.3. Tusk in Va and XIV. Changes in spatial distribution of the Icelandic fishery in 1996–2010 as reported in logbooks. All gears combined.**

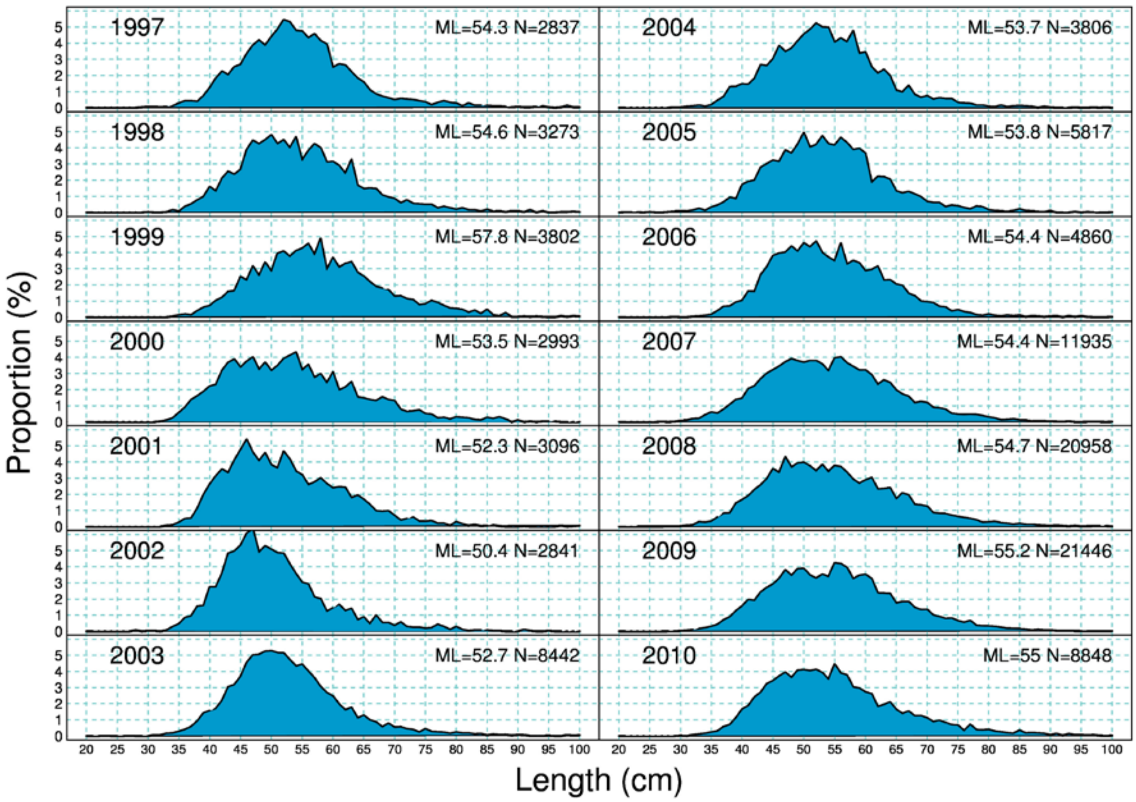



**Figure 7.2.4. Tusk in Va and XIV. Length distributions from Icelandic commercial longline catches. Small numbers to the right refer to mean length.**

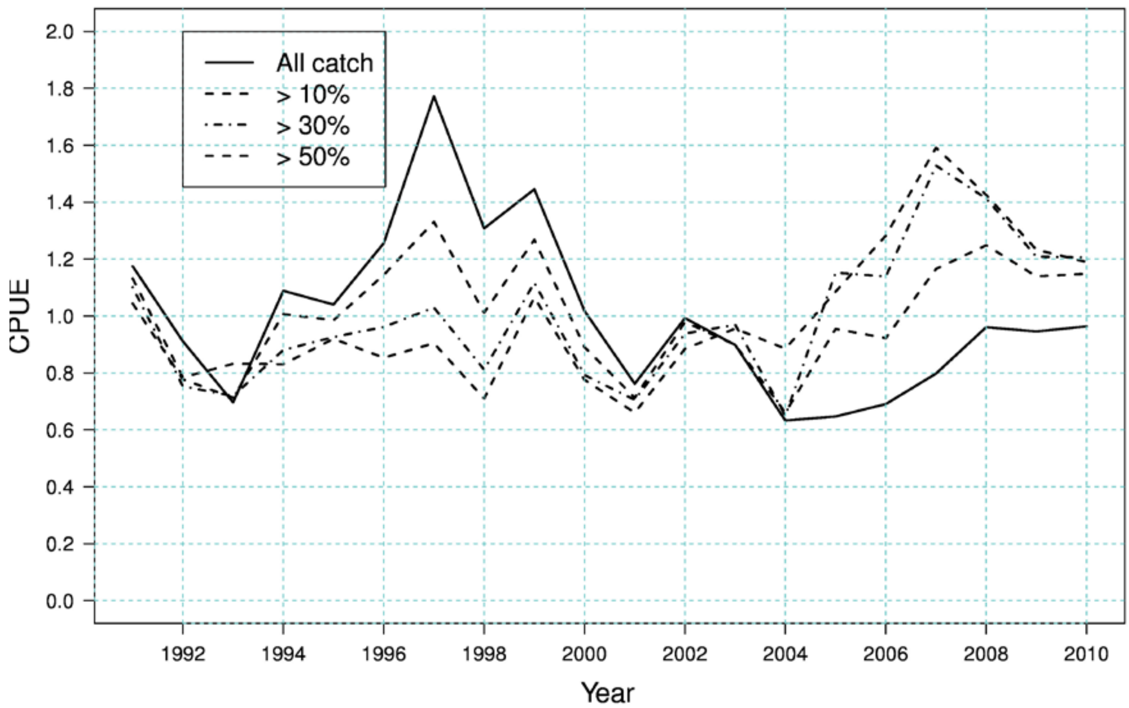



**Figure 7.2.5. Tusk in Va and XIV. Index of raw cpue (sum(yield)/sum(effort)) from the Icelandic longline fishery for catches where tusk composed at least 10%, 30% or 50% of the total catch in each set.**

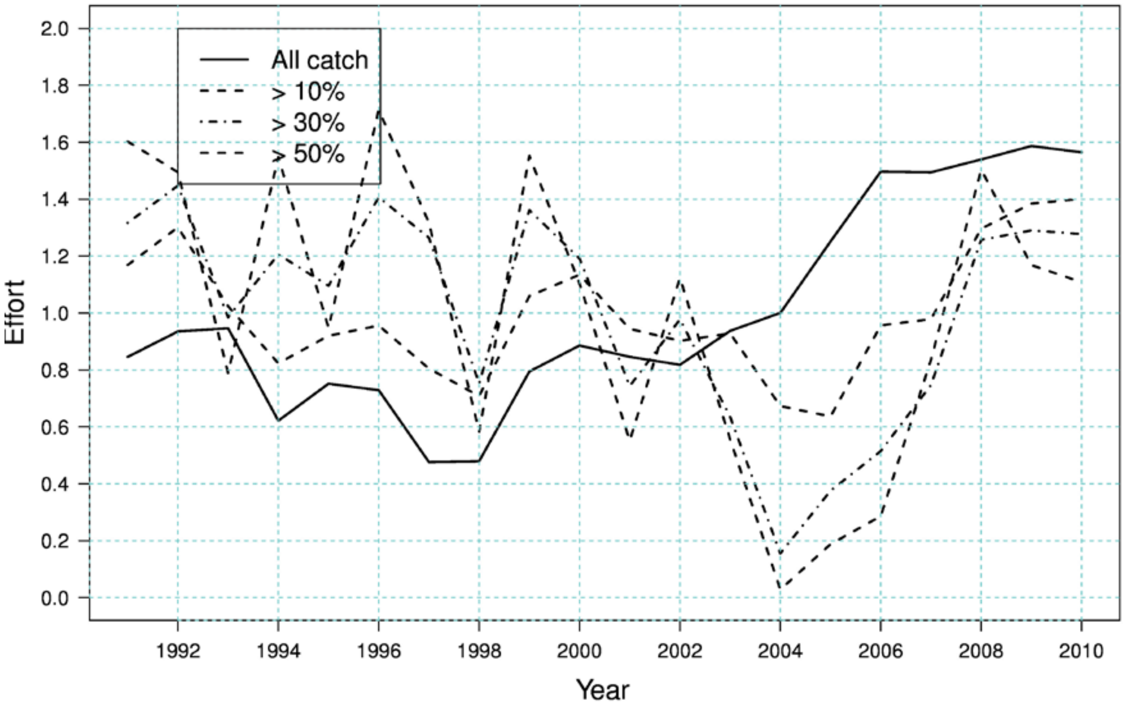



**Figure 7.2.6. Tusk in Va and XIV. Index of raw effort from the Icelandic longline fishery for catches where tusk composed at least 10%, 30% or 50% of the total catch in each set.**

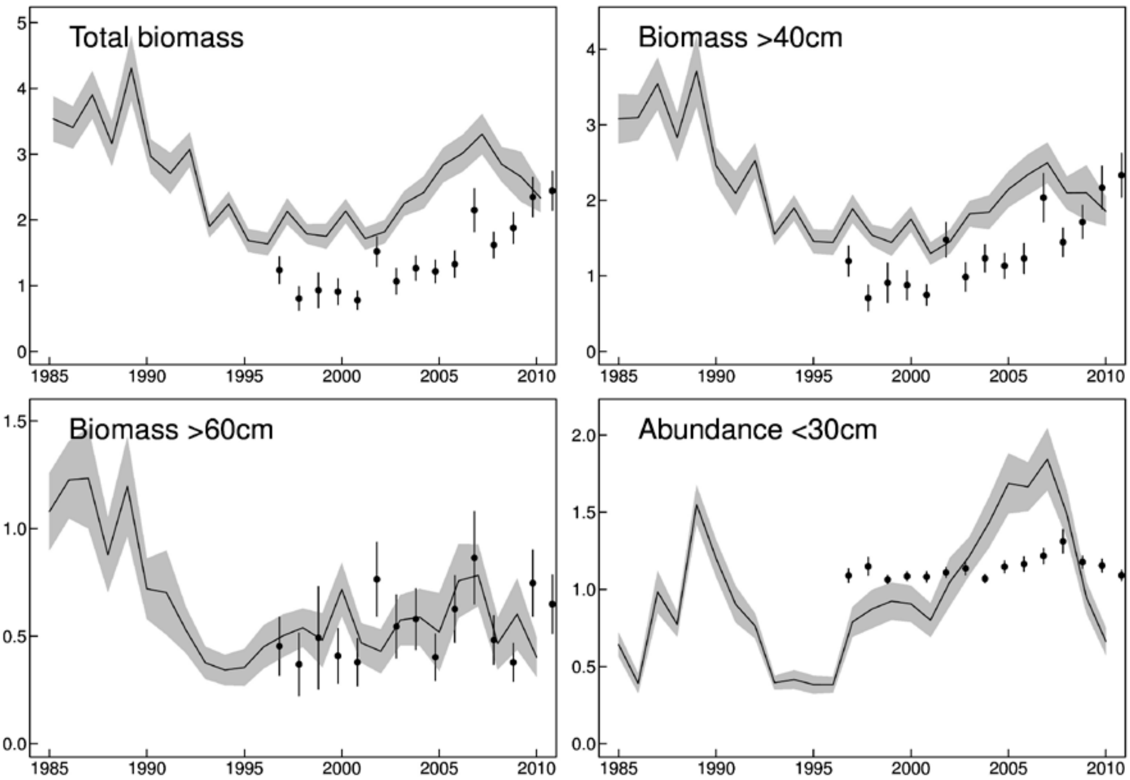



**Figure 7.2.7. Tusk in Va and XIV. Indices in the Spring Survey (March) 1985 and onwards (line, shaded area) and the Autumn Survey (October) 1996 onwards.**

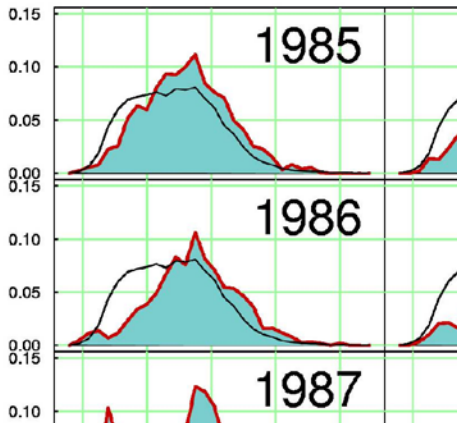



**Figure 7.2.8. Tusk in Va and XIV. Length disaggregated abundance indices from the Spring Survey 1985 and onwards. Black line is the average over the whole period.**

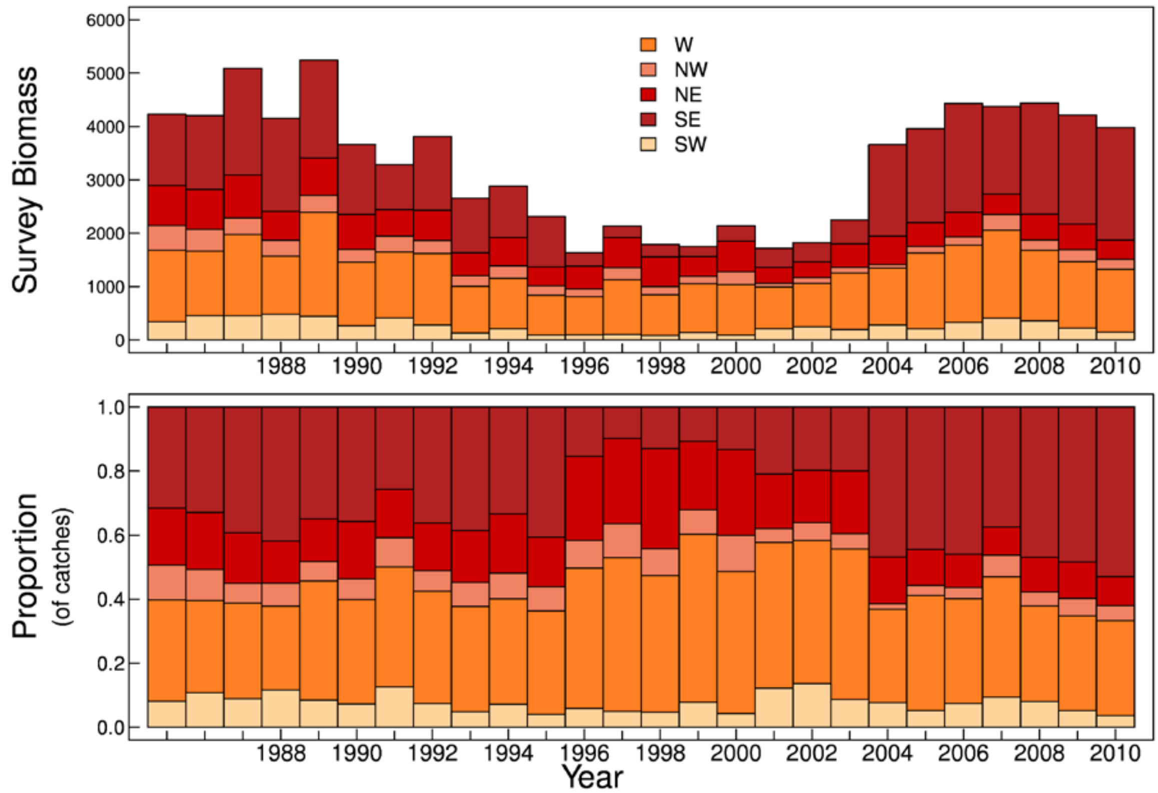



**Figure 7.2.9. Tusk in Va and XIV. Estimated survey biomass in the Spring Survey by year from different parts of the continental shelf (upper panel) and as a proportion of the total (lower panel).**

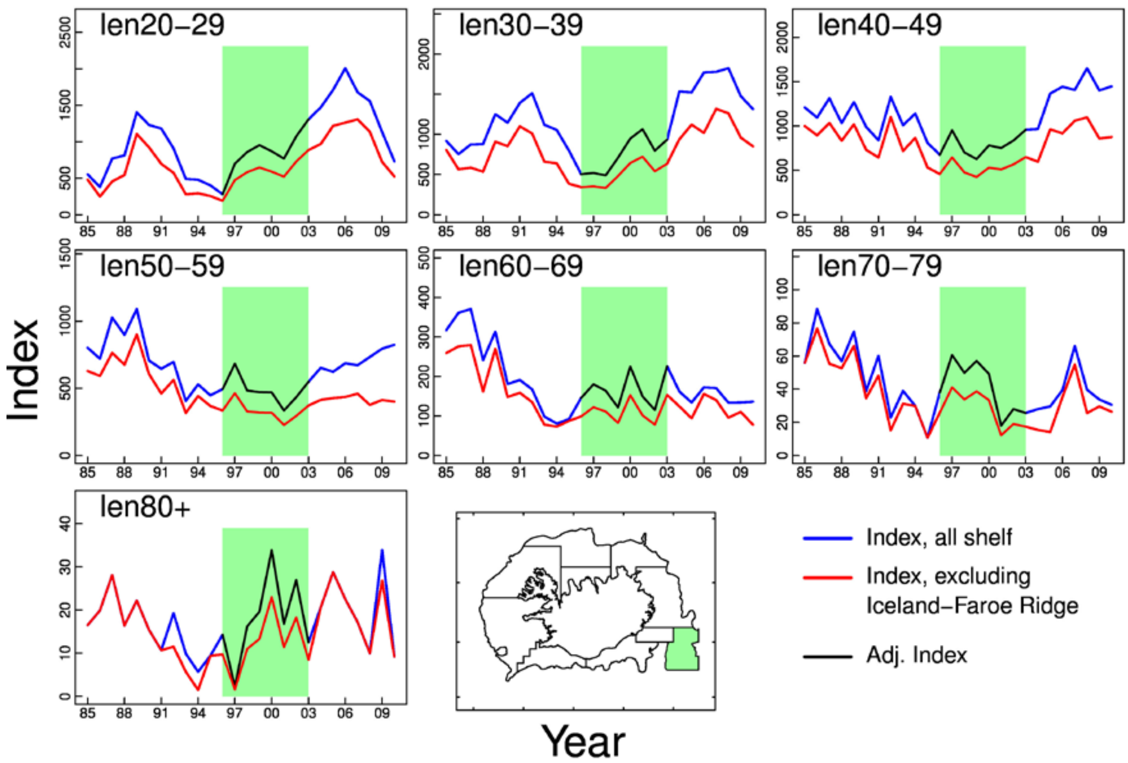



**Figure 7.2.10. Tusk in Va and XIV Indices from the Icelandic spring survey. The red line is the previously used tuning index that does not include the Iceland–Faroe Ridge. The blue line is the same index including the Ridge. In the period between 1996 and 2004 the Ridge was not surveyed, therefore the red line is scaled up proportionally based on comparisons of the indices in other periods. The map shows the Iceland–Faroe Ridge survey area in green.**

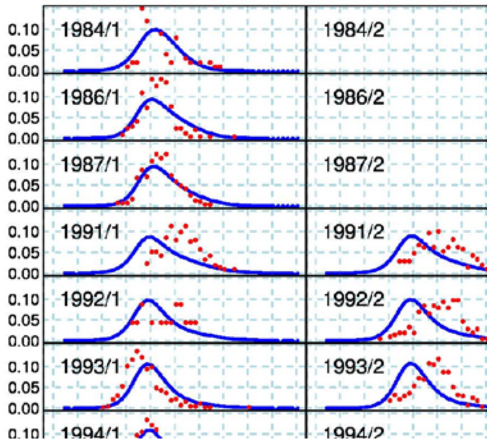



**Figure 7.2.11. Tusk in Va and XIV. Predicted proportional length distributions (blue line) and observed proportional length distributions (red dots) by year (top to bottom) and step (left to right from commercial catches (longlines).**

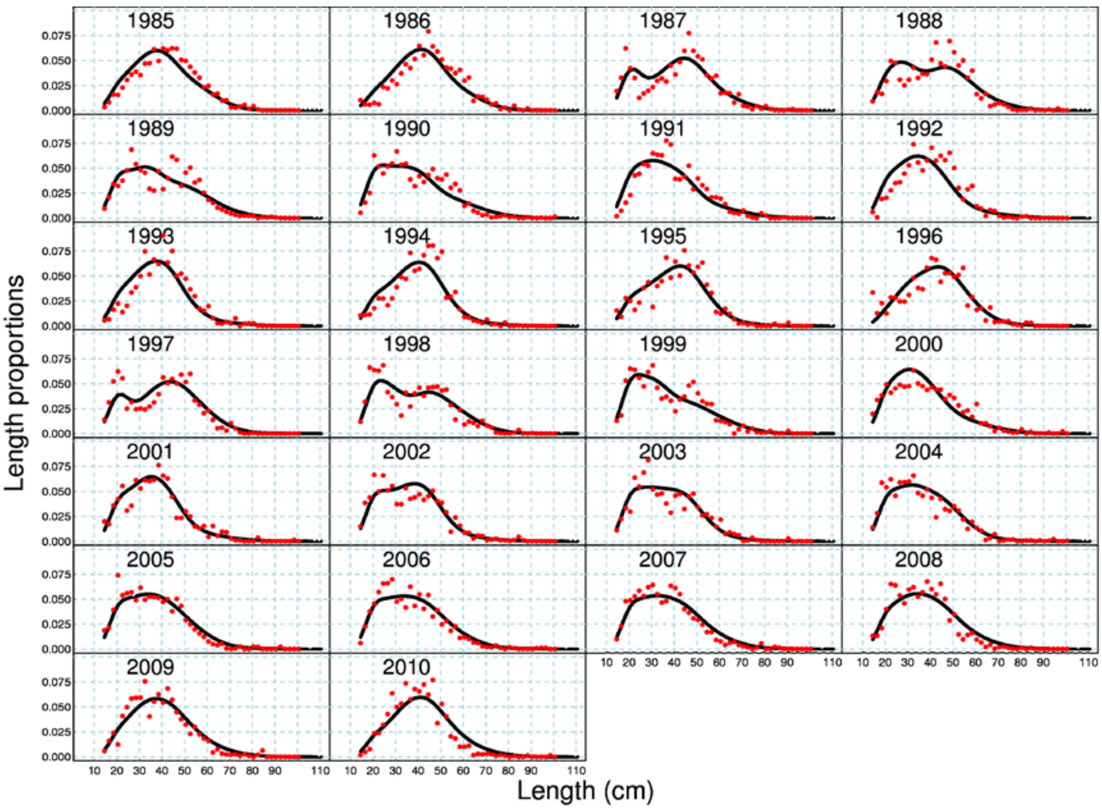



**Figure 7.2.12. Tusk in Va and XIV. Predicted proportional length distributions (black lines) and observed proportional length distributions (red points) by year from the Icelandic Spring Survey.**

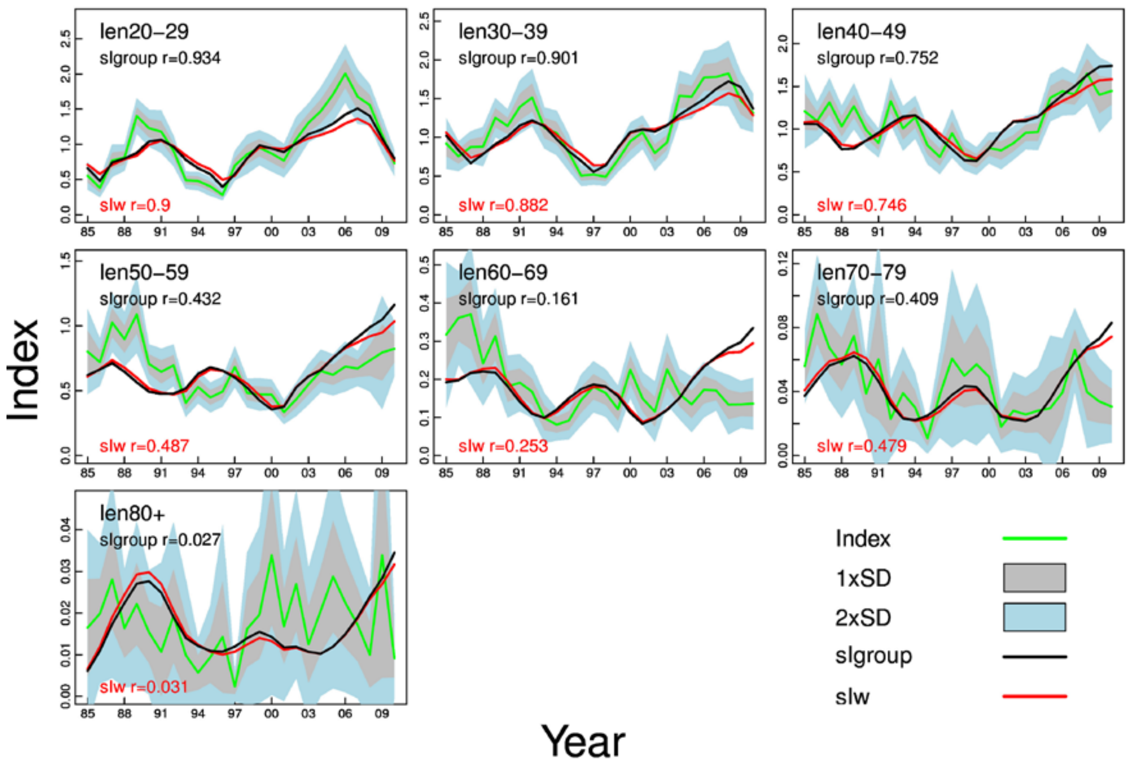



**Figure 7.2.13. Tusk in Va and XIV. Trends in aggregated length indices (10 cm) from the Icelandic Spring (March) Survey (green line) and standard deviation of the survey estimates (1 s.d. grey, 2 s.d. light blue) and predictions from the Gadget model using either slw weights (red line).or the slgroup weights (black line; see stock annex for details).**

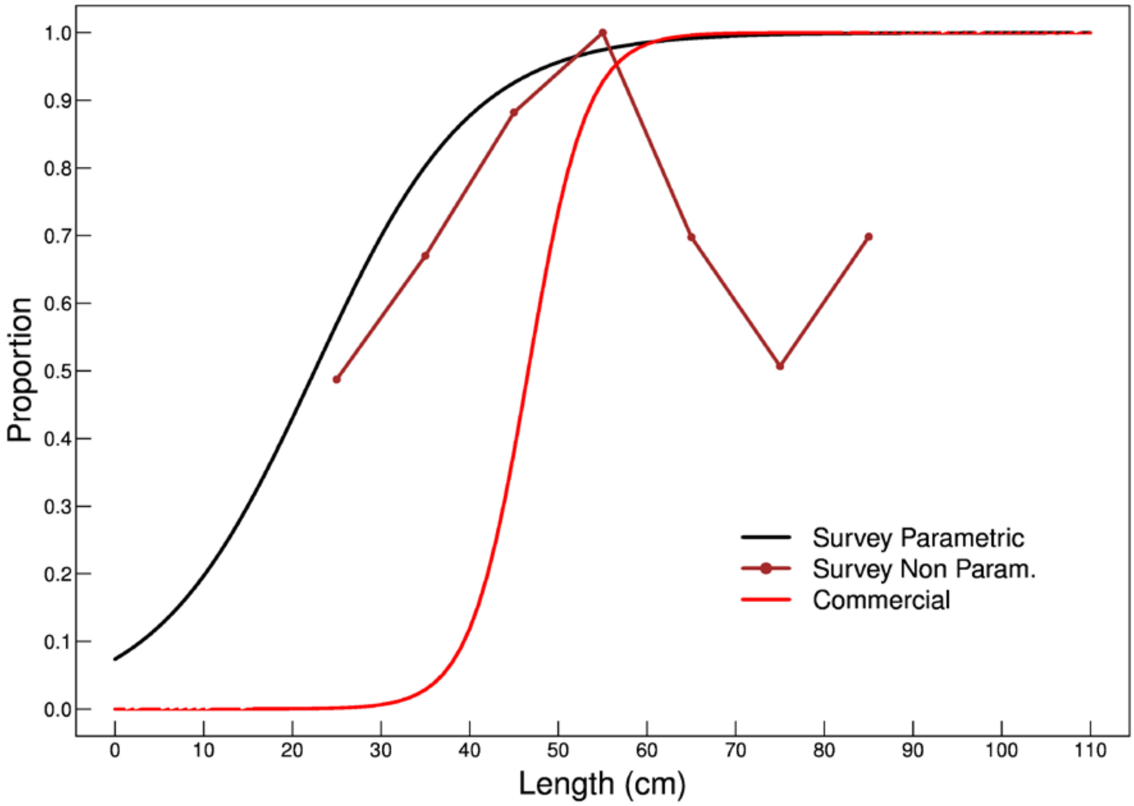



**Figure 7.2.14. Tusk in Va and XIV. Estimated selection curves from the Gadget model.**

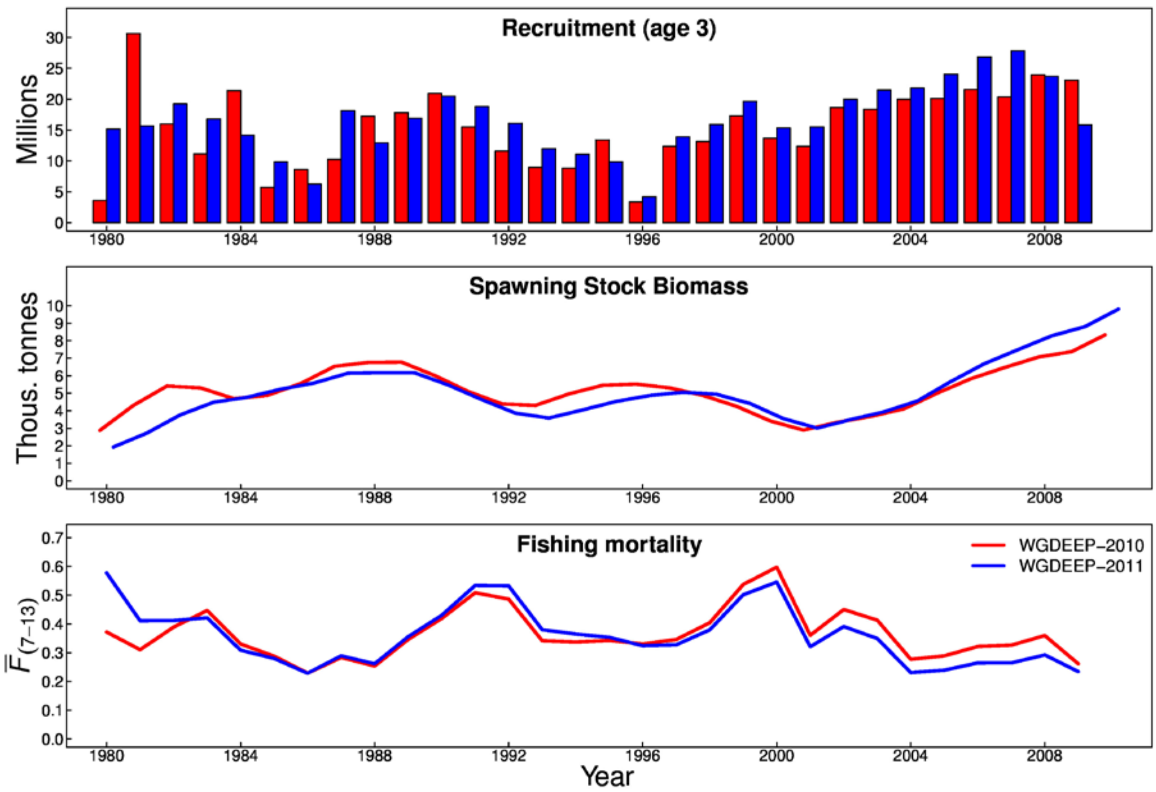



**Figure 7.2.15. Tusk in Va and XIV. Comparison of the WGDEEP-2010 Gadget assessment (red bars and lines) and the current assessment (blue bars and lines).**

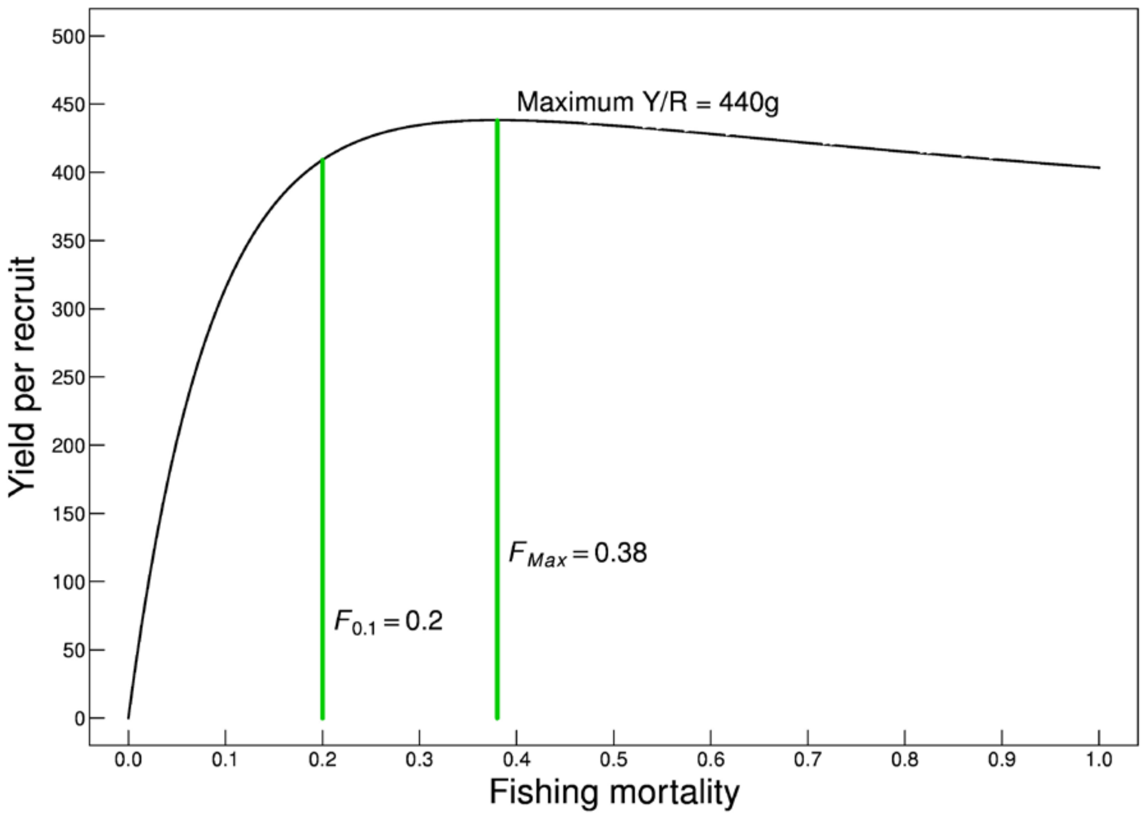



**Figure 7.2.16. Tusk in Va and XIV. Yield-per-recruit analysis from the Gadget model.**

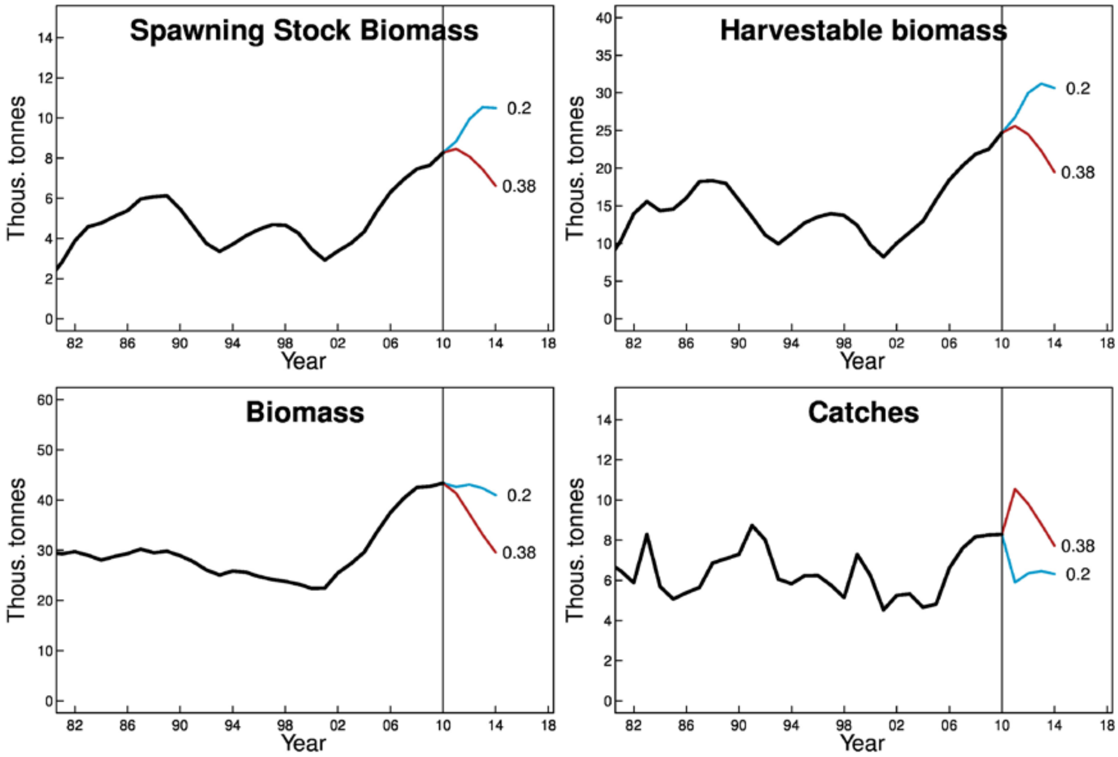



**Figure 7.2.17. Tusk in Va and XIV. Prognosis assuming fishing at $F_{0.1}$ = 0.2 and $F_{max}$ = 0.38 from Gadget.**

## 7.3 Tusk (*Brosme brosme*) in Subareas I and II

### 7.3.1 The fishery

Tusk has been caught, primarily as a bycatch in the ling and cod fisheries, in these subareas. Currently, the major fisheries in Subareas I and II are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears, e.g. trawls and handlines. Of the Norwegian landings, usually around 85% is taken by longlines, 10% by gillnets and the remainder by a variety of other gears. Other nations catch tusk as a bycatch in trawl and longline fisheries.

Russian landings (107 t) from Subdivisions IIa and IIb in 2010 were mainly taken as bycatch in longline fisheries. In Subarea I one tonne was caught (Vinnichenko *et al.*, WD 13, 2011).

#### 7.3.1.1 Landings trends

Landing statistics by nation in the period 1988–2010 are given in Table 7.3.1a–d. Landings declined from 1989 to 2005, after this the landings decreased (Figures 7.3.1 and 7.3.2). The preliminary landings for 2010 are 12 655 t which is an increase compared with previous years.

#### 7.3.1.2 ICES Advice

**Advice for 2011:** ICES advises that catches should be less than 9900 t and a reduction below recent levels should be considered in order to be consistent with MSY.

#### 7.3.1.3 Management

There is no quota set for the Norwegian fishery for tusk but the vessels participating in the directed fishery for ling and tusk in Subareas I and II are required to have a specific licence. The quota for the EU in Areas I and II in the Norwegian zone for by-catch species such as ling and tusk is in 2011 set to 5000 t. There is no minimum landing size in the Norwegian EEZ.

The EU TAC (for community vessels fishing in community waters and waters not under the sovereignty or jurisdiction of third countries in I, II and XIV) was set at 20 t in 2010 and increased to 21 t in 2011.

### 7.3.2 Data available

#### 7.3.2.1 Landings and discards

Landings were available for all relevant fleets. New discard data were not available.

#### 7.3.2.2 Length compositions

Average length data from 1988 to 2009 are presented in Helle and Pennington, WD21, 2011. In this period the estimated mean length has varied around 51 cm without any clear trend.

#### 7.3.2.3 Age compositions

No new age compositions were available.

#### 7.3.2.4 Weight-at-age

No new data were presented.

#### 7.3.2.5 Maturity and natural mortality

No new data were presented.

#### 7.3.2.6 Catch, effort and research vessel data

Catch and effort data for Norwegian longliners were presented (Figure 7.3.3). No research vessel data were available.

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

An analysis based on these data is in Helle and Pennington, WD21, 2011.

### 7.3.3 Data analyses

No analytical assessments were possible due to lack of age-structured data and/or tuning-series.

The only source of information on abundance trends was the nominal cpue series from the Norwegian longliners presented by Helle and Pennington (WD21, 2011). The number of longliners has declined in recent years (Table 7.3.2), from 72 to 35 in the period 2000–2010. The numbers of fishing days per vessel has remained relatively stable during the last years (Helle and Pennington, WD21, 2011). The number of hooks set per day increased over the period 2000–2009 in Subareas I and II (Figure 7.3.4).

Table 7.3.3 gives estimates of cpue based on the Norwegian official logbooks.

### 7.3.4 Comments on the assessment

The cpue series starting in 2000 shows an upward trend for the period 2004–2006 and has remained stable at a high level since then. No further analysis was carried out. A further analysis will be carried out when a standardized index is available.

### 7.3.5 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, e.g. $F_{proxy}$, CUSUM.

**Table 7.3.1a. Tusk I. WG estimates of landings.**

| Year | Norway | Russia | Faroes | Iceland | Ireland | Total |
|---|---|---|---|---|---|---|
| 1996 | 587 | | | | | 587 |
| 1997 | 665 | | | | | 665 |
| 1998 | 805 | | | | | 805 |
| 1999 | 907 | | | | | 907 |
| 2000 | 738 | 43 | 1 | 16 | | 798 |
| 2001 | 595 | 6 | | 13 | | 614 |
| 2002 | 791 | 8 | n/a | 0 | | 799 |
| 2003 | 571 | 5 | | | 5 | 581 |
| 2004 | 620 | 2 | | | 1 | 623 |
| 2005 | 562 | | | | | 562 |
| 2006 | 442 | 4 | | | | 446 |
| 2007 | 355 | 2 | | | | 357 |
| 2008 | 627 | 7 | | | | 634 |
| 2009 | 869 | 1 | | | | 870 |
| 2010 | 725 | 1 | | | | 726 |

***Preliminary.**

**Table 7.3.1b. Tusk IIa. WG estimates of landings.**

| Year | Faroes | France | Germany | Greenland | Norway | E & W | Scotland | Russia | Ireland | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 115 | 32 | 13 | - | 14 241 | 2 | - | | | 14 403 |
| 1989 | 75 | 55 | 10 | - | 19 206 | 4 | - | | | 19 350 |
| 1990 | 153 | 63 | 13 | - | 18 387 | 12 | + | | | 18 628 |
| 1991 | 38 | 32 | 6 | - | 18 227 | 3 | + | | | 18 306 |
| 1992 | 33 | 21 | 2 | - | 15 908 | 10 | - | | | 15 974 |
| 1993 | - | 23 | 2 | 11 | 17 545 | 3 | + | | | 17 584 |
| 1994 | 281 | 14 | 2 | - | 12 266 | 3 | - | | | 12 566 |
| 1995 | 77 | 16 | 3 | 20 | 11 271 | 1 | | | | 11 388 |
| 1996 | 0 | 12 | 5 | | 12 029 | 1 | | | | 12 047 |
| 1997 | 1 | 21 | 1 | | 8642 | 2 | + | | | 8667 |
| 1998 | | 9 | 1 | | 14 463 | 1 | 1 | - | | 14 475 |
| 1999 | | 7 | + | | 16 213 | | 2 | 28 | | 16 250 |
| 2000 | | 8 | 1 | | 13 120 | 3 | 2 | 58 | | 13 192 |
| 2001 | 11 | 15 | + | | 11 200 | 1 | 3 | 66 | 5 | 11 301 |
| 2002 | | 3 | | | 11 303 | 1 | 4 | 39 | 5 | 11 355 |
| 2003 | 6 | 2 | | | 7284 | | 3 | 21 | | 7316 |
| 2004 | 12 | 2 | | | 6607 | | 1 | 61 | 1 | 6684 |
| 2005 | 29 | 6 | | | 6249 | | | 37 | 3 | 6324 |
| 2006 | 33 | 9 | | | 9246 | 1 | | 51 | 11 | 9351 |
| 2007 | 54 | 7 | | | 9856 | 0 | 5 | 85 | 12 | 10 019 |
| 2008 | 52 | 6 | | | 10 848 | 1 | 3 | 56 | 0 | 10 966 |
| 2009 | 59 | 1 | | | 8354 | | 1 | 82 | | 8497 |
| 2010 | 39 | 3 | | | 11 445 | | 1 | 49 | | 11 537 |

*** Preliminary.**

**(1) Includes IIb.**

**Table 7.3.1c. Tusk IIb. WG estimates of landings.**

| Year | Norway | E & W | Russia | Ireland | Total |
|---|---|---|---|---|---|
| 1988 | | - | | | 0 |
| 1989 | | - | | | 0 |
| 1990 | | - | | | 0 |
| 1991 | | - | | | 0 |
| 1992 | | - | | | 0 |
| 1993 | | 1 | | | 1 |
| 1994 | | - | | | 0 |
| 1995 | 229 | - | | | 229 |
| 1996 | 161 | | | | 161 |
| 1997 | 92 | 2 | | | 94 |
| 1998 | 73 | + | - | | 73 |
| 1999 | 26 | | 4 | | 26 |
| 2000 | 15 | - | 3 | | 18 |
| 2001 | 141 | - | 5 | | 146 |
| 2002 | 30 | - | 7 | | 37 |
| 2003 | 43 | | | | 43 |
| 2004 | 114 | | 5 | | 119 |
| 2005 | 148 | | 16 | | 164 |
| 2006 | 168 | | 23 | | 191 |
| 2007 | 350 | | 17 | 1 | 368 |
| 2008 | 271 | | 11 | 0 | 313 |
| 2009 | 249 | | 39 | | 288 |
| 2010 | 334 | | 58 | | 392 |

**Table 7.3.1d. Tusk I and II. WG estimates of total landings by subareas or divisions.**

| Year | I | IIa | IIb | All areas |
|---|---|---|---|---|
| 1988 | | 14 403 | 0 | 14 403 |
| 1989 | | 19 350 | 0 | 19 350 |
| 1990 | | 18 628 | 0 | 18 628 |
| 1991 | | 18 306 | 0 | 18 306 |
| 1992 | | 15 974 | 0 | 15 974 |
| 1993 | | 17 584 | 1 | 17 585 |
| 1994 | | 12 566 | 0 | 12 566 |
| 1995 | | 11 388 | 229 | 11 617 |
| 1996 | 587 | 12 047 | 161 | 12 795 |
| 1997 | 665 | 8667 | 94 | 9426 |
| 1998 | 805 | 14 475 | 73 | 15 353 |
| 1999 | 907 | 16 250 | 26 | 17 183 |
| 2000 | 798 | 13 192 | 18 | 14 008 |
| 2001 | 614 | 11 301 | 146 | 12 061 |
| 2002 | 799 | 11 355 | 37 | 12 191 |
| 2003 | 581 | 7316 | 43 | 7940 |
| 2004 | 623 | 6684 | 119 | 7426 |
| 2005 | 562 | 6324 | 164 | 7050 |
| 2006 | 446 | 9351 | 191 | 9988 |
| 2007 | 357 | 10 019 | 368 | 10 744 |
| 2008 | 635 | 10 965 | 313 | 11 913 |
| 2009 | 870 | 8471 | 288 | 9655 |
| 2010 | 726 | 11 537 | 392 | |

***Preliminary.**

**Table 7.3.2. Summary statistics for the Norwegian longliner fleet during the period 1995–2009 (vessels exceeding 21 m). This list only includes vessels that landed 8 tonnes or more of ling, blue ling and tusk in a given year.**

| Year | Number of longliners |
|---|---|
| 1995 | 65 |
| 1996 | 66 |
| 1997 | 65 |
| 1998 | 67 |
| 1999 | 71 |
| 2000 | 72 |
| 2001 | 65 |
| 2002 | 58 |
| 2003 | 52 |
| 2004 | 43 |
| 2005 | 39 |
| 2006 | 35 |
| 2007 | 38 |
| 2008 | 36 |
| 2009 | 34 |
| 2010 | 35 |

**Table 7.3.3. Estimated mean cpue ([kg/hook]x1000) of tusk in Subarea I and II based on logbook data. Standard error (se) and number of catches sampled (n) is also given.**

| Tusk | Area | I | IIA | IIB |
|---|---|---|---|---|
| 2000 | cpue | 21,6 | 59,5 | 4,1 |
| | n | 189 | 1678 | 8 |
| | se | 2,1 | 0,7 | 10,4 |
| 2001 | cpue | 18,8 | 52,5 | 10,8 |
| | n | 53 | 1959 | 17 |
| | se | 3,2 | 0,5 | 5,6 |
| 2002 | cpue | 4,2 | 47 | |
| | n | 115 | 1809 | |
| | se | 2,0 | 0,5 | |
| 2003 | cpue | 11,9 | 40,1 | 5,3 |
| | n | 141 | 1473 | 5 |
| | se | 1,7 | 0,5 | 9,0 |
| 2004 | cpue | 3,8 | 36,1 | 2,2 |
| | n | 122 | 1096 | 20 |
| | se | 2,2 | 0,8 | 5,6 |
| 2005 | cpue | 3,5 | 49,5 | 2,7 |
| | n | 73 | 1060 | 12 |
| | se | 3,7 | 1,0 | 9,2 |
| 2006 | cpue | 7,8 | 56,3 | 5,62 |
| | n | 18 | 1145 | 6 |
| | se | 9,5 | 1,2 | 16,4 |
| 2007 | cpue | 7,95 | 53,1 | 2,85 |
| | n | 108 | 1853 | 19 |
| | se | 2,7 | 0,7 | 6,4 |
| 2008 | cpue | 6,78 | 57,5 | 8,02 |
| | n | 32 | 1247 | 68 |
| | se | 6,38 | 1,03 | 4,42 |
| 2009 | cpue | 3.76 | 57.6 | 2 |
| | n | 78 | 1195 | 26 |
| | se | 5.26 | 1.34 | 9.11 |

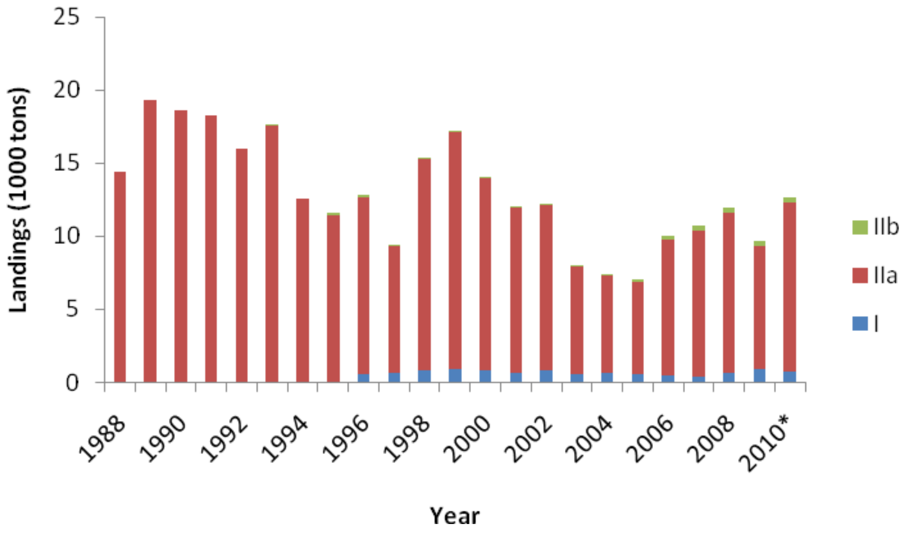



**Figure 7.3.1.Total landings of tusk in Areas I and II for the period 1988–2010.**

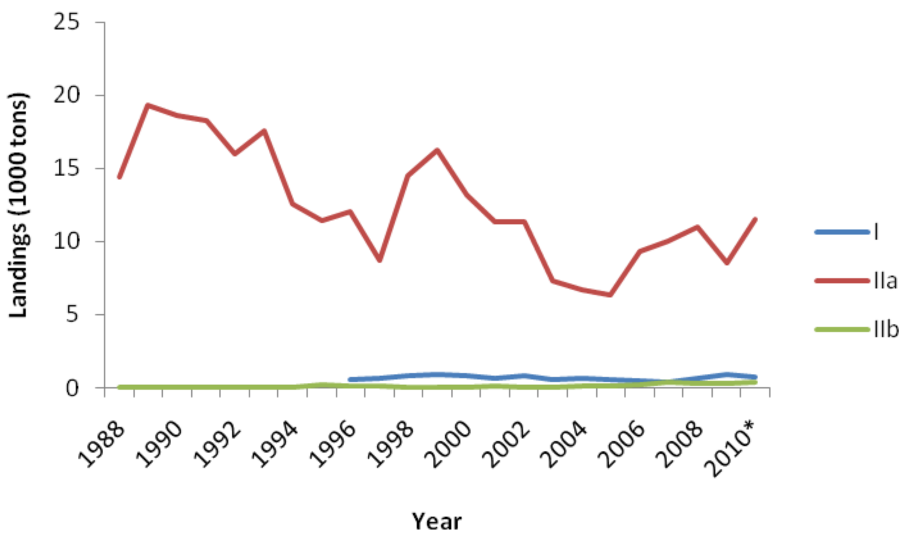



**Figure 7.3.2. Total landings of tusk in Areas I and II in each area for the period 1988–2010.**

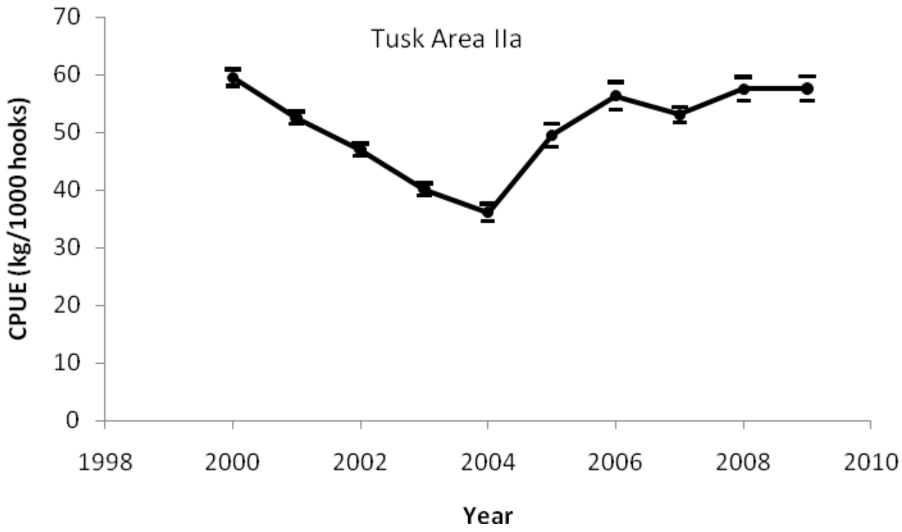



**Figure 7.3.3. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbooks 2000–2009. The bars denote the 95% confidence interval.**

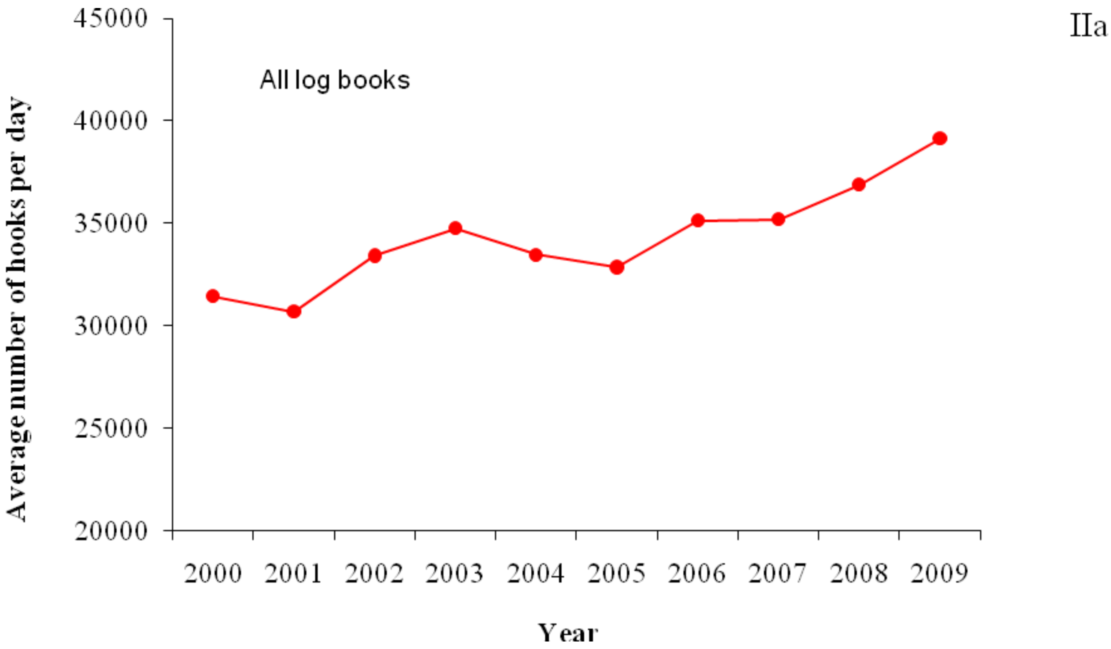



**Figure 7.3.4. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES Subarea IIa for the years 2000–2009 in the fishery for tusk, ling and blue ling.**

## 7.4 Tusk (*Brosme brosme*) on the Mid-Atlantic Ridge (Subdivisions XIIa1 and XIVb1)

### 7.4.1 The fishery

Tusk is a bycatch species in the gillnet and longline fisheries in Subdivisions XIIa1 and XIVb1. Russia reported catches of tusk in 2005–2007 and 2009. No catches were reported for 2010. During the period 1996–1997 Norway also had a fishery in this area.

#### 7.4.1.1 Landings trends

Landing statistics by nation in the period 1988–2010 are in Table 7.4.1.

The reported catches are generally very low in this area.

#### 7.4.1.2 ICES Advice

**Advice Summary for 2011:** Fisheries should not be allowed to expand and measures should be considered to limit occasional high levels of bycatch, in order to be consistent with MSY.

#### 7.4.1.3 Management

NEAFC recommends that in 2009–2010 the effort in areas beyond national jurisdiction shall not exceed 65 per cent of the highest level for deep-water fishing in previous years.

### 7.4.2 Data available

#### 7.4.2.1 Landings and discards

Landings were available for all the relevant fleets. New discard data were not available.

#### 7.4.2.2 Length compositions

No length compositions were available.

#### 7.4.2.3 Age compositions

No age compositions were available.

#### 7.4.2.4 Weight-at-age

No data were available.

#### 7.4.2.5 Maturity and natural mortality

No data were available.

#### 7.4.2.6 Catch, effort and research vessel data

No data were available.

### 7.4.3 Data analyses

There are insufficient data to assess this stock.

### 7.4.4 Comments on the assessment

No assessment was carried out this year.

### 7.4.5 Management considerations

No management advice is required this year.

**Table 7.4.1. Tusk XII. WG estimate of landings.**

| TUSK XII | | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Faroes | France | Iceland | Norway | Scotland | Russia | Total |
| 1988 | | 1 | | | | | 1 |
| 1989 | | | | | | | 0 |
| 1990 | | | | | | | 0 |
| 1991 | | | | | | | 0 |
| 1992 | | | | | | | 0 |
| 1993 | | | + | | | | 0 |
| 1994 | | | + | | | | 0 |
| 1995 | 8 | - | 10 | | | | 18 |
| 1996 | 7 | - | 9 | 142 | | | 158 |
| 1997 | 11 | - | + | 19 | | | 30 |
| 1998 | | | | - | | | 0 |
| 1999 | | | | + | | | 0 |
| 2000 | | | | | | | 0 |
| 2001 | | | | | | | 0 |
| 2002 | | | | | | | 0 |
| 2003 | | | | | | | 0 |
| 2004 | | | | | | 5 | 5 |
| 2005 | | | | | | | 0 |
| 2006 | | | | | | 64 | 64 |
| 2007 | | | | | | 19 | 19 |
| 2008 | | | | | | 0 | 0 |
| 2009 | | | | | | 2 | 2 |
| 2010* | | | | | | 0 | 0 |

***Preliminary.**

**Table 7.4.1. (continued). Tusk, total landings by subareas or division.**

| Year | XII | All areas |
|---|---|---|
| 1988 | 1 | 1 |
| 1989 | 0 | 0 |
| 1990 | 0 | 0 |
| 1991 | 0 | 0 |
| 1992 | 0 | 0 |
| 1993 | 0 | 0 |
| 1994 | 0 | 0 |
| 1995 | 18 | 18 |
| 1996 | 158 | 158 |
| 1997 | 30 | 30 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | 5 | 5 |
| 2005 | 0 | 0 |
| 2006 | 64 | 64 |
| 2007 | 19 | 19 |
| 2008 | 0 | 0 |
| 2009 | 2 | 2 |
| 2010* | 0 | 0 |

***Preliminary.**

## 7.5 Tusk (*Brosme brosme*) in VIb

### 7.5.1 The fishery

Tusk is a bycatch species in the trawl, gillnet and longline fisheries in Subarea VIb. Norway has traditionally landed the largest percentage of the total catch. Longliners catch about 90% of the Norwegian landings. Since January 2007 parts of the Rockall Bank has been closed to fishing with bottom trawls, gillnets and longlines. The areas closed are traditional areas fished by the Norwegian longline fleet.

In 2004 Russia started a longline fishery for ling taking a bycatch of tusk in the international waters of the Rockall Bank. A maximum catch (137 t) was taken in 2005. In recent years the activity in this fishery has decreased. Small bycatches of tusk were also taken in the area by trawlers participating in the haddock fishery.

#### 7.5.1.1 Landings trends

Landing statistics by nation in the period 1988–2010 are in Table 7.5.1.

Landings varied considerably between 1988–2000, and since then have been low with a declining trend (Figure 7.5.1).

#### 7.5.1.2 ICES Advice

Advice Summary for 2011: ICES advises to reduce catches by at least the rate of decline of the cpue.

#### 7.5.1.3 Management

Apart from the closed areas, there are no management measures that apply exclusively to this area.

Norway, which also has a licensing scheme, had a catch allocation in EU waters (Subareas V, VI and VIII) in 2009 of 3350 t and 2923 t in 2010 In 2011 the Norwegian quota in the EU zone is 2923 t (up to 2000 t are interchangeable with ling quota).

EU TACs cover Subarea V, VI, VII (EU and international waters) and in 2011 is set at 294 t.

NEAFC recommended in 2009 that the effort in the NEAFC regulatory area shall not exceed 65 per cent of the highest level put into deep-fishing in previous years.

### 7.5.2 Data available

#### 7.5.2.1 Landings and discards

Landings were available for all relevant countries. Discard data were not available.

#### 7.5.2.2 Length compositions

Average length for tusk in area VIb is presented in Helle and Pennington, WD 2011. Average length for the period 1988–2009 was 59 cm. Data on length from Russian catches were presented in Vinnichenko *et al*., WD 2011.

#### 7.5.2.3 Age compositions

No new age composition data were available.

#### 7.5.2.4 Weight-at-age

No new data were presented.

#### 7.5.2.5 Maturity and natural mortality

No new data were presented.

#### 7.5.2.6 Catch, effort and research vessel data

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

An analysis based on these data is in Helle and Pennington, WD, 2011.

### 7.5.3 Data analyses

No analytical assessments were carried out.

One source of information on abundance trends was the cpue series based on the Norwegian longliners' data (see Helle and Pennington, WD21, 2011). The number of longliners has declined from 72 to 34 during the period 2000–2009. The number of fishing days with a tusk catch in Division VIb has remained very stable in the period 2000–2008 with an average between 5 and 8 days per vessel, however in 2009 this had declined to two (Helle and Pennington, WD, 2011). The number of hooks set per day and the total set per year also remained stable during the period 2000–2008; however in 2009 there was a large increase in Subarea VIb (Figure 7.5.3)

Table 7.5.2 gives estimates of cpue and standard errors and number of fishing days, which are based on the Norwegian official logbooks.

The cpue series shows a decline in Area VIb (Figure 7.5.2).

A standardised series will be developed in preparation for WGDEEP 2012.

### 7.5.4 Comments on the assessment

The only cpue series available for VIb is based on the Norwegian longliners' data, and this series shows a declining trend.

### 7.5.5 Management considerations

No management advice is required this year

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g. $F_{proxy}$, CUSUM.

**Table 7.5.1. Tusk VIb. WG estimate of landings.**

| Year | Faroes | France | Germany | Ireland | Iceland | Norway | E & W | N.I. | Scot. | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 217 | | - | - | | 601 | 8 | - | 34 | | 860 |
| 1989 | 41 | 1 | - | - | | 1537 | 2 | - | 12 | | 1593 |
| 1990 | 6 | 3 | - | - | | 738 | 2 | + | 19 | | 768 |
| 1991 | - | 7 | + | 5 | | 1068 | 3 | - | 25 | | 1108 |
| 1992 | 63 | 2 | + | 5 | | 763 | 3 | 1 | 30 | | 867 |
| 1993 | 12 | 3 | + | 32 | | 899 | 3 | + | 54 | | 1003 |
| 1994 | 70 | 1 | + | 30 | | 1673 | 6 | - | 66 | | 1846 |
| 1995 | 79 | 1 | + | 33 | | 1415 | 1 | | 35 | | 1564 |
| 1996 | 0 | 1 | | 30 | | 836 | 3 | | 69 | | 939 |
| 1997 | 1 | 1 | | 23 | | 359 | 2 | | 90 | | 476 |
| 1998 | | 1 | | 24 | 18 | 630 | 9 | | 233 | | 915 |
| 1999 | | | | 26 | - | 591 | 5 | | 331 | | 953 |
| 2000 | | 2 | | 22 | | 1933 | 14 | | 372 | 1 | 2344 |
| 2001 | 1 | 1 | | 31 | | 476 | 10 | | 157 | 6 | 681 |
| 2002 | | 8 | | 3 | | 515 | 8 | | 88 | | 622 |
| 2003 | | 7 | | 18 | | 452 | 11 | | 72 | 1 | 561 |
| 2004 | | 9 | | 1 | | 508 | 4 | | 45 | 60 | 627 |
| 2005 | | 5 | | 9 | | 503 | 5 | | 33 | 137 | 692 |
| 2006 | 10 | 1 | | 16 | | 431 | 2 | | 25 | 2 | 487 |
| 2007 | 4 | 0 | | 8 | | 231 | 1 | | 30 | 25 | 299 |
| 2008 | 41 | 0 | | 2 | | 190 | 0 | | 16 | 44 | 293 |
| 2009 | 70 | | | 4 | | 358 | | | 17 | 3 | 452 |
| 2010* | 57 | | | 1 | | 348 | | | 13 | | 419 |

***Preliminary.**

**Table 7.5.1. (continued). Tusk, total landings in Subarea VIb.**

| Year | VIb | All areas |
|---|---|---|
| 1988 | 860 | 860 |
| 1989 | 1593 | 1593 |
| 1990 | 768 | 768 |
| 1991 | 1108 | 1108 |
| 1992 | 867 | 867 |
| 1993 | 1003 | 1003 |
| 1994 | 1846 | 1846 |
| 1995 | 1564 | 1564 |
| 1996 | 939 | 939 |
| 1997 | 476 | 476 |
| 1998 | 915 | 915 |
| 1999 | 953 | 953 |
| 2000 | 2344 | 2344 |
| 2001 | 681 | 681 |
| 2002 | 622 | 622 |
| 2003 | 561 | 561 |
| 2004 | 627 | 627 |
| 2005 | 692 | 692 |
| 2006 | 487 | 487 |
| 2007 | 299 | 299 |
| 2008 | 293 | 293 |
| 2009 | 452 | 469 |
| 2010 | 419 | 419 |

***Preliminary.**

**Table 7.5.2. Estimated mean cpue ([kg/hook]x1000) based on logbook data along with its standard error (*se*) and number of catches sampled for tusk in SubareaVIb.**

| Tusk | Area | VIB |
|---|---|---|
| 2000 | cpue | 76,8 |
| | n | 222 |
| | se | 2,0 |
| 2001 | cpue | 50,6 |
| | n | 132 |
| | se | 2,0 |
| 2002 | cpue | 55,2 |
| | n | 149 |
| | se | 1,7 |
| 2003 | cpue | 44,9 |
| | n | 94 |
| | se | 2,1 |
| 2004 | cpue | 62,7 |
| | n | 111 |
| | se | 2,4 |
| 2005 | cpue | 72,5 |
| | n | 136 |
| | se | 2,7 |
| 2006 | cpue | 41,2 |
| | n | 138 |
| | se | 3,4 |
| 2007 | cpue | 26,1 |
| | n | 135 |
| | se | 2,4 |
| 2008 | cpue | 29,6 |
| | n | 35 |
| | se | 6,16 |
| 2009 | cpue | 17.9 |
| | n | 27 |
| | se | 8.94 |

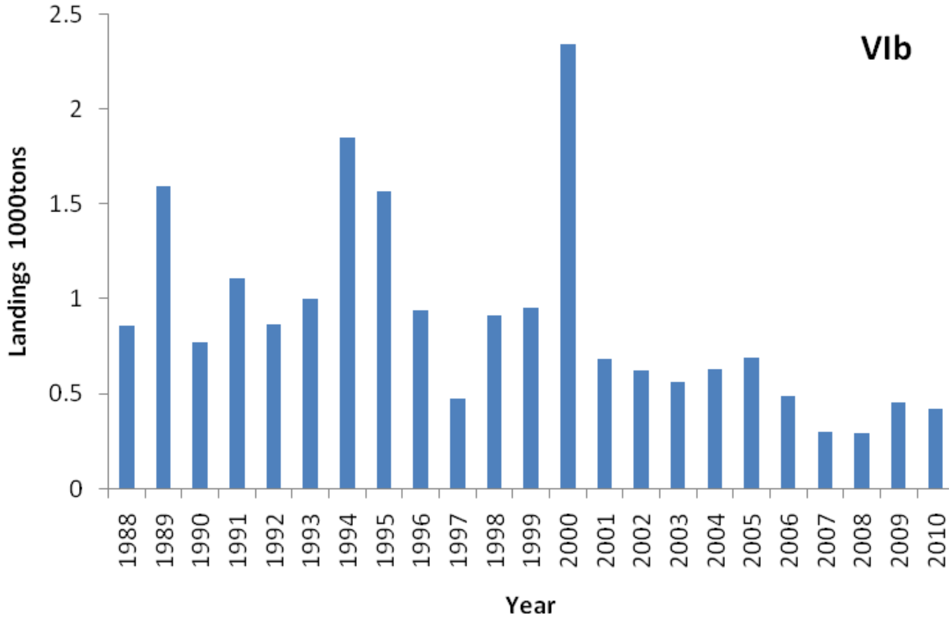



**Figure 7.5.1. Trend with time in international landings of tusk from Subarea VIb.**

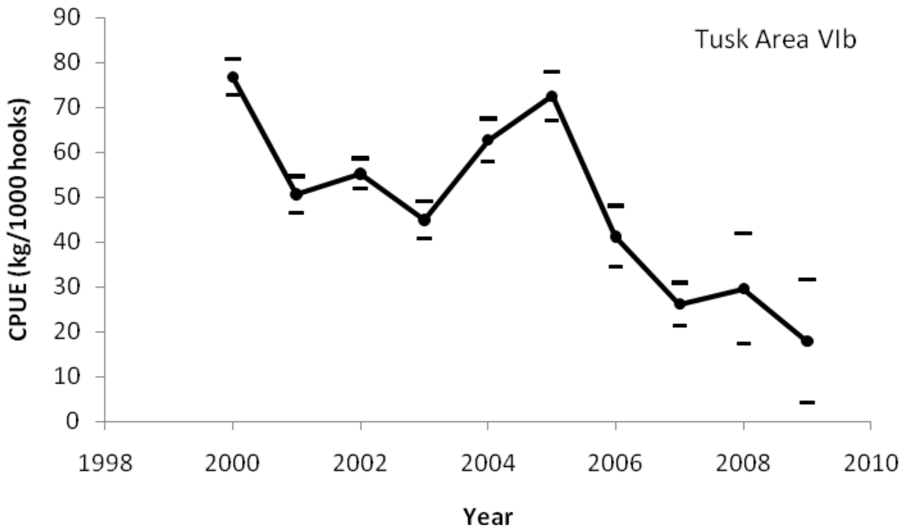
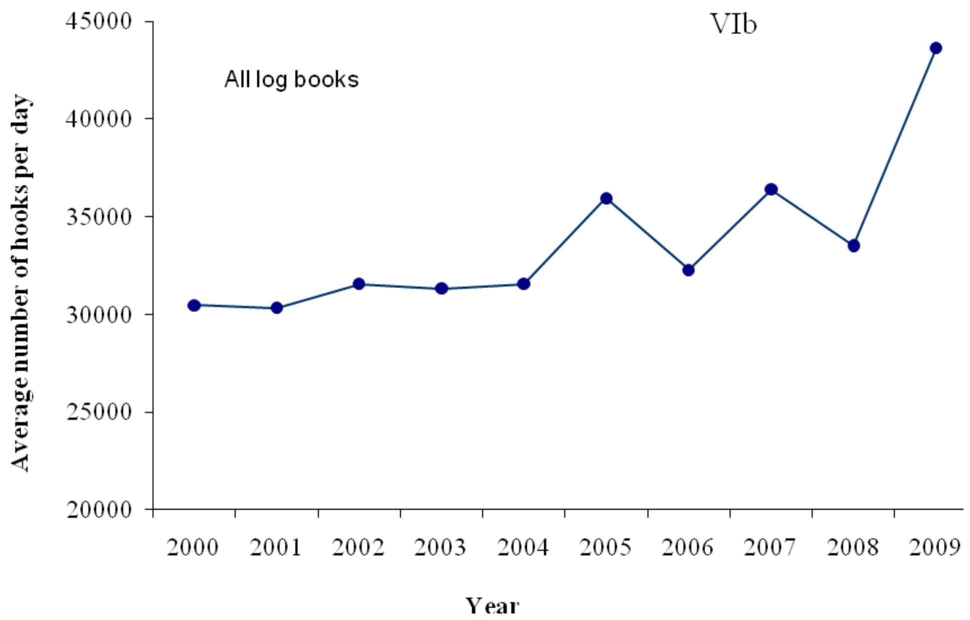



**Figure 7.5.2. Estimated mean cpue([kg/hook]x1000) based on data from the logbooks for tusk in ICES Subarea VIb for the years 2000–2009. The bars denote the 95% confidence interval.**




**7.5.3. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES Subarea VIb for the years 2000–2009 in the fishery for tusk, ling and blue ling.**

## 7.6 Tusk (*Brosme brosme*) in other Areas (IIIa, IVa, Vb, VIa, VII, VIII, IX and other Areas of XII)

### 7.6.1 The fishery

Tusk is a bycatch species in the trawl, gillnet and longline fisheries in these Subareas/Divisions. Norway has traditionally landed a dominant proportion of the total landings. Around 90% of the Norwegian landings are taken by longliners.

When landings from Areas III–IV and VIa–XIV are pooled over the period 1988–2010, 36% of the landings have been in Subarea IV, 46% in Division Vb, and 15% in Division VIa.

#### 7.6.1.1 Landings trends

Landing statistics by nation in the period 1988–2010 are in Table 7.6.1 and by year in Figure 7.6.1.

For all Subareas/Divisions the catches have been stable during the last five years except for Division Vb which shows a large increase in 2010 (Figure 7.6.2).

#### 7.6.1.2 ICES Advice

Advice for 2011: ICES advises that catches in 2011 should be less than 6900 t, and a reduction from recent levels should be considered in order to be consistent with MSY.

#### 7.6.1.3 Management

There is a licensing scheme and effort limitation in Vb. The minimum landing length for tusk in Division Vb is 40 cm. Norway has a bilaterally agreed quota in Vb and the quota for 2010 was 1774 t. There is no quota agreement yet for 2011. Norway also has a licensing scheme in EU waters and could in 2009 catch 3350 t. In 2010 and 2011 the

Norwegian quota in the EC zone is 2923 t for each year. The quota for the EU in the Norwegian zone (Area IV) is set at 170 t.

EU TACs for areas partially covered in this section are in 2011:

- Subarea III: 24 t;
- Subarea IV: 196 t;
- Subarea V, VI, VII (EU and international waters): 294 t.

NEAFC recommends that in 2009 the effort in areas beyond national jurisdiction shall not exceed 65 per cent of the highest level for deep-water fishing in previous years.

## 7.6.2 Data available

### 7.6.2.1 Landings and discards

Landings were available for all relevant countries. Discard data were not available.

### 7.6.2.2 Length compositions

Average length data from 1988 to 2009 is presented in Helle and Pennington WD 2011.

In this period the mean length has varied around 50 cm without any clear trend.

Length distributions from Faroese longliners in Vb were presented for the period 1995–2009. No trend in the composition can be seen in this series (Figure 7.6.3).

Length composition of tusk in longline catches in the southern part of Faroes Fishing Zone (Division Vb) in June–July 2008 are presented in Figure 7.6.4.

Russian investigations in Division Vb showed that fish length in 2009 varied from 42–90 cm, mainly 53–66 cm (Figure 7.6.5; Vinnichenko *et al.*, WD 2010).

### 7.6.2.3 Age compositions

No new age composition data were available.

### 7.6.2.4 Weight-at-age

No new data were presented.

### 7.6.2.5 Maturity and natural mortality

Russian investigations in Division Vb showed that the ratio of males to females was close to equal. The bulk of catches was made up of mature specimens. Most of them had gonads at the stage of post-spawning recovery. Moreover, a small number of fish were in the pre- and post-spawning conditions (Figure 7.6.6; Vinnichenko *et al.*, WD 2010).

### 7.6.2.6 Catch, effort and research vessel data

Catch and effort data for Norwegian and Faroese longliners and Danish trawlers were presented. Abundance indices and length frequency data from the Faroese groundfish surveys were presented.

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

An analysis based on these data is in Helle and Pennington, WD, 2011 (Table.7.6.2, Figure 7.6.7)

A cpue series for Danish trawlers fishing in IVa was available for the period 1992–2010 (Figure 7.6.8).

Data from Faroese summer and autumn surveys were available for the period 1994 onwards (Table 7.6.3 and Figure 7.6.9).

A cpue series for the Faroese longliners (>100 GRT) for the period 1987–2009 was also available (Figure 7.6.10).

### 7.6.3 Data analyses

No analytical assessments were attempted this year.

One source of information on abundance trends in Area IVa is the cpue series from the Norwegian longliners presented by Helle and Pennington (WD, 2010). The number of longliners has declined in recent years, from 72 to 35 in the period 2000–2010. The number of fishing days with tusk catch has remained relatively stable in Division IVa. In Division VIa the number of fishing days has varied from 23 in 2005 to six days in 2009, with an average of 13 days (Helle and Penningtion WD 2011)). The number of hooks set per day has remained rather stable in Subareas IVa, Vb and IV (Figure 7.6.11).

Cpue estimates based on the Norwegian official logbook data are given in Table 7.6.2 and are shown in Figure 7.6.7.

There was an overall increase in cpue in Divisions Vb and VIa. In Subarea IV there has been an increase in cpue until 2008 but in 2009 there was a relatively large decline. In this area the number of hooks has increased (Figure 7.6.11) and could influence the cpue negatively.

Cpue estimates for tusk caught by Danish trawlers in Division IVa based on logbook data show a declining trend for the period 1992–2005 followed by a slight increasing trend for the period 2006 through to 2009 (Figure 7.6.8).

The Faroese groundfish survey-series from Vb (Table 7.6.3, Figure 7.6.9) shows a decreasing trend until 2000 and subsequently an increasing trend. For the longer series from commercial longliners, there is a general declining trend since 1986, perhaps with a levelling off in the last decade (Figure 7.6.10).

### 7.6.4 Comments on the assessment

There was an increase in cpue for these Areas from 2002–2003 through 2009, with an exceptionally large increase in Division VIa. The estimates for Division IVa show a decline in 2009. The Danish cpue series for IVa trawlers for the last two decades show a recent increase and this corresponds with the Norwegian longline data from the same period and area.

In Vb the groundfish survey-series indicates a recent increase in abundance; this is also reflected in the longline cpue series for commercial vessels. The trend in the Faeroese cpue data is similar to the Norwegian longliner data.

The only cpue series available for VIa is from Norwegian longliners, and these show a very large increase in cpue over the period 2003 through 2009.

### 7.6.5 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g $F_{proxy}$, CUSUM.

**Table 7.6.1. Tusk IIIa, IV, Vb, VI, VII, VIII, IX. WG estimate of landings.**

**TUSK IIIa.**

| Year | Denmark | Norway | Sweden | Total |
|---|---|---|---|---|
| 1988 | 8 | 51 | 2 | 61 |
| 1989 | 18 | 71 | 4 | 93 |
| 1990 | 9 | 45 | 6 | 60 |
| 1991 | 14 | 43 | 27 | 84 |
| 1992 | 24 | 46 | 15 | 85 |
| 1993 | 19 | 48 | 12 | 79 |
| 1994 | 6 | 33 | 12 | 51 |
| 1995 | 4 | 33 | 5 | 42 |
| 1996 | 6 | 32 | 6 | 44 |
| 1997 | 3 | 25 | 3 | 31 |
| 1998 | 2 | 19 | | 21 |
| 1999 | 4 | 25 | | 29 |
| 2000 | 8 | 23 | 5 | 36 |
| 2001 | 10 | 41 | 6 | 57 |
| 2002 | 17 | 29 | 4 | 50 |
| 2003 | 15 | 32 | 4 | 51 |
| 2004 | 18 | 21 | 6 | 45 |
| 2005 | 9 | 30 | 5 | 44 |
| 2006 | 4 | 21 | 4 | 29 |
| 2007 | 1 | 19 | 1 | 21 |
| 2008 | 0 | 43 | 1 | 44 |
| 2009 | 1 | 17 | 21 | 39 |
| 2010* | 1 | 17 | | 18 |

***Preliminary.**

**TUSK IVa.**

| Year | Denmark | Faroes | France | Germany | Norway | Sweden[1] | E & W | N.I. | Scotland | Ireland | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 83 | 1 | 201 | 62 | 3,998 | - | 12 | - | 72 | | 4,429 |
| 1989 | 86 | 1 | 148 | 53 | 6,050 | + | 18 | + | 62 | | 6,418 |
| 1990 | 136 | 1 | 144 | 48 | 3,838 | 1 | 29 | - | 57 | | 4,254 |
| 1991 | 142 | 12 | 212 | 47 | 4,008 | 1 | 26 | - | 89 | | 4,537 |
| 1992 | 169 | - | 119 | 42 | 4,435 | 2 | 34 | - | 131 | | 4,932 |
| 1993 | 102 | 4 | 82 | 29 | 4,768 | + | 9 | - | 147 | | 5,141 |
| 1994 | 82 | 4 | 86 | 27 | 3,001 | + | 24 | - | 151 | | 3,375 |
| 1995 | 81 | 6 | 68 | 24 | 2,988 | | 10 | | 171 | | 3,348 |
| 1996 | 120 | 8 | 49 | 47 | 2,970 | | 11 | | 164 | | 3,369 |
| 1997 | 189 | 0 | 47 | 19 | 1,763 | + | 16 | | 238 | - | 2,272 |
| 1998 | 114 | 3 | 38 | 12 | 2,943 | | 11 | | 266 | - | 3,387 |
| 1999 | 165 | 7 | 44 | 10 | 1,983 | | 12 | | 213 | 1 | 2,435 |
| 2000 | 208 | + | 32 | 10 | 2,651 | 2 | 12 | | 343 | 1 | 3,259 |
| 2001 | 258 | | 30 | 8 | 2443 | 1 | 11 | | 343 | 1 | 3095 |
| 2002 | 199 | | 21 | | 2438 | 1 | 8 | | 294 | | 2961 |
| 2003 | 217 | | 19 | 6 | 1560 | | 4 | | 191 | | 1997 |
| 2004 | 137 | + | 14 | 3 | 1370 | + | 2 | | 140 | | 1666 |
| 2005 | 123 | 17 | 11 | 4 | 1561 | 1 | 2 | | 107 | | 1826 |
| 2006 | 155 | 8 | 14 | 3 | 1854 | | 5 | | 120 | | 2159 |
| 2007 | 95 | 0 | 22 | 4 | 1975 | 1 | 6 | | 74 | 3 | 2180 |
| 2008 | 57 | 0 | 17 | 2 | 1975 | | 3 | | 85 | 1 | 2140 |
| 2009 | 48 | | 8 | | 2108 | 7 | 3 | | 93 | | 2267 |
| 2010* | 36 | | 3 | | 1734 | | 8 | | 76 | | 1857 |

**[1]) Includes IVb 1988–1993.**

***Preliminary.**

**Table 7.6.1 (continued).**

**Tusk IVb.**

| Year | Denmark | France | Norway | Germany | E & W | Scotland | Ireland | sweden | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | | n.a. | | - | - | | | | |
| 1989 | | 3 | | - | 1 | | | | 4 |
| 1990 | | 5 | | - | - | | | | 5 |
| 1991 | | 2 | | - | - | | | | 2 |
| 1992 | 10 | 1 | | - | 1 | | | | 12 |
| 1993 | 13 | 1 | | - | - | | | | 14 |
| 1994 | 4 | 1 | | - | 2 | | | | 7 |
| 1995 | 4 | - | 5 | 1 | 3 | 2 | | | 15 |
| 1996 | 4 | - | 21 | 4 | 3 | 1 | | | 33 |
| 1997 | 6 | 1 | 24 | 2 | 2 | 3 | | | 38 |
| 1998 | 4 | 0 | 55 | 1 | 3 | 3 | | | 66 |
| 1999 | 8 | - | 21 | 1 | 1 | 3 | | | 34 |
| 2000 | 8 | | 106 | + | - | 2 | | | 116 |
| 2001 | 6 | | 45(1) | 1 | 1 | 3 | | | 56 |
| 2002 | 6 | | 61 | 1 | 1 | 2 | | | 71 |
| 2003 | 2 | | 5 | 1 | | | | | 8 |
| 2004 | 2 | | 19 | 1 | | 1 | | | 23 |
| 2005 | 2 | | 4 | 1 | | | | | 7 |
| 2006 | 2 | | 30 | | | | | | 32 |
| 2007 | 1 | | 6 | | | | 8 | | 15 |
| 2008 | 0 | | 69 | | | 0 | 2 | | 71 |
| 2009 | 1 | | 3 | | | 0 | 0 | 13 | 17 |
| 2010* | 1 | | 13 | | | | | | 14 |

**(1) Includes IVc.**

***Preliminary.**

**TUSK Vb1.**

| Year | Denmark | Faroes(4) | France | Germany | Norway | E & W | Scotland (1) | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | + | 2827 | 81 | 8 | 1143 | - | | | 4059 |
| 1989 | - | 1828 | 64 | 2 | 1828 | - | | | 3722 |
| 1990 | - | 3065 | 66 | 26 | 2045 | - | | | 5202 |
| 1991 | - | 3829 | 19 | 1 | 1321 | - | | | 5170 |
| 1992 | - | 2796 | 11 | 2 | 1590 | - | | | 4399 |
| 1993 | - | 1647 | 9 | 2 | 1202 | 2 | | | 2862 |
| 1994 | - | 2649 | 8 | 1 (2) | 747 | 2 | | | 3407 |
| 1995 | | 3059 | 16 | 1 (2) | 270 | 1 | | | 3347 |
| 1996 | | 1636 | 8 | 1 | 1083 | | | | 2728 |
| 1997 | | 1849 | 11 | + | 869 | | 13 | | 2742 |
| 1998 | | 1272 | 20 | - | 753 | 1 | 27 | | 2073 |
| 1999 | | 1956 | 27 | 1 | 1522 | | 11(3) | | 3517 |
| 2000 | | 1150 | 12 | 1 | 1191 | 1 | 11(3) | | 2367 |
| 2001 | | 1916 | 16 | 1 | 1572 | 1 | 20 | | 3526 |
| 2002 | | 1033 | 10 | | 1642 | 1 | 36 | | 2722 |
| 2003 | | 1200 | 11 | | 1504 | 1 | 17 | | 2733 |
| 2004 | | 1705 | 13 | | 1798 | 1 | 19 | | 3536 |
| 2005 | | 1838 | 12 | | 1398 | | 24 | | 3272 |
| 2006 | | 2736 | 21 | | 778 | | 24 | 1 | 3559 |
| 2007 | | 2291 | 28 | | 1108 | 2 | 2 | 37 | 3431 |
| 2008 | | 2824 | 18 | | 816 | 18 | 13 | 109 | 3689 |
| 2009 | | 2553 | 14 | | 499 | 4 | 31 | 34 | 3101 |
| 2010* | | 3925 | 5 | | 866 | | 58 | | 4854 |

**1)Included in $Vb_2$ until 1996.**

**(2)Includes $Vb_2$.**

**(3)Reported as Vb.**

**(4) 2000–2003 Vb1 and Vb2 combined.**

***Preliminary.**

**Table 7.6.1. (continued).**

**TUSK Vb2.**

| Year | Faroe | Norway | E & W | Scotland [1] | Total |
|---|---|---|---|---|---|
| 1988 | 545 | 1061 | - | + | 1606 |
| 1989 | 163 | 1237 | - | + | 1400 |
| 1990 | 128 | 851 | - | + | 979 |
| 1991 | 375 | 721 | - | + | 1096 |
| 1992 | 541 | 450 | - | 1 | 992 |
| 1993 | 292 | 285 | - | + | 577 |
| 1994 | 445 | 462 | + | 2 | 909 |
| 1995 | 225 | 404 | -2 | 2 | 631 |
| 1996 | 46 | 536 | | | 582 |
| 1997 | 157 | 420 | | | 577 |
| 1998 | 107 | 530 | | | 637 |
| 1999 | 132 | 315 | | | 447 |
| 2000 | | 333 | | | 333 |
| 2001 | | 469 | | | 469 |
| 2002 | | 281 | | | 281 |
| 2003 | | 559 | | | 559 |
| 2004 | | 107 | | | 107 |
| 2005 | | 360 | | | 360 |
| 2006 | | 317 | | | 317 |
| 2007 | | 344 | | | 344 |
| 2008 | | 61 | | | 61 |
| 2009 | | 164 | | | 164 |
| 2010* | | 126 | | | 127 |

**[1]Includes Vb1.**
**[2]See $Vb_1$.**
**[3]Included in $Vb_1$.**
***Preliminary.**

**TUSK Via.**

| Year | Denmark | Faroes | France (1) | Germany | Ireland | Norway | E & W | N.I. | Scot. | Spain | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | - | - | 766 | 1 | - | 1310 | 30 | - | 13 | | 2120 |
| 1989 | + | 6 | 694 | 3 | 2 | 1583 | 3 | - | 6 | | 2297 |
| 1990 | - | 9 | 723 | + | - | 1506 | 7 | + | 11 | | 2256 |
| 1991 | - | 5 | 514 | + | - | 998 | 9 | + | 17 | | 1543 |
| 1992 | - | - | 532 | + | - | 1124 | 5 | - | 21 | | 1682 |
| 1993 | - | - | 400 | 4 | 3 | 783 | 2 | + | 31 | | 1223 |
| 1994 | + | | 345 | 6 | 1 | 865 | 5 | - | 40 | | 1262 |
| 1995 | | 0 | 332 | + | 33 | 990 | 1 | | 79 | | 1435 |
| 1996 | | 0 | 368 | 1 | 5 | 890 | 1 | | 126 | | 1391 |
| 1997 | | 0 | 359 | + | 3 | 750 | 1 | | 137 | 11 | 1261 |
| 1998 | | | 395 | + | | 715 | - | | 163 | 8 | 1281 |
| 1999 | | | 193 | + | 3 | 113 | 1 | | 182 | 47 | 539 |
| 2000 | | | 267 | + | 20 | 1327 | 8 | | 231 | 158 | 2011 |
| 2001 | | | 211 | + | 31 | 1201 | 8 | | 279 | 37 | 1767 |
| 2002 | | | 137 | | 8 | 636 | 5 | | 274 | 64 | 1124 |
| 2003 | | | 112 | | 4 | 905 | 3 | | 104 | 0 | 1128 |
| 2004 | | 1 | 140 | | 22 | 470 | | | 93 | 0 | 726 |
| 2005 | | 10 | 204 | | 7 | 702 | | | 96 | 0 | 1019 |
| 2006 | | 5 | 239 | | 10 | 674 | 16 | | 115 | 0 | 1059 |
| 2007 | | 39 | 261 | | 3 | 703 | 9 | | 70 | 0 | 1085 |
| 2008 | | 30 | 307 | | 1 | 964 | 0 | | 44 | 0 | 1346 |
| 2009 | | 33 | 217 | | 4 | 898 | 0 | | 88 | 2 | 1242 |
| 2010* | | 41 | 163 | | 5 | 939 | | | 48 | | 1196 |

**Not allocated by divisions before 1993.**

*** Preliminary.**

**Table 7.6.1. (continued).**

**TUSK VIIa.**

| Year | France | E & W | Scotland | Total |
|---|---|---|---|---|
| 1988 | n.a. | - | + | + |
| 1989 | 2 | - | + | 2 |
| 1990 | 4 | + | + | 4 |
| 1991 | 1 | - | 1 | 2 |
| 1992 | 1 | + | 2 | 3 |
| 1993 | - | + | + | + |
| 1994 | - | - | + | + |
| 1995 | - | - | 1 | 1 |
| 1996 | - | - | | |
| 1997 | - | - | 1 | 1 |
| 1998 | - | - | 1 | 1 |
| 1999 | - | - | + | + |
| 2000 | | - | + | + |
| 2001 | | - | 1 | 1 |
| 2002 | n/a | - | - | - |
| 2003 | | - | - | - |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010* | | | | |

***Preliminary.**

**TUSK VIIb, c.**

| Year | France | Ireland | Norway | E & W | N.I. | Scotland | Total |
|---|---|---|---|---|---|---|---|
| 1988 | n.a. | - | 12 | 5 | - | + | 17 |
| 1989 | 17 | - | 91 | - | - | - | 108 |
| 1990 | 11 | 3 | 138 | 1 | - | 2 | 155 |
| 1991 | 11 | 7 | 30 | 2 | 1 | 1 | 52 |
| 1992 | 6 | 8 | 167 | 33 | 1 | 3 | 218 |
| 1993 | 6 | 15 | 70 | 17 | + | 12 | 120 |
| 1994 | 5 | 9 | 63 | 9 | - | 8 | 94 |
| 1995 | 3 | 20 | 18 | 6 | | 1 | 48 |
| 1996 | 4 | 11 | 38 | 4 | | 1 | 58 |
| 1997 | 4 | 8 | 61 | 1 | | 1 | 75 |
| 1998 | 3 | | 28 | - | | 2 | 33 |
| 1999 | - | 16 | 130 | - | | 1 | 147 |
| 2000 | 3 | 58 | 88 | 12 | | 3 | 164 |
| 2001 | 4 | 54 | 177 | 4 | | 25 | 263 |
| 2002 | 1 | 31 | 30 | 1 | | 3 | 66 |
| 2003 | 1 | 19 | | 1 | | | 21 |
| 2004 | 2 | 19 | | | | | 21 |
| 2005 | 4 | 18 | | | | 1 | 23 |
| 2006 | 4 | 23 | 63 | | | 0 | 90 |
| 2007 | 2 | 4 | 7 | | | | 13 |
| 2008 | 2 | 2 | 0 | | | | 4 |
| 2009 | 0 | 4 | 0 | | | | 4 |
| 2010* | | 3 | | | | | 3 |

***Preliminary.**

**Table 7.6.1. (continued).**

**TUSK VIIg–k.**

| Year | France | Germany | Ireland | Norway | E & W | Scotland | Spain | Total |
|---|---|---|---|---|---|---|---|---|
| 1988 | n.a. | | - | - | 5 | - | | 5 |
| 1989 | 3 | | - | 82 | 1 | - | | 86 |
| 1990 | 6 | | - | 27 | 0 | + | | 33 |
| 1991 | 4 | | - | - | 8 | 2 | | 14 |
| 1992 | 9 | | - | - | 38 | - | | 47 |
| 1993 | 5 | | 17 | - | 7 | 3 | | 32 |
| 1994 | 4 | | 12 | - | 12 | 3 | | 31 |
| 1995 | 3 | | 8 | - | 18 | 8 | | 37 |
| 1996 | 3 | | 20 | - | 3 | 3 | | 29 |
| 1997 | 4 | 4 | 11 | - | | + | 0 | 19 |
| 1998 | 2 | 3 | 4 | - | | 1 | 0 | 10 |
| 1999 | 2 | 1 | - | - | | + | 6 | 8 |
| 2000 | 2 | | 5 | - | - | + | 6 | 13 |
| 2001 | 3 | | - | 9 | - | + | 2 | 14 |
| 2002 | 1 | | | | 1 | | 3 | 5 |
| 2003 | 1 | | 1 | | | | 1 | 3 |
| 2004 | 1 | | | | | | 0 | 1 |
| 2005 | 1 | | | | | | 1 | 2 |
| 2006 | 1 | | 1 | | | | 1 | 3 |
| 2007 | 1 | | | | | | 1 | 1 |
| 2008 | 0 | | | | | | 0 | 0 |
| 2009 | 0 | | 0 | | 0 | 0 | 0 | 0 |
| 2010* | | | | | | | | 0 |

***Preliminary.**

**TUSK VIIIa.**

| Year | E & W | France | Total |
|---|---|---|---|
| 1988 | 1 | n.a. | 1 |
| 1989 | - | - | - |
| 1990 | - | - | - |
| 1991 | - | - | - |
| 1992 | - | - | - |
| 1993 | - | - | - |
| 1994 | - | - | - |
| 1995 | - | - | - |
| 1996 | - | - | - |
| 1997 | + | + | + |
| 1998 | - | 1 | 1 |
| 1999 | - | - | 0 |
| 2000 | - | | - |
| 2001 | - | | - |
| 2002 | - | + | + |
| 2003 | - | - | - |
| 2004 | | 1 | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010* | | 4 | 4 |

***Preliminary.**

**Table 7.6.1. (continued).**

**Tusk, total landings by subareas or division.**

| Year | III | IVa | IVb | Vb1 | Vb2 | VIa | VIIa | VIIb,c | VIIg-k | VIIIa | All areas |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 61 | 4429 | | 4059 | 1606 | 2120 | | 17 | 5 | 1 | 12 298 |
| 1989 | 93 | 6418 | 4 | 3722 | 1400 | 2297 | 2 | 108 | 86 | | 14 130 |
| 1990 | 60 | 4254 | 5 | 5202 | 979 | 2256 | 4 | 155 | 33 | | 12 948 |
| 1991 | 84 | 4537 | 2 | 5170 | 1096 | 1543 | 2 | 52 | 14 | | 12 500 |
| 1992 | 85 | 4932 | 12 | 4399 | 992 | 1682 | 3 | 218 | 47 | | 12 370 |
| 1993 | 79 | 5141 | 14 | 2862 | 577 | 1223 | | 120 | 32 | | 10 048 |
| 1994 | 51 | 3375 | 7 | 3407 | 909 | 1262 | | 94 | 31 | | 9136 |
| 1995 | 42 | 3348 | 15 | 3347 | 631 | 1435 | 1 | 48 | 37 | | 8904 |
| 1996 | 44 | 3369 | 33 | 2728 | 582 | 1391 | | 58 | 29 | | 8234 |
| 1997 | 31 | 2272 | 38 | 2742 | 577 | 1261 | 1 | 75 | 19 | | 7016 |
| 1998 | 21 | 3387 | 66 | 2073 | 637 | 1281 | 1 | 33 | 10 | 1 | 7510 |
| 1999 | 29 | 2435 | 34 | 3517 | 447 | 539 | | 147 | 8 | 0 | 7156 |
| 2000 | 36 | 3260 | 116 | 2367 | 333 | 2011 | | 164 | 13 | | 8300 |
| 2001 | 57 | 3095 | 56 | 3526 | 469 | 1767 | 1 | 263 | 14 | | 9248 |
| 2002 | 50 | 2961 | 71 | 2722 | 281 | 1124 | | 66 | 5 | | 7280 |
| 2003 | 51 | 1997 | 8 | 2733 | 559 | 1128 | | 21 | 3 | | 6500 |
| 2004 | 45 | 1666 | 23 | 3536 | 107 | 726 | | 21 | 1 | | 6125 |
| 2005 | 44 | 1826 | 7 | 3272 | 360 | 1019 | | 23 | 2 | | 6553 |
| 2006 | 29 | 2159 | 32 | 3559 | 317 | 1059 | | 90 | 3 | | 7248 |
| 2007 | 21 | 2180 | 15 | 3431 | 344 | 1085 | | 13 | 1 | | 7090 |
| 2008 | 44 | 2140 | 71 | 3689 | 61 | 1346 | | 4 | 0 | | 7355 |
| 2009 | 39 | 2267 | 17 | 3101 | 164 | 1242 | | 4 | 0 | | 6834 |
| 2010* | **18** | **1857** | **14** | **4854** | **127** | **1196** | | **3** | **0** | **4** | 8073 |

***Preliminary.**

**Table 7.6.2. Estimated mean cpue ([kg/hook]x1000) based on logbook data along with its standard error (*se*) and number of catches sampled for tusk.**

| Tusk | Area | IVA | IVB | VB | VIA | VIIC | XII | XIVA | XIVB |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | cpue | 35,7 | 18,1 | 56,8 | 48 | 62,7 | 47,2 | 74,6 | 40,9 |
| | n | 664 | 17 | 405 | 430 | 60 | 17 | 6 | 84 |
| | se | 1,2 | 7,2 | 1,5 | 1,4 | 3,8 | 7,2 | 12,0 | 3,2 |
| 2001 | cpue | 32,6 | 16,5 | 50,2 | 40,7 | 4,8 | 28,2 | | 48,5 |
| | n | 721 | 2 | 608 | 444 | 25 | 97 | | 48 |
| | se | 0,8 | 12,4 | 1,0 | 1,1 | 4,6 | 2,3 | | 3,3 |
| 2002 | cpue | 25 | | 50,1 | 45,9 | | | | 85,1 |
| | n | 649 | | 473 | 186 | | | | 70 |
| | se | 0,9 | | 1,0 | 1,6 | | | | 2,6 |
| 2003 | cpue | 29,8 | 7,22 | 53,7 | 36,1 | | 6,47 | | 49,7 |
| | n | 496 | 13 | 514 | 300 | | 7 | | 42 |
| | se | 0,9 | 5,6 | 0,9 | 1,2 | | 7,6 | | 3,1 |
| 2004 | cpue | 49,3 | | 59,3 | 50,3 | 7,05 | | | 17,9 |
| | n | 437 | | 693 | 307 | 23 | | | 60 |
| | se | 1,2 | | 0,9 | 1,4 | 5,2 | | | 3,2 |
| 2005 | cpue | 36,4 | | 66,5 | 59,1 | 15,9 | | | 8,7 |
| | n | 329 | | 374 | 368 | 7 | | | 47 |
| | se | 1,8 | | 1,7 | 2,7 | 12,0 | | | |
| 2006 | cpue | 44,6 | | 98,9 | 106 | | | | |
| | n | 664 | | 159 | 247 | | | | |
| | se | 1,6 | | 3,2 | 2,6 | | | | |
| 2007 | cpue | 51,2 | | 64,7 | 66,1 | 5,14 | | | |
| | n | 583 | | 353 | 249 | 10 | | | |
| | se | 1,2 | | 1,5 | 2,4 | 8,8 | | | |
| 2008 | cpue | 59,4 | | 78,9 | 126 | | | | 59,3 |
| | n | 395 | | 188 | 137 | | | | 34 |
| | se | 1,83 | | 2,66 | 3,11 | | | | 6,25 |
| 2009 | cpue | 32.3 | | 125 | 118 | | | | 70.4 |
| | n | 663 | | 57 | 99 | | | | 20 |
| | se | 1.81 | | 6.16 | 4.67 | | | | 10.4 |

**Table 7.6.3. Tusk in Vb (Faroes). Abundance index from spring and summer survey.**

| | Spring survey | | | Summer survey | | |
|---|---|---|---|---|---|---|
| | Catch (kg) | Effort (h) | cpue (kg/h) | Catch (kg) | Effort (h) | cpue (kg/h) |
| 1994 | 429 | 91 | 4.71 | | | |
| 1995 | 300 | 91 | 3.29 | | | |
| 1996 | 142 | 100 | 1.42 | 467 | 200 | 2.33 |
| 1997 | 331 | 98 | 3.38 | 311 | 200 | 1.56 |
| 1998 | 261 | 99 | 2.63 | 463 | 201 | 2.31 |
| 1999 | 143 | 100 | 1.43 | 157 | 199 | 0.79 |
| 2000 | 104 | 100 | 1.04 | 163 | 200 | 0.81 |
| 2001 | 198 | 100 | 1.98 | 331 | 200 | 1.66 |
| 2002 | 245 | 100 | 2.45 | 167 | 199 | 0.84 |
| 2003 | 302 | 100 | 3.02 | 123 | 200 | 0.62 |
| 2004 | 201 | 100 | 2.01 | 708 | 200 | 3.54 |
| 2005 | 210 | 100 | 2.10 | 968 | 200 | 4.84 |
| 2006 | 386 | 100 | 3.86 | 427 | 200 | 2.14 |
| 2007 | 391 | 100 | 3.91 | 391 | 199 | 1.97 |
| 2008 | 204 | 99 | 2.06 | 847 | 200 | 4.24 |
| 2009 | 378 | 100 | 3.78 | 712 | 200 | 3.56 |

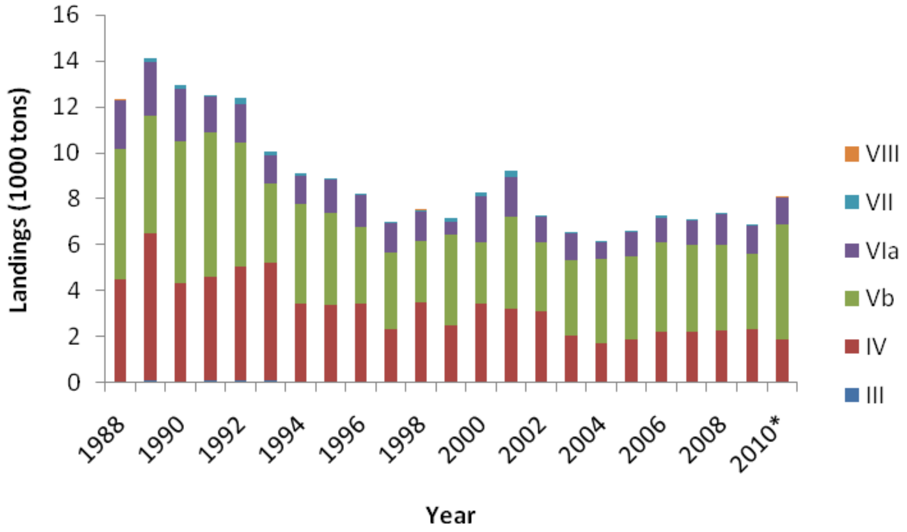



**Figure 7.6.1. Landings of tusk per year for the period 1988–2010.**

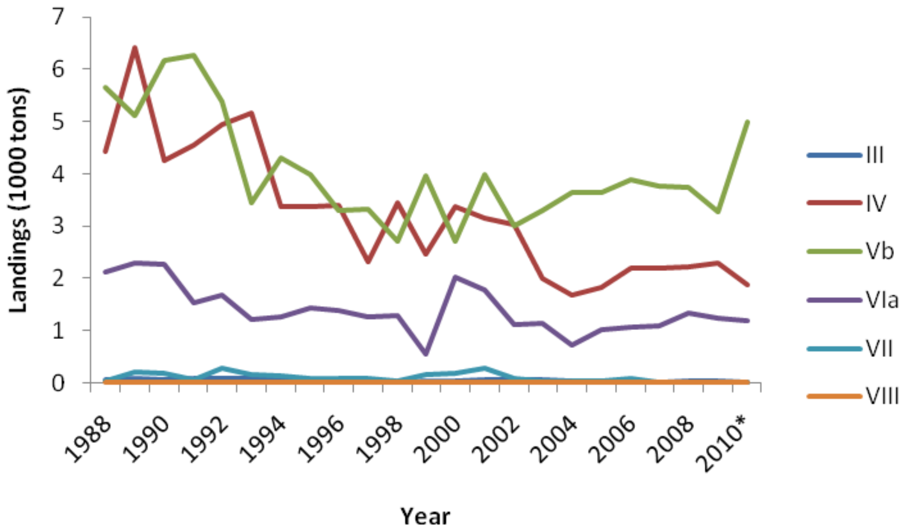



**Figure 7.6.2. Landings of tusk in each area for the period 1988–2010.**

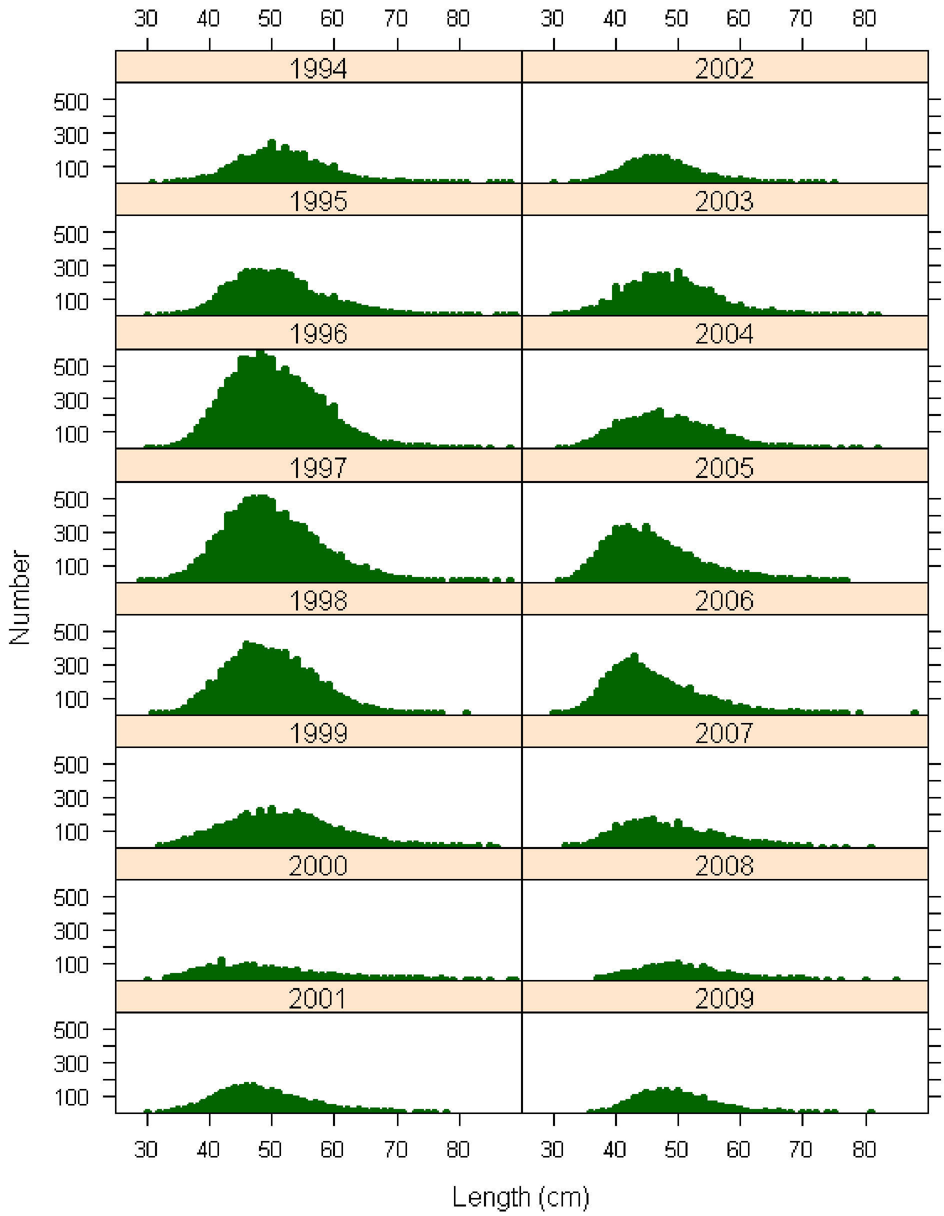



**Figure 7.6.3. Tusk in Vb (Faroes). Length distribution from the Faroes groundfish survey.**

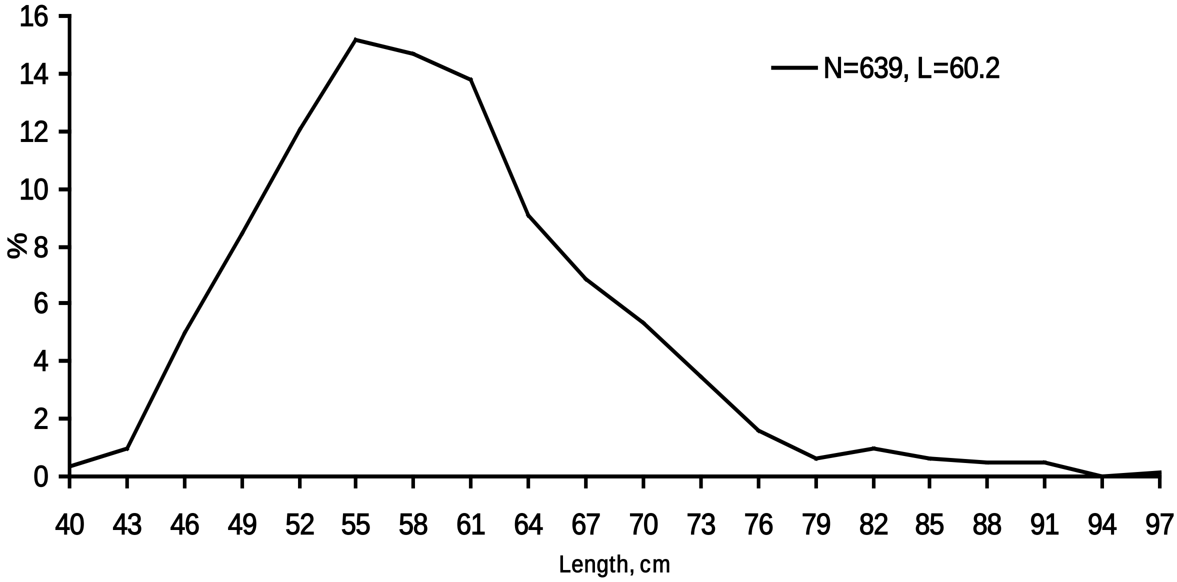



**Figure 7.6.4. Length composition of tusk in longline catches in the southern part of Faroes Fishing Zone (Division Vb) in June–July 2008.**

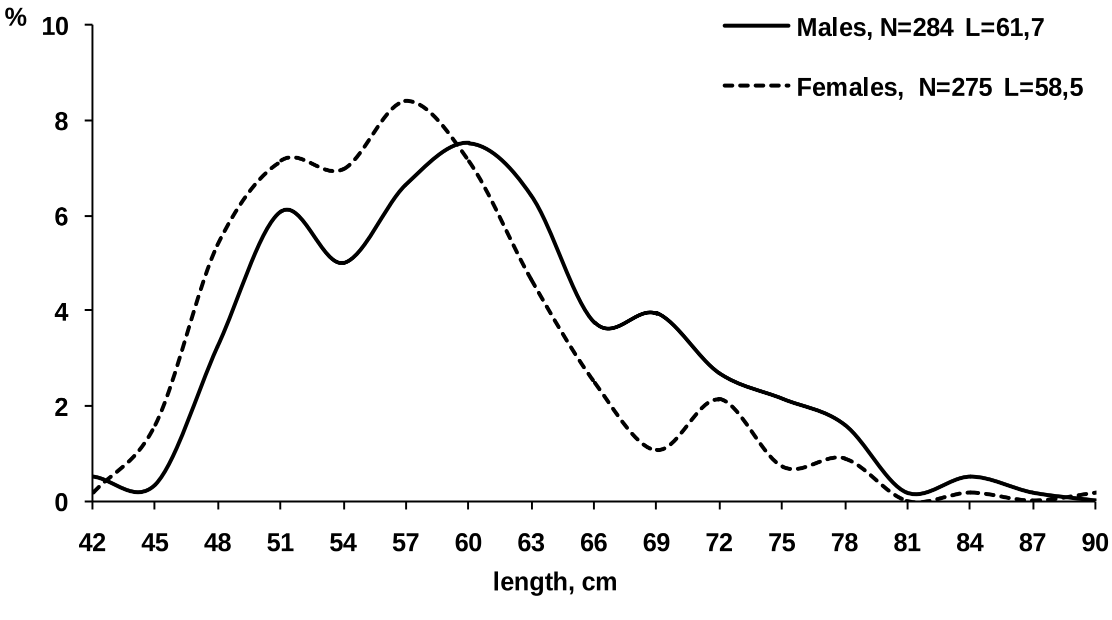



**Figure 7.6.5. Length composition of tusk in Faroes Fishing Zone in June–August 2009 (from Russian investigations).**

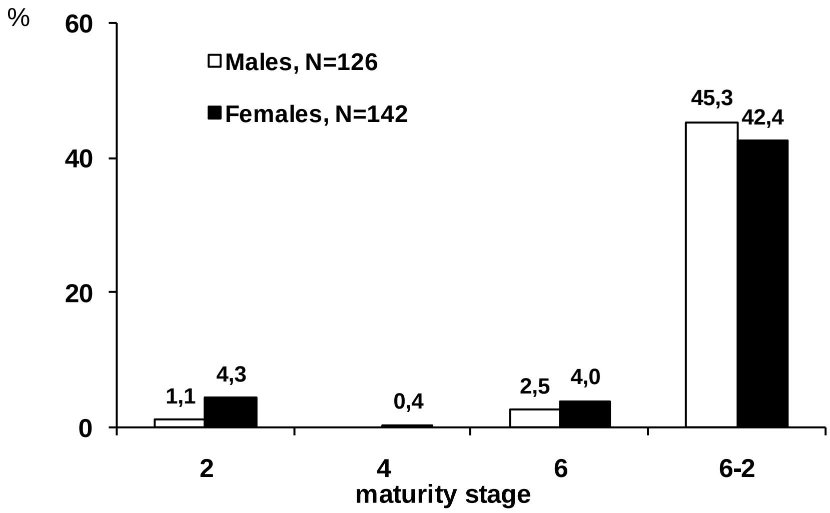



**Figure 7.6.6. Maturity of tusk in Faroes Fishing Zone in June–August 2009.**

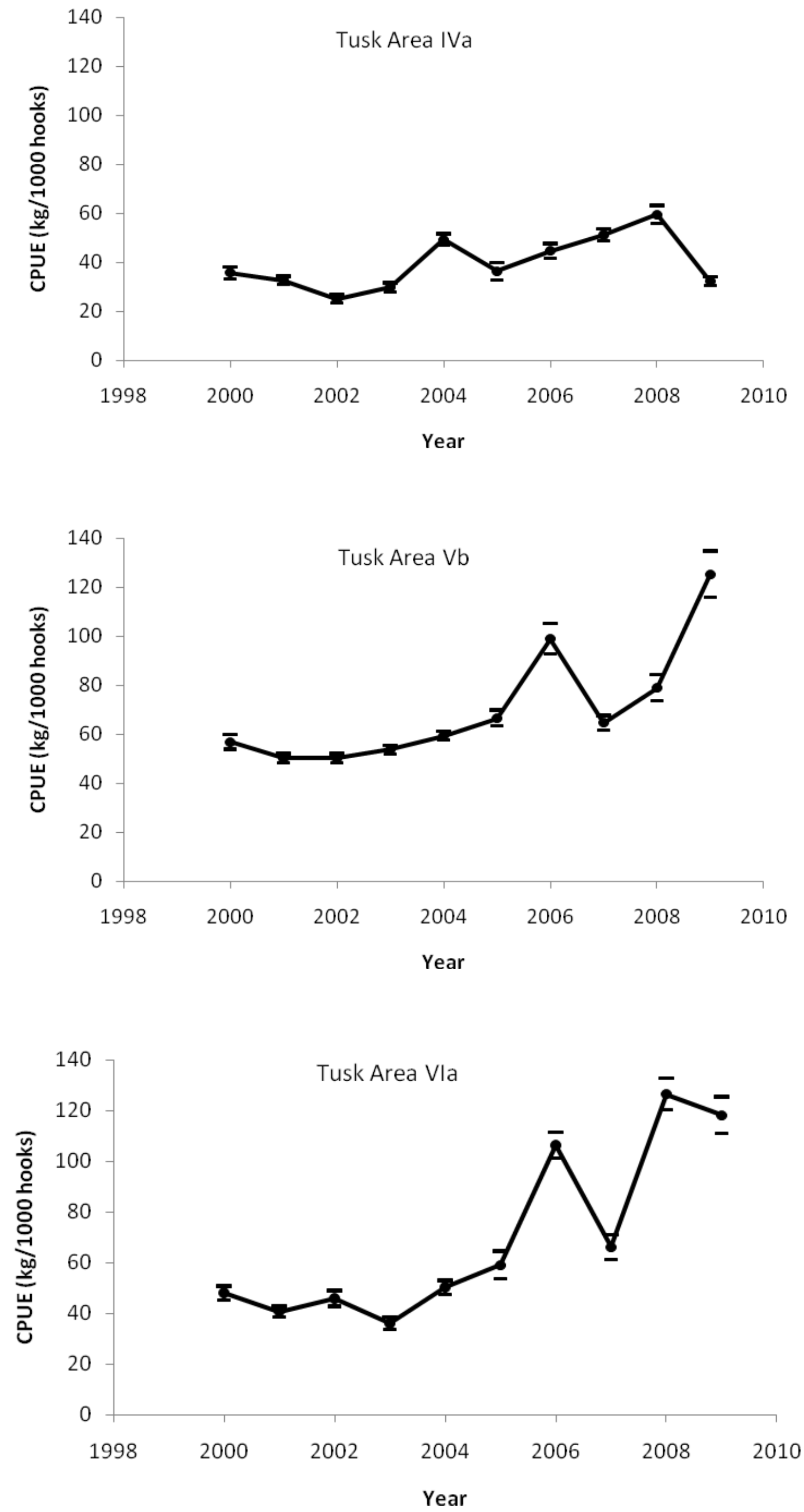



**Figure 7.6.7. Estimates of cpue (kg/1000 hooks) of tusk in Subareas IVa ,Vb and VIa based on skippers' logbooks (during the period 2000–2009.The bars denote the 95% confidence interval.**

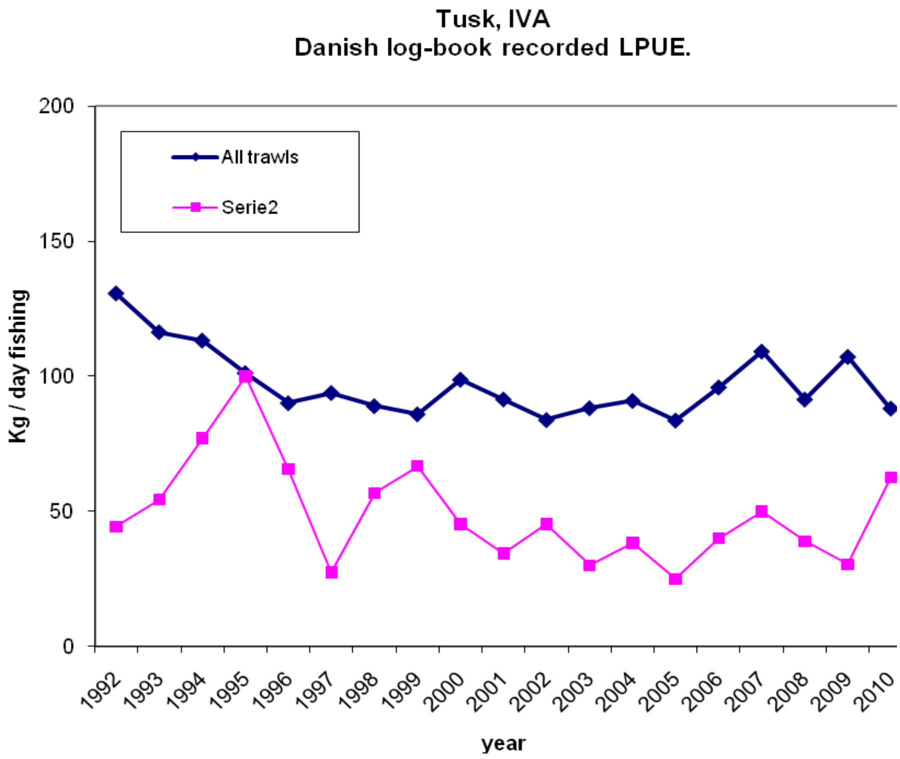



**Figure 7.6.8. Tusk in IVa. Cpue of tusk for Danish. Based on logbook data.**

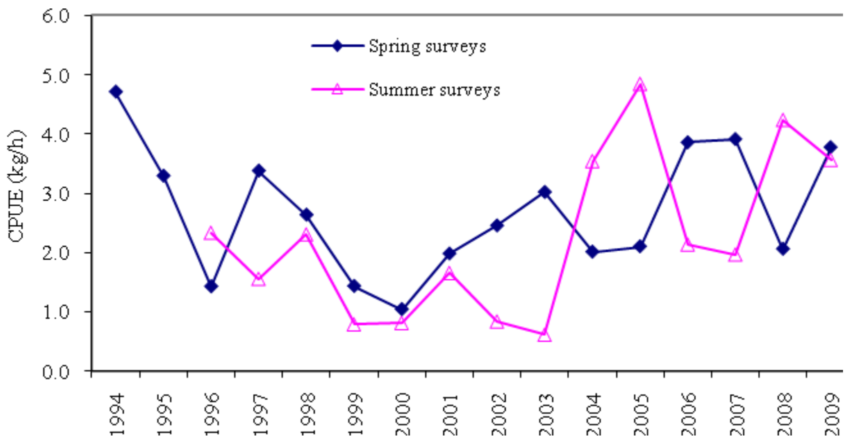



**Figure 7.6.9. Tusk in Vb (Faroes). Cpue in spring and autumn bottom-trawl survey.**

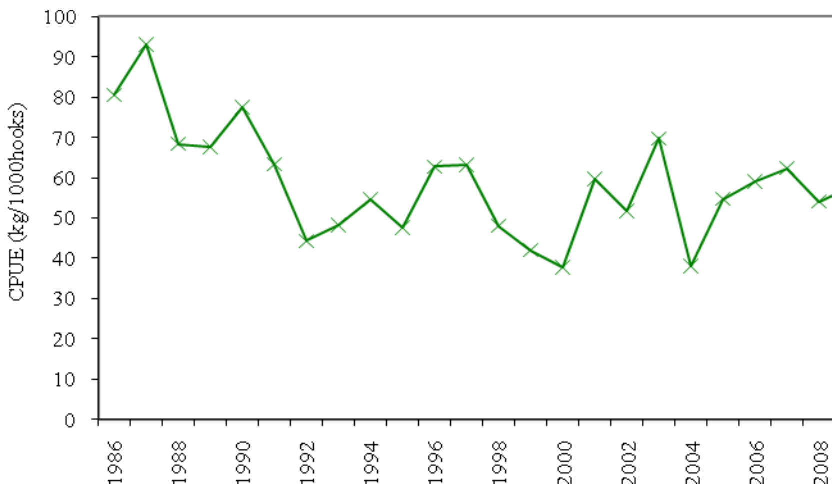



**Figure 7.6.10. Tusk in Vb (Faroes). Cpue (kg/1000hooks) from longliners >100 GRT.**

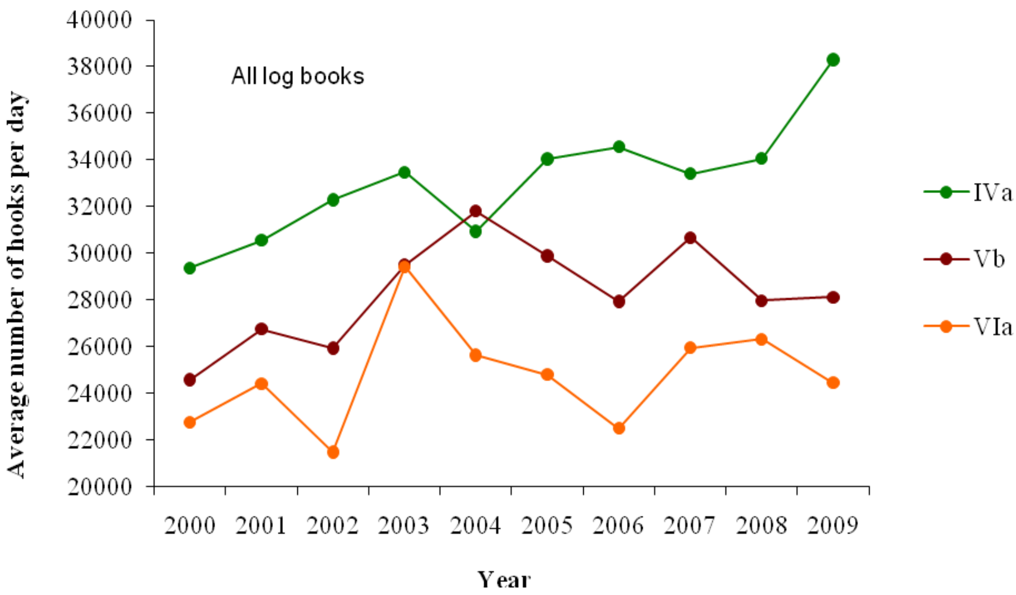



**Figure 7.6.11. Average number of hooks the Norwegian longliner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000–2009 in the fishery for tusk, ling and blue ling.Data from 2010 was not available to the Working Group.**

# 8 Greater silver smelt

## 8.1 Stock description and management units

The current ICES structure for greater silver smelt is that ICES Subareas I, II, IV, VI, VII, VIII, IX, X, XII and XIV and Divisions IIIa and Vb, are treated as a single assessment unit. Only the greater argentine around Iceland (Division Va) is treated as a separate assessment unit.

During the WKDEEP 2010 meeting (Benchmark), acknowledged that there was considerable uncertainty over stock structure in the Northeast Atlantic and recommended for further appraisal:

- Oceanographic conditions;
- Genetic characteristics;
- Morphometric and meristic characters.

Landings of greater silver smelt in NE Atlantic are shown in Figure 8.1.1.

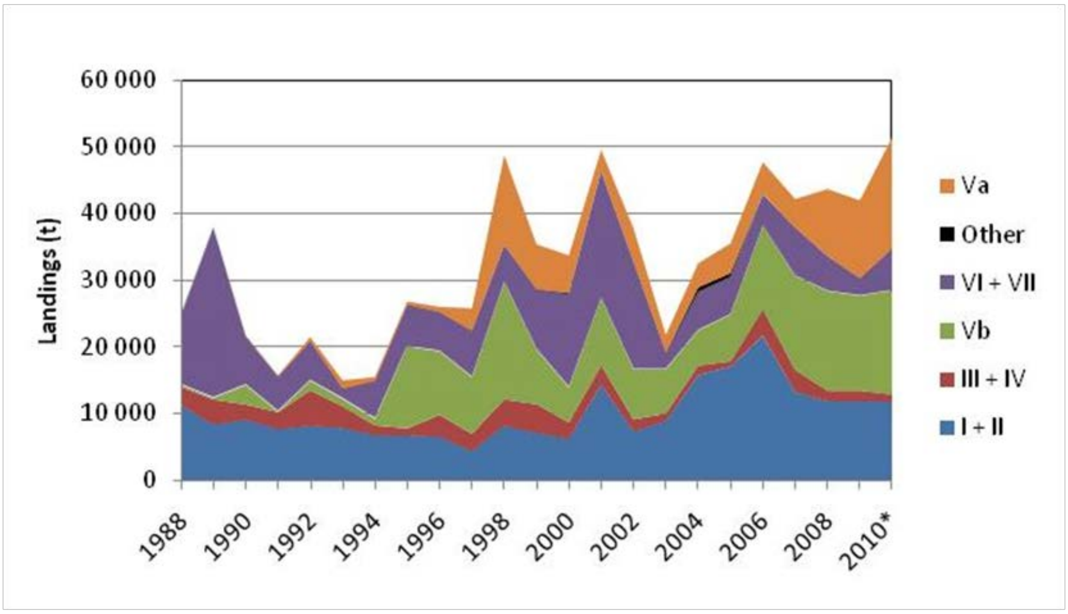



**Figure 8.1.1. Landings of greater silver smelt in the NE Atlantic, by ICES areas.**

## 8.2 Greater silver smelt (*Argentina silus*) in Division Va

### 8.2.1 The fishery

Greater silver smelt is mostly fished along the south and southwest coast of Iceland, at depths between 500 and 800 m. Greater silver smelt has been caught in bottom trawls for years as a bycatch in the redfish fishery. Only small amounts were reported prior to 1996 as most of the greater silver smelt was discarded. However discarding is not considered as significant because of the relatively large mesh-size used in the redfish fishery. Since 1997, a directed fishery for greater silver smelt has been ongoing and the landings have increased significantly (Table. 8.2.1).

#### 8.2.1.1 Fleets

In the period from 1996–2010 between 20–36 trawlers reported catches of greater silver smelt in Va (Table 8.2.2). The trawlers participating in the greater silver smelt fishery also target redfish (*Sebastes marinus* and *S. mentella*) and to lesser extent Greenland halibut and blue ling.

The number of hauls has varied greatly but seems to be increasing in recent years. In most years between 70–90% of the greater silver smelt catches are taken in hauls were the species is more than 50% of the catch.

#### 8.2.1.2 Targeting and mixed fisheries issues in the Greater silver smelt fishery in Va

##### 8.2.1.2.1 Targeting of Greater silver smelt by the fleet in Va

In Figure 8.2.1 an attempt is made to plot the targeting of the greater silver smelt fishery in Va during 1993–2010 by looking at the relationship between the proportion of the species in each haul/set and the proportion of the annual catch. In short, if the line rises rapidly up the $y$-axis (proportion of annual catches), the fishery can be termed mainly a bycatch fishery. On the other hand if the line crawls along the $x$-axis (proportion of species in set) then rises rapidly the fishery can be termed a directed-fishery.

At a quick glance of Figure 8.2.1 there does not seem to be much changes in the targeting of greater silver smelt except maybe for the year 1998 when the species seems to have been targeted directly. The main points worth noting in Figure 8.2.1 is that the greater silver smelt fishery before 1997 can be considered a bycatch fishery, and post-1998, as a mixed/directed fishery. The second point worth noting is the relative stability in the targeting of greater silver smelt since 2004, where around 70% of the annual catch is taken in hauls where greater silver smelt was more than 50% of the catch in a given haul.

##### 8.2.1.2.2 Mixed fisheries issues: species composition in the fishery

Redfish spp. (*Sebastus marinus* and *S. mentella*) are the main species when it comes to the mixed fishery of greater silver smelt. Other species of lesser importance are Greenland halibut, blue ling and ling. Other species than these rarely exceed 10% of the bycatch in the greater silver smelt fishery in Va.

#### 8.2.1.3 Temporal and spatial development of the fishery

In this subsection an overview of catches in time and space is given. That is how the greater silver smelt catch is taken over the year and from where it is mainly taken.

##### 8.2.1.3.1 Catches by month

Table 8.2.3 gives an overview of the proportional catches by month of greater silver smelt in Va. It should be noted that in 1998 a ban on targeting greater silver smelt was put in effect in July as catches had reached more than four times previous years landings. The fishery has changed from taking mainly place in summer to be spread out over the whole year. In June 2010 the Ministry of Fisheries and Agriculture withdrew exploratory fishing licences for fishing for greater silver smelt in Va. This resulted in a near drop in landings which then resumed at the start of the 2010/2011 fishing year.

#### 8.2.1.3.2 Spatial distribution of catches through time

Spatial distribution of catches in 1996–2010 is presented in Figure 8.2.2. With the exception of 1996 most of the catches have been from the southern edge of the Icelandic shelf. However in recent years there has been a gradual increase in the proportion caught in the western area and even in the northwestern area. The reason for this is the fleet is focusing on redfish and Greenland halibut but then takes few hauls of greater silver smelt in the area.

## 8.2.2 Landings trends

Landings of greater silver smelt are presented in Table 8.2.1. Since directed fishery started in 1997–1998, the landings have increased from 800 t in 1996 to 13 000 t in 1998. Between 1999 and 2007 catches varied between 2600 to 6700 t. Since 2008 landings have increased substantially, from 4200 t in 2007 to almost 16500 t in 2010.

## 8.2.3 ICES Advice

The latest advice from ICES ACOM in May 2010 states: *Reduce exploitation rates of the fishery to levels that occurred between 2001 and 2007.*

## 8.2.4 Management

The greater silver smelt fishery is at present not managed by quotas but rather as an exploratory fishery subject to licensing since 1997. Detailed description of regulations on the fishery of greater silver smelt in Va is given in the Stock Annex.

## 8.2.5 Data available

### 8.2.5.1 Landings and discards

Landings by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Discarding is banned in Icelandic waters and currently there is no available information on greater silver smelt discards. It is however likely that unknown quantities of greater silver smelt were discarded prior to 1996.

### 8.2.5.2 Length compositions

Table 8.2.4 gives the number of samples and measurements available for calculations of catch in numbers of Greater Silver Smelt in Va. Mean length in the catches has decreased since 1997 from around 45 cm down to 38 cm in 2008, however in 2009-10 mean length increased slightly to approx 39 cm (Figure 8.2.3). The reasons for this may either be increased recruitment or depletion by the fishery.

### 8.2.5.3 Age compositions

Table 8.2.4 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in Va. At the WKDEEP-2010 meeting, estimates of catch in numbers were presented for 1997, 1998 and 2006–2008. A continuous downward trend in mean age in the commercial catches was noted. Preliminary estimates of catch in numbers from 2009 indicate that mean age in the catches is still decreasing (Figure 8.2.4). Estimates of catch in numbers are given in Table 8.2.5. Due to technical reasons estimates of catch in numbers from 2010 were not presented at the meeting.

No marked changes can be observed in mean weight-at-age from commercial catches between 1997–1998 and 2006–2008 (Table 8.2.6).

#### 8.2.5.4 Maturity and natural mortality

Estimates of maturity ogives of greater silver smelt in Va were presented at the WKDEEP-2010 meeting for both age and length (WKDEEP-2010-GSS-04) using data collected in the Icelandic autumn survey (See Stovk Annex for details). Males tend to on average to mature at a slightly higher age at 6.5 compared to 5.6 years for females but at a similar length as females 35.3 cm. Most of the greater silver smelt caught in commercial catches in Va is mature. No information exists on natural mortality of greater silver smelt in Va.

#### 8.2.5.5 Catch, effort and research vessel data

##### Catch per unit of effort and effort data from the commercial fleets

At WKDEEP-2010 a glm cpue series was presented (WKDEEP-2010-GSS-05), however because of strong residual patterns the group concluded that the glm-cpue series was not suitable to use as an indicator of stock trends.

The cpue is not considered to represent changes in stock abundance as the fishery is mostly controlled by market factors, oil prices and quota status in other species, mainly redfish.

##### Icelandic survey data

**Indices:** The Icelandic spring ground-fish survey, which has been conducted annually in March since 1985, gives trends on fishable biomass of many exploited stocks on the Icelandic fishing grounds. In total, about 550 stations are taken annually at depths down to 500 m. The survey area does not cover the most important distribution area of the greater silver smelt fishery in Va and is therefore not considered representative of stock biomass. However the survey may be indicative of recruitment but the data have not been explored in sufficient detail. In addition, the autumn survey was commenced in 1996 and expanded in 2000. A detailed description of the autumn ground-fish survey is given in the Stock Annex for greater silver smelt in Va. The survey is considered representative of stock biomass of greater silver smelt since it was expanded in 2000.

Greater silver smelt is among the most difficult demersal fish stocks to get reliable information on from bottom trawl surveys. This is in large part due to the fact that most of the smelt caught in the survey is taken in few but relatively large hauls. This can result in very high indices with large variances particularly if the tow-station in question happens to be in a large stratum with relatively few tow-stations. In an attempt to reduce variance, Winsorized-indices were presented at the WKDEEP-2010 and the Group concluded that they should be presented along with standard indices when giving advice for greater silver smelt in Va. A detailed description of index calculation and the Winsorization is given in the Stock Annex. The ADGD-2010 however decided to base the advice only on the Winsorized indices as they were considered a better and more conservative estimate of stock biomass.

For calculation of survey indices the same stratification scheme has been used for both the Spring (March) and the Autumn (October) surveys. However because the Autumn survey has fewer stations and a wider area, the stratification scheme results in relatively few stations in each strata, often leading to high CV estimates.

In 2008 the whole stratification scheme for the Autumn survey was revised, the number of strata was reduced from 74 down to 34 and the average size of the strata subsequently increased. This results in more tow-stations per strata. It should be noted that both stratification schemes were designed mostly with cod in mind. However the main feature of the schemes is depth stratification and similar oceanographic conditions in each stratum. At the meeting survey indices estimated from the re-stratification were presented (Thordarson WD-01). The group considered the revised indices a step forward and that the data from the Icelandic autumn survey should in the future be processed using the revised stratification scheme.

In Figure 8.2.5 all three versions of the indices from the Autumn survey are presented. The Figure shows trends in total biomass, biomass at depths less than 400 m, biomass at depths greater than 400 m and finally a recruitment index which is the abundance of greater silver smelt less than 25 cm.

In Figure 8.2.6 both the winsorized and the revised length disaggregated indices are presented for the 'Total' region which is then divided by the 400 m depth contour. The main thing to note is that hardly any silver smelt smaller than 30 cm are found at depths greater than 400 m. Few fish longer than 45 cm are caught at depths above 400 m.

**Spatial distribution as observed in surveys:** Changes in the distribution of greater silver smelt in Va as observed from the Autumn survey are presented in Figure 8.2.7. In general there seems to be a slight increase in biomass in the north-western part of the shelf and on the Faroe-Iceland ridge.

### 8.2.6 Data analyses

The information presented on greater silver smelt in Va gives a contradictory message on the state of the assessment unit. On one hand the biological information from the commercial catches shows a clear downward trend in terms of mean length and mean age. On the other hand the autumn survey gives the impression that the biomass may be increasing.

In the WGDEEP-2008 Report the possible explanations for the decrease in mean length form the catches were listed as:

- Change to a smaller mesh size in 2000;
- Changes in the depth distribution of catches;
- Overfishing of large fish.

It is unlikely that the change in mesh size in 2000 accounts for these changes as a similar shift is seen in the age distribution from the autumn survey as in the commercial catches. It should however be noted that the age data from the autumn survey in 1998 is from before the expansion of the survey, however if otoliths from comparable areas are compared between 1998 and 2007–2009 the trend is apparent. The number of comparable otoliths is however low and no firm conclusions can be drawn from the comparisons. Changes in the depth distribution are not significant enough to explain the shift; there has also been a slight shift to catch greater silver smelt in deeper waters in 2008–2009. Overfishing of large fish may therefore be the most plausible explanation however in the absence of an analytical assessment it is difficult to evaluate.

The trends in the autumn survey indicate that biomass and recruitment may be increasing. However greater silver smelt is difficult to assess in a trawl survey. The three approaches to calculate survey indices (winsorized, un-winsorized and revised) do in most cases show the same trend. There is though considerable difference between the indices from the original stratification scheme and the revised one in recent years. The indices from the original stratification show an increase in biomass from 2006 to 2009 (Total and >400 m) then a decrease in 2010, however the revised indices decreased from 2008 (Total) and from 2007 in the case of the exploitable biomass (>400 m; Figure 8.2.5). In last year's report there was inconsistency between the recruitment indices as the un-winsorized index showed a continuous upward trend whereas the winsorized index has not changed at all during the survey period. It was discovered at this meeting the reason was an error in a script used for plotting of the indices. There is not much trend in the recruitment index (abundance <25 cm) but recruitment does seem to have been slightly higher after 2004 than before.

In Figure 8.2.8 estimates of relative fishing mortality ($F_{proxy}$) are presented. It seems that the $F_{proxy}$ decreased between 2000 and 2004. The $F_{proxy}$ estimates all show significant increase from 2009 to 2010, the reason is the high landing figures and decreased survey indices.

### 8.2.7 Comments on the assessment

At the WKDEEP-2010 an analytical assessment was attempted on greater silver smelt in Va. The model (Colraine) did not capture the trends in the data and it was therefore concluded that it was not suitable to be used as basis for Advice.

No analytical assessment was attempted at the meeting.

#### Response to ICES WGDEEP 2010 Report Review Group technical minutes

***Reviewer 2 Technical comments:***

*Changes in length or age frequency could also be due to spatial change in the fishery?*

In theory this could be the case, however it seems from samples collected in the west and north (where the fishery has expanded to) the greater silver smelt is larger and older than in the south and southeast.

*Difficult to compare the fishery-derived indices (cpue, length–age frequencies) with those from the autumn survey (which is the reference here), given exploitation shifts and the lack of inter-calibration/standardization to account for it;*

These so called exploitation shifts are not the main issue here; the fleet has simply followed the increase in the area occupied by greater silver smelt. It is clearly stated and explained that cpue series is not considered an indicator of stock trends.

*The trends in recruitment are different depending on whether the series is winsorised or not. Can we qualify which series should be considered or not?*

This was addressed in Section 8.2.6.

*It would be useful to have the mean or the median of the length distribution derived from the autumn survey in Figure 8.2.8. Eye-balling the figure gives me the impression of a slight increase in ( or at least relatively stable) mean length, but that would need to be confirmed.*

A good point but not implemented at the WGDEEP-2011 meeting due to time constraints. This will be included at the WGDEEP-2012 meeting.

***Reviewers 1 conclusions:***

*The basis for the increase in the abundance comes from the survey; however this has not covered the entire area of distribution of the fish as evidenced by the SW fishery in the late 1990s.*

There is no basis for this statement in the report. The Icelandic autumn survey covers the entire distributional range of greater silver smelt in Va. If the reviewer is stating that the survey did not go back to 1997 but only commenced in 2000 then that is right.

*It may be possible that there has been some movement of fish from outside the survey area to inside, which is reflected as an increase in abundance by the survey, but which may not necessarily be the case.*

Theoretically this may be the case but it should be noted that all available data on the ecology of greater silver smelt supports the notion that the juveniles of the species migrate from shallower water to deeper water as they grow.

#### *8.1.8 Management considerations*

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME. However, there is conflicting information in the data and no suitable methods were identified.

**Table 8.2.1. Greater silver smelt in Va. Nominal landings in 1988–2009.**

| Year | Landings |
|---|---|
| 1988 | 206 |
| 1989 | 8 |
| 1990 | 112 |
| 1991 | 247 |
| 1992 | 657 |
| 1993 | 1255 |
| 1994 | 613 |
| 1995 | 492 |
| 1996 | 808 |
| 1997 | 3367 |
| 1998 | 13 387 |
| 1999 | 6704 |
| 2000 | 5657 |
| 2001 | 3043 |
| 2002 | 4960 |
| 2003 | 2686 |
| 2004 | 3637 |
| 2005 | 4481 |
| 2006 | 4775 |
| 2007 | 4226 |
| 2008 | 8778 |
| 2009 | 10 829 |
| 2010 | 16 428 |

**Table. 8.2.2. Greater silver smelt in Va. Information on the fleet reporting catches of greater silver smelt.**

| Year | Number Trawlers | Number Hauls | Reported catch | No. Hauls which gss >50% of catch | Proportion of reported catch in hauls were gss> 50% |
|---|---|---|---|---|---|
| 1996 | 22 | 298 | 250 | 32 | 0.42 |
| 1997 | 26 | 854 | 2257 | 397 | 0.854 |
| 1998 | 39 | 2587 | 11 132 | 1998 | 0.958 |
| 1999 | 24 | 1451 | 4456 | 858 | 0.877 |
| 2000 | 23 | 1263 | 3491 | 678 | 0.844 |
| 2001 | 26 | 767 | 1577 | 264 | 0.724 |
| 2002 | 32 | 1134 | 3127 | 512 | 0.782 |
| 2003 | 30 | 1127 | 1965 | 255 | 0.541 |
| 2004 | 27 | 1017 | 2688 | 345 | 0.707 |
| 2005 | 30 | 1368 | 3520 | 365 | 0.734 |
| 2006 | 31 | 1542 | 3725 | 402 | 0.72 |
| 2007 | 27 | 1260 | 3441 | 464 | 0.761 |
| 2008 | 31 | 3103 | 8407 | 865 | 0.665 |
| 2009 | 34 | 3410 | 10 197 | 1018 | 0.697 |
| 2010 | 36 | 4697 | 16 261 | 1780 | 0.720 |

**Table. 8.2.3. Greater silver smelt in Va. Proportion of annual catches by month.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 0.110 | 0.165 | 0.021 | 0.080 | 0.567 | 0.011 | 0.005 | 0.012 | 0.000 | 0.000 | 0.017 | 0.014 |
| 1994 | 0.000 | 0.027 | 0.003 | 0.057 | 0.608 | 0.250 | 0.006 | 0.023 | 0.007 | 0.015 | 0.005 | 0.000 |
| 1995 | 0.140 | 0.060 | 0.002 | 0.093 | 0.205 | 0.007 | 0.127 | 0.136 | 0.004 | 0.009 | 0.074 | 0.143 |
| 1996 | 0.154 | 0.054 | 0.081 | 0.119 | 0.045 | 0.016 | 0.004 | 0.000 | 0.115 | 0.049 | 0.188 | 0.175 |
| 1997 | 0.038 | 0.020 | 0.004 | 0.009 | 0.006 | 0.175 | 0.150 | 0.125 | 0.028 | 0.049 | 0.278 | 0.120 |
| 1998 | 0.036 | 0.020 | 0.021 | 0.047 | 0.276 | 0.489 | 0.095 | 0.009 | 0.003 | 0.002 | 0.002 | 0.001 |
| 1999 | 0.021 | 0.038 | 0.009 | 0.187 | 0.239 | 0.274 | 0.071 | 0.012 | 0.033 | 0.051 | 0.048 | 0.018 |
| 2000 | 0.079 | 0.059 | 0.031 | 0.055 | 0.155 | 0.263 | 0.066 | 0.014 | 0.056 | 0.073 | 0.109 | 0.041 |
| 2001 | 0.050 | 0.082 | 0.060 | 0.000 | 0.080 | 0.228 | 0.088 | 0.025 | 0.064 | 0.177 | 0.071 | 0.073 |
| 2002 | 0.035 | 0.139 | 0.093 | 0.138 | 0.134 | 0.088 | 0.126 | 0.027 | 0.026 | 0.049 | 0.060 | 0.085 |
| 2003 | 0.149 | 0.069 | 0.077 | 0.149 | 0.029 | 0.047 | 0.044 | 0.022 | 0.057 | 0.088 | 0.159 | 0.109 |
| 2004 | 0.113 | 0.166 | 0.116 | 0.243 | 0.011 | 0.014 | 0.017 | 0.028 | 0.070 | 0.113 | 0.083 | 0.026 |
| 2005 | 0.065 | 0.176 | 0.060 | 0.105 | 0.048 | 0.118 | 0.022 | 0.106 | 0.044 | 0.106 | 0.083 | 0.067 |
| 2006 | 0.101 | 0.081 | 0.055 | 0.154 | 0.191 | 0.073 | 0.027 | 0.041 | 0.036 | 0.097 | 0.096 | 0.049 |
| 2007 | 0.244 | 0.020 | 0.028 | 0.178 | 0.252 | 0.085 | 0.029 | 0.029 | 0.037 | 0.039 | 0.045 | 0.015 |
| 2008 | 0.042 | 0.049 | 0.063 | 0.069 | 0.057 | 0.047 | 0.067 | 0.117 | 0.083 | 0.227 | 0.119 | 0.060 |
| 2009 | 0.158 | 0.051 | 0.046 | 0.016 | 0.019 | 0.003 | 0.011 | 0.043 | 0.130 | 0.173 | 0.215 | 0.134 |
| 2010 | 0.102 | 0.107 | 0.111 | 0.131 | 0.038 | 0.009 | 0.007 | 0.009 | 0.092 | 0.136 | 0.139 | 0.119 |

**Table 8.2.4. Greater silver smelt in Va. Available data for estimation of catch in numbers.**

| Year | No. Otoliths samples | No. Otoliths aged | No. Length samlpes | No. Length measurements | Landings (tonnes) |
|---|---|---|---|---|---|
| 1986 | 0 | 0 | 0 | 0 | 53 |
| 1987 | 1 | 93 | 1 | 100 | 42 |
| 1988 | 0 | 0 | 0 | 0 | 206 |
| 1989 | 21 | 266 | 0 | 0 | 8 |
| 1990 | 0 | 0 | 0 | 0 | 112 |
| 1991 | 0 | 0 | 2 | 335 | 247 |
| 1992 | 0 | 0 | 0 | 0 | 657 |
| 1993 | 0 | 0 | 2 | 612 | 1255 |
| 1994 | 1 | 95 | 6 | 1003 | 613 |
| 1995 | 1 | 91 | 2 | 330 | 492 |
| 1996 | 0 | 0 | 0 | 0 | 808 |
| 1997 | 19 | 985 | 45 | 4863 | 3367 |
| 1998 | 24 | 890 | 141 | 14 911 | 13 387 |
| 1999 | 2 | 82 | 58 | 4163 | 6704 |
| 2000 | 0 | 0 | 27 | 2967 | 5657 |
| 2001 | 1 | 17 | 10 | 489 | 3043 |
| 2002 | 4 | 127 | 20 | 2220 | 4960 |
| 2003 | 0 | 0 | 63 | 5095 | 2686 |
| 2004 | 3 | 84 | 34 | 996 | 3637 |
| 2005 | 0 | 0 | 49 | 3708 | 4481 |
| 2006 | 10 | 465 | 29 | 4186 | 4775 |
| 2007 | 8 | 272 | 14 | 2158 | 4226 |
| 2008 | 31 | 1387 | 37 | 3378 | 8778 |
| 2009 | 29 | 1387 | 69 | 5236 | 10 829 |
| 2010 | 26 | 1262 | 121 | 15 599 | 16 428 |

**Table 8.2.5. Greater silver smelt in Va. Catch in numbers (in millions). Estimates for 2009 are preliminary.**

| Year | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0.04 | 0.04 | 0.08 | 0.13 | 0.27 | 0.4 | 0.36 | 0.46 |
| 1998 | 0.11 | 0.07 | 0.48 | 0.22 | 0.32 | 0.23 | 0.51 | 0.45 | 0.94 | 1.98 | 1.29 |
| 2006 | 0.22 | 0.55 | 0.89 | 1.35 | 1.35 | 1.76 | 1.16 | 0.92 | 0.6 | 0.22 | 0.39 |
| 2007 | 0.25 | 0.22 | 0.92 | 0.63 | 1.25 | 1.26 | 1.56 | 1.25 | 0.74 | 0.26 | 0.16 |
| 2008 | 0.12 | 0.86 | 1.45 | 2.44 | 3.71 | 3.5 | 2.96 | 2.13 | 1.25 | 0.64 | 0.39 |
| *2009* | *0.67* | *1.15* | *1.43* | *2.79* | *4.18* | *2.87* | *3.31* | *2.78* | *1.83* | *1.13* | *0.37* |

| Year | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 0.41 | 0.38 | 0.54 | 0.5 | 0.35 | 0.33 | 0.18 | 0.07 | 0.06 | 0.06 | 0.02 |
| 1998 | 2.54 | 2.07 | 2.03 | 1.78 | 1.69 | 1.03 | 0.86 | 0.84 | 0.41 | 0.12 | 0 |
| 2006 | 0.12 | 0.22 | 0.18 | 0.06 | 0.05 | 0.12 | 0.05 | 0.05 | 0.02 | 0 | 0 |
| 2007 | 0.12 | 0.2 | 0.12 | 0.16 | 0.14 | 0.03 | 0.03 | 0 | 0 | 0 | 0 |
| 2008 | 0.34 | 0.21 | 0.12 | 0.18 | 0.15 | 0.21 | 0.11 | 0.05 | 0.04 | 0.05 | 0 |
| *2009* | *0.24* | *0.38* | *0.3* | *0.2* | *0.21* | *0.09* | *0* | *0.03* | *0* | *0* | *0* |

**Table 8.2.6. Greater silver smelt in Va. Mean weight-at-age (g) from commercial catches. Estimates for 2009 are preliminary.**

| Year | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 201 | 259 | 259 | 321 | 438 | 450 | 494 | 516 | 539 | 568 | 625 |
| 1998 | 104 | 197 | 256 | 292 | 356 | 406 | 458 | 515 | 516 | 561 | 567 |
| 2006 | 280 | 303 | 344 | 378 | 411 | 437 | 474 | 543 | 529 | 575 | 689 |
| 2007 | 220 | 266 | 345 | 384 | 418 | 432 | 442 | 478 | 531 | 528 | 543 |
| 2008 | 151 | 233 | 296 | 331 | 361 | 407 | 445 | 471 | 506 | 545 | 617 |
| *2009* | *179* | *264* | *340* | *367* | *392* | *441* | *480* | *504* | *555* | *569* | *637* |

| Year | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 692 | 765 | 806 | 846 | 829 | 891 | 853 | 985 | 1070 | 910 | 1011 |
| 1998 | 617 | 688 | 717 | 768 | 831 | 833 | 848 | 1022 | 977 | 973 | |
| 2006 | 740 | 806 | 727 | 778 | 683 | 818 | 683 | 683 | 539 | | |
| 2007 | 637 | 670 | 787 | 699 | 734 | 922 | 838 | | | | |
| 2008 | 600 | 682 | 766 | 773 | 699 | 764 | 706 | 588 | 720 | 674 | |
| *2009* | *733* | *732* | *737* | *849* | *787* | *770* | | *834* | | | |

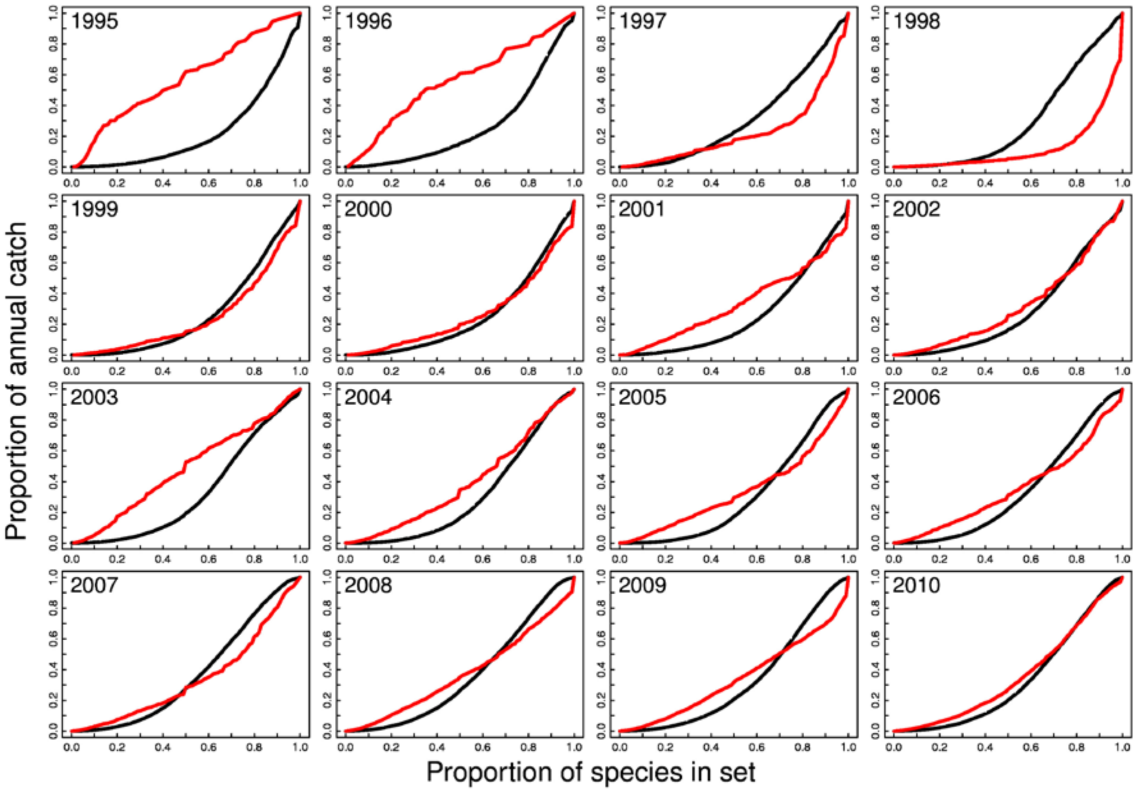



**Figure 8.2.1. Greater silver smelt in Va. Plot of the fishery (red line) in 1995–2010 and, for comparison, the cod longline fishery. The plot is best explained by an example. In 2005 only 20% of the annual longline catch of cod was caught were it was less than 50% of the catch in the haul/set. So the longline fishery of cod can be considered a directed fishery.**

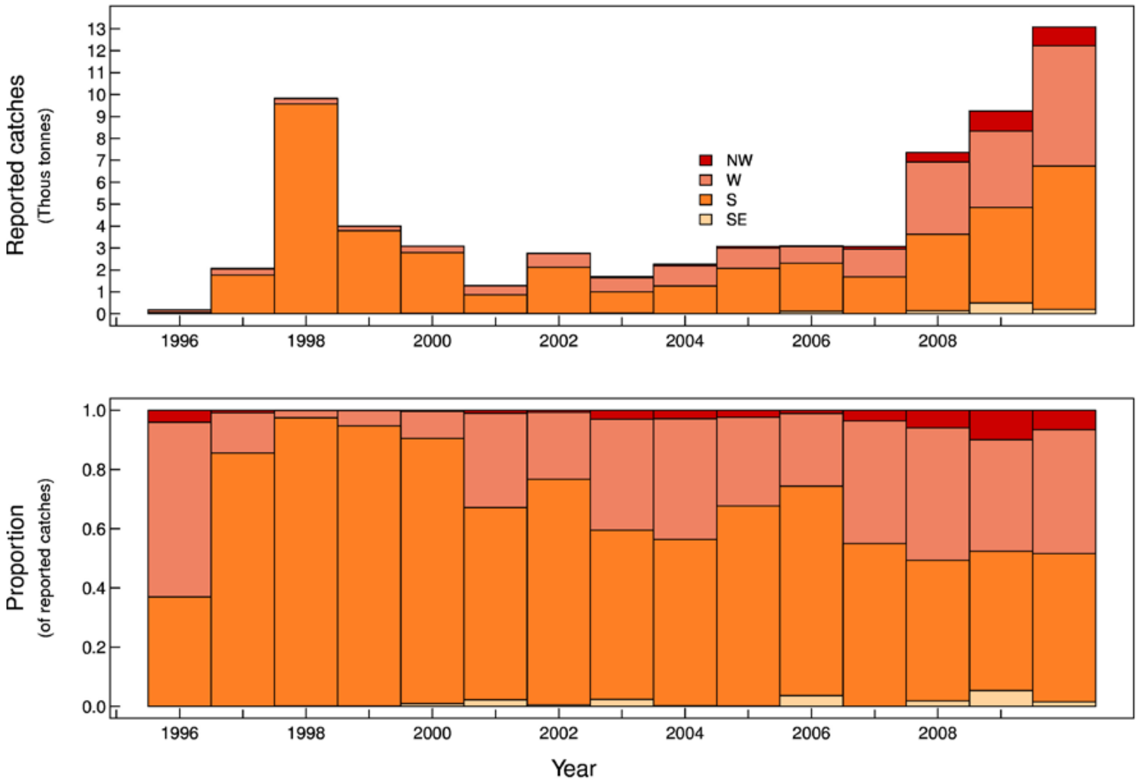



**Figure 8.2.2. Greater silver smelt in Va. Catches defined by survey regions deeper than 400 m by year (See Stock Annex for details). Above are the catches on absolute scale and below in proportions.**

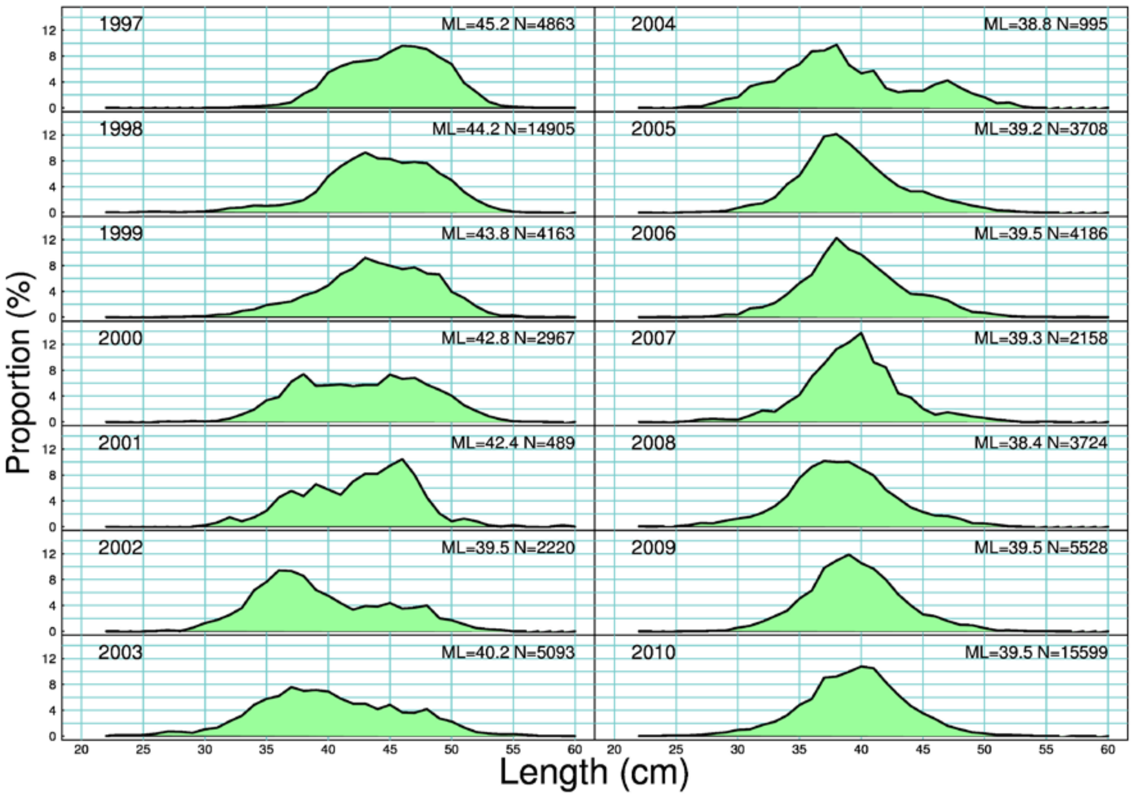



**Figure 8.2.3. Greater silver smelt in Va. Length distributions from commercial catches.**

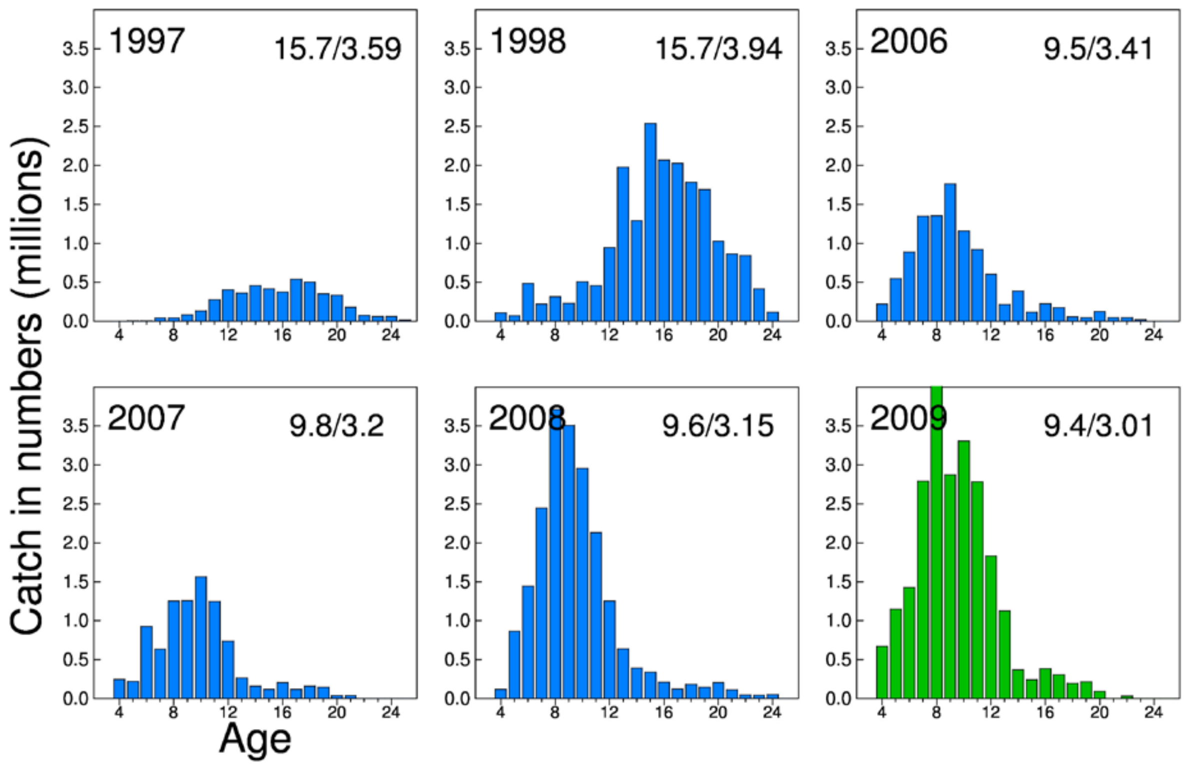



**Figure 8.2.4. Greater silver smelt in Va. Catch in numbers, preliminary estimates for 2009.**

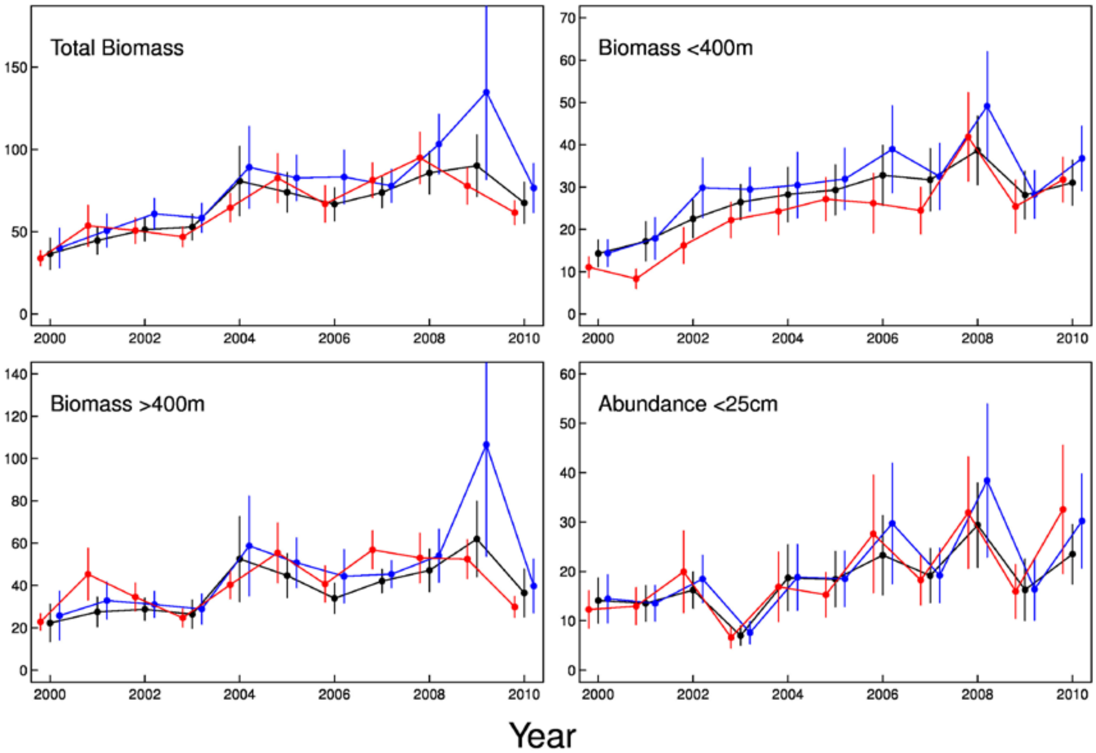



**Figure 8.2.5. Greater silver smelt in Va. Indices from the autumn survey. Black lines are winsorized indices, blue un-winsorized indices and red lines are indices from a revised stratification of the autumn survey. Vertical lines represent +/- 1 standard error.**

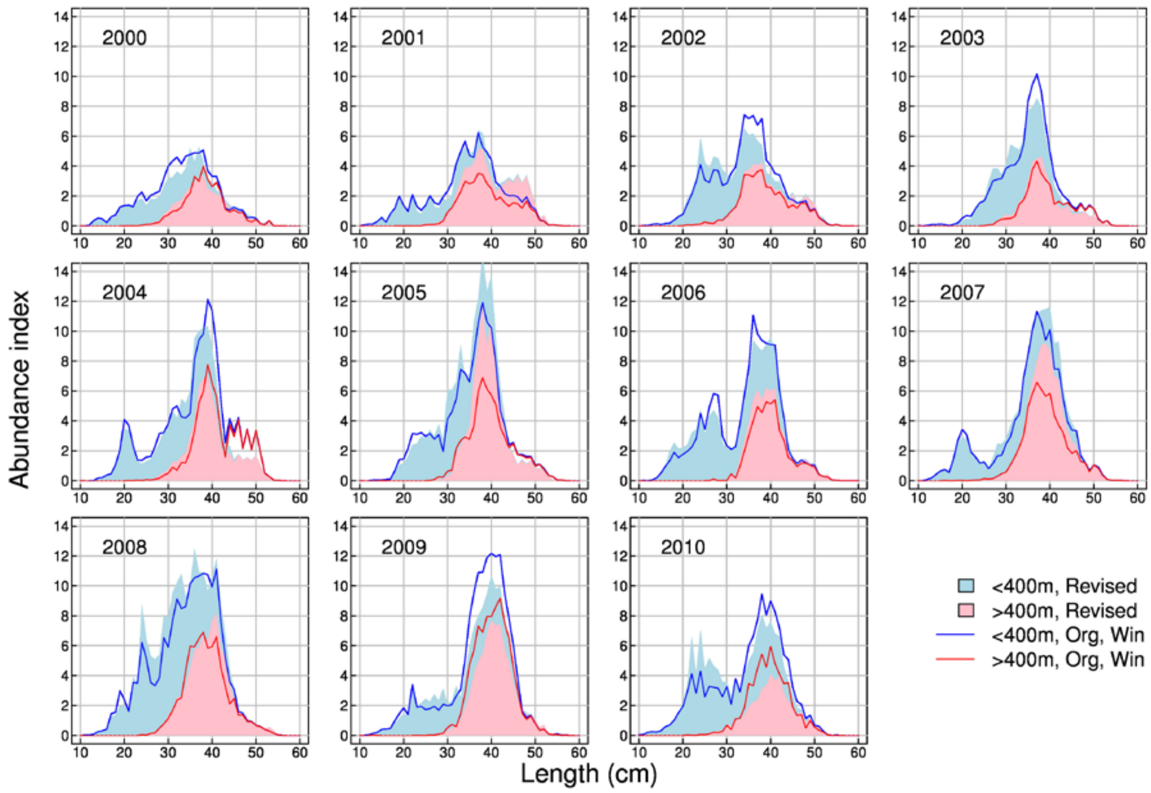



**Figure 8.2.6. Greater silver smelt in Va. Length disaggregated indices from the autumn survey divided by the 400 m depth contour. Total abundance index is the sum of both red and blue curves. Shaded areas are the indices calculated using the revised stratification scheme and the lines represent the Winsorized indices.**

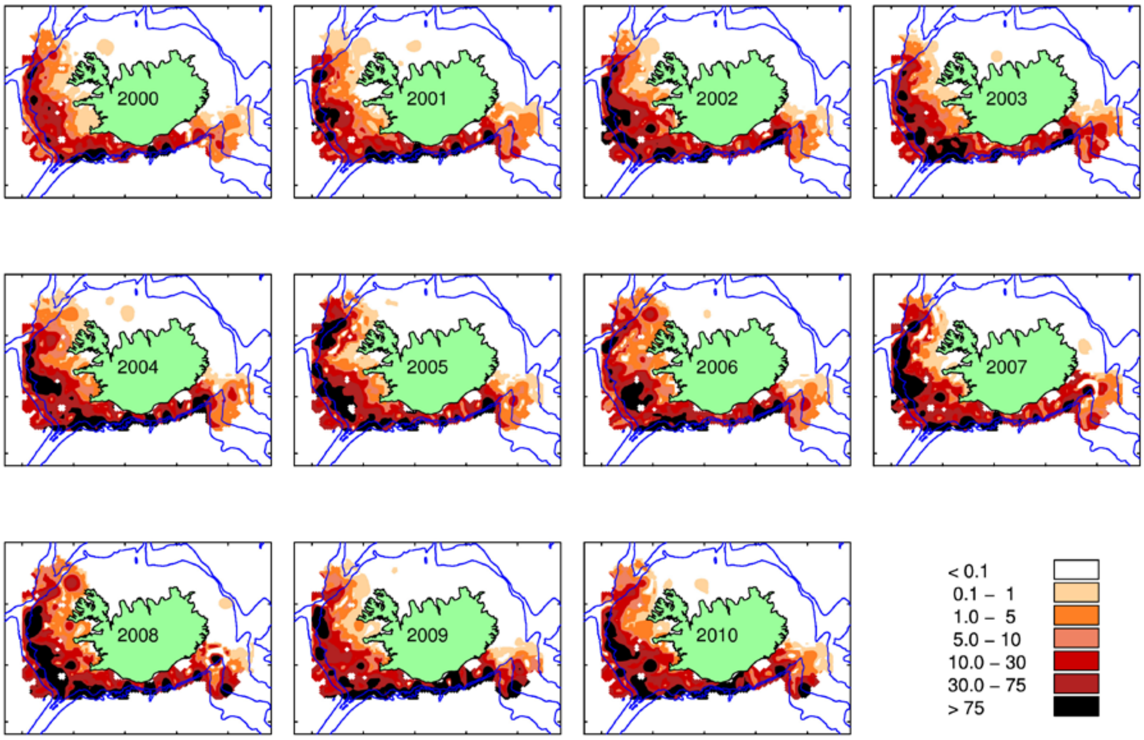



**Figure 8.2.7. Greater silver smelt in Va. Contour plot of the stock distribution in Va as observed from the autumn survey (kg per standardized haul) in 2000–2009. The 500 m depth contour is shown as a blue line.**

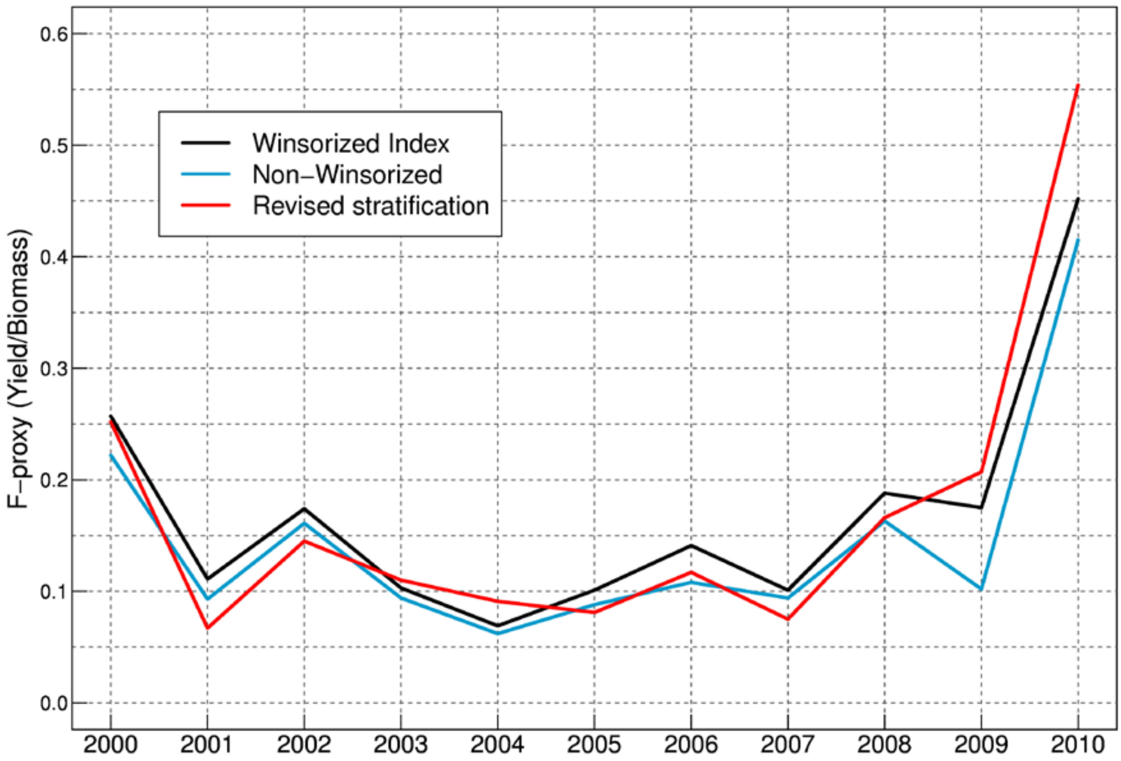



**Figure 8.2.8. Greater silver smelt in Va. Estimates of trends in relative fishing mortality (Yield/Survey biomass). Black line is the winsorized index on biomass estimates at depths greater than 400 m, the blue line is based on the un-winsorized index and finally the red line is based on the survey index estimated from the revised stratification scheme for the autumn survey (WD-01).**

## 8.3 Greater silver smelt (*Argentina silus*) in I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, XIV

### 8.3.1 The fishery

Significant fisheries occur in Subareas I to VII; other areas have only minor bycatch of this species. Presently, the main actors in directed fisheries are Faroese fleets in Vb and VIa, Norwegian fleets in IIa2 and Dutch fleets in VIa.

### 8.3.2 Landings trends

Preliminary figures for total landings in 2010 are 34700 t (Tables 8.3.1 and 8.3.2, Figure 8.3.1). Landings in area I and II, mainly conducted by Norway, were reduced in 2007 to stabilise around 12000 t since then, and preliminary numbers for 2010 landings are at that level. Landings in Vb increased rapidly from 2004 (5300 t) to 2006 (12400 t) and have further increased with preliminary landings for 2010 being 15567 t. These landings are manly from the Faroese directed fisheries. In areas VI and VII landings were reduced to 2600 t in 2009, but have increased again in 2010 to 6200 t, mainly taken in Faroese (3000 t) and Dutch fisheries (3100 t).

Updated data for landings from the Netherlands for 1997-2010 were presented to the meeting. Noticeably, Dutch landings were considerably higher than previously recorded in ICES areas VI and VII in the years 1999 and 2005-2009.

It should be noted that *Argentina sphyraena* may in some areas have been included in the landings figures.

It should be noted that *Argentina sphyraena* may in some areas have been included in the landing figures.

### 8.3.3 ICES Advice

ICES advice in 2010 was;

*The fishery should not be allowed to expand, and a reduction in catches should be considered, in light of survey data indicating a recent decline.*

### 8.3.4 Management

Fisheries in Norwegian EEZ are regulated by TAC set to 12 000 t for 2010 and 2011. In addition there is a licensing system that regulates the number of trawlers that can take part in the directed fishery, equipment restriction, bycatch restrictions, and an area- and time restriction.

There is no species-specific management of greater silver smelt in Vb, except minimum landing size (28 cm) and a licensing system. At present licences are issued to three pairs of pairtrawlers.

The EU introduced TAC management in 2003. For 2010 the EU TAC is set to 6488 t (I and II = 111 t; III and IV = 1278 t; V,VI and VII = 5099 t) and for 2011 the EU TAC is set to 5979 t (I and II = 113 t; III and IV = 1176 t; V,VI and VII = 4691 t).

### 8.3.5 Data available

#### 8.3.5.1 Landings and discards

*Argentina silus* can be a very significant discard of the trawl fisheries of the continental slope of Subareas VI and VII particularly at depths 300–700 m (e.g. Girard and Biseau, WD 2004). No new information was provided.

#### 8.3.5.2 Length compositions

Length distributions in samples taken from the Norwegian fisheries in IIa in 2010 do not show profound changes compared to 2009 (Figure 8.3.2; Hallfredsson, 2010, WD WGDEEP 2010; Hallfredsson, 2011, WD-11). No considerable increase in occurrence of large greater silver smelt was found in 2010, as were noticeably represented in published studies from the 1980s and 1990s (Bergstad, 1993; Monstad and Johannessen, 2003; Johannessen and Monstad, 2003).

The average length in Faroese commercial catches decreased 1994–2000 but seems to have stabilized since then (Figure 8.3.3; Ofstad and Steingrund, 2011, WD-9).

Recent investigations have revealed that survey catches from the Spanish Porcupine survey contain both *A. Silus* and *A. Sphyraena* (Figure 8.3.4). Single species length distributions exist only for the most recent two years (Figure 8.3.5; Velasco *et al.*, 2011, WD-6).

#### 8.3.5.3 Age compositions

The average age in Faroese commercial catches decreased 1994–2000 but seems to have stabilized since then (Figure 8.3.6) (Ofstad and Steingrund WD-09).

Age distributions in samples taken from Norwegian fisheries in 2010 vary by fishing area (Figure 8.3.7) (Hallfredsson WD ICES WGDEEP 2011). The distributions found in 2010 catches have a considerably larger proportion of fish less than 10 year of age than Monstad and Johannesen (2003) found in surveys in 1981 and 1983 in a similar area.

#### 8.3.5.4 Weight-at-age

No new data.

#### 8.3.5.5 Maturity and natural mortality

No new data on maturity and natural mortality were presented.

#### 8.3.5.6 Catch, effort and research vessel data

CPUE indices for greater silver smelt from the annual Faroese summer groundfish surveys for cod, haddock and saithe in Vb are shown in Figure 8.3.8. (Ofstad and Steingrund 2011 WD WGEEP 2011).

Logbooks from three pairs of pairtrawlers (>1000 HP) fishing greater silver smelt in Faroese waters (Area Vb) are available. Standardised CPUE indices for greater silver smelt from different pairs of pair-trawlers are shown in Figure 8.3.9. Figure 8.3.10 shows the spatial distribution of commercial trawl hauls containing more than 50% greater silver smelt (1995-2009) (Ofstad and Steingrund WD-09). To some extent, there is also trawling on the Bill Bailey Bank and Lousy Bank and north of the Faroes (ICES,2009)

Spanish bottom-trawl surveys have been carried out in Subarea VII (Porcupine) since 2001. Recent investigations have revealed that survey catches from the Spanish Porcupine survey contain both *A. Silus* and *A. Sphyraena*. Single species abundance indices exist only for the most recent two years (Velasco et al. WD-06).

An acoustic survey was conducted off Norway by IMR in 2009 with redfish and greater silver smelt as the focus species. Highest registrations of greater silver smelt were found at the slope north from 70°N and has vertical distribution and distance from bottom that makes it suitable for registrations with a 38 kHz echosounder (Figure 8.3.11 and 8.3.12) (Hallfredsson 2010 WD ICES WGDEEP 2010, Harbitz WD ICES WKDEEP 2010, Hallfredsson 2011 WD ICES WGDEEP 2011).

### 8.3.6 Data analyses

The Faroese summer survey biomass index showed no strong trend between 1996 and 2010 (Figure 8.3.8). The survey CPUE fluctuates. Given the reported low turnover rate (high turnover time) in this species you would not expect to see large changes in abundance by year. This implies that the large changes in year values in the Faroese survey may be noise related. The relatively shallow depth range covered by the survey will likely result in poor sampling of adult fish as large individuals are generally found at greater depths.

CPUE indices for greater silver smelt from four different pairs of Faroese pair-trawlers are shown in Figure 8.3.9. The period from 1995 to 1997 can be treated as a "learning" period, i.e. the CPUE is not believed to be proportional to abundance in those years. There is overall a small increase in the commercial CPUE series. Length and age composition in the catches shifted to smaller lengths and lower ages in 1994-1999 but seem to have stabilised since then (Figure 8.3.3 and 8.3.6).

Length distributions in samples taken from catches in Norwegian fisheries in Division IIa (Figure 8.3.2) are skewed toward smaller fish compared to findings in the 1990s and 1980s.

An exploratory assessment has earlier been trialled for Division Vb (ICES, 2009). The exercise carried out then was simply to trial an age based method (XSA) on what is a long-lived, bentho-pelagic species. A similar exploratory assessment for Division Vb was presented to the meeting (Ofstad and Steingrund 2011 WD WGEEP 2011). WGDEEP recognises that progress has been made but considers that the concerns raised are WKDEEP 2010 are still valid because of the uncertainty regarding the stock structure of this species.

### 8.3.7 Comments on the assessment

Diagnostics are not available from the GLM used in the Faroese commercial cpue series.

### 8.3.8 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WGFRAME however, given the conflicting signals given by the different time-series, no obvious candidate could be identified at present.

**Table 8.3.1. Greater silver smelt I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, XIV. WG estimates of landings in tonnes. *) landings in 2009 are preliminary.**

Greater silver smelt (*Argentina silus*) I and II

| Year | Germany | Netherlands | Norway | Poland | Russia/USSR | Scotland | France | Faroes | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | 11 332 | 5 | 14 | | | | **11 351** |
| 1989 | | | 8367 | | 23 | | | | **8390** |
| 1990 | | 5 | 9115 | | | | | | **9120** |
| 1991 | | | 7741 | | | | | | **7741** |
| 1992 | | | 8234 | | | | | | **8234** |
| 1993 | | | 7913 | | | | | | **7913** |
| 1994 | | | 6217 | | | 590 | | | **6807** |
| 1995 | 357 | | 6418 | | | | | | **6775** |
| 1996 | | | 6604 | | | | | | **6604** |
| 1997 | | | 4463 | | | | | | **4463** |
| 1998 | 40 | | 8221 | | | | | | **8261** |
| 1999 | | | 7145 | | | 18 | | | **7163** |
| 2000 | | 3 | 6075 | | 195 | 18 | 2 | | **6293** |
| 2001 | | | 14 357 | | 7 | 5 | | | **14 369** |
| 2002 | | | 7405 | | | 2 | | | **7407** |
| 2003 | | 575 | 8345 | | 7 | 2 | 4 | 4 | **8937** |
| 2004 | | 4235 | 11 557 | | 4 | | | | **15796** |
| 2005 | | | 17 063 | | 16 | | | 14 | **17 093** |
| 2006 | | | 21 681 | | 4 | | | | **21 685** |
| 2007 | | | 13 272 | | 1 | | | | **13 273** |
| 2008 | | | 11 876 | | | | | | **11 876** |
| 2009 | | | 11 929 | | | | | | **11 929** |
| 2010* | | | 11 820 | | | | 23 | | **11 843** |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) III and IV

| Year | Denmark | Faroes | France | Germany | Netherlands | Norway | Scotland | Sweden | Ireland | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 1062 | | | 1 | | 1655 | | | | **2718** |
| 1989 | 1322 | | | | 335 | 2128 | 1 | | | **3786** |
| 1990 | 737 | | | 13 | | 1571 | | | | **2321** |
| 1991 | 1421 | | 1 | | 3 | 1123 | 6 | | | **2554** |
| 1992 | 4449 | | | 1 | 70 | 698 | 101 | | | **5319** |
| 1993 | 2347 | | | | 298 | 568 | 56 | | | **3269** |
| 1994 | 1480 | | | | | 4 | 24 | | | **1508** |
| 1995 | 1061 | | | | | 1 | 20 | | | **1082** |
| 1996 | 2695 | 370 | | | | 213 | 22 | | | **3300** |
| 1997 | 1332 | | | 1 | | 704 | 19 | 542 | | **2598** |
| 1998 | 2716 | | | 128 | 250 | 434 | | 427 | | **3955** |
| 1999 | 3772 | | 82 | | 7 | 5 | 452 | | 2 | **4313** |
| 2000 | 1806 | | 270 | | | 32 | 78 | 273 | 12 | **2471** |
| 2001 | 1653 | | 28 | | | 3 | 227 | 1011 | 3 | **2925** |
| 2002 | 1161 | | | | | 1 | 161 | 484 | 4 | **1811** |
| 2003 | 1119 | | | | 42 | 6 | 20 | | 1 | **1188** |
| 2004 | 1036 | | | 4 | 320 | 17 | 12 | | 46 | **1435** |
| 2005 | 733 | | | 1 | 28 | 11 | | | 18 | **791** |
| 2006 | 548 | | | | | 3468 | | | | **4016** |
| 2007 | 243 | | | | | 3100 | | | | **3343** |
| 2008 | 23 | 58 | | | | 1548 | | | | **1629** |
| 2009 | 6 | | | | | 1566 | | | | **1572** |
| 2010* | 47 | | | | | 1034 | 10 | | | **1091** |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) Vb

| Year | Faroes | Russia/USSR | UK (Scot) | UK(EWN) | Ireland | France | Netherlands | Norway | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 287 | | | | | | | | **287** |
| 1989 | 111 | 116 | | | | | | | **227** |
| 1990 | 2885 | 3 | | | | | | | **2888** |
| 1991 | 59 | | 1 | | | | | | **60** |
| 1992 | 1439 | 4 | | | | | | | **1443** |
| 1993 | 1063 | | | | | | | | **1063** |
| 1994 | 960 | | | | | | | | **960** |
| 1995 | 5534 | 6752 | | | | | | | **12 286** |
| 1996 | 9495 | | 3 | | | | | | **9498** |
| 1997 | 8433 | | | | | | | | **8433** |
| 1998 | 17 570 | | | | | | | | **17 570** |
| 1999 | 8186 | | 15 | 23 | | 5 | | | **8229** |
| 2000 | 3713 | 1185 | 247 | | | 64 | | | **5209** |
| 2001 | 9572 | 414 | 94 | | 1 | | | | **10 081** |
| 2002 | 7058 | 264 | 144 | | | | 5 | | **7471** |
| 2003 | 6261 | 245 | 1 | | | | 51 | | **6558** |
| 2004 | 3441 | 702 | 42 | | | | 1125 | | **5310** |
| 2005 | 6939 | 59 | | | | | 15 | | **7013** |
| 2006 | 12 524 | 35 | | | | | | | **12 559** |
| 2007 | 14 085 | 8 | | | | | 0.4 | 32 | **14 126** |
| 2008 | 14 930 | 19 | | | | | | 3 | **14 952** |
| 2009 | 14 200 | 28 | | | | | | | **14 228** |
| 2010* | 15 567 | 2 | 40 | | | | | | **15 609** |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) VI and VII

| Year | Faroes | France | Germany | Ireland | Netherlands | Norway | E&W | Scotland | N.I. | Russia | Spain | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | | 5454 | | 4984 | | | | | | **10 438** |
| 1989 | 188 | | | 6103 | 3715 | 12184 | 198 | 3171 | | | | **25 559** |
| 1990 | 689 | | 37 | 585 | 5871 | | | 112 | | | | **7294** |
| 1991 | | 7 | | 453 | 4723 | | | 10 | 4 | | | **5197** |
| 1992 | | 1 | | 320 | 5118 | | | 467 | | | | **5906** |
| 1993 | | | | | 1168 | | | 409 | | | | **1577** |
| 1994 | | | 43 | 150 | 4137 | | | 1377 | | | | **5707** |
| 1995 | 1597 | | 357 | 6 | 4136 | | | 146 | | | | **6242** |
| 1996 | | | 1394 | 295 | 3953 | | | 221 | | | | **5863** |
| 1997 | | | 1496 | 1089 | 4695 | | | 20 | | | | **7000** |
| 1998 | | | 463 | 405 | 4696 | | | | | | | **5564** |
| 1999 | | 21 | 24 | 394 | 8188 | | | 387 | | 5 | | **9019** |
| 2000 | | 17 | 482 | 4703 | 3689 | | | 4965 | | 29 | 34 | **13 919** |
| 2001 | | 12 | 189 | 7494 | 3658 | | | 7620 | | 76 | | **19 049** |
| 2002 | | | 150 | 7589 | 4010 | | | 4197 | | 29 | | **15 975** |
| 2003 | | | 164 | 95 | 1958 | | | 89 | | 163 | 7 | **2476** |
| 2004 | | 147 | 652 | 46 | 3359 | | | 526 | | 12 | 19 | **5761** |
| 2005 | 103 | 10 | 131 | 1 | 5276 | | | 75 | | 4 | 19 | **5619** |
| 2006 | 53 | | | | 4630 | | | | | | | **4683** |
| 2007 | 254 | | | | 6976 | 3 | | | | | | **7233** |
| 2008 | 991 | | | | 4176 | 3 | | | | 1 | | **5171** |
| 2009 | | | | 0.5 | 2501 | 83 | | 7 | | 36 | | **2627** |
| 2010* | 3060 | | | 0.1 | 3147 | 7 | 3 | 20 | | 11 | | **6247** |

Greater silver smelt (*Argentina silus*) VIII

| Year | Netherlands | TOTAL |
|---|---|---|
| 2002 | 195 | **195** |
| 2003 | 43 | **43** |
| 2004 | 23 | **23** |
| 2005 | 202 | **202** |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010* | | |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) IX

| Year | Nederlands | Portugal | TOTAL |
|---|---|---|---|
| 2006 | | | |
| 2007 | 1 | | 1 |
| 2008 | | 0.5 | 0.5 |
| 2009 | | 2 | 2 |
| 2010* | | 2 | 2 |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) XII

| Year | Faroes | Iceland | Russia | Netherlands | TOTAL |
|---|---|---|---|---|---|
| 1988 | | | | | |
| 1989 | | | | | |
| 1990 | | | | | |
| 1991 | | | | | |
| 1992 | | | | | |
| 1993 | 6 | | | | **6** |
| 1994 | | | | | |
| 1995 | | | | | |
| 1996 | 1 | | | | **1** |
| 1997 | | | | | |
| 1998 | | | | | |
| 1999 | | | | | |
| 2000 | | 2 | | | **2** |
| 2001 | | | | | |
| 2002 | | | | | |
| 2003 | | | | | |
| 2004 | | | 4 | 625 | **629** |
| 2005 | | | | 362 | **362** |
| 2006 | | | | | |
| 2007 | | | | | |
| 2008 | | | | | |
| 2009 | | | | | |
| 2010* | | | | | |

**Table 8.3.1. (continued).**

Greater silver smelt (*Argentina silus*) XIV

| Year | Norway | Iceland | TOTAL |
|---|---|---|---|
| 1988 | | | |
| 1989 | | | |
| 1990 | 6 | | **6** |
| 1991 | | | |
| 1992 | | | |
| 1993 | | | |
| 1994 | | | |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | | | |
| 1999 | | | |
| 2000 | | 217 | **217** |
| 2001 | 66 | | **66** |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010* | | | |

**Table 8.3.2.**

Greater silver smelt (*Argentina silus*; all areas)

| Year | I + II | III + IV | Vb | VI + VII | VIII | IX | XII | XIV | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 11 351 | 2718 | 287 | 10 438 | | | | | 24 794 |
| 1989 | 8390 | 3786 | 227 | 25 559 | | | | | 37 962 |
| 1990 | 9120 | 2321 | 2888 | 7294 | | | | 6 | 21 629 |
| 1991 | 7741 | 2554 | 60 | 5197 | | | | | 15 552 |
| 1992 | 8234 | 5319 | 1443 | 5906 | | | | | 20 902 |
| 1993 | 7913 | 3269 | 1063 | 1577 | | | 6 | | 13 828 |
| 1994 | 6807 | 1508 | 960 | 5707 | | | | | 14 982 |
| 1995 | 6775 | 1082 | 12 286 | 6242 | | | | | 26 385 |
| 1996 | 6604 | 3300 | 9498 | 5863 | | | 1 | | 25 266 |
| 1997 | 4463 | 2598 | 8433 | 7000 | | | | | 22 494 |
| 1998 | 8261 | 3955 | 17 570 | 5564 | | | | | 35 350 |
| 1999 | 7163 | 4313 | 8229 | 9019 | | | 2 | | 28 726 |
| 2000 | 6293 | 2471 | 5209 | 13 919 | | | | 217 | 28 109 |
| 2001 | 14 369 | 2925 | 10 081 | 19 049 | | | | 66 | 46 490 |
| 2002 | 7407 | 1811 | 7471 | 15 975 | 195 | | | | 32 858 |
| 2003 | 8937 | 1188 | 6558 | 2476 | 43 | | | | 19 203 |
| 2004 | 15 796 | 1435 | 5310 | 5761 | 23 | | 629 | | 28 953 |
| 2005 | 17 093 | 791 | 7013 | 5619 | 202 | | 362 | | 31 080 |
| 2006 | 21 685 | 4016 | 12 559 | 4683 | | | | | 42 943 |
| 2007 | 13 273 | 3343 | 14 126 | 7233 | | | | | 37 975 |
| 2008 | 11 876 | 1629 | 14 952 | 5171 | 10 | 0.5 | | | 33 638 |
| 2009 | 11 929 | 1572 | 14 228 | 2627 | | 1.9 | | | 30 358 |
| 2010* | 11 843 | 1091 | 15 609 | 6247 | | 2.9 | | | 34 793 |

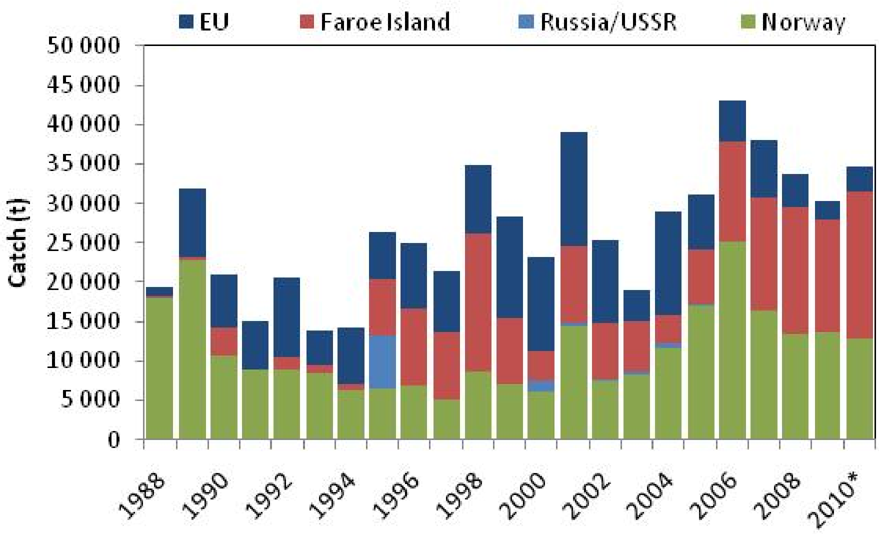



**Figure 8.3.1. Total catches of greater silver smelt in I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, and XIV by countries.**

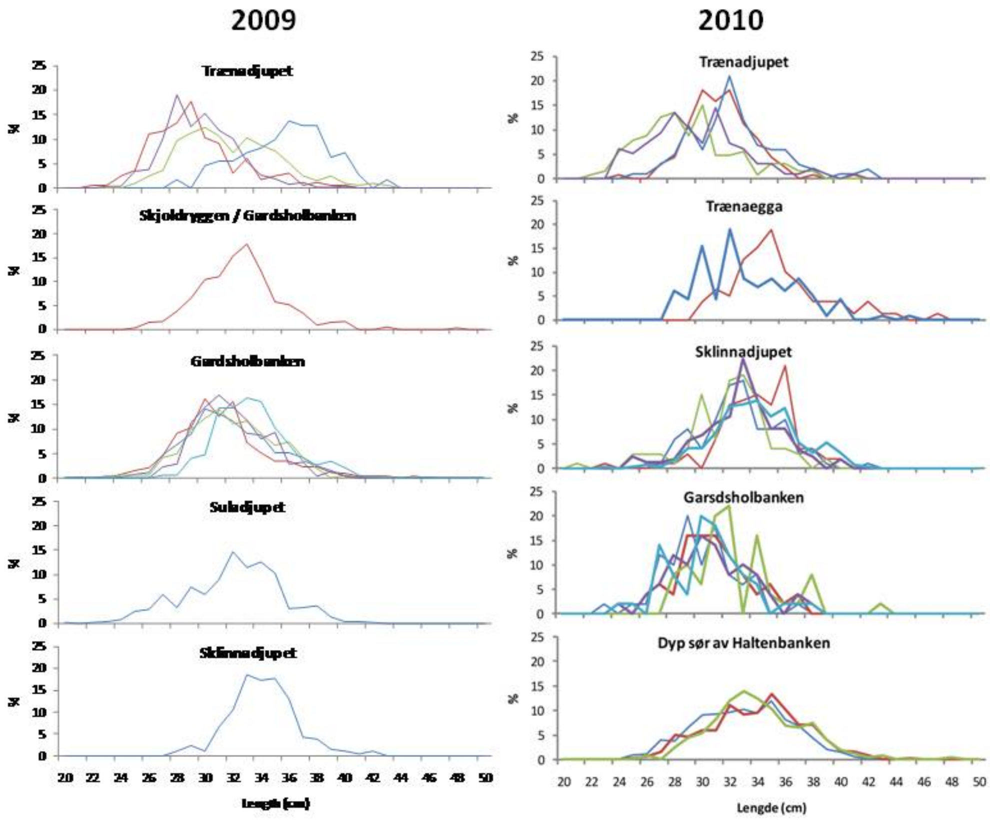



**Figure 8.3.2. Length distributions per sample in Norwegian fisheries in Area IIa in 2009 and 2010, sorted by fishing grounds within the main area for the direct fisheries (Hallfredsson, 2010, WD ICES WGDEEP 2010; Hallfredsson, 2011, WD ICES WGDEEP 2011).**

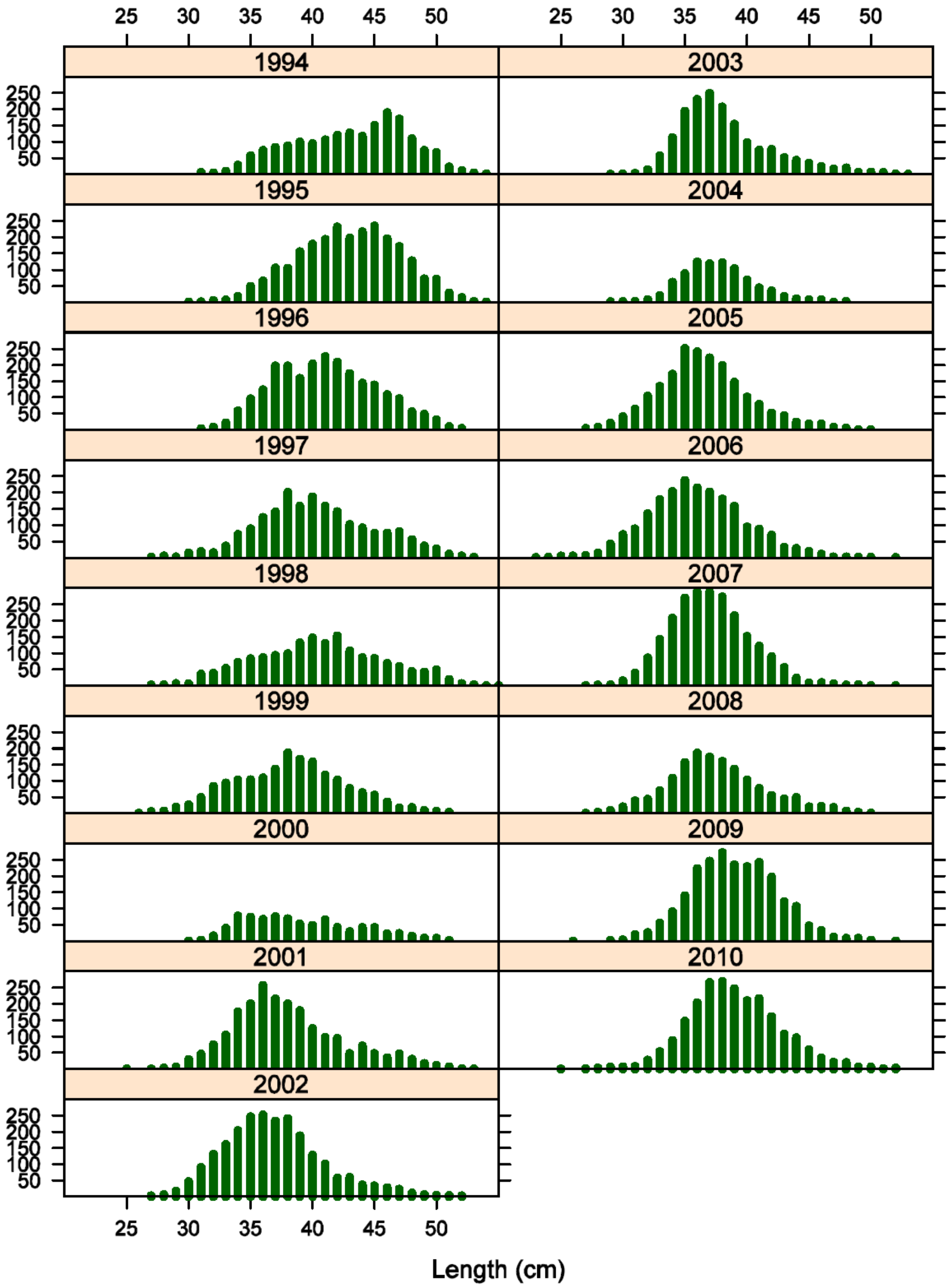



**Figure 8.3.3. Length distributions of greater silver smelt in the Faroese landings 1994–2010 (Ofstad and Steingrund, 2010, WD WGEEP 2011).**

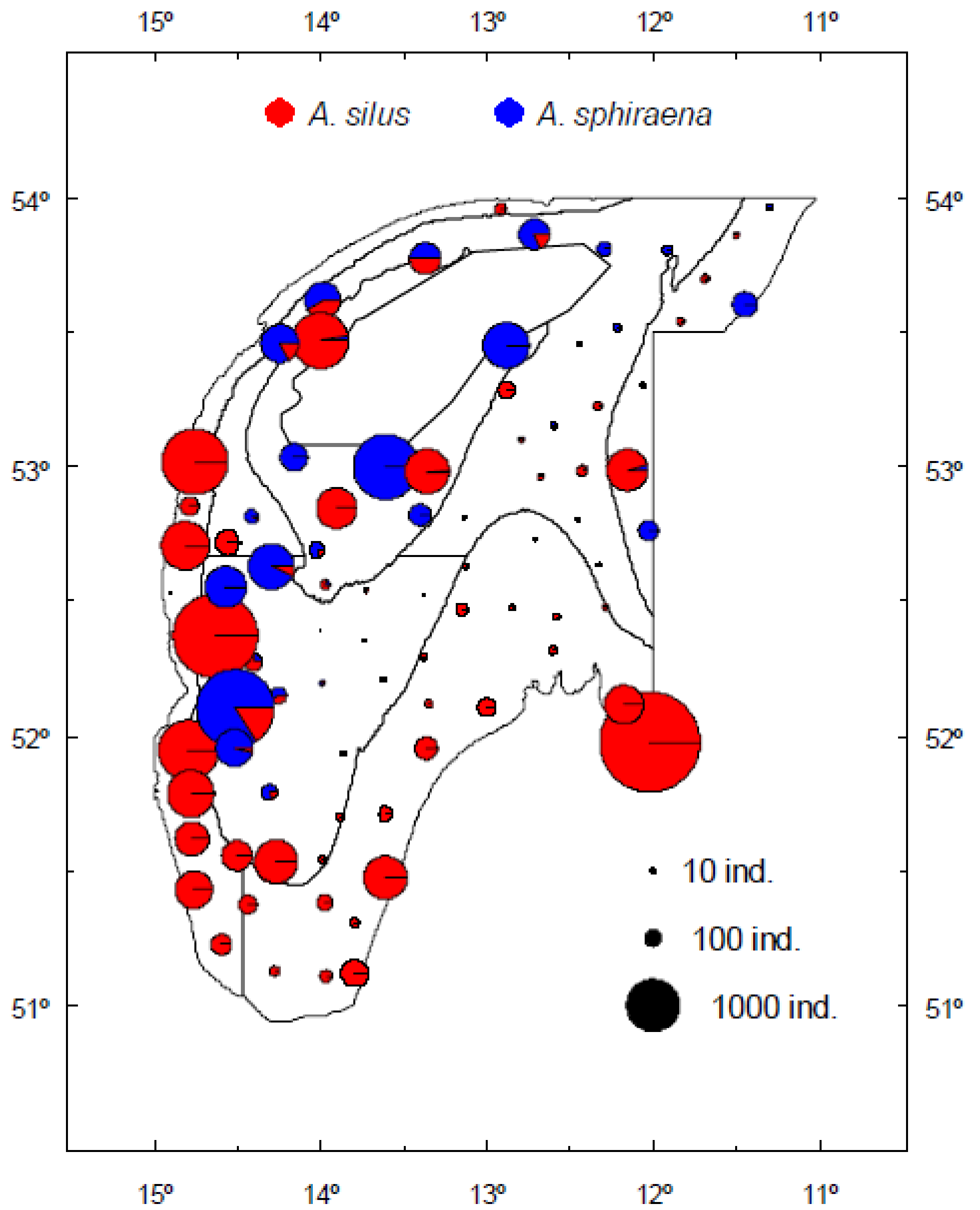



**Figure 8.3.4. Distribution of *Argentina silus* and *A. sphyraena* by numbers during the 2010 Porcupine bank survey (Velasco *et al.*, 2011, WD ICES WGDEEP 2011).**

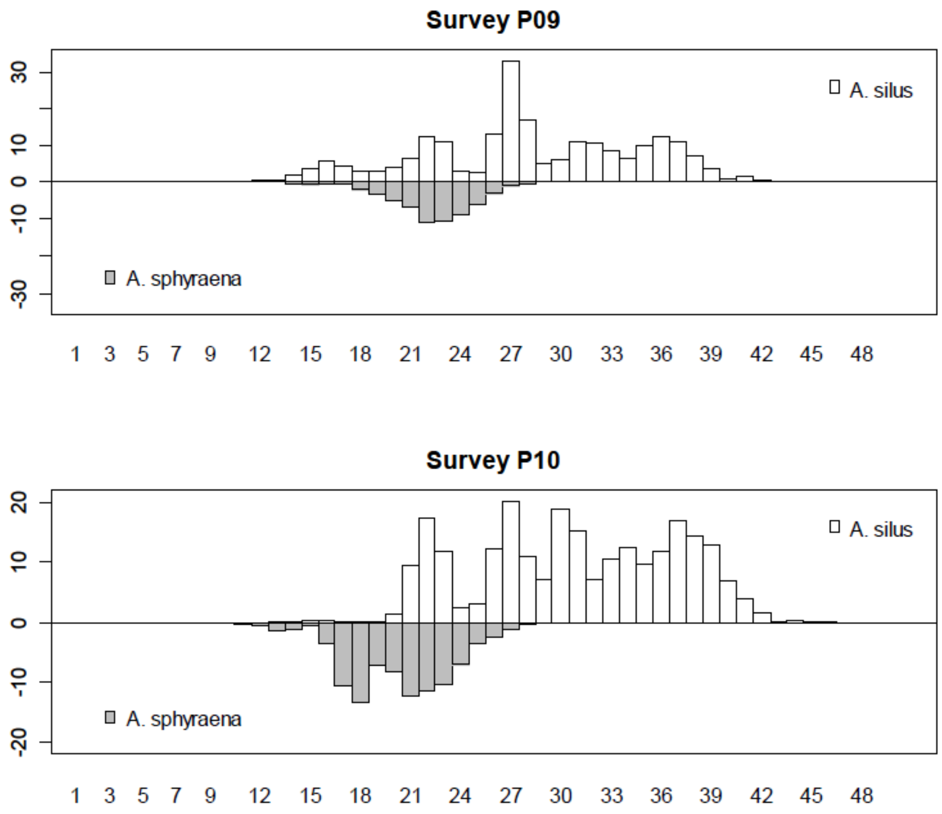



**Figure 8.3.5. Mean stratified length distributions of *A. silus* and *A. sphyraena* in 2009 and 2010 in Spanish Porcupine surveys. (Velasco *et al.*, 2011, WD ICES WGDEEP 2011).**

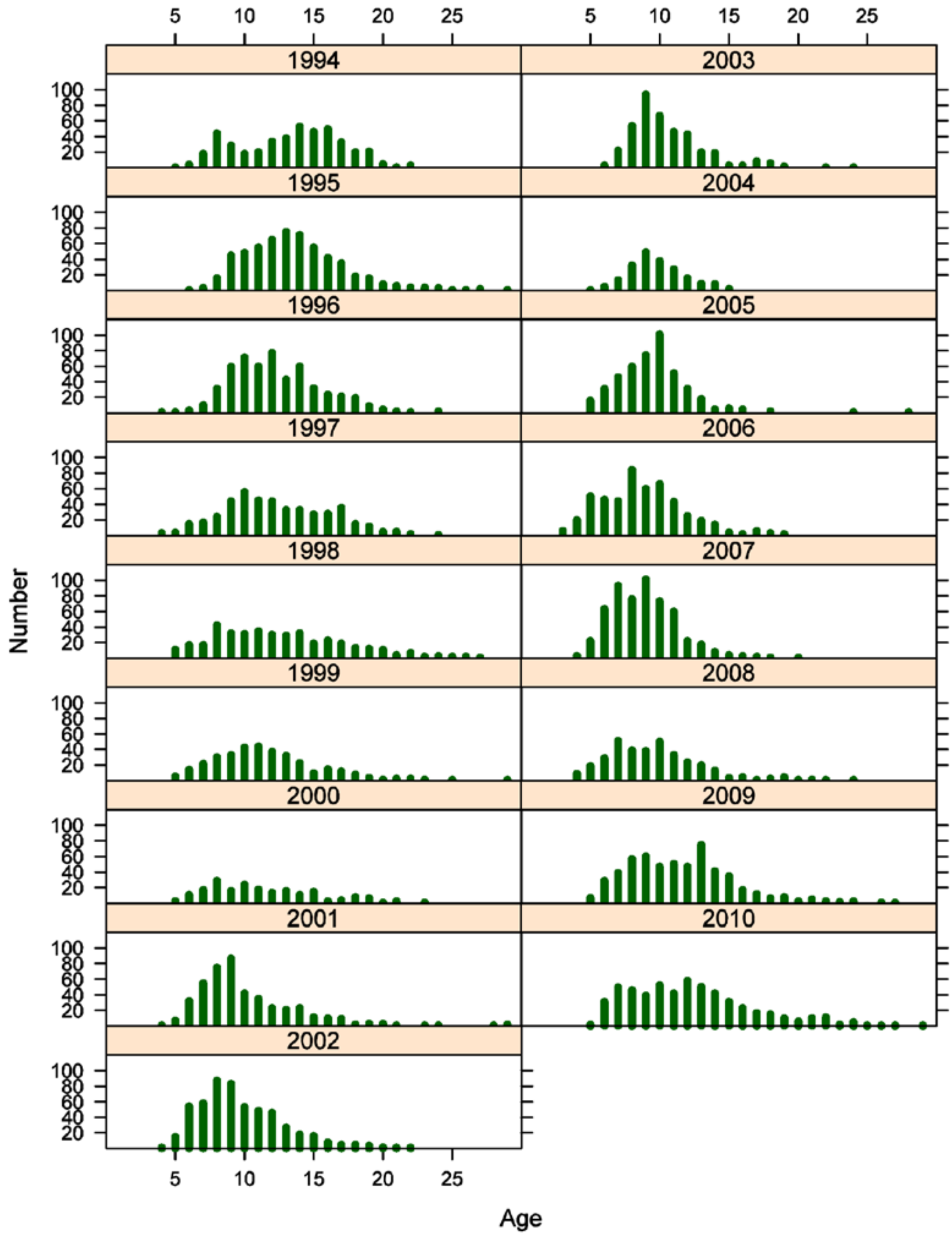



**Figure 8.3.6. Age distributions of greater silver smelt in the Faroese landings 1994–2010 (Ofstad and Steingrund, W-09).**

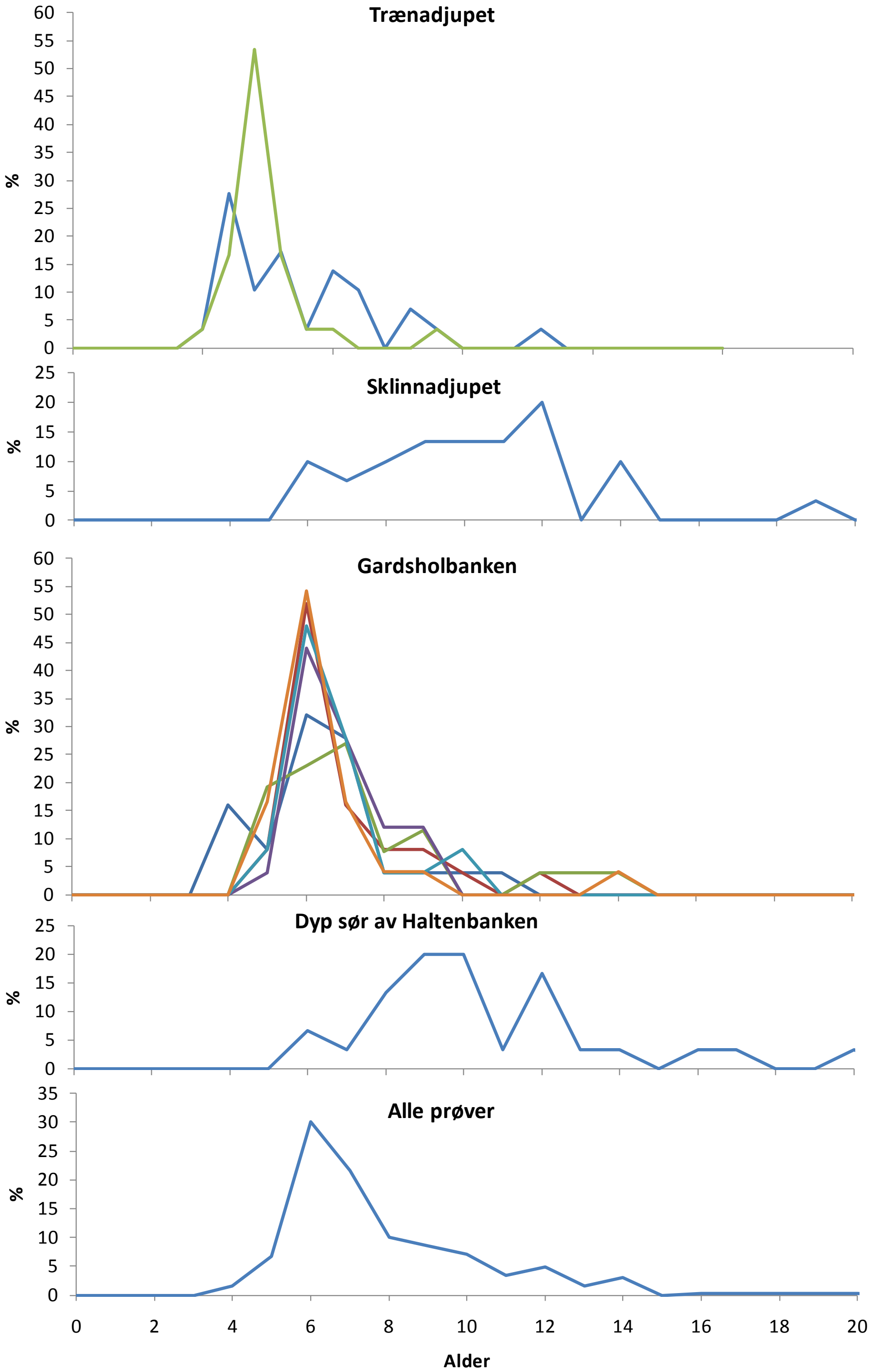



**Figure 8.3.7. Age distributions per sample taken from Norwegian fisheries in 2010, divided on fishing fields. Also shown is age distribution for all samples lumped (lowermost panel), but it should be noted that the lumped distribution cannot be taken as statistically representative distribution for greater silver smelt in the area.**

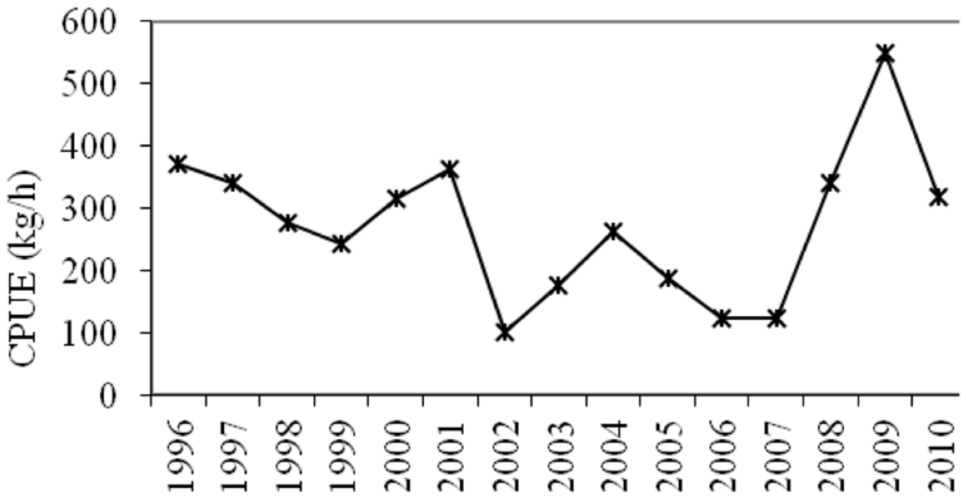



**Figure 8.3.8. Standardized cpue of greater silver smelt from the annual Faroese groundfish summer surveys (Ofstad and Steingrund, 2010, WD WGEEP 2011).**

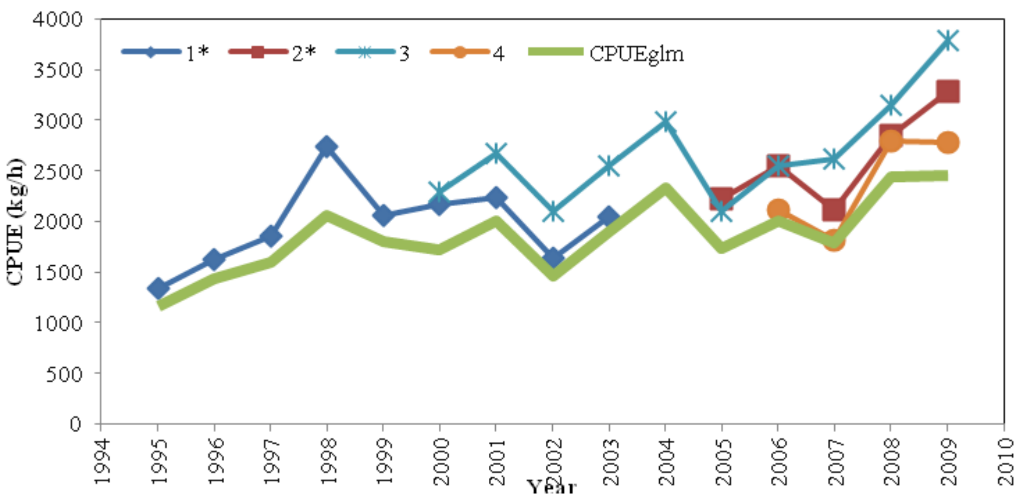



**Figure 8.3.9 CPUE (kg/h) for different pairs of Faroese pair-trawlers. CPUEglm is the predicted CPUE from a GLM where each haul was standardized by area, month and pair (Ofstad and Steingrund WD-09).**

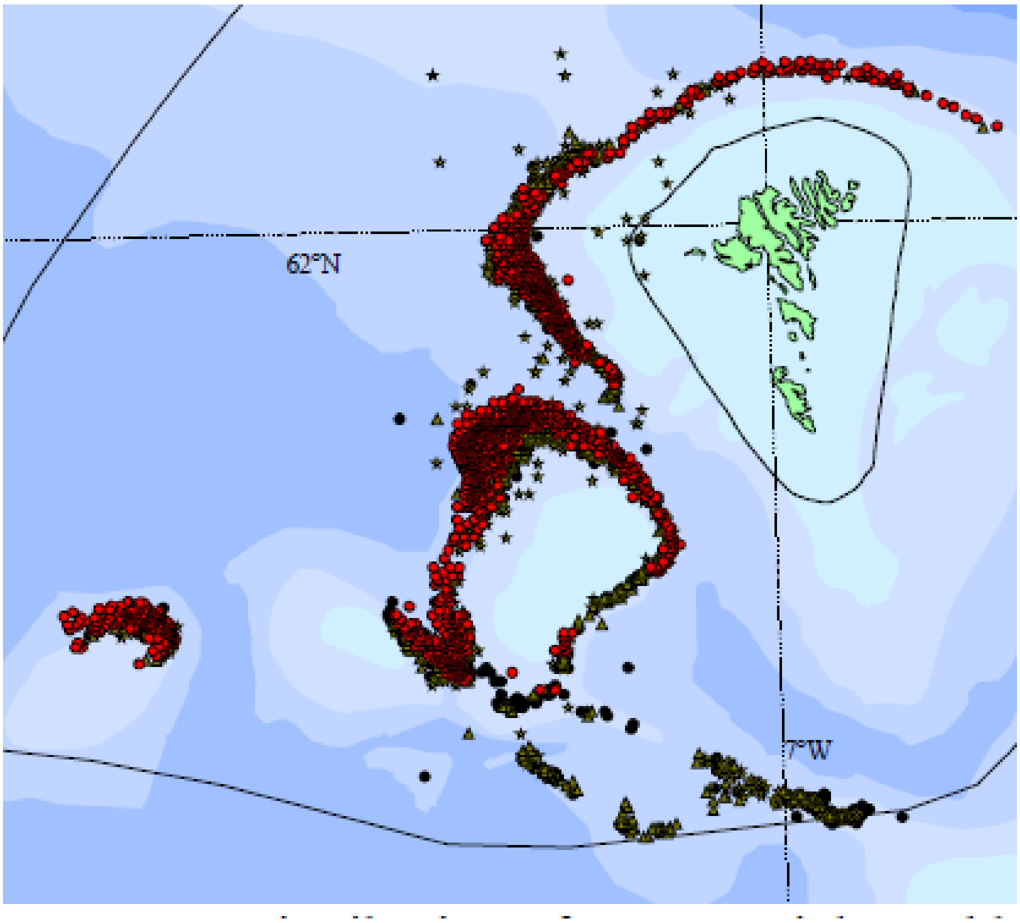



**Figure 8.3.10. Distribution of commercial trawl hauls containing more than 50% greater silver smelt (1995–2009; Ofstad and Steingrund, 2010, WD WGEEP 2011).**

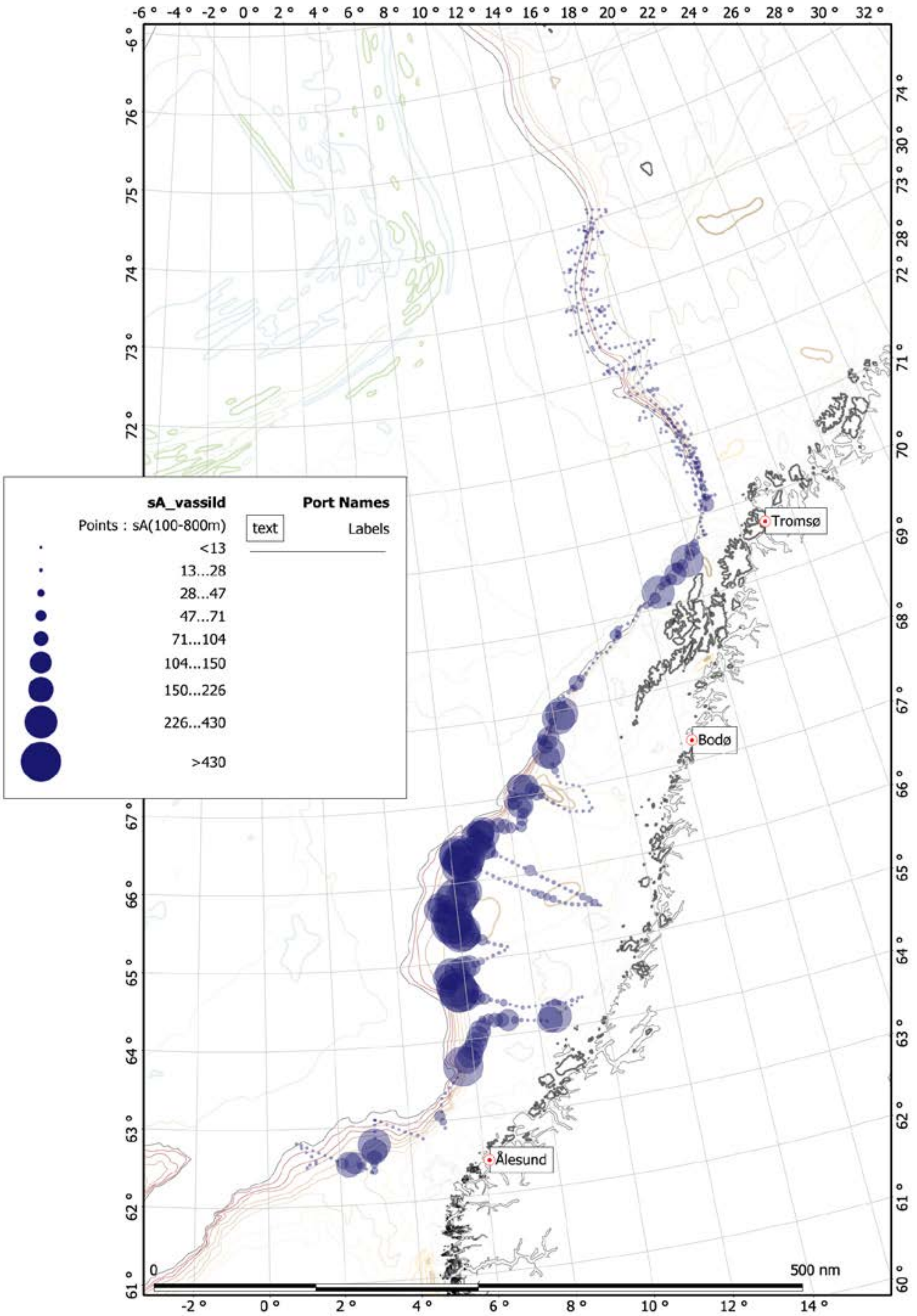



**Figure 8.3.11. Registrations of greater silver smelt in Norwegian acoustical survey in March–April 2009. Blue line shows the survey transects with point-area proportional to SA-values allocated to greater silver smelt (Hallfredsson, 2010, ICES WGDEEP 2010, WD).**

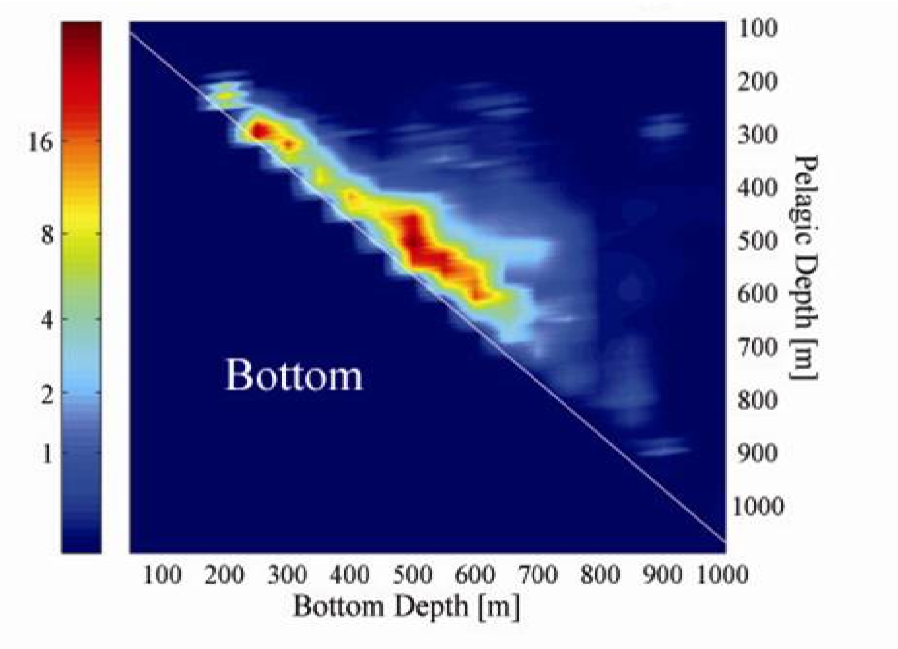



**Figure 8.3.12. Vertical distribution for greater silver smelt in IMR survey in 2009. Average acoustical SA values are shown per 10 m vertical channel for the whole survey.**

### 8.3.9 Greater silver smelt (*Argentina silus*) in I, II, IIIa, IV, Vb, VI, VII, VIII, IX, X, XII, XIV-References

Bergstad O. A. 1993. Distribution, population structure, growth, and reproduction of the greater silver smelt, *Argentina silus* (Pisces, Argentinidae), of the Skagerrak and the northeastern North Sea. ICES J. Mar. Sci. 50(2): 129–143.

Girard, M. and Biseau A. 2004. Preliminary results concerning spatial variability of the catch in the ICES Subarea VI: Composition and importance of the discard fraction. 8 p. WD ICES WGDEEP 2004.

Hallfredsson, E.H. 2010. Norwegian research on greater silver smelt in 2009. WD ICES WGDEEP 2010.

Hallfredsson E. H. 2011. Observations on the status of greater silver smelt in the North East Atlantic and research on Greater silver smelt in Norway 2010. WD ICES WGDEEP 2010.

Harbitz A. 2010. Working document on acoustics for greater silver smelt. Arbeidsdokument. ICES WKDEEP 2010 WD GSS-01.

ICES. 2009. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 9–16 March 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:14. 511 pp.

Johannessen A. and Monstad T. 2003. Distribution, growth and exploitation of greater silver smelt (*Argentina silus* (Ascanius, 1775)) in Norwegian waters 1980–1983. J. Northwest Atl. Fish. Sci., 31: 319–332.

Monstad T. and Johannessen A. 2003. Acoustic recordings of greater silver smelt (*Argentina silus*) in Norwegian waters and west of the British Isles, 1989–1994. J. Northw. Atl. Fish. Sci. 31: 339–351.

Ofstad and Steingrund. 2011. Greater silver smelt (*Argentina silus*) in Faroese area (Division Vb). Distribution and assessment. WD ICES WGDEEP 2011.

Velasco F., Blanco M., Baldó F. and Gil J. 2011. Results on Argentine (*Argentina* spp.), Bluemouth (*Helicolenus dactylopterus*), Greater forkbeard (*Phycis blennoides*) and Spanish ling

(*Molva macrophthalma*) from 2010 Porcupine Bank (NE Atlantic) survey. WD ICES WGDEEP 2011.

# 9 Orange roughy (*Hoplostethus atlanticus*) in the Northeast Atlantic

## 9.1 Stock description and management units

There is no information to determine the existence of separate populations of orange roughy in the North Atlantic.

The current ICES practice is to assume three assessment units;

- Subarea VI;
- Subarea VII;
- Orange roughy in all other areas.

Given the scarcity of spatial fisheries data and genetics data, etc, WGDEEP saw no reason to change this.

Orange roughy is an aggregating species and the spatial scale of current management units would not prevent sequential depletion of local aggregations. ICES recommended that where the small-scale distribution is known, this be used to define smaller and more meaningful management units.

Figure 9.1.1 shows the accumulated catch of orange roughy in the NEA in the different ICES areas for catches from 1991 to 2009.

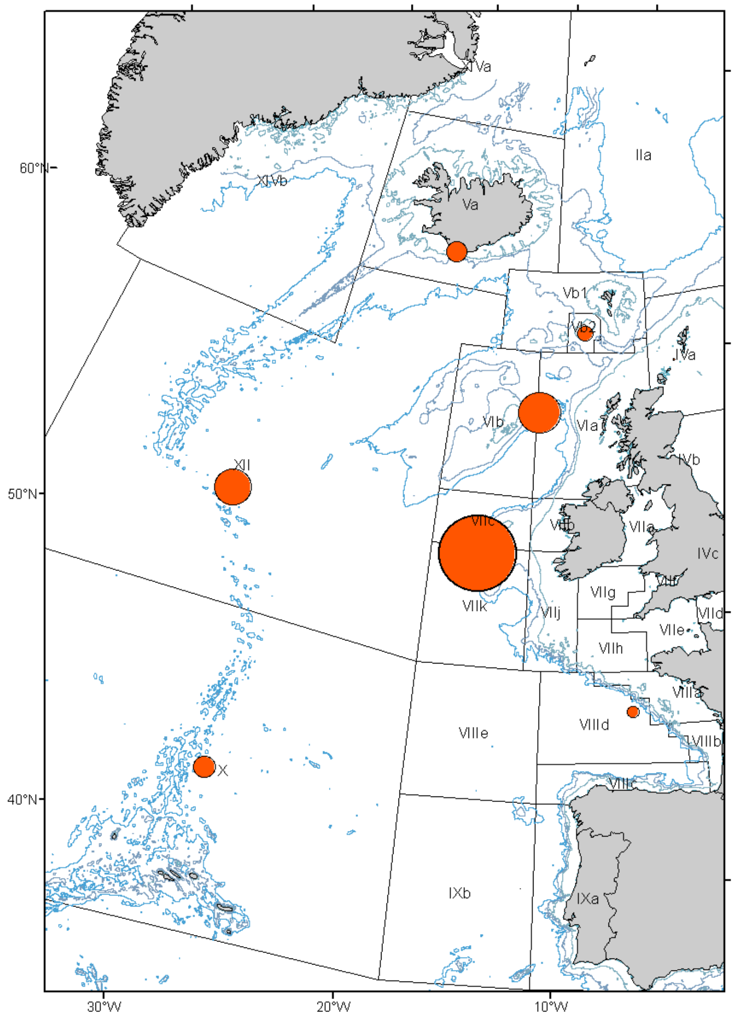



**Figure 9.1.1. Fisheries for orange roughy by ICES areas in Northeast Atlantic. Size of circles reflects historical accumulated catch 1991–2009).**

## 9.2 Orange roughy (*Hoplostethus atlanticus*) in Subarea VI

### 9.2.1 The fishery

There was a French target fishery, centred on spawning aggregations around the Hebrides Terrace Seamount. Irish vessels fished there for two years starting in 2001, but they have now effectively abandoned it.

#### 9.2.1.1 Landings trends

Table 9.2.0 and Figure 9.2.1 show the landings data for orange roughy for ICES Subarea VI as reported to ICES or as reported to the Working Group. There were no catches of orange roughy in Area VI recorded in 2010. The cumulative catch in Area VI until 2010 was 7185 tons (9.2.2).

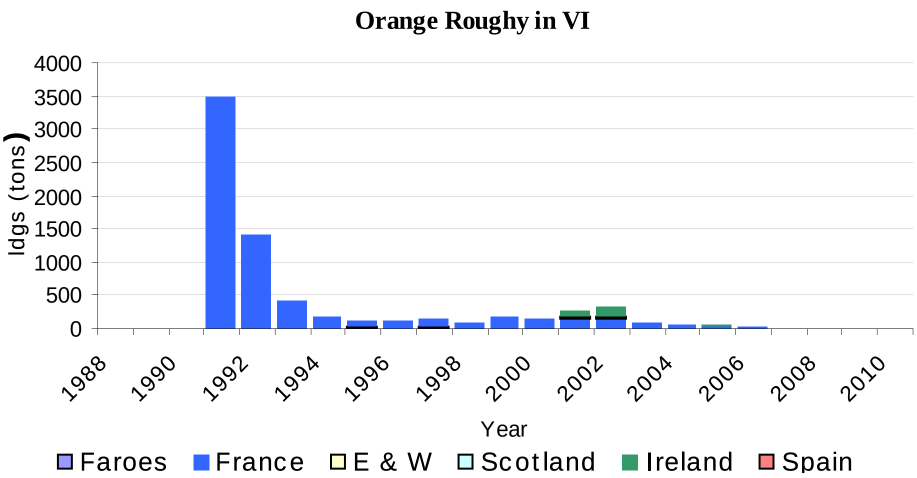



**Figure 9.2.1. Time-series of orange roughy landings by country in ICES Area VI.**

### 9.2.1.2 ICES Advice

ICES Advice in 2010 was:

*No directed fisheries for this species and measures to minimize bycatch should be taken.*

### 9.2.1.3 Management

In 2003 a TAC was introduced for orange roughy in VI, this TAC remained at 88 tons until 2006. In order to align the TAC with landings, the TAC for EC vessels in Area VI was reduced annually and is set for 0 in 2011 and 2012.

Landings in relation to TAC are displayed in the Table below.

| | | Landing (t) | |
|---|---|---|---|
| Year | TAC (t) | EC vessels | Total |
| 2003 | 88 | 81 | 81 |
| 2004 | 88 | 56 | 56 |
| 2005 | 88 | 45 | 45 |
| 2006 | 88 | 33 | 33 |
| 2007 | 51 | 12 | 12 |
| 2008 | 34 | 5 | 5 |
| 2009 | 17 | 2 | 2 |
| 2010 | 0 | 0 | 0 |
| 2011 | 0 | | |
| 2012 | 0 | | |

In addition to a TAC, a number of orange roughy protection areas have been introduced in 2005, from which EU vessels have no permission to land or retain any catches of orange roughy.

#### 9.2.1.4 Data available

#### 9.2.1.5 Landings and discards

Landings are in Table 9.2.0. Landings data were provided by France at the level of ICES statistical rectangles to display the geographic distribution of the fishery in Figures 9.1.2 and 9.1.3.

#### 9.2.1.6 Length compositions

Length distributions are available from historical observer programmes and current deep-water surveys. Available information can be found in the stock annex.

#### 9.2.1.7 Age compositions

No new information. Available information can be found in the stock annex.

#### 9.2.1.8 Weight-at-age

No information.

#### 9.2.1.9 Maturity and natural mortality

No new information. Available information can be found in the stock annex.

#### 9.2.1.10 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

### 9.2.2 Data analyses

No assessment was carried out for this stock in 2011. Preliminary productivity–susceptibility analysis for orange roughy in the mixed deep-water fishery was carried out and presented in ICES 2010. The analysis needs to be further improved and adapted before it can be used for the provision of management advice.

#### 9.2.2.1 Comments on the assessment

No assessment has been performed for this stock in 2011.

### 9.2.3 Management considerations

Management advice for deep-water species is not requested this year. Productivity susceptibility analysis (PSA) as recommended by WKFRAME will be further developed in order to assess whether existing fisheries pose a risk to the long-term sustainability of this stock.

**Table 9.2.0. Orange roughy catch in Subarea VI.**

| Year | Faroes | France | E & W | Scotland | Ireland | Spain | Total |
|---|---|---|---|---|---|---|---|
| 1988 | - | - | - | - | - | - | 0 |
| 1989 | - | 5 | - | - | - | - | 5 |
| 1990 | - | 15 | - | - | - | - | 15 |
| 1991 | - | 3,502 | - | - | - | - | 3502 |
| 1992 | - | 1,422 | - | - | - | - | 1422 |
| 1993 | - | 429 | - | - | - | - | 429 |
| 1994 | - | 179 | - | - | - | - | 179 |
| 1995 | 40 | 74 | - | 2 | - | - | 116 |
| 1996 | 0 | 116 | - | 0 | - | - | 116 |
| 1997 | 29 | 116 | 1 | - | - | - | 146 |
| 1998 | - | 100 | - | - | - | 2 | 102 |
| 1999 | - | 175 | - | - | 0 | 1 | 176 |
| 2000 | - | 136 | - | - | 2 | - | 138 |
| 2001 | - | 159 | - | 11 | 110 | - | 280 |
| 2002 | n/a | 152 | - | 41 | 130 | - | 323 |
| 2003 | - | 79 | - | - | 2 | - | 81 |
| 2004 | - | 54 | - | - | 2 | - | 56 |
| 2005 | - | 41 | - | - | 6 | - | 47 |
| 2006 | | 32 | | | 1 | | 33 |
| 2007 | | 12 | | | | | 12 |
| 2008 | | 5 | | | | | 5 |
| 2009 | | 3 | | | | | 3 |
| 2010* | | 0 | | | | | 0 |

*** Preliminary.**

## 9.3 Orange roughy (*Hoplostethus atlanticus*) in Subarea VII

### 9.3.1 The fishery

After the collapse of the VI fishery, the main fishery for orange roughy in the northern hemisphere moved to this subarea. In recent years some targeted fishing from a few or even one single 20–24 m trawlers was carried out until 2008, however now catches of orange roughy are a bycatch of some remaining deep-water fishing by large trawlers.

#### 9.3.1.1 Landings trends

Table 9.3.1 and Figure 9.3.1 show the landings data for orange roughy as reported to ICES or as reported to the Working Group. The preliminary landings for 2010 are zero tonnes.

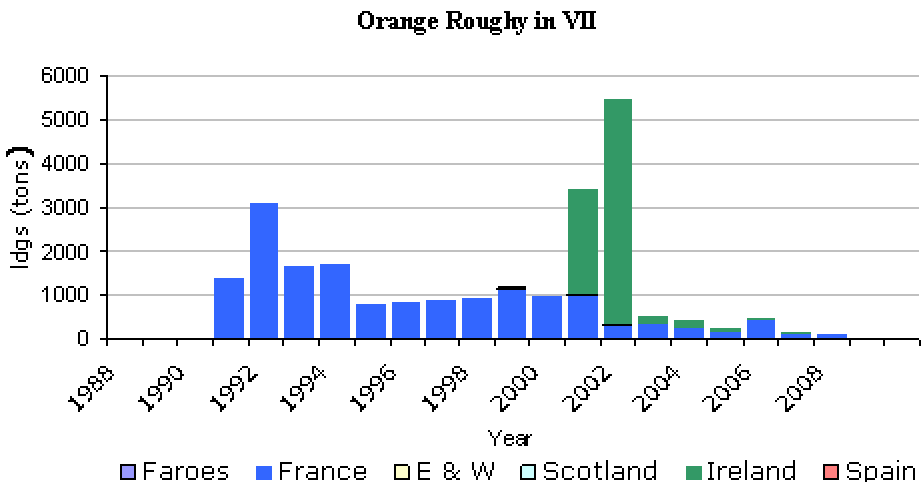



**Figure 9.3.1. Time-series of orange roughy landings by country in ICES Subarea VII.**

#### 9.3.1.2 ICES Advice

The ICES Advice statement from 2010 was:

*No directed fisheries for this species and measures to minimize bycatch should be taken.*

#### 9.3.1.3 Management

A TAC for orange roughy in Area VII was first introduced in 2003. Landings in relation to TAC are displayed in the table below:

| | | Landing (t) | |
|---|---|---|---|
| Year | TAC (t) | EC vessels | Total |
| 2003 | 1349 | 541 | 541 |
| 2004 | 1349 | 467 | 467 |
| 2005 | 1149 | 255 | 255 |
| 2006 | 1149 | 489 | 489 |
| 2007 | 193 | 172 | 172 |
| 2008 | 130 | 118 | 118 |
| 2009 | 65 | 15 | 15 |
| 2010 | 0 | 0 | 0 |
| 2011 | 0 | | |
| 2012 | 0 | | |

The TAC for orange roughy in VII is set to 0 t for 2011 and 2012.. Further to a TAC, a number of orange roughy protection areas have been introduced in 2005, from which EU vessels have no permission to land or retain any catches of orange roughy.

### 9.3.2 Data available

#### 9.3.2.1 Landings and discards

Landings are shown are in Table 9.3.0.

No new information on discarding is available. Historical information can be found in the stock annex.

#### 9.3.2.2 Length compositions

No new information available. Historical information can be found in the stock annex.

#### 9.3.2.3 Age compositions

No new information available. Historical information can be found in the stock annex.

#### 9.3.2.4 Weight-at-age

No data.

#### 9.3.2.5 Maturity and natural mortality

No new information available. Historical information can be found in the stock annex.

#### 9.3.2.6 Catch, effort and research vessel data

No new information. Available information can be found in the stock annex.

### 9.3.3 Data analyses

No assessment was carried out for this stock in 2011. Preliminary productivity–susceptibility analysis for orange roughy in the mixed deep-water fishery was carried out and is presented in ICES 2010. The analysis needs to be further improved and adapted before it can be used for the provision of management advice.

### 9.3.4 Comments on the assessment

None available.

### 9.3.5 Management considerations

Management advice for deep-water species is not requested this year. Productivity susceptibility analysis (PSA) as recommended by WKFRAME will be further developed in order to assess whether existing fisheries pose a risk to the long-term sustainability of this stock.

**Table 9.3.1. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus,* by nation in Subarea VII.**

| Year | France | Spain | E & W | Ireland | Scotland | Faroes | Total |
|---|---|---|---|---|---|---|---|
| 1988 | - | - | - | - | - | - | 0 |
| 1989 | 3 | - | - | - | - | - | 3 |
| 1990 | 2 | - | - | - | - | - | 2 |
| 1991 | 1406 | - | - | - | - | - | 1406 |
| 1992 | 3101 | - | - | - | - | - | 3101 |
| 1993 | 1668 | - | - | - | - | - | 1668 |
| 1994 | 1722 | - | - | - | - | - | 1722 |
| 1995 | 831 | - | - | - | - | - | 831 |
| 1996 | 879 | - | - | - | - | - | 879 |
| 1997 | 893 | - | - | - | - | - | 893 |
| 1998 | 963 | 6 | - | - | - | - | 969 |
| 1999 | 1157 | 4 | - | - | - | - | 1161 |
| 2000 | 1019 | - | - | 1 | | - | 1020 |
| 2001 | 1022 | - | 1 | 2367 | 22 | - | 3412 |
| 2002 | 300 | | 14 | 5114 | 33 | 4 | 5465 |
| 2003 | 369 | | | 172 | | | 541 |
| 2004 | 279 | | | 188 | | | 467 |
| 2005 | 165 | | | 90 | | | 255 |
| 2006 | 451 | | | 37 | | | 489 |
| 2007 | 145 | | | 28 | | | 164 |
| 2008 | 118 | | | | | | 118 |
| 2009 | 15 | | | | | | 15 |
| 2010* | | | | | | | |

***Preliminary.**

## 9.4 Orange roughy (*Hoplostethus atlanticus*) IN I, II, IIIa, IV, V, VIII, IX, X, XII, XIV

### 9.4.1 The fishery

Small fisheries have existed in Subareas Va, Vb, VIII, X, and XII. Most started in the early 1990s, the exception being Subarea X which started in 1996.

### 9.4.2 Landing trends

Table 9.4.0 and Figure 9.4.1 show the landings data for orange roughy for the ICES area as reported to ICES or as reported to the Working Group.

A Faroese exploratory trawl fishery is taking place in the Mid-Atlantic Ridge area. This fishery is mainly targeting orange roughy and black scabbard fishing ICES Areas X and XII. No updated information is available in 2009 and 2010.

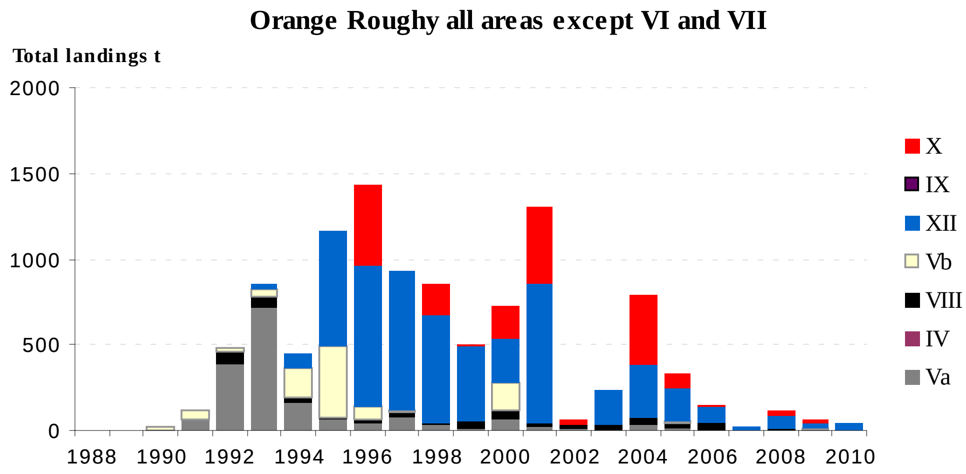



**Figure 9.4.1. Time-series of orange roughy landings by in all areas (except VI and VII).**

#### 9.4.2.1 ICES Advice

The ICES Advice statement from 2010 was:

*No directed fisheries for this species and measures to minimize bycatch should be taken.*

#### 9.4.2.2 Management measures

The EU TAC is set for 0 for 2011 and 2012. The TAC applies to Community waters and EC vessels in international waters. Landings in relation to EU TAC are shown in the table below. In addition there are a number of management measures that are currently in place in the NEAFC regulatory area in relation to bottom trawling in known VMEs and outside existing fishing areas.

| | | Landing (t) | |
|---|---|---|---|
| Year | TAC (t) | EC vessels | Total |
| 2005 | 102 | 71 | 278 |
| 2006 | 102 | 58 | 149 |
| 2007 | 44 | 16 | 36 |
| 2008 | 30 | 8 | 112 |
| 2009 | 15 | 5 | 62 |
| 2010 | 0 | | |
| 2011 | 0 | | |
| 2012 | 0 | | |

### 9.4.3 Data available

#### 9.4.3.1 Landings and discards

Landings are in Table 9.4.0.

#### 9.4.3.2 Length composition

No new information. Length frequencies on orange roughy from the Faroese exploratory fishery in 2008 are presented in the stock annex.

#### 9.4.3.3 Age composition

No data.

#### 9.4.3.4 Weight-at-age

No data.

#### 9.4.3.5 Maturity and natural mortality

No data.

#### 9.4.3.6 Catch, effort and research vessel data

No data.

#### 9.4.3.7 Data analysis

No assessment has been carried out during WGDEEP 2011.

### 9.4.4 Management considerations

Management advice for deep-water species is not requested this year. WKFRAME recommended carrying out productivity susceptibility analyses (PSA) on data poor stocks such as orange roughy. Further data on current fisheries would be required to carry out such an analysis.

**Table 9.4.0a. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Division Va.**

| Year | Iceland | Total |
|---|---|---|
| 1988 | - | 0 |
| 1989 | - | 0 |
| 1990 | - | 0 |
| 1991 | 65 | 65 |
| 1992 | 382 | 382 |
| 1993 | 717 | 717 |
| 1994 | 158 | 158 |
| 1995 | 64 | 64 |
| 1996 | 40 | 40 |
| 1997 | 79 | 79 |
| 1998 | 28 | 28 |
| 1999 | 14 | 14 |
| 2000 | 68 | 68 |
| 2001 | 19 | 19 |
| 2002 | 10 | 10 |
| 2003 | 0 | 0 |
| 2004 | 28 | 28 |
| 2005 | 9 | 9 |
| 2006 | 2 | 2 |
| 2007 | 0 | 0 |
| 2008 | 4 | 4 |
| 2009 | <1 | <1 |
| 2010* | <1 | <1 |

**Table 9.4.0b. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Division Vb.**

| Year | Faroes | France | Total |
|---|---|---|---|
| 1988 | - | - | 0 |
| 1989 | - | - | 0 |
| 1990 | - | 22 | 22 |
| 1991 | - | 48 | 48 |
| 1992 | 1 | 12 | 13 |
| 1993 | 36 | 1 | 37 |
| 1994 | 170 | + | 170 |
| 1995 | 419 | 1 | 420 |
| 1996 | 77 | 2 | 79 |
| 1997 | 17 | 1 | 18 |
| 1998 | - | 3 | 3 |
| 1999 | 4 | 1 | 5 |
| 2000 | 155 | 0 | 155 |
| 2001 | 1 | 4 | 5 |
| 2002 | 1 | 0 | 1 |
| 2003 | 2 | 3 | 5 |
| 2004 | | 7 | 7 |
| 2005 | 3 | 10 | 13 |
| 2006 | 0 | 0 | 0 |
| 2007 | 0 | 1 | 1 |
| 2008 | 0 | <1 | <1 |
| 2009 | <1 | 2 | 2 |
| 2010 | <1 | <1 | <1 |

**Table 9.4.0c. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea VIII.**

| Year | France | Spain VIII and IX | E & W | Total |
|---|---|---|---|---|
| 1988 | - | - | - | 0 |
| 1989 | 0 | - | - | 0 |
| 1990 | 0 | - | - | 0 |
| 1991 | 0 | - | - | 0 |
| 1992 | 83 | - | - | 83 |
| 1993 | 68 | - | - | 68 |
| 1994 | 31 | - | - | 31 |
| 1995 | 7 | - | - | 7 |
| 1996 | 22 | - | - | 22 |
| 1997 | 1 | 22 | - | 23 |
| 1998 | 4 | 10 | - | 14 |
| 1999 | 33 | 6 | - | 39 |
| 2000 | 47 | - | 5 | 52 |
| 2001 | 20 | - | - | 20 |
| 2002 | 20 | - | - | 20 |
| 2003 | 31 | | | 31 |
| 2004 | 43 | | | 43 |
| 2005 | 29 | | | 29 |
| 2006 | 43 | | | 43 |
| 2007 | 1 | | | 1 |
| 2008 | 8 | | | 8 |
| 2009 | 13 | | | 13 |
| 2010* | 8 | | | 8 |

**Table 9.4.0d. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea IX.**

| Year | Spain | Total |
|---|---|---|
| 1990 | - | 0 |
| 1991 | - | 0 |
| 1992 | - | 0 |
| 1993 | - | 0 |
| 1994 | - | 0 |
| 1995 | - | 0 |
| 1996 | - | 0 |
| 1997 | 1 | 1 |
| 1998 | 1 | 1 |
| 1999 | 1 | 1 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | 0 | 0 |
| 2005 | 0 | 0 |
| 2006 | 0 | 0 |
| 2007 | 0 | 0 |
| 2008 | 0 | 0 |
| 2009* | 0 | 0 |
| 2010 | 0 | 0 |

**Table 9.4.0e. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea X.**

| Year | Faroes | France | Norway | E & W | Portugal | Ireland | Total |
|---|---|---|---|---|---|---|---|
| 1989 | - | - | - | - | - | | 0 |
| 1990 | - | - | - | - | - | | 0 |
| 1991 | - | - | - | - | - | | 0 |
| 1992 | - | - | - | - | - | | 0 |
| 1993 | - | - | 1 | - | - | | 1 |
| 1994 | - | - | - | - | - | | 0 |
| 1995 | - | - | - | - | - | | 0 |
| 1996 | 470 | 1 | - | - | - | | 471 |
| 1997 | 6 | - | - | - | - | | 6 |
| 1998 | 177 | - | - | - | - | | 177 |
| 1999 | - | 10 | - | - | - | | 10 |
| 2000 | - | 3 | - | 28 | 157 | | 188 |
| 2001 | 84 | - | - | 28 | 343 | | 455 |
| 2002 | 30 | - | - | - | - | | 30 |
| 2003 | | 1 | | | | | 1 |
| 2004 | 384 | | | | | 19 | 403 |
| 2005 | 128 | 2 | | | | | 130 |
| 2006 | 8 | | | | | | 8 |
| 2007 | 0 | | | | | | 0 |
| 2008 | 37 | | | | | | 37 |
| 2009 | 26 | | | | | | 26 |
| 2010 | 39 | | | | | | 39 |

**Table 9.4.0f. Working Group estimates of landings of orange roughy, *Hoplostethus atlanticus*, in Subarea XII.**

| Year | Faroes | France | Iceland | Spain | E & W | Ireland | New Zealand | Russia | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1989 | - | 0 | - | - | - | | | - | 0 |
| 1990 | - | 0 | - | - | - | | | - | 0 |
| 1991 | - | 0 | - | - | - | | | - | 0 |
| 1992 | - | 8 | - | - | - | | | - | 8 |
| 1993 | 24 | 8 | - | - | - | | | - | 32 |
| 1994 | 89 | 4 | - | - | - | | | - | 93 |
| 1995 | 580 | 96 | - | - | - | | | - | 676 |
| 1996 | 779 | 36 | 3 | - | - | | | - | 818 |
| 1997 | 802 | 6 | - | - | - | | | - | 808 |
| 1998 | 570 | 59 | - | - | - | | | - | 629 |
| 1999 | 345 | 43 | - | 43 | - | | | - | 431 |
| 2000 | 224 | 21 | - | - | 2 | | | 12 | 259 |
| 2001 | 345 | 14 | - | - | 2 | | 450 | - | 811 |
| 2002 | + | 6 | - | - | - | | 0 | - | 6 |
| 2003 | | 64 | | | | 136 | 0 | - | 200 |
| 2004 | 176 | 131 | | | | | 0 | | 307 |
| 2005 | 158 | 36 | | | | | 0 | | 193 |
| 2006 | 81 | 15 | | | | | | | 96 |
| 2007 | 20 | | | | | | | | 20 |
| 2008 | 71 | | | | | | | | 71 |
| 2009 | 34 | | | | | | | | 34 |
| 2010 | 35 | | | | | | | | 35 |

**Table 9.4.0g. Orange roughy total international landings in the ICES area, excluding VI and VII.**

| Year | IV | Va | Vb | VIII | IX | X | XII | All areas |
|---|---|---|---|---|---|---|---|---|
| 1988 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | | 0 | 22 | 0 | 0 | 0 | 0 | 22 |
| 1991 | | 65 | 48 | 0 | 0 | 0 | 0 | 113 |
| 1992 | | 382 | 13 | 83 | 0 | 0 | 8 | 486 |
| 1993 | | 717 | 37 | 68 | 0 | 1 | 32 | 855 |
| 1994 | | 158 | 170 | 31 | 0 | 0 | 93 | 452 |
| 1995 | | 64 | 420 | 7 | 0 | 0 | 676 | 1167 |
| 1996 | | 40 | 79 | 22 | 0 | 471 | 818 | 1430 |
| 1997 | | 79 | 18 | 23 | 1 | 6 | 808 | 935 |
| 1998 | | 28 | 3 | 14 | 1 | 177 | 629 | 852 |
| 1999 | | 14 | 5 | 39 | 1 | 10 | 431 | 500 |
| 2000 | | 68 | 155 | 52 | 0 | 188 | 259 | 722 |
| 2001 | | 19 | 5 | 20 | 0 | 455 | 811 | 1310 |
| 2002 | | 10 | 1 | 20 | 0 | 30 | 6 | 67 |
| 2003 | | + | 5 | 31 | 0 | 1 | 200 | 237 |
| 2004 | | 28 | 7 | 43 | 0 | 403 | 307 | 788 |
| 2005 | | 9 | 13 | 29 | 0 | 83 | 193 | 327 |
| 2006 | | 2 | 0 | 43 | 0 | 8 | 96 | 149 |
| 2007 | 14 | | 1 | 1 | 0 | 0 | 20 | 36 |
| 2008 | 7 | 4 | <1 | 8 | 0 | 37 | 71 | 127 |
| 2009 | 0 | 1 | 2 | 3 | 0 | 26 | 34 | 66 |
| 2010 | 0 | <1 | <1 | 8 | 0 | 39 | 35 | 83 |
| Total | 14 | 1688 | 1004 | 545 | 3 | 1935 | 5527 | 10 681 |

***Preliminary.**

# 10 Roundnose grenadier (*Coryphaenoides rupestris*)

## 10.1 Stock description and management units

ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the NE Atlantic (Figure A.1):

- Skagerrak (IIIa);
- The Faroe–Hatton area, Celtic sea (Divisions Vb and XIIb, Subareas VI, VII);
- the Mid-Atlantic Ridge 'MAR' (Divisions Xb, XIIc, Subdivisions Va1, XIIa1, XIVb1);
- All other areas (Subareas I, II, IV, VIII, IX, Division XIVa, Subdivisions Va2, XIVb2).

This current perception is based on what are believed to be natural restrictions to the dispersal of all life stages. The Wyville–Thomson Ridge may separate populations further south on the banks and slopes off the British Isles and Europe from those distributed to the north along Norway and in the Skagerrak. Considering the general water circulation in the North Atlantic, populations from the Icelandic slope may be separated from those distributed to the west of the British Isles. It has been postulated that a single population occurs in all the areas south of the Faroese slopes, including also the slopes around the Rockall Trough and the Rockall and Hatton Banks but the biological basis for this remains hypothetical.

In 2007, WGDEEP examined the available evidence of stock discrimination in this species but, on the available evidence, was not able to make further progress in discriminating stocks. On this basis WGDEEP concluded there was no basis on which to change current practice.

Recent genetic analyses have brought forward new information regarding the issue of stock discrimination in the roundnose grenadier. White *et al*. (2010), investigating a limited geographic area in the central and eastern North Atlantic, found evidence of population substructure and local adaptation to depth. An ongoing study, to be published soon (Knutsen *et al*., in prep), covers a larger geographic range and finds indication for population structure throughout the species' distribution range. More specifically, they found that stock structure is clearly evident in the outskirts of the distribution range (Canada and Norway) however, significant but weaker structure, is found among some pairwise samples in the central distribution areas like MAR, west of UK and Greenland (Oral presentation by Knutsen *et al*., 2010 Iceland DSBS). This is ongoing work and the implications for stock structure have yet to be identified.

## 10.2 Roundnose grenadier (*Coryphaenoides rupestris*) in Division Vb and XIIb, Subareas VI and VII

### 10.2.1 The fishery

The majority of landings of roundnose grenadier from this area are taken by bottom trawlers. To the west of the British Isles, in Divisions Vb, VIa, VIb2 and Subareas VII, French trawlers catch roundnose grenadier in a multispecies deep-water fishery. The Spanish trawling fleet operates further offshore along the western slope of the Hatton Bank in ICES Divisions VIb1 and XIIb.

#### 10.2.1.1 Landings trends

Official French landings data for 2009 and 2010 are still very preliminary due to some changes in the processing of the fishing data by the administration which has severely delayed the availability of data for use in spring ICES working groups. To partly overcome this issue, total landings for 2009 and 2010 were provided with revisions made according to statistics on national quota consumption provided by the National Association of Fishing Organizations (ANOP).

Evidence of substantial mismatches between observer and official Spanish data of landings in Subarea VI and Division XIIb was presented at WGDEEP in 2010. This has raised some concerns regarding possible misreporting between the different species of grenadiers (*Coryphaenoides rupestris*, *Macrourus berglax* and *Trachyrincus scabrus*). No new information has been presented on this issue. Catches of *Macrourus berglax* and *Trachyrincus scabrus* are this year almost absent from the revised 2009 and preliminary 2010 data.

Over the past two decades, landings from Division Vb, have reached more than 3800 t in 1991 and more than 2000 t in 2001. Between these two periods, the landings were low (less than 700 t in 1994). After 2001, landings decreased to about 1000 t in 2002 but increased further to about 1830 t in 2005 then decreased to 450 t in 2009 and 370 t in 2010. These landings are almost exclusively from French and Faroese trawlers (Table 10.2.0a–f).

In Subarea VI, the highest landings were observed in 2001 (close to 15 000 t) and have decreased to around 3010 t in 2009 and 2450 t in 2010. Most of these landings are caught by French trawlers.

In Subarea VII landings close to 2000 t were recorded in 1993–1994; recent annual landings are much lower (from 200 to 400 t/year in 2005–2007, 60 t in 2009). In 2010, provisional landings are 18 t.

In ICES Division XIIb, the recent fishery is exclusively from Spanish trawlers. After a peak to more than 27 000 t in 2004, reported landings have decreased to about 2430 t in 2008, 5335 t in 2009 and 2760 t in 2010. There were significant Faroese landings in the mid-1990s, but this fishery disappeared in the 2000s. French fisheries have landed up to 1700 t in 2004 but have since strongly decreased. There were no French and Faroese landings in Division XIIb for 2007–2010.

The landings data are considered uncertain in Division XIIb, because unreported landings may occur in international waters. This is a serious issue for assessment considering the magnitude of the Spanish landings. In addition to this, all national landings data were not reported by new ICES divisions and some landings were allocated to divisions according to knowledge of the fisheries from the working group.

#### 10.2.1.2 ICES advice

In 2010, ICES advised: *Catches should be less than 6000 t and a further reduction in catches from recent levels should be considered in order to be consistent with MSY.*

#### 10.2.1.3 Management

TACs for EU vessels for deep-water species have been set since year 2003. These TACs are revised every second year. The EU TAC and national quotas from member countries apply to all vessels in EU EEZ and to EU vessels in international waters.

For Division Vb and Subareas VI and VII, a TAC was set at 2924 in 2011 and 2546 in 2012.

In Subareas VIII, IX, X, XII and XIV the TAC was set at 4573 t in 2011 and 3979 for 2012. This TAC covers areas with minor roundnose grenadier catches (VIII, IX and X), part of this assessment area (Division XIIb, the western slope of the Hatton bank) and the Mid-Atlantic Ridge (Divisions XIIa,c and Subarea XIV). The main countries having quotas allocations under this TAC are Spain and Poland. Therefore these quota allocations are based upon historical landings in XIIb for Spain and in XIIa,c (Mid-Atlantic Ridge) for Poland.

The table below summarizes the TACs in the two management areas and landings in the assessment area.

| | Vb, VI, VII | | VIII, IX, X, XII, XIV | | Total international Landings Vb, VI, VII, XIIb |
|---|---|---|---|---|---|
| | EU TAC | EU Landings | EU TAC | EU Landings XIIb | |
| 2005 | 5253 | 5777 | 7190 | 8782 | 14558 |
| 2006 | 5253 | 4676 | 7190 | 4361 | 9037 |
| 2007 | 4600 | 3778 | 6114 | 4258 | 8036 |
| 2008 | 4600 | 3102 | 6114 | 2432 | 5534 |
| 2009 | 3910 | 4046 | 5197 | 5335 | 9381 |
| 2010 | 3324 | 3978* | 5197 | 2758* | 6736* |
| 2011 | 2924 | | 4573 | | |
| 2012 | 2546 | | 3979 | | |

***: provisional.**

After the introduction of TACs in 2003 and 2005, the reported landings have decreased. However, the reported decrease may not be real as significant misreporting is likely to have occurred.

In addition to TACs, further management measures applicable to EU fleets are a licensing system, fishing effort limits, the obligation to land the fish in designated harbours and a regulation for on-board observations according to Council Regulation (EC) No 2347/2002 of 16 December 2002. In the Faroes waters, the catch of roundnose grenadier is subject to a minimum size of 40 cm total length, other regulations that may apply to roundnose grenadier are detailed in the overview section.

### 10.2.2 Data available

#### 10.2.2.1 Landings and discards

Landings time-series data per ICES areas are presented in Table 10.2.0

Landings data by new ICES areas were available from France, Norway and UK (England&Wales and Scotland) from 2005. No other country provided data by new ICES area. Catch in Subarea XII were allocated to Division XIIb (western Hatton bank) or XIIa,c (Mid-Atlantic Ridge) according to knowledge of the fisheries from WG members.

Catch and discards by haul were available from observer programmes from France and Spain (Figure 10.2.1–10.2.3).

*French observer programme:* New discards data are available from France in 2008–2010. The length distributions of discards from all these observations seem quite consistent and stable in recent years. *Based on French observer* programme 2004–2010, about 30% by weight and 50% by number of the catch of roundnose grenadier is discarded, because of small size. This figure is higher than in previous sampling where the discarding rate in the French fisheries was estimated slightly above 20% from sampling in 1997-1998 (Allain *et al*., 2003). The change may come from a combination of changes in the depth distribution of the fishing effort and a decrease in the abundance of larger fish as visible in the landings.

*Spanish Observer programme (Hatton Bank)*: New discard data are available from the Spanish Observer Programme. For the period 2002–2009, *observers have cover*ed on average 18±9% (range 8–27%) of the fleet fishing days in Division VIb, and 10±8% (range 3–28%) in Division XIIb. Although occasionally the discards reached 19% of the total weight catch, they are negligible in most sampled months. Annual average discards range from 2 to 15% in weight in Division VIb and from 0 to 12% by weight in Division XIIb. Average discarding for the whole period is 5% by weight in both areas. These discards, however, correspond to undersized individuals.

The Spanish official landings data show that on average, landings in Division VIb represent 38% and 43% of live weight estimates and catch respectively. In Division XII, landings represent 37% of both live weight and catch. Roundnose grenadier is processed in six different ways and the conversion factors range from 2 to 6, which probably translates into a significant loss of live weight. The question remains if this loss can account for as much as 60% of the catch, as the official data suggest.

#### 10.2.2.2 Length composition of the landings and discards

Length composition of landings and discards were available from France (Figures 10.2.1–10.2.2) and Spain (Figures 10.2.3-10.2.4) covering different periods and areas. In 2010, data from both countries are still very preliminary leading to substantial changes in modal lengths for Spanish data and French discards.

For France, the modal discarded length has remained constant (Figures 10.2.1–10.2.2) at around 12.5 cm while the average pre-anal length of the individuals in the landings has decreased from 20.8 cm in 1990 to 15.7 cm in 2010 (Figure 10.2.5).

Size frequency data provided by Spain for the period 2002–2010 in VI and XIIb shows the modal length (PAFL) of landings to be closely similar between divisions with female being larger than male by around 2 cm (Figure 10.2.6). The modal length of discards is around 9.5 cm. Over the period 2002–2010, there is no apparent trend in size of discards. However for landed individuals, both the average size for male and female have decreased by 1 cm (from 15.5 cm to 14 cm for females and 13.5 to 12.2 cm for males).

The difference of modes of the length distributions of landed catch between the Spanish fleet in Divisions VIb and XIIb and the French fleet is possibly because of different sorting habits in relation to different markets.

It is therefore important that length distribution of the landings and discards are provided to the working group by all fleets exploiting the stock.

#### 10.2.2.3 Age composition

No new data.

#### 10.2.2.4 Weight-at-age

No new data.

#### 10.2.2.5 Maturity and natural mortality

No new data.

#### 10.2.2.6 Research vessel survey and cpue

*Research vessel survey*

No new data were available this year.

*Lpues from the French trawl fishery to the West of the British Isles*

Haul by haul data from French skippers' personal tallybooks were updated for 2009 and 2010. Discards are not available from those datasets therefore only lpues are calculated and provided for roundnose grenadier.

### 10.2.3 Data analyses

**Benchmark assessments**

**Trends from lpues**

Abundance indices (2000–2010) were calculated based on French tallybook data (see stock annex). Grenadier abundance was predicted for the mean length of all tows carried out in every rectangle of the five small areas and averaged across rectangles (Figure 10.2.7–10.2.9). Trends in each box are relatively the same: after a period of decline from 2000 to 2003, indices have been stable since then.

**Multiyear Catch curve analysis**

The Multi year catch curve (MYCC) model developed as part of the EU-Deepfishman project (Trenkel, 2011, WD 15) with which first trials were prepared for WKDEEP (see stock annex).

In 2011, two datasets were provided for roundnose grenadier (Figures 10.2.10–10.2.11). In both cases the same age–length key was used for all years. The first one consisted of international landings-at-age for ICES Areas Vb, VI and VII for the years 1990 to 2010. The second one were of catches-at-age (landings plus discard estimates) for the period 1997–2010. No discards estimates were available prior to 1997. The time-trends of total catches and landings are similar during the period 1997–2010. For the analysis the datasets were restricted to the fully recruited age classes to avoid fitting catch curves to the ascending limb of the size distribution created by gear selectivity. Further, a plus group was created for ages 46 and above, called 46+. Visually the annual age distribution of landings and discards are rather similar for the age range 26 to 46+; they are descending in all years.

MYCCs were fitted to landings and catches fixing natural mortality at 0.1 The QQ-plots for the recruitment random effect showed that by fixing $M$ the model asumptions were met for both dataset. Further, the QQ-plots also indicated that model assumptions were better met by the landings data compared to the catch data. Residuals for catch-at-age by year were generally positive younger ages and sometimes negative for the oldest age classes. This might stems from the fact that all ages do not have the same total mortality as assumed in the model. Overall, the results obtained by fixing natural mortality and using the landings dataset seem to be more reliable than all other estimates.

The results, as shown in Figure 10.2.12, for the landings data show that since the beginning of the time-series, *Z* increased and peaked at a high level in 2001–2003. Thereafter, Z declined toward lower levels, close to those from 1990 or even below in the most recent years. Taking M=0.1, Z=0.13 (2010) implies F=0.03, which is much below $F_{msy}$ taking $F_{msy}$=M as a proxy. This suggests fishing mortality in recent years was below $F_{msy}$. Further, the results suggest that stock abundance is following a rebuilding trajectory. Because individuals have higher survival in recent years and hence the proportion in young individuals is increasing, the stock increase in biomass is less than in numbers.

### Bayesian surplus production model

A Bayesian surplus production model is used for this stock and results are used as indicators of trends (see stock annex). The following datasets were used for the reference assessment ('Ref'):

landings in Vb, VI, VII (1988–2010);

abundances indices from the French tallybooks (2000–2010).

A working document (Roel *et al*., WD-27) explored this year the sensitivity of some parameters used in the surplus production model. The main conclusions were:

- A correlation exists between Q and K. The distribution of *K* is influenced by a rather informative prior. Sensitivity analysis using a less informative prior suggests there is little information in the data to estimate *K*. However, the history of exploitation of the stock and the declining trend in lpue data suggest that large values of *K* are unlikely and that proposing a more informative prior is probably defensible.
- The stock biomass trajectory suggests that the stock has declined since the start of exploitation but has increased in recent years. Examination of the posterior distribution of the model estimates expressed in relative terms suggests that the current biomass is likely to be above $B_{msy}$ and that the current catch is below MSY. The current harvest rate is also likely to be below harvest rate MSY. However, the time-series of abundance indices remain too short and credibility intervals are wide.
- However, given the results of the sensitivity analysis, relative parameters such as current biomass/$B_{msy}$ and current catch/MSY are likely to be more robust and therefore more appropriate to providing management advice. It is there advisable to present results in terms of relative abundance in respect to MSY (B/$B_{msy}$) rather than in absolute values (stock biomass).

Exploratory assessments

The benchmarked assessment methodology uses data only from Vb, VI and VII. This year, some additional exploratory assessment was carried out:

- Adding XIIb landings to Vb, VI, VII data. Abundances indices from Spanish lpues for 2002–2010 were combined with a weighting corresponding to the relative importance of the landings in XIIb and Vb, VI, VII (run "567XIIb").

- Adding in VI landings data of *Macrourus berglax* and *Trachyrincus scabrous* for those regions to take account of misreported landings (run "56inf7").
- Adding in VI and XIIb landings data of *Macrourus berglax* and *Trachyrincus scabrous* for those regions to take account of misreported landings. (run "56inf7XIIbinf").

The various time-series used for those runs are listed in Table 10.2.1.

#### 10.2.3.1 Comments on the assessments

The benchmark assessment is considered as indicative of trends only. Diagnostic plots of the reference assessment are presented in Figure 10.2.13 and biomass and harvest rates are shown in Figure 10.2.14. The reference run shows a decline of the biomass of around 50% up to 2003. Biomass is then stable at low levels. Exploitation rates have gradually doubled and are stable at high level since 2005. The apparent stability is likely to be the consequence of the regulations in place since 2003 (TACs and deep-sea fishing permit).

The summary of the results from the exploratory assessment is presented in Table 10.2.2.

Uncertainties on exploitable biomass estimates and harvest rate estimates are high (Figures 10.2.14–10.2.17). All simulations present a decline of around 50% in average biomass from 1988 to 2003. Then biomass is relatively stable. Median estimated harvest rate, expressed as the ratio of landings over biomass exhibits an increase up to 2006 with increasing uncertainties followed by a decrease to the 2002–2003 levels. Harvest rates in 2006 were more or less the double of those in 1988.

In the exploratory assessments, the inclusion of XIIb (Figure 10.2.16) data resulted in an increase of 68% of the median biomass estimates in 1988 and by 88% in 2010 compared with the reference assessment. It is worth noting that the same exercise carried out last year led to a respective increase of 85% and 110% for 1988 and 2009 biomass estimates. The model appears to be quite sensitive to the level of landings provided in recent years. Using average biomass, the inclusion of XIIb led to an increase of biomass of around 50% in both 1988 and 2010 estimates. Those results highlight the need of accurate landings and effort data in XIIb.

Considering all Spanish landings of grenadier species in VI (Figure 10.2.15) and in XIIb (Figure 10.2.17) as *those of Coryphaenoides rupestris* has led to an increase of landings ranging year by year ranging up to 134%.

Using inflated landings, median and average biomasses in 1988 have increased by around 10%. Median biomass in 2010 has increased by 40% in VI and by 13% for the entire stock. Average biomass increased respectively by 9 and 17% for VI and the entire stock area.

Those changes in biomass are quite unpredictable and but remain small in comparison of the amplitude of uncertainties in the biomass estimates therefore the effect of misreporting does not seem to be substantial for the assessment in terms of quantitative results. Including those landings does not change as well the overall trends of abundance compared with the reference assessment.

Assessments also include relative values of Biomass in reference to $B_{msy}$ ($B/B_{msy}$) and harvest rate at MSY ($H/H_{msy}$). The time-series are still too short for these values to be of use for advice. The exploratory assessment suggests here using inflated landings or adding XIIb data does not substantially change those values. $B/B_{msy}$ is around 0.5–0.6

while $H/H_{msy}$ is around 2. Both indicators have very wide confidence intervals (of the magnitudes of the median values).

### 10.2.4 Management considerations

Management advice for deep-water species is not requested this year. In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME e.g. Bayesian surplus production model.

**Table 10.2.0a. Working Group estimates of landings of roundnose grenadier from Division Vb.**

| Year | Faroes | France | Norway | Germany | Russia/USSR | UK (E+W) | UK (Scot) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1988 | | | | 1 | | | | 1 |
| 1989 | 20 | 181 | | 5 | 52 | | | 258 |
| 1990 | 75 | 1470 | | 4 | | | | 1549 |
| 1991 | 22 | 2281 | 7 | 1 | | | | 2311 |
| 1992 | 551 | 3259 | 1 | 6 | | | | 3817 |
| 1993 | 339 | 1328 | | 14 | | | | 1681 |
| 1994 | 286 | 381 | | 1 | | | | 668 |
| 1995 | 405 | 818 | | | | | | 1223 |
| 1996 | 93 | 983 | | 2 | | | | 1078 |
| 1997 | 53 | 1059 | | | | | | 1112 |
| 1998 | 50 | 1617 | | | | | | 1667 |
| 1999 | 104 | 1861 | 2 | | | 29 | | 1996 |
| 2000 | 48 | 1699 | | 1 | | 43 | | 1791 |
| 2001 | 84 | 1932 | | | | | | 2016 |
| 2002 | 176 | 774 | | | | 81 | | 1031 |
| 2003 | 490 | 1032 | | | | 10 | | 1532 |
| 2004 | 508 | 985 | 0 | 0 | 6 | 0 | 76 | 1575 |
| 2005 | 903 | 884 | 1 | 0 | 1 | 0 | 48 | 1837 |
| 2006 | 900 | 875 | 0 | 0 | 0 | 0 | 0 | 1775 |
| 2007 | 838 | 862 | 0 | 0 | 0 | 0 | 0 | 1700 |
| 2008 | 665 | 447 | 0 | 0 | 0 | 0 | 0 | 1112 |
| 2009 | 322 | 122 | 0 | 0 | 0 | 0 | 2 | 446 |
| 2010* | 224 | 144 | 0 | 0 | 0 | 0 | 1 | 369 |

*** Preliminary.**

**Table 10.2.0b. Working Group estimates of landings of roundnose grenadier from Subarea VI.**

| Year | Estonia | Faroes | France | Germany | Ireland | Lithuania | Norway | Poland | Russia | Spain | UK (E+W) | UK (Scot) | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | 27 | | 4 | | | | | | | 1 | | 32 |
| 1989 | | 2 | 2211 | 3 | | | | | | | | 2 | 2218 |
| 1990 | | 29 | 5484 | 2 | | | | | | | | | 5515 |
| 1991 | | | 7297 | 7 | | | | | | | | | 7304 |
| 1992 | | 99 | 6422 | 142 | | | 5 | | | | 2 | 112 | 6782 |
| 1993 | | 263 | 7940 | 1 | | | | | | | | 1 | 8205 |
| 1994 | | | 5898 | 15 | 14 | | | | | | | 11 | 5938 |
| 1995 | | | 6329 | 2 | 59 | | | | | | | 82 | 6472 |
| 1996 | | | 5888 | | | | | | | | | 156 | 6044 |
| 1997 | | 15 | 5795 | | 4 | | | | | | | 218 | 6032 |
| 1998 | | 13 | 5170 | | | | 21 | | | 3 | | | 5207 |
| 1999 | | | 5637 | 3 | 1 | | | | | 1 | | | 5642 |
| 2000 | | | 7478 | | 41 | | 1 | | | 1002 | 1 | 433 | 8956 |
| 2001 | 680 | 11 | 5897 | 6 | 31 | 137 | 32 | 58 | 3 | 6942 | 21 | 955 | 14 773 |
| 2002 | 821 | | 7209 | | 12 | 1817 | | 932 | | | 6 | 741 | 11 538 |
| 2003 | 52 | 32 | 4924 | | 11 | 939 | | 452 | 3 | | | 185 | 6598 |
| 2004 | 26 | 12 | 4574 | 0 | 8 | 961 | 0 | 13 | 72 | 1991 | 0 | 72 | 7729 |
| 2005 | 80 | 24 | 2897 | 0 | 17 | 92 | 1 | 0 | 71 | 467 | 0 | 44 | 3694 |
| 2006 | 34 | 25 | 1931 | 0 | 5 | 112 | 0 | 0 | 0 | 393 | 0 | 15 | 2515 |
| 2007 | 0 | 10 | 1552 | 0 | 2 | 31 | 0 | 0 | 0 | 252 | 0 | 4 | 1851 |
| 2008 | 0 | 6 | 1433 | 0 | 0 | 23 | 0 | 0 | 16 | 458 | 0 | 27 | 1963 |
| 2009 | 0 | 6 | 1090 | 0 | 0 | 0 | 0 | 0 | 0 | 1900 | 0.3 | 15 | 3012 |
| 2010* | 0 | 13 | 464 | 0 | 0 | 0 | 2 | 0 | 0 | 1947 | 1.2 | 23 | 2450 |

*** Preliminary.**

**Table 10.2.0c. Working Group estimates of landings of roundnose grenadier from Subarea VII.**

| Year | Faroes | France | Ireland | Spain | UK (Scot) | TOTAL |
|---|---|---|---|---|---|---|
| 1988 | | | | | | 0 |
| 1989 | | 222 | | | | 222 |
| 1990 | | 215 | | | | 215 |
| 1991 | | 489 | | | | 489 |
| 1992 | | 1556 | | | | 1556 |
| 1993 | | 1916 | | | | 1916 |
| 1994 | | 1922 | | | | 1922 |
| 1995 | | 1295 | | | | 1295 |
| 1996 | | 1051 | | | | 1051 |
| 1997 | | 1033 | | 5 | | 1038 |
| 1998 | | 1146 | | 11 | | 1157 |
| 1999 | | 892 | | 4 | | 896 |
| 2000 | | 859 | | | | 859 |
| 2001 | | 938 | 416 | | | 1354 |
| 2002 | 1 | 449 | 605 | | 3 | 1058 |
| 2003 | | 373 | 213 | | 1 | 587 |
| 2004 | 0 | 248 | 320 | 0 | 0 | 568 |
| 2005 | 0 | 191 | 55 | 0 | 0 | 246 |
| 2006 | | 248 | 138 | 0 | 0 | 386 |
| 2007 | | 207 | 20 | 0 | 0 | 227 |
| 2008 | | 27 | | | | 27 |
| 2009 | | 59 | | | | 59 |
| 2010* | | 18 | | | | 18 |

*** Preliminary.**

**Table 10.2.0d. Working Group estimates of landings of roundnose grenadier from Subarea XIIb.**

| Year | Estonia | Faroes | France** | Germany | Iceland | Ireland | Lithuania | Spain | USSR/Russia | UK (E+W) | UK (Scotl.) | Norway | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | | | | | | | | | | | 0 |
| 1989 | | | 0 | | | | | | 52 | | | | 52 |
| 1990 | | | 0 | | | | | | | | | | 0 |
| 1991 | | | 14 | | | | | | 158 | | | | 172 |
| 1992 | | | 13 | | | | | | | | | | 13 |
| 1993 | | 263 | 26 | 39 | | | | | | | | | 328 |
| 1994 | | 457 | 20 | 9 | | | | | | | | | 486 |
| 1995 | | 359 | 285 | | | | | | | | | | 644 |
| 1996 | | 136 | 179 | | 77 | | | 1136 | | | | | 1528 |
| 1997 | | 138 | 111 | | | | | 1800 | | | | | 2049 |
| 1998 | | 19 | 116 | | | | | 4262 | | | | | 4397 |
| 1999 | | 29 | 287 | | | | | 8251 | 6 | | | | 8573 |
| 2000 | | 6 | 374 | 9 | | | | 5791 | | 9 | 6 | | 6195 |
| 2001 | | 2 | 159 | | | 3 | | 5922 | | | 7 | 1 | 6094 |
| 2002 | | | 14 | | | | 18 | 10 045 | | 1 | 2 | | 10 080 |
| 2003 | | | 539 | | | 1 | 31 | 11 663 | | | 1 | | 12 235 |
| 2004 | | 8 | 1693 | | | | 120 | 10 880 | 91 | | 4 | | 12 796 |
| 2005 | 20 | 5 | 508 | | | | 13 | 7804 | 81 | | 350 | | 8782 |
| 2006 | 27 | 1 | 85 | | | | 6 | 4242 | | | | | 4361 |
| 2007 | 140 | 2 | 0 | | | | 8 | 4108 | | | | | 4258 |
| 2008 | | 0 | 0 | | | | 3 | 2416 | 13 | | | | 2432 |
| 2009 | | | | | | | | 5335 | | | | | 5335 |
| 2010* | | | | | | | | 2758 | | | | | 2758 |

*** Preliminary.**

**** French landings reported in former ICES Subarea XII allocated to XIIb.**

**Table 10.2.0e. Working Group estimates of landings of roundnose grenadier unallocated landings in Vb VI and VII.**

| Year | Unallocated |
|---|---|
| 1988 | |
| 1989 | |
| 1990 | |
| 1991 | |
| 1992 | |
| 1993 | |
| 1994 | |
| 1995 | |
| 1996 | |
| 1997 | |
| 1998 | |
| 1999 | |
| 2000 | |
| 2001 | 208 |
| 2002 | 504 |
| 2003 | 952 |
| 2004 | 0 |
| 2005 | 0 |
| 2006 | 0 |
| 2007 | 0 |
| 2008 | 0 |
| 2009 | 0 |
| 2010* | 0 |

*** Preliminary.**

**Table 10.2.0f. Working Group estimates of landings of roundnose grenadier Vb, VI, VI and XIIb.**

| Year | Vb | VI | VII | XIIb | Unallocated | Vb,VI,VII | Overall total |
|---|---|---|---|---|---|---|---|
| 1988 | 1 | 32 | 0 | 0 | 0 | 33 | 33 |
| 1989 | 258 | 2218 | 222 | 52 | 0 | 2698 | 2750 |
| 1990 | 1549 | 5515 | 215 | 0 | 0 | 7279 | 7279 |
| 1991 | 2311 | 7304 | 489 | 172 | 0 | 10 104 | 10 276 |
| 1992 | 3817 | 6782 | 1556 | 13 | 0 | 12 155 | 12 168 |
| 1993 | 1681 | 8205 | 1916 | 328 | 0 | 11 802 | 12 130 |
| 1994 | 668 | 5938 | 1922 | 486 | 0 | 8528 | 9014 |
| 1995 | 1223 | 6472 | 1295 | 644 | 0 | 8990 | 9634 |
| 1996 | 1078 | 6044 | 1051 | 1528 | 0 | 8173 | 9701 |
| 1997 | 1112 | 6032 | 1038 | 2049 | 0 | 8182 | 10 231 |
| 1998 | 1667 | 5207 | 1157 | 4397 | 0 | 8031 | 12 428 |
| 1999 | 1996 | 5642 | 896 | 8573 | 0 | 8534 | 17 107 |
| 2000 | 1791 | 8956 | 859 | 6195 | 0 | 11 606 | 17 801 |
| 2001 | 2016 | 14 773 | 1354 | 6094 | 208 | 18 143 | 24 445 |
| 2002 | 1031 | 11 538 | 1058 | 10 080 | 504 | 13 627 | 24 210 |
| 2003 | 1532 | 6598 | 587 | 12 235 | 952 | 8717 | 21 904 |
| 2004 | 1575 | 7729 | 568 | 12 796 | 0 | 9872 | 22 668 |
| 2005 | 1837 | 3694 | 246 | 8782 | 0 | 5777 | 14 558 |
| 2006 | 1775 | 2515 | 386 | 4361 | 0 | 4676 | 9037 |
| 2007 | 1700 | 1851 | 227 | 4258 | 0 | 3778 | 8036 |
| 2008 | 1112 | 1963 | 27 | 2432 | 0 | 3102 | 5534 |
| 2009 | 446 | 3012 | 59 | 5335 | 0 | 4046 | 9381 |
| 2010* | 369 | 2450 | 18 | 2758 | 0 | 3978 | 6736 |

*** Preliminary.**

**Table 10.2.1. Time-series of landings and lpues used for the reference and exploratory assessments.**

| | Landings data (1988–2010) | | | | Tallybook | Abundance indices |
|---|---|---|---|---|---|---|
| | Vb, VI, VII | Vb, VI, VII | Vb, VI, VII | Vb, VII | abundance | France + Spain |
| | | and VI (combined species) | XIIb | VI+XIIb (combined species) | indices | Vb, VI, VII, XIIb |
| Year | Ref | 56inf7 | 567XIIb | +XIIbSP | Ref | 567XIIb |
| | | | | | and 56inf7 | and 56inf712inf |
| 1988 | 33 | 33 | 33 | 33 | - | - |
| 1989 | 2698 | 2698 | 2750 | 2750 | - | - |
| 1990 | 7279 | 7279 | 7279 | 7279 | - | - |
| 1991 | 10 104 | 10 104 | 10 276 | 10 276 | - | - |
| 1992 | 12 155 | 12 155 | 12 168 | 12 168 | - | - |
| 1993 | 11 802 | 11 802 | 12 130 | 12 130 | - | - |
| 1994 | 8528 | 8528 | 9014 | 9014 | - | - |
| 1995 | 8990 | 8990 | 9634 | 9634 | - | - |
| 1996 | 8173 | 8173 | 9701 | 9701 | - | - |
| 1997 | 8182 | 8182 | 10 231 | 10 231 | - | - |
| 1998 | 8031 | 8031 | 12 428 | 12 428 | - | - |
| 1999 | 8534 | 8534 | 17 107 | 17 107 | - | - |
| 2000 | 11 606 | 11 606 | 17 801 | 17 801 | 1.000 | - |
| 2001 | 18 143 | 18 143 | 24 237 | 24 237 | 0.690 | - |
| 2002 | 13 627 | 13 627 | 23 706 | 24 843 | 0.724 | 1.000 |
| 2003 | 8717 | 8717 | 20 952 | 21 174 | 0.277 | 1.055 |
| 2004 | 9872 | 9894 | 36 759 | 37 484 | 0.287 | 0.894 |
| 2005 | 5777 | 8346 | 14 558 | 16 993 | 0.295 | 0.528 |
| 2006 | 4676 | 8695 | 9037 | 10 475 | 0.265 | 0.447 |
| 2007 | 3778 | 8804 | 8036 | 10 471 | 0.259 | 0.405 |
| 2008 | 3102 | 4274 | 5534 | 6347 | 0.273 | 0.459 |
| 2009 | 3215 | 3311 | 6615 | 6803 | 0.289 | 0.359 |
| 2010 | 2614 | 2761 | 4427 | 4789 | 0.263 | 0.409 |

**Table 10.2.2. Summary of results from the exploratory assessments.**

| Simulation | Year | Ref | 56inf7 | 567XIIb | 567infXIIbinf |
|---|---|---|---|---|---|
| Median biomass +/- std dev | 1988<br>2010 | 134581 +/- 131887<br>34804 +/- 143691 | 149158 +/- 93481<br>48633 +/- 105645 | 226232 +/- 116569<br>65308 +/- 134634 | 240386 +/- 150844<br>73746 +/- 168674 |
| Average biomass | 1988<br>2010 | 169729<br>77140 | 179150<br>84231 | 263624<br>110740 | 288475<br>129361 |
| Median B/Bmsy +/- std dev | 2010 | 0.511 +/- 0.407 | 0.629 +/- 0.41 | 0.565 +/- 0.377 | 0.604 +/- 0.374 |
| Median harvest +/- std dev | 2010 | 2.545 +/- 2.986 | 2.037 +/- 2.124 | 2.075 +/- 2.877 | 1.967 +/- 2.532 |

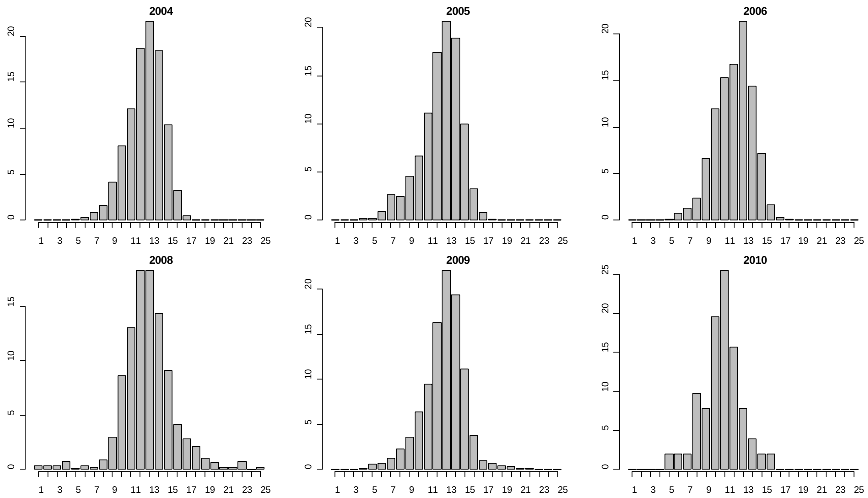



**Figure 10.2.1. Sampling of the length distribution of discards of roundnose grenadier from the on-board observation programme 2004–2010.**

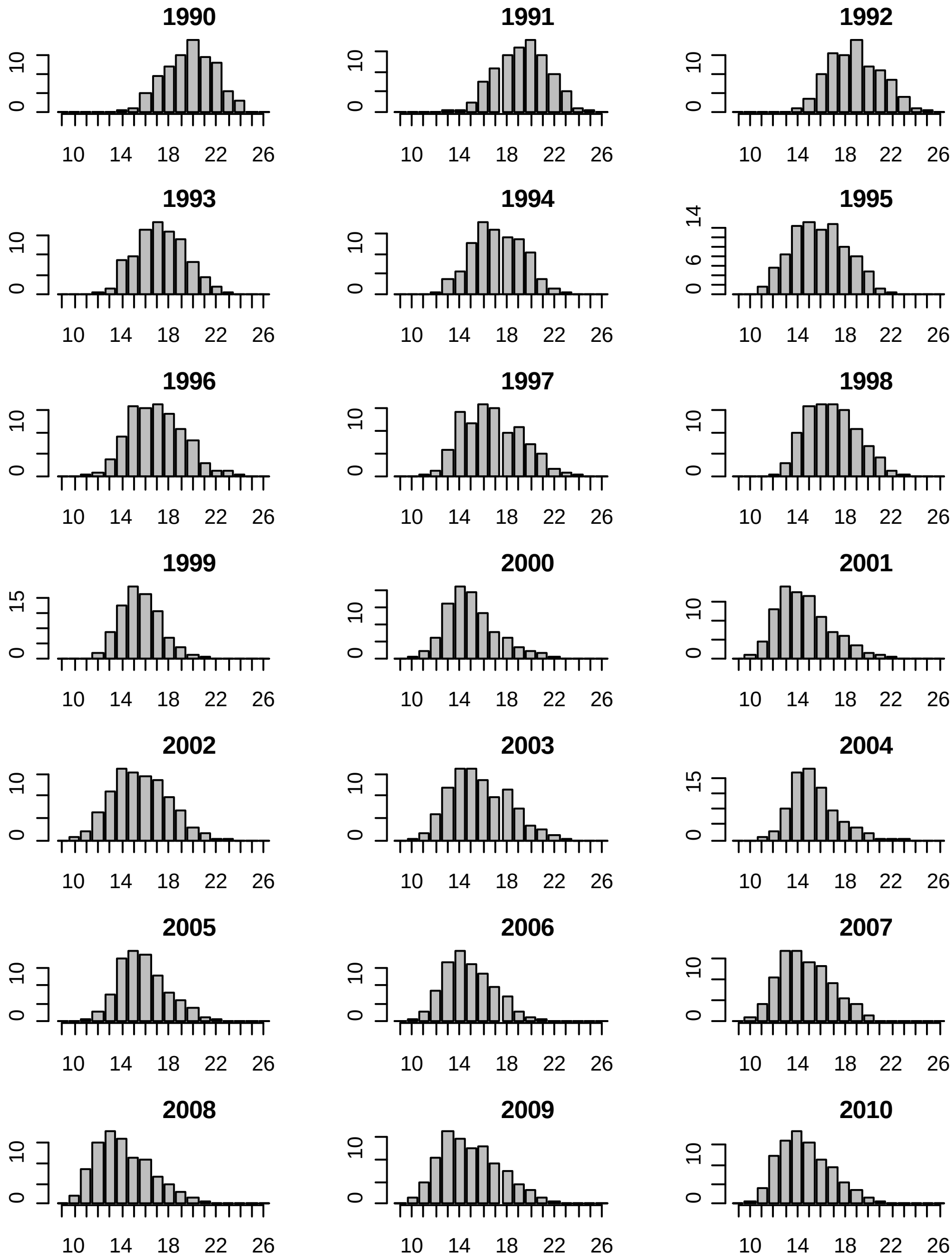



**Figure 10.2.2. Length distribution (PAFL, cm) of the landings of the French fleet, sampled at fish-markets, 1997–2010.**

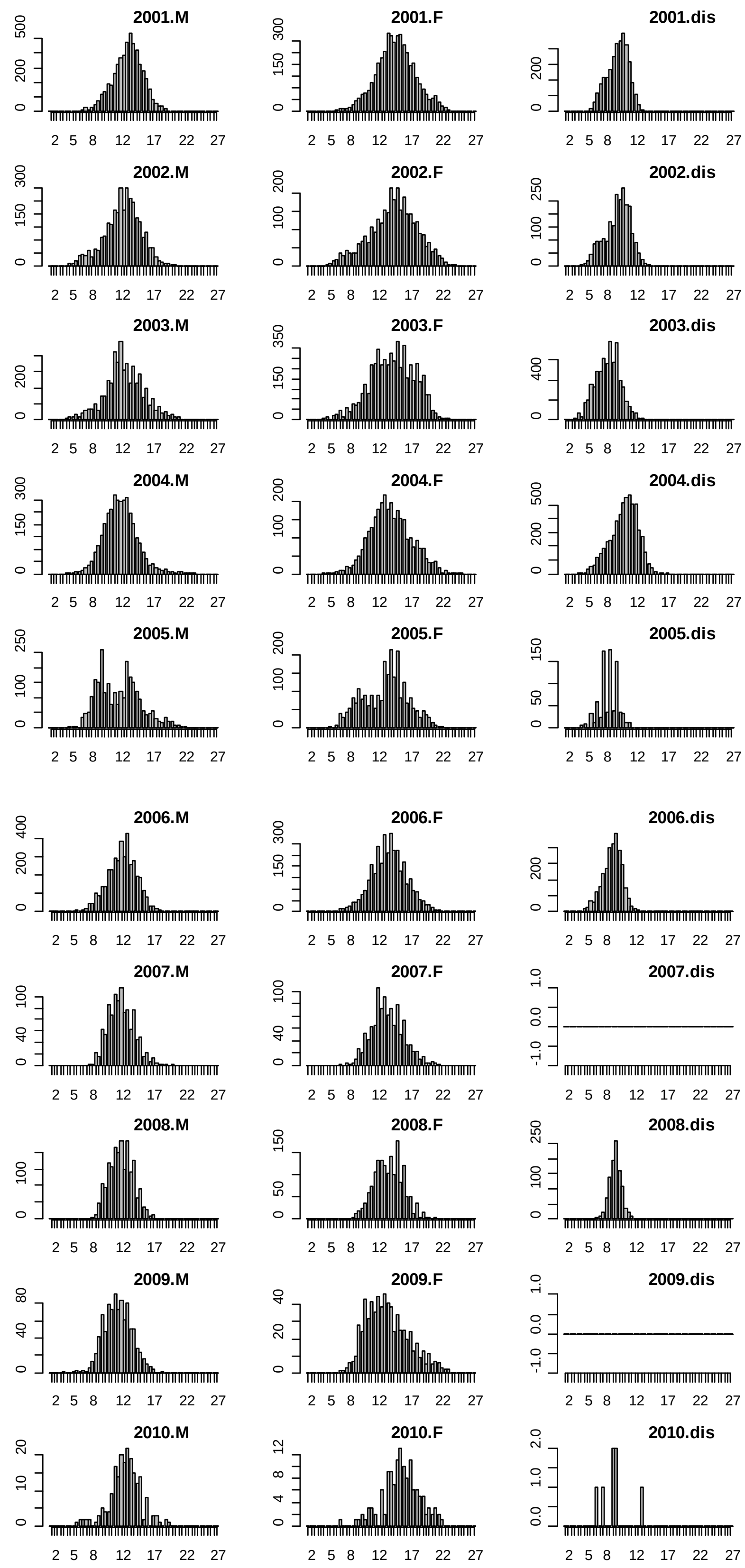


**Figure 10.2.3. Length distribution of the landings by sex and discards of the Spanish fleet in Division VIb based from on-board observations, 2001–2010.**

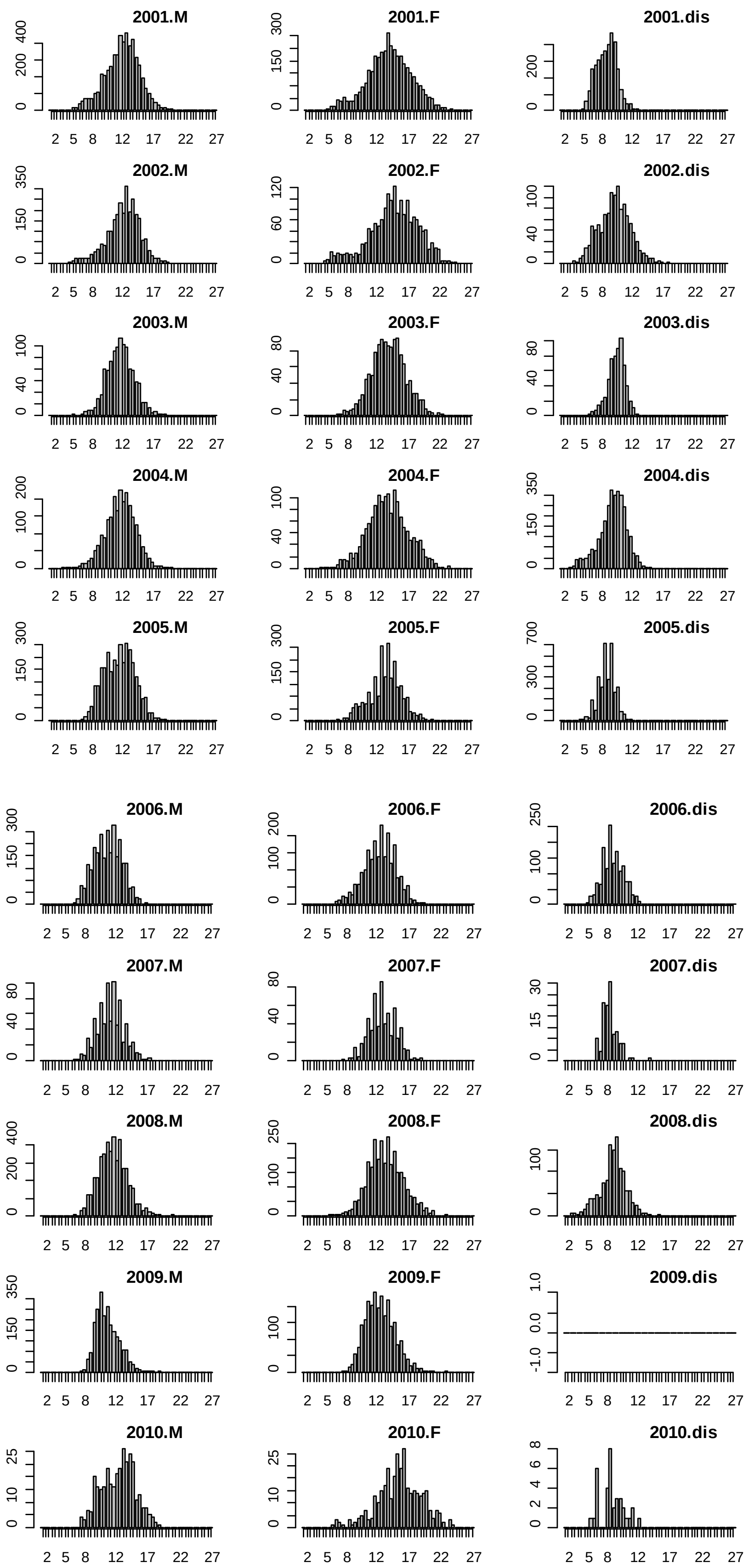



**Figure 10.2.4. Length distribution of the landings by sex and discards of the Spanish fleet in Division XIIb based from on-board observations, 2001–2010.**

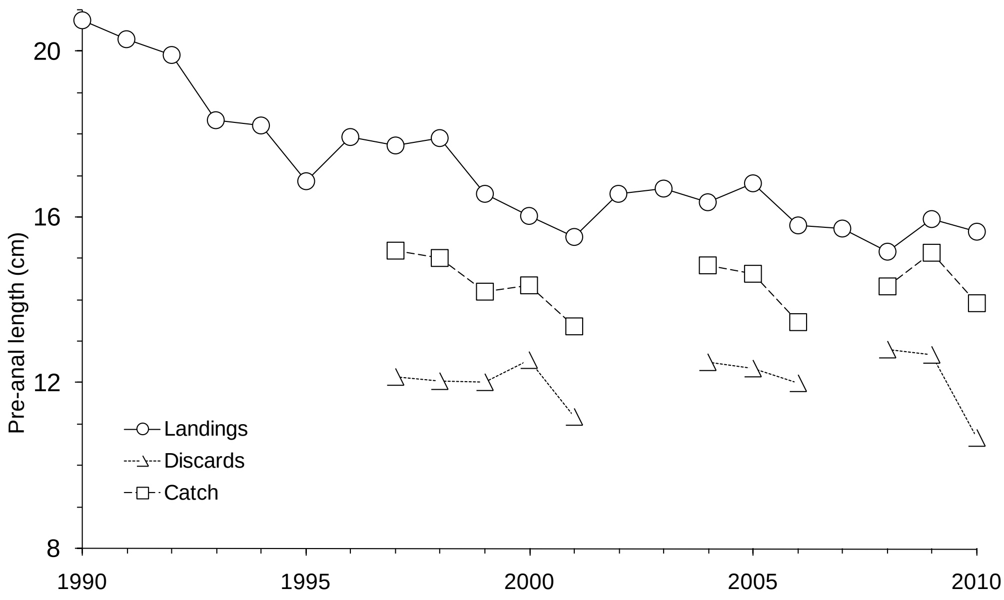



**Figure 10.2.5. Trends in pre-anal length of Roundnose grenadier from French landings, catch and discards, 1990–2010.**

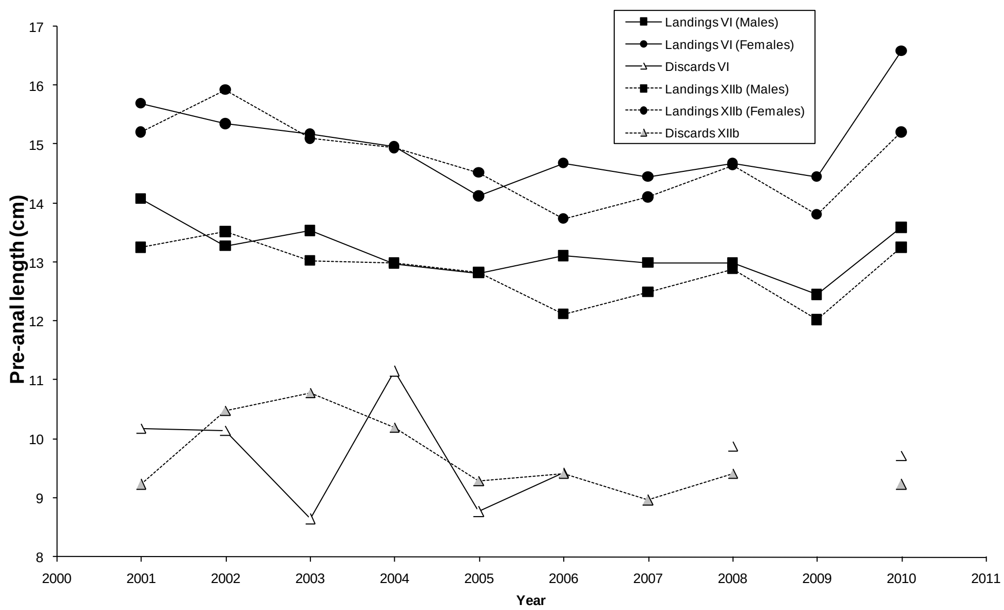



**Figure 10.2.6. Trends in pre-anal length of Roundnose grenadier from Spanish landings and discards in Divisions VIb and XIIb, 2001–2010.**

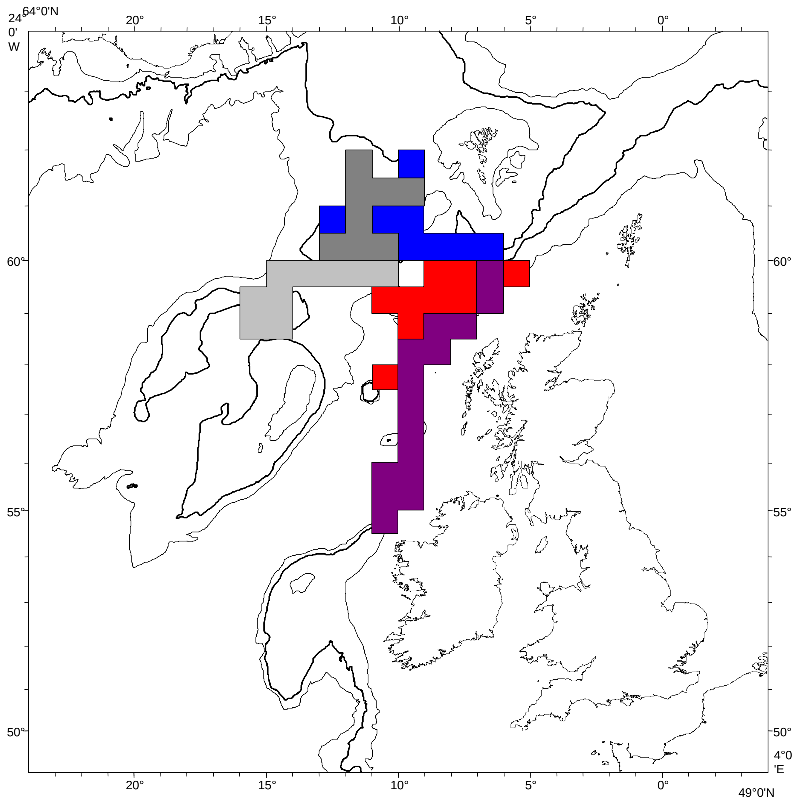



**Figure 10.2.7. Reference areas used to calculate French lpues (brown: New grounds in V (new5), grey new grounds in VI (new6); red: others in VI (other6); purple: edge in VI (edge6); blue: Reference grounds in V (ref5). Depth contours are 200, 1000 and 2000 m.**

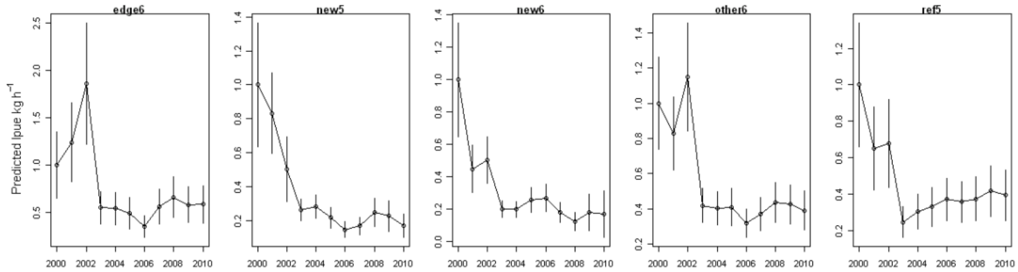



**Figure 10.2.8. Lpue of French trawlers in five areas (labelled according to Biseau, 2006 WD) from tows targeting roundnose grenadier (defined as tows where the total catch include >10% of roundnose grenadier).**

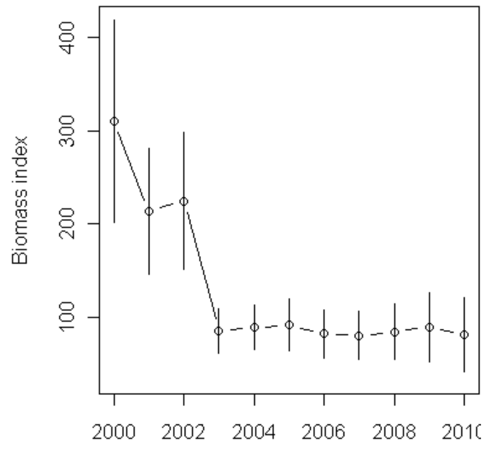



**Figure 10.2.9. Time-series of abundance indices (calculated from the tallybook data). Grenadier abundance was predicted for the mean length of all tows carried out in every rectangle of the five small areas and averaged across rectangles.**

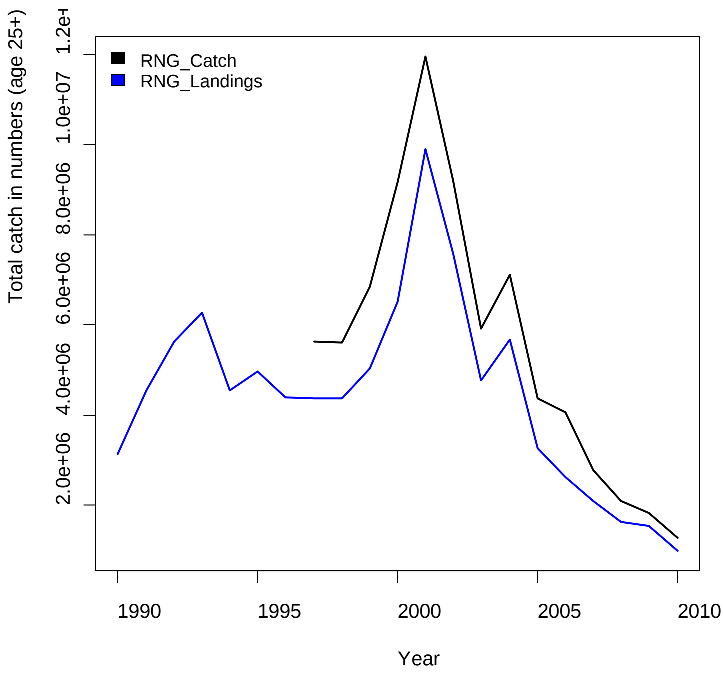



**Figure 10.2.10. Roundnose grenadier catch and landings in ICES Areas Vb, VI and VII.**

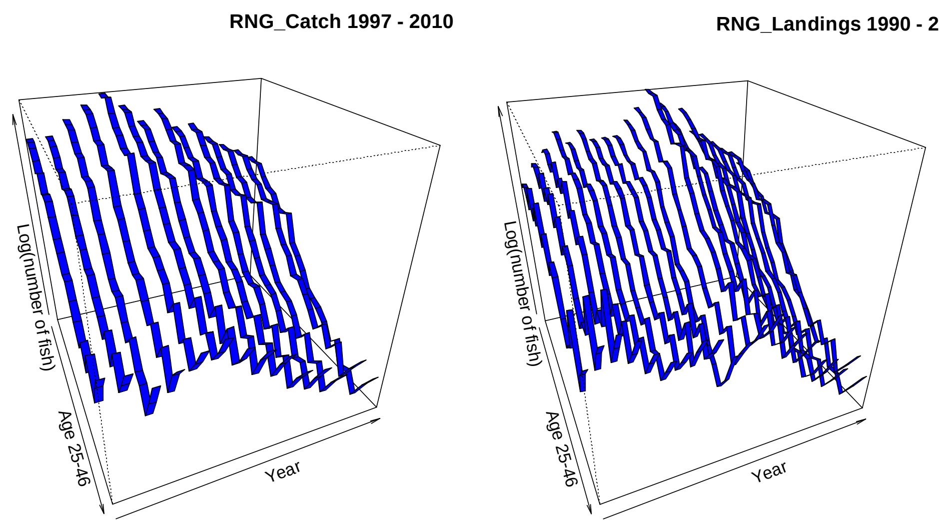



**Figure 10.2.11. Log-numbers in catch and landings of roundnose grenadier for ages 26 to 46+.**

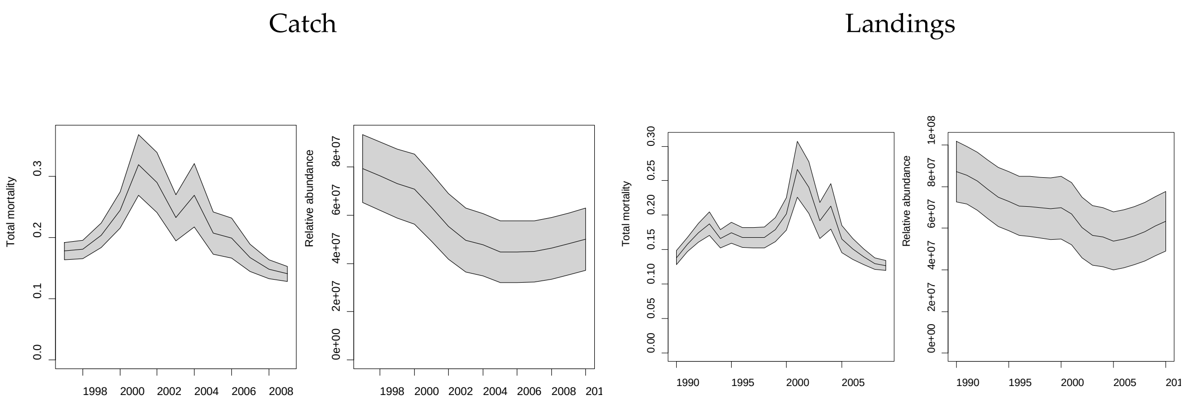



**Figure 10.2.12. Time-series of Z estimated from the MYCC run on catch-at-age and landings-at-age tables including international landings reported as roundnose grenadier in Vb, VI and VII, top row fixing natural mortality M=0.1.**

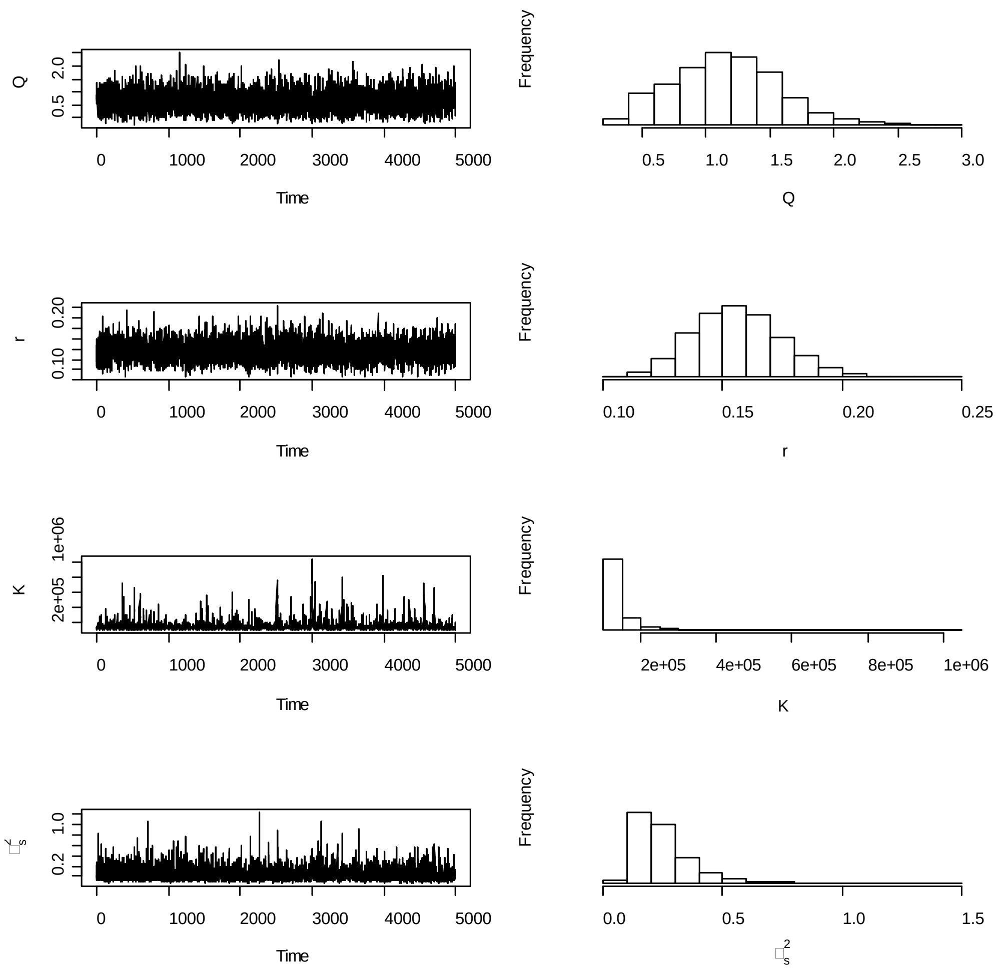



**Figure 10.2.13. Diagnostic plots of the reference assessment on Roundnose grenadier in Vb, VI, VII.**

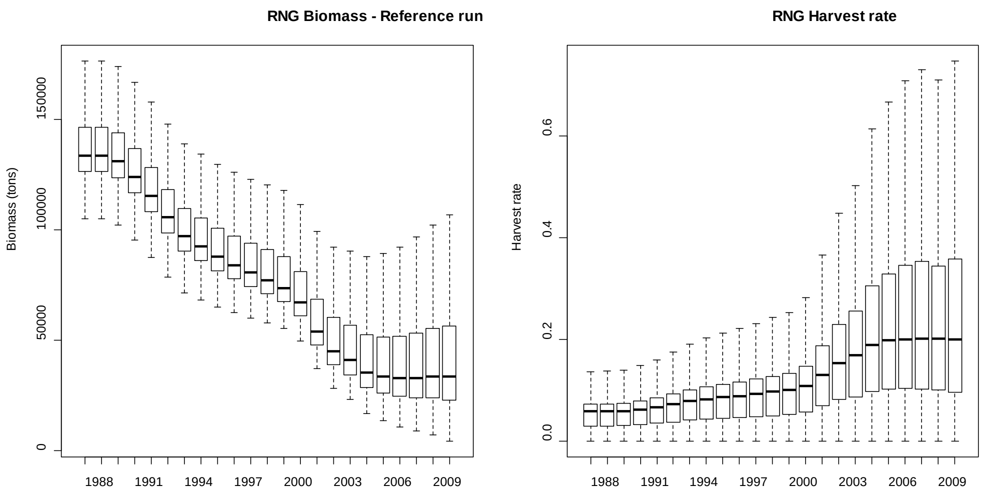



**Figure 10.2.14. Estimated biomass and harvest rates from the reference simulations.**

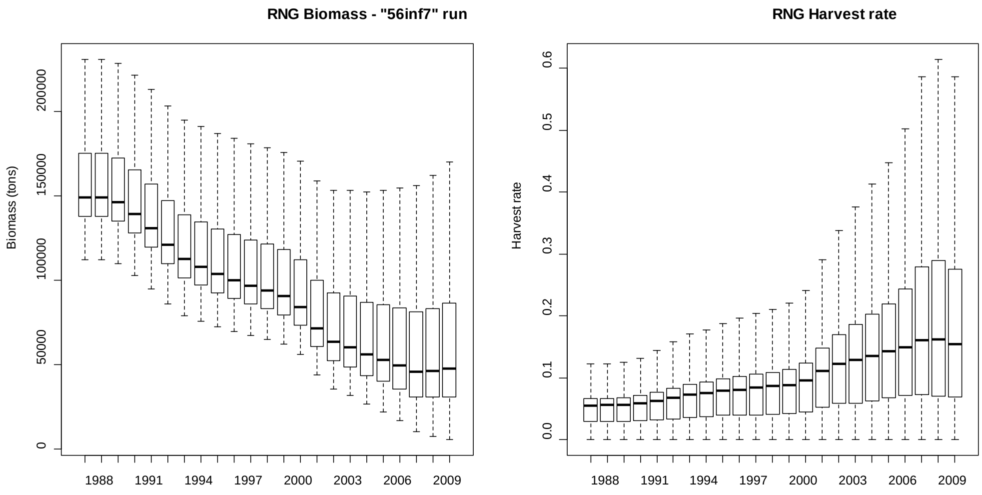



**Figure 10.2.15. Estimated biomass and harvest rates using inflated Spanish landings in VI.**

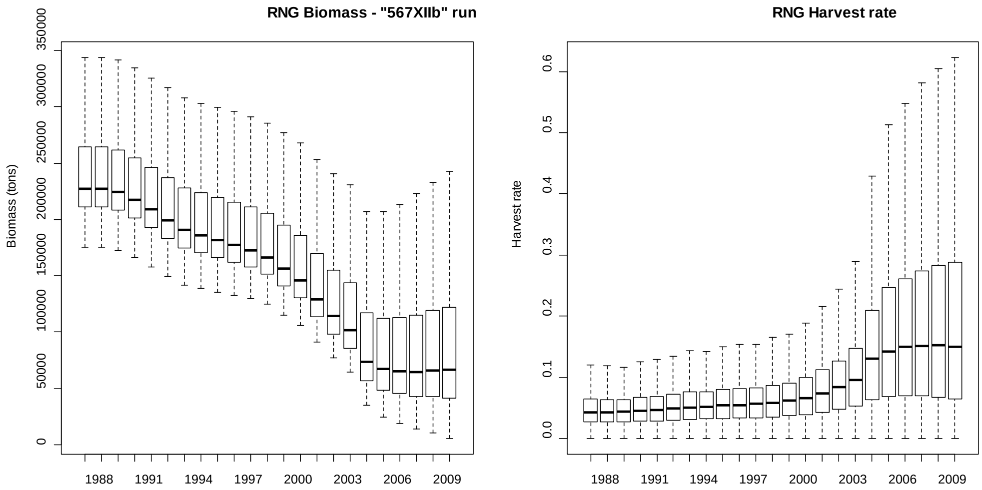



**Figure 10.2.16. Estimated biomass and harvest rates using landings in Vb, VI, VII and XIIb.**

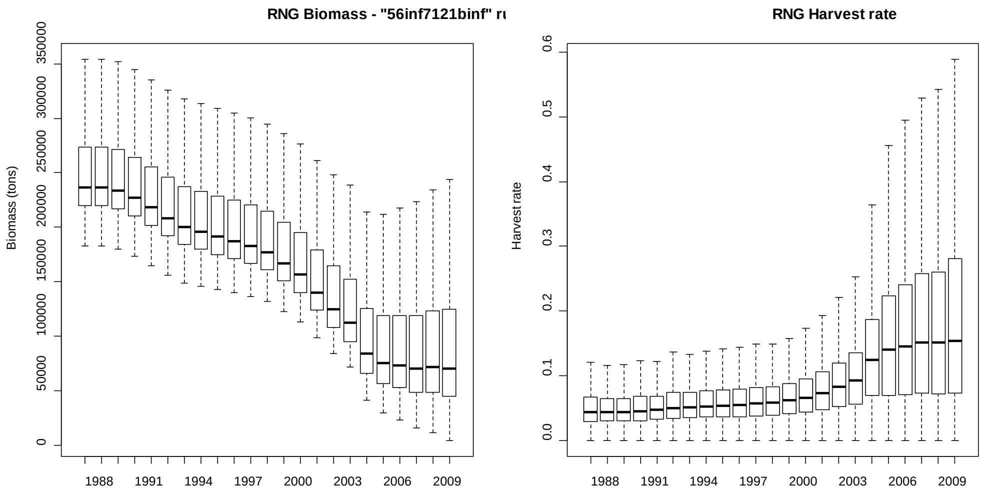



**Figure 10.2.17. Estimated biomass and harvest rates using inflated Spanish landings in VI and XIIb.**

## 10.3 Roundnose grenadier (*Coryphaenoides rupestris*) in Division IIIa

### 10.3.1 The fishery

From the late 1980s until 2006 a Danish directed fishery for roundnose grenadier was conducted in the deeper part of Division IIIa. Until 2003 landings increased gradually, from around 1000 t to 4000 t with fluctuations. In 2004 and 2005 exceptionally high catches were reported; reaching almost 12 000 tonnes in 2005. This directed fishery stopped in 2007 due to implementation of new agreed regulations between EU and Norway.

At present, there are no directed fisheries for roundnose grenadier in Division IIIa.

### 10.3.2 Landings trends

The total landings by all countries from 1988–2010 are shown in Table 10.3.0 and Figure 10.3.0.

The landings from the directed fishery ceased in 2007 and the total landings have since been minor (<2 tonnes). The landings are now bycatches from other fisheries.

### 10.3.3 ICES Advice

The Advice for 2011 and 2012 is: *"ICES advises to constrain catches to 1000 t. However, re-establishment of a fishery should be accompanied with a monitoring programme to assure exploitation consistent with MSY."*

### 10.3.4 Management

There has been no directed fishery for roundnose grenadier since 2007. However, should a new fishery begin this would be subject to management regulations agreed at the consultative meeting in Oslo 31 January 2006 between the EU and Norway.

In Council Regulation (EU) No 1225/2010, fixing for 2011 and 2012 the fishing opportunities for EU vessels for fish stocks of certain deep-sea fish species, a TAC was set to 850 tonnes for EU vessels in EU waters and international waters of Subarea III but outside Division IIIa. Pending consultations between EU and Norway, no directed fishery for roundnose grenadier is allowed in Division IIIa.

## 10.3.5 Data available

### 10.3.5.1 Length compositions

Since the directed fishery has stopped there is no new information on size compositions from commercial catches other than the data given for the period 1996–2006 in the Stock Annex.

Updated information on size distribution from the Norwegian shrimp survey is given (Figure 10.3.1).

### 10.3.5.2 Age composition

No recent age composition data are available.

### 10.3.5.3 Effort and cpue

No new data on effort or commercial cpue are available.

## 10.3.6 Data analyses

### 10.3.6.1 Trends in effort and cpue

The information on effort and nominal commercial cpue in the Danish fishery from 1996–2006 is regarded to be unreliable (ICES 2007).

### 10.3.6.2 Size compositions

The Danish and Norwegian length distributions agree well for those years covered by samples from both countries (1987 and 2004–2006). Note that both in 1987 and 2004 there appear to be two clearly distinguishable components in the length compositions. In the Norwegian data several years show two modes. With the current lack of knowledge of the age structure, it is impossible to say whether the smaller one represents "recruits" to the fishery.

### 10.3.6.3 Survey indices

The abundance indices for roundnose grenadier from the Norwegian shrimp survey alone have not been considered sufficiently reliable to be used to assess development of this stock. However, Hansen (2011, WD-12) propose that taken all information available from both the survey abundance indices and size compostions from 1984–2011, the targeted fishery in 2004–2005 is likely to have reduced the abundance. Further, the level of abundance indices is now at the lowest seen in the time-series since 1984.

## 10.3.7 Comments on assessment

No analytical assessment was carried out.

## 10.3.8 Management considerations

Management advice for deep-sea stock not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, e.g. $F_{proxy}$, CUSUM or PSA.

**Table 10.3.0. Roundnose grenadier in Division IIIa. WG estimates of landings.**

| Year | Denmark | Norway | Sweden | TOTAL |
|---|---|---|---|---|
| 1988 | 612 | | 5 | 617 |
| 1989 | 884 | | 1 | 885 |
| 1990 | 785 | 280 | 2 | 1067 |
| 1991 | 1214 | 304 | 10 | 1528 |
| 1992 | 1362 | 211 | 755 | 2328 |
| 1993 | 1455 | 55 | | 1510 |
| 1994 | 1591 | | 42 | 1633 |
| 1995 | 2080 | | 1 | 2081 |
| 1996 | 2213 | | | 2213 |
| 1997 | 1356 | 124 | 42 | 1522 |
| 1998 | 1490 | 329 | | 1819 |
| 1999 | 3113 | 13 | | 3126 |
| 2000 | 2400 | 4 | | 2404 |
| 2001 | 3067 | 35 | | 3102 |
| 2002 | 4196 | 24 | | 4220 |
| 2003 | 4302 | | | 4302 |
| 2004 | 9874 | 16 | | 9890 |
| 2005 | 11 922 | | | 11 922 |
| 2006 | 2261 | 4 | | 2265 |
| 2007 | + | 1 | | 1 |
| 2008 | + | + | | + |
| 2009 | 2 | + | + | 2 |
| 2010* | 1 | + | + | 1 |

*** Preliminary data.**

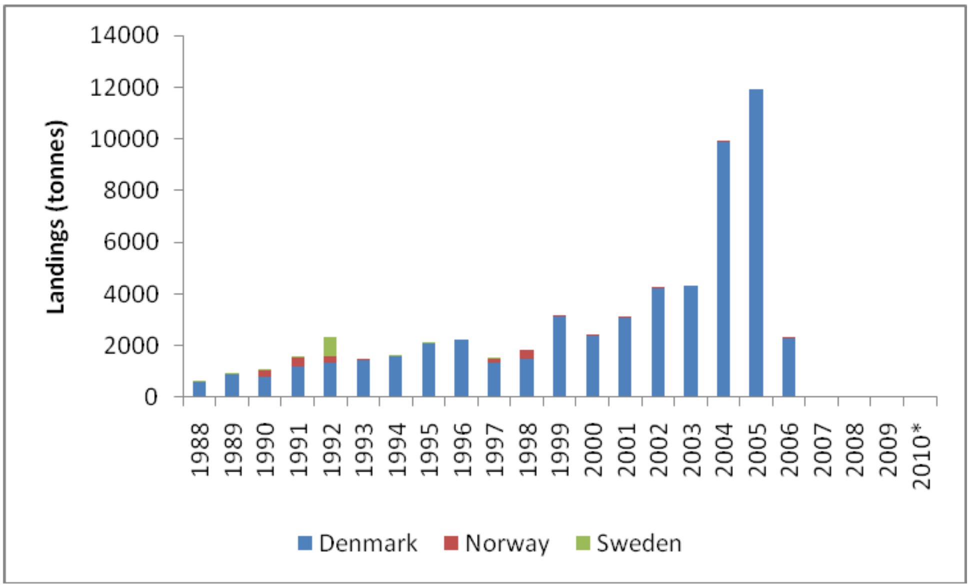
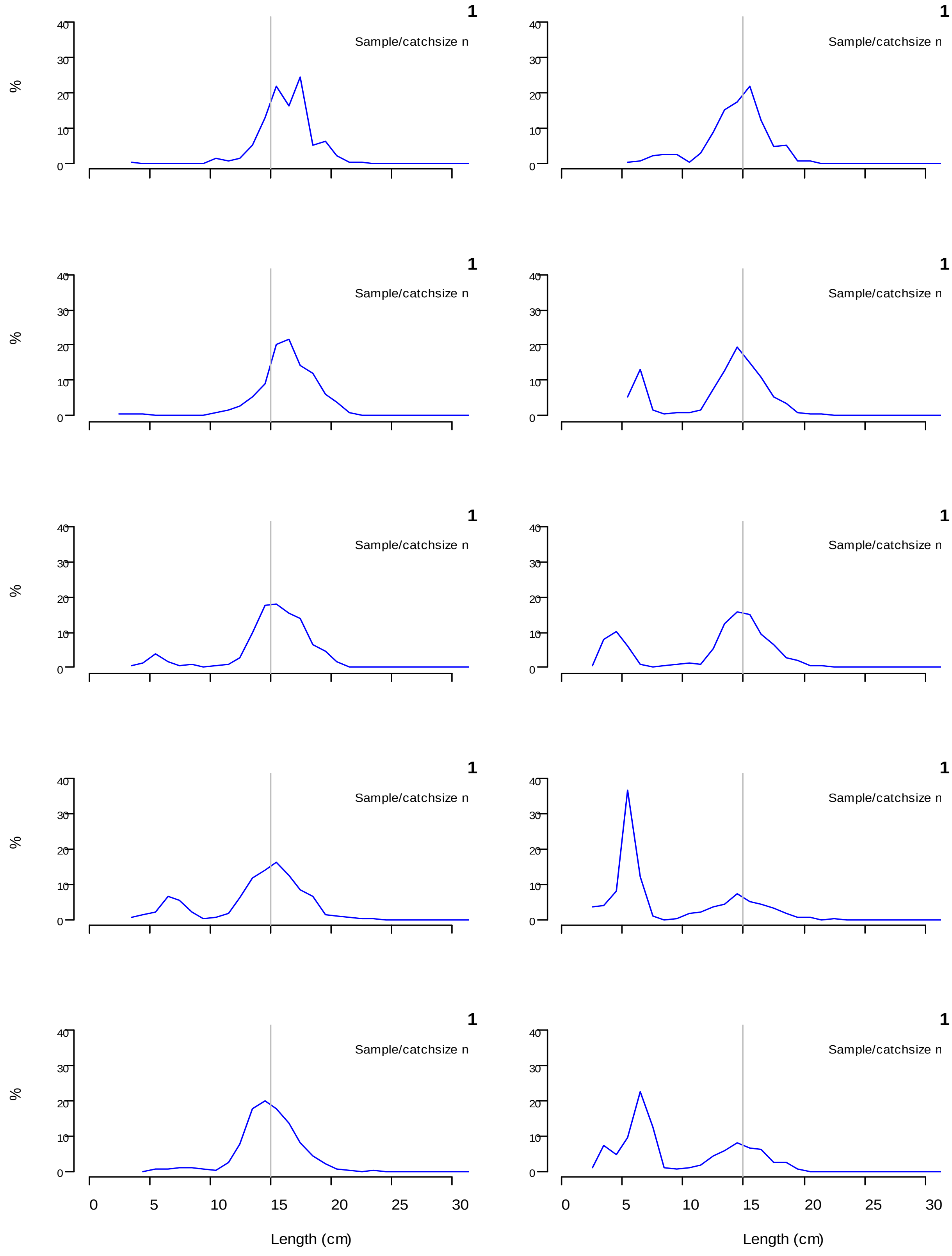
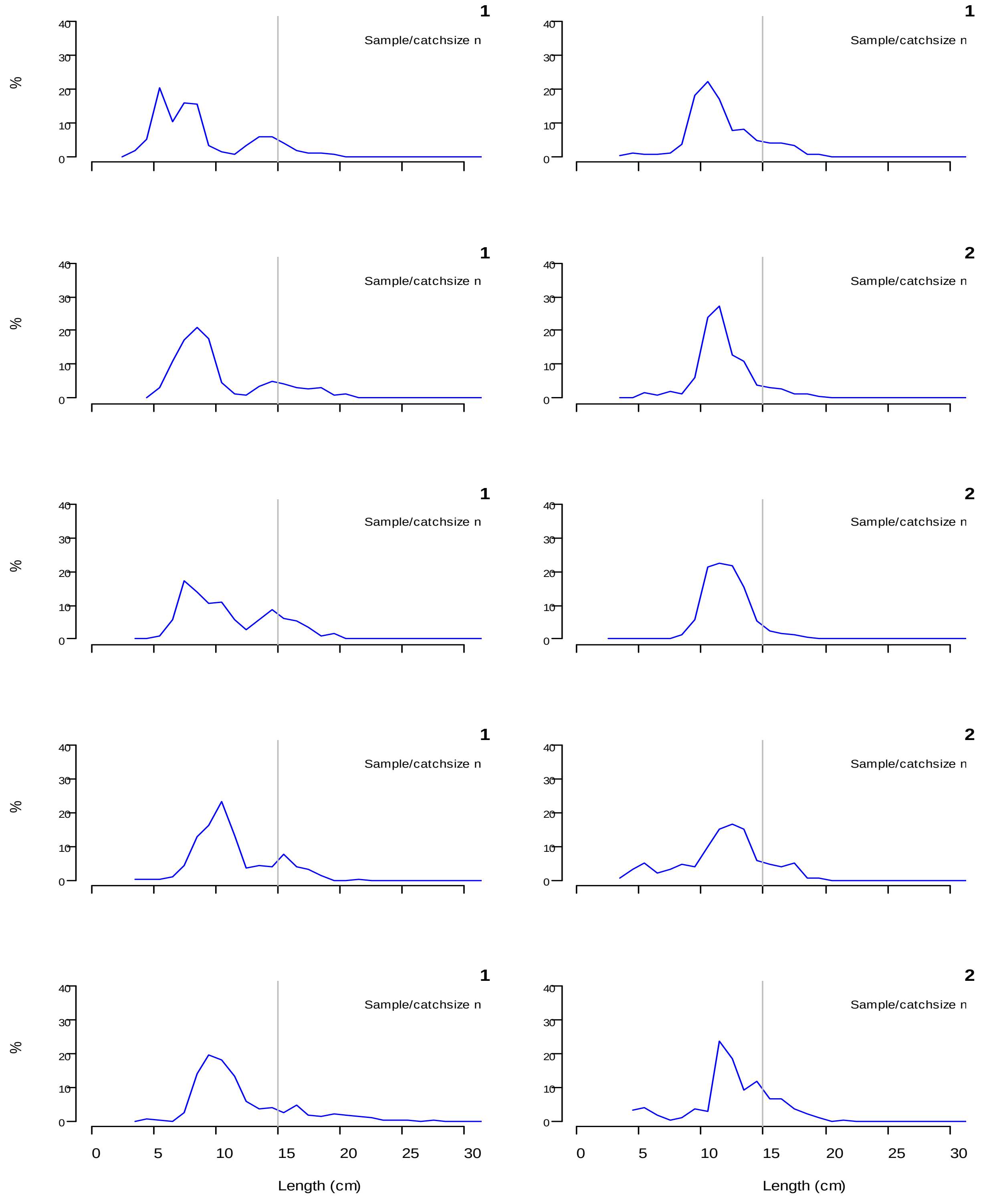



**Figure 10.3.0. Landings of roundnose grenadier from Area IIIa**


1
Sample/catchsize n
%
0
10
20
30
40
0
5
10
15
20
25
30
Length (cm)


1
Sample/catchsize n
1
Sample/catchsize n
1
Sample/catchsize n
2
Sample/catchsize n
1
Sample/catchsize n
2
Sample/catchsize n
1
Sample/catchsize n
2
Sample/catchsize n
1
Sample/catchsize n
2
Sample/catchsize n
%
0
10
20
30
40
0 5 10 15 20 25 30
Length (cm)
Length (cm)

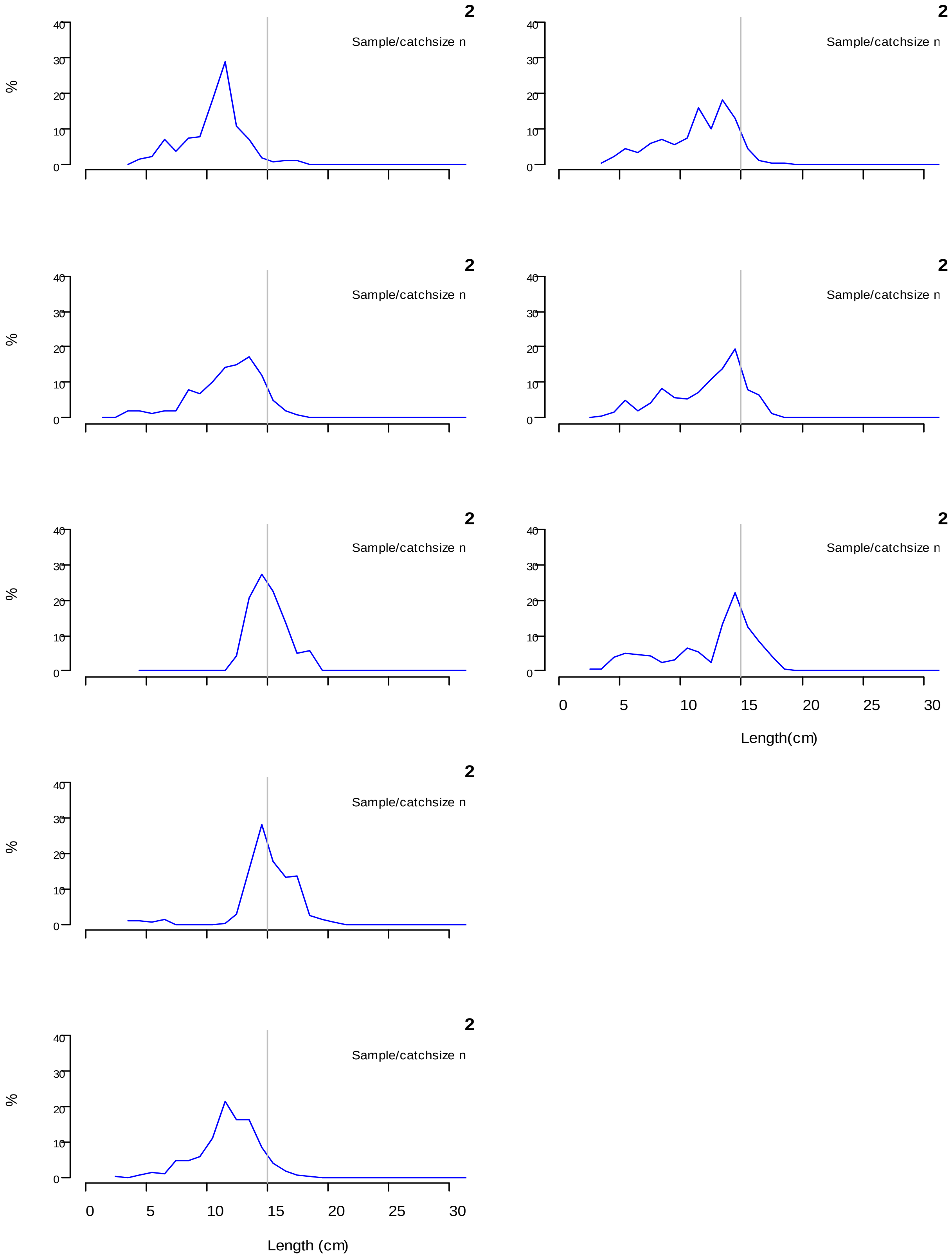



**Figure 10.3.1. Length frequency distributions for roundnose grenadier, 1984–2009. Data from shrimp survey, all catches deeper than 300 m.**

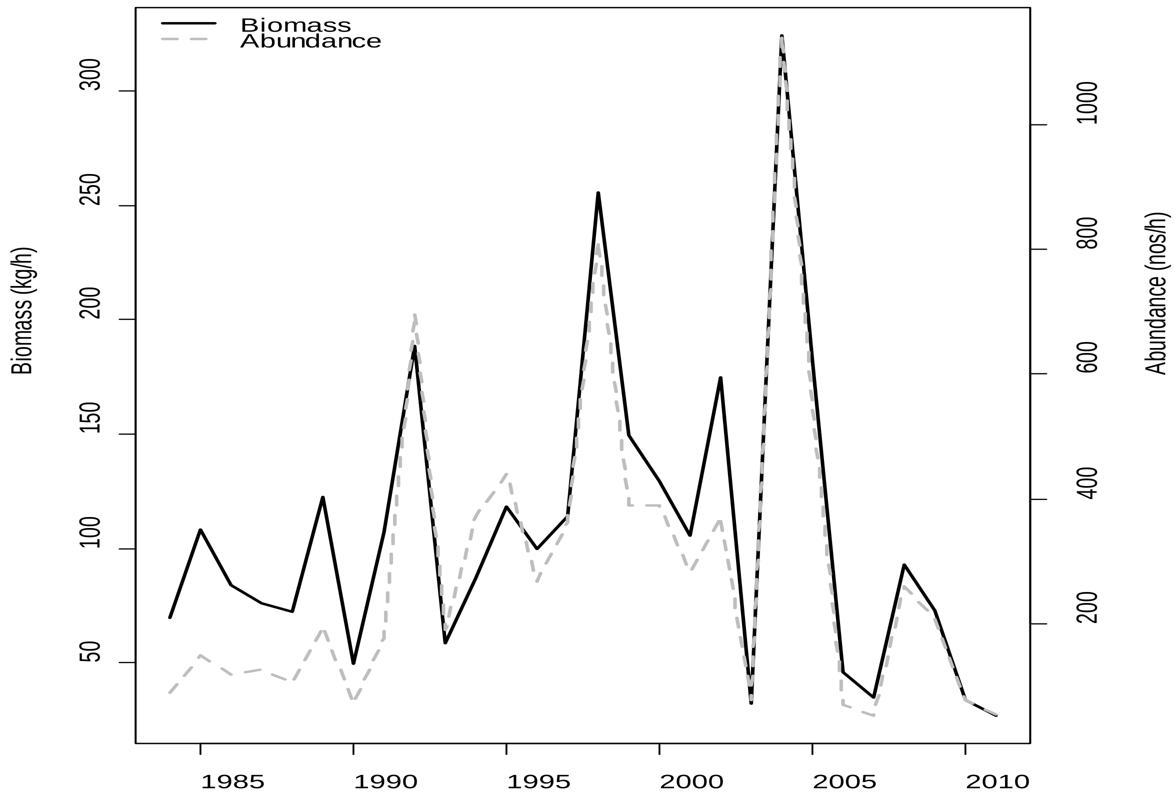



**Figure 10.3.2. Mean standardized catch of roundnose grenadier in terms of numbers (upper) and weight (lower) in the 1984–2009 shrimp survey in ICES Division IIIa. For each year, the average catch was calculated for all trawls deeper than 300 m, including 0-catches. Note: in 1984, 2003, 2006, and 2007 only a single or no trawls were made deeper than 400 m and data from these years are unreliable.**

## 10.4 Roundnose grenadier (*Coryphaenoides rupestris*) in Divisions Xb, XIIc and Subareas Va1, XIIa1, XIVb1

### 10.4.1 The fishery

The fishery on the Northern Mid-Atlantic Ridge (MAR) started in 1973, when dense concentrations of roundnose grenadier were discovered by USSR exploratory trawlers. Roundnose grenadier aggregations may have occurred on 70 seamount peaks between 46–62° N, but only 30 of them were commercially important and subsequently exploited. The fishery is mainly conducted using pelagic trawls although on some seamounts it is possible to use bottom gear.

#### 10.4.1.1 Landings trends

The greatest annual catch (almost 30 000 t) was taken by the Soviet Union in 1975 (Tables 10.4.1–10.4.4, Figure 10.4.1) and in subsequent years the Soviet catch varied from 2800 to 22 800 t. The fishery for grenadier declined after the dissolution of the Soviet Union in 1992. In the last 15 years, there has been a sporadic fishery by vessels from Russia (annual catch estimated at 200–3200 t), Poland (500–6700 t), Latvia (700–

4300 t) and Lithuania (data on catch are not available). Grenadier has also been taken as bycatch in the Faroese orange roughy fishery and Spanish blue ling fishery.

There is no information about target fishery of roundnose grenadier on the MAR in 2006 and 2007. In 2008 and 2009 Russian trawlers made attempts at fishing with pelagic and bottom trawls in the southern part of the Division XIIc. Total catches were 30 t and 12 t respectively including 13 t and 5 t of roundnose grenadier.

In 2010 Spanish started new target bottom fishery of roughhead grenadier *Macrourus berglax* in the Division XIVb where they were taken as bycatch 211 t of roundnose grenadier. In the same year Russian trawler caught 73 t roundnose grenadier during a short-term fishery (two days) in the southern part of the Division Xb.

#### 10.4.1.2 ICES advice

ICES advice in 2010: *"The fishery should not be allowed to expand and a reduction in catches should be considered in order to be consistent with the MSY".*

#### 10.4.1.3 Management

There is TAC-based species-specific management of the roundnose grenadier fisheries in Subareas VIII, IX, X, XII, XIV for European Community vessels (Table 10.4.6). In the international waters there are NEAFC regulations of efforts in the fisheries for deep-water species.

### 10.4.2 Data available

#### 10.4.2.1 Landings and discards

Data on catches are given in Tables 10.4.1–10.4.4. There were no discards of roundnose grenadier on Russian trawlers where smallest fish and waste were used for fishmeal processing. There is no information on discards by other countries' vessels.

#### 10.4.2.2 Length compositions

According to Russian research data in October 2010 large mature specimens of grenadier of 60–85 cm in total length prevailed in catches taken on the MAR between 46–50°N (Figure 10.4.2). The retrospective data analysis demonstrates that the length of fish caught in the last decade in the surveyed area decreased as compared to 1980s. The length curves in 2003 and 2010 are generally similar; however, in 2010 the number of small immature grenadier up to 50 cm in length was lower.

#### 10.4.2.3 Age compositions

No new data on age compositions were presented.

#### 10.4.2.4 Weight-at-age

No new weight-at-age data are available.

#### 10.4.2.5 Maturity and natural mortality

No new data on natural mortality are available. According to Russian research data in October 2010, gonads of roundnose grenadier were mostly at the stage of maturation. The total proportion of females at prespawning and spawning states constituted 25%, which is comparable with the results observed in May–June 2003 (21%). In the both cases a small number of juvenile specimens were observed in catches (2.3% and 3.4%respectively).

#### 10.4.2.6 Catch, effort and research vessel data

Catch and cpue data are given in Tables 10.4.1–10.4.5 and Figure 10.4.1. The data for 2000–2010 are presented together with data for the period 1973–1999. There are gaps in the cpue time-series due to lack of catch statistics for 1973 and 1982 and absence of target fishery in 1994–1995 and 2006–2010 (data for the three most recent years cannot be used owing to short fishing periods). Effort data separated by Subareas and Divisions are available for Russian fleet in 2003–2005 only (Table 10.4.5). According to last Russian survey in 2010 the grenadier catches varied from several kg to 10 t in the investigated area.

### 10.4.3 Data analyses

The only source of information on abundance trends was the cpue series from the Soviet/Russian official data (Table 10.4.5, Figure 10.4.1). The cpue varied strongly, but generally declined in the 1978, then the level appears to have remained comparatively stable till to 1990. Further decline occurred in 1991–1993 and 1998-2000. There is some increasing of cpue in 2004–2005 but it remained at a low level, almost half that observed in the early 1970s when a virgin stock was exploited. These data must be treated with caution because the fishery on MAR is very difficult and its effectiveness depends on many factors (distribution of pelagic concentrations, experience of vessel crew, environmental conditions, etc.) that could not be taken in account during current analysis of cpue dynamics.

According to Soviet trawl acoustic survey data and analytical assessments in the 1970–1980s a stock size was estimated as 400 000–800 000 t (Baidalinov, 1986; Pavlov *et al.*, 1991; Shibanov, 1997). In the 1990s no research surveys were conducted.

In 2003 trawl acoustic survey was carried out by Russia in the area between 47° and 58°N. According to results of this survey the biomass of the pelagic component of the grenadier only amounted to about 130 000 t (Gerber *et al.*, 2004). It was concluded that the depths of aggregations and the number of small immature fish may have increased as compared to 1970–1980s. Last conclusion was related primarily to northern part of surveyed area (50–58°N).

The most recent trawl acoustic survey was carried out by Russian RV "Atlantida" in October 2010 in the southern part of fishing area (44–50° N), where 17 seamounts were surveyed (Figure 10.4.3). The typical echo-indications of grenadier were obtained over 13 seamounts located to the north of 46°N. Similar to 2003, considerable increase of the grenadier distribution depths (mainly 1200–1350 m, sometimes up to 1500 m) was observed (Figure 10.4.4) as compared to 1970s–1980s, when it was mainly from 600 to 1200 m (Chuksin, Sirotin, 1975). The biomass of the pelagic component of the grenadier on the 13 seamounts amounted to about 59 400 t. In 2003 the biomass was estimated 35 100 t on the nine seamounts of this area. The biomass values were higher in 2010 comparatively 2003 at the most seamounts (Table 10.4.7). The average biomass per one seamount increased from 3900 t in 2003 to 4600 t in 2010. Some increasing of biomass, permanent length composition and limited fishery scale of grenadier give grounds to make a preliminary conclusion on the stable state of its stock during several last years.

### 10.4.4 Comments on the assessment

No analytical assessments were carried out.

### 10.4.5 Management considerations

No management advice is required this year.

**Table 10.4.1. Working group estimates of catch of roundnose genadier from Subdivision Va1.**

| Year | USSR/ Russia | Total |
|---|---|---|
| 1973 | 820 | 820 |
| 1974 | 12 561 | 12 561 |

**Table 10.4.2. Working group estimates of catch of roundnose genadier from Subarea Xb.**

| Year | USSR/ Russia | Faroes1 | Total |
|---|---|---|---|
| 1976 | 170 | | 170 |
| 1993 | | 249 | 249 |
| 1994 | | | |
| 1995 | | | |
| 1996 | | 3 | 3 |
| 1997 | | 1 | 1 |
| 1998 | | 1 | 1 |
| 1999 | | 3 | 3 |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | 1 | 1 |
| 2005 | 799 | | 799 |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010[1] | 73 | | 73 |

**[1]–preliminary data.**

**Table 10.4.3. Working group estimates of catch of roundnose genadier from Subareas XIIa1 and XIIc.**

| Year | USSR/Russia | Poland[2] | Latvia[2] | Faroes[2] | Spain[2] | Total |
|---|---|---|---|---|---|---|
| 1973 | 226 | | | | | 226 |
| 1974 | 5874 | | | | | 5874 |
| 1975 | 29 894 | | | | | 29 894 |
| 1976 | 4545 | | | | | 4545 |
| 1977 | 9347 | | | | | 9347 |
| 1978 | 12 310 | | | | | 12 310 |
| 1979 | 6145 | | | | | 6145 |
| 1980 | 17 419 | | | | | 17 419 |
| 1981 | 2954 | | | | | 2954 |
| 1982 | 12 472 | | | | | 12 472 |
| 1983 | 10 300 | | | | | 10 300 |
| 1984 | 6637 | | | | | 6637 |
| 1985 | 5793 | | | | | 5793 |
| 1986 | 22 842 | | | | | 22 842 |
| 1987 | 10 893 | | | | | 10 893 |
| 1988 | 10 606 | | | | | 10 606 |
| 1989 | 9495 | | | | | 9495 |
| 1990 | 2838 | | | | | 2838 |
| 1991 | 32 141 | | 4296 | | | 75 101 |
| 1992 | 295 | | 1684 | | | 1979 |
| 1993 | 473 | | 2176 | 263 | | 2912 |
| 1994 | | | 675 | 457 | | 1132 |
| 1995 | | | | 359 | | 359 |
| 1996 | 208 | | | 136 | | 344 |
| 1997 | 705 | 5867 | | 138 | | 6710 |
| 1998 | 812 | 6769 | | 19 | | 7600 |
| 1999 | 576 | 546 | | 29 | | 1151 |
| 2000 | 2325 | | | | | 2325 |
| 2001 | 1714 | | | 2 | | 1716 |
| 2002 | 737 | | | | | 737 |
| 2003 | 510 | | | | | 510 |
| 2004 | 436 | | | 8 | | 444 |
| 2005 | 600 | | | | | 600 |
| 2006 | | | | 1 | | 1 |
| 2007 | | | | 2 | | 2 |
| 2008 | 13 | | | | | 13 |
| 2009 | 5 | | | | | 5 |
| 2010[3] | | | | | | |

**[1]– revised catch data [2]– official ICES data [3]– preliminary data.**

**Table 10.4.4. Working group estimates of catch of roundnose genadier from Subdivision XIVb1.**

| Year | USSR/Russia | Spain[2] | Total |
|---|---|---|---|
| 1976 | 11 | | 11 |
| 1982 | 153 | | 153 |
| 1997 | 3361 | | 3361 |
| 1998 | | | |
| 1999 | | | |
| 2000 | 5 | | 5 |
| 2001 | 69 | | 69 |
| 2002 | 4 | 235 | 239 |
| 2003 | | 272 | 272 |
| 2004 | 201 | | 201 |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010[3] | | 211 | 211 |

**[1]– revised catch data [2]– official ICES data [3]– preliminary data.**

**Table 10.4.5. Soviet/Russian efforts and cpue on roundnose grenadier fishery by the MAR area.**

| Year | ICES Subarea and Division | Number of fishing days | Catch per fishing day, t |
|---|---|---|---|
| 1974 | XIIa1+XIIc, Va1 | | 35.2 |
| 1975 | XIIa1+XIIc | | 36.6 |
| 1976 | XIIa1+XIIc, XIVb1, Xb | | 24.0 |
| 1977 | XIIa1+XIIc | | 17.3 |
| 1978 | XIIa1+XIIc | | 17.0 |
| 1979 | XIIa1+XIIc | | 19.6 |
| 1980 | XIIa1+XIIc | | 17.3 |
| 1981 | XIIa1+XIIc | | 18.4 |
| 1982 | XIIa1+XIIc, XIVb1 | | |
| 1983 | XIIa1+XIIc | | 17.3 |
| 1984 | XIIa1+XIIc | | 18 |
| 1985 | XIIa1+XIIc | | 18.5 |
| 1986 | XIIa1+XIIc | | 21 |
| 1987 | XIIa1+XIIc | | 17.3 |
| 1988 | XIIa1+XIIc | | 21.8 |
| 1989 | XIIa1+XIIc | | 15.6 |
| 1990 | XIIa1+XIIc | | 18.4 |
| 1991 | XIIa1+XIIc | | 14.5 |
| 1992 | XIIa1+XIIc | | 12.9 |
| 1993 | XIIa1+XIIc, Xb | | 10.7 |
| 1994 | XIIa1+XIIc | | |
| 1995 | XIIa1+XIIc | | |
| 1996 | XIIa1+XIIc, Xb | | 22.2 |
| 1997 | XIIa1+XIIc, XIVb1, Xb | | 20.3 |
| 1998 | XIIa1+XIIc, Xb | | 6.8 |
| 1999 | XIIa1+XIIc, Xb | | 8.8 |
| 2000 | XIIa1+XIIc, XIVb1 | | 9.1 |
| 2001 | XIIa1+XIIc | | 15.8 |
| | XIVb1 | | |
| 2002 | XIIa1+XIIc | | 13.2 |
| | XIVb1 | | |
| 2003 | XIIa1+XIIc | 51 | 10.1 |
| 2004 | XIIa1+XIIc | 25 | 16.1 |
| 2005 | XIIa1+XIIc | 42 | 17.7 |
| | Xb | 37 | |
| 2006 | XIIc | | |
| 2007 | XIIc | | |
| 2008 | XIIc | 7 | |
| 2009 | XIIc | 1 | |
| 2010[1] | Xb | 2 | |

[1] - preliminary data.

**Table 10.4.6. Fishing opportunities applicable for European Community vessels for roundnose grenadier fisheries by countries and by areas in 2009–2010 (EC and international waters).**

| Country | TAC, t |
|---|---|
| Areas VIII, IX, X, XII, XIV | |
| Germany | 34 |
| Spain | 3734 |
| France | 172 |
| Ireland | 7 |
| United Kingdom | 15 |
| Latvia | 60 |
| Lithuania | 7 |
| Poland | 1168 |
| Total for EC vessels | 5197 |

**Table 10.4.7. Biomass of roundnose grenadier (t) according results of the acoustic surveys on the MAR in 2003 and 2010.**

| Seamount number | 2003 | 2010 |
|---|---|---|
| 462 | Not surveyed | 2188 |
| 473-A | 1662 | 10 259 |
| 473-B | 7016 | 6417 |
| 476-A | 3159 | 4357 |
| 485-A | 971 | 6350 |
| 485-B | Not surveyed | 2097 |
| 491-B | 3228 | 2203 |
| 493-A | Fish records are weak | 1828 |
| 494-A | 18 086* | 12 274 |
| 494-B | | 8227 |
| 495 | 977 | 1350 |
| 495-B | Not surveyed | 241 |
| 496-A | Fish records are weak | 1573 |
| TOTAL | 35 099 | 59 364 |

*** – total for two seamounts.**

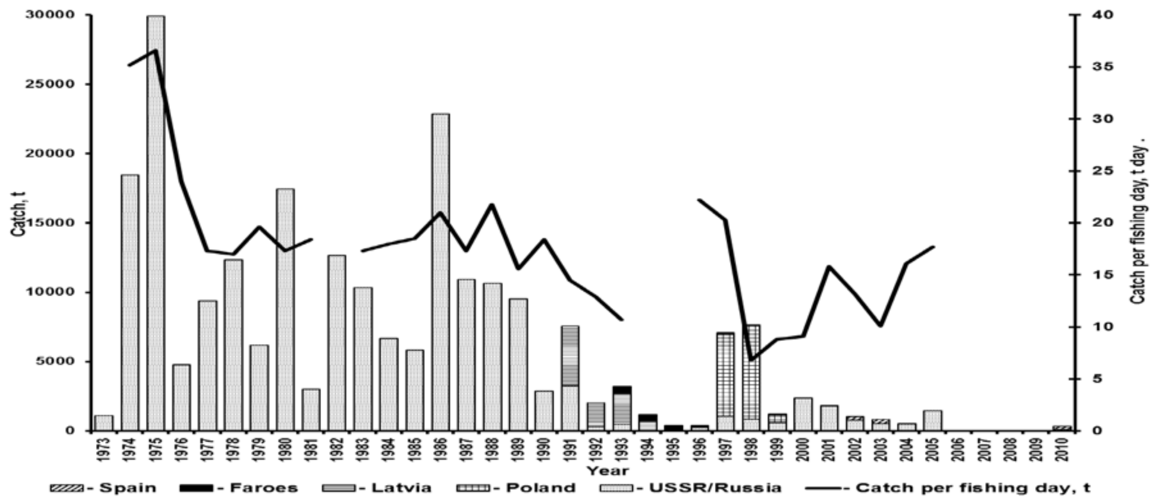



**Figure 10.4.1. International catch in 1973–2010 and Soviet/Russian cpue of roundnose grenadier on the MAR in 1973–2005.**

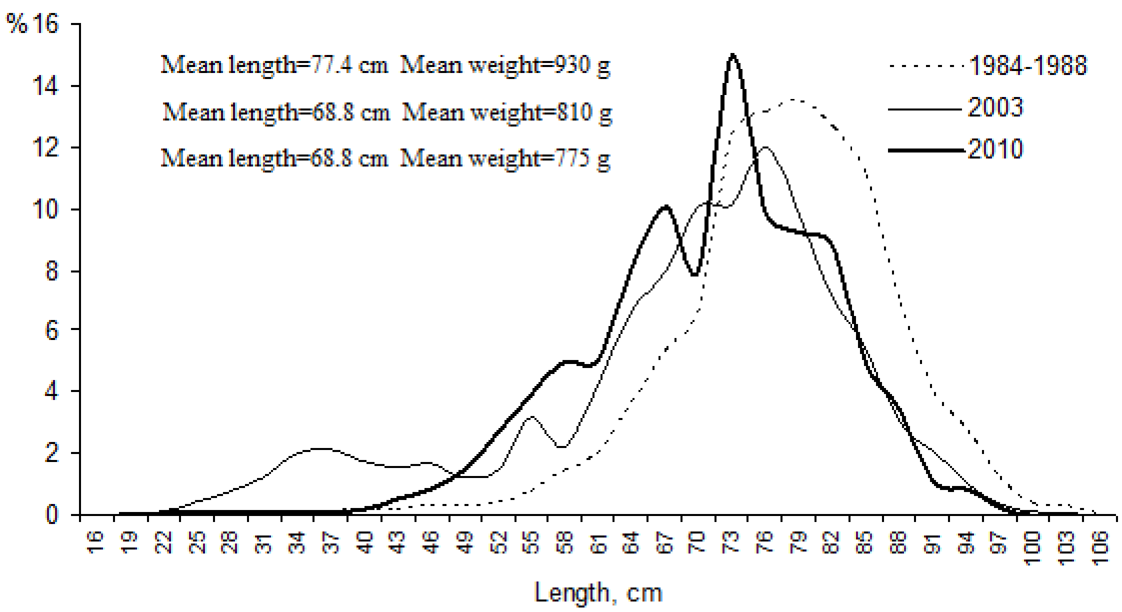



**Figure 10.4.2. Total length composition of roundnose grenadier on the MAR in 1984–1988 (47–51°N), in 2003 (47–51°N) and in 2010 (47–50°N).**

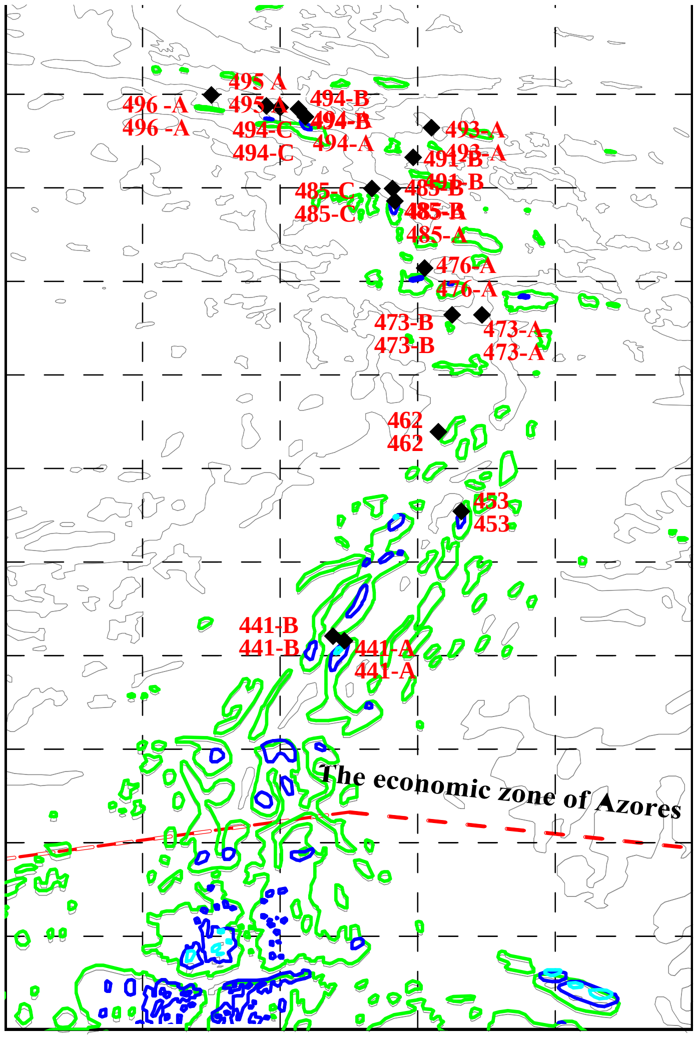



**Figure 10.4.3. Location of seamounts surveyed at RV "Atlantida" on the MAR in October 2010.**

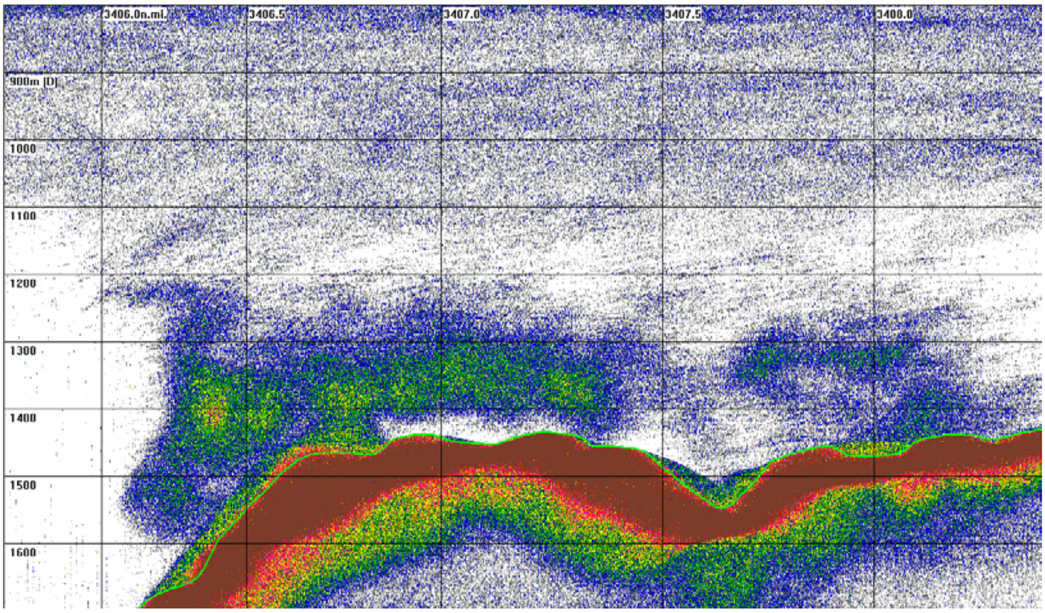



**Figure 10.4.4. Echo-records of grenadier at the seamount 494-A.**

## 10.5 Roundnose grenadier (*Coryphaenoides rupestris*) in other areas (I, II, IV, Va2, VIII, IX, XIVa, XIVb2)

### 10.5.1 The fishery

Outside the main fisheries covered in other sections, catches of roundnose grenadier were insignificant.

#### 10.5.1.1 Landings trends

Landing statistics by nations in the period 1988–2010 are presented in Table 10.5.1–10.5.6.

In the Subareas I and II, the catch of roundnose grenadier in 2010 amounted to 21 t and was taken as bycatch by Norwegian and Russian fleets. During 1989–2010 catches varied from 0 to 106 t (Figure 10.5.1). France substantially contributed to the total catch in 1990–1992, when roundnose grenadier was taken as bycatch in the fisheries for saithe *Pollachius virens* and other gadoids. In 1997–1998, when total catch exceeded 100 t, the major contribution was made by Norway. Roundnose grenadier was partly taken in mixed deep-water fisheries; directed local fisheries in Norwegian fjords for this species also exist.

In Subarea IV, the catch of roundnose grenadier in 2010 comprised 3 t which was taken by the French and Norway fleets. During 1989–2010 total catches in this area varied between 0 and 521 t (Figure 10.5.2). The main contribution to the total catch in 1989–1994 (167–521 t) was made by the French fleet that conducted directed fishery in Division IVa off Shetland Islands. Roundnose grenadier is caught as incidental bycatch in this area by Scottish vessels in insignificant amount as well. In this area, reported catch may include a large proportion of misreported roughhead grenadier.

In 2004, the major part of the total catch (370 of 377 t) was taken by Danish fleet in the northeastern corner of IVb Division during directed trawl fishery. The WG notes that catches coming from this location in IV probably are taken from the same stock as the one in IIIa.

During 1989–2010, catches of roundnose grenadier within Icelandic waters (Division Va) peaked in 1995 (398 t) and again in 2003 (572 t) but in recent years have been less than 100 t (Figure 10.5.3) and comprise a bycatch in trawl fisheries for Greenland halibut and redfish.

Roundnose grenadier catches in Subareas VIII and IX during 1989–2010 were minor and amounted 0 to 28 t annually (Figure 10.5.4). The main contribution to the total catch was made by France.

Total catch in Greenland waters (Subdivision XIVb2) in 1989–2010 amounted to 2–126 t (Figure 10.5.5). There is no directed fishery for roundnose grenadier in these areas. The majority of catches is taken as bycatch by Greenland and Norway during Greenland halibut bottom-trawl fisheries. Prior to 2007 Germany also contributed to roundnose grenadier bycatch, especially in 1998 and 1999, when 116 and 105 t were caught respectively.

#### 10.5.1.2 ICES advice

ICES advice applicable to 2010 was: *"The fishery should not be allowed to expand, and in the light of the vulnerability of deep-sea species a reduction in catches should be considered until such time there is sufficient scientific information to prove the fishery is sustainable"*.

#### 10.5.1.3 Management

There is a TAC management of the roundnose grenadier fisheries in Subareas I, II, IV, VIII, IX, Division Va and Subdivision XIVb1 for European Community vessels (Table 10.5.7). In international waters there are NEAFC regulation of efforts in the fisheries for deep-water species.

### 10.5.2 Data available

#### 10.5.2.1 Landings and discards

Landings are given in Table 10.5.1–10.5.6. No discard data are available.

#### 10.5.2.2 Length compositions

No data.

#### 10.5.2.3 Age compositions

No data.

#### 10.5.2.4 Weight-at-age

No data.

#### 10.5.2.5 Maturity and natural mortality

No data.

#### 10.5.2.6 Catch, effort and research vessel data

No data.

### 10.5.3 Data analyses

No assessment was carried out for this stock in 2011.

### 10.5.4 Comments on the assessment

No assessment was carried out for this stock in 2011.

### 10.5.5 Management considerations

No management advice is required this year.

Catches of roundnose grenadier in these areas are insignificant. It is unlikely that suitable targets for management under the msy framework can be identified.

**Table 10.5.1. Working group estimates of landings of roundnose genadier from Subareas I and II.**

| Year | Faroes | Denmark | France | Germany | Norway | Russia/USSR | Germany | UK (E+W) | UK (Scot) | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | | | 1 | 2 | | 16 | 3 | | | 22 |
| 1990 | | | 32 | 2 | | 12 | 3 | | | 49 |
| 1991 | | | 41 | 3 | 28 | | | | | 72 |
| 1992 | | 1 | 22 | | 29 | | | | | 52 |
| 1993 | | | 13 | | 2 | | | | | 15 |
| 1994 | | | 3 | 12 | | | | | | 15 |
| 1995 | | | 7 | | | | | | | 7 |
| 1996 | | | 2 | | | | | | | 2 |
| 1997 | 1 | | 5 | | 100 | | | | | 106 |
| 1998 | | | | | 87 | 13 | | | | 100 |
| 1999 | | | | | 44 | 2 | | | | 46 |
| 2000 | | | | | | | | | | 0 |
| 2001 | | | | | | | | 2 | | 2 |
| 2002 | | | | | 11 | 1 | | | | 12 |
| 2003 | | | | | 4 | | | | | 4 |
| 2004 | | | | | 27 | | | | | 27 |
| 2005 | | | 1 | | 12 | | | | | 13 |
| 2006 | | | | | 6 | 2 | | | | 8 |
| 2007 | | | | | 11 | 1 | | | | 12 |
| 2008 | | | | | 10 | | | | | 10 |
| 2009 | | | | | 8 | | | | | 8 |
| 2010* | | | | | 20 | 1 | | | | 21 |

*** Preliminary data.**

**Table 10.5.2. Working group estimates of landings of roundnose genadier from Subarea IV.**

| Year | France | Germany | Norway | UK (Scot) | Denmark | TOTAL |
|---|---|---|---|---|---|---|
| 1989 | 167 | 1 | | 2 | | 170 |
| 1990 | 370 | 2 | | | | 372 |
| 1991 | 521 | 4 | | | | 525 |
| 1992 | 421 | | | 4 | 1 | 426 |
| 1993 | 279 | 4 | | | | 283 |
| 1994 | 185 | 2 | | | 25 | 212 |
| 1995 | 68 | 1 | | 15 | | 84 |
| 1996 | 59 | | | 5 | 7 | 71 |
| 1997 | 1 | | | 10 | | 11 |
| 1998 | 35 | | | | | 35 |
| 1999 | 56 | | 5 | | | 61 |
| 2000 | 2 | | | | | 2 |
| 2001 | 2 | | | | 17 | 19 |
| 2002 | 11 | | 1 | 26 | | 38 |
| 2003 | 5 | | 1 | 11 | | 17 |
| 2004 | 5 | | | 1 | 371 | 377 |
| 2005 | 18 | | 2 | | | 20 |
| 2006 | 7 | | 4 | | | 11 |
| 2007 | 25 | | 1 | | | 25 |
| 2008 | 1 | | | | | 1 |
| 2009 | 0 | | | | | 0 |
| 2010* | 1 | | 2 | | | 3 |

*** Preliminary data.**

**Table 10.5.3. Working group estimates of landings of roundnose genadier from Division Va.**

| Year | Faroes | Iceland** | Norway | Russia | UK (E+W) | TOTAL |
|---|---|---|---|---|---|---|
| 1989 | 2 | 2 | | | | 4 |
| 1990 | | 7 | | | | 7 |
| 1991 | | 48 | | | | 48 |
| 1992 | | 210 | | | | 210 |
| 1993 | | 276 | | | | 276 |
| 1994 | | 210 | | | | 210 |
| 1995 | | 398 | | | | 398 |
| 1996 | 1 | 139 | | | | 140 |
| 1997 | | 198 | | | | 198 |
| 1998 | | 120 | | | | 120 |
| 1999 | | 129 | | | | 129 |
| 2000 | | 54 | | | | 54 |
| 2001 | | 40 | | | | 40 |
| 2002 | | 60 | | | | 60 |
| 2003 | | 572 | | | | 57 |
| 2004 | | 181 | | | | 181 |
| 2005 | | 76 | | | | 76 |
| 2006 | | 62 | | | | 62 |
| 2007 | 1 | 13 | 2 | | | 16 |
| 2008 | | 29 | | | | 29 |
| 2009 | 46 | 46 | | | | |
| 2010* | 59 | 59 | | | | |

*** Preliminary data, ** includes other grenadiers from 1989 to 1996.**

**Table 10.5.4. Working group estimates of landings of roundnose genadier from Subareas VIII and IX.**

| Year | France | Spain | TOTAL |
|---|---|---|---|
| 1989 | | | 0 |
| 1990 | 5 | | 5 |
| 1991 | 1 | | 1 |
| 1992 | 12 | | 12 |
| 1993 | 18 | | 18 |
| 1994 | 5 | | 5 |
| 1995 | | | 0 |
| 1996 | 1 | | 1 |
| 1997 | | | 0 |
| 1998 | 1 | 19 | 20 |
| 1999 | 9 | 7 | 16 |
| 2000 | 4 | | 4 |
| 2001 | 7 | | 7 |
| 2002 | 3 | | 3 |
| 2003 | 2 | | 2 |
| 2004 | 2 | | 2 |
| 2005 | 8 | | 8 |
| 2006* | 27 | 1 | 28 |
| 2007 | 10 | | 10 |
| 2008 | 8 | | 8 |
| 2009 | 1 | | 1 |
| 2010* | | | |

*** Preliminary data.**

**Table 10.5.5. Working group estimates of landings of roundnose genadier from Division XIVb2.**

| Year | Faroes | Germany | Greenland | Iceland | Norway | UK (E+ W) | UK (Scot) | Russia | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1989 | 3 | 42 | | | | | | | 45 |
| 1990 | | 45 | 1 | | | 1 | | | 47 |
| 1991 | | 23 | 4 | | | 2 | | | 29 |
| 1992 | | 19 | 1 | 4 | 6 | | 1 | | 31 |
| 1993 | | 4 | 18 | 4 | | | | | 26 |
| 1994 | | 10 | 5 | | | | | | 15 |
| 1995 | | 13 | 14 | | | | | | 27 |
| 1996 | | 6 | 19 | | | | | | 25 |
| 1997 | 6 | 34 | 12 | | 7 | | | | 59 |
| 1998 | 1 | 116 | 3 | | 6 | | | | 126 |
| 1999 | | 105 | 0 | | 19 | | | | 124 |
| 2000 | | 41 | 11 | | 5 | | | | 57 |
| 2001 | | 11 | 5 | | 7 | 2 | 72 | | 97 |
| 2002 | | 25 | 5 | | 15 | 1 | 1 | | 47 |
| 2003 | | | 15 | | 5 | 1 | | | 21 |
| 2004 | | 27 | 3 | | | | | | 30 |
| 2005 | | | 7 | | 6 | 1 | | | 14 |
| 2006* | | 35 | 0 | | 17 | | | | 53 |
| 2007 | 1 | | | | 1 | | | | 2 |
| 2008 | | | | | | | | 12 | 12 |
| 2009 | | | | | 2 | | | | 2 |
| 2010* | | | | | 6 | | | | 6 |

*** Preliminary data.**

**Table 10.5.6. Working group estimates of landings of roundnose grenadier from I, II, IV, Va2, VIII, IX, XIVb2.**

| YEAR | I+II | IV | VA | VIII+IX | XIVB2 | UNALLOCATED | TOTAL |
|---|---|---|---|---|---|---|---|
| 1989 | 22 | 170 | 4 | 0 | 45 | 0 | 241 |
| 1990 | 49 | 372 | 7 | 5 | 47 | 0 | 480 |
| 1991 | 72 | 525 | 48 | 1 | 29 | 0 | 675 |
| 1992 | 52 | 426 | 210 | 12 | 31 | 0 | 731 |
| 1993 | 15 | 283 | 276 | 18 | 26 | 0 | 618 |
| 1994 | 15 | 212 | 210 | 5 | 15 | 0 | 457 |
| 1995 | 7 | 84 | 398 | 0 | 27 | 0 | 516 |
| 1996 | 2 | 71 | 140 | 1 | 25 | 0 | 242 |
| 1997 | 106 | 11 | 198 | 0 | 57 | 0 | 373 |
| 1998 | 100 | 35 | 120 | 20 | 126 | 0 | 402 |
| 1999 | 46 | 61 | 129 | 16 | 124 | 0 | 382 |
| 2000 | 0 | 2 | 54 | 5 | 57 | 0 | 118 |
| 2001 | 2 | 19 | 40 | 7 | 97 | 208 | 373 |
| 2002 | 12 | 38 | 60 | 3 | 47 | 504 | 664 |
| 2003 | 4 | 17 | 57 | 2 | 21 | 952 | 1 054 |
| 2004 | 27 | 377 | 181 | 2 | 30 | 0 | 617 |
| 2005 | 13 | 20 | 76 | 7 | 14 | 0 | 131 |
| 2006 | 8 | 11 | 62 | 28 | 53 | 0 | 162 |
| 2007 | 12 | 25 | 16 | 10 | 2 | 0 | 65 |
| 2008 | 10 | 1 | 29 | 8 | 12 | 0 | 60 |
| 2009 | 8 | 0 | 46 | 1 | 2 | 0 | 57 |
| 2010* | 21 | 3 | 59 | 0 | 6 | 0 | 89 |

*** Preliminary data**

**Table 10.5.7. Fishing opportunities applicable for European Community vessels for roundnose grenadier fisheries by countries and by areas in 2009–2010 (EC and international waters).**

| Country | TAC, t |
|---|---|
| Areas VIII, IX, X, XII, XIV | |
| Germany | 34 |
| Spain | 3734 |
| France | 172 |
| Ireland | 7 |
| United Kingdom | 15 |
| Latvia | 60 |
| Lithuania | 7 |
| Poland | 1168 |
| Total for EC vessels | 5197 |

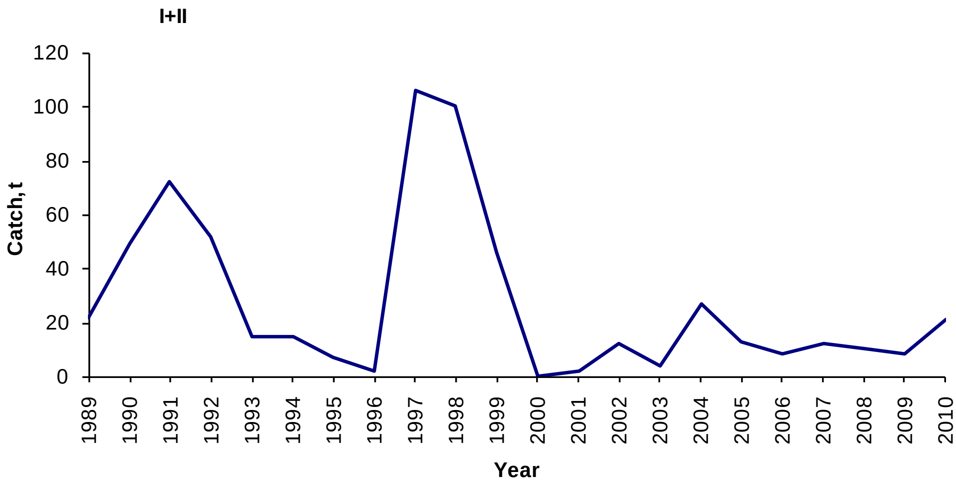



**Figure 10.5.1. Roundnose grenadier catches in Subareas I and II, 1989–2010 (data for 2010 is preliminary).**

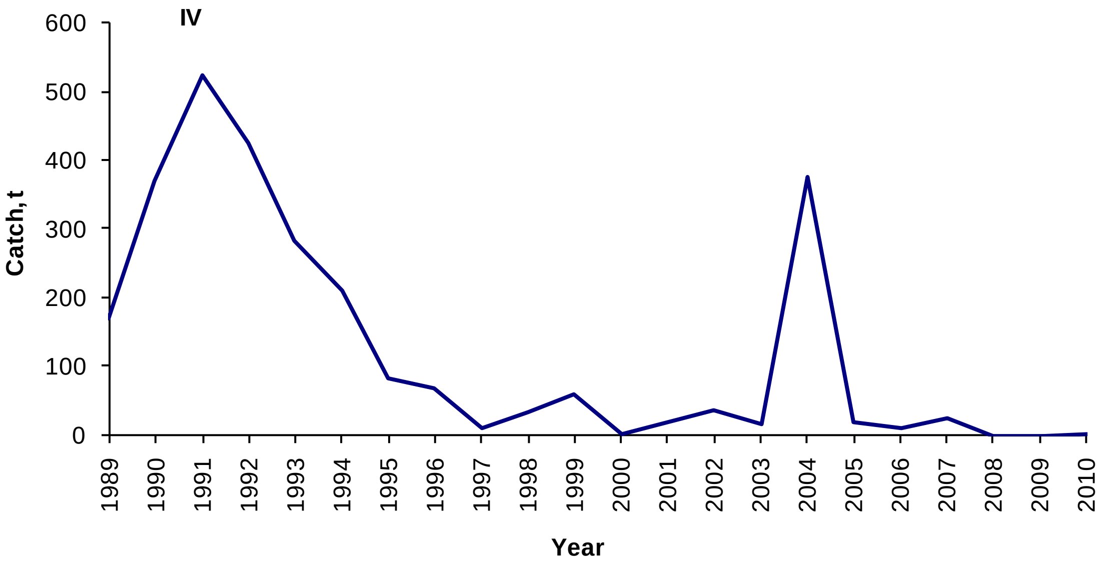



**Figure 10.5.2. Roundnose grenadier catches in Subareas IV, 1989–2010 (data for 2010 is preliminary).**

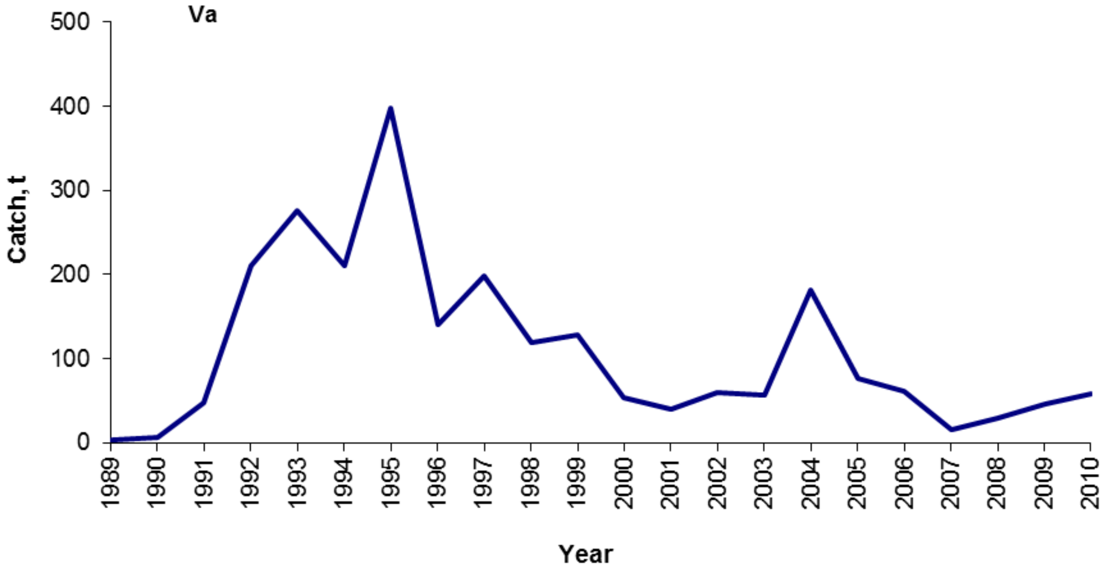



**Figure 10.5.3. Roundnose grenadier catches in Division Va, 1989–2010 (data for 2010 is preliminary).**

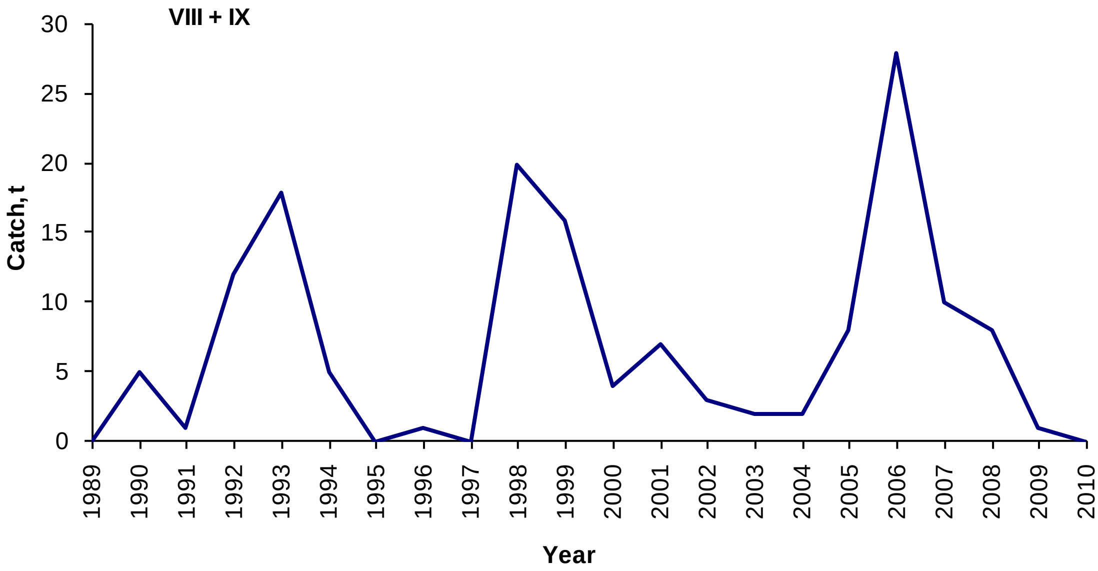



**Figure 10.5.4. Roundnose grenadier catches in Subareas VIII–IX, 1989–2010 (data for 2010 is preliminary).**

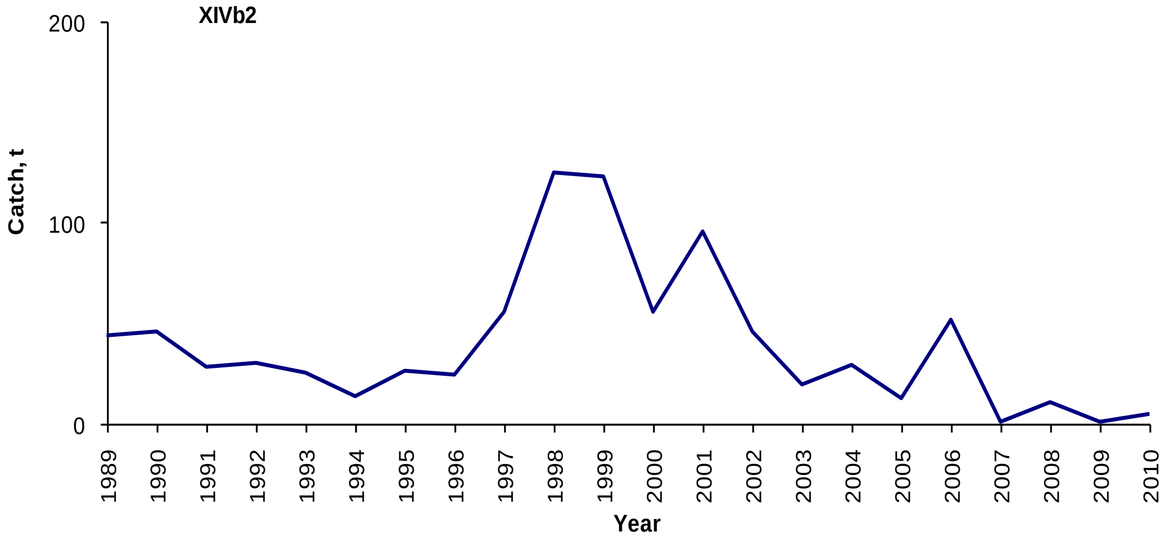



**Figure 10.5.5. Roundnose grenadier catches in Subarea XIVb2, 1989–2010 (data for 2010 is preliminary).**

# 11 Black scabbard fish (*Aphanopus carbo*) in the Northeast Atlantic

## 11.1 Stock description and management units

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30ºN. It occurs only sporadically north of the Scotland–Iceland–Greenland ridges. Juveniles are mesopelagic and adults are bentho-pelagic. It is admitted that the species life cycle is not completed in just one area and also that either small or large-scale migrations occur seasonally. It has been postulated that fish caught to the west of the British Isles are pre-adults that migrate further south (possibly down to Madeira) as they reach maturity.

The stock structure is uncertain. Three management units are considered:

i ) Northern (Divisions Vb and XIIb and Subareas VI and VII);

ii ) Southern (Subareas VIII and IX);

iii ) Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

The Northern component is exploited mainly by trawl fisheries while the southern component by a longline fishery in Subarea IXa. In other areas the species is exploited by both longliners and trawlers, but the overall landings are much lower than at the other two management units.

## 11.2 Black scabbard fish in Subareas Vb and XIIb and Divisions VI and VII

### 11.2.1 The fishery

This component is exploited mainly by trawl fisheries. These are described in the stock annex.

#### 11.2.1.1 Landings trends

The historical landings trends in this assessment unit are described in the stock annex.

Total landings for ICES Division Vb and Subareas VI, VII and XII show a markedly increasing trend from 1999 to 2002 followed by a decreasing trend until 2005 (Figure 11.2.1). There was a peak in 2006 then there was a decrease mainly due continuous decreases of landings from ICES Divisions VI and VII (Figure 11.2.1). For the years 2009 and 2010, French data are partial because not all data logbooks were available. For those years, the total French landings for 2009 and 2010 were extracted from sales in auction market. These data do not include fishing locations.

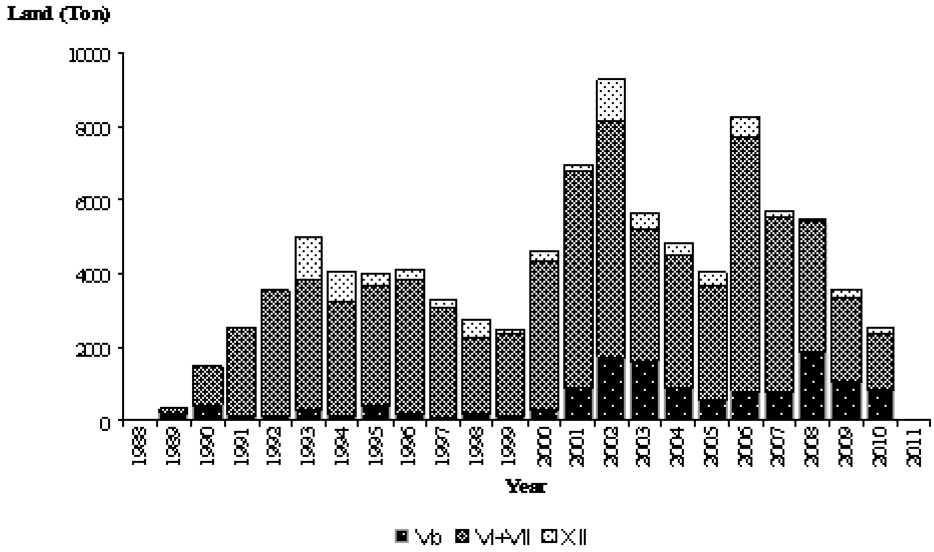



**Figure11.2.1. Annual landings for ICES Subareas Vb and Divisions VI+VII and XII (2010 provisional data). Note: that total French landings in 2009 and 2010 have been updated but not by ICES subareas or division.**

In earlier years French landings represent more than 75% of the Northern Component total landings however at recent years both Faroese and Spanish landings have increased their relative contribution (Figure 11.2.2). Faroese landings in ICES Division Vb area have increase in recent years (2010 landings ~ 800t).

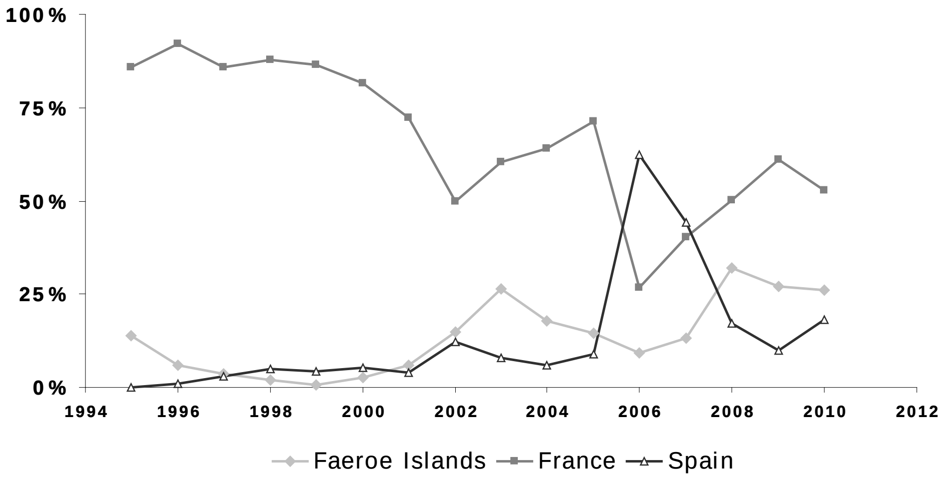



**Figure 11.2.2. French, Spanish and Faroes relative contribution to the annual landings for Northern Component (NC).**

### 11.2.1.2 ICES Advice

The most recent ICES Advice, in 2010, was: "*Catches in 2011 should be less than 2000 t.*"

#### 11.2.1.3 Management

Since 2003, management of black scabbardfish by EU vessels fishing in EU and international waters includes a combination of TAC and licensing system. The TACs for 2007–2008; 2009–2010 and the total landings in Subareas V, VI, VII and XII in 2006, 2007, 2008 and 2009 are presented in the Table below. From 2006 to 2009 the overall TAC has been significantly overshot.

| Year | EU TAC V, VI, VII & XII | EU Landinds Vb, VI, VII and XII |
|---|---|---|
| 2006 | 3042 | 7495 |
| 2007 | 3042 | 4936 |
| 2008 | 3042 | 3666 |
| 2009* | 2738 | 3122 |
| 2010* | 2547 | 2445 |
| 2011 | 2356 | |
| 2012 | 2179 | |

*** landing estimates are preliminary.**

### 11.2.2 Data available

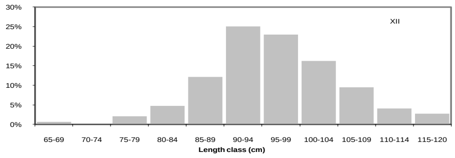
#### 11.2.2.1 Landings and discards

2010 landing data have been updated.

In 2011 new estimates of deep-sea discards from three otter trawl Spanish bottom otter trawl métiers operating in the Northeast Atlantic ICES V I, V II, V IIIc and North IXa were presented (Santos *et al*., 2011, WD-5). Data were derived from the `Spanish Discard Sampling Programme' carried out by the IEO. The results showed that the largest amounts of discards occur at depths less than 600 m. Discards of black scabbardfish were low and highly variable discards in both in Subareas VI–VII and in Divisions IXa and VIIIc.

#### 11.2.2.2 Length compositions

Length data have been provided from observers on board Spanish trawling fleet operating on the Northern and Western Hatton Bank (Divisions VIb1 and XIIb) in 2010. Length frequency distributions are presented in (Figure 11.2.5).



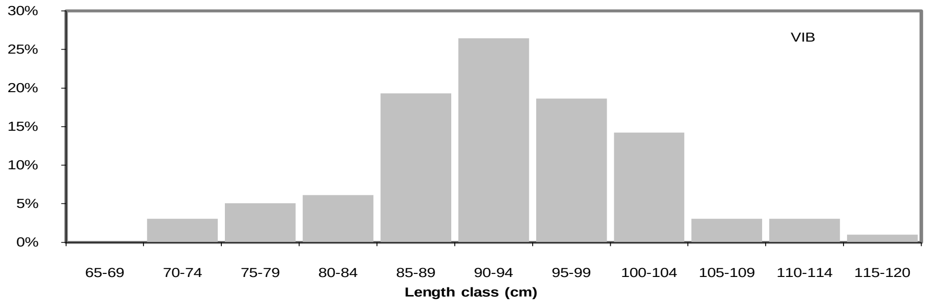




**Figure 11.2.5. Black scabbard fish length frequency distribution by year from on-board observations of Spanish trawlers in Subarea VIb and XIIb in 2010.**

#### 11.2.2.3 Age compositions

No data on age data are available.

#### 11.2.2.4 Weight-at-age

No data are available.

#### 11.2.2.5 Maturity and natural mortality

No new data.

#### 11.2.2.6 Catch, effort and research vessel data

### 11.2.3 Data analyses

France, Spanish and Faroese cpue dataseries are available but only the former have been used for analysis stock status.

### 11.2.4 Comments on the assessment

The French tallybooks database is considered to give more accurate lpue estimates than EU logbooks, especially because they provide information on haul by haul basis and include data on fishing depth, which is considered an important auxiliary source of information to identify deep-water hauls. Several factors, such as seasonal, fishing depth and species directivity are known to greatly affect commercial cpue and consequently their interpretation.

Data from the French fishing industry only allow lpue estimates from 2000 onwards, while cpue from French logbook data begin at 1989. Index abundance from French logbook data for directed fisheries (reference fleet in a reference area) indicated a fairly strong overall declining trend in abundance from 1991. However, most of the vessels formerly used as the reference fleet and used to derive abundance indices have been recently decommissioned or moved to other fisheries. As a consequence the lpue estimates from logbooks after 2008 onwards are considered not reliable as it includes only a few fishing days and will not be available in future.

### 11.2.5 Management considerations

Management advice for deep-water species is not requested this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WGFRAME, e.g. PSA, $F_{proxy}$ and CUSUM.

**Table 11.2.0a. Landings of black scabbard fish from Division Vb. Working Group estimates.**

| Year | Faroe Islands | | | France | Germany* | | Scotland | E&W&NI | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Vb 1 | Vb 2 | Vb | | Vb1 | Vb | | | |
| 1988 | | | | | . | . | - | - | |
| 1989 | - | - | | 170 | . | . | - | - | 170 |
| 1990 | 2 | 10 | | 415 | . | . | - | - | 427 |
| 1991 | - | 1 | | 134 | - | - | - | - | 135 |
| 1992 | 1 | 3 | | 101 | - | - | - | - | 105 |
| 1993 | 202 | - | | 75 | 9 | - | - | - | 286 |
| 1994 | 114 | - | | 45 | - | 1 | - | - | 160 |
| 1995 | 164 | 85 | | 175 | - | - | - | - | 424 |
| 1996 | 56 | 1 | | 129 | - | - | - | - | 186 |
| 1997 | 15 | 3 | | 50 | - | - | - | - | 68 |
| 1998 | 36 | - | | 144 | - | - | - | - | 180 |
| 1999 | 13 | - | | 134 | - | - | 6 | - | 153 |
| 2000 | | | 116 | 186 | - | - | 9 | - | 311 |
| 2001 | 122 | 281 | | 456 | - | - | 20 | 0 | 879 |
| 2002 | 222 | 1138 | | 304 | - | - | 80 | | 1744 |
| 2003 | 222 | 1230 | | 172 | - | - | 11 | | 1635 |
| 2004 | 80 | 625 | | 94 | - | - | 70 | | 869 |
| 2005 | 65 | 363 | | 106 | - | - | 20 | | 553 |
| 2006 | 54 | 637 | | 92 | - | - | | | 783 |
| 2007 | 78 | 596 | | 115 | - | - | 0 | | 789 |
| 2008 | 94 | 787 | 828 | 159 | . | . | 0 | | 1868 |
| 2009 | 117 | 852 | 0 | 96 | . | . | 1 | 0 | 1067 |
| 2010 | 97 | 665 | 0 | 48 | | | 31 | 0 | 840 |

***STATLAND data.**

**Table 11.2.0b. Landings of black scabbard fish from Division XII. Working Group estimates.**

| Year | France | Spain | Scotland | Russia(XIIc)** | Poland* | Total |
|---|---|---|---|---|---|---|
| 1988 | | | | . | - | 0 |
| 1989 | 0 | | | . | - | 0 |
| 1990 | 0 | | | . | - | 0 |
| 1991 | 2 | | | . | - | 2 |
| 1992 | 7 | | | . | - | 7 |
| 1993 | 24 | | | . | - | 24 |
| 1994 | 9 | | | . | - | 9 |
| 1995 | 8 | | | . | - | 8 |
| 1996 | 7 | 41 | | . | - | 48 |
| 1997 | 1 | 98 | | . | - | 99 |
| 1998 | 324 | 134 | | . | - | 458 |
| 1999 | 1 | 109 | 0 | . | - | 109 |
| 2000 | 5 | 237 | | . | - | 242 |
| 2001 | 3 | 115 | | . | - | 118 |
| 2002 | 0 | 1117 | 1 | . | - | 1119 |
| 2003 | 7 | 444 | | . | 1 | 452 |
| 2004 | 10 | 230 | 1 | . | - | 242 |
| 2005 | 14 | 239 | | . | - | 253 |
| 2006 | 0 | 492 | | . | - | 492 |
| 2007 | 0 | 134 | 0 | . | - | 134 |
| 2008 | 0 | 70 | 0 | 4 | . | 74 |
| 2009 | 0 | 127 | | 0 | . | 127 |
| 2010 | 0 | 188 | 0 | 0 | | 188 |

*** STATLAND data. *STATLAND data from 1988 to 2007.**

| Year | Faroes | Germany | Ireland | E&W&NI | Iceland* | Lituania* | Estonia | Poland | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | | . | | | | . | . | | 0 |
| 1989 | | . | | | | . | . | - | 0 |
| 1990 | | . | | | | . | . | - | 0 |
| 1991 | | - | | | | . | - | - | 0 |
| 1992 | | - | | | | - | - | - | 0 |
| 1993 | 1051 | 93 | | | | - | - | - | 1144 |
| 1994 | 779 | 45 | | | | - | - | - | 824 |
| 1995 | 301 | - | | | | - | - | - | 301 |
| 1996 | 187 | - | | | 0 | - | - | - | 187 |
| 1997 | 102 | - | | | | - | - | - | 102 |
| 1998 | 20 | - | | | | - | - | - | 20 |
| 1999 | | - | | | | - | - | - | 0 |
| 2000 | 1 | - | | | | - | - | - | 1 |
| 2001 | | - | | | | - | - | - | 0 |
| 2002 | | - | | 0 | | - | - | - | 0 |
| 2003 | | - | 1 | | | 1 | - | 1 | 3 |
| 2004 | 95 | - | | | | 1 | - | - | 96 |
| 2005 | 127 | - | 0 | | | - | 1 | - | 128 |
| 2006 | 8 | - | | | | - | 2 | | 10 |
| 2007 | 0 | - | 0 | | | - | 7 | | 7 |
| 2008 | 1 | . | 0 | | | - | . | | 1 |
| 2009 | 156 | - | 0 | 0 | | . | . | | 156 |
| 2010 | 27 | | 0 | 0 | | | | | 27 |

*** STATLAND data.**

**Table 11.2.0c. Landings of black scabbard fish from Division VI. Working Group estimates.**

| Year | France | | Faroes | | Germany* | | Ireland | Scotland | Scotland | Netherlands * | | Lituania* | Estonia * | Poland* | Russia** | Spain | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VIa | VIb | VIa | VIb | VIa | VI b | VIa | VIa | VIb | VIa | Vib | Via | VIb | VIb | VIb | | |
| 1988 | | | | | . | . | | | | - | - | . | . | | . | | |
| 1989 | 138 | 0 | 46 | | . | . | | - | - | - | - | . | . | - | . | | 184 |
| 1990 | 971 | 53 | | | . | . | | - | - | - | - | . | . | - | . | | 1023 |
| 1991 | 2244 | 62 | | | - | - | | - | - | - | - | . | - | - | - | | 2307 |
| 1992 | 2998 | 113 | 3 | | - | - | | - | - | - | - | - | - | - | - | | 3113 |
| 1993 | 2857 | 87 | | 62 | 48 | - | | - | - | - | - | - | - | - | - | | 3054 |
| 1994 | 2331 | 55 | | | 30 | 15 | | 2 | - | - | - | - | - | - | - | | 2433 |
| 1995 | 2598 | 15 | | | - | 3 | | 14 | 4 | - | - | - | - | - | - | | 2634 |
| 1996 | 2980 | 1 | | | - | 2 | | 36 | <0.5 | - | - | - | - | - | - | | 3019 |
| 1997 | 2278 | 16 | | 3 | - | - | | 147 | 88 | - | - | - | - | - | - | 0 | 2533 |
| 1998 | 1553 | 7 | | | - | - | | 142 | 6 | - | - | - | - | - | - | 1 | 1709 |
| 1999 | 1610 | 8 | | | - | - | | 133 | 58 | 11 | - | - | - | - | - | 0 | 1821 |
| 2000 | 2971 | 27 | | | - | - | | 333 | 41 | 7 | - | - | - | - | - | 1 | 3380 |
| 2001 | 3791 | 29 | | 3 | - | - | | 486 | 145 | - | - | 3 | 225 | - | 226 | 150 | 5057 |
| 2002 | 3830 | 156 | 2 | | - | - | | 603 | 300 | 21 | 2 | 9 | - | 2 | - | | 4925 |
| 2003 | 2933 | 67 | 45 | | - | - | | 78 | 9 | - | 2 | 12 | 7 | 2 | 7 | | 3162 |
| 2004 | 2637 | 99 | 59 | | - | - | | 100 | 24 | - | - | 85 | 5 | - | 5 | 62 | 3075 |
| 2005 | 2519 | 59 | 38 | | - | - | | 18 | 62 | - | - | 5 | 11 | - | 11 | 126 | 2850 |
| 2006 | 1714 | 36 | 59 | | - | - | 1 | 63 | 0 | - | - | 1 | 3 | - | 3 | 4647 | 6527 |
| 2007 | 1936 | 4 | 44 | 37 | - | - | 0 | 53 | 0 | - | - | - | - | - | - | 2374 | 4448 |
| 2008 | 2384 | 0 | 37 | 0 | . | . | 0 | 26 | 0 | 14 | . | - | . | . | 1 | 870 | 3333 |
| 2009 | 1691 | 1 | 39 | 0 | . | . | 0 | 80 | 0 | . | . | . | . | . | 0 | 295 | 2107 |
| 2010 | 868 | 1 | 69 | | | | 0 | 73 | 0 | | | | | | 0 | 415 | 1425 |

***STATLAND data *STATLAND data from 1988 to 2007.**

**Table 11.2.0d. Landings of black scabbard fish from Division VII. Working Group estimates.**

| Year | France | | | | | | | Ireland | | | Scotland | E&W&NI | Spain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VII | VIIa | VIIb | VIIc | VIId-h | VIIj | VIIk | VIIb,j | VIIc | VIIk | VIIb,c,j,k | VIIj,k | VII | Total |
| 1988 | | | | | | | | | | | | | | |
| 1989 | | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | | | 0 |
| 1990 | | 0 | 2 | 8 | 0 | 0 | 0 | | | | 0 | | | 10 |
| 1991 | | 0 | 14 | 17 | 7 | 7 | 49 | | | | 0 | | | 94 |
| 1992 | | 0 | 9 | 69 | 11 | 49 | 183 | | | | 0 | | | 322 |
| 1993 | | 0 | 24 | 149 | 16 | 170 | 109 | | | | 0 | | | 468 |
| 1994 | | 0 | 32 | 165 | 8 | 120 | 336 | | | | 0 | | | 662 |
| 1995 | | 0 | 52 | 121 | 9 | 74 | 385 | | | | 0 | | | 641 |
| 1996 | | 0 | 104 | 130 | 2 | 60 | 360 | | | | 0 | | | 658 |
| 1997 | | 0 | 24 | 200 | 1 | 33 | 202 | | | | 0 | | 1 | 462 |
| 1998 | | 0 | 15 | 104 | 6 | 52 | 211 | | | | 0 | | 2 | 390 |
| 1999 | | 1 | 7 | 97 | 3 | 70 | 177 | | | | 0 | | 0 | 355 |
| 2000 | | | 25 | 173 | 5 | 100 | 253 | | | | 3 | | 0 | 559 |
| 2001 | | 2 | 40 | 236 | 4 | 180 | 267 | | | | 41 | | 0 | 770 |
| 2002 | | 3 | 33 | 105 | 8 | 138 | 49 | | | | 53 | | | 389 |
| 2003 | | 0 | 15 | 29 | 4 | 159 | 36 | | | | 1 | | | 245 |
| 2004 | | 0 | 31 | 28 | 16 | 115 | 63 | | | | 0 | | | 253 |
| 2005 | 3 | 14 | 4 | 2 | 34 | 103 | 23 | | | | | | | 183 |
| 2006 | | | 3 | 10 | 24 | 315 | 20 | 1 | 32 | 37 | 0 | 2 | | 445 |
| 2007 | | 56 | 2 | 7 | 5 | 168 | 7 | 0 | 52 | 17 | 0 | 0 | | 313 |
| 2008 | | | 2 | 20 | 6 | 162 | 4 | 0 | 0 | 0 | 0 | 0 | | 195 |
| 2009 | | 1 | 2 | 45 | 17 | 61 | 8 | 0 | 0 | 0 | 0 | 0 | | 134 |
| 2010 | | 1 | 2 | 24 | 7 | 28 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 62 |

**Table 11.2.0d. Landings of black scabbard fish from Division VI and VII. Working Group estimates.**

| Year | Ireland | E&W&NI | Total |
|---|---|---|---|
| 1988 | | | |
| 1989 | | | 0 |
| 1990 | | | 0 |
| 1991 | | | 0 |
| 1992 | | | 0 |
| 1993 | 8 | | 8 |
| 1994 | 3 | | 3 |
| 1995 | | | 0 |
| 1996 | | 1 | 1 |
| 1997 | 0 | 2 | 2 |
| 1998 | 0 | 1 | 1 |
| 1999 | 1 | 1 | 2 |
| 2000 | 59 | 40 | 99 |
| 2001 | 68 | 37 | 105 |
| 2002 | 1050 | 43 | 1093 |
| 2003 | 159 | 5 | 164 |
| 2004 | 293 | 2 | 295 |
| 2005 | 79 | 0 | 79 |
| 2006 | | | 0 |
| 2007 | | | 0 |
| 2008 | | | 0 |
| 2009 | | 0 | 0 |
| 2010 | 0 | 0 | 0 |

## 11.3 Black scabbard fish in Subareas VIII, IX

### 11.3.1 The fishery

The main fishery taking place in these Subareas is derived from the Portuguese longliners. This fishery was described in 2007 report (Bordalo_Machado and Figueiredo, 2007 WD) and updated later (Bordalo_Machado and Figueiredo, 2009).

The French bottom trawlers operating in Subareas mainly VI and VII have a small marginal activity in Subarea VIII.

#### 11.3.1.1 Landings trends

Landings in Subareas VIII and IX are almost all from the Portuguese longline fishery that takes place in Subarea IXa (more than 99% of the total landings; Figure 11.3.1).

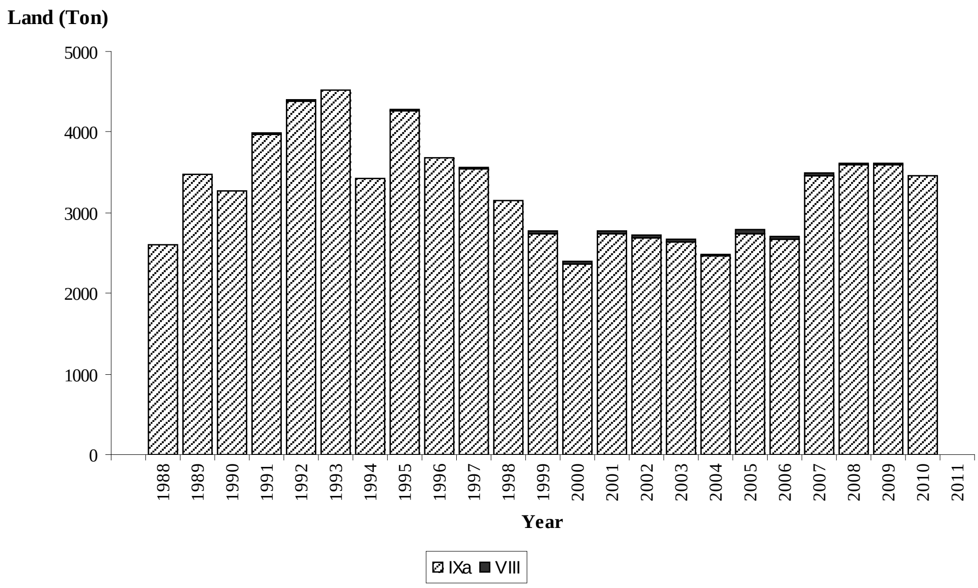



**Figure 11.3.1. Annual landings for ICES Subareas VIII and Division IXa (2010 provisional data).**

#### 11.3.1.2 ICES Advice

The most recent ICES Advice, in 2010, was: "*Catches in 2011 should be less than 2800 t.*."

#### 11.3.1.3 Management

Since 2003, management of black scabbardfish by EU vessels fishing in EU and international waters has included a combination of TAC and licensing system. The TAC adopted from 2006 till 2010, as well as, the total landings in Subareas VIII, IX and X are next presented.

| Year | EU TAC VIII, IX and X | EU Landinds |
|---|---|---|
| 2006 | 3042 | 2791 |
| 2007 | 4000 | 3556 |
| 2008 | 4000 | 3719 |
| 2009 | 3600 | 3601 |
| 2010* | 3348 | 3453 |
| 2011 | 3348 | |
| 2012 | 3348 | |

*** 2010 landing estimates are preliminary.**

### 11.3.2 Data available

#### 11.3.2.1 Landings and discards

Recent discard data from the Portuguese black scabbardfish fishery in 2009 showed that the fishery is quite selective for black scabbardfish (93% of catches in number).

#### 11.3.2.2 Length compositions

New length frequency distributions by quarter were made available for 2010 data collected under the National Minimum Landings Sampling Programme (Figure 11.3.3.).

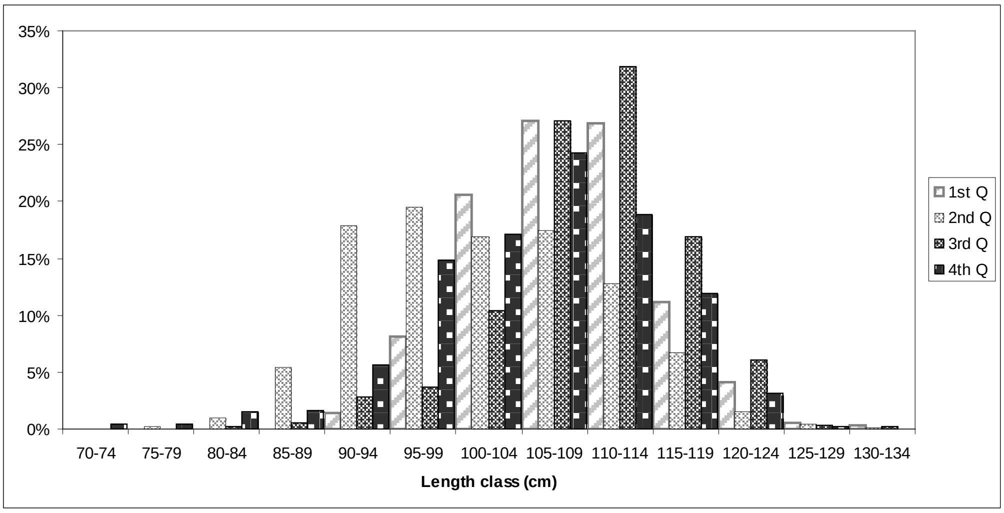



**Figure 11.3.3. 2010 Length frequency distribution by quarter derived from National Minimum Landing Sampling Programme for the deep-water longline fishery in IXa.**

#### 11.3.2.3 Age compositions

No new data available.

### 11.3.3 Weight-at-age

No new data are available.

#### 11.3.3.1 Maturity and natural mortality

No new data are available.

#### 11.3.3.2 Catch, effort and research vessel data

Monthly standardized black scabbardfish lpue from the longline fleet operating in Subarea IXa are available for the period 1995–2009.

The monthly lpue estimates and the corresponding confidence intervals are shown in Figure 11.3.5.

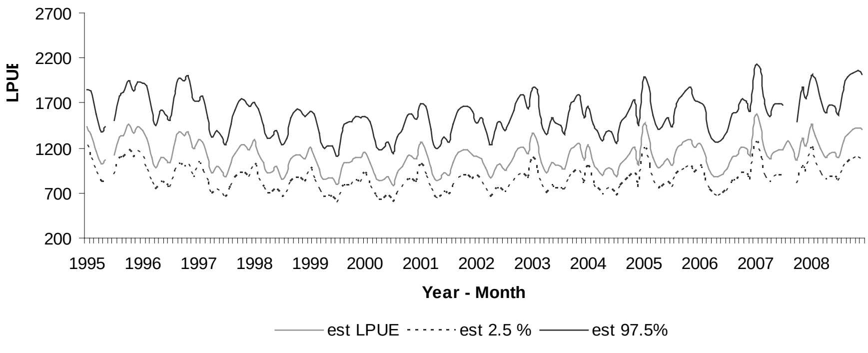



**Figure 11.3.5. Monthly lpue estimates for ICES Subarea IXa with 95% confidence intervals from the adjusted GLM model.**

The monthly lpue estimates did not show any marked long-term trend and seem to follow a seasonal pattern along the period in analysis.

Figure 11.3.5 shows the variation of the estimated Year effects for the selected model during the period 1995–2009.

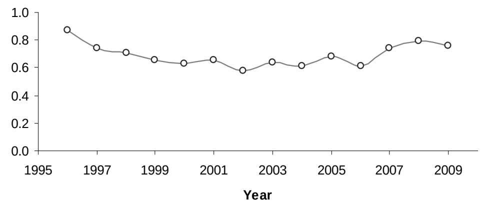



**Figure 11.3.6. ICES Subarea IXa Year effects for the selected model during the period 1996–2009 (Figueiredo and Farias, WD 2010).**

### 11.3.4 Data analyses

Standardized black scabbardfish lpue from the longline fleet operating in Subarea IXa were estimated for the period 1995–2009.

### 11.3.5 Comments on the assessment

The lpue estimate, as well as, other information on the species for the southern component and other components will be analysed under DEEPFISHMAN Project aiming to the development of new approaches that take into consideration spatial stock dynamics.

### 11.3.6 Management considerations

Management advice for deep-water species is not requested this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WGFRAME, e.g. CUSUM.

**Table 11.3.0a. Black scabbard fish from Subarea IX; Working Group estimates of landings.**

| Year | Portugal | Spain | Total |
|---|---|---|---|
| 1988 | 2602 | | 2602 |
| 1989 | 3473 | | 3473 |
| 1990 | 3274 | | 3274 |
| 1991 | 3978 | | 3978 |
| 1992 | 4389 | | 4389 |
| 1993 | 4513 | | 4513 |
| 1994 | 3429 | | 3429 |
| 1995 | 4272 | | 4272 |
| 1996 | 3686 | | 3686 |
| 1997 | 3553 | 0 | 3553 |
| 1998 | 3147 | 0 | 3147 |
| 1999 | 2741 | 0 | 2741 |
| 2000 | 2371 | 0 | 2371 |
| 2001 | 2744 | 0 | 2744 |
| 2002 | 2692 | | 2692 |
| 2003 | 2630 | | 2630 |
| 2004 | 2463 | | 2463 |
| 2005 | 2746 | | 2746 |
| 2006 | 2674 | | 2674 |
| 2007 | 3453 | | 3453 |
| 2008 | 3602 | | 3602 |
| 2009 | 3601 | | 3601 |
| 2010 | 3453 | 0 | 3453 |

**Table 11.3.0b. Black scabbard fish from Subarea VIII; Working Group estimates of landings.**

| Year | France | | | | Spain | |
|---|---|---|---|---|---|---|
| | VIIIa | VIIIb | VIIIc | VIIId | | Total |
| 1988 | | | | | | 0 |
| 1989 | 0 | 0 | | 0 | | 0 |
| 1990 | 0 | 0 | | 0 | | 0 |
| 1991 | 1 | 0 | | 0 | | 1 |
| 1992 | 4 | 0 | | 4 | | 9 |
| 1993 | 5 | 0 | | 7 | | 11 |
| 1994 | 3 | 0 | | 2 | | 5 |
| 1995 | 0 | 0 | | 0 | | 0 |
| 1996 | 0 | 0 | | 0 | 3 | 3 |
| 1997 | 1 | 0 | | 0 | 1 | 2 |
| 1998 | 2 | 0 | | 0 | 3 | 6 |
| 1999 | 7 | | | 4 | 0 | 12 |
| 2000 | 15 | 0 | | 20 | 1 | 35 |
| 2001 | 16 | 0 | | 12 | 1 | 29 |
| 2002 | 17 | 2 | | 16 | 1 | 36 |
| 2003 | 25 | | | 8 | 1 | 35 |
| 2004 | 25 | 0 | 0 | 14 | 1 | 40 |
| 2005 | 21 | 0 | | 6 | 1 | 28 |
| 2006 | 30 | 2 | 0 | 19 | 0 | 52 |
| 2007 | 14 | 1 | | 13 | 1 | 29 |
| 2008 | 10 | 0 | | 35 | 1 | 45 |
| 2009 | 4 | 0 | 1 | 0 | 1 | 6 |
| 2010 | 15 | 0 | 0 | 0 | 0 | 15 |

## 11.4 Black scabbard fish other areas (I, II, IIIa, IV, X, Va, XIV)

### 11.4.1 The fishery

This assessment unit is made up of diverse areas. In some of these areas fisheries have occurred sporadically or at very low levels.

A Faroese exploratory trawl fishery took place in 2008 in the Mid-Atlantic Ridge area. This fishery was mainly targeting at orange roughy and black scabbard fish, and was undertaken in the period 13 February to 9 March 2008 in ICES Areas X (and XII) according to a resolution adopted at the 26th Annual Meeting of NEAFC on management measures for orange roughy. The fishery was performed with one trawler (M/S Ran TG0752) with many years participation in the Faroese orange roughy fishery. The gear was a traditional bottom trawl, but in the fishing operations the trawl doors did not touch the bottom. All information for the fishery was registered in accordance with NEAFC Recommendation X: 2007 concerning submission of scientific information on deep-sea fisheries. The Faroese Fisheries Laboratory provided instructions for how to keep logbook such that all the information mentioned in NEAFC recommendation was properly recorded (Reinert, 2010 WD). No updated information is available.

#### 11.4.1.1 Landings trends

In 2010 Icelandic landings in ICES Subarea Va have increased from around 20 tonnes to 109 tonnes.

In 2010 111 t was reported by Spain in ICES Subarea XIV. This may be area-misreporting.

#### 11.4.1.2 ICES Advice

The most recent ICES Advice, in 2010, was: *"The fishery should not be allowed to expand, and a reduction in catches should be considered until such time there is sufficient scientific information to prove the fishery is sustainable."*

#### 11.4.1.3 Management

Since 2003, management of black scabbardfish by EU vessels fishing in EU and international waters includes a combination of TAC and licensing system. The TAC adopted from 2007 to 2012 by subareas are presented next.

Both in 2009 and 2010 the TACs have been exceeded, particularly in the latter year. More information is needed in order to track the situation.

| Year | EU and international waters of I, II, III and IV | EU Landings |
|---|---|---|
| 2007 | 15 | 1 |
| 2008 | 15 | 0 |
| 2009 | 12 | 25 |
| 2010* | 12 | 161 |
| 2011 | 12 | |
| 2012 | 9 | |

*** 2010 landing estimates are preliminary.**

### 11.4.2 Data available

#### 11.4.2.1 Landings and discards

Landings are given in Tables 11.4.0a–e and in Figure 11.4.1. In Subareas II, IV and XIV reported landings are considered to be misreported although the extent of this is unknown.

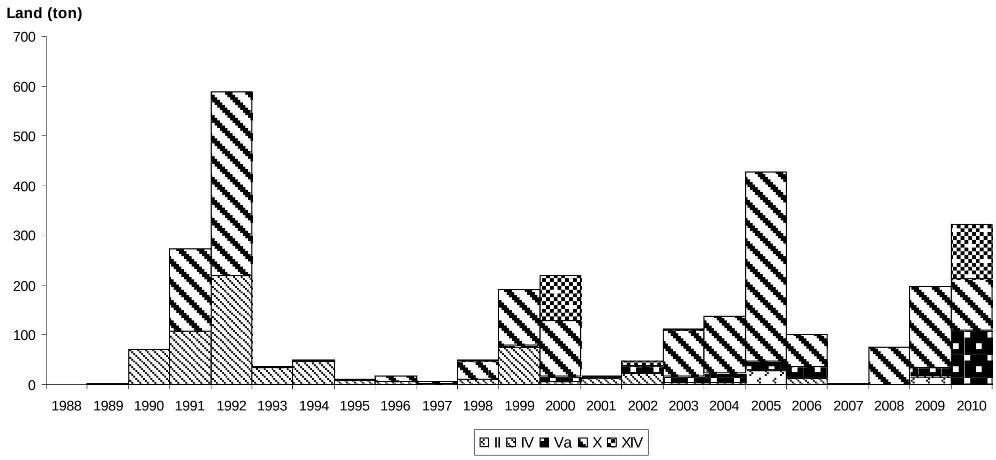



**Figure 11.4.1. Annual landings for black scabbardfish by ICES Subareas II, IV, V, X and XIV.**

#### 11.4.2.2 Length compositions

No new data were available.

#### 11.4.2.3 Age compositions

No data were available.

#### 11.4.2.4 Weight-at-age

No data were available.

#### 11.4.2.5 Maturity and natural mortality

No new data were available.

#### 11.4.2.6 Catch, effort and research vessel data

No new data were available.

### 11.4.3 Data analyses

Apart from the data presented for Faroese exploratory survey, the data available only refer to landings.

The overall landings were quite variable along years and do not appear to reflect abundance trends.

### 11.4.4 Comments on the assessment

Despite the variability on the overall landings data along years, the landing data available for different ICES subareas give evidence that the areas of major concentration of the species is at ICES Division X. This spatial aspect is consistent with the current perception on the spatial distribution of the species at NE Atlantic.

### 11.4.5 Management considerations

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WGFRAME, e.g. PSA.

**Table 11.4.0a. Black scabbard fish other Areas II. Working Group estimates of landings.**

| Year | France | Faroes | Total |
|---|---|---|---|
| | | II a | |
| 1988 | | | 0 |
| 1989 | 0 | | 0 |
| 1990 | 1 | | 1 |
| 1991 | 0 | | 0 |
| 1992 | 0 | | 0 |
| 1993 | 0 | | 0 |
| 1994 | 0 | | 0 |
| 1995 | 1 | | 1 |
| 1996 | 0 | | 0 |
| 1997 | 0 | | 0 |
| 1998 | 0 | | 0 |
| 1999 | 0 | | 0 |
| 2000 | 0 | | 0 |
| 2001 | 0 | | 0 |
| 2002 | 0 | | 0 |
| 2003 | 0 | | 0 |
| 2004 | 0 | | 0 |
| 2005 | 0 | 27 | 27 |
| 2006 | 0 | 0 | 0 |
| 2007 | 0 | 0 | 0 |
| 2008 | 0 | 0 | 0 |
| 2009 | 15 | 0 | 15 |
| 2010 | 0 | 0 | 0 |

**Table 11.4.0b. Black scabbard fish other Areas IV. Working Group estimates of landings.**

| Year | France | France | France | Scotland | | | Germany * | E&W&NI | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | IVa | IVb | IVa | IVb | IVc | IVa | IVa | |
| 1988 | | | | - | | | . | - | 0 |
| 1989 | 3 | | | - | | | . | - | 3 |
| 1990 | 70 | | | - | | | . | - | 70 |
| 1991 | 107 | | | - | | | - | - | 107 |
| 1992 | 219 | | | - | | | - | - | 219 |
| 1993 | 34 | | | - | | | - | - | 34 |
| 1994 | 45 | | | - | | | 3 | - | 48 |
| 1995 | 6 | | | 2 | | | - | - | 8 |
| 1996 | 6 | | | 1 | | | - | - | 7 |
| 1997 | 0 | | | 2 | | | - | - | 2 |
| 1998 | 2 | | | 9 | | | - | - | 11 |
| 1999 | 71 | | | 3 | | | - | - | 74 |
| 2000 | | 4 | | 3 | | | - | - | 7 |
| 2001 | | 1 | | 10 | | | - | 1 | 12 |
| 2002 | | 0 | | 24 | | | - | | 24 |
| 2003 | | 0 | | 4 | | | - | | 4 |
| 2004 | | 4 | 1 | 0 | | | - | | 5 |
| 2005 | | 1 | 1 | 0 | | | - | | 2 |
| 2006 | | 13 | | 0 | 0 | 0 | - | | 13 |
| 2007 | | 1 | 0 | 0 | | | - | | 1 |
| 2008 | | 0 | | 0 | | | - | | 0 |
| 2009 | | 5 | 0 | 0 | 0 | 0 | - | 0 | 5 |
| 2010 | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |

***STATLAND data.**

**Table 11.4.0c. Black scabbard fish other Areas Va. Working Group estimates of landings.**

| Year | Iceland | Total |
|---|---|---|
| 1988 | - | 0 |
| 1989 | - | 0 |
| 1990 | - | 0 |
| 1991 | - | 0 |
| 1992 | - | 0 |
| 1993 | 0 | 0 |
| 1994 | 1 | 1 |
| 1995 | + | 0 |
| 1996 | 0 | 0 |
| 1997 | 1 | 1 |
| 1998 | 0 | 0 |
| 1999 | 6 | 6 |
| 2000 | 10 | 10 |
| 2001 | 5 | 5 |
| 2002 | 13 | 13 |
| 2003 | 14 | 14 |
| 2004 | 19 | 19 |
| 2005 | 19 | 19 |
| 2006 | 23 | 23 |
| 2007 | 1 | 1 |
| 2008 | 0 | 0 |
| 2009 | 15 | 15 |
| 2010 | 109 | 109 |

**Table 11.4.0d. Black scabbard fish other Areas X. Working Group estimates of landings.**

| Year | Faroes | Portugal | France | Ireland | Total |
|---|---|---|---|---|---|
| 1988 | - | - | | | 0 |
| 1989 | - | - | 0 | | 0 |
| 1990 | - | - | 0 | | 0 |
| 1991 | - | 166 | 0 | | 166 |
| 1992 | 370 | - | 0 | | 370 |
| 1993 | - | 2 | 0 | | 2 |
| 1994 | - | - | 0 | | 0 |
| 1995 | - | 3 | 0 | | 3 |
| 1996 | 11 | 0 | 0 | | 11 |
| 1997 | 3 | 0 | 0 | | 3 |
| 1998 | 31 | 5 | 0 | | 36 |
| 1999 | - | 46 | 66 | | 112 |
| 2000 | - | 112 | 1 | | 113 |
| 2001 | - | + | 0 | | 0 |
| 2002 | 2 | + | 0 | | 2 |
| 2003 | | 91 | 0 | | 91 |
| 2004 | 111 | 2 | 0 | | 113 |
| 2005 | 56 | 323 | 0 | 0 | 379 |
| 2006 | 10 | 55 | 0 | | 65 |
| 2007 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 75 | 0 | 0 | 0 | 75 |
| 2009 | 157 | 5 | 0 | 0 | 162 |
| 2010 | 53 | 49 | 0 | 0 | 102 |

**Table 11.4.0f. Black scabbard fish other Areas XIV. Working Group estimates of landings.**

| Year | Faroes | Spain | Total |
|---|---|---|---|
| | XIVb | | |
| 1988 | - | - | 0 |
| 1989 | - | - | 0 |
| 1990 | - | - | 0 |
| 1991 | - | - | 0 |
| 1992 | - | - | 0 |
| 1993 | - | - | 0 |
| 1994 | - | - | 0 |
| 1995 | - | - | 0 |
| 1996 | - | - | 0 |
| 1997 | - | | 0 |
| 1998 | 2 | | 2 |
| 1999 | - | | 0 |
| 2000 | - | 90 | 90 |
| 2001 | - | 0 | 0 |
| 2002 | | 8 | 8 |
| 2003 | | 2 | 2 |
| 2004 | | | 0 |
| 2005 | 0 | | 0 |
| 2006 | - | | 0 |
| 2007 | 0 | | 0 |
| 2008 | 0 | | 0 |
| 2009 | 0 | | 0 |
| 2010 | | 111 | 111 |

# 12 Greater forkbeard (*Phycis blennoides*) in all ecoregion

## 12.1 The fishery

Greater forkbeard may be considered as a bycatch species in the traditional demersal trawl and longline mixed fisheries targeting species such as hake, megrim, monkfish, ling, and blue ling in Subareas VI, VII and VIII.

Since 1988, 79% of landings have come from Subareas VI and VII. Spanish, French and UK trawl and longline are the main fleets involved in this fishery. The Irish mixed deep-water fishery around Porcupine Bank historically landed important quantities of this species. Russian fisheries in the North-East Atlantic land small quantities of greater forkbeard as bycatch of the trawler fleet targeting roundnose grenadier, tusk and ling on Hatton and Rockall Banks.

A further 12% of landings in this period come the French and Spanish trawl and longline fleets in Subareas VIII and IX (mainly from VIII). In Subarea IX since 2001 small amounts of *Phycis* spp (probably *Phycis phycis*) have been landed in ports of Strait of Gibraltar by the longliner fleet targeting scabbardfish in Algeciras, Barbate and Conil.

Minor quantities of *Phycis blennoides* from Subarea X and Division Vb are landed by Portuguese and Norwegian vessels respectively. The Azores deep-water fishery is a multispecies and multi-gear fishery dominated by the main target species *Pagellus bogaraveo*. Target species can change seasonally according to abundance and market prices, but *P. blennoides,* representing less than 1% of total deep-water landings in the last three years, can be considered as bycatch.

### 12.1.1 Landings trends

Tables 12.0a–h show landings of greater forkbeard by subarea and country. Landings in Subareas VIII, IX and X may include some landings of *Phycis* spp. Data for 2010 are preliminary.

Landings in the Northeast Atlantic have decreased by a factor of five since 2001. This is particularly reflected in the landings reported by Ireland, Spain, UK (England and Wales), UK (Scotland) and to a lesser extent by France and Norway in Subareas VI and VII. This important reduction could be linked with the bycatch nature of the landings.

In Subareas I, II, III, IV and V only Norwegian landings are significant. The Norwegian longliners which fish in these areas catch *P. blennoides* as a bycatch in the ling fishery. The quantity of this bycatch depends on market price. After eight years without *P. blennoides* records, in 2002 the Norwegian fleet in Subareas I and II reported 315 t, since when the landings of this country have been reduced until 2007. In 2008 and 2010 landings increased again (112 and 127 t respectively).

Trends in Division Vb show a peak in 2002 in which most of the landings were reported by Norwegian vessels. After this year the landings decreased to an average of 49 t/year.

From 1998 to 2007, Subareas VIII and IX landed on average 467 t with a peak of 586 tonne in 2007. Most of these landings come from the Spanish trawl fleet. Since 2007 landings decrease strongly until 69 t reported in 2010.

In Subarea X landings peaked at 136 t in 1994. Since 2000 landings have continuously decreased with the lowest landings recorded in the two most recent years.

Although there are many countries involved in the fishery, landings in Subarea XII are negligible.

Spanish landings by subarea and gear from 2003 to 2010 are shown in Table 12.1. During this period, Spanish landings in Subareas VII and VIII of were from trawl (63%) and longline (32%) respectively).

### 12.1.2 ICES Advice

In 2010 ICES advised; *the fishery should not be allowed to expand, and a reduction in catches should be considered, in light of survey data indicating a recent decline.*

### 12.1.3 Management

Biannual EU TACs in 2009–2010 by subarea and landings in the same period are shown below. Because in some cases international landings were not available by species, these summary tables may include landings of *Phycis* spp. The landings in 2009 and 2010 were well below the TAC. Note that landings in Subareas I and II include Norwegian landings while only EU TACs are shown.

| PHYCIS BLENNOIDES | EU TAC | Total International LANDINGS | |
|---|---|---|---|
| Subarea | 2009-2010 | 2009 | 2010 |
| I,II,III,IV | 31 | 231 | 310 |
| V,VI,VII | 2028 | 818 | 831 |
| VIII, IX | 267 | 203 | 69 |
| X,XII | 54 | 57 | 14 |
| Total | 2380 | 1309 | 1224 |

## 12.2 Stock identity

ICES currently considers greater forkbeard as a single-stock for the entire ICES area. It is considered probable that the stocks structure is more complex however further study would be required to justify change to the current assumption.

## 12.3 Data available

### 12.3.1 Landings and discards

Landings are presented in Table 12.0a–h. Catches aggregated at the level of statistical rectangle were not provided to the Working Group.

Estimates of discards from Basque Country (Spain) trawlers by subarea since 2003 are presented in Table 12.2. The estimates were made by taking on board a subsample of the total discard of each haul then extrapolated to the whole discard of the trip and to the total fleet for each year. Discarding of this species was negligible in Subareas VII and VIII, however in Subarea VI in some years of the series (2008) the discards estimated were significant higher than landings reported by this fleet. Estimated discards from Spanish fisheries in Subareas VI, VII, VIII and North IXa from 2003 to 2009 are presented in a Working Document (Santos *et al.*, WD5). According the authors, greater forkbeard is one of the most discarded species both in Northern and Southern fishing areas and the main factor is the low value of small individuals in the markets (Table 12.3).

### 12.3.2 Length compositions

Figure 12.2 presents length frequency distributions from 2001–2010 Spanish bottom-trawl surveys in on the Porcupine Bank. Since 2003 the number of greater forkbeard of all sizes have recorded in this survey have decreased strongly. Length distribution of greater forkbeard shows a small trace of individuals smaller than 23 cm (4.8 ind/haul) with the same value found in 2001, but much smaller than 2002 cohort (14.4 ind/haul) that produced the high abundances of subsequent years (2003–2006).

### 12.3.3 Age compositions

No data available.

### 12.3.4 Weight-at-age

No data available.

### 12.3.5 Maturity and natural mortality

No data available.

### 12.3.6 Catch, effort and research vessel data

Biomass and abundance of greater forkbeard in Spanish bottom-trawl surveys on the Porcupine Bank from 2001 to 2010 are presented in Figure 12.3. The results of the survey in 2010 show similar biomass and abundance values to the last two years, remaining at the levels of 2008, suggesting that the gear problems in 2008 were not so relevant to this species. Nevertheless recruits are more abundant than in the period 2008–2009 when less than one individual per haul <23 cm was recorded.

A geographic representation of *Phycis blennoides* catches (kg/30 min haul) in Porcupine bank is shown in Figure 12.4. The geographical distribution of catch abundance shows a continuous decreasing trend in recent years although a slight increase is observed in 2009 and 2010 in the mid-southern part of the area.

A historical dataseries of Effort (days at sea) and lpue of *Phycis spp*. From the commercial Basque Country trawl fleet in Subareas VI, VII and VIII is shown in Table 12.4 and Figure 12.5. The only subarea in which landings and lpue are significant is Subarea VI. The historical trend indicates a stabilization of lpue since 2002 between, oscillating between 50 and 100 kg/days after the peak in 2000. However this is a bycatch fishery and lpue indices should be treated with caution.

## 12.4 Data analyses

### 12.4.1 Exploratory assessment

No assessment was presented in WGDEEP 2011.

### 12.4.2 Comments on the assessment

No assessment was presented in WGDEEP 2011.

## 12.5 Management considerations

No management advice is required this year. In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME, e.g. $F_{proxy}$ and CUSUM.

**Table12.0a. Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic. Working Group estimates of landings.**

| YEAR | I+II | III+IV | VB | VI+VII | VIII+IX | X | XII | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1988 | 0 | 15 | 2 | 1898 | 81 | 29 | 0 | 2025 |
| 1989 | 0 | 12 | 1 | 1815 | 145 | 42 | 0 | 2015 |
| 1990 | 23 | 115 | 38 | 1921 | 234 | 50 | 0 | 2381 |
| 1991 | 39 | 181 | 53 | 1574 | 130 | 68 | 0 | 2045 |
| 1992 | 33 | 145 | 49 | 1640 | 179 | 91 | 1 | 2138 |
| 1993 | 1 | 34 | 27 | 1462 | 395 | 115 | 1 | 2035 |
| 1994 | 0 | 12 | 4 | 1571 | 320 | 136 | 3 | 2046 |
| 1995 | 0 | 3 | 9 | 2138 | 384 | 71 | 4 | 2609 |
| 1996 | 0 | 18 | 7 | 3590 | 456 | 45 | 2 | 4118 |
| 1997 | 0 | 7 | 7 | 2335 | 361 | 30 | 2 | 2742 |
| 1998 | 0 | 12 | 8 | 3040 | 665 | 38 | 1 | 3764 |
| 1999 | 0 | 31 | 34 | 3455 | 379 | 41 | 0 | 3940 |
| 2000 | 0 | 11 | 32 | 4967 | 417 | 91 | 6 | 5524 |
| 2001 | 8 | 27 | 102 | 4405 | 497 | 83 | 8 | 5131 |
| 2002 | 318 | 585 | 149 | 3417 | 493 | 57 | 81 | 5099 |
| 2003 | 155 | 233 | 73 | 3287 | 427 | 45 | 82 | 4302 |
| 2004 | 75 | 143 | 50 | 2606 | 500 | 37 | 54 | 3464 |
| 2005 | 51 | 83 | 46 | 2290 | 384 | 22 | 77 | 2952 |
| 2006 | 49 | 139 | 39 | 2081 | 321 | 15 | 42 | 2686 |
| 2007 | 47 | 239 | 56 | 1995 | 586 | 17 | 37 | 2978 |
| 2008 | 117 | 245 | 45 | 1418 | 178 | 18 | 17 | 2038 |
| 2009 | 82 | 149 | 22 | 796 | 203 | 13 | 44 | 1309 |
| 2010(1) | 128 | 183 | 60 | 772 | 69 | 14 | 0 | 1224 |

**(1) Preliminary.**

**Table12.0b. Greater forkbeard *(Phycis blennoides)* in Subareas I and II. Working Group estimates of landings.**

| YEAR | NORWAY | FRANCE | RUSSIA | UK (SCOT) | GERMANY | UK (E +W) | FAROE ISLANDS | IRELAND | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 0 | | | | | | | | 0 |
| 1989 | 0 | | | | | | | | 0 |
| 1990 | 23 | | | | | | | | 23 |
| 1991 | 39 | | | | | | | | 39 |
| 1992 | 33 | | | | | | | | 33 |
| 1993 | 1 | | | | | | | | 1 |
| 1994 | 0 | | | | | | | | 0 |
| 1995 | 0 | | | | | | | | 0 |
| 1996 | 0 | | | | | | | | 0 |
| 1997 | 0 | | | | | | | | 0 |
| 1998 | 0 | | | | | | | | 0 |
| 1999 | 0 | 0 | | | | | | | 0 |
| 2000 | 0 | 0 | | | | | | | 0 |
| 2001 | 0 | 1 | 7 | | | | | | 8 |
| 2002 | 315 | 0 | | 1 | | 2 | | | 318 |
| 2003 | 153 | 0 | | | | 2 | | | 155 |
| 2004 | 72 | 0 | 3 | 0 | | | | | 75 |
| 2005 | 51 | 0 | | | | | | | 51 |
| 2006 | 46 | 0 | 3 | | | | | | 49 |
| 2007 | 41 | 0 | 5 | 1 | 0 | | | | 47 |
| 2008 | 112 | 0 | 4 | 1 | | | 0 | | 117 |
| 2009 | 76 | 0 | 6 | 0 | | | | | 82 |
| 2010 | 127 | 0 | | | | | | 0 | 128 |

**Table12.0c. Greater forkbeard *(Phycis blennoides)* in Subareas III and IV. Working Group estimates of landings.**

| YEAR | FRANCE | NORWAY | UK (EWNI) | UK (SCOT)(1) | GERMANY | TOTAL |
|---|---|---|---|---|---|---|
| 1988 | 12 | 0 | 3 | 0 | | 15 |
| 1989 | 12 | 0 | 0 | 0 | | 12 |
| 1990 | 18 | 92 | 5 | 0 | | 115 |
| 1991 | 20 | 161 | 0 | 0 | | 181 |
| 1992 | 13 | 130 | 0 | 2 | | 145 |
| 1993 | 6 | 28 | 0 | 0 | | 34 |
| 1994 | 11 | | | 1 | | 12 |
| 1995 | 2 | | | 1 | | 3 |
| 1996 | 2 | 10 | | 6 | | 18 |
| 1997 | 2 | | | 5 | | 7 |
| 1998 | 1 | | 0 | 11 | | 12 |
| 1999 | 3 | | 5 | 23 | | 31 |
| 2000 | 4 | | 0 | 7 | | 11 |
| 2001 | 6 | | 1 | 19 | 2 | 27 |
| 2002 | 2 | 561 | 1 | 21 | 0 | 585 |
| 2003 | 1 | 225 | 0 | 7 | | 233 |
| 2004 | 2 | 138 | | 3 | | 143 |
| 2005 | 2 | 81 | 0 | 1 | | 83 |
| 2006 | 1 | 134 | 3 | | | 139 |
| 2007 | 1 | 236 | 0 | 2 | | 239 |
| 2008 | 0 | 244 | | 1 | | 245 |
| 2009 | 4 | 142 | | 3 | | 149 |
| 2010 | 0 | 181 | | 1 | | 183 |

**Table12.0d. Greater forkbeard (*Phycis blennoides*) in Division Vb. Working Group estimates of landings.**

| YEAR | FRANCE | NORWAY | UK(SCOT)[1] | UK(EWNI) | FAROEISLANDS | RUSSIA | TOTAL |
|---|---|---|---|---|---|---|---|
| 1988 | 2 | 0 | | | | | 2 |
| 1989 | 1 | 0 | | | | | 1 |
| 1990 | 10 | 28 | | | | | 38 |
| 1991 | 9 | 44 | | | | | 53 |
| 1992 | 16 | 33 | | | | | 49 |
| 1993 | 5 | 22 | | | | | 27 |
| 1994 | 4 | | | | | | 4 |
| 1995 | 9 | | | | | | 9 |
| 1996 | 7 | | | | | | 7 |
| 1997 | 7 | 0 | | | | | 7 |
| 1998 | 4 | 4 | | | | | 8 |
| 1999 | 6 | 28 | 0 | | | | 34 |
| 2000 | 4 | 26 | 1 | 0 | | | 32 |
| 2001 | 9 | 92 | 1 | 0 | | | 10 |
| 2002 | 10 | 133 | 5 | 0 | | | 14 |
| 2003 | 11 | 55 | 7 | 0 | | | 73 |
| 2004 | 9 | 37 | 2 | 2 | | | 50 |
| 2005 | 7 | 39 | | 0,3 | | | 46 |
| 2006 | 8 | 26 | | | 6 | | 39 |
| 2007 | 11 | 34 | 0 | 0 | 9 | 2 | 56 |
| 2008 | 10 | 20 | 0 | | 4 | 1 | 45 |
| 2009 | 0 | 13 | 3 | | 3 | 2 | 22 |
| 2010 | 1 | 45 | 3 | | 11 | | 60 |

**[1]Includes Moridae, in 2005 only data from January to June.**

**Table12.0e. Greater forkbeard (*Phycis blennoides*) in Subareas VI and VII. Working Group estimates of landings.**

| Year | France | Ireland | Norway | Spain (1) | Uk (WENI) | Uk | Germany | Russia | Faroe Islands | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 252 | 0 | 0 | 1584 | 62 | 0 | | | | 1898 |
| 1989 | 342 | 14 | 0 | 1446 | 13 | 0 | | | | 1815 |
| 1990 | 454 | 0 | 88 | 1372 | 6 | 1 | | | | 1921 |
| 1991 | 476 | 1 | 126 | 953 | 13 | 5 | | | | 1574 |
| 1992 | 646 | 4 | 244 | 745 | 0 | 1 | | | | 1640 |
| 1993 | 582 | 0 | 53 | 824 | 0 | 3 | | | | 1462 |
| 1994 | 451 | 111 | | 1002 | 0 | 7 | | | | 1571 |
| 1995 | 430 | 163 | | 722 | 808 | 15 | | | | 2138 |
| 1996 | 519 | 154 | | 1428 | 1434 | 55 | | | | 3590 |
| 1997 | 512 | 131 | 5 | 46 | 1460 | 181 | | | | 2335 |
| 1998 | 357 | 530 | 162 | 530 | 1364 | 97 | | | | 3040 |
| 1999 | 314 | 686 | 183 | 824 | 929 | 518 | 1 | | | 3455 |
| 2000 | 671 | 743 | 380 | 1613 | 731 | 820 | 8 | 2 | | 4967 |
| 2001 | 683 | 663 | 536 | 1332 | 538 | 640 | 10 | 4 | | 4405 |
| 2002 | 613 | 481 | 300 | 1049 | 421 | 545 | 9 | 0 | | 3417 |
| 2003 | 469 | 319 | 492 | 1100 | 245 | 661 | 1 | 1 | | 3287 |
| 2004 | 441 | 183 | 165 | 1131 | 288 | 397 | | 1 | | 2606 |
| 2005 | 598 | 237 | 128 | 979 | 179 | 164 | | 5 | | 2290 |
| 2006 | 625 | 68 | 162 | 1075 | 148 | | | 2 | 0 | 2081 |
| 2007 | 578 | 56 | 188 | 875 | 117 | 179 | | 2 | 0 | 1995 |
| 2008 | 711 | 43 | 174 | 236 | 31 | 196 | | 27 | 0 | 1418 |
| 2009 | 304 | 7 | 222 | 48 | 31 | 184 | | 1 | | 796 |
| 2010(3) | 300 | 0 | 200 | 23 | 13 | 234 | | | 1 | 772 |

**(1) *Phycis* spp.**

**(2) Includes Moridae, in 2005 only data from January to June.**

**(3) Preliminary.**

**Table12.0f. Greater forkbeard *(Phycis blennoides*) in Subareas VIII and IX. Working Group estimates of landings.**

| YEAR | FRANCE | PORTUGAL | SPAIN(1 ) | UK (EWNI) | IRELAND | UK (SCOT) | TOTAL |
|---|---|---|---|---|---|---|---|
| 1988 | 7 | 0 | 74 | | | | 81 |
| 1989 | 7 | 0 | 138 | | | | 145 |
| 1990 | 16 | 0 | 218 | | | | 234 |
| 1991 | 18 | 4 | 108 | | | | 130 |
| 1992 | 9 | 8 | 162 | | | | 179 |
| 1993 | 0 | 8 | 387 | | | | 395 |
| 1994 | | 0 | 320 | | | | 320 |
| 1995 | 54 | 0 | 330 | | | | 384 |
| 1996 | 25 | 2 | 429 | | | | 456 |
| 1997 | 4 | 1 | 356 | | | | 361 |
| 1998 | 3 | 6 | 656 | | | | 665 |
| 1999 | 8 | 10 | 361 | | | | 379 |
| 2000 | 36 | 6 | 375 | | | | 417 |
| 2001 | 36 | 8 | 453 | | | | 497 |
| 2002 | 67 | 88 | 418 | | | | 493 |
| 2003 | 28 | 11 | 387 | | | | 427 |
| 2004 | 44 | 10 | 446 | | | | 500 |
| 2005 | 58 | 14 | 312 | 0 | | | 384 |
| 2006 | 54 | 10 | 257 | | | | 321 |
| 2007 | 32 | 44 | 510 | 0 | | | 586 |
| 2008 | 41 | 13 | 123 | | | | 178 |
| 2009 | 8 | 13 | 183 | 0 | | | 203 |
| 2010(2) | 9 | 12 | 48 | | 0 | 0 | 69 |

**(2)preliminary.**

**Table 12.0g. Greater forkbeard (*Phycis blennoides*) in Subarea X. Working Group estimates of landings.**

| YEAR | PORTUGAL(1) | TOTAL |
|---|---|---|
| 1988 | 29 | 29 |
| 1989 | 42 | 42 |
| 1990 | 50 | 50 |
| 1991 | 68 | 68 |
| 1992 | 91 | 91 |
| 1993 | 115 | 115 |
| 1994 | 136 | 136 |
| 1995 | 71 | 71 |
| 1996 | 45 | 45 |
| 1997 | 30 | 30 |
| 1998 | 38 | 38 |
| 1999 | 41 | 41 |
| 2000 | 91 | 91 |
| 2001 | 83 | 83 |
| 2002 | 57 | 57 |
| 2003 | 45 | 45 |
| 2004 | 37 | 37 |
| 2005 | 22 | 22 |
| 2006 | 15 | 15 |
| 2007 | 17 | 17 |
| 2008 | 18 | 18 |
| 2009 | 13 | 13 |
| 2010 | 14 | 14 |

**(1)from 1988 to 2005 *Phycis* spp.**

**Table 12.0h. Greater forkbeard (*Phycis blennoides*) in Subarea XII. Working Group estimates of landings.**

| Year | France | UK | Norway | UK | Spain(2) | Russia | TOTAL |
|---|---|---|---|---|---|---|---|
| 1988 | | | | | | | 0 |
| 1989 | | | | | | | 0 |
| 1990 | | | | | | | 0 |
| 1991 | | | | | | | 0 |
| 1992 | 1 | | | | | | 1 |
| 1993 | 1 | | | | | | 1 |
| 1994 | 3 | | | | | | 3 |
| 1995 | 4 | | | | | | 4 |
| 1996 | 2 | | | | | | 2 |
| 1997 | 2 | | | | | | 2 |
| 1998 | 1 | | | | | | 1 |
| 1999 | 0 | 0 | | | | | 0 |
| 2000 | 2 | 4 | | | | | 6 |
| 2001 | 0 | 1 | 6 | 1 | | | 8 |
| 2002 | 0 | | 2 | 4 | 73 | | 79 |
| 2003 | 3 | | 8 | 0 | 141 | | 153 |
| 2004 | 3 | | 6 | | 34 | | 43 |
| 2005 | 1 | 0 | 0 | | 60 | | 61 |
| 2006 | | | | | | | 0 |
| 2007 | | | | | | | 0 |
| 2008 | 0 | | | | 17 | | 17 |
| 2009 | 1 | | 0 | | 37 | 6 | 44 |
| 2010(3) | | | 0 | | | | 0 |

**Table 12.1.** ***Phycis*** **spp. Spanish landings (t) by subarea and gear in the period 2003–2010.**

| *PHYCIS* SPP | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **2003** | | | | | | **2004** | | | |
| **Gear** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** |
| LLS | 64 | 359 | 103 | 5 | 0 | 0 | 1 | 157 | 242 | 0 | 0 | 0 |
| GNS | 0 | 43 | 37 | 1 | 0 | 0 | 0 | 26 | 28 | 0 | 0 | 0 |
| OTB | 66 | 541 | 167 | 34 | 71 | 0 | 57 | 891 | 112 | 32 | 34 | 0 |
| Others | 0 | 27 | 10 | 31 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 |
| | | | **2005** | | | | | | **2006** | | | |
| **Gear** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** |
| LLS | 1 | 180 | 148 | 0 | 0 | 0 | 0 | 376 | 80 | 1 | 0 | 0 |
| GNS | 0 | 10 | 8 | 0 | 0 | 0 | 0 | 9 | 21 | 1 | 0 | 0 |
| OTB | 146 | 699 | 97 | 39 | 3 | 0 | 37 | 653 | 84 | 28 | 0 | 0 |
| Others | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 0 |
| | | | **2007** | | | | | | **2008*** | | | |
| **Gear** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** |
| LLS | 0 | 325 | 294 | 3 | 0 | 0 | 0 | 75 | 20 | 14 | 0 | 0 |
| GNS | 0 | 2 | 41 | 4 | 0 | 0 | 0 | 0 | 3 | 29 | 0 | 0 |
| OTB | 37 | 512 | 113 | 55 | 0 | 0 | 28 | 133 | 56 | 0 | 0 | 0 |
| Others | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | **2009** | | | | | | **2010** | | | |
| **Gear** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** | **VI** | **VII** | **VIII** | **IX** | **XII** | **XIV** |
| LLS | 0 | 0 | 20 | 5 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 |
| GNS | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 0 |
| OTB | 9 | 0 | 58 | 53 | 37 | 0 | 0 | 21 | 2 | 15 | 0 | 0 |
| Others | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |

**Table 12.2. Landings and estimate of discards (tonnes) of *Phycis blennoides* by the Basque Country (Spain) OTB Fleet.**

| | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| VI | Discard | 0 | | | 7 | | 372 | 13 | 7 |
| | Landing | 65 | 53 | 50 | 37 | 37 | 27 | 37 | 21 |
| VII | Discard | 0 | | | | | | | |
| | Landing | 13 | 17 | 27 | 4 | 5 | 0 | 0 | 2 |
| VIII | Discard | | | | | 0 | 0 | | 7 |
| | Landing | 12 | 10 | 9 | 13 | 8 | 20 | 6 | 25 |

**Table 12.3. Discard estimates (biomass (tonnes) and associated CV) of *Phycis blennoides* by the Spanish OTB in VI, VII, VIII and North IXa.**

| | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| VI, VII | biomass (tonne) | 914 | 586 | 3096 | 493 | 617 | 118 | 537 |
| | CV | 43 | 32 | 62 | 36 | 35 | 70 | 21 |
| VIII, North Ixa | biomass (tonne) | 14 | 7 | 8 | 24 | 115 | 11 | 69 |
| | CV | 46 | 58 | 77 | 67 | 70 | 55 | 32 |

**Table 12.4. *Phycis* spp landings (t), effective effort (fishing days) and lpue (kg/day) of the Basque Country (Spain) OTB fleet in the period 1996–2010.**

| (Year | | OTB-VIII | | | OTB-VII | | | OTB-VI | |
|---|---|---|---|---|---|---|---|---|---|
| | Landings | Effort | lpue | Landings | Effort | lpue | Landings | Effort | lpue |
| | (t) | (days) | (kg/days) | (t) | (days) | (kg/days) | (t) | (days) | (kg/days) |
| 1996 | 5 | 4378 | 1.2 | 63 | 1170 | 54.0 | 46 | 695 | 65.7 |
| 1997 | 7 | 4286 | 1.6 | 15 | 540 | 28.6 | 36 | 710 | 51.0 |
| 1998 | 1 | 3002 | 0.3 | 52 | 1196 | 43.9 | 54 | 750 | 72.2 |
| 1999 | 1 | 2337 | 0.6 | 42 | 1384 | 30.5 | 141 | 855 | 164.7 |
| 2000 | 7 | 2227 | 3.3 | 60 | 1850 | 32.2 | 191 | 763 | 250.0 |
| 2001 | 4 | 2707 | 1.5 | 59 | 1531 | 38.3 | 184 | 1171 | 156.9 |
| 2002 | 11 | 3617 | 3.1 | 24 | 1055 | 22.4 | 164 | 1592 | 103.1 |
| 2003 | 12 | 3363 | 3.5 | 13 | 1060 | 12.7 | 65 | 827 | 78.8 |
| 2004 | 10 | 4232 | 2.4 | 17 | 1074 | 15.8 | 53 | 510 | 103.5 |
| 2005 | 9 | 3697 | 2.3 | 27 | 663 | 40.3 | 50 | 484 | 103.1 |
| 2006 | 13 | 2979 | 4.4 | 4 | 501 | 7.9 | 37 | 449 | 82.7 |
| 2007 | 8 | 2780 | 3.0 | 5 | 476 | 9.5 | 37 | 369 | 99.6 |
| 2008 | 20 | 2967 | 6.6 | 0 | 107 | 0.6 | 27 | 349 | 77.6 |
| 2009 | 6 | 2274 | 2.5 | 0 | 0 | 0.0 | 37 | 380 | 98.5 |
| 2010 | 6 | 1844 | 3.1 | 2 | 138 | 0 | 21 | 394 | 53.1 |

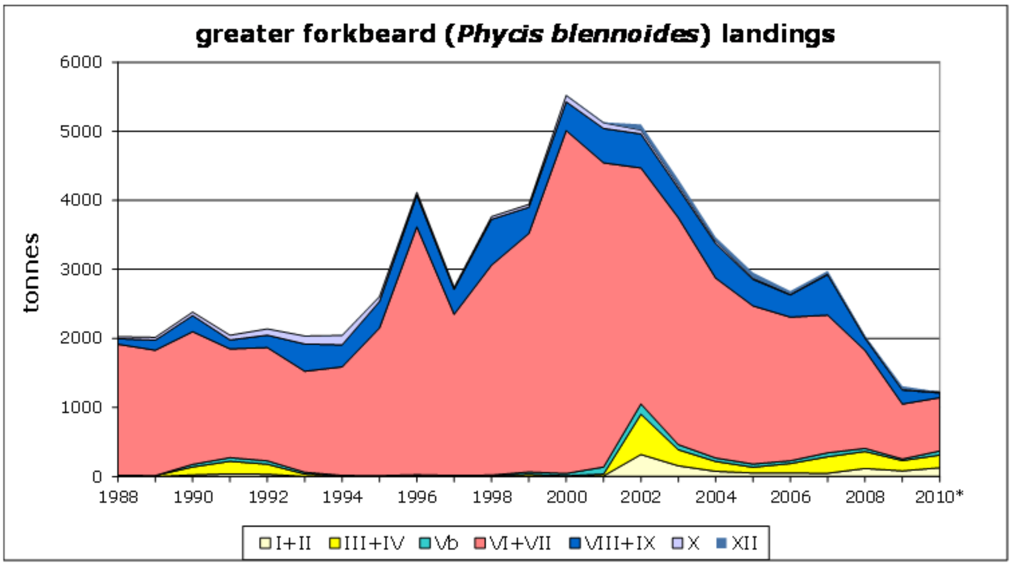



**Figure 12.1. Greater forkbeard landing trends in all ICES subareas since 1988.**

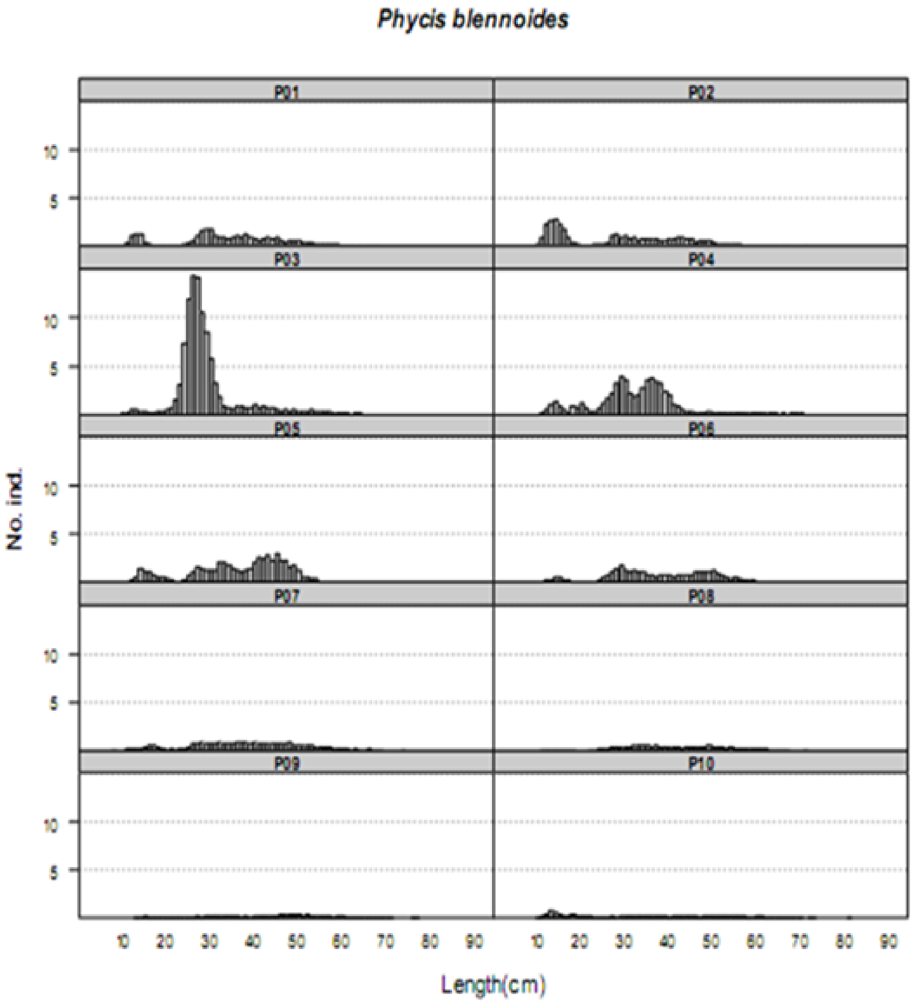



**Figure 12.2. Mean stratified length distributions of *Phycis blennoides* in Spanish Porcupine surveys (2001–2009).**

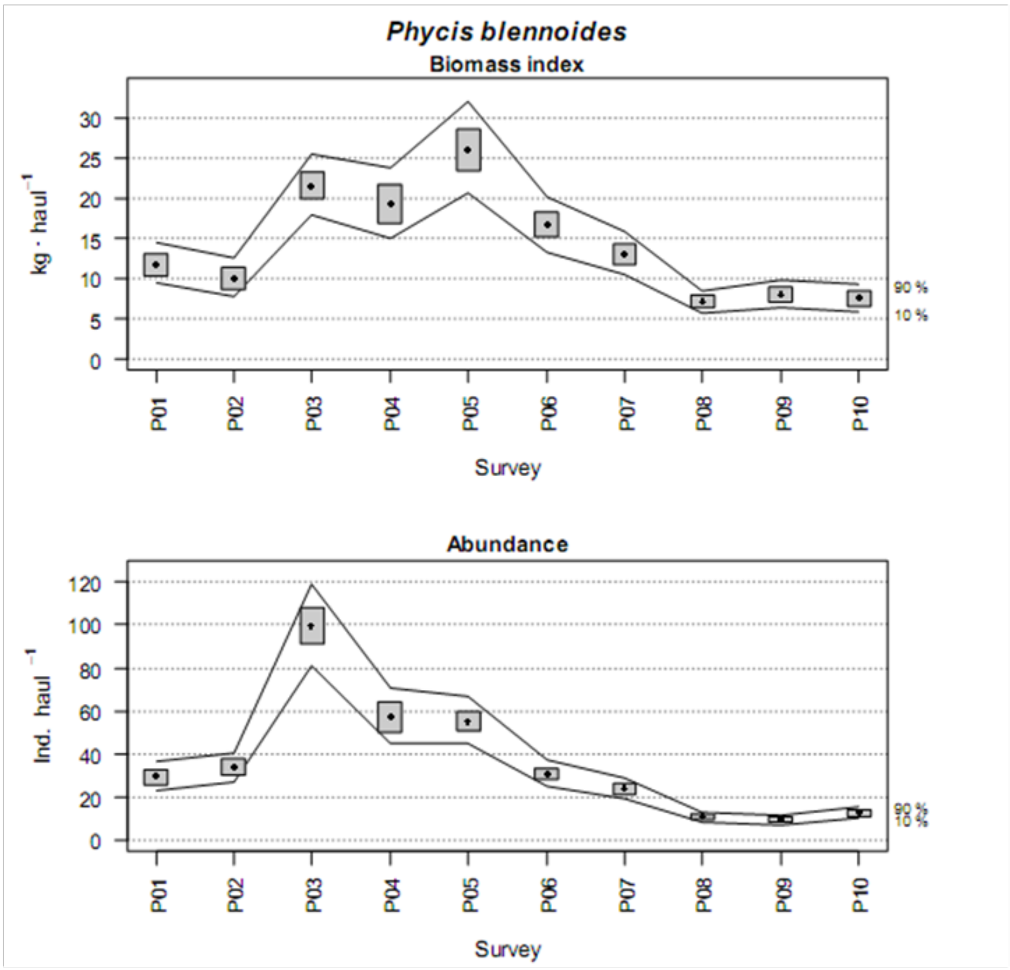



**Figure 12.3.** ***Phycis blennoides*** **biomass and abundance indices in Spanish Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (a= 0.80, bootstrap iterations = 1000).**

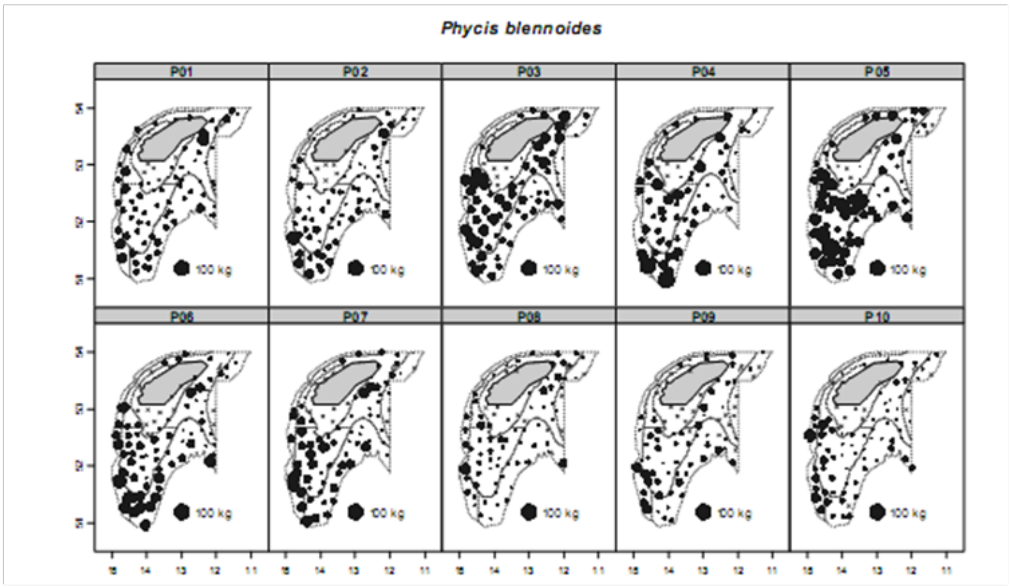



**Figure 12.4. Geographic distribution of** ***Phycis blennoides*** **catches (kg/30 min haul) in Porcupine surveys between 2001 and 2010.**

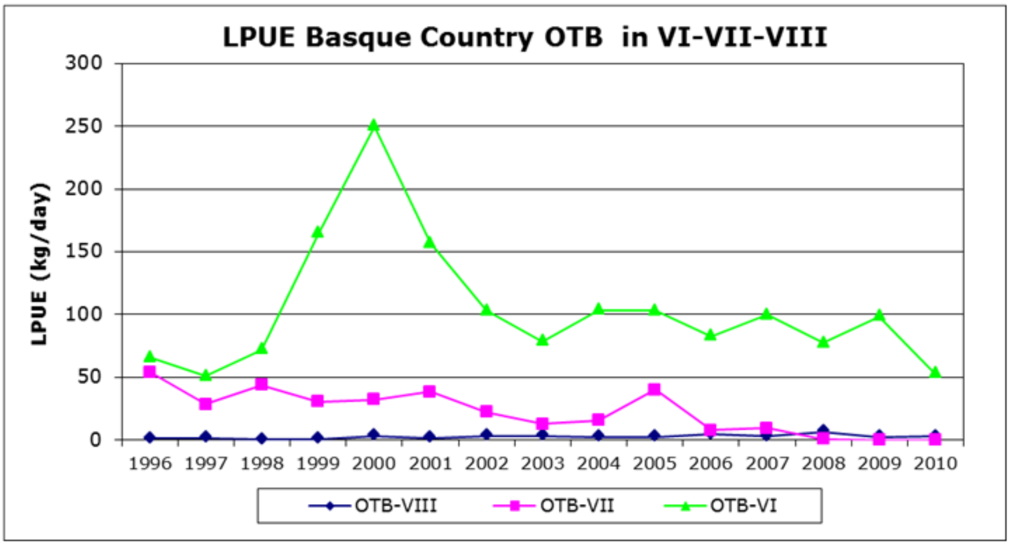



**Figure 12.5. Greater forkbeard Historical series showing the lpue trends (kg/day) of the Basque Country (Spain) OTB fleet in the period 1996–2010.**

# 13 Alfonsinos/Golden eye perch (*Beryx* Spp.) in all ecoregions

## 13.1 The fishery

Alfonsinos, *Beryx splendens* and *Beryx decadactylus*, are generally considered as by-catch species in the demersal trawl and longline mixed fisheries targeting deep-water species. For most of the fisheries, the catches of alfonsinos are reported under a single category, as *Beryx* spp.

The proportions of each species in the catches are not well known. Detailed landings data by species are available only for the Portuguese (Azores) longline fishery in Division Xa, where the landings of *B. decadactylus* averaged 18% of the catches of both species in the last ten years, and for the Russian trawl fishery that targeted *B. splendens*.

Portuguese, Spanish and French trawlers and longliners are the main fleets involved in this fishery.

### 13.1.1 Landings trends

The available landings data for Alfonsinos, (*Beryx* spp), by ICES subareas/divisions as officially reported to ICES or to the Working Group, are presented in Tables 13.1(a–g), 13.2 and 13.3 and Figures 13.1, 13.2, 13.3 and 13.4.

### 13.1.2 ICES Advice

ICES Advice in 2010 was: *Fisheries should not be allowed to expand, and in the light of the vulnerability of deep-sea species a reduction in catches should be considered until such time there is sufficient scientific information to prove the fishery is sustainable.*

### 13.1.3 Management

Fishing with trawl gears is forbidden in the Azores region (EC. Reg. 1568/2005). A box of 100 miles limiting the deep-water fishing to vessels registered in the Azores was created in 2003 under the management of fishing effort of the CFP for deep-water species (EC. Reg. 1954/2003). An EU TAC of 328 t for EC vessels is in force for 2011–2012 (EC. Reg. 1225/2010).

Technical measures have been introduced in the Azores since 1998. During 2009 new measures were introduced, particularly to control the effort of longliners through restrictions on fishing area, minimum length, gear and effort. A seamount (Condor) is closed to the fishery for two years (2010–2011).

There are NEAFC regulations of effort in the fisheries for deep-water species and closed areas to protect vulnerable habitats.

## 13.2 Stock identity

No new information.

## 13.3 Data available

### 13.3.1 Landings and discards

Tables 13.1 a–g describe the alfonsinos landings by subarea and country.

### 13.3.2 Length compositions

Length compositions were updated with new data for 2009. These are shown in Figures 13.5 and 13.6. No trends are observed in these distributions. Data for 2010 are not yet available.

### 13.3.3 Age compositions

No information about age compositions of *Beryx* species was available during the WGDEEP meeting.

### 13.3.4 Weight-at-age

No new information.

### 13.3.5 Maturity, sex-ratio, length-weight and natural mortality

No new information.

### 13.3.6 Catch, effort and research vessel data

Nominal cpue for *Beryx splendens* and *Beryx decadactylus* species from commercial longline fisheries in the Azores was presented to the Group last year (Figures 13.7a and b) and was not updated. These indices will be standardised to take account of area, season, vessel class and will be presented next year.

Trends in this time-series shows interannual variability for *Beryx splendens* around a mean value of 10 kg per thousand hooks. For *Beryx decadactylus,* cpue increases until 1996 and decreases suddenly in 1997 and is maintained thereafter at low levels.

Abundance indices from the Azorean longline survey were updated and are presented for the golden eye perch (*Beryx decadactylus*) (Figure 13.8) and the alfonsinos (*Beryx splendens*) (Figure 13.9).

Survey abundance indices for *Beryx splendens* shows a decreasing pattern, similar to the one observed for landings. However for *Beryx decadactylus* high annual variability is observed.

## 13.4 Data analyses

### 13.4.1 *Beryx decadactylus*

No data analyses were carried out this year.

### 13.4.2 *Beryx splendens*

No data analyses were carried out this year.

## 13.5 Comments on the assessment

No assessment was carried out this year.

## 13.6 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the MSY framework using methods developed by WGFRAME, e.g. YPR.

**Table 13.1a. Landings (tonnes) of *Beryx* spp. IV.**

| YEAR | FRANCE | TOTAL |
|---|---|---|
| 1988 | 0 | 0 |
| 1989 | 0 | 0 |
| 1990 | 1 | 1 |
| 1991 | 0 | 0 |
| 1992 | 2 | 2 |
| 1993 | 0 | 0 |
| 1994 | 0 | 0 |
| 1995 | 0 | 0 |
| 1996 | 0 | 0 |
| 1997 | 0 | 0 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | 0 | 0 |
| 2005 | 0 | 0 |
| 2006 | 0 | 0 |
| 2007 | 0 | 0 |
| 2008 | 0 | 0 |
| 2009 | 0 | 0 |
| 2010* | 0 | 0 |

***Preliminary.**

**Table 13.1b. Alfonsinos (*Beryx* spp.) Vb.**

| YEAR | FAROES | FRANCE | TOTAL |
|---|---|---|---|
| 1988 | | | 0 |
| 1989 | | | 0 |
| 1990 | | 5 | 5 |
| 1991 | | 0 | 0 |
| 1992 | | 4 | 4 |
| 1993 | | 0 | 0 |
| 1994 | | 0 | 0 |
| 1995 | 1 | 0 | 1 |
| 1996 | 0 | 0 | 0 |
| 1997 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 |
| 2001 | 0 | 0 | 0 |
| 2002 | 0 | 0 | 0 |
| 2003 | 0 | 0 | 0 |
| 2004 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 0 |
| 2006 | 0 | 0 | 0 |
| 2007 | 0 | 0 | 0 |
| 2008 | 0 | 0 | 0 |
| 2009 | 0 | 0 | 0 |
| 2010* | 0 | 0 | 0 |

***Preliminary.**

**Table 13.1c. Alfonsinos (*Beryx* spp.) VI and VII.**

| | France | E & W | Spain | Ireland | Scotland | TOTAL |
|---|---|---|---|---|---|---|
| 1988 | | | | | | 0 |
| 1989 | 12 | | | | | 12 |
| 1990 | 8 | | | | | 8 |
| 1991 | | | | | | 0 |
| 1992 | 3 | | | | | 3 |
| 1993 | 0 | | 1 | | | 1 |
| 1994 | 0 | | 5 | | | 5 |
| 1995 | 0 | | 3 | | | 3 |
| 1996 | 0 | | 178 | | | 178 |
| 1997 | 17 | 4 | 5 | | | 26 |
| 1998 | 10 | 0 | 71 | | | 81 |
| 1999 | 55 | 0 | 20 | | | 75 |
| 2000 | 31 | 2 | 100 | | | 133 |
| 2001 | 51 | 13 | 116 | | | 180 |
| 2002 | 35 | 15 | 45 | | | 95 |
| 2003 | 20 | 5 | 55 | 4 | | 84 |
| 2004 | 15 | 3 | 46 | | | 64 |
| 2005 | 15 | 0 | 55 | 0 | | 70 |
| 2006 | 27 | 0 | 51 | 0 | | 78 |
| 2007 | 17 | 1 | 47 | 0 | | 65 |
| 2008 | 18 | 0 | 32 | 0 | | 22 |
| 2009 | 6 | 0 | 0 | 0 | 1 | 7 |
| 2010* | 12 | 0 | 0 | 0 | 1 | 13 |

***Preliminary.**

**Table 13.1d. Alfonsinos (*Beryx* spp.) VIII and IX.**

| Year | France | Portugal | Spain | E & W | TOTAL |
|---|---|---|---|---|---|
| 1988 | | | | | 0 |
| 1989 | | | | | 0 |
| 1990 | 1 | | | | 1 |
| 1991 | | | | | 0 |
| 1992 | 1 | | | | 1 |
| 1993 | 0 | | | | 0 |
| 1994 | 0 | | 2 | | 2 |
| 1995 | 0 | 75 | 7 | | 82 |
| 1996 | 0 | 43 | 45 | | 88 |
| 1997 | 69 | 35 | 31 | | 135 |
| 1998 | 1 | 9 | 258 | | 268 |
| 1999 | 11 | 29 | 161 | | 201 |
| 2000 | 7 | 40 | 117 | 4 | 168 |
| 2001 | 6 | 43 | 179 | 0 | 228 |
| 2002 | 13 | 60 | 151 | 14 | 238 |
| 2003 | 10 | 0 | 95 | 0 | 110 |
| 2004 | 21 | 53 | 209 | 0 | 287 |
| 2005 | 9 | 45 | 141 | 0 | 196 |
| 2006 | 9 | 20 | 64 | 3 | 97 |
| 2007 | 8 | 45 | 67 | 0 | 120 |
| 2008 | 5 | 42 | 54 | 0 | 58 |
| 2009 | 0 | 42 | 18 | 0 | 60 |
| 2010 | 0 | 27 | 1 | 0 | 28 |

*** Preliminary.**

**Table 13.1e. Alfonsinos (*Beryx* spp.) X.**

| | Xa | Xb | | | | |
|---|---|---|---|---|---|---|
| Year | Portugal | Faroes | Norway | Russia** | E & W | TOTAL |
| 1988 | 225 | | | | | 225 |
| 1989 | 260 | | | | | 260 |
| 1990 | 338 | | | | | 338 |
| 1991 | 371 | | | | | 371 |
| 1992 | 450 | | | | | 450 |
| 1993 | 533 | | 195 | | | 728 |
| 1994 | 644 | | 0 | 837 | | 1481 |
| 1995 | 529 | 0 | 0 | 200 | | 729 |
| 1996 | 550 | 0 | 0 | 960 | | 1510 |
| 1997 | 379 | 5 | 0 | | | 384 |
| 1998 | 229 | 0 | 0 | | | 229 |
| 1999 | 175 | 0 | 0 | 550 | | 725 |
| 2000 | 203 | 0 | 0 | 266 | 15 | 484 |
| 2001 | 199 | 0 | 0 | | 0 | 199 |
| 2002 | 243 | 0 | 0 | | 0 | 243 |
| 2003 | 172 | 0 | 0 | | 0 | 172 |
| 2004 | 139 | 0 | 0 | | 0 | 139 |
| 2005 | 157 | 0 | 0 | | 0 | 157 |
| 2006 | 192 | 0 | 0 | | 0 | 192 |
| 2007 | 211 | 0 | 0 | | 0 | 211 |
| 2008 | 250 | 2 | 0 | 0 | 0 | 252 |
| 2009 | 311 | 1 | 0 | 0 | 0 | 312 |
| 2010* | 240 | 0 | 0 | 5 | 0 | 245 |

*** Preliminary.**

**** Not official data from ICES Area Xb.**

**Table 13.1f. Alfonsinos (*Beryx* spp.) XII.**

| Year | Faroes | TOTAL |
|---|---|---|
| 1988 | | |
| 1989 | | |
| 1990 | | |
| 1991 | | |
| 1992 | | |
| 1993 | | |
| 1994 | | |
| 1995 | 2 | 2 |
| 1996 | 0 | 0 |
| 1997 | 0 | 0 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | 0 | 0 |
| 2005 | 0 | 0 |
| 2006 | 0 | 0 |
| 2007 | 0 | 0 |
| 2008 | 0 | 0 |
| 2009 | 0 | 0 |
| 2010* | 0 | 0 |

*** Preliminary.**

**Table 13.1g. Alfonsinos (*Beryx* spp.) in Madeira (Portugal) outside the ICES area.**

| Year | Portugal | TOTAL |
|---|---|---|
| 1988 | | 0 |
| 1989 | | 0 |
| 1990 | | 0 |
| 1991 | | 0 |
| 1992 | | 0 |
| 1993 | | 0 |
| 1994 | | 0 |
| 1995 | 1 | 1 |
| 1996 | 11 | 11 |
| 1997 | 4 | 4 |
| 1998 | 3 | 3 |
| 1999 | 2 | 2 |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010* | | |

*** Preliminary.**

**Table 13.2. Reported landings for the Alfonsinos, (*Beryx* spp), by ICES subareas/divisions.**

| Year | IV | Vb | VI+VII | VIII+IX | Xa | Xb | XII | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1988 | | | 0 | 0 | 225 | 0 | | 225 |
| 1989 | | | 12 | 0 | 260 | 0 | | 272 |
| 1990 | 1 | 5 | 8 | 1 | 338 | 0 | | 353 |
| 1991 | | | 0 | 0 | 371 | 0 | | 371 |
| 1992 | 2 | 4 | 3 | 1 | 450 | 0 | | 460 |
| 1993 | | | 1 | 0 | 533 | 195 | | 729 |
| 1994 | | | 5 | 2 | 644 | 837 | | 1488 |
| 1995 | | 1 | 3 | 82 | 529 | 200 | 2 | 817 |
| 1996 | | | 178 | 88 | 550 | 960 | | 1776 |
| 1997 | | | 26 | 135 | 379 | 5 | | 545 |
| 1998 | | | 81 | 268 | 229 | 0 | | 579 |
| 1999 | | | 75 | 201 | 175 | 550 | | 1001 |
| 2000 | | | 133 | 168 | 203 | 281 | | 785 |
| 2001 | | | 180 | 228 | 199 | 0 | | 607 |
| 2002 | | | 95 | 238 | 243 | 0 | | 577 |
| 2003 | | | 84 | 105 | 172 | 0 | | 361 |
| 2004 | | | 64 | 283 | 139 | 0 | | 486 |
| 2005 | | | 70 | 195 | 157 | 0 | | 422 |
| 2006 | | | 78 | 97 | 192 | 0 | | 367 |
| 2007 | | | 65 | 120 | 211 | 0 | | 396 |
| 2008 | 0 | 0 | 50 | 101 | 250 | 2 | | 403 |
| 2009 | | | 7 | 60 | 311 | 1 | | 379 |
| 2010* | 0 | 0 | 13 | 28 | 240 | 5 | | 286 |

***Preliminary.**

**Table 13.3. Reported landings of *Beryx splendens* and *B. decadactylus* in Azores (ICES Division Xa).**

| Year | *B. splendens* | *B. decadactylus* | Total |
|---|---|---|---|
| 1988 | 122 | 103 | 225 |
| 1989 | 113 | 147 | 260 |
| 1990 | 137 | 201 | 338 |
| 1991 | 203 | 168 | 371 |
| 1992 | 274 | 176 | 450 |
| 1993 | 316 | 217 | 533 |
| 1994 | 410 | 234 | 644 |
| 1995 | 335 | 194 | 529 |
| 1996 | 379 | 171 | 550 |
| 1997 | 268 | 111 | 379 |
| 1998 | 161 | 68 | 229 |
| 1999 | 119 | 56 | 175 |
| 2000 | 168 | 35 | 203 |
| 2001 | 182 | 17 | 199 |
| 2002 | 223 | 20 | 243 |
| 2003 | 150 | 22 | 172 |
| 2004 | 110 | 29 | 139 |
| 2005 | 134 | 23 | 157 |
| 2006 | 152 | 40 | 192 |
| 2007 | 165 | 46 | 211 |
| 2008 | 187 | 63 | 250 |
| 2009 | 243 | 68 | 311 |
| 2010 | 189 | 51 | 240 |

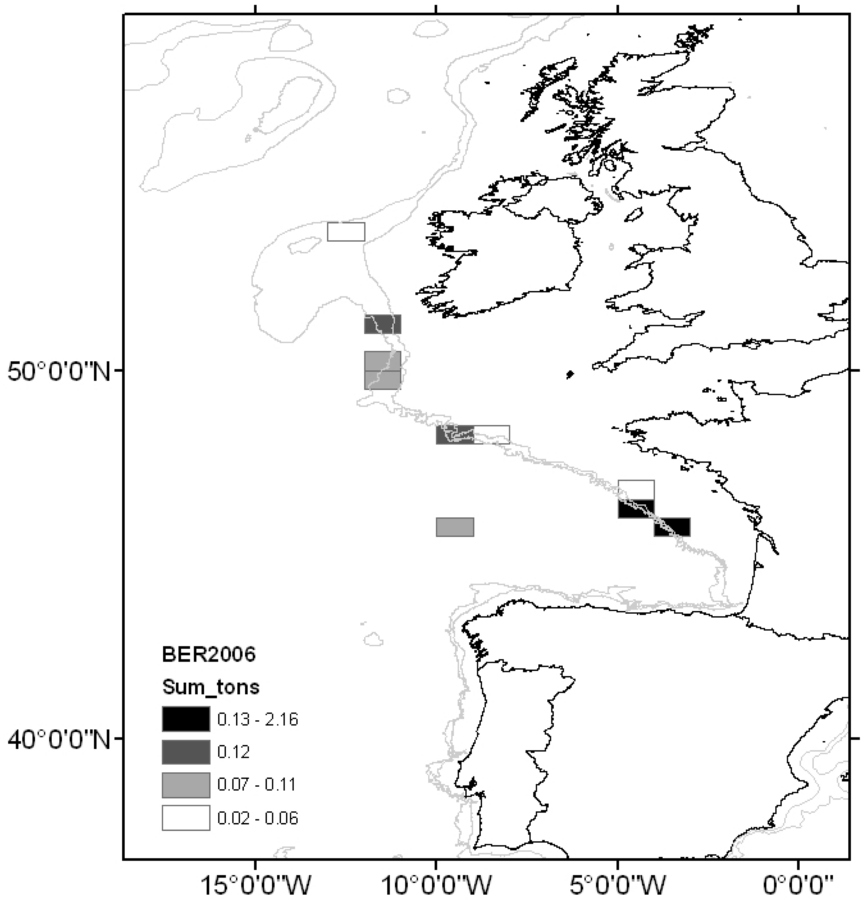



**Figure 13.1. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2006.**

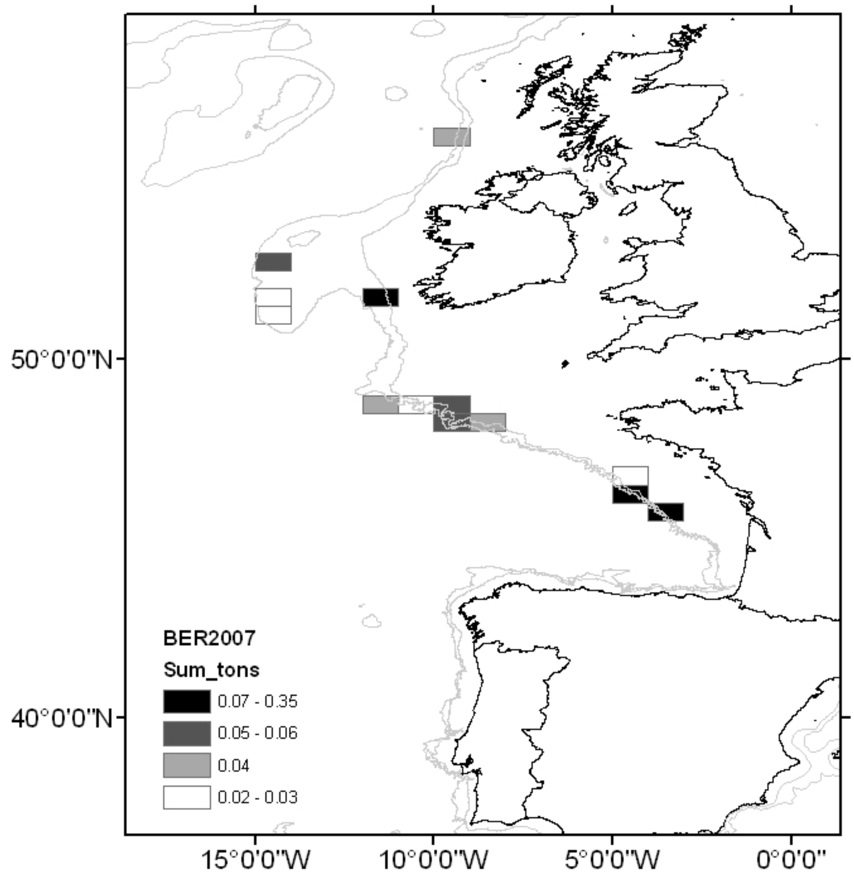



**Figure 13.2. Catches of alfonsinos by French, Irish, UK (England and Wales and Scotland) and Icelandic vessels, 2007.**

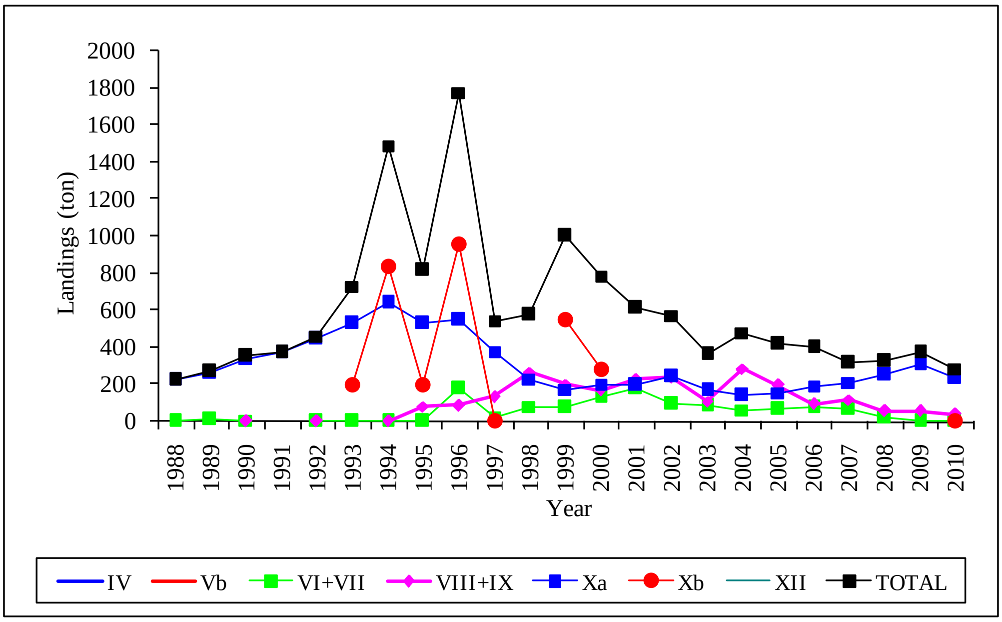



**Figure 13.3. Reported landings for the alfonsinos, (*Beryx* spp), by ICES subareas/divisions.**

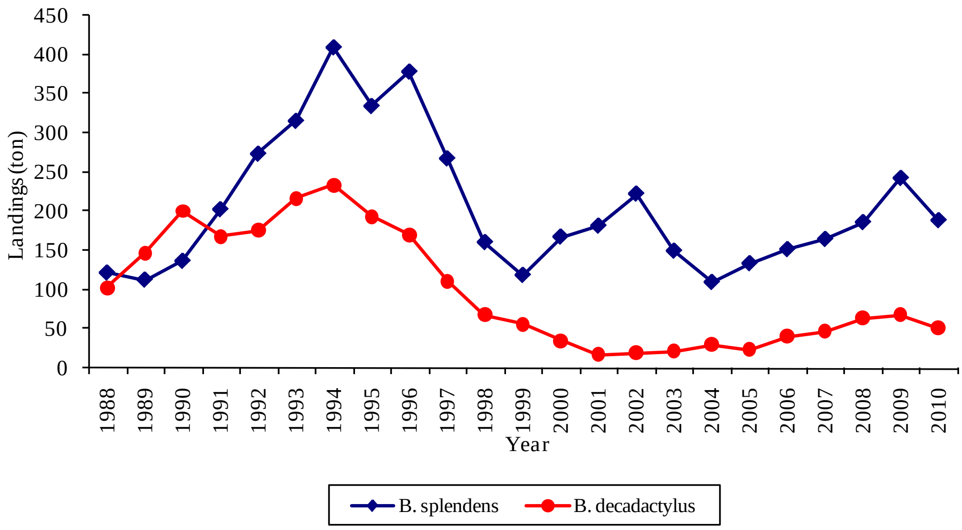



**Figure 13.4. Landings of *Beryx splendens* and *B. decadactylus* in Azores (ICES Subarea X).**

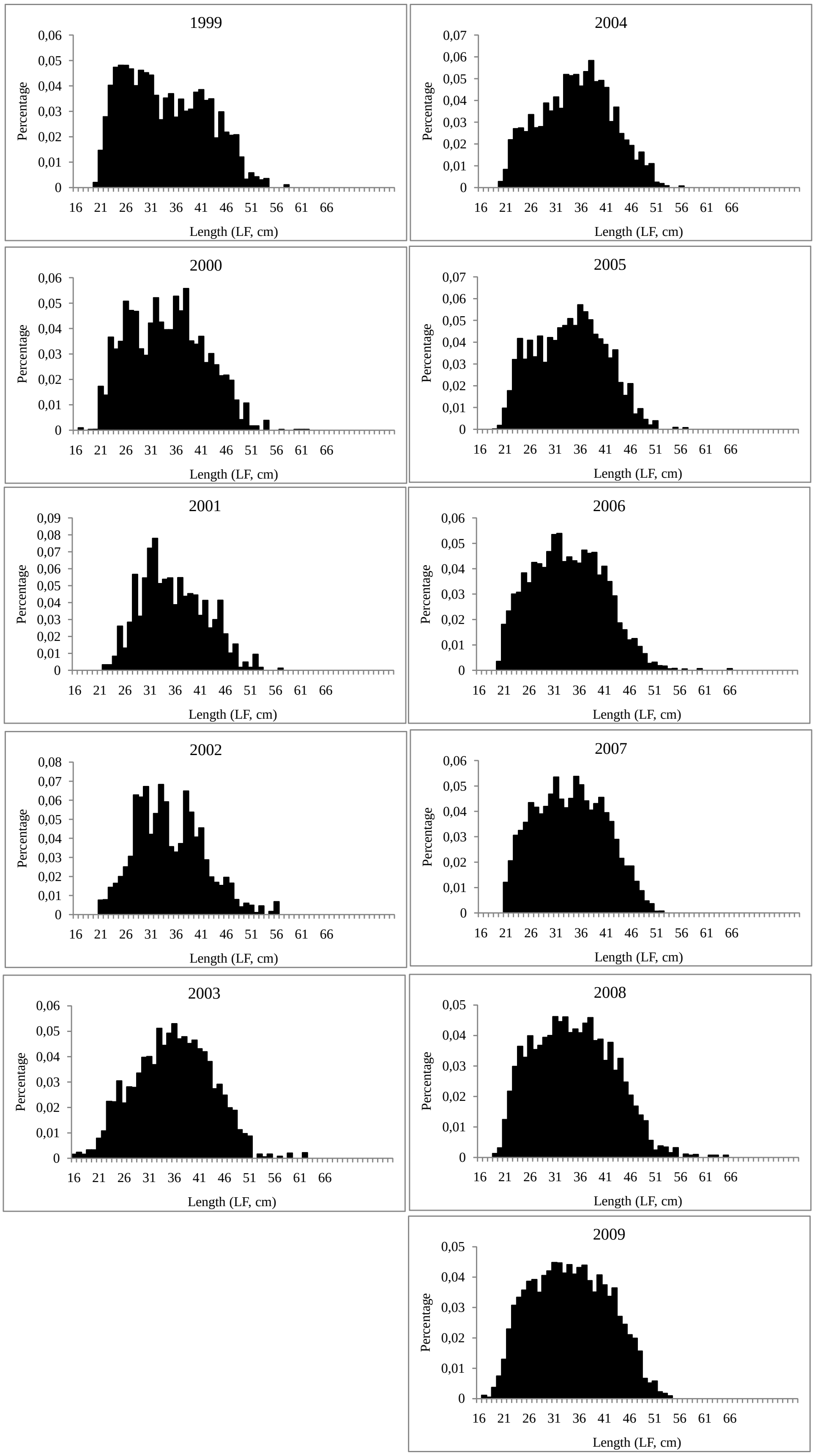



**Figure 13.5. *Beryx decadactylus* fishery length compositions, in number and weight, by year from the Azorean fishery in the ICES Xa2.**

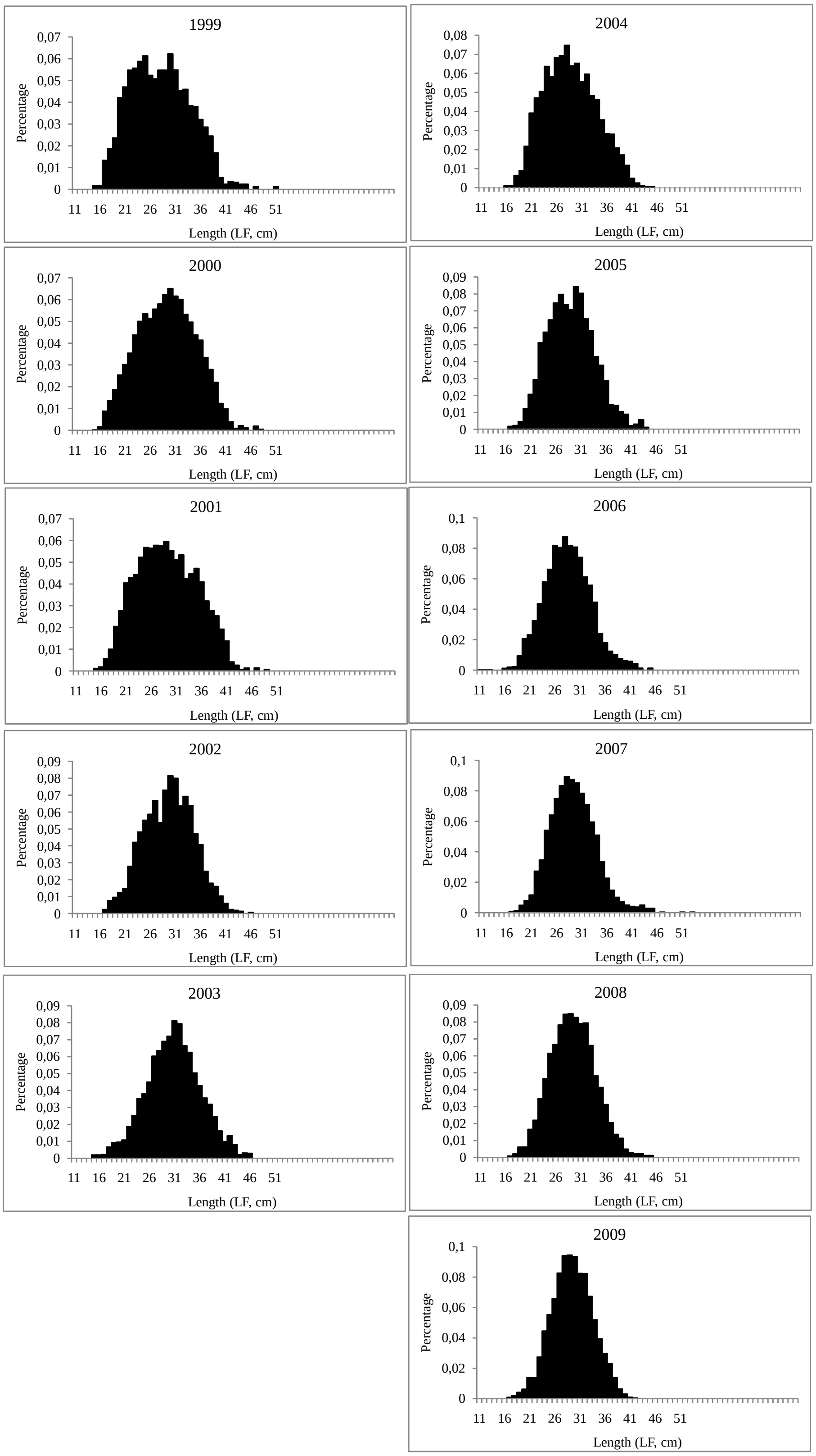



**Figure 13.6.** ***Beryx splendens*** **fishery length compositions, in number and weight, by year from the Azorean fishery in the ICES Xa2.**

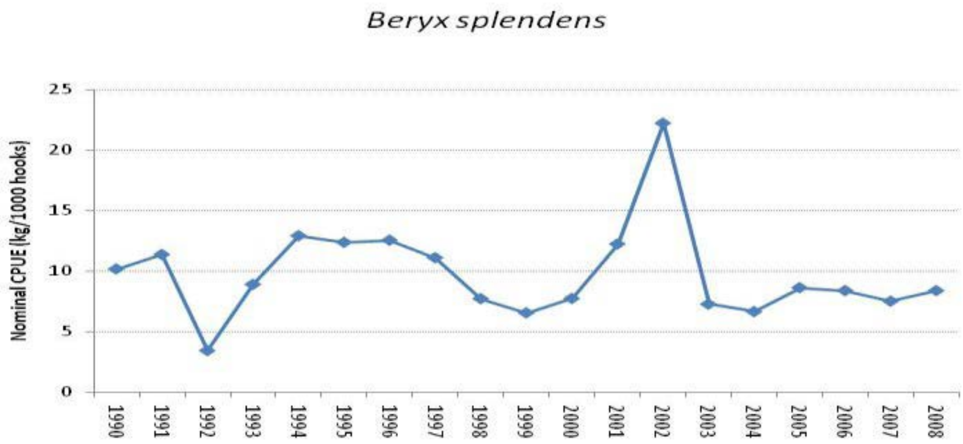



**Figure 13.7a. Nominal cpue for *Beryx splendens* from the Azores longline fishery (ICES, Xa2).**

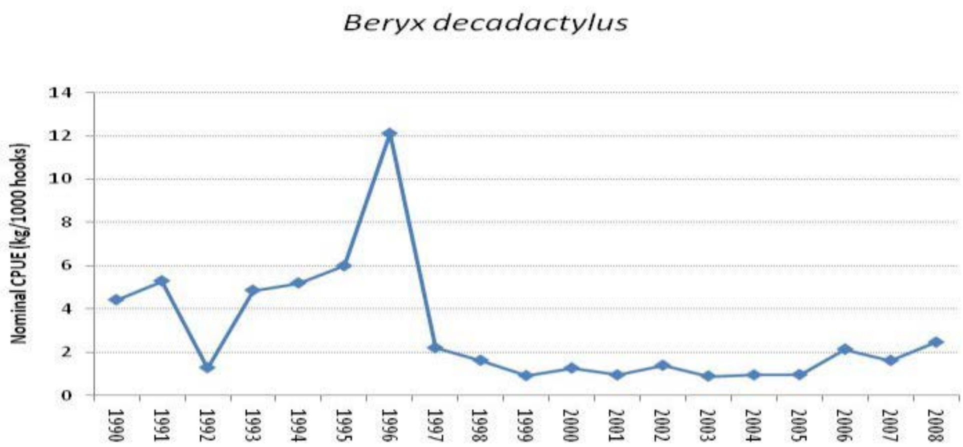



**Figure 13.7b. Nominal cpue for *Beryx decadactylus* from the Azores longline fishery (ICES, Xa2).**

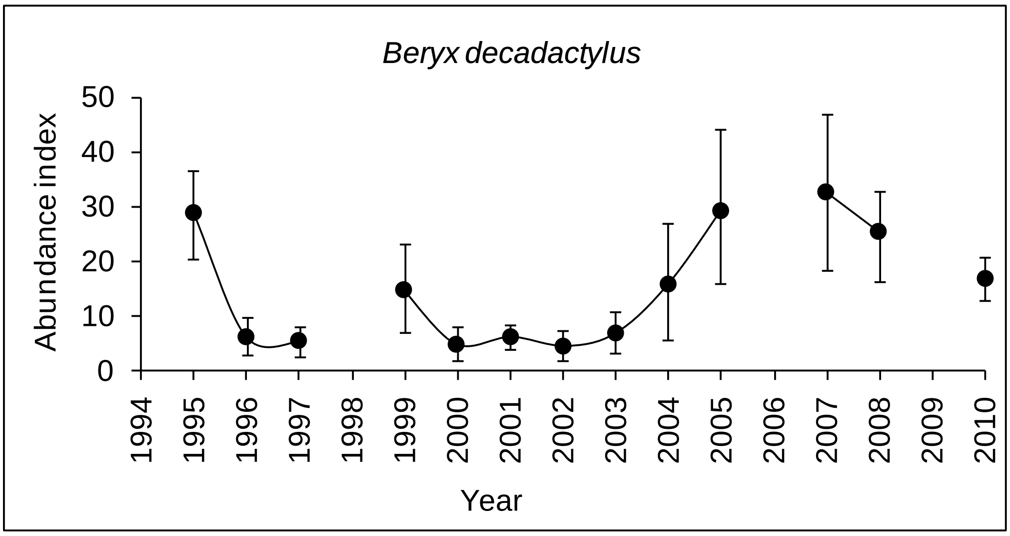



**Figure 13.8. Annual bottom longline survey abundance index in number available for the golden eye perch (*B. decadactylus*) from the Azorean deep-water species surveys (ICES Subarea X).**

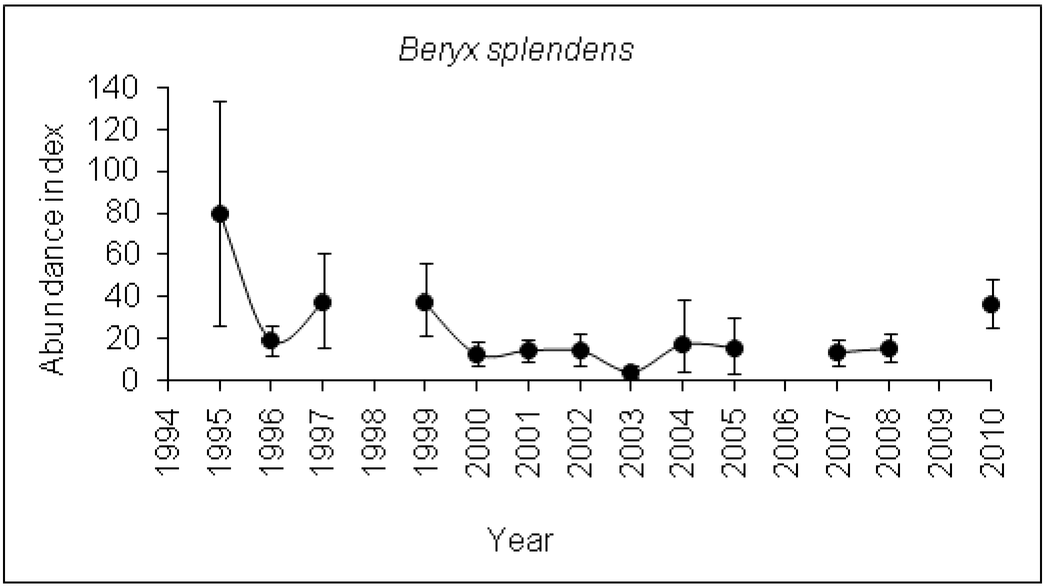



**Figure 13.9. Annual bottom longline survey abundance index in number available for the Alfonsinos (*Beryx splendens*) from the Azorean deep-water species surveys (ICES Subarea X).**

# 14 Red (black spot) sea bream (*Pagellus bogaraveo*)

## 14.1 Current ICES stock structure

ICES considered three different components for this species: a) Areas VI, VII, and VIII; b) Area IX, and c) Area X (Azores region), (ICES, 1996; 1998a). This separation does not pre-suppose that there are three different stocks of red (blackspot) sea bream, but it offers a better way of recording the available information.

The interrelationships of the (blackspot) sea bream from Areas VI, VII, and VIII, and the northern part of Area IXa, and their migratory movements within these areas have been observed by tagging methods (Gueguen, 1974). However, there is no evidence of movement to the southern part of IXa where the main fishery currently occurs.

Recent studies show that there are no genetic differences between populations from different ecosystems within the Azores region (East, Central and West group of Islands, and Princesa Alice bank) but there are genetic differences between Azores (ICES Area Xa2) and mainland Portugal (ICES Area IXa; Stockley *et al.*, 2005). These results, combined with the known distribution of the species by depth, suggest that Area X component of this stock can effectively be considered as a separate assessment unit.

Available information, particularly genetics and tagging, seems to support the current assumption of three assessment units (VI–VIII, IX and X).

## 14.2 Red (blackspot) sea bream in Subareas VI, VII & VIII

### 14.2.1 The fishery

This Section includes a description of the *Pagellus bogaraveo* in Subareas VI, VII, VIII by the Spanish, French, and UK fleets.

From the 1950s to the 1970s, red blackspot sea bream was exploited mainly by French and Spanish bottom offshore trawlers, by artisanal pelagic trawlers in the eastern Bay of Biscay (ICES Divisions VIIIa,b), and by Spanish longliners in the Cantabrian Sea (ICES Division VIIIc), with smaller contributions from other fisheries (Lorance, 2010). Currently, EU Regulations state that no directed fisheries are permitted under the quota, therefore catches should be only bycatches.

The fishery in Subareas VI, VII and VIII strongly declined in the mid-1970s, and the stock is seriously depleted. Since the 1980s, it has been mainly a bycatch of otter trawl, longline and gillnet fleets and only a few small-scale handliners have been targeting the species. Since 1988 the landings from Subarea VIII represent 67% and VI and VII 33% of total accumulated landings. At present the red sea bream catches in these areas are almost all bycatches of longline and otter trawl fleets from France, Ireland and Spain.

#### 14.2.1.1 Landings trends

Landings data by ICES Subareas reported to the Working Group are shown in Table 14.2.1a–c. For these three subareas combined, landings fell from more than 461 t in 1989 to 52 t in 1996, then increased until 2000 (220 t) and again in 2007 (322 t) then strongly declined to only 14 t in 2010. However this low value is preliminary because French and Spanish data for 2010 are provisional.

In the period considered (1988–2010), most of the estimated landings from the Subareas VI, VII and VIII were taken by Spain (65%), followed by France (18%), UK (15%) and Ireland (2%).

#### 14.2.1.2 ICES Advice

In 2010, ICES advised; *The fishery should not be allowed to expand and a reduction in catches should be considered in order to be consistent with the MSY.*

#### 14.2.1.3 Management

The EU TAC for the Subareas VI, VII and VIII was reduced from 253 t in 2009 to 215 t in 2010. Below a summary table of red sea bream EU TACs and the total international landings for the period 2009–2010 is shown. A minimum landing size of 35 cm (total length) applies in 2010.

| Pagellus bogaraveo | landings | | TAC | TAC |
|---|---|---|---|---|
| Subarea | 2009 | 2010 | 2009 | 2010 |
| VI, VII, VIII | 74 | 14* | 253 | 215 |

***preliminary.**

### 14.2.2 Data available

#### 14.2.2.1 Landings and discards

A Spanish, French and UK extended landing series of *P. bogaraveo* in Northeast Atlantic was updated in 2010 (Figure 14.2.1).

Information from observers in the Basque country fleet in Subareas VI, VII and VIII indicates that there were no discard for this species in the period 2003–2010.

#### 14.2.2.2 Length compositions

No length data were available to the Working Group.

#### 14.2.2.3 Age compositions

No age data were available to the Working Group.

#### 14.2.2.4 Weight-at-age

Mean size and weight-at-age (Table 14.2.2) derived from Guéguen (1969b) and Krug (1998) were used by Lorance (2010) in a yield-per-recruit model to simulate the effect of fishing mortality on a red blackspot sea bream stock of Bay of Biscay.

#### 14.2.2.5 Maturity and natural mortality

Natural Mortality of 0.2 was estimated by Lorance (2010). M was derived from the presumed longevity in the population according the rule M ¼ 4.22/t max, where t is the maximum age in the population derived from data from many populations (Hewitt and Hoenig (2005).

#### 14.2.2.6 Catch, effort and research vessel data

No catch, effort and research vessel data were available to the Working Group.

### 14.2.3 Data analyses

No data analysis was carried out by the Working Group.

### 14.2.4 Management considerations

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WKFRAME. However, current stock levels are probably below any posible candidate for $B_{trigger}$ and no suitable options have been identified.

**Table 14.2.1a. Red sea bream in Subareas VI and VII; WG estimates of landings by country.**

| YEAR | FRANCE* | IRELAND | SPAIN | UK (E & W) | CH.ISLANDS | TOTAL |
|---|---|---|---|---|---|---|
| 1988 | 52 | 0 | 47 | 153 | 0 | 252 |
| 1989 | 44 | 0 | 69 | 76 | 0 | 189 |
| 1990 | 22 | 3 | 73 | 36 | 0 | 134 |
| 1991 | 13 | 10 | 30 | 56 | 14 | 123 |
| 1992 | 6 | 16 | 18 | 0 | 0 | 40 |
| 1993 | 5 | 7 | 10 | 0 | 0 | 22 |
| 1994 | 0 | 0 | 9 | 0 | 1 | 10 |
| 1995 | 0 | 6 | 5 | 0 | 0 | 11 |
| 1996 | 0 | 4 | 24 | 1 | 0 | 29 |
| 1997 | 0 | 20 | 0 | 36 | | 56 |
| 1998 | 0 | 4 | 7 | 6 | | 17 |
| 1999 | 2 | 8 | 0 | 15 | | 25 |
| 2000 | 4 | n.a. | 3 | 13 | | 20 |
| 2001 | 2 | 11 | 2 | 37 | | 52 |
| 2002 | 4 | 0 | 9 | 13 | | 25 |
| 2003 | 13 | 0 | 7 | 20 | | 40 |
| 2004 | 33 | | 4 | 18 | | 55 |
| 2005 | 29 | | 4 | 7 | | 41 |
| 2006 | 36 | 0 | 8 | 19 | | 63 |
| 2007 | 46 | 0 | 27 | 57 | | 130 |
| 2008 | 39 | 0 | 2 | 22 | | 63 |
| 2009 | 6 | 1 | 0 | 10 | | 17 |
| 2010(1) | 3 | 4 | | 1 | | 8 |

(1) preliminary

**Table 14.2.1b. Red sea bream in Subarea VIII; WG estimates of landings by country.**

| YEAR | FRANCE* | SPAIN | ENGLAND (1) | TOTAL |
|---|---|---|---|---|
| 1988 | 37 | 91 | 9 | 137 |
| 1989 | 31 | 234 | 7 | 272 |
| 1990 | 15 | 280 | 17 | 312 |
| 1991 | 10 | 124 | 0 | 134 |
| 1992 | 5 | 119 | 0 | 124 |
| 1993 | 3 | 172 | 0 | 175 |
| 1994 | 0 | 131 | 0 | 131 |
| 1995 | 0 | 110 | 0 | 110 |
| 1996 | 0 | 23 | 0 | 23 |
| 1997 | 18 | 7 | 0 | 25 |
| 1998 | 18 | 86 | 0 | 104 |
| 1999 | 13 | 84 | 0 | 97 |
| 2000 | 11 | 189 | 0 | 200 |
| 2001 | 8 | 168 | 0 | 176 |
| 2002 | 10 | 111 | 0 | 121 |
| 2003 | 6 | 83 | 0 | 89 |
| 2004 | 37 | 82 | 8 | 128 |
| 2005 | 28 | 90 | 0 | 118 |
| 2006 | 20 | 57 | 0 | 77 |
| 2007 | 44 | 149 | 1 | 193 |
| 2008 | 55 | 40 | 0 | 95 |
| 2009 | 28 | 28 | 0 | 56 |
| 2010(2) | 3 | 3 | | 6 |

**(1)In 2005 England and Wales.**

**(2)*preliminary.**

**Table 14.2.1c. Red sea bream in Subareas VI, VII and VIII; WG estimates of landings by subarea.**

| YEAR | VI AND VII* | VIII* | TOTAL |
|---|---|---|---|
| 1988 | 252 | 137 | 389 |
| 1989 | 189 | 272 | 461 |
| 1990 | 134 | 312 | 446 |
| 1991 | 123 | 134 | 257 |
| 1992 | 40 | 124 | 164 |
| 1993 | 22 | 175 | 197 |
| 1994 | 10 | 131 | 141 |
| 1995 | 11 | 110 | 121 |
| 1996 | 29 | 23 | 52 |
| 1997 | 56 | 25 | 81 |
| 1998 | 17 | 104 | 121 |
| 1999 | 25 | 97 | 122 |
| 2000 | 20 | 200 | 220 |
| 2001 | 52 | 176 | 227 |
| 2002 | 25 | 121 | 147 |
| 2003 | 40 | 89 | 129 |
| 2004 | 55 | 128 | 183 |
| 2005 | 41 | 118 | 158 |
| 2006 | 63 | 77 | 139 |
| 2007 | 130 | 193 | 324 |
| 2008 | 63 | 95 | 159 |
| 2009 | 17 | 56 | 74 |
| 2010([1]) | 8 | 6 | 14 |

**([1])preliminary.**

**Table 14.2.2. Mean size and weight-at-age of red blackspot sea bream in Bay of Biscay. From Lorance (2010), derived from Guéguen (1969b) and Krug (1998).**

| Age group | Mean size (total length, cm) | Mean weight (g) | Proportion of females mature |
|---|---|---|---|
| 0 | | | 0 |
| 1 | 11.2 | 18 | 0 |
| 2 | 17.6 | 72 | 0 |
| 3 | 22.3 | 149 | 0 |
| 4 | 26 | 239 | 0 |
| 5 | 29.2 | 342 | 0 |
| 6 | 31.9 | 449 | 0.007 |
| 7 | 34.3 | 562 | 0.05 |
| 8 | 36.1 | 658 | 0.15 |
| 9 | 37.9 | 765 | 0.31 |
| 10 | 39.5 | 870 | 0.45 |
| 11 | 40.9 | 969 | 0.54 |
| 12 | 42.3 | 1076 | 0.62 |
| 13 | 43.7 | 1190 | 0.68 |
| 14 | 44.8 | 1285 | 0.73 |
| 15 | 45.9 | 1386 | 0.77 |
| 16 | 46.7 | 1462 | 0.80 |
| 17 | 47.8 | 1572 | 0.83 |
| 18 | 49.2 | 1719 | 0.86 |
| 19 | 49.9 | 1796 | 0.88 |
| 20 | 50.2 | 1830 | 0.89 |

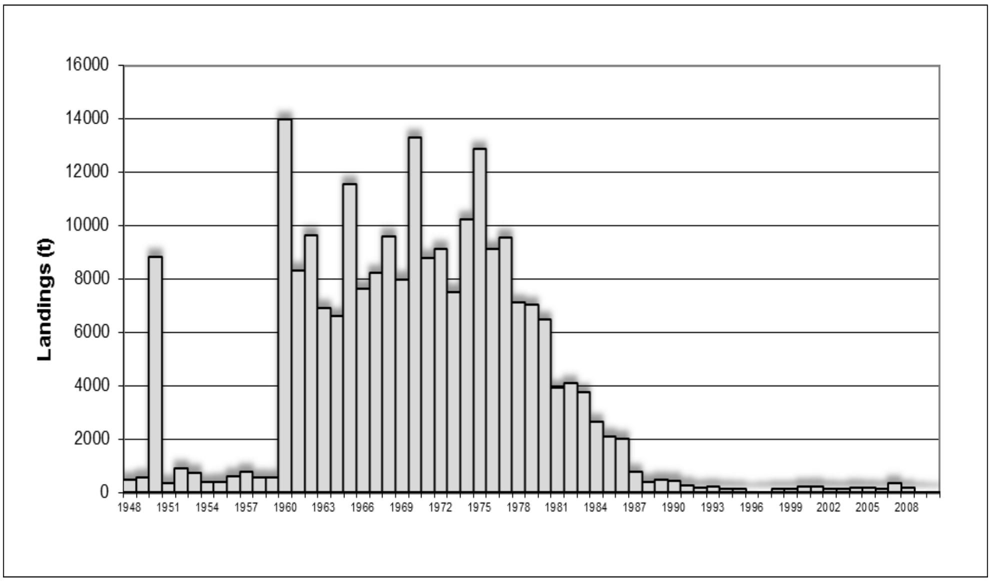



**Figure 14.2.1. Historical series of Red Sea bream landings since 1900 in Northeast Atlantic (Subareas VI, VII and VIII).**

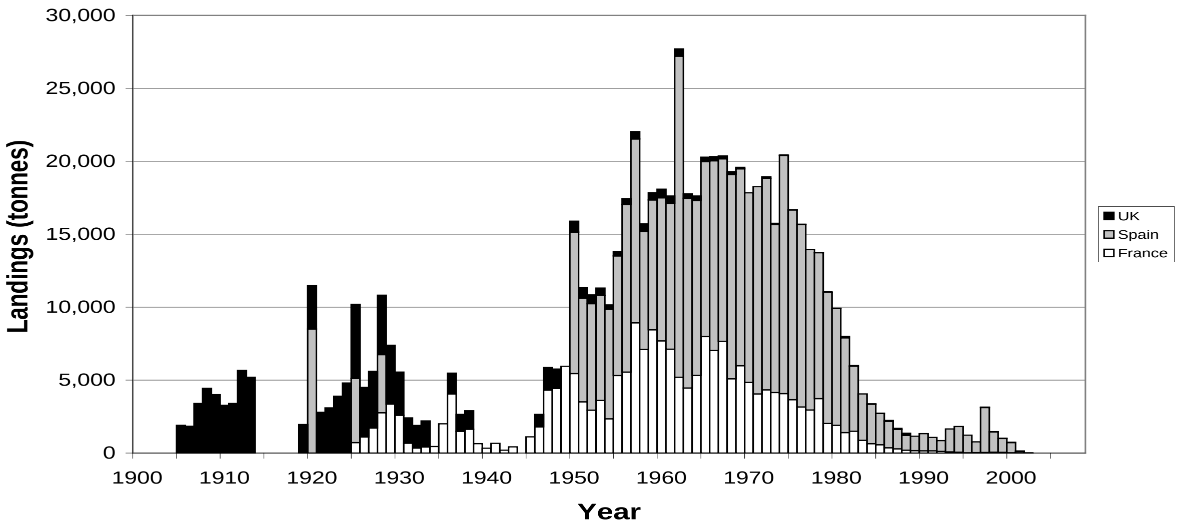



**Figure 14.2.2. Reconstructed time-series of landings of red sea bream by country from the Bay of Biscay population (catch from ICES Subareas VI, VII and VIII). Lorance (2010; see data References/Sources at the end of this section).**

| Reference/Source (1) ofreconstructed landings data for red sea bream in the Bay of Biscay | |
|---|---|
| France | Years 1977–1987:Landings of *P.bogaraveo* (sic?) from the Northeast Atlantic. M.Pinho, pers. com. Source: SGDeep 1995.<br><br>Years 1950–1984: Landings of *Pagellus* sp. ("sea breams") from the Northeast Atlantic. Source: Dardignac (1988), quoted by Castro (1990). SGDeep |
| Portugal | Years 1948–1987 Subarea X.: Landings of *P.bogaraveo* (sic). M.Pinho, pers. com. Source: H. Krug (for 1948–1969) and SGDeep 1995 (for 1970–1987).<br><br>Years 1948–1987, Subarea IX: Landings of *P.bogaraveo* (sic?). M.Pinho, pers. com. Source: H. Krug (for 1948–1969) and SGDeep 1995 (for 1970–1987). |
| Spain | Years 1960–1986: Landings of *Pagellus* sp. ("sea breams") from the Northeast Atlantic. Source: Anuarios de Pesca maritima. Castro (1990). SGDeep 1996.Table 14.2.3.<br><br>Years 1983–1987: Landings of *P.bogaraveo* (sic) from Div. IXa correspond only to southern IXa (Tarifa & Algeciras ports). Source: Cofradias de Pescadores.(WD Gil, 2004) and Cofradias de Pescadores. (Lucio, 1996).<br><br>Years 1985–1987: Landings of *Pagellus* sp. (mainly *P. bogaraveo*). Source: SGDeep 1996. Table 14.2.4.<br><br>Years 1948–1984: Landings of *P.bogaraveo* (sic) from "Div. VIIIc" -mainly Div. VIIIc (eastern) + Div. VIIIb (southern)- correspond only to the Basque |
| UK | Years 1978–1987: Landings of *P.bogaraveo* (sic?) from the Northeast Atlantic. M Pinho, pers. com. Source: SGDeep 1995. |
| All countries | Years 1979–1985 SGDeep official data<br>Years 1988–2010 WDDeep official data |

Reference/Source (2) of reconstructed landings data for red sea bream in the Bay of Biscay (SP: scientific paper; OF official landings statistics). Lorance (2010).

| Reported years of landings | Country | Data Source | Years used |
|---|---|---|---|
| 1926–1930 | France | SP, Desbrosses, 1932 | 1926–1930 |
| 1931–1951 | France | OF, yearly official landings statistics reported in Revue des Travaux de l'Office des Pêches Maritimes | 1931–1947 |
| 1948–1956 | France | OF, yearly official landings statistics reported by the Directorate of Marine fisheries | 1948–1954 |
| 1955–1967 | France | SP, Guéguen, 1969 (1) | 1955–1967 |
| 1968–1969 | France | SP, Njock, 1978 | 1968–1969 |
| 1970–1972 | France | SP, Dardignac, 1988 | 1970–1972 |
| 1973–2002 | France | OF, landings statistics from Ofimer and Ifremer | 1973–2002 |
| 1950–2002 | Spain | OF, FAO landings statistics | 1950–1959 |
| 1960–1981 | Spain | SP, Sanchez, 1982 | 1960–1981 |
| 1982–2001 | Spain | OF, ICES landings statistics | 1982–2001 |
| 1905–1913; 1919–1930 | UK | SP, Desbrosses, 1932 | 1905–1913; 1919–1929 |
| 1930–1938; 1946–1951 | UK | OF, yearly sea fisheries statistical tables, reported by the Ministry of agriculture and fisheries | 1930–1938; 1946–1951 |
| 1950–2002 | UK | OF, FAO landings statistics | 1950–2002 |
| 1932–1938 1947–1973 | International landings | SP, Postuma, 1978 | 1932–1938 1947–1973 |
| 1950–2008 | International landings | OF, ICES landings statistics | 1974–2002 |

**(1) landings in the three main ports (La Rochelle, Lorient and Concarneau) reported to produce 80% of total landings.**

## 14.3 Red sea bream in Subarea IX

### 14.3.1 The fishery

Although *Pagellus bogaraveo* is caught by Spanish and Portuguese fleets in Subarea IX, only an update of the description of the Spanish fishery located in the southern part of Subarea IX close to the Strait of Gibraltar was provided to the Working Group (Gil *et al.*, WD 19). Currently, about 100 boats are involved in the fishery. The fishing grounds are on both sides of the Strait of Gibraltar and quite close to the main ports. Fishing is carried out taking advantage of the turnover of the tides in depths from 200 to 400 fathoms with "*voracera*" gear, a mechanized handline. Since 2002 other artisanal boats have joined the red sea bream fishery, although they operate in other fishing grounds and use longlines. Nowadays, this section of the fleet counts about six boats. Landings are classified into categories due to the wide size range and to market demands. These categories have varied with time.

The majority of deep-water species landings in mainland Portugal are by the artisanal fleet, which uses mainly longlines (I. Figueiredo, *pers. com.*).

#### 14.3.1.1 Landing trends

Catches in Subarea IX, most of them taken with lines are by Spain (72%) and Portugal (28%). Spanish landings data from this area are available from 1983 and Portuguese data from 1988 onwards. The maximum catch in this period was obtained in 1993–1994 and 1997 (about 1000 t) and the minimum in 2002 (359 t). Catches in 2009 amounted to 718 t, but decreased again (484 t) in 2010 (Figure 14.3.1).

#### 14.3.1.2 ICES Advice

ICES advises that catches in 2011 should be less than 500 t, which is a reduction from 2008–2009 landings.

#### 14.3.1.3 Management

Since 2003, EU TAC and quotas have been applied to the *P. bogaraveo* fishery in Subarea IX. The following table shows a summary of *P. bogaraveo* TACs, which have always been far above the landings. There is also a minimum landing size of 35 cm, although 15% of the landings could be ≥30 cm. A maximum of 8% of each quota can be fished in EU waters and in international waters within Areas VI, VII and VIII.

| *P. bogaraveo* | 2003–2004 | | 2005–2006 | | 2007–2008 | | 2009–2010 | | 2011–2012 |
|---|---|---|---|---|---|---|---|---|---|
| ICES Subarea | TAC | Landings | TAC | Landings | **TAC** | **Landings** | **TAC** | **Landings** | **TAC** |
| **IX** | **1271** | **471–480** | **1080** | **494–544** | **1080** | **592–602** | **918–780** | **718–484*** | **780–780** |

***Preliminary.**

Moreover, some technical measures were implemented by the Spanish Central Government in 1998 and by the Regional Government of Andalucía in 1999, in order to regulate the fishing activity and to conserve the resource. Among the technical measures adopted by this Regional Fishing Plan for the period 2003–2010 were the closure of the fishery during two and half months (15th January–31st March), a minimum landing size (33 cm total length), the issuing of licences, and restrictions on hook size, maximum hooks per line (100), maximum number of lines per boat (30), maximum number of automatic hauling machines per boat (3), and landing ports (only Tarifa and Algeciras). The fishing plan only applies to the Tarifa and Algeciras fleets.

#### 14.3.1.4 Stock identity

No new information.

### 14.3.2 Data available

#### 14.3.2.1 Landings and discards

Historical landing dataseries available to the Working Group are described in Section 14.3.1. Discard data were available to the Working Group, but for this species discards can be considered minor and mainly related with smallest samples (Santos *et al.*, WD 5, 2011). The full time-series is presented in Table 14.3.1.

#### 14.3.2.2 Length compositions

Length frequencies of landings are only available for the Spanish red sea bream fishery in the Strait of Gibraltar (1983–2010). Figure 14.3.2 shows the updated mean length distribution data (Gil *et al.*, WD 19 2011). There is a decrease of the mean size from 1995 to 1998. It is necessary to point out that the red sea bream may have a variable length distribution depending on its geographic and bathymetric distribution, as suggested by the different mean lengths of landings measured in ports (Tarifa and Algeciras). The mean length of the landings increased steadily in both ports from 1999 onwards then decreased but then increased again between 2006 and 2009. The mean length from both landing ports declined in 2010. However the median value is lower than the mean since 1995, and very close to the minimum landing size in Algeciras.

A Kolmogorov-Smirnoff test reflects significant differences ($p<0.05$) between the length distributions from Spain and Morocco (Belcaid *et al*., WD 20, 2011) and also within Spain (Gil *et al*., WD 19, 2011). Differences among the sampling protocols may be the explanation for the observed difference. In the Moroccan and Spanish observer programmes the sampling covers all the boats (random sampling) while in the Spanish first sale fish market the sampling covers the four market categories (stratified sampling). So raising the random sampled weight to the total landings does not take into account of the difference due to the variability of the length composition related to bathymetric distribution of the species and the stratified sampling seems to be more appropriate.

#### 14.3.2.3 Age compositions

Padillo *et al*. (2011, WD17) presents new information based on Discriminant Analysis of several of the samples used to make the ALK, combining morphometric and morphological variables to re-estimate red sea bream ages. The re-classification success percentage was 85.3%, well above from the 70% adopted by other authors (Palmer *et al*., 2004 and Galley *et al*., 2006). Changes in otolith shape could be related to growth rate and also be strongly influenced by environmental components. Therefore, future work should include the analysis of such factors throughout years and cohorts.

#### 14.3.2.4 Weight-at-age

No new information was presented to the Group.

#### 14.3.2.5 Maturity and natural mortality

No new information was presented to the Group.

#### 14.3.2.6 Catch, effort and research vessel data

Survey data are not available for the species in this Sub-area. Gil *et al*. (2011, WD19) presents a short series of cpue (2005–2009) from the on-board observer programme in the red sea bream fishery off the Strait of Gibraltar. The sampling level was five boats and three trips per month. The number and length measurements of captured species were recorded. Values vary around three red sea bream per ±70 hooks but the general trend seems to be slightly decreasing throughout the years. Further work should be done to standardize the cpue.

### 14.3.3 Data analyses

New assessment exercises were presented to the Group. An attempted Extended Survivors Analysis (XSA) using the Strait of Gibraltar Spanish red sea bream fishery data are described by González and Gil (2011, WD18). Belcaid *et al*. (2011, WD20) presents the results obtained from a Yield-per-recruit analysis from 2005–2007.

Despite the use of a single ALK combined to obtained the catch-at-age matrix, the XSA assessment should be considered to reflect the dynamics of the stock (González and Gil, 2011, WD18). The results indicate that the stock increased from 2002 and has remained stable over the last years. The rate of exploitation has been increasing in 2009. Spawning biomass estimates from the XSA assessment are different from those previously reported using Separable VPA (Figure 14.3.3). The general trend is quite similar in both cases, but from the XSA assessment the current SSB estimate is close to 70% of the size estimated for the virgin stock, whereas using Separable VPA it is less than 40%. The estimate for fishery recovery depends largely on the assessment technique used.

The Yield-per-recruit model shows that the stock is fully exploited (Belcaid *et al*., WD 20). $F_{MAX}$ and $F_{0.1}$ estimates, 0.37 and 0.18, were below current F (0.39).

### 14.3.4 Management considerations

Management advice for deep-water species is not required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g. catch curves, $F_{proxy}$ and yield-per-recruit.

**Table 14.3.1. Red sea bream (*Pagellus bogaraveo*) in Subarea IX: Working Group estimates of landings (tonnes).**

| Year | Portugal | Spain | TOTAL |
|---|---|---|---|
| 1988 | 370 | 319 | 689 |
| 1989 | 260 | 416 | 676 |
| 1990 | 166 | 428 | 594 |
| 1991 | 109 | 423 | 532 |
| 1992 | 166 | 631 | 797 |
| 1993 | 235 | 765 | 1000 |
| 1994 | 150 | 854 | 1004 |
| 1995 | 204 | 625 | 829 |
| 1996 | 209 | 769 | 978 |
| 1997 | 203 | 808 | 1011 |
| 1998 | 357 | 520 | 877 |
| 1999 | 265 | 278 | 543 |
| 2000 | 83 | 338 | 421 |
| 2001 | 97 | 277 | 374 |
| 2002 | 111 | 248 | 359 |
| 2003 | 142 | 329 | 471 |
| 2004 | 183 | 297 | 480 |
| 2005 | 129 | 365 | 494 |
| 2006 | 104 | 440 | 544 |
| 2007 | 185 | 407 | 592 |
| 2008 | 158 | 444 | 602 |
| 2009 | 124 | 594 | 718 |
| 2010 | 105 | 379 | 484 |

***provisional.**

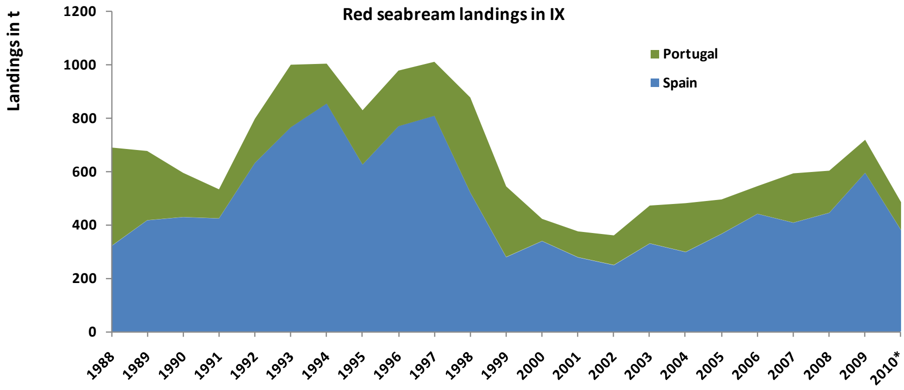



**Figure 14.3.1. Red sea bream in ICES Subarea IX: Total landings by country.**

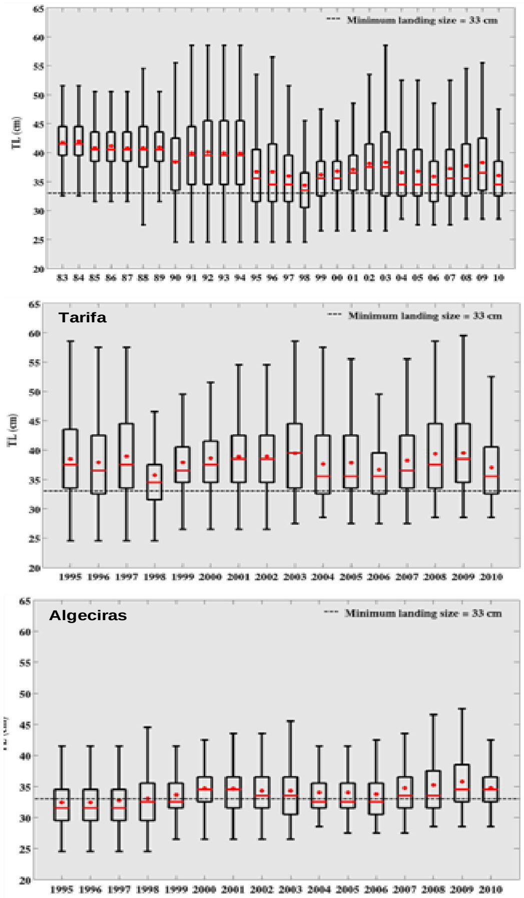



**Figure 14.3.2. Red sea bream fishery of the Strait of Gibraltar (ICES Subarea IX): 1983–2010 landings mean length distribution (from Gil *et al.*, WD 19).**

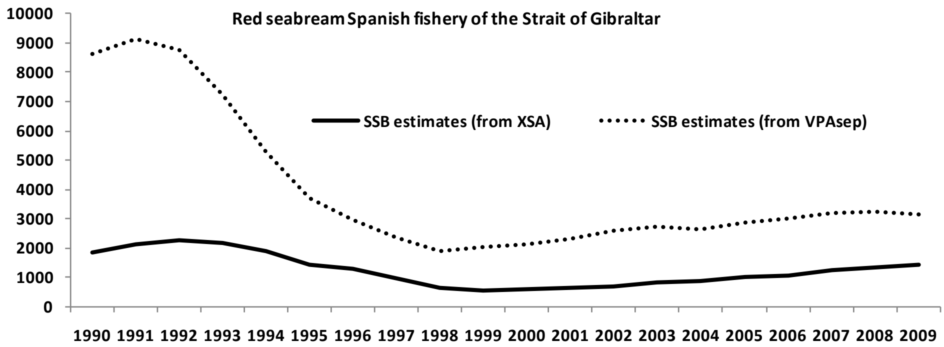



**Figure 14.3.3. Red sea bream (ICES Subarea IX): 1990–2009 Red sea bream Spanish fishery of the Strait of Gibraltar: Contrast between spawning biomass estimates from XSA and Separable VPA (from González and Gil, WD 18).**

## 14.4 Red (blackspot) sea bream in Division Xa

### 14.4.1 The fishery

Blackspot sea bream has been exploited in the Azores (Area Xa2), at least since the XVI century, as part of the demersal fishery. The directed fishery is a hook and line fishery where two components of the fleet can be defined: the artisanal (handlines) and the longliners (Pinho *et al.*, 1999; Pinho, 2003). The artisanal fleet is composed of small open deck boats (<12 m) that operate in local areas near the coast of the islands using several types of handlines. Longliners are closed deck boats (>12 m) that operate in all areas including banks and seamounts. The tuna fishery caught, until the end of the nineties, juveniles (age 0) of blackspot sea bream as live bait, but in a seasonal and irregular way because these catches depend on tuna abundance and on the occurrence of other preferred bait species like *Trachurus picturactus* (Pinho *et al.*, 1995).

The Azorean demersal fishery is a multispecies and multigear fishery where *P. bogaraveo* is considered the target species. The effect of these characteristics on the dynamics of the target fishery is not well understood.

#### 14.4.1.1 Landings trends

Historically, landings increased from 400 t at the start of the eighties to approximately 1000 t at the start of the nineties (Figure 14.4.1), due to the development of new markets, increased fish value, entry of new and modern boats, better professional education of the fisher and introduction of bottom longline gear, permitting the expansion of the exploitable area to deeper waters, banks, and seamounts as well as the expansion of the fishing season (ICES, 2006). During the last 17 years annual landings have fluctuated around 1050 t. In 2010 the landings decreased significantly to 687 t, which correspond to about 60% of the actual TAC (1136 t).

#### 14.4.1.2 ICES Advice

ICES advised in 2010: *Less than 1050 t and a reduction in catches should be considered in order to be consistent with the MSY.*

#### 14.4.1.3 Management

Under the European Union Common Fisheries policy a TAC was introduced in 2003 (EC. Reg. 2340/2002). TACs and landings are given below.

| *P. bogaraveo* | 2003 | | 2004 | | 2005 | | 2006 | |
|---|---|---|---|---|---|---|---|---|
| ICES Subarea | TAC | Landing | TAC | Landing | TAC | Landing | TAC | Landing |
| Xa2 | 1136 | 1068 | 1136 | 1075 | 1136 | 1113 | 1136 | 958 |

| *P. bogaraveo* | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|
| ICES Subarea | TAC | Landing | TAC | Landing | TAC | Landing | TAC | Landing |
| Xa2 | 1136 | 1070 | 1136 | 1089 | 1136 | 1042 | 1136 | 687 |

For the 2006 the Regional Government introduced a quota system by Island and vessel. Specific access requirements and conditions applicable to fishing for deep-water stocks were established (EC. Reg 2347/2002). Fishing with trawl gears was forbidden in the Azores region. Since 2003 deep-water fishing within 100 miles of the Azores baseline is restricted to vessels registered in the Azores under the management of fishing effort of the common fishery policy for deep-water species (EC. Reg. 1954/2003).

For 2009, the Regional Government introduce new technical measures, including the minimum landing size (30 cm total length), area restrictions by vessel size and gear, and gear restrictions (hook size and maximum number of hooks on the longline gear). A seamount (Condor) was also closed to fisheries for a two year period (2010–2011) to allow a multidisciplinary research (ecological, oceanography and geological).

### 14.4.2 Data available

#### 14.4.2.1 Landings and discards

Total annual landings data are available since 1980. However, detailed and precise landing data are available for the assessment since 1990 (ICES, 2006). Landings from Area Xa2 are presented in the Table 14.2.1 and Figure 14.2.1.

Since the introduction of minimum landing size, discards have increased. (16.4% and 30% of the total landings in 2007 and 2008 respectively).

#### 14.4.2.2 Length compositions

Fishery length composition data for the period 1990 to 2009 were presented to the group (WD Pinho and Pereira, 2011; Figure 14.4.2). Length compositions are similar to those from surveys (Figure 14.4.3) with a mode around 25 cm. Large quantities of adult individuals greater than 40 cm are observed in the fishery for the years 1998–2000 and in 2005. This increase may probably relate to catchability factors or due to an expansion of the fishery to offshore areas and deeper depth strata.

Survey length composition data were updated (Figure 14.4.3; Pinho, 2011). No trends are observed in these data.

#### 14.4.2.3 Age compositions

No new information was presented to the Working Group.

#### 14.4.2.4 Weight-at-age

No new information was presented to the Group.

#### 14.4.2.5 Maturity, sex-ratio and natural mortality

No new information was presented to the Working Group.

#### 14.4.2.6 Catch, effort and research vessel data

Standardized fishery cpue was not updated during 2010. Catch rates for the period 1990–2008 were estimated last year using a Generalized Linear Mixed modelling approach assuming a delta-lognormal error distribution. The explanatory variables considered for standardization include geographical area, season, vessel category and port of fishing operation.

Abundance indices from surveys were updated (WD Pinho, 2011).

### 14.4.3 Data analyses

The fishery cpue has been variable but shows no overall trend.

Survey indices from 1995 to 2010 show an increasing trend with a high value every three years (Figure 14.4.5). These high values may be related with some sort of catchability variability (fish are more available to the gear in some years) as a function of the feeding behaviour (bentho-pelagic) and reproduction (protandric forming spawning aggregations) of the species.

Survey abundance indices of mature and immature follows the same trend of the total abundance estimates (Figure 14.4.6).

Annual mean length data from the fishery and from the survey follow a similar trend (Figure 14.4.7). An increase on the mean length by year, with interanual variability, is observed. No data analyses were carried out this year.

Mean length of mature stock is around 37 cm (Figure 14.4.8) and immature about 25 cm (Figure 14.4.9). Variance of the estimates is high but the trends with time are stable.

#### 14.4.3.1 Comments on the assessment

The assessment followed the procedure described in the Stock Annex. This is considered to be appropriate to assess this stock.

### 14.4.4 Management considerations

No management advice is required this year.

In preparation for advice next year, an attempt will be made to explore suitable management targets for the msy framework using methods developed by WGFRAME, e.g. catch curves, $F_{proxy}$, CUSUM.

**Table 14.4.1. Historical landings of *Pagellus bogaraveo* from the Azores (ICES Area Xa2).**

| Year | Azores (Xa2) | Total |
|---|---|---|
| 1980 | 415 | 415 |
| 1981 | 407 | 407 |
| 1982 | 369 | 369 |
| 1983 | 520 | 520 |
| 1984 | 700 | 700 |
| 1985 | 672 | 672 |
| 1986 | 730 | 730 |
| 1987 | 631 | 631 |
| 1988 | 637 | 637 |
| 1989 | 924 | 924 |
| 1990 | 889 | 889 |
| 1991 | 874 | 874 |
| 1992 | 1090 | 1090 |
| 1993 | 830 | 830 |
| 1994 | 989 | 989 |
| 1995 | 1115 | 1115 |
| 1996 | 1052 | 1052 |
| 1997 | 1012 | 1012 |
| 1998 | 1119 | 1119 |
| 1999 | 1222 | 1222 |
| 2000 | 947 | 924 |
| 2001 | 1034 | 1034 |
| 2002 | 1193 | 1193 |
| 2003 | 1068 | 1068 |
| 2004 | 1075 | 1075 |
| 2005 | 1113 | 1113 |
| 2006 | 958 | 958 |
| 2007 | 1063 | 1070 |
| 2008 | 1089 | 1089 |
| 2009 | 1042 | 1042 |
| 2010 | 687 | 687 |

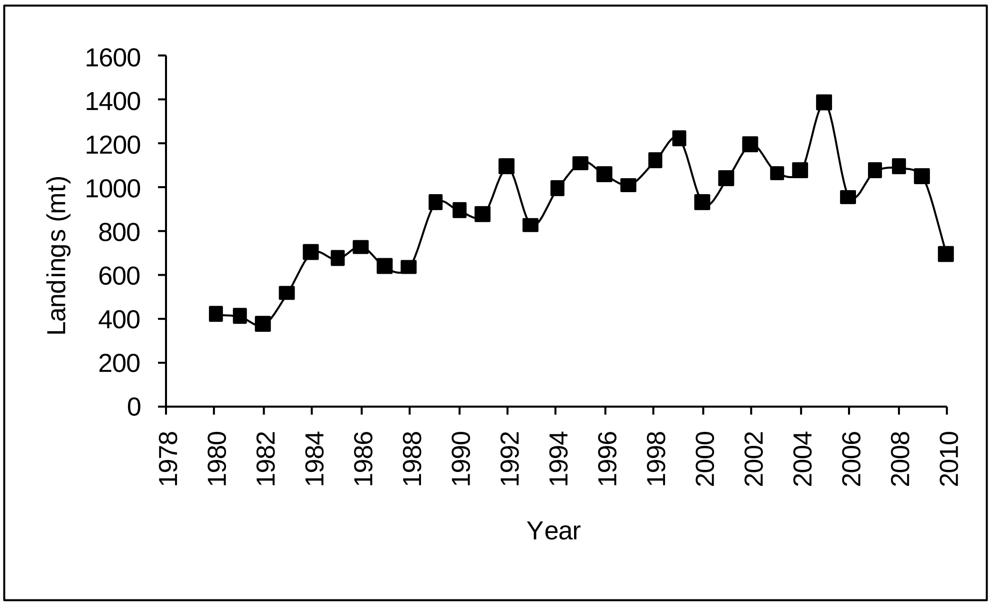



**Figure 14.4.1. Historical landings of *Pagellus bogaraveo* from the Azores (ICES Area Xa2).**

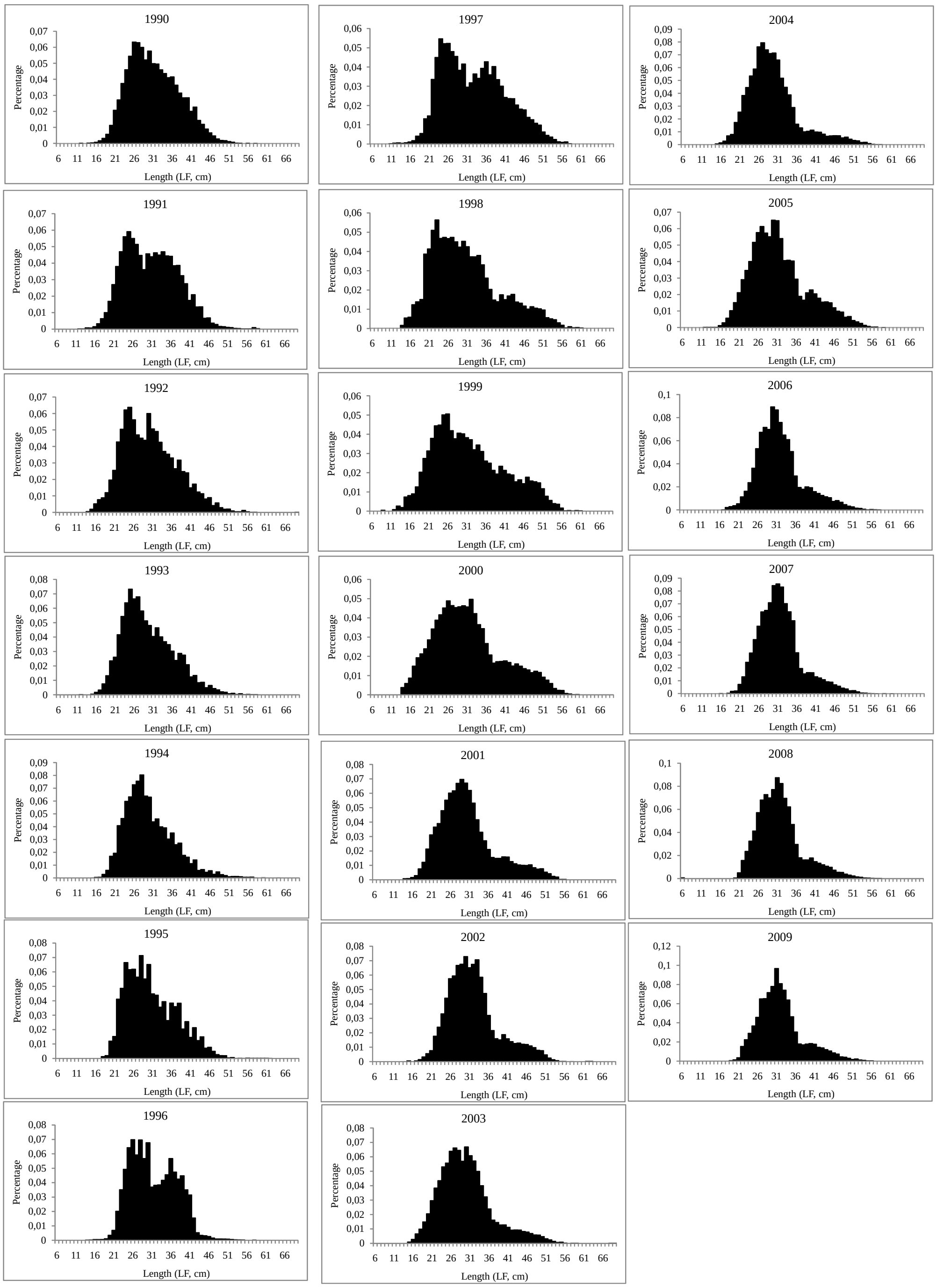



**Figure 14.4.2. Annual length composition of *Pagellus bogaraveo* from the fishery for the period 1990–2009 (ICES Area Xa2).**

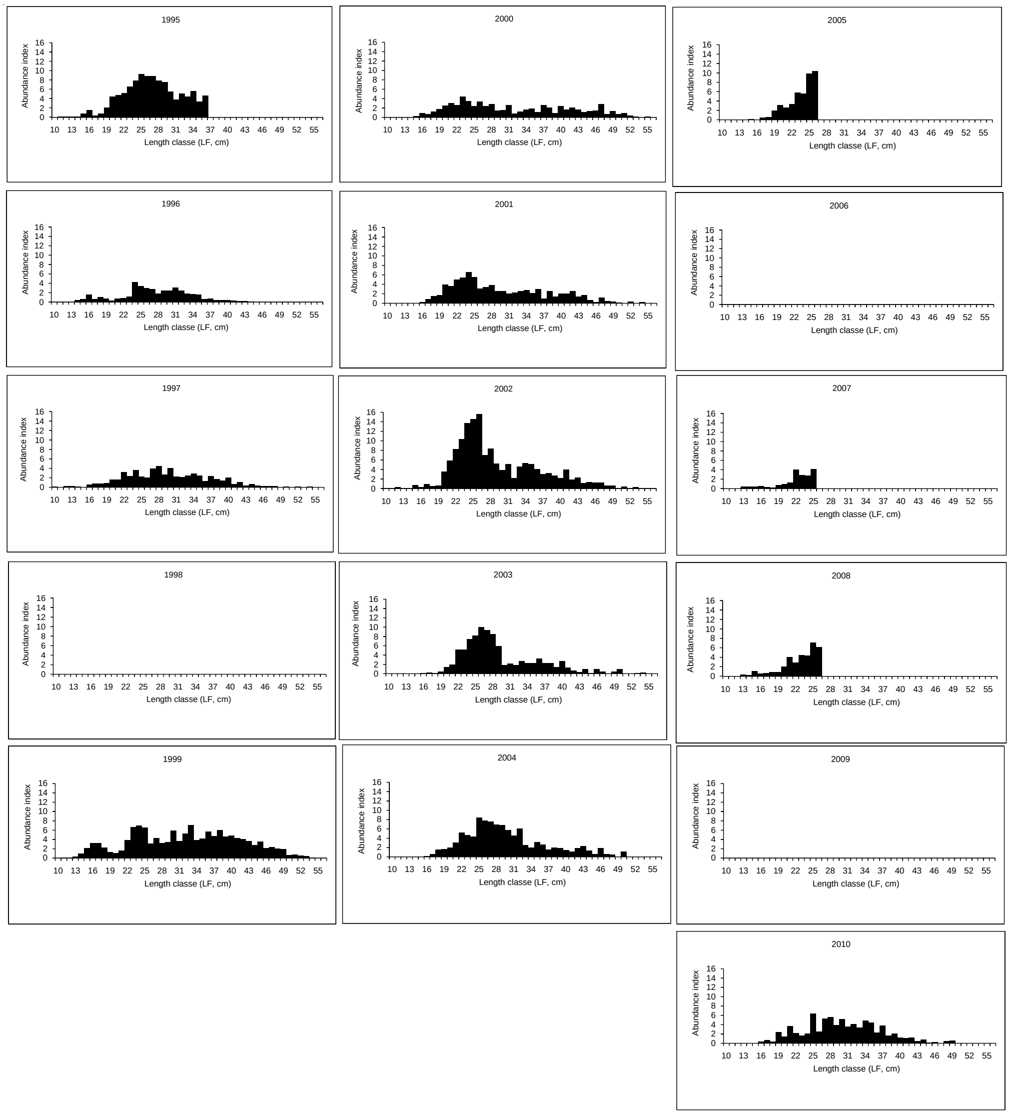



**Figure 14.4.3. Annual length composition of *Pagellus bogaraveo* from the Azorean spring bottom longline survey for the period 2002–2008 (ICES Area Xa2).**

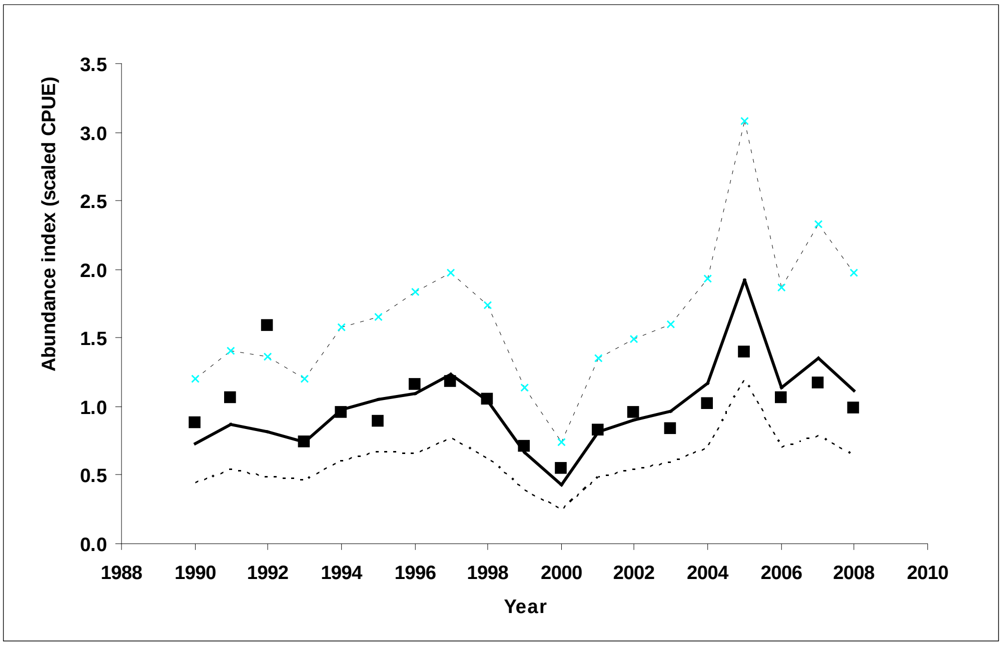



**Figure 14.4.4. Standardized fishery catch rates of *Pagellus bogaraveo* from ICES Area Xa2. In the graph are shown the nominal cpue (squares), standardized cpue (solid line) and confidence intervals (dashed line).**

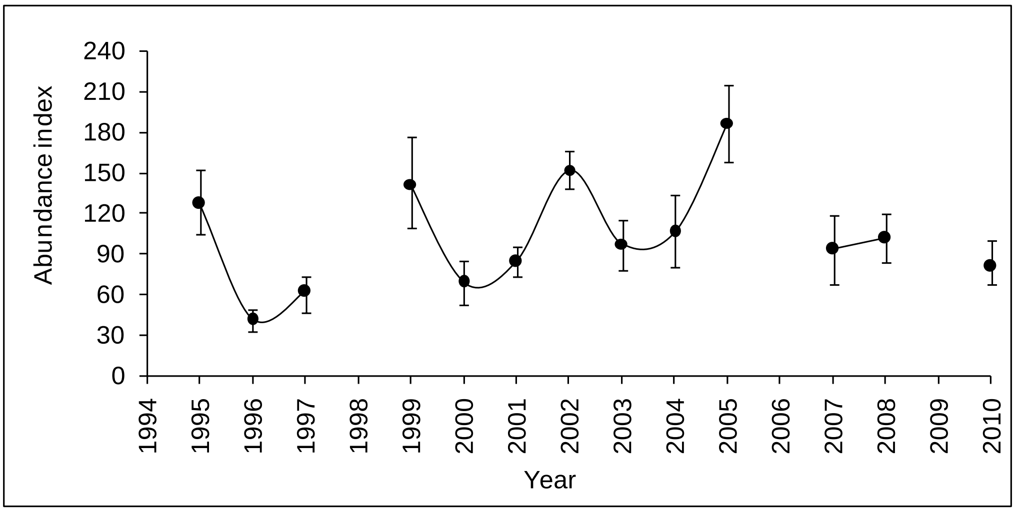



**Figure 14.4.5. Annual abundance in number (Relative Population Number) and in weight (Relative Population Weight) of *Pagellus bogaraveo* from surveys for ICES Area Xa2.**

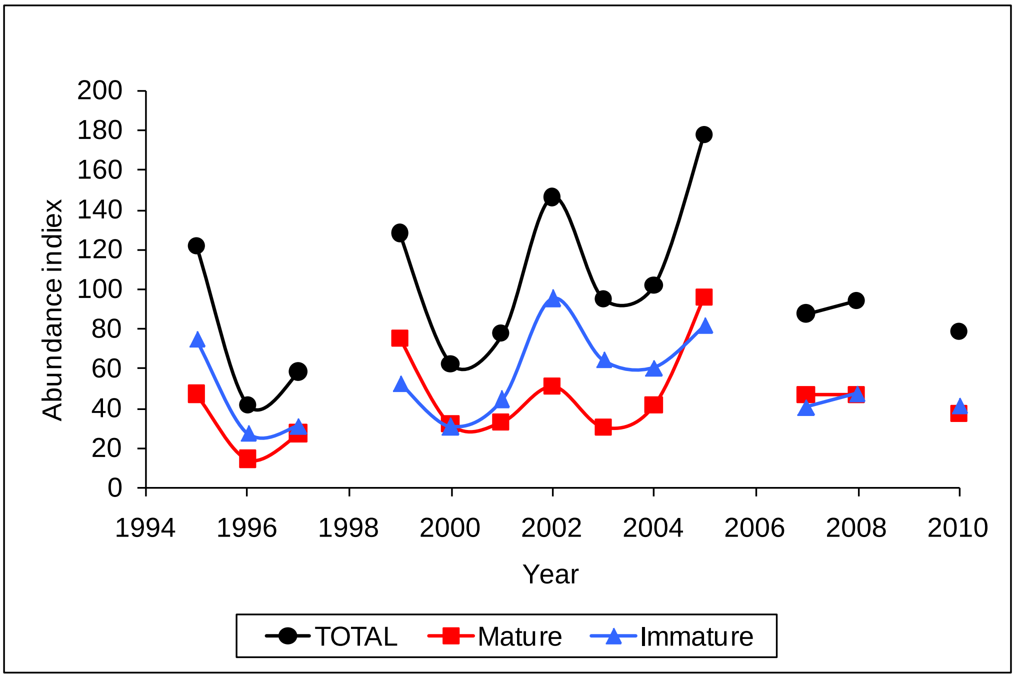



**Figure 14.4.6. Survey abundance indices for mature and immature stock.**

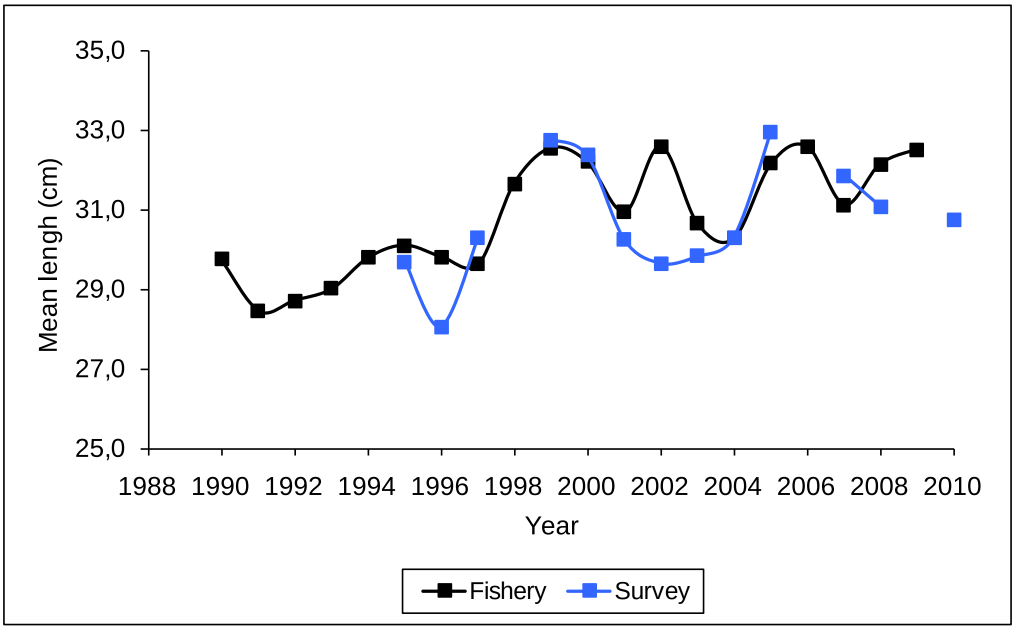



**Figure 14.4.7. Annual mean length from the fishery (1990–2010) and from survey length compositions (1995–2008).**

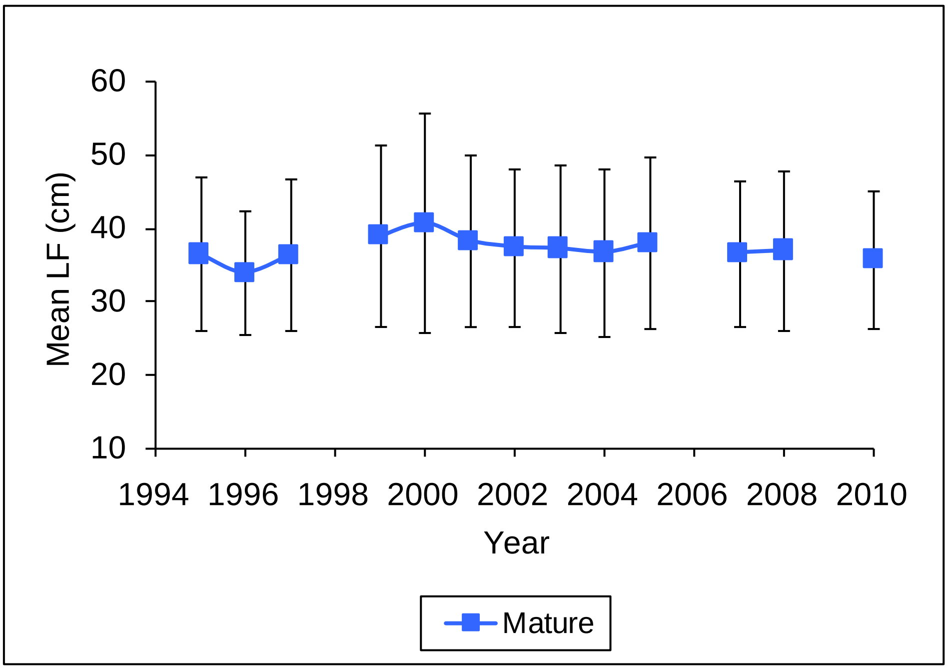



**Figure 14.4.8. Annual mean length of mature individuals from the Azorean longline survey.**

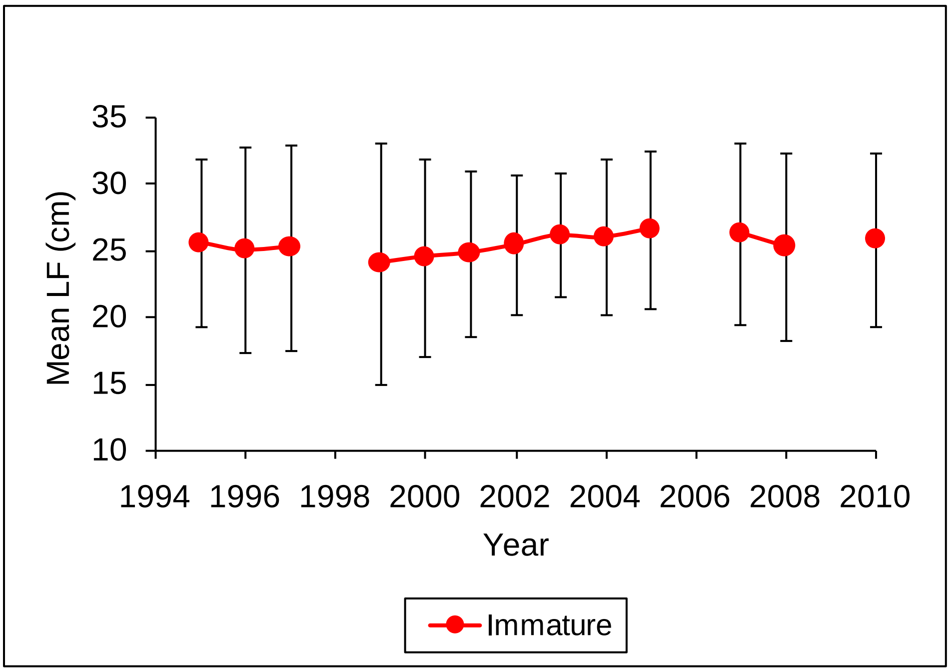



**Figure 14.4.9. Annual mean length of mature individuals from the Azorean longline survey.**

# 15 Other deep-water species in the Northeast Atlantic

## 15.1 The fisheries

The following species are considered in this chapter: roughhead grenadier (*Macrourus berglax*), common Mora (*Mora moro*) and Moridae, rabbit fish (*Chimaera monstrosa* and *Hydrolagus* spp), Baird's smoothhead (*Alepocephalus bairdii*) and Risso's smoothhead (*A. rostratus*), wreckfish (*Polyprion americanus*), bluemouth (*Helicolenus dactylopterus*), silver scabbard fish (*Lepidopus caudatus*), deep-water cardinal fish (*Epigonus telescopus*) and deep-water red crab (*Chaceon affinis*).

Roughhead grenadiers are predominantly taken as bycatch in trawl and longline fisheries targeting Greenland halibut in Subareas I and II but substantial catches have been reported in recent years from mixed trawl fisheries on the Hatton Bank. Mora, rabbitfish, smoothheads, bluemouth and deep-water cardinal fish are taken as bycatch in mixed-species demersal trawl fisheries in Subareas VI, VII and XII and to a lesser extent, II, IV and V. A small bycatch of rabbitfish was taken in the Roundnose grenadier fishery in Subarea III.

Mora, wreckfish, bluemouth and silver scabbardfish are caught in targeted and mixed species longline fisheries in Subareas VIII, IX and X.

Deep-water red crab are caught in directed tanglenet and trap fisheries principally in Subareas VI and VII but increasingly in other areas including Subarea IX.

### 15.1.1 Landings trends

Landings are presented in Tables 15.1–15.9.

### 15.1.2 ICES Advice

ICES has not previously given specific advice on the management of any of the stocks considered in this chapter.

### 15.1.3 Management

No quotas are set for any of these species in EC waters or in the NEAFC Regulatory Area. None of these species are included in Appendix I of Council Regulation (EC) No 2347/2002 meaning that vessels are not required to hold a Deep-water Fishing Permit in order to land them; they are therefore not necessarily affected by EC regulations governing deep-water fishing effort.

## 15.2 Stock identity

No information available.

## 15.3 Data available

### 15.3.1 Landings and discards

Landings for all of these species are presented in Tables 15.1–15.9.

### 15.3.2 Length compositions

Updated length composition data on bluemouth from the Spanish survey on Porcupine Bank and roughhead grenadier from Russian commercial bottom-trawl catches in East Greenland are provided in Figures 15.1 and 15.2.

Trends in mean length of bluemouth and silver scabbardfish in Azorean surveys are shown in Figures 15.3 and 15.4.

### 15.3.3 Age compositions

No new information.

### 15.3.4 Weight-at-age

No new information.

### 15.3.5 Maturity and natural mortality

New information was presented to the Working Group on maturities of male and female roughhead grenadier from Russian surveys in East Greenland (Figures 15.3).

### 15.3.6 Catch, effort and research vessel data

A standardized abundance index for bluemouth in the Spanish Porcupine Bank Survey from 2001 to 2010 is shown in Figure 15.6. There has been a declining trend in abundance since 2005. The geographic distribution of catch rates are given in Figure 15.7.

An update on abundance indices of bluemouth and silver scabbard fish from Portuguese survey at the Azores are given in Figures 15.8 and 15.9. The abundance of bluemouth shows no trend across the time-series. Abundance of Silver scabbard fish has been at a very low level since 2000.

### 15.3.7 Data analysis

No assessment was required for these stocks this year.

### 15.3.8 Comments on the assessment

No assessment was required for these stocks this year.

### 15.3.9 Management considerations

No advice was required for these stocks this year.

**Table 15.1. Working Group estimates of landings of roughhead grenadier (t). Data from 2010 are provisional.**

| Year | I and II | III and IV | Va | Vb | VI and VII | VIII | XII | XIV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | | | | | | | |
| 1989 | | | | | | | | | |
| 1990 | 589 | | | | | | | | 589 |
| 1991 | 829 | | | | | | | | 829 |
| 1992 | 424 | 7 | | | | | | | 431 |
| 1993 | 136 | | | | 18 | | | 52 | 206 |
| 1994 | 0 | | | | 5 | | | 5 | 10 |
| 1995 | 1 | | | | 4 | | | 2 | 7 |
| 1996 | 3 | 4 | 15 | | 13 | | | | 35 |
| 1997 | 21 | 5 | 4 | 6 | 12 | | | | 48 |
| 1998 | 55 | 1 | 1 | 9 | 10 | | | 6 | 82 |
| 1999 | 0 | | | 99 | 38 | | | 14 | 151 |
| 2000 | 48 | 4 | 2 | 1 | 11 | | 7 | | 73 |
| 2001 | 94 | 10 | 1 | 4 | 45 | | 10 | 26 | 190 |
| 2002 | 29 | 3 | 4 | 3 | 12 | 1 | 1143 | 53 | 1248 |
| 2003 | 77 | 2 | 33 | 12 | 11 | | 225 | 33 | 393 |
| 2004 | 79 | 1 | 3 | 10 | 33 | | 752 | 55 | 933 |
| 2005 | 77 | 39 | 5 | 6 | 1488 | | 2205 | 40 | 3860 |
| 2006 | 78 | | 7 | 10 | 2003 | 3 | 976 | 4 | 3081 |
| 2007 | 49 | | 2 | 5 | 1180 | | 420 | 15 | 1671 |
| 2008 | 55 | | | 3 | 128 | | 73 | 3 | 262 |
| 2009 | 53 | | 5 | | 210 | | 7 | 4 | 279 |
| 2010 | 45 | | 22 | 1 | 11 | | 1 | 422 | 502 |

**Table 15.2. Working Group estimates of landings of *Mora moro* and *Moridae* (t). Data from 2010 are provisional.**

| Year | II | Vb | VI and VII | VIII and IX | X | XII | XIVb | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1988 | | | | | | | | |
| 1989 | | | | | | | | |
| 1990 | | | | | 2 | | | 2 |
| 1991 | | 5 | 1 | | 4 | | | 10 |
| 1992 | | | 25 | | | | | 25 |
| 1993 | | | 10 | | | | | 10 |
| 1994 | | | 10 | | | | | 10 |
| 1995 | | | | 83 | | | | 83 |
| 1996 | | | | 52 | | | | 52 |
| 1997 | | | | 88 | | | | 88 |
| 1998 | | | 41 | | | | | 41 |
| 1999 | | 1 | 20 | | | | | 21 |
| 2000 | 8 | 3 | 159 | 25 | | 1 | | 196 |
| 2001 | 1 | 100 | 194 | 25 | | 87 | | 407 |
| 2002 | 1 | 19 | 159 | 10 | 100 | 13 | | 302 |
| 2003 | | 8 | 327 | 12 | 125 | 15 | 7 | 494 |
| 2004 | | 1 | 71 | 15 | 87 | 4 | | 178 |
| 2005 | | 1 | 63 | 19 | 69 | | | 152 |
| 2006 | | 5 | 111 | 45 | 92 | | | 253 |
| 2007 | | 8 | 64 | 18 | 86 | | | 176 |
| 2008 | | 4 | 57 | 4 | 53 | | | 118 |
| 2009 | | 1 | | 5 | 68 | | | 74 |
| 2010 | | 11 | 1 | 4 | 54 | | | 70 |

**Table 15.3. Working Group estimates of landings of rabbitfish (t) (*Chimaera monstrosa* and *Hydrolagus* spp.) Data from 2010 are provisional.**

| Year | I/II | III/IV | Va | Vb | VI/VII | VIII | XII | XIV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1991 | | | 499 | | | | | | 499 |
| 1992 | | 122 | 106 | | | | | | 228 |
| 1993 | | 8 | 3 | | | | | | 11 |
| 1994 | | 167 | 60 | | 2 | | | | 229 |
| 1995 | | | 106 | 1 | | | | | 107 |
| 1996 | | 14 | 32 | | | | | | 46 |
| 1997 | | 38 | 16 | | | | 32 | | 86 |
| 1998 | | 56 | 32 | | 2 | | 42 | | 132 |
| 1999 | | 47 | 9 | 3 | 237 | 2 | 114 | | 412 |
| 2000 | 6 | 34 | 6 | 54 | 404 | 2 | 48 | | 554 |
| 2001 | 7 | 23 | 1 | 96 | 797 | 7 | 79 | | 1010 |
| 2002 | 15 | 24 | | 64 | 570 | 6 | 98 | 1 | 778 |
| 2003 | 57 | 25 | 1 | 61 | 469 | 2 | 80 | 4 | 699 |
| 2004 | 22 | 40 | | 100 | 444 | 6 | 128 | 5 | 745 |
| 2005 | 77 | 171 | | 63 | 571 | 14 | 249 | 1 | 1146 |
| 2006 | 29 | 17 | 1 | 62 | 325 | 10 | | 5 | 449 |
| 2007 | 64 | 2 | 1 | 78 | 391 | 3 | | | 539 |
| 2008 | 81 | 12 | 1 | 49 | 370 | 3 | | | 516 |
| 2009 | 89 | 6 | 2 | 6 | 47 | | 70 | | 220 |
| 2010 | 197 | 21 | 7 | 5 | 31 | | 25 | | 286 |

**Table 15.4. Working Group estimates of landings of Baird's smoothhead (t). Data from 2010 are provisional.**

| Year | Va | Vb | VI and VII | XII | XIV | TOTAL |
|---|---|---|---|---|---|---|
| 1991 | | | 31 | | | 31 |
| 1992 | 10 | | 17 | | | 27 |
| 1993 | 3 | | | 2 | | 5 |
| 1994 | 1 | | | | | 1 |
| 1995 | 1 | | | | | 1 |
| 1996 | | | | 230 | | 230 |
| 1997 | | | | 3692 | | 3692 |
| 1999 | | | | 4643 | | 4643 |
| 1999 | | | | 6549 | | 6549 |
| 2000 | | | 978 | 4146 | 12 | 5136 |
| 2001 | | | 5305 | 3132 | | 8897 |
| 2002 | | | 260 | 12538 | 661 | 13 459 |
| 2003 | | | 393 | 6883 | 632 | 7908 |
| 2004 | | 6 | 2657 | 4368 | 245 | 7276 |
| 2005 | | 1 | 5978 | 6928 | | 12 412 |
| 2006 | | | 4966 | 3512 | | 8150 |
| 2007 | | | 2565 | 1781 | | 4140 |
| 2008 | | | 896 | 744 | | 1611 |
| 2009 | | | 295 | 508 | | 803 |
| 2010 | | | 511 | 317 | | 828 |

**Table 15.5. Working Group estimates of landings of Wreckfish (t). Data from 2010 are provisional.**

| WRECKFISH (*Polyprion americanus*) All areas | | | | |
|---|---|---|---|---|
| Year | VI and VII | VIII and IX | X | TOTAL |
| 1980 | | | 38 | 38 |
| 1981 | | | 40 | 40 |
| 1982 | | | 50 | 50 |
| 1983 | | | 99 | 99 |
| 1984 | | | 131 | 131 |
| 1985 | | | 133 | 133 |
| 1986 | | | 151 | 151 |
| 1987 | | | 216 | 216 |
| 1988 | 7 | 198 | 191 | 396 |
| 1989 | | 284 | 235 | 519 |
| 1990 | 2 | 163 | 224 | 389 |
| 1991 | 10 | 194 | 170 | 374 |
| 1992 | 15 | 270 | 240 | 525 |
| 1993 | | 350 | 315 | 665 |
| 1994 | | 410 | 434 | 844 |
| 1995 | | 394 | 244 | 638 |
| 1996 | 83 | 294 | 243 | 620 |
| 1997 | | 222 | 177 | 399 |
| 1998 | 12 | 238 | 140 | 390 |
| 1999 | 14 | 144 | 133 | 291 |
| 2000 | 14 | 123 | 263 | 400 |
| 2001 | 17 | 167 | 232 | 416 |
| 2002 | 9 | 156 | 283 | 448 |
| 2003 | 2 | 243 | 270 | 515 |
| 2004 | 2 | 141 | 189 | 332 |
| 2005 | | 195 | 279 | 474 |
| 2006 | | 331 | 497 | 828 |
| 2007 | 2 | 553 | 662 | 1217 |
| 2008 | 3 | 317 | 513 | 833 |
| 2009 | 8 | 13 | 382 | 403 |
| 2010 | 3 | 5 | 238 | 246 |

**Table 15.6. Working Group estimates of landings of bluemouth (t). Data from 2010 are provisional.**

| Year | III and IV | Vb | VI | VII | VIII and IX | X | TOTAL |
|---|---|---|---|---|---|---|---|
| 1980 | | | | | | 18 | 18 |
| 1981 | | | | | | 22 | 22 |
| 1982 | | | | | | 42 | 42 |
| 1983 | | | | | | 93 | 93 |
| 1984 | | | | | | 101 | 101 |
| 1985 | | | | | | 169 | 169 |
| 1986 | | | | | | 212 | 212 |
| 1987 | | | | | | 331 | 331 |
| 1988 | | | | | | 439 | 439 |
| 1989 | | | 79 | 48 | 2 | 481 | 610 |
| 1990 | 4 | | 69 | 31 | 5 | 480 | 589 |
| 1991 | 5 | | 99 | 29 | 12 | 483 | 628 |
| 1992 | 3 | | 112 | 47 | 11 | 575 | 748 |
| 1993 | 1 | | 87 | 65 | 8 | 650 | 811 |
| 1994 | 2 | | 62 | 55 | 4 | 708 | 831 |
| 1995 | 2 | | 62 | 9 | | 589 | 662 |
| 1996 | 2 | | 77 | 10 | | 483 | 572 |
| 1997 | 1 | | 78 | 10 | 1 | 410 | 500 |
| 1998 | | | 53 | 92 | 3 | 381 | 529 |
| 1999 | 8 | 64 | 194 | 160 | 29 | 340 | 795 |
| 2000 | | 16 | 213 | 119 | 33 | 441 | 822 |
| 2001 | | | 177 | 102 | 34 | 301 | 614 |
| 2002 | | | 81 | 115 | 18 | 280 | 494 |
| 2003 | | | 184 | 213 | 124 | 338 | 859 |
| 2004 | 2 | 3 | 142 | 291 | 135 | 282 | 855 |
| 2005 | | | 103 | 204 | 206 | 190 | 703 |
| 2006 | | | 59 | 160 | 287 | 209 | 715 |
| 2007 | | | 61 | 259 | 293 | 274 | 887 |
| 2008 | | | 64 | 193 | 214 | 281 | 752 |
| 2009 | | | 94 | 14 | 75 | 267 | 450 |
| 2010 | | | 69 | 6 | 6 | 213 | 294 |

**Table 15.7. Working Group estimates of landings of silver scabbardfish (t). Data from 2010 are provisional.**

| | VI and VII | VIII and IX | X | XII | TOTAL |
|---|---|---|---|---|---|
| 1980 | | | 13 | | 13 |
| 1981 | | | 6 | | 6 |
| 1982 | | | 10 | | 10 |
| 1983 | | | 43 | | 43 |
| 1984 | | | 38 | | 38 |
| 1985 | | | 28 | | 28 |
| 1986 | | | 65 | | 65 |
| 1987 | | | 30 | | 30 |
| 1988 | | 2666 | 70 | | 2736 |
| 1989 | | 1385 | 91 | 102 | 1578 |
| 1990 | | 584 | 120 | 20 | 724 |
| 1991 | | 808 | 166 | 18 | 992 |
| 1992 | | 1374 | 2160 | | 3534 |
| 1993 | 2 | 2397 | 1724 | 19 | 4142 |
| 1994 | | 1054 | 374 | | 1428 |
| 1995 | | 5672 | 788 | | 6460 |
| 1996 | | 1237 | 826 | | 2063 |
| 1997 | | 1725 | 1115 | | 2840 |
| 1998 | | 966 | 1187 | | 2153 |
| 1999 | 18 | 3069 | 86 | | 3173 |
| 2000 | 17 | 16 | 27 | | 60 |
| 2001 | 6 | 706 | 14 | | 726 |
| 2002 | 1 | 1832 | 10 | | 1843 |
| 2003 | | 1681 | 25 | | 1706 |
| 2004 | | 836 | 29 | | 865 |
| 2005 | 57 | 527 | 31 | | 615 |
| 2006 | 377 | 624 | 35 | | 1036 |
| 2007 | 88 | 649 | 55 | | 792 |
| 2008 | 40 | 845 | 63 | | 948 |
| 2009 | 44 | 898 | 64 | 25 | 1031 |
| 2010 | 32 | 829 | 68 | 43 | 972 |

**Table 15.8. Working group estimates of landings of deep-water cardinal fish (t). Data from 2010 are provisional.**

| Year | Vb | VI | VII | VIII and IX | X | XII | TOTAL |
|---|---|---|---|---|---|---|---|
| 1990 | | | | | 3 | | 3 |
| 1991 | | | | | 11 | | 11 |
| 1992 | | | | | | | 0 |
| 1993 | | 15 | 15 | | | | 30 |
| 1994 | 4 | 35 | 182 | | | | 221 |
| 1995 | 3 | 20 | 71 | | | | 94 |
| 1996 | 8 | 13 | 32 | | | | 53 |
| 1997 | 8 | 27 | 22 | | | | 57 |
| 1998 | | 86 | 29 | | | | 115 |
| 1999 | 8 | 54 | 224 | 3 | | | 289 |
| 2000 | 2 | 121 | 181 | 5 | 3 | | 312 |
| 2001 | 7 | 109 | 284 | 4 | | | 404 |
| 2002 | | 97 | 888 | 8 | 14 | | 1007 |
| 2003 | 2 | 47 | 1031 | 5 | 16 | 1 | 1102 |
| 2004 | 1 | 30 | 843 | 10 | 21 | 2 | 907 |
| 2005 | | 50 | 637 | 8 | 4 | | 699 |
| 2006 | | 30 | 383 | 12 | 10 | | 435 |
| 2007 | | 6 | 218 | 19 | 7 | | 250 |
| 2008 | | 19 | 5 | 6 | 7 | | 37 |
| 2009 | | 8 | 2 | 130 | 7 | | 147 |
| 2010 | | 4 | 6 | | 5 | | 15 |

**Table 15.9. Working Group estimates of landings of deep-water red crab (t). Data from 2010 are provisional.**

| year | IV/V | VI | VII | VIII/IX | XII | Total |
|---|---|---|---|---|---|---|
| 1995 | | 6 | 4 | | | 12 |
| 1996 | 20 | 1288 | 77 | 2 | 17 | 1413 |
| 1997 | 58 | 139 | 48 | 11 | 4 | 437 |
| 1998 | 35 | 313 | 34 | 188 | 2 | 384 |
| 1999 | 642 | 289 | 46 | | 3 | 980 |
| 2000 | 38 | 580 | 108 | | | 726 |
| 2001 | 13 | 335 | 20 | | | 368 |
| 2002 | 29 | 972 | 21 | | 6 | 1028 |
| 2003 | 26 | 960 | 123 | | 92 | 1201 |
| 2004 | 21 | 546 | 115 | | 13 | 695 |
| 2005 | 94 | 626 | 184 | | 15 | 1230 |
| 2006 | 16 | 185 | 19 | 310 | | 530 |
| 2007 | 11 | 732 | 104 | 85 | 24 | 957 |
| 2008 | 2 | 124 | 1 | | | 127 |

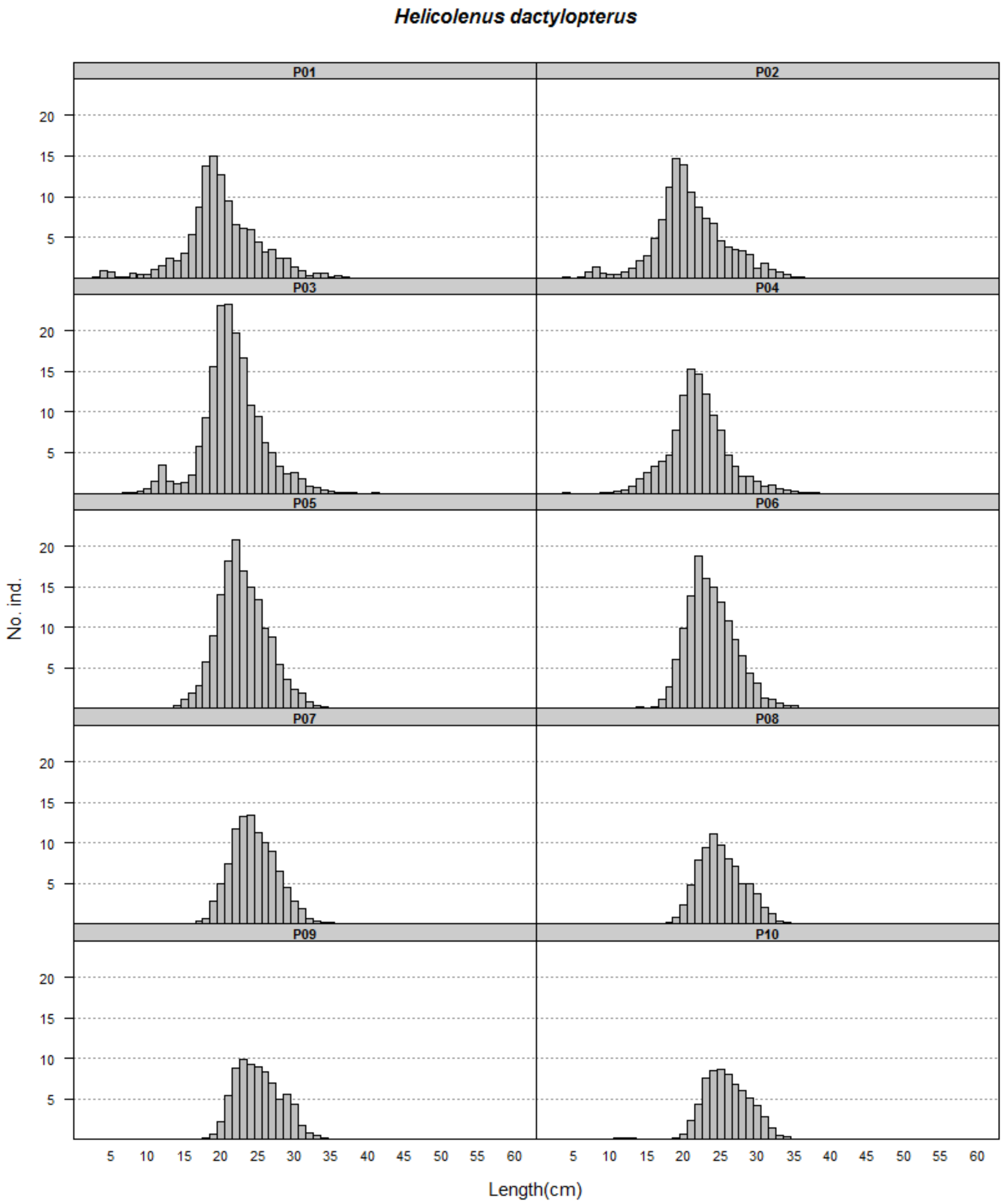



**Figure 15.1. Mean stratified length distributions of *Helicolenus dactylopterus* in Spanish surveys on the Porcupine bank (2001–2010).**

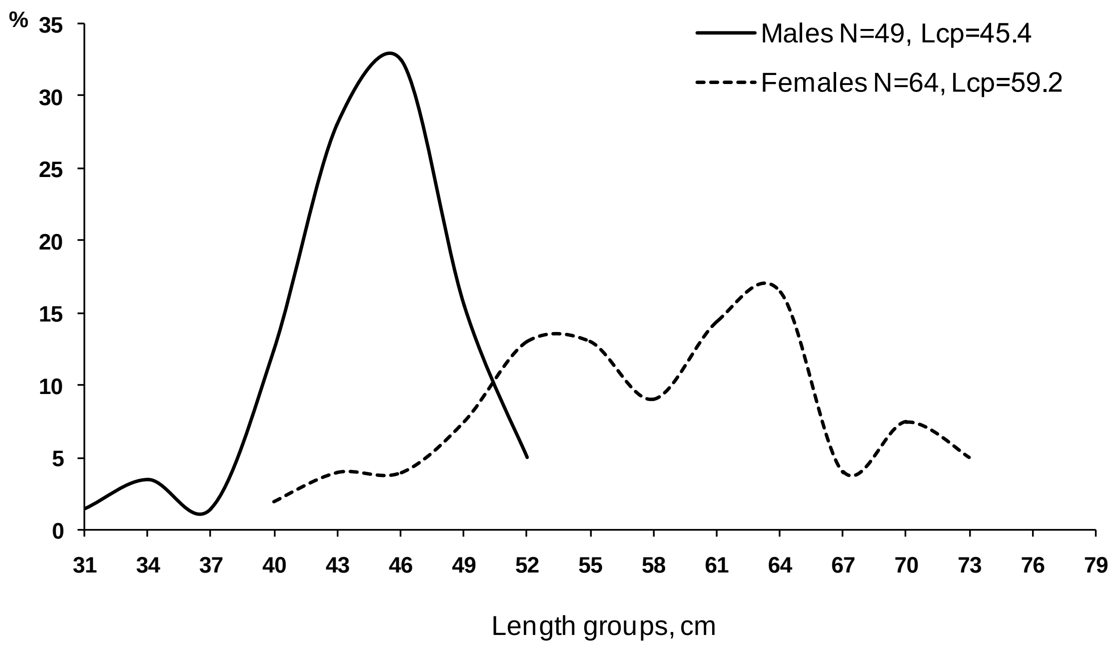



**Figure 15.2. Length composition of Roughhead grenadier from commercial bottom-trawl catches in Eastern Greenland in October–November 2010.**

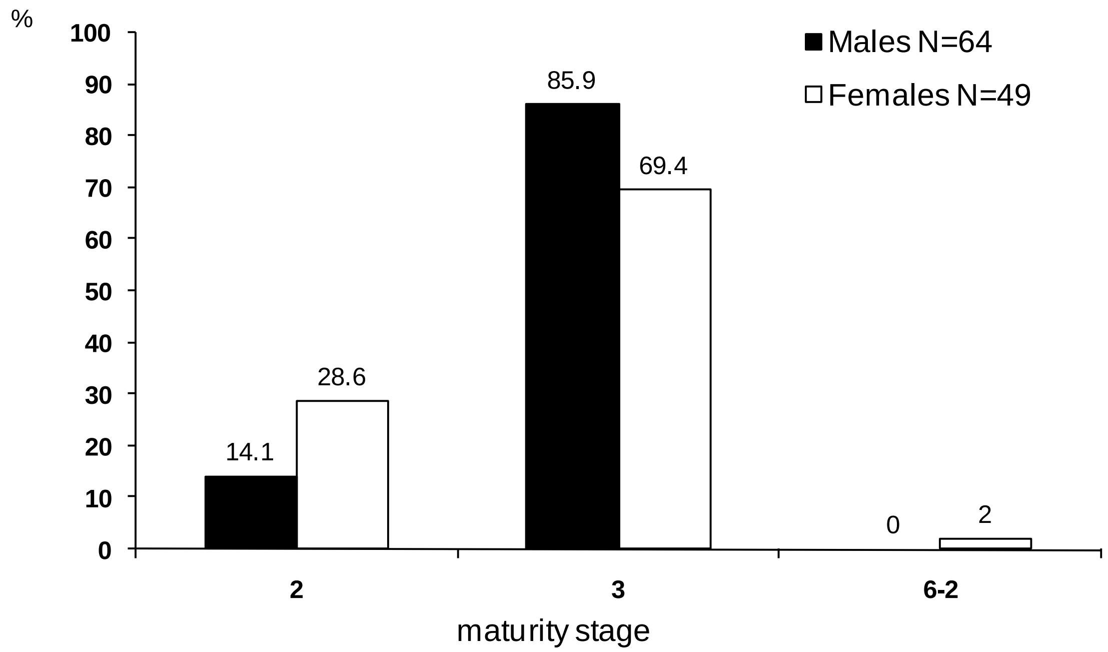



**Figure 15.3. Maturity of Roughhead grenadier from commercial bottom-trawl catches in Eastern Greenland in October–November 2010.**

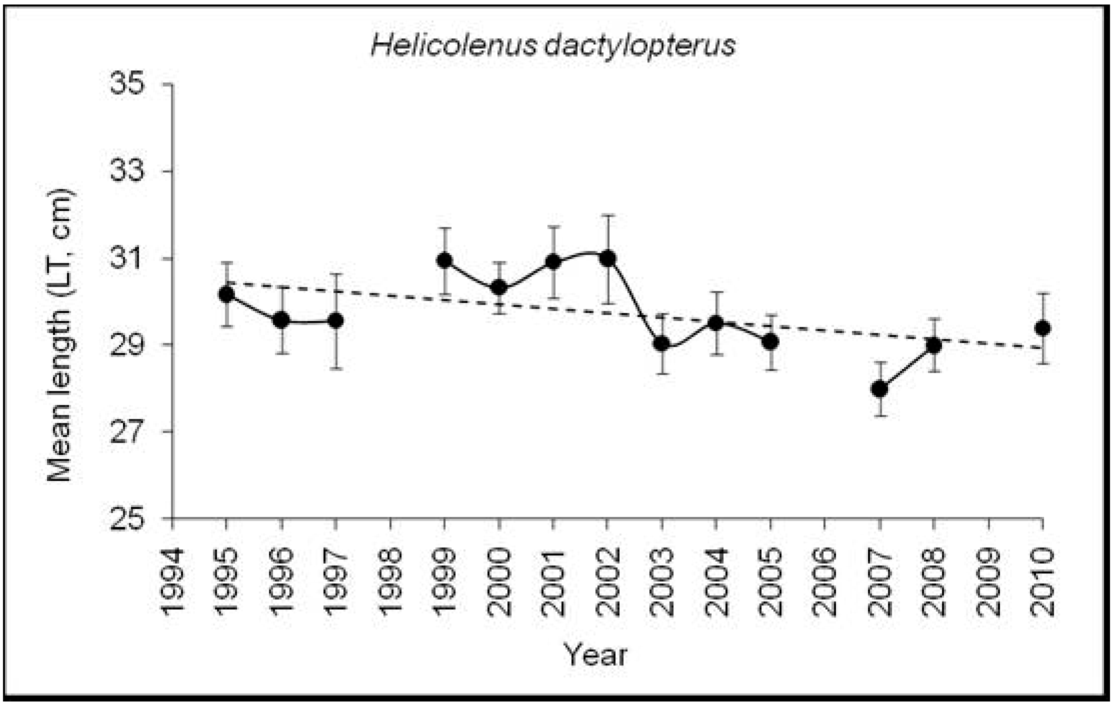



**Figure 15.4. Mean length of bluemouth in Azores bottom longline survey 1995–2010.**

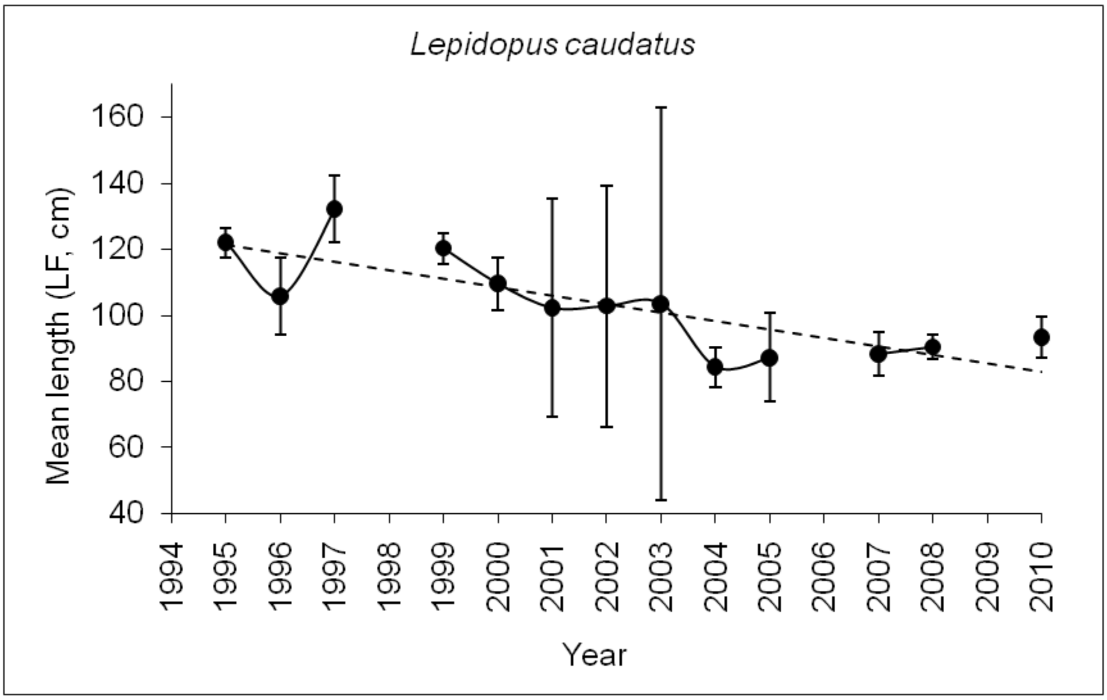



**Figure 15.5. Mean length of silver scabbardfish in Azores bottom longline survey 1995–2010.**

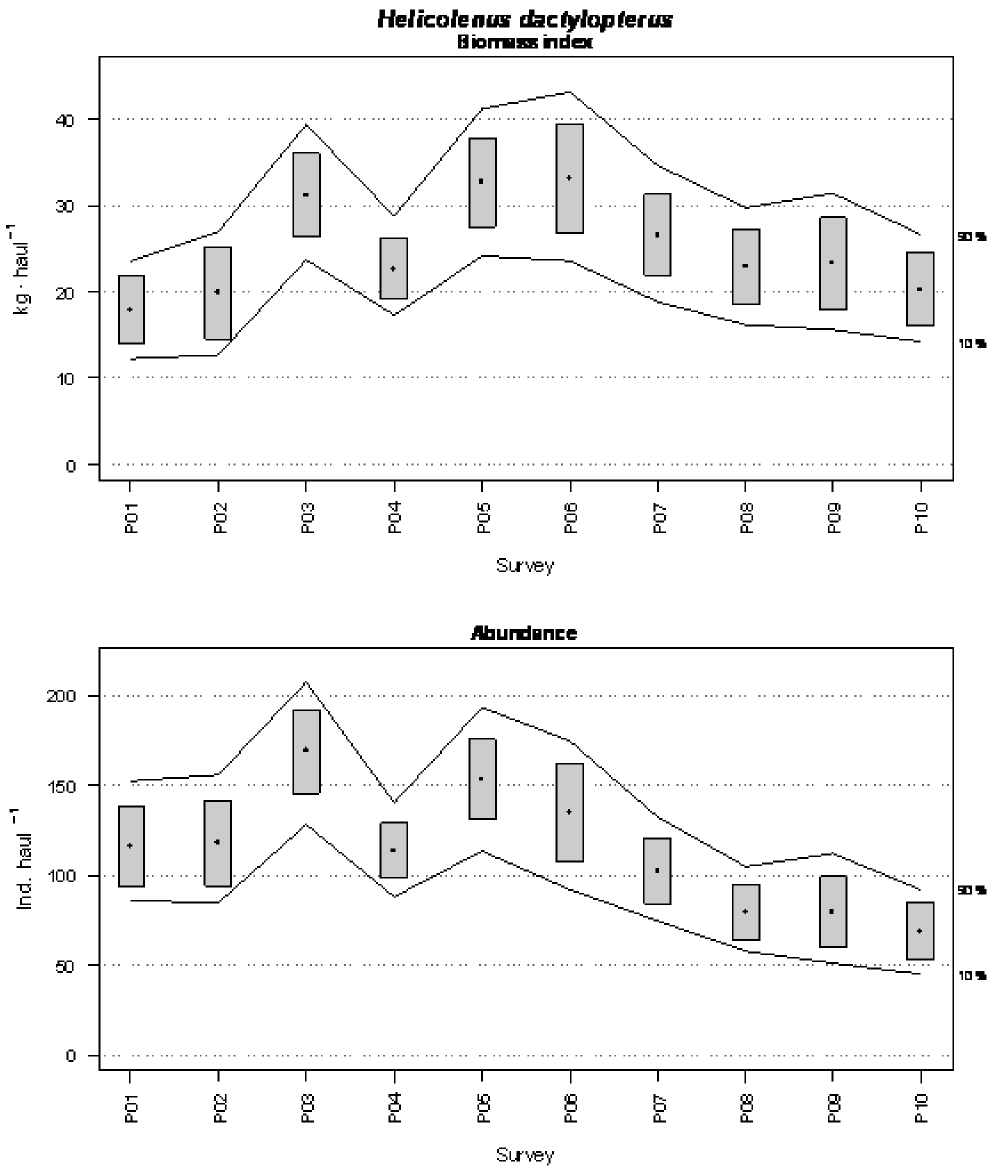



**Figure 15.6. Changes in *Helicolenus dactylopterus* biomass and abundance indices during Porcupine Survey time-series (2001–2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).**

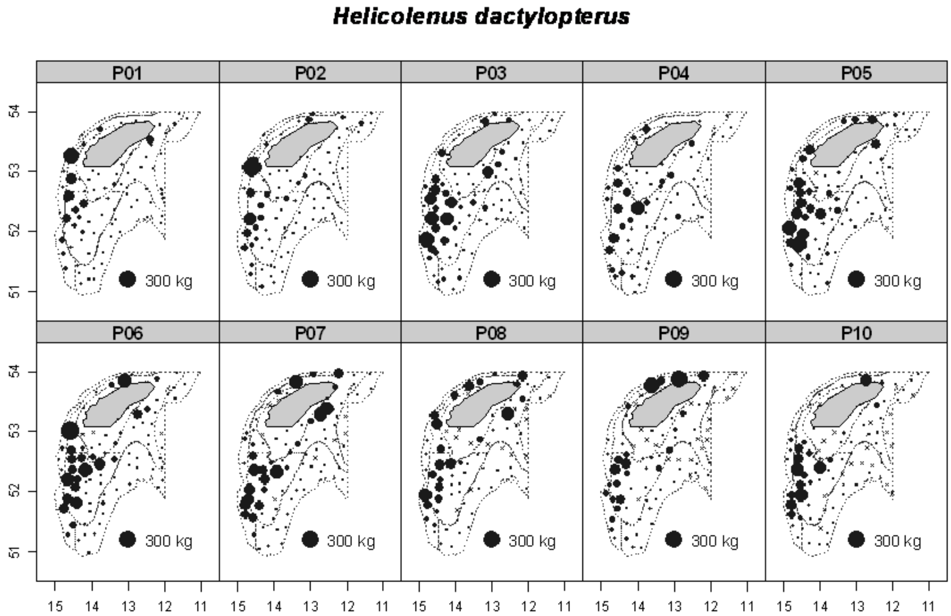



**Figure 15.7. Geographic distribution of *Helicolenus dactylopterus* catches (kg/30 min haul) in Porcupine surveys (2001–2008).**

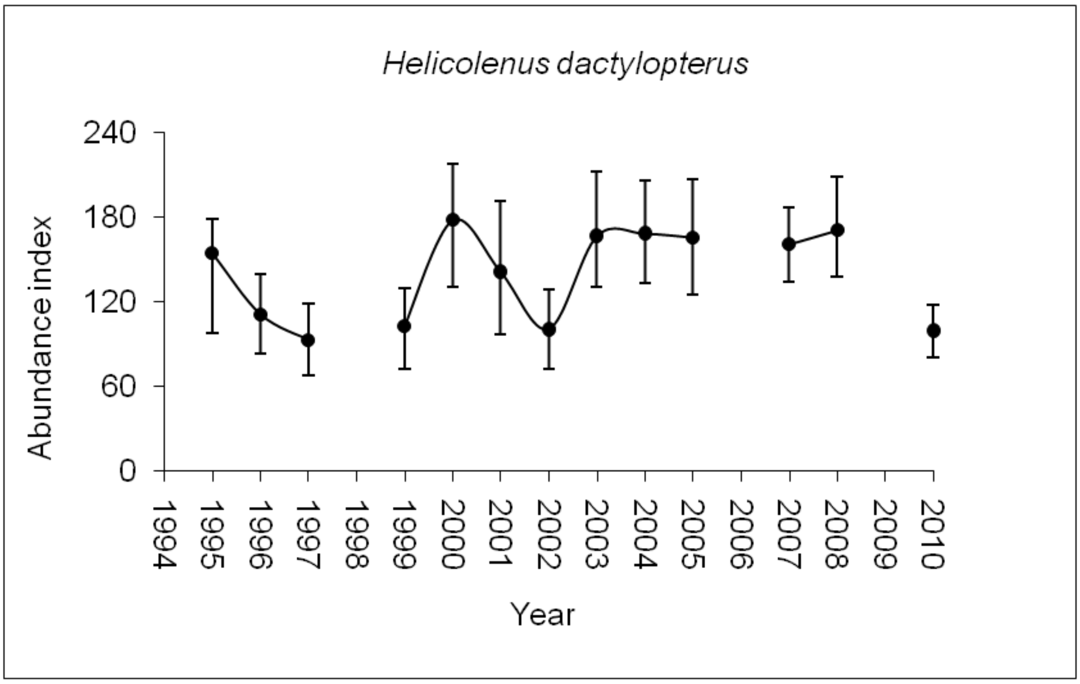



**Figure 15.8. Annual bottom longline survey abundance index (number) for bluemouth in Azorean bottom longline surveys.**

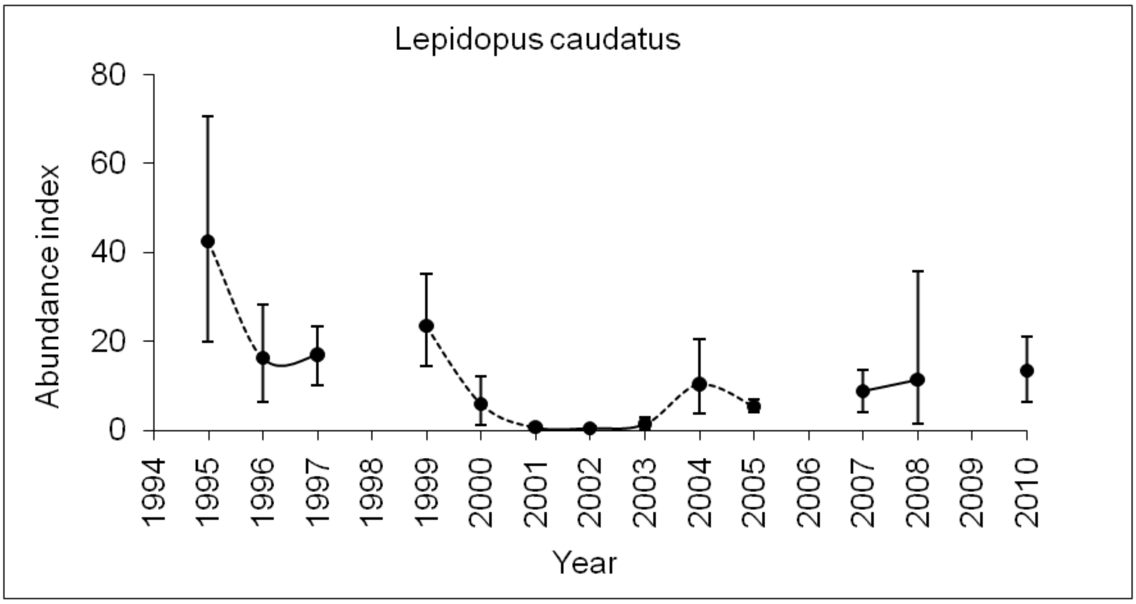



**Figure 15.9. Annual bottom longline survey abundance index (numbers) for Silver scabbardfish in Azorean bottom longline surveys.**

# 16 Requirement and need for fisheries independent deep-water surveys in the NE Atlantic

## 16.1 Term of Reference

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

This ToR has been addressed jointly by WGDEEP, WGDEC and WGEF.

## 16.2 Background

Under the current MoU between ICES and the EC, ICES is required to provide fisheries management advice for deep-water fish stocks in relation to the MSY framework. ICES, as well as EU project Deepfishman, have made considerable progress in assessing deep-water stocks however progress has frequently been hampered by the lack of appropriate fisheries independent dataseries leaving assessments heavily dependent on abundance indices derived from commercial landings data. Problems related to the use of commercial cpue series are well known but may be particularly acute for deep-water fisheries because of the large spatial extent of stocks relative to fishing areas, the effects of depth on catch rates, and potential for sequential depletion of local aggregations. Additionally, the introduction of very low or zero TACs for a number of stocks has led to the truncation of some commercial cpue series and reduction in the quality of others, further increasing the need for fisheries independent data in order to monitor stock recovery.

In addition to the requirement for abundance indices, the DCF ecosystem indicators, the Marine Strategy Framework Directive and OSPAR's Quality Status report create a requirement for data to monitor wider ecosystem quality. Indicators of deep-water fish biodiversity and community structure can only be reliably generated from trawl survey time-series. There is a need also for size-based indicators to be developed; information on individual weights and lengths of the species that make up the community allow potential effects of fishing to be assessed quantitatively. The MSFD will also require information on benthic diversity, vulnerable marine ecosystems and seabed integrity. Thus in addition to traditional survey methods, future deep-water surveys will need to utilize a range of acoustic, televisual and novel sampling approaches.

Dedicated deep-water surveys have been conducted by a number of countries however these are usually limited in their spatial extent and may not cover the full area of the stocks' distribution. Lack of adequate national and/or DCF funding has resulted in the discontinuation of some of these surveys and consequent truncation of dataseries.

In 2007, ICES received requests from the EU Regional Coordination Meeting for the NE Atlantic and NEAFC to consider coordination and development of deep-water surveys for the NE Atlantic. In response ICES set up an international deep-water survey planning group, the Planning Group on the Northeast Atlantic Continental Slope Surveys (PGNEACS) in 2008. PGNEACS reviewed existing NEA deep-water and slope surveys, and developed a proposal for international coordination.

## 16.3 Response to request

For the purpose of single-stock assessment, details of the data needed, survey periodicity and how they can be collected are summarized in Table 16.1. Colour coding indicates whether there are already existing surveys which adequately address these data requirements (green shading), surveys that are limited in their suitability by not covering the core stock unit adequately (orange shading) or if there are no current surveys present to provide any data (red shading). The table also gives details on what additional survey effort is required to address the deficiencies and how this would improve current stock assessments.

From Table 16.1 it is apparent, that for the majority of deep-water stocks, fished by EU fleets, there are currently no adequate surveys that provide sufficient data for stock assessment purposes.

The additional survey requirements to address stock assessment and ecosystem monitoring needs are compared to the current situation and are described in more detail below.

### 16.3.1 Proposed deep-water trawl survey in Vb, VI, VII and XIIb

Following recommendation from WGDEEP and WGDEC in 2007, WGNEACS (2009 and 2010) proposed a coordinated deep-water survey to cover ICES Subareas VI and VII and Divisions Vb and XIIb which incorporates the existing deep-water trawl survey from Scotland and the now discontinued survey from Ireland. WGDEEP, WGDEC and WGEF have evaluated the survey design and consider that the proposed survey will meet current and near future data requirements for stock assessment and some ecosystem monitoring in this region. However, the area proposed in the Bay of Biscay is largely unsuitable for deep-water trawling. Consequently this area should be moved to the southern longline survey (see Section 1.3.2)

The area covered by the proposed survey corresponds to the current perception of the distribution of the main commercial deep-water stocks in this region. The survey design is optimized in order to maintain available time-series (Scottish and discontinued Irish deep-water trawl surveys) and provide representative abundance indices by following a depth and area stratified sampling design. Additional biological sampling requirements specified in Table 16.1 should be fully satisfied by the proposed survey methodology. All species will be identified, recorded and measured and this will provide appropriate data for the development and monitoring of ecosystem indicators.

WGDEEP, WGDEC and WGEF concur with the WGNEACS recommendation that surveys be carried out annually for the first five years in order to rapidly build the time-series after which the survey can be biennial to coincide with the two year management cycle for deep-water species.

The additional survey effort allocation and methodologies for the central European deep-water survey has been described in PGNEACS 2009 and WGNEACS 2010 and are summarized here.

The proposed survey should cover four geographical regions, only one of which is currently surveyed (Scottish slope), and these should be further subdivided into sampling areas that can be trawled (as documented in ICES 2009). The proposed sampling strategy is summarized by geographical region and depth range in Table 16.2.

**Table 16.2. Survey sampling strategy by area for the proposed deep-water trawl survey (from ICES 2009).**

| Region | N sample areas | Depth range | Total number of Hauls per region |
|---|---|---|---|
| Scottish Slope | 4 | 500–1800 | 20 |
| Northern | 6 | 500–1500 | 24 |
| Rockall and Hatton Banks | 8 | 500–1800 | 36 |
| Irish slope and Porcupine | 4 | 500–1800 | 20 |
| Total | | | 100 |

The total area coverage of the proposed survey is presented in Figure 16.1.

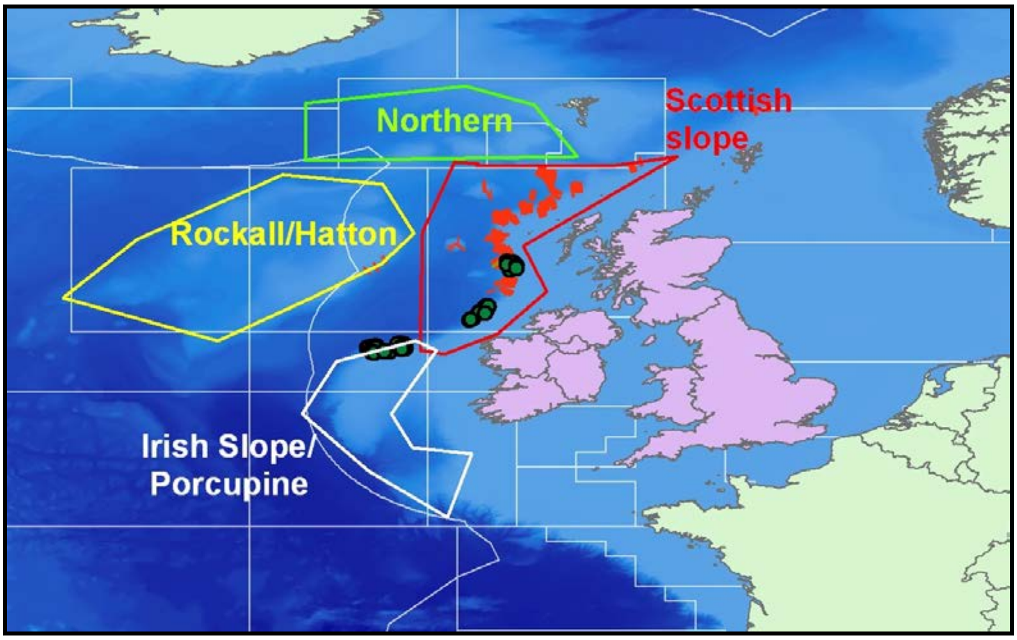



**Figure 16.1. Area coverage of the proposed deep-water trawl survey (WGNEACS 2010). Red symbols = trawl hauls of the existing Scottish Deep-water survey (1998+), green symbols = trawl hauls from discontinued Irish Trawl survey (2006–2009) and polygons represent proposed sample regions.**

The surveys require large research vessels such as RV Scotia, RV Celtic Explorer, RV Thalassa, and RV GO Sars because commercial vessels generally do not carry enough warp to fish to the bathyl limits of the species range. Vessels can expect to complete 4–5 one-hour hauls per day and this gives a duration of 20–25 fishing days plus steaming time. At least two ships are necessary to cover the entire survey area.

### 16.3.2 Proposed international longline survey in the southern area (ICES Subarea VIII and Division IXa)

For deep-water surveys in VIII and IXa, trawl surveys are not appropriate due to the rough bottom topography. A previous trawl survey, discontinued in 2003, in this area did not allow to properly sample the main commercial deep-water species. Therefore an internationally coordinated longline survey was proposed by WGNEACS 2009 and 2010. WGDEEP, WGDEC and WGEF have evaluated the survey design and consider that the proposed survey will meet current and near future data requirements for stock assessment and ecosystem monitoring in this region. WGDEEP further recommend that the survey should be expanded to cover the Bay of Biscay (Figure 16.2).

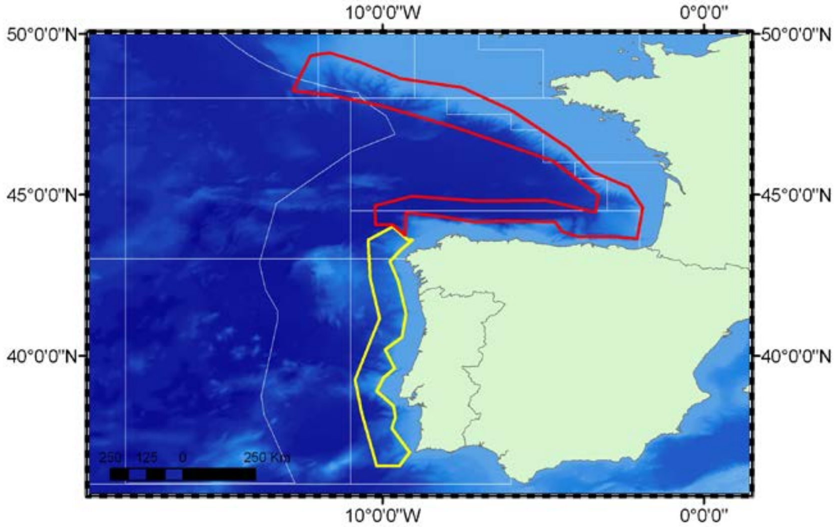



**Figure 16.2. Area coverage of the proposed deep-water longline survey (WGNEACS 2010). Polygons represent proposed sample regions.**

The main objective of the survey is to produce abundance estimates for black scabbardfish and deep-water sharks. The TAC for the latter is currently set to zero and the long-term recovery can only be monitored from survey indicators.

In Division IXa, fishing hauls will be randomly set within each cell of a regular grid established for the Portuguese slope. The sampling effort will be of two longline sets per day of ca. 10 hours soak time each. Relative depth and area stratified abundance indices will be computed, together with other population indicators (length distribution, sex ratio, maturity, age distribution). In Subarea VIII, a similar sampling grid will be developed and a lower intensity will be applied owing to the insignificant landings of deep-water species.

As a preliminary estimate, 40 fishing days of 15–25 m long chartered commercial longliners will be required to cover Division IXa and Subarea VIII.

## 16.4 How this would improve the current situation (identification of the added value for stock assessment coming from the extension and/or harmonization of the surveys)?

Table 16.1 identifies the expected input of data from expanded/new fisheries surveys into stock assessments. WGDEEP, WGDEC and WGEF consider that the survey proposed by WGNEACS will satisfy all of these requirements.

For the main commercial deep-water species such as black scabbard, roundnose grenadier and blue ling, it is anticipated that the data will provide spatially and depth stratified abundance indices and length/age distribution. In some cases, e.g. blue ling, it is hoped that the data will also allow the estimation of recruitment indices. For stocks, that are currently severely depleted and have TACs set at zero, such as the deep-water sharks and orange roughy, it is anticipated that the surveys would be the main data source to monitor the long-term recovery.

For the provision of deep-water ecosystem advice three key uses of data from deep-water surveys were identified:

a ) mapping of the spatial and bathyal distribution of non commercial species;

b ) provision of indices of biodiversity and any other ecosystem indicators as required by DCF, MSFD, OSPAR;

c ) addressing specific research and monitoring needs such as stock identification, habitat mapping and contaminant monitoring.

There will be an increasing need to research and monitor the status of deep-water ecosystems within the EEZ of the EC as part of the Marine Strategy Framework Dircetive (MSFD). This requires the development of indicators of ecological quality or 'good environmental status' (GES). Qualitative descriptor No. 1 of the MSFD's for GES is maintaining biological diversity. Indicators of deep-water fish biodiversity have been generated from scientific trawl survey time-series and used to assess spatial and temporal variability of deep-water fish communities (Campbell *et al*., 2011). Size based indicators are also being developed; information on individual weights and lengths of the species that make up the community allow potential effects of fishing to be assessed quantitatively. Such indicators track changes in community structure and the proportional representation of species.

For deep-water benthos, while bycatch records are informative, the fishing gears are not designed to sample benthic animals. Consequently data cannot be used in the same way as for the fish community. Benthic sledges and beam trawls are one way to sample benthos more effectively, but clearly these are not to be desirable in deep-water ecosystems where they cause significant adverse impacts. In cases where this is clearly the case, alternative non-destructive methods need to be developed and adopted, such as ROV and or drop frame/towed camera surveys. Future deep-water surveys therefore need to have a multidisciplinary design in which the information is gained is appropriate to the impact the sampling is likely to have on the VMEs.

Deep-water surveys also provide the platform to collect acoustic and physical data on the seabed. Such data can be extremely valuable for modelling the likelihood of the presence of different types of deep-water VMEs such as coral reefs or seapen/mud habitats.

As well as targeted data collection, deep-water surveys are important platforms to collect samples for further information on stock discrimination, foodwebs and other projects outside the Data Collection Framework. In recent years, several PhD projects have used samples collected by deep-water surveys in the NE Atlantic. Genetic samples from Portuguese dogfish collected on Irish, Scottish, Portuguese and US surveys have been used to assess the level of mixing within populations from distinct fishing areas. Other theses have looked at dentition as a method of species discrimination, bioluminescence in deep-water fish, and elasmobranch cartilage as novel polymers.

Muscle samples taken from 30 different deep-water species to the west of Scotland and west of Ireland have been used in stable isotope studies to determine the trophic levels of these species within the ecosystem.

Studies such as these show the value that can be incidentally derived from surveys that have other primary objectives. Several projects are now stalled due to the lack of availability of new samples, particularly now that commercial fishing has ended.

Additional biological data (e.g. genetic samples, blood for endocrinology, parasites and tissues for contaminants) will be collected depending on monitoring requirements and use in research projects. The surveys will include a multidisciplinary component with oceanographic data, salinity and temperature collected for sensors attached and video observations from a small towed camera (one tow per day).

## 16.5 Survey coordination and data management

It is anticipated that the proposed surveys are internationally coordinated by ICES WGNEACS, whereby the working group will be the forum for coordination, method review as well as quality control and management of data. Survey data will be housed in the DATRAS database. In relation to the longline surveys, institutes will keep dedicated database as DATRAS may not accommodate all information relevant to longlines.

## 16.6 Other deep-water survey requirements

### 16.6.1 Proposed longline survey in the southern area (ICES Subdivision Xa2)

Since 1995, a longline spring survey has been conducted annually in ICES Division Xa2. The surveyed area covers around 70% of the area of distribution of main demersal species of red (blackspot) sea bream, blue-mouth redfish and alfonsinos. The survey provides abundance and length distribution data. Indices produced from this survey have been available to WGDEEP and WKDEEP. WKDEEP concluded that interannual variability of the cpue index for red (blackspot) sea bream may be a result of factors relating to the spatial distribution of the stock that are not adequately accounted for in the survey design.

Spatial extension of the survey to cover offshore seamounts will facilitate coverage of the entire area of the stocks and may be expected to improve confidence in the use of survey indices for stock assessment.

Additional resource requirements to meet this objective are currently being considered by DOP.

### 16.6.2 Tagging survey proposal in IXa (Strait of Gibraltar)

Given the special features of the hydrography of the Strait of Gibraltar the development of a longline survey presents important obstacles in developing abundance indices, mainly related with the high mobility of fish that would make difficult the standardization of the methodologies with other similar surveys. However, information from tag and recaptures may be an effective way to independently estimate mortality rates and/or stock size for red sea bream. Additionally, tagging surveys may provide valuable information on growth and stock structure.

From an average of previous tag–recapture experience in this area a provision of twelve days tagging may generate around 1000 fish tagged.

### 16.6.3 References

Campbell, N., Neat, F., Burns, F. and Kunzlik, P. 2011. Species richness, taxonomic diversity, and taxonomic distinctness of the deep-water demersal fish community on the Northeast Atlantic continental slope (ICES Subdivision VIa). ICES Journal of Marine Science, 68(2): 365–376.

Neat, F. and Burns, F. 2010. Stable abundance, but changing size structure in grenadier fishes (*Macrouridae*) over a decade (1998–2008) in which deep-water fisheries became regulated . Deep Sea Research (Part I, Oceanographic Research Papers). Vol. 57, no. 3, pp. 434–440. March 2010.

PGNEACS. 2009. Report of the Planning Group on the Northeast Atlantic Continental Slope Surveys. 9–11 June 2009. Tromso, Norway. 59pp. ICES CM 2009/LRC:03.

WGDEEP. 2010. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources. 7–13 April 2010. Copenhagen. Denmark. 613pp. ICES CM 2010/ACOM:17.

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

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

**Table 16.1. Review of data requirements for single-stock assessment for the main commercial deep-water species exploited by EU fleets. Letter coding in data requirement column are B=biomass, N=number, L=length, M=maturity, S=sex. Colour coding of table indicates existing surveys addressing data needs (green shading), surveys with limited suitability due to partial stock coverage (orange shading), no surveys present to provide required data (red shading).**

| Species | Stock area | Depth | Data requirements | Periodicity | How produced? | Additional survey requiements | expected input into assessments |
|---|---|---|---|---|---|---|---|
| *Aphanopus carbo* | Vb, XIIb, VI, VII | 500 - 1700m | B, N, L, A, M, S | Annually for 5 years, then biennially | Deepwater trawl survey in Vb,VI,VII, XIIb | expansion of current spatial survey coverage to stock area | Spatially and depth stratified abundance index and length/age distribution, |
| *Aphanopus carbo* | VIII, IX | 500 - 1700m | B, N, L, A, M, S | Annually for 5 years, then biennially | Deepwater longline survey in VIII, IX | New deepwater long line survey | Spatially and depth stratified abundance index and length/age distribution, |
| *Aphanopus carbo* | I, II, IIIa, IV, Va, X, XIV | 500 - 1700m | B, N, L, A, M, S | Annually for 5 years, then biennially | Deepwater longline survey in X as no significant catches in other areas | New deepwater long line survey | Spatially and depth stratified abundance index and length/age distribution, |
| *Coryphaenoides rupestris* | Vb, XIIb, VI, VII | 400 - 1800m | B, N, L, (A), (M), (S) | Annually for 5 years, then biennially | Deepwater trawl survey in Vb,VI,VII, XIIb | expansion of current spatial survey coverage to stock area | Spatially and depth stratified abundance index and length/age distribution, |
| *Molva dypterygia* | Vb, VI, VII | 300 - 1500m | B, N, L, A, M,S | Annually for 5 years, then biennially | Deepwater trawl survey in Vb,VI,VII | expansion of current spatial survey coverage to stock area | Spatially and depth stratified abundance index and length/age distribution, recruitment index |
| *Brosme brosme* | VIb | 100-1000m | B, N, L, A, M,S | Annually for 5 years, then biennially | Rockall haddock and Rockall monkfish surveys. | | Spatially and depth stratified abundance index and length/age distribution, |
| *Hoplostethus atlanticus* | VI | 500 - 1550m | B, N, L, (M), (S) | Annually for 5 years, then biennially | Deepwater trawl survey in VI | expansion of current spatial survey coverage to stock area | Monitoring of the long term recovery of the stock with indicators, possible recruit index |
| *Hoplostethus atlanticus* | VII | 501 - 1550m | B, N, L, (M), (S) | Annually for 5 years, then biennially | Deepwater trawl survey in VII | New deepwater trawl survey | Monitoring of the long term recovery of the stock with indicators, possible recruit index |
| *Phycis blennoides* | VI, VII, XII | 200 - 1100m | B, N, L, S | Annually for 5 years, then biennially | IBTS and deepwater trawl survey in VI, VII | expansion of current spatial survey coverage to stock area | Spatially and depth stratified abundance index and length distribution, recruit index |
| *Phycis blennoides* | VIII, IX | 200 - 1100m | B, N, L, S | Annually for 5 years, then biennially | IBTS and deepwater longline survey in VIII and IX | expansion of current spatial survey coverage to stock area | Spatially and depth stratified abundance index and length distribution, recruit index |
| *Phycis blennoides* | X | 200 - 1100m | B, N, L, S | Annually for 5 years, then biennially | deepwater longline survey in X | New deepwater long line survey | Spatially and depth stratified abundance index and length distribution, recruit index |
| *Pagellus bogaraveo* | VI, VII, VIII | 30-800m | B, N, L, A, M, S | Annually for 5 years, then biennially | IBTS | | Monitoring of the long term recovery of the stock with indicators |
| *Pagellus bogaraveo* | IX | 200 -800m | B, N, L, A, | Annually for 5 years, then biennially | Tagging survey | New tagging survey | evaluation of stock biomass and fishing mortality |
| *Pagellus bogaraveo* | X | 200 -800m | B, N, L, A, M, S | Annually for 5 years, then biennially | deepwater long line survey | expand survey to offshore areas (seamounts) | Spatially and depth stratified abundance index and length distribution, |
| *Centrophorus squamosus* | Global distribution, all ICES areas except northern seas | 300 - 1800m | B, N, L, M, S | Annually for 5 years, then biennially | Deepwater trawl survey in V,VI,VII, XIIb and deepwater long line survey in VIII, IX and X | expansion of current spatial survey coverage to stock area and new long line survey in VIII, IX and X | Monitoring of the long term recovery of the stock with indicators |
| *Centroscymnus coelolepis* | Global distribution, all ICES areas except northern seas | 500 - 1800m | B, N, L, M, S | Annually for 5 years, then biennially | Deepwater trawl survey in V,VI,VII, XIIb and deepwater long line survey in VIII, IX and X | expansion of current spatial survey coverage to stock area and new long line survey in VIII, IX and X | Monitoring of the long term recovery of the stock with indicators |

# 17 Recommendations

## 17.1 Working group recommendations

1 ) ICES should take steps to ensure that participation in WGDEEP includes all countries with deep-water fisheries and surveys.

2 ) WGDEEP recommends that the meeting in 2012 should be held towards the end of March to facilitate the provision of Icelandic spring survey data.

3 ) All countries should provide landings data by statistical rectangle.

4 ) WGDEEP recognizes the useful data on discards supplied by Spain and anticipates that this will continue to be available in future.

5 ) WGDEEP recommends that no benchmark meetings for deep-water stocks should be held in 2011 or 2012. The WG will discuss stocks for benchmark in 2013 and make recommendations next year.

6 ) WGDEEP recommends that a workshop should be held in 2012 to investigate how impacts of fisheries on deep-water ecosystems should be assessed and monitored including spatial aspects. It is expected that WGDEEP and WGDEC members will participate. WGDEEP will work intersessionally with input from WGDEC and WGNEACS to agree on terms of reference by September 2011.

7 ) WGDEEP recommends that ICES should hold a workshop on the application of GADGET as this method is likely to be useful for stocks where age based assessment is inappropriate.

8 ) Species to be considered for inclusion in WKAMDEEP 2012 should be; red sea bream, blue ling, tusk, ling, greater silver smelt and black scabbardfish.

9 ) WGDEEP has considered the WACCU scorecards and PGCCDBS template but has made no progress on their completion. We recommend that the ICES Secretariat circulate both documents to stock coordinators with full instructions on what information is required and how they should be completed.

10 ) Due to the diversity and number of stocks, WGDEEP envisages to complete the advisory workload required, nine days will be needed for WGDEEP in 2012. Workload during the meeting should be restricted to advisory ToR with other requests being dealt with as far as possible intersessionally.

11 ) WGDEEP discussed the recommendation from the NWWG requesting the views of WGDEEP on the possibility of moving tusk in Va and XIV and ling in V from WGDEEP to the NWWG.

The group concluded that those species would be better served in the WGDEEP than in another EG which has already has great work load. The arguments raised by WGDEEP were among others:

- Stock identity for these species is uncertain and therefore having all the management units in one expert group is necessary for comparing trends in different areas.
- Ling and tusk which are of relatively low commercial value (as opposed to many NWWG stocks such as cod and haddock) may get little attention when placed among ‘valuable’ stocks.

- Despite considerable efforts towards analytical assessments of the management units in Va the fact remains that these stocks are still data poor and WGDEEP expertise in such situations is a valuable asset in assessing them.

## 17.2 Internal recommendations

In addition to the usual external recommendations, WGDEEP 2011 has made the following recommendations regarding the future work of the group. These recommendations are intended to be followed up by members of the working group intersessionally or at future meetings and so will require no action from ICES or any other Expert Groups.

1) WGDEEP members should work intersessionally to agree a common format for landings and cpue figures appearing in the report.
2) All commercial cpue series used in assessments should be standardized and include estimates of confidence and statistical diagnostics including model parameters.
3) Available Spanish data on *Argentina silus* from the Porcupine survey is currently combined with *Argentina sphyraena* for most years. WGDEEP recommends that these data should be reanalysed to split the species as far as possible. If this cannot be done, the indices should be recalculated with appropriate depth or size filters to ensure that *A. sphyraena* are excluded as far as possible.
4) Abundance indices for *A. Silus* from the Faroese Spring should be recalculated to disaggregate juvenile and mature fish and provide a juvenile fish index.
5) Updated information is required from exploratory fisheries in the NEAFC regulatory area.
6) In future, all comments from the review group will be addressed directly in the subsequent year's report.
7) France will supply maturity/length data for blue ling.

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## 18.2 List of Working Documents

WD01-GSSVaSurveyStratification

WD02-LingTuskVaDiscard

WD03-GadgetLicCompWeighingTskVa

WD04-TuskGadgetRevised

WD05_Spanish_discards_Santos_et_al

WD06_Porcupine_deep-water_fish_2010

WD07-LingVaGadgetExplAssess

WD09_WGDEEP_Greater_silver_smelt_in_Faroese_area_WD2011

WD11_On_status_of_GSS_and_Norvegian_research_on_GSS_2010

WD12_WGDEEP_2011_Rng_IIIa_survey

WD13_Russian_Fisheries_2010

WD14_UK_E+W_Observer_data_summary

WD15_WGDEEP11_MYCC_RNG_VTrenkel

WD16_RNG_MAR_2010

WD17_Strait_of_Gibraltar_Strait_of_Gibraltar_Red_seabream_otoliths_shape

WD19_Strait_of_Gibraltar_Red_seabream_Spanish_fishery_data_updated

WD20_Strait_of_Gibraltar_Red_seabream_joint_assessment_exercise_(Spain-Morocco)

WD21_Ling-tusk_Norway_WDGEEP_2011

WD26_Southernbluelingstockreduction

WD27_RoundNoseGrenSpBayesWGDEEP2011

See Annex 2 for Working Documents made available in this report.

# 19 Stock Annexes

## 19.1 Alfonsinos/Golden eye perch

| | |
|---|---|
| Stock: | Alfonsinos/Golden eye perch (*Beryx* Spp.) |
| Working Group: | WGDEEP |
| Date: | March 2011 |

## A. General

### A.1. Stock definition

The alfonsinos *Beryx spp*. are deep-water species that occur throughout the world's tropical and temperate waters, in depths from 25 to 1300 meters. The 2004 WGDEEP Report made reference to preliminary genetic results for *B. splendens* suggesting that significant genetic differentiation may occur between populations of the species within the North Atlantic, which may have some implications for future management of the fisheries. No further information is available. Because very little is known about stock structure of these species, the WG has assumed single-stocks of both *B. splendens* and *B. decadactylus* in the North Atlantic.

### A.2. Fishery

Alfonsinos, *Beryx splendens* and *Beryx decadactylus*, are generally considered as bycatch species in the demersal trawl and longline mixed fisheries targeting deep-water species. For most of the fisheries, the catches of alfonsinos are reported under a single category, as *Beryx spp*. Historica- time-series by species is only available from the Azores fishery.

From 1988 to 1993 almost only the Azores (Subdivision Xa) was involved on the fishery (representing 94% of the landings). The Azores deep-water fishery is a multispecies (up to 20 or more) and multigear fishery dominated by the main target species *Pagellus bogaraveo*. This fishery has continued throughout the period from 1994 onwards.

During 1994 to 2000, Russian pelagic trawlers were responsible for high catches in Subdivision Xb (a seamount fishery on Mid-Atlantic Ridge).

Other ICES Subareas with important catches from the mixed demersal and deep-water fisheries (mainly trawlers and longliners) are VI and VII, with an average contribution of around 10–20% of the total reported catch to ICES during 1996 to 2007 and Areas VIII and IX, which landings averaged around 30% of the total from 1997 to 2007.

### A.3. Ecosystem aspects

The Azores (Division Xa) are considered a "seamount ecosystem area" because of its high seamount density. The deep-water fishery in the Azores is mostly a seamount fishery where only bottom longlines and handlines are used.

## B. Data

### B.1. Commercial catch

For this species data are available from commercial fisheries reported to ICES for the different ICES Sub areas from 1988 to present. Landings data are usual aggregated by species. More detailed data by species is available from the Azores (Division Xa). Azorean data from commercial fisheries include landings (auction data) and some effort data from longliners inquires (since 1990), logbooks and observers (from large longliners and for recent years; WD Pereira, 2006a; 2010a).

Discards from this fishery have been increased in the recent years, due to quota restrictions. Information on discarding in the Azores has been made available to the WG since 2007 (ICES, 2006; 2010).

### B.2. Biological

Length compositions and biological information including (ageing, weights, sex ratio and maturity) by species have been collected since 2002, analysed and reported to ICES (WD Pereira, 2006b; 2010b).

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

Annually survey (ARQDAÇO) data are available from the Azores, since 1995. The survey was conducted annually each spring (usually from April to June) since 1995, with exception of the years 1998, 2006 and 2009. The survey followed a stratified design (six statistical areas and twelve depth strata) and covered the Azores archipelago around the islands, and major seamounts). The survey is design for abundance estimation of red (blackspot) sea bream, covering the depth strata from 50 to 600 m. During 2004 this depth was extended to 800 m in order to cover the depth range of the species. Additionally depth from 800 to 1200 m is covered in one transect by statistical area for ecological studies. Details of the survey design can be found Menezes *et al.* (2006) and a resume of the survey design can be found in the ICES WGNEACS 2010 report.

Abundance index time-series (computed for the depth range 50–600 m) is available by species. Length composition, and several biological data (sex, weight, otoliths and maturity) have been also collected and reported to ICES.

### B.4. Commercial cpue

Standardized cpue was presented to ICES in 2006. Since then only nominal cpue has been available (WD Pereira, 2006c; WD Pereira and Pinho, 2010). Standardized series will be computed and made available from 2012.

### B.5. Other relevant data

## C. Assessment: data and method

\Landings and trends in abundance indices

Model used:

Software used:

Model Options chosen:

Input data types and characteristics:

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:

5 ) Weight-at-age in the stock:

6 ) Weight-at-age in the catch:

7 ) Exploitation pattern:

8 ) Intermediate year assumptions:

9 ) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

No biological reference points have been defined.

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References

ICES. 2006. Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources. ICES CM 2006/ACFM:28.

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Pereira. 2006b. Statistics and biological data on the Alfonsinos, *Beryx decadactylus and Beryx splendens* from the Azores. WD WGDEEP 2006.

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Pereira. 2010a. Statistical data on selected deep-sea species from the Azores fishery. WD WGDEEP10.

Pereira. 2010b. Updated statistics and biological data on the Alfonsinos, *Beryx decadactylus and Beryx splendens* from the Azores

## 19.2 Black scabbardfish in Vb, XIIb and VI, VII

Stock: Black scabbard fish in Subareas Vb and XIIb and Divisions VI and VII

Working Group: WGDEEP

Date: March 2011

# A. General

### A.1. Stock definition

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30ºN. It occurs only sporadically north of the Scotland–Iceland–Greenland ridges. Juveniles are mesopelagic and adults are bentho-pelagic. It is admitted that the species' life cycle is not completed in just one area and also that either small or large-scale migrations occur seasonally. It has been postulated that fish caught to the west of the British Isles are pre-adults that migrate further south (possi-bly down to Madeira) as they reach maturity.

The stock structure is uncertain. Three management units are considered:

i ) Northern (Divisions Vb and XIIb and Subareas VI and VII);

ii ) Southern (Subareas VIII and IX);

iii ) Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

### A.2. Fishery

The Faroese fisheries take mostly place in Subarea Vb with a minor activity in Subarea VI. The Faroese deep-sea trawl fishery started in the late 1970s as a mixed redfish, blue ling, grenadier and black scabbardfish fishery; a more directed black scabbard fishery began in the late 1980s (1988) as a result of improvements of the gear and handling of the fish. And from 1993 onwards some of the otter board trawlers have targeted black scabbardfish either seasonally or throughout the year. The main fishing grounds for the species are located on the bank area southwest of the Faroes Islands. The fleet of otter board trawlers (the so called deep-sea trawlers) consist of 13 vessels >1000 HP, but only 1–3 trawlers > 2000 HP are targeting black scabbardfish. Landings are mostly derived from Division Vb and the values (about 1400 t) were registered in 2001 and 2002.

In ICES Subarea VI a Scottish mixed deep-water trawl fishery included some catches of black scabbard fish between 1999–2005. This fishery has decreased since the introduction of TACs in 2003.

Following the decline of target orange roughy Irish trawl fishery, landings of black scabbardfish derived from ICES Suabreas VI and VII reached about 1000 t in 2002. In the recent years (2008–2010) Irish landings have been null.

The French deep-water fishery operates mainly in Subareas VI and VII targeting roundnose grenadier, black scabbardfish, blue ling and deep-water sharks. Over recent years, the landings of black scabbardfish have declined but landings of other deep-water species (roundnose grenadier, orange roughy, deep-water sharks) have declined in a larger proportion.

The Spanish fishery in Hatton Bank started in 1996, triggered by the decline in catches in traditional fishing grounds. Durán Muñoz and Román Marcote (2001) described the beginning of this fishery and the fleet operating in Hatton. In all 48 vessels have logged in fishing days at Hatton for the period 2002–2009, but the maximum number of vessels in the fishing grounds in any given month is 16. Most often, and on average, vessels stayed in Division VIb less than two weeks per month, but stayed in Division XII between three and four weeks.

The Northern component comprises fish exploited mainly by trawl fisheries.

Total landings from the ICES Subareas Vb and Divisions VI, VII and XII show a markedly increasing trend from 1999 to 2002 followed by a decreasing trend till 2005. There was a peak in 2006 then there was a decrease mainly due continuous decreases of landings from ICES Divisions VI and VII.

### A.3. Ecosystem aspects

A large proportion of deep-water trawl catches (upwards of 50%) can consist of unpalatable species and numerous small species, including juveniles of the target species, which are usually discarded (Allain *et al*., 2003). The main species in the discards of the trawl fishery in by far the Baird's smoothhead (*Alepocephalus bairdii*) however, a large number of other non marketable bentho-pelagic species are discarded. The survival of these discards is unknown, but believed to be virtually zero because of fragility of these species and the effects of pressure changes during retrieval (Gordon, 2001). Therefore such fisheries tend to deplete the whole fish community biomass. Depletion of dominant species can induce major changes to fish communities through removing key predatory or forage species.

A study of the impacts of deep-water fishing to the West of Britain using historical survey data found some evidence of changes in size spectra and a decline in species diversity between pre- and post-exploitation data, but the scarce and unbalanced nature of the time-series hampered firm conclusions (Basson *et al*., 2001).

The effects of fishing on the benthic habitat relates to the physical disturbance by the gear used. This includes the removal of physical features, reduction in complexity of habitat structure and resuspension of sediment. More attention has been paid to biogenic habitat that occurs along the slope, mainly the cold-water coral. The main reef building species is *L. pertusa*. Any long-lived sessile organisms that stand proud of the seabed will be highly vulnerable to destruction by towed demersal fishing gear. There are a number of documented reports of damage to Lophelia reefs in various parts of the Northeast Atlantic by trawl gear where trawl scars and coral rubble have been observed (e.g. Hall-Spencer *et al*., 2002). Damage can also be caused on a smaller scale by static gears such as gillnets and longlines (Grehan *et al*., 2003).

In Divisions VI, VII and XIIb there are a number of known areas of cold-water corals. These include the shelf break to the west and north of Scotland, Rockall Bank, Hatton Bank and the Porcupine Bank. The best known site is the Darwin Mounds, located at

1000 m to the south of the Wyville Thompson Ridge. Some of these areas have been heavily impacted by deep-water trawling activities (Hall-Spencer, 2002; Grehan *et al*., 2003).

## B. Data

### B.1. Commercial catch

The landings from Spanish trawling fleet operating on the Northern and Western Hatton Bank (Divisions VIb1 and XIIb) are available in a routine way since 2004.

Landings from other fleets are available from 1988.

**Discard –** Discard data from Spanish bottom otter trawl métiers operating Hatton Bank are available from the `Spanish observer Programme' carried out by the IEO since 1996. Trip was the sampling unit, being raised to fleet level using using fishing effort as auxiliary variable.

No data are available on discarding from other fisheries.

### B.2. Biological

Since 2003 French length data of back scabbardfish by depth are available based on data from on-board observations of French trawlers.

French length distributions of back scabbardfish by depth have been provided (Figure 19.2.1). Data were derived from on-board observations of French trawlers.

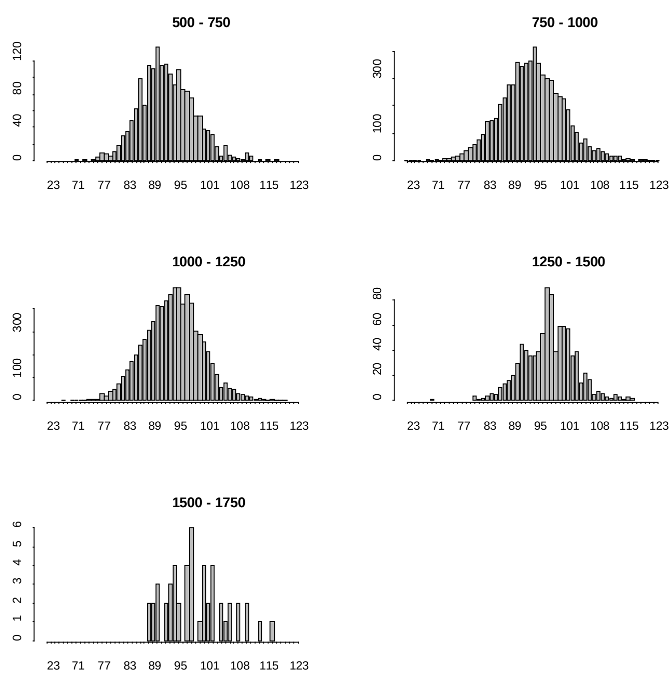
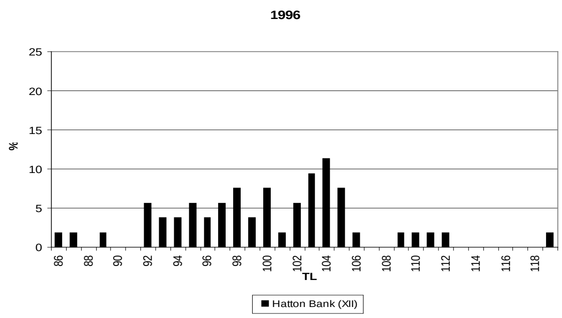
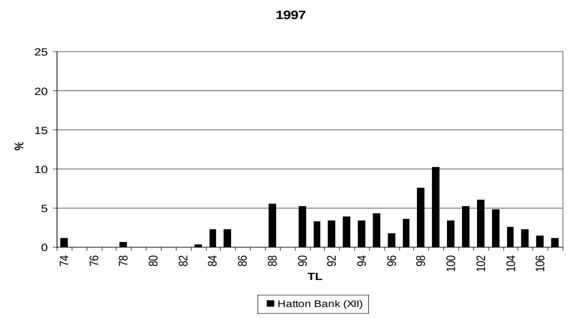
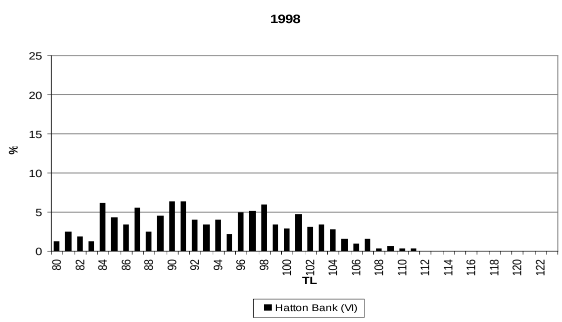


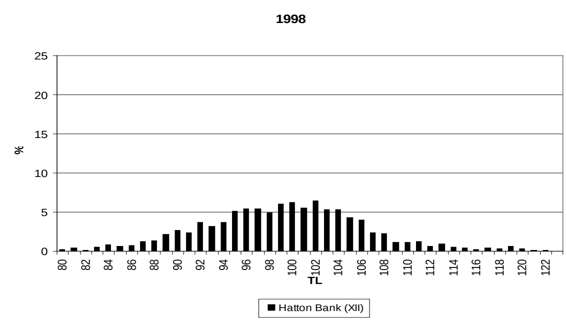

**Figure 19.2.1. Black scabbard fish Length distribution by depth from on-board observations of French trawlers in subarea VI. Numbers were raised to total numbers in haul where black scabbardfish was measured. 2003–2005 combined data.**

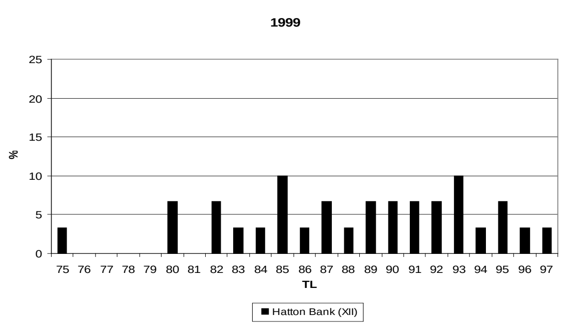
Length frequency distributions for the period 1996–2001 (Figure 19.2.2) have been provided from observers on board Spanish trawling fleet operating on the Northern and Western Hatton Bank (Divisions VIb1 and XIIb).

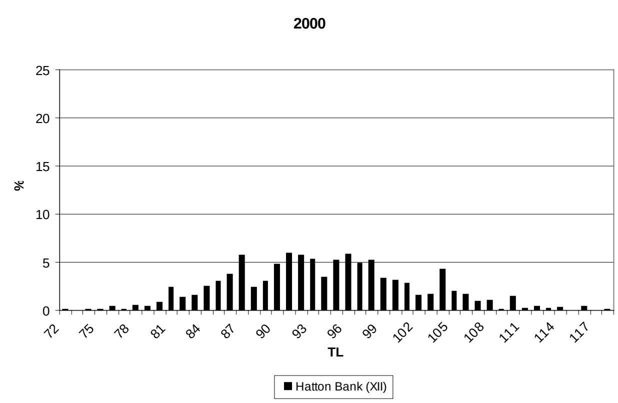


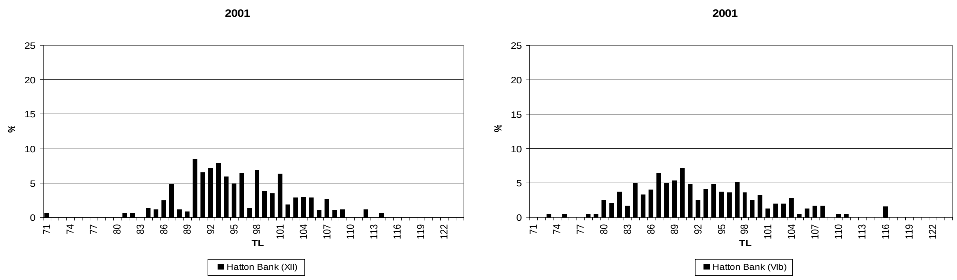



**Figure 19.2.2. Black scabbard fish length frequency distribution by year from on-board observations of Spanish trawlers.**

Length on data from Soviet exploratory fishing surveys at late 1970s at Lauzy Bank, Anthon-Dorn Bank and Anthon-Dorn Bank and the Hatton-Rockall Plateau showed that the size range of the species (70–130 cm with higher frequencies at lengths varying between 96–110 cm) do not greatly differ among areas (Vinnichenko *et al*., 2003).

| LHC | Best estimate | Derived from? | Other estimates |
|---|---|---|---|
| Maximum observed length | 1510 mm | Figueiredo *et al*., 2003 | |
| Maximum observed age | 32 y | Kelly *et al*., 1998 | 15 y (Anon., 2000) |
| Length at 50% maturity | 1028 mm (females) | Figueiredo *et al*., 2003 | 1095 mm (males) and 1144 mm (females; Pajuelo *et al*., 2008). |
| Growth parameters: (von Bertalanffy parameters: B0,T0, L infinity, for example) | (Madeira) Females: Linf = 142 cm; k = 0.260 y-1; t0 = -2.079 y. Males: Linf = 155.3 cm; k = 0.155 y-1; t0 = -3.265 y. | Morales-Nin and Sena-Carvalho, 1996 | Males: Linf = 1410 mm; k = 0.263 y-1; t0 = -3.507 y. Females: Linf = 1483 mm; k = 0.196 y-1; t0 = -4.467 y. All: Linf = 1477 mm; k = 0.200 y-1; t0 = -4.58 y. (Canary Islands, Pajuelo *et al*., 2008) |
| Fecundity, egg size, etc | 73–373 oocytes g-1 female (Madeira). Vitellogenic oocytes ranged from 0.60 to 1.50 mm. | Neves et al. (2009) | |

## B.3. Surveys

Survey data on the species are available both from Scottish and Irish surveys. The former is conducted by the Marine Scotland - Science [formerly Fisheries Research Services, (FRS)] along the continental shelf/slope to the northwest of Scotland. The survey was initiated in 1996 with strictly comparable data available between 1998 and 2008. The core area is surveyed between 55–59°N, with trawling undertaken at depths ranging from 300 to 1900 m with most of the hauls being conducted at fixed stations, at depths of around 500 m, 1000 m, 1500 m and 1800 m. Further hauls have been made on seamounts in the area, and on the slope around Rockall Bank, but these are exploratory, irregular and not included in the survey dataset.

The Irish deep-water trawl survey sampled the fish community of the continental shelf slope to west and northwest of Ireland since 2006. Methodology and trawl gear is standardized in accordance with the Scottish deep-water survey with trawling at fixed stations around 500 m, 1000 m, 1500 m and 1800 m.

Length data from Scottish and Irish deep-water surveys were analysed. Mean length by depth stratum show that smaller length classes are preferentially distributed at depths shallower than 1000 m deep (Figure 19.2.3).

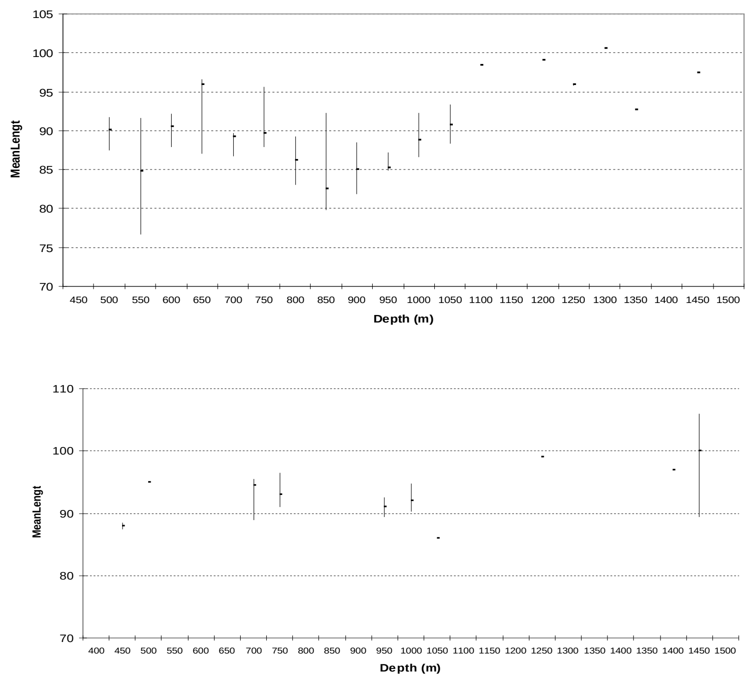



**Figure 19.2.3. Black scabbard fish mean length per depth stratum from Scottish (upper) and Irish(lower) deep-water surveys.**

Annual mean catch rates (kg/h) at depths shallower than 1000 m using on Scottish survey data are presented in Figure 19.2.4. The analysis of this suggests the existence of pulses of entrance of smaller specimens. This aspect should be further explored using appropriate statistical tools that enter into consideration the spatial correlation aspects.

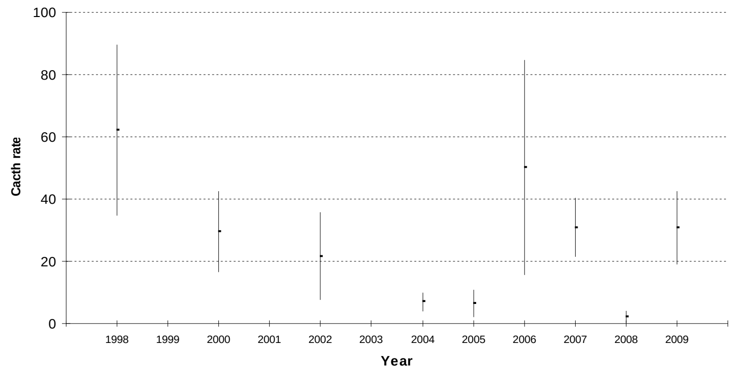



**Figure 19.2.4. Black scabbard fish average catch rates +/- standard error along years based on Scottish survey data for fishing held at depth shallower than 1000 m.**

## B.4. Commercial cpue

A lpue series for black scabbardfish was presented based upon the French tallybooks (Pawlowski *et al.*, WD 2009). The tallybook (from skipper own logbooks) database provided by the French industry (PROMA/PMA a producers organization and EURONOR a ship owner), has the advantage in relation to logbook of having the records on a haul by haul resolution and on having fishing depth available (Pawlowski *et al.*, WD 2009).

Lpues estimated for areas to west of the British Isles as defined by Biseau, 2006WD and for the all ICES rectangles are presented in Figures 19.2.5 and 19.2.6. Estimates show rather wide confidence intervals with no clear trends during the 2000s.

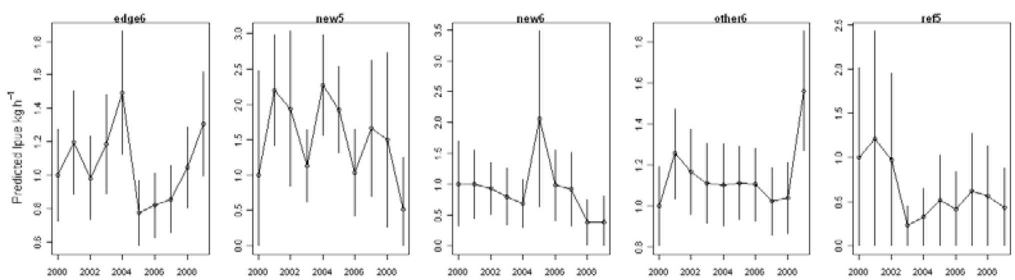



**Figure 19.2.5. Lpue of French trawlers in 5 areas (labeled according to Biseau, 2006 WD) from tows targeting black scabbardfish (defined as tows where the total catch include >10% of black scabbardfish). Absolute levels should not be compared over areas as the predictions were carried out for one particular rectangle.**

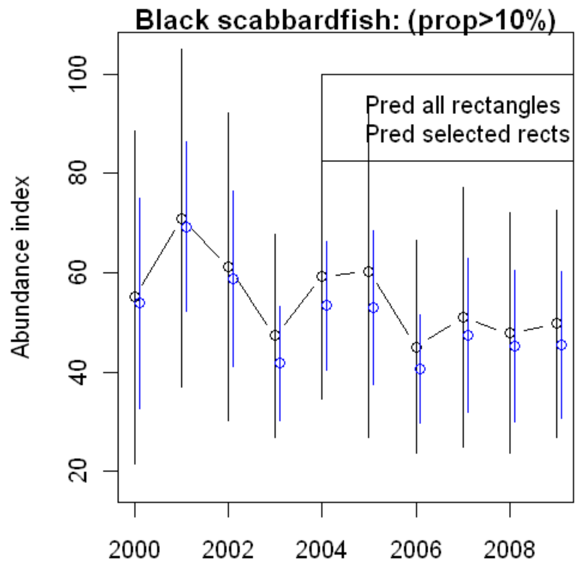



**Figure 19.2.6. Lpue of French trawlers for the overall rectangles.**

Unstandardized cpue series were determined for the Spanish trawlers operating Hatton Bank using the available data on annual catch and nominal effort (number fishing days). Figure 19.2.7. Cpue estimates were presented for Subdivisions VIb1 and XIIb separately, as well as, for the two combined.

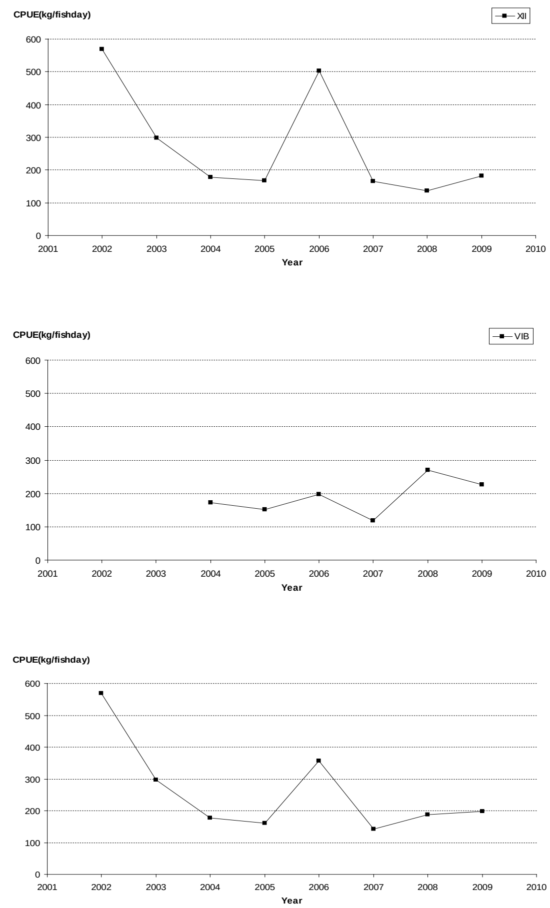



**Figure 19.2.7. Black scabbard fish cpue (kg/fishing days) in VIb (upper left). XIb (upper right) and the two subareas combined (center) from Spanish trawlers.**

### B.5. Other relevant data

Information available for ICES Subareas Vb, VI, VII and XII consistently points out to the predominance of small and absence of mature specimens.

## C. Assessment: data and method

Model used:

The stock is evaluated based on cpue trends.

Lpues for black scabbardfish are estimated based upon French skippers' tallybooks. The lpue estimates based on tallybooks demonstrate rather wide confidence intervals and do not indicate significant trends during the 2000s. Both the Spanish and the Faroese cpue series were not standardized and both covered a small time range of years.

Software used:

Model Options chosen:

Input data types and characteristics:

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:

9 ) Stock recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

The previous assessment trials were done taking into consideration a unique stock in NE Atlantic. However due to the different nature of fisheries in the northern and southern areas and lack of information on migration, the stock has traditionally been divided into northern and southern components for management purposes.

| Year | Assessment type[3] | Assessment method(s) used | Assessment package/program used | Reference |
|---|---|---|---|---|
| 1998 | Exploratory | Scheafer Production model | CEDA | WGDEEP, 1998 |
| 2006 | Exploratory | Dynamic Production model | ASPIC | WGDEEP, 2006 |
| 2006 | Exploratory | Bayesian approach to Production model | Winbugs | WGDEEP, 2006 |

[3] Exploratory, Benchmark (to identify best practise), Update (repeat of previous years' assessment using same method and settings but with the addition of data for another year).

## 19.3 Black scabbardfish in Subareas VIII, IX

| | |
|---|---|
| Stock: | Black scabbard fish in Subareas VIII, IX |
| Working Group: | WGDEEP |
| Date: | March 2011 |

# A. General

### A.1. Stock definition

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30ºN. It occurs only sporadically north of the Scotland–Iceland–Greenland ridges. Juveniles are mesopelagic and adults are bentho-pelagic. It is admitted that the species' life cycle is not completed in just one area and also that either small or large-scale migrations occur seasonally. It has been postulated that fish caught to the west of the British Isles are pre-adults that migrate further south (possibly down to Madeira) as they reach maturity.

The stock structure is uncertain. Three management units are considered:

i ) Northern (Divisions Vb and XIIb and Subareas VI and VII);

ii ) Southern (Subareas VIII and IX);

iii ) Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

### A.2. Fishery

The main fishery taking place in these Subareas is derived from the Portuguese longliners.

In the early 1980s, an artisanal longline fishery targeting this species initiated in Portuguese continental waters. The fishery takes at grounds around Sesimbra port (south of Lisboa; latitude 38º 20' N), following a series of exploratory surveys conducted by the Portuguese Fisheries Research Institute (former IPIMAR) in close collaboration with professionals from the fisheries sector some of them from Madeira. These surveys were oriented towards the search of new fishing grounds for the species, the environmental characterization of the ocean layer where black scabbardfish occurrs, the experimentation of longline fishing gears and preliminary studies on the biology of the species. For this venture, fishers from Madeira with large experience in deep-sea longline fishing have greatly contributed. The number of vessels involved in this fishery has rapidly increased, with the fleet comprising altogether 15 longline vessels in 1984.

The fishing method and gear presented by the black scabbardfish longline fleet have developed soon after the initial fishing trials off the Sesimbra coast by fishers from Madeira. Gear design has been modified from the one initially used (similar to the Madeira traditional longline fishing gears) to catch the species in continental waters to a different configuration; setting horizontal bottom longline, where alternating floats and sinkers occur at constant intervals on the main line. This rearrangement aims to match the intricate vertical distribution exhibited by the species in the slopes and to prevent gear loss on the hard grounds (Henriques, 1997).

At the beginning of the fishery, the fleet was composed by small artisanal vessels, having an average LOA around 11 m and an average tonnage of ca. 16 GRT. In 1988, vessels showed there was a slight increase in both size and engine's power of vessels. However, from 1992 to 1995, average LOA and engine's power characteristics registered the highest raise in relation to 1988; about 30%. In 2000, the fleet experienced again technological improvements, indicated by the increase of engine's power, tonnage and LOA average values. Such improvements were experienced by a limited number of vessels (four), fact also reflected by the increase in standard deviation estimates.

The number of fleet vessels registered its highest value in 1986, but decreased from 1995 to 2004, when the fleet presented the same number of vessels exhibited twenty years before. In the period 1995–2004, the number of new vessels that entered the fleet attained its maximum in 1997 before an equal number of vessels left the fleet in 1998. During the same period, the number of vessels that remained in the fleet has decreased from 17 to 14.

The number of hooks by fishing gear varied since the beginning of the fishery till present days. In the first years of the fishery, gears used 3600 to 4000 hooks (Martins *et al*., 1989), while, in 1996, its number ranged from 4800 to 5400 (Henriques, 1997). More recently in 2004, the number of hooks by gear varied between 4000 and 10 000. The No. 5 Hook has been commonly used in fishing gears since the beginning of the fishery. The most common bait of the gear is sardine (*Sardina pilchardus*), however, chub mackerel (*Scomber japonicus*) can also be used when sardine is less available or its market price increases. The process of gear preparation, including disentangling, baiting and coiling of the main line into the tubs is carried out ashore by people hired for these tasks and by crewmen when they are not at sea (Henriques, 1997). All the work is performed by hand and is very intensive and laboriously.

Fishing operations usually start at dusk following a well-defined pattern: vessels leave the port early in the night, carrying a previously equipped longline gear, and navigate offshore for a period that varies between one to almost six hours (depending on the vessel and location of the fishing ground). When the vessel is at the fishing ground, two fishing operations generally occur: 1) the longline gear is deployed into the sea and set, 2) another longline gear previously set in the last 24–48 hours (average around 38 hours) is recovered with the aid of a hauling winch installed on board. The occasional presence of cetaceans, whose species and numbers are still to be confirmed, can result in a great economic loss for the fishers as these marine mammals are attracted by the catch when it reaches the surface and feed on the fish captured.

Fishing takes place on hard bottoms along the slopes of canyons at depths normally ranging from 800 to 1200 m and may attain 1450 m.

The French bottom trawlers operating in Subareas mainly VI and VII have a small marginal activity in Subarea VIII.

### A.3. Ecosystem aspects

The Bay of Biscay and Iberian Coast region is situated in temperate latitudes with a climate that is strongly influenced by the inflow of oceanic water from the Atlantic Ocean and by the large-scale westerly air circulation which frequently contains low pressure system. The bottom topography of region is highly variable, from continental shelf to abyssal plain. Some remarkable topographic features such as seamounts, banks and submarine canyons can be found. The coastline is also highly diversified with estuaries, rias and wetlands, which all support extremely productive ecosystems.

In Subarea VIII there are historical records of impacts on deep-water ecosystems, in particular corals (Joubin, 1922).

In Division IXa some sporadic information available suggests the existence of coral and sponges. The topography of the region reveals the existence of seamount and canyons usually considered as VME´s.

## B. Data

### B.1. Commercial catch

Landing data from Subareas VIII and IX are available to WGDEEP. Almost all landing are derived from the Portuguese longline fishery that takes place in Subarea IXa.

The artisanal segment of the commercial fishing fleet of mainland Portugal is responsible for the largest landings' quantities of deep-water species. The on-board discard sampling for longline Portuguese commercial fleet started in mid-2005 and is integrated in the Portuguese Discard Sampling programme, included in the EU DCR/NP. On-board sampling in longline commercial vessels is carried out in a monthly basis to get discards and trip information.

### B.2. Biological

Length data - In the scope of the National Minimum Landings Sampling Programme, length frequency and biological samples from Portuguese landing port at Sesimbra were collected on a monthly basis along years.

Ageing - Sectioned otoliths were considered more appropriate to age assignment because growth increments are more evident and ageing of larger specimens is easier than in whole otoliths. In addition although vertebrae are not the most appropriate structure for age assignment, this structure may be useful in the absence of otoliths. The growth parameter estimates of the von Bertalanffy model for Portugal Mainland (ICES Subarea IXa) and Madeira, as well as, for sex separated (Vieira *et al.*, 2009) are shown in table 19.3.1

in parenthesis.

| Area | Sex | $L_\infty$ (mm) | k (year$^{-1}$) | $T_0$ (year) | r |
|---|---|---|---|---|---|
| Mainland | females | 1354 (42.68) | 0.170 (0.022) | –2.040 (0.378) | 0.952 |
| | males | 1240 (28.99) | 0.208 (0.021) | –1.654 (0.284) | 0.941 |
| Madeira | females | 1586 (41.37) | 0.119 (0.009) | –2.282 (0.224) | 0.971 |
| | males | 1461 (12.78) | 0.146 (0.004) | –1.441 (0.065) | 0.965 |

**Table 19.3.1. Von Bertalanffy growth model estimates for Aphanopus carbo caught off mainland Portugal and Madeira. Standard deviation in parentheses (Vieira *et al.*, 2009).**

Females, particularly those from Madeiran waters, presented a lower growth rate than those from Mainland (ICES Subarea IXa). This reduction in the growth rate seems to be related to the reproductive effort. The differential growth pattern between the females from mainland Portugal (non-reproductive females) and Madeira (reproductive females) may reflect the optimization of the energetic balances (Vieira *et al*., 2009).

**Maturity** - In ICES Subarea IXa only immature and early developing specimens have been observed (Figueiredo, 2009 WD). Mature individuals only occurred in Madeira (Figueiredo *et al*., 2003) and, in Canary Islands (Pajuelo *et al*., 2008) and the northwest coast of Africa although it is possible that two species may occur in these areas.

In Madeira the spawning season takes place from September to December, and females had a GSI peak in November while males achieved theirs a month early. Such high GSI values are typical of synchronous spawners which, according to Tyler and Sumpter (1996) usually present GSI values ranging between 18 and 25 in mature female.

An increase in the relative weight of the liver just before the increase in weight of gonads in females was very conspicuous in Madeira, but it could also be perceived in mainland females. Such strategy is typical of thin fish in which the majority of the energy necessary to maturity is stored in the liver and, after the maturation is reached, the HSI present a sharp decrease. In males, the HSI did not follow the same conspicuous pattern shown in females since the energy needed for their reproduction has lower energy costs than females.

The HSI revealed a correlation with GSI in females but not in males and no relation of the Fulton's condition factor with the reproduction in both sexes was perceived.

**Length of first maturity** - The length at first maturity was estimated as 1078 mm for females and 1062 mm for males. This estimative was larger than the one presented by Figueiredo *et al*. (2003) in Madeira waters (1028 mm) but lower to the one found by Pajuelo *et al*. (2008) in Canary Islands (1095 mm for males and 1144 mm for females). It is probable that individuals from Canary Islands mature at larger sizes than those in Madeira, influenced by the fact that in the former archipelago they are distributed deeper and that they are subjected to different exploitation levels and regional oceanographic conditions (Morales-Nin *et al*., 2002).

**Fecundity** - Black scabbardfish has a determinate fecundity strategy the relative fecundity estimates ranged from 73 to 373 oocytes/female weight(g). Skipped spawning was also considered to occur in this species; the percentages of non-reproductive females between 21% and 37% (Vieira *et al*., 2009).

### B.3. Surveys

No independent fishery data are available for this stock.

### B.4. Commercial cpue

The commercial daily landings from Portugues longline vessels have been used to derive black scabbardfish monthly lpue values. Data has been provided by the Portuguese General Directorate of Fisheries and Aquaculture.

Monthly lpue are calculated for each vessel as the *ratio* total landed weight (kg)/number of fishing trips. Only vessels having total monthly landings >= 1000 kg and a monthly number of fishing trips >= five were considered in the analysis.

Although there is no information on the number of hooks used per trip, it is known from interviews with the fishers that each vessel uses the same number of hooks on each trip (Bordalo-Machado and Figueiredo, 2008). Hence, the effect of the number of hooks on the effort estimates is extracted from the model when we extract the effect of the vessel.

Standardized monthly effort of the fleet are estimated based on the adjustment of GLM model. Factors considered are YEAR, MONTH and VESSEL and the model is expressed as:

$$g(LPUE_{ijkl}) = \alpha_i YEAR_i + \beta_j MONTH_j + \lambda_k VESSEL_k + \varepsilon_{ijkl,} \quad (1)$$

where $\alpha_i$ (i = 1995,…, lastyear), $\beta_j$ (j = 1,…,12) and $\lambda_k$ (k = 1,…,33) are coefficients to be determined. The most appropriate distribution the expected or a function of the expected response variable was chosen among the exponential family group of distributions. The quality of the model adjustment was evaluated by quantile residuals analysis.

### B.5. Other relevant data

**Weight–length relationship** - The weight (total weight W)–length (Total length TL) relationship for the species (Morales-Nin and Carvalho, 1996) estimated for the species has the following expression:

males W= 0.000154 TL 3.4519, $r^2$ = 0.95

females W= 0.000201 TL 3.3906, $r^2$ = 0.95

**Seasonal effect on abundance** - Monthly standardized black scabbardfish lpue from the longline fleet operating in Subarea IXa were estimated for the period 1995–2009 (Figueiredo and Farias, 2010 WD). The monthly lpue estimates and the corresponding confidence intervals are shown in Figure 19.3.1.

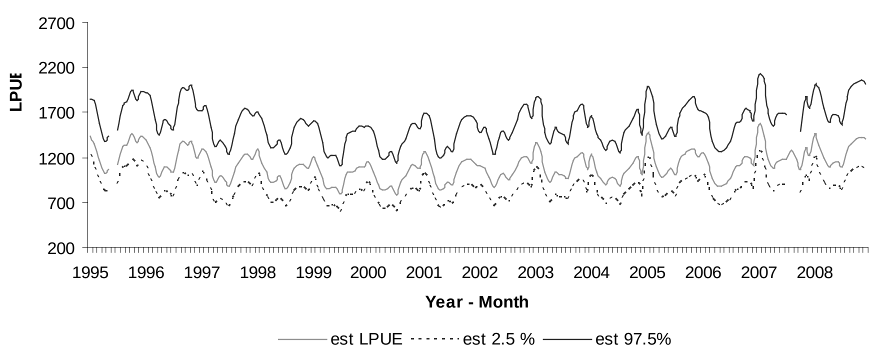



**Figure 19.3.1. Monthly lpue estimates for ICES Subarea IXa with 95% confidence intervals from the adjusted GLM model (Figueiredo and Farias, WD 2010).**

The monthly lpue estimates did not show any marked long-term trend and seem to follow a seasonal pattern along the period in analysis.

## C. Assessment: data and method

Model used:

The stock is evaluated based on cpue trends.

The lpue estimate, as well as, other information on the species for the southern component and other components will be analysed under DEEPFISHMAN Project aiming to the development of new approaches that take into consideration spatial stock dynamics.

Software used:

Model Options chosen:

Input data types and characteristics:

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:

3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

The previous assessment trials were done taking into consideration a unique stock in NE Atlantic. However due to the different nature of fisheries in the northern and southern areas and lack of information on migration, the stock has traditionally been divided into northern and southern components for management purposes.

| Year | Assessment type[3] | Assessment method(s) used | Assessment package/ program used | Reference |
|---|---|---|---|---|
| 1998 | Exploratory | Scheafer Production model | CEDA | WGDEEP, 1998 |
| 2006 | Exploratory | Dynamic Production model | ASPIC | WGDEEP, 2006 |
| 2006 | Exploratory | Bayesian approach to Production model | Winbugs | WGDEEP, 2006 |

## I. References


Bordalo-Machado, P. and Figueiredo. 2009. Fishery for black scabbardfish (*Aphanopus carbo* Lowe, 1839) in the Portuguese continental slope. Rev. Fish Biol. Fish., 19: 49–67.

Figueiredo, I., P. Bordalo-Machado, S. Reis, D. Sena-Carvalho, T. Blasdale, A. Newton and L.S. Gordo. 2003. Observations on the reproductive cycle of the black scabbardfish (*Aphanopus carbo* Lowe, 1839) in the NE Atlantic. ICES J. Mar. Sci., 60(4): 774–779.

Henriques, V. 1997. Final report of Sub-task 1.3: description of Portuguese deep-water fisheries. Final Report of European Commission FAIR Contract CT95- 655 Developing deep-water fisheries: data for the assessment of their interaction with and impact on a fragile environment, 9 pp.

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Pajuelo, J.G., J.A. González, J.I Santana, J.M. Lorenzo, A. García-Mederos and V. Tuset. 2008. Biological parameters of the bathyal fish black scabbardfish (*Aphanopus carbo* Lowe, 1839) off the Canary Islands, Central-east Atlantic. Fish. Res., 92(2–3): 140–147.

Tyler, C.R. and J.P. Sumpter. 1996. Oocyte growth and development in teleosts. Rev. Fish Biol. Fish., 6(3): 287–318.

Vieira, A.R.Farias, I. Figueiredo, I., Neves, A. Moraráles-Nnin, B., Sequeirara, V., Martins, R. ang Gordo, L.S. 2009. Age and growth of black scabbardfish (*Aphanopus carbo* Lowe, 1839) in the southern NE Atlantic Scientia Marina 73Ss.


[3] Exploratory, Benchmark (to identify best practise), Update (repeat of previous years' assessment using same method and settings but with the addition of data for another year).

## 19.4 Black scabbardfish in other areas

| | |
|---|---|
| Stock | Black scabbard fish other Areas (I, II, IIIa, IV, X, Va, XIV). |
| Working Group: | WGDEEP |
| Date: | March 2011 |

## A. General

### A.1. Stock definition

The species is distributed on both sides of the North Atlantic and on seamounts and ridges south to about 30ºN. It occurs only sporadically north of the Scotland–Iceland–Greenland ridges. Juveniles are mesopelagic and adults are bentho-pelagic. It is admitted that the species life cycle is not completed in just one area and also that either small or large-scale migrations occur seasonally. It has been postulated that fish caught to the west of the British Isles are pre-adults that migrate further south (possi-bly down to Madeira) as they reach maturity.

The stock structure is uncertain. Three management units are considered:

i ) Northern (Divisions Vb and XIIb and Subareas VI and VII);

ii ) Southern (Subareas VIII and IX);

iii ) Other areas (Divisions IIIa and Va Subareas I, II, IV, X, and XIV).

### A.2. Fishery

The fisheries in the other areas have been taken place in different ICES subareas and different years.

In ICES Division IXa2 (Azorean EEZ) black scabbardfish fishery in the Azores has received sporadic experimental activity despite previous indications that a potential for a fishery exists (Vinnichenko, 1998; Hareide and Garnes, 2001). The absence of a local market and the complexity of the gear and labour requirements for its operation have thus far limited the development of the fishery. The commercial value of the species is, however, well-established in other regions

A Faroese exploratory trawl fishery took place in 2008 in the Mid-Atlantic Ridge area. This fishery was mainly targeting at orange roughy and black scabbard fish, and was undertaken in the period 13 February to 9 March 2008 in ICES Areas X and XII according to a resolution adopted at the 26th Annual Meeting of NEAFC on management measures for orange roughy. The fishery was performed with one trawler (M/S Ran TG0752) with many years participation in the Faroese orange roughy fishery. The gear used was a bottom trawl. Locations of catches of black scabbardfish are shown in Figure 19.4.1.

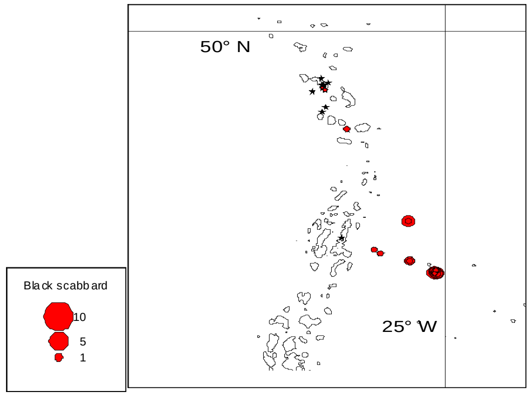


**Figure 19.4.1. Faroese exploratory survey total catches of black scabbardfish (tonnes).**

Total landings in "other areas" were quite variable along the years under analysis. Such variability seems to clearly reflect the ICES subarea where fisheries took place.

Landings from 1989 to 1992 were mainly derived from French trawlers operating at ICES Subarea IV (this may be misreported). In Faroese landings derived from ICES Subarea X (370 t) had significantly contributed for the maximum observed.

Landings from 1998 to 2000 were mainly derived from Portuguese longliners operating in ICES Subarea X. From 2004 onwards landings were mainly derived from Faroese trawlers both operating in ICES Subarea X. In 2009 the Faoese landings attained nearly 160 t.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

Landing data are available from 1989 to present but these are derived from experimental fisheries that have been taken place in different ICES subareas and different years.

In Subareas II, IV and XIV reported landings are considered to be misreported although the extent of this is unknown.

Two species of Trichiuridae occur in the Azores, *Aphanopus. carbo* and *Aphanopus intermedius.* Landings in Subarea X may contain a mixture of these two species.

### B.2. Biological

Considerable general information is available on the life-history characteristics of this species.

Recent genetic studies have shown that two species two species of Trichiuridae occurred in the Azores—*A. carbo* and *Aphanopus intermedius* and that in Pico *A. intermedius* dominated, characterized by smaller fish (Stefanni and Knutsen, 2007).

**Length** - Length frequency distribution based on data collected at 2008 Faroese exploratory survey for the all hauls pooled is shown in Figure 14.4.2. This distribution mainly reflects the length composition of the species from western seamounts of ICES Subarea Xb.

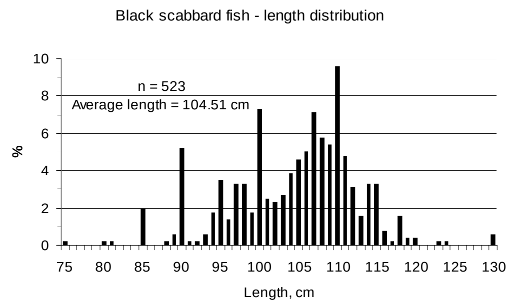


**Figure 19.4.2. Faroese exploratory survey in Subarea X, 2009. Black scabbardfish. Total length distribution in all hauls.**

**Reproduction** - ICES Subarea X - In Azorean waters females in spawning condition (GSI > 3 up to 9) with total lengths between 108 and 137 cm occurred predominantly in October and in November (J. Pereira, pers comm.). The length 108 cm corresponds to the estimate of first maturity determined for Madeira specimens. Spawners were observed around the Azores from November to April (Vinnichenko, 2002).

### B.3. Surveys

No surveys are available for this stock.

### B.4. Commercial cpue

No data are available for this stock.

### B.5. Other relevant data

The spatial coverage of the EC TAC management units for this species does not correspond to the assessment units considered by ICES (Figure 19.4.3).

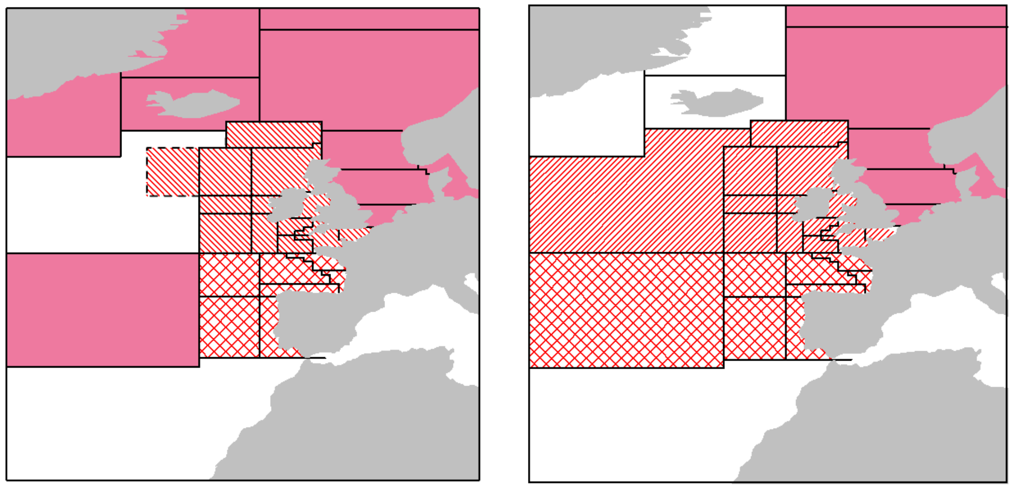

**Figure 19.4.3. Black scabbardfish in other areas. ICES assessment units (left; solid pink I, II, III, IV, Va, X, XIV; diagonal lines Vb, VI, VII, XIIb; cross-hatched VIII, IX). Management areas for EU TAC, excluding CECAF areas, are shown to the right (solid pink I, II, III, IV; diagonal lines V, VI, VII, XII; cross-hatched VII, XI, X).**

## C. Assessment: data and method

Model used:

Only landings data available.

Software used:

Model Options chosen:

Input data types and characteristics

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References

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Vinnichenko V. I.ICES Document CM 1998/O: 18. 1998. Russian investigations and fishery on sea-mounts in the Azores area; p. 19.

Stefanni S., Knutsen H. 2007. Phylogeography and demographic history of the deep-sea fish, *Aphanopus carbo*, in the NE Atlantic: vicariance followed by secondary contact or speciation? Molecular Phylogeny and Evolution; 42:38–46.

Vinnichenko. 2002.

Reinert. 2010. WD

## 19.5 Blue ling in Va, XIV

| | |
|---|---|
| Stock: | Blue ling in Va and XIV |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Gudmundur Thordarson |

# A. General

### A.1. Stock definition

Biological investigations in the early 1980s suggested that at least two adult stock components were found within the Area, a northern stock in Subarea XIV and Division Va with a small component in Vb, and a southern stock in Subarea VI and adjacent waters in Division Vb. However, the observations of spawning aggregations in each of these areas and elsewhere suggest further stock separation. This is supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larval data from early studies also suggest the existence of many spawning grounds. The conclusion is that stock structure is uncertain within the areas under consideration.

However, as in previous years, on the basis of similar trends in the cpue series from Division Vb and Subareas VI and VII, blue ling from these areas has been treated for assessment purposes as a single southern stock. Blue ling in Va and XIV has been treated as a single northern stock. All remaining areas are grouped together as “other areas”.

### A.2. Fishery

The change in geographical distribution of the Icelandic blue ling fisheries from 1996 indicates that there has been an expansion of the fishery of blue ling to northwestern waters. This increase is likely to be the result of increased availability of blue ling in the northwestern area, rather than being the result of an increase in effort or reporting.

The fishery for blue ling in Va changed substantially in nature and extent in the early 1980s. At the start of this period catches were high, in part because of fisheries on spawning aggregations. These aggregations diminished relatively quickly and since the mid-1980s blue ling has largely been a bycatch in the redfish and Greenland halibut fishery. In 1993, the Icelandic fleet fished on aggregations of spawning blue ling in a small area on the Reykjanes ridge at the border between Subareas Va and XIV. This was a transient fishery that declined rapidly in the years thereafter.

Before 2008 the majority of the catches of blue ling in Va were caught by trawlers, as bycatch where the main target species are cod, haddock and other demersal species. 50% of the bottom-trawl catches in 2007 were taken within the depth range of 300–700 m and 50% of the longline catches was taken at depths greater than 400 m. After 2008 there has been a substantial change in the fishery for blue ling in Va as longliners started targeting blue ling.

The gross fluctuation in catches in the late seventies, early eighties and again in the early nineties is most likely a reflection transient fisheries on spawning grounds. As a result of depletion of fish on spawning grounds, total international landings in Va declined from around 8500 t in 1980 to a level of between 2000 and 3000 t in the late 1980s. Landings were at a historical low in the late 1990s, but have increased in recent years.

Historically the fisheries in Subarea XIV have been relatively small.

### A.3. Ecosystem aspects

Blue ling in Icelandic waters is mainly found on the continental shelf and slopes of south-east, south, and west of Iceland at depths of 0–1000 m, but mainly but is mainly caught in the fisheries at depths greater than 500 meters. Warming of sea temperature, have been documented in Va and an expansion of distributional area of warm-water species such as anglerfish. The significance and reliability of such metrics is considered at the moment insufficient for their consideration in the provision of management advice of blue ling in Va.

### A.4. Management

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations. Below is a short account of the main feature of the management system and where applicable emphasis will be put on blue ling.

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The ITQ system allows free transferability of quota between boats. This transferability can either be on a temporary (one year leasing) or a permanent (permanent selling) basis. This system has resulted in boats having quite diverse species portfolios, with companies often concentrating/specializing on particular group of species. The system allows for some but limited flexibility with regards converting a quota share of one species into another within a boat, allowance of landings of fish under a certain size without it counting fully in weight to the quota, and allowance of transfer of unfished quota between management years. The objective of these measures is to minimize discarding, which is effectively banned. Since 2006/2007 fishing season, all boats operate under the TAC system.

At the beginning, only few commercial exploited fish species were included in the ITQ system, but many other species have gradually been included. Blue ling in Va is one of the few species in the Icelandic fisheries that is not included in the ITQ-system and as such not subjected to annual TAC.

Landings in Iceland are restricted to particular licensed landing sites, with information being collected on a daily basis time by the Directorate of Fisheries in Iceland (the enforcement body). All fish landed has to be weighted, either at harbour or inside the fish processing factory. The information on each landing is stored in a centralized database maintained by the Directorate and is available in real time on the Internet (www.fiskistofa.is). The accuracy of the landings statistics are considered reasonable.

All boats operating in Icelandic waters have to maintain a logbook record of catches in each haul/set. The records are available to the staff of the Directorate for inspection purposes as well as to the stock assessors at the Marine Research Institute.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place.

A system of instant area closure is in place for many species. The aim of the system is to minimize fishing on juveniles. An area is closed temporarily (for two weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than a certain percentage of the catch is composed of fish less than the defined minimum length. The only restrictions on the Icelandic fleet regarding the blue ling fishery was the introduction of closed areas in 2003 to protect known spawning locations of blue ling, which are in effect during the spawning period of blue ling in Va 15th of February until 30th of April.

## B. Data

### B.1. Commercial catch

The text table below shows which data from landings is supplied from ICES Division Va.

| ICES Division Va | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (Catch in weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | $Mat_{prop}$ (proportion mature-by-age) | Length composition in catch |
| Iceland | x | | | | x |
| The Faroe Islands | x | | | | |
| Norway | x | | | | |

Icelandic blue ling catch in tonnes by month, area and gear are obtained from Statistical Iceland and Directorate of Fisheries. Catches are only landed in authorized ports where all catches are weighed and recorded. The distribution of catches is obtained from logbook statistic where location of each haul, effort, depth of trawling and total catch of blue ling is given. Logbook statistics are available since 1991. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard and reported to the Directorate of Fisheries.

Discard is banned in the Icelandic demersal fishery and there is no information available on possible discard of blue ling. Being a relatively valuable species and not subjected to TAC constraints nor minimum landing size there should be little incentive to discard blue ling in Va.

### B.2. Biological

Biological data from the commercial longline and trawl fleet catches are collected from landings by scientists and technicians of the Marine Research Institute (MRI) in Iceland. The biological data collected are length (to the nearest cm), sex and maturity stage (if possible since most blue ling is landed gutted), and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted (to the nearest gramme). Biological sampling is also collected directly on board on the commercial vessels during trips by personnel of the Directorate of Fisheries in Iceland or from landings (at harbour). These are only length samples.

The general process of the sampling strategy is to take one sample of blue ling for every 180 tonnes landed. Each sample consists of 150 fish. Otoliths are extracted from 50 fish which are also length measured and weighed gutted. In most cases blue ling is landed gutted so it not possible to determine sex and maturity. If blue ling is landed ungutted, the ungutted weight is measured and the fish is sex and maturity determined. The remaining 100 in the sample are only length measured. Age reading of blue ling from commercial catches ended in 1998. The reason was great uncertainty in ageing and cost saving.

Earlier observations indicates that blue ling becomes mature-at-age of about 8–13 years or at around the length of 90 cm. The mean length-at-maturity is close to the mean length of blue ling in the commercial catches. This means that a large proportion of the blue ling is caught as immature.

No estimates of natural mortality are available for blue ling in Va and XIV.

The biological data from the fishery is stored in a database at the Marine Research Institute. The data are used for description of the fishery.

### B.3. Surveys

For detailed description of the surveys relevant to blue ling in Va, please refer to the stock annex for tusk in Va and XIV.

The Icelandic Spring survey (March) commenced in 1985 and covers the Icelandic shelf down to 500 meters. As such the survey is not considered descriptive of biomass trends. However smaller blue ling is found at shallower depths and therefore the Spring Survey may contain valuable information on smaller and younger blue ling. This has at present not been explored.

The Icelandic Autumn survey (October) commences in 1996 and after its expansion in 2000 the survey is considered to cover the distributional range of blue ling in Va and therefore to be representative of stock biomass.

### B.4. Commercial cpue

Data used to estimate cpue for blue ling in Division Va since 1991 are obtained from logbooks of the Icelandic trawl and longline fleet. Non-standardized cpue and effort is calculated for each year which is simply the sum of all catch divided by the sum of number of hooks.

### B.5. Other relevant data

NA.

## C. Assessment: data and method

Blue ling in Va and XIV is assessed based on trends in survey indices from the Icelandic autumn survey. Supplementary information includes relevant information from the fishery such as length distributions, maturity data, effort, cpue and analysis of changes in spatial and temporal distribution. Indices from the Icelandic spring survey may also be indicative of biomass of smaller blue ling. No data, other than landings, is available from XIV.

## D. Short-term projection

No short-term predictions are performed.

## E. Medium-term projections

No medium-term predictions are performed.

## F. Long-term projections

No long-term predictions are performed.

## G. Biological reference points

No biological reference points are defined for blue ling in Va and XIV.

## H. Other issues

### H.1. Historical overview of previous assessment methods

At WGDEEP-2004, exploratory runs of Delury, surplus production and stock reduction models were carried out using total international catch data for Division Va and Subareas XIV combined (1966–2003) and cpue data from Icelandic spring groundfish trawl survey (1985–2003). Although the survey data are fisheries independent and are considered to be a better indicator of changes in stock abundance than longline and trawl data from Icelandic commercial vessels, the fits from the models were generally poor reflecting a high variability of the survey-series, particularly in the early years.

## I. References

## 19.6 Blue ling in Vb, VI, VII

| | |
|---|---|
| Stock: | Blue ling (*Molva dypterygia*) in ICES Division Vb and Su bareas VI and VI. |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Pascal Lorance |

## A. General

### A.1. Stock definition

Biological found within the Area, a northern stock in Subarea XIV and Division Va with a small component in Vb, and a southern stock in Subarea VI and adjacent waters in Division Vb. However, the observations of spawning aggregations in each of these areas and elsewhere suggest further stock separation. This is supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larval data from early studies also suggest the existence of many spawning grounds. The conclusion is that stock structure is uncertain within the areas under consideration.

However, as in previous years, on the basis of similar trends in the cpue series from Division Vb and Subareas VI and VII, blue ling from these areas has been treated for assessment purposes as a single southern stock. Blue ling in Va and XIV has been treated as a single northern stock. All remaining areas are grouped together as "other areas.

The assessment unit was defined as ICES division Vb and Subareas VI and VII. In Subareas VI and VII, only adults fish occur, juveniles are not caught to any significant level in. The situation is slightly different in Division Vb where some small fish occur and could be used for age and growth estimation purposes (Magnussen, 2007) but the numbers previously reported from Faroese trawl surveys do not seem significant to the size of the exploited adult stock.

Similarly, in the neighbouring ICES division, from where landings are currently a few hundred tonnes per year but have been higher in the past, only adult fish are known to be caught and these should probably be considered as the same stock as blue ling in Vb, VI and VII.

### Spawning areas

Blue ling is known to concentrate of spawning aggregation. From 1970 to 1990, the bulk of the fishery for blue ling was seasonal fisheries targeting these aggregations, which are subject to sequential depletion. Known spawning aggregations are shown in Figure 19.6.1. In Iceland, the depletion of the spawning aggregation in a few years was documented (Magnússon and Magnússon, 1995) and blue ling is an aggregating species at spawning time. To prevent depletion of adult populations temporal closures have been set both in the Icelandic and EU EEZs.

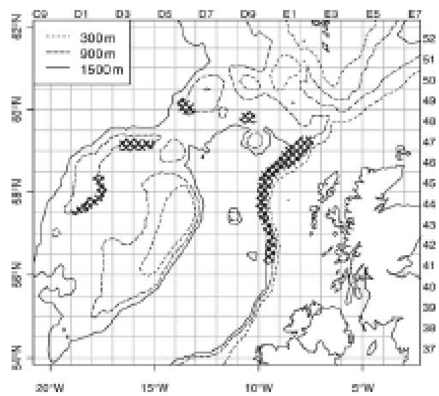


**Figure 19.6.1. Known spawning areas of blue ling to the West of Scotland (from Large *et al.*, 2010).**

### A.2. Fishery

The main fisheries are those by Faroese trawlers in Vb and French trawlers in VI and, to a lesser extent, Vb. Total international landings from Subarea VII are small bycatch in other fisheries. In Subarea Vb and Division VI, other fisheries landings blue ling are the Norwegian longline fishery for ling and tusk where blue ling is a bycatch and Scottish trawlers. Landings from these fleets have been small since the 2000s but where high in the 1960s and 1970s for some fleet. Landings from Subareas VIII and IX previously reported as blue ling are now ascribed to the closely related Spanish ling (*Molva dypterygia*) and blue ling is not known to occur to any significant level in these Subareas. The area of distribution of the stock is limited to somewhere between 50 and 55°N along the Porcupine Bank slope (Bridger, 1978; Ehrich, 1983, Lorance *et al.*, 2009).

Landings by Faroese trawlers are mostly taken in the spawning season. Historically, this was also the case for French trawlers fishing in Vb and VI. However, in recent years blue ling has been taken mainly as a bycatch in French trawl fisheries for roundnose grenadier, black scabbardfish and deep-water sharks.

The rapid increase in the size of this fishery in the early 1970s is considered to be related to the expansion of national fisheries limits to 200 nautical miles and the resultant displacement of fishing effort and the associated development of markets.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

#### B. 1.1. Landings and discards

In 2008, the landings time-series from the southern blue ling stock was extended back to 1966 based upon Northwestern Working Group reports from 1989–1991 and data in Moguedet, (1988). Landings data in the 1980s for French freezer trawlers may be underestimated in some years but were included in 2011 for years 1988–2000.

Large French catches were reported as ling at the start of the fishery in 1973–1975. In order to derive a best estimate of blue ling landings, the average ling landings in the years preceding the start of the French blue ling fishery were subtracted from estimates of blue ling and ling combined.

Landings data by ICES statistical rectangles have been provided by France, (UK) Scotland, UK (England and Wales) and Ireland and have been aggregated by quarter and plotted to display the geographical distribution of the fishery by year starting from 2005.

Blue ling is not discarded to any significant level because no small blue ling are caught in the fishery.

In 2008, the landings time-series from the southern blue ling stock was extended back to 1966 based upon Northwestern Working Group reports from 1989–1991 and data in Moguedet, (1988). Landings data in the 1980s for French freezer trawlers may be underestimated in some years.

Large French catches were reported as ling at the start of the fishery in 1973–1975. In order to derive a best estimate of blue ling landings, the average ling landings in the years preceding the start of the French blue ling fishery were subtracted from estimates of blue ling and ling combined.

### B.2. Biological

Available growth parameter in length and weight for blue ling are summarized in Tables 19.6.1 and 19.6.2 and maturity parameters in Table 3.

**Table 19.6.1. Growth parameters of blue ling.**

| L∞ (cm) | K (year–1) | t0 | Number of fish | Age range | Sex | Maximum observed size | Area | Reference |
|---|---|---|---|---|---|---|---|---|
| 160 | 0.11 | N/A | 79 | 3–17 | Combined | | Faroe Bank | Magnussen, 2007 |
| 165.8 | 0.084 | -0.138 | N/A | ?–20 | Female | 147 ([1]) | ICES VIa | Moguedet, (1985, 1988) |
| 112.2 | 0.158 | 0.318 | N/A | ? –19 | Male | 110 | ICES VIa | ([1]) |
| 125 | 0.152 | 1.559 | 2619 | 5-25 (2,3) | Combined | 136 ([3]) | Vb VIa,b | |
| 145.2 | 0.155 | 1.281 | 1412 | | Female | | Vb VIa,b | Ehrich and Reinsch, 1985 |
| 109.7 | 0.199 | 1.833 | 1391 | | Males | | Vb VIa,b | ([4]) |
| 116.25 | 0.17 | 0.57 | 590 | 5–20+ | Female | 130 | Faroe Islands ([5]) | |
| 104.2 | 0.197 | 0.57 | 331 | 5–20+ | Male | 107 | Faroe Islands ([5]) | |
| 137.37 | 0.13 | 0.46 | 117 | 6–18+ | Female | 139 | Shetland Islands ([5]) | Thomas, 1987 |
| 108.31 | 0.185 | 0.57 | 227 | 5–20+ | Male | 109 | Shetland Islands ([5]) | |
| | | | 563 | 20 + | Female | 138.5 ([7]) | Icelandic slope | |
| | | | 431 | 17 | Male | 115 ([7]) | Icelandic slope | |
| | | | 1492 | 20+ (6) | Combined | 137.86 ([7]) | Icelandic slope | |
| | | | ? | ? | Combined | 145-150 ([8]) | Iceland and RR ([9]) | Magnússon and Magnússon, 1995 |
| | | | ? | ? | Female | 140 | Spawning aggreg. RR ([9]) | |
| | | | ? | ? | Male | 124 | Spawning aggreg. RR ([9]) | |
| | | | 1399 | | Combined | 130–135 ([10]) | West of the British Isles | Bridger, 1978 |
| | | | | | Female | Ca. 145 ([11]) | West of the British Isles | Ehrich, 1983 |
| | | | | | Males | Ca. 112 ([11]) | West of the British Isles | |
| | | | 240 (♂+♀) | | Female | 150–155 ([12]) | West of the British Isles | Gordon and Hunter, 1994 |
| | | | 240 (♂+♀) | | Male | 110–115 ([12]) | West of the British Isles | Gordon and Hunter, 1994 |
| | | | 197 | | Combined | 140 | Norwegian Deep | Bergstad, 1991 |

**([1]) from sampling in 1984–1985; Female>= 130cm were 3% of total female numbers; ([2]) the bulk in age groups 7–20;([3]) from length distribution of German landings 1980 and 1982; ([4]) estimates based upon length and age data from sampling of German blue ling landings (Ehrich and Reinsch, 1985). ([5]) based upon sampling in 1977 and 1979 (Shetland Islands) and 1977 and 1978 (Faroe Islands); areas are defined according to Thomas, (1987). ([6]) Magnússon and Magnússon (1995) reported mean length by age for the years 1978–1982. In their sample (n=1492), there was 7 fish of the age group 20+. ([7]) from age estimation sample; mean length of the oldest age group: 6 individuals for females, 1 for males, 7 combined; ([8]) visually from length distribution plots; few fish above 130 cm; ([9]) RR: Reykjanes Ridge; ([10]) from a plot of length distribution by 5 cm length classes. Largest length class was 130–135 cm. It included 1–2% of total number of fish measured, they modal size class was 95–99 cm; ([11]) from plot, modal size by 120 cm for females and 95 cm for males. ([12]) From SAMS surveys (unpublished data), from histogram by 5 cm size classes. Modal sizes of 95–100 cm for males and 105–110 for females, n=240 (sex combined).**

**Table 19.6.2a. Growth parameters in weight.**

| W∞ (g) | K | t0 | Number of fish aged | Length range (TL, cm) | Age range (y) | Sex | Reference | Area |
|---|---|---|---|---|---|---|---|---|
| 19 688 | 0.094 | | 79 | NA | 3–17 | Combined | Magnussen, 2007 | Faroe Islands |
| 5191 | | | | | | Male | Ehrich and Reinsch, 1985 | |
| 13 166 | | | | | | Female | Ehrich and Reinsch, 1985 | |

**Table 19.6.2b. Maturity parameters, A50: age at 50% maturity; m: rate at which the population attains maturity (Magnussen, 2007); L50 length at 50% maturity; M50 weight at 50% maturity.**

| Sex | Area | A50 | m | L50 (cm) | M50 (g) | Reference |
|---|---|---|---|---|---|---|
| Combined | Faroe Bank | 6.2 | 1.66 | 79 | 1696 | Magnussen, 2007 |
| Female | Iceland | 11 | N/A | 88 | N/A | Magnússon and Magnússon, 1995 |
| Male | Iceland | 9 | N/A | 75 | N/A | Magnússon and Magnússon, 1995 |
| Female | Faroe Islands | 8.1 | N/A | N/A | N/A | Thomas, 1987 (1) |
| Male | Faroe Islands | 6.4 | N/A | N/A | N/A | Thomas, 1987 (1) |
| Female | South and West of the Faroe Islands | 7 | N/A | 85 | | Magnússon *et al.*, 1997 |
| Male | South and West of the Faroe Islands | 6 | N/A | 80 | | Magnússon *et al.*, 1997 |
| Combined | ICES IIa | N/A | M/A | 75 | | Joenes, 1961 |

**(1) The author specified that not too much significance should be given do the result because very few immature fish were caught and stated "it might be sufficient to know that the fish mature at an age between 6 and 8 years".**

#### B. 2.1. Length composition

Length composition of the landings have been available from Faroese trawlers in Division Vb since 1996 and French trawlers in Division VIa since 1984. Mean length of blue ling from the Norwegian reference fleet in Divisions Vb, VIa, VIb are also provided.

Age estimation of blue was carried out in the past and was disrupted because of poor consistency between readers. Nevertheless, there is a general agreement that blue ling recruits to this stock at a size of 70–80 cm have an age of 6–8 years. Otoliths readings of blue ling sampled from the French landings were resumed in 2009 in application of DCF. Age readings of blue ling seem relatively straightforward and the reading scheme do not significantly differ for that of most gadoid species although the number of growth increments to count is higher. Nevertheless, age estimation for this species are unvalidated.

#### B.2.3. Weight-at-age

No time-series but overall weight-at-age are derived from age–length keys and length–weight relationships.

#### B 2.4. Maturity and natural mortality

Natural mortality (M). was estimated using the relationship (Annala, J. H., Sullivan, K. J., 1996):

$$M = \ln(100)/\text{maximum age}$$

In this relationship, the maximum age should be set at the age where 1% of a year class is still alive. Based on Faroese and French age readings, it is reasonable to assume the maximum age for blue ling is around 30 years. Given this and the relationship above, M may be in the order of 0.15.

Juvenile blue ling are not known to occur on the fishing nor in Subareas Vb, VI and VII to any significant level. Fish recruit to this area and to the spawning–stock at an age of 6 to 8 years. All blue ling occurring in Vb, VI and VI can be considered as mature fish.

### B.3. Surveys

Weight and number per hour trawling in the Faroese spring survey since 1994 have been provided. Number have been provided for small (<80 cm) and large (>80 cm) fish. However, it was stressed that these surveys are limited to depth shallower than 500 m. These number have been small are have not been taken into account in assessment in any way. There is however a need to analyse these data to assess their representativity of variation of blue ling abundance in Vb.

An index of abundance in number per hour was available from a Scottish deep-water survey to the west of Scotland for years 1998–2009. The fish community of the continental shelf slope to the northwest of Scotland has been surveyed by Marine Scotland-Science since 1996, with strictly comparable data available between 1998 and 2008. This has focused on a core area between 55–59°N, with trawling undertaken at depths ranging from 300 to 1900 m with most of the hauls being conducted at fixed stations, at depths of around 500 m, 1000 m, 1500 m and 1800 m. Further hauls have been made on seamounts in the area, and on the slope around Rockall Bank, but these are exploratory, irregular and are not taken into account in the index of abundance.

This survey was conducted biennially, in September, until 2004, and annually in 2004–2009. Locations of trawl sites between depths of 500–1500 m are shown in Figure 19.6.2. From 1998 to 2008 the bottom trawl was rigged with 21″ rock-hopper groundgear, however in 2009, a switch was made to lighter groundgear, with 16″ bobbins.

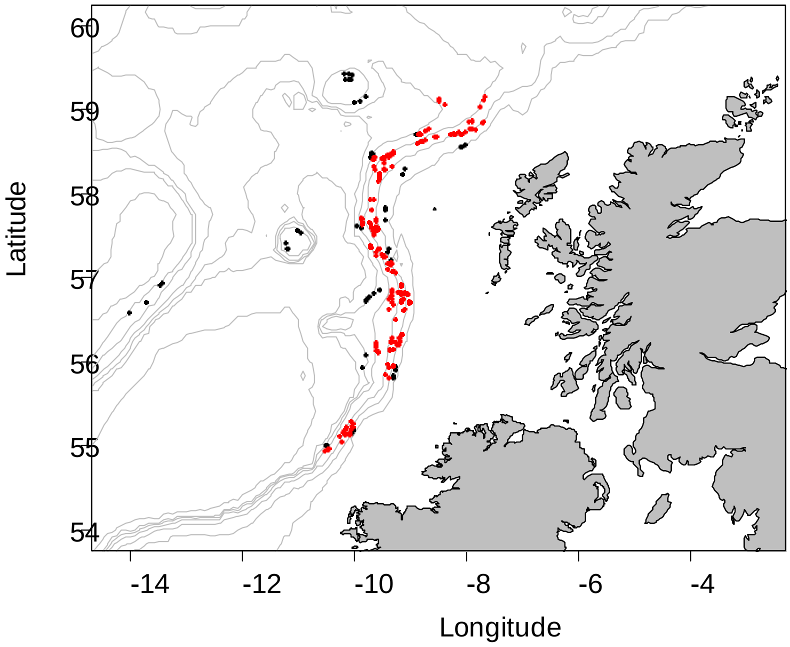


**Figure 19.6.2. Sites of valid hauls in the 500–1500 m depth band in the Scottish Deep-water Survey dataset, 1998–2009 (in red). Valid hauls at other depths are shown in black.**

An index of abundance was available from an Irish deep-water trawl survey of the fish community of the continental shelf slope to west and northwest of Ireland carried out from 2006 to 2009. The sampling protocol of this survey was standardized in accordance with the Scottish deep-water survey with trawling at fixed stations around 500 m, 1000 m, 1500 m and 1800 m. The gear used throughout the survey-series was the same as that used by Scotland in 2009. To be consistent across the years the haul data used for the index calculation only includes the areas that are covered in all four years and the depth bands (500–1500 m) that are covered in all four years. In total, the dataset comprised 42 valid hauls.

### B.4. Commercial cpue

A French deep-water tallybook database (based on fishers' own records) developed by the French industry is use to compute landings per unit of effort (lpue) indices starting from year 2000 (Lorance *et al.*, 2010). The database includes more years back to 1992 with landings of blue ling back to 1993. However, there is not enough data one blue ling before 2000 because of different components of deep-water vessels being included and small catch of blue ling from vessel contributing to the data in 1993–1999. The abundance index is standardized using a GAM model.

To represent the spatial aspect in the model, five small areas where the fleet has caught blue ling were defined as cluster of ICES rectangles (Figure 19.6.3). Fishing area definition was based on ICES (2006), in which reference fishing grounds, exploited since the 1990s (ref5, ref6) and new fishing grounds, i.e. not fished by French trawlers for fresh fish before 200 (new5 and new6) were defined in ICES Division Vb and Subareas VI respectively. Area ref6 was further split between statistical rectangles from the slope to the west of Scotland, along the Rockall Trough, referred to as edge6, and other rectangles, referred to as other6 (Figure 19.6.3).

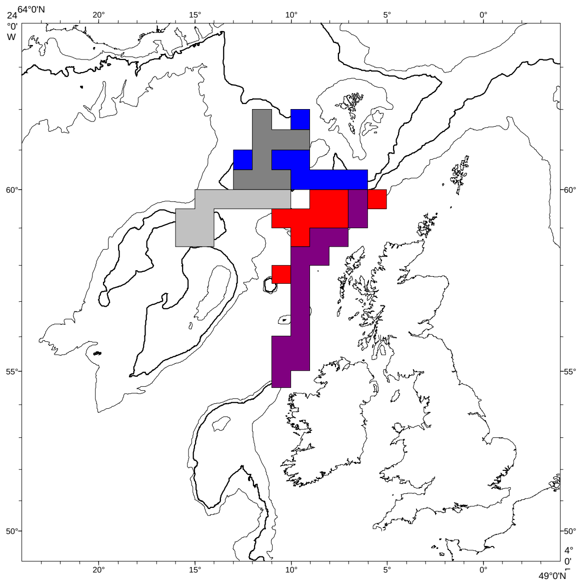

**Figure 19.6.3. Areas (clusters of statistical rectangles) used to calculate French lpue for blue ling. Dark grey, new grounds in ICES Division Vb (new5); light grey, new grounds in Subarea VI (new6); red, others in Subarea VI (other6); purple, edge in VI (edge6); blue, reference in Division Vb (ref5).**

The GAM models has the form:

log(E[landings]) = s(haul duration) + s(depth) + month + vessel.id+ rectangle + year :Area

where E[] denotes expected value, s() indicates a smooth non-linear function (cubic regression spline), vessel.id the vessel identity and year:area an interaction term. The dependent variable was landings and not lpue, which allows including haul duration as explanatory variable and have a non-proportional relationship between landings and fishing time. The fit was done assuming a Tweedie distribution of the dependent variable with a log-link function using the mgcv package in R (Wood, 2006).

The Tweedie distribution has mean $\mu$ and variance $\phi\mu^p$, where $\phi$ is a dispersion parameter and $p$ is called the index. As a Poisson-Gamma compound distribution was used, $1<p<2$, the index $p$ could not be estimated simultaneously with the model parameters. In 2010, a detailed study was carried out and p=1.7 provided the best fit. A model with a gamma distribution fit to haul where roundnose grenadier made up >= 10% of the total catch gave similar results.

The model fit was restricted to haul durations from 60 to 300 minutes and depth 700–1500 m covering the species depth range and excluding too short and long hauls for which there is a few data.

This lpue standardization method allowed estimating lpue time-trends for the five small areas. In order to derive standardized lpue for the whole area, lpue were predicted for all rectangles in the five small areas (using average haul depth in each rectangle and five hours haul duration) and averaged.

### B.5. Other relevant data

No other relevant data.

## C. Assessment: data and method

There is no benchmark assessment method for this stock. All assessments described below are exploratory.

#### Model used: SRA.

Stock reduction analysis (SRA) is a developed form of delay-difference model (Quinn and Deriso, 1999). The method uses biological parameters and information for time delays due to growth and recruitment to predict the basic biomass dynamics of age structured populations without requiring information on age structure. Thus, it can be considered to be a conceptual hybrid between dynamic surplus production and full age based models (Hilborn and Walters, 1992). A full description of the general approach can be found in Kimura and Tagart (1982), Kimura *et al*. (1984) and Kimura (1985 and 1988); (Large, unpublished 2002).

#### Software used: *FLaspm*

*FLaspm* is a package for the statistical computing environment R (R Development Core Team, 2010). The package is open source and is currently hosted at GoogleCode (the source code is freely available at http://code.google.com/p/deepfishman/. *FLaspm* is part of the FLR project (Kell *et al*., 2007) and requires that the package *FLCore* is also installed (v > 2.3). The stock reduction model used in this analysis implements the model described in Francis (1992) and is capable of fitting multiple indices simultaneously. The method requires time-series data of annual catches, one or more abundance index and a range of biological parameters. The effect of these biological parameters on results is investigated using sensitivity analysis. A Beverton–Holt stock–recruitment relationship with a steepness of 0.75 is used throughout.

#### Input data:

Total international landings from 1966 should be used for this assessment. Three tuning indices were available: French abundance index derived from skipper tallybook data (2000 to 2009), Marine Scotland's FRV SCOTIA deep-water survey (1998 to 2009) and Irish (2006 to 2009).

#### Other stock indicators

Change in mean length in the landings, catch curve to estimate total mortality Z are used to track trends in the stock.

Model Options chosen:

Input data types and characteristics:

| Parameter | Symbol | Value |
|---|---|---|
| Maximum age | Amax | 30 |
| Natural mortality | M | 0.15 |
| Steepness of Beverton–Holt stock–recruitment relationship | h | 0.75 |
| Age of first selectivity | Asel | 7 |
| Age of maturity | Amat | 7 |

| Parameter | Symbol | Value |
|---|---|---|
| von Bertalanffy growth parameters | $L_\infty$ | 125 cm |
| | k | 0.152 |
| | t0 | 1.552 |
| Length–weight parameters | a | 2e-6 |
| | b | 3.15 |

## D. Short-term projection

No short-term predictions are carried out for this stock.

## E. Medium-term projections

None.

## F. Long-term projections

None.

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

The stock identity is an issue for blue ling. The only area were juvenile are known to occur in large numbers in the Icelandic shelf. No juvenile are known to occur in Subareas VI and VII and number observed in the Faroese survey (about one fish smaller than 80 cm per hour) and for blue ling size up to 80 cm cover age up to 6–7 years.

### H.1. Historical overview of previous assessment methods

Exploratory assessment carried out far are summarized below (synthesis carried out as part of the DEEPFISHMAN project).

| Year | Assessment type[3] | Method | Assessment package/ program used | Used for advice? | If not, what was latest scientific advice based on? |
|---|---|---|---|---|---|
| 1998 | Exploratory | Schaefer & DeLury depletion model | CEDA ([1]) | No | French OTB and Faroese longline lpue |
| 2000 | Exploratory | Schaefer & DeLury depletion model | CEDA ([1]) | No | French OTB unstandardized lpue |

[3] Exploratory, Benchmark (to identify best practise), Update (repeat of previous years' assessment using same method and settings but with the addition of data for another year).

| | | | | | |
|---|---|---|---|---|---|
| 2004 | Exploratory | Schaefer, Pella-Tomlinson and Fox production models & DeLury depletion model | CEDA (1) | No | Trend in French commercial otter trawl lpue |
| | Exploratory | Stock reduction | PMOD | No | Trend in French commercial otter trawl lpue |
| 2006 | Exploratory | Catch Survey analysis | CSA (Mesnil, 2003) | No | Trend in French commercial otter trawl lpue |

**(1) MRAG (UK) software.**

Summary of data ranges used in recent assessments:

| Data | 2007 assessment | 2008 assessment | 2009 assessment | 2010 assessment |
|---|---|---|---|---|
| Landings | Years: 1988–2006 | Years: 1988-2007 | Years: 1966–2008 | Years: 1966–2009 |
| Quarterly length dist. of French landings | Years: 1989–2006 | Years: 1984–2007 | Years: 1984–2008 | Years: 1984–2010 |
| Quarterly length dist. of Faroese landings | Years: 1995–2006 | Years: 1995–2007 | Years: 1995–2008 | Years: 1995–2009 |
| Quartely age dist. | | | | Year: 2009 |
| Survey: Scottish deep-water | | | Years: 1998–2008<br>N° per hour | Years: 1998–2009<br>N° per hour |
| Survey: Irish | | | | Years: 2006–2009<br>N° per hour |
| Survey: spring and autumn Faroese | | | | Years: 1994–2009<br>N° per hour<br>Size |
| Haul-by-haul lpues from French trawlers | Not used | Not used | Years: 2000–2008 | Years: 2000–2009 |
| Aggregated unstandardized French lpue | Years: 1989–2006 | Years: 1989–2007 | Years: 1989–2008 | Not used |

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## 19.7 Blue ling other areas

| | |
|---|---|
| Stock: | Blue ling in Subareas I, II, III, IV, VIII, IX, X and XII. |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Pascal Lorence |

## A. General

### A.1. Stock definition

Biological investigations in the early 1980s suggested that at least two adult stock components were found within the Area, a northern stock in Subarea XIV and Division Va with a small component in Vb, and a southern stock in Subarea VI and adjacent waters in Division Vb. However, the observations of spawning aggregations in each of these areas and elsewhere suggest further stock separation. This is supported by differences in length and age structures between areas as well as in growth and maturity. Egg and larval data from early studies also suggest the existence of many spawning grounds. The conclusion is that stock structure is uncertain within the areas under consideration.

However, as in previous years, on the basis of similar trends in the cpue series from Division Vb and Subareas VI and VII, blue ling from these areas has been treated for assessment purposes as a single southern stock. Blue ling in Va and XIV has been treated as a single northern stock. All remaining areas are grouped together as "other areas.

### A.2. Fishery

Blue ling has been an important bycatch in trawl fisheries for mixed deep-water species on Hatton Bank (Division XIIb) although historically there have been directed fisheries on spawning aggregations in that area. Historiclly there was a directed fishery on spawning aggregations in Subarea II but now this species is now only taken as bycatch in Norwegian longline fisheries in this area. In other areas blue ling is taken in small quantities. Small reported landings in Subareas VIII, IX and X probably refer to *Molva macropthalma*.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time-series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

There is limited data on discarding from Spanish observers in Subarea XII. Discard data for other areas is unavailable but it is thought the discarding of this species is insignificant.

### B.2. Biological

No data available.

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

No data available.

### B.4. Commercial cpue

No data available.

### B.5. Other relevant data

## C. Assessment: data and method

Model used: Landing trends (total landings split on area and countries).

Software used:

Model Options chosen:

Input data types and characteristics:

| Type | Name | Year range | Split on areas and countries Yes/No | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1988–2010 | Yes | No |

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological Reference Points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

# H. Other issues

## H.1. Historical overview of previous assessment methods

# I. References

## 19.8 Greater forkbeard in all areas

| | |
|---|---|
| Stock: | Greater forkbeard in all ecoregions |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Guzman Diez |

# A. General

### A.1. Stock definition

The greater forkbeard is a gadoid fish which is widely distributed in the northeastern Atlantic from Norway and Iceland to Cape Blanc in West Africa and the Mediterranean (Svetovidov, 1986; Cohen *et al*., 1990). It is distributed along the continental shelf and slope in depths ranging between 60 and 800 meters but recent observations on board of commercial longliners and research surveys extend the depth range to below 1000 m (Stefanescu *et al*., 1992).

Unfortunately very little is known about stock structure of the species. Currently ICES considered greater forkbeard as a single stock for all the ICES area greater forkbeard in the Northeast Atlantic. Probably the stock structure is more complex, but further studies needs to be implemented to allow a scientific basis for the stock structure.

### A.2. Fishery

Greater forkbeard may be considered as a bycatch species in the traditional demersal trawl and longline mixed fisheries targeting species such as hake, megrim, monkfish, ling, and blue ling. Since 1988, around 80% of landings came from the Subareas VI and VII. Spanish, French and UK trawlers and longliners are the main fleets involved in this fishery. But also the Irish deep-water fishery around Porcupine Bank is based on the flat grounds and targets orange roughy, black scabbard, roundnose grenadier and deep-water siki sharks has landed historically important quantities of this species. The Russian fishery in the North-East Atlantic targeting roundnose grenadier, tusk and ling fish small quantities of greater forkbeard as bycatch of the trawler fleet in Hatton and Rockall Banks. The rest of landings in that period (11%), come from Subareas VIII and IX (mainly from VIII) by the trawler and longliner Spanish and French fleet. In Subarea IX since 2001 small amounts of *Phycis* spp (probably *P. phycis*) are landed in ports of Strait of Gibraltar by the longliner fleet targeting scabbardfish in Algeciras, Barbate and Conil.

Minor quantities of *P. blennoides* from X Subdivision and Vb Subarea are landed by Portuguese and Norwegian vessels respectively. The Azores deep-water fishery is a multispecies and multigear fishery dominated by the main target species *Pagellus bogaraveo*. Target species can change seasonally according to abundance and market prices, but landings of *Phycis blennoides* representing less than 0.6% of total deep-water landings in last two years, and can be considered as bycatch.

Catches data for greater forkbeard in 2006 and 2007 aggregated at the level of statistical rectangle were provided to the Working Group by Basque Country (Spain) France, Ireland, the UK (England and Wales and Scotland) and Iceland.

### A.3. Ecosystem aspects

For greater forkbeard can be applied the same ecosystem considerations of other deep-water fisheries in the areas defined for the stocks. Fishing is a major disturbance factor of the continental shelf communities of the regions. As the fishery of Greater forkbeard is mainly a bycatch of trawler fishery in all ecoregions the main affections on the ecosystem is the impact on the sediment compound.

## B. Data

### B.1. Commercial catch

Commercial landings are available from the Basque Country trawler fleet (OTB and PTB) operating in Subareas VI, VII and VIII from 2001 to 2008. . Owing to the bycatch status of the species, they may be unreliable and significant discards occur in some fisheries, in particular on the shelf where juvenile greater forkbeard occur.

### B.2. Biological

The biology of the species is poorly known. In general most of biological data are not reliable or not available (e.g. age composition, maturity, growth, natural mortality…) In Tables 19.8.3 and 19.8.4 a compilation of biological available data are shown. (WGDEEP 2001 (ICES C.M. 2001/ACFM: 23; Lorance 2010)). The spawning areas and seasonality are also not well (or not at all) identified. Only historical series of length frequencies from surveys were available.

**Table 19.8.3. Life-history characteristics of greater forkbeard (from WGDEEP 2001 (ICES C.M. 2001/ACFM: 23; Lorance, 2010).**

| LHC | SEX | ESTIMATE | AREA (month) | REFERENCE |
|---|---|---|---|---|
| Maximum observed length (TL, cm) | combined | 50 | VIIIc and IXa | Sanchez *et al.*, 1995 |
| | female | 84 | VIIIc and IXa | Casas and Piñeiro, 2000 |
| | male | 44 | VIIIc and IXa | Casas and Piñeiro, 2000 |
| Maximum observed age (year) | female | 14 | VIIIc and IXa | Casas and Piñeiro, 2000 |
| | male | 6 | VIIIc and IXa | Casas and Piñeiro, 2000 |
| | combined | 2 | Atlantic | Cohen *et al.*, 1990 |
| | female | 9 | NE Atlantic | Kelly, 1997 |
| | male | 7 | | |
| | combined | 15 | NE Atlantic | EC FAIR, 1999, Sub-t. 5.12, Doc.55 |
| Length at 50% maturity (PAFL, cm) | female | 33 cm | NE Atlantic | Cohen *et al.*, 1990(1,2) |
| | male | 18 cm | Mediterranean | Cohen *et al.*, 1990(1,2) |
| | female | 32 cm | NE Atlantic | Kelly, 1997 |
| | male | 31 cm | Mediterranean | |
| Age at 50% maturity Combined (year) | combined | 3–4 yrs | Mediterranean sea | Muus and Nielsen, 1999 |
| Length of smallest individuals caught (TL) | combined | 6 cm | VIIIc and IXa | Casas and Piñeiro, 2000 |
| | | 8 cm | VIIIa,b,d (Oct.–Nov.) | Data from French western IBTS |
| | | 8 cm | VIIg-k (Oct.–Nov.) | Data from French western IBTS |

| LHC | SEX | ESTIMATE | AREA (month) | REFERENCE |
|---|---|---|---|---|
| Age of youngest individuals caught (year) | combined | < 1yr | VIIIc and IXa | Casas and Piñeiro, 2000 |
| Length of the first mode of the length distribution | combined | 13.9 cm | VIIIc, IXa (April) | Casas and Piñeiro, 2000 |
| | | 16.9 cm | VIIIc, IXa (Sept.) | Casas and Piñeiro, 2000 |
| | | 17.4 cm | VIIIc, IXa (Oct.) | Casas and Piñeiro, 2000 |
| | | 16 cm | VIIIa,b,d (Oct.–Nov.) | Data from French western IBTS |

**Unclear whether it is mean length at first maturity or length of smallest mature individual.**

**Table 19.8.4. Growth parameters of greater forkbeard. (from WGDEEP 2001 (ICES C.M. 2001/ACFM:23; Lorance, 2010)).**

| SEX | L∞ | K | T0 | AREA | REFERENCE |
|---|---|---|---|---|---|
| Male | 41.7 | 0.208 | N/A | Gulf of Lions (Med.) | Nony, 1983 (from FishBase) |
| Female | 51.2 | 0.258 | N/A | Gulf of Lions (Med.) | Nony, 1983 (from FishBase) |
| Combined | 57.7 | 0.168 | -0.66 | Aegean sea (Med.) | Papaconstantinou *et al.*, 1993 |
| Male | 54.9 | 0.217 | -0.663 | VIIIc and IXa | Casas and Piñeiro, 2000 |
| Female | 113.3 | 0.0886 | -0.556 | VIIIc and IXa | Casas and Piñeiro, 2000 |

### B.3. Surveys

Data of abundance, length frequencies of *P. blennoides* and area covered by hauls from the of Spanish survey in Porcupine and data of length frequencies from Spanish Cantabrian sea and French western and Scottish IBTS and Irish surveys has been used in the assessment.

Data from surveys are available in the DATRAS database and at national level. Most survey do not cover the deeper part of the depth distribution of the species.

### B.4. Commercial cpue

Commercial effort (number of total trips) and lpue (kg/day) is available from the Basque Country trawler fleet (OTB and PTB) operating in Subareas VI, VII and VIII from 2001 to 2010.

### B.5. Other relevant data

Landings and effort data in XIIb should be included into the assessment if they become reliable. Landings and discards from all areas and fisheries were greater forkbeard occur should be compiled. Because greater forkbeard is a bycatch in shelf and slope fisheries and is subject to discards data on total catch are essential to assess the stock (s).

Greater forkbeard is caught in a number of surveys that are likely to provide reliable trends in either total abundance, recruitment of both. It is recommended that survey data are used to assess stocks trends.

Stock identity knowledge is lacking for greater forkbeard in the Northeast Atlantic. Survey based population indicators of greater forkbeard should be calculated from all relevant survey and provided to WGDEEP. The recommended indicators are: abundance, log abundance, mean length, quantiles of mean length, biomass, per strata and for the whole survey. Interpretation of trends by survey and strata should be used to define the overall trend of greater forkbeard in areas where it is caught.

## C. Assessment: data and method

Model used:

Not applicable

Software used: Not applicable

Model Options chosen: Not applicable

Input data types and characteristics

## D. Short-term projection

Not applicable

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Not applicable

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

Not applicable

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References

## 19.9 Greater silver smelt in Va

| | |
|---|---|
| Stock: | Greater Silver Smelt in Division Va |
| Working Group: | WKDEEP |
| Date: | February 2010 |
| Revised by: | Gudmundur Thordarson |

# A. General

### A.1. Stock definition

Greater Silver Smelt (*Argentina silus*) stock in Division Va (Icelandic waters) is treated as a separate assessment unit is from greater silver smelt in Subareas I, II, IV, VI, VII, VIII, IX, XII, XIV and Divisions IIIa and Vb.

### A.2. Fishery

Greater silver smelt is mostly fished along the south, southwest, and west coast of Iceland, at depths between 500 and 800 m.

Greater silver smelt was caught in bottom trawls for years as bycatch in the redfish fishery. Only small amounts were reported prior to 1996 as most of the greater silver smelt was discarded. Since 1997, direct fishery for greater silver smelt has been ongoing and the landings have increased significantly. At the beginning, the fishery was mainly located along the slopes of the south and southwest coast, but in recent years the fishery has expanded and significant catches are taken along the slopes west of Iceland.

The greater silver smelt fishery is at present not managed by quotas but rather as an exploratory fishery subject to licensing (see A.2.1) since 1997. Greater silver smelt is now mainly taken both in a directed fishery with, but also as a bycatch in the redfish fishery.

#### A.2.1. Fleet

Greater silver smelt in Va is caught only in bottom trawls, often as a bycatch or in conjunction with redfish and Greenland halibut fishing. Between 20 and 30 trawlers have participated in the fishery since 1996. In recent years, the majority of the greater silver smelt landings have been taken in hauls were the species was 50% or more of the catch in the haul. The trawlers that target greater are mainly freezer trawlers that are between 1000 and 2000 GRT. The fleet uses a bottom trawl with small mesh size belly (80 mm) and codend (40 mm).

#### A.2.2. Regulations

The greater silver smelt fishery is subject to regulation nr 717, 6th of October 2000 with amendments 1138/2005 from the Ministry of Fisheries. In short the regulation states among others that:

1 ) All fishing of greater silver smelt is subject to licensing by the Directorate of Fisheries that has to be renewed each year.

2 ) Fishing for Greater silver smelt is only allowed south and west of Iceland. That is west of W19°30 and south of N66°00 at depths greater than 220

fathoms (approx 430 m). Between W19°30 and W14°30 taking of greater silver smelt is allowed south of given line (Figure 19.9.1 and Table 19.9.1).

3 ) It is mandatory to keep logbooks were the date, exact position of haul, catch and depth are recorded.

4 ) Samples shall be collected, at least one from each fishing trip. The sample shall consist of randomly selected 100–200 specimens of greater silver smelt. The sample is frozen on board and sent to the Marine Research Institute in Reykjavik for further investigation.

5 ) Minimum mesh size in the trawl is 80 mm but 40 mm in the codend.

A revised regulation will soon come into effect that expands the fishing area north to 67°N and east to 12°W.

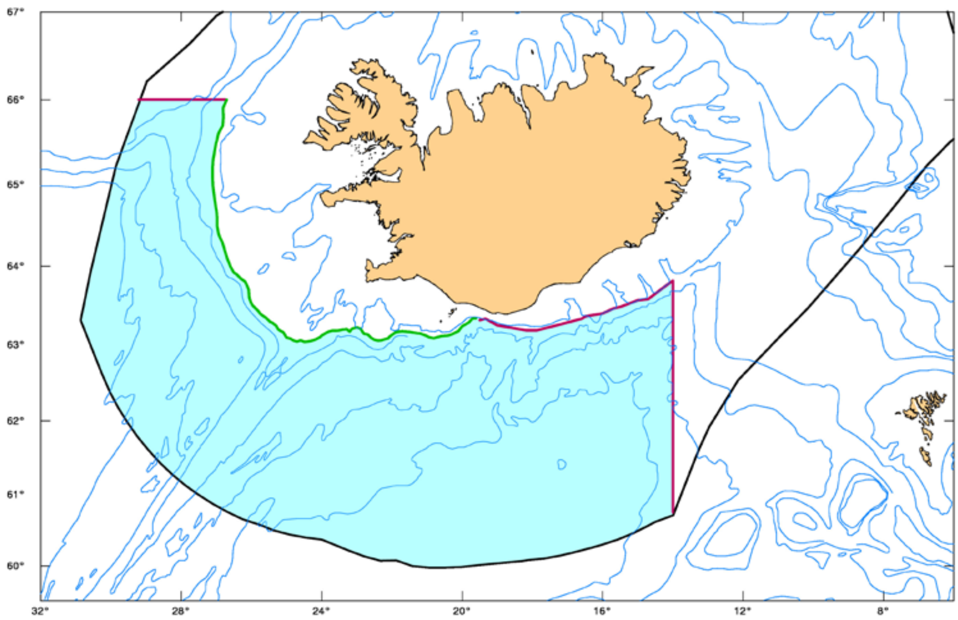



**Figure 19.9.1. Area open to commercial fishing of Greater Silver Smelt in Va according to regulation nr 717, 6th of October 2000 with amendments 1138/2005 from the Ministry of Fisheries (the shaded blue area). The red-line off the south coast drawn according to Table 19.9.1 and the green line is an approximation of the 400 m depth contour.**

### A.3. Ecosystem aspects

Warming of sea temperature has been documented in Va and an expansion of distributional area of warm-water species such as anglerfish. The significance and reliability of such metrics is considered at the moment insufficient for their consideration in the provision of management advice of greater silver smelt in Va.

## B. Data

### B.1. Commercial catches

Icelandic commercial catches in tonnes by month and gear are provided by Statistical Iceland and the Directorate of Fisheries. Data on catch in tonnes from other countries are taken from ICES official statistics (STATLAN) and/or from the Icelandic Coast Guard. Annual landings are available from 1985 or from the commencing of the targeted fishery. The fishing statistics are considered accurate. Discards are not considered to be of relevance and therefore not included in the assessment. There are limited measurements of discard from 2002 to 2009. The distribution of catches is obtained from logbook statistics where location of each haul, effort, depth of trawling and total catch of greater silver smelt is given. From the logbook catch per unit of effort and effort is estimated.

### B.2. Biological

Biological data from the greater silver smelt catch is collected on board of the fishing vessel, as it is mandatory to send at least one sample from each fishing trip. The sample is sent to the Marine Research Institute and analysed by scientists and technicians. Each sample consists of randomly selected 100–200 specimens of greater silver smelt. In each sample, otoliths are extracted from 50 specimens. The biological data collected are length (to the nearest cm), sex and maturity stage, and ungutted weight (to the nearest gramme). The rest of the sample is only length measured.

From 1987–1996, biological sampling from the catches were sporadic. Biological sampling of the catches has been generally considered sufficient since 1997. Age reading is considered accurate.

Greater silver smelt in Va reaches 50% maturity at around 36 cm or at around 6–8 years of age. The species enters the fishery at around 30 cm or 3–4 years of age. Only very few greater silver smelt have been measured 60 cm or larger.

### B.3. Surveys

The annual Icelandic groundfish surveys give trends on fishable biomass of many exploited stocks on Icelandic fishing grounds. The main objective in the design of the surveys was to monitor the most important commercial stocks such as cod, haddock, saithe, and redfish. However the surveys are considered representative for many other exploited stocks of lesser economic importance.

#### B.3.1. The Icelandic groundfish survey in March

In the Icelandic groundfish survey which has been conducted annually in March since 1985 gives trends on fishable biomass of many exploited stocks on Icelandic fishing grounds. Total of more than 500 stations are taken annually in the survey at depths down to 500 meters. Therefore the survey area does not cover the most important distribution area of greater silver smelt and is not considered fully representative for greater silver smelt in Va.

#### B.3.2. The Icelandic groundfish survey in October (autumn Survey)

The Icelandic Autumn Groundfish Survey (AGS) has been conducted annually since 1996 by the Marine Research Institute (MRI). The objective is to gather fishery-independent information on biology, distribution and biomass of demersal fish species in Icelandic waters, with particular emphasis on Greenland halibut (*Reinhardtius hippoglossoides*) and deep-water redfish (*Sebastes mentella*). This is because the Icelandic Groundfish Survey (IGS) conducted annually in March does not cover the distribution of these deep-water species. Secondary aim of the survey is to have another fisheries independent estimate on abundance, biomass and biology of demersal species, such as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and golden redfish (*Sebastes marinus*), in order to improve the precision of stock assessment.

AGS is conducted in October as it is considered the most a suitable month in relation to diurnal vertical migration, distribution and availability of Greenland halibut and deep-sea redfish. The research area is the Icelandic continental shelf and slopes within the Icelandic Exclusive Economic Zone to depths down to 1500 m. The research area is divided into a shallow-water area (0–400 m) and a deep-water area (400–1500 m). The shallow-water area is the same area as covered by IGS. The deep-water area is directed at the distribution of Greenland halibut, mainly found at depths from 800–1400 m west, north and east of Iceland, and deep-water redfish, mainly found at 500–1200 m depths southeast, south and southwest of Iceland and on the Reykjanes Ridge.

Initially, a total of 430 stations were divided between the two areas. Of them, 150 stations were allocated to the shallow-water area and randomly selected from the IGS station list. In the deep-water area, half of the 280 stations were randomly positioned in the area. The other half were randomly chosen from logbooks of the commercial bottom-trawl fleet fishing for Greenland halibut and deep-water redfish in 1991–1995. The locations of those stations were, therefore, based on distribution and pre-estimated density of the species.

Because MRI was not able to finance a project in order of this magnitude, it was decided to focus the deep-water part of the survey on the Greenland halibut main distributional area. For this reason, important deep-water redfish areas south and west of Iceland were omitted. The number and location of stations in the shallow-water area were unchanged.

The number of stations in the deep-water area was therefore reduced to 150. Altogether 100 stations were randomly positioned in the area. The remaining stations were located on important Greenland halibut fishing grounds west, north and east of Iceland and randomly selected from a logbook database of the bottom-trawl fleet fishing for Greenland halibut 1991–1995. The number of stations in each area was partly based on total commercial catch.

In 2000, with the arrival of a new research vessel, MRI was able finance the project according to the original plan. Stations were added to cover the distribution of deep-water redfish and the location of the stations selected in a similar manner as for Greenland halibut. Altogether 30 stations were randomly assigned to the distribution area of deep-water redfish and 30 stations were randomly assigned to the main deep-water redfish fishing grounds based on logbooks of the bottom-trawl fleet 1996–1999. The years 1996–1999 cannot be used for abundance and biomass estimates of greater silver smelt since the AGS in those years did not cover adequately the distribution of the species.

In addition, 14 stations were randomly added in the deep-water area in areas where great variation had been observed in 1996–1999. However, because of rough bottom which made it impossible to tow, five stations have been omitted. Finally, 12 stations were added in 1999 in the shallow-water area, making total stations in the shallow-water area 162. Total number of stations taken since 2000 has been around 381 (Figure 19.9.2).

The RV "Bjarni Sæmundsson" has been used in the shallow-water area from the beginning of the survey. For the deep-water area MRI rented one commercial trawler 1996–1999, but in 2000 the commercial trawler was replaced by the RV "Árni Friðriksson".

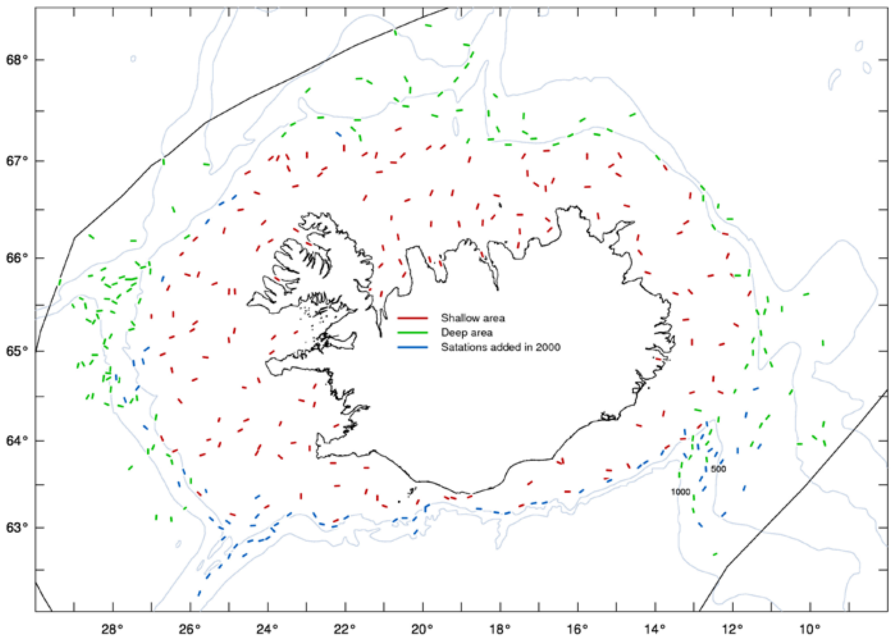



**Figure 19.9.2. Stations in the Autumn Groundfish Survey (AGS). RV "Bjarni Sæmundsson" takes stations in the shallow-water area (red lines) and RV "Árni Friðriksson" takes stations in the deep-water areas (green lines), the blue lines are stations added in 2000.**

### B.3.2.1. Data collection (biological sampling)

#### *B.3.2.1.1. Length measurement, counting (subsampling)*

All fish species are measured for length. For the majority of species including greater silver smelt, total length is measured to the nearest cm from the tip of the snout to the tip of the longer lobe of the caudal fin. At each station, the general rule, which also applies to greater silver smelt is to measure at least four times the length interval of a given species. Example: If the continuous length distribution of greater silver smelt at a given station is between 15 and 45 cm, the length interval is 30 cm and the number of measurements needed is 120. If the catch of greater silver smelt at this station exceeds 320 individuals, the rest is counted.

Care is taken to ensure that the length measurement sampling is random so that the fish measured reflect the length distribution of the haul in question.

#### *B.3.2.1.2. Recording of weight, sex and maturity stages*

Sex and maturity data has not been collected from greater silver smelt sampled in the autumn survey, nor has silver smelt been weighted. Collection of these data is supposed to commence in 2010.

#### *B.3.2.1.3. Otolith sampling and weighing*

For greater silver smelt a minimum of one and a maximum of 25 otoliths are collected from each haul. Otoliths are sampled at a 30 fish interval so that if in total 300 greater silver smelt are caught in a single haul, ten otoliths are sampled.

### B.3.2.2. Station information

At each station relevant information on the haul and environmental factors, are filled out by the captain and the first officer in cooperation with the cruise leader.

#### Tow information

- **General:** Year, Station, Vessel registry no., Cruise ID, Day/month, Statist. Square, Sub-square, Tow number, Gear type no., Mesh size, Briddles length (m).
- **Start of haul:** Pos. N, Pos. W, Time (hour:min), Tow direction in degrees, Bottom depth (m), Towing depth (m), Vert. opening (m), Horizontal opening (m).
- **End of haul:** Pos. N, Pos. W, Time (hour:min), Warp length (fm), Bottom depth (m), Tow length (naut. miles), Tow time (min) , Tow speed (knots).
- **Environmental factors:** Wind direction, Air temperature °C, Windspeed, Bottom temperature °C, Sea surface, Surface temperature °C, Towing depth temperature °C, Cloud cover, Air pressure, Drift ice.

#### B.3.2.3. Fishing gear

Two types of the bottom survey trawl "Gulltoppur" are used for sampling: "Gulltoppur" is used in the shallow water and "Gulltoppur 66.6 m" is used in deep waters. The trawls were common among the Icelandic bottom-trawl fleet in the mid-1990s and are well suited for fisheries on cod, Greenland halibut and redfish.

The bottom trawl used in the shallow water is called "Gulltoppur". The headline is 31.0 m, and the fishing line is 19.6 m. The trawl used in the deep-water area is "Gulltoppur 66.6 m". The headline is 35.6 m and the fishing line is 22.6 m.

**Towing speed and distance:** The towing speed is 3.8 knots over the bottom. The trawling distance is 3.0 nautical miles calculated with GPS when the trawl touches the bottom until the hauling begins (i.e. excluding setting and hauling of the trawl).

#### B.3.2.4. Data processing

##### *B.3.2.4.1. Abundance and biomass estimates at a given station*

As described above the normal procedure is to measure at least four times the length interval of a given species. The number of fish caught of the length interval $L_1$ to $L_2$ is given by:

$$P = \frac{n_{measured}}{n_{counted} + n_{measured}}$$

$$n_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i}{P}$$

Where $n_{measured}$ is the number of fished measured and $n_{counted}$ is the number of fish counted.

Biomass of a given species at a given station is calculated as:

$$B_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i \alpha L_i^{\beta}}{P}$$

Where Li is length and alpha and beta are coefficients of the length–weight relationship.

***B.3.2.4.2. Index calculation***

For calculation of indices the Cochran method is used (Cochran, 1977). The survey area is split into subareas or strata and an index for each subarea is calculated as the mean number in a standardized tow, divided by the area covered multiplied with the size of the subarea. The total index is then a summed up estimates from the subareas.

A 'tow-mile' is assumed to be 0.00918 square nautical mile. That is the width of the area covered is assumed to be 17 m (17/1852=0.00918). The following equations are a mathematical representation of the procedure used to calculate the indices:

$$I_{strata} = \frac{\sum_{strata} Z_i}{N_{strata}}$$

$$\sigma^2_{strata} = \frac{\sum_{strata} (Z_i - I_{strata})^2}{N_{strata} - 1}$$

$$I_{region} = \sum_{region} I_{strata}$$

$$\sigma^2_{strata} = \sum_{region} \sigma^2_{strata}$$

$$CV_{region} = \frac{\sigma_{region}}{I_{region}}$$

Where *strata* refers to the subareas used for calculation of indices which are the smallest components used in the estimation, *I* refers to the stations in each subarea and region is an area composed of two or more subareas. *Zi* is the quantity of the index (abundance or biomass) in a given subarea. *I* is the index and sigma is the standard deviation of the index. CV refers to the coefficient of variation.

The subareas or strata used in the Icelandic groundfish surveys (same strata division in both surveys) are shown in Figure 19.9.3. The division into strata is based on the so-called BORMICON areas and the 100, 200, 400, 500, 600, 800 and 1000 m depth contours.

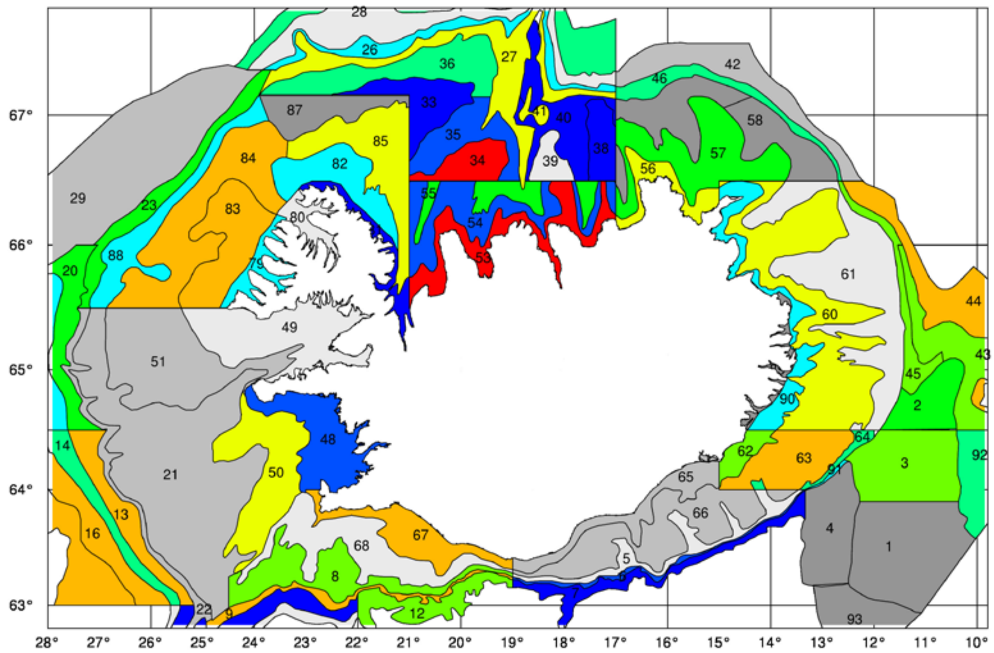



**Figure 19.9.3. Subareas or strata used for calculation of survey indices in Icelandic waters.**

#### *B.3.2.4.3. Stratification for greater silver smelt*

The standard calculations of regional survey indices are not particularly applicable to greater silver smelt (originally designed for cod). Therefore, the processing of the autumn survey data is done at a slightly different regional scale. In short, the main distributional area of greater silver smelt off the southeast, south and west coast of Iceland, and in recent years also off the northwest coast. Also, fishing of greater silver smelt is banned at depths less than 220 fathoms (~400 m). To get a proxy for 'fishable' survey indices a few regions are defined for depths greater than 400 m (Table 19.9.1 and Figure 19.9.4).

**Table 19.9.1. Survey regions used for calculation of various Autumn Groundfish Survey indices for greater silver smelt in Va.**

| Region | No. strata | Area (km2) | No. stations |
|---|---|---|---|
| Total | 74 | 339 691 | 378 |
| GSS fishing grounds | 13 | 46 993 | 80 |
| Depth >400 m | 32 | 152 626 | 186 |
| Depth <400 m | 41 | 186 870 | 192 |
| NW >400 m | 2 | 20 081 | 16 |
| W >400 m | 9 | 31 613 | 60 |
| S >400 m | 6 | 26 715 | 24 |
| SE >400 m | 7 | 30 358 | 36 |

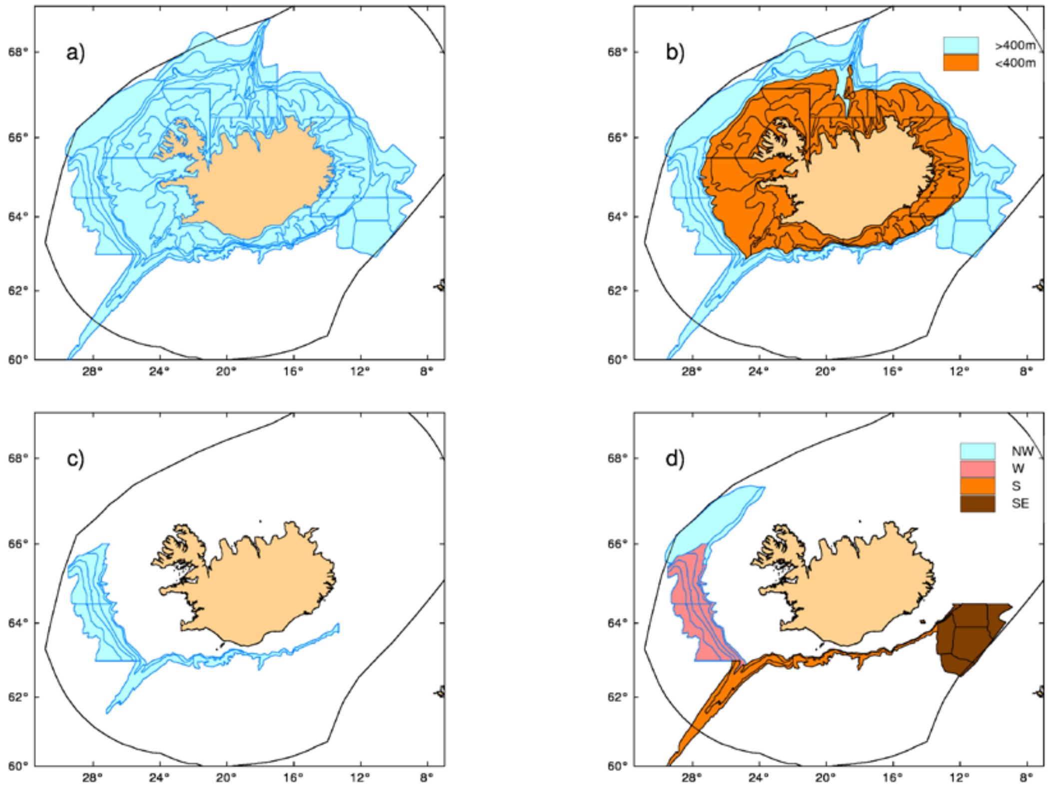



**Figure 19.9.4. Divisions used in calculation of indices for greater silver smelt in Va. a) Total area. b) Division at 400 m depth contour. c) Greater silver smelt fishing area. d) Subdivisions of the main distributional area of greater silver smelt.**

#### *B.3.2.4.4. Winsorization of survey data*

One of the main problems when calculating indices from tow surveys is how to treat few large hauls. In some cases, one or two hauls, that happens to be inside a large stratum, can result in very marked increase in survey estimates. This is a problem for greater silver smelt as for many other species. Not only can exceptionally large hauls increase survey estimates but also greatly affect estimated *CV* of the index in question.

Winsorization is one way to deal with outliers (Sokal and Rolf, 1995). A typical way to go when applying Winsorization is to set all outliers to a specified percentile of the data; for example, a 90% Winsorisation would set all data below the 5th percentile to the 5th percentile, and data above the 95th percentile set to the 95th percentile. Winsorised estimators are usually more robust to outliers than their un-winsorised counterparts.

This strategy is applied to the greater silver smelt data from Autumn Groundfish Survey. The numbers of greater silver smelt in a tow that are greater than the 95th percentile are set at the quantile. The same is done for the 5th percentile quantile, that is, numbers of greater silver smelt in a tow that are lower than 5th percentile quantile are set at the quantile. It should be noted that tow-stations that have no greater silver smelt are excluded from the Winsorization.

### B.4. Commercial cpue

Catch per unit of effort (cpue) has been calculated using all data where catches of the greater silver smelt were more than 30%, 50% and 70% of the total reiterated catch in each haul. Estimates of Raw-cpue is simply the sum of all catch divided by the sum of the hours trawled. As the trawlers do not set out the trawl except when the captain is certain there is an aggregation of greater silver smelt and as the fishery is largely driven by markets and quota shares in other species (deep-water redfish and Greenland halibut) it is not certain how representative the cpue series is of stock trends.

## C. Historical stock development

Greater silver smelt in Va is assessed based on trends in survey biomass indices (standard un-winsorized and winsorized) from the Icelandic Autumn survey and changes in age distributions from commercial catches and surveys. Supplementary data used includes relevant information from the fishery and surveys such as changes in spatial (geographical and depth range) and temporal distribution, length distributions and maturity ogives.

At present analytical assessments cannot be conducted because of contrasting signals in the available data and the relative shortness of the time-series available.

## D. Short-term predictions

No short-term predictions are performed.

## E. Medium-term predictions

No medium-term predictions are performed.

## F. Long-term predictions

No long-term predictions are performed.

## G. Biological reference points

No biological reference points are defined for greater silver smelt in Division Va.

## H. Other issues

Stock identity of greater silver smelt in the Northeast Atlantic is unclear and further research is needed. Strong recommendations are given in the 2010 WKDEEP Report on this issue (Section 7.1, WKDEEP 2010 Report).

## I. References

Cochran,W.G. 1977. Sampling techniques, 3rd edition. New York: Wiley & Sons.

Sokal, R. R. and Rohlf, F. J. 1995. Biometry. W. H. Freeman and Company, 3rd edition.

## 19.10 Ling in I and II

| | |
|---|---|
| Stock: | Ling in Subareas I and II |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Kristin Helle |

# A. General

### A.1. Stock definition

WGDEEP 2006 indicated: '*There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e. stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Va), the Norwegian Coast (II), and the Faroes and Faroe Bank (Vb) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas IV, VI, VII and VIII) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in future*'

### A.2. Fishery

Ling has been fished in these Subareas for centuries, and the historical development is described in, e.g. Bergstad and Hareide (1996). In particular, the post-World War II increase in catch, because of a series of technical advances, is well documented. Currently the major fisheries in Subareas I and II are the Norwegian longline and gillnet fisheries, but there are also bycatches taken by other gears, i.e. trawls and handlines. Around 50% of the Norwegian landings are taken by longlines and 45% by gillnets, partly in the directed ling fisheries and partly as bycatch in fisheries for other groundfish. Other nations catch ling as bycatch in their trawl fisheries.

During the period 2000–2005 the landings varied between 6000 and 7000 tonnes, which are about the same catches as in the preceding decade. In 2007 and 2008 the landings increased to over 10 000 tonnes.

### A.3. Ecosystem aspects

# B. Data

### B.1. Commercial catch

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time-series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

### B.2. Biological

Length data for the Norwegian reference fleet in Subarea IIa have been routinely collected since 2002.

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

No data available.

### B.4. Commercial cpue

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding eight tonnes in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. Cpue were calculated as the average total catch of ling per vessel (*C*), and the average number of hooks per set and per vessel (*N*) associated with these catches. Then, for each year and catch category, the estimated cpue for the entire fleet was determined as *C*/*N*. Thus the estimated cpue for each year and subarea was the mean catch in kg per hook for the entire fleet.

The boats that provided logbooks are the primary sampling units, and *C* and *N* are both random variables. It follows that this is a ratio-type estimator, therefore the standard errors of the cpue estimates could be calculated as described in Cochran (1977, page 32). This cpue estimator is a weighted average, that is the more hooks a boat sets, the more influence it has on the estimate (Cochran, 1977). For comparison, an unweighted cpue series was also constructed (i.e. the average cpue per boat).

A standardized series will be developed in preparation for WGDEEP 2012.

### B.5. Other relevant data

## C. Assessment: data and method

Model used: The stock is assessed using trends in catch and cpue.

Software used:

Model Options chosen:

Input data types and characteristics

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1) Initial stock size:
2) Natural mortality:
3) Maturity:
4) F and M before spawning:
5) Weight-at-age in the stock:
6) Weight-at-age in the catch:
7) Exploitation pattern:
8) Intermediate year assumptions:
9) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References

## 19.11 Ling in Va

| | |
|---|---|
| Stock: | Ling in Va |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Gudmundur Thordarson |

# A. General

### A.1. Stock definition

WGDEEP 2006 indicated: '*There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e. stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Va), the Norwegian Coast (II), and the Faroes and Faroe Bank (Vb) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas IV, VI, VII and VIII) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in future*'.

WGDEEP 2007 examined available evidence on stock discrimination and concluded that available information is not sufficient to suggest changes to current ICES interpretation of stock structure.

### A.2. Fishery

The fishery for ling in Va has not changed substantially in recent years. Around 150 longliners annually report catches of ling, around 70 gillnetters and a similar number of trawlers. Most of ling in Va is caught on longlines and the proportion caught by that gear has increased since 2000 to around 65% in 2010. At the same time the proportion caught by gillnets has decreased from 20–30% in 2000–2001 to 4–8% in 2008–2010. Catches in trawls have varied less and have been at around 20%.

Most of the ling caught in Va by Icelandic longliners is caught at depths less than 300 meters and less than 500 meters by trawlers. The main fishing grounds for ling in Va as observed from logbooks are on the south, southwestern and western part of the Icelandic shelf.

In the 1950s until 1970 the total landings of Ling in Va amounted to 10 000 to 16 000 tonnes annually of which more than half was usually caught by foreign fleets. This changed with the extension of the Icelandic EEZ in the early 1970s when total landings fell to 4000–8000 tonnes of which the Icelandic fleet caught the main share. Between 1980 and 2000 catches varied between 3200 to 5800 tonnes.

### A.3. Ecosystem aspects

Ling in Icelandic waters is mainly found on the continental shelf and slopes of southeast, south, and west of Iceland at depths of 0–1000 m, but mainly but is mainly caught in the fisheries at depths around than 200–500 meters. Warming of sea temperature, have been documented in Va and an expansion of distributional area of warm-water species such as anglerfish. The significance and reliability of such metrics is considered at the moment insufficient for their consideration in the provision of management advice of ling in Va.

### A.4. Management

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations. Below is a short account of the main feature of the management system and where applicable emphasis will be put on ling.

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The ITQ system allows free transferability of quota between boats. This transferability can either be on a temporary (one year leasing) or a permanent (permanent selling) basis. This system has resulted in boats having quite diverse species portfolios, with companies often concentrating/specializing on particular group of species. The system allows for some but limited flexibility with regards converting a quota share of one species into another within a boat, allowance of landings of fish under a certain size without it counting fully in weight to the quota, and allowance of transfer of unfished quota between management years. The objective of these measures is to minimize discarding, which is effectively banned. Since 2006/2007 fishing season, all boats operate under the TAC system.

At the beginning, only few commercially exploited fish species were included in the ITQ system, but many other species have gradually been included. Ling in Va was included in the ITQ-system in the 2001/2002 quota year.

Landings in Iceland are restricted to particular licensed landing sites, with information being collected on a daily basis time by the Directorate of Fisheries in Iceland (the enforcement body). All fish landed has to be weighted, either at harbour or inside the fish processing factory. The information on each landing is stored in a centralized database maintained by the Directorate and is available in real time on the Internet (www.fiskistofa.is). The accuracy of the landings statistics are considered reasonable.

All boats operating in Icelandic waters have to maintain a logbook record of catches in each haul/set. The records are available to the staff of the Directorate for inspection purposes as well as to the stock assessors at the Marine Research Institute.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place.

A system of instant area closure is in place for many species. The aim of the system is to minimize fishing on juveniles. An area is closed temporarily (for two weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than a certain percentage of the catch is composed of fish less than the defined minimum length.

## B. Data

### B.1. Commercial catch

The text table below shows which data from landings is supplied from ICES Division Va.

| ICES Division Va | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (Catch in weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | $Mat_{prop}$ (proportion mature-by-age) | Length composition in catch |
| Iceland | x | | | | x |
| The Faroe Islands | x | | | | |
| Norway | x | | | | |

Icelandic $B_{ling}$ catch in tonnes by month, area and gear are obtained from Statistical Iceland and Directorate of Fisheries. Catches are only landed in authorized ports where all catches are weighed and recorded. The distribution of catches is obtained from logbook statistic where location of each haul, effort, depth of trawling and total catch of ling is given. Logbook statistics are available since 1991. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard and reported to the Directorate of Fisheries.

Discard is banned in the Icelandic demersal fishery. Based on limited data discard rates in the Icelandic longline fishery for ling are estimated very low (<1% in either numbers or weight; WGDEEP-2011, WD02). Measures in the management system such as converting quota share from one species to another are used by the fleet to a large extend and this is thought to discourage discards in mixed fisheries.

### B.2. Biological

Biological data from the commercial longline and trawl fleet catches are collected from landings by scientists and technicians of the Marine Research Institute (MRI) in Iceland. The biological data collected are length (to the nearest cm), sex and maturity stage (if possible since most ling is landed gutted), and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted (to the nearest gramme). Biological sampling is also collected directly on board on the commercial vessels during trips by personnel of the Directorate of Fisheries in Iceland or from landings (at harbour). These are only length samples.

The general process of the sampling strategy is to take one sample of ling for every 180 tonnes landed. Each sample consists of 150 fish. Otoliths are extracted from 50 fish which are also length measured and weighed gutted. In most cases ling is landed gutted so it not possible to determine sex and maturity. If ling is landed ungutted, the ungutted weight is measured and the fish is sexed and maturity determined. The remaining 100 in the sample are only length measured. Age reading of ling from commercial catches ended in 1998. The reason was uncertainty in ageing and cost saving.

At 60 cm around 10% of ling in Va is mature, at 75 cm 50% of ling is mature and at 100 cm more or less every ling is mature. Ling is a relatively slow growing species; mean length in catch is around 80 cm which according to available ageing means that it is approximately eight years old.

No information is available on natural mortality of ling in Va.

The biological data from the fishery is stored in a database at the Marine Research Institute. The data are used for description of the fishery.

### B.3. Surveys

For detailed description of the surveys relevant to ling in Va, please refer to the stock annex for tusk in Va and XIV.

The Icelandic spring survey (March) commenced in 1985 and covers the Icelandic shelf down to 500 meters. The survey is considered descriptive of biomass trends. The Icelandic autumn survey (October) commences in 1996 and was expanded in 2000 the survey is considered to cover the distributional range of ling in Va and therefore to be representative of stock biomass, it is however a shorter time-series and has fewer stations that the spring survey.

### B.4. Commercial cpue

Data used to estimate cpue for ling in Division Va since 1991 are obtained from logbooks of the Icelandic trawl and longline fleet. Non-standardized cpue and effort is calculated for each year which is simply the sum of all catch divided by the sum of number of hooks.

### B.5. Other relevant data

NA.

## C. Assessment: data and method

Ling in Va and XIV is assessed based on trends in survey indices from the Icelandic spring and autumn survey. Supplementary information includes relevant information from the fishery such as length distributions, maturity data, effort, cpue and analysis of changes in spatial and temporal distribution.

## D. Short-term projection

No short-term predictions are performed.

## E. Medium-term projections

No medium-term predictions are performed.

## F. Long-term projections

No long-term predictions are performed.

## G. Biological reference points

No biological reference points are defined for ling in Va.

## H. Other issues

## I. References

## 19.12 Ling in other areas

| | |
|---|---|
| Stock: | Ling (*Molva Molva*) in areas (IIIa, IV, VI, VII, VIII, IX, X, XII, XIV) |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Kristin Helle |

# A. General

### A.1. Stock definition

WGDEEP 2006 indicated: '*There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e. stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Va), the Norwegian Coast (II), and the Faroes and Faroe Bank (Vb) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas IV, VI, VII and VIII) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in future*'

### A.2. Fishery

Significant fisheries for ling have been conducted in Subarea III and IV at least since the 1870s, pioneered by Swedish longliners. Since the mid-1900s and currently, the major targeted ling fishery in IVa is by Norwegian longliners conducted around Shetland and in the Norwegian Deep. There is little activity in IIIa. Of the total Norwegian 2010 landings, 83% were taken by longlines, 8% by gillnets, and the remainder by trawls. The bulk of the landings from other countries were taken by trawls as bycatches in other fisheries, and the landings from the UK (Scotland) are the most substantial. The comparatively low landings from the central and southern North Sea (IVb,c), are only bycatches from various other fisheries.

The major directed ling fishery in VI is the Norwegian longline fishery. Trawl fisheries by the UK (Scotland) and France primarily take ling as bycatch.

When Areas III–IV and VI–Xiv are pooled over the period 1988–2010, 40% of the landings were in Area IV, 29% in Area VI, and 26% in Area VI.

In Subarea VII the Divisions b, c, and g–k provide most of the landings of ling. Norwegian landings, and some of Irish and Spanish landings are from targeted longline fisheries, whereas other landings are primarily bycatches in trawl fisheries. Data split by gear type were not available for all countries, but the bulk of the total landings (at least 60–70%) were taken by trawls in these areas.

In Subareas VIII and IX, XII and XIV all landings are bycatches in various fisheries.

There was a decline in landings from 1988 to 2003, thereafter the landings have been stable (Figure 19.12.1). When Areas III–IV are pooled, the total landings averaged 32 thousand tons in 1988–1998 then declined to an average of 15 thousand tons in 2003–2010. The decline has been simultaneous in the main Areas IV, VI and VII, but Area VII has had a greater reduction in landings than in Areas IV and VI (Figure 19.12.2).

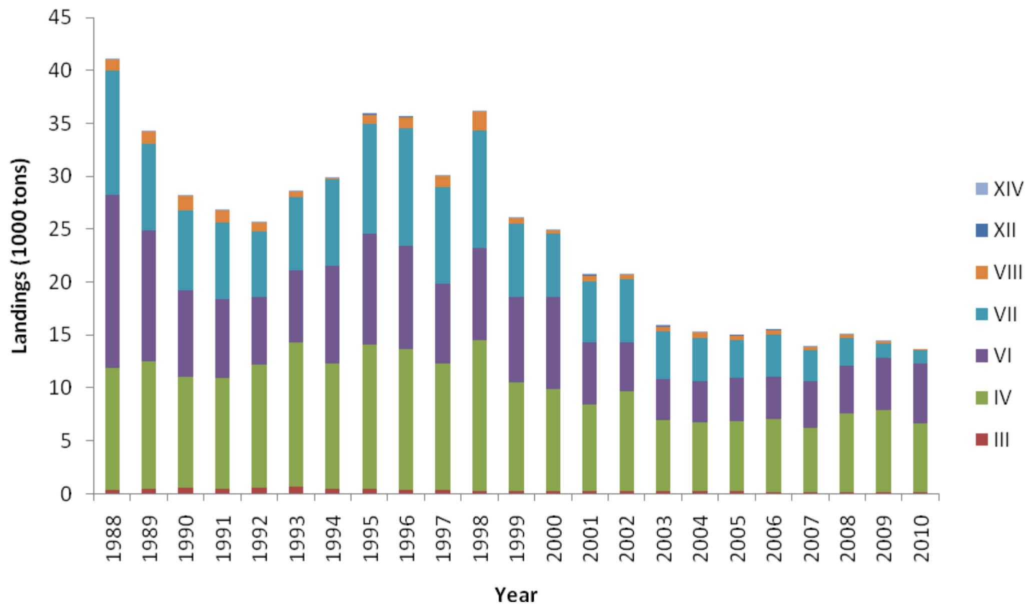



**Figure 19.12.1 international landings. Ling in other areas**

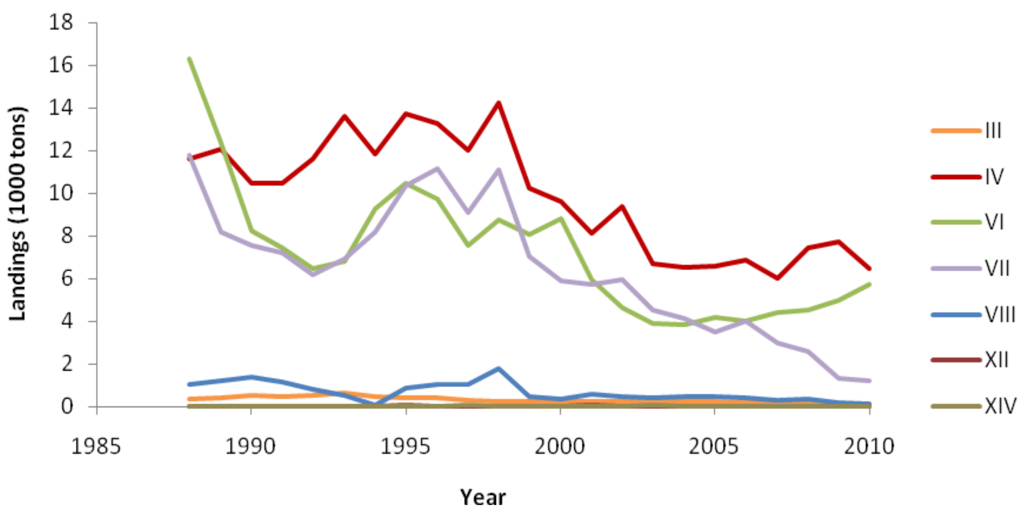



**Figure 19.12.2. international landings. Ling in other areas**

In Division IVa the total landings have varied between 10 000 and 13 000 t until 1998, then declined until 2003 to about half previous level, and have since remained stable.

In Division VIa the statistics are incomplete for the period 1989–1993. In the period 1994–2008, when the data are complete, they demonstrate a declining trend towards a level less than half that in the 1990s. The Norwegian landings declined substantially since the mid-1990s compared with earlier years. In Division VIb landings decreased in the late 1990s and reached a minimum in 2002, after which a gradual increase has occurred. In 2010 the landings were above the mean annual landings for the period 1988–1995.

In Subarea VII landings were around 10 000 t in the period 1995–1998. After this there was a gradual decrease, and the preliminary estimate of catch for 2010 is only 1233 t.

In Subarea VIII annual ling landings have totaled only a few hundred tons since 1999, and in Subareas IX, XII, and XIV the landings have remained minor.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time-series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

### B.2. Biological

Length data for the Norwegian reference fleet in other areas have been routinely collected since 2002.

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

### B.4. Commercial cpue

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding eight tonnes in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. Cpue were calculated as the average total catch of ling per vessel (*C*), and the average number of hooks per set and per vessel (*N*) associated with these catches. Then, for each year and catch category, the estimated cpue for the entire fleet was determined as *C*/*N*. Thus the estimated cpue for each year and Subarea was the mean catch in kg per hook for the entire fleet.

The boats that provided logbooks are the primary sampling units, and *C* and *N* are both random variables. It follows that this is a ratio-type estimator, therefore the standard errors of the cpue estimates could be calculated as described in Cochran (1977, page 32). This cpue estimator is a weighted average, that is the more hooks a boat sets, the more influence it has on the estimate (Cochran, 1977). For comparison, an unweighted cpue series was also constructed (i.e. the average cpue per boat).

A standardized series will be developed in preparation for WGDEEP 2012.

### B.5. Other relevant data

## C. Assessment: data and method

Model used: The stock is assessed using trends in catch and cpue.

Software used:

Model Options chosen:

Input data types and characteristics

## D. Short-term projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

## F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological Reference Points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other Issues

### H.1. Historical overview of previous assessment methods

## I. References

## 19.13 Orange roughy in all areas

| | |
|---|---|
| Stock: | Orange roughy (*Hoplostethus atlanticus*) in I, II, IIIa, IV, V, VI, VII, VIII, IX, X, XII, XIV |
| Working Group: | WGDEEP |
| Date: | March 2011 |

## A. General

### A.1. Stock definition

The current practice is to assume three assessment units;

- Subarea VI;
- Subarea VII;
- Orange roughy in all other areas.

Orange Roughy is an aggregating species and the spatial scale of current management units would not prevent sequential depletion of local aggregations. ICES recommended that where the small-scale distribution is known, this be used to define smaller and more meaningful management units.

### A.2. Fishery

The main fishery for orange roughy was conducted in Areas VI and VII on the peak fisheries. Small fisheries have existed in Subareas Va, Vb, VIII, X and XII.

In VI, there was a French target fishery, centred on spawning aggregations around the Hebrides Terrace Seamount. Irish vessels fished there for two years starting in 2001, but they have now abandoned it. The fishery began in 1989 with landings peaking at 3500 t in 1991, and 5300 t were removed from the stock by the end of 1993 (Figure 19.13.1). It is not clear if over-reporting was a feature of the fishery in this area in the years preceding the introduction of TACs. Reported landings since 2003 have been decreasing to very low levels.

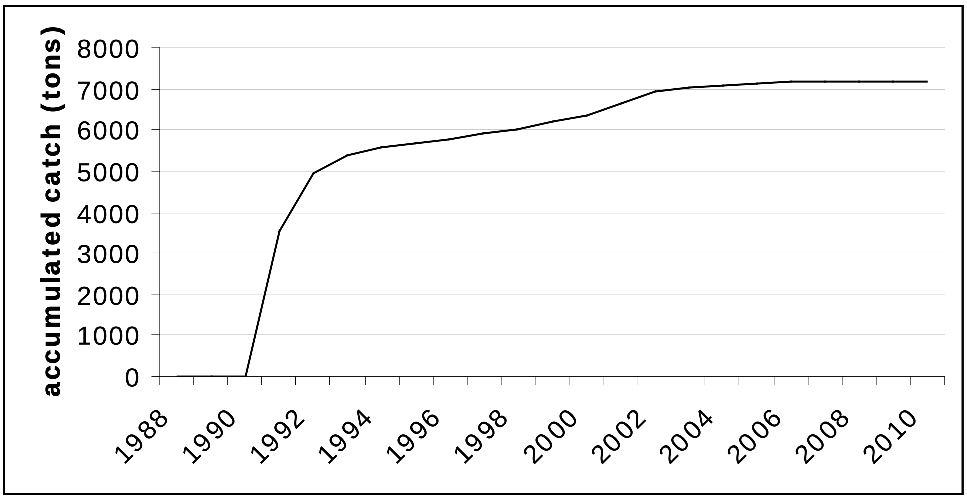



**Figure 19.13.1. Accumulated catches of orange roughy in ICES Area VI.**

After the collapse of the VI fishery, the main fishery for orange roughy in the northern hemisphere moved to Subarea VII. French vessels used to prosecute this fishery alone, but in 2001, new Irish vessels became heavily involved in this fishery for a short number of years. Orange roughy aggregations are mainly associated with seamounts, but they are also found close to other features and on the flat grounds of the continental slope. Initially, trawlers targeted orange roughy at the base of seamounts, but from 2000 onwards, there was a shift to fishing down the slopes of seamounts. Before the fishery closure, new features were found to replace them, as catch rates declined. Large (~50 m) high-sea French trawlers targeted orange roughy in Subarea VII up to 2001. These large trawlers have reduced their activity in VII. There were two fisheries for Orange Roughy in the area. A single targeted peak fishery that has been occurring on distinct topographical features and a mixed trawl flat fishery that occurs along the continental slope and has Orange Roughy as a bycatch. In recent years some targeted fishing from a few or even one single 20–24 m trawlers was carried out until 2008. Since 2010, the TAC has been set at zero.

When the French fishery in VII developed in 1991, landings peaked at over 3000 t in 1992. By the end of 2000 the French fleet had removed over 13 500 t of orange roughy from Subarea VII (Figure 19.13.2). An Irish fishery commenced in 2001, and since then the combined Irish and French accumulated landings have amounted to a further 10 800 t (Figure 19.13.2). Historical landings data suggest several pulses in landings (Figures 19.13.3). The first occurred in 1992 when over 3000 t were landed. Landings declined until 1995, but then increased again to the highest in the series in 2002. The total accumulated catch in Area VII is close to 25 thousand tons. A restrictive quota was introduced in 2003 and resulted in a decrease in declared landings since then. Since 2010, the TAC has been set at zero.

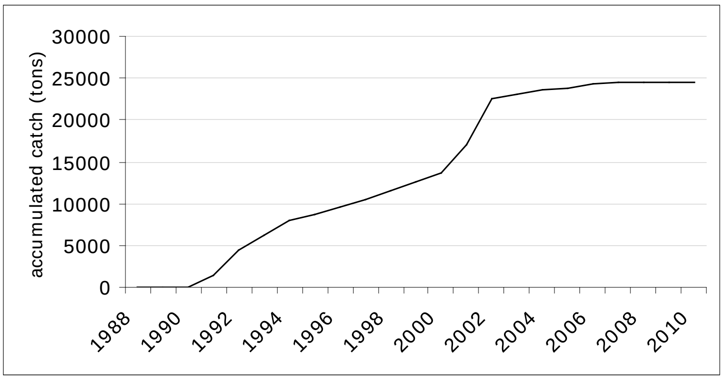



**Figure 19.13.2. Accumulated catches of orange roughy in ICES Area VII.**

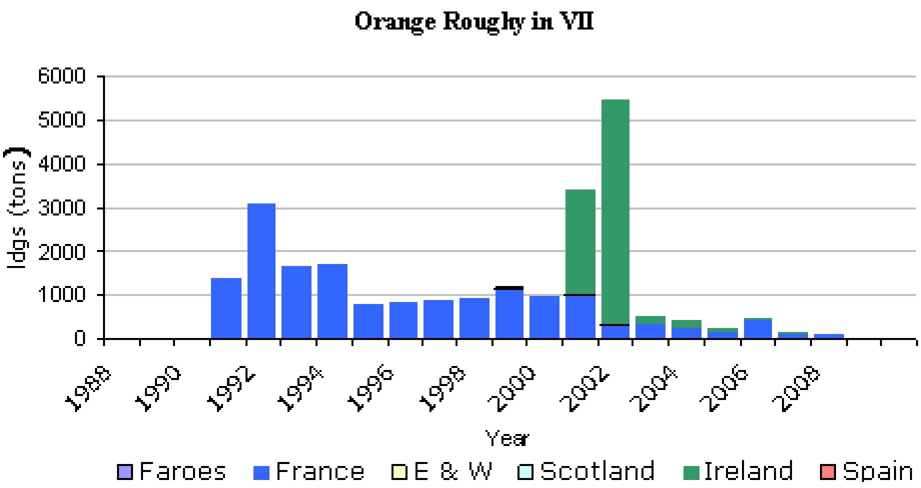



**Figure 19.13.3. Time-series of Orange Roughy landings by country in ICES Subarea VII.**

In Division Va, the fishery peaked with landings of over 700 t in 1993, and landings have declined to very low levels by 2002. In Division Vb, landings were highest in 1995, at 420 t, but since 1997 they have been trivial except for 2000.

In Subarea VIII, there have been small landings by France since the early 1990s. In Subareas VIII and IX, Spain has recorded small landings in some years.

In Subarea X, there are fluctuating Faroese landings, and in 2000, there was an experimental fishery by the Azores (Portugal).

In Subarea XII, the Faroes dominated the fishery throughout the 1990s, with small landings by France. New Zealand and Ireland have targeted orange roughy in this area for single years. There are many areas of the Mid-Atlantic Ridge where aggregations of this species occur, but the terrain is very difficult for trawlers.

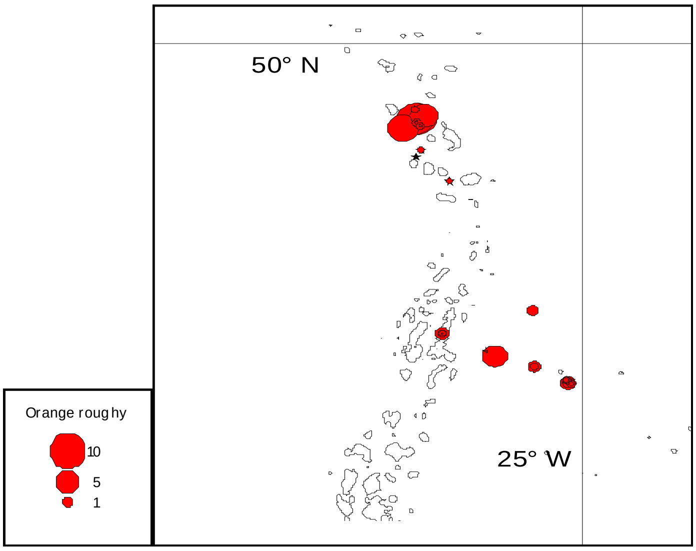



**Figure 19.13.4. Total catches of orange roughy (tonnes) during the Faroese exploratory orange roughy fishery on the Mid-Atlantic Ridge (X and XII) in 2008.**

### A.2.1. Fleet

### A.2.2. Regulations

In 2003 an EU TAC was introduced for orange roughy in VI and VII. For the other areas, an EU TAC was introduced in 2005. EU TACs have been decreasing in the last years and are now set to zero for all three management areas.

**Table 19.13.1. Development of EU TAC for orange roughy in VI, VII and other areas since 2003.**

| Year | EU TAC (t) VI | EU TAC (t) VII | EU TAC (t) other |
|---|---|---|---|
| 2003 | 88 | 1349 | |
| 2004 | 88 | 1349 | |
| 2005 | 88 | 1149 | 102 |
| 2006 | 88 | 1149 | 102 |
| 2007 | 51 | 193 | 44 |
| 2008 | 34 | 130 | 30 |
| 2009 | 17 | 65 | 15 |
| 2010 | 0 | 0 | 0 |
| 2011 | 0 | 0 | 0 |
| 2012 | 0 | 0 | 0 |

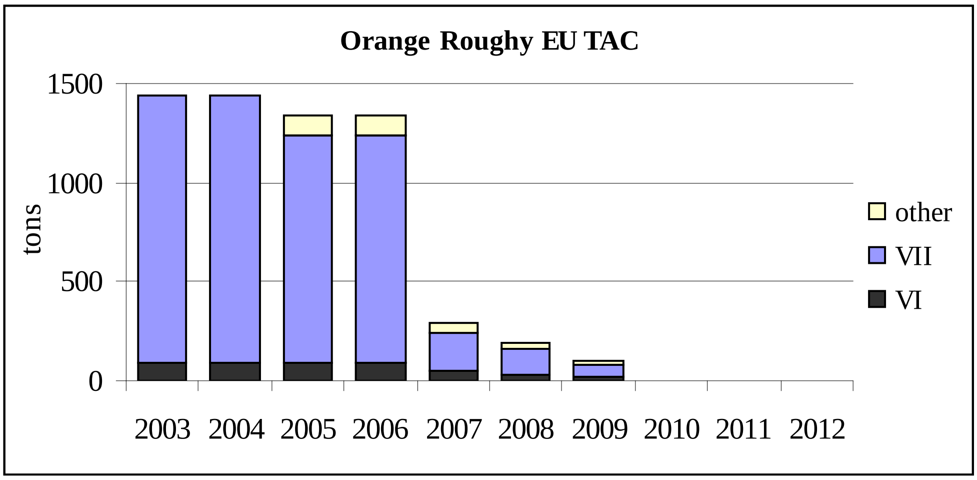



**Figure 19.13.5. Total allowable catch for orange roughy in VI, VII and all other areas for EU vessels since 2003.**

## A.3. Ecosystem aspects

Directed trawl fisheries for orange roughy have been associated with seamounts and other bathymetric features. In ICES Divisions VI and VI there has been a spatial overlap of historical orange roughy fisheries with vulnerable habitats such as cold-water corals. The direct impact of this fishery on vulnerable habitats has not been evaluated. However, in other areas of the world, such fisheries have been demonstrated to have considerable impact. There are currently no directed fisheries targeting orange roughy in Subareas VI and VII. The spatial resolution of catch data for orange roughy in other areas currently available to the working group is not sufficient to assess the spatial overlap with vulnerable habitats. There are currently orange roughy fisheries occurring in ICES Subarea X and XII. The potential impact on vulnerable habitats should be evaluated. However, NEAFC have introduced precautionary closed areas to protect VMEs on the Mid-Atlantic Ridge.

## B. Data

### B.1. Commercial catch

Landings data are available for all fleets. On-board observations of the French deep-water fishery in Area Va, VI and VII are available and suggest that the bycatch of orange roughy might be minor on most fishing grounds. Irish discard information is available from three observer discard trips carried out in 2003 and 2004, covering targeted fishery on peaks and in canyons for orange roughy and fishing on flat grounds for a mixture of roundnose grenadier, black scabbard, blue ling, siki sharks and orange roughy. Discarding of orange roughy was zero in the peak fishery and <1% of landed orange roughy on the flat fishery.

## B.2. Biological

### Summary of life characteristics

**Table 19.13.2. Summary of biological parameters for orange roughy in VI, VII.**

| LHC | Best estimate | Derived from? |
|---|---|---|
| Maximum observed length | 70.6 cm SL | Nolan(ed) 2004 |
| | 60 cm SL | Shepard and Rogan 2004 |
| Maximum observed age | >130 | Thompson 1998 |
| | 169 years | Shepard and Rogan 2004 |
| | 187 years | Nolan(ed) 2004 |
| Length at 50% maturity | 34 -37 cm SL | Shepard and Rogan 2004 |
| Age at 50% maturity | Approx 30 years | Shepard and Rogan 2004 |
| | 20-40 years | Nolan(ed) 2004 |
| | 27.5 years (37cm) | Minto and Nolan 2006 |
| Length at recruitment | 30-34 cm SL | Shepard and Rogan 2004 |
| | Approx 35 cm | Nolan(ed) 2004 |
| Age at recruitment | 30-40 years | Shepard and Rogan 2004 |
| | 30-35 years | Nolan(ed) 2004 |
| Growth parameters: (von Bertalanffy parameters: $B_0$,$T_0$, L infinity, for example) | $L\infty$=476 mm, | Shepard and Rogan 2004 |
| | k=0.039 $yr^{-1}$ and | |
| | $t_0$=2.61 years. | |
| Fecundity, egg size etc | 22000 eggs per kg body weight. Diameter 2mm | Panchurts & Conroy 1987 |
| | 48,530 eggs per kg body mass | Gordon 1999 |
| | 33376 eggs | Minto and Nolan 2006 |
| Natural mortality | M= 0.04 | Annala (1993) |
| | M=0.025 | WGDEEP, 2002 |
| | M= 0.045 | Large (2002) WD from WGDEEP 2002 |

### Length compositions

There are a number of historical length frequencies available for Areas VI, VII and X and XII from observer programmes (Figures 19.13.6 to 19.13.8). Length frequencies from most of the commercial catches show a distribution between 45 and 65 cm. Survey data show that the length frequency distribution on bathymetric features is mainly between 38 and 55 cm (Figure 19.13.9). Survey length frequency information is available from the Irish and Scottish deep-water trawl surveys (Figure 1913.10) which sample the flat grounds along the continental slope in VI and VII. Survey data show that the length frequency on gentle slopes has several peaks between 7 and 23 cm with a further peak between 45 and 65 cm suggesting the presence of several juvenile cohorts.

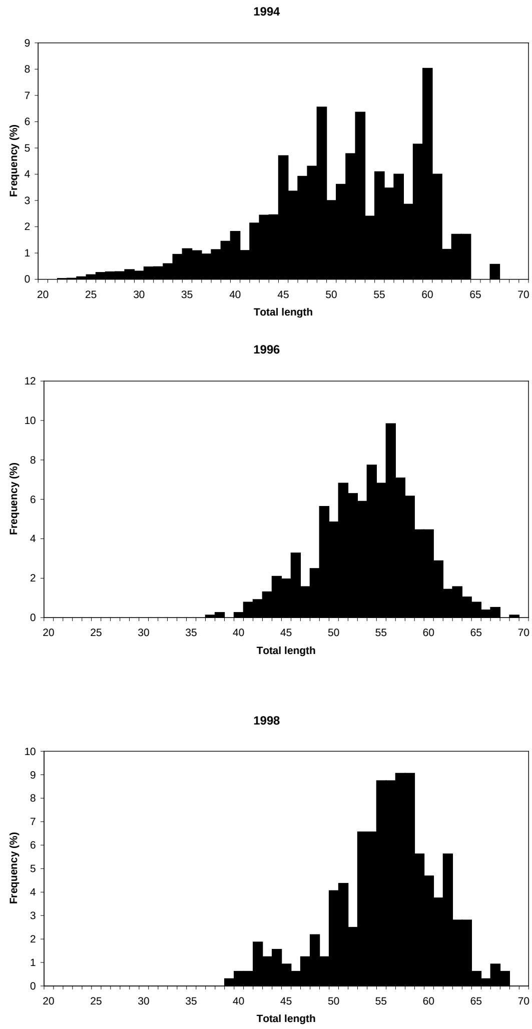



**Figure 19.13.6. Length distribution of French landings of orange roughy from 1994 to 1998.**

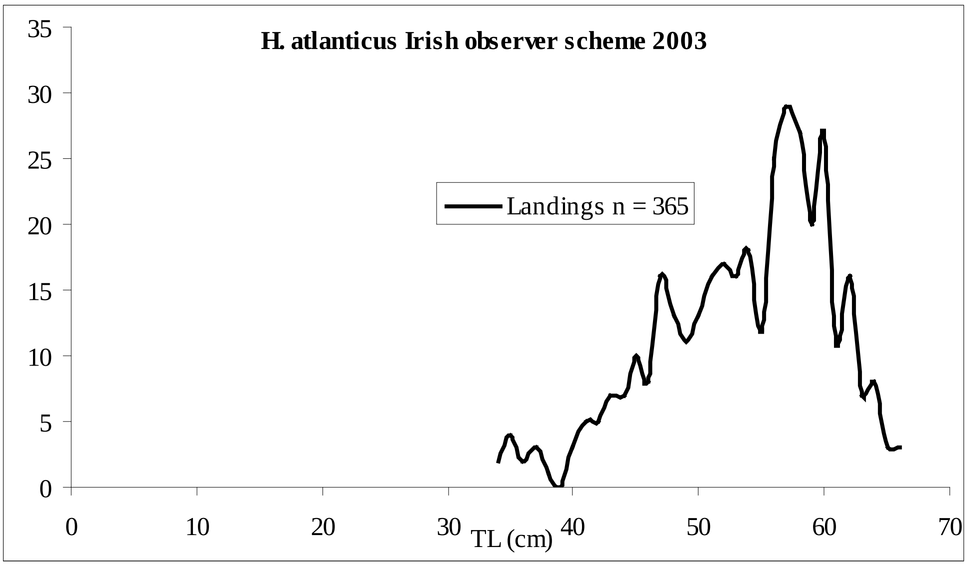



**Figure 19.13.7. Length frequencies from Irish fishery in 2003 (VI and VII) from Irish Marine Institute observer scheme.**

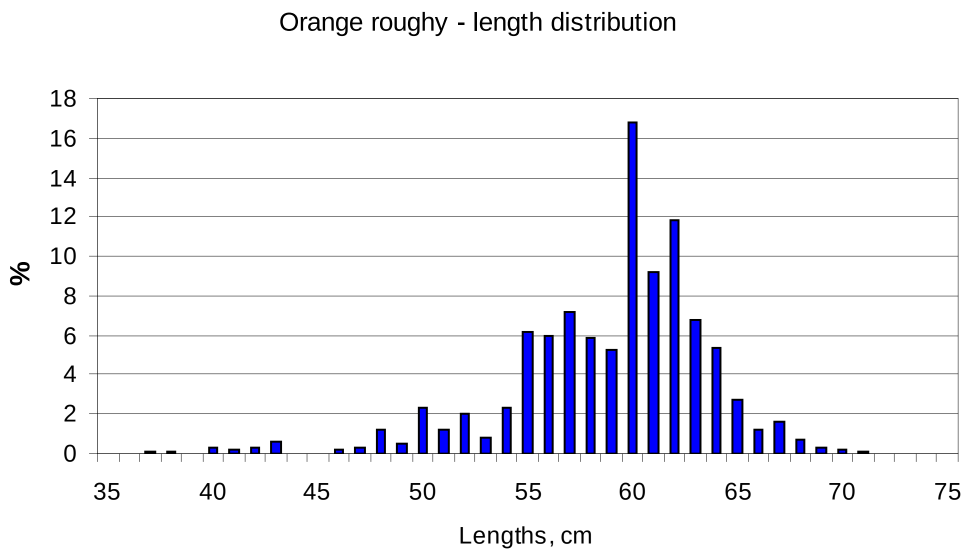



**Figure 19.13.8. Orange roughy length frequencies from Faroese exploratory fishery in 2008 in the Mid-Atlantic Ridge (MAR_X and XII).**

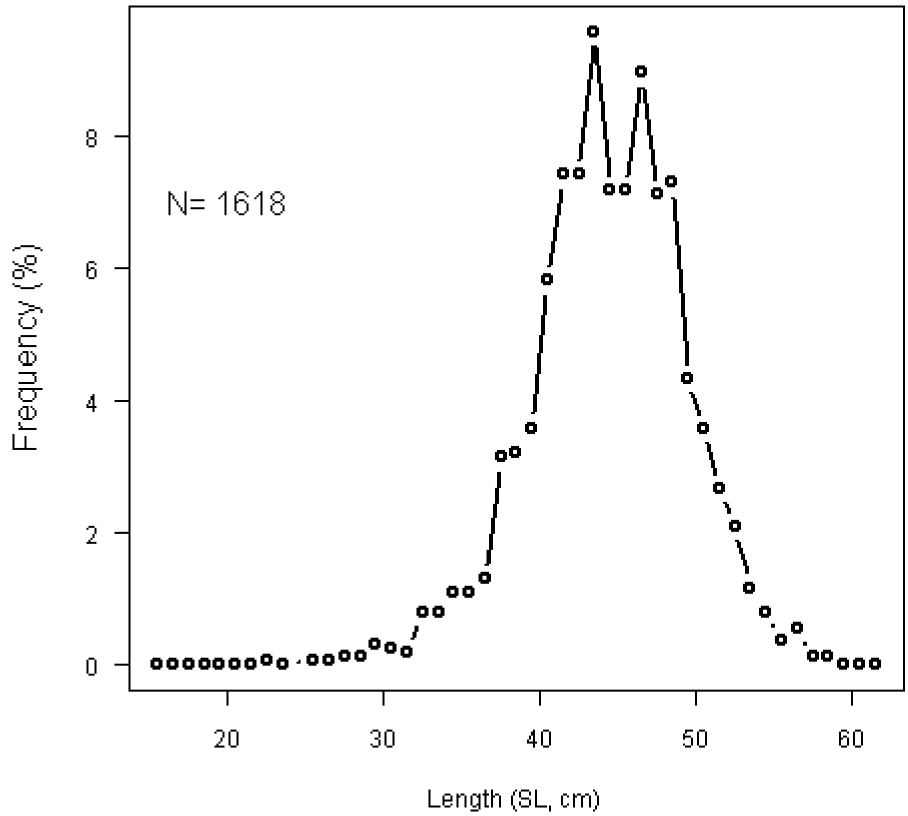



**Figure 19.13.9. Length frequency from bathymetric feature trawl data sampled on the 2005 acoustic survey, VII.**

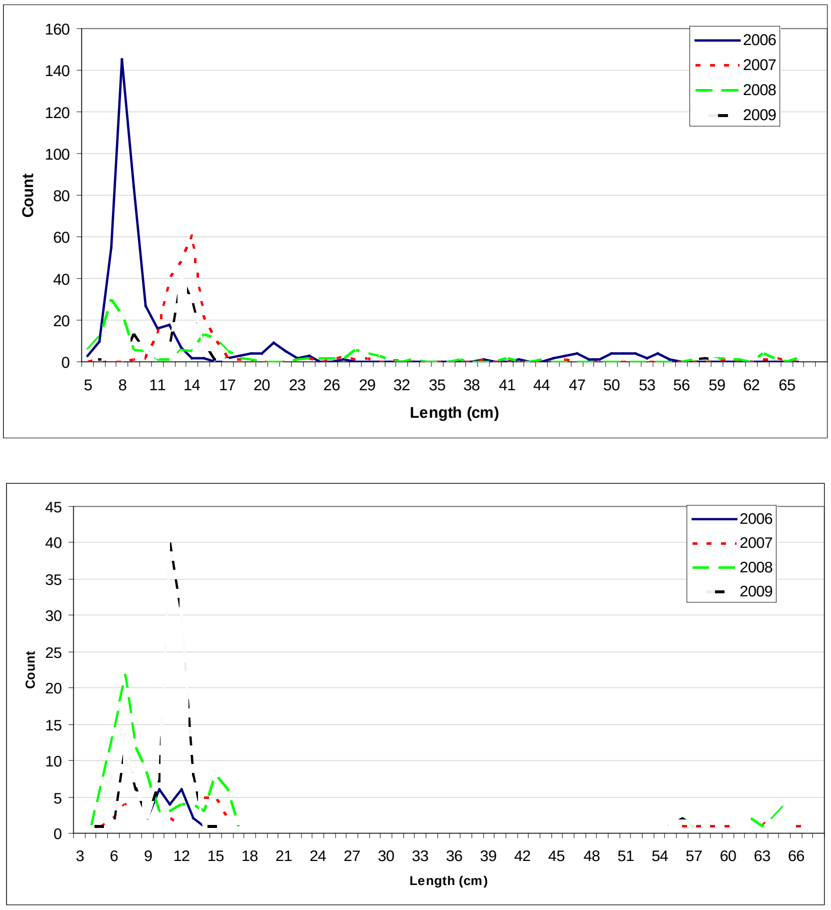



Figure 19.13.10. Length frequency of orange roughy caught at the Irish (upper panel) and Scottish (lower panel) deep-water survey 2006–2009.

### Age compositions

Age data were available from sampling at-sea on commercial trawlers operating on the Porcupine Bank during September 2003–April 2004 and February 2005 (Sheppard and Rogan, 2006). Most otolith samples were of juvenile fish (< 30 cm SL). Otoliths were prepared and sectioned according to Tracey and Horn (1999). Age estimates (6–169 years) were obtained from in all 151 otoliths. The von Bertalanffy growth model was fitted to the data ($R^2$=0.92) (Figure 19.13.11). Estimated growth parameters were: $L_\infty$=47.6 cm, k=0.039 $yr^{-1}$ and $t_0$=2.61 years.

Age estimates were presented by Talman *et al.* (2002) based on samples taken from the Irish developmental fishery in 2001, in VI and VII (BIM, WD 2002). Age estimates from sectioned otoliths ranged from 20 to 187 years (Standard Lengths 30 to 68 cm). Empirical growth curves presented by Talman *et al*. (2002) suggest that growth slows and reaches an asymptote at about 55 cm SL and 37 years. This asymptote is far greater than estimate above and the cause of this is unknown (it possibly could be TL rather than SL). The orange roughy in the area west of Ireland appear to reach the greatest age of any populations so far examined.

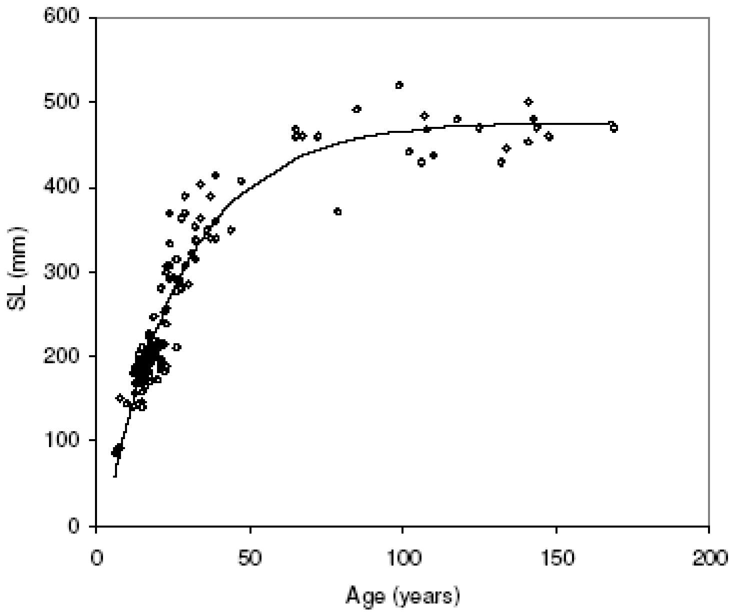



**Figure 19.13.11. Age estimates and the estimated von Bertalanffy growth curve (Sheppard and Rogan, 2006). Note that the y-axis refers to standard length rather than total length as used elsewhere.**

#### Weight-at-age

No data.

#### Maturity and natural mortality

Recently estimated maturity L50 was 34 cm SL for Orange Roughy collected from the flats fishery and 37 cm SL from hill aggregations on the Porcupine Bank (Sheppard and Rogan, 2006). This is similar to the estimate from the west of Ireland of 36 cm SL (Minto and Nolan, 2003). These are higher than that estimated for orange roughy in New Zealand and Australia.

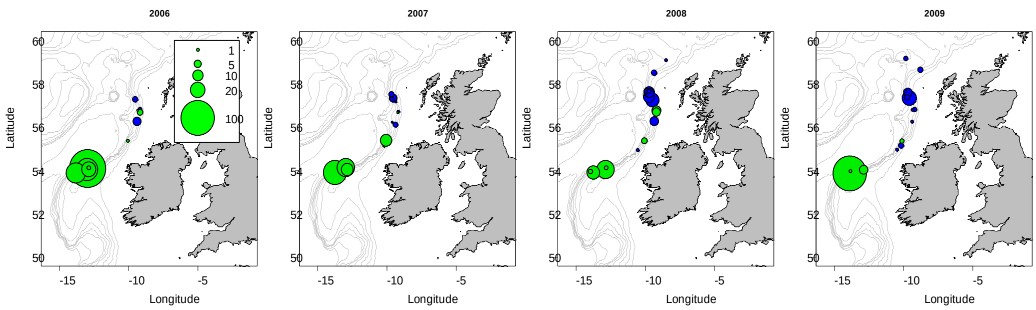
### B.3. Surveys

In 2005 an acoustic survey was carried out on the slopes to the west and north of the Porcupine Bank. Estimates of biomass were considered to be unreliable due to concerns over target strength.

Biological samples and multibeam echosounder and a ROV were used on selected sea-mounds to map the orange roughy habitats (O'Donnell *et al.*, 2007).

Distribution of juvenile and adult cpues of orange roughy in VI and VII within the survey areas of the Scottish and Irish Deep-water survey are shown in Figure 19.13.12. Mean catch rates (number/hours) for orange roughy from the Irish deep-water trawl survey are shown in Figure 19.13.13 for individuals >23 cm (a.) and <23 cm (b.) caught in the 1000 m to 1500 m depth band between 2006–2009. Data are very variable, but do indicate the entry of juveniles into the population.

a.)




b.)

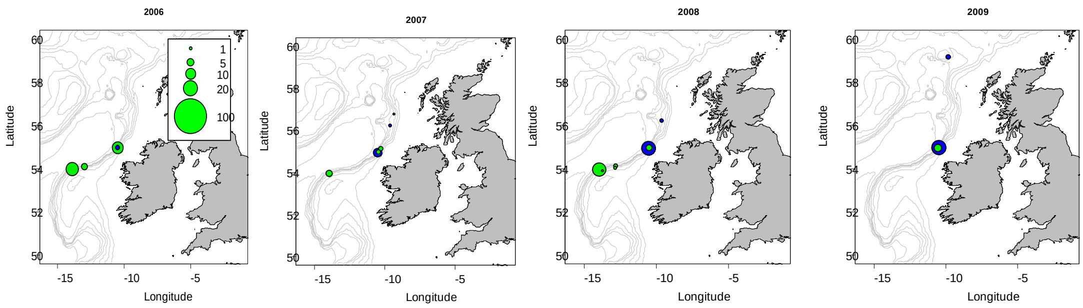



**Figure 19.13.12. Cpue of a.) orange roughy (≤23 cm) and cpue of b.) orange roughy (>23 cm), 2006–2009. Combined Irish (green) and Scottish (blue) Deep-water survey data.**

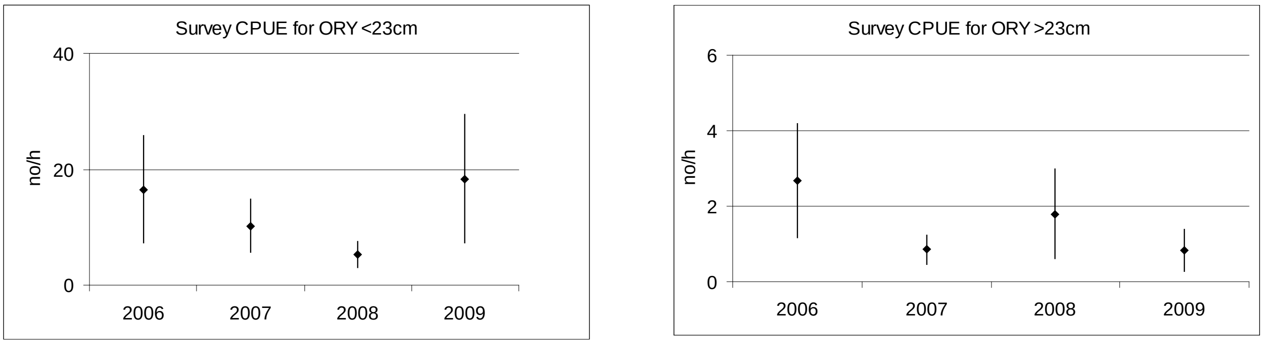



**Figure 19.13.13. Mean catch rates (number/hours) for orange roughy >23 cm (a.) and < 23 cm (b.) caught at the Irish deep-water survey 2006–2009 in the 1000 m to 1500 m depth band (±1SE).**

## B.4. Commercial cpue

Historical French cpue series is shown in Figure 19.13.14 and 19.13.15 for Subarea VI and VII . No new data are available for this cpue from 2006 onwards, as the fishery has virtually ceased.

Standardized cpues for Irish deep-water trawlers targeting orange roughy are shown in Figure 19.13.16. These are based on personal logbooks and are calculated using the mean catch weight per haul per month for the period of January 2001 to December 2003, i.e. the main period when the Irish trawlers were participating in the fishery. In the peak fishery for orange roughy the trawl is often fast on the bottom or sometimes lifted over coral and rocks. Effective fishing time can be as short as 20 minutes.

Trawling time therefore does not give any good indication of effort and consequently, only catch per haul is used for the analysis. The cpue from fishery on flat ground was also worked up but the data were scarcer as it only developed as a regular fishery since the second half of 2002.

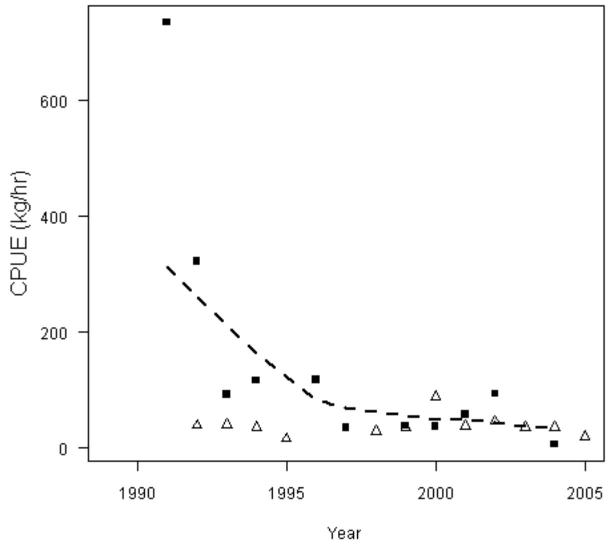



**Figure 19.13.14. French 2006 cpue series (VIa) for 400–600 kw power vessels (open triangles) and for 1400–1600 kw vessels (solid squares). The line is a smooth curve through the latter series.**

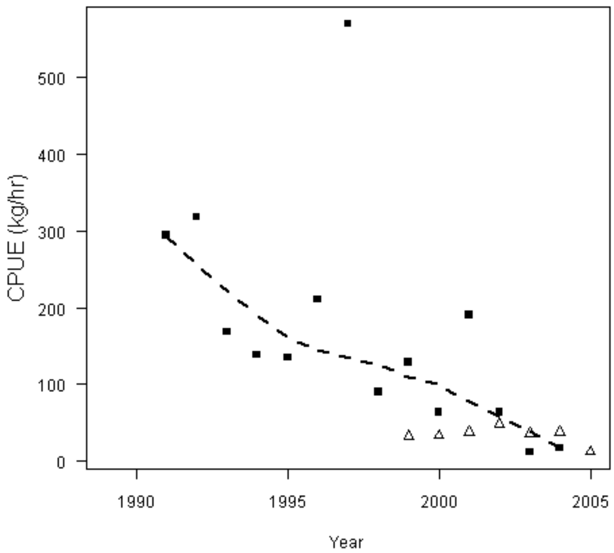



**Figure 19.13.15. 2006 cpue series for 400–600 kw power vessels (open triangles) and for 1400–1600 kw vessels (solid squares). The line is a smooth curve through the latter series excluding the high 1997 point.**

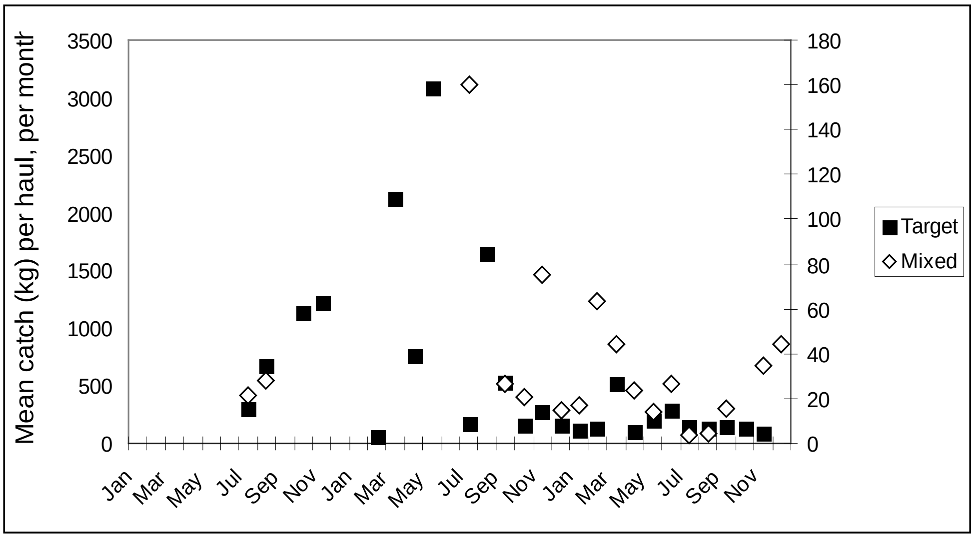



**Figure 19.13.16. Cpue series for Irish deep-water trawlers targeting orange roughy with mean catch weight by haul per month between January 2001 and December 2003 for targeted (closed squares) and mixed fisheries hauls (open diamonds). Secondary axis corresponds to mixed fishery.**

### B.5. Other relevant data

## C. Assessment: data and method

No assessment. Advice is based on historical landings and cpue trends.

Model used:

Software used:

Model Options chosen:

Input data types and characteristics

## D. Short-term projection

NA.

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

## E. Medium-term projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

## F. Long-term projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References

## 19.14Red sea bream in VI, VII, VII

| | |
|---|---|
| Stock: | Red Sea bream (*Pagellus Bogaraveo*) in Subareas VI, VII, VII |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by | Guzman Diez |

# A. General

### A.1. Stock definition

*"Stock limits are generally determined not only by biological considerations but also by agreed boundaries and coordinates. ICES considered three different components for this species: a) Areas VI, VII, and VIII; b) Area IX, and c) Area X (Azores region). This separation does not pre-suppose that there are three different stocks of red (blackspot) seabream, but it offers a better way of recording the available information" (ICES, 2007).*

In fact, the interrelationships of the red (blackspot) sea bream (*Pagellus bogaraveo*) from Subareas VI, VII, and VIII, and the northern part of DivisionIXa, and their migratory movements within these sea areas have been confirmed by tagging results (Gueguen, 1974). Possible links between red (blackspot) sea bream from the Azores region (Subarea X) with the others areas are not yet fully studied. However, recent studies show that there are no genetic differences between populations from different ecosystems within the Azores region (East, Central and West group of Islands, and Princesa Alice bank) but there are genetic differences between Azores (ICES Subarea X) and mainland Portugal (ICES Division IXa; Stockley *et al.*, 2005). These results, combined with the known distribution of the species by depth and tagging information, suggest that Subarea X component of this stock can be considered as a separate management unit.

### A.2. Fishery

The fishery in Subareas VI, VII and VIII strongly declined in the mid-1970s, and the stock is seriously depleted. Since 1988 the landings from Subarea VIII represents the 67% and VI and VII the 23% of total accumulated landings. At present red sea bream catches in these areas are almost all bycatches of LLS and OTB fleets. Small artisanal and recreational landings from Bay of Biscay from are not reported to the Working Group.

### A.3. Ecosystem aspects

The red blackspot sea bream is found in the Northeast Atlantic, from south of Norway to Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira, and Canary Archipelagos (Desbrosses, 1938; Pinho and Menezes, 2005**)**. Hareide (2002) reported also occasional occurrence of this species along the Mid-Atlantic Ridge (north and south of the Azores).

Red sea bream is a bentho-pelagic species that inhabits various types of bottom (rock, sand, and mud) down to a depth of 900 m. The vertical distribution of this species varies according to individual size, and season of the year. Blackspot sea bream undertakes a vertical spawning migration, with the adults moving from deeper to shallower waters during the spawning season and forming aggregations.

## B. Data

### B.1. Commercial catch

Landing series were performed from two different sources. The first source has been updated from a table performed in WGDEEP 2004 (S1; Figure 19.14.1), and the second one come from several data sources compiled by Lorance (2010; S2; Figure 19.14.2). According the source S2 landings *of P. bogaraveo* in Areas VI–VIII were on the order of 10–30 thousand t/year during 1950–1980, and between 10–15 thousand t/year according the source S1. Despite the different level of landings showing both series, in the period in which the series coincides the historical trend is very similar, giving a clear perspective of the important decline of this fishery in Northeast Atlantic in last 30 years.

The information of observers in the Basque country fleet in Subareas VI, VII and VIII indicates that there was no discard for this species in the period 2003–2010.

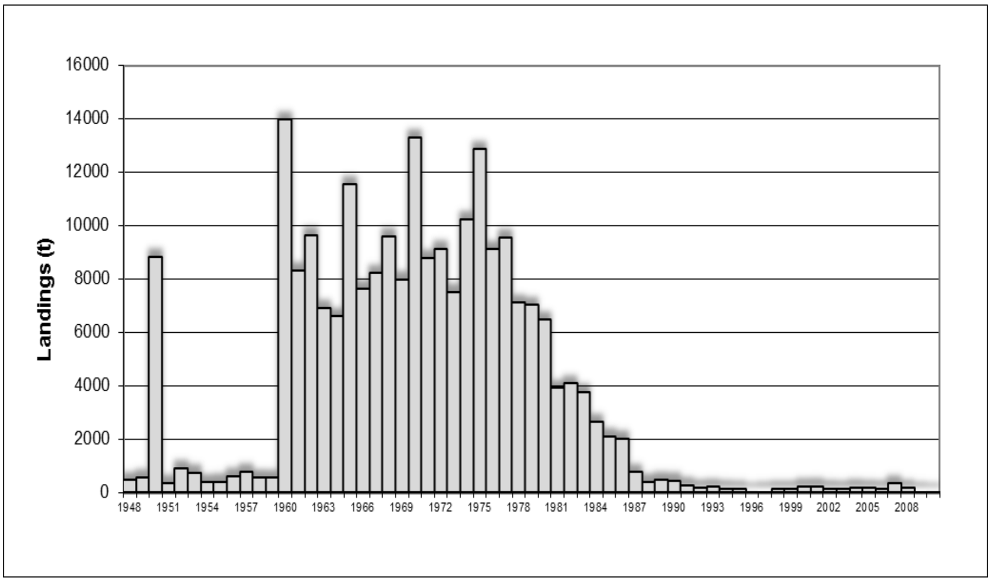



**Figure 19.14.1. Historical series of Red Sea bream landings since 1900 in Northeast Atlantic (Subareas VI, VII and VIII).**

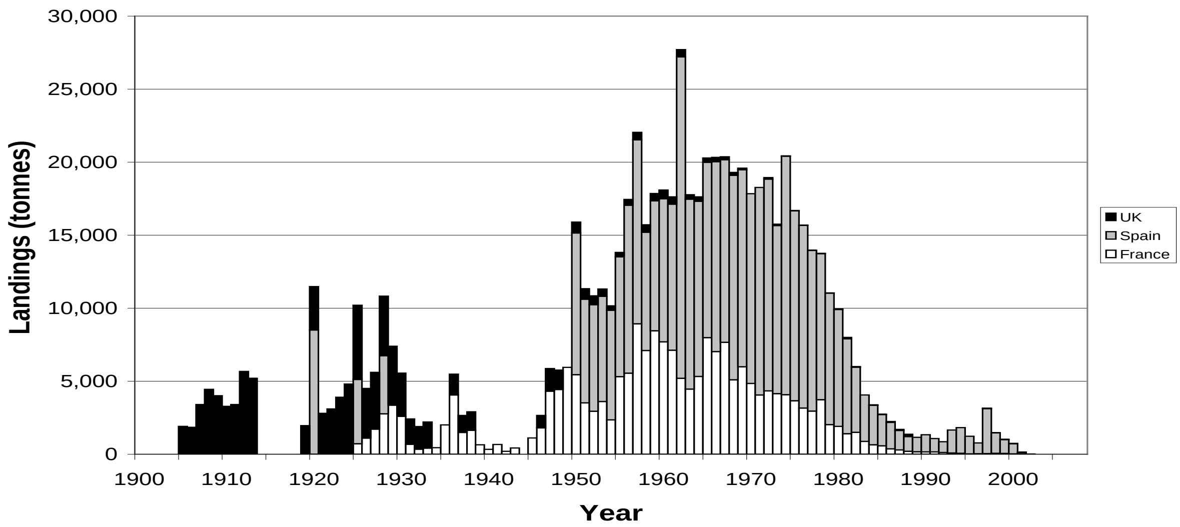



**Figure 19.14.2. Reconstructed time-series of landings of red sea bream by country from the Bay of Biscay population (catch from ICES Subareas VI, VII and VIII). Lorance (2010).**

## B.2. Biological

*Pagellus bogaraveo* is a protandric hermaphrodite species changing from males to females. Sexing and staging this species may be sometimes problematic because macroscopic scales are not validated with microscopic observations. Red (blackspot) sea bream is considered a slow growing species. Gueguen (1969b) reported a maximum age of 20 years. Natural Mortality of 0.2 estimated by Lorance (2010) was derived from the presumed longevity in the population according the rule M ¼ 4.22/t max , where t is the maximum age in the population derived from data from many populations (Hewitt and Hoenig (2005)). According to this rule the 1% of the population survives to 23 years.

**Table 19.14.1. Von Bertalanffy growth coefficient for *P. bogaraveo* for the Bay of Biscay. From Lorance, 2010.**

| K | L | To | N | ICES Area | |
|---|---|---|---|---|---|
| 0.092 | 56.8 | –2.92 | | VIII | Walford method from Guéguen (1969b) |
| 0.162 | 48.3 | –0.72 | 10186a | VIII | New fit using data from Guéguen (1969b) |
| 0.137 | 51.4 | –0.97 | 20b | VIII | New fit to mean length-at-ages from Guéguen (1969b) |
| 0.209 | 51.56 | –0.53 | 530 | VIIIc | Sánchez (1983) |
| 0.174 | 53.9 | –0.66 | | VIIIc | Ramos and Cendrero (1967) |
| 0.196 | 48.06 | –0.47 | | VIIIc | Alcazar *et al*. (1987) |
| 0.174 | 54.2 | –0.66 | | VIIIB,c | Castro Uranga (1990) |

[a] **Size-at-age derived from back calculation (Guéguen, 1969b).**

[b] **Number of age groups.**

## B.3. Surveys

In the current Western IBTS time-series, only a few individuals (zero in some years) are caught which reflects that the stock remains at very low levels compared to historical abundance.

In two French surveys in 1973 and 1976, conducted with the same protocols as the current western IBTS survey in the Bay of Biscay, red sea bream was caught in significant numbers. In the current Western IBTS time-series, only a few individuals (zero in some years) are caught which reflects that the stock remains at very low levels compared to historical abundance.

### B.4. Commercial cpue

No effort and commercial cpue data were available to the Working Group.

### B.5. Other relevant data

## C. Assessment: data and method

No assessment has been carried out before for this stock.

Model used: Not applicable

Software used: Not applicable

Model Options chosen: Not applicable

Input data types and characteristics

## D. Short-term projection

Not applicable.

## E. Medium-term projections

Not applicable.

## F. Long-term projections

Not applicable.

## G. Biological reference points

Not applicable.

## H. Other issues

Its peculiar reproductive biology and aggregative distribution makes red sea bream especially vulnerable to fishing.

Because of the sex-changing in red sea bream only the old ages contribute significantly to the production of oocytes. Therefore if young fish that are sexually immature then males are exploited the proportion of fish reaching the female stage may become very low. It is therefore essential to avoid catching small fish (red sea bream forms shoals that can be targeted). This is the reason for the minimum landing size at 35 cm.

In the 1920s and 1930s, it was reported that juveniles were widely distributed on the coasts of Brittany and in the Western Chanel French and UK coasts.

## 19.15 Red sea bream in IX

| | |
|---|---|
| Stock: | Red sea bream in ICES Subarea IX |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Juan Gil |

## A. General

### A.1. Stock definition

Stock limits are generally determined not only by biological considerations but also by agreed boundaries and coordinates. ICES considered three different components for this species: a) Areas VI, VII, and VIII; b) Area IX, and c) Area X (Azores region). This separation does not pre-suppose that there are three different stocks of red sea bream, but it offers a better way of recording the available information" (ICES, 2007). The inter-relationships of the red sea bream from Areas VI, VII, and VIII, and the northern part of Area IXa, and their migratory movements within these areas have been observed by tagging methods (Gueguen, 1974). However, there is no evidence of movement to the southern part of IXa where the main fishery currently occurs. Tagging has been done also in the Strait of Gibraltar area, where the majority of the fishery currently occurs. No significant movements are reported, although local migrations are also observed: feeding grounds are distributed along the entire Strait of Gibraltar and the species seems to remain in this area as a resident population (Gil, 2006). In 2007, Piñera *et al*. suggests no significant genetic differences are present along Spanish coasts (Mediterranean and Atlantic areas).

Besides, in the case of the Strait of Gibraltar red sea bream also inhabit in Morocco waters. In fact recaptures of tagged fish were also notified by Moroccan fishers.

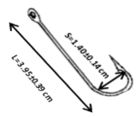
### A.2. Fishery

Although *Pagellus bogaraveo* is caught by Spanish and Portuguese fleets in Subarea IX, only a more complete description of one of the fisheries has been provided to the Working Group, the corresponding to the Spanish fishery in the southern part of Subarea IX, close to the Strait of Gibraltar.

The majority of landings on deep-water species at mainland Portugal are conducted by the artisanal fleet, mainly longline fisheries. These operated in the Portuguese continental slope and located in ports as Peniche, Sesimbra and Sagres. Red sea bream landings reflect a seasonal activity probably related with a larger availability of the species or market demands that lead fishers to spend some time targeting this species (I. Figueiredo, pers. comm.).

In relation to the Spanish fishery in the southern ICES Subarea IXa, an updated description of it has been presented to the Working Group by Gil *et al*. (WD 2011), that complete the information offered in the previous WGs (Gil *et al*., 2000; 2003, 2005, 2006, 2007, 2008, 2009 and 2010; Gil and Sobrino, 2001, 2002 and 2004). This artisanal longline fishery targeted red sea bream has been developed along the Strait of Gibraltar area. Actually this fishery covers more than the 70% of the landings for the species in the Subarea IX. The base and landing ports are two: Algeciras and mainly Tarifa (Cádiz, SW Spain). The "*voracera*", a particular mechanized hook and line baited with sardine, is the gear used by the fleet (Table 19.15.1). The mean technical characteristics of this fleet by port are 8.95 and 6.52 meters length and 5.84 and 4.0 tons G.T.R. for Tarifa and Algeciras, respectively (Gil *et al.*, 2000). Currently around 100 boats are involved in the fishery. Fishing grounds are located at both sides of the Strait of Gibraltar and quite close to the main ports (Figure 19.15.1). Fishing is carried out taking advantage of the turnover of the tides in depths from 200 to 400 fathoms. Landings are distributed in categories due to the wide range of sizes and to market reasons (these categories have varied in time but from 2000 onwards still the same).

**Table 19.15.1. Red sea bream Spanish fishery of the Strait of Gibraltar: Fleet and gear summary descriptive.**

| Fleet ID | Gear type | Nº boats | Number of lines | Hook type and size | Mean soaktime | Effort (days at sea) |
|---|---|---|---|---|---|---|
| LHM_DEF | Vertical mechanized handline ("voracera") | ±100 | Maximum of 30 lines per day (each line attached a maximum of 100 hooks, usually ±70) | L=3.95±0.39 cm S=1.40±0.14 cm  | ±30 min | Maximum 140 days |

From 2002 onwards artisanal boats from other port, Conil, have began to direct its fishing activity to *P. bogaraveo* in different fishing grounds and with different fishing gear (longlines) than the "*voracera*" fleet boats. Nowadays, only around six boats are developing this fishery.

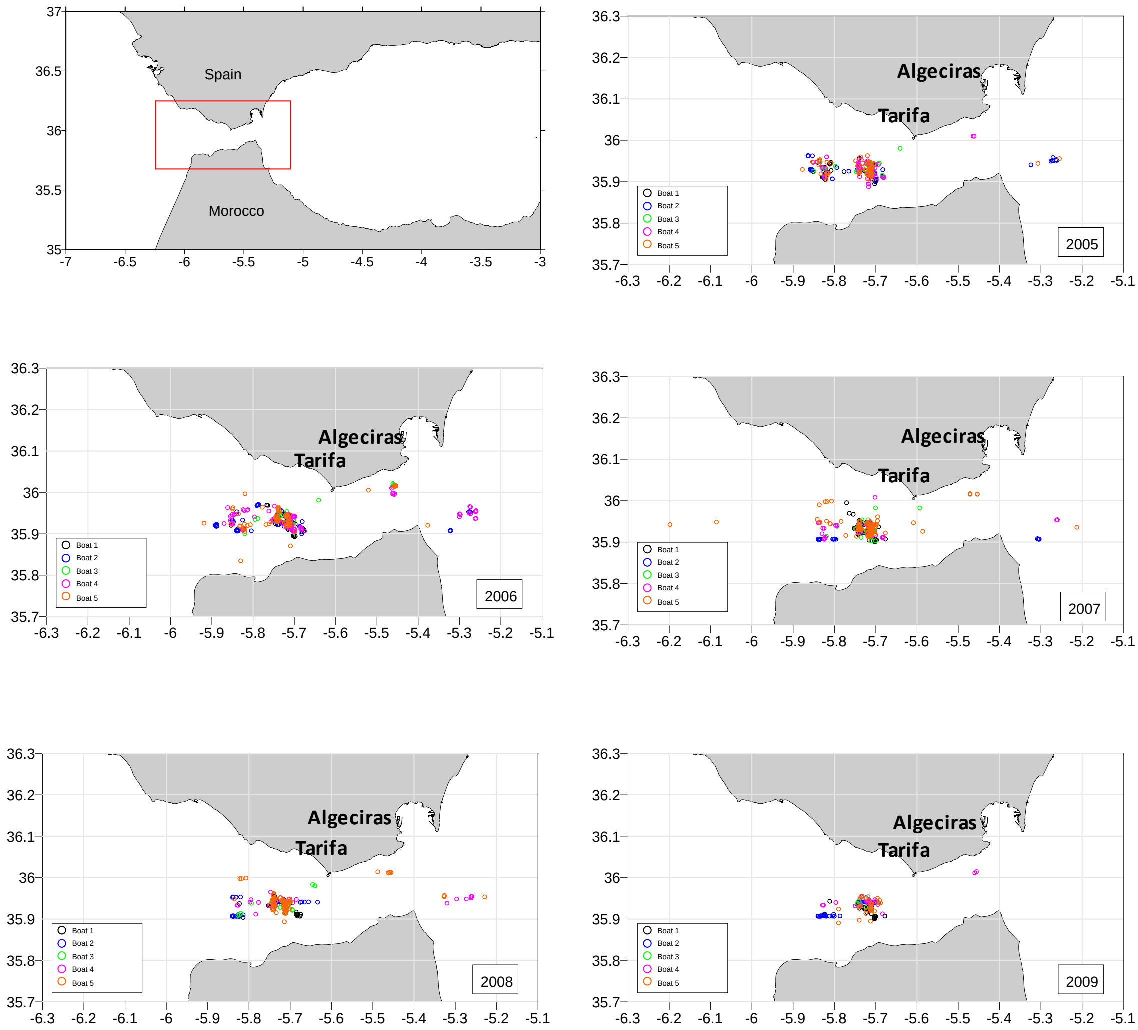



**Figure 19.15.1. Red sea bream Spanish fishery of the Strait of Gibraltar: Yearly soaking positions footprints from observers on-board programme (from Gil *et al.*, WD 19).**

## A.3. Ecosystem aspects

Red sea bream is a bentho-pelagic species that inhabits various types of bottom (rock, sand, and mud) down to a depth of 900 m. It is found in the Northeast Atlantic, from South of Norway to Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira and Canary Archipelagos (Desbrosses, 1938; Pinho and Menezes, 2005**)**. Hareide (2002) reported also occasional occurrence of this species along the Mid-Atlantic Ridge (north and south of the Azores).

Feeding habit of this species has been little studied. Morato *et al*. (2001) describes the diet of *Pagellus bogaraveo* and *Pagellus acarne* in the Azores and Olaso and Pereda (1986) describe the diet of 22 demersal fish in the Cantabrian Sea including *Pagellus bogaraveo*. In the Strait of Gibraltar fishery, feeding studies presents the difficult of the use of bait (sardine), which should be ignored to describe the feeding habit of the species. Altogether 1106 red sea bream stomachs contents were analysed: 725 stomachs were empty and 381 were fullness. Vacuity index (VI) was 66%. The trophic spectrum is composed of 24 prey taxa, six orders, eleven families and 15 species and genera are represented. Despite the trophic spectrum diversity observed, the overall diet is not very diverse. Red sea bream in the Strait of Gibraltar has only a main prey, *Sergia robusta* (Polonio *et al*., in preparation).

Main red sea bream predators are unknown in the Strait of Gibraltar waters but maybe dolphins' predation should be taken into account (personal communication from Ceuta veterinary). Studies in Azores (Gomes *et al*., 1998) cite that *Conger conger, Raja clavata* and *Galeorhinus galeus* must be considered as potential predators (all three species are present in Strait of Gibraltar area).

Deep-sea coral ecosystems represent true biodiversity hot spots. OSPAR identified cold-water coral ecosystems as one of the most vulnerable ecosystems where action is required now to mitigate further loss of biodiversity. Figure 19.15.2 shows the deep-water coral occurrences in the Strait of Gibraltar.

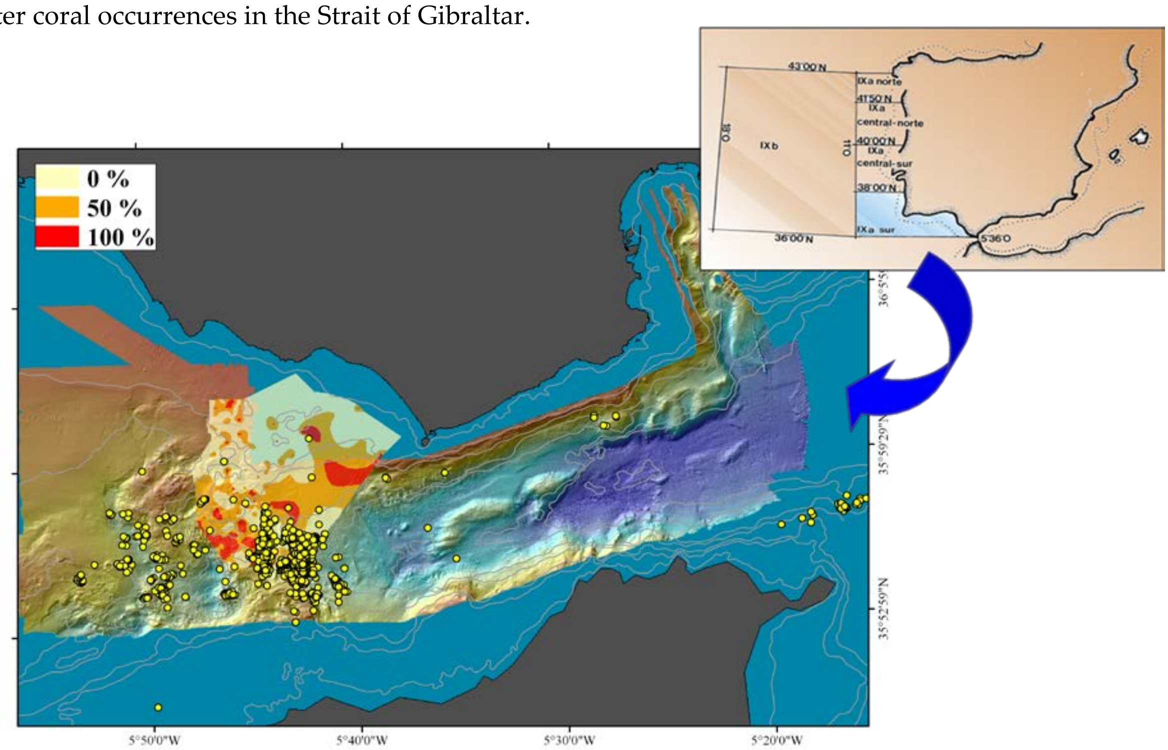



**Figure 19.15.2. Coral distribution in the Strait of Gibraltar (adapted from Álvarez-Pérez *et al*. in Freiwald and Roberts, (eds.) 2005). Yellow points correspond to "*voracera*" fleet fishing grounds from observers on-board programme. Legend refers to percentage cover of coral.**

## B. Data

### B.1. Commercial catch

In Subarea IX, catches -most of them taken by lines- correspond to Spain (72%) and Portugal (28%). Spanish landings data from this area are available from 1983 and Portuguese from 1988 onwards. The maximum catch in this period was obtained in 1993–1994 and 1997 (about 1000 t) and the minimum in 2002 (359 t). Catches in 2009 amount to 718 t, but decreases again (484 t) along the last year.

Almost all Spanish catches in this area are taken in waters close to the Gibraltar Strait. Until 2002 they were restricted to two ports (Tarifa and Algeciras), but from 2002 significant catches were obtained also by artisanal Spanish boats of a third port (Conil) in different fishing grounds of the same area. An increasing trend in landings was observed but since 2008 it only rates an average of 15 t, lower than in the early years.

In the Portuguese landings no clear tendency is observed. The maximum values took place in 1988 (370 t) and in 1998 (357 t) and the minimum one in 2000 (83 t). In 2010 landings was 105 t.

Length frequencies of landings are only available for the Spanish red sea bream fishery in the Strait of Gibraltar (1983–2010). There is a decrease of the mean size from 1995 to 1998. It is necessary to point out that the red sea bream may have a variable length distribution depending on its geographic and bathymetric distribution, as suggests the different mean length of landings measured in ports (Tarifa and Algeciras). The mean length of the landings increases steadily in both ports from 1999 onwards then decreased but has been increasing again between 2006 and 2009. The mean length from both landing ports declined in 2010. However the median value is lower than the mean since 1995, and very close to the minimum landing size in Algeciras.

A Kolmogorov–Smirnoff test reflects significant differences ($p<0.05$) between the length distributions from Spain and Morocco (Belcaid *et al.*, WD 20) and also within Spain (Gil *et al.*, WD 19). Differences among the sampling protocols may be the explanation to the observed difference. In Morocco and Spanish observers programme the sampling covers certain the boats (random sampling) while in the Spanish first sale fish market the sampling covers the 4 market categories (stratified sampling). So raising the random sampling weight to the total landings did not take into account the difference due to the variability of the length composition related to bathymetric distribution of the species and the stratified sampling seems to be more appropriate.

### B.2. Biological

Red sea bream is a protandric hermaphrodite species changing from males to females. Red sea bream have a low productivity and they change sex as they age, starting as males and becoming females between ages 4 and 6. Measures to ensure balanced exploitation between younger fish (males) and older fish (females) are essential.

An annual reproductive cycle has been described for the species in this area (Gil, 2006). The spawning season seems to take place during the first quarter of the year. The smallest specimens are mainly males, maturing at a $L_{50}$=30.15 cm. At about 32.5 cm in total length, an important percentage of individuals change sex and became females, maturing at $L_{50}$=35.73 cm. Thus, from age 5 all individuals can be considered mature, whether they are males or females.

Red sea bream is considered a slow growing species. A combined ALK was obtained by three agreed readings from 1497 otoliths collected from 2003 to 2008 (Gil *et al.*, 2009). It comprises lengths from 24 to 54 cm and ages between 3 and 10, but it has not been validated yet. According to the available information the maximum age recorded in Subarea IX is ten years. However, the ages of older fish may be underestimated and it is possible that this species may be slower growing and longer-lived than current studies indicate. In fact, there was one recapture from tagging surveys notified more than ten years after its release (J. Gil, pers. comm.). Table 19.15.2 presents different estimates of von Bertalanffy Growth Function (VBGF) parameters available from otoliths readings or tag-recapture data.

**Table 19.15.2. Red sea bream of the Strait of Gibraltar: VBGF parameter estimates.**

| Authors | Study Area | Methodology | t0 | k | L∞ |
|---|---|---|---|---|---|
| Sobrino and Gil, 2001 | Strait of Gibraltar | Otholits reading | -0.67 | 0.169 | 58.00* |
| Gil *et al*., 2008 | Strait of Gibraltar | Otholits reading | -1.23 | 0.169 | 62.00* |
| Gil *et al*., 2009 | Strait of Gibraltar | Otholits reading | -0.34 | 0.162 | 62.00* |
| Gil *et al*., 2008 | Strait of Gibraltar | Recaptures (1) | | 0.079 | 62.00* |
| Gil *et al*., 2008 | Strait of Gibraltar | Recaptures (2) | | 0.098 | 62.00* |
| Gil *et al*., 2008 | Strait of Gibraltar | Recaptures (3) | | 0.161 | 62.00* |
| Gil *et al*., 2008 | Strait of Gibraltar | Recaptures (4) | | 0.080 | 62.00* |

**(1)Gulland y Holt, 1959 (2)Munro, 1982 (3)Fabens, 1965 (4)Appeldoorn, 1987.**

***Fixed (from the largest observed sample).**

Padillo *et al*. (2011,WD17) present new information based on Discriminant Analysis of several of the samples used to make the ALK, combining morphometric and morphological variables to re-estimate red sea bream ages. The reclassification success percentage was 85.3%, well above from the 70% adopted by other authors (Palmer *et al*., 2004; Galley *et al*., 2006). Changes in otolith shape could be related to the growth rate and be also strongly influenced by environmental components. Therefore, future work should include the analysis of such factors throughout years and cohorts.

The natural mortality of *Pagellus bogaraveo* is uncertain because there is no data available to estimate M directly. A mortality rate of 0.2 year$^{-1}$ has been adopted by several authors in several studies from other areas (Silva, 1987; Silva *et al*., 1994; Krug, 1994; Pinho *et al*., 1999; Pinho, 2003) and also by Gil (2006) for the Strait of Gibraltar.

### B.3. Surveys

Only tagging surveys were carried out in the Strait of Gibraltar area. Since 1997, 7066 samples were tagged (juveniles + adults) and at the moment 396 recaptures were notified. Recaptures from tagged juveniles show significant displacements from South Mediterranean breeding areas toward the Strait of Gibraltar. However, recaptures from tagged adults did not reflect big displacements, which are limited to feeding movements between the different fishing grounds where the "*voracera*" fleet works (Gil, 2006).

B.4. Commercial cpue

It should be noted that the effort unit from the historical series, number of sales, may be inappropriate, as it fails to consider the missing effort from boats that have not caught enough fish to go to the market. Thus, in the years this missing effort has increased substantially (fishing vessels with no catches and no sale sheet to be recorded) and its lpue values may be overestimated.

Gil *et al*. (2011, WD19) presents a short series of cpue (2005–2009) from the observers on-board programme in the red sea bream fishery of the Strait of Gibraltar. Sampling level was five boats and three trips per month. Number and length measurements of caught species were recorded. Values vary around three red sea bream per ±70 hooks but the general trend seems to be slightly decreasing throughout the years. Further work should be done to standardize the cpue.

### B.5. Other relevant data

## C. Assessment: data and method

Model used: No model was adopted for the assessment yet. Till the moment the assessments attempts were no accepted and only several trends (landings and length distributions) were used for the scientific advice.

Software used: None

Model Options chosen: None

Input data types and characteristics

## D. Short-term projection

NA.

## E. Medium-term projections

NA.

## F. Long-term projections

NA.

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | N/A | |
| Approach | $F_{MSY}$ | F0.1= | YpR Analysis |
| | $B_{lim}$ | N/At | |
| Precautionary | $B_{pa}$ | N/A | |
| Approach | $F_{lim}$ | N/A | |
| | $F_{pa}$ | N/A | |

No biological reference points have been defined.

## H. Other issues

### H.1. Historical overview of previous assessment methods

Historical series of landings data available to the Working Group have been exploratory assess by the WGDEEP since 2006. No discard data were available to the Working Group, but for this species this could be considered minor. The landings data used in the assessment exercise of red sea bream in IX included Spanish and Portuguese landings from 1990 onwards.

New assessment exercises were presented to the Group in 2011. An Extended Survivors Analysis (XSA) attempt with the Strait of Gibraltar Spanish red sea bream fishery data is described by González and Gil (2011, WD18). Belcaid *et al*. (2011, WD20) presents the results obtained by a Yield-per-recruit analysis from 2005–2007 Spanish and Morocco landings length distribution available information from the Strait of Gibraltar area.

## 19.16 Roundnose grenadier in Vb, VI, VII and XIIb

| | |
|---|---|
| Stock | Roundnose grenadier (*Coryphaenoides rupestris*) in Division Vb and Subareas VI, VII and Division XIIb |
| Working Group | WKDEEP |
| Date | 11th March 2010 |
| Revised by | Lionel Pawlowski and Pascal Lorance |

# A. General

### A.1. Stock definition

ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the NE Atlantic (Figure 19.16.1):

Skagerrak (IIIa)The Faroe-Hatton area;

Celtic Sea (Divisions Vb and XIIb, Subareas VI, VII);

The Mid-Atlantic Ridge 'MAR' (Divisions Xb, XIIc, Subdivisions Va1, XIIa1, XIVb1);

All other areas (Subareas I, II, IV, VIII, IX, Division XIVa, Subdivisions Va2, XIVb2).

Roundnose grenadier is widely distributed in the North Atlantic. Its area stretches from Norway to northwest Africa in the east to the Canadian–Greenland coasts and the Gulf of Mexico in the west, and from Iceland in the north to the areas south of the Azores in the south (Parr, 1946; Andriyashev, 1954; Leim and Scott, 1966; Zilanov *et al*., 1970; Geistdoerfer, 1977; Gordon, 1978; Parin *et al*., 1985; Pshenichny *et al*., 1986; Sauskan, 1988; Eliassen, 1983). Aggregations of this species are found on the continental slope of Europe and Canada, on the MAR seamounts, in the Faroe-Hatton area (banks Hatton, Rockall, Louzy, Bill Baileys, etc.) and in the Skagerrak and Norwegian fjords.

Fish in all maturity stages have been observed throughout the distribution area (Allain, 2001; Kelly *et al*., 1996, 1997; Shibanov, 1997; Vinnichenko *et al*., 2004), which would be consistent with the existence of several populations.

No genetic results are available to validate the hypothetical stock structure presented above. Several authors also consider that roundnose grenadier is a poor swimmer and is therefore unlikely to make extended migrations. No pattern in seasonal density variation has been observed from surveys or from fisheries. However, there are no data available to indicate whether or not individuals move around during their lifespan.

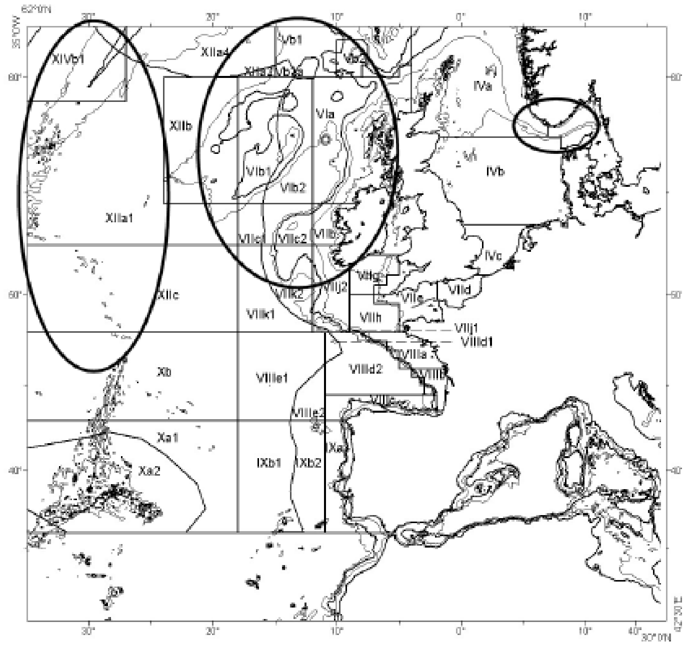



**Figure 19.16.1. Areas of the main fisheries for roundnose grenadier, Skagerrak, west of the British Isles and mid-Atlantic Ridge. The isobaths displayed are 100, 200, 1000 and 2000 m (from Lorance *et al.*, 2008).**

The current perception is based on what is believed to be natural restrictions to the dispersal of all life stages. The Wyville Thomson Sill may separate populations further south on the banks and slopes off the British Isles and Europe from those distributed to the north along Norway and in the Skagerrak. Considering the general water circulation in the North Atlantic, populations from the Icelandic slope may be separated from those distributed to the west of the British Isles.

It has been postulated that a single population occurs in all the areas south of the Faroese slopes, including also the slopes around the Rockall Trough and the Rockall and Hatton Banks but the biological basis for this remains hypothetical.

Published results on length (11.5–12.5 cm pre-anal fin length, PAFL) and age (9–14 years) at first maturity of females to the West of British Isles and in the Skagerrak (Allain, 2001; Bergstad, 1990; Kelly *et al*., 1996; 1997) do not seem to clearly discriminate these two groups, although they are most likely to be demographically different unit.

Some studies have detected genetic differentiation in at least parts of the species range and indicating the presence of distinct populations within the species (Logvinenko *et al*., 1983; Duschenko, 1989).

In 2007, WGDEEP examined the available evidence of stock discrimination in this species based on length distribution, commercial catch, cpue, age, maturity, reproduction. Length distribution, catch and cpue data were considered too aggregated or too dependent on external factors (e.g. fleet dynamics, depth) to be usable to discriminate stocks. Analyses on age data on longevity were unable to conclude if the differences of longevity from one region to another were local changes or the effect of exploitation.

New genetic studies are likely to become available in the forthcoming months. Preliminary results were presented in the ICES symposium "Issues confronting the Deep Oceans" (Horta, Azores, 27–30 April 2009). Microsatellite DNA was used to characterize the large-scale population structure from samples spanning over the entire North

Atlantic. Samples of *ca.* 800 individuals were analysed for eight microsatellite loci. Roundnose grenadier was found to display a trend of increasing genetic differentiation with distance among samples. In absolute terms the amount of genetic differentiation among roundnose grenadier samples was considerably higher than in other deep-sea fish species, such as Greenland halibut (Knutsen *et al*., 2007) and tusk (Knutsen *et al*., submitted) over comparable distances. The gene flow appeared restricted also among relatively closely situated localities (less than 500 km; Knutsen *et al*., 2009). If these preliminary results are confirmed, the current stock structure used for assessment and primarily based upon bathymetry and hydrology will need revision towards a structuring at smaller spatial scale.

### A.2. Fishery

The majority of landings of roundnose grenadier from this area are taken by bottom trawlers. To the west of the British Isles, in Divisions Vb, VIa, VIb2 and Subareas VII, French trawlers catch roundnose grenadier in a multispecies deep-water fishery. The Spanish trawl fleet operates further offshore along the western slope of the Hatton Bank in ICES Divisions VIb1 and XIIb.

French trawlers began to land increasing amounts of roundnose grenadier, from the west of Scotland in 1987 (Charuau *et al*., 1995). Landings of these species have been reported separately in French landings statistics since 1989 (Lorance *et al*., 2001). The quantities landed in 1987 and 1988 are not known with accuracy but they are believed to be less compared with landings in the 1990s.

The activity of the Spanish fishery in international waters is poorly known. New information on landings data in Division VIb and Subarea XII from the Spanish fisheries for the years 2005, 2007 and 2008 have been made available. These newly obtained data are from the freezer fleet operating mostly in those regions. Data from 2006 are incomplete and of no use for stock assessment. The main problem associated to Spanish official landing data for roundnose grenadier is the uncertainty regarding their accuracy. The disagreement between observer catch data and official landings data suggests that catches of this species might be reported as corresponding to several species. Roughhead grenadier is mostly absent from observer data despite recorded annual catches above 1000 tonnes in 2005 and 2007. Similarly, roughsnout grenadier is absent from observer data although apparently between 1300 and 4800 tonnes where landed in the years 2005, 2007 and 2008. Gunther´s grenadier was recorded by the observers but not in the logbooks. The distribution of the catch and effort are poorly known. Effort directed at deep-water species increased from 1989 to 1996 (Lorance and Dupouy, 2001). In 1995 an effort regulation was introduced but was not a constraint to this fleet. TACs and a new effort regulation was introduced in 2003 (Council Regulation (EC) No 2347/2002 of 16 December 2002) and the fishery has reduced. Part of the fishing time of the licensed fleet is expended on the shelf mainly in the Celtic Sea.

### A.3. Ecosystem aspects

Roundnose grenadier is a slow-moving species, which prefers grounds with slow currents. Vertical diurnal migrations are also observed, the pattern of which depends on feeding (Savvatimsky, 1969) and water circulation and meteorological processes (Shibanov and Vinnichenko, 2007).

There is no direct evidence of long distance migrations made by adult fish. The distribution and dispersal of the eggs and larval stages is poorly known, except in the

Skagerrak (Bergstad and Gordon, 1994). Juveniles grenadier of 2–8 cm pre-anal length were caught in the midwater by 120–840 m over bottoms of 1200–3200 m along Greenland slope, on the Mid-Atlantic Ridge, Hatton bank, in the Irminger and Labrador seas suggesting that some passive migrations of juveniles in the open ocean occurs (Vinnichenko and Khlivnoy, 2007).

In the Skagerrak (ICES Division IIIa), available information indicates that roundnose grenadier spawn in the late autumn (Bergstad, 1990a). Eggs (diameter 2.4–2.6 mm), postlarvae and pelagic juveniles have been caught with plankton net from 150 to 550 m. The newly hatched larvae appear very primitive and the pelagic phase is extensive. The mean size of larvae, assumed to belong to the same cohort sampled repeatedly in the same year, increased from February to October, when they attained a demersal stage of life cycle (Bergstad and Gordon, 1994). To the west of the British Isles, females with maturing ovaries have been observed from February to December, but they were more abundant from May to October and spawning appears to extend at least from May to November (Kelly *et al*., 1996; Allain, 2001). Studies in Icelandic waters indicate year-round spawning, with no obvious peaks (Magnússon *et al*., 2000). There appear thus to be differences in the timing of spawning between areas, perhaps reflecting varying environmental conditions. Roundnose grenadier is a batch spawner with a fecundity of 4000–70 000 oocytes per batch (Allain, 2001).

There is a lack of knowledge of the distribution and dispersal of the eggs and larval stages, except in the Skagerrak (Bergstad and Gordon, 1994), and so the biological basis for the current hypothetical population structure must await the results from future studies of genetics and otolith microchemistry. To date, only a single study of whole otolith microchemistry of roundnose grenadier from a wide area of the Atlantic (Mid-Atlantic Ridge, Reykjanes Ridge, Hatton Bank, Porcupine Seabight, Rockall Trough, Skagerrak and two Norwegian fjords) has been carried out using solution-based, inductively coupled, plasma mass spectrometry (SO-ICPMS; Gordon *et al*., 2001). Discriminant analysis of eight elements separated samples from the Norwegian fjords and the Skagerrak from those from the NE Atlantic areas. Differences between samples from six areas of the Atlantic (Hatton Bank, Rockall Trough, Porcupine Seabight, Mid-Atlantic Ridge, and Reykjanes Ridge) were small, and elemental concentrations overlapped. Therefore, this study supports the view that populations in the NE Atlantic are separate from the Norwegian fjords and the Skagerrak, but does not demonstrate any difference in populations between the Mid-Atlantic Ridge and the remainder of the NE Atlantic.

## B. Data

### B.1. Commercial catch

Landings time-series data per ICES areas are available.

Landings data by ICES statistical rectangle are available from France, Norway and UK (England and Wales and Scotland). No other country provided data by rectangle. Landings by ICES division are available from other countries.

Catch in Subarea XII are allocated to Division XIIb (western Hatton Bank) or XIIa, c (Mid-Atlantic Ridge) according to knowledge of the fisheries from WG members. For each country, the time-series of landings are checked and revised if needed according to Statland data. Statland reports landings in Subarea XII consistently with what this Working Group did in the past.

Catch and discards by haul are available from observer programmes. From the French observer programme, total catch, landings and discards and catch, landings and discards of roundnose grenadier are available on a haul by haul basis for 2004–2006.

Discard data (quantities and length distribution) are also available from the on-board observation of the French fishery, 2004–ongoing, from French on-board observations on French vessels in 1997–1998 and from Scottish observers on board of French vessels, 1997–2001. The length distributions of discards from all these observations seem quite consistent.

Based on EU observer programme 2004–2005, about 30% by weight and 50% by number of the catch of roundnose grenadier is discarded, because of small size. This figure is higher than in previous sampling where the discarding rate in the French fisheries was estimated slightly above 20% from sampling in 1997-1998 (Allain *et al.*, 2003). The change may come from a combination of changes in the depth distribution of the fishing effort and a decrease in the abundance of larger fish as visible in the landings. The modal discarded length has remained constant.

The mode of the length distribution of the discards from the Spanish fleet in Divisions VIb and XIIb is slightly smaller, probably because of different sorting habits in relation to different markets. It is therefore important that length distribution of the landings and discards are provided to the working group by all fleets exploiting the stock. Larger variations in discards levels have been reported between species and between observers and vessels.

Misreporting or underreporting is not known to have been a problem in the French trawling fleet. Concerns have been repeatedly expressed that misreporting could occur in international waters (NEAFC regulatory area). There are also been regular complains from the French Industry that IUU fish was landed in France and was pulling the prices down. This seems to have disappeared in recent years. Misreporting is not an issue that scientists have the power to inquire and this should stay in hand on management and regulation authorities to monitor misreporting. No quantitative data on misreporting is available.

The landings data were however considered uncertain in Division XIIb, because unreported landings may occur in international waters. In addition to this, all national landings data were not reported by new ICES divisions and some landings were allocated to divisions according to knowledge of the fisheries from the Working Group. Lastly significant unallocated landings occurred in 2005. This has led the Working Group to remove in 2008, XIIb from the exploratory assessments although the stock definition consider the Faroe–Hatton area, Celtic Sea catches (Divisions Vb and XIIb, Subareas VI, VII) belonging to the same stock.

### B.2. Biological data

Size frequency data (and corresponding weight data) for roundnose grenadier are available for French catches for every year since 1990. Historical length frequency series from sampling on board French trawlers by French and Scottish observer are presented in Figures 19.16.2 and 19.16.3.

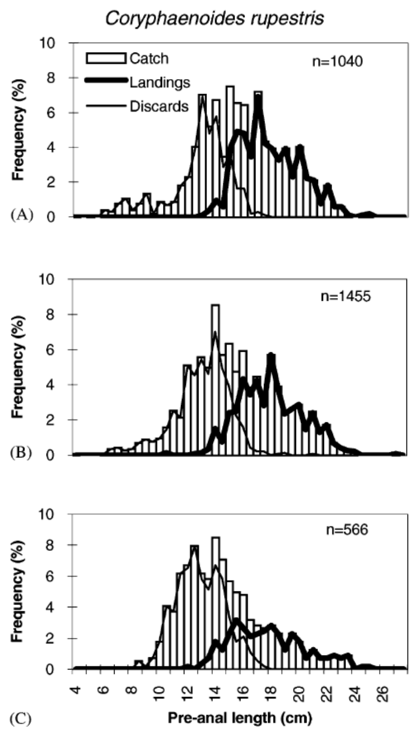



**Figure 19.16.2. Length distribution of the discards and landings of roundnose grenadier in 1996–1997 by depth, A) 800–1000 m, B) 1000–1200 m, c) 1200–1400 m, sampled on board French vessels, (redrawn from Allain, 2003).**

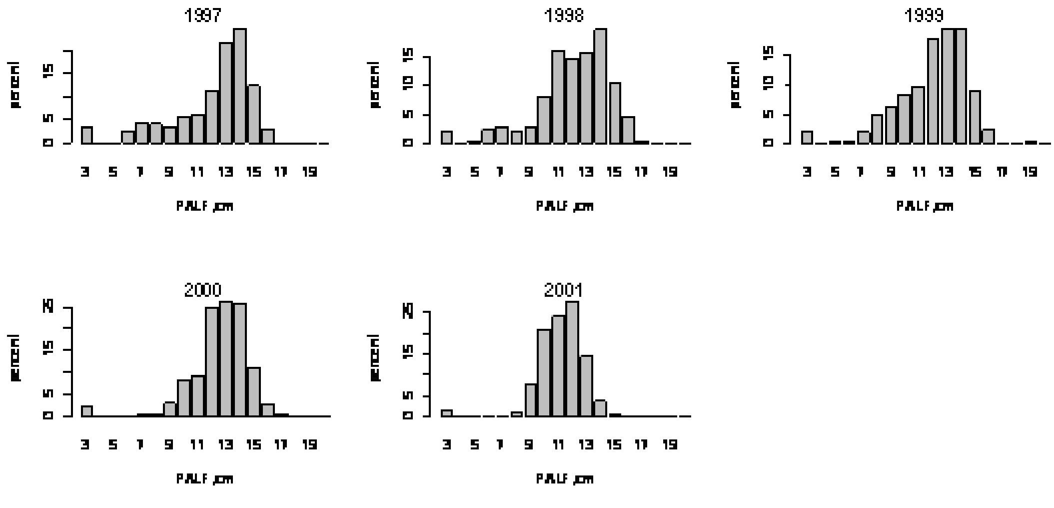



**Figure 19.16.3. Length distribution of the discards of the French fleet, sampled on board French vessels by Scottish observers, 1997–2001.**

Age estimates were available from France. This dataset may be heterogeneous, because three different readers estimated the age over these different years and also because measuring the fish on board may lead to different age–length relationship than measuring the landed fish that may have lost water for some days in ice. Large discrepancies between readers were observed in a recent otolith reading exchange and workshop (ICES, 2007a).

Age composition of the French landings has been routinely estimated since 2001. Formerly age–length keys (ALK) were derived from a cruise in 1999 and from sampling on board of commercial trawler in 1996–1997 (Lorance *et al.*, 2001; 2003). Preliminary analysis of the length-at-age data demonstrated that ALK is very stable over years. ALK for years 1999 and 2001–2004 were very similar, the ALK for 2005 appeared different and the change was ascribed to a change of the reader.

These data are based upon ALK from age estimates in 1996, 1999 and 2002–2005. Otoliths from 1996 and 1999 were collected respectively on board of commercial trawlers and during a scientific cruise; otoliths for 2002–2005 were routinely sampled from the landings.

No new data on maturity and natural mortality has been collected in recent years. Natural mortality was previously estimated from catch curves and an estimated M=0.1 was used by the Working Group since 2002. It should be kept in mind than this estimate is based on limited data.

### B.3. Surveys

Only one cruise relevant to roundnose grenadier is currently carried out on a yearly basis by FRS (Scotland). Stock indicators were derived from this survey (Neat and Burns, in press) but have not yet been formally integrated into stock assessment.

Another cruise has been carried out since 2006 on the RV Celtic explorer every year during autumn. The surveys aim to collect biological data on the main deep-water fish species and invertebrates along the continental slope in Subareas VI and VII north. Fishing tows were carried out at four depths, 500 m, 1000 m, 1500 m and 1800 m in three distinct areas. The effective fishing time, from when the net touched the bottom, was set at two hours. Tows were carried out along the depth contour. At each station the entire catch was sorted to species level and weighed. Full biological sampling, i.e. length, weight, sex, maturity, and age, was carried out on specific commercial species. Additional biological sampling, without age, was carried out on an *ad-hoc* basis on other species.

### B.4. Commercial cpue

Time-series of French fishing effort are available based upon logbook data (1987–2009). Following their requirement under the Data Collection Regulation (DCF), VMS data (starting back from 2003) are made available from 2010. Lpues databased upon French tallybooks are available from 2000 based upon a voluntary participation of fishers. These data are used in the Working Group as indicators of trends and also in the assessment.

Time-series of fishing effort of past years can be improved from tallybooks. In EU logbooks, fishing operations (individual tows and lines and net setting) carried out in the same day and rectangle are cumulated. For the French trawling fleet, tallybooks of haul by haul data were provided by the industry and allowed for better account of all factors in lpues (Lorance *et al.*, 2009). Applied to all fleets such data would allow effort to be properly handled. Electronic logbooks are under development on French vessels and data will be reported haul by haul including depth. It should be noted that this improvement is particular to deep-water fisheries where depth may vary a lot in a single statistical rectangle. Therefore haul by haul data and fishing depth are much more crucial in deep-water fisheries than in shelf fisheries were most of the depth information is conveyed by the statistical rectangle.

VMS data also allows for improvement of effort data as is allows for some particular uses such as estimating the fishery footprint and fine scale changes in effort distribution. Nevertheless, data such as tallybooks provided to Ifremer by the industry includes all the effort information (tow duration, depth, location) coupled with catch, while using VMS requires assumptions to identify fishing and steaming activities and coupling catch to VMS data is an unresolved issue.

Overall the knowledge of the fleet activity at sea is reliable in Division Vb and Subareas VI and VII, the situation is poorer in Divisions VIb and XIIb. Distribution of catch and effort at the resolution of ICES rectangle has been available, from France, Ireland and UK (ICES, 2006; ICES, 2007b).

The French fleet is known based upon the licensing scheme since 2003. Before this time, catch composition was used to identify which vessels were fishing in the deep water. Therefore, composition of the fleet, number of vessels can be considered available since the early 1980s.

### B.5. Other relevant data

No other source of data is used in the assessment.

## C. Historical stock development

### Past assessments

Based upon what is believed to be natural restrictions to the dispersal of all life stages, the area of this stock is considered to include Division Vb and XIIb and Subareas VI and VII. Due to uncertainties in the catch in Division XIIb, assessment has been restrained to Vb, VI, VII. Therefore only a portion of the regions of this stock has been assessed in 2008 and 2009.

Given the lack of data, assessments have only been exploratory until 2009. Exploratory assessments focused on integrating discard data into the assessment (WGDEEP, 2008) and rebuilding catch at the beginning of the fishery (WGDEEP, 2009; Pawlowski and Lorance, 2009). The assessment model used was the Separable VPA. The main criticisms against the use of this model were the short time-series of available data and the uncertainties around the age- and length-based approach for this species.

The *Bayesian Surplus Production model*, *Multiyear Catch Curve model* and other *indicators* of trends are currently used for assessment until the next Benchmark Workshop.

### Bayesian surplus production model

In 2010, WKDEEP considered the Bayesian Surplus Production Model as the most parsimonious short-term approach. Such an approach can be informative on relative trends such as changes in exploitation biomass and depletion. However, interpreting absolute levels are inappropriate with the current data.

### Multiyear catch curve model

A Multi year catch curve (MYCC) model developed as part of the EU-DEEPFISHMAN project, returns realistic trends in total mortality Z per year. Absolute level may have to interpret with caution. Nevertheless, this model should be used further, to derive an indicator of total mortality and to explore the stock dynamic. Input data are age distribution of the landings or of the catch (landings and discards) per year. The model was run on age 25–46+ (fully recruited stock). The model requires some parameter to be fixed.

M=0.1 (depending on model setting)

Coefficient of variations of the recruitement (CVrec= 0.1)

Coefficient of variations of the landings or catch (CVo=0.1 : CV of observations

### Other indicators of trends

Biological indicators such as trends in mean length, ratio of mature/immature provide valuable insights of the state of stocks. Information from length distribution of landings and discards in addition to information on fishing depths are useful indicators of trends in the fishery and in the population structures.

Lpues databased upon French tallybooks are used as indicators of trends and also in the assessment. Catch rates from surveys are used to check the consistency of the analysis on the commercial cpues.

### Stock assessment parameters

Assessment Model used: Surplus Production Model (based on Pella Tomlinson biomass dynamic model).

Software used: FLBayes package version 1.4, FLCore 1.99–91, R 2.9.2 (URL: http://code.google.com/p/wgdeep-rng/)

Model Options chosen:

Initial parameters

Age-at-maturity: 11 (variance 0.1)

Longevity: 50 (variance 0.1)

Priors for Q (logQ.mean = 0, loqQ.var = 100)

Priors for K (K.mean = log(100000) , K.var = 1)

Priors for r (r.mean = mean(log(r.mc)), r.var = mean(var(r.mc)))

sigma.shape = 2

sigma.rate = 1

Input data types and characteristics:

Landings data are used from 1988 in Vb, VI, VII and XIIb when available.

Lpues from French tallybooks from 2000 (past lpues may be included when data will be available). Lpues are provided by region and are combined. The weight of each region is the proportion between the local and the total landings.

## D. Short-term projection

No projections are performed.

## E. Medium-term projections

No projections are performed.

## F. Long-term projections

No projections are performed.

## G. Biological reference points

The current data are inappropriate to provide MSY absolute estimates from the Bayesian Surplus Production model.

## H. Other issues

Landings and effort data in Division XIIb should be included into the assessment if they become reliable. A separate assessment for Division XIIb should be carried out separately from the one for Division Vb, and Subareas VI, VII.

As the performance of this model depends on the length of the time-series, separate exploratory runs may be performed to evaluate the effects of new datasets or data points.

Because discarding is no longer allowed for this species (ref), all catch should be landed in the forthcoming years and will be integrated into the assessment.

New stock identity results are likely to become available in the next few years and should be considered to evaluate the assessment area.

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## 19.17Roundnose grenadier in Xb, XIIc, Va1, XIIa1, XIVb1

| | |
|---|---|
| Stock: | Roundnose grenadier (*Coryphaenoidesrupestris*) in Divisions Xb, XIIc and Subdivisions Va1, XIIa1, XIVb1 |
| Working Group: | WGDEEP |
| Date: | 8th March 2011 |
| Revised by: | Vladimir Vinnichenko |

# A. General

### A.1. Stock definition

ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the NE Atlantic:

- Skagerrak, IIIa
- Celtic Sea and the Faroe–Hatton area, Divisions Vb and XIIb, Subareas VI, VII
- the Mid-Atlantic Ridge (MAR) Divisions Xb, XIIc, Subdivisions Va1, XIIa1, XIVb1
- All other areas: Subareas I, II, IV, VIII, IX, Division XIVa, Subdivisions Va2, XIVb2

Roundnose grenadier is widely distributed in the North Atlantic. Its area of distribution stretches from Norway to Northwest Africa in the east to the Canadian–Greenland coasts and the Gulf of Mexico in the west, and from Iceland in the north to the areas south of the Azores in the south. Aggregations of this species are found on the continental slope of Europe and Canada, on the MAR seamounts, in the Faroe-Hatton area (banks Hatton, Rockall, Louzy, Bill Baileys, etc.) and in the Skagerrak and Norwegian fjords.

Recent genetic studies using different method and number of loci, provided different views of the population structure of roundnose grenadier but consistently showed that roundnose grenadier form the MAR is genetically different from Celtic Sea and the Faroe–Hatton area (Knutsen *et al*., 2010; White *et al*., 2010)

Studies have allowed observing fish in all maturity stages and/or larvae in all the distribution area (Allain, 2001; Kelly *et al*., 1996, 1997; Shibanov, 1997; Vinnichenko *et al*., 2004; Bergstad and Gordon, 2001), therefore allowing for distinct populations to exist.

### A.2. Fishery

The fishery on the northern Mid-Atlantic Ridge (MAR) started in 1973, when dense concentrations of roundnose grenadier were discovered by USSR exploratory trawlers. Roundnose grenadier aggregations may have occurred on 70 seamounts between 46 and 62°N but only 30 of them were commercially important and subsequently exploited. The fishery is mainly conducted using pelagic trawls although on some seamounts it is possible to use bottom gear.

The greatest annual catch of roundnose grenadier (almost 30 000 t) on the MAR was taken by the Soviet Union in 1975, fluctuating in subsequent years between 2800 and 22 800 t. The fishery for grenadier declined after the dissolution of the Soviet Union in 1992. In the last 15 years, there has been a sporadic fishery by vessels from Russia (annual catch estimated at 200–3200 t), Poland (500–6700 t), Latvia (700–4300 t) and

Lithuania (data on catch are not available). Grenadier has also been taken as bycatch in the Faroese orange roughy fishery and Spanish blue ling and roughhead grenadier fishery. During the entire fishing period to 2010, the catch of roundnose grenadier from the northern MAR amounted to more than 232 000 t, mostly from ICES Subarea XII.

### A.3. Ecosystem aspects

The depth in most of Divisions Xb, XIIc and Subdivisions Va1, XIIa1, XIVb1 is > ca. 4000 m and abyssal is not exploited by fisheries. The major topographic feature is the Northern part of the MAR, located between Iceland and the Azores. Numerous seamounts of variable heights occur all long this ridge along with isolated seamounts in other areas such as Altair and Antialtair. The physical structure of seamounts often amplify water currents and create unique hard substrata environments that are densely populated by filter-feeding epifauna such as sponges, bivalves, brittlestars, sea lilies and a variety of corals such as the reef-building cold-water coral *Lophelia pertusa*. This benthic habitat supports elevated levels of biomass in the form of aggregations of fish such as orange roughy and alfonsinos, and a number of seamounts have been targeted by commercial fleets. Such habitats are however highly susceptible to damage by mobile bottom fishing gear and the fish stocks can be rapidly depleted due to the life-history traits of the species which are slow growing and longer-living than non-seamount species.

The MAR is isolated from the continental slope except for the relatively continuous shallower connections via the Greenland and Scotland ridges, and some seamount chains, e.g. the New England seamounts. Along with much of the general biology, the intraspecific status of species inhabiting the MAR is unclear. Based on geographical patterns it is probable that MAR populations of both fish and benthic organisms are isolated from the others in the North Atlantic and endemism.

## B. Data

### B.1. Commercial catch

Landings time-series data per ICES subarea are available for whole fishery period. Landings by ICES division are available by countries. Landings data by ICES statistical rectangle are not available.

Catch in Subarea XII are allocated to MAR (Divisions XIIa,c) and western Hatton Bank (XIIb) according to knowledge of the fisheries from WG members.

There were no discards of roundnose grenadier on Russian trawlers where smallest fish and waste were used for fishmeal processing. There is no information on discards by other countries vessels.

### B.2. Biological data

Size frequency data (total length distribution) for roundnose grenadier are available for Russian catches for 1972–1990 (Shibanov, 1997). Age estimates were available from Russia for 1974–1990 (Shibanov, 1997).

According to retrospective Russian data, maturation of roundnose grenadier starts when fish are at least 50 cm long total length. Mean length-at-maturity of males and females being 76 and 79 cm (TL) respectively (Savvatimsky, 1992). Some individuals mature at the age 6, though some fish may remain immature until the age 20 (Savvatimsky, 1969; Shibanov 1985). No new data on maturity has been collected in recent years.

No specific information is available from the Mid-Atlantic Ridge but natural mortality of 0.1 has been used for roundnose grenadier in Vb, VI, VII and XIIb since 2002. This is based on catch curves from pre-exploitation surveys.

### B.3. Surveys

There have been number of investigations from the Soviet Union on the northern MAR in the 1972–1990 including trawl acoustic surveys and underwater observations (Shibanov *et al.*, 2002). In the 1990s no researches of roundnose grenadier were conducted in the area.

In recent years the MAR-ECO project yielded some biological data (length, age maturity) for roundnose grenadier on the northern MAR.

Trawl acoustic surveys on the MAR were resumed in 2003, when Russian RV *Atlantida* investigated area between 47° and 58°N (Gerber *et al.*, 2004). New data were obtained on grenadier biology, behaviour, distribution and living conditions. Acoustic estimates of the biomass of roundnose grenadier were carried out for several seamounts. Similar research was carried out again in 2010 in the area between 44° and 50°N (Shnar *et al.*, 2011).

### B.4. Commercial cpue

Only nominal catch per fishing day are available from the Soviet/Russian official data from 1974 to 2010. There are gaps in the series due to the lack of catch statistics for 1973 and 1982, as well as absence or too limited of target fishery in 1994–1995 and 2006–2010. These data must be treated with caution because catch rates might be sensitive to several factors (distribution of pelagic concentrations, experience of vessel crew, environmental conditions, etc.) that could not be taken in account so far.

### B.5. Other relevant data

No other source of data is used in the assessment.

## C. Assessment: data and method

No analytical assessments are used.

## D. Short-term projection

No projections are performed.

## E. Medium-term projections

No projections are performed.

## F. Long-term projections

No projections are performed.

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

The current data are inappropriate to provide MSY estimates.

## H. Other issues

Because of the particular environmental conditions on the MAR and roundnose grenadier occurring in large concentration, unlike in other areas where it is rather a dispersed species, it may remain impossible to assess the biomass reliably without extensive acoustic surveys.

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White, T. A., Stamford, J., and Hoelzel, A. R. 2010. Local selection and population structure in a deep-sea fish, the roundnose grenadier (*Coryphaenoides rupestris*). Molecular Ecology, 19: 216–226.

### 19.18 Roundnose grenadier in IIIa

| | |
|---|---|
| Stock: | Roundnose grenadier (*Coryphaenoides rupestris*) in Division IIIa |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | WGDEEP |

## A. General

### A.1. Stock definition

Roundnose grenadier (*Coryphaenoides rupestris*) in Division IIIa is treated as one stock separated from three other stocks within the distribution area in Northeast Atlantic.

The current perception is based on what is believed to be natural restrictions to the dispersal of all life stages. The stock in Skagerrak (Division IIIa) is thought to be separated from the other stocks through the Wyville–Thomson Sill.

In 2007, WGDEEP examined the available evidence of stock discrimination in this species but, on the available evidence, was not able to make further progress in discriminating stocks. On this basis WGDEEP concluded there was no basis on which to change current practice.

Recent genetic analyses have brought forward new information regarding the issue of stock discrimination in the roundnose grenadier. White *et al*. (2010), investigating a limited geographic area in the central and eastern North Atlantic, found evidence of population substructure and local adaptation to depth. An ongoing study, to be published soon (Knutsen *et al*., in prep), covers a larger geographic range and finds indication for population structure throughout the species' distribution range. More specifically, they found that stock structure is clearly evident in the outskirts of the distribution range (Canada and Norway) however, significant but weaker structure, is found among some pairwise samples in the central distribution areas like MAR, west of UK and Greenland (Oral presentation by Knutsen *et al*., 2010 ICELAND DSBS).

### A.2. Fishery

For many years the grenadier was only taken as bycatch in bottom-trawl fisheries for *Pandalus borealis* and perhaps *Nephrops,* and it is uncertain if all catches were landed. The interest in marketing bycatches and developing targeted fisheries grew in the 1980s, probably stimulated by the new fisheries to the west of the British Isles and marketing opportunities in e.g. France. The potential for landing and marketing grenadier for human consumption was explored and exploratory surveys were conducted, but a major sustained fishery never developed in this area.

The stock of roundnose grenadier found in the deep parts of Skagerrak (IIIa) was then the basis for commercial exploitation by a few Danish vessels from the late 1980s until 2006, in some years mainly by a single vessel. This directed fishery began in 1987 as an exploratory fishery. Up to 2003 landings increased gradually, from around 1000 t to 4000 t with fluctuations. However, in 2004 and 2005 exceptionally high catches were reported. The catches were landed mainly for reduction. The fishery and catches were both mainly conducted in the Norwegian economic zone of Skagerrak. This directed fishery stopped in 2006 due to implementation of new agreed regulations between EU and Norway concerning this fishery (Bergstad, 2006). Roundnose grenadier is also taken as bycatch in the Danish fisheries for *Pandalus*, in IIIa. However, the landings of this bycatch (also for reduction) are generally insignificant.

Other countries' bycatches of roundnose grenadier in IIIa, from such as the Norwegian *Pandalus borealis* fishery, is minor due to an introduction of sorting grid in this fishery since the mid 1990s.

Only Denmark has contributed significantly to this fishery and since 2007 landings have been negligible.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

Landings have been reported to WGDEEP since 1988. Prior to 1988 landings were small or at the level observed in the early 1990s. Danish landings were always dominant, and Norway and Sweden and all other nations reported very minor landings. Until 2000 the landings were mostly below 2500 tonnes per year. Subsequently, the Danish fishery expanded, and in 2005 the landings reported to WGDEEP reached almost 12 000 tonnes. The landings declined again in 2006 to very low levels and have since been stable reflecting only bycatches from other fisheries.

The total Danish landings of this species split in landings for H.C. and for reduction is shown in Table 19.18.1. These landings figures have been estimated on basis of reported logbook records combined with samples of the landed catches for reduction. They differ slightly from the logbook recorded catches, which generally overestimate the true landings. For the period 2001–2006 peak landings within a year were recorded in March–April.

Data are given on the geographical distribution of this fishery from 2006 (Figure 19.18.1). This fishery had a very small geographical distribution and landings were mainly from a very few rectangles in Norwegian zone of Skagerrak.

**Table 19.18.1. Danish landings, 1996–2006 of roundnose grenadier split into H.C. landings and landings for reduction.**

| | Landings of roundnose grenadier (kg) | | Total landings |
|---|---|---|---|
| year | H. C. | Reduction | (tons) |
| 1996 | 6493 | 2 207 000 | 2213 |
| 1997 | | 1 356 280 | 1356 |
| 1998 | 635 | 1 489 000 | 1490 |
| 1999 | | 3 113 000 | 3113 |
| 2000 | 315 | 2 400 000 | 2400 |
| 2001 | 6401 | 3 061 000 | 3067 |
| 2002 | 4 | 4 195 738 | 4196 |
| 2003 | 7 | 4 301 661 | 4302 |
| 2004 | 3129 | 9 870 664 | 9874 |
| 2005 | 17 056 | 1 904 545 | 11 922 |
| 2006 | 2448 | 2 259 000 | 2261 |

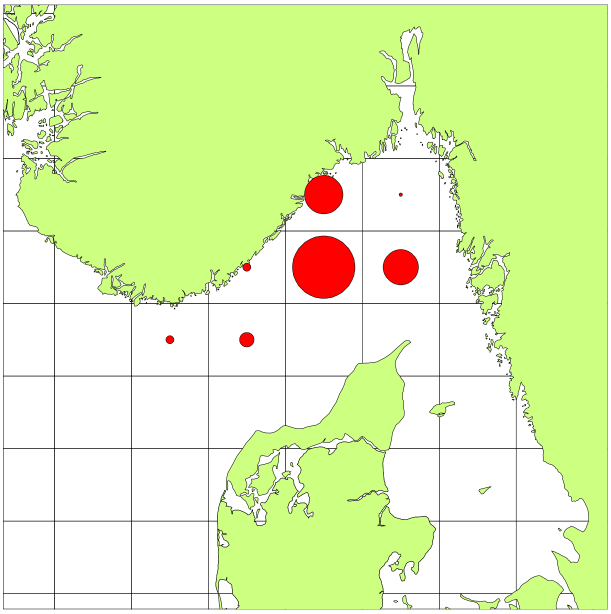
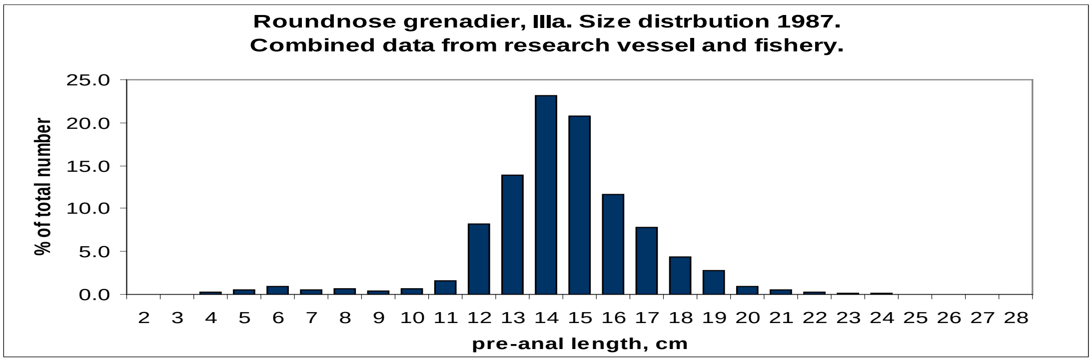
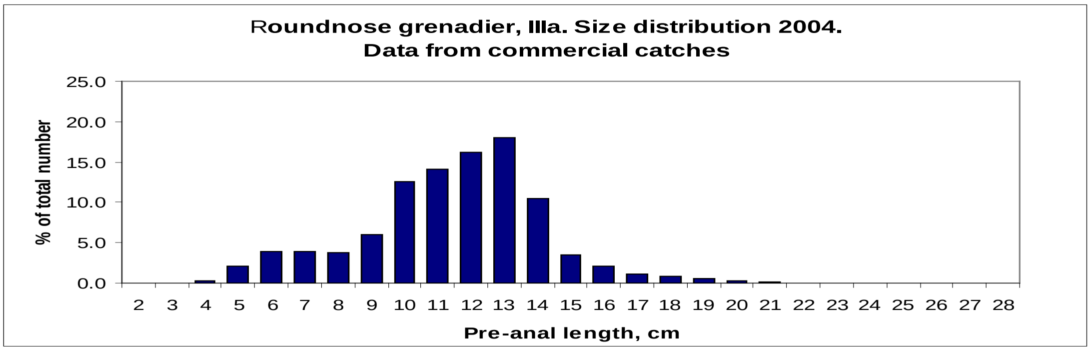


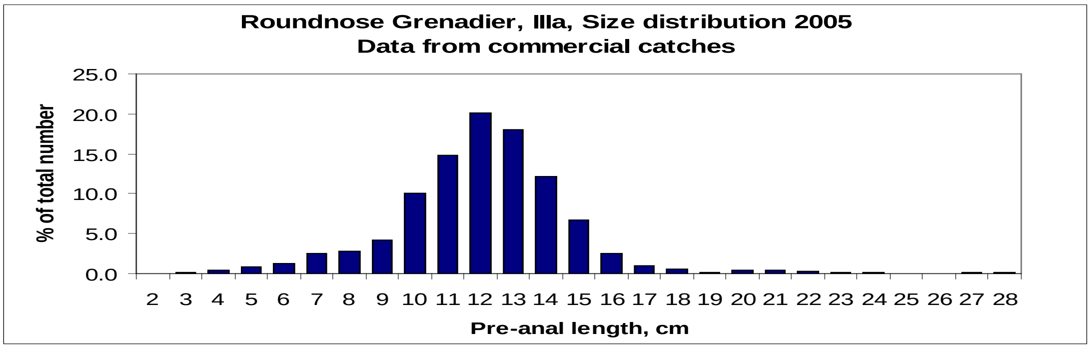
**Figure 19.18.1. Geographical distribution of the fishery for roundnose grenadier in IIIa in 2006.**

## B.2. Biological

Length frequency data for roundnose grenadier in IIIa are available from a 1987 survey by the Danish research vessel and an experimental Danish fishery in the same year. Samples of the Danish landings 2004–2006 have provided information of the size composition in landings during the major expansion of the fishery, see Figure 19.18.2.



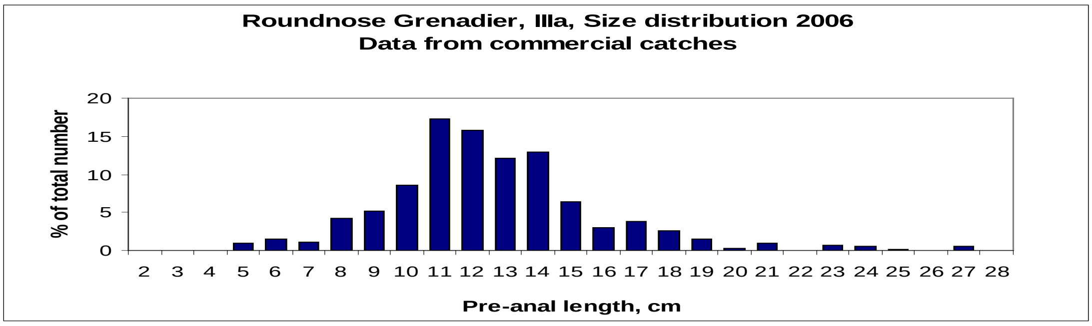




**Figure 19.18.2. Size compositions from Danish commercial catches in 1987, 2004–2006.**

## B.3. Surveys

### B.3.1. *Pandalus borealis* survey

An annual *Pandalus borealis* shrimp survey performed by the Institute of Marine Research have been conducted in the area since 1984. The survey is a depth stratified research survey with approximately 25% of the stations deeper than 300 m (depth range 110–520 m). The stations are placed at random within strata and subareas, and the same sites area sampled every year. The survey is thought to have a representative sampling for roundnose grenadier although the survey originally was designed primarilly for sampling shrimp. Although some changes occurred over the years, the overall standardization was maintained throughout the time-series (Bergstad *et al.*, 2009 and 2011, WD's to WGDEEP). At present, data from this survey is the only fishery-independent information on this stock from this area.

Biomass and abundance was calculated as mean of all stations at depths>300 m including the stations with zero catches. Percentage length distributions were standardized to catch size and trawling distance for all stations >300 m with positive catches.

#### B.3.2. Other survey data

Investigations by Bergstad (1990) based on data from 1987 in Skagerrak suggest very slow growth and consequently the age distributions in catches could span over 20–30 years.

### B.4. Commercial cpue

The overall trends in logbook recorded catch, effort and cpue for the Danish directed fishery on this stock for the period 1996–2006 is showed in Table 19.18.2 A–C. A number of different mesh sizes were used in the fishery. The evaluation of the Danish cpue data is presented in ICES (2007) together with suggestive comments. Here it suffices to state, that these cpue figures (Tables 19.18.2 A–C) do not provide any clear indications of stock development and status for that period (Figure 19.18.3).

**Table 19.18.2 A–C. The Danish fishery for roundnose grenadier in IIIa. Trends in catch, effort and cpue by major ICES rectangle, see text.**

| | Total catch (tons) by ICES rectangle | | | | | |
|---|---|---|---|---|---|---|
| year | 44F8 | 44F9 | 45F8 | 45F9 | 46F9 | Total |
| 1996 | 80 | 40 | 25 | 709 | 98 | 951 |
| 1997 | 28 | 0 | 115 | 1088 | 163 | 1393 |
| 1998 | 238 | 235 | 180 | 1483 | 1112 | 3248 |
| 1999 | 0 | 25 | 61 | 704 | 1353 | 2143 |
| 2000 | 0 | 0 | 40 | 893 | 854 | 1787 |
| 2001 | 105 | 11 | 65 | 862 | 956 | 1999 |
| 2002 | 165 | 79 | 0 | 928 | 1531 | 2702 |
| 2003 | 0 | 120 | 545 | 1223 | 1769 | 3657 |
| 2004 | 1104 | 5786 | 215 | 1704 | 1721 | 10 529 |
| 2005 | 518 | 4073 | 682 | 4739 | 2823 | 12 834 |
| 2006 | 26 | 517 | 40 | 1067 | 487 | 2136 |
| | Total effort (days) by ICES rectangle | | | | | |
| year | 44F8 | 44F9 | 45F8 | 45F9 | 46F9 | Total |
| 1996 | 5 | 23 | 2 | 59 | 6 | 95 |
| 1997 | 3 | | 7 | 67 | 5 | 82 |
| 1998 | 7 | 9 | 4 | 54 | 32 | 106 |
| 1999 | | 2 | 4 | 43 | 65 | 114 |
| 2000 | | 2 | 4 | 57 | 48 | 111 |
| 2001 | 5 | 8 | 3 | 49 | 65 | 130 |
| 2002 | 11 | 7 | | 42 | 70 | 130 |
| 2003 | | 5 | 17 | 70 | 96 | 188 |
| 2004 | 99 | 391 | 9 | 74 | 65 | 638 |
| 2005 | 47 | 178 | 9 | 107 | 77 | 418 |
| 2006 | 2 | 19 | 2 | 24 | 20 | 67 |
| | Total cpue (tons/day) by ICES rectangle | | | | | |
| year | 44F8 | 44F9 | 45F8 | 45F9 | 46F9 | Average |
| 1996 | 16.0 | 1.7 | 12.5 | 12.0 | 16.3 | 10.0 |
| 1997 | 9.2 | | 16.4 | 16.2 | 32.5 | 17.0 |
| 1998 | 34.0 | 26.1 | 45.0 | 27.5 | 34.8 | 30.6 |
| 1999 | | 12.5 | 15.3 | 16.4 | 20.8 | 18.8 |
| 2000 | | 0.0 | 10.0 | 15.7 | 17.8 | 16.1 |
| 2001 | 21.0 | 1.4 | 21.7 | 17.6 | 14.7 | 15.4 |
| 2002 | 15.0 | 11.3 | | 22.1 | 21.9 | 20.8 |
| 2003 | | 24.0 | 32.1 | 17.5 | 18.4 | 19.5 |
| 2004 | 11.2 | 14.8 | 23.9 | 23.0 | 26.5 | 16.5 |
| 2005 | 11.0 | 22.9 | 75.7 | 44.3 | 36.7 | 30.7 |
| 2006 | 12.8 | 27.2 | 20.0 | 44.5 | 24.3 | 31.9 |

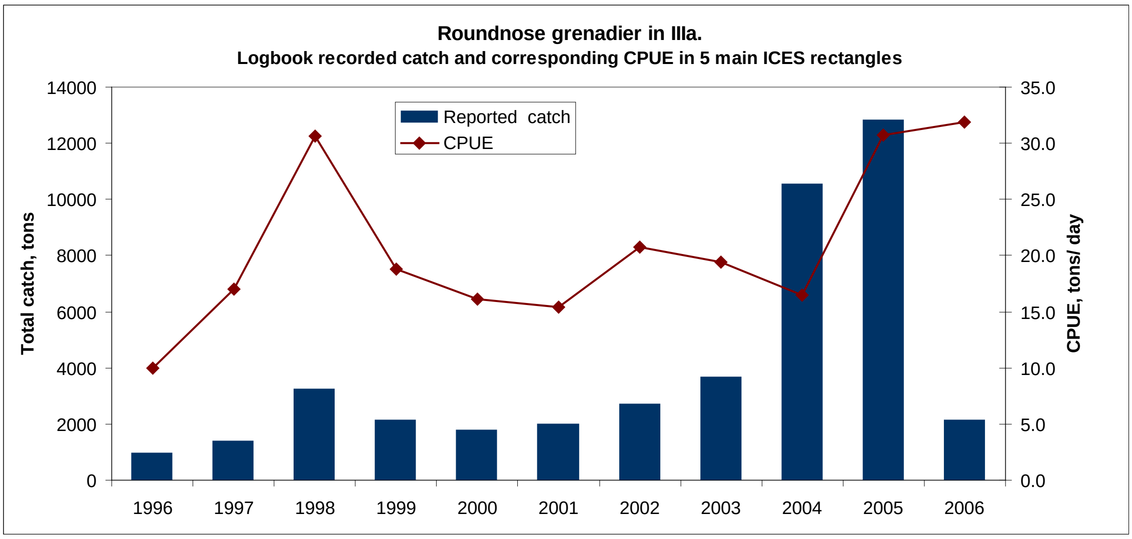



**Figure 19.18.3. Danish catches and cpue by main ICES rectangle. Based on logbook records.**

### B.5. Other relevant data

## C. Assessment: data and method

Model used: Survey trends, landings and size distribution from landings during directed fishery.

Software used:

Model Options chosen:

Input data types and characteristics:

| Type | Name | Year range | Split on countries | Variable from year to year Yes/No |
|---|---|---|---|---|
| Landings | Catches in tonnes | 1988–2010 | Yes | No |
| Danish cpue commercial catches | Tonnes/day | 1996–2006 | Danish only | No |
| Danish commercial length compositions | % of total number | 1987 and 2004–2006 | Danish only | Yes |
| Survey catch rate | Kg/hour | 1984–2010 | Norwegian only | No |
| Survey length compositions | % of total number | 1984–2010 | Norwegian only | No |

## D. Short-term projection

NA.

## E. Medium-term projections

NA.

## F. Long-term projections

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

No biological reference points have been set.

## H. Other issues

### H.1. Historical overview of previous assessment methods

## I. References


Bergstad, O.A., H.Ø. Hansen, and T. Jørgensen. 2009. Fisheries-independent information on temporal variation in abundance, size structure, recruitment and distribution of the roundnose grenadier *Coryphaenoides rupestris*, 1984-2009. Working Document for ICES WGDEEP, Copenhagen 2009.

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## 19.19 Roundnose grenadier in other areas

| | |
|---|---|
| Stock: | Roundnose grenadier (*Coryphaenoides rupestris*) in other areas (I, II, IV, Va2, VIII, IX, XIVa, XIVb2) |
| Working Group: | WGDEEP |
| Date: | 8th March 2011 |
| Revised by> | Vladimir Vinnichenko |

## A. General

### A.1. Stock definition

See Annex "Roundnose grenadier in Vb, VI, VII and XIIb".

### A.2. Fishery

There have been no directed fisheries of roundnose grenadier, and this species was taken as bottom-trawl bycatch only in small amounts in a number of discrete areas. The total catch had permanent decrease tendency during recent years and amounted only 46 t in 2009 and 59 t in 2010.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

Landings data per ICES areas and by countries are available for 1989–2010. Catch in Division XIVb are allocated to MAR (Division XIVb1) and East Greenland (Division XIVb2) according to knowledge of the fisheries from WG members. There is no information on discards.

### B.2. Biological data

There was only occasional sampling for roundnose grenadier in other areas in the previous years.

### B.3. Surveys

There were no special surveys earlier for roundnose grenadier in other areas.

### B.4. Commercial cpue

There is no information on cpue.

### B.5. Other relevant data

No other relevant sources of data.

## C. Assessment: data and method

No analytical assessments are used.

## D. Short-term projection

No projections are performed.

## E. Medium-term projections

No projections are performed.

## F. Long-term projections

No projections are performed.

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

No biological reference points have been defined.

## H. Other issues

No comments.

## I. References

No references.

## 19.20 Tusk in I and II

| | |
|---|---|
| Stock: | Tusk (*Brosme Brosme*) in Subareas I and II |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Kristin Helle |

# A. General

### A.1. Stock definition

In 2007, WGDEEP examined the available evidence of stock discrimination in this species. Based on the genetic investigation, the Group suggested that Tusk in I and II should be treated as one unit.

### A.2. Fishery

Tusk has been caught, primarily as bycatch in the ling and cod fisheries, in these subareas for centuries, and the historical development is described by e.g. Bergstad and Hareide, 1996, including the post-World War II increase caused by a series of technical advances. Currently the major fisheries in Subareas I and II are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears, i.e. trawls and handlines. Of the Norwegian landings, usually around 85% is taken by longlines, 10% by gillnets and the remainder by a variety of other gears. Other nations catch tusk as a bycatch in trawl and longline fisheries.

Russian landings (107 tonnes) from Subdivisions IIa and IIb in 2010 were mainly taken as bycatch in longline fisheries. In Subarea I one tonne was caught (Vinnichenko *et al*., WD 2011).

### A.3. Ecosystem aspects

# B. Data

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time-series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

### B.2. Biological

Length data for the Norwegian reference fleet in Subarea IIa have been routinely collected since 2002.

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

No data available.

### B.4. Commercial cpue

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 tonnes in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. Cpue were calculated as the average total catch of ling per vessel (*C*), and the average number of hooks per set and per vessel (*N*) associated with these catches. Then, for each year and catch category, the estimated cpue for the entire fleet was determined as *C*/*N*. Thus the estimated cpue for each year and Subarea was the mean catch in kg per hook for the entire fleet.

The boats that provided logbooks are the primary sampling units, and *C* and *N* are both random variables. It follows that this is a ratio-type estimator, therefore the standard errors of the cpue estimates could be calculated as described in Cochran (1977, page 32). This cpue estimator is a weighted average, that is the more hooks a boat sets, the more influence it has on the estimate (Cochran, 1977). For comparison, an unweighted cpue series was also constructed (i.e. the average cpue per boat).

A standardized series will be developed in preparation for WGDEEP 2012.

### B.5. Other relevant data

## C. Assessment: data and method

## D. Short-term projection

## E. Medium-term projections

## F. Long-term projections

## G. Biological Reference Points

No biological reference points have been defined.

## H. Other Issues

## I. References

No references.

## 19.21 Tusk MAR

| | |
|---|---|
| Stock: | Tusk (*Brosme Brosme*) on the Mid-Atlantic Ridge (Subdivisions XIIa1 and XIVb1) |
| Working Group: | WGDEEP |
| Date: | March 2011 |
| Revised by: | Kristin Helle |

## A. General

### A.1. Stock definition

In 2007, WGDEEP examined the available evidence of stock discrimination in this species. Based on the genetic investigation, the Group suggested that Tusk on the Mid Atlantic Ridge should be treated as one unit.

### A.2. Fishery

Tusk is a bycatch species in the gillnet and longline fisheries in Subdivisions XIIa1 and XIVb1. Russia reported catches of tusk in 2005–2007 and 2009. No catches were reported for 2010. During the period 1996–1997 Norway also had a fishery in this area.

### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

### B.2. Biological

### B.3. Surveys

### B.4. Commercial cpue

### B.5. Other relevant data

## C. Assessment: data and method

## D. Short-term projection

## E. Medium-term projections

## F. Long-term projections

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

## H. Other issues

## I. References

No references.

## 19.22 Tusk in VIb

Stock: Tusk (*Brosme Brosme*) in VIb

Working Group: WGDEEP

Date: March 2011

Revised by: Kristin Helle

# A. General

### A.1. Stock definition

In 2007, WGDEEP examined the available evidence of stock discrimination in this species. Based on the genetic investigation, the Group suggested that Tusk in VIb should be treated as one unit.

### A.2. Fishery

Tusk is a bycatch species in the trawl, gillnet and longline fisheries in Subarea VIb. Norway has traditionally landed the largest percentage of the total catch. Longliners catch about 90% of the Norwegian landings. Since the 12th of January 2007 parts of the Rockall bank has been closed to fishing with bottom trawls, gillnets and longlines. The areas closed are traditional areas fished by the Norwegian longline fleet.

In 2004 Russia started longline fishery of ling with bycatch of tusk in international waters of the Rockall Bank. Maximum catch (137 t) was taken in 2005. In recent years, intensity of Russian longline fishery decreased. Small bycatches of tusk were also taken in the area by trawlers on haddock fishery.

### A.3. Ecosystem aspects

# B. Data

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time-series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

### B.2. Biological

Length data for the Norwegian reference fleet in Subarea IIa have been routinely collected since 2002.

Considerable general information is available on the life-history characteristics of this species.

### B.3. Surveys

No data available.

### B.4. Commercial cpue

Norway started in 2003 to collect and enter data from official logbooks into an electronic database and data are now available for the period 2000–2009. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 tonnes in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. Cpue were calculated as the average total catch of ling per vessel (*C*), and the average number of hooks per set and per vessel (*N*) associated with these catches. Then, for each year and catch category, the estimated cpue for the entire fleet was determined as *C*/*N*. Thus the estimated cpue for each year and subarea was the mean catch in kg per hook for the entire fleet.

The boats that provided logbooks are the primary sampling units, and *C* and *N* are both random variables. It follows that this is a ratio-type estimator, therefore the standard errors of the cpue estimates could be calculated as described in Cochran (1977, page 32). This cpue estimator is a weighted average, that is the more hooks a boat sets, the more influence it has on the estimate (Cochran, 1977). For comparison, an unweighted cpue series was also constructed (i.e. the average cpue per boat).

A standardized series will be developed in preparation for WGDEEP 2012.

### B.5. Other relevant data

## C. Assessment: data and method

## D. Short-term projection

## E. Medium-term projections

## F. Long-term projections

## G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | xxx t | Explain |
| Approach | $F_{MSY}$ | Xxx | Explain |
| | $B_{lim}$ | xxx t | Explain |
| Precautionary | $B_{pa}$ | xxx t | Explain |
| Approach | $F_{lim}$ | Xxx | Explain |
| | $F_{pa}$ | Xxx | Explain |

No biological reference points have been defined.

## H. Other issues

**H.1**. Historical overview of previous assessment methods

## I. References

There are no references.

## 19.23 Tusk in V and XIV

| | |
|---|---|
| Stock: | Tusk (Division Va, XIV) |
| Working Group: | WKDEEP |
| Date: | February 2010 |
| Revised by: | Kristjan Kristinsson, Gudmundur Thordarson |

Likelihood weighting text added by WGDEEP 2011.

# A. General

### A.1. Stock definition

Tusk in Icelandic and Greenland waters (ICES Divisions Va and XIV respectively) is considered as one stock unit and is separated from the tusk found on the Mid-Atlantic Ridge, on Rockall (VIb), and in Divisions I and II. This stock discrimination is based on genetic investigation (Knutsen *et al.*, 2009) and was reviewed at the WGDEEP meeting in 2007.

### A.2. Fishery

The tusk in ICES Division Va is mainly caught by Iceland (75—85% of the total annual catches in recent years), but the Faroe Islands and Norway also important fishing nations. Foreign catches of tusk in Va, mainly conducted by the Faroese fleet, has always been considerable but have decreased since 1990, whereas the Icelandic catches have increased.

Over 95% of the Icelandic tusk catch in Va comes from longliners and mainly caught as either bycatch in other fisheries or in mixed fishery. The Icelandic longline fleet mainly targets cod and haddock where tusk is often caught as bycatch. The directed fishery for tusk has traditionally been little but has increased in recent years. Tusk is then often caught with ling and blue ling along the south and southwest coast of Iceland.

In recent years between 150–250 longliners have annually reported tusk catches, whereof 80–85% have been caught by about 20–25 vessels (annual catch of each vessel from about 50 tonnes up to 800 tonnes).

Since 1991, 60–80% of the catches have been taken within the depth range of 100–300 m, with 80–95% of the catches taken at depth less than 400 m. In some years, about 20% of the annual tusk catch has been taken at depths between 600–700 m.

The longline fleet in Icelandic waters is composed of both small boats (<10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but tusk, ling and blue ling are also caught, sometimes in directed fisheries. The ten longline vessels that fish about 65% of the total tusk catch in Va are vessels between 300–600 GRT.

Tusk fishery in ICES Division XIV has traditionally been very little, with less than 100 t caught annually. The tusk is caught as bycatch in other fisheries.

### A.3. Ecosystem aspects

Tusk in Icelandic waters is mainly found on the continental shelf and slopes of south-east, south, and west of Iceland at depths of 0–1000 m, but mainly at depths between 100–500 m.

### A.4. Management

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations. Below is a short account of the main feature of the management system and where applicable emphasis will be put on tusk.

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The ITQ system allows free transferability of quota between boats. This transferability can either be on a temporary (one year leasing) or a permanent (permanent selling) basis. This system has resulted in boats having quite diverse species portfolios, with companies often concentrating/specializing on particular group of species. The system allows for some but limited flexibility with regards converting a quota share of one species into another within a boat, allowance of landings of fish under a certain size without it counting fully in weight to the quota, and allowance of transfer of unfished quota between management years. The objective of these measures is to minimize discarding, which is effectively banned. Since 2006/2007 fishing season, all boats operate under the TAC system.

At the beginning, only few commercial exploited fish species were included in the ITQ system, but many other species have gradually been included. Tusk was included into the ITQ system in the 2001/2002 quota year.

Landings in Iceland are restricted to particular licensed landing sites, with information being collected on a daily basis time by the Directorate of Fisheries in Iceland (the enforcement body). All fish landed has to be weighted, either at harbour or inside the fish processing factory. The information on each landing is stored in a centralized database maintained by the Directorate and is available in real time on the Internet (www.fiskistofa.is). The accuracy of the landings statistics are considered reasonable.

All boats operating in Icelandic waters have to maintain a logbook record of catches in each haul/set. The records are available to the staff of the Directorate for inspection purposes as well as to the stock assessors at the Marine Research Institute.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place.

A system of instant area closure is in place for many species, including tusk. The aim of the system is to minimize fishing on juveniles. For tusk, an area is closed temporarily (for two weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than 25% of the catch is composed of fish less than 55 cm in length. Since tusk is often bycatch in other fisheries, this rule does only apply when the tusk catch is more than 30% of the total catch in a set/haul. Because of repeated instant area closures off the south and southeast coast of Iceland in 2003, four areas were closed permanently for longline fishery in order to protect juvenile tusk (Figure 19.23.1).

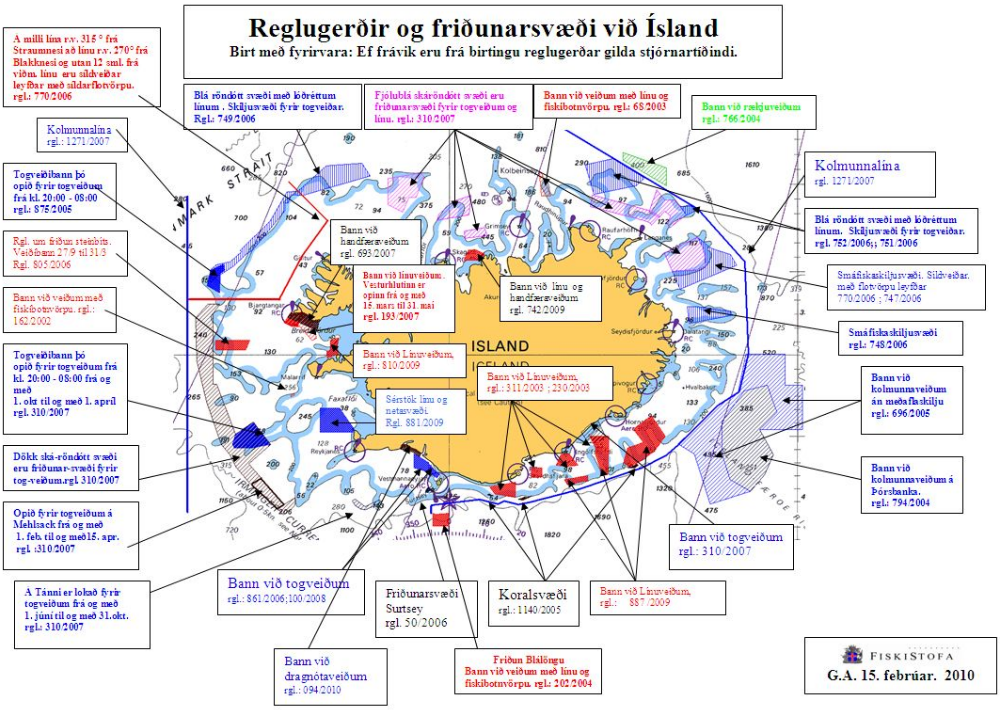


**Figure 19.23.1. Marine protected areas in Icelandic waters. These areas are closed for various types of fisheries and may be closed permanently (all year around) or temporarily (closed part of the years. Four areas marked red south and southeast of Iceland (reference to the box *Bann við Línu-veiðum, rgl.: 311/2003; 230/2003*) are areas permanently closed for longline fisheries in order to protect juvenile tusk. Trawling does not occur within these areas. Figure provided by Directorate of Fisheries in Iceland.**

## B. Data

### B.1. Commercial catch

#### Landings and discards

The text Table below shows which data from landings is supplied from ICES Division Va.

| ICES Division Va | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (Catch in weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | Matprop (proportion mature-by-age) | Length composition in catch |
| Iceland | x | Two years | Two years | | x |
| The Faroe Islands | x | | | | x |
| Norway | x | | | | |

Icelandic tusk catch in tonnes by month, area and gear are obtained from Statistical Iceland and Directorate of Fisheries. Catches are only landed in authorized ports where all catches are weighed and recorded. The distribution of catches is obtained from logbook statistic where location of each haul, effort, depth of trawling and total catch of tusk is given. Logbook statistics are available since 1991. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard and reported to the Directorate of Fisheries.

Discard is banned in the Icelandic demersal fishery and there is no information available on possible discard of tusk.

### B.2. Biological

At 45 cm around 20% of tusk in Va is mature, at 58 cm 50% of tusk is mature and at 80 cm more or less every tusk is mature.

No information is available on natural mortality of tusk in Va. In the Gadget model it is assumed to be 0.2 but different variants of natural mortality are tested.

Biological data from the commercial longline catch are collected from landings by scientists and technicians of the Marine Research Institute (MRI) in Iceland. The biological data collected are length (to the nearest cm), sex and maturity stage (if possible since most tusk is landed gutted), and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted (to the nearest gramme). Biological sampling is also collected directly on board on the commercial vessels during trips by personnel of the Directorate of Fisheries in Iceland or from landings (at harbour). These are only length samples.

The general process of the sampling strategy is to take one sample of tusk for every 180 tonnes landed. This means that between 30–40 samples are taken from the commercial longline catch each year. Each sample consists of 150 fish. Otoliths are extracted from 50 fish which are also length measured and weighed gutted. In most cases the tusk is landed gutted so it not possible to determine sex and maturity. If tusk is landed ungutted, the ungutted weight is measured and the fish is sex and maturity determined. The remaining 100 in the sample are only length measured.

Age reading of tusk from the commercial catch is not done on regular basis and otoliths from only two years have been age read.

Earlier observations indicates that tusk becomes mature-at-age of about 8–10 years or at around the length of 56 cm. However, new ageing of tusk otoliths from 1995 and 2009 suggest that tusk grows considerably faster than previously assumed. The new age-readings are considered more plausible than the older estimates as they results in more similar estimates of growth of tusk in Va as has been reported in other management units.

The mean length-at-maturity is close to the mean length of tusk in the commercial catches. This means that a large proportion of the tusk is caught as immature.

No estimates of natural mortality are available for tusk in Va and XIV. In the Gadget model (see below) natural mortality is assumed to be 0.2 year$^{-1}$.

The biological data from the fishery is stored in a database at the Marine Research Institute. The data are used for description of the fishery and as input data for the GADGET model.

## B.3. Surveys

### Iceland

Two bottom-trawl surveys, conducted by the Marine Research Institute in Va, are considered representative for tusk are the Icelandic Groundfish Survey (IGS or the spring survey) and the Autumn Groundfish Survey (AGS or the autumn survey) The spring survey has been conducted annually in March since 1985 on the continental shelf at depths shallower than 500 m and has a relatively dense station-net (approximately 550 stations). The autumn survey has been conducted in October since 1996 and covers larger area than the spring survey. It is conducted on the continental shelf and slopes and extends to depths down to 1500 m. The number of stations is about 380 so the distance between stations is often greater. The main target species in the autumn survey are Greenland halibut (*Reinhardtius hippoglossoides*) and deep-water redfish (*Sebastes mentella*).

The text in the following description of the surveys is mostly a translation from Björnsson *et al*. (2007). Where applicable the emphasis has been put on tusk.

### B.3.1. Spring survey in Va

From the commencing of the spring survey the stated aim has been to estimate abundance of demersal fish stocks, particularly the cod stock with increased accuracy and thereby strengthening the scientific basis of fisheries management. That is, to get fisheries independent estimates of abundance that would result in increased accuracy in stock assessment relative to the period before the spring survey. Another aim was to start and maintain dialogue with fishers and other stakeholders.

To help in the planning, experienced captains were asked to map out and describe the various fishing grounds around Iceland then they were asked to choose half of the tow-stations taken in the survey. The other half was chosen randomly.

#### *B.3.1.1. Timing, area covered and tow location*

It was decided that the optimal time of the year to conduct the survey would be in March, or during the spawning of cod in Icelandic waters. During this time of the year, cod is most easily available to the survey gear as diurnal vertical migrations are at minimum in March (Pálsson, 1984). Previous survey attempts had taken place in March and for possible comparison with that data it made sense to conduct the survey in March.

The total number of stations was decided to be 600 (Figure 19.23.2). The reason of having so many stations was to decrease variance in indices but was inside the constraints of what was feasible in terms of survey vessels and workforce available. With 500–600 tow-stations the expected CV of the survey would be around 13%.

The survey covers the Icelandic continental shelf down to 500 m and to the EEZ-line between Iceland and Faroe Islands. Allocation of stations and data collection is based on a division between northern and southern areas. The northern area is the colder part of Icelandic waters where the main nursery grounds of cod are located, whereas the main spawning grounds are found in the warmer southern area. It was assumed that 25–30% of the cod stock (in abundance) would be in the southern area at the survey time but 70–75% in the north. Because of this, 425 stations were allocated in the colder northern area and 175 stations were allocated in the southern area. The two areas were then divided into ten strata, four in the south and six in the north.

Stratification in the survey and the allocation of stations was based on pre-estimated cod density patterns in different "statistical squares" (Palsson *et al.*, 1989). The statistical squares were grouped into ten strata depending on cod density. The number of stations allocated to each stratum was in proportion to the product of the area of the stratum and cod density. Finally the number of stations within each stratum was allocated to each statistical square in proportion to the size of the square. Within statistical squares, stations were divided equally between fishers and fishery scientist at the MRI for decisions of location. The scientist selected random position for their stations, whereas the fishers selected their stations from their fishing experience. Up to 16 stations are in each statistical square in the Northern area and up to seven in the Southern are. The captains were asked to decide the towing direction for all the stations.

#### *B.3.1.2. Vessels, fishing gear and fishing method*

In the early stages of the planning it was apparent that consistency in conducting the survey on both spatial and temporal scale was of paramount importance. It was decided to rent commercial stern trawlers built in Japan in 1972–1973 to conduct the survey. Each year, up to five trawlers have participated in the survey each in a dedicated area (NW, N, E, S, SW). The ten Japanese built trawlers were all built on the same plan and were considered identical for all practical purposes. The trawlers were thought to be in service at least until the year 2000. This has been the case and most of these trawlers still fish in Icelandic waters but have had some modifications since the start of the survey, most of them in 1986–1988.

The survey gear is based on the trawl that was the most commonly used by the commercial trawling fleet in 1984–1985. It has relatively small vertical opening of 2–3 m. The headline is 105 feet, fishing line is 63 feet, footrope 180 feet and the trawl weight 4200 kg (1900 kg submerged).

Length of each tow was set 4 nautical miles and towing speed at approx. 3.8 nautical miles per hour. Minimum towing distance so that the tow is considered valid for index calculation is 2 nautical miles. Towing is stopped if wind is more than 17–21 m/sec, (8 on Beaufort scale).

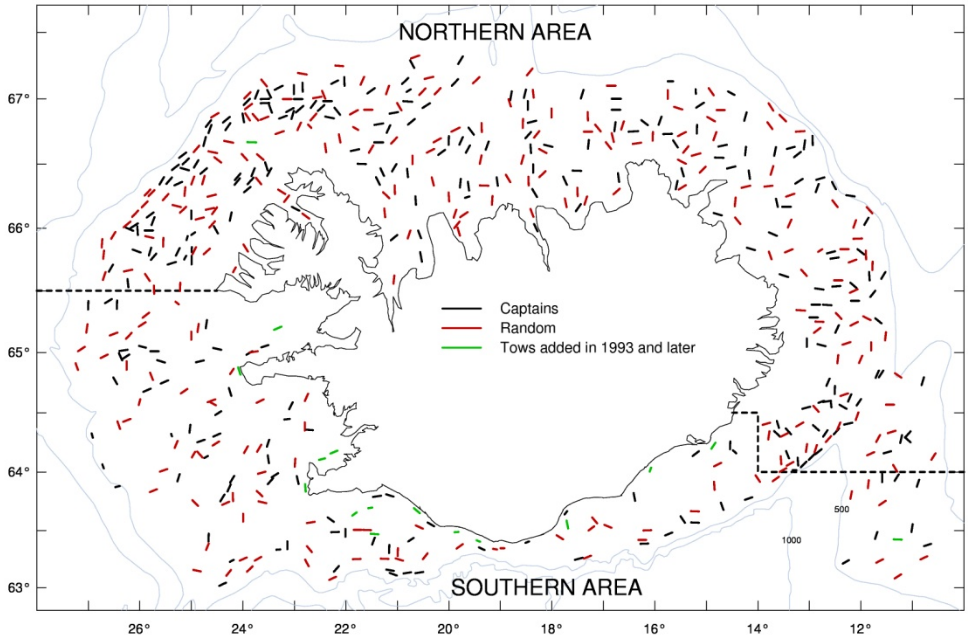


**Figure 19.23.2. Stations in the spring survey in March. Black lines indicate the tow-stations selected by captains of commercial trawlers, red lines are the tow-stations selected randomly, and green lines are the tow-stations that were added in 1993 or later. The broken black lines indicate the original division of the study area into northern and southern area. The 500 and 1000 m depth contours are shown.**

### *B.3.1.3. Later changes in vessels and fishing gear*

The trawlers used in the survey have been changed somewhat since the beginning of the survey. The changes include alteration of hull shape (bulbous bow), the hull extended by several meters, larger engines, and some other minor alterations. These alterations have most likely changed the qualities of the ships but it is very difficult to quantify these changes.

The trawlers are now considered old and it is likely that they will soon disappear from the Icelandic fleet. Some search for replacements is ongoing. In recent years, the MRI research vessels have taken part in the Spring Survey after elaborate comparison studies. The RV Bjarni Sæmundsson has surveyed the NW-region since 2007 and RV Árni Friðriksson has surveyed the Faroe–Iceland ridge in recent years and will in 2010 survey the SW area.

The trawl has not changed since the start of the survey. The weight of the otter-boards has increased from 1720–1830 kg to 1880–1970 kg. The increase in the weight of the otter-boards may have increased the horizontal opening of the trawl and hence decreased the vertical opening. However, these changes should be relatively small as the size (area) and shape of the otter-boards is unchanged.

### *B.3.1.4. Later changes in trawl-stations*

Initially, the numbers of trawl stations surveyed was expected to be 600 (Figure 19.23.2). However, this number was not covered until 1995. The first year 593 stations were surveyed but in 1988 the stations had been decreased down to 545 mainly due to bottom topography (rough bottom that was impossible to tow), but also due to drift ice that year. In 1989–1992, between 567 and 574 stations were surveyed annually. In 1993, 30 stations were added in shallower waters as an answer to fishers' critique.

In short, until 1995 between 596 and 600 stations were surveyed annually. In 1996 14 stations that were added in 1993 were omitted. Since 1991 additional tows have been taken at the edge of the survey area if the amount of cod has been high at the outermost stations.

In 1996, the whole survey design was evaluated with the aim of reduce cost. The number of stations was decreased to 532 stations. The main change was to omit all of the 24 stations from the Iceland-Faroe Ridge. This was the state of affairs until 2004 when in response to increased abundance of cod on the Faroe-Iceland ridge nine stations were added. Since 2005 all of the 24 stations omitted in 1996 have been surveyed each year.

In the early 1990s there was a change from Loran C positioning system to GPS. This may have slightly changed the positioning of the stations as the Loran C system was not as accurate as the GPS.

#### B.3.2. Autumn survey in Va

The Icelandic autumn survey has been conducted annually since 1996 by the MRI. The objective is to gather fishery-independent information on biology, distribution and biomass of demersal fish species in Icelandic waters, with particular emphasis on Greenland halibut (*Reinhardtius hippoglossoides*) and deep-water redfish (*Sebastes mentella*). This is because the spring survey does not cover the distribution of these deep-water species. Secondary aim of the survey is to have another fishery-independent estimate on abundance, biomass and biology of demersal species, such as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and golden redfish (*Sebastes marinus*), in order to improve the precision of stock assessment.

##### *B.3.2.1. Timing, area covered and tow location*

The autumn survey is conducted in October as it is considered the most a suitable month in relation to diurnal vertical migration, distribution and availability of Greenland halibut and deep-sea redfish. The research area is the Icelandic continental shelf and slopes within the Icelandic Exclusive Economic Zone to depths down to 1500 m. The research area is divided into a shallow-water area (0–400 m) and a deep-water area (400–1500 m). The shallow-water area is the same area covered in the spring survey. The deep-water area is directed at the distribution of Greenland halibut, mainly found at depths from 800–1400 m west, north and east of Iceland, and deep-water redfish, mainly found at 500–1200 m depths southeast, south and southwest of Iceland and on the Reykjanes Ridge.

##### *B.3.2.2. Preparation and later alterations to the survey*

Initially, a total of 430 stations were divided between the two areas. Of them, 150 stations were allocated to the shallow-water area and randomly selected from the spring survey station list. In the deep-water area, half of the 280 stations were randomly positioned in the area. The other half were randomly chosen from logbooks of the commercial bottom-trawl fleet fishing for Greenland halibut and deep-water redfish in 1991–1995. The locations of those stations were, therefore, based on distribution and pre-estimated density of the species.

Because MRI was not able to finance a project in order of this magnitude, it was decided to focus the deep-water part of the survey on the Greenland halibut main distributional area. For this reason, important deep-water redfish areas south and west of Iceland were omitted. The number and location of stations in the shallow-water area were unchanged.

The number of stations in the deep-water area was therefore reduced to 150. A total of 100 stations were randomly positioned in the area. The remaining stations were located on important Greenland halibut fishing grounds west, north and east of Iceland and randomly selected from a logbook database of the bottom-trawl fleet fishing for Greenland halibut 1991–1995. The number of stations in each area was partly based on total commercial catch.

In 2000, with the arrival of a new research vessel, MRI was able finance the project according to the original plan. Stations were added to cover the distribution of deep-water redfish and the location of the stations selected in a similar manner as for Greenland halibut. A total of 30 stations were randomly assigned to the distribution area of deep-water redfish and 30 stations were randomly assigned to the main deep-water redfish fishing grounds based on logbooks of the bottom-trawl fleet 1996–1999.

In addition, 14 stations were randomly added in the deep-water area in areas where great variation had been observed in 1996–1999. However, because of rough bottom which made it impossible to tow, five stations have been omitted. Finally, 12 stations were added in 1999 in the shallow-water area, making total stations in the shallow-water area 162. Total number of stations taken since 2000 has been around 381 (Figure 19.23.3).

The RV "Bjarni Sæmundsson" has been used in the shallow-water area from the beginning of the survey. For the deep-water area MRI rented one commercial trawler 1996–1999, but in 2000 the commercial trawler was replaced by the RV "Árni Friðriksson".

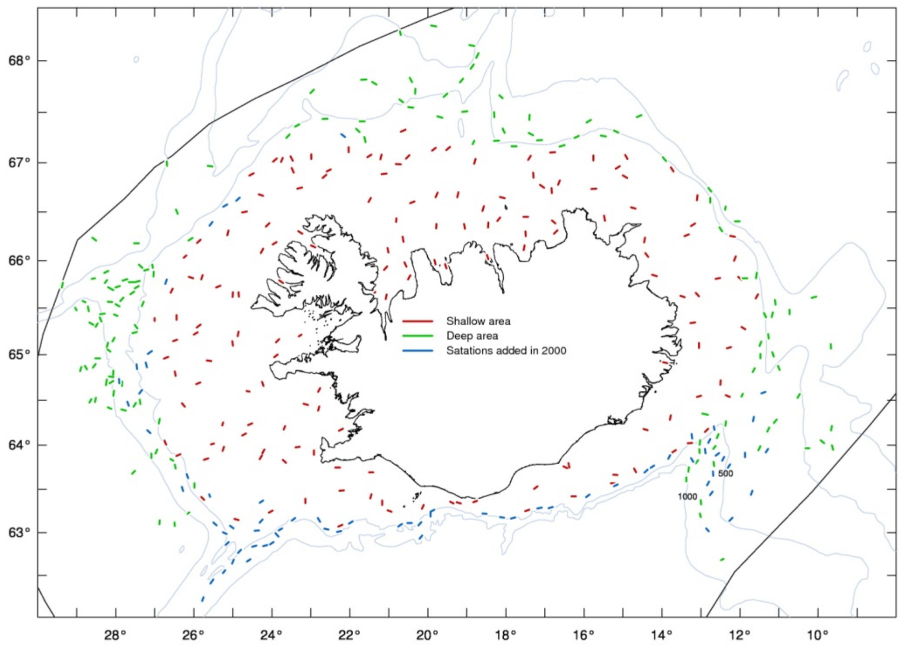


**Figure 19.23.3. Stations in the Autumn Groundfish Survey (AGS). RV "Bjarni Sæmundsson" takes stations in the shallow-water area (red lines) and RV "Árni Friðriksson" takes stations in the deep-water areas (green lines), the blue lines are stations added in 2000.**

#### *B.3.2.3. Fishing gear*

Two types of the bottom survey trawl "Gulltoppur" are used for sampling: "Gulltoppur" is used in the shallow water and "Gulltoppur 66.6m" is used in deep waters. The trawls were common among the Icelandic bottom-trawl fleet in the mid 1990s and are well suited for fisheries on cod, Greenland halibut and redfish.

"Gulltoppur", the bottom trawl used in the shallow water, has a headline of 31.0 m, and the fishing line is 19.6 m. The deep-water trawl, "Gulltoppur 66.6m" has a headline of 35.6 m and the fishing line is 22.6 m.

The towing speed is 3.8 knots over the bottom. The trawling distance is 3.0 nautical miles calculated with GPS when the trawl touches the bottom until the hauling begins (i.e. excluding setting and hauling of the trawl).

### B.3.3. Data sampling

The data sampling in the spring and autumn surveys is quite similar. In short there is more emphasis on stomach content analysis in the autumn survey than the spring Survey. For tusk, the sampling procedure is the same in both surveys except tusk is weighed ungutted and stomach content analysed in the autumn survey.

#### *B.3.3.1. Length measurements and counting*

All fish species are measured for length. For the majority of species including tusk, total length is measured to the nearest cm from the tip of the snout to the tip of the longer lobe of the caudal fin. At each station, the general rule, which also applies to tusk, is to measure at least four times the length interval of a given species. Example: If the continuous length distribution of tusk at a given station is between 15 and 45 cm, the length interval is 30 cm and the number of measurements needed is 120. If the catch of tusk at this station exceeds 120 individuals, the rest is counted.

Care is taken to ensure that the length measurement sampling is random so that the fish measured reflect the length distribution of the haul in question.

#### *B.3.3.2. Recording of weight, sex and maturity stages*

Sex and maturity data has been sampled for tusk from the start of both surveys. Tusk is weighted as ungutted in the autumn survey.

#### *B.3.3.3. Otolith sampling*

For tusk a minimum of one otolith in the spring and autumn surveys is collected and a maximum of 25. Otoliths are sampled at a four fish interval so that if in total 40 tusks are caught in a single haul, ten otoliths are sampled.

#### *B.3.3.4. Stomach sampling and analysis*

Stomach samples of tusk are routinely sampled in the autumn survey.

#### *B.3.3.5. Information on tow, gear and environmental factors*

At each station/haul relevant information on the haul and environmental factors, are filled out by the captain and the first officer in cooperation with the cruise leader.

#### Tow information

- **General:** Year, Station, Vessel registry no., Cruise ID, Day/month, Statist. Square, Sub-square, Tow number, Gear type no., Mesh size, Briddles length (m).
- **Start of haul:** Pos. N, Pos. W, Time (hour:min), Tow direction in degrees, Bottom depth (m), Towing depth (m), Vert. opening (m), Horizontal opening (m).
- **End of haul:** Pos. N, Pos. W, Time (hour:min), Warp length (fm), Bottom depth (m), Tow length (naut. miles), Tow time (min) , Tow speed (knots).
- **Environmental factors:** Wind direction, Air temperature °C, Windspeed, Bottom temperature °C, Sea surface, Surface temperature °C, Towing depth temperature °C, Cloud cover, Air pressure, Drift ice.

#### Greenland

Two research vessel series from Greenland waters are conducted annually, but very little tusk is caught.

### *B.3.2.4. Data processing*

#### *B.3.2.4.1. Abundance and biomass estimates at a given station*

As described above the normal procedure is to measure at least four times the length interval of a given species. The number of fish caught of the length interval $L_1$ to $L_2$ is given by:

$$P = \frac{n_{measured}}{n_{counted} + n_{measured}}$$

$$n_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i}{P}$$

Where $n_{measured}$ is the number of fished measured and $n_{counted}$ is the number of fish counted.

Biomass of a given species at a given station is calculated as:

$$B_{L_1-L_2} = \sum_{i=L_1}^{i=L_2} \frac{n_i \alpha L_i^{\beta}}{P}$$

Where Li is length and alpha and beta are coefficients of the length–weight relationship.

#### *B.3.2.4.2. Index calculation*

For calculation of indices the Cochran method is used (Cochran, 1977). The survey area is split into subareas or strata and an index for each subarea is calculated as the mean number in a standardized tow, divided by the area covered multiplied with the size of the subarea. The total index is then a summed up estimates from the subareas.

A 'tow-mile' is assumed to be 0.00918 square nautical mile. That is the width of the area covered is assumed to be 17 m (17/1852=0.00918). The following equations are a mathematical representation of the procedure used to calculate the indices:

$$I_{strata} = \frac{\sum_{strata} Z_i}{N_{strata}}$$

$$\sigma^2_{strata} = \frac{\sum_{strata} (Z_i - I_{strata})^2}{N_{strata} - 1}$$

$$I_{region} = \sum_{region} I_{strata}$$

$$\sigma^2_{strata} = \sum_{region} \sigma^2_{strata}$$

$$CV_{region} = \frac{\sigma_{region}}{I_{region}}$$

Where *strata* refers to the subareas used for calculation of indices which are the smallest components used in the estimation, *I* refers to the stations in each subarea and region is an area composed of two or more subareas. *Zi* is the quantity of the index (abundance or biomass) in a given subarea. *I* is the index and sigma is the standard deviation of the index. CV refers to the coefficient of variation.

The subareas or strata used in the Icelandic groundfish surveys (same strata division in both surveys) are shown in Figure 19.23.4. The division into strata is based on the so-called BORMICON areas and the 100, 200, 400, 500, 600, 800 and 1000 m depth contours.

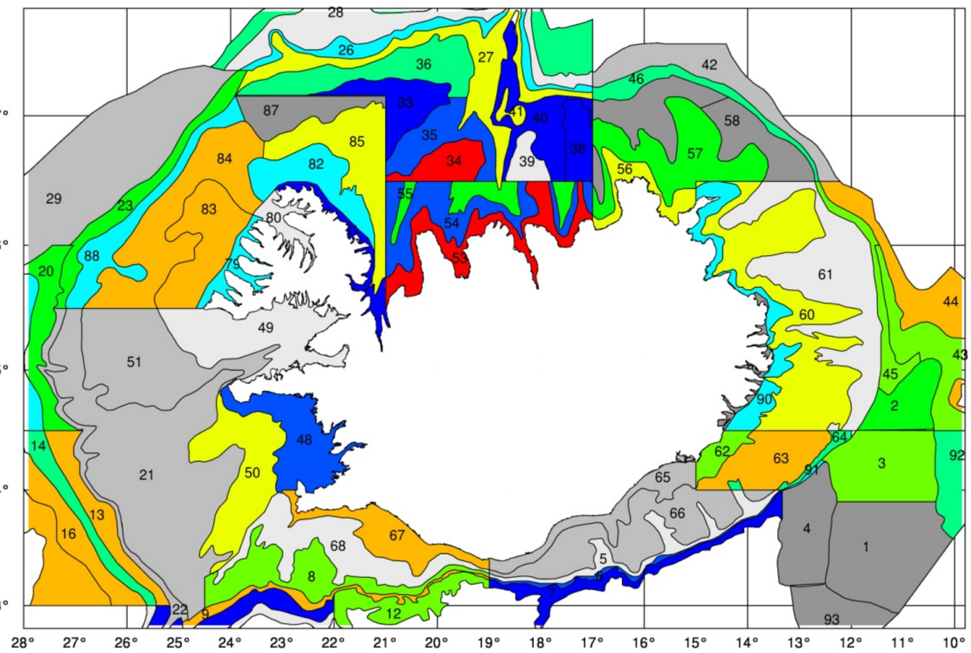


**Figure 19.23.4. Subareas or strata used for calculation of survey indices in Icelandic waters.**

### B.4. Commercial cpue

Data used to estimate cpue for tusk in Division Va since 1991 were obtained from logbooks of the Icelandic longline fleet. Only sets were used where catches of tusk was registered, but also for sets where tusk constituted tom more than 10% and 30% of the catch.

Non-standardized cpue and effort is calculated for each year which is simply the sum of all catch divided by the sum of number of hooks.

### B.5. Other relevant data

No other relevant data available.

## C. Historical stock development

### C.1. Description of gadget

Gadget is shorthand for the "Globally applicable Area Disaggregated General Ecosystem Toolbox", which is a statistical model of marine ecosystems. Gadget (previously known as BORMICON and Fleksibest). Gadget is an age–length structured forward-simulation model, coupled with an extensive set of data comparison and optimization routines. Processes are generally modelled as dependent on length, but age is tracked in the models, and data can be compared on either a length and/or age scale. The model is designed as a multi-area, multi-area, multifleet model, capable of including predation and mixed fisheries issues; however it can also be used on a single species basis. Gadget models can be both very data- and computationally intensive, with optimization in particular taking a large amount of time. Worked examples, a detailed manual and further information on Gadget can be found on www.hafro.is/gadget. In addition the structure of the model is described in Björnsson and Sigurdsson (2004), Begley and Howell (2004), and a formal mathematical description is given in Frøysa *et al*. (2002).

Gadget is distinguished from many stock assessment models used within ICES (such as XSA) in that Gadget is a forward simulation model, and is structured be both age and length. It therefore requires direct modelling of growth within the model. An important consequence of using a forward simulation model is that the plus groups (in both age and length) should be chosen to be large enough that they contain few fish, and the exact choice of plus group does not have a significant impact on the model.

#### Setup of a Gadget run

There is a separation of model and data within Gadget. The simulation model runs with defined functional forms and parameter values, and produces a modelled population, with modelled surveys and catches. These surveys and catches are compared against the available data to produce a weighted likelihood score. Optimization routines then attempt to find the best set of parameter values. Growth is modelled by calculating the mean growth for fish in each length group for each time-step, using a parametric growth function. In the tusk model a von Bertanlanffy function has been employed to calculate this mean growth. The actual growth of fish in a given length cell is then modelled by imposing a beta-binomial distribution around this mean growth. This allows for the fish to grow by varying amounts, while preserving the calculated mean. The beta-binomial is described in Stefansson (2001). The beta-binomial distribution is constrained by the mean (which comes from the calculated mean growth), the maximum number of length cells a fish can grow in a given time-step (which is set based on expert judgement about the maximum plausible growth), and a parameter $\beta$, which is estimated within the model. In addition to the spread of growth from the beta-binomial distribution, there is a minimum to this spread due by discretization of the length distribution.

#### Catches

All catches within the model are calculated on length, with the fleets having size-based catchability. This imposes a size-based mortality, which can affect mean weight and length-at-age in the population (Kvamme, 2005). A fleet (or other preditor) is modelled so that either the total catch in each area and time interval is specified, or that the catch per time-step is estimated. In the hake assessment described here the commercial catch and the discards are set (in kg per quarter), and the surveys are modelled as fleets with small total landings. The total catch for each fleet for each quarter is then allocated among the different length categories of the stock according to their abundance and the catchability of that size class in that fleet.

#### Likelihood data

A significant advantage of using an age–length structured model is that the modelled output can be compared directly against a wide variety of different data sources. It is not necessary to convert length into age data before comparisons. Gadget can use various types of data that can be included in the objective function. Length distributions, age–length keys, survey indices by length or age, cpue data, mean length and/or weight-at-age, tagging data and stomach content data can all be used. Importantly this ability to handle length date directly means that the model can be used for stocks such as hake where age data are sparse or considered unreliable. Length data can be used directly for model comparison. The model is able to combine a wide selection of the available data by using a maximum likelihood approach to find the best fit to a weighted sum of the datasets.

#### Optimization

The model has two alternative optimizing algorithims linked to it; a wide area search simulated annealing Corona *et al*. (1987) and a local search Hooke and Jeeves algorithim, HookeJeeves1961. Simulated annealing is more robust than Hooke and Jeeves and can find a global optima where there are multiple optima but needs about 2–3 times the order of magnitude number of iterations than the Hooke and Jeeves algorithim. The model is able to use both in a single run optimization, attempting to utilize the strengths of both. Simulated annealing is used first to attempt to reach the general area of a solution, followed by Hooke and Jeeves to rapidly home in on the local solution. This procedure is repeated several times to attempt to avoid converging to a local optimum. The algorithms are not gradient-based, and there is therefore no requirement on the likelihood surface being smooth. Consequently neither of the two algorithims returns estimates of the Hessian.

#### Likelihood weighting

The total objective function to be minimized is a weighted sum of the different components. Selection of the weights estimated following the procedure laid out by Taylor *et al*. (2007) where an objective re-weighting scheme for likelihood components is described for Gadget models using cod as a case study. The iterative re-weighting heuristic tackles this problem by optimizing each component separately in order to determine the lowest possible value for each component. This is then used to determine the final weights. The iterative re-weighting procedure has now been implemented in the R statistical language as a part of the **rgadget** package which is written and maintained by B. Th. Elvarsson.

Conceptually the likelihood components can roughly be thought of as residual sums of squares (SS), and as such their variance can be estimated by dividing the SS by the degrees of freedom. Then the optimal weighting strategy is the inverse of the variance. The variances and hence the final weights are calculated according the following algorithm:

1 ) Calculate the initial SS given the initial parameterization. Assign the inverse SS as the initial weight for all likelihood components. With these initial weights the objective function will start off with value equal to the number of likelihood components.
2 ) For each likelihood component, do an optimization run with the initial score for that component set to 10 000. Then estimate the residual variance using the resulting SS of that component divided by the effective number of datapoints that is all non-zero data-points.
3 ) After the optimization set the final weight for that all components as the inverse of the estimated variance from step 3 (weight =(1/SS) * d.f.*).

The effective number of datapoints (d.f.*) in 3) is used as a proxy for the degrees of freedom determined from the number of non-zero datapoints. This is viewed as satisfactory proxy when the dataset is large, but for smaller datasets this could be a gross overestimate. In particular, if the survey indices are weighed on their own while the yearly recruitment is estimated they could be over-fitted. If there are two surveys within the year Taylor *et al*. (2007) suggest that the corresponding indices from each survey are weighed simultaneously in order to make sure that there are at least two measurements for each yearly recruit. In general problem such as those mentioned here could be solved with component grouping that is in step 2) above likelihood components that should behave similarly, such as survey indices, should be heavily weighted and optimized together.

Another approach for estimating the weights of each index component, in the case of a single survey fleet, would be to estimate the residual variances from a model of the form:

$$\log(I_{lt} = \mu + Y_t + \lambda_t + \varepsilon_{lt}$$

where $t$ is denotes year, $l$ length-group and the residual term, $\varepsilon_{lt}$, is independent normal with variance $\sigma_s^2$ where $s$ denotes the likelihood component. The inverse of the estimated residual variance are then set as weights for the survey indices. In the RGadget routines this approach is termed **sIw** as opposed to **sIgroup** for the former approach.

### C.2. Settings for the tusk assessment

Population is defined by 10 cm length groups, from 20–110 cm and the year is divided into four quarters. The age range is 2 to 20 years, with the oldest age treated as a plus group. Recruitment happens in the first and was set at age 2. The length-at-recruitment is estimated and mean growth is assumed to follow the von Bertalanffy growth function estimated by the model.

Weight–Length relationship is obtained from spring survey data.

Natural mortality was assumed to be 0.2 year$^{-1}$. However different values of M are tested (0.1 and 0.3).

The commercial landings are modelled as one fleet, starting in 1980 with a selection pattern described by a logistic function and the total catch in tonnes specified for each quarter. The survey (1985 onwards), on the other hand is modelled as one fleet with constant effort and a nonparametric selection pattern that is estimated for each length group (one 10 cm length group).

Data used for the assessment are described below:

- Length disaggregated survey indices (10 cm increments) from the Icelandic groundfish survey in March 1985–2009.
- Length distribution from the Icelandic commercial catch since 1979. The sampling effort was though relatively limited until the 1990s.
- Landings data divided into four month periods per year (quarters).
- Age–length keys and mean length-at-age from the Icelandic commercial fishery.

| Description | period | by quarter | area | Likelihood component |
|---|---|---|---|---|
| Length distribution of landings | 1981–1989, 1991+ | YES | Iceland | ldist.catch |
| Length distribution of Icelandic GFS | 1985+ | - | Iceland | ldist.survey |
| Abundace index of Icelandic GFS of 20–39 cm individuals | 1985+ | - | Iceland | si2039 |
| Abundace index of Icelandic GFS of 40-59 cm individuals | 1985+ | - | Iceland | si4059 |
| Abundace index of Icelandic GFS of 60–110 cm individuals | 1985+ | - | Iceland | si60110 |
| Age–length key of the landings | See stock section | YES | Iceland | alkeys.catch |
| Age–length key of the Icelandic GFS | See stock section | 1st quarter | Iceland | alkeys.survey |
| Mean length by age of landings | 1995, 2009 | YES | Iceland | meanl.catch |

Description of the likelihood components weighting procedure:

| Component | Description | Quarters | Type |
|---|---|---|---|
| Bounds | Keeps estimates inside bounds | All | 8 |
| Understocking | Makes sure there is enough biomass | All | 2 |
| Si2039 | Survey Index 20–39 cm | 1 | 1 |
| Si4049 | Survey Index 40–59 cm | 1 | 1 |
| Si60110 | Survey Index 60–100 cm | 1 | 1 |
| Si2080-2 | Survey Index (To get a smoothed estimate of the survey selection curve | 1 | 1 |
| Ldist.catch | Length distribution commercial catches (Longlines) | All | 3 |

| Component | Description | Quarters | Type |
|---|---|---|---|
| Ldist.survey | Length distribution from the spring survey | 1 | 3 |
| Alkeys.catch | Age–length data from commercial catches | All | 3 |
| Meanl.catch | Mean length-at-age from commercial catches | All | 4 |
| Alkeys.survey | Age–length data from the spring survey | 1 | 3 |

The parameters estimated are:

- The number of fish by age when simulation starts (ages 3 to 5); 3 parameters. Older ages are assumed to be a fraction of age 5;
- Recruitment each year (1980 and onwards);
- Parameters in the growth equation; Linf is constant at 120 cm and K is estimated;
- Parameter β that models the transition from one length class to the next;
- Length-at-recruitment (mean length and SD);
- The selection pattern of:
    - The commercial catches (1980 and onwards; two params.
    - Icelandic spring survey; one parameter as the slope is kept constant.

The estimation can be difficult because of some or groups of parameters are correlated and therefore the possibility of multiple optima cannot be excluded. The optimization is started with simulated anneling to make the results less sensitive to the initial (starting) values then the optimization was changed to Hooke and Jeeves when the 'optimum' was approached. The model runs presented at WGDEEP-2010 was started using the initial values and bounds below:

Inital parameter values used and the bounds assigned.

| Switch | Value | Lower | Upper | Optimize |
|---|---|---|---|---|
| Linf | 120 | 50 | 200 | 0 |
| K | 90 | 0.1 | 1000 | 1 |
| Bbeta | 0.1 | 0.001 | 15 | 1 |
| Ic03 | 4 | 0.001 | 15 | 1 |
| Ic04 | 3 | 0.001 | 15 | 1 |
| Ic05 | 2 | 0.001 | 15 | 1 |
| Recl | 15 | 5 | 40 | 1 |
| Recsdev | 4 | 0.01 | 15 | 1 |
| Rec1980 | 2 | 0.01 | 15 | 1 |
| Rec1981 | 2 | 0.01 | 15 | 1 |
| Rec1982 | 2 | 0.01 | 15 | 1 |
| Rec1983 | 2 | 0.01 | 15 | 1 |
| Rec1984 | 2 | 0.01 | 15 | 1 |
| Rec1985 | 2 | 0.01 | 15 | 1 |
| Rec1986 | 2 | 0.01 | 15 | 1 |
| Rec1987 | 2 | 0.01 | 15 | 1 |
| Rec1988 | 2 | 0.01 | 15 | 1 |

| Switch | Value | Lower | Upper | Optimize |
|---|---|---|---|---|
| Rec1989 | 2 | 0.01 | 15 | 1 |
| Rec1990 | 2 | 0.01 | 15 | 1 |
| Rec1991 | 2 | 0.01 | 15 | 1 |
| Rec1992 | 2 | 0.01 | 15 | 1 |
| Rec1993 | 2 | 0.01 | 15 | 1 |
| Rec1994 | 2 | 0.01 | 15 | 1 |
| Rec1995 | 2 | 0.01 | 15 | 1 |
| Rec1996 | 2 | 0.01 | 15 | 1 |
| Rec1997 | 2 | 0.01 | 15 | 1 |
| Rec1998 | 2 | 0.01 | 15 | 1 |
| Rec1999 | 2 | 0.01 | 15 | 1 |
| Rec2000 | 2 | 0.01 | 15 | 1 |
| Rec2001 | 2 | 0.01 | 15 | 1 |
| Rec2002 | 2 | 0.01 | 15 | 1 |
| Rec2003 | 2 | 0.01 | 15 | 1 |
| Rec2004 | 2 | 0.01 | 15 | 1 |
| Rec2005 | 2 | 0.01 | 15 | 1 |
| Rec2006 | 2 | 0.01 | 15 | 1 |
| Rec2007 | 2 | 0.01 | 15 | 1 |
| Rec2008 | 2 | 0.01 | 15 | 1 |
| Alphacomm | 0.9 | 0.03 | 10 | 1 |
| L50comm | 40 | 20 | 50 | 1 |
| L50sur | 15 | 5 | 100 | 1 |

However multiple optimization cycles were conducted to ensure that the model had converged to an optimum, and to provide opportunities to escape convergence to a local optimum.

The **diagnostics** run to analyse the model are:

- Likelihood profiles plot. To analyse convergence and problematic parameters.
- Plot comparing observed and modelled proportions in fleets (catches). To analyse how estimated population abundance and exploitation pattern fits observed proportions.
- Plot for residuals in catchability models. To analyse precision and bias in abundance trends.
- Retrospective analysis. To analyse how additional data affects historical predictions of the model.

## D. Short-term projection

Short and medium-term forecasts for tusk in Va and XIV can be done in gadget using the settings described below. However the model setup was not finalized at the Benchmark meeting (WKDEEP-2010). The Benchmark meeting concluded that the setup presented at the meeting as indicative of trends and suggested further improvements. If assessment improvements were addressed properly, WKDEEP agreed with the following parameters as input for short-term forecast. The ADGDEEP and subsequently ACOM decided to base the ICES advice for 2010 for tusk in Va and XIV based on projections from Gadget.

Model used: Age–length forward projection

Software used: GADGET (script: run.sh)

Initial stock size: abundance-at-age and mean length for ages 0 to 20+

Maturity: Fixed maturity ogive

F and M before spawning: NA

Weight-at-age in the stock: modelled in GADGET with VB parameters and length–weight relationship

Weight-at-age in the catch: modelled in GADGET with VB parameters and length–weight relationship

Exploitation pattern:

Landings: logistic selection parameters estimated by GADGET.

Intermediate year assumptions: F = last assessment year F

Stock–recruitment model used: geometric mean of years 1989–2007

Procedures used for splitting projected catches: driven by selection functions and provide by GADGET.

## E. Medium-term projections (NA)

## F. Long-term projections

Model used: Age–length forward projection

Software used: GADGET

Initial stock size: 1 year class of 1 million individuals

Maturity: Fixed maturity ogive

F and M before spawning: NA

Weight-at-age in the stock: modelled in GADGET with VB parameters and length–weight relationship

Weight-at-age in the catch: modelled in GADGET with VB parameters and length–weight relationship

Exploitation pattern:

Landings: logistic selection parameters estimated by GADGET.

Procedures used for splitting projected catches:

Driven by selection functions and provided by GADGET.

Yield-per-recruit is calculated by following one year class of one million fish for 29 years through the fisheries calculating total yield from the year class as function of fishing mortality of fully recruited fish. In the model, the selection of the fisheries is length based so only the largest individuals of recruiting year classes are caught reducing mean weight of the survivors, more as fishing mortality is increased. This is to be contrasted to age based yield-per-recruit where the same weights-at-age are assumed in the landings independent of the fishing mortality even when the catch weights are much higher as the mean weight in the stock.

## G. Biological reference points

There are no reference points defined for this stock.

## H. Other issues

## I. References


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## Annex 2: Working documents

A total of 27 Working Documents were received by WGDEEP including the following exploratory assessments of:

- Ling in Va using Gadget, by Gudmunder Thordarson;
- Roundnose grenadier in Vb, VI, VII and XIIb using Bayesian surplus production methods, by Beatriz Roel, Lionel Pawlowski and Phil Large (funded by the EU DEEPFISHMAN project);
- Blue ling in Vb, VI and VII using stock reduction in FLR, by Finlay Scott and Phil Large (again funded by the DEEPFISHMAN project);
- Joint assessment between Spain and Morocco of red seabream in the Strait of Gibraltar by Belcaidi *et al*.;
- Greater silver smelt in the Faroese area (Division Vb) by Lise Ofstad and Petur Steingrund.

# Restratification of the Icelandic Autumn Groundfish Survey and its effect on biomass indices of Greater Silver Smelt in Va

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February 21, 2011

**Abstract**

This document describes the re-stratification of the Icelandic Autumn Groundfish Survey done in 2008 and its effect on survey index estimates for Greater Silver Smelt in Va. The number of strata was reduced from 74 to 34 which results higher number of stations per strata.

The result of the revised stratification on calculation of survey indices of GSS is mainly a lower estimated CV and a different trend in the time-series. The index of total biomass reached a peek in 2008 according to the revised stratification but peeked in 2009 according to the original stratification. The index of exploitable biomass (>400 m depth) was at a stable high level in 2006 to 2009 and then decreased significantly in 2010. According the original stratification the biomass increased from 2006 to 2009 and then sharply decreased.

It is recommended that the index from the revised stratification scheme will be used as basis for ICES advice on GSS in Va and that the Stock Annex be changed accordingly.

## 1 Re-stratification of the Icelandic Autumn Groundfish Survey

The Icelandic Spring (March) Groundfish Survey (ISGS) commenced in 1985 and covers the Icelandic shelf down to 500 meters. Annually around 500 stations are towed. The Icelandic Autumn (October) Groundfish Survey (IAGS) commenced in 1996 and was expanded in 2000. The IAGS covers the Icelandic shelf down to 1500 meters and since 2000 around 380 stations have been towed annually. A thorough description of the surveys can be found in the stock annex for Greater Silver Smelt (GSS) in Va (WGDEEP-2010).

For calculation of survey indices the same stratification scheme has been used for both the ISGS and the IAGS (Figure 1a). However because the IAGS has fewer stations and wider area the stratification scheme results in relatively few stations in each strata, often leading to high CV estimates. This specially applies to stocks such as GSS where often relatively few large hauls from the bulk of the biomass/abundance index. At the WKDEEP-2010 a Winsorizing approach to decrease the large CV in the GSS indices was presented. This resulted in considerable reduction in the estimated CV and GSS indices.

In 2008 the whole stratification scheme for the IAGS was revised, the number of strata was reduced from 74 down to 34 and the average size of the strata subsequently increased. This results in more tow-stations per strata (Figure 1b). It should be noted that both the stratification schemes were designed mostly with cod in mind. However the main feature of the schemes is depth stratification and similar oceanographic conditions in each strata.

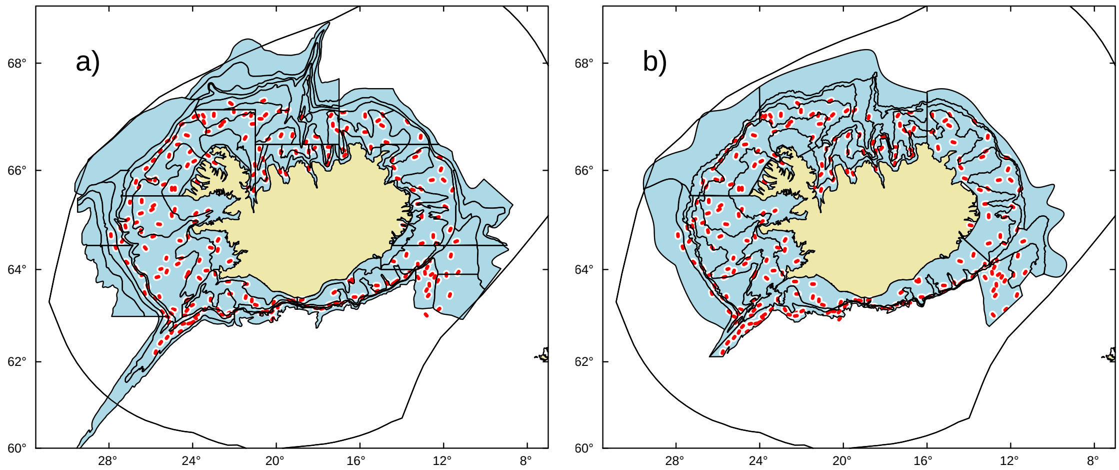


**Figure 1:** Comparison of the original (a) and the revised (b) stratification scheme (black lines) for the Icelandic Autumn Groundfish Survey. The red dots represents stations occupied in the 2005 IAGS.

## 2 Area division for GSS in Va

As stated in the stock annex for GSS in Va (WGDEEP-2010) the standard calculations of regional survey indices are not particularly applicable to GSS as they were originally designed for cod. Therefore the processing of the IAGS data was done on a slightly different regional scale. In table 1 a comparison of the old stratification and the revised is given. It can be seen that for most of the sub areas the number of strata decreases often by more than 50%. Furthermore in most cases the area decreases slightly.

As for the division into deeper and shallower than 400 meters it should be noted that the areas are not completely comparable in the revised and original stratification schemes as in some cases the deeper area has strata that are defined by the 300 meter contour. This is though only in regions where there is a steep slope off the shelf so it does not vastly increase the deeper sub-area.

Additionally to the previous sub-area division the shelf above 400 m is divided into several sub-areas. These are listed in table 1 and shown in figure 2.

**Table 1:** Greater Silver Smelt in Va. Survey regions used for calculation of various IAGS indices. Comparison of the number of strata and size of areas in the original and the revised stratification.

| Region | Original str. | | Revised str. | |
|---|---|---|---|---|
| | No. strata | Area | No. strata | Area (km$^2$) |
| Total | 74 | 339,691 | 34 | 298,239 |
| Depth >400 m | 32 | 152,626 | 14 | 119,108 |
| Depth <400 m | 41 | 186,870 | 20 | 179,131 |
| NW >400 m | 2 | 20,081 | 2 | 19,915 |
| W >400 m | 9 | 31,613 | 3 | 29,646 |
| S >400 m | 6 | 26,715 | 2 | 9,578 |
| SE >400 m | 7 | 30,358 | 3 | 20,243 |
| NE >400 m | | | 4 | 39,727 |
| NW <400 m | | | 4 | 24,122 |
| W <400 m | | | 5 | 49,895 |
| SW <400 m | | | 2 | 13,568 |
| SE <400 m | | | 2 | 17,833 |
| E <400 m | | | 2 | 35,767 |
| N <400 m | | | 5 | 37,945 |

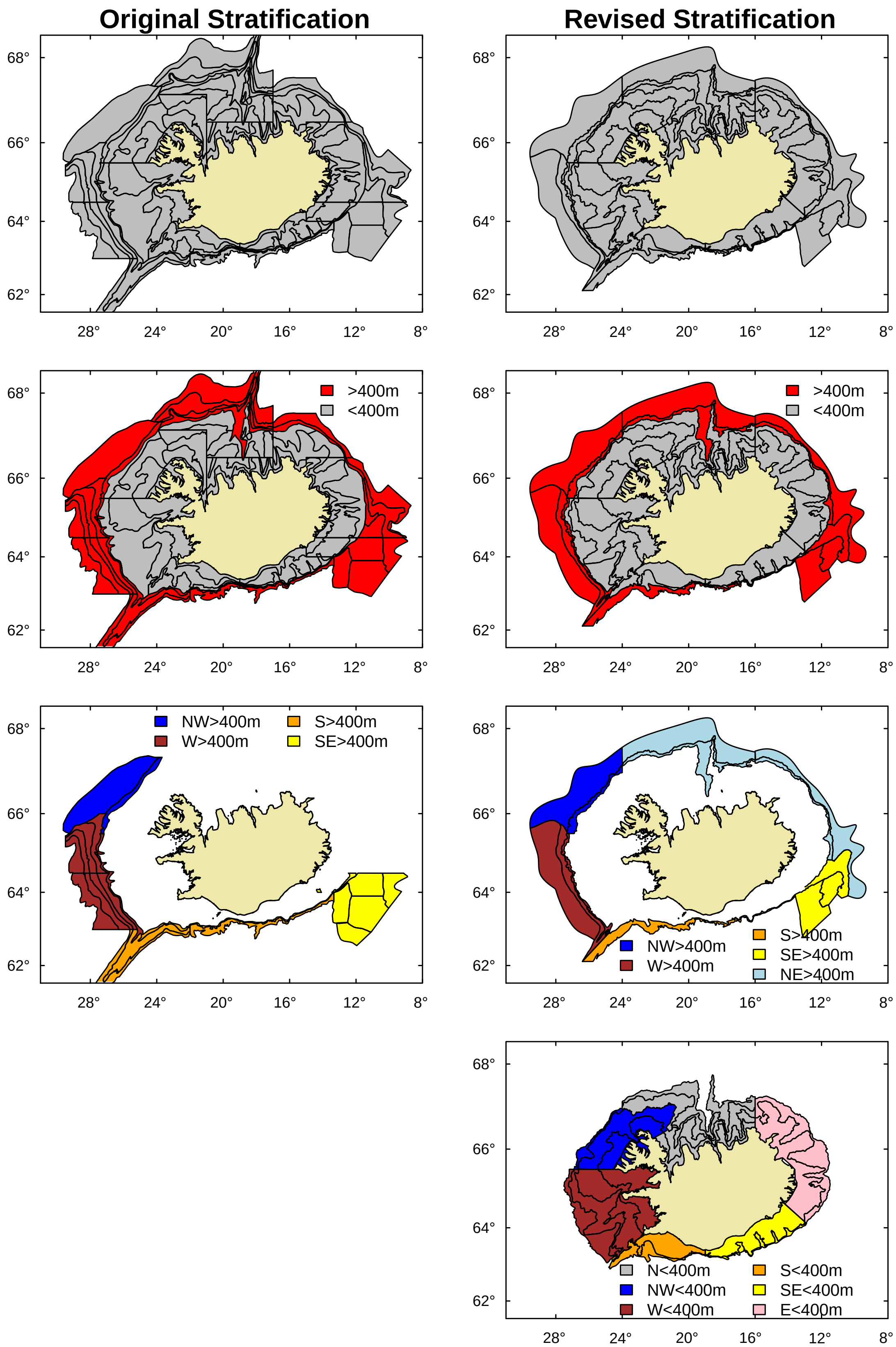


**Figure 2:** Comparison of division into sub-areas of the original (left-panel) and the revised stratification scheme (right-panel) for the Icelandic Autumn Groundfish Survey.

# 3 Difference in survey estimates

## 3.1 Total biomass indices

The main indices used in formulation of advice are the >400m index which can be termed as a proxy for fishable biomass and the total index (Figure 3). Roughly the three indices shown in figure 3 have the same trend, i.e. a slow increase until 2006-2008. However the revised stratification index has very noteworthy difference during the last 2-3 years. The >400m index peaked in 2007 and remained more or less staple until 2009 and then there is a relatively sharp drop in 2010 close to the historical low value.

As for the total index the picture is similar. The revised index peaked in 2008 and has decreased considerably in 2009 and 2010. This is contrary to the original stratification indices which increased and peaked in 2009 but decreased in 2010 to similar levels as 2004 to 2007. The indices for GSS at depths <400m show roughly the same trend regardless of the stratification scheme.

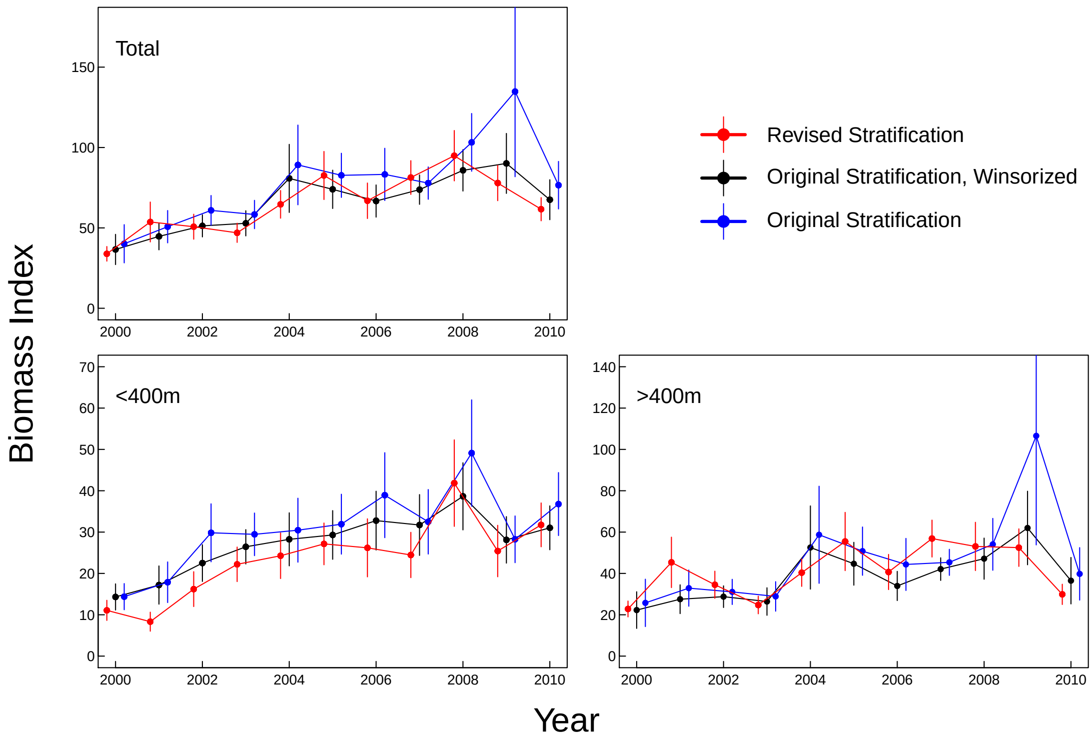


**Figure 3:** Comparison of the original (black and blue lines) and the revised (red) stratification survey indices biomass indices from the Icelandic Autumn Groundfish Survey.

### 3.1.1 Sub areas deeper than 400 m

Looking at the indices on a finer scale reveals considerable differences between the original and the revised stratification schemes. It should be noted that the sub areas are not exactly the same as can be seen in figure 2 on page 4.

Looking at the south east deeper waters the index calculated according the revised stratification decreased considerably from 2008 after a rather rapid increase since 2006. This is contrary to what is observed in the original stratification indices (Figure 4). The southern deeper waters (S >400m) have remained more or less stable according to the revised stratification which is not the case with the original stratification indices which area characterized by rather large fluctuations with high standard deviations. In the deep western area the trend for all the indices is the same. The deep NW area the trend in the indices is roughly the same but the revised stratification index is an order of magnitude higher than the original stratification indices. The index for the NE is zero in all years (not plotted).

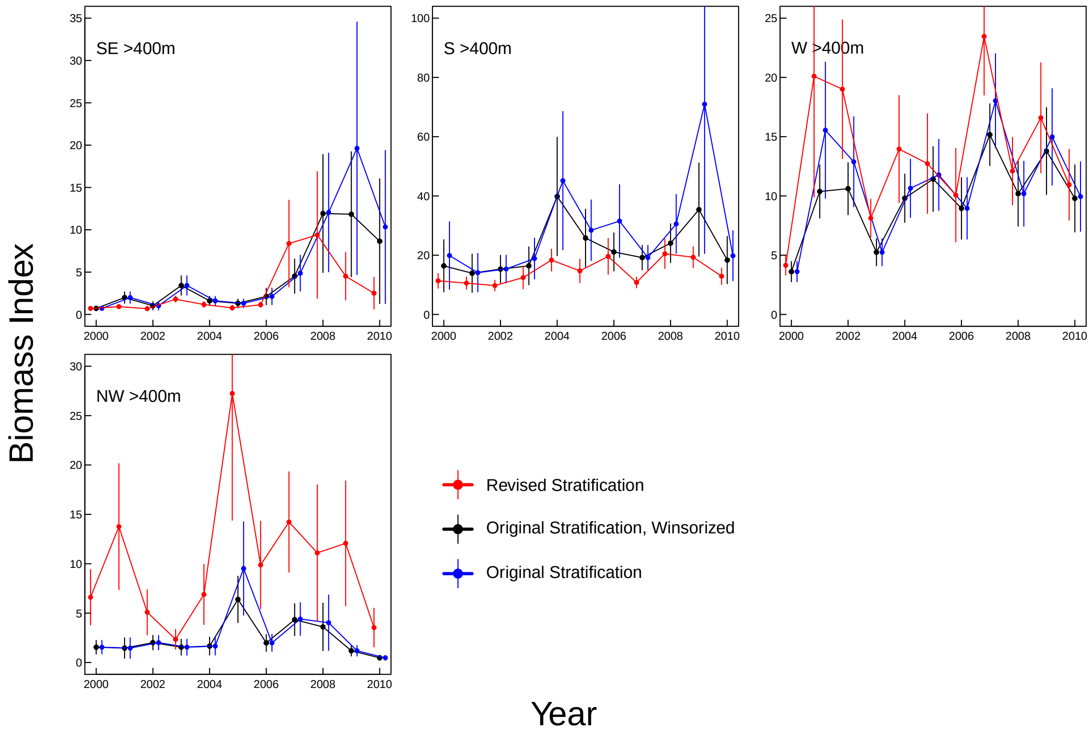


**Figure 4:** Comparison of the original (black and blue lines) and the revised (red) stratification survey indices biomass indices from the Icelandic Autumn Groundfish Survey divided by sub area ($> 400$m).

### 3.1.2 Sub-areas shallower than 400 m

In the calculation of GSS indices according to the original stratification no sub-areas were defined for depths less than 400 meters. The trends in the revised indices by sub-area are presented in figure 5.

## 3.2 Abundance indices by length

In figure 6 length disaggregated indices are plotted. In general the length-distributions by year and depth are quite similar regardless of the stratification scheme. The most noteworthy difference in 2005, 2007 and 2010. However it should be kept in mind that the areas are not completely comparable as in some cases the deeper area has strata that are defined by the 300 meter contour. This is though only in regions where there is a steep slope off the shelf so it does not vastly increase the deeper sub-area.

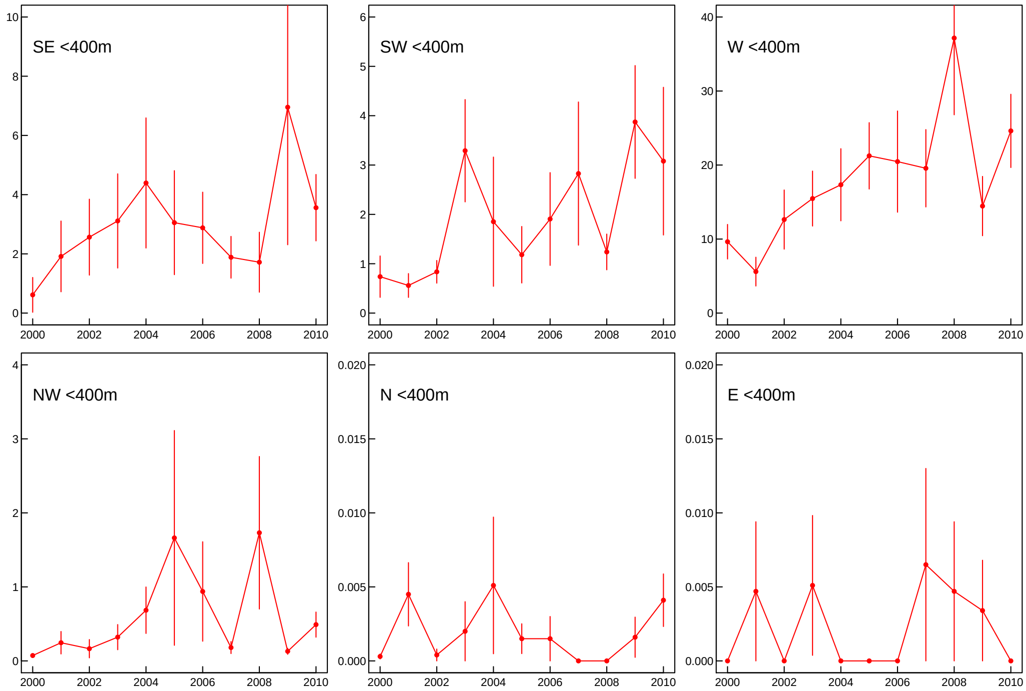


**Figure 5:** Comparison of the original (black and blue lines) and the revised (red) stratification survey indices biomass indices from the Icelandic Autumn Groundfish Survey divided by sub area (> 400m).

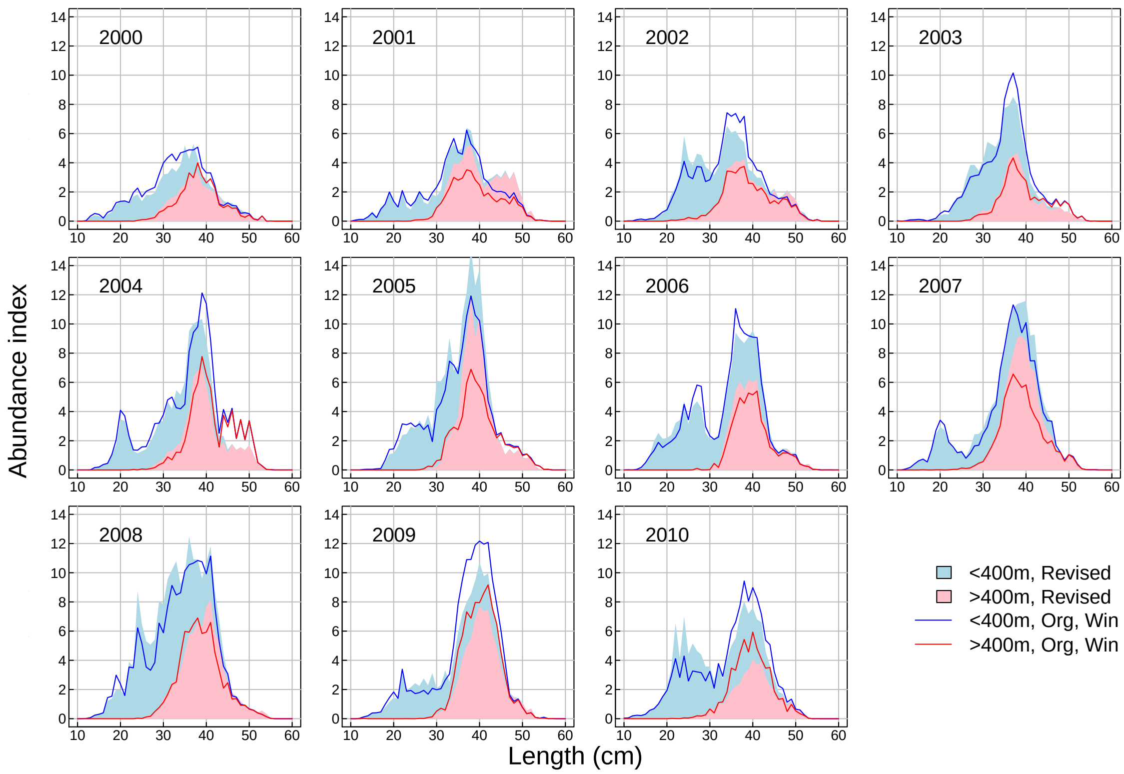


**Figure 6:** Length disaggregated survey indices divided by the 400m depth contour. Shaded area represent the revised stratification and the lines the original stratification, Winsorized version.

# 4 Conclusions

The overall picture emerging from the comparisons presented in this document is that in general the trends in the survey indices are the same regardless of the stratification scheme used. However the CV is normally lower when using the revised stratification scheme, even lower than when using Winsorization to calculate the indices using the original stratification scheme.

The main point to note is that it appears that the trend in the survey indices in the last 2-3 years is different. The revised indices (Figure 3 on page 5) show a decrease in for the last 2-3 years whereas the original stratification scheme only shows an decrease in 2010.

The main driver for the re-stratification of the IAGS were drastic increases in the cod indices in 2008. That on top of the underlying suspicion that the IAGS was over stratified (fewer stations than ISGS and larger area) resulted in the scheme presented here. However to fulfill the theoretical criteria for post-stratification the stratification should be done on stock basis and not as a blanket stratification as is used here. Nevertheless this approach has been used in Va for all stocks since the commencing of the surveys and there does not seem to be any plans to change that at present.

It is suggested that the revised stratification scheme will be used for calculating indices of GSS from the IAGS in the future and they be used as basis for advice. Therefore the Stock Annex for greater silver smelt in Va needs to be revised accordingly.

# Estimates of tusk and ling discards in the Icelandic longline fishery

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February 25, 2011

**Abstract**

Based on limited number of measurements discarding does not seem to be a significant factor in catches in the Icelandic longline fishery for tusk and ling. Discard rates are estimated to be less than 1% in numbers and less than 0.5% in weight for the two species. In the Icelandic management system is is possible to change TAC from one species to another under strict conditions. This feature of the system may contribute significantly in reducing the incentive to discard as considerable part of catches in both tusk and ling are landed using this option of the management system.

## 1 Introduction

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socioeconomic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. Since 2006/2007 fishing season, all boats operate under the TAC system.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place. Within this system individual boat owners have substantial flexibility in exchanging quota, both among vessels within individual company as well as among different companies. The latter can be done via temporary or permanent transfer of quota. In addition, some flexibility is allowed by individual boats with regard to transfer allowable catch of one species to another. These measures, which can be acted on more or less instantaneously, are likely to result in lesser initiative to discards and misreporting than can be expected if individual boats are restricted by strict TAC measures alone. They may however result in fishing pressures of individual species to be different than intended under the single species TAC allocation.

More on the point of discarding and species conversion. Discarding is banned according to Icelandic laws. As state above a holder of quota can convert according to strict regulations quota from one species to another. The conversion of one species to another is done by different species factors which roughly equals the price of cod (Cod equivalents). For example ling has the factor 0.48 and haddock has a factor of 0.76. A vessel that has 500 kg of haddock quota has therefore 380 cod equivalents and can therefore convert these 500kg of haddock to 792 kg of ling (380/0.48).

For many years the Fisheries Directorate in Iceland in cooperation with the Marine Research Institute has carried on a on-board measuring in Icelandic fishing vessels with the aim of monitoring discarding. The main focus has been on cod and haddock, the largest and most valuable demersal fisheries in Iceland. However considerable number of on-board measuring of tusk and ling has been done. The aim of this paper is to estimate possible discard rates and to look at how options in the Icelandic ITQ-management system aimed at reducing discard are being used by fishers in the Icelandic longline fishery for tusk and ling.

# 2 Materials and methods

## 2.1 Estimates of discards from samples

The material used in the analysis covers the period 2001 to 2010 and the number of measurements are presented in table 1. In total around 53,000 tusks have been measured at sea in the period and little less than 4,000 ling. The figures for ashore are around 39,000 tusks and 34,000 for ling.

The method used here for estimating discard rate is taken from Pálsson (2003). The available data from the longline fishery is to limited for a year to year analysis of discards. Therefore the data is analysed using pooled length distributions, and average landings for the period 2001 to 2010, producing 'smoothed' average values of discards.

Length distributions of landings obtained by sampling at port are calculated as a product of numbers landed and the proportion of fish numbers measured at each length, giving the length distributions in number of fish (Fig 1A and 2A). As year to year estimation of discards is not possible the average number landed in 2001 to 2010 is used for raising of length-distributions. For tusk the average from table 1 is 4.9 millions and for ling 1.32 millions.

The length distributions at sea are found by sampling the catch prior to discarding. This gives length distributions at sea as proportions of fish numbers

**Table 1:** Tusk and ling in Va. Discard data (numbers measured at sea and ashore) and estimates of number of landed (in millions) in the Icelandic longline fishery in 2001-2010. Estimated landings in millions, for tusk total, for ling only from the longline fishery.

| Year | Tusk | | | Ling | | |
|---|---|---|---|---|---|---|
| | At sea | Ashore | Landed | At sea | Ashore | Landed |
| 2001 | 193 | 2904 | 3.62 | 0 | 1661 | 0.40 |
| 2002 | 140 | 2703 | 4.34 | 140 | 1364 | 0.47 |
| 2003 | 3227 | 5217 | 4.38 | 101 | 2303 | 0.77 |
| 2004 | 2195 | 1614 | 3.76 | 622 | 2018 | 0.82 |
| 2005 | 3434 | 2386 | 3.82 | 88 | 2235 | 0.92 |
| 2006 | 1689 | 3172 | 5.19 | 375 | 2979 | 1.45 |
| 2007 | 7418 | 4518 | 6.01 | 210 | 3451 | 1.51 |
| 2008 | 14596 | 6368 | 6.51 | 296 | 5551 | 2.03 |
| 2009 | 15623 | 5828 | 5.92 | 1792 | 7222 | 2.44 |
| 2010 | 4129 | 4054 | 5.79 | 225 | 6067 | 2.45 |
| Total | 52644 | 38764 | | 3849 | 34851 | |

measured at each length (Fig 1A and 2A). This however the numbers (or weight) of the discards are not known and therefore the numbers caught at sea has to be estimated differently. The approach taken here is to assume that discarding is nil above some set length $d_l$. The $d_l$ values for tusk and ling are shown in table 2. The values in this length interval are then used to calculate a raising factor, which raises the proportions measured at sea to numbers. Under these assumptions the raising factor ($k$) can be calculated as follows:

$$k = \frac{\sum_l L_l : l > d_l}{\sum_l c_l : l > d_l} \tag{1}$$

where $L_l$ is the numbers landed and $c_l$ the proportions at length measured at sea.

From the calculations described above, two length distributions have been produced (Fig 1B and 2B). One for the numbers at length landed (excluding discards), the other for numbers at length caught at sea (including discards). The proportion discarded at length ($PD_l$), in numbers is obtained by:

$$PD_l = \frac{CN_l - LN_l}{CN_l} \tag{2}$$

where $CN_l$ is the number at length caught at sea and $LN_l$ the numbers at length landed.

Proportion discarded by length is modeled with logistic regression (Fig 1C and 2C):

$$\widehat{PD}_l = \frac{\mathrm{e}^{a+b\times L}}{1+\mathrm{e}^{a+b\times L}} \tag{3}$$

where $\widehat{PD}_l$ is the proportion of successful events, in this case the fish discarded, and $a$ and $b$ are the parameters of the model. The size at which 50% of fish is being discarded ($d_{50}$) can be estimated from the two regression parameters. This is given by:

$$\mathrm{d}_{50} = -\frac{a}{b} \tag{4}$$

Discarded numbers at length ($DN_l$) are then calculated as:

$$DN_l = CN_l \times \widehat{PD}_l \tag{5}$$

which summed over length gives the total discards in numbers (Fig 1D and 2D).

To obtain the discards in weight the discards in numbers from equation 5 are multiplied with weight at length ($W_l$), which is obtained from the weight relationship:

$$W_l = \alpha \times L^{\beta} \tag{6}$$

where $L$ is the length in centimeters and $W_l$ the weight in grammes. The parameters used in the length-weight relationship for ling and tusk are listed in table 2

**Table 2:** Tusk and ling in Va. Parameters used in the length-weight relationship used for estimating discards.

| Species | $\alpha$ | $\beta$ | $d_l$ |
|---|---|---|---|
| Tusk | 0.00902 | 3.02761 | 40 |
| Ling | 0.00495 | 3.01793 | 60 |

## 2.2 Quota transfers

To look at how fishers use the options in the Icelandic ITQ-management system in the tusk and ling fishery information from the Directorate of Fisheries is used. The data contains all transactions of all vessels in Iceland, however the focus here is on tusk and ling.

# 3 Results

## 3.1 Estimates of discards from samples

Discard is estimated to be less than 1% in numbers and less than 0.5% in weight for tusk and less than 0.1% for Ling (Table 3). A crude estimate of the quality of the data uses is how well the length-distributions in fall togeather above the discard size. As can be seen in figures 1A and 2 the two length-distribution are quite different. One might assume that 'low-grading' is taking place. However where there is much more data available such as for cod and haddock this descrepancy has been shown not to seriously affect discard estimates (Höskuldur Björnsson pers. comm).

**Table 3:** Tusk and ling in Va. Discard estimates. Length at which discard is 50% ($d_{50}$) the $b$ parameter from logistic regression and estimates of discard in numbers and weight in percentages.

| Species | $d_{50}$ | $b$ | % Numbers | % Weight |
|---|---|---|---|---|
| Tusk | 31.64 | -0.43 | <1.0% | <0.5% |
| Ling | 41.93 | -0.36 | <0.1% | <0.1% |

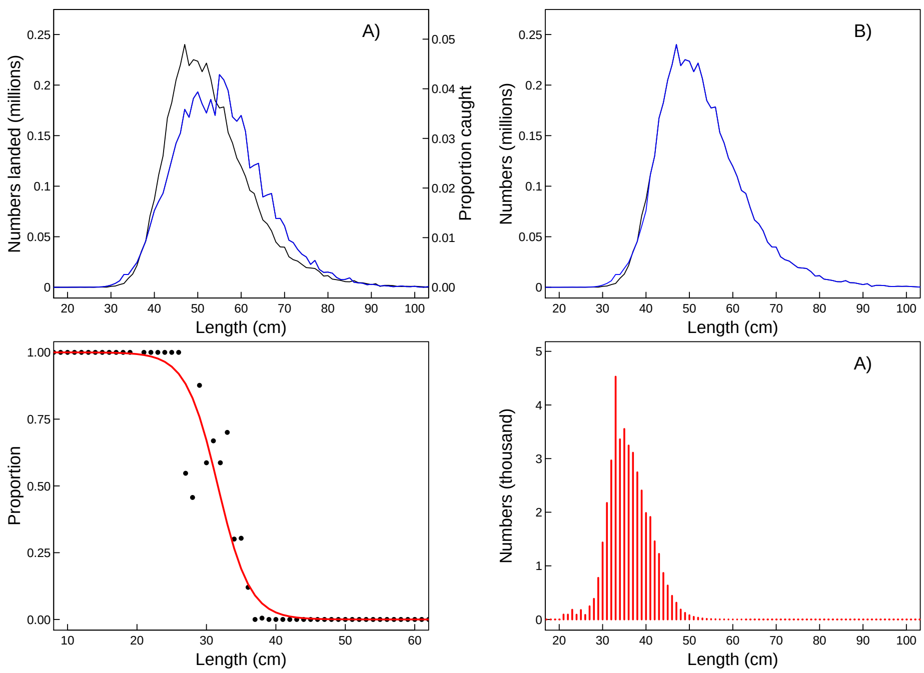


**Figure 1:** Tusk in Va. Length distributions and discards as estimated from longlines pooling all data from 2001-2010. A) numbers landed (black line) and proportions caught (blue line); B) Numbers landed (black line) and caught (blue line); C) Proportions discarded by length; D) Numbers discarded by length.

## 3.2 Quota transfers

Tables 4 and 5 give an overview of the composition of the total landings by Icelandic vessels in Va for tusk and ling. In general there is always something left of

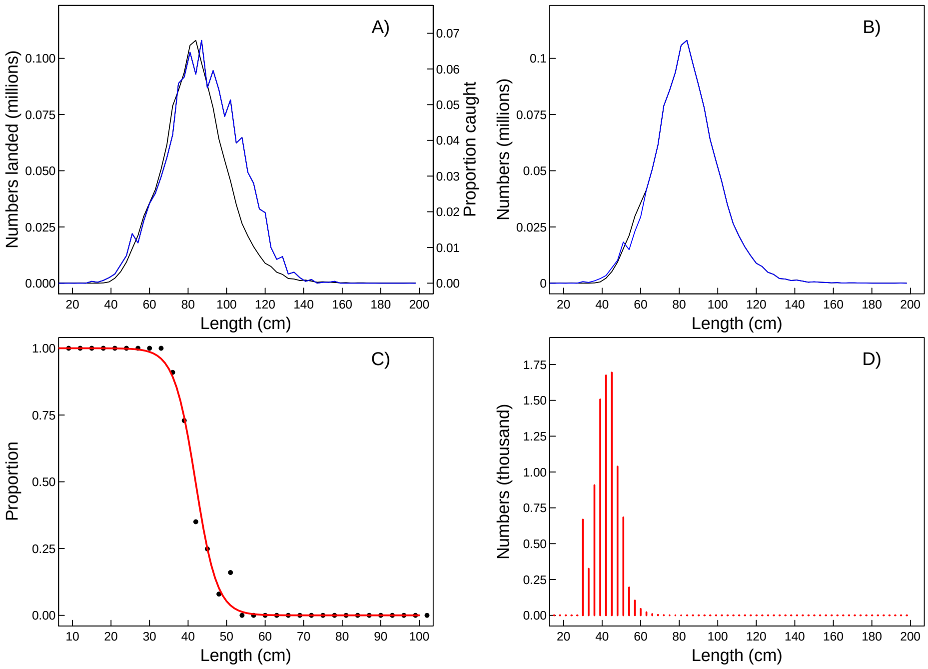


**Figure 2:** Ling in Va. Length distributions and discards as estimated from longlines pooling all data from 2001-2010. A) numbers landed (black line) and proportions caught (blue line); B) Numbers landed (black line) and caught (blue line); C) Proportions discarded by length; D) Numbers discarded by length.

last years quota (column 3 in tables 4 and 5). This indicates that the holders of tusk and ling quota do not utilize it fully in these years. However this is normally quite small proportion of the set TAC.

In recent years the landings have exceeded the 'available' TAC (columns 6 and 7 in tables 4 and 5). This fishing in excess of the 'available' TAC is then met with converting TAC from other species to either ling and tusk. This is a reversal of the trend at the beginning of the tables when considerable proportion of the TAC was either converted to other species or moved to the next Quota year.

**Table 4:** Tusk in Va. Overview of TAC composition of landings (thous. tonnes).

| Quota year | Set TAC (1) | Other TAC (2) | TAC P.Y. (3) | Vessel tr. (4) | Eff. TAC (5) | Land. (6) | TAC-Land (7) | Species tr. (8) | TAC left (9) | TAC moved (10) | Conf. (11) | U.TAC n.-tr. (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001/2002 | 4.500 | 0.001 | 0.000 | 0.000 | 4.501 | 3.483 | 1.018 | -0.623 | 0.394 | 0.296 | 0.003 | 0.101 |
| 2002/2003 | 3.500 | 0.001 | 0.296 | 0.000 | 3.797 | 3.735 | 0.063 | 0.168 | 0.231 | 0.188 | 0.001 | 0.045 |
| 2003/2004 | 3.500 | 0.001 | 0.188 | 0.000 | 3.689 | 3.370 | 0.319 | 0.223 | 0.542 | 0.496 | 0.002 | 0.048 |
| 2004/2005 | 3.500 | 0.001 | 0.496 | 0.000 | 3.997 | 3.516 | 0.480 | -0.136 | 0.344 | 0.289 | 0.001 | 0.057 |
| 2005/2006 | 3.500 | 0.001 | 0.289 | 0.000 | 3.789 | 4.664 | -0.875 | 1.017 | 0.142 | 0.114 | 0.005 | 0.033 |
| 2006/2007 | 5.000 | 0.001 | 0.114 | 0.000 | 5.115 | 6.306 | -1.190 | 1.645 | 0.454 | 0.445 | 0.003 | 0.012 |
| 2007/2008 | 5.500 | 0.001 | 0.445 | 0.000 | 5.947 | 6.097 | -0.150 | 0.740 | 0.590 | 0.538 | 0.000 | 0.052 |
| 2008/2009 | 5.500 | 0.001 | 0.538 | 0.000 | 6.039 | 7.059 | -1.020 | 1.228 | 0.207 | 0.205 | 0.002 | 0.005 |
| 2009/2010 | 5.500 | 0.003 | 0.205 | 0.000 | 5.709 | 6.965 | -1.257 | 1.332 | 0.076 | 0.056 | 0.002 | 0.021 |

(1) TAC for the quota-year set by the Ministry of Fisheries and Agriculture.
(2) TAC by other means such as quota allocated to rural towns.
(3) TAC transferred from previous fishing-year.
(4) TAC transferred between ships (should be zero).
(5) Total TAC in effect (the sum of the previous 3 columns).
(6) Landings during the fishing-year.
(7) TAC minus landings
(8) Nett species TAC transfers. Negative number indicates the TAC of species in question to have been changed to a TAC for another species.
(9) Effective TAC left, taking in all the numbers in previous columns.
(10) TAC transferred to next fishing year
(11) Catch in excess of TAC, confiscated by the Directorate of Fisheries / Icelandic Coast Guard.
(12) TAC that can not be moved to the next fishing year.

**Table 5:** Ling in Va. Overview of TAC composition of landings (thous. tonnes).

| Quota year | Set TAC (1) | Other TAC (2) | TAC P.Y. (3) | Vessel tr. (4) | Eff. TAC (5) | Land. (6) | TAC-Land (7) | Species tr. (8) | TAC left (9) | TAC moved (10) | Conf. (11) | U.TAC n.-tr. (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001/2002 | 3.000 | 0.007 | 0.000 | 0.000 | 3.007 | 2.546 | 0.460 | -0.145 | 0.315 | 0.220 | 0.006 | 0.101 |
| 2002/2003 | 3.000 | 0.008 | 0.220 | 0.000 | 3.228 | 3.134 | 0.094 | 0.188 | 0.282 | 0.208 | 0.004 | 0.078 |
| 2003/2004 | 3.000 | 0.008 | 0.208 | 0.000 | 3.216 | 3.796 | -0.580 | 0.838 | 0.258 | 0.210 | 0.002 | 0.050 |
| 2004/2005 | 3.999 | 0.007 | 0.210 | 0.000 | 4.216 | 4.461 | -0.245 | 0.576 | 0.331 | 0.281 | 0.005 | 0.054 |
| 2005/2006 | 5.000 | 0.010 | 0.281 | 0.000 | 5.292 | 5.853 | -0.561 | 0.902 | 0.341 | 0.310 | 0.007 | 0.038 |
| 2006/2007 | 5.000 | 0.012 | 0.310 | 0.000 | 5.321 | 6.609 | -1.288 | 1.961 | 0.674 | 0.638 | 0.005 | 0.041 |
| 2007/2008 | 7.000 | 0.021 | 0.638 | 0.000 | 7.659 | 6.733 | 0.925 | 0.255 | 1.180 | 1.044 | 0.000 | 0.137 |
| 2008/2009 | 7.000 | 0.030 | 1.044 | 0.000 | 8.074 | 9.178 | -1.104 | 1.459 | 0.355 | 0.359 | 0.010 | 0.006 |
| 2009/2010 | 7.000 | 0.017 | 0.359 | 0.000 | 7.375 | 9.616 | -2.241 | 2.351 | 0.110 | 0.105 | 0.008 | 0.012 |

(1) TAC for the quota-year set by the Ministry of Fisheries and Agriculture.
(2) TAC by other means such as quota allocated to rural towns.
(3) TAC transferred from previous fishing-year.
(4) TAC transferred between ships (should be zero).
(5) Total TAC in effect (the sum of the previous 3 columns).
(6) Landings during the fishing-year.
(7) TAC minus landings
(8) Nett species TAC transfers. Negative number indicates the TAC of species in question to have been changed to a TAC for another species.
(9) Effective TAC left, taking in all the numbers in previous columns.
(10) TAC transferred to next fishing year
(11) Catch in excess of TAC, confiscated by the Directorate of Fisheries / Icelandic Coast Guard.
(12) TAC that can not be moved to the next fishing year.

# 4 Discussion

The estimates of discard presented here are based on limited data. However the indication from the analysis is that discarding in the form of highgrading is not a serious problem in the Icelandic longline fishery of tusk and ling. The measures set do discourage discarding in the ITQ-system in force in Iceland seem to work, as TAC from one species is converted to a TAC in another. However this flexibility within the system is one of the main contributing factor in landings exceeding TAC in most years that the tusk- and ling fishery have been part of the management system.

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# Iterative re-weighing of likelihood components in Gadget using tusk in Va as a case study

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February 25, 2011

**Abstract**

This paper describes re-iterative weighting procedure for allocating weight to various likelihood components in Gadget models. Here the Tusk in Va Gadget model that formed the basis for the ICES advice in 2010 is used as a case study. The results of the re-iterative weighting procedure are similar to the *ad-hoc* weights assigned previously and the estimates do not change the perception of stock trends. The re-iterative weighting is found to be a valuable tool as it eliminates the need for 'expert-judgment' for assigning weights to likelihood components but rather extracts the information needed from the data.

## 1 Introduction

Gadget (described in Begley & Howell, 2004) is a powerful set of tools for creating ecosystem models. The program was developed with the aim of modeling marine ecosystems in a fisheries management and biology context. A Gadget model is constructed from a number of key (optional) components. Theses include one or more species, each of which may be split into multiple sub-stocks; multiple areas with migration between areas; predation between and within species; maturation; reproduction and recruitment; multiple commercial and survey fleets taking catches from the populations.

Gadget can and has been used in a number of ways, in Taylor et al. (2007) it was used to build single species models of cod in Icelandic waters and similarly for hake in the Mediterranean in Bartolino et al. (2010). Lindstrøm et al. (2009) used Gadget as a multispecies model for minke whales in the Barent sea is illustrated and Howell & Bogstad (2010) used Gadget as a tool to calculate a harvest control rule in Norwegian waters in combination with FLR. Models built using Gadget have been used as a basis and auxiliary tool for harvesting advice for a number of fish stock. Most recently a model for tusk (*brosme brosme*) was approved as a basis for advice by ICES.

One of the main aims of a multi-species model, such as those implemented using Gadget, is to estimate values of selected unknown parameters. The likelihood function serves as a general measure of how well a model with a given set of parameters fits data. Parameter estimation is therefore undertaken by maximizing the likelihood function over values of the unknown parameters.

The form of the likelihood function for a particular model and data set will vary depending on the nature of the data. Since fisheries data come from various sources, a large number of different likelihood functions have been implemented in Gadget. When such different data sources are combined in one analysis, the likelihood function becomes the product of the likelihood functions for each subset. The individual pieces will be from now on referred to as likelihood components.

As is common practice, maximum likelihood estimation of parameters is implemented in Gadget through minimizing the negative log likelihood. The negative log likelihood function will referred to as the objective function. Thus the objective function serves as a measure of the discrepancy between the output of the model and measurements.

Typically, several components enter the objective function in any single estimation. Thus the objective function becomes a weighted sum of several components:

$$l = \sum_i w_i l_i$$

The weights, $w_i$, are necessary for several reasons. Notably, they can be used to prevent some components from dominating the likelihood function, to reduce the effect of low quality data and as a priori estimates of the variance in each subset of the data.

Choosing these weights is, however, not trivial as the data sources have different natural scales that should not affect the outcome. As an example consider the trivial case where on one hand the length distribution is in centimeters from the survey while in meters in the commercial catch. Even if these sources were otherwise similar the variance for the survey is greater by a factor of ten thousand, and assigning the likelihood components that correspond to the two data sources the same weight would implicitly mean that the survey data would be given greater significance.

The weights have therefore often been assigned according to expert judgment where weights represent the relative quality of the data. As an example one might attempt to emphasize a long time series of survey indices while reducing the effect of sporadic age measurements. The issue here is what constitutes a *high* and *low* weight, as that may vary between data-sets and models.

An early attempt to remove the alchemy from the weight assignment used the following heuristic. After the model has been designed, an initial simulation is started from a sensible starting point. Then the weights of the likelihood function is set to be the inverse of the initial sums of squares (likelihood score) for the respective component. As a result of this the initial score equal to the number of components. This heuristic is easy to implement and has the intuitive advantage of all components being normalized. There is however a drawback to this approach as the component scores, given the initial parametrization, are most likely not equally far from their respective optima and as a result the weighting could be sub-optimal.

A more objective weighting scheme, *iterative re-weighting*, was introduced in (Stefánsson, 2003) and implemented for cod in (Taylor et al., 2007). This document details an independent re-implementation in R (Gentleman et al., 1997) of the iterative re-weighting algorithm for Gadget and its use is illustrated on tusk in Icelandic waters. Additionally diagnostics for the weighting procedure are shown.

## 1.1 The WGDEEP-2010 Gadget assessment

The Gadget setup presented at WKDEEP-2010 was preliminary and was improved vastly before the WGDEEP-2010 meeting. Therefore between the WKDEEP-2010 and WGDEEP-2010 meetings considerable work was done on the model, mostly by assigning different weight to the likelihood components. The weighting was though completely *ad hoc*.

In the WGDEEP-2010 report the EG recommended that the Gadget model should be used as basis for advice and the ADG drafted the advice accordingly and subsequently ACOM based its advice on the Gadget prognosis. Therefore Gadget is now the accepted model for basis of advice of tusk in Va.

### 1.2 Likelihood weighting

In Taylor et al. (2007) an objective re-weighting scheme for likelihood components is described for cod in Icelandic waters. The iterative re-weighting heuristic tackles this problem by optimizing each component separately in order to determine the lowest possible value for each component. This is then used to determine the final weights. The iterative re-weighting procedure has now been implemented in the `R` statistical language as a part of the `rgadget` package (Elvarsson et al., 2011) which is written and maintained by B. Th. Elvarsson.

Conceptually the likelihood components can roughly be thought of as residual sums of squares (SS), and as such their variance can be estimated by dividing the SS by the degrees of freedom. Then the optimal weighting strategy is the inverse of the variance. The variances, and hence the final weights, are calculated according the following algorithm:

1) Calculate the initial SS given the initial parametrization. Assign the inverse SS as the initial weight for all likelihood components. With these initial weights the objective function will start off with value equal to the number of likelihood components.
2) For each likelihood component, do an optimization run with the initial score for that component set to 10000. Then estimate the residual variance using the resulting SS of that component divided by the effective number of data-points, that is all non-zero data-points.
3) After the optimization set the final weight for that all components as the inverse of the estimated variance from step 3 (weight $= (1/SS) \times df^*$).

The effective number of data-points ($df^*$) in 3) is used as a proxy for the degrees of freedom determined from the number of non-zero data-points. This is viewed as satisfactory proxy when the data-set is large, but for smaller data-sets this could be a gross overestimate. In particular, if the survey indices are weighed on their own while the yearly recruitment is estimated they could be over-fitted. If there are two surveys within the year Taylor et al. (2007) suggest that the corresponding indices from each survey are weighed simultaneously in order to make sure that there are at least two measurement for each yearly recruit. In general problem such as those mentioned here could be solved with component grouping, that is in step 2) above likelihood components that should behave similarly, such as survey indices, should be heavily weighted and optimized together.

Another approach for estimating the weights of each index component, in the case of a a single survey fleet, would be to estimate the residual variances from a model of the form

$$\log(I_{lt}) = \mu + Y_t + \lambda_l + \epsilon_{lt}$$

where $t$ is denotes year, $l$ length-group and the residual term, $\epsilon_{lt}$, is independent normal with variance $\sigma_s^2$ where $s$ denotes the likelihood component. The inverse of the estimated residual variance are then set as weights for the survey indices. In the RGadget routines this approach is termed `sIw` as opposed to `sIgroup` for the former approach.

### 1.3 Tusk in Va

Tusk (*Brosme brosme*) is a cod-like fish in the gadoid family. It is a bottom dwelling fish that is mainly caught on longline south and south west of Iceland, although tusk appears in catch all around Iceland. As stated above the weighting of likelihood components in the tusk in Va assessment is completely *ad hoc*. It is therefore interesting and valuable to use a statistical procedure to try to eliminate this 'expert judgment' component from the model.

# 2 Materials and methods

In effect the iterative weighting procedure is applied to the Gadget model of tusk in Va that was used as basis for advice in 2010. So exactly the same data was used. However one likelihood component was omitted from the iterative weighting or the `si2080-2`. The reason is that in the original model this component was simply inserted to get an estimate of the selection curve from the survey on a finer scale than is obtained from the 10 cm survey likelihood components. As this component was a kind of 'dummy-component' it was assigned very low weight.

## 2.1 Basic properties of the model

The model for tusk consist of one area all around Iceland and a single stock. The model operates on quarterly time-steps. The age range is between 2 and 20 years, length between 6.5 and 110.5 cm with 1 cm length-groups and the growth follows the usual Von Bertalanffy curve (Putter, 1920). Recruitment is estimated annually. In the model there are two fleets, survey which is the Icelandic March Survey and a commercial longline fleet.

In all there are 12 likelihood components in the model:

- Penalty function to ensure that the parameter values stay within limits.
- Understocking function that penalizes parameter values indicating lower biomass than is consumed by the fleet.
- Five length based survey indices components, based on 20 - 29 cm, 30 - 39 cm, 40 - 49 cm, 50 - 59 cm and 60+ cm.
- Two length-distributions from the commercial fleet and survey using a multinomial likelihood function.
- Two age - length - keys from the commercial fleet and survey using a multinomial likelihood function.
- Mean length from the commercial fleet using a length given variance likelihood function.

## 2.2 Data issues

Tusk age readings have historically been error prone and at the time only two years, 1995 and 2009, were considered to have reliable age readings.

# 3 Results

## 3.1 The weights

It is not just important to get the weights right, it is equally important to find where these discrepancies lie. Following the methodology set out in Taylor et al. (2007) two types of tables are produced to analyze the model. First there is an overview of all likelihood scores from each of likelihood components under all re-weightings schemes described earlier. The second table illustrates the ratio of each of the final likelihood component scores to the one obtained with the re-weighting algorithm. The ratio should illustrate what data-set is best represented in the final model and, probably more importantly, what data-set has the least influence.

In tables 1 and 2 the results from the re-weighting of the tusk likelihood components can be seen. One of the most obvious discrepancies in the weights can be seen when the age - length - keys are heavily weighted. It was, as noted earlier, expected that the age readings would be problematic. A possible explanation is that when the age - length - keys are, individually, heavily weighted the model could easily over-fit the sparse age readings resulting in an abnormally high weight. A possible remedy is to weigh the age - length - key at the same time as the length distribution.

**Table 1:** Tusk in Va. These tables illustrate the likelihood component scores (columns) when one component is heavily weighed (rows). Survey indices were grouped together. The top table shows the absolute score while the lower shows the score relative to the minimum.

| Component | si2029 | si3039 | si4049 | si5059 | si60110 | ld.c | ld.s | alk.c | alk.s | ml.c |
|---|---|---|---|---|---|---|---|---|---|---|
| indices | 0.85 | 0.58 | 0.66 | 1.30 | 24.66 | 268900.00 | 56150.00 | 3389.00 | 2732.00 | 6944.00 |
| ld.c | 15.83 | 4.73 | 3.69 | 4.46 | 56.58 | 23900.00 | 153500.00 | 4063.00 | 4132.00 | 906.30 |
| ld.s | 1.80 | 0.87 | 1.28 | 1.95 | 45.11 | 288100.00 | 10250.00 | 1691.00 | 1053.00 | 1237.00 |
| alk.c | 43.61 | 26.07 | 16.65 | 15.24 | 68.86 | 280500.00 | 89540.00 | 1110.00 | 1298.00 | 1781.00 |
| alk.s | 31.14 | 15.79 | 10.70 | 5.30 | 54.14 | 40060.00 | 552500.00 | 5208.00 | 9.33 | 159.60 |
| ml.c | 54.21 | 39.38 | 32.15 | 38.21 | 644.30 | 254300.00 | 552800.00 | 7456.00 | 33.74 | 71.05 |
| indices | 1.00 | 1.00 | 1.00 | 1.00 | 1.29 | 11.25 | 5.48 | 3.05 | 292.76 | 97.73 |
| ld.c | 18.72 | 8.12 | 5.58 | 3.44 | 2.97 | 1.00 | 14.98 | 3.66 | 442.78 | 12.76 |
| ld.s | 2.13 | 1.48 | 1.94 | 1.50 | 2.37 | 12.05 | 1.00 | 1.52 | 112.84 | 17.41 |
| alk.c | 51.58 | 44.71 | 25.16 | 11.73 | 3.61 | 11.74 | 8.74 | 1.00 | 139.09 | 25.07 |
| alk.s | 36.83 | 27.08 | 16.17 | 4.08 | 2.84 | 1.68 | 53.90 | 4.69 | 1.00 | 2.25 |
| ml.c | 64.12 | 67.54 | 48.59 | 29.41 | 33.79 | 10.64 | 53.93 | 6.72 | 3.62 | 1.00 |
| df* | 26 | 26 | 26 | 26 | 78 | 2274 | 841 | 437 | 201 | 60 |

**Table 2:** Tusk in Va. A comparison of the likelihood component scores, absolute minimum ($sse_m$) from the reweighing procedure and the minimum from the final model run ($sse_f$).

| | si2029 | si3039 | si4049 | si5059 | si60110 | ml.c | alk.s | alk.c | ld.s | ld.c |
|---|---|---|---|---|---|---|---|---|---|---|
| $sse_m$ | 0.85 | 0.58 | 0.66 | 1.30 | 24.66 | 71.05 | 9.33 | 1110.00 | 10250.00 | 23900.00 |
| $sse_f$ | 2.33 | 1.26 | 1.24 | 2.48 | 29.64 | 196.60 | 743.80 | 1710.00 | 15150.00 | 27650.00 |
| $sse_f$:$sse_m$ | 2.75 | 2.16 | 1.87 | 1.91 | 1.20 | 2.77 | 79.70 | 1.54 | 1.48 | 1.16 |

A comparison of the original *ad-hoc* weights and the final weights from the re-iterative procedure are shown in table 3. In general the weights are quite similar for the various likelihood components except for the survey age data (alk.s).

**Table 3:** Tusk in Va. Comparisons of the weights assigned to the likelihood components of the model that were used in the 2010 assessment (Original) and the weights obtained from the re-iterative weighting procedure.

| Component | Original Weight | % | Re-iterative Weight | % |
|---|---|---|---|---|
| si2029 | 50.00 | 32.20 | 30.75 | 19.13 |
| si3039 | 50.00 | 32.20 | 44.58 | 27.73 |
| si4049 | 20.00 | 12.88 | 39.29 | 24.44 |
| si5059 | 20.00 | 12.88 | 20.02 | 12.45 |
| si60110 | 5.00 | 3.22 | 3.16 | 1.97 |
| si2080-2* | 0.10 | | | |
| ld.c | 0.10 | 0.06 | 0.10 | 0.06 |
| ld.s | 0.10 | 0.06 | 0.08 | 0.05 |
| alk.c | 5.00 | 3.22 | 0.39 | 0.24 |
| alk.s | 5.00 | 3.22 | 21.53 | 13.39 |
| ml.c | 0.01 | 0.06 | 0.84 | 0.52 |

* This component was omitted in the re-iterative weighing (see 2). Subsequently it is not included in calculations of % of the total weight.

## 3.2 The fit

The fit to the observed data is quite similar as with the original *ad-hoc* weights (Figure 1). This should not be surprising as the weights are quite similar. The re-iterative fit does though seem to follow the survey data better for the main length-groups (40-79cm) and the overestimation at the end of the time series is less than in with the original weights.

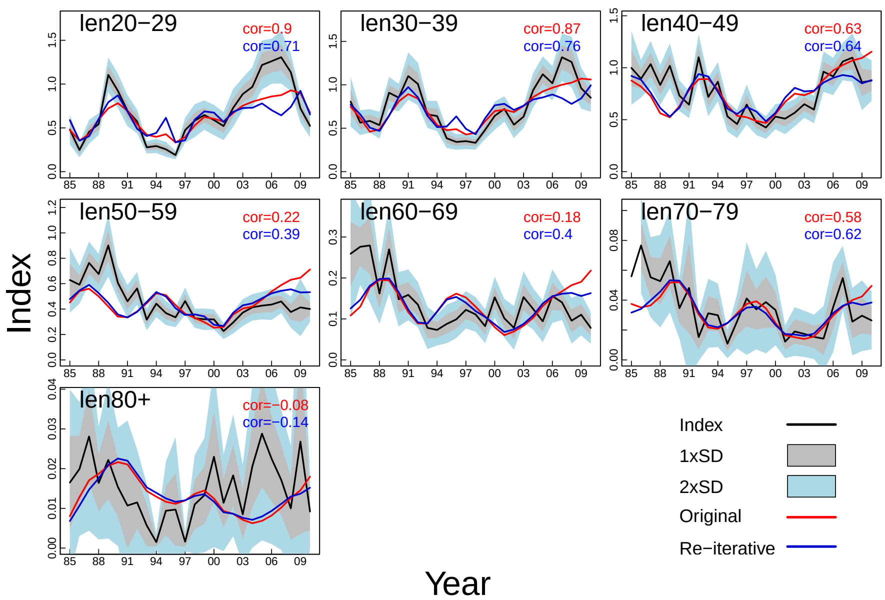


**Figure 1:** Tusk in Va. Estimates from the gadget model (red line) plotted against observed values from the spring survey (dotted line and points) of the 2010 Gadget assessment presented at the WGDEEP in 2010 and used by ICES as bases for advice.

### 3.3 Estimates of recruitment, biomass and fishing mortality

Estimates of recruitment, biomass and fishing mortality are in general quite similar irrespective of the weights used (Figure 2). The main difference is between estimates of fishing mortality but that is only on the second and third digit.

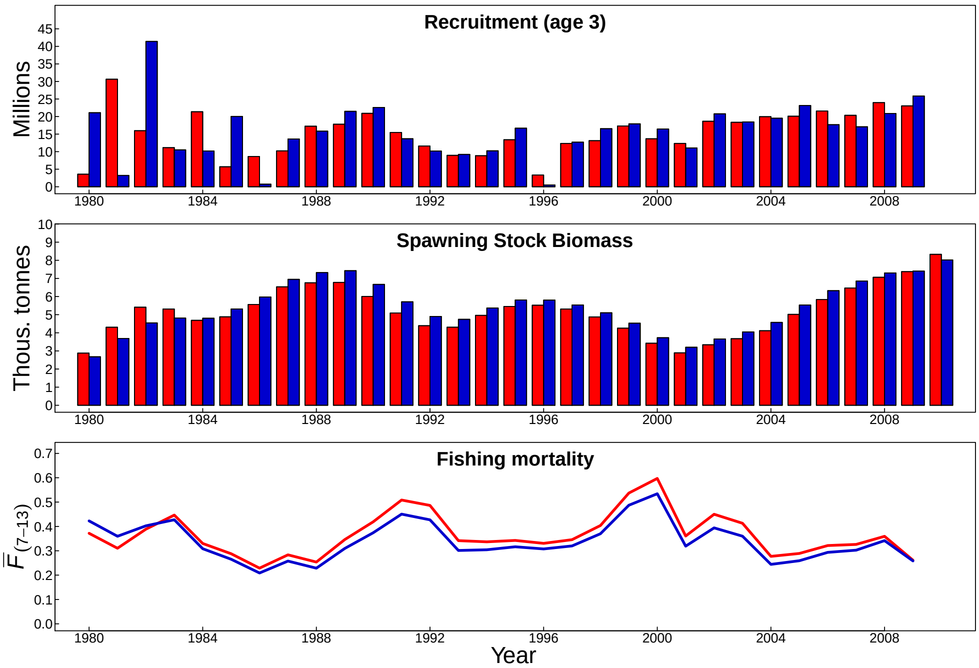


**Figure 2:** Tusk in Va. Recruitment (age 3), spawning stock biomass and fishing mortality estimates form the original *ad-hoc* weighting (red bars and lines) and from the re-iterative weighting procedure (blue bars and lines).

## 4 Discussion

The weights assigned to the various likelihood components is really only a major issue when there is apparent inconsistency between the data sets. Basically, one can get very different results from different choices of weights only if the model can not fit well to all data sets simultaneously. What this means is that if the model can not explain all the data sets at the same time, i.e. there is something missing from the model. For example, if there is a good survey data available but a typical catchability trend in commercial CPUE data then these will seem to be inconsistent when a model is fitted assuming constant catchability in both. The inconsistency would disappear if there was added a time trend in $q$ for the CPUE data.

The results of the re-iterative procedure are surprisingly similar to those used for the 2010 assessment. So the general view of the stock status does not alter significantly at all. Though this exercise in light of the results may appear to be of little value the results are important in two ways.

First the results indicate that 'expert judgment' in assigning weight to the likelihood components is not needed when using Gadget. Or more clearly, that the 'expert judgment' can be extracted from the data. Building a Gadget model is therefore much more straight forward and does not rely so much on 'trial and error' process of assigning weights.

The second thing worth noting is that the iterative procedure simply confirms the estimated stock status from the WGDEEP-2010 assessment. If the results would have been vastly different that in itself would have been a cause for serious concern.

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# An updated Gadget assessment of Tusk in Va,

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February 24, 2011

**Abstract**

## 1 Introduction

### 1.1 Previous Gadget assessments of tusk in Va

The first Gadget assessment of tusk in Va was presented at the WGDEEP-2009 (WD-16). The group concluded that the approach was promising and subsequently tusk in Va was proposed by the group as a candidate for benchmark. ACOM accepted the proposal by WGDEEP and tusk was benchmarked in the WKDEEP-2010 meeting along with several other WGDEEP stocks.

Shortly before the WKDEEP-2010 meeting the 2009 tusk otoliths were aged. A considerable discrepancy between the old and new ageing was detected which resulted in the older ageing data being discarded. This is documented in the WKDEEP-2010 report.

Due to the above mentioned reason and time constraints[1] the Gadget setup presented at WKDEEP-2010 was preliminary. However the WKDEEP-2010 meeting concluded that the gadget setup at the meeting was usable for *Indicative of trends*. Considerable work was put into improving the setup before the WGDEEP-2010 meeting. Therefore between the WKDEEP-2010 and WGDEEP-2010 meetings considerable work was done on the model, mostly by assigning different weight to the likelihood components. The weighting was though completely *ad hoc*.

In the WGDEEP-2010 report the EG recommended that the Gadget model should be used as basis for advice and the ADG drafted the advice accordingly and subsequently ACOM based its advice on the Gadget prognosis. Therefore Gadget is now the accepted model for basis of advice of tusk in Va.

## 2 Changes to the assessment since 2010

### 2.1 Changes to survey indices

Two changes have been made to the survey data used as tuning series. First the length distribution in the likelihood component `ldist.survey` was extended downwards from 20cm to 10 cm.

[1] The stock coordinator was also benchmarking Greater Silver Smelt in Va at the WKDEEP-2100

This results in less steeper slope in the length distribution and therefore the estimated selection curve becomes more plausible.

The second change and the more drastic one is the inclusion of the 'Faroe-ridge' survey area into the tuning series. This topic was mentioned at the WKDEPP-2010 meeting but not acted upon (see: WKDEEP-2010-WD:TUSK-01). One of the problem when calculating spring survey indices for tusk in Icelandic waters is whether to use stations from the Iceland-Faroe Ridge. 24 stations on the Iceland-Faroe Ridge were omitted in 1996 from the survey. It was not until 2004 that 9 of the stations were included again in the survey and all of the 24 stations in 2005. Inclusion of the Iceland-Faroe Ridge has a great impact on the total survey index for the years when this area was surveyed (Figure 1). When the area is included the survey index increases considerable and the difference is between 17-37% in biomass but around 47% in abundance (Table 1). This indicates that a considerable portion of the Icelandic tusk population is located in this area. This is especially evident in later years (2004-2009) compared to the beginning of the survey (1985-1995) (Table 1). To scale the total area index (include the Iceland-Faroe Ridge) the abundance index is multiplied with 1.47 in 1996 to 2003. in general the two indices show the same trend, the largest difference in in the `len50-59` interval (See figure 1)

**Table 1:** Difference in total biomass indices (in thousand tonnes) for tusk with or without the Iceland-Faroe Ridge. Note that no stations were taken on the Iceland-Faroe Ridge in 1996-2003.

| Year | With Iceland-Faroe Ridge | Without Iceland-Faroe Ridge | Difference % |
|---|---|---|---|
| 1985 | 4.2 | 3.5 | 16.4 |
| 1986 | 4.2 | 3.4 | 19.0 |
| 1987 | 5.1 | 3.9 | 23.3 |
| 1988 | 4.2 | 3.2 | 23.9 |
| 1989 | 5.2 | 4.3 | 17.7 |
| 1990 | 3.7 | 3.0 | 19.0 |
| 1991 | 3.6 | 2.7 | 24.4 |
| 1992 | 4.0 | 3.1 | 22.4 |
| 1993 | 2.7 | 1.9 | 28.6 |
| 1994 | 2.9 | 2.2 | 22.1 |
| 1995 | 2.3 | 1.7 | 27.0 |
| 1996 | 1.6 | 1.6 | 0.0 |
| 1997 | 2.1 | 2.1 | 0.0 |
| 1998 | 1.8 | 1.8 | 0.0 |
| 1999 | 1.8 | 1.8 | 0.0 |
| 2000 | 2.1 | 2.1 | 0.0 |
| 2001 | 1.7 | 1.7 | 0.0 |
| 2002 | 1.8 | 1.8 | 0.0 |
| 2003 | 2.2 | 2.2 | 0.0 |
| 2004 | 3.7 | 2.4 | 33.9 |
| 2005 | 4.0 | 2.8 | 28.4 |
| 2006 | 4.4 | 3.0 | 31.9 |
| 2007 | 4.4 | 3.3 | 24.4 |
| 2008 | 4.4 | 2.8 | 35.9 |
| 2009 | 4.2 | 2.7 | 36.9 |

### 2.2 Age data

In the assessment presented at the WGDEEP-2010 there were only two years of aged otoliths i.e. 1995 and 2009. In both instances there was data from both the commercial catches and the survey. In the present assessment there is aged data for 1984, 1995, 2008-2010 from the commercial catches (Table 2). For the survey there is now data from 1985, 1995, 2009 and 2010 (Table 3). It should be noted that in the case of the commercial data the years 2008 and 2010 does not contain all the available material (approx. 50%).

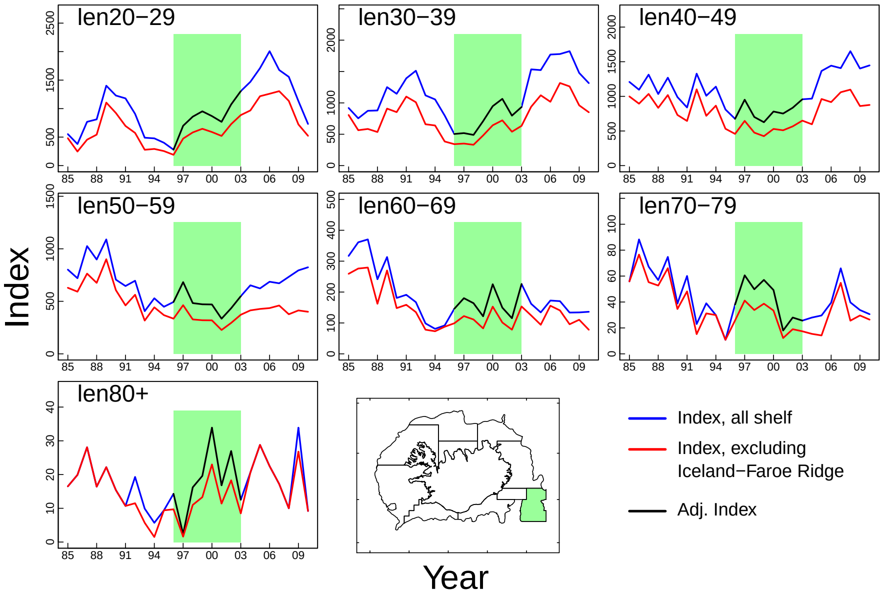


**Figure 1:** Tusk in Va. Indices from the Icelandic spring survey. The red line is the previously used tuning index that does not include the Iceland-Faroe Ridge. The blue line is the same index including the ridge. In the period between 1996 to 2004 the Ridge was nor surveyed, therefore the red line is scaled up so proportionally based on comparisons of the indices in the other periods. The map shows the Iceland-Faroe Ridge survey area in green

**Table 2:** Tusk in Va. Number of aged otoliths from commercial catches (longlines) used as input data in the Gadget assessment.

| Year | Age | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | $\sum$ |
| 1984 | 0 | 0 | 6 | 14 | 22 | 31 | 13 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 91 |
| 1995 | 0 | 0 | 26 | 95 | 144 | 131 | 63 | 38 | 7 | 4 | 0 | 0 | 0 | 0 | 508 |
| 2008 | 0 | 3 | 30 | 97 | 149 | 148 | 70 | 49 | 21 | 5 | 3 | 0 | 0 | 0 | 575 |
| 2009 | 7 | 42 | 112 | 238 | 242 | 215 | 126 | 69 | 24 | 11 | 2 | 0 | 1 | 1 | 1090 |
| 2010 | 0 | 1 | 27 | 121 | 181 | 184 | 108 | 68 | 21 | 9 | 1 | 1 | 0 | 0 | 722 |

**Table 3:** Tusk in Va. Number of aged otoliths from Icelandic Spring Survey used as input data in the Gadget assessment.

| Year | Age | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | $\sum$ |
| 1985 | 17 | 28 | 59 | 81 | 114 | 106 | 91 | 71 | 47 | 21 | 5 | 1 | 1 | 642 |
| 1995 | 25 | 54 | 82 | 100 | 103 | 102 | 102 | 49 | 15 | 4 | 0 | 1 | 0 | 637 |
| 2009 | 6 | 35 | 76 | 79 | 75 | 80 | 45 | 23 | 11 | 2 | 1 | 0 | 0 | 433 |
| 2010 | 0 | 13 | 26 | 45 | 61 | 65 | 68 | 51 | 23 | 5 | 5 | 0 | 0 | 362 |

### 2.3 Other data

Additionally over 8862 length measurements from commercial catches and catches from 2010 have been included in the assessment (8283 tonnes).

### 2.4 Model settings and fitting

In the 2010 assessment the weights used for the various likelihood components were assigned based on expert judgment. This year the re-iterative weighting procedure is used for the same purposes. For detailed description of the procedure see WD XX. In the re-iterative weighting procedure it was necessary to weigh the `sur.alkeys` and `sur.ledist` components simutainiously. The reason is that the limited age data can easily be fitted 'perfectly' by the model which then results in very high weight on this component, even 'Inf' weight.

The number of the survey indices likelihood components has now been reduced. The `si2029` and `si3039` have now been joined into one component `si2039`. Similarly the `si4049` and `si5059` have been joined into `si4059`. This reduces the survey components from five to three. The justification for this is the fact that the trends in the length-groups in the new components are quite similar. Additionally the components can now be looked at as a proxy for 'pre-recruits', 'fishable stock' and 'old-timers'.

Additionally the `alphasur` parameter was estimated but it was fixed in the 2010 assessment. The reason why this parameter is now estimated is the change in the survey length distributions (See subsection 2.1)

## 3 Results

### 3.1 Re-iterative weighting of likelihood components

In Taylor et al. (2007) an objective re-weighting scheme for likelihood components is described for cod in Icelandic waters. The iterative re-weighting heuristic tackles this problem by optimizing each component separately in order to determine the lowest possible value for each component. This is then used to determine the final weights. The iterative re-weighting procedure has now been implemented in the `R` statistical language as a part of the `rgadget` package (Elvarsson et al., 2011) which is written and maintained by B. Th. Elvarsson.

Conceptually the likelihood components can roughly be thought of as residual sums of squares (SS), and as such their variance can be estimated by dividing the SS by the degrees of freedom. Then the optimal weighting strategy is the inverse of the variance. The variances, and hence the final weights, are calculated according the following algorithm:

1) Calculate the initial SS given the initial parametrization. Assign the inverse SS as the initial weight for all likelihood components. With these initial weights the objective function will start off with value equal to the number of likelihood components.
2) For each likelihood component, do an optimization run with the initial score for that component set to 10000. Then estimate the residual variance using the resulting SS of that component divided by the effective number of data-points, that is all non-zero data-points.
3) After the optimization set the final weight for that all components as the inverse of the estimated variance from step 3 (weight $= (1/SS) \times df^*$).

The effective number of data-points ($df^*$) in 3) is used as a proxy for the degrees of freedom determined from the number of non-zero data-points. This is viewed as satisfactory proxy when the data-set is large, but for smaller data-sets this could be a gross overestimate. In particular, if the survey indices are weighed on their own while the yearly recruitment is estimated they could be over-fitted. If there are two surveys within the year Taylor et al. (2007) suggest that the corresponding indices from each survey are weighed simultaneously in order to make sure that there are at least two measurement for each yearly recruit. In general problem such as those mentioned here could be solved with component grouping, that is in step 2) above likelihood components that should behave similarly, such as survey indices, should be heavily weighted and optimized together.

Another approach for estimating the weights of each index component, in the case of a a single survey fleet, would be to estimate the residual variances from a model of the form

$$\log(I_{lt}) = \mu + Y_t + \lambda_l + \epsilon_{lt}$$

where $t$ is denotes year, $l$ length-group and the residual term, $\epsilon_{lt}$, is independent normal with variance $\sigma_s^2$ where $s$ denotes the likelihood component. The inverse of the estimated residual variance are then set as weights for the survey indices. In the RGadget routines this approach is termed `sIw` as opposed to `sIgroup` for the former approach.

The results from the re-iterative procedure can be seen in tables 4 and 5. In general the survey indices have the lowest scores and subsequently the highest weights. The scores of the survey otolith data suggests that this data is the most contrary to all the data components.

**Table 4:** Tusk in Va. Results of the re-iterative procedure, likelihood component scores (columns) when one component is heavily weighed (rows). Survey indices (indices), ldist.survey and alkeys.survey (alk.ld.s) were grouped together. The top table shows the absolute score while the lower shows the score relative to the minimum.

| Component | si2039 | si4059 | si60110 | ld.c | ld.s | alk.c | alk.s | ml.c |
|---|---|---|---|---|---|---|---|---|
| indices | 0.93 | 2.02 | 12.84 | 285000.00 | 62720.00 | 5571.00 | 4729.00 | 2009.00 |
| alk.ld.s | 6.50 | 4.40 | 56.04 | 158900.00 | 20300.00 | 4519.00 | 1943.00 | 789.70 |
| ld.c | 30.96 | 14.19 | 76.55 | 25400.00 | 343400.00 | 8745.00 | 4559.00 | 663.70 |
| alk.c | 45.77 | 45.30 | 66.37 | 254800.00 | 82920.00 | 2523.00 | 3529.00 | 1240.00 |
| ml.c | 88.21 | 49.14 | 383.30 | 196500.00 | 644900.00 | 12840.00 | 30.17 | 72.86 |
| base | 3.56 | 2.50 | 15.05 | 29840.00 | 22290.00 | 3543.00 | 2436.00 | 130.70 |
| indices | 1.00 | 1.00 | 1.00 | 11.22 | 3.09 | 2.21 | 156.75 | 27.57 |
| alk.ld.s | 7.02 | 2.18 | 4.36 | 6.26 | 1.00 | 1.79 | 64.40 | 10.84 |
| ld.c | 33.44 | 7.03 | 5.96 | 1.00 | 16.92 | 3.47 | 151.11 | 9.11 |
| alk.c | 49.44 | 22.44 | 5.17 | 10.03 | 4.08 | 1.00 | 116.97 | 17.02 |
| ml.c | 95.28 | 24.34 | 29.85 | 7.74 | 31.77 | 5.09 | 1.00 | 1.00 |
| base | 3.85 | 1.24 | 1.17 | 1.17 | 1.10 | 1.40 | 80.74 | 1.79 |
| df* | 52 | 52 | 78 | 2372 | 919 | 944 | 397 | 60 |

**Table 5:** Tusk in Va. Weights from the re-iterative procedure and the likelihood scores from the final model (sIw-score) and the minimum score for each component from table 4 and the ratio between them.

| Component | sIgroup weight | sIw weight | sIw score | Minimum score | sIw/Min |
|---|---|---|---|---|---|
| si2039 | 56.17 | 8.10 | 2.05 | 0.93 | 2.21 |
| si4059 | 25.76 | 20.84 | 3.11 | 2.02 | 1.54 |
| si60110 | 6.07 | 6.13 | 21.97 | 12.84 | 1.71 |
| ld.c | 0.09 | 0.09 | 27620.00 | 25400.00 | 1.09 |
| ld.s | 0.05 | 0.05 | 14170.00 | 20300.00 | 0.70 |
| alk.c | 0.37 | 0.37 | 3598.00 | 2523.00 | 1.43 |
| alk.s | 0.20 | 0.20 | 2487.00 | 30.17 | 82.43 |
| ml.c | 0.82 | 0.82 | 179.50 | 72.86 | 2.46 |

## 3.2 Fit to survey indices

In general the fit to the survey 10 cm tuning data is good for the smaller length-groups (20-29, 30-39 and 40-49). For the larger tusk this does not hold as well as the model seems to be overestimating abundance in recent years (length-groups 50-59 and 60-69). The fit to the survey indices is shown in three graphs, as a time-series (Figure 2), as a XY-plot (Figure 3) and finally as a bubble-plot (Figure 4).

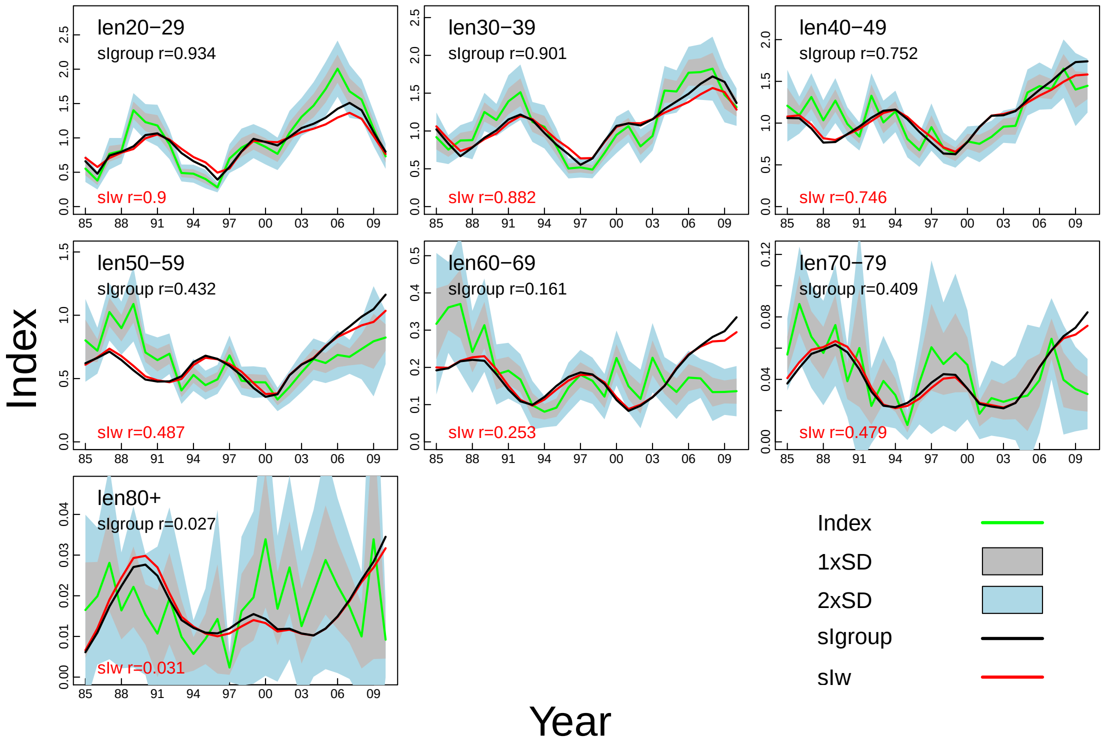


**Figure 2:** Tusk in Va. Trends in aggregated length indices (10 cm) from the Icelandic Spring (March) Groundfish Survey (green line) and standard deviation of the survey estimates (1 sd grey, 2 sd lightblue) and predictions from the Gadget model using either the sIw weights (red line) or the sIgroup weights (black line)

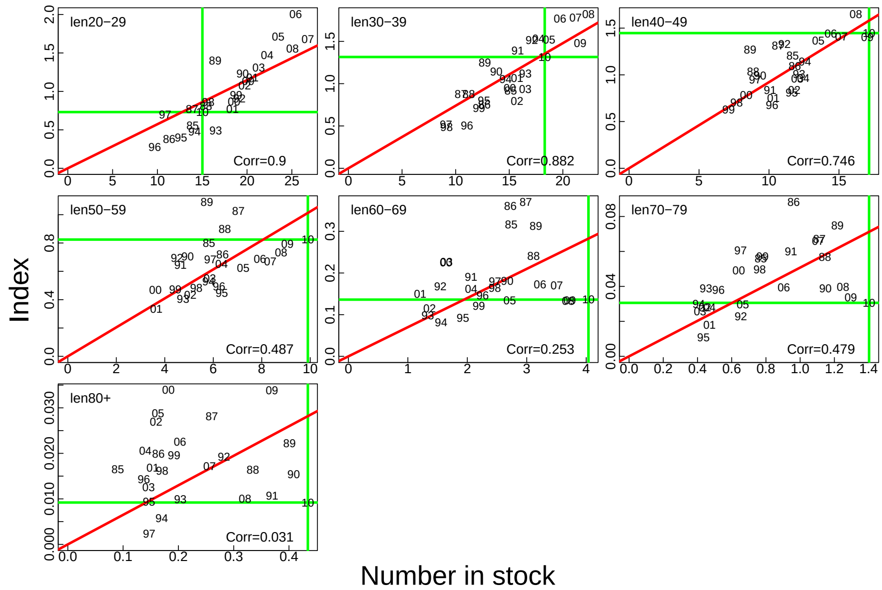


**Figure 3:** Tusk in Va. Estimates from the Gadget model (sIw-weights) plotted against observed values from the Icelandic spring (March) survey.

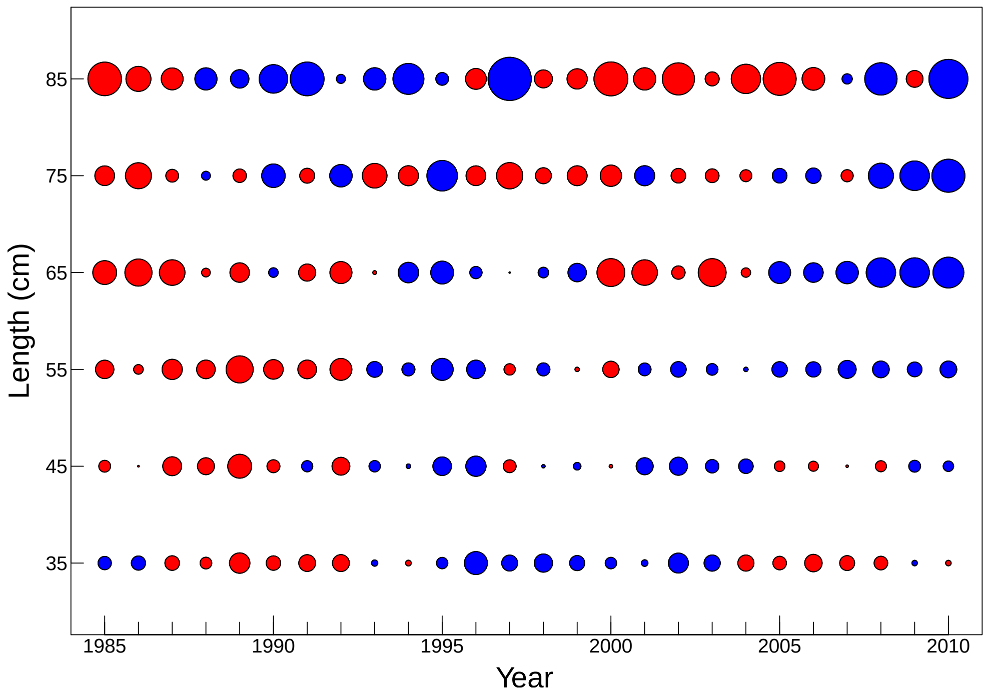


**Figure 4:** Tusk in Va. Residuals from the fit between model and survey indices. The red circles indicate positive trends (model below survey). Largest residuals correspond to log(obs/mod)=1.

## 3.3 Fit to length distributions

The model does seem to capture the main trends in the length-distributions from surveys (Figure 5) and from the commercial longline catches (Figure 6).

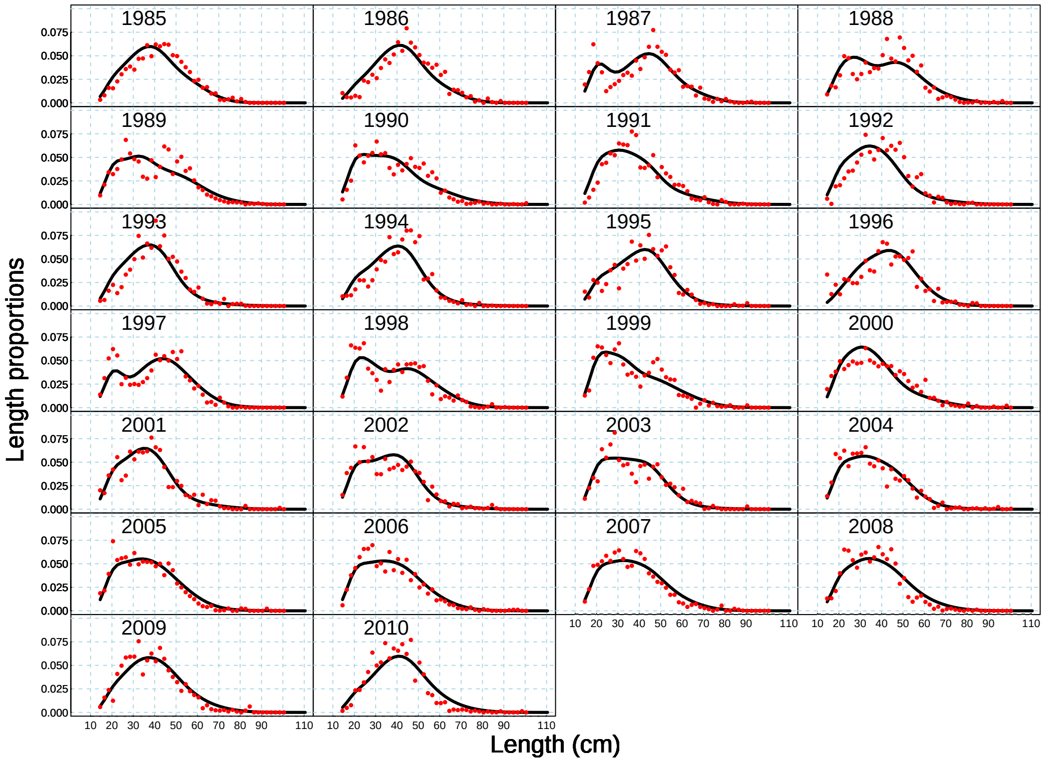


**Figure 5:** Tusk in Va. Predicted proportional length distributions (black lines) and observed proportional length distributions (red points) by year from the Icelandic Spring Survey.

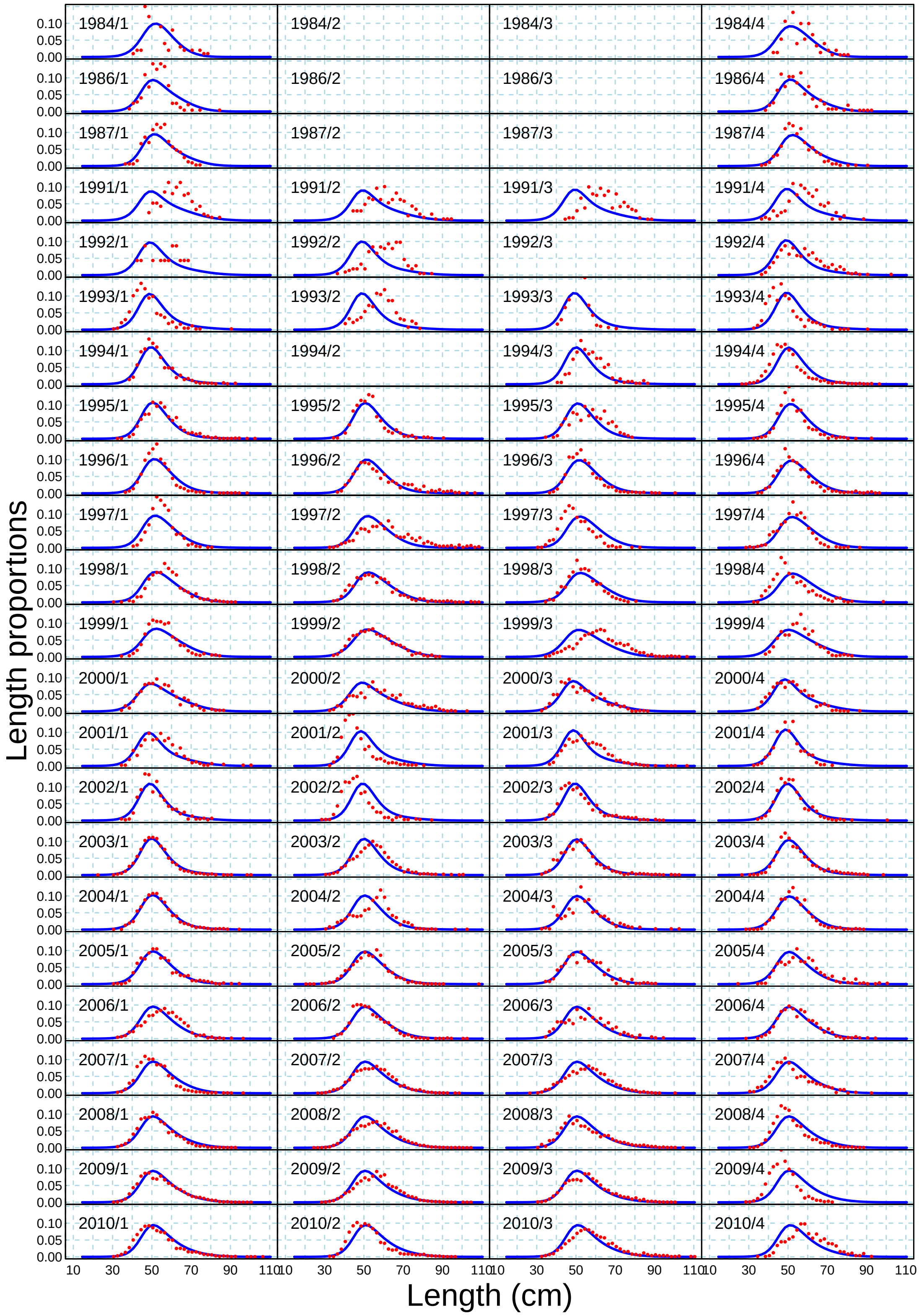


**Figure 6:** Tusk in Va. Predicted proportional length distributions (blue lines) and observed proportional length distributions from commercial catches (red points) by year (top to bottom) and quarter/step (left to right).

## 3.4 Estimates

### 3.4.1 Growth and selection

The estimated growth from the model does seem to be similar to what is observed in the survey data (Figure 7). The selection curves do similarly look reasonable. The commercial catch selection curve has its $L_{50}$ at 46.6 cm but the parametric survey selection curve at 22.5 cm. The parametric survey selection curve is the result of the `sur.alkeys` and `sur.ldist` likelihood components in the model. However the non-paramteric curve is the obtained from the `si...` components. The two survey curves are quite similar from 25 to 55 cm but then the non-parametric turns downward (Figure 8). This likeness between the curves between should not be surprising as they are obtained from the same data, but at a different aggregation. The difference between the curves above 55 cm is then an indication that another selection function for the parametric selection curve might be more suitable, such as the Andersen function in Gadget.

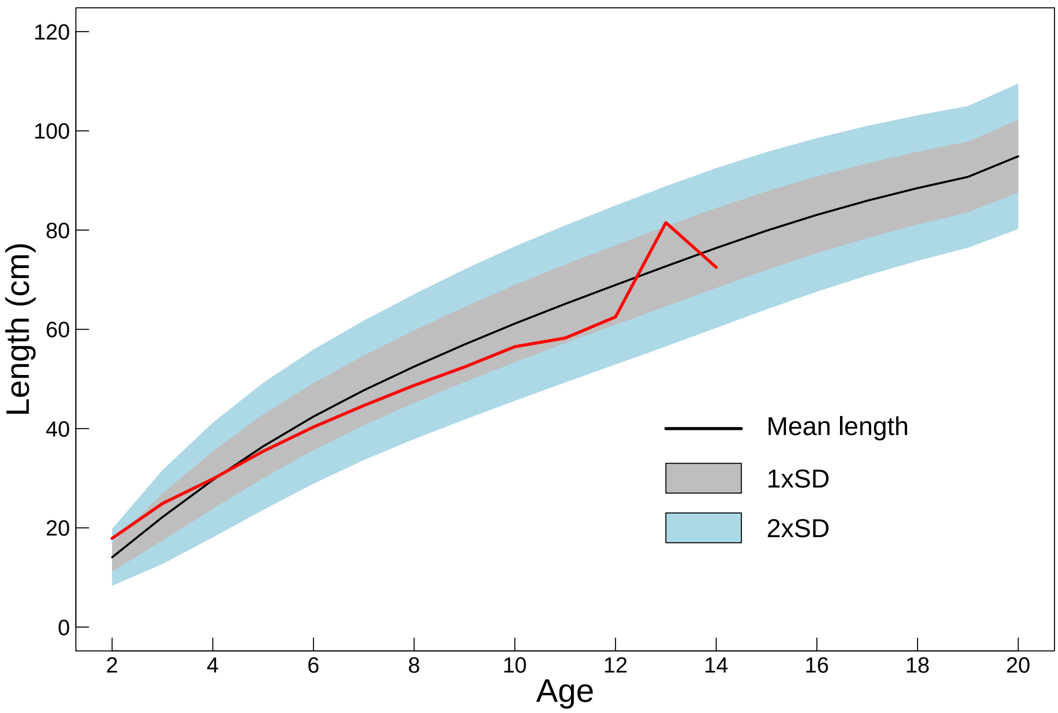


**Figure 7:** Tusk in Va. Predicted length at age in the stock from the Gadget model. The red line is the mean length at age as observed in the survey age data (`suralkeys.dat`).

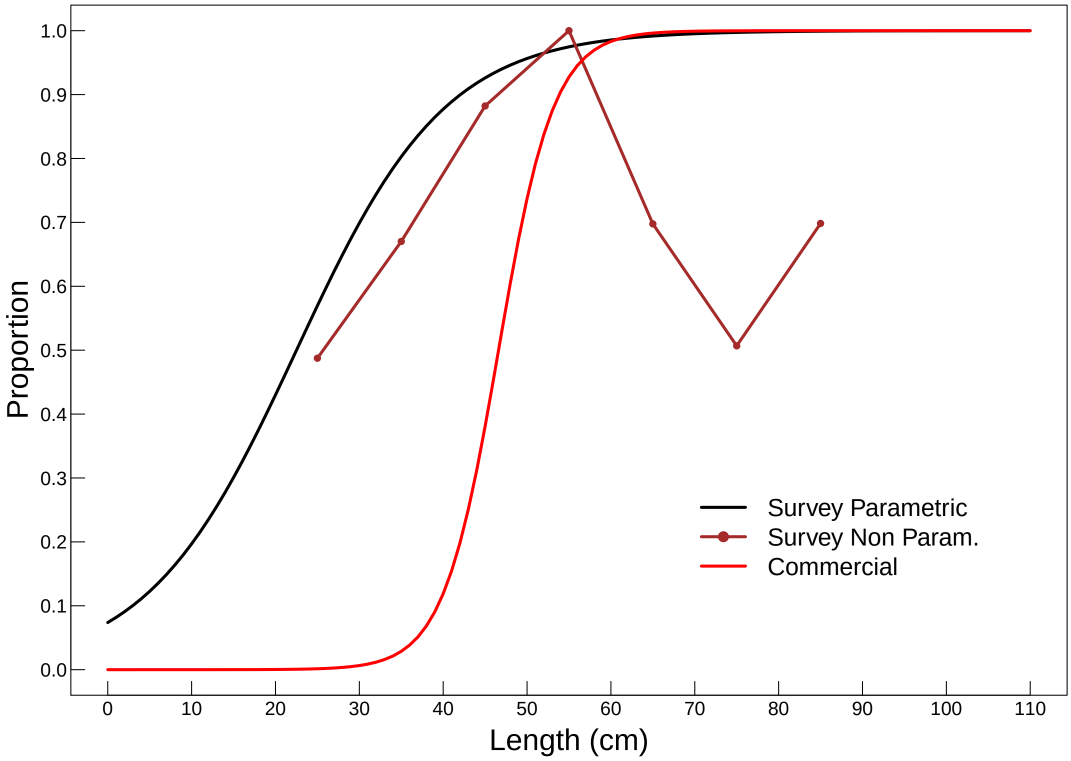


**Figure 8:** Tusk in Va. Estimated selection curves from the Gadget model

### 3.4.2 Stock trends

In the current assessment the spawning stock biomass is estimated at highest level observed or at around 10 thous. tonnes. Recruitment has been decreasing from its highest level in 2007 at 28 million aged 3 recruits to around 16 million recruits in 2009. Fishing mortality was estimated at 0.23 in 2009, close to the $F_{0.1}$ of 0.2 (Figure 9).

Overall the assessment presented here is on par with the assessment presented at WGDEEP in 2010 (Figure 10). Now recruitment is estimated to have risen slowly until 2007 and then decreased considerably. This is contrary to the 2010 assessment when it was estimated at a more or less constant level from 2002. Spawning stock biomass is estimated at a slightly higher level than in 2010 and fishing mortality at a slightly lower level.

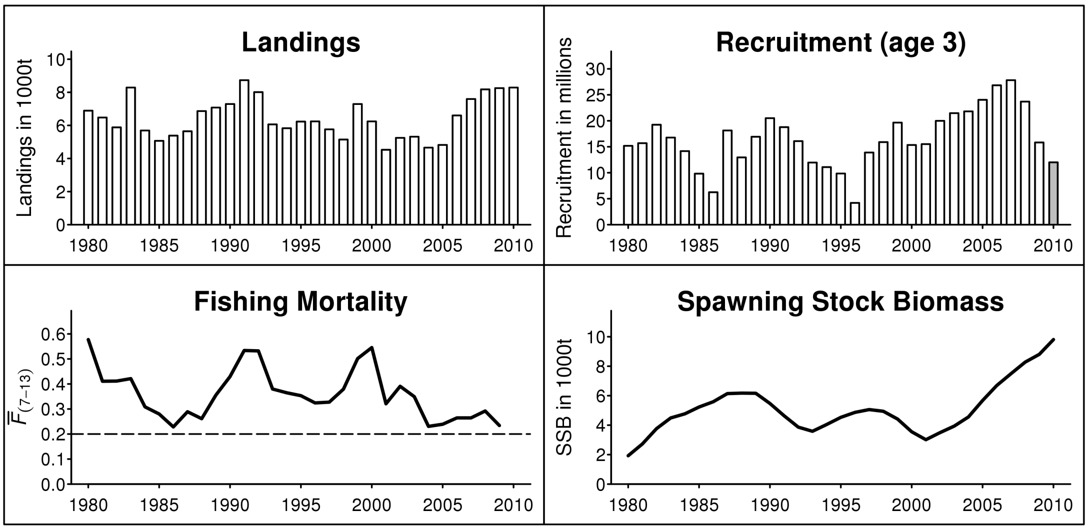


**Figure 9:** Tusk in Va. Ices standard graph, landings, recruitment, fishing mortality and spawning stock biomass.

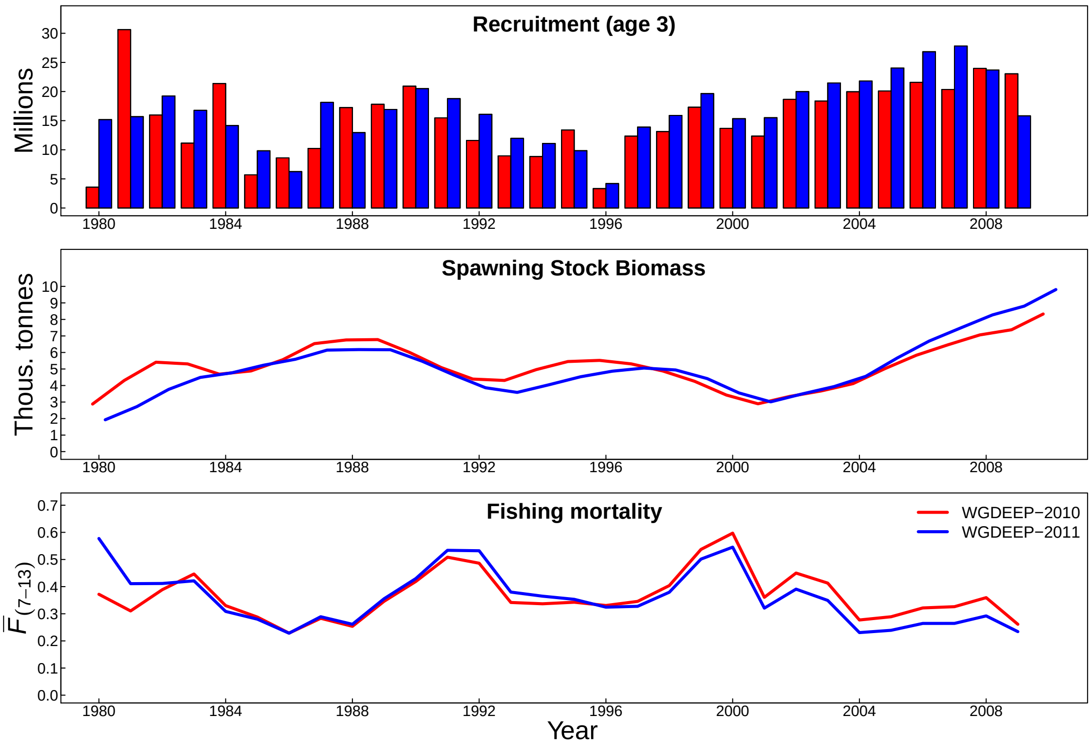


**Figure 10:** Tusk in Va. Comparison of the WGDEEP-2010 gadget assessment (Red bars and lines) and the new assessment, WGDEEP-2011 (Blue bars and lines)

## 3.5 Forward projections

### 3.5.1 Yield per recruit

The yield per recruit curve has not changed markedly since the WGDEEP-2010 assessment. $F_{0.1}$ and $F_{max}$ points are estimated at the same $F$ (Figure 11). However the maximum yield is 10 Gram's lower than last year.

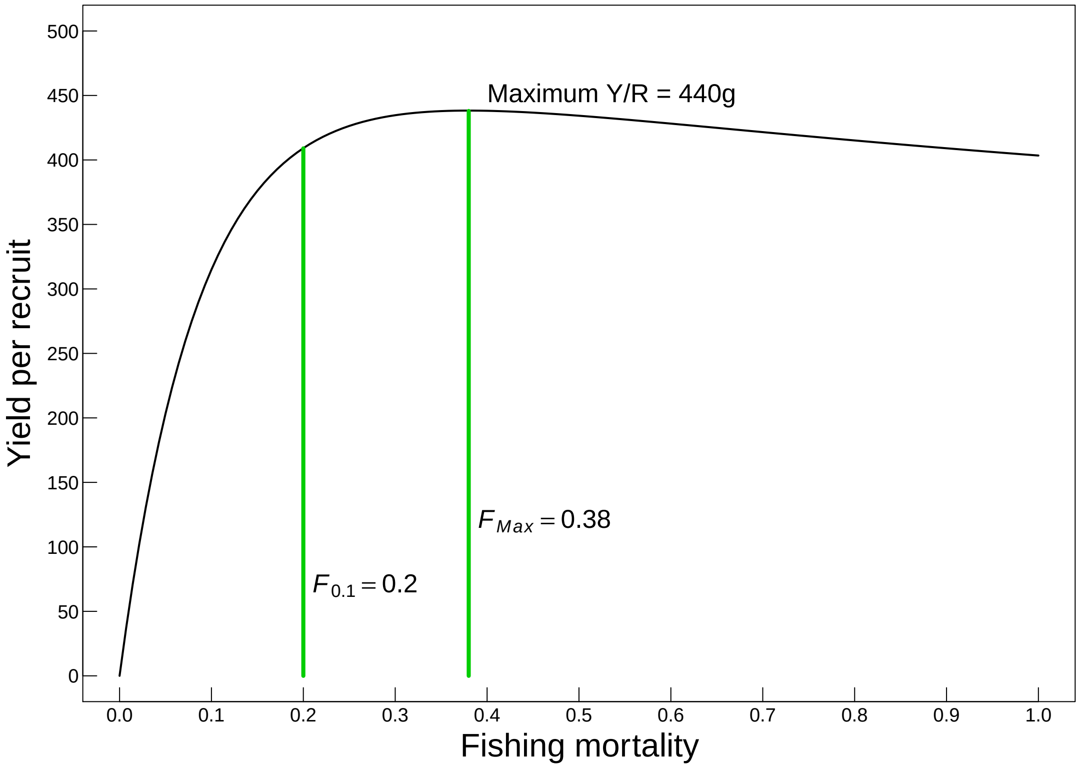


**Figure 11:** Tusk in Va. Yield per recruit analysis from the Gadget model for $\bar{F}_{7-13}$

### 3.5.2 Prognosis

Forward projections were made for fishing at $F_{0.1} = 0.2$ and at $F_{max} = 0.38$ (Table 6 and figure 12. If fished at $F_{0.1}$ SSB will increase from current levels and catches remain around 6 thous. tonnes. Fishing at $F_{max}$ will result in decreasing SSB and catches in excess of 7.7 thous. tonnes.

**Table 6:** Tusk in Va. Forward projections from the Gadget model fishing at $F_{0.1} = 0.2$ and at $F_{max} = 0.38$.

| Year | Biomass | Harv.bio | SSB | Catches | $F$ |
|---|---|---|---|---|---|
| $F = 0.2$ | | | | | |
| 2010 | 43.35 | 24.71 | 8.27 | 8.28 | 0.31 |
| 2011 | 42.62 | 26.75 | 8.84 | 5.90 | 0.20 |
| 2012 | 43.08 | 30.00 | 9.94 | 6.34 | 0.20 |
| 2013 | 42.37 | 31.22 | 10.54 | 6.46 | 0.20 |
| 2014 | 40.98 | 30.63 | 10.49 | 6.31 | 0.20 |
| $F = 0.38$ | | | | | |
| 2010 | 43.35 | 24.71 | 8.27 | 8.28 | 0.35 |
| 2011 | 41.33 | 25.60 | 8.46 | 10.55 | 0.38 |
| 2012 | 37.24 | 24.49 | 8.08 | 9.81 | 0.38 |
| 2013 | 33.15 | 22.29 | 7.45 | 8.80 | 0.38 |
| 2014 | 29.57 | 19.48 | 6.62 | 7.72 | 0.38 |

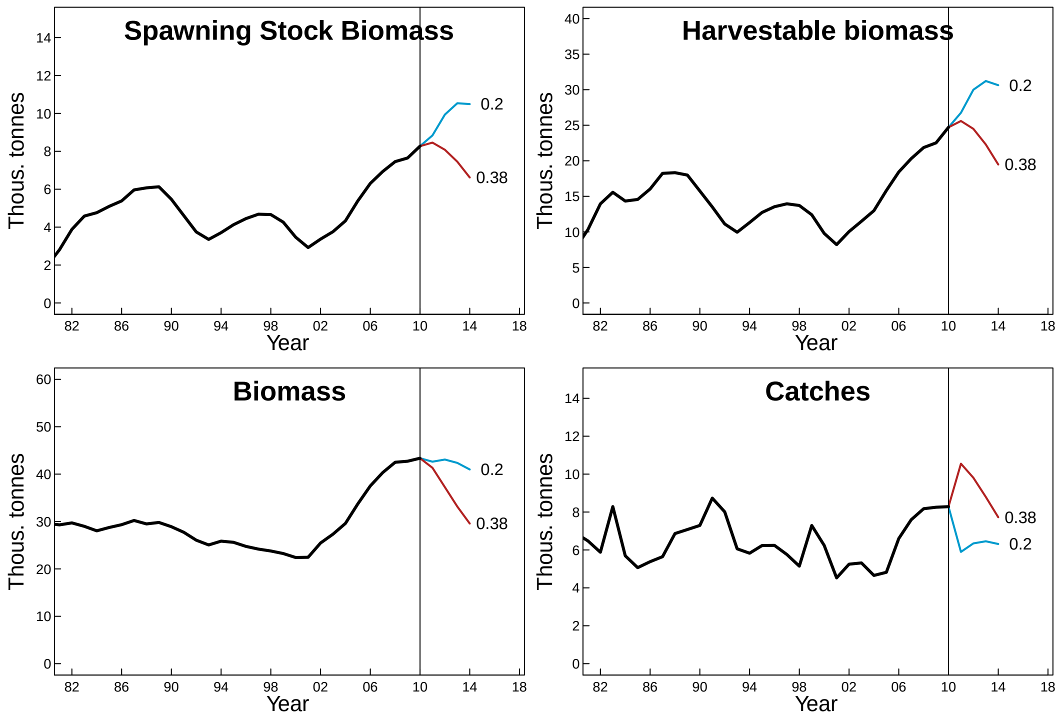


**Figure 12:** Tusk in Va. Yield per recruit analysis from the Gadget model for $\bar{F}_{7-13}$

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Taylor, L., Begley, J., Kupca, V. & Stefansson, G. (2007). A simple implementation of the statistical modelling framework Gadget for cod in Icelandic waters. African Journal of Marine Science, **29**, 223–245.

Working Document 5 presented to the ICES Working Group on the Biology and Assessment of Deep Sea Fisheries Resources -ICES WDEEP-
Copenhaguen, 2-8 March 2011
This Working Document has not been peer-reviewed by ICES WGDEEP and should not interpreted as the view of the Group. The Working Document is appended for information only.

# Deep Species Results from Spanish Discard Sampling Programme

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**Abstract**

Estimations of deep species discards from three Spanish bottom otter trawl métiers operating in the Northeast Atlantic ICES $VI$, $VII$, $VIII_c$ and North $IX_a$ are presented in this paper. Information has been obtained from the 'Spanish Discard Sampling Programme' carried out by the IEO. Trip was the sampling unit, being raised to fleet level using fishing effort as auxiliary variable. Discard weigth estimates from time series of seven years (2003-2009) is presented for twelve species. Further, discard length distributions are presented for those species that have been observed whitin discarded fraction for more than three years. Estimates show high between-years variation in discard amounts, exceeding 35% CV in almost all cases. Results show that the largest amounts of discards of most of the species occur at depths less than 600m. Low market value is the main factor that forces the fleet to discard most of deep species.

Keywords: Discards, Northeast Atlantic waters, Bottom Trawl.

## 1 Introduction

The 'Spanish Discards Sampling Programme' for Otter Botton Trawlers (OTB) fleets, covering ICES $VI$, $VII$ $VIII_c$ and North $IX_a$, was started in 1988 (Table 1), however, it did not have yearly continuity until 2003. This lack of continuity is the main reason that led to omit the estimates from previous years.

| Year | Project |
|---|---|
| 1988-1989 | National Project |
| 1994 | EC Project: Pem/93/005 |
| 1997 | EC Project: 95/ 094 |
| 1999-2000 | EC Project: 98/095 |
| 2001 | EC Project: 99/063 |
| 2003-2009 | DCR |

Table 1: Summary of funded projects which have supported the Spanish Discards Sampling Programme

Spanish data on deep species discards (in this case from the Instituto Español de Oceanografía (IEO)) have never been provided to ICES WGDEEP in the past.

The main objective of this working document is to provide the information of the most discarded species by the Spanish fleets operating in ICES Subareas $VI$ and $VII$ and Divisions $VIII_c$ and $IX_a$.

# 2 Material and methods

## 2.1 Sampling strategy

The sampling strategy and the estimation methodology used in the 'Spanish Discards Sampling Programme' has been little modified since 1988, and since 2003 follows the guidelines established in the ICES 'Workshop on Discard Sampling Methodology and Raising Procedures' (2003). The observers-on-board programme is based on a stratified random sampling design. Métier is the lower stratum and trips (the sampling unit considered in the raising protocol) are randomly or quasi-randomly selected for sampling within métiers. Until 2009 the DCR asked for annual estimates and, hence, sampling was organised to obtain annual results.

Only trawl fleet is considered herein. Other fleets (i.e. long line fleet) were evaluated, showing low discard levels for deep species along the areas under study (Pérez et al., 1996). Gillnet discard information is also being obtained since 2008, but the short time series available has been considered as insufficient to be presented in the present document.

## 2.2 Fleets stratification

Fishing area, gear and target species are the auxiliary covariates used to stratify fleets into métiers. Two métiers are considered within the Spanish bottom otter trawl fleets operating in the ICES Subareas $VI$ and $VII$:

- `OTB-DEF_80_100_0_0 trips targeting Megrim and Monk`
- `OTB-DEF_80_110_0_0 trips targeting Hake and Monk`

Discard information from the former métiers was aggregated in order to present discard estimations from the whole Spanish trawl fleet operating in the area.

In the other hand, one métier is defined in this document for the Northern Spanish coastal bottom otter trawl fleet (ICES $VIII_c$ and $IX_a$ Divisions):

- `OTB_DEF_55_80_0: trips targeting a mixed of demersal species in` $VIII_c$ `and North` $IX_a$.

## 2.3 Sampling scheme & Raising procedures

Let $h_{ij}$ be the $j$-th ($j = 1, \ldots, J$) sampled haul in sampled trip $i$ ($i = 1, \ldots, t$). Let $d_{ij}^s$ be a randow sample drawn from the total discards $d_{ij}$ ocurred in $h_{ij}$.Let

$$r_{ij} = \frac{d_{ij}}{d_{ij}^s} \tag{1}$$

be the ratio of the sampled weigth to the total weight of discards.

For a given species, let $f_{ijlk}$ be the $k$-th (k= 1,..., n) fish of size $l$ sampled in $d_{ij}^s$. The total individuals of size $l$ in $d_{ij}^s$ is denoted as $F_{ijl} = \sum_{k=1}^{n} f_{ijlk}$. Alternatively, biomass by size can be obtained using the species weigth-length relationship available

$$w_{ijl} = \sum_{k=1}^{n} f_{ijl} \times a \times b^l \tag{2}$$

Further steps will be expressed in terms of numbers

### 2.3.1 Trip level

Let

$$y_{ijl} = F_{ijl} \times r_{ijl} \tag{3}$$

be the estimated numbers of individuals of size $l$ discarded in haul $j$ and,

$$y_{ijl}^w = w_{ijl} \times r_{ij} \tag{4}$$

the estimated discards in terms of biomass. the mean discards for size $l$ in trip $i$ can be calculated as follows,

$$\bar{y}_{il} = \frac{1}{J} \sum_{j=1}^{J} y_{ijl} \tag{5}$$

with variance

$$Var(\bar{y}_{il}) = \frac{1}{J-1} \sum_{j=1}^{J} (y_{ijl} - \bar{y}_{il})^2 \tag{6}$$

if $J$ is the total number of hauls carried out in trip $i$ , the estimated total discards in numbers by size is:

$$Y_i = \sum_{j=1}^{J} y_{ijl} \tag{7}$$

else,

$$Y_i = \bar{y}_{il} \times H_i \tag{8}$$

with $H_i$ being the total number of hauls (sampled + unsampled). The variance associated to (8) is

$$Var(Y_i) = (1 - \frac{J}{H}) \times H^2 \times \frac{Var(\bar{y}_{il})}{J} \tag{9}$$

### 2.3.2 strata level

- Raising by number of trips (assumed known)

Mean discarded by trip is estimated to be

$$\bar{Y} = \frac{1}{t}\sum_{i=1}^{t} \times Y_i \tag{10}$$

with associated variance

$$Var(\bar{Y}) = \frac{1}{t-1}\sum_{i=1}^{t}(Y_i - \bar{Y})^2 \tag{11}$$

(10) and (11) can be raised to the total fishing effort of the fleet ($T$), to obtain a estimation of total Discarded ($D$) of the fleet:

$$D = \bar{Y} \times T \tag{12}$$

with variance

$$Var(D) = (1 - \frac{t}{T}) \times T^2 \times \frac{Var(\bar{Y})}{t} \tag{13}$$

### 2.3.3 Species selection for report

Discards estimations in terms of biomass are presented for twelve deep species:

- *Aphanopus carbo*
- *Argentina silus*
- *Argentina sphyraena*
- *Beryx decadactylus*
- *Beryx splendens*
- *Brosme brosme*
- *Coryphaenoides rupestris*
- *Hoplostethus atlanticus*
- *Molva molva*
- *Molva spp.**
- *Pagellus bogaraveo*
- *Phycis blennoides*

* Taxonomic difficulties detected to distinguish onboard between *Molva dypterygia* and *Molva macropthalma* have led to aggregate both species into a higher taxon.

### 2.3.4 Exploratory Data Analysis

A preliminary EDA has been conducted on the catch estimates of the most discarded species ($\geq 10$ $tons/year$) that also showed a continued presence in the yearly discard estimations ($> 3$ $years$). Former species selection are presented below:

- Subareas $VI$-$VII$:
  - *Argentina silus*
  - *Argentina sphyraena*
  - *Coryphaenoides rupestris*
  - *Molva molva*
  - *Molva spp.*
  - *Phycis blennoides*
- Divisions $VIII_c$-$IX_a$ North:
  - *Argentina sphyraena*
  - *Molva spp.*
  - *Phycis blennoides*

# 3 Results

Sampling level values (Table 2) on Subareas $VI$, $VII$ show stability since 2003 and a steady increase has occurred in the Divisions $VIII_c$, $IX_a$ during the last years. Mean proportion of sampled hauls $\hat{p} = \frac{J_i}{H_i}$ within trip is $\sim 0.5$ in the Northern area, while short trips and low effective hauls characterizing the Southern waters require higher sampling coverage within trip, yielding higher $\hat{p}$ ($\sim 0.8$) than in the Northern trips. The information coming from the analized métiers can be considered representative of the discard behaviour of the whole fleets operating in the areas.

Table 3 shows estimations on biomass discarded ($tons$) for the selected species. Amounts of discarded is clearly higher in the Northern fishing area for all species. Only Silver Smelt (*Argentina sphyraena*) and Greater Forkbeard (*Phycis blennoides*) appeared continuously in the discarded catch along the years sampled in both areas. Greater Silver Smelt (*Argentina silus*), Greater Forkbeard and Silver Smelt are the most discarded deep species in Subareas $VI$ and $VII$. Maximum biomass discarded for Greater Forkbeard, Ling ( *Molva molva*) and Roundnose Grenadier(*Coryphaenoides rupestris*) have ocurred simultaneously in 2005 (Figure 1).

Silver Smelt, Greater Forkbeard and *Molva spp.* represents the bulk of deep species biomass discarded in Divisions $VIII_c$ and $IX_a$ (table 3). Years 2006 and 2007 show the highest discard values for Silver Smelt, *Molva spp.* and Greater Forkbeard, while largest amounts of Roundnose Grenadier discard was found in 2004 (Figure 2).

Only discard length distributions from the most important species are presented in the paper (Figures 3 and 4). High yearly variation in length sizes of discarded catch are found for all species and areas.*Molva spp.*,Greater Forkbeard and Ling show the widest length range over the species under study.Silver Smelt and Greater Silver Smelt species show the opposite length size estructure.

Figures 5 to 11 plot haul catches of the selected species (log) in relation with setting depth and year. Most of the sampling hauls ocurred at depths $< 600mts$. Only Greater Forkbeard catches show a clear positive relation with setting depth (Figures 11 and 13). Opposite trend is found for Ling when setting depth exceeds $\sim 300mts$ (Figure 9).

By-haul discards in a Spatio-temporal basis are showed in Figures 14 to 22. Northern discards of Silver Smelt took place mostly in the *Grand Sole Bank* except in 2005, where highest values took place in *Porcupine Bank* (Figure 14). Great Silver Smelt discards present a wider dispersion along the Northern area (Figure 15). Roundnose Grenadier discards were found mostly in *Porcupine Bank* and *Rockall Bank* during 2004 and 2005 (Figure 16). No clear spatial trend were found for Discarded of *Molva spp.* and Ling in the northern area (Figures 17 and 18). Greater Forkbeard discards were found in *Grand Sole Bank* and *Porcupine Bank* (Figure 19).

Discards in the southern area took place mostly off the Galician western coast ($IX_a$) and Gulf of Viscay ($VIII_c$/East)

# 4 Conclusions

Negligible discards were found for Golden Eye Perch (*Beryx spp.*), Tusk (*Brosme brosme*), Orange Roughy (*Hoplostethus atlanticus*)in Subareas $VI$-$VII$ and for Orange Roughy (*Hoplostethus atlanticus*), Greater Silver Smelt and Ling in Divisions $IX_a$ and $VIII_c$. Low and high variable discards were found for Black scabbard fish (*Aphanopus carbo*) in both Fishing Areas. No discards were observed for Seabram in Subareas $VI$-$VII$ and for Tusk and Golden Eye Perch in $IX_a$ and $VIII_c$.

Different factors including market value, species availability, length sizes or quotas interacts during onboard catch sorting process. Greater Silver Smelt, Silver Smelt, Roundnose Grenadier are species with no commercial value to the Spanish markets, being the main reason to discard the bulk of their catches. Greater Forkbeard is one of the most discarded species both in Northern and Southern Fishing Areas and the main factor is the low market value for small fishes. Ling is also discarded due to the same reason. Further research efforts must be employed in determining discard causes for Southern Sea Bram.

Sampling trips show that most of the fishing effort takes place at depths $< 600mts$ and therefore catches information from this métiers should not be considered as part of a deep fisheries fleet. Only Greater Forkbeard catches has found to be positive related with fishing depth. This trend and the change in fishing behavior observed in northern areas along 2005 to deeper waters may explain the peak of discards for the species estimated in the same year.

| Fishing Area | Year | Trips Sampled | Quarter | Hauls Sampled | $\hat{p}$ | Total Trips |
|---|---|---|---|---|---|---|
| Subareas $VI$, $VII$ | 2003 | 9 | 1 | 0 | 0.63 | 1172 |
| | | | 2 | 107 | | |
| | | | 3 | 121 | | |
| | | | 4 | 141 | | |
| | 2004 | 11 | 1 | 102 | 0.58 | 1222 |
| | | | 2 | 118 | | |
| | | | 3 | 86 | | |
| | | | 4 | 94 | | |
| | 2005 | 10 | 1 | 71 | 0.49 | 1194 |
| | | | 2 | 105 | | |
| | | | 3 | 109 | | |
| | | | 4 | 52 | | |
| | 2006 | 13 | 1 | 131 | 0.46 | 1152 |
| | | | 2 | 122 | | |
| | | | 3 | 109 | | |
| | | | 4 | 14 | | |
| | 2007 | 12 | 1 | 82 | 0.49 | 1233 |
| | | | 2 | 99 | | |
| | | | 3 | 71 | | |
| | | | 4 | 116 | | |
| | 2008 | 11 | 1 | 57 | 0.53 | 1206 |
| | | | 2 | 66 | | |
| | | | 3 | 112 | | |
| | | | 4 | 118 | | |
| | 2009 | 15 | 1 | 91 | 0.53 | 1304 |
| | | | 2 | 144 | | |
| | | | 3 | 118 | | |
| | | | 4 | 75 | | |
| Divisions $VIII_c$, $IX_a$ | 2003 | 23 | 1 | 0 | 0.80 | 6214 |
| | | | 2 | 32 | | |
| | | | 3 | 33 | | |
| | | | 4 | 35 | | |
| | 2004 | 26 | 1 | 46 | 0.88 | 10343 |
| | | | 2 | 15 | | |
| | | | 3 | 34 | | |
| | | | 4 | 26 | | |
| | 2005 | 32 | 1 | 56 | 0.92 | 4929 |
| | | | 2 | 37 | | |
| | | | 3 | 38 | | |
| | | | 4 | 26 | | |
| | 2006 | 25 | 1 | 28 | 0.78 | 6648 |
| | | | 2 | 37 | | |
| | | | 3 | 31 | | |
| | | | 4 | 15 | | |
| | 2007 | 37 | 1 | 17 | 0.81 | 7961 |
| | | | 2 | 35 | | |
| | | | 3 | 41 | | |
| | | | 4 | 64 | | |
| | 2008 | 32 | 1 | 19 | 0.69 | 4476 |
| | | | 2 | 33 | | |
| | | | 3 | 30 | | |
| | | | 4 | 17 | | |
| | 2009 | 33 | 1 | 12 | 0.86 | 5549 |
| | | | 2 | 43 | | |
| | | | 3 | 48 | | |
| | | | 4 | 51 | | |

Table 2: Sampling effort in recent years for VI-VII and VIIIc-IXa

| Fishing Area | Species | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| Subareas $VI$-$VII$ | *Aphanopus carbo* | 0.00 | 0.00 | 69.50 | 0.00 | 125.2 | 1.80 | 0.00 |
| | | | | 99.70 | | 99.7 | 99.40 | |
| | *Argentina silus* | 2210.70 | 2978.30 | 2148.70 | 1147.00 | 1822.6 | 3080.10 | 4203.70 |
| | | 63.50 | 44.00 | 61.90 | 40.00 | 55.3 | 33.60 | 36.60 |
| | *Argentina sphyraena* | 318.60 | 200.30 | 662.80 | 975.30 | 209.8 | 617.40 | 369.30 |
| | | 43.50 | 54.10 | 54.40 | 82.50 | 49.5 | 50.00 | 41.80 |
| | *Beryx decadactylus* | 0.00 | 8.10 | 8.40 | 0.90 | 0.0 | 0.00 | 0.00 |
| | | | 74.10 | 99.70 | 99.60 | | | |
| | *Beryx splendens* | 0.00 | 0.00 | 1.90 | 0.00 | 0.0 | 4.70 | 0.00 |
| | | | | 99.70 | | | 99.50 | |
| | *Brosme brosme* | 0.00 | 0.00 | 308.10 | 4.90 | 0.0 | 0.00 | 0.00 |
| | | | | 99.70 | 99.40 | | | |
| | *Coryphaenoides rupestris* | 0.00 | 345.20 | 729.20 | 54.20 | 15.2 | 0.00 | 0.00 |
| | | | 58.90 | 83.80 | 51.50 | 52.2 | | |
| | *Hoplostethus atlanticus* | 0.00 | 0.00 | 74.10 | 0.00 | <0.1 | 0.00 | 0.00 |
| | | | | 99.70 | | 82.9 | | |
| | *Molva spp.* | 103.90 | 174.00 | 190.60 | 18.70 | 108.5 | 458.70 | 112.80 |
| | | 57.60 | 43.30 | 44.90 | 57.70 | 59.0 | 65.00 | 36.70 |
| | *Molva molva* | 23.80 | 8.30 | 188.50 | 28.00 | 9.6 | 6.30 | 13.30 |
| | | 97.70 | 67.90 | 98.70 | 80.30 | 90.2 | 90.80 | 90.90 |
| | *Pagellus bogaraveo* | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |
| | *Phycis blennoides* | 914.30 | 586.30 | 3096.20 | 492.80 | 617.3 | 1184.20 | 537.20 |
| | | 42.50 | 31.70 | 62.30 | 35.80 | 34.8 | 70.40 | 41.00 |
| Divisions $VIII_c$, North $IX_a$ | Aphanopus carbo | 3.40 | 0.00 | 0.00 | 2.90 | 10.2 | 0.20 | 1.30 |
| | | 99.40 | | | 99.40 | 59.6 | 111.40 | 68.20 |
| | *Argentina silus* | | | 0.10 | 0.00 | 5.7 | 4.80 | |
| | | | | 99.70 | | 87.8 | 64.10 | |
| | *Argentina sphyraena* | 36.60 | 57.10 | 35.60 | 203.40 | 39.4 | 9.30 | 40.20 |
| | | 37.10 | 67.40 | 43.40 | 62.20 | 39.2 | 59.20 | 48.00 |
| | *Beryx decadactylus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |
| | *Beryx splendens* | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |
| | *Brosme brosme* | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |
| | *Coryphaenoides rupestris* | 0.00 | 100.70 | 16.60 | 0.20 | 2.0 | 0.10 | 4.80 |
| | | | 86.60 | 72.90 | 96.10 | 68.5 | 88.10 | 90.80 |
| | *Hoplostethus atlanticus* | 0.00 | 0.10 | 0.00 | 0.70 | 3.3 | 0.00 | 0.00 |
| | | | 99.90 | | 95.60 | 68.8 | | |
| | *Molva spp.* | 0.00 | 0.90 | 4.90 | 6.00 | 67.1 | 11.40 | 37.10 |
| | | | 99.90 | 65.40 | 62.10 | 37.3 | 35.10 | 38.50 |
| | *Molva molva* | 0.00 | 2.90 | 0.00 | 0.00 | 0.0 | 0.00 | 0.70 |
| | | | 100.20 | | | | | 88.60 |
| | *Pagellus bogaraveo* | 0.00 | 63.10 | 5.50 | 41.60 | 0.0 | 0.00 | 0.00 |
| | | | 65.70 | 85.50 | 88.00 | | | |
| | *Phycis blennoides* | 13.80 | 6.80 | 8.20 | 23.80 | 114.8 | 11.20 | 69.00 |
| | | 45.80 | 58.20 | 77.30 | 67.30 | 70.4 | 55.40 | 31.60 |

Table 3: Discard estimates in terms of biomass ($tons$) and associated $CV$ in recent years for VI-VII and VIIIc-IXa

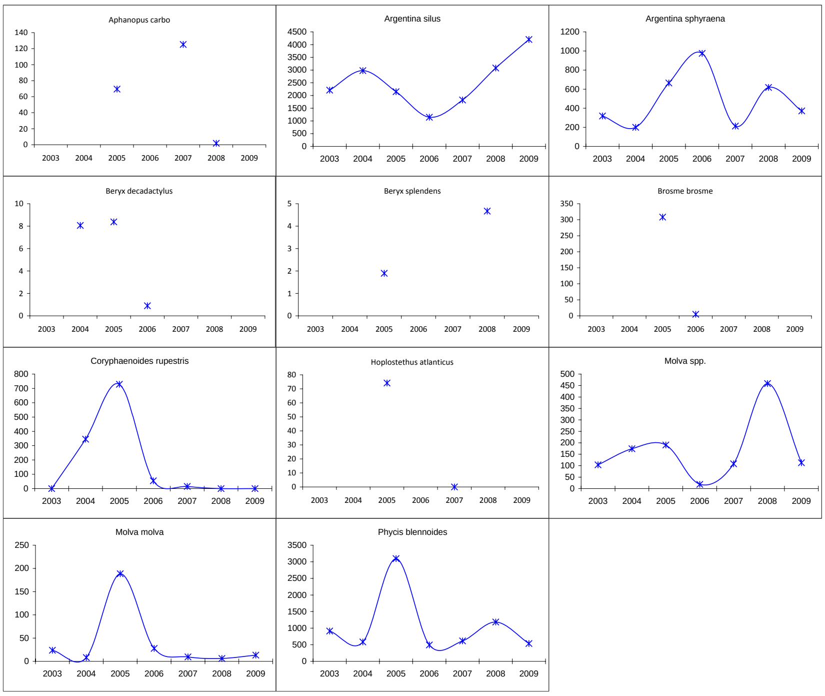


Figure 1: Biomass discarded ($tons$) of deep species in ICES $VI$, $VII$

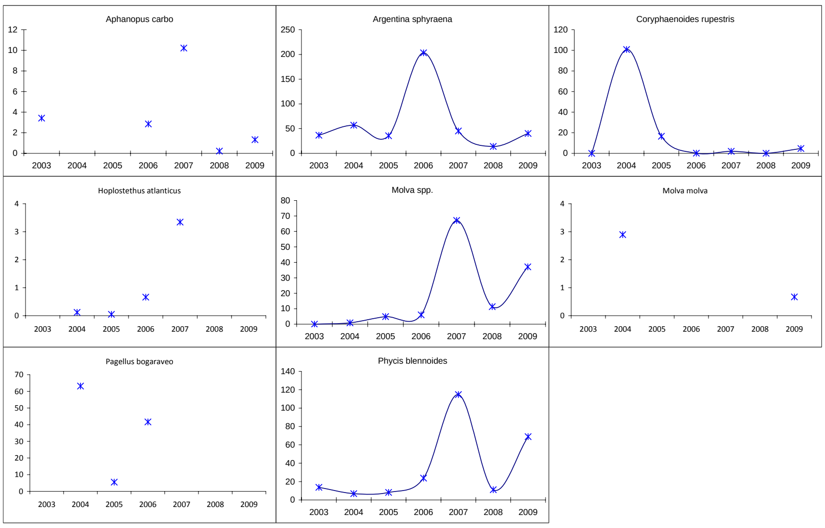


Figure 2: Biomass discarded ($tons$) of deep species in ICES $VIII_c$, North $IX_a$

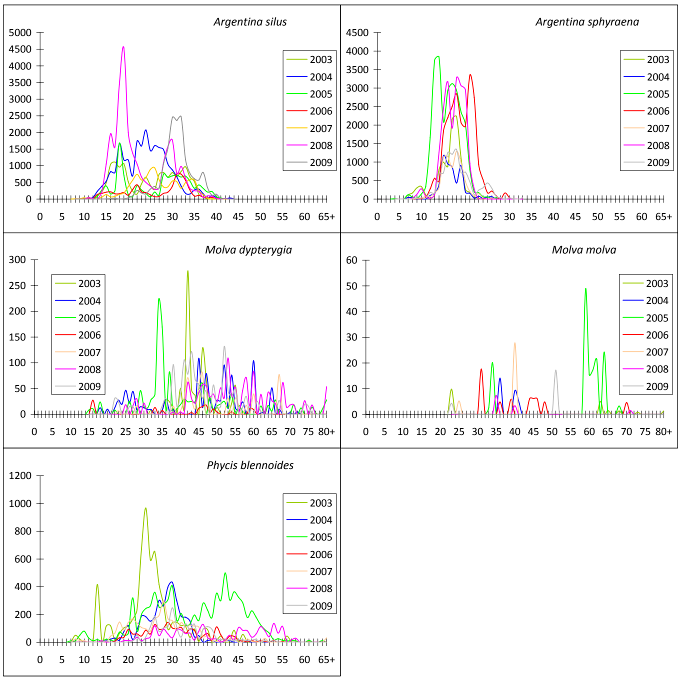


Figure 3: Annual length size distribution ($n$) for deep species in ICES $VI$, $VII$

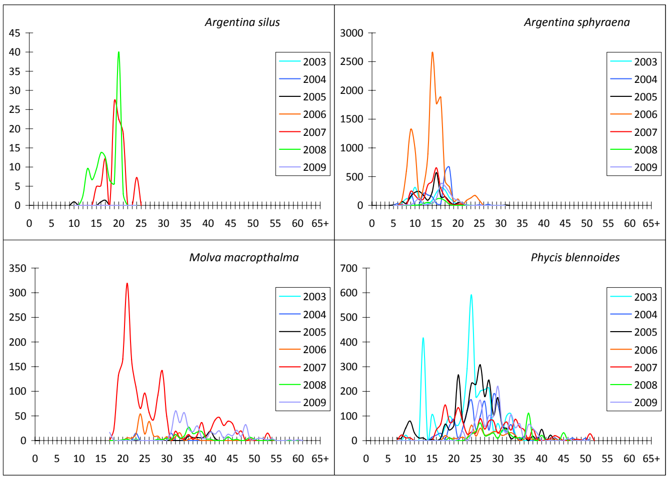


Figure 4: Annual length size distribution ($n$) for deep species in ICES $VIII_c$, North $IX_a$

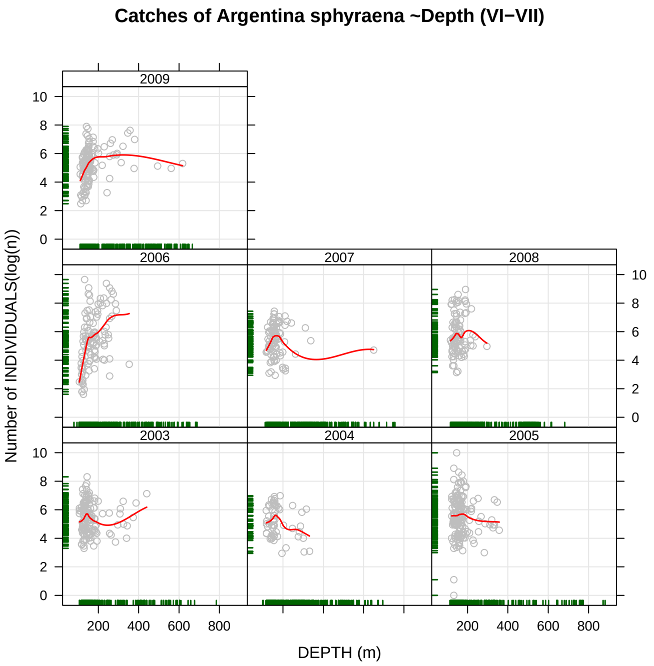


Figure 5: Catches of Silver Smelt by setting depth and year ($VI$-$VII$)

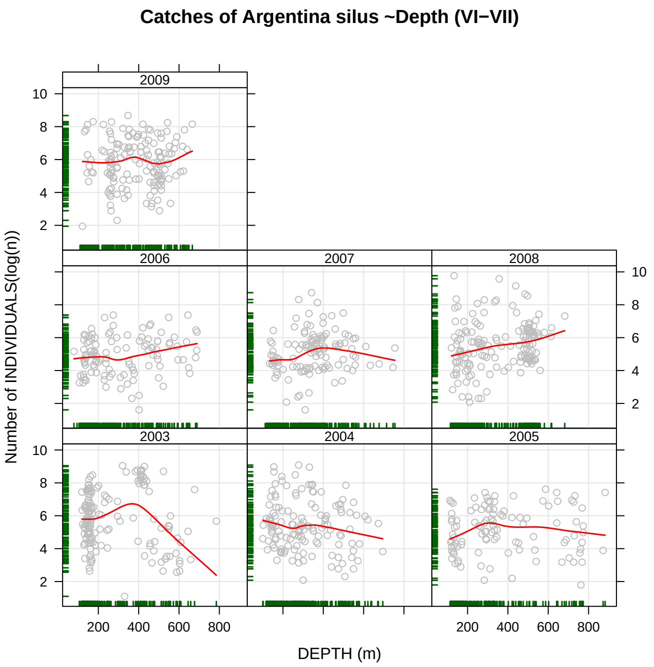


Figure 6: Catches of Greater Silver Smelt by setting depth and year $VI$-$VII$)

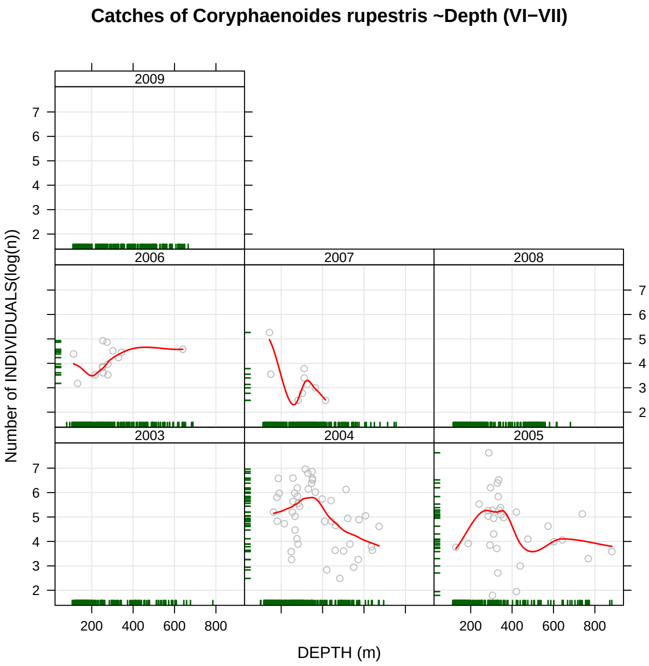


Figure 7: Catches of Roundnose Grenadier by setting depth and year ($VI$-$VII$)

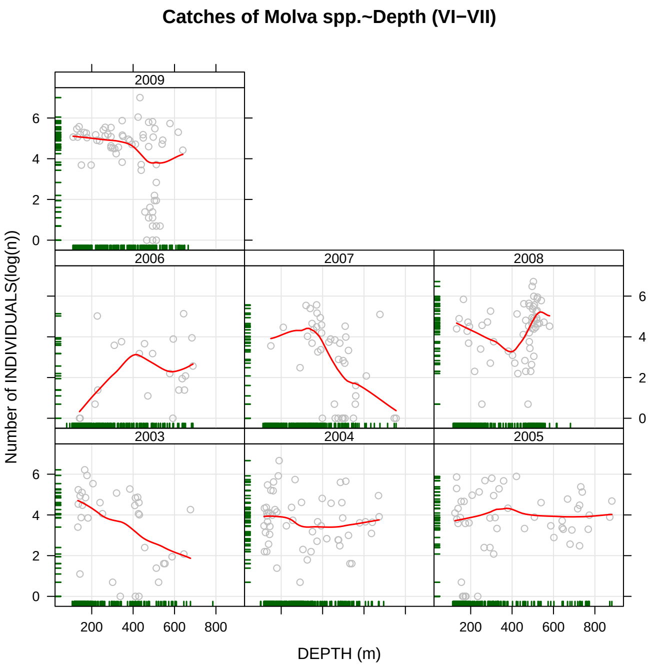


Figure 8: Catches of Molva spp. by setting depth and year ($VI$-$VII$)

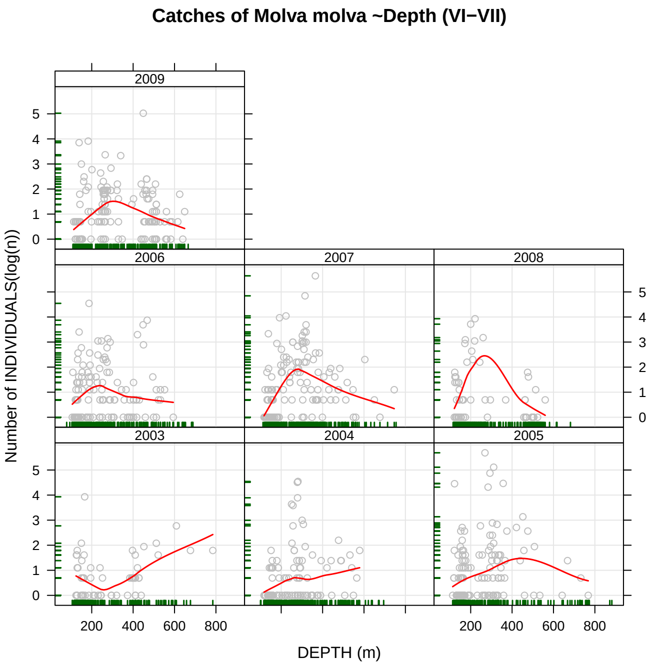


Figure 9: Catches of Ling by setting depth and year ($VI$-$VII$)

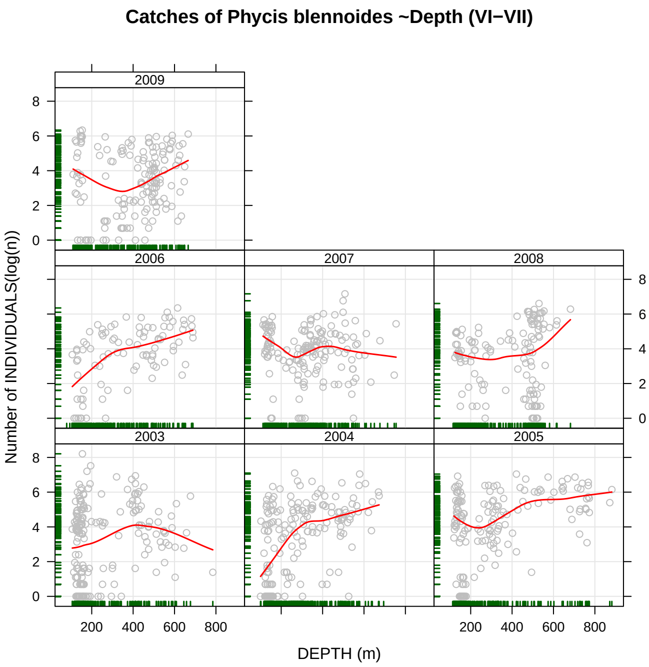


Figure 10: Catches of Greater Forkbeard by setting depth and year ($VI$-$VII$)

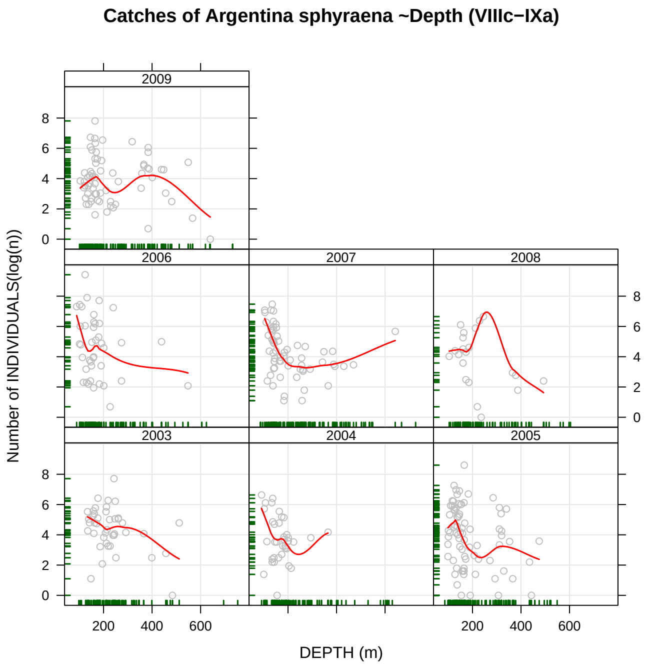


Figure 11: Catches of Silver Smelt by setting depth and year ($VIII_c$-North $IX_a$)

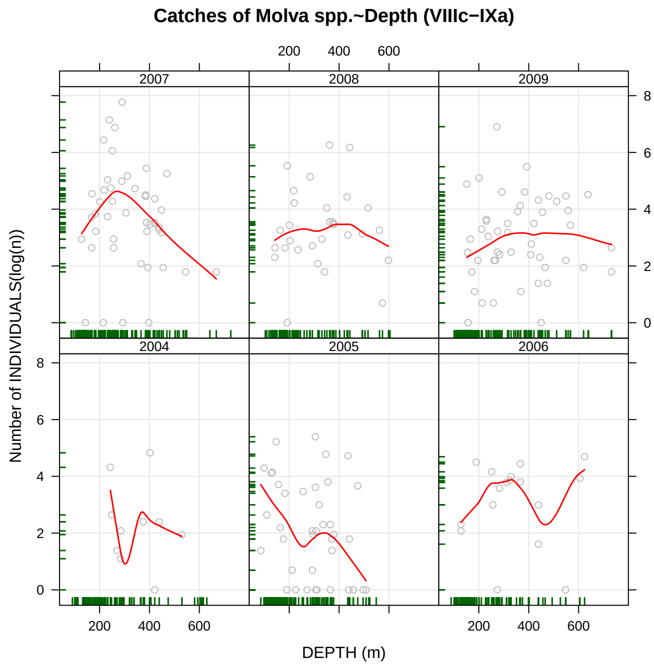


Figure 12: Catches of *Molva spp.* by setting depth and year ($VIII_c$-North $IX_a$)

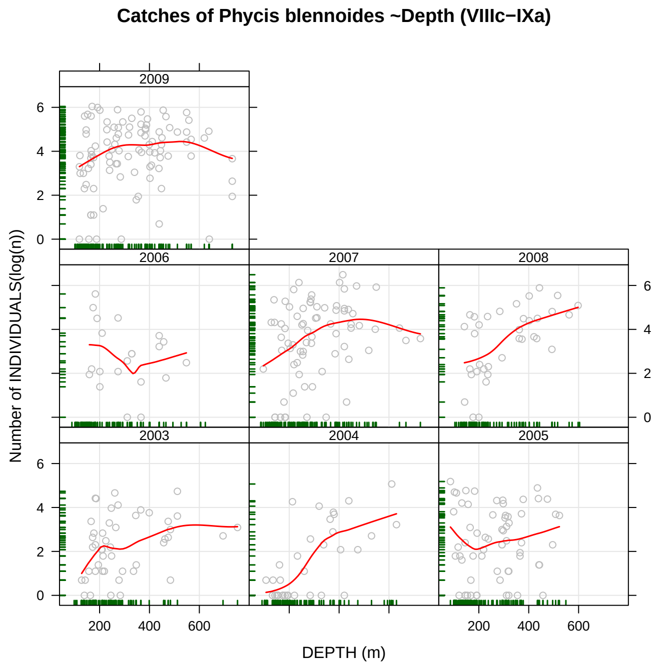


Figure 13: Catches of Greater Forkbeard by setting depth and year ($VIII_c$-North $IX_a$)

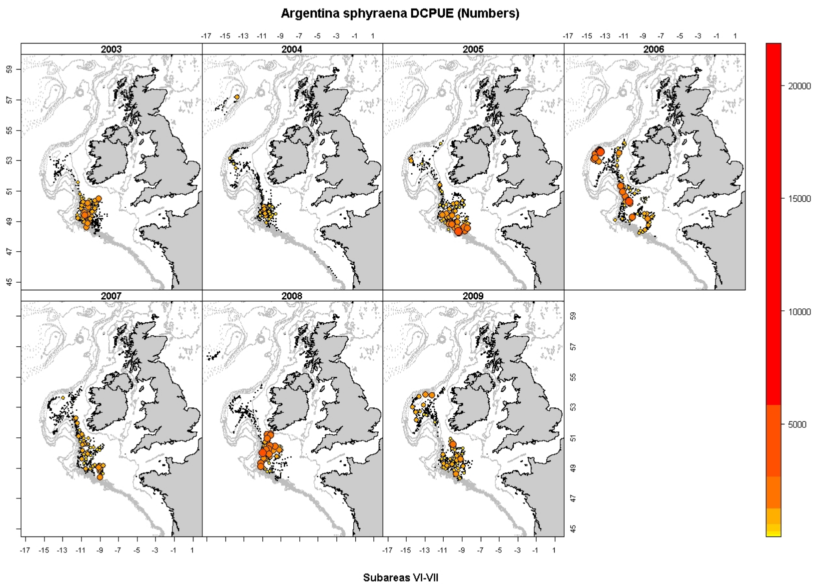


Figure 14: Spatio temporal trends of Silver Smelt discards ($VI$-$VII$))

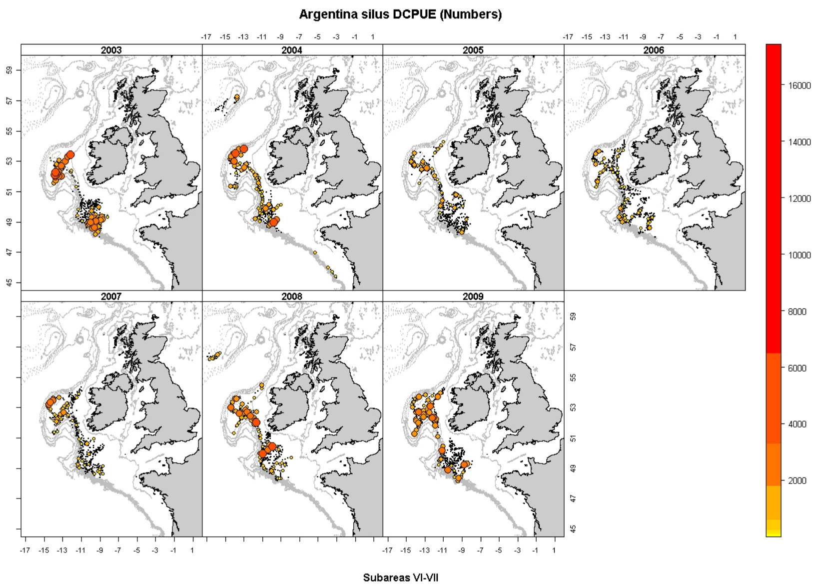


Figure 15: Spatio temporal trends of Greater Silver Smelt discards ($VI$-$VII$))

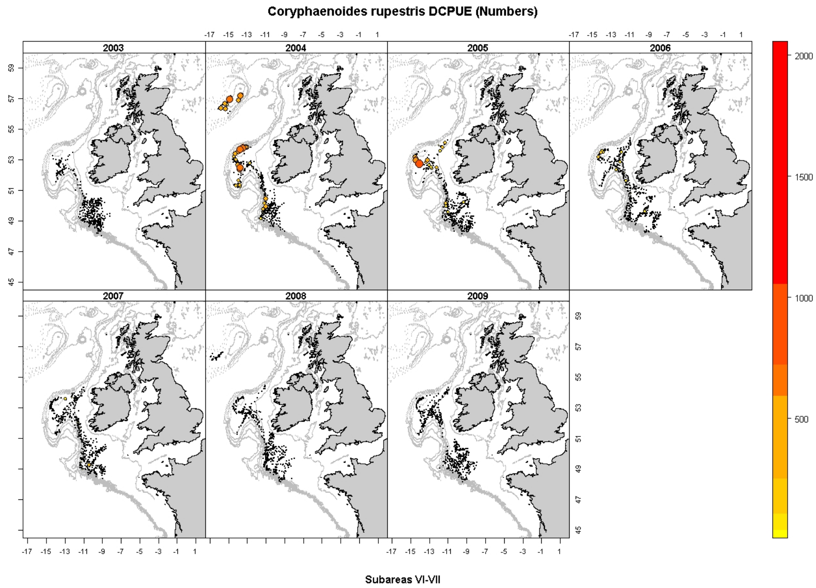


Figure 16: Spatio temporal trends of Roundnose grenadier discards ($VI$-$VII$))

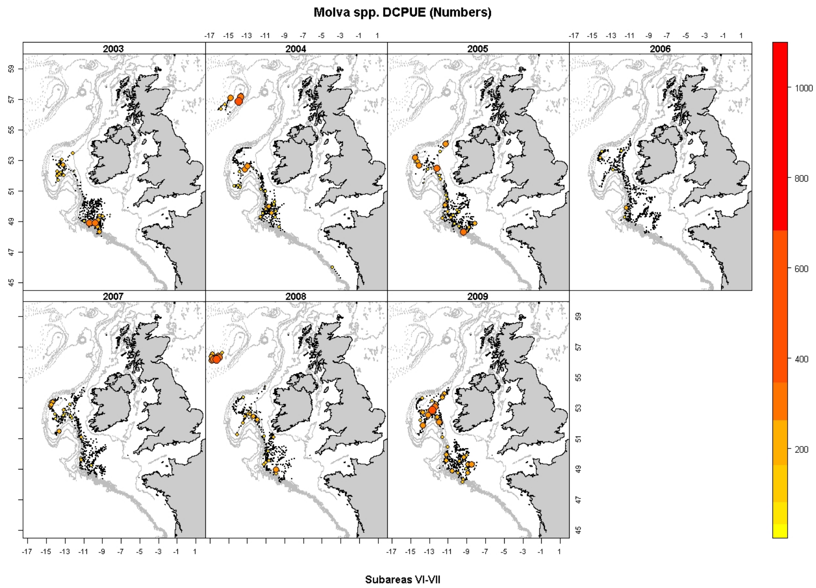


Figure 17: Spatio temporal trends of *Molva spp.* discards ($VI$-$VII$))

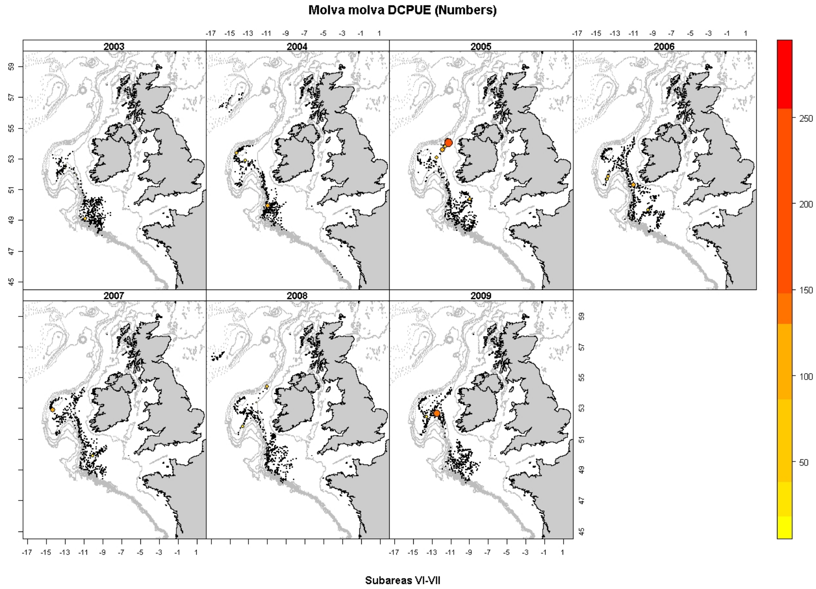


Figure 18: Spatio temporal trends of Ling discards ($VI$-$VII$))

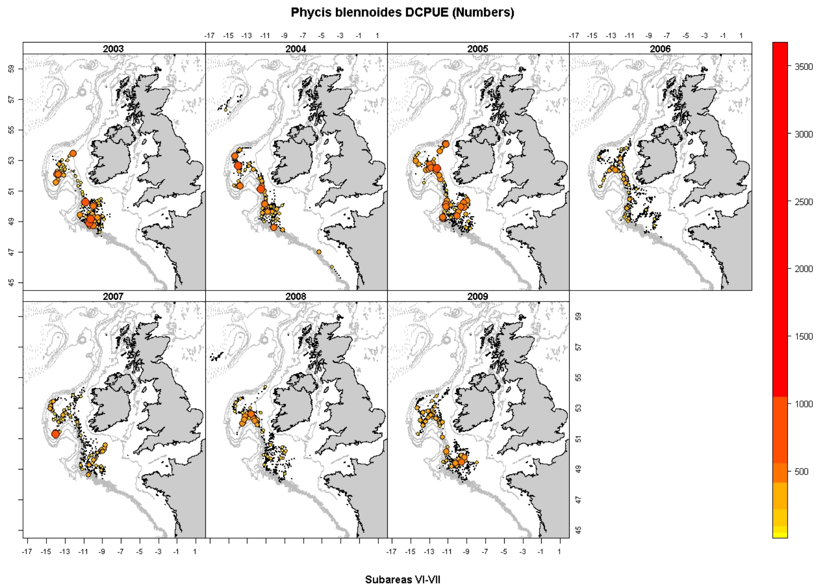


Figure 19: Spatio temporal trends of Greater Forkbeard discards ($VI$-$VII$))

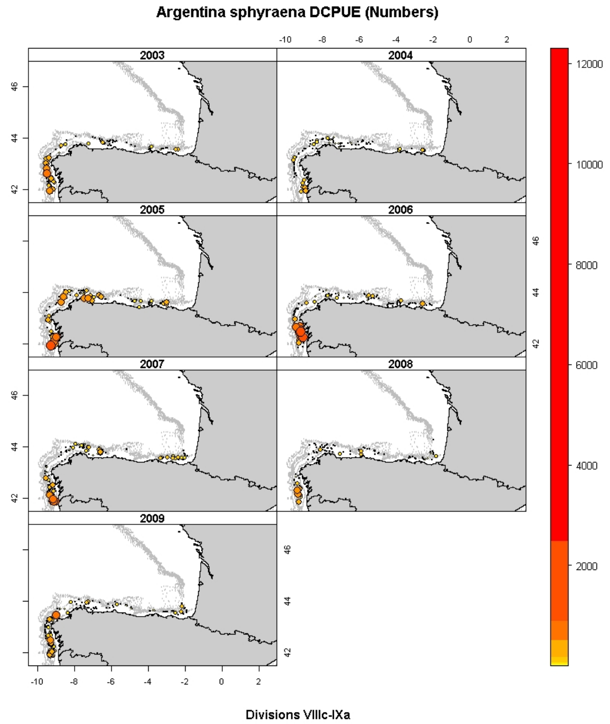


Figure 20: Spatio temporal trends of Silver Smelt discards ($VIII_c$-$IX_a$)

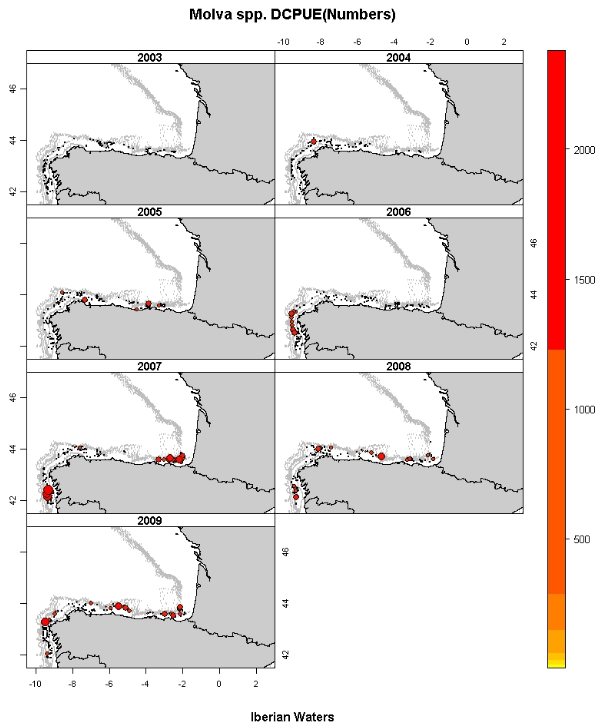


Figure 21: Spatio temporal trends of *Molva spp.* discards ($VIII_c$-$IX_a$)

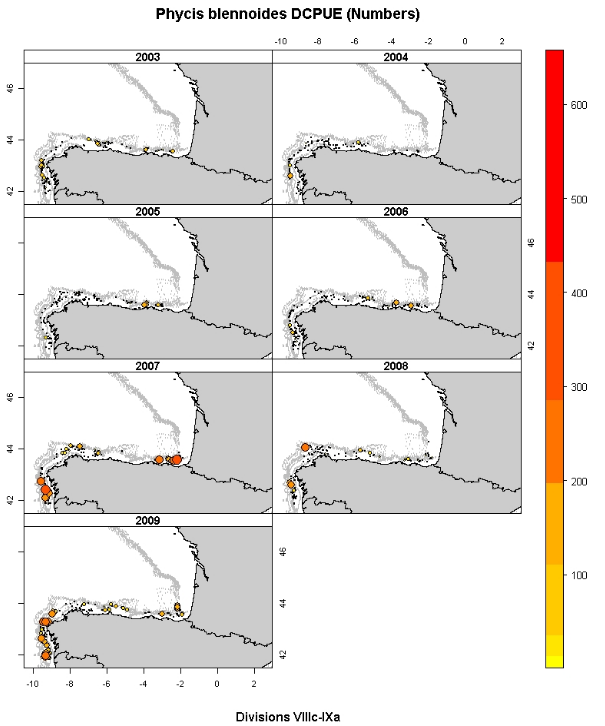


Figure 22: Spatio temporal trends of Greater Forkbeard discards ($VIII_c$-$IX_a$)

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Working Document to be presented to the Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP, - Copenhagen 2-8 March 2011

# Results on Argentine (*Argentina* spp.), Bluemouth (*Helicolenus dactylopterus*), Greater forkbeard (*Phycis blennoides*) and Spanish ling (*Molva macrophthalma*) from 2010 Porcupine Bank (NE Atlantic) survey

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**Abstract**

*This paper presents the results on four of the most important deep fish species in the Porcupine bottom trawl survey organized by the Spanish Institute of Oceanography in 2010, and updates the documents presented in previous years with the information on the first nine years (2001-2009) of the Porcupine Spanish surveys. The document presents total abundances in weight, length frequencies and geographical distributions for Argentina spp. (mostly A. silus, results on A. silus/A. sphiraena distribution in last survey is presented), bluemouth, greater fork-beard and Spanish ling and information on records of blue ling during the survey series.*

## 1. Introduction

Since 2001 a Spanish bottom trawl survey has been carried out annually in the areas surrounding the Porcupine Bank (ICES Divisions VIIc and VIIk) to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES, 2007). The main target species for this survey series are hake, monkfish, white anglerfish and megrim, which abundance indices are estimated by age (Velasco *et al*., 2005; Velasco *et al*., 2007). Nevertheless data are also collected for all the fish species captured, Norway lobster (*Nephrops norvegicus*) and other benthic invertebrates according to the IBTSWG (ICES, 2010a) protocols.

In 2008, a working document (Baldó et al. 2008) was presented to the WGDEEP summarizing the results on the most common deep water fish species with commercial importance caught in the Porcupine Survey. In 2009 the information was updated (Velasco et al. 2009), and the aim of the present working document is to update those results with the information obtained in 2010 survey (abundance indices, length frequency distributions and geographic and bathymetric distributions). In previous reports from the survey, Argentine species have been always treated as *Argentina* spp. an unidentified compound of both *A. silus* and *A. sphyraena* given the problems to distinguish both species, especially because of the huge catches of *Argentina* spp., that in 2001-2002 made up more than the 20% of the total fish biomass recorded, reaching hauls with more than 10 000 individuals. In recent years the abundance of this species has decreased steadily reaching around a 10% in weight. To assess the importance of each species to the compoundattempts to evaluate the proportion of the two species of *Argentine* caught in the Porcupine were done in 2009 and 2010, these results are presented in this document although they are still considered preliminary due to the difficulty of identification and changes in the scientific crew between both surveys.

## 2. Material and methods

The area covered in Porcupine surveys (Figure 1) is the Porcupine bank from longitude 12° W to 15° W and from latitude 51° N to 54° N. The survey covers depths between 180 and 800 m, and in 2010 was carried out between September the $6^{th}$ and the $7^{th}$ of October on board the R/V "Vizconde de Eza" (SGMAR), the stern trawler of 53 m and 1800 Kw used along this series.

The sampling design is random stratified (Velasco and Serrano, 2003), with two geographical sectors (North and South) and three depth strata defined by the 300, 450 and 800 m isobaths, resulting in 5 strata, given that there are no grounds shallower than 300 m in the Southern sector (Figure 1). As described in 2008 Working Document on deep species in this survey (Baldó et al. 2008), sampling was random stratified and allocated proportionally to strata area using a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. The gear used was the Porcupine baca 40/52, based in the commercial gears used in the area but modified for scientific purposes as described in ICES (2010b), with 250 m sweeps, 850 kg doors, 90 mm net mesh all along the gear and a and 20 mm liner covering the cod-end inner part. Vertical opening was 2.90±0.04 m while door spread was 145.0±1.9 m, both within the ranges of the survey (see Velasco et al. 2009 for gear problems in 2008 survey). Gear horizontal opening is not recorded regularly due to the unavailability of sensors, but varies around 25.0±1.4 m ICES (2010b).

Two different methods were used to estimate abundance variability: (i) the parametric standard error derived from the random stratified sampling (Grosslein and Laurec, 1982), and (ii) a non parametric bootstrap procedure implemented in R (R Development Core Team, 2008) re-sampling randomly with replacement stations within each stratum thus maintaining the sampling intensity, and using 80% bootstrap confidence intervals from the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993).

## 3. Results and discussion

A total of 200 species, 103 fish species, were captured in 2010, similar to the number of species found in the last four years (102.0 species) and larger than the mean in the whole time series (94.1 species).

*Argentina* spp. presents a slight increase both in abundance and biomass, in 2009-10 (Figure 2), reaching in 2010 the levels found in 2006, before the minimum found in 2008, probably influenced by gear problems (Velasco *et al*., 2009). Nevertheless the species remains in abundances levels relatively low compared with the high values found in the first years of the series, when mean stratified capture in biomass was more than 100 kg per 30' haul. Regarding the length distribution the most remarkable result is that no evident mode is found in 2010 (Figure 3), the abundance is almost uniform along the length distribution (11-46 cm). In this sense it has to be born in mind that the length distribution can be driven by the relative species composition, since *A. silus* (maximum length: $L_{max}$: 60 cm) is larger than *A. sphyraena* ($L_{max}$: 32 cm) (Queró *et al*. 2003).

Figure 4 presents the comparison of length distributions of *A. silus* and *A. sphyraena* in 2009 and 2010. In terms of biomass *A. silus* made up the 91% of the argentines caught in 2009, 92% in 2010, while in number it was 78%, 71% respectively, the differences between both years are probably due to the improvement of the identification skills of the team in charge, and in 2010 small individuals were split more carefully, since as shown in Figure 4. Figure 5 presents the distribution of *Argentina* spp. in Porcupine bank along the time series, while Figure 6 presents the distribution of both species with a comparison of the proportion of each of them in each station. It is clear that in the deeper hauls (>450 m since most of them are below the isobaths that defines the deeper strata) in the southern and western part of the bank *A. silus* is the dominant species, while *A. sphyraena* is clearly less abundant in the survey area, but more abundant around the central part of the bank and also predominates in the hauls on the border of the Irish shelf, where the shoals are smaller.

Greater forkbeard (Figure 10) presents similar biomass and abundance values to the last two years, remaining at the levels of 2008, suggesting that the gear problems in 2008 were not so relevant for this species. Length distribution of greater forkbeard (Figure 11) shows a small trace of individuals smaller than 23 cm (4.8 ind/haul) with the same value found in 2001, but much smaller than 2002 cohort (14.4 ind/haul) that produced the high abundances of subsequent years (2003-6). Nevertheless recruits are more abundant than in lasts years 2008-9 when less than 1 individual <23 cm per haul was found. Geographical distribution (Figure 12) follows the similar patterns to the rest of the years.

Bluemouth continues the decrease in biomass and abundance indices (Figure 7) that started after the peak in 2005-6. Nevertheless both the length (Figure 8) and geographical (Figure 9) distribution maintain the same patterns of previous years, with only 0.7 ind/haul smaller than 15 cm, while between 2001 and 2005 more than 5 individuals per haul were captured.

Spanish ling is the most abundant ling in the Porcupine survey area (Velasco et al. 2010), and it presents abundance and biomass indices (Figure 13) with slight increases from 2008 and 2009. Nevertheless, and specially in the case of biomass, it looks like there is a quite stable abundance level since 2005, especially if we consider 2008 low value might be a result of the problems in the gear. Figure 14 and Figure 15 present length and geographical distributions of Spanish ling, with patterns similar to previous years and small trace of recruits/juveniles, as in 2008-9.

Finally, it is important to consider the results on blue ling that sometimes may be misidentified and confounded with Spanish ling (Queró et *al*. 2003), as commented in Velasco et *al*. (2010). In 2010 another individual of blue ling was captured in a deep haul from the south-western corner of the study area (Figure 16), both in the central part of the surveyed area (52º N) but one in the western part and the other in the easternmost part. The individual captured in 2010 measured 129 cm and weighted 10.2 kg.

## 4. Conclusions

The results of Porcupine bottom trawl survey in 2010 present relatively low values compared with the results in the beginning of the series 2002-4, when there were important recruitments of some of the deep species considered in this working document, as greater forkbeard in 2002, bluemouth in 2002 and Spanish ling in 2004. Nevertheless some recruitment signals have been found, and the decreasing trends found in the lasts years and probably remarked by the problems of the gear in 2008, are now becoming stable abundance levels except in the case of blue mouth that keeps decreasing in abundance with very low recruitment signals.

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## 5. Tables and figures

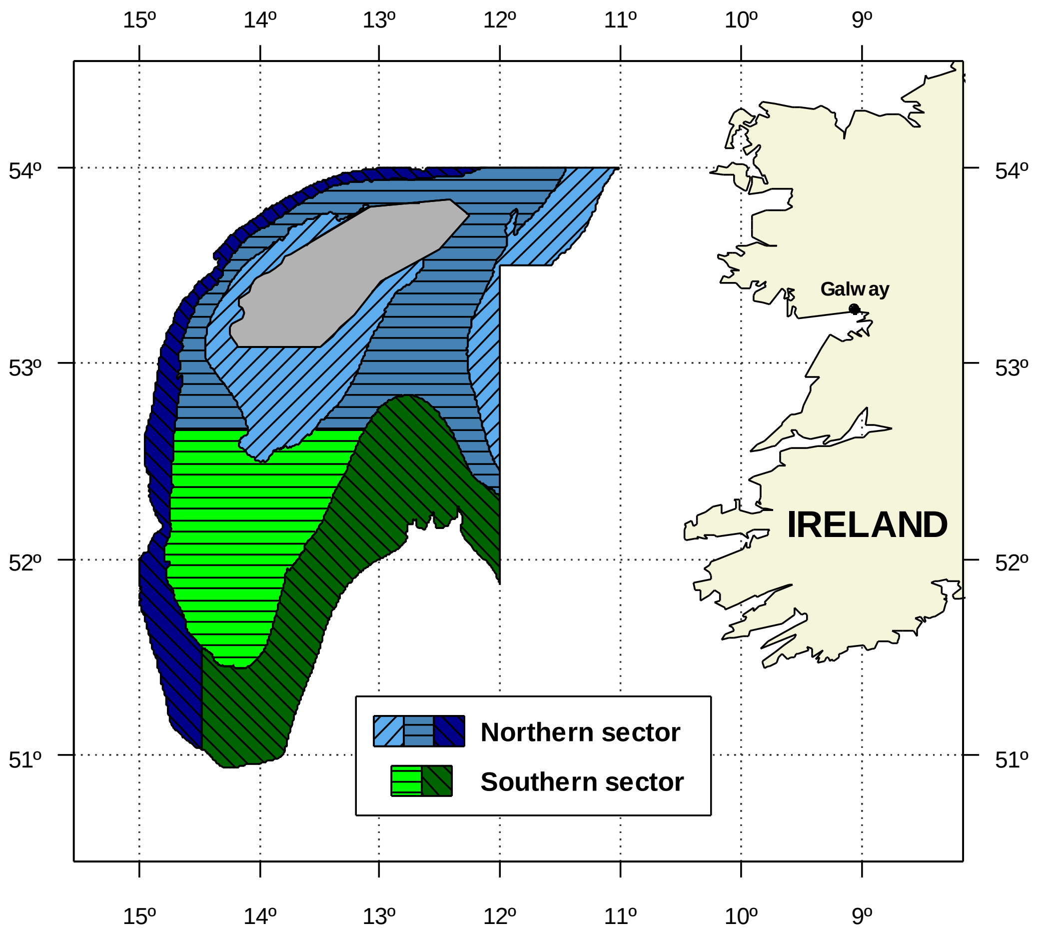



**Figure 1.** Stratification design used in Porcupine surveys from 2003. Depth strata are: A) shallower than 300 m, B) 301 – 450 m and C) 451 – 800 m. The grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification.

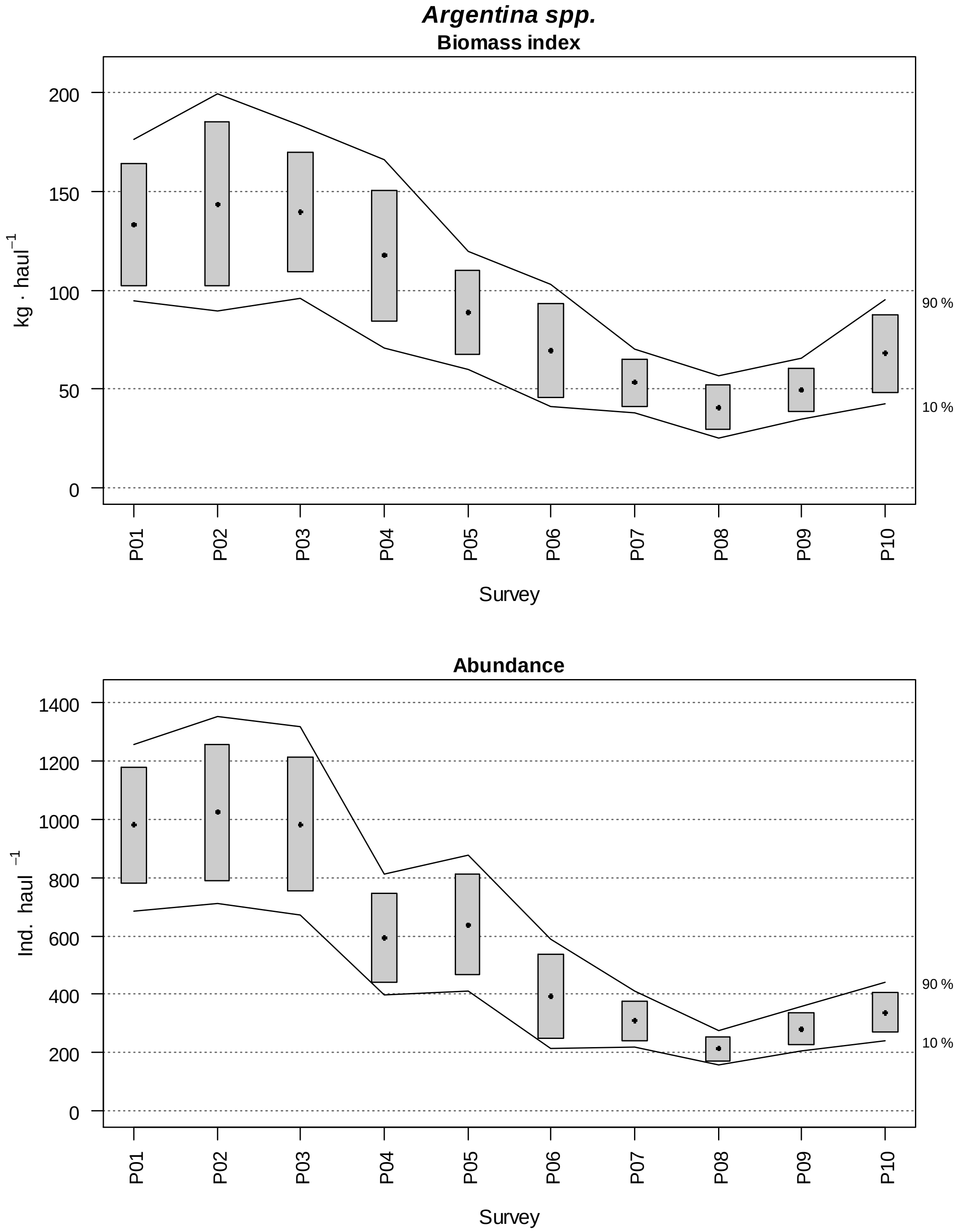



**Figure 2.** Changes in *Argentina* spp. (mainly *Argentina silus*) biomass and abundance indices during Porcupine Survey time series (2001-2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000)

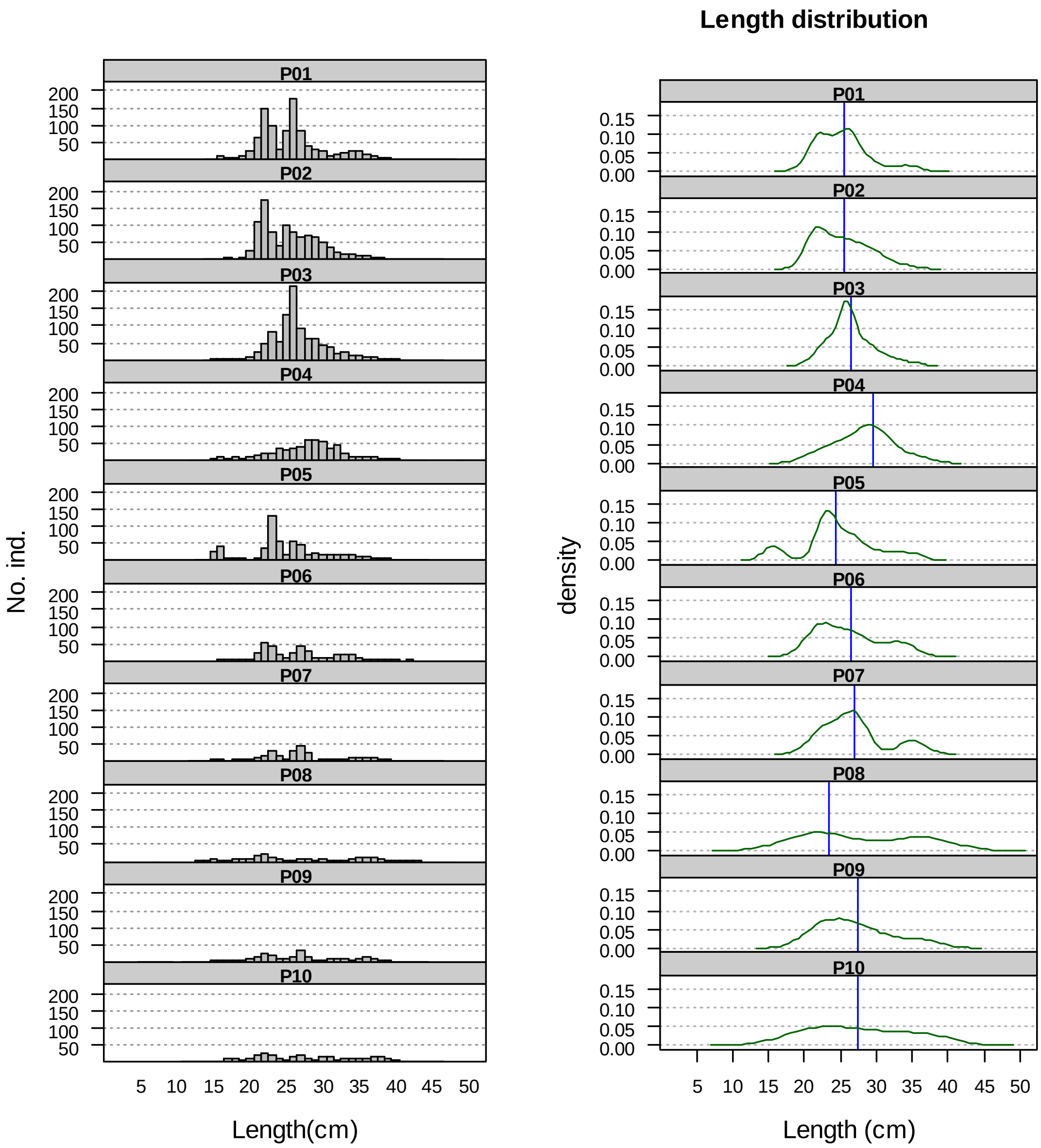
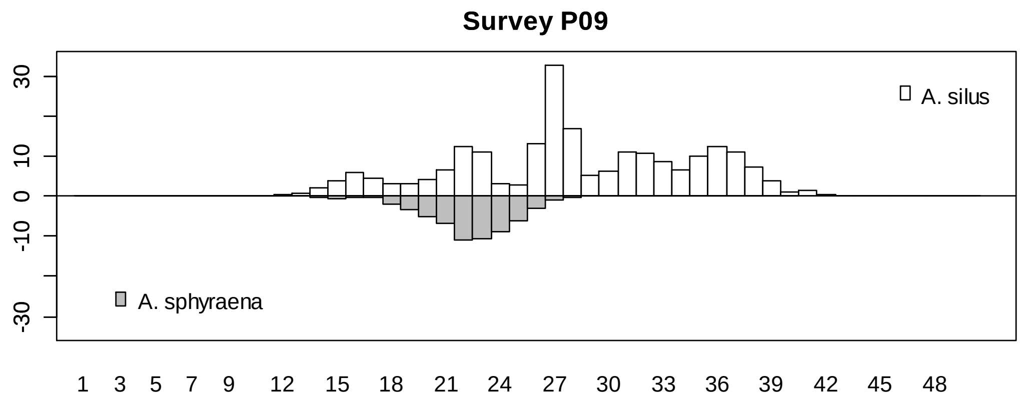



**Figure 3.** Mean stratified length distributions of *Argentina* spp. in Porcupine surveys (2001-2010)



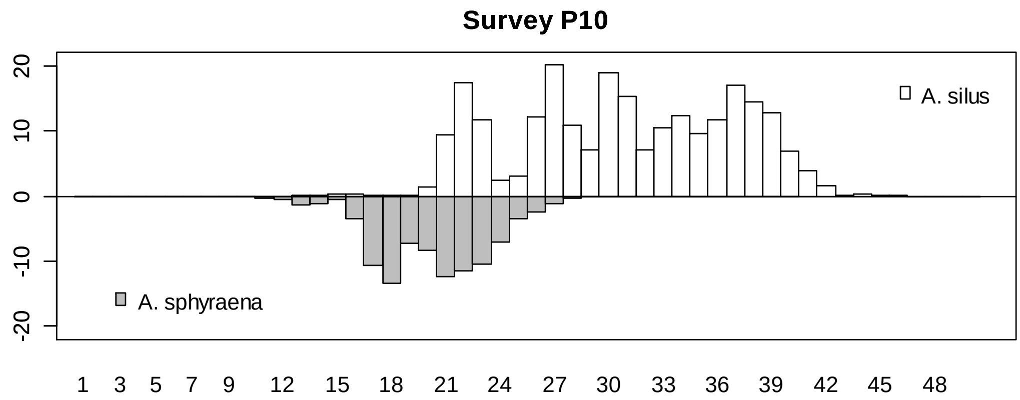




**Figure 4.** Mean stratified length distributions of *A. silus* and *A. sphyraena* in 2009 and 2010 surveys.

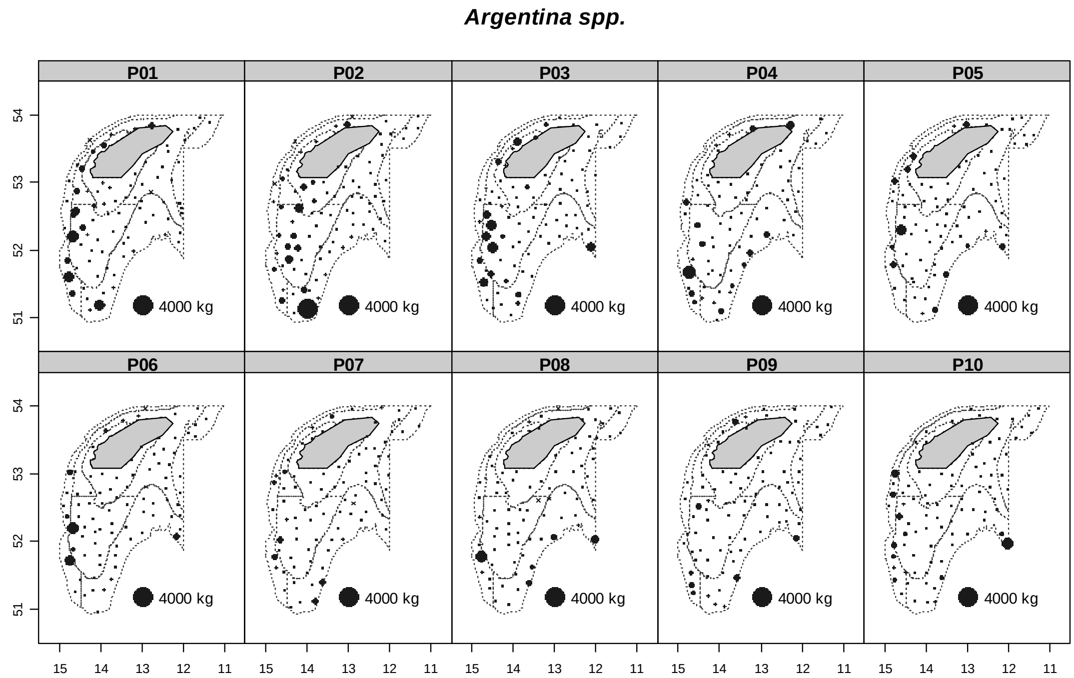



**Figure 5.** Geographic distribution of *Argentina* spp. catches (kg/30 min haul) in Porcupine surveys (2001-2010)

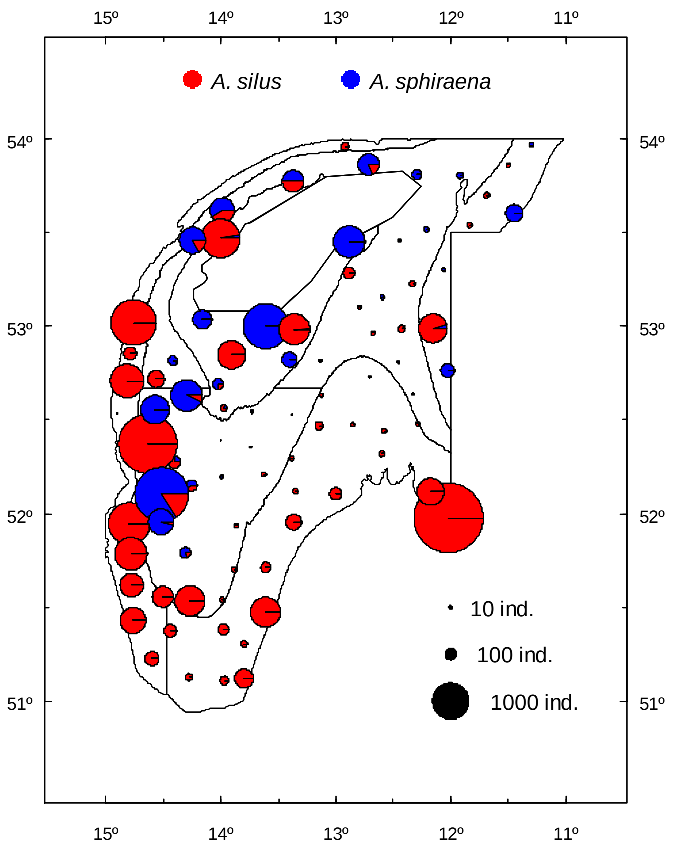



**Figure 6**. Distribution of *Argentina silus* and *A. sphyraena* during the 2010 Porcupine bank survey.

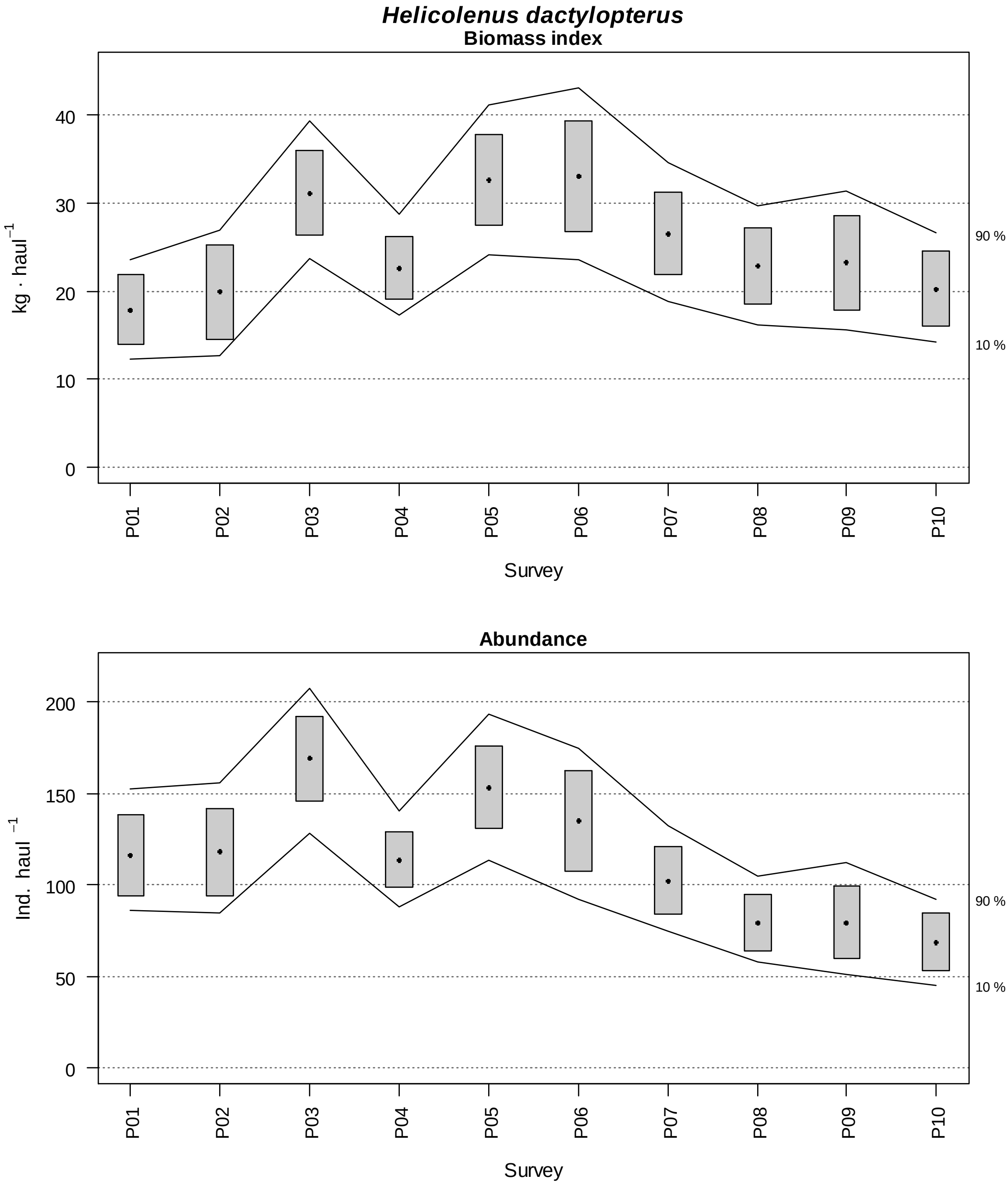



**Figure 7.** Changes in *Helicolenus dactylopterus* biomass and abundance indices during Porcupine Survey time series (2001-2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000)

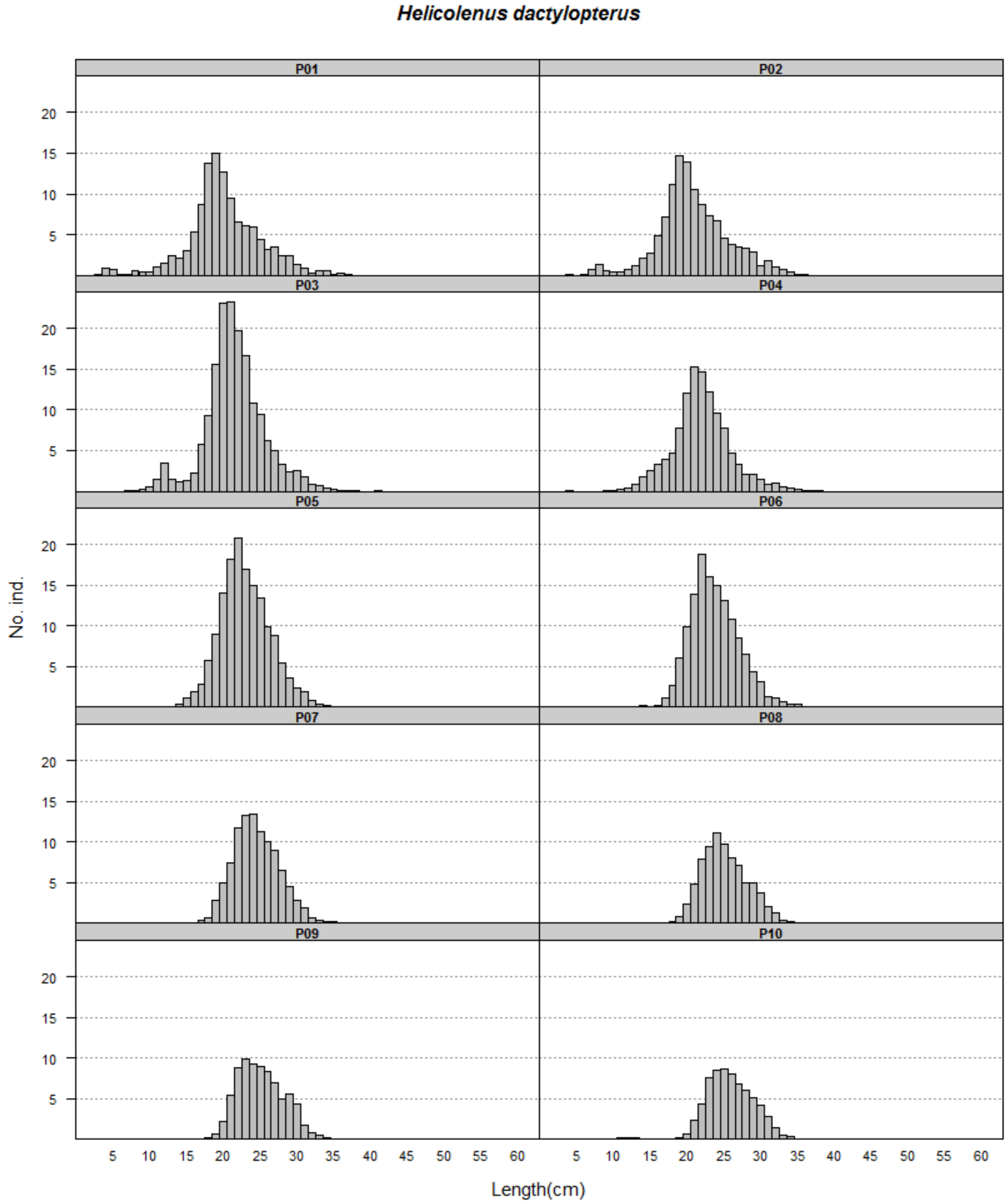



**Figure 8.** Mean stratified length distributions of *Helicolenus dactylopterus* in Porcupine surveys (2001-2010)

*Helicolenus dactylopterus*

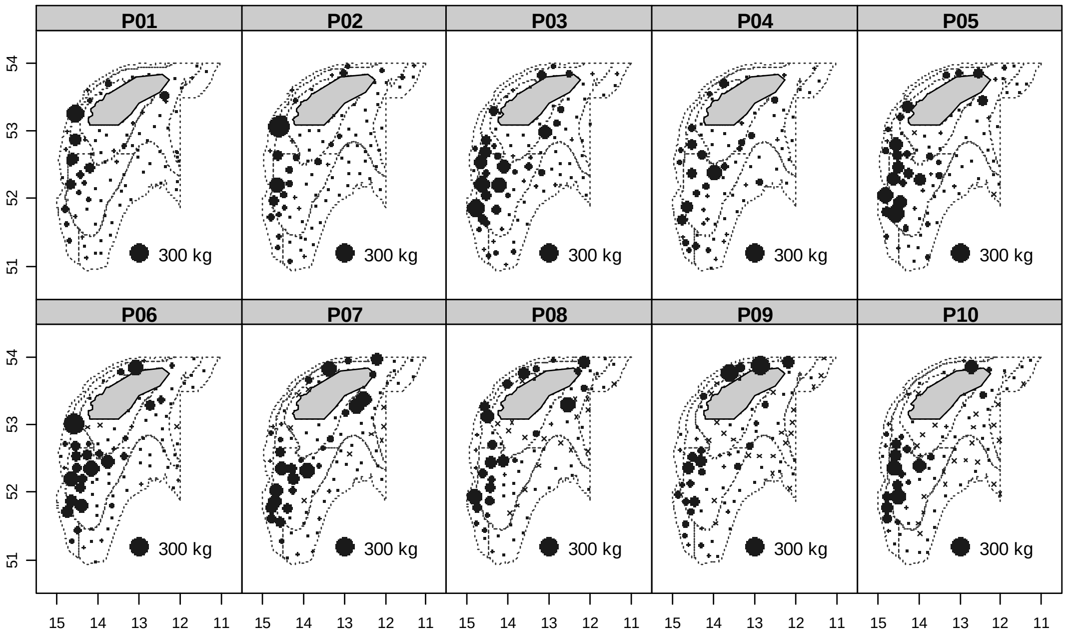



**Figure 9.** Geographic distribution of *Helicolenus dactylopterus* catches (kg/30 min haul) in Porcupine surveys (2001-2008)

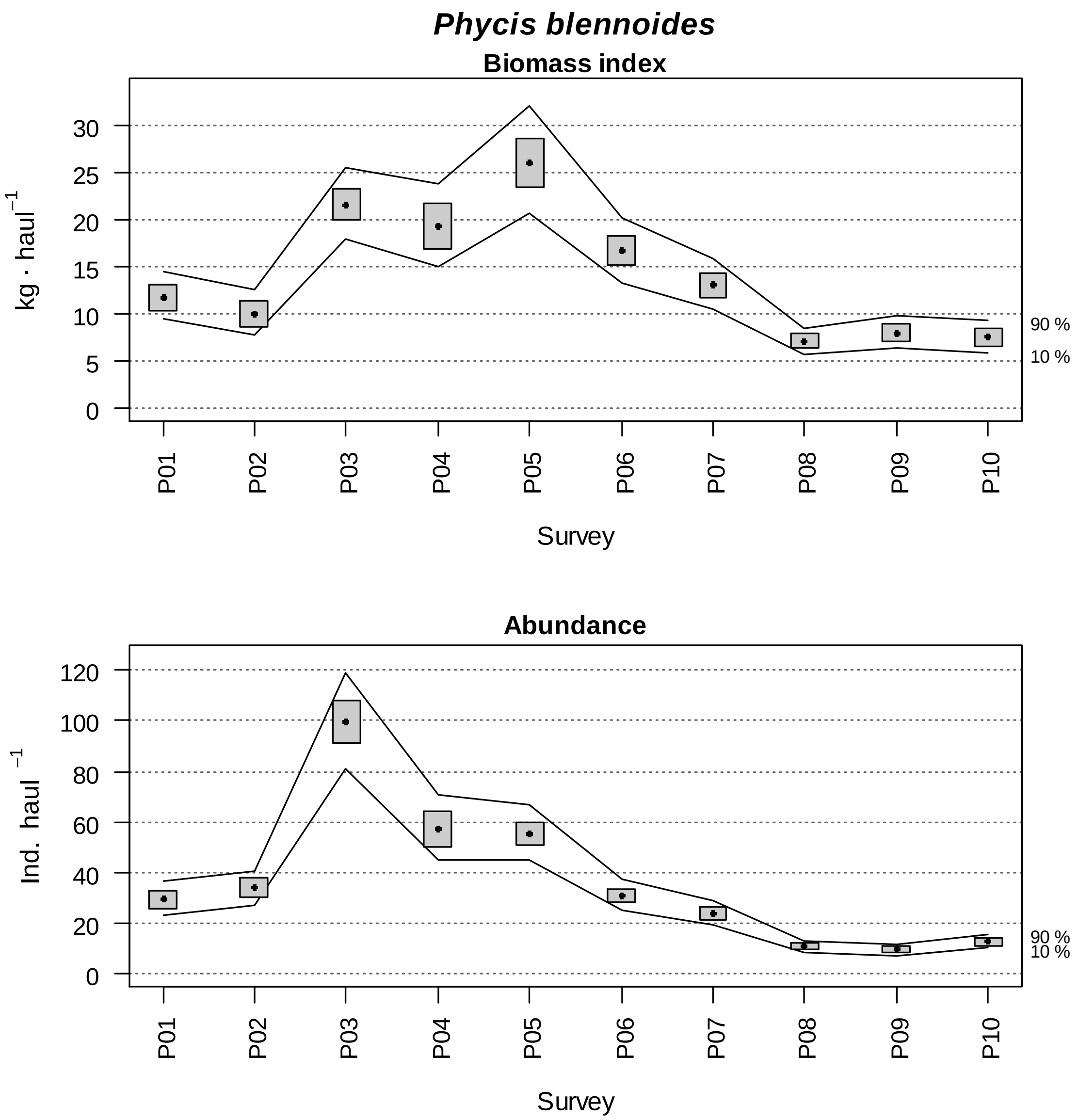



**Figure 10.** Changes in *Phycis blennoides* biomass and abundance indices during Porcupine Survey time series (2001-2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).

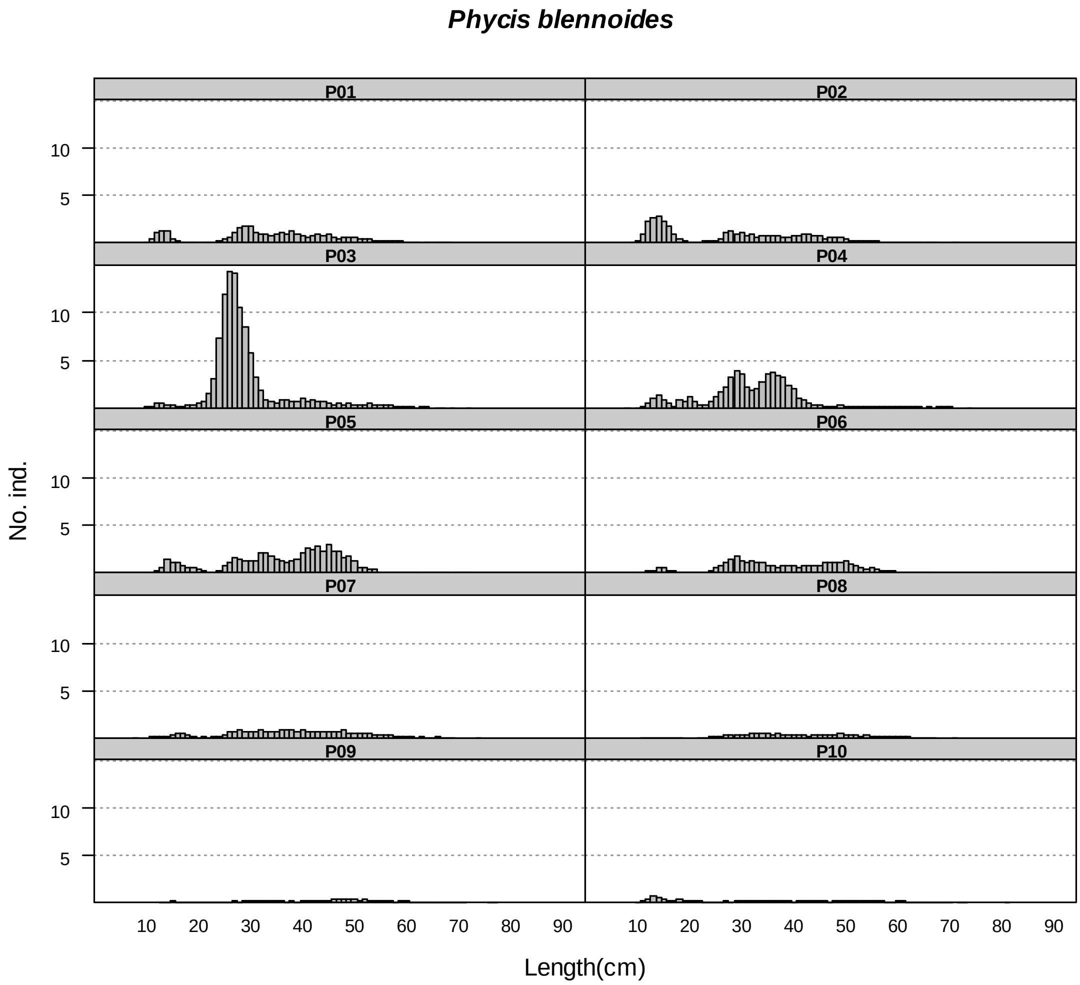



**Figure 11.** Mean stratified length distributions of *Phycis blennoides* in Porcupine surveys (2001-2010)

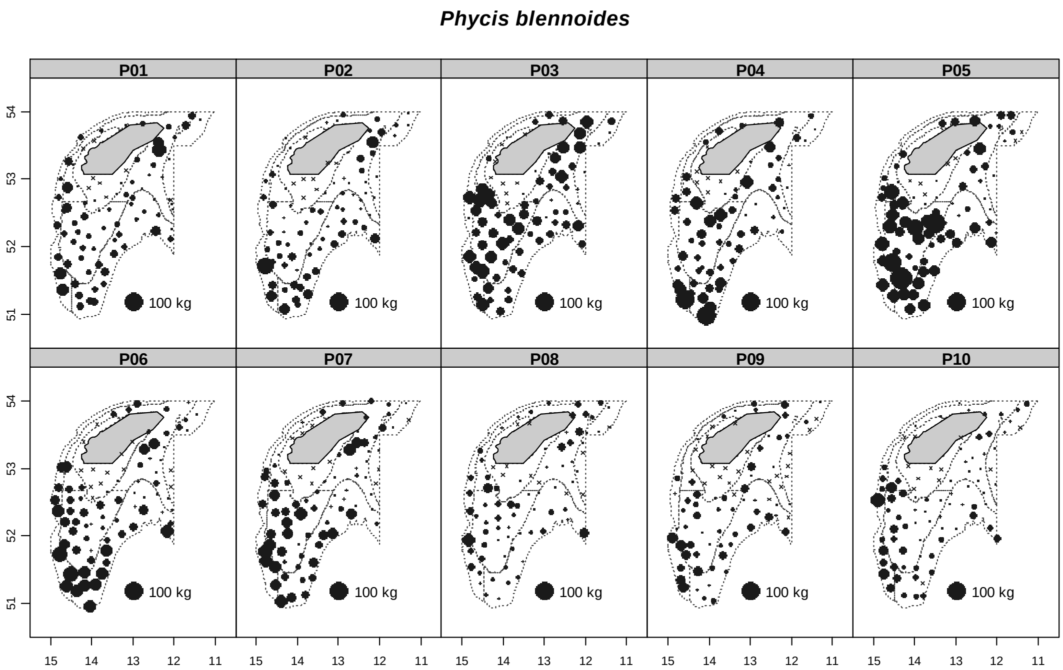



**Figure 12.** Geographic distribution of *Phycis blennoides* catches (kg/30 min haul) in Porcupine surveys (2001-2010)

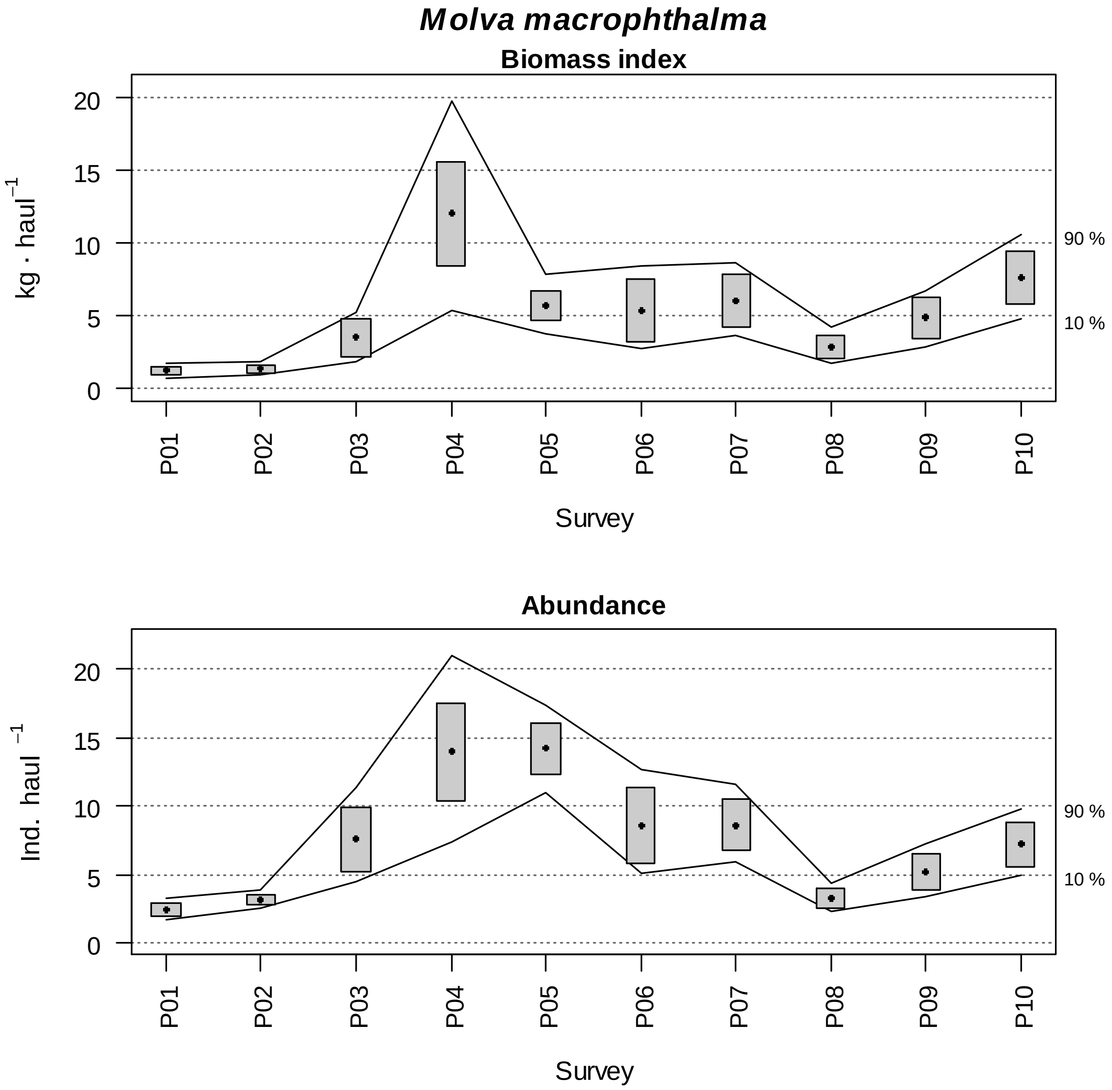



**Figure 13.** Changes in *Molva macrophthalma* biomass and abundance indices during Porcupine Survey time series (2001-2010). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha$ = 0.80, bootstrap iterations = 1000).

## *Molva macrophthalma*

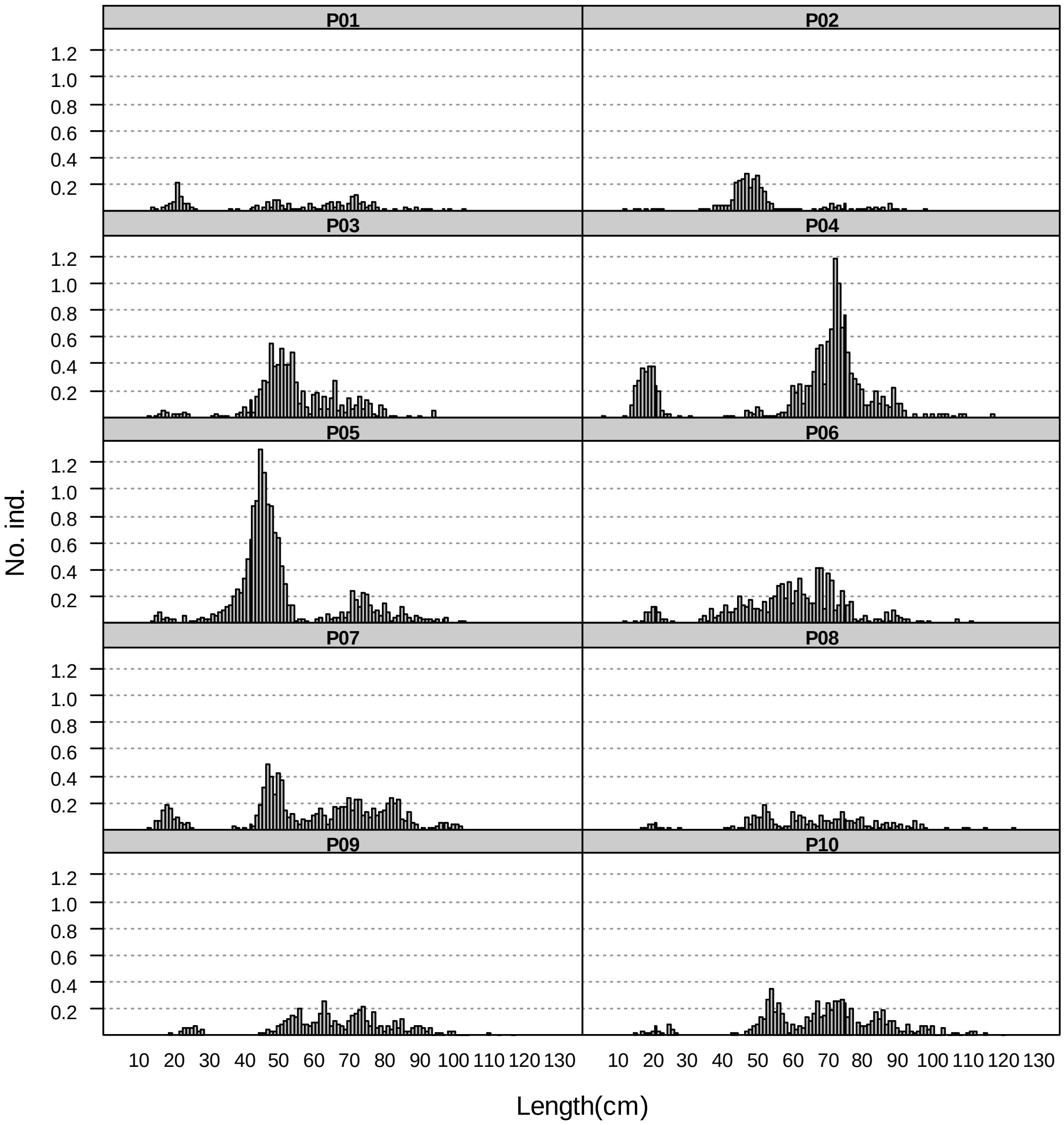



**Figure 14**. Mean stratified length distributions of *Molva macrophthalma* in Porcupine surveys (2001-2010)

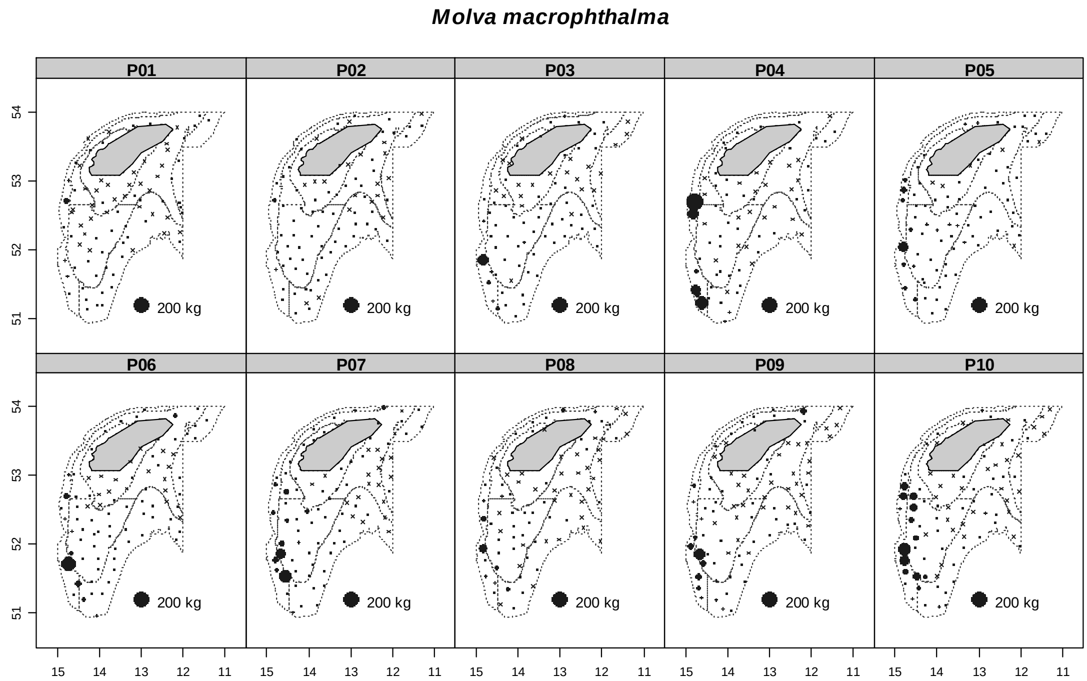



**Figure 15.** Geographic distribution of *Molva macrophthalma* catches (kg/30 min haul) in Porcupine surveys (2001-2010).

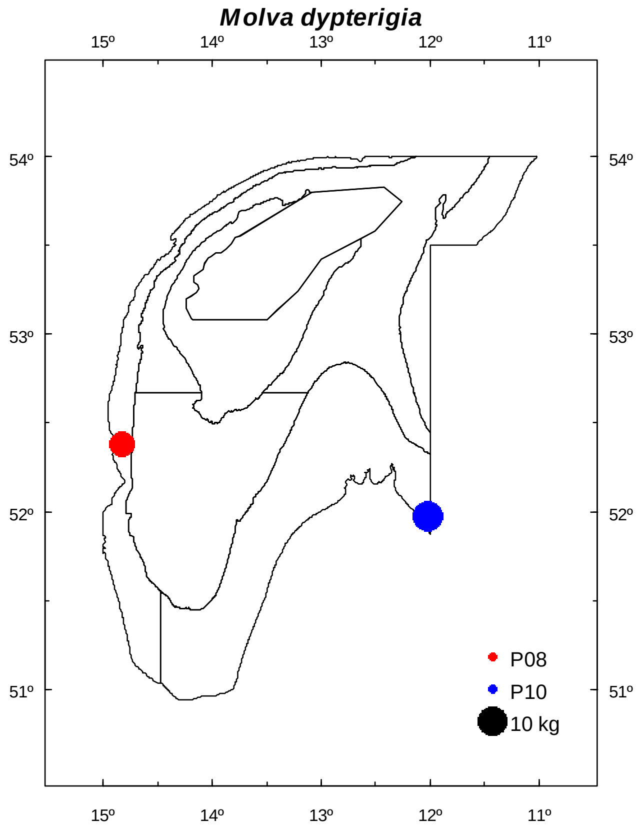



**Figure 16**. Blue lings caught in Porcupine bank surveys in 2008 and 2010.

# Ling in Va, exploratory GADGET stock assessment

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February 25, 2011

**Abstract**

This document describes a stock assessment of Ling in Va using the Gadget model. The model appears to capture the main trends in the data and as such should be usable for basing advice on. However currently the ageing material is quite limited and furthermore the quality of the aged data is questionable. Therefore the model can not be used in its present state for forward projections. The aim is to address the ageing issue in 2011 so the model can be used for the 2012 WGDEEP assessment.

## 1 Description of gadget

Gadget is a shorthand for the "Globally applicable Area Disaggregated General Ecosystem Toolbox", which is a statistical model of marine ecosystems. Gadget (previously known as BORMICON and Fleksibest). Gadget is an age-length structured forward-simulation model, coupled with an extensive set of data comparison and optimization routines. Processes are generally modeled as dependent on length, but age is tracked in the models, and data can be compared on either a length and/or age scale. The model is designed as a multi-area, multi-area, multi-fleet model, capable of including predation and mixed fisheries issues, however it can also be used on a single species basis. Gadget models can be both very data- and computationally- intensive, with optimization in particular taking a large amount of time. Worked examples, a detailed manual and further information on Gadget can be found on `www.hafro.is/gadget`. In addition the structure of the model is described in Begley and Howell (2004), and a formal mathematical description is given in Froysa et al (2002).

Gadget is distinguished from many stock assessment models used within ICES (such as XSA) in that Gadget is a forward simulation model, and is structured be both age and length. It therefore requires direct modeling of growth within the model. An important consequence of using a forward simulation model is that the plus groups (in both age and length) should be chosen to be large enough that they contain few fish, and the exact choice of plus group does not have a significant impact on the model.

### 1.1 Setup of a gadget run

There is a separation of model and data within Gadget. The simulation model runs with defined functional forms and parameter values, and produces a modeled population, with modeled surveys and catches. These surveys and catches are compared against the available data to produce a weighted likelihood score. Optimization routines then attempt to find the best set of parameter values (Figure 1).

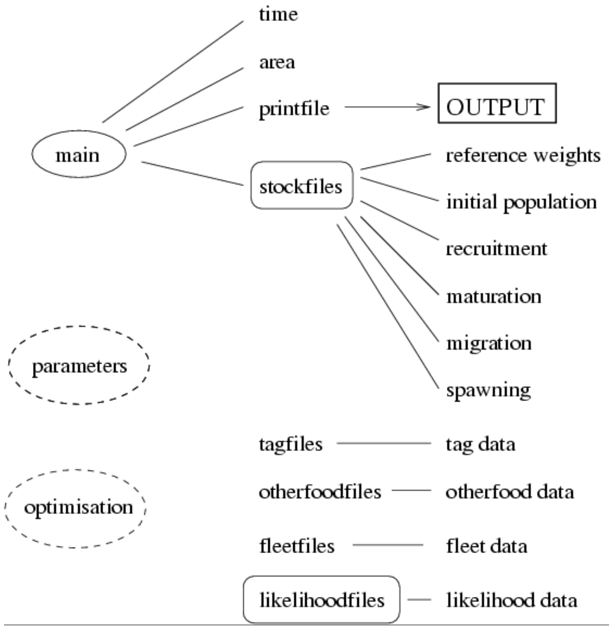


**Figure 1:** Schematic description of a Gadget model

### 1.2 Growth

Growth is modeled by calculating the mean growth for each length group for each time step, using a parametric growth function. In the Ling model a Von Bertanlanffy function has been employed to calculate this mean growth. Then the length distributions are updated according to the calculated mean growth by allowing some portion of the fish to have no growth, a proportion to grow by one length group and a proportion two length groups etc. How these proportions are selected affects the spread of the length distributions but these two equations must be satisfied:

$$\sum p_{il} = 1$$

and

$$\sum i p_{il} = \mu_l$$

Here $\mu$ is the calculated mean growth and $p_{il}$ is the proportion of fish in length group $l$ growing $i$ length groups.

The proportions are selected from a beta-binomial distribution. That is a binomial distribution $f(n, p)$ where $n$ is the maximum number of length groups that a fish can grow in one time interval. The probability $p$ in the binomial distribution comes from a beta distribution described by $\alpha$ and $\beta$ (Stefansson 2001).As in all discrete probability distributions the condition $\sum p_{il} = 1$ is automatically satisfied. The mean of the distribution is given by:

$$\mu_l = \frac{n\alpha}{\alpha + \beta} = \sum_{i=0}^{n} p_{il} i$$

For a given value of $\beta$, a value of $\alpha$ is selected so that $\mu_l = G_l$ where $G_l$ is the calculated mean growth from the parametric growth equation. $\beta$, which can either be estimated or specified in the input files, affects the spread of the length distribution.

### 1.3 Fleets

All fleets or predators in the model work on size. To be specific the predators have size preference for their prey and through predation can affect mean weight and length at age in the population. A fleet (or predator) is modeled so that either the total catch or the total effort in each area and time interval is specified. In the tusk assessment described here the commercial catch is given in weight but the survey is modeled as a fleet with a constant effort.

The first step in estimating catch in numbers by age and length in the model is to calculate the 'modeled CPUE' for each fleet:

$$CPUE_{mod} = \sum_{prey} \sum_{l} S_{prey,l} N_{prey,l} W_{prey,l}$$

where $S_{prey,l}$ is the selection of prey length $l$, $N_{prey,l}$ is the number of fish and $W_{prey,l}$ is the mean weight of prey of length $l$. The total catch of each length group of each prey is then calculated from:

$$C_{prey,l} = C \frac{S_{prey,l} N_{prey,l} W_{prey,l}}{CPUE_{mod}} \tag{1}$$

where $C_{prey,l}$ is the amount caught by the predator of length-group $l$ of prey (in this case tusk) and $C$ is the total amount caught by the fleet, either specified or calculated from $C = E \times CPUE_{mod}$, where $E$ is the specified effort.

In the Ling assessment described here the commercial catch are set (in kg per quarter), and the survey is modeled as fleet with small total landings. The total catch for each fleet for each quarter is then allocated among the different length categories of the stock according to their abundance and the catchability of that size class in that fleet.

### 1.4 Likelihood Data

A significant advantage of using an age-length structured model is that the modeled output can be compared directly against a wide variety of different data sources. It is not necessary to convert length into age data before comparisons. Gadget can use various types of data that can be included in the objective function. Length distributions, age length keys, survey indices by length or age, CPUE data, mean length and/or weight at age, tagging data and stomach content data can all be used.

Importantly this ability to handle length data directly means that the model can be used for stocks such as Ling where age data is sparse or considered unreliable. Length data can be used directly for model comparison. The model is able to combine a wide selection of the available data by using a maximum likelihood approach to find the best fit to a weighted sum of the datasets.

### 1.5 Optimization

The model has three alternative optimizing algorithms linked to it, a wide area search `simulated annealing` (Corona et al. 1987), a local search `Hooke and Jeeves algorithm` (Hooke-Jeeves 1961) and finally one based on the Boyden-Fletcher-Goldfarb-Shanno algorithim hereafter termed `BFGS`.

The simulated annealing and Hooke-Jeeves algorithms are not gradient based, and there is therefore no requirement on the likelihood surface being smooth. Consequently neither of the two algorithms returns estimates of the Hessian matrix. Simulated annealing is more robust than Hooke and Jeeves and can find a global optima where there are multiple optima but needs about 2-3 times the order of magnitude number of iterations than the Hooke and Jeeves algorithm.

BFGS is a quasi-Newton optimization method that uses information about the gradient of the function at the current point to calculate the best direction to look for a better point. Using this information the BFGS algorithim can iteratively calculate a better approximation to the inverse Hessian matrix. In comparison to the two other algorithms implemented in Gadget, BFGS is very local search compared to simulated annealing and more computationally intensive than the Hooke and Jeeves. However the gradient search in BFGS is more accurate than the stepwise search of Hooke and Jeeves and therefore give a more accurate estimation of the optimum.

The model is able to use all three algorithms in a single run optimization, attempting to utilize the strengths of all. Simulated annealing is used first to attempt to reach the general area of a solution, followed by Hooke and Jeeves to rapidly home in on the local solution and finally BFGS is used for fine-tuning the optimization. This procedure is repeated several times to attempt to avoid converging to a local optimum.

### 1.6 Likelihood weighting

In Taylor et. al an objective reweighing scheme for likelihood components in a Gadget model is described using cod in Icelandic waters as a case study. The authors note that the issue of component weighting has been discussed for some time, as the data sources have different natural scales such as g vs. kg which should not affect the outcome. A simple heuristic, where the weights are the inverse of the initial sums of squares ($SS$) for the respective component resulting in an initial score equal to the number of components, is therefore often used. This has the intuitive advantage of all components being normalized. There is however a drawback to this since the component scores, given the initial parametrization, are most likely not equally far from their respective optima resulting in sub-optimal weighting. The iterative reweighing heuristic tackles this problem by optimizing each component separately in order to determine the lowest possible value for each component. This is then used to determine the final weights.

The reasoning for this approach is as follows: Conceptually the likelihood components can be thought of as residual sums of squares, and as such their variance can be estimated by dividing the $SS$ by the degrees of freedom. The optimal weighting strategy is the inverse of the variance. Here the iteration starts with assigning the inverse $SS$ as the initial weight, that is the initial score of each component when multiplied with the weight is 1. Then an optimization run for each component with the initial score for that component set to 10000. After the optimization run the inverse of the resulting $SS$ is multiplied by the effective number of datapoints and used as the final weight for that particular component.

The effective number of datapoints is used as a proxy for the degrees of freedom is determined from the number of non-zero datapoints. This is viewed as satisfactory proxy when the data-set is large, but for smaller data-sets this could be a gross overestimate. In particular, if the surveyindices are weighed on their own while the yearly recruitment is estimated they could be over fitted.

The iterative weighting procedure has been implemented in the `R` statistical language as a part of the `rgadget` package which is written and maintained by B. Th. Elvarsson.

## 2 Model settings

Ling is a rather long lived species, reaches 20 years of age in Icelandic waters, so it takes a cohort a long time to pass through the fishery. Because of this the simulation time needs to be long but the obvious difficulty is that the data before 1985 is limited. That is before the groundfish survey started. In the assessment described here the simulation is started in 1982 but apart from the total catch there is very little data before 1985.

In the assessment 10cm length groups are used and the year is divided into four time steps. The age range is 0 to 20 years, with the oldest age treated as a plus group. The length at recruitment is estimated and mean growth is assumed to follow the von Bertalanffy growth function.

Choice of natural mortality ($M$) is problematic as is normally the case in stock assessments. Here $M$ is assumed to be 0.2.

The commercial catch is modeled as three fleets, each with its own selection pattern described by a logistic function and total catch in tonnes is specified for each time step. The fleets are longlines, trawls and gillnets. The survey on the other hand is modeled as fleet with constant effort and a nonparametric selection pattern that is estimated for each length group.

Data/constrains used in the objective function to be minimized are as follows:

a) Length distributions from the commercial catch and surveys using multinomial likelihood function.
b) Age-length keys from the commercial catch using multinomial likelihood function
c) Length disaggregated survey indices in 10cm length groups using lognormal errors.
d) Mean length at age from the commercial catch and survey
e) Understocking, i.e. to small biomass to cover the specified catch in tonnes.

The total objective function to be minimized is a weighted sum of the different components. Weights to the various likelihood components were assigned according to the procedure described in 1.6.

The parameters estimated are

a) The number of fishes when simulation starts.
b) Recruitment each year.
c) Parameters of the growth equation.
d) Parameter $\beta$ of the beta-binomial distribution controlling the spread of the length distributions.
e) The selection pattern of the commercial catches.

The estimation can be difficult because of some or groups of parameters are correlated and therefore the possibility of multiple optima cannot be excluded. The optimization was started with simulated annealing to make the results less sensitive to the initial (starting) values and then the optimization was changed to Hooke and Jeeves when the 'optimum' was approached.

# 3 Input data

## 3.1 Commercial catches

### 3.1.1 Landings

Longline is the main commercial gear for ling in Va as can be seen in table 1 and figure 2, followed by trawl and gillnets. The amount caught in gillnets has been decreasing in recent years.

**Table 1:** Ling in Va. Commercial catches in tonnes by commercial gear types, quarters and year.

| Year | Longlines | | | | | Gillnets | | | | | Trawls | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | $\sum$ | 1 | 2 | 3 | 4 | $\sum$ | 1 | 2 | 3 | 4 | $\sum$ |
| 1982 | 495 | 435 | 519 | 611 | 2061 | 106 | 416 | 17 | 50 | 590 | 654 | 637 | 497 | 546 | 2335 |
| 1983 | 656 | 397 | 473 | 547 | 2072 | 118 | 302 | 21 | 8 | 449 | 772 | 830 | 631 | 389 | 2622 |
| 1984 | 358 | 297 | 306 | 530 | 1491 | 179 | 516 | 6 | 19 | 720 | 524 | 546 | 321 | 276 | 1667 |
| 1985 | 374 | 260 | 298 | 430 | 1362 | 112 | 482 | 3 | 16 | 613 | 219 | 399 | 411 | 436 | 1466 |
| 1986 | 391 | 302 | 318 | 409 | 1420 | 158 | 611 | 14 | 21 | 805 | 284 | 434 | 389 | 265 | 1372 |
| 1987 | 516 | 442 | 468 | 765 | 2192 | 205 | 685 | 51 | 96 | 1037 | 305 | 478 | 457 | 505 | 1746 |
| 1988 | 655 | 457 | 526 | 798 | 2436 | 405 | 880 | 70 | 57 | 1412 | 456 | 596 | 509 | 436 | 1998 |
| 1989 | 516 | 470 | 464 | 856 | 2306 | 290 | 1227 | 40 | 82 | 1639 | 297 | 529 | 372 | 404 | 1602 |
| 1990 | 599 | 342 | 427 | 1078 | 2446 | 352 | 602 | 60 | 72 | 1086 | 548 | 713 | 342 | 421 | 2024 |
| 1991 | 717 | 437 | 613 | 1049 | 2816 | 240 | 594 | 46 | 57 | 937 | 637 | 618 | 416 | 358 | 2029 |
| 1992 | 725 | 519 | 651 | 801 | 2696 | 262 | 713 | 51 | 123 | 1149 | 300 | 426 | 281 | 253 | 1260 |
| 1993 | 674 | 591 | 619 | 638 | 2522 | 263 | 799 | 191 | 118 | 1370 | 263 | 303 | 239 | 142 | 947 |
| 1994 | 602 | 432 | 593 | 834 | 2460 | 240 | 729 | 207 | 109 | 1285 | 152 | 334 | 243 | 129 | 859 |
| 1995 | 667 | 485 | 503 | 944 | 2598 | 191 | 321 | 174 | 138 | 824 | 188 | 335 | 218 | 154 | 895 |
| 1996 | 797 | 563 | 586 | 601 | 2548 | 171 | 343 | 104 | 132 | 750 | 249 | 340 | 235 | 155 | 979 |
| 1997 | 610 | 629 | 585 | 816 | 2640 | 116 | 257 | 116 | 125 | 613 | 202 | 382 | 137 | 173 | 893 |
| 1998 | 681 | 920 | 542 | 606 | 2749 | 128 | 413 | 114 | 63 | 718 | 145 | 412 | 169 | 125 | 850 |
| 1999 | 1082 | 679 | 607 | 647 | 3016 | 179 | 366 | 70 | 66 | 681 | 246 | 278 | 157 | 131 | 812 |
| 2000 | 762 | 601 | 464 | 441 | 2269 | 128 | 441 | 58 | 77 | 703 | 238 | 273 | 92 | 120 | 723 |
| 2001 | 575 | 303 | 483 | 309 | 1670 | 231 | 653 | 115 | 60 | 1059 | 201 | 130 | 86 | 77 | 494 |
| 2002 | 432 | 459 | 487 | 567 | 1945 | 160 | 415 | 24 | 48 | 647 | 206 | 247 | 127 | 82 | 663 |
| 2003 | 751 | 669 | 727 | 979 | 3125 | 130 | 251 | 19 | 55 | 454 | 161 | 224 | 117 | 81 | 583 |
| 2004 | 1144 | 592 | 537 | 987 | 3261 | 140 | 320 | 30 | 55 | 545 | 167 | 229 | 147 | 113 | 657 |
| 2005 | 1213 | 1094 | 545 | 726 | 3579 | 151 | 267 | 34 | 50 | 502 | 211 | 341 | 245 | 187 | 985 |
| 2006 | 1757 | 1681 | 981 | 1118 | 5536 | 177 | 264 | 116 | 71 | 628 | 293 | 473 | 264 | 212 | 1242 |
| 2007 | 1824 | 1650 | 1272 | 812 | 5558 | 179 | 288 | 82 | 81 | 630 | 258 | 530 | 371 | 237 | 1396 |
| 2008 | 2028 | 1877 | 1707 | 1690 | 7303 | 130 | 212 | 54 | 80 | 476 | 378 | 565 | 308 | 258 | 1509 |
| 2009 | 2806 | 2242 | 2022 | 1612 | 8680 | 225 | 327 | 81 | 89 | 722 | 397 | 563 | 296 | 284 | 1540 |

### 3.1.2 Length measurements

An overview of the available length measurements divided by gear, year and quarter is given in table 2. As can be seen in table 2 there is very limited number of measurements available from gillnets and trawls. The bulk of the available data is from longlines. This is again clearly seen in figures 3-5 which show the length frequency distribution by gear, year and quarter.

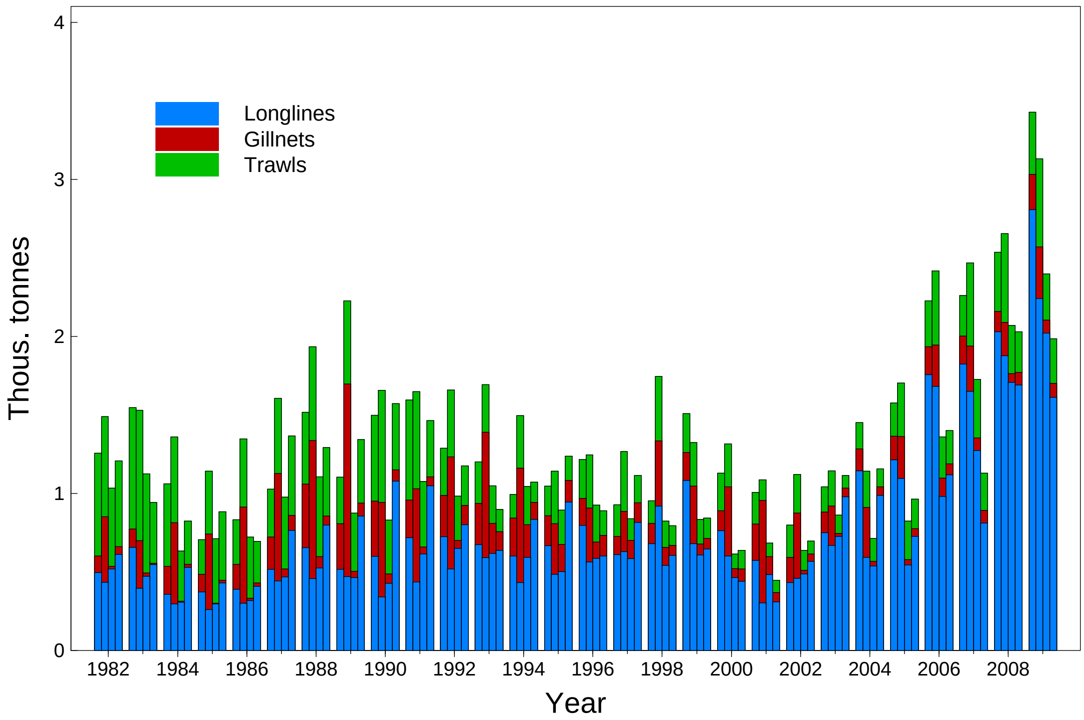


**Figure 2:** Ling in Va. Commercial catches by year, quarter and fleet in the Gadget model. From the input file `fleet.data`.

**Table 2:** Ling in Va. Number of length measurements by commercial gear types, quarters and year.

| Year | Longlines | | | | Gillnets | | | | Trawls | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 256 | 0 | 0 | 0 | 0 | 0 | 18 |
| 1983 | 0 | 0 | 0 | 0 | 62 | 64 | 0 | 0 | 59 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 98 | 88 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 220 | 40 | 0 | 32 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 291 | 0 | 0 | 0 | 0 | 0 | 3 |
| 1993 | 0 | 0 | 0 | 356 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 422 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 |
| 1995 | 300 | 0 | 257 | 591 | 200 | 262 | 0 | 0 | 288 | 0 | 0 | 0 |
| 1996 | 853 | 0 | 400 | 867 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 900 | 300 | 562 | 466 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 300 |
| 1998 | 599 | 743 | 300 | 1009 | 0 | 0 | 0 | 0 | 0 | 201 | 3 | 0 |
| 1999 | 900 | 417 | 300 | 315 | 0 | 204 | 0 | 0 | 0 | 86 | 0 | 133 |
| 2000 | 163 | 797 | 378 | 285 | 0 | 451 | 0 | 115 | 150 | 88 | 139 | 0 |
| 2001 | 481 | 0 | 896 | 283 | 0 | 302 | 150 | 41 | 0 | 0 | 0 | 37 |
| 2002 | 228 | 159 | 643 | 474 | 66 | 300 | 0 | 0 | 70 | 94 | 0 | 57 |
| 2003 | 634 | 336 | 390 | 1044 | 0 | 150 | 0 | 150 | 0 | 86 | 51 | 0 |
| 2004 | 1059 | 356 | 130 | 1095 | 0 | 198 | 0 | 0 | 91 | 0 | 0 | 50 |
| 2005 | 892 | 806 | 236 | 388 | 0 | 1 | 0 | 0 | 43 | 268 | 0 | 38 |
| 2006 | 957 | 1367 | 431 | 595 | 38 | 150 | 314 | 139 | 383 | 630 | 144 | 0 |
| 2007 | 1521 | 1061 | 531 | 418 | 0 | 0 | 0 | 0 | 251 | 149 | 0 | 0 |
| 2008 | 1396 | 2171 | 400 | 1879 | 142 | 147 | 0 | 68 | 0 | 290 | 379 | 150 |
| 2009 | 2783 | 2797 | 1912 | 953 | 0 | 280 | 0 | 130 | 96 | 174 | 0 | 96 |

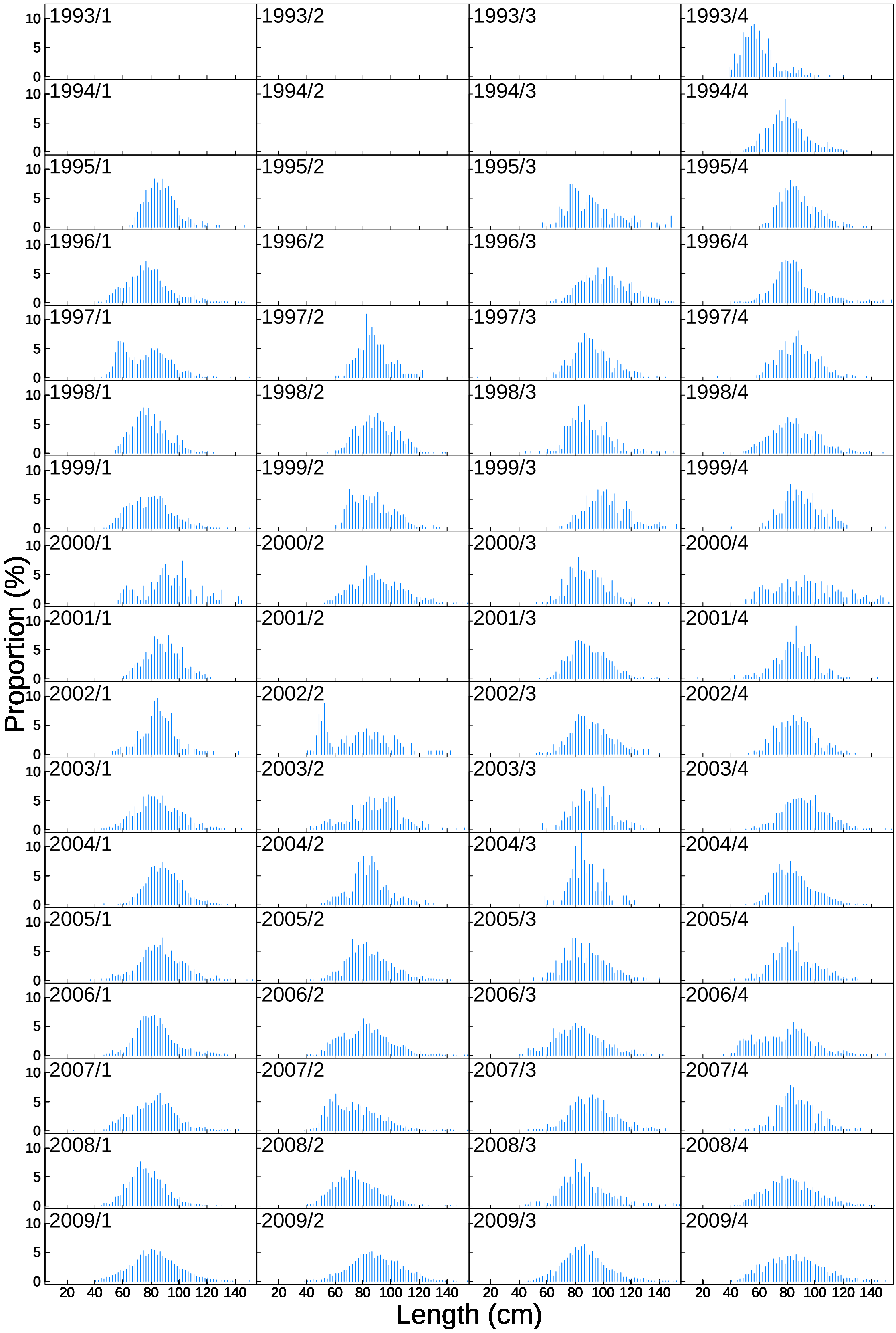


**Figure 3:** Ling in Va. Length distribution data from longlines used as input data for the Gadget model. From the input file `longlineledist.dat`.

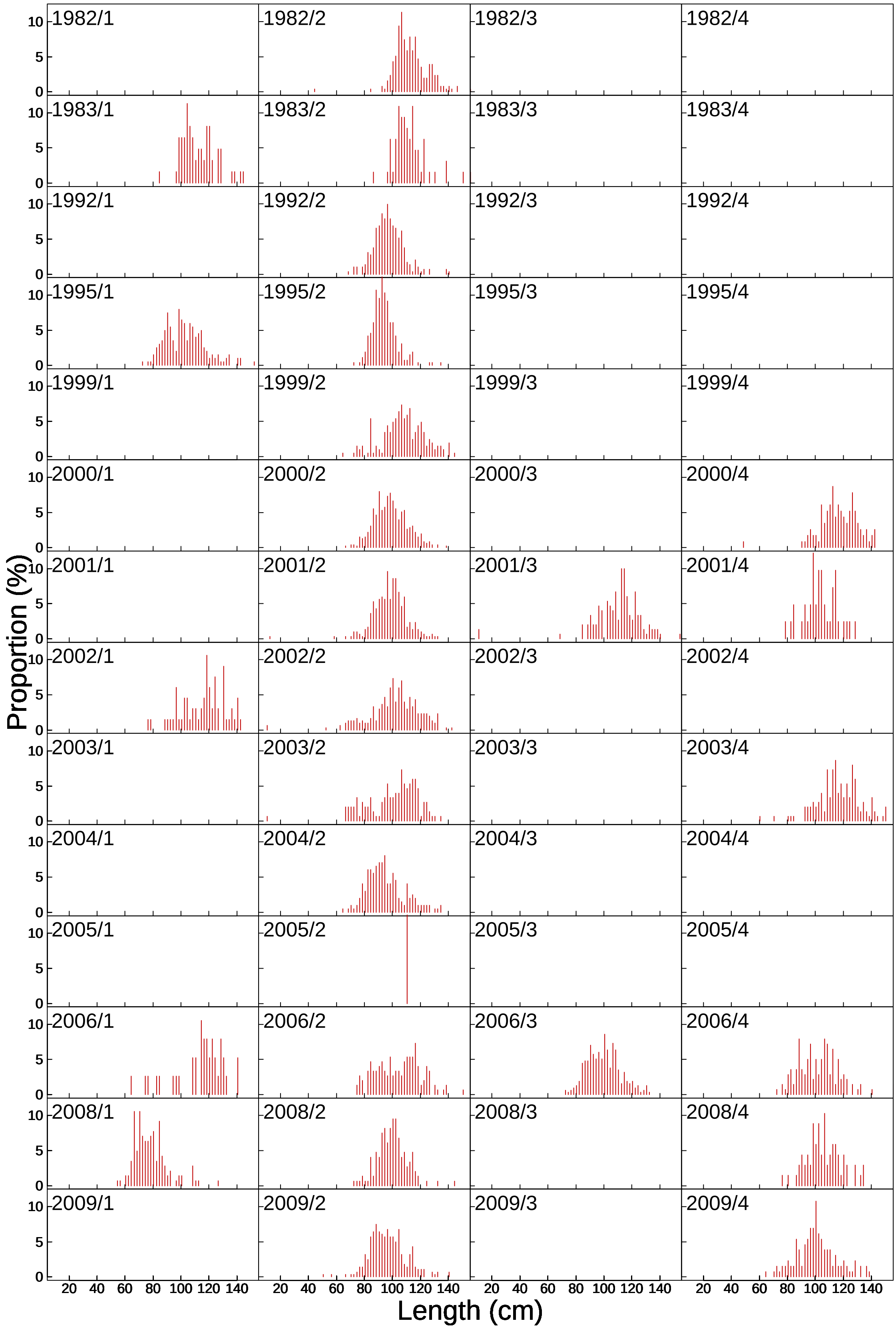


**Figure 4:** Ling in Va. Length distribution data from gillnets used as input data for the Gadget model. From the input file `gillnetledist.dat`.

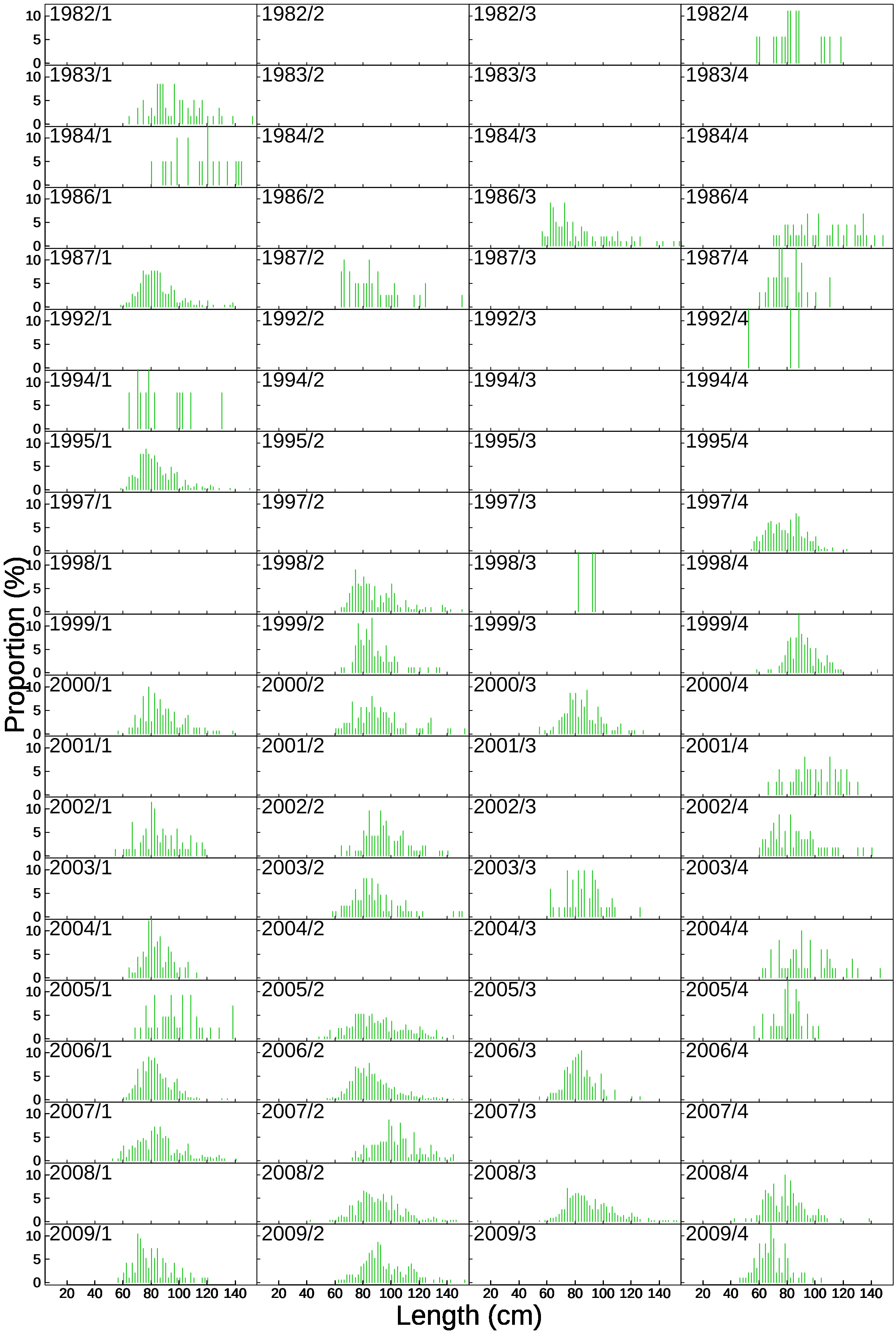


**Figure 5:** Ling in Va. Length distribution data from trawls used as input data for the Gadget model. From the input file `trawlledist.dat`.

### 3.1.3 Aged otoliths

Quite limited number of aged otoliths are available and they area all from the 1994-1998 period. Most of the aged otoliths were collected from longlines (Table 3 and figure 6).

**Table 3:** Ling in Va. Number of aged otoliths by commercial gear types, quarters and year. From input files `longlinealkeys.dat`, `gillnetsalkeys.dat` and `trawlalkeys.dat`

| Year | Longlines | | | | Gillnets | | | | Trawls | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 1994 | 0 | 0 | 0 | 212 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 93 | 0 | 91 | 187 | 94 | 93 | 0 | 0 | 88 | 0 | 0 | 0 |
| 1996 | 279 | 0 | 193 | 286 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 285 | 97 | 194 | 192 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 97 |
| 1998 | 168 | 261 | 92 | 362 | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 |

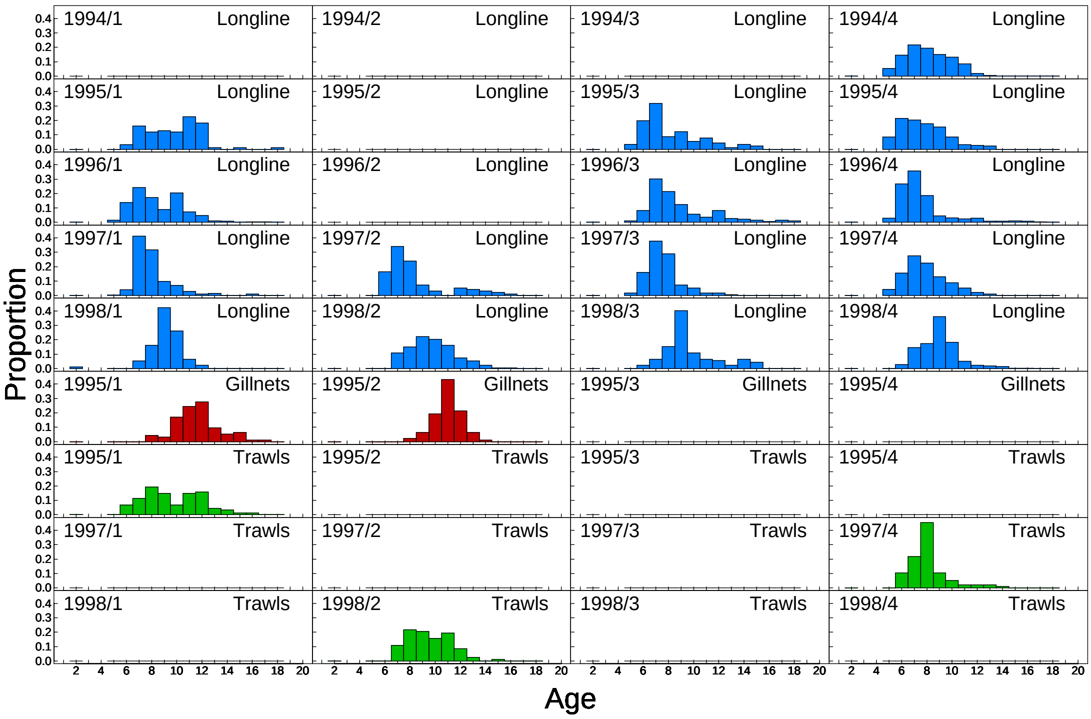


**Figure 6:** Ling in Va. Available age distributions from commercial catches by gear, year and quarter. For number of otoliths in each cell refer to table 3.

### 3.2 Survey data

The survey data used is the Icelandic Spring (March) Groundfish Survey. Data from the whole Icelandic shelf except the Faroe Ridge is used[1].

#### 3.2.1 Aggregated (10 cm) abundance indices (Tuning data)

All the 10 cm length groups show the same trend, that is a rapid increase after the year 2000 (Figure 6). In the present Gadget setup the `len010-019` and `len020-029` are not included in the overall likelihood function. The reason for this is the many zero values in length-group 10-19 cm and two zeros in the 20-29cm length-group

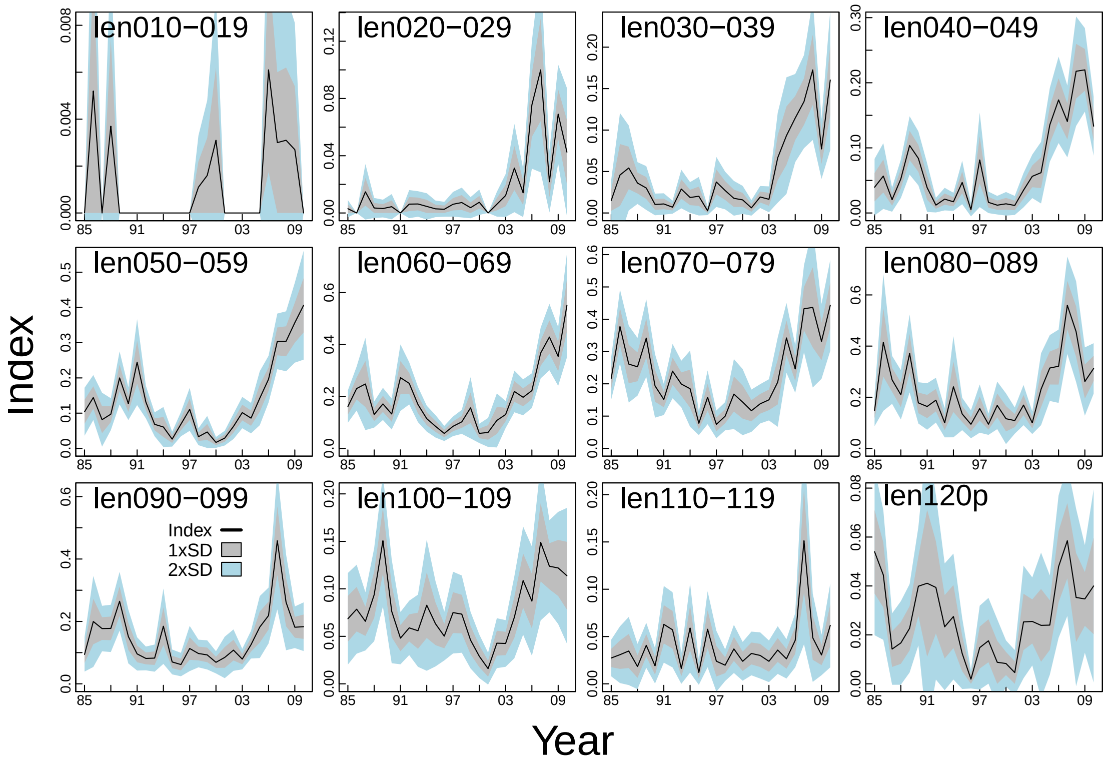


**Figure 7:** Ling in Va. Trends in aggregated length indices (10 cm) from the Icelandic Spring (March) Groundfish Survey. The shaded area shows $\pm sd$. From the input file `surveyindices.dat`

[1]`aggr.visit[aggr.visit$lengd %in% 10:180 & %aggr.visit$svaedi=="Heild.an.Faereyjahryggs",]`

### 3.2.2 Length distributions

The length distributions from the the Icelandic Spring (March) Groundfish Survey are shown in figure 8.

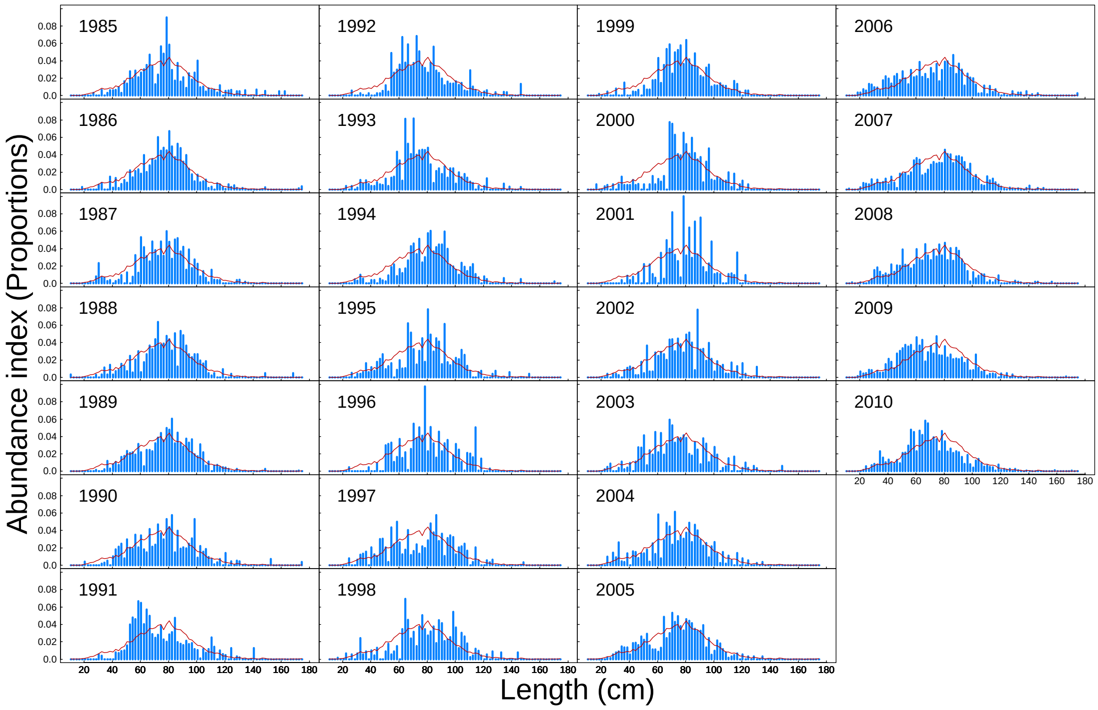


**Figure 8:** Ling in Va. Length disaggregated indices (2 cm), length distributions, from the Icelandic Spring (March) Groundfish Survey. The red line represents the mean from all years. From the input file `surveyledist.dat`

### 3.2.3 Otolith data

As with the commercial catches the number of available aged otoliths is limited and only from 1989 to 1997. An overview of the available otoliths by year and age from the March survey is given in table 4 and in figure 9.

**Table 4:** Ling in Va. Number of aged otoliths from the Icelandic Spring (March) Groundfish Survey by year. From input file `surveyalkeys.dat`.

| Year | Age | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | $\sum$ |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 1990 | 1 | 2 | 24 | 20 | 15 | 11 | 19 | 19 | 6 | 8 | 2 | 1 | 0 | 2 | 130 |
| 1991 | 0 | 1 | 6 | 44 | 32 | 18 | 7 | 9 | 10 | 5 | 4 | 1 | 0 | 0 | 137 |
| 1992 | 2 | 1 | 2 | 5 | 25 | 40 | 20 | 8 | 8 | 5 | 4 | 1 | 0 | 1 | 122 |
| 1993 | 0 | 0 | 6 | 5 | 8 | 31 | 28 | 6 | 5 | 3 | 4 | 1 | 0 | 1 | 98 |
| 1994 | 0 | 2 | 4 | 6 | 8 | 13 | 20 | 22 | 8 | 1 | 1 | 1 | 0 | 0 | 86 |
| 1995 | 1 | 0 | 23 | 34 | 8 | 18 | 25 | 30 | 12 | 3 | 2 | 1 | 0 | 1 | 158 |
| 1996 | 0 | 1 | 9 | 23 | 13 | 5 | 4 | 5 | 11 | 1 | 0 | 1 | 0 | 0 | 73 |
| 1997 | 0 | 1 | 4 | 14 | 29 | 15 | 7 | 6 | 5 | 3 | 1 | 0 | 0 | 1 | 86 |

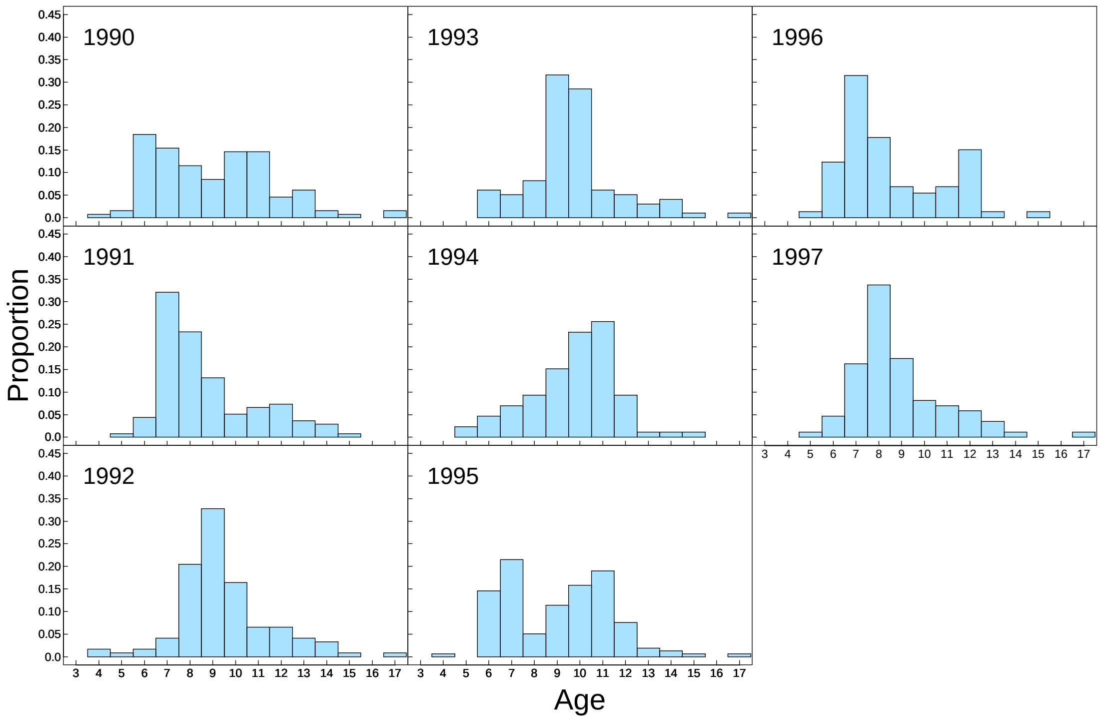


**Figure 9:** Ling in Va. Available age distributions from the Icelandic Spring (March) Groundfish Survey by year. For number of otoliths in each cell refer to table 4.

## 3.3 Auxiliary files

In the present Gadget setup there are two auxiliary files that contain mean length by age and its standard deviation. The file for the commercial catches is named `lingmeanl.dat` and contains data from the longline fishery (Table 5, figure 10).

**Table 5:** Ling in Va. Number of aged otoliths used for estimation of mean length at age (likelihood component `meanl.catch`). From input file `lingmeanl.dat`.

| Year | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1994 | 0 | 212 | 0 | 0 |
| 1995 | 368 | 278 | 0 | 0 |
| 1996 | 471 | 384 | 0 | 0 |
| 1997 | 481 | 385 | 0 | 0 |
| 1998 | 578 | 454 | 0 | 0 |

As there is considerable lack of age structured data the Gadget model has a tendency to vastly change growth to unrealistic values. To force the model to predict realistic values a high weight was put on the `meanl.sur` likelihood component (Data file: `lingSurML.dat`) which comes from the Spring survey (March). Also a little cheating was conducted as the survey length distributional data was replicated 3 times. That is for years 1985, 1995 and 2005.

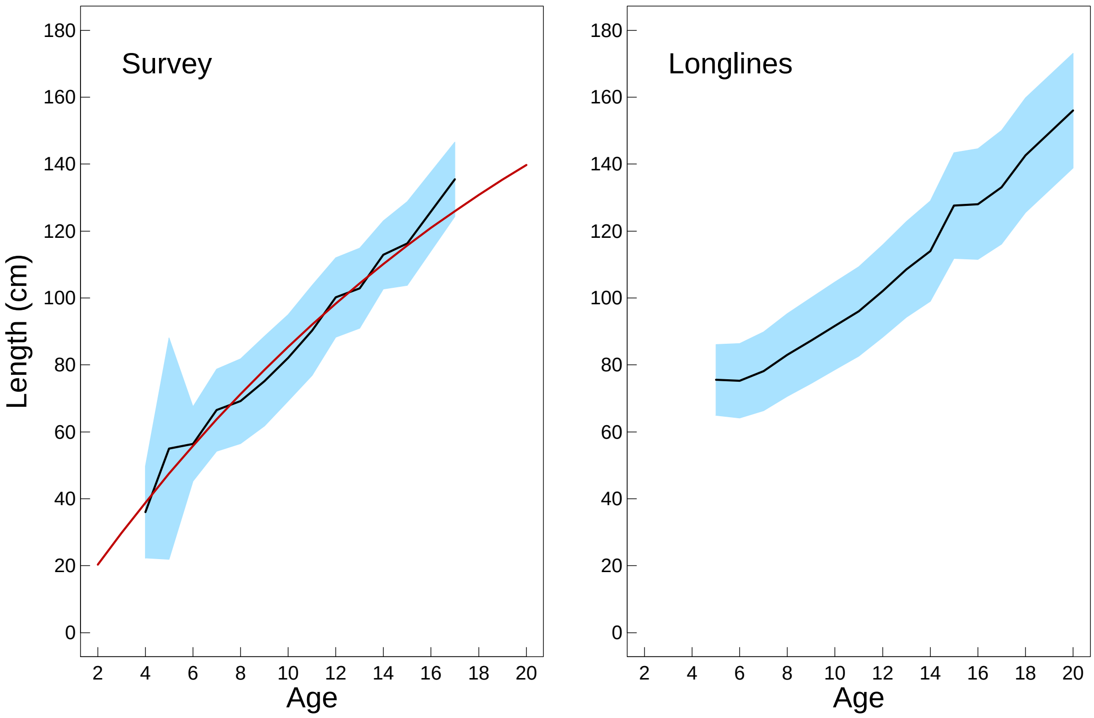


**Figure 10:** Ling in Va. Mean estimates of length at age (black line) and its ± standard deviation (blue area) for the survey likelihood component (`meanl.sur`) and the commercial catch component (`meanl.catch`). The red line is the fitted curve to the survey data (ages ≤15) used as initial values in the initial conditions.

In addition there is a auxiliary file containing a reference length-weight relationship. This file is called `lingrefw.dat`. The relationship was constructed using all available data on ungutted ling and was fitted on a log-log scale. After transformation the length-weight relationship is:

$$W = \alpha \times L^{\beta} \tag{2}$$

where $alpha = 0.00000495$ and $\beta = 3.01793$. Weight ($W$) is in kg and length ($L$) is in cm.

# 4 Base model - Using older ageing data.

## 4.1 Likelihood components

The re-iterative weighting procedure was used to assign weights to the likelihood components in the model. The results are presented in table 7 on page 17. The resulting weight of individual components is presented in table 6

**Table 6:** Ling in Va. Likelihood weighing in the GADGET model for ling.

| Component | Weight | Minimum | % Minimum |
|---|---|---|---|
| bounds | 10.00 | 0.00 | 0.00 |
| Understocking | 1.00 | 0.00 | 0.00 |
| si3039 | 1.67 | 24.68 | 0.19 |
| si4049 | 2.34 | 34.39 | 0.26 |
| si5059 | 3.89 | 37.04 | 0.28 |
| si6069 | 9.94 | 49.65 | 0.37 |
| si70180 | 6.05 | 205.70 | 1.55 |
| ld.l | 0.12 | 2693.66 | 20.26 |
| ld.g | 0.16 | 848.14 | 6.38 |
| ld.t | 0.19 | 1241.91 | 9.34 |
| ld.s | 0.09 | 1463.43 | 11.01 |
| alk.l | 0.76 | 4479.66 | 33.69 |
| alk.g | 0.80 | 340.85 | 2.56 |
| alk.t | 1.16 | 704.39 | 5.30 |
| al.s | 0.31 | 655.15 | 4.93 |
| ml.c | 0.08 | 139.47 | 1.05 |
| ml.s | 0.96 | 378.10 | 2.84 |

**Table 7:** Ling in Va. Results of the re-iterative procedure, likelihood component scores (columns) when one component is heavily weighed (rows). Survey indices (indices), ldist.survey and alkeys.survey (alk.ld.s) were grouped together. The top table shows the absolute score while the lower shows the score relative to the minimum..

| Component | si3039 | si4049 | si5059 | si6069 | si70180 | ld.l | ld.g | ld.t | ld.s | alk.l | alk.g | alk.t | alk.s | m.l | ml.s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Results** | | | | | | | | | | | | | | | |
| base | 13.76 | 13.18 | 8.66 | 4.13 | 31.85 | 23600.00 | 5254.00 | 6440.00 | 17350.00 | 6491.00 | 362.60 | 599.30 | 2071.00 | 1733.00 | 246.10 |
| indices | 15.59 | 11.12 | 6.68 | 2.62 | 25.77 | 69370.00 | 10690.00 | 10390.00 | 16940.00 | 7101.00 | 404.00 | 677.00 | 2206.00 | 3143.00 | 457.60 |
| alkld.s | 12.56 | 11.15 | 7.32 | 3.52 | 35.43 | 71400.00 | 14320.00 | 10220.00 | 14170.00 | 7699.00 | 342.50 | 658.50 | 2007.00 | 5883.00 | 475.10 |
| ld.l | 19.39 | 15.19 | 10.37 | 7.60 | 96.52 | 20840.00 | 18610.00 | 10880.00 | 43030.00 | 11580.00 | 784.80 | 1115.00 | 2992.00 | 2051.00 | 1240.00 |
| ld.g | 45.19 | 30.77 | 16.19 | 5.66 | 253.30 | 204200.00 | 4739.00 | 26160.00 | 36830.00 | 8930.00 | 472.00 | 1186.00 | 3301.00 | 4249.00 | 637.90 |
| ld.t | 48.79 | 84.58 | 94.24 | 96.31 | 730.80 | 159100.00 | 25960.00 | 5989.00 | 30920.00 | 11120.00 | 625.10 | 988.90 | 3274.00 | 11710.00 | 407.70 |
| alk.l | 30.84 | 24.59 | 13.07 | 8.52 | 90.61 | 300400.00 | 9192.00 | 10050.00 | 30840.00 | 1828.00 | 589.80 | 644.90 | 2800.00 | 18180.00 | 2939.00 |
| alk.g | 18.33 | 16.46 | 10.01 | 4.87 | 91.73 | 47150.00 | 24840.00 | 8161.00 | 32670.00 | 11780.00 | 140.80 | 877.80 | 3226.00 | 2804.00 | 861.70 |
| alk.t | 19.12 | 17.50 | 13.69 | 6.01 | 114.30 | 50370.00 | 7093.00 | 41120.00 | 32280.00 | 12120.00 | 446.60 | 149.40 | 2845.00 | 2247.00 | 895.40 |
| ml.l | 17.13 | 14.17 | 10.82 | 4.58 | 47.48 | 91530.00 | 8662.00 | 7715.00 | 32460.00 | 10740.00 | 349.90 | 721.50 | 2456.00 | 1365.00 | 349.30 |
| ml.s | 45.15 | 31.44 | 21.75 | 18.98 | 590.90 | 76490.00 | 18170.00 | 12170.00 | 58220.00 | 14480.00 | 481.00 | 1062.00 | 3438.00 | 6510.00 | 40.65 |
| **Standardized results** | | | | | | | | | | | | | | | |
| base | 1.10 | 1.19 | 1.30 | 1.58 | 1.24 | 1.13 | 1.11 | 1.08 | 1.22 | 3.55 | 2.58 | 4.01 | 1.03 | 1.27 | 6.05 |
| indices | 1.24 | 1.00 | 1.00 | 1.00 | 1.00 | 3.33 | 2.26 | 1.73 | 1.20 | 3.88 | 2.87 | 4.53 | 1.10 | 2.30 | 11.26 |
| alkld.s | 1.00 | 1.00 | 1.10 | 1.35 | 1.37 | 3.43 | 3.02 | 1.71 | 1.00 | 4.21 | 2.43 | 4.41 | 1.00 | 4.31 | 11.69 |
| ld.l | 1.54 | 1.37 | 1.55 | 2.90 | 3.75 | 1.00 | 3.93 | 1.82 | 3.04 | 6.33 | 5.57 | 7.46 | 1.49 | 1.50 | 30.50 |
| ld.g | 3.60 | 2.77 | 2.42 | 2.17 | 9.83 | 9.80 | 1.00 | 4.37 | 2.60 | 4.89 | 3.35 | 7.94 | 1.64 | 3.11 | 15.69 |
| ld.t | 3.88 | 7.61 | 14.11 | 36.82 | 28.36 | 7.63 | 5.48 | 1.00 | 2.18 | 6.08 | 4.44 | 6.62 | 1.63 | 8.58 | 10.03 |
| alk.l | 2.46 | 2.21 | 1.96 | 3.26 | 3.52 | 14.41 | 1.94 | 1.68 | 2.18 | 1.00 | 4.19 | 4.32 | 1.40 | 13.32 | 72.30 |
| alk.g | 1.46 | 1.48 | 1.50 | 1.86 | 3.56 | 2.26 | 5.24 | 1.36 | 2.31 | 6.44 | 1.00 | 5.88 | 1.61 | 2.05 | 21.20 |
| alk.t | 1.52 | 1.57 | 2.05 | 2.30 | 4.44 | 2.42 | 1.50 | 6.87 | 2.28 | 6.63 | 3.17 | 1.00 | 1.42 | 1.65 | 22.03 |
| ml.l | 1.36 | 1.27 | 1.62 | 1.75 | 1.84 | 4.39 | 1.83 | 1.29 | 2.29 | 5.88 | 2.49 | 4.83 | 1.22 | 1.00 | 8.59 |
| ml.s | 3.59 | 2.83 | 3.26 | 7.26 | 22.93 | 3.67 | 3.83 | 2.03 | 4.11 | 7.92 | 3.42 | 7.11 | 1.71 | 4.77 | 1.00 |
| df* | 26 | 26 | 26 | 26 | 156 | 2547 | 780 | 1158 | 1288 | 1391 | 113 | 174 | 613 | 106 | 39 |

## 4.2 Aggregated survey indices

In figures 11 to 13 the fit of the Gadget model to the observed aggregated indices is shown. In figure 11 the indices are shown on the same scale as in figure 7 (page 12) but the fit is superimposed as a red line. In general the model appears to capture the overall trend in the data.

In figure 12 the observed values are plotted against the predicted values. In general the relationship seem to be fair for the first four length-groups (30-39, 40-49, 50-59 and 60-69). After that the relationships are not as good. A notable exception from this is the 100-109 length-group as there the relationship is fairly good.

The main information demonstrated in the bubble-plot (Figure 13) is that in the beginning of the period the model underestimates stock size, then in the period between 1995-2004 there is a fairly large negative block. The model does not fully capture the rapid increase in survey indices in 2005-2007 so there is a positive block in that period. Again the model is not responsive enough to follow the decline in the indices in 2009-2010 and so the residuals from the last two years are negative.

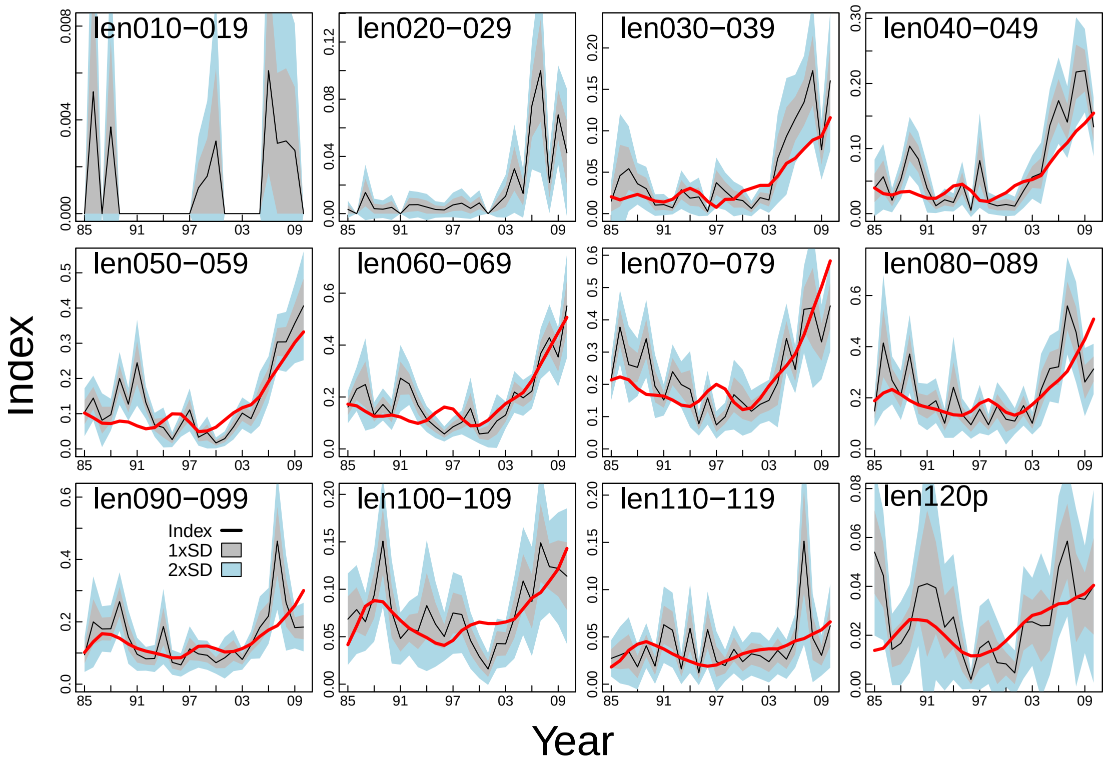


**Figure 11:** Ling in Va. Trends in aggregated length indices (10 cm) from the Icelandic Spring (March) Groundfish Survey (points) and predictions from the Gadget model (red line)

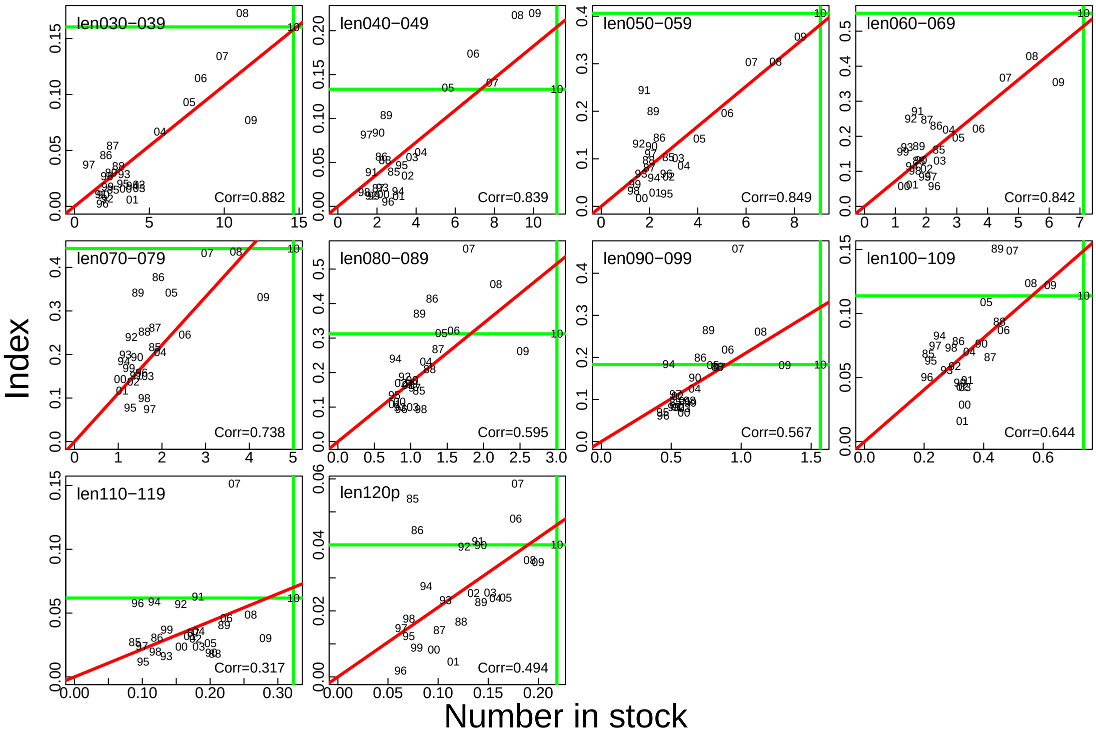

**Figure 12:** Ling in Va. Estimates from the Gadget model plotted against observed values from the Icelandic spring (March) survey.

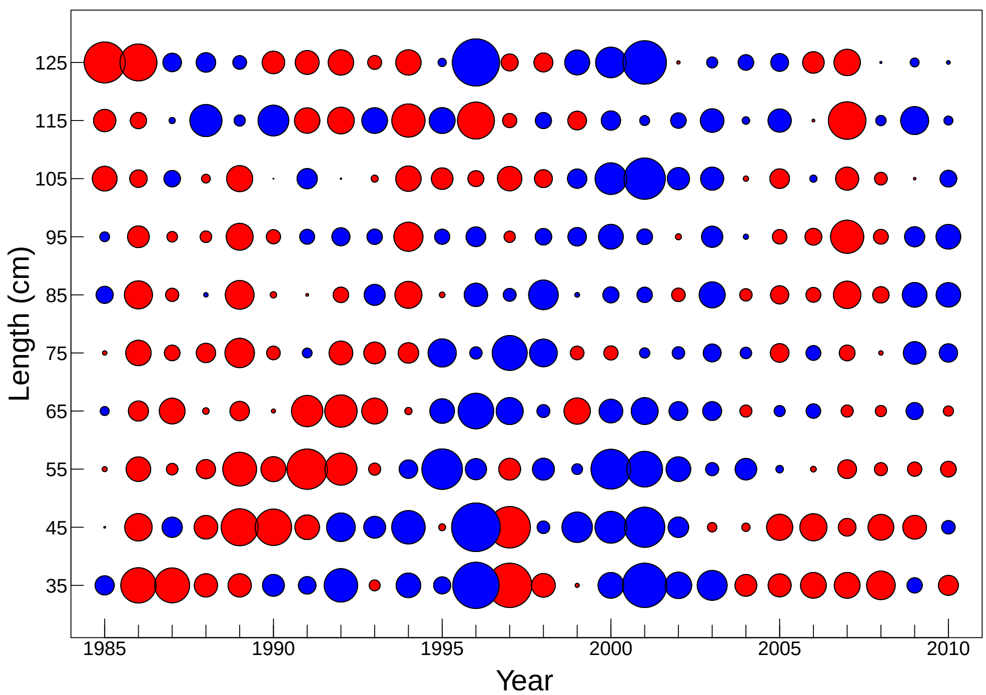

**Figure 13:** Ling in Va. Residuals from the fit between model and survey indices. The red circles indicate positive trends (model below survey). Largest residuals correspond to log(obs/mod)=1.

## 4.3 Estimates

According to the model, recruitment has increased rapidly in recent years and fishing mortality has remained more or less staple at around 0.4. Spawning stock biomass is estimated at record high level (Figure 14).

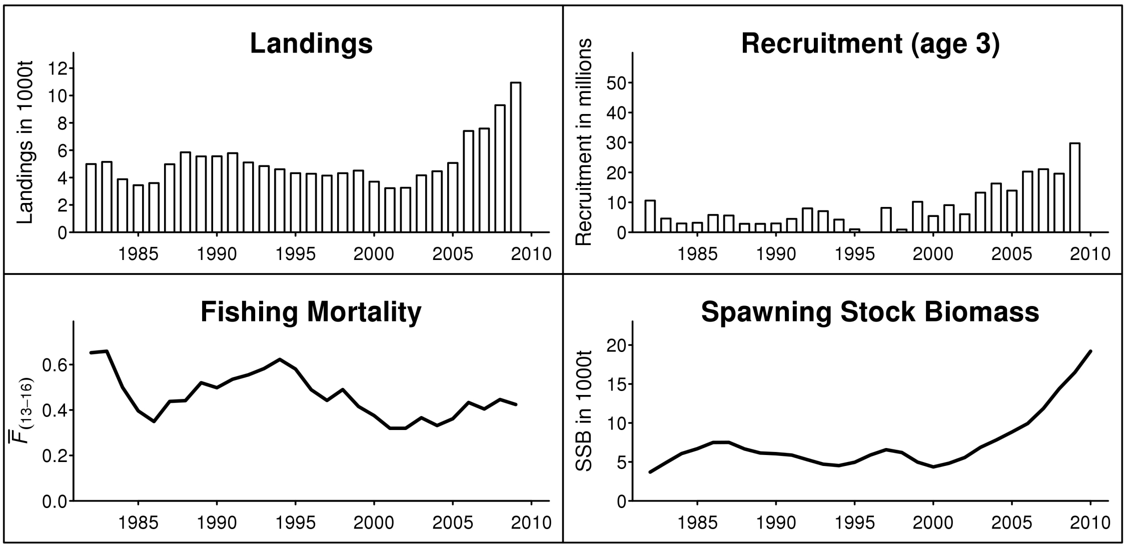


**Figure 14:** Ling in Va. Landings, estimates of recruitment, spawning stock biomass trends and fishing mortality $\bar{F}_{13-16}$ from Gadget.

# 5 Alternative model - New ageing

As described in the next section there are strong indications that the ageing data available from before 1999 may not be accurate the model was re-run using all the same settings as before. The difference in short is that the old age data was discarded and replaced with survey and longline data from 2010. Similarly the ml.c component was dropped and the ml.s component updated.

## 5.1 Age data

In order to anchor the model at the end of the time series a few otoliths were aged that were sampled in 2010. The results indicate a similar problem as encountered in tusk in Va, namely the ling appears to grow faster in recent years. This can be seen clearly in figure 15. Obviously this has to be looked into and steps are being taken to address this.

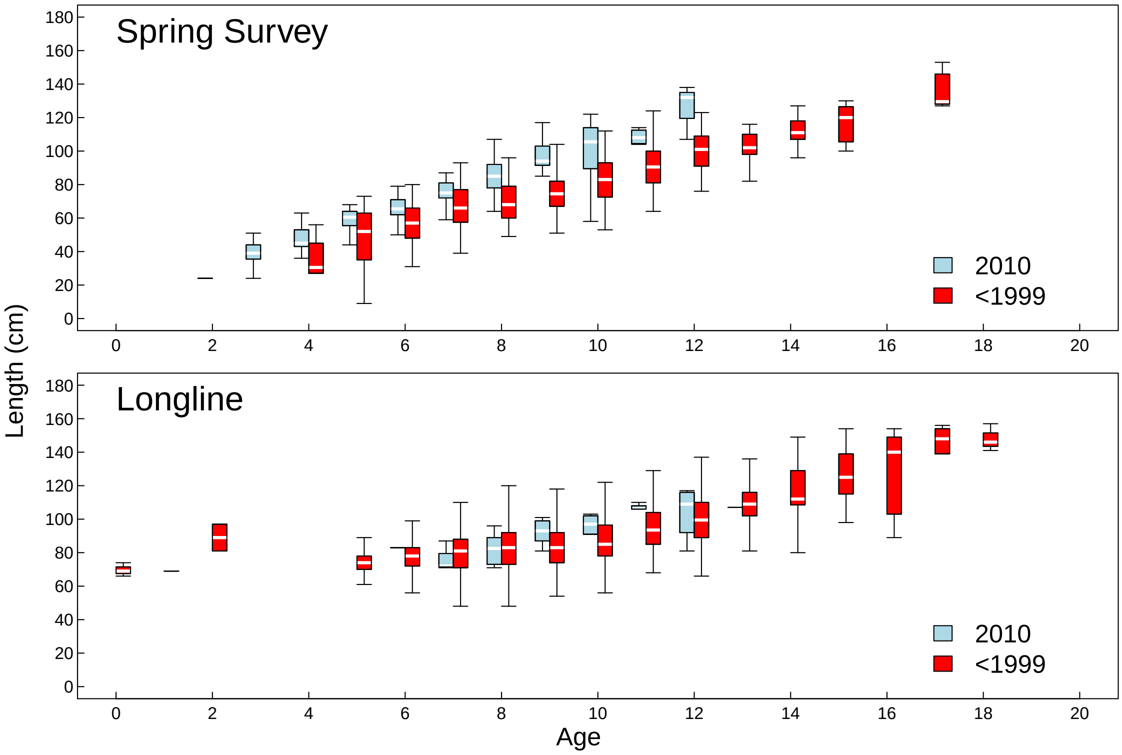


**Figure 15:** Ling in Va. Comparison of length at age between aged otolith from 2010 and before 1999.

## 5.2 Likelihood components

The re-iterative weighting procedure was used to assign weights to the likelihood components in the model. The results are presented in table 9 on page 23. The resulting weight of individual components is presented in table 8. The weights using the new ageing data are quite similar as those obtained with the old ageing data (Table 6). This results in the predicted survey indices between the two models are quite similar (Figure 16).

**Table 8:** Ling in Va. Likelihood weighing in the GADGET model for ling.

| Component | Weight | Minimum | % Minimum |
|---|---|---|---|
| bounds | 10.00 | 0.00 | 0.00 |
| Understocking | 1.00 | 0.00 | 0.00 |
| si3039 | 1.68 | 22.38 | 0.29 |
| si4049 | 2.24 | 23.32 | 0.30 |
| si5059 | 4.17 | 29.09 | 0.38 |
| si6069 | 11.06 | 34.94 | 0.46 |
| si70180 | 6.03 | 197.43 | 2.58 |
| ld.l | 0.12 | 2948.37 | 38.46 |
| ld.g | 0.17 | 778.00 | 10.15 |
| ld.t | 0.19 | 1511.15 | 19.71 |
| ld.s | 0.09 | 1330.36 | 17.35 |
| alk.l | 1.01 | 125.24 | 1.63 |
| alk.s | 0.24 | 133.05 | 1.74 |
| ml.s | 0.01 | 532.80 | 6.95 |

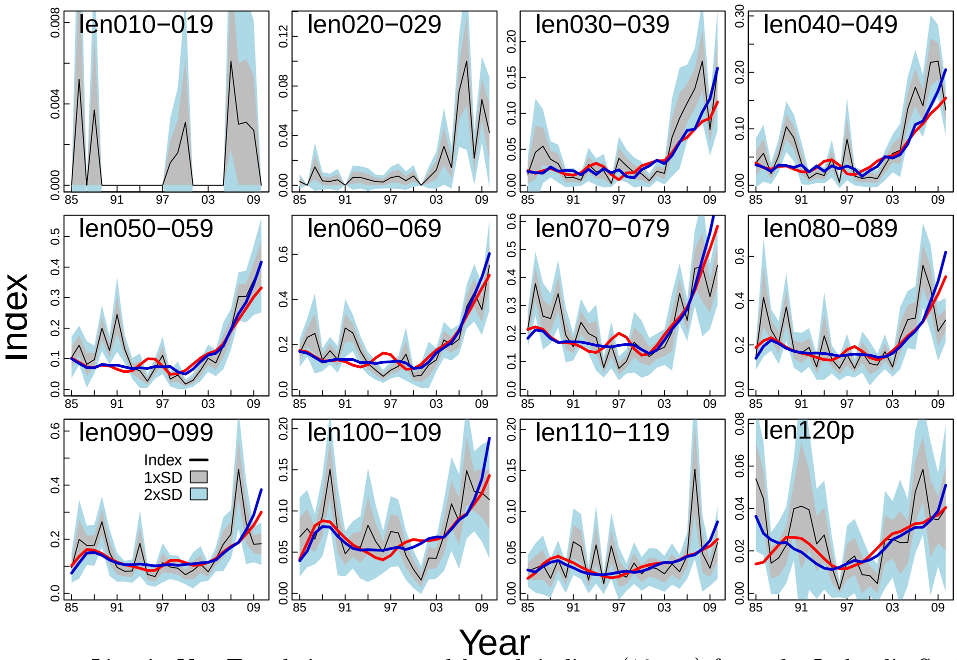


**Figure 16:** Ling in Va. Trends in aggregated length indices (10 cm) from the Icelandic Spring (March) Groundfish Survey (points) and predictions from the Gadget model using older age data (red line) and new age data (blue line)

**Table 9:** Ling in Va. Results of the re-iterative procedure, likelihood component scores (columns) when one component is heavily weighed (rows). Survey indices (indices), ldist.survey and alkeys.survey (alk.ld.s) were grouped together. The top table shows the absolute score while the lower shows the score relative to the minimum.

| Component | si3039 | si4049 | si5059 | si6069 | si70180 | ld.l | ld.g | ld.t | ld.s | alk.l | alk.s | ml.s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Results** | | | | | | | | | | | | |
| base | 10.92 | 9.45 | 7.74 | 2.73 | 27.95 | 22230.00 | 5124.00 | 6482.00 | 15210.00 | 109.10 | 489.80 | 44640.00 |
| indices | 15.51 | 11.63 | 6.24 | 2.35 | 25.87 | 47890.00 | 12120.00 | 9866.00 | 14840.00 | 134.90 | 991.30 | 54770.00 |
| alkld.s | 14.21 | 10.29 | 5.82 | 2.49 | 38.75 | 62430.00 | 10990.00 | 23310.00 | 14290.00 | 132.70 | 472.00 | 44180.00 |
| ld.l | 17.88 | 15.51 | 8.64 | 7.54 | 369.50 | 20560.00 | 19580.00 | 11460.00 | 19730.00 | 182.50 | 1037.00 | 49460.00 |
| ld.g | 60.79 | 36.03 | 19.09 | 7.85 | 442.60 | 204400.00 | 4679.00 | 24550.00 | 29670.00 | 147.20 | 1815.00 | 67590.00 |
| ld.t | 64.01 | 48.85 | 33.73 | 43.67 | 649.20 | 38520.00 | 5483.00 | 5945.00 | 31980.00 | 224.20 | 1642.00 | 76960.00 |
| alk.l | 38.04 | 30.08 | 11.98 | 7.27 | 55.71 | 295400.00 | 6909.00 | 8029.00 | 26890.00 | 31.71 | 665.10 | 43010.00 |
| ml.s | 17.16 | 10.05 | 6.93 | 3.14 | 37.38 | 28180.00 | 5840.00 | 9105.00 | 22490.00 | 138.90 | 511.10 | 42400.00 |
| **Standardized results** | | | | | | | | | | | | |
| base | 1.00 | 1.00 | 1.33 | 1.16 | 1.08 | 1.08 | 1.10 | 1.09 | 1.06 | 3.44 | 1.04 | 1.05 |
| indices | 1.42 | 1.23 | 1.07 | 1.00 | 1.00 | 2.33 | 2.59 | 1.66 | 1.04 | 4.25 | 2.10 | 1.29 |
| alkld.s | 1.30 | 1.09 | 1.00 | 1.06 | 1.50 | 3.04 | 2.35 | 3.92 | 1.00 | 4.18 | 1.00 | 1.04 |
| ld.l | 1.64 | 1.64 | 1.48 | 3.21 | 14.28 | 1.00 | 4.18 | 1.93 | 1.38 | 5.76 | 2.20 | 1.17 |
| ld.g | 5.57 | 3.81 | 3.28 | 3.34 | 17.11 | 9.94 | 1.00 | 4.13 | 2.08 | 4.64 | 3.85 | 1.59 |
| ld.t | 5.86 | 5.17 | 5.79 | 18.58 | 25.09 | 1.87 | 1.17 | 1.00 | 2.24 | 7.07 | 3.48 | 1.82 |
| alk.l | 3.48 | 3.18 | 2.06 | 3.09 | 2.15 | 14.37 | 1.48 | 1.35 | 1.88 | 1.00 | 1.41 | 1.01 |
| ml.s | 1.57 | 1.06 | 1.19 | 1.34 | 1.44 | 1.37 | 1.25 | 1.53 | 1.57 | 4.38 | 1.08 | 1.00 |
| df* | 26 | 26 | 26 | 26 | 156 | 2769 | 728 | 1294 | 1288 | 32 | 112 | 494 |

### 5.3 Estimates

As is to be expected from above is that the estimates of recruitment, spawning stock biomass and fishing mortality are quite similar between the two models. The SSB is in most cases slightly lower with the new ageing data and sub-sequentially estimates of fishing mortality are higher for most of the time series (Figure 17),

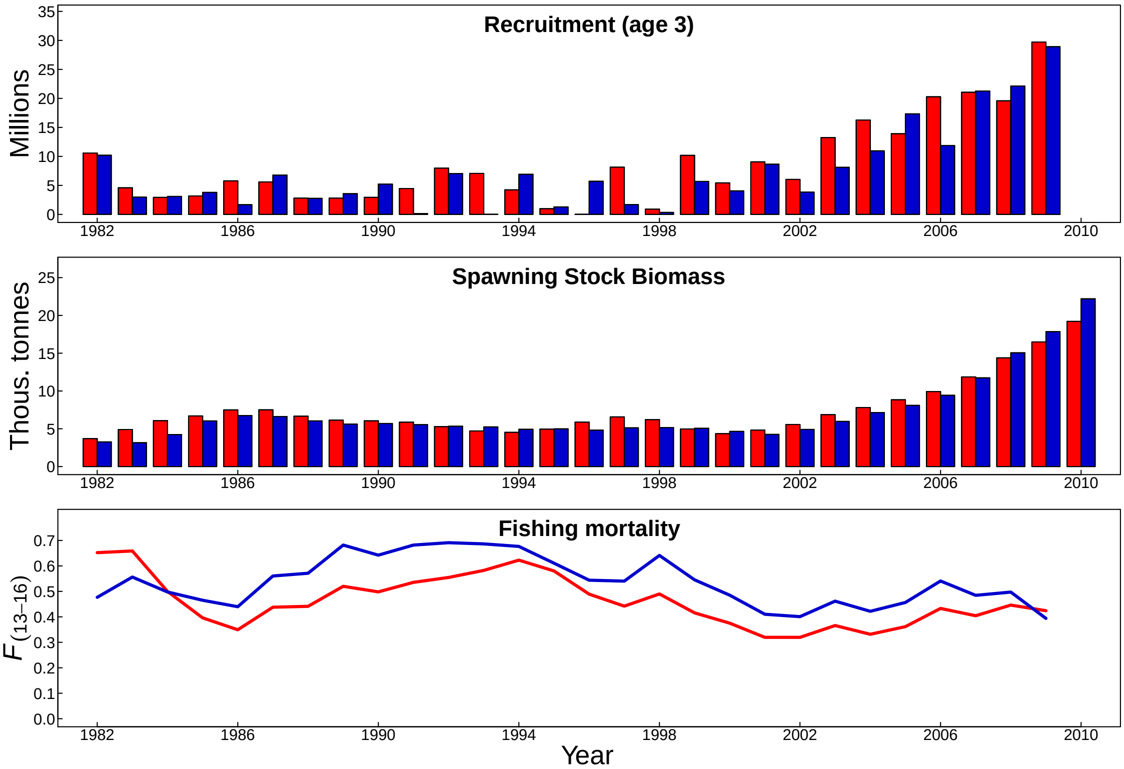


**Figure 17:** Ling in Va. Landings, estimates of recruitment, spawning stock biomass trends and fishing mortality $\bar{F}_{13-16}$ from Gadget.

## 6 Conclusions

In short the Gadget model does seem to fit reasonably well to the observed data. Therefore this exercise is promising and there does not seem to be any major problem with using Gadget as an assessment model for ling in Va.

There is however the question with the ageing and this has to be explored in much greater detail. In an attempt to clarify this the following steps will be taken:

1) Part of older age data will be re-read to see if there is discrepancy between the ageing or if growth has changed.
2) Ling is routinely aged in the Faroe Islands (Vb) and there will be an otolith exchange between the two nation to calibrate ageing.

Finally the Marine Research Institute in Reykjavik has finally decided to start routine ageing of ling and tusk so in the very near future a decent amount of aged material should be available for assessment purposes.

Working Document

*Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources*
*WGDEEP 2011*

# Greater silver smelt (*Argentina silus*) in Faroese area (Division Vb)

## Distribution and assessment

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## Introduction

The biology of greater silver smelt in the North Atlantic is poorly known, especially in terms of stock definitions and genetics. However, an investigation of genetics in Faroese waters will be initiated in 2011, and, hopefully, cast some light onto the stock definition of greater silver smelt in Faroese waters.

It is to be expected that a slow growing deepwater species is not very resilient to exploitation. Hence, there is a need to get estimates of stock size and fishing mortality of greater silver smelt in Faroese waters. Faroe Marine Research Institute has gathered data on length, weight and age twice a month of the directed fishery for greater silver smelt since 1994. Logbooks from the commercial fishery (date, position, catch etc., CPUE) are available since 1995. CPUE, lengths and weights of greater silver smelt are also available from the two annual demersal trawl surveys for cod, haddock and saithe (spring survey: 1994 onwards, summer survey: 1996 onwards).

An effort has been made to assess the stock size and fishing mortality of greater silver smelt in Faroese waters. An implicit assumption is, of course, that the exchange rate to other stocks/units is not great. The motivation to perform the stock-assessment was an application from the Faroese fishing industry to Marine Stewardship Council to get the fishery for greater silver smelt classified as sustainable. The stock assessment is presented in this working document. One of the greatest problems in the assessment was that there was not much contrast in the tuning series, i.e., the CPUE was more or less constant during the period.

## Management regulations

The major demersal fish stocks in Faroese waters are regulated by a combination of allowed effort (numbers of fishing days) and closed areas, not by TAC's. The effort management system was adopted in June 1996. The directed fishery for greater silver smelt started in 1994 and has not been formally included in the effort management system. In practice, however, the extent of the fishery for greater silver smelt has been limited to a few pair trawlers (1-3 pairs) operating during the summer months (April-September). In order to harvest the stock in a sustainable way, the fishery has adopted their own harvest-control rule in the sense that they don't fish more than 20 thousand tonnes per year (in the WGDEEP 2009 report is an exploratory assessment for Faroese waters presented, with 20 thousand tonnes per year set as an upper limit for a sustainable fishery). Minimum landing size is 28 cm.

## Size composition

The majority of the landed greater silver smelt in Faroese waters ranged between 4 and 14 years, corresponding to a length range between 30 and 45 cm (Figure 1). The composition shifted to lower ages and hence shorter lengths the first six years (1994-1999) of commercial exploitation and has remained stable since then (or probably increased somewhat the last three years). The size composition from the groundfish surveys does not show the same shift to smaller fish (Figure 2), although these diagrams are noisier than the diagrams from the commercial landings. The shift to lower size and age is probably a response to a new fishery on a virgin population where the largest individuals are fished out.

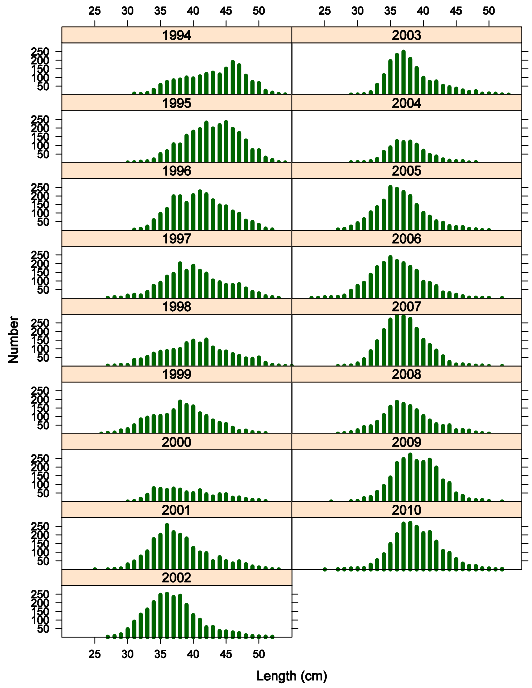


**Figure 1 a**. Length distribution from the landings.

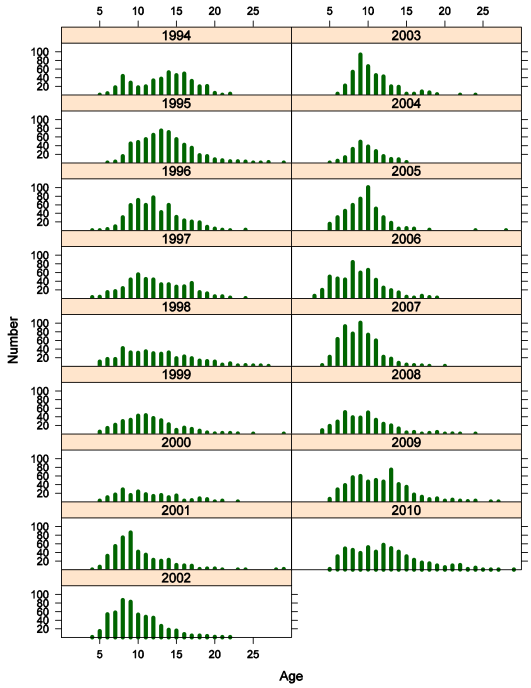


**Figure 1 b**. Age distribution from the landings

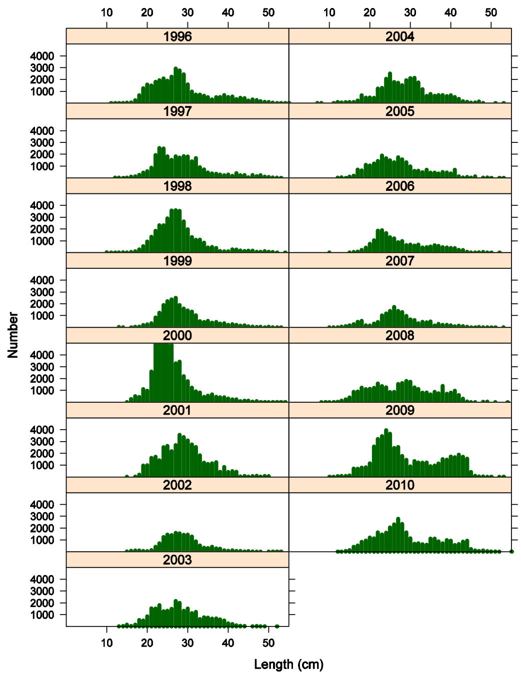


**Figure 2**. Length distribution from the annual Faroese groundfish summer survey.

## Geographical range of this fishery

The geographical range of the directed silver smelt fishery in Faroe Island is inside the 200 nm EEZ, in depths below 350 m. The main fishing areas are west of the islands, around the banks and on the ridge south of the islands (Figure 3).

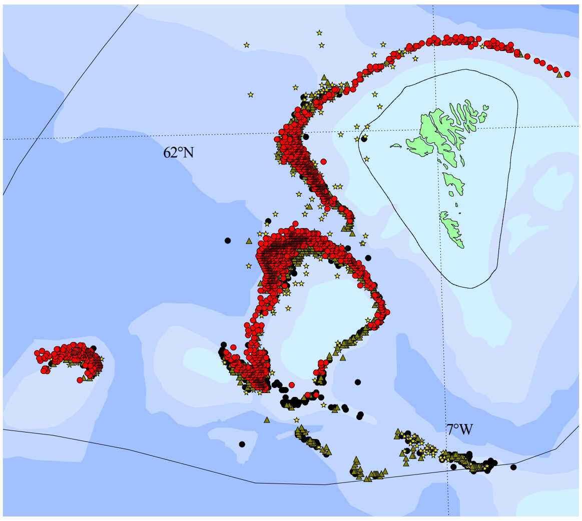


**Figure 3**. Distribution of commercial trawl hauls containing more than 50% greater silver smelt (1995-2009).

**CPUE**

There are several abundance indices available of greater silver smelt in Faroese waters. Two are based on the annual surveys in March (spring) and August (summer), respectively (Figure 4), and one is based on the commercial fishery (Figure 5). A standardized version of the commercial CPUE series is used as tuning-series in the XSA assessment model. There is overall a small increase in the commercial CPUE series. The period from 1995 to 1997 is not used in the tuning-series, because it is handled as a "learning" period, i.e., the CPUE is not believed to be proportional to stock abundance in those years. Mean CPUE from 1998 to 2009 is about 2000 kg/hour.

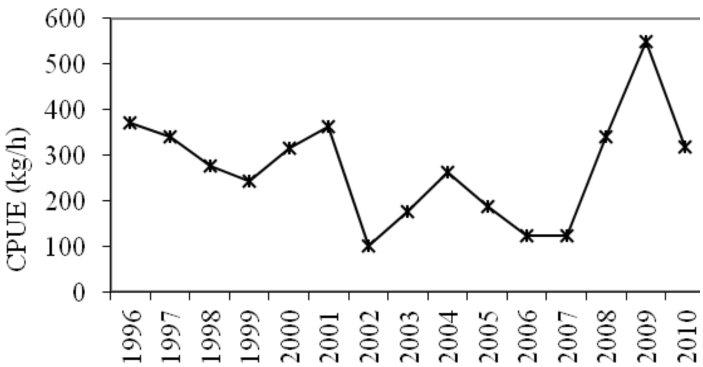


**Figure 4**. Standardized CPUE of greater silver smelt from the annual Faroese groundfish summer surveys.

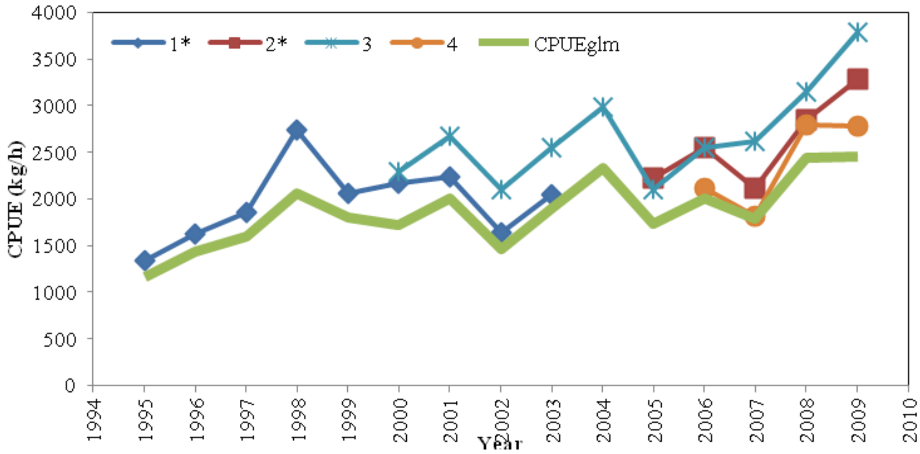


**Figure 5**. CPUE (kg/h) for different pairs of pair-trawlers (numbered 1 to 4, *means that the logbook data are stored in a database at the Institute and they are quality checked). CPUEglm is the predicted CPUE from a GLM where each haul was standardized by area, month and pair.

## Assessment

No formal stock assessment is available for greater silver smelt in Faroese waters. The reason is partially that the stock structure of greater silver smelt in the North Atlantic Ocean is uncertain. At the present time, the greater silver smelt population at Iceland is regarded as a stock unit whereas all other populations (off British Isles, Faroes, Norwegian coast) are not allocated to stock units (WGDEEP 2010). There is clearly a need for more genetic work, but it has proven difficult to get funding for this. In the absence of accepted stock units, it is not possible to assess the abundance of greater silver smelt in the various parts of the North Atlantic Ocean (probably except at Iceland).

Despite these difficulties, the Faroe Marine Research Institute has made an effort to assess the local abundance of greater silver smelt in Faroese waters. Although there might be some migrations to and from neighbouring populations of greater silver smelt, the extent of it might be limited. Also, the exchange occurring before recruitment is no problem as long as the extent of exchange is limited for the ages considered by the assessment. It is believed that these assumptions may be as valid as for saithe in Faroese waters, which is accepted as a separate management unit, and for which there has been an accepted stock assessment for decades (see ICES North Western Working Group, Faroe saithe).

An age-based stock assessment was performed (eXtended Survivor Analysis, XSA). The input files were:
1) landings (in tonnes),
2) catch number at age (appendix 1),
3) catch weights at age (from the commercial fleet, appendix 2),
4) stock weight at age (same as catch weight at age),
5) natural mortality (M),
6) proportion mature at age (appendix 3),
7) proportion of M before spawning (set to 0),
8) proportion of F before spawning (set to 0), and
9) a tuning fleet (the standardized pair trawler series, appendix 4).

The instantaneous mortality rate (M) was estimated at 0.10. For the virgin population in 1995, it was observed that 20% of the fish in the catch were 14+ years old (mean age of about 18 years). This corresponds to a natural mortality of 0.11, i.e., justifies the choice of M=0.10.

Other settings in the stock assessment were as follows. The youngest age group in the catch-at-age was age 4 years. Ages 14+ were put in the plus group, thus omitting the problem of low, or imprecisely estimated catch numbers of older fish. The tuning considered ages 6 to 13. The catchability was considered independent of stock for ages < 6 years, and independent of age for ages ≥ 11 years. The XSA run was performed with default settings, e.g., applying shrinkage of 0.5 and tapered weighting of the CPUE. See Appendix 5 for more information.

The quality of the XSA run can be judged by the correspondence between the tuning series and the catch-at-age matrix, i.e., how large the logQ residuals are (Figure 6). Many of them are less than 0.5, and are not worse than for Faroe saithe.

The results from the stock assessment show that the stock size, on average, has been around 145 thousand tonnes in these years, and that the recruitment has been rather stable (Table 1, Figure 7). The fishing mortality is at the same level as the natural mortality.

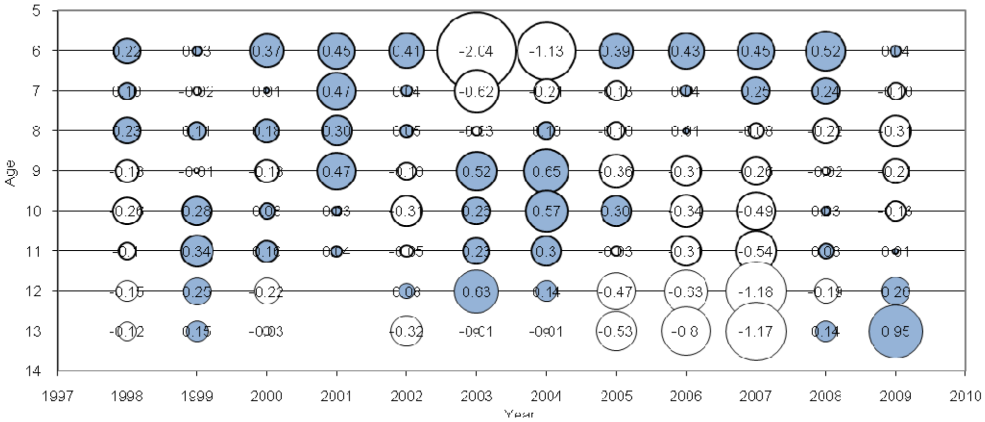


**Figure 6**. Log catchability residuals for age groups 4-11 from XSA.

Preliminary runs indicated that the settings (e.g. having plus-group of 14+ or 20+) had big influences on the results, and average biomasses ranging from 70 thousand to 500 thousand tonnes were obtained from these runs. This is probably not so strange, since there is little variation in the abundance index (commercial CPUE). In order to investigate a likely level of the biomass, the proportion of survey hauls that contained at least one individual of greater silver smelt was calculated and compared similar values for Faroe saithe (where the stock size is known). The average stock size of saithe 1996-2009 was 253 thousand tonnes. The average proportion of saithe in the surveys was 74% (March) and 80% (August), on average 77%. The corresponding figures for greater silver smelt was 29% and 61%, on average 45%. One estimate of the stock size for greater silver smelt is thus: 253*45/77 = 148 thousand tonnes, i.e., quite close to the XSA estimate of 145 thousand tonnes. We left out the terminal (2009) estimates in these calculations, since they are regarded to be uncertain.

The retrospective pattern showed that the last XSA-run (up to 2009) was more optimistic in terms of lower fishing mortalities (Figure 8 a) and higher stock sizes (Figure 8 b) than the other runs. As such, the retrospective pattern shows the difficulties, mentioned earlier, to precisely estimate the stock size and fishing mortalities. Applying a shrinkage of 2.0 in the XSA-run (up to 2009) gives an average total stock size of 121 thousand tonnes and a fishing mortality of 0.12 – however, the XSA-run did not converge, and the result was highly dependent on the number of iterations. Applying the 0.5 shrinkage had the advantage that all XSA-runs in the retrospective analyses converged. If the XSA-runs prior to terminal year 2009 are taken to be more consistent, and thus more reliable than the adopted assessment, then the fishing morality, averaged over the whole period, was probably closer to 0.15 than 0.10. The average total stock size could then lie somewhere around 100 thousand tonnes rather than around 150 thousand tonnes obtained in the current assessment. Hence, it might be concluded that the total stock size, averaged over the 1995-2009 period, is somewhere between 100 and 200 thousand tonnes, and the fishing mortality somewhere between 0.10 and 0.20.

A positive correlation was found between a gyre index (see Hátún *et al*., 2005, Steingrund *et al*., 2010) and the recruitment of greater silver smelt (Figure 9 and 10). Hence, it seems that the current fishery for greater silver smelt in Faroese waters has been carried on during a high-productive period, and the long-term catch may not match the level observed the last ten years. On the other hand, however, yield-per-recruit calculations (see below) show that an increased effort (in this case by a factor of 2) would lead to a 38% higher catch (Table 2). It should be noted, however, that recruitment of greater silver smelt could be hampered at low stock sizes. No biological reference points have so far been suggested for this stock. However, the observation that the recruitment largely seems to be governed by natural conditions indicates that the stock size most likely is above any candidate for $B_{lim}$.

Yield-per-recruit calculations (selection pattern based on the years 1995-2003, weights based on 1995-2009, recruitment = 74.544 millions) showed that the current fishing mortality ($F_{multiplier}$ = 1) is below $F_{max}$ (Figure 11), thus indicating that the low fishing mortalities obtained in the XSA run are real. The yield-per-recruit curve is flat at $F_{multipliers}$ above around 4, i.e., increasing fishing mortalities by e.g. a factor of 5 or 6 will not result in greater catches, compared to a factor of 4.

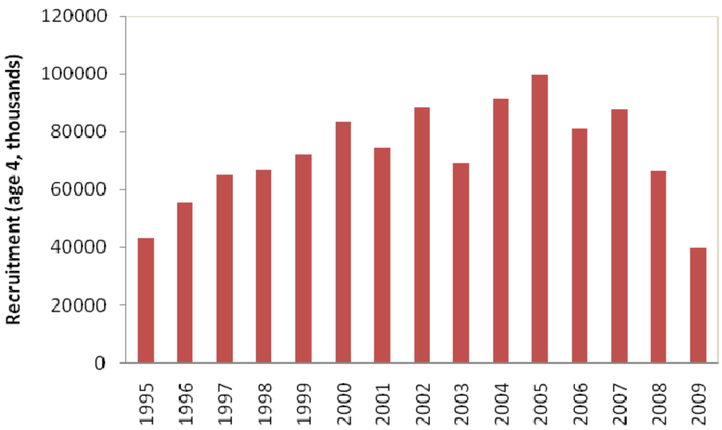


**Figure 7 a**. Recruitment (thousands) for greater silver smelt from the XSA model

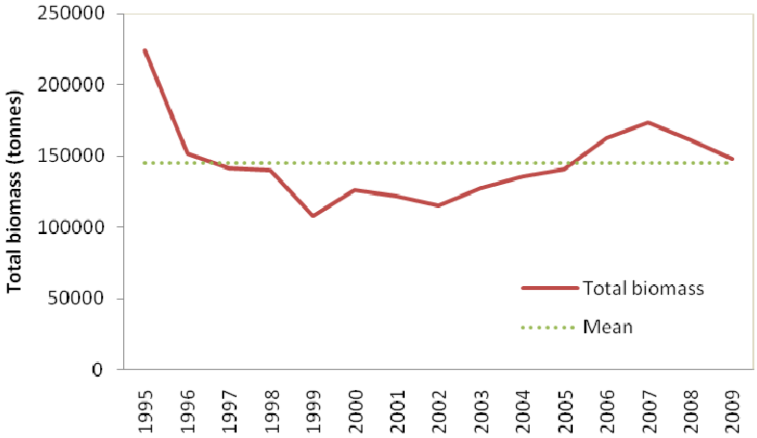


**Figure 7 b**. Total biomass (tonnes) for greater silver smelt from the XSA model.

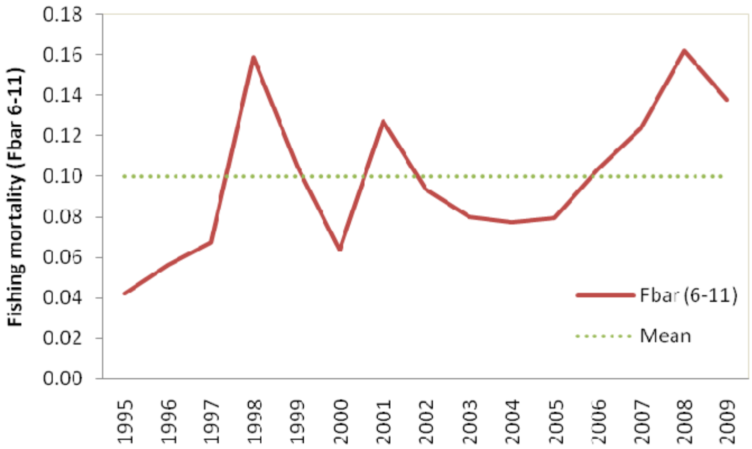


**Figure 7 c**. $F_{bar}$ (6-11) for greater silver smelt from the XSA model.

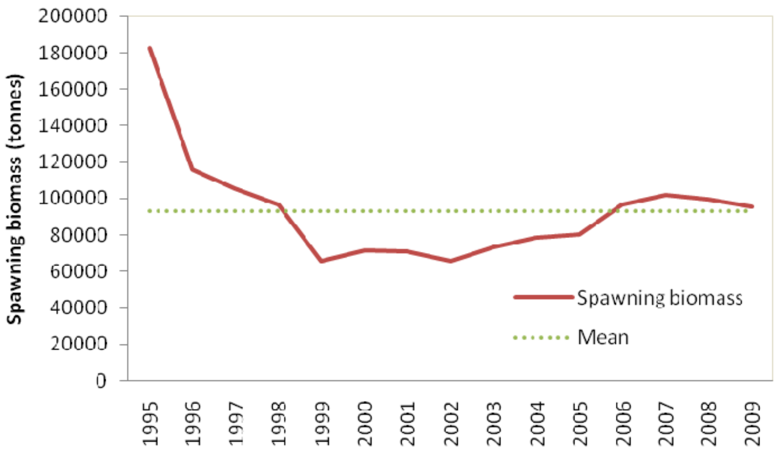


**Figure 7 d**. Spawning stock biomass for greater silver smelt from the XSA model.

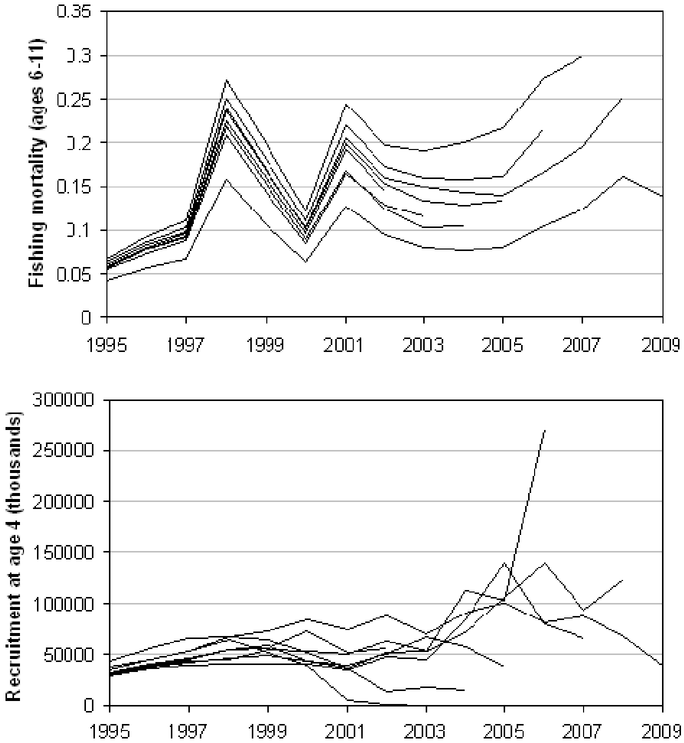


**Figure 8 a**. Retrospective pattern: Fishing mortality and recruitment.

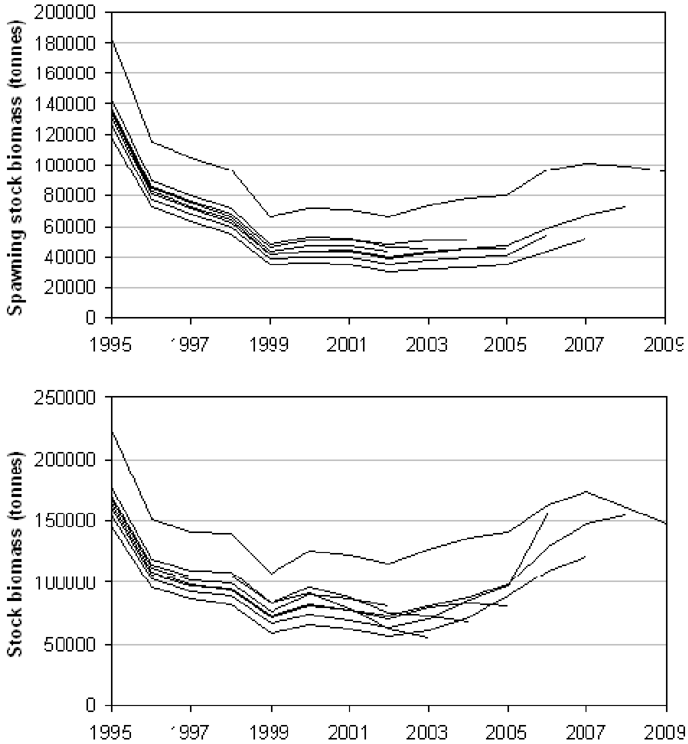


**Figure 8 b**. Retrospective pattern: Spawning stock biomass and total stock biomass.

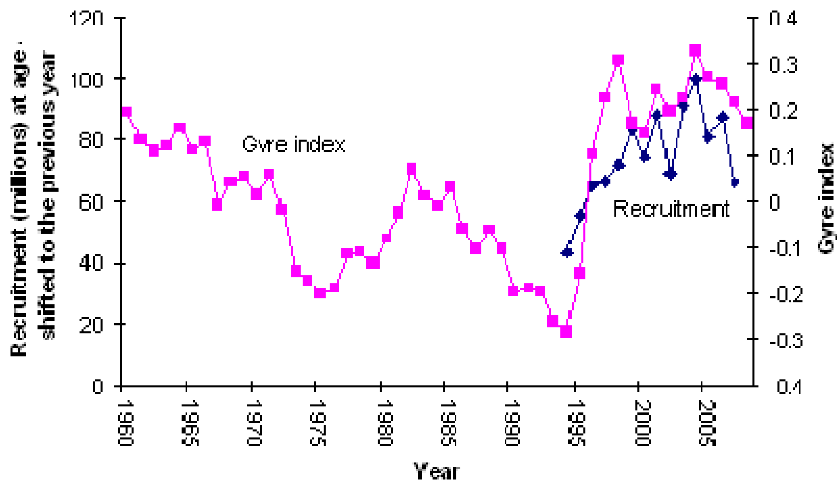


**Figure 9**. Gyre index and recruitment (age 4) of greater silver smelt (shifted one year).

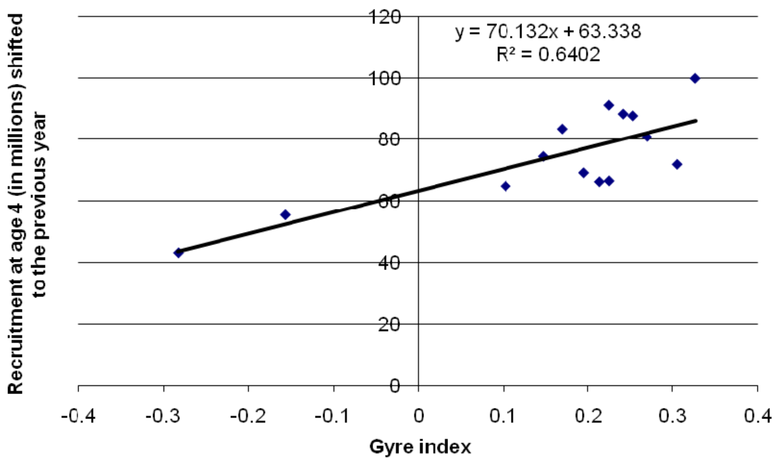


**Figure 10**. Relation between gyre index and recruitment (age 4) shifted to the previous year.

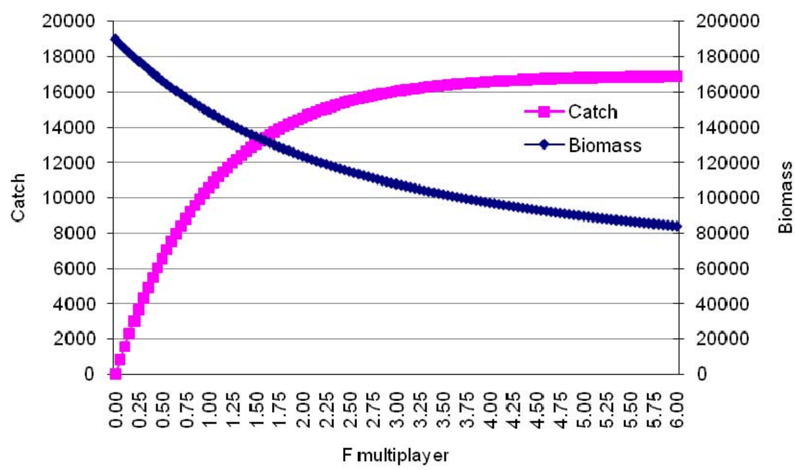


**Figure 11**. Yield with average recruitment (74544 thousands).

**Table 1**. Summary table for greater silver smelt XSA output. (Rec- recruitment, SSB- spawning stock biomass).

| Year | Rec (age 4) | Total biomass | SSB | Landings | Yield/SSB | Fbar (6-11) |
|---|---|---|---|---|---|---|
| 1995 | 43270 | 223600 | 182770 | 12286 | 0.067 | 0.042 |
| 1996 | 55521 | 151183 | 115815 | 9498 | 0.082 | 0.056 |
| 1997 | 64920 | 141208 | 105342 | 8433 | 0.080 | 0.067 |
| 1998 | 66599 | 140127 | 96844 | 17570 | 0.181 | 0.159 |
| 1999 | 71926 | 107444 | 65896 | 8214 | 0.125 | 0.105 |
| 2000 | 83480 | 125860 | 71598 | 5209 | 0.073 | 0.064 |
| 2001 | 74492 | 121739 | 70811 | 10081 | 0.142 | 0.127 |
| 2002 | 88307 | 115309 | 65615 | 7471 | 0.114 | 0.094 |
| 2003 | 69207 | 127394 | 73148 | 6549 | 0.090 | 0.080 |
| 2004 | 91158 | 135780 | 78391 | 6451 | 0.082 | 0.078 |
| 2005 | 99752 | 140591 | 80305 | 7009 | 0.087 | 0.080 |
| 2006 | 80951 | 162778 | 96408 | 12559 | 0.130 | 0.104 |
| 2007 | 87725 | 173065 | 101840 | 14093 | 0.138 | 0.124 |
| 2008 | 66313 | 160860 | 99488 | 19249 | 0.194 | 0.162 |
| 2009 | 39692 | 147586 | 95520 | 19740 | 0.207 | 0.138 |
| Mean | 72221 | 144968 | 93319 | 10961 | 0.1195 | 0.099 |
| Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | |

**Table 2**. Yield when recruitment is low (average 1995-1996), average (1995-2008), high (1997-2008) and very high (2000-2007).

| | | | | Increased F by factor 2 | | | |
|---|---|---|---|---|---|---|---|
| Gyre Index | Recruitment | Total biomass | Catch | Total biomass | Catch | Gain | Gain (factor) |
| Low | 49396 | 98557 | 7008 | 82065 | 9641 | 2633 | 1.38 |
| Average | 74544 | 148733 | 10576 | 123846 | 14550 | 3974 | 1.38 |
| High | 78736 | 157097 | 11170 | 130810 | 15368 | 4198 | 1.38 |
| Very high | 84384 | 168366 | 11972 | 140194 | 16470 | 4499 | 1.38 |

## References


ICES WKDEEP report 2010 (page 133-198)
http://www.ices.dk/reports/ACOM/2010/WKDEEP/wkdeep_final_2010.pdf

ICES WGDEEP report 2010

ICES NWWG report 2010

Hátún, H, Sandø, A.B., Drange, H., Hansen, B., Valdimarsson, V. 2005. Influence of the Atlantic Subpolar Gyre on the Thermohaline Circulation Science 309, 1841 (2005) DOI:10.1126/science.1114777

Steingrund, P., Mouritsen, R., Reinert, J., Gaard, E., and Hátún, H. 2010. Total stock size and cannibalism regulate recruitment in cod (*Gadus morhua*) on the Faroe Plateau. ICES Journal of Marine Science, 67: 111–124.

## Appendix

**Appendix 1**. Catch numbers at age (thousands) from the commercial fleet.

| YEAR | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 10 | 10 | 40 | 203 | 847 | 2486 | 2635 | 2820 | 3377 | 4237 | 4395 |
| 1996 | 39 | 48 | 207 | 469 | 1390 | 2736 | 3226 | 2683 | 3461 | 1994 | 3181 |
| 1997 | 57 | 202 | 882 | 994 | 1340 | 2394 | 2971 | 2281 | 2244 | 1739 | 2525 |
| 1998 | 10 | 1558 | 2686 | 2963 | 5333 | 3912 | 3936 | 4143 | 3820 | 4428 | 4705 |
| 1999 | 10 | 708 | 1381 | 1780 | 2248 | 2279 | 2755 | 2706 | 2364 | 2101 | 1627 |
| 2000 | 10 | 273 | 1339 | 1448 | 2123 | 1245 | 1502 | 1213 | 831 | 963 | 898 |
| 2001 | 73 | 662 | 2612 | 3888 | 4658 | 4943 | 2303 | 1821 | 1384 | 1408 | 1401 |
| 2002 | 64 | 1023 | 2921 | 2754 | 3669 | 3342 | 1969 | 1594 | 1508 | 818 | 617 |
| 2003 | 10 | 10 | 156 | 1145 | 2572 | 4223 | 2869 | 1738 | 1656 | 749 | 897 |
| 2004 | 10 | 76 | 372 | 1270 | 2833 | 4414 | 3093 | 1827 | 1041 | 560 | 491 |
| 2005 | 10 | 1374 | 1911 | 2398 | 3096 | 2939 | 3939 | 1851 | 1024 | 651 | 185 |
| 2006 | 2100 | 4979 | 3968 | 3318 | 6183 | 4257 | 4228 | 2465 | 1291 | 963 | 776 |
| 2007 | 516 | 2351 | 5272 | 6376 | 5149 | 6205 | 3937 | 3248 | 1063 | 798 | 328 |
| 2008 | 1410 | 3046 | 4588 | 6530 | 5543 | 5591 | 6880 | 4953 | 3604 | 3116 | 2107 |
| 2009 | 10 | 903 | 3211 | 3838 | 5355 | 5895 | 4181 | 4674 | 4234 | 7294 | 4125 |

**Appendix 2**. Catch weight at age (kg) from the commercial fleet.

| YEAR | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 0.190 | 0.236 | 0.455 | 0.338 | 0.363 | 0.432 | 0.469 | 0.543 | 0.592 | 0.680 | 0.722 |
| 1996 | 0.202 | 0.224 | 0.260 | 0.294 | 0.359 | 0.373 | 0.430 | 0.485 | 0.502 | 0.624 | 0.659 |
| 1997 | 0.161 | 0.198 | 0.274 | 0.340 | 0.363 | 0.400 | 0.453 | 0.479 | 0.523 | 0.579 | 0.689 |
| 1998 | 0.190 | 0.257 | 0.268 | 0.308 | 0.398 | 0.416 | 0.470 | 0.517 | 0.529 | 0.628 | 0.636 |
| 1999 | 0.190 | 0.212 | 0.234 | 0.291 | 0.324 | 0.371 | 0.419 | 0.446 | 0.505 | 0.532 | 0.602 |
| 2000 | 0.190 | 0.288 | 0.286 | 0.345 | 0.366 | 0.377 | 0.459 | 0.517 | 0.573 | 0.598 | 0.705 |
| 2001 | 0.187 | 0.220 | 0.261 | 0.314 | 0.352 | 0.399 | 0.426 | 0.497 | 0.531 | 0.618 | 0.652 |
| 2002 | 0.146 | 0.218 | 0.254 | 0.296 | 0.353 | 0.376 | 0.406 | 0.454 | 0.506 | 0.548 | 0.639 |
| 2003 | 0.190 | 0.236 | 0.249 | 0.324 | 0.352 | 0.362 | 0.386 | 0.456 | 0.484 | 0.540 | 0.668 |
| 2004 | 0.190 | 0.218 | 0.276 | 0.304 | 0.374 | 0.374 | 0.410 | 0.455 | 0.497 | 0.563 | 0.626 |
| 2005 | 0.190 | 0.215 | 0.271 | 0.308 | 0.317 | 0.383 | 0.391 | 0.443 | 0.513 | 0.536 | 0.639 |
| 2006 | 0.210 | 0.245 | 0.298 | 0.335 | 0.350 | 0.375 | 0.418 | 0.489 | 0.513 | 0.603 | 0.645 |
| 2007 | 0.221 | 0.280 | 0.319 | 0.367 | 0.380 | 0.411 | 0.485 | 0.489 | 0.539 | 0.630 | 0.668 |
| 2008 | 0.201 | 0.254 | 0.301 | 0.356 | 0.367 | 0.371 | 0.428 | 0.472 | 0.536 | 0.579 | 0.634 |
| 2009 | 0.190 | 0.248 | 0.318 | 0.356 | 0.411 | 0.397 | 0.463 | 0.469 | 0.474 | 0.547 | 0.597 |

**Appendix 3**. Proportion mature at age

| AGE | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Prop Mature | 0.05 | 0.13 | 0.29 | 0.52 | 0.75 | 0.89 | 0.96 | 0.98 | 0.99 | 1 | 1 |

**Appendix 4**. Effort (hours) and catch in numbers at age for commercial pair trawlers (1998-2009)

Argentina Silus (ICES Div. Vb)    PairTrawl_hags_6-13.dat

101

PairTrawl >1000 HP

1998 2009

1 1 0 1

6 13

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1762 | 554 | 610 | 1099 | 806 | 811 | 854 | 787 | 912 |
| 739 | 224 | 289 | 365 | 370 | 447 | 440 | 384 | 341 |
| 2896 | 1280 | 1384 | 2030 | 1190 | 1435 | 1159 | 794 | 920 |
| 3557 | 1843 | 2744 | 3287 | 3488 | 1625 | 1285 | 977 | 993 |
| 3264 | 1871 | 1764 | 2350 | 2140 | 1261 | 1021 | 966 | 524 |
| 2779 | 125 | 918 | 2063 | 3388 | 2302 | 1394 | 1328 | 601 |
| 1133 | 152 | 519 | 1158 | 1805 | 1264 | 747 | 426 | 229 |
| 3666 | 1730 | 2171 | 2802 | 2660 | 3565 | 1675 | 927 | 590 |
| 5011 | 3168 | 2649 | 4937 | 3399 | 3375 | 1968 | 1031 | 769 |
| 6527 | 4370 | 5285 | 4268 | 5143 | 3263 | 2692 | 881 | 661 |
| 5900 | 3426 | 4877 | 4140 | 4175 | 5138 | 3699 | 2692 | 2327 |
| 6652 | 2662 | 3182 | 4439 | 4887 | 3466 | 3874 | 3510 | 6046 |

**Appendix 5**. Diagnostics from XSA (M=0.1,  sh=0.5) with commercial pair trawler tuning series.

```
Lowestoft VPA Version 3.1
    2/09/2010  15:58
 Extended Survivors Analysis

 Argentina Silus (ICES Division Vb)                 AS_IND

 CPUE data from file D:\gulllaksur\Stovnsmeting\XSA2010\NyTunserieGL4-14\PairTrawl_hags_6-13.DAT
 Catch data for  15 years. 1995 to 2009. Ages  4 to  14.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 PairTrawl >1000 HP            1998  2009    6     13    .000   1.000

 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years

 Catchability analysis :

      Catchability dependent on stock size for ages <    6
         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  6

      Catchability independent of age for ages >=   11


 Terminal population estimation :
      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.
      S.E. of the mean to which the estimates  are shrunk =    .500
      Minimum standard error for population
      estimates derived from each fleet =    .300
      Prior weighting not applied

 Tuning converged after  119 iterations
```

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .751 | .820 | .877 | .921 | .954 | .976 | .990 | .997 | 1.000 | 1.000 |

Fishing mortalities

| Age | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | .000 | .001 | .001 | .000 | .000 | .000 | .028 | .006 | .023 | .000 |
| 5 | .004 | .009 | .016 | .000 | .001 | .018 | .060 | .035 | .041 | .016 |
| 6 | .026 | .048 | .046 | .003 | .005 | .036 | .059 | .075 | .081 | .051 |
| 7 | .034 | .090 | .059 | .021 | .025 | .040 | .073 | .113 | .112 | .081 |
| 8 | .070 | .132 | .103 | .065 | .059 | .071 | .122 | .140 | .122 | .114 |
| 9 | .065 | .206 | .118 | .149 | .136 | .072 | .118 | .156 | .198 | .166 |
| 10 | .093 | .147 | .106 | .127 | .140 | .155 | .127 | .137 | .231 | .200 |
| 11 | .095 | .140 | .130 | .116 | .100 | .104 | .123 | .122 | .228 | .217 |
| 12 | .065 | .134 | .148 | .173 | .085 | .067 | .089 | .064 | .174 | .277 |
| 13 | .078 | .134 | .098 | .091 | .073 | .063 | .075 | .065 | .243 | .553 |

XSA population numbers (Thousands)

| | AGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 2000 | 8.35E+04 | 6.51E+04 | 5.38E+04 | 4.54E+04 | 3.30E+04 | 2.08E+04 | 1.78E+04 | 1.41E+04 | 1.39E+04 | 1.34E+04 |
| 2001 | 7.45E+04 | 7.55E+04 | 5.86E+04 | 4.74E+04 | 3.97E+04 | 2.79E+04 | 1.77E+04 | 1.47E+04 | 1.16E+04 | 1.18E+04 |
| 2002 | 8.83E+04 | 6.73E+04 | 6.77E+04 | 5.06E+04 | 3.92E+04 | 3.15E+04 | 2.05E+04 | 1.38E+04 | 1.15E+04 | 9.18E+03 |
| 2003 | 6.92E+04 | 7.98E+04 | 6.00E+04 | 5.85E+04 | 4.31E+04 | 3.20E+04 | 2.53E+04 | 1.67E+04 | 1.10E+04 | 9.01E+03 |
| 2004 | 9.12E+04 | 6.26E+04 | 7.22E+04 | 5.41E+04 | 5.18E+04 | 3.66E+04 | 2.49E+04 | 2.02E+04 | 1.34E+04 | 8.34E+03 |
| 2005 | 9.98E+04 | 8.25E+04 | 5.66E+04 | 6.50E+04 | 4.77E+04 | 4.42E+04 | 2.89E+04 | 1.96E+04 | 1.65E+04 | 1.12E+04 |
| 2006 | 8.10E+04 | 9.02E+04 | 7.33E+04 | 4.94E+04 | 5.65E+04 | 4.03E+04 | 3.72E+04 | 2.24E+04 | 1.60E+04 | 1.40E+04 |
| 2007 | 8.77E+04 | 7.13E+04 | 7.69E+04 | 6.26E+04 | 4.15E+04 | 4.53E+04 | 3.24E+04 | 2.96E+04 | 1.79E+04 | 1.33E+04 |
| 2008 | 6.63E+04 | 7.89E+04 | 6.22E+04 | 6.46E+04 | 5.05E+04 | 3.27E+04 | 3.51E+04 | 2.55E+04 | 2.37E+04 | 1.52E+04 |
| 2009 | 3.97E+04 | 5.87E+04 | 6.85E+04 | 5.19E+04 | 5.22E+04 | 4.05E+04 | 2.42E+04 | 2.52E+04 | 1.84E+04 | 1.80E+04 |

Estimated population abundance at 1st Jan 2010

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0.00E+00 | 3.59E+04 | 5.22E+04 | 5.89E+04 | 4.34E+04 | 4.22E+04 | 3.10E+04 | 1.80E+04 | 1.83E+04 | 1.26E+04 |

Taper weighted geometric mean of the VPA populations:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7.27E+04 | 6.78E+04 | 5.95E+04 | 5.00E+04 | 4.18E+04 | 3.33E+04 | 2.61E+04 | 2.09E+04 | 1.67E+04 | 1.39E+04 |

Standard error of the weighted Log(VPA populations) :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .2619 | .2056 | .2231 | .2304 | .2379 | .2439 | .2642 | .2847 | .3110 | .4117 |

Log catchability residuals.

Fleet : PairTrawl >1000 HP

| Age | 1998 | 1999 |
|---|---|---|
| 6 | .22 | .03 |
| 7 | .10 | -.02 |
| 8 | .23 | .11 |
| 9 | -.18 | -.01 |
| 10 | -.26 | .28 |
| 11 | -.10 | .34 |
| 12 | -.15 | .25 |
| 13 | -.12 | .15 |

| Age | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | .37 | .45 | .41 | -2.04 | -1.13 | .39 | .43 | .45 | .52 | .04 |
| 7 | .01 | .47 | .04 | -.62 | -.21 | -.13 | .04 | .25 | .24 | -.10 |
| 8 | .18 | .30 | .05 | -.03 | .10 | -.10 | .01 | -.08 | -.22 | -.31 |
| 9 | -.18 | .47 | -.10 | .52 | .65 | -.36 | -.31 | -.26 | -.02 | -.21 |
| 10 | .08 | .03 | -.31 | .26 | .57 | .30 | -.34 | -.49 | .03 | -.13 |
| 11 | .16 | .04 | -.05 | .23 | .30 | -.03 | -.31 | -.54 | .08 | .01 |
| 12 | -.22 | .00 | .08 | .63 | .14 | -.47 | -.63 | -1.18 | -.19 | .26 |
| 13 | -.03 | .00 | -.32 | -.01 | -.01 | -.53 | -.80 | -1.17 | .14 | .95 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| Age | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|
| Mean Log q | -12.0136 | -11.4039 | -10.8570 | -10.5740 | -10.4718 | -10.5348 | -10.5348 | -10.5348 |
| S.E(Log q) | .8121 | .2784 | .1798 | .3569 | .3253 | .2575 | .5205 | .5878 |

```
Regression statistics :
 Ages with q independent of year class strength and constant w.r.t. time.
 Age  Slope   t-value   Intercept  RSquare  No Pts  Reg s.e   Mean Q
  6     1.19     -.086      12.19      .02      12     1.02   -12.01
  7     1.22     -.388      11.53      .26      12      .36   -11.40
  8     1.80    -2.035      11.01      .43      12      .28   -10.86
  9     1.49     -.710      10.65      .19      12      .55   -10.57
 10     1.56     -.865      10.65      .22      12      .51   -10.47
 11     2.10    -1.778      11.23      .23      12      .49   -10.53
 12     4.75    -1.276      14.50      .01      12     2.29   -10.68
 13      .69      .726      10.31      .39      12      .40   -10.69

 Terminal year survivor and F summaries :

 Age  4   Catchability dependent on age and year class strength
 Year class = 2005
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP                  1.    .000        .000     .00    0   .000       .000
   P shrinkage mean        67822.     .21                             .855      .000
   F shrinkage mean          834.     .50                             .145      .011

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     35907.        .19     10.60     2   55.765    .000

 Age  5   Catchability dependent on age and year class strength
 Year class = 2004
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP                  1.    .000        .000     .00    0   .000       .000
   P shrinkage mean        59472.     .22                             .834      .014
   F shrinkage mean        27185.     .50                             .166      .031

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     52222.        .20     10.87     2   53.335    .016

 Age  6   Catchability constant w.r.t. time and dependent on age
 Year class = 2003
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              61176.    .850        .000     .00    1   .248       .049
   F shrinkage mean        58186.     .50                             .752      .051

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     58912.        .43       .04     2     .101    .051

 Age  7   Catchability constant w.r.t. time and dependent on age
 Year class = 2002
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              41725.    .283        .189     .67    2   .741       .084
  F shrinkage mean        48367.     .50                             .259      .073

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     43354.        .25       .13     3     .515    .081
```

```
Age  8   Catchability constant w.r.t. time and dependent on age
 Year class = 2001
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              41259.    .206        .204     .99    3   .832       .116
   F shrinkage mean        46981.     .50                              .168      .103

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     42170.        .19       .15     4     .810    .114

 Age  9   Catchability constant w.r.t. time and dependent on age
 Year class = 2000
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              29854.    .181        .137     .76    4   .850       .172
   F shrinkage mean        38440.     .50                              .150      .136

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     31008.        .17       .12     5     .699    .166

 Age 10   Catchability constant w.r.t. time and dependent on age
 Year class = 1999
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              17242.    .162        .049     .30    5   .862       .208
   F shrinkage mean        23216.     .50                              .138      .158

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     17963.        .16       .06     6     .412    .200

 Age 11   Catchability constant w.r.t. time and dependent on age
 Year class = 1998
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              17109.    .145        .083     .57    6   .880       .231
   F shrinkage mean        30583.     .50                              .120      .136

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     18344.        .14       .11     7     .769    .217

 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11
 Year class = 1997
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP              10638.    .140        .144    1.03    7   .871       .321
   F shrinkage mean        39989.     .50                              .129      .096

 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
     12628.        .14       .22     8    1.587    .277

 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11
 Year class = 1996
 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 PairTrawl >1000 HP               7403.    .137        .159    1.16    8   .838       .661
   F shrinkage mean        32189.     .50                              .162      .195
 Weighted prediction :
 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      9389.        .14       .25     9    1.775    .553
```

**Appendix 6**. Fishing mortality (F) at age.

| YEAR\AGE | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ | FBAR (6-11) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.07 | 0.07 | 0.09 | 0.13 | 0.07 | 0.07 | 0.04 |
| 1996 | 0.00 | 0.00 | 0.01 | 0.02 | 0.04 | 0.09 | 0.11 | 0.08 | 0.14 | 0.09 | 0.09 | 0.06 |
| 1997 | 0.00 | 0.00 | 0.03 | 0.03 | 0.05 | 0.09 | 0.11 | 0.09 | 0.08 | 0.09 | 0.09 | 0.07 |
| 1998 | 0.00 | 0.03 | 0.06 | 0.11 | 0.21 | 0.18 | 0.19 | 0.21 | 0.20 | 0.20 | 0.20 | 0.16 |
| 1999 | 0.00 | 0.01 | 0.03 | 0.05 | 0.10 | 0.11 | 0.17 | 0.17 | 0.16 | 0.14 | 0.14 | 0.11 |
| 2000 | 0.00 | 0.00 | 0.03 | 0.03 | 0.07 | 0.06 | 0.09 | 0.09 | 0.06 | 0.08 | 0.08 | 0.06 |
| 2001 | 0.00 | 0.01 | 0.05 | 0.09 | 0.13 | 0.21 | 0.15 | 0.14 | 0.13 | 0.13 | 0.13 | 0.13 |
| 2002 | 0.00 | 0.02 | 0.05 | 0.06 | 0.10 | 0.12 | 0.11 | 0.13 | 0.15 | 0.10 | 0.10 | 0.09 |
| 2003 | 0.00 | 0.00 | 0.00 | 0.02 | 0.06 | 0.15 | 0.13 | 0.12 | 0.17 | 0.09 | 0.09 | 0.08 |
| 2004 | 0.00 | 0.00 | 0.01 | 0.03 | 0.06 | 0.14 | 0.14 | 0.10 | 0.08 | 0.07 | 0.07 | 0.08 |
| 2005 | 0.00 | 0.02 | 0.04 | 0.04 | 0.07 | 0.07 | 0.15 | 0.10 | 0.07 | 0.06 | 0.06 | 0.08 |
| 2006 | 0.03 | 0.06 | 0.06 | 0.07 | 0.12 | 0.12 | 0.13 | 0.12 | 0.09 | 0.08 | 0.08 | 0.10 |
| 2007 | 0.01 | 0.04 | 0.07 | 0.11 | 0.14 | 0.16 | 0.14 | 0.12 | 0.06 | 0.07 | 0.07 | 0.12 |
| 2008 | 0.02 | 0.04 | 0.08 | 0.11 | 0.12 | 0.20 | 0.23 | 0.23 | 0.17 | 0.24 | 0.24 | 0.16 |
| 2009 | 0.00 | 0.02 | 0.05 | 0.08 | 0.11 | 0.17 | 0.20 | 0.22 | 0.28 | 0.55 | 0.55 | 0.14 |
| FBAR | 0.01 | 0.03 | 0.07 | 0.10 | 0.13 | 0.17 | 0.19 | 0.19 | 0.17 | 0.29 | | |

**Appendix 7**. Stock number at age (start of year) (Thousands).

| YEAR\AGE | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 43270 | 42014 | 35427 | 37655 | 39586 | 39751 | 43015 | 34262 | 30192 | 61914 | 64156 |
| 1996 | 55521 | 39143 | 38007 | 32018 | 33878 | 35014 | 33604 | 36415 | 28319 | 24106 | 38411 |
| 1997 | 64920 | 50201 | 35372 | 34193 | 28525 | 29332 | 29079 | 27337 | 30398 | 22332 | 32389 |
| 1998 | 66599 | 58688 | 45231 | 31167 | 29993 | 24536 | 24264 | 23486 | 22566 | 25370 | 26901 |
| 1999 | 71926 | 60251 | 51621 | 38372 | 25383 | 22066 | 18480 | 18211 | 17310 | 16785 | 12977 |
| 2000 | 83480 | 65072 | 53844 | 45395 | 33027 | 20829 | 17799 | 14101 | 13904 | 13414 | 12495 |
| 2001 | 74492 | 75527 | 58620 | 47447 | 39698 | 27865 | 17662 | 14676 | 11605 | 11790 | 11713 |
| 2002 | 88307 | 67333 | 67710 | 50557 | 39233 | 31489 | 20511 | 13791 | 11547 | 9184 | 6919 |
| 2003 | 69207 | 79842 | 59953 | 58488 | 43126 | 32009 | 25314 | 16686 | 10962 | 9014 | 10782 |
| 2004 | 91158 | 62612 | 72235 | 54099 | 51833 | 36575 | 24946 | 20176 | 13445 | 8344 | 7308 |
| 2005 | 99752 | 82473 | 56581 | 65007 | 47743 | 44205 | 28896 | 19630 | 16518 | 11175 | 3173 |
| 2006 | 80951 | 90250 | 73318 | 49379 | 56540 | 40254 | 37203 | 22399 | 16001 | 13972 | 11247 |
| 2007 | 87725 | 71250 | 76925 | 62566 | 41524 | 45278 | 32374 | 29641 | 17923 | 13251 | 5441 |
| 2008 | 66313 | 78886 | 62233 | 64590 | 50547 | 32675 | 35067 | 25548 | 23731 | 15206 | 10257 |
| 2009 | 39692 | 58662 | 68481 | 51947 | 52232 | 40465 | 24247 | 25185 | 18406 | 18044 | 10154 |
| 2010 | 0 | 35907 | 52222 | 58912 | 43354 | 42170 | 31008 | 17963 | 18344 | 12628 | 14672 |

# Observations on the status of greater silver smelt in the North East Atlantic and research on Greater silver smelt in Norway 2010.

Elvar H. Hallfredsson

## *Greater silver smelt in NE Atlantic*

Stock structure for greater silver smelt is unknown and within ICES greater silver smelt in all areas is considered one assessment unit, with the exception of greater silver smelt around Iceland. For the assessment unit in other areas the ICES advice is that catches should not increase and reduction in catches should be considered. The base for advice considers survey data from the Faroe Islands and Porcupine-bank that show downward trends. Also considered are acoustical data from Norway in 2007 and 2009, but as the surveys so far cannot be considered as time series showing trends these surveys count for less in the ICES considerations. It should be noted that the Porcupine survey covers quite small part of the total distribution area of the assessment unit.

Immigrations between the two assessment units cannot be out ruled, and if Icelandic landings are included the total landings of greater silver smelt in the NE Atlantic have been at a high level in recent years (figure 1). Total landings for the assessment unit in other areas than Iceland in 2009 were 30358 t, Norwegian landings were 13578 t and Faroese landings 14200 t.

ICES suggest improvements in the data for greater silver smelt in the North East Atlantic. Collection of biological data from the EU fisheries, improved data collection in Norwegian fisheries and establish acoustical time series in Norwegian waters, and deeper stations on the Faroese surveys (ICES 2010a).

Greater silver smelt was amongst the deepseafish species that were subject to ICES benchmark in February 2010 (ICES 2010b, Hallfredsson 2010a). A thorough analysis was done on available data from Iceland, Faroe Islands and Norway. Even though one could find differences in growth pattern and age at maturity the data were considered to week to support changes in stock structure (figure 2 and 3) (ICES 2010b, Hallfredsson 2010b). It was however commented that differences in growth pattern and age at maturity are potentially important for assessment. These variables indicate that response to fisheries can differ between fleets (e.g. growth is faster around Iceland than in Norway), and this will be reflected in potential differences in production parameters in assessment models (ICES 2010b). To reveal stock structure a holistic approach in methods is advised (genetics, morphometircs, meristics and tagging) in the whole distribution area for greater silver smelt in the North East Atlantic (ICES 2010a, ICES 2010b, ICESc 2010c). So far no such studies on greater silver smelt are funded.

On the benchmark acoustics was considered as method for abundance estimates for greater silver smelt. The meeting considered acoustics as suited method to use on greater silver smelt, i.a. regarding vertical distribution of the species (figure 4) (ICES 2010b, Harbitz 2010). At the IMR in Norway one is presently working on a multiennial survey strategy for deep-sea fish species, including greater silver smelt (Harbitz et al 2010). Implementation of this strategy in the institute's survey activities is considered from 2010 on.

It is possible that greater silver smelt in Skagerrak is a separate population, while greater silver smelt in North Sea (ICES område IVa) might rather be a component of the same population as is found north form 62°N (Bergstad 1993, Johannessen og Monstad 2003, Monstad og Johannessen 2003) . It is likely that greater silver smelt has a wider distribution off spawning season and thus catches taken off spawning season in the North Sea can be from both assumed populations. On survey in 2007 small amounts of greater silver smelt were found in North Sea-Skagerrak. The survey was conducted to late in the year to be at assumed time for peak in spawning (Bergstad etal. 2008) but there are reasons to believe that amounts of greater silver smelt in this area are considerably reduced. Historically there has been a limited direct fishery on greater silver smelt in this area (Bergstad etal. 2008).

## *Norwegian regulations*

For a period after 1983 a precautionary unilateral annual TAC applied in IIa, but the landings never exceeded the quota and this regulation was abandoned in 1992. In 2007 a 12 000 t TAC was introduced as a precautionary measure to reduce an increase in the fishery. This TAC has been the same for the years 2007-2009. In addition there is a licensing system that regulates number of trawlers that can take part in the aimed fishery, equipment restriction and an area- and time restriction. Bycatch of greater silver smelt in other fisheries is now regulated in the Norwegian EEZ not to exceed 10% in total catches and in individual catches.

## *Samples from the catches in Norway in 2010*

On request from IMR inspectors from the Norwegian directorate of fisheries conducted sampling of greater silver smelt at fishing ports also in the 2010 fishing season. Additionally data came from one boat in the commercial reference fleet (Cetus). In addition to field measurements frozen samples were sent to IMR for biological sampling. Length measured samples from the fisheries were nineteen, biological samples were ten and genetic samples were taken from four samples (Table 1).

The samplings from the fisheries were in the time period 27. February to 17. June 2010 and came from the traditional fishing grounds in the direct fisheries (figure 5). Here the samples are analysed separately for five known fishing fields: Trænadjupet, Trænaegga, Sklinnadjupet og Gardsholbanken and deep south from Haltenbanken. The samples taken from catches of the reference fleet boat were from Gardsholbanken, while the samples from catches taken in the other fishing fields were taken at port by the directorate of fisheries inspectors.

Length distributions from the fishing fields showed that greater silver smelt was smallest in catches from Trænadjupet and Gardsholbanken with mean length per sample from 29 cm to 33 cm (see also figure 6). In catches from the other fishing fields mean length per sample were between 33 cm and 35 cm. No considerable increase in occurrence of large greater silver smelt (> 40 cm) was found, as were noticeably represented in studies from the 1980ties and 1990ties (Bergstad 1993, Monstad and Johannessen 2003, Johannessen and Monstad 2003) (figure 7). However, the 2010 results on length distributions are not substantially different from results in surveys and from fisheries in 2008 and 2009 (Hallfredsson and Svellingen 2009, Hallfredsson et al. 2009).

Age distributions in the biological samples show that greater silver smelt in general were less than 14 year old, and those from the fishing fields Trænadjupet and Gardsholbanken were mostly less than 10 year old (figure 8). This distribution is similar to that found in acoustic method development survey in 2008 where supporting trawling was approximately similar to commercial fishing praxis (Hallfredsson et al. 2008). Age distributions from the fisheries cannot be considered as representative for age distribution in nature. Still it should be noted that the age distributions found in today's catches has considerably larger proportion of fish under 10 year of age than Monstad and Johannesen (2003) found in surveys in 1981 and 1983 (figur7). Especially there was a large proportion of older fish in depths below 300 m in the 1981 and 1983 surveys. Today's age distributions are similar only to those found on the depths shallower than 300m, where small fish traditionally is assumed to be more represented.

Parameters in von Bertanlanffy's growth function from greater silver smelt in the catches ($L_\infty$ = 38,9; K = 0,13; $t_0$ -5,11; figure 9) do somewhat deviate from those found for greater silver smelt at ICES "benchmark" based on data from surveys in 2007-2009 ($L_\infty$ = 39,5; K = 0,19; $t_0$ = -2.13; figure 3) (WKDEEP 2010), but are possibly within uncertainty boundaries. These growth curves indicate marked slower growth than Monstad and Johannesen (2003) found in 1980-83 surveys (figure 10). A possible explanation is evolutionary adaption to lower age at maturity and smaller maximum length, as response to a potentially too high exploration rate.

## ***Conclusion***

Sampling from the Norwegian fisheries indicates that large and old individuals make up lesser proportion of the greater silver smelt in the area in 2010 compared to in the 1980ties, but there are small changes compared to 2008 and 2009. Changes in growth pattern can also give ground for concern. Lack of time series with data in later years, other than amounts of catch, and lack of knowledge about stock structure imply caution in management of greater silver smelt fisheries. In this context resent high levels of landings of greater silver smelt in NE Atlantic give rice to concern.

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Table 1. Overview over greater silver smelt sampling from Norwegian catches in 2010. Sampling type 1 is length measurements in field while sampling type 2 is full biological sampling at IMR from frozen samples.

| | Type of sampling | | | | Vessel | | Depth | Position (desimal) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ser.nr. | 1 | 2 | | | Calling signal | Name | m | N | E | Fishing field |
| 48201 | length | | | | LAKF | Ingrid Majala | 400 | 66.45 | 6.75 | Trænaegga |
| 48202 | length | | | | LAKF | Ingrid Majala | 410 | 66.45 | 6.82 | Trænaegga |
| 48203 | length | | | | LAKF | Ingrid Majala | 400 | 67.12 | 8.48 | Trænadjupet |
| 48204 | length | bio. sample | aged | | LAKF | Ingrid Majala | 500 | 67.03 | 8.37 | Trænadjupet |
| 48205 | length | | | | LDAM | Fiskebank 1 | 475 | 64.10 | 8.37 | Sør av Haltenbanken |
| 48206 | length | bio. sample | aged | | LDAM | Fiskebank 1 | 485 | 64.15 | 8.43 | Sør av Haltenbanken |
| 48207 | length | | | | LIYY | Kastafjord | 450 | 67.07 | 8.40 | Trænadjupet |
| 48208 | length | | | | LLVN | Trønderkari | | 65.72 | 9.33 | Sklinnadjupet |
| 48209 | length | | | | LLVN | Trønderkari | | 65.72 | 9.28 | Sklinnadjupet |
| 48210 | length | | | | LIOD | Straumberg | | 65.65 | 9.98 | Sklinnadjupet |
| 48211 | length | | | | LIOD | Straumberg | 440 | 65.68 | 9.38 | Sklinnadjupet |
| 48212 | length | bio. sample | aged | | LJVY | Trønderbas | 440 | 67.13 | 8.52 | Trænadjupet |
| 48213 | length | bio. sample | aged | | LGGM | Dyrnesvåg | 450 | 65.68 | 9.62 | Sklinnadjupet |
| 48214 | length | | | | LEQI | | 500 | 64.25 | 8.62 | Sør av Haltenbanken |
| 86496 | length | | | | LLYM | Cetus | 400 | 65.04 | 6.00 | Gardsholbanken |
| 86497 | | bio. sample | aged | gen. sample | LLYM | Cetus | 400 | 65.06 | 5.08 | Gardsholbanken |
| 86498 | length | bio. sample | aged | | LLYM | Cetus | 400 | 65.03 | 6.00 | Gardsholbanken |
| 86499 | | bio. sample | aged | | LLYM | Cetus | 400 | 65.07 | 5.08 | Gardsholbanken |
| 86500 | length | bio. sample | aged | gen. sample | LLYM | Cetus | 400 | 65.06 | 5.08 | Gardsholbanken |
| 86501 | length | bio. sample | aged | gen. sample | LLYM | Cetus | 400 | 65.06 | 5.09 | Gardsholbanken |
| 86502 | length | bio. sample | aged | gen. sample | LLYM | Cetus | 400 | 65.06 | 5.09 | Gardsholbanken |

## *Figures*

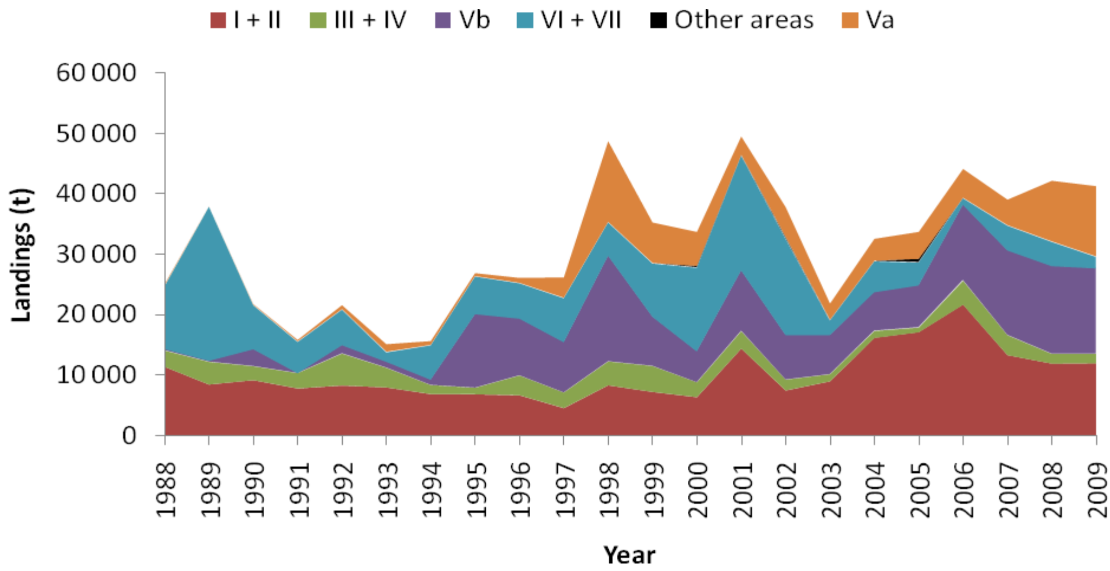



Figure 1. Catches of greater silver smelt deviated on ICES areas. (based on numbers from ICES WGDEEP 2010).

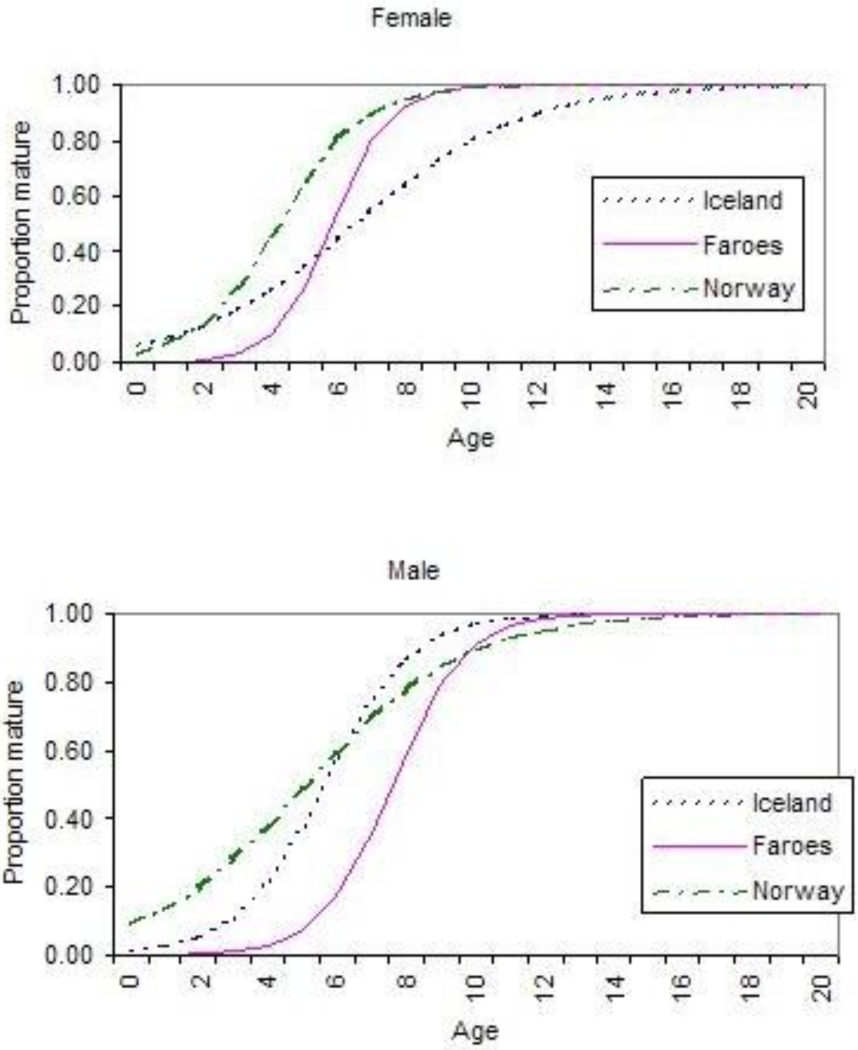
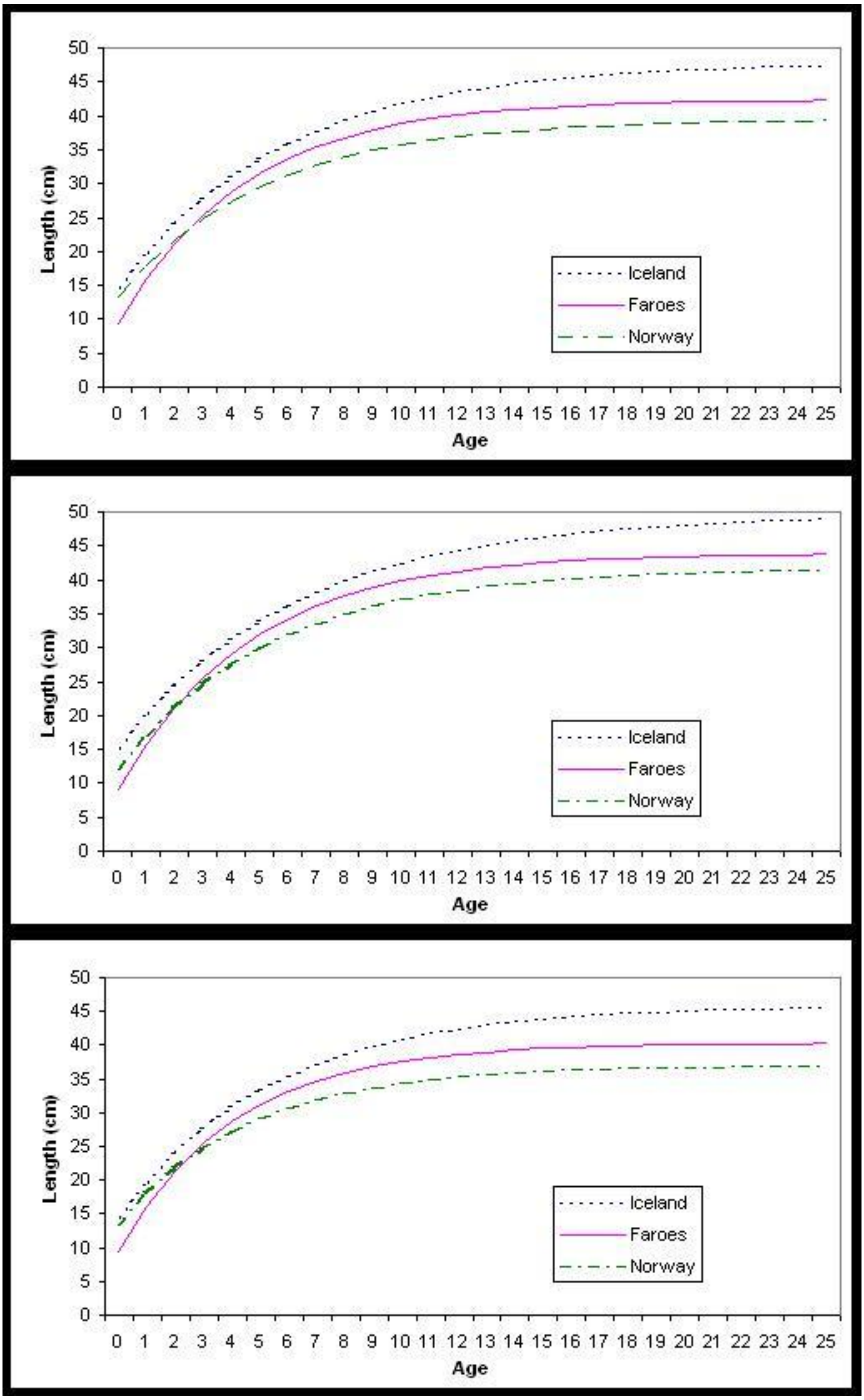



Figure 2. Maturity ogive plots for female (top) and male (bottom) greater silver smelt by area. (ICES WKDEEP 2010).




Figur 3. Growth curves for greater silver smelt by area (combined sexes (top), female (middle), male (bottom) (ICES WKDEEP 2010).

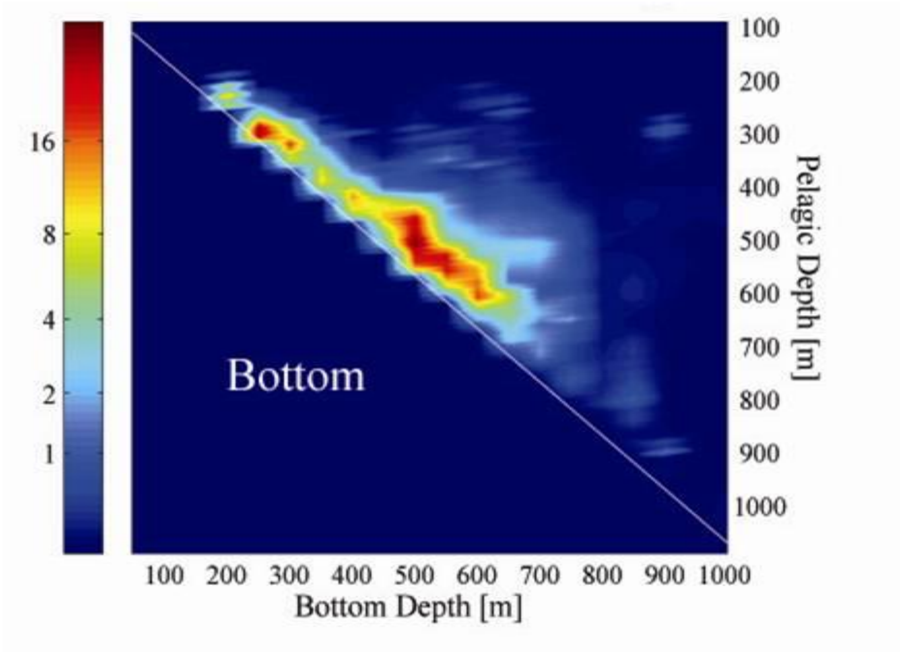



Figure 4. Vertical distribution for greater silver smelt in IMR survey in 2009. Average acoustical $S_A$ values are shown per 10 m vertical channel for the whole survey. The figure shows that greater silver smelt has vertical distribution and distance from bottom that makes it suitable for registrations with a 38 kHz echosounder (Hallfredsson 2010c).

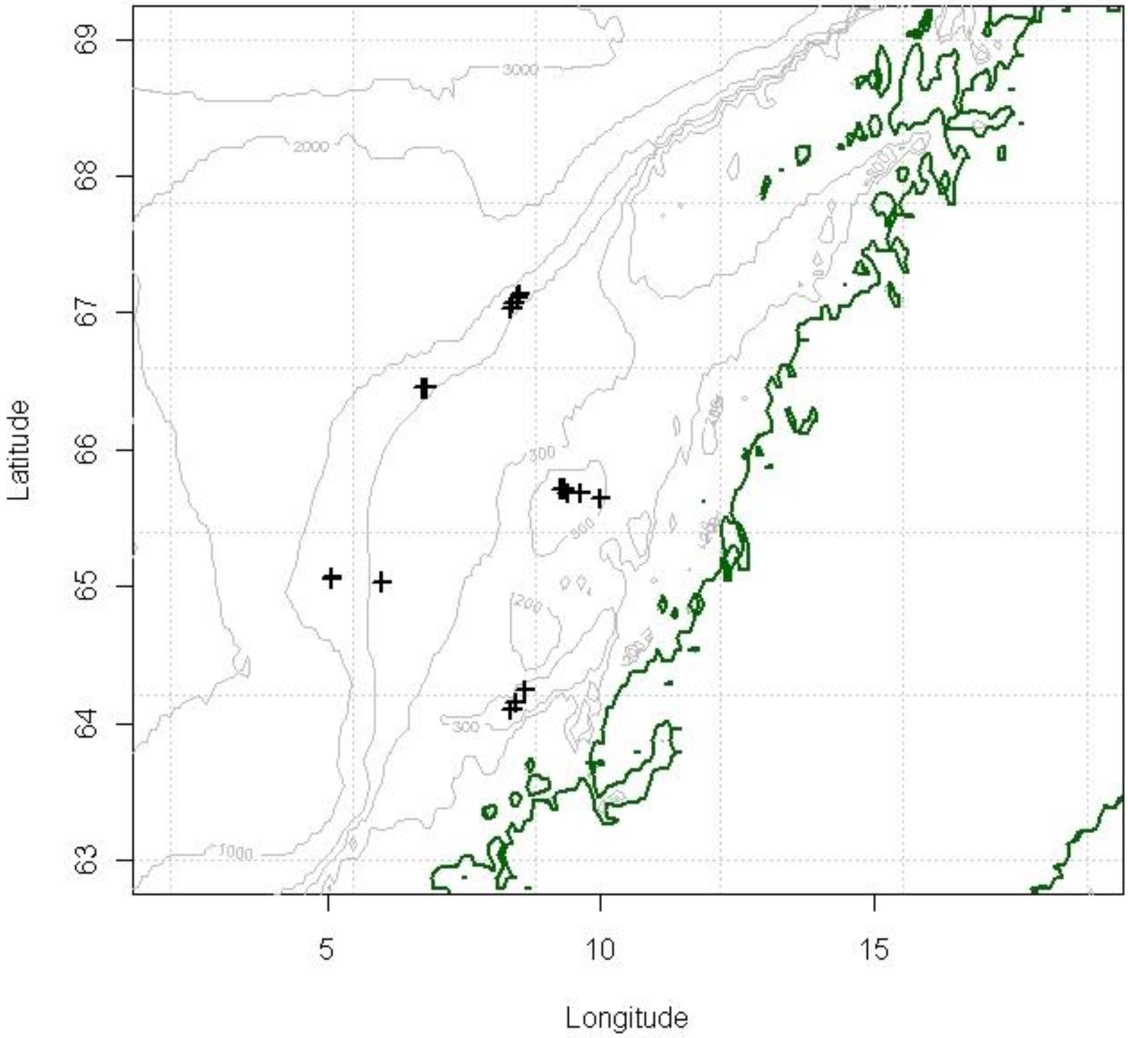



Figure 5. Positions for greater silver smelt catches that samples were taking from in 2010.

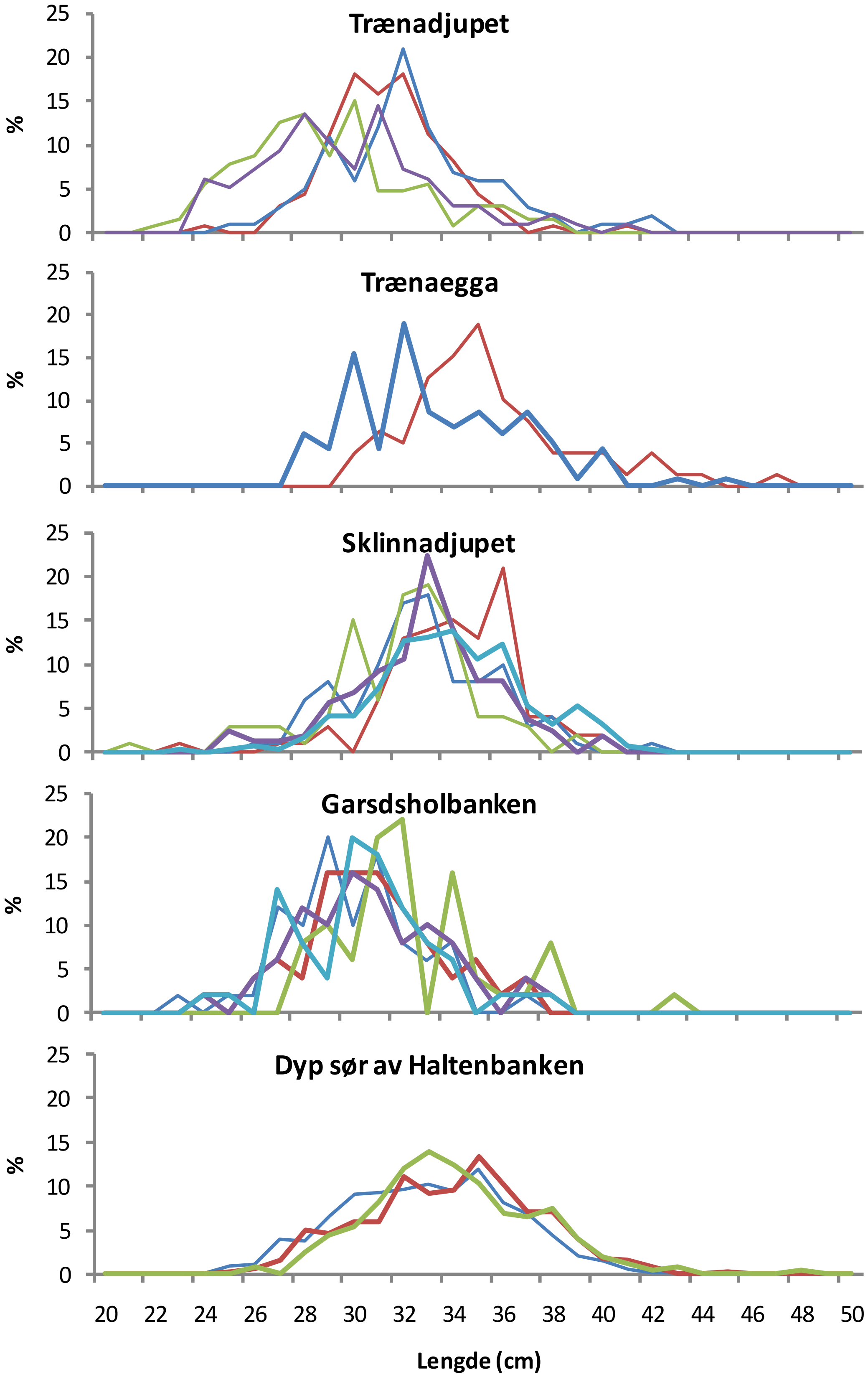



Figure 6. Length distributions per sample taken from the fisheries in 2010, divided on fishing fields.

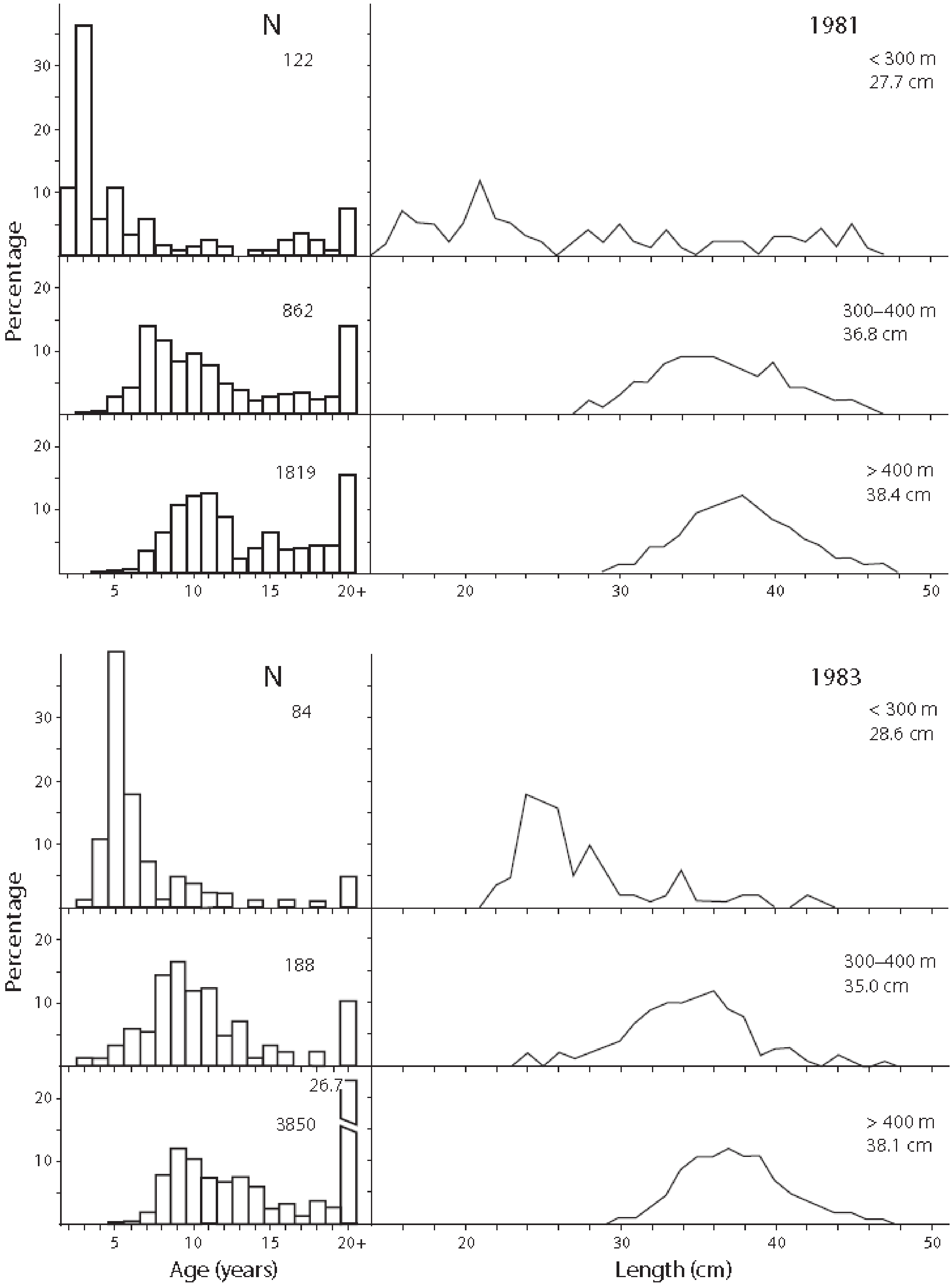



Figure 7. Age and length distributions for greater silver smelt in 1981 and 1983. Bottom trawl samples from three different depth intervals in geographic area limited to 64°-66°N (Monstad and Johannesen 2003).

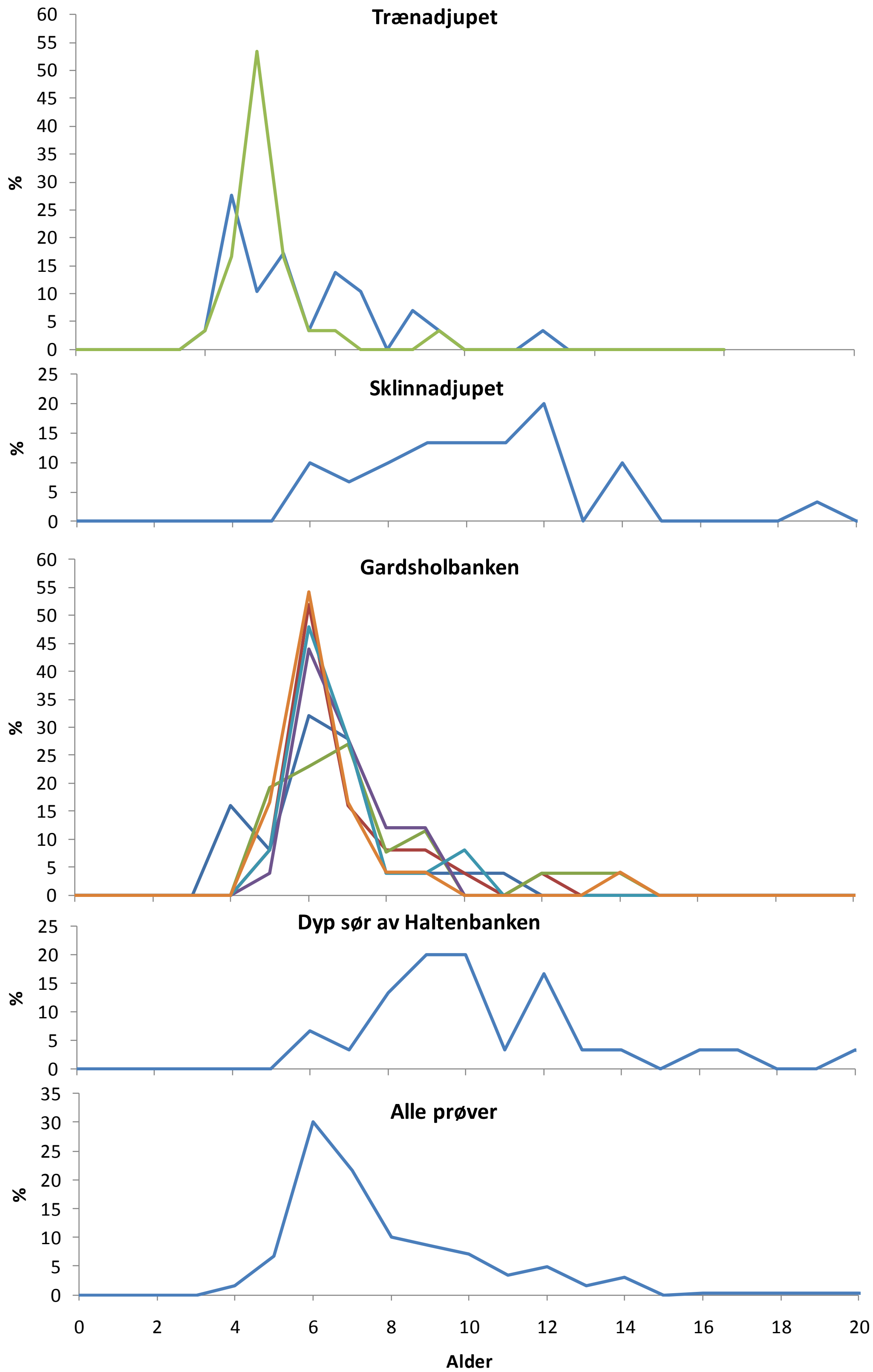



Figure 8. Age distributions per sample taken from the fisheries in 2010, divided on fishing fields. Aslo shown is age distribution for all samples lumped (lowermost panel), but it should be noted that the lumped distribution cannot be taken as statistically representative distribution for greater silver smelt in the area.

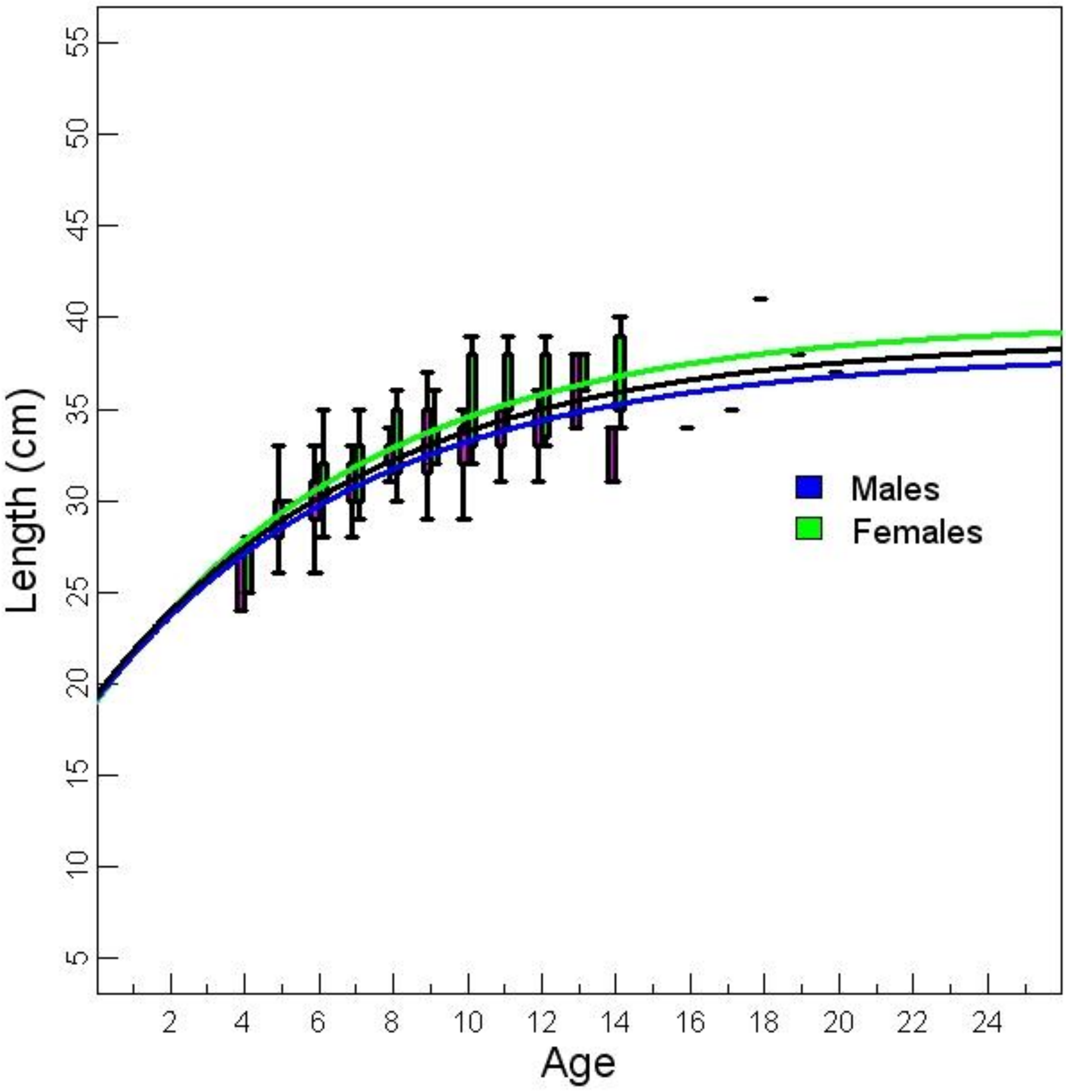
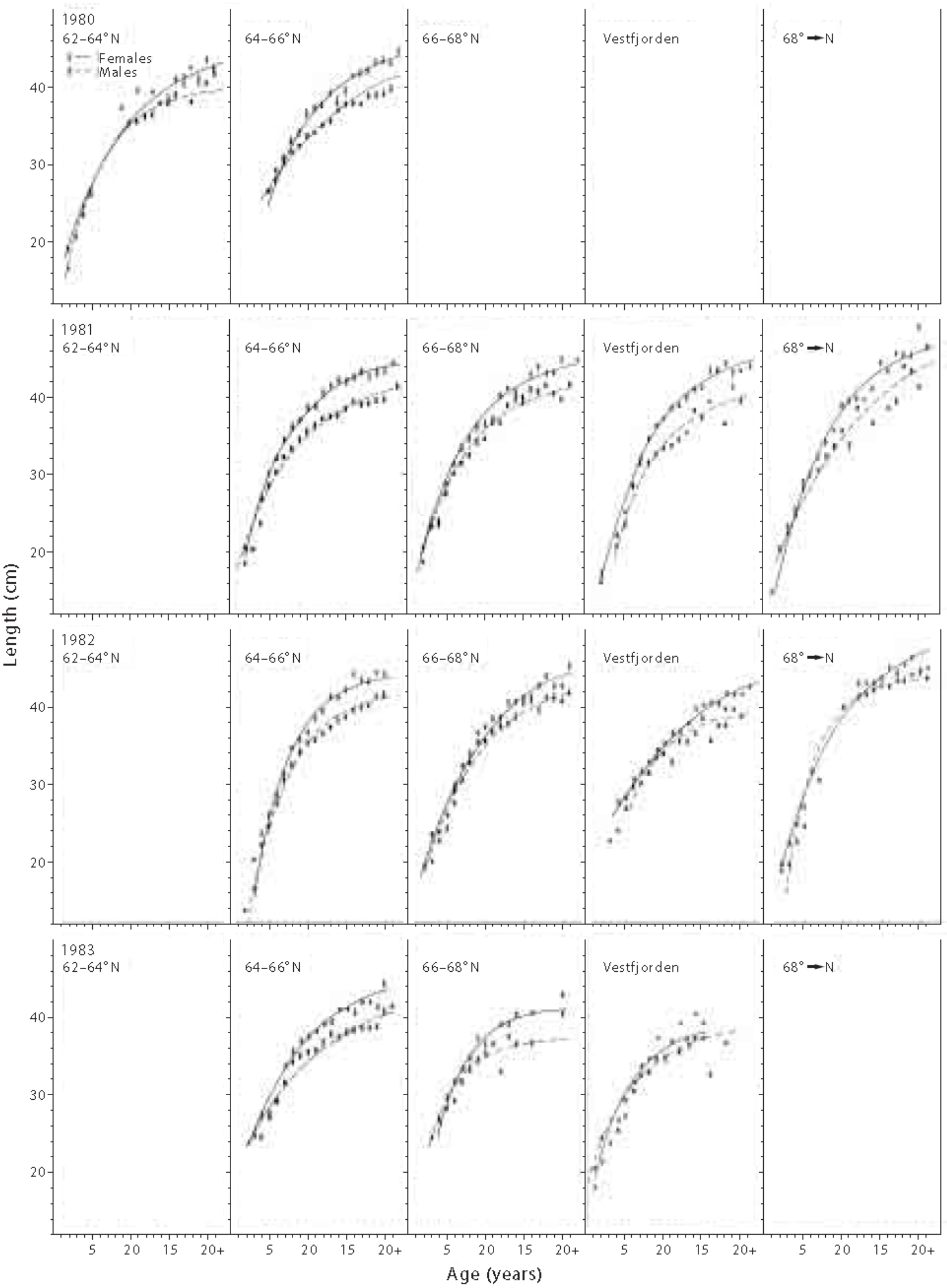



Figure 9. Length at age for greater silver smelt in the catches in 2010 divided by sex. Lines show von Bertalanffy's growth curve males, females and total (black line).




Figur 10. Von Bertalanffy's growth curves fitted to estimates of mean length (± SD) per age group for for spring 1980-83 in geographical areas limited by 62-66°N (Monstad og Johannesen 2003)

ICES WGDEEP, Copenhagen 2011
WD 12



# Update on Norwegian fishery independent information on roundnose grenadier (*Coryphaenoides rupestris*) in the Skagerrak and north-eastern North Sea (ICES Division IIIa and IVa)

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## Introduction

This Working Document presents fishery independent information on roundnose grenadier (*Coryphaenoides rupestris*) from ICES Divisions IIIa and IVa. The data are collected from a research survey conducted annually during the past 28 years (1984-2011). Information is reported as temporal variation on biomass and abundance (kg/h and number/h), length distributions and geographical distribution. The information in this Working Document is an update of a WD submitted to WGDEEP in 2009 (Bergstad *et al*. 2009).

The roundnose grenadier is a long-lived deepwater species which in the relevant study area reaches ages of 70 years or more and attains maturity at the age of 8-12 year (Bergstad 1990). Its life history strategy and limited area of distribution in the deep Skagerrak basin (300-720m) would seem to make the grenadier in this area particularly vulnerable to overexploitation, but also a good candidate for studies of population-level impacts of fisheries. The 2003-2005 major expansion of the targeted grenadier fishery followed by a complete closure created an exceptional opportunity to study such impacts, if any, on a deepwater fish population.

## Material and Methods

Data was collected from the annual *Pandalus borealis* shrimp survey performed by the Institute of Marine Research in the years 1984-2011. The survey is a depth stratified research survey with approximately 25% of the stations deeper than 300 m (depth range 110-520 m). The stations are placed at random within strata and subareas, and the same sites area sampled every year. Although some changes occurred over the years, the overall standardization was maintained throughout the time series (Bergstad *et al.* 2009). The changes refer to vessels used, gear and season of the survey. The changes that may have affected the sampling of roundnose grenadier is listed in Table 1.

Biomass and abundance was calculated as mean of all stations at depths>300m including the stations with zero catches. Percentage length distributions were standardized to catch size and trawling distance for all stations >300m with positive catches.

## Results

### Biomass and abundance

The estimates of mean catch rates (kg/h) and abundance (nos/h) varied through the time series (Figure 1). However, making log transformations, the overall trend seems to show an increase in biomass from 1998 (Figure 2c). The transformed catch rate in 2010 was the lowest observed in the whole time series. The decline in survey catch rates has continued in 2011.

### Size distributions

Length frequency distributions showed a major shift in the early 1990s (Figure 3). From the beginning of the time series and until 1989 the majority of the fish were 15 cm (large fish). From 1990, an increasing proportion of small fish appeared (fish<5cm). From 1992 the proportion of large fish declined to less than 10% while small fish increased and became a very distinct part of the distribution. This pronounced mode of small fish can be followed through the following years, and continue growing until 2007, and by then representing more or less the same proportion of the distribution. From 2008, a decline in the fish>15cm appeared. Contrary to the early 90's this decline did not seem to be followed by an increase of small fish.

### Geographical distribution

The area sampled and the geographical distribution of positive catches is presented in Figure 4. The overall distribution area does not seem to have changed considerably during the years investigated; catches of roundnose grenadier are restricted to the Norwegian Deep north to 59°N and eastwards into the Skagerrak basin. The trend seen earlier, that biomass became more restricted to eastern parts of the distribution area is strengthened (Bergstad *et al*. 2008 and 2009).

## Discussion

The geographical distribution of roundnose grenadier in this area has been described earlier (Bergstad 1990a and b). The data presented here does not show any major changes of the distribution area. However, this dataset also gives an opportunity to study the temporal distribution of survey catches. The survey catch rates have declined in areas which earlier represented high survey catches as in the eastern part of Skagerrak (Figure 4). In view of roundnose grenadier as an aggregating species a truncation of catch areas in addition to lower catch rates, could reflect an overexploitation during the limited time period from 2003-05.

Despite high inter annual variability, the survey data suggest a long term variation in biomass and abundance through the time series 1984-2011. The long term increase in biomass and abundance seen from the late 1980s until 1998-2004 seemed to be followed by a major decline during the recent seven years. The earlier uncertainty in the data related to sampling depth in 2006-07 is now weakened by the fact that this decline in biomass and abundance have continued since 2008. The catch rates in 2011 are now the lowest seen in the whole time series.

The length distribution time series seems to reflect a population normally dominated by 15 cm sized fish. Periodically, however, the population is rejuvenated by a pulse in recruitment such as seen in 1992 and onwards. The recruits from1992 can be traced as a distinct year class for 15 years until 2005.

The proposed increase in biomass and the development in length distributions indicate that the observed high survey catch rates that coincided with very high commercial landings in 2004-05 was a result of an large pulse in recruitment from 1992. From the recent length distributions no similar pulse in recruitment has been seen.

The changes on survey catch rates, abundance and length distributions of roundnose grenadier in the Skagerrak may be related to the increase in commercial landings from the targeted fishery in the years 2004-05. The landings peaked in 2005 to 11000 tons (Figure 5) and have since then declined to less than a ton per year. From 2006 onwards this decline in landings is a result of regulations implemented to restrict the targeted fishery on roundnose grenadier in this area (Bergstad 2006). Figure 4 shows that the survey catch rates in 2004-05 were distributed in the same area as the directed fishery took place in those years (ICES 2010). The catch rate decreased in 2005 while the landings reached all time high level at 11000 tonnes in the same year. Since 2006 both the landings and survey catch rates have been very low (Figure 5). At the same time, length distributions show that the majority of the fish are <15 cm and there is no signal in the data suggesting a new pulse in recruitment as seen in 1992.

## Conclusion

The decline in survey catch rates have continued since 1998. The catch rate level is now at the lowest seen so far in the time series. The percentage of fish >15cm is at the same level as in the late 80s and early 90s however, there is no suggestion of a new recruitment pulse as seen in 1992. The low survey catch rates is seen after a period with exceptionally high commercially landings and taken all information on biomass, abundance, length distributions and geographical distribution into consideration, the targeted fishery in 2004-05 is likely to have reduced the abundance.

Since the targeted fishery has stopped and the by-catch in the shrimp fishery, which presently is the major fishery in this region, seems to be at very low levels, the potential for recovery of the roundnose grenadier in Skagerrak seems good.

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Bergstad, O.A. 2006. Exploitation and advice options for roundnose grenadier in the Skagerrak (IIIa). Working Document for ICES WGDEEP, Vigo, 2006. 8 p.

Bergstad, O.A. 1990b. Distribution, population structure, growth and reproduction of the roundnose grenadier *Coryphaenoides rupestris* (Pisces:Macrouridae) in the deep waters of the Skagerrak. *Marine Biology* 107: 25 - 39.

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Table 1. Summary of data on the bottom trawl survey series, 1984-2011. Rg- rockhopper ground gear. 'Strapping' – maximum width of trawl constrained by rope connecting warps in front of otter doors. MS – RV Michael Sars, HM – RV Håkon Mosby. Data from 2011 survey is included.

| YEAR | Survey month | Vessel | IMR Gear code | Additional gear info. | No. Trawls >300m | No. trawls >400m |
|---|---|---|---|---|---|---|
| 1984 | OCT | MS | 3230 | Shrimp trawl (see text) | 10 | 1 |
| 1985 | OCT | MS | 3230 | " | 21 | 5 |
| 1986 | OCT/NOV | MS | 3230 | " | 24 | 9 |
| 1987 | OCT/NOV | MS | 3230 | " | 35 | 14 |
| 1988 | OCT/NOV | MS | 3230 | " | 31 | 11 |
| 1989 | OCT | MS | 3236 | Campelen 1800 35mm/40, Rg | 31 | 7 |
| 1990 | OCT | MS | 3236 | " | 26 | 5 |
| 1991 | OCT | MS | 3236 | " | 28 | 9 |
| 1992 | OCT | MS | 3236 | " | 27 | 10 |
| 1993 | OCT | MS | 3236 | " | 30 | 10 |
| 1994 | OCT/NOV | MS | 3236 | " | 27 | 10 |
| 1995 | OCT | MS | 3236 | " | 29 | 12 |
| 1996 | OCT | MS | 3236 | " | 27 | 11 |
| 1997 | OCT | MS | 3236 | " | 25 | 6 |
| 1998 | OCT | MS | 3270 | Campelen 1800 20mm/40, Rg | 23 | 6 |
| 1999 | OCT | MS | 3270 | " | 27 | 8 |
| 2000 | OCT | MS | 3270 | " | 25 | 10 |
| 2001 | OCT | MS | 3270 | " | 18 | 4 |
| 2002 | OCT | MS | 3270 | " | 24 | 6 |
| 2003 | OCT/NOV | HM | 3230 | Shrimp trawl (as in 1984-1988) | 13 | 0 |
| 2004 | MAY | HM | 3270 | Campelen 1800 20mm/40, Rg | 17 | 6 |
| 2005 | MAY | HM | 3270 | " | 23 | 8 |
| 2006 | FEB | HM | 3270 | " | 10 | 0 |
| 2007 | FEB | HM | 3270 | " | 11 | 1 |
| 2008 | FEB | HM | 3271 | Campelen 1800 20mm/40, Rg and strapping* | 18 | 5 |
| 2009 | JAN/FEB | HM | 3271 | " | 25 | 7 |
| 2010 | JAN | HM | 3271 | " | 24 | 7 |
| 2011 | JAN | HM | 3271 | " | 22 | 7 |

* Strapping was standardized as 10 m rope connecting warps 200 m in front of otter doors.

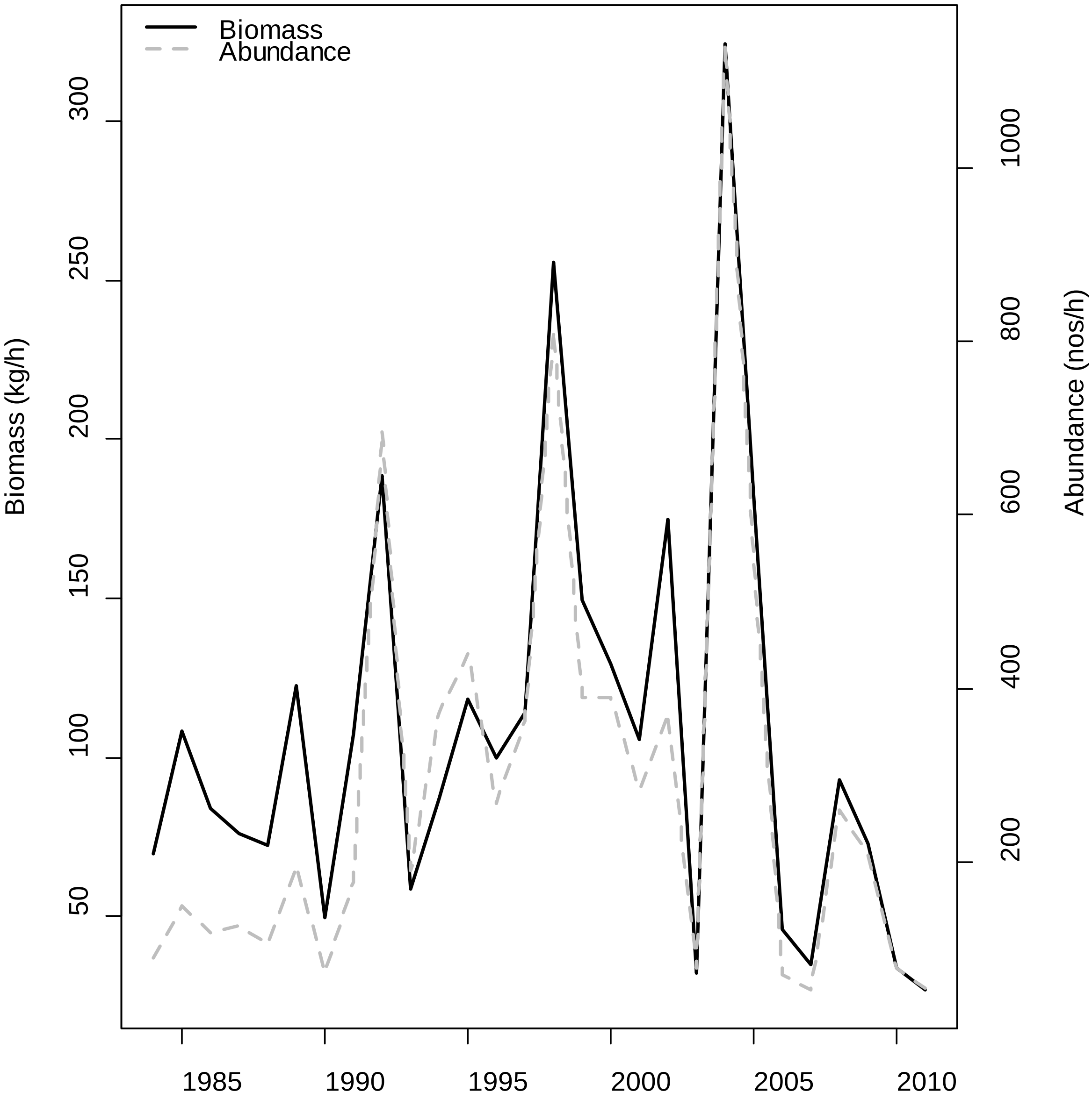


Figure 1. Biomass (kg/h) and abundance (nos/h) from survey catches. Data from recent survey 2011 is included.

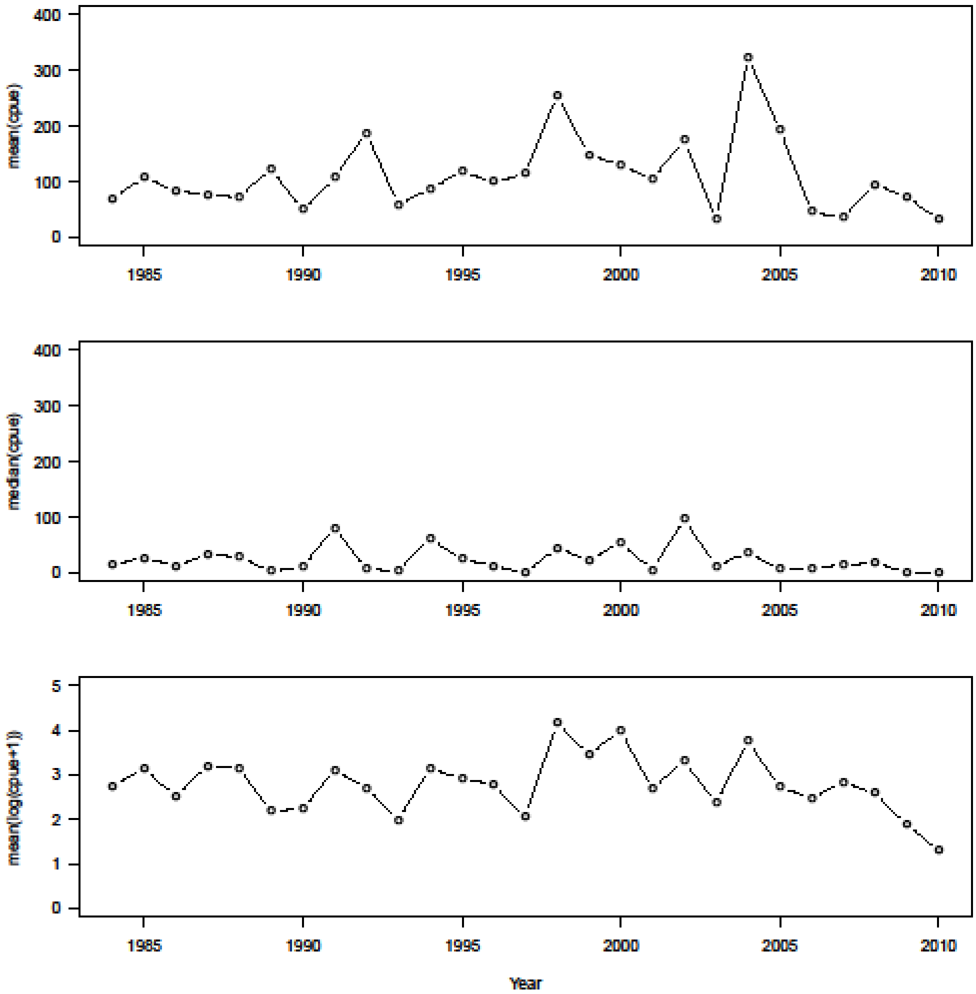

Figure 2. Biomass (kg/h) as mean, median and log mean from survey catches.

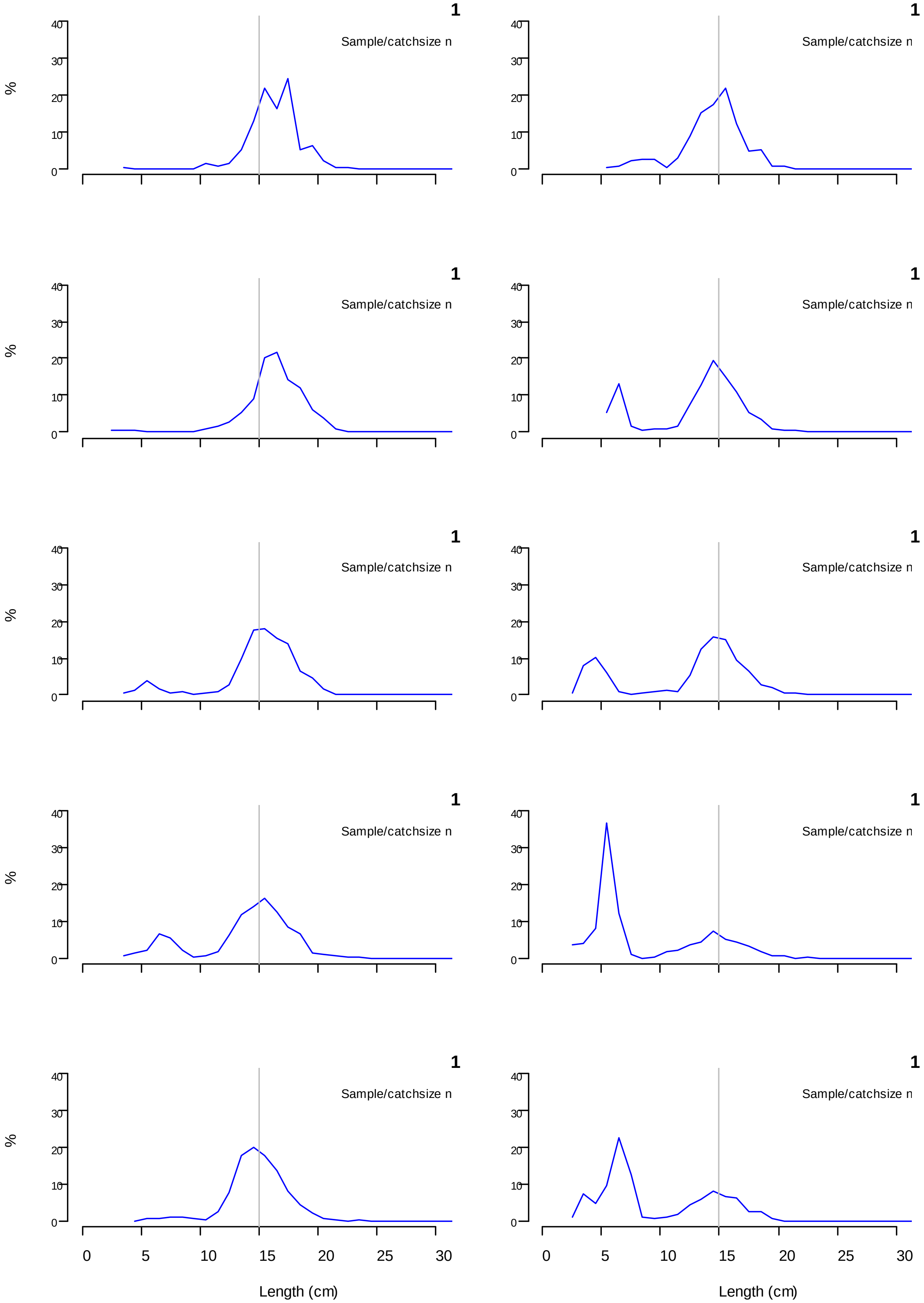


Figure 3. Length distributions on  roundnose grenadier. Length is measured as pre-anus fin length in cm. The distributions are calculated as percent number of fish in each cm length interval standardized to total catch number and trawling distance for each station each year. Data from 2011 survey is included.

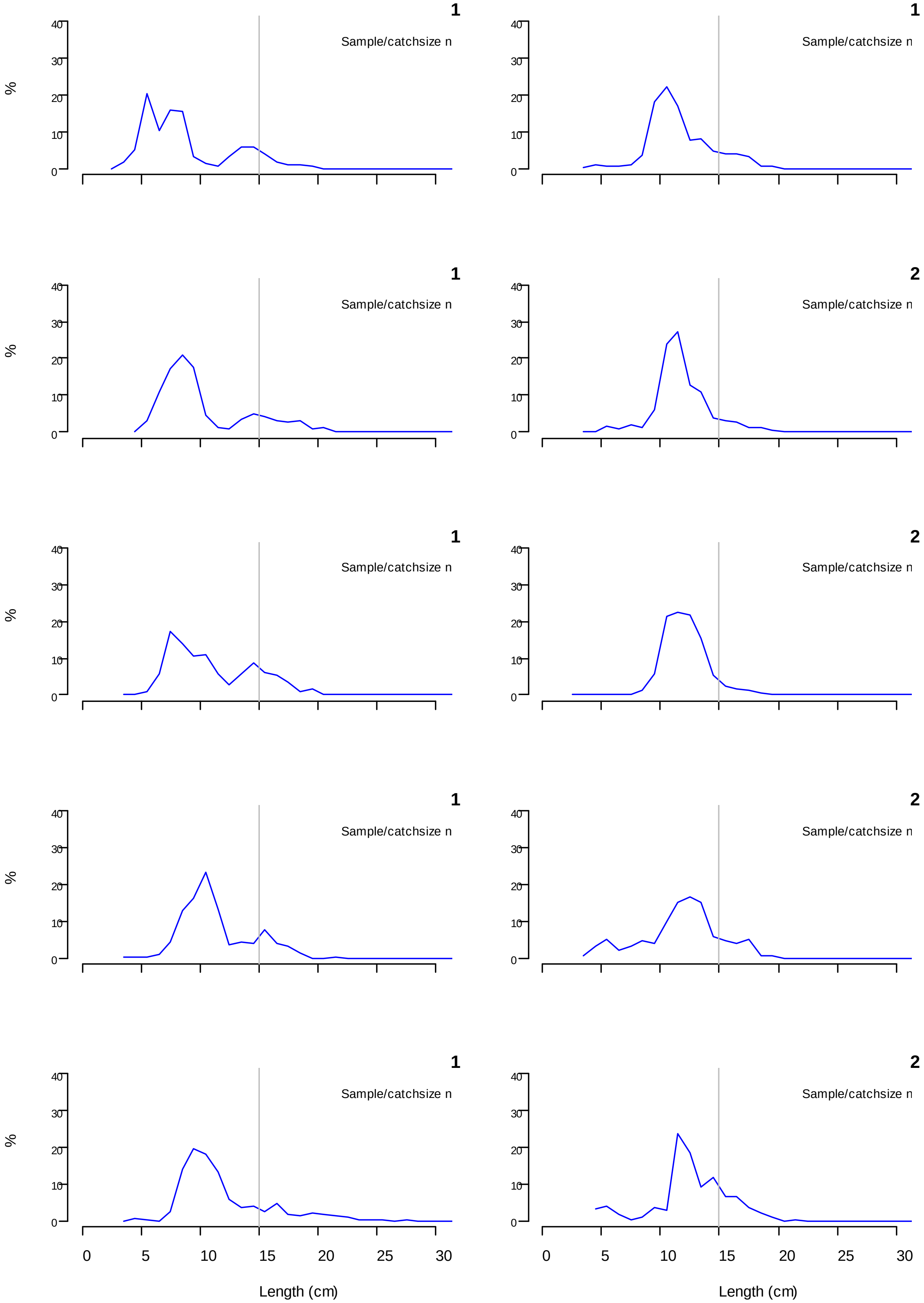


Figure 3 continued

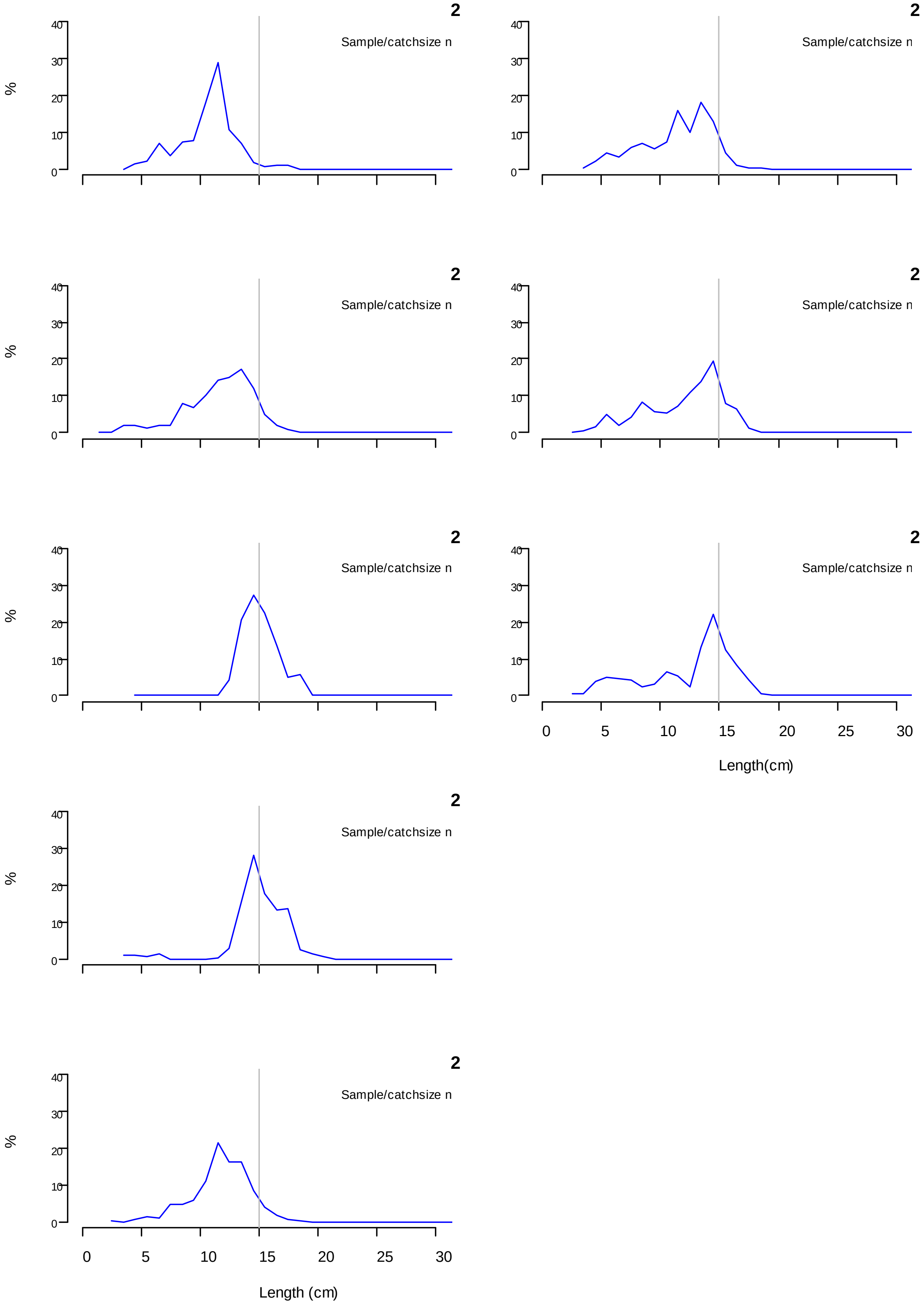


Figure 3 continued

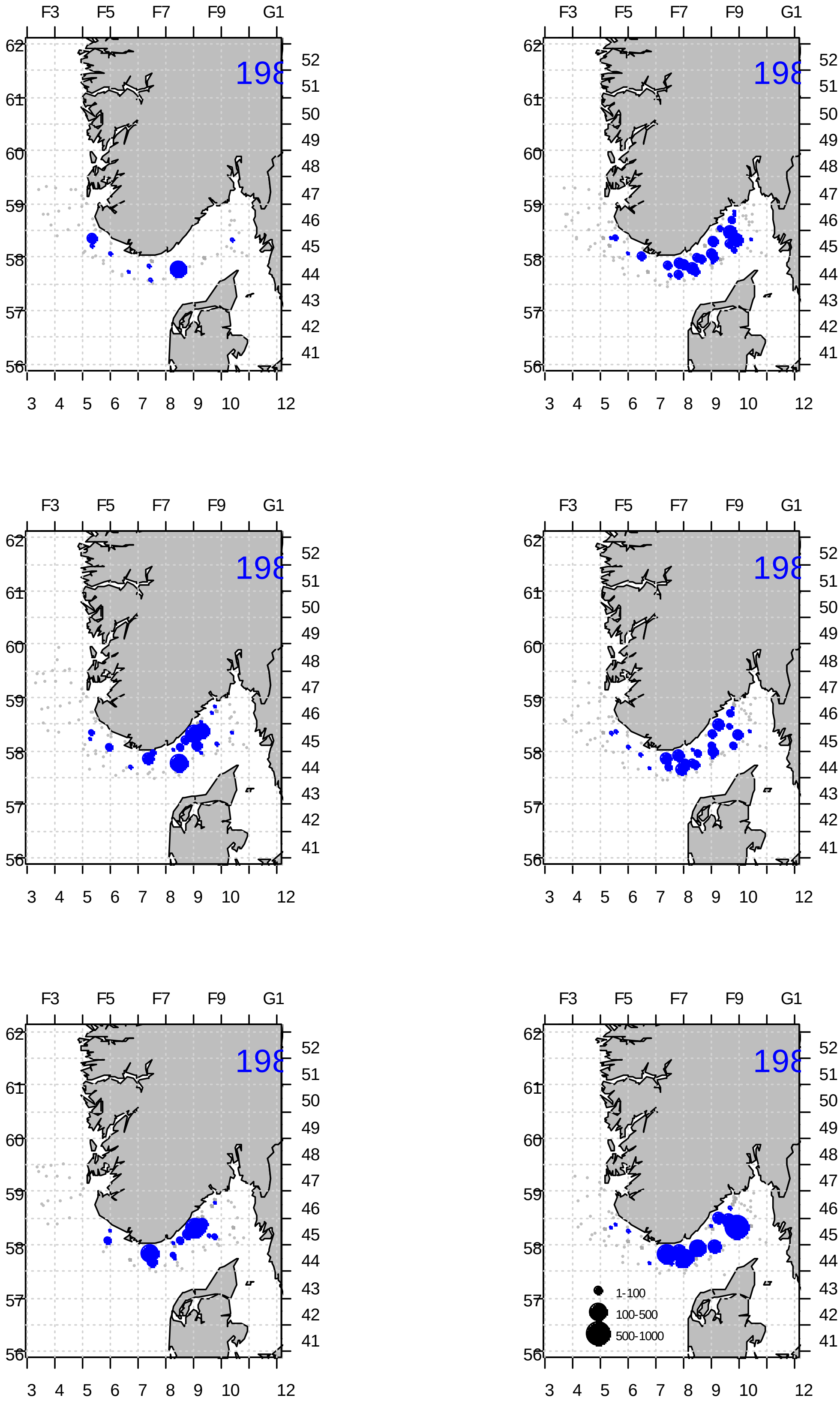


Figure 4. Geographical distributed biomass (kg/h) on roundnose grenadier from the survey (black dots). Grey scaled dots are stations with zero catches; open dots are all stations taken the actual year, filled dots are stations>300m. Data from 2011 survey is included.

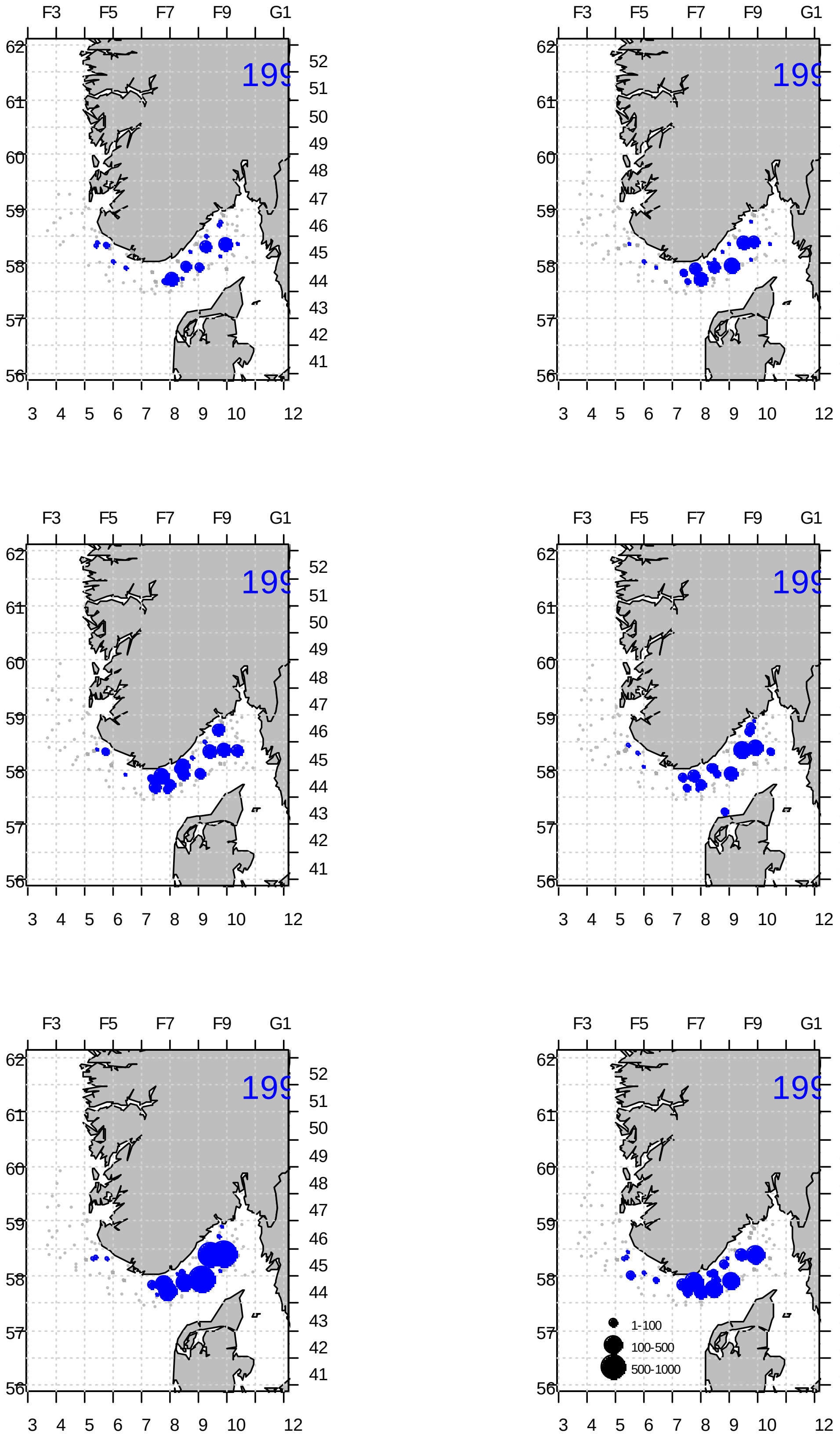


Figure 4 continued.

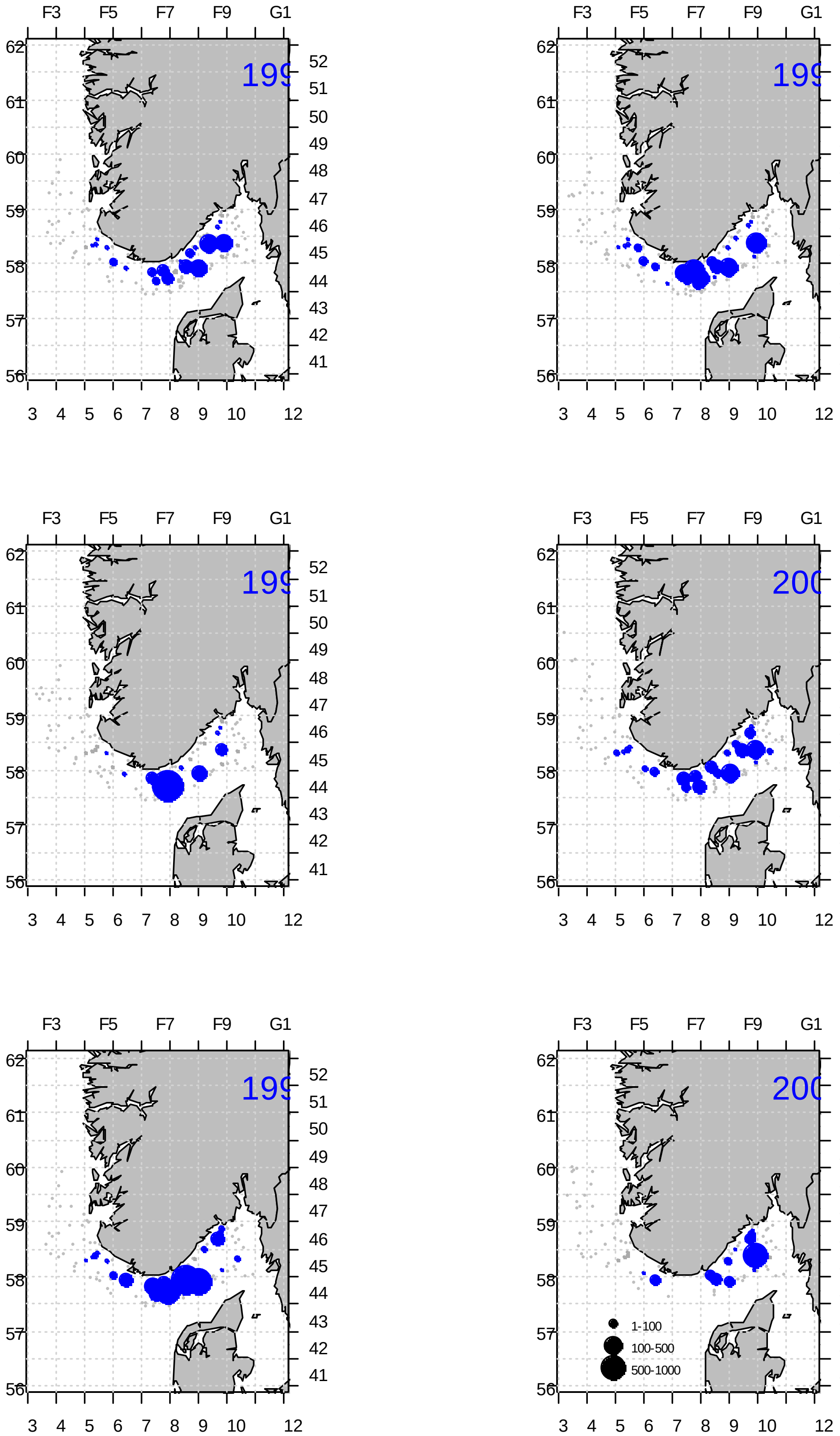


Figure 4 continued.

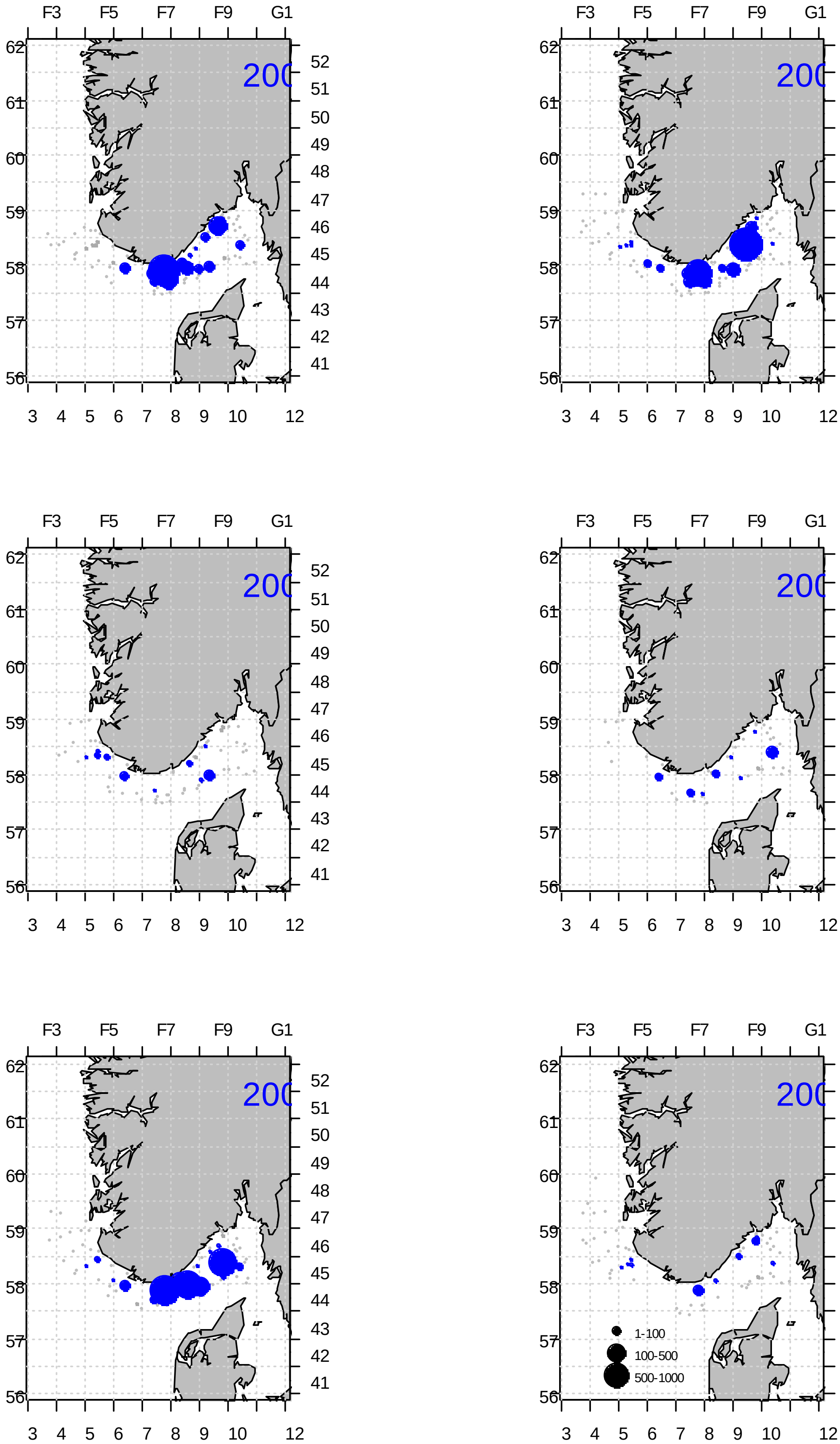


Figure 4 continued.

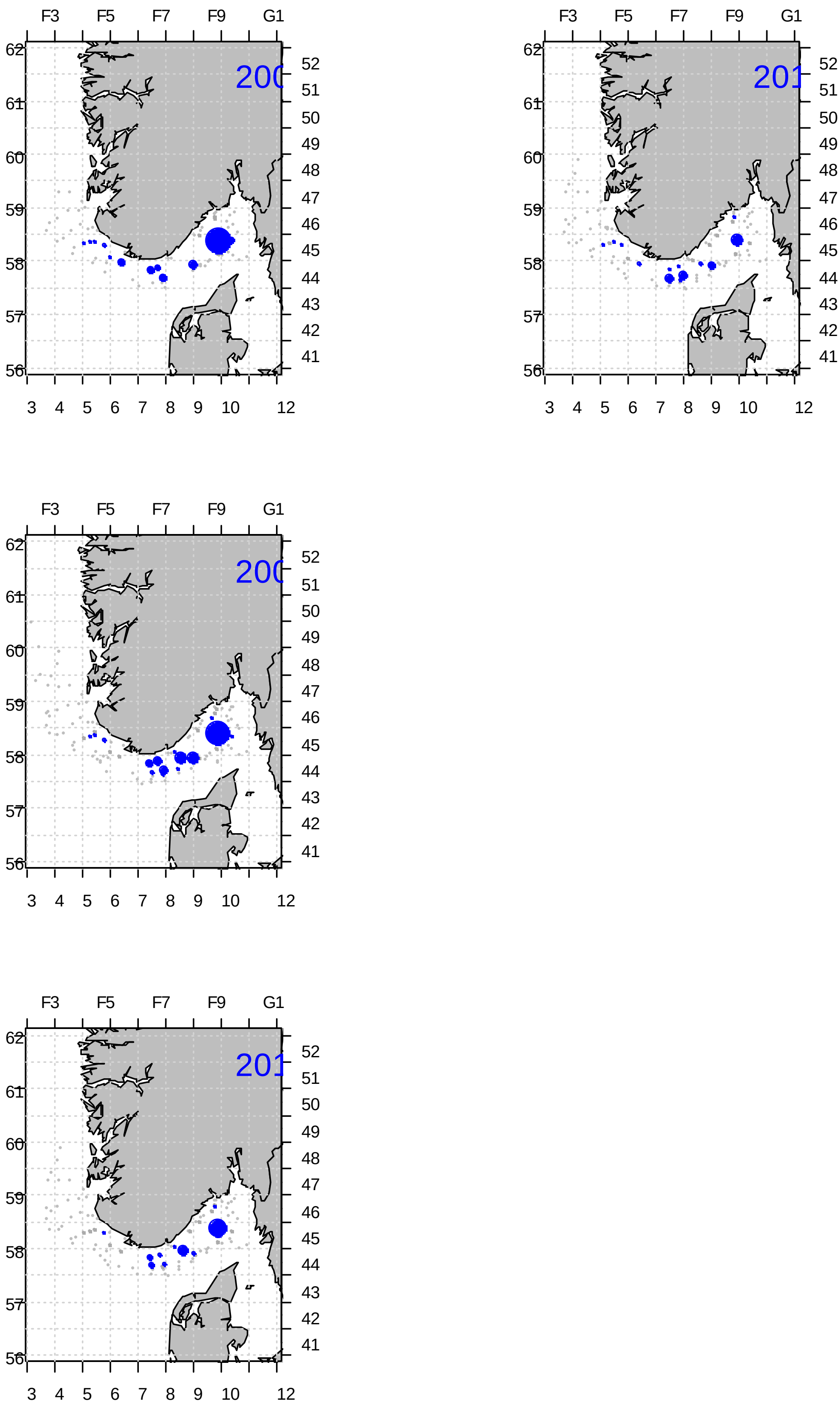


Figure 4 continued.

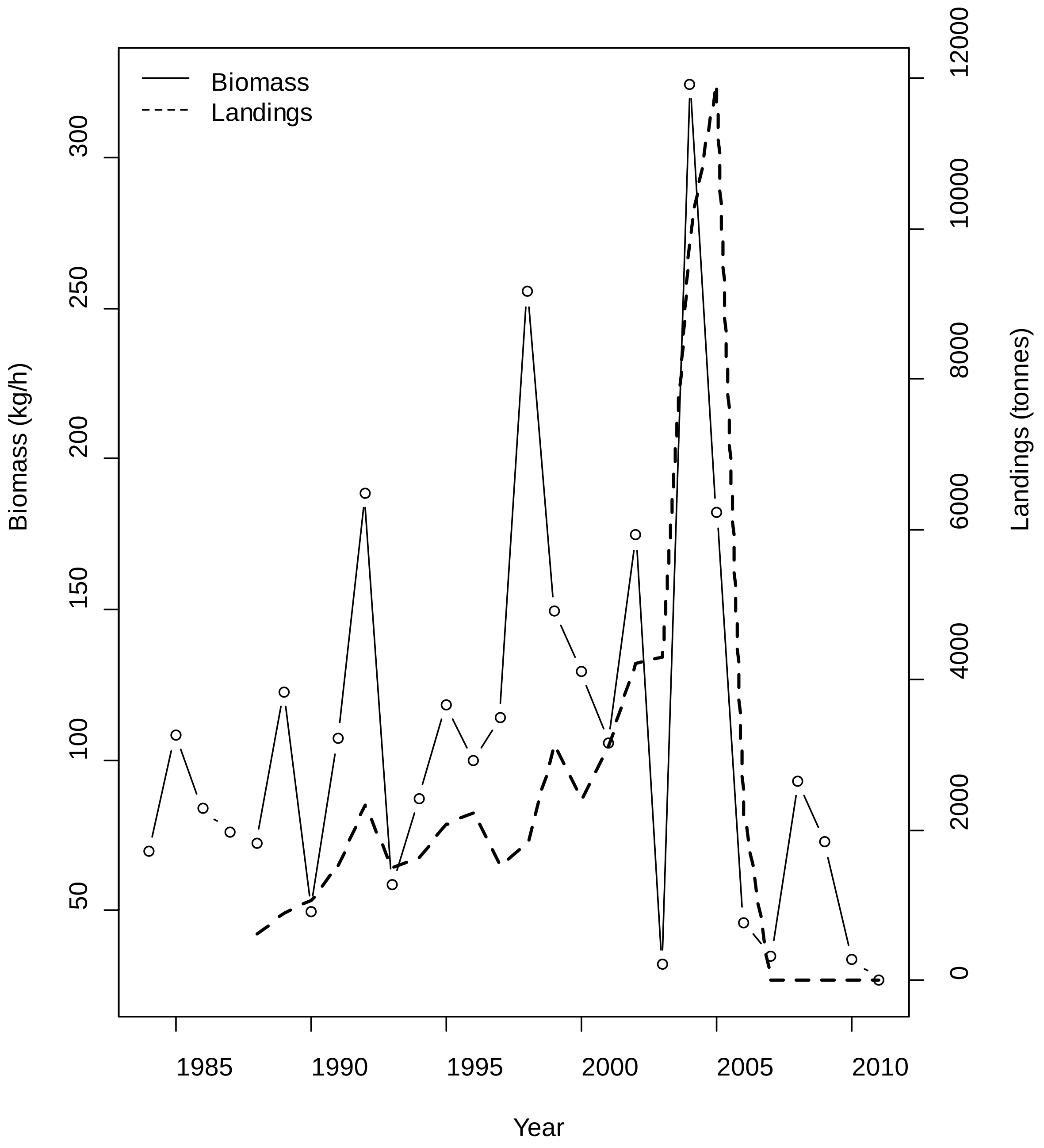


Figure 5. Biomass (kg/h) and total landings (tons) from Division IIIa. Data from 2011 survey on catch rate is included. Numbers on total landings taken from WGDEEP report 2010.

ICES Working Group on the Biology and Assessment
of Deep-Sea Fisheries Resources (WGDEEP) 2011

Working Document 13

# RUSSIAN FISHERIES AND INVESTIGATIONS OF DEEPWATER FISH IN THE NORTHEAST ATLANTIC IN 2010

by

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## Introduction

Russian directed deep-sea fishery in the deep waters of the Northeast Atlantic was occasionally carried out in the Mid-Atlantic Ridge in 2010. In other areas deepwater fish were taken as by-catch. The total catch of deep-water fish in 2010 comprised 277 tons (Table).

## Materials and Methods

Essential materials to be used to prepare this Working Document were as follows:

- daily vessel reports from PINRO fisheries database;
- materials collected during research surveys for demersal and pelagic fish;
- information collected by observers on board fishing trawlers.

Catches of deep-water fish were taken by bottom and pelagic trawls with 16-135 mm mesh size.

Sampling of the biological material was performed in accordance with PINRO techniques (Instructions.., 2004). The greater silver smelt length was measured as a fork length. Total length was used when measuring other fish species. Maturity stages of gonads of greater silver smelt were assigned using the maturity scale for Norwegian herring: 2 – immature, 3 – first maturing, 4 – re-maturing, 5 – pre-spawning, 6 – spawning, 7 – post-spawning, 7-2 – post-spawning recovery. Maturity of all remaining species was assigned by the scale as follows: 2 – immature, 3 – maturing, 4 – pre-spawning, 5 – spawning, 6 – post-spawning, 6-2 – post-spawning recovery.

Intensity of feeding was estimated using the following scale: 0 – no food, 1 – very little food, 2 – little food; 3 – stomach is full of food and has folds on its walls; 4 – very much food, stomach is stretched; 5 – stomach is inverted. Intensity of feeding was expressed using mean index for stomach fullness (MISF).

All data are presented for individual fish species and different ICES Divisions according to the structure of the WGDEEP report. The data were aggregated in accordance with new ICES statistical areas.

## Fishery

### *The Faroese Fishing Zone (Division Vb and VIa)*

Small amounts (65-1620 kg per trawling) of greater silver smelt (*Argentina* spp.) were caught at 300-600 m trawling depth in pelagic fishery for blue whiting (*Micromesistius poutassou*) in the Faroese Fishing Zone in April. The catch of greater silver smelt in Division Vb comprised 2,0 tons and in Division VIa it was 11,4 tons (Table).

### *The Rockall Bank (Sub-Division VIb1)*

One fishing vessel carried out demersal fishery for haddock (*Melanogrammus aeglefinus*) on the Rockall Bank at 240-340 m depth within 6 days in March-April. Greater forkbeard (*Phycis blennoides*) and roughhead grenadier (*Macrourus berglax*) occasionally occurred in the catches, 3,3 tons and 1,0 ton respectively.

### *Eastern Greenland (Sub-Division XIVb2)*

Roughhead grenadier (13,1 t) and Greater forkbeard (0,4 t) occasionally occurred in the catches taken in trawl fishery for Greenland halibut (*Reinhardtius hippoglossoides*) at a depth of 600-1500 m in Greenland Zone in May-October.

According to observation data small by-catches (up to 1 %) of roughhead grenadier, roundnose grenadier (*Coryphaenoides rupestris*), Murray's longsnout grenadier (*Trachyrhynchus murrayi*), ling (*Molva molva*) and *Agassiźs* smoothhead (*Alepocephalus agassizii*) were observed at a depth of 820-1280 m in October-November. There was no information on these by-catches in the daily vessel reports.

### *The Mid-Atlantic Ridge (Division Xb)*

One vessel operated within 2 days at 960-1140 m depth in the southern part of Division Xb in February 2010. The total catch was 77,9 tons including 72,8 tons of roundnose grenadier (*Coryphaenoides rupestris*) and 5,1 tons of alfonsino (*Beryx splendens*).

### *Norwegian Sea (Divisions IIa and IIb)*

Deep-water fish were mainly caught as by-catches taken by bottom trawls and longlines. Tusk (*Brosme brosme*, 48,7 tons), ling (46,5 tons) and rough-head grenadier (5,8 tons) were the most abundant species in the catches. Roundnose grenadier (1,1 t) and skates (1,0 t) also occurred in the catches (Table).

### *Barents Sea (Subarea I)*

Small catches of tusk (0,1 t) and skates (0,5 t) were taken. All the species were taken as a by-catch in trawl and longline fishery for demersal fish.

## Investigations

### *Greater silver smelt (Argentina silus)*

*The Faroese Fishing Zone (Division Vb and VIa)*

This species was caught by pelagic trawls at a depth of 90-300 m. The length of males was 30-38 cm (mode was 33 and 35 cm). The length of females was 30-41 cm, mode was 36 and 39 cm (Figure 1). Most males and females were mature and had maturing and prespawning gonads (Figure 2). The fish fed relatively actively and MISF was 1,6. The food bolus mainly consisted of jellies and digested food (Figure 3).

*Norwegian Sea (Divisions IIa and IIb)*

This species was registered in catches taken by bottom trawls at 187-757 m depth in November. The length of caught specimens varied from 18 to 45 cm. Fish of 25-27, 31-32 and 36 cm prevailed (Figure 4).

*The Rockall Bank (Sub-Division VIb1)*

In March-May this species occurred almost in each catch taken during demersal fish surveys at a depth of 185-310 m and the number of specimens varied from 1 to 39.
Fish of 16-28 cm length were caught (Figure 5), specimens of 22-24 cm and 97,3 g were predominating. Most fish were prespawners (64 %) and spawners (34 %). Greater silver smelt fed inactively and MISF was 0,2 (Figure 6). It mainly fed on euphausiids (75 %) (Figure 7).

### *Ling (Molva molva)*

*The Rockall Bank (Sub-Division VIb1)*

This species occurred almost in each catch taken by trawls. The number of specimens varied from 1 to 16.
Individuals of 38-121 cm length were caught, those of 69 cm were prevalent. Most fish were immature. The gonads of mature fish were prespawning (38 %) and spawning (20 %). The feeding was inactive and MISF was 0,6. The fish mainly fed on other fish species (anchovies, haddock etc.).

*Eastern Greenland (Division XIVb)*

Single specimens of this species were caught by bottom trawl on the Gauss Bank at 731-1100 m depth in July-October and the number of individuals varied from 1 to 8 per a haul. The length of caught fish varied from 67 to 130 cm. The length of males was predominantly 75 cm, that of females was 90-110 cm (Figure 8). Females were more abundant than males and comprised 65 %. Maturing fish predominated in the catches, some individuals were recovering after spawning (Figure 9). Ling fed inactively and MISF was 0,5. Digested food as well as shrimp and various lanternfishes were found in the fish stomachs (Figure 10).

In October-November the fish occasionally caught and the number of individuals varied from 1 to 4 (7-30 kg) per a haul at a depth of 900-1200 m. Specimens of 80-111 cm and 4,7-11,7 kg occurred in the catches. The length of females varied from 88 to 111 cm and their average weight was 9,2 kg. The only male was 80 cm in length and its average weight was 4,7 kg. Male and female gonads were maturing. Link fed inactively and MISF was 0,7. The stomachs were mainly full of digested fish.

### *Roughhead grenadier (Macrourus berglax)*

*Eastern Greenland (Division XIVb)*

Roughhead grenadier occurred in two catches taken by bottom trawl at 850-950 m depth in July-October. Two females of 69 and 72 cm length were caught. The fish were recovering after spawning.

The species was observed in all the catches taken by bottom trawl in October-November. The by-catch varied from 3 to 8 kg. The length of males varied from 32 to 54 cm, that of females varied from 36 to 79 cm. Males of 43-46 cm were prevalent and females of 52-64 cm were predominant (Figure 11). Males prevailed in the catches (56,6 %) and the number of maturing individuals comprised 85,9 %. Mature females made up 71,4 % of the total number of females, 69,4 % of females had maturing gonads and 2 % of females were recovering after spawning (Figure 12). The feeding was moderate and MISF was 1,6. Food spectrum included 5 food items (Figure 13), digested fish (56 %), shrimps (20 %) and worms (18 %) were the most abundant.

### *Roundnose grenadier (Coryphaenoides rupestris)*

*Eastern Greenland (Division XIVb)*

In October-November roundnose grenadier was caught by bottom trawl at depths more than 900 m. The size of catches varied from 3 to 5 kg. The species most frequently occurred at 1000-1200 m depth.

Immature specimens of 32-63 cm and 190-1300 g were mainly distributed in the survey area (88,9 % of males and 93,1 % of females). The male-to-female ratio was 1:1,6. The fish fed moderately and MISF was 2,6. Shrimp was a prevalent food item.

### *Agassiźs smoothhead (Alepocephalus agassizii)*

*Eastern Greenland (Division XIVb)*

Single specimens of the species occurred in areas with depths more than 1000 m in October-November. The length of fish varied from 57 to 62 cm. The average length was 60,0 cm. The male-female ratio was 1:2,0. All the examined fish were mature, male and female gonads were at the stage of maturing. The fish did not feed.

### ***Murray's longsnout grenadier*** (*Trachyrincus murrayi*)

*Eastern Greenland (Division XIVb)*

1-2 individuals of the grenadier were occasionally taken as by-catch at depths more than 900 m. The length of males averaged 41,0 cm, the average length of females was 44 cm. All the males were immature, maturing females were predominant (66,7 %). The sex ratio was equal. The fish fed inactively and MISF was 0,3. Digested fish was prevalent in feeding.

### *Tusk (Brosme brosme)*

*Eastern Greenland (Division XIVb)*

The species was registered in commercial catches taken at 700-900 m depth in July-October. The length of fish varied from 45 to 57 cm. Females were smaller than males, the average length was 48 and 58 cm respectively. The number of females in the catches was 75 % and more. All the fish were immature.

*Barents Sea (Subarea I)*

The species was caught at a depth of 140-260 m. The length of 6 examined specimens comprised 30-63 cm, the average length was 50 cm. All the fish were immature. No investigation into feeding was carried out.

*Norwegian Sea (Divisions IIa and IIb)*

The species was caught by trawls at 187-400 m depth. The length of specimens varied from 31 to 65 cm, the average length was 47 cm. One of the examined females was immature, the other female had maturing gonads. No investigation into feeding was carried out.

## References


Anonymous, 2004. Instructions and methodical recommendations on the collection and processing of biological information in the seas of the European North and the North Atlantic. Moscow, VNIRO Press, 300 pp.  (in Russian).

Table. Russian catches (t) of deep-sea fish in 2010 (preliminary data)

| Species | ICES areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | I | IIa | IIb | Vb | VIa | VIb1 | X | XIVb2 | Total |
| Greater silver smelt | | + | | 2 | 11 | | | | 13 |
| Ling | | 47 | + | | | | | | 47 |
| Tusk | + | 49 | 58 | | | | | | 107 |
| Greater forkbeard | | | | | | 3 | | + | 3 |
| Roundnose grenadier | | 1 | 5 | | | | 73 | | 79 |
| Roughheade grenadier | | 6 | | | | 1 | | 13 | 20 |
| Skates | | 1 | 1 | | | | | | 2 |
| Other deep-sea species | + | + | | | | | | 1 | 1 |
| Slender alfonsino | | | | | | | 5 | | 5 |
| Total | + | 104 | 64 | 2 | 11 | 4 | 78 | 14 | 277 |

+ — catches under 0.5 t

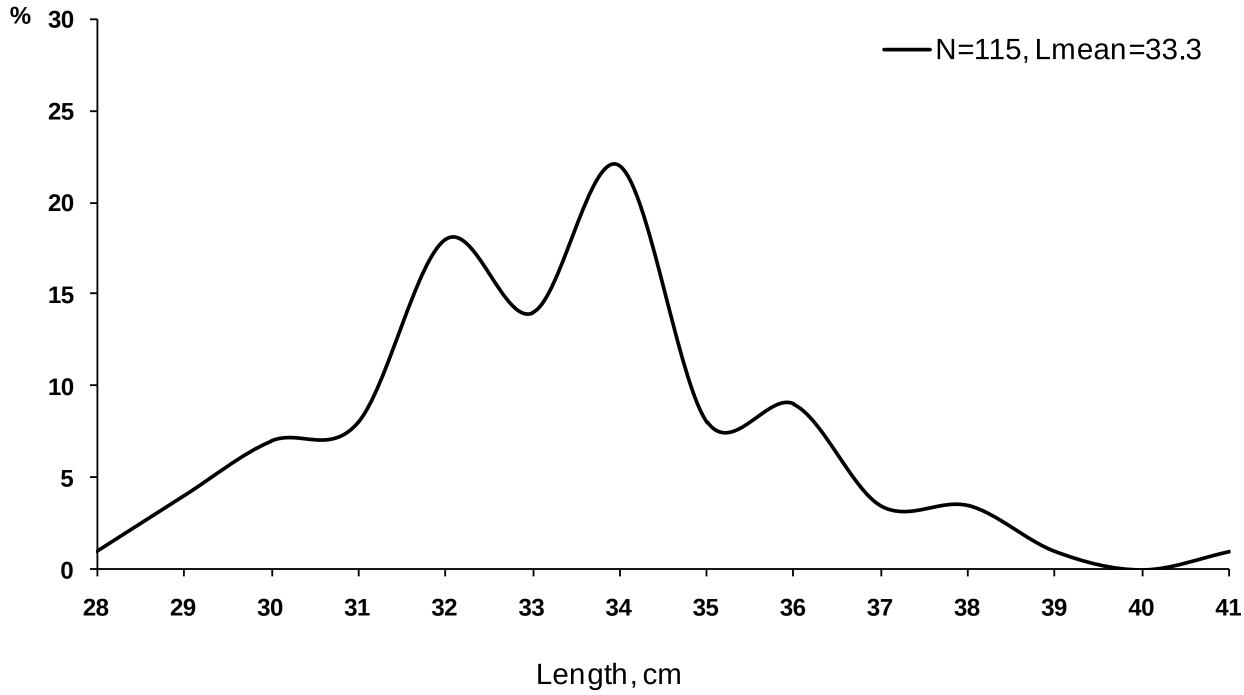


Fig. 1. Length composition of Greater silver smelt from commercial bottom trawl catches in the southern part of the Faroese EEZ in April 2010.

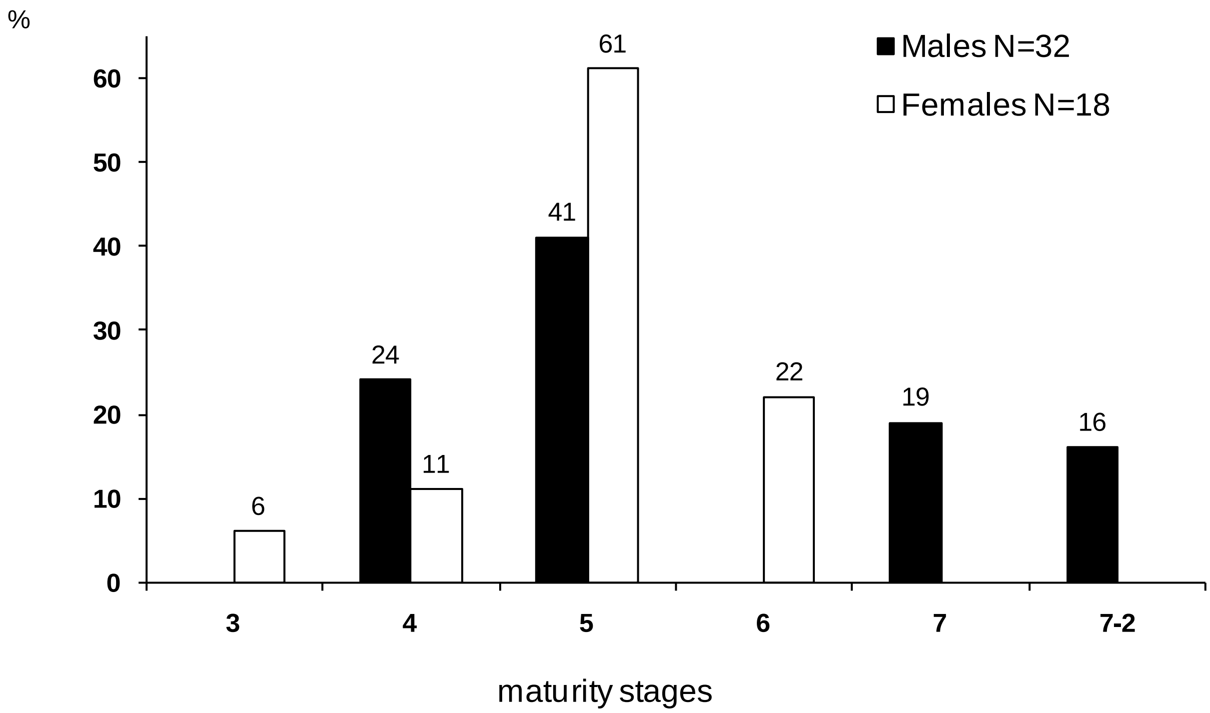


Fig. 2. Maturity of Greater silver smelt from commercial bottom trawl catches in the southern part of the Faroese EEZ in April 2010

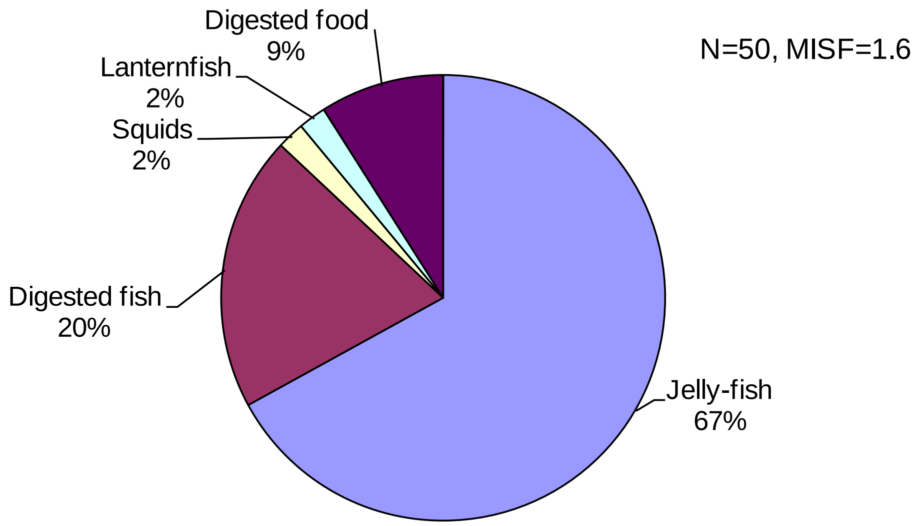


Fig. 3. Food composition of Greater silver smelt from commercial bottom trawl catches in the southern part of the Faroese EEZ in April 2010, % by weight.

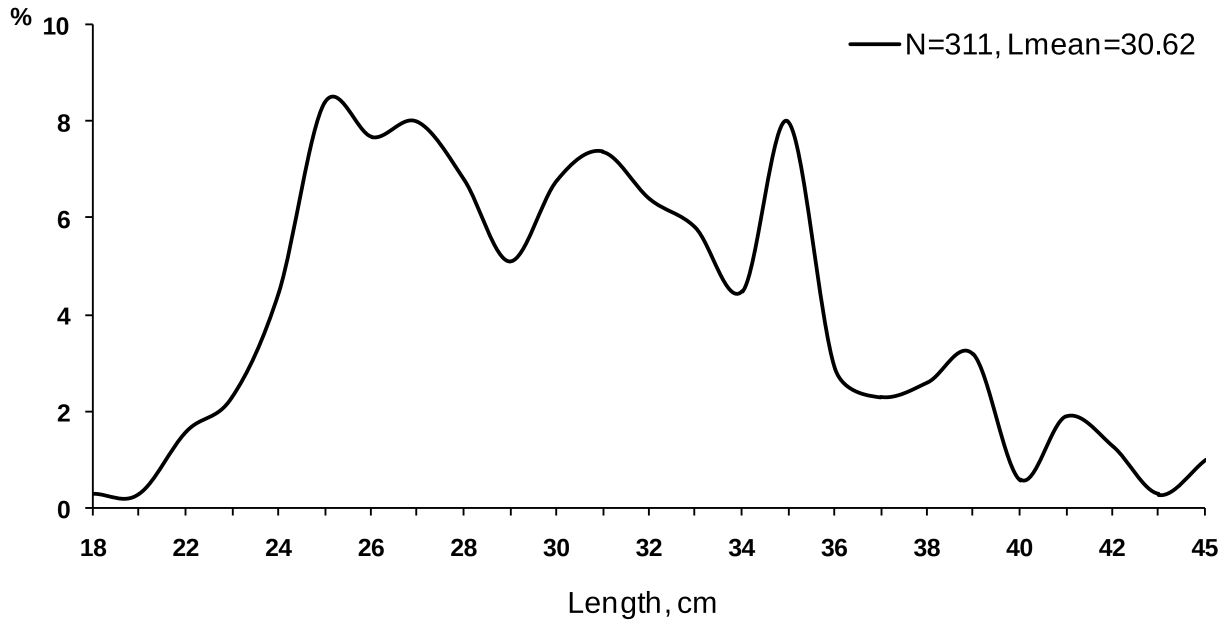


Fig. 4. Length composition of Greater silver smelt from commercial bottom trawl catches in the Norwegian Sea in 2010.

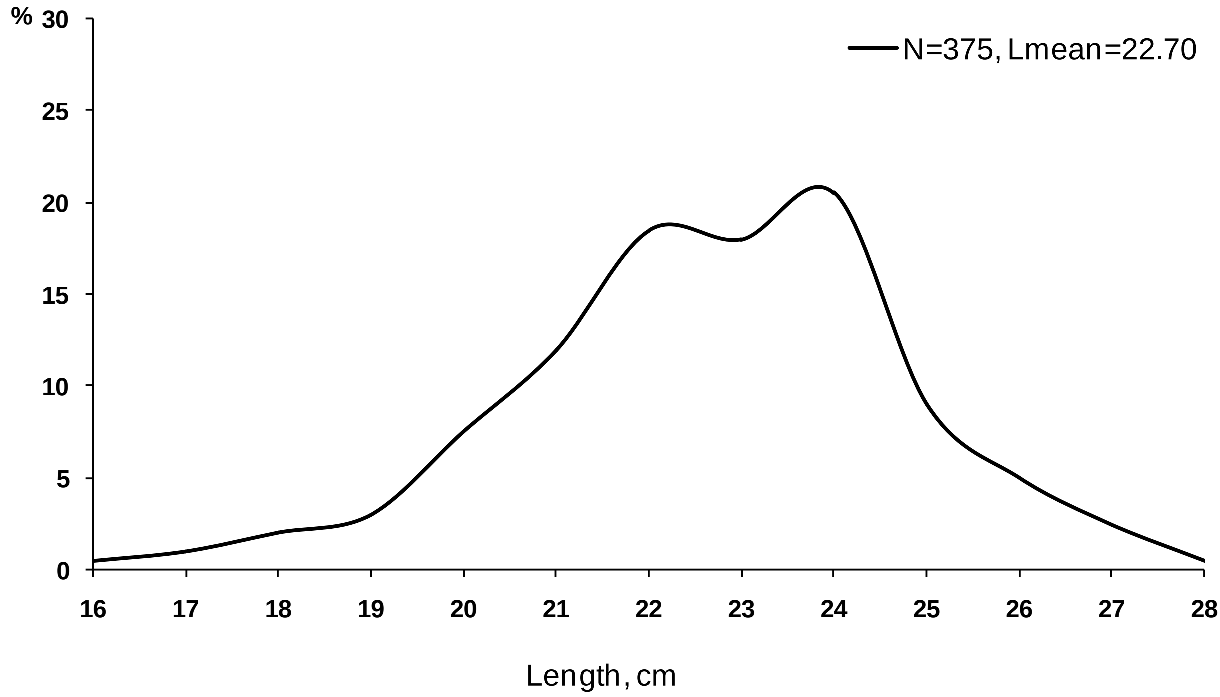


Fig. 5. Length composition of Greater silver smelt on the Rockall Bank in March-May 2010 based on the data of the Russian spring survey.

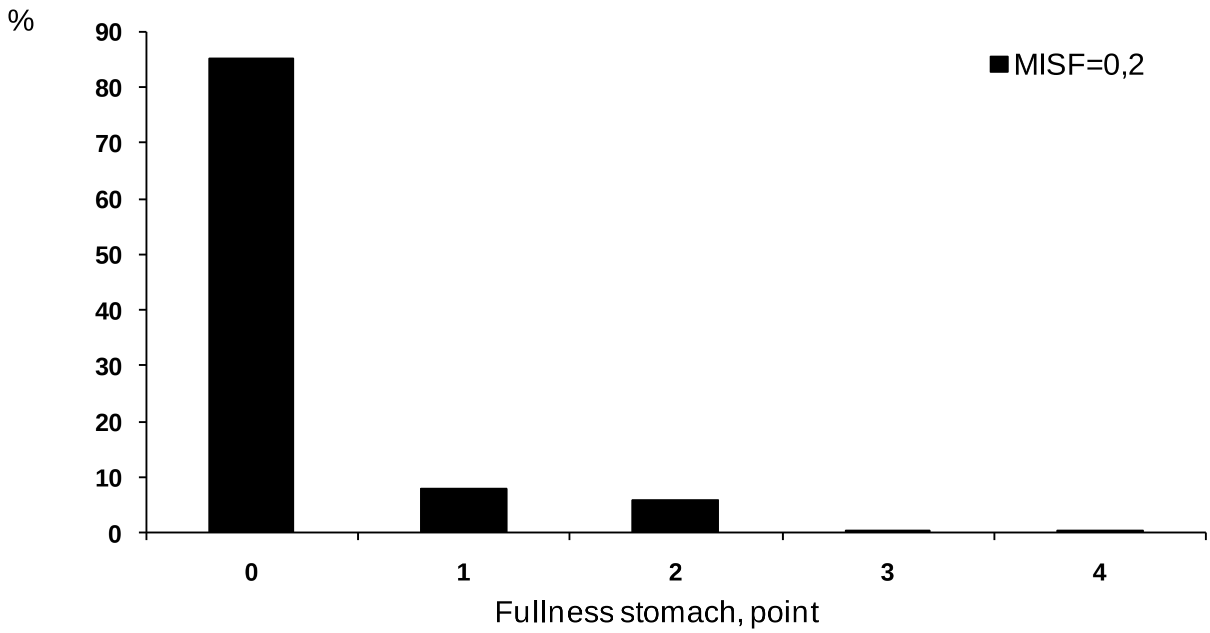


Fig. 6. Mean Index for Stomach Fullness of Greater silver smelt on the Rockall Bank in March-May 2010 based on the data of the Russian spring survey.

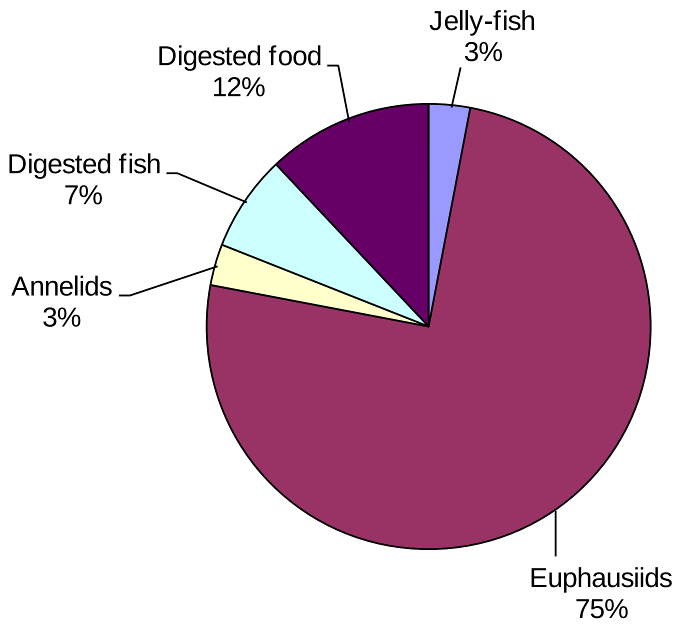


Fig. 7. Food composition of Greater silver smelt on the Rockall Bank in March-May 2010 г based on the data of the Russian spring survey, % by weight.

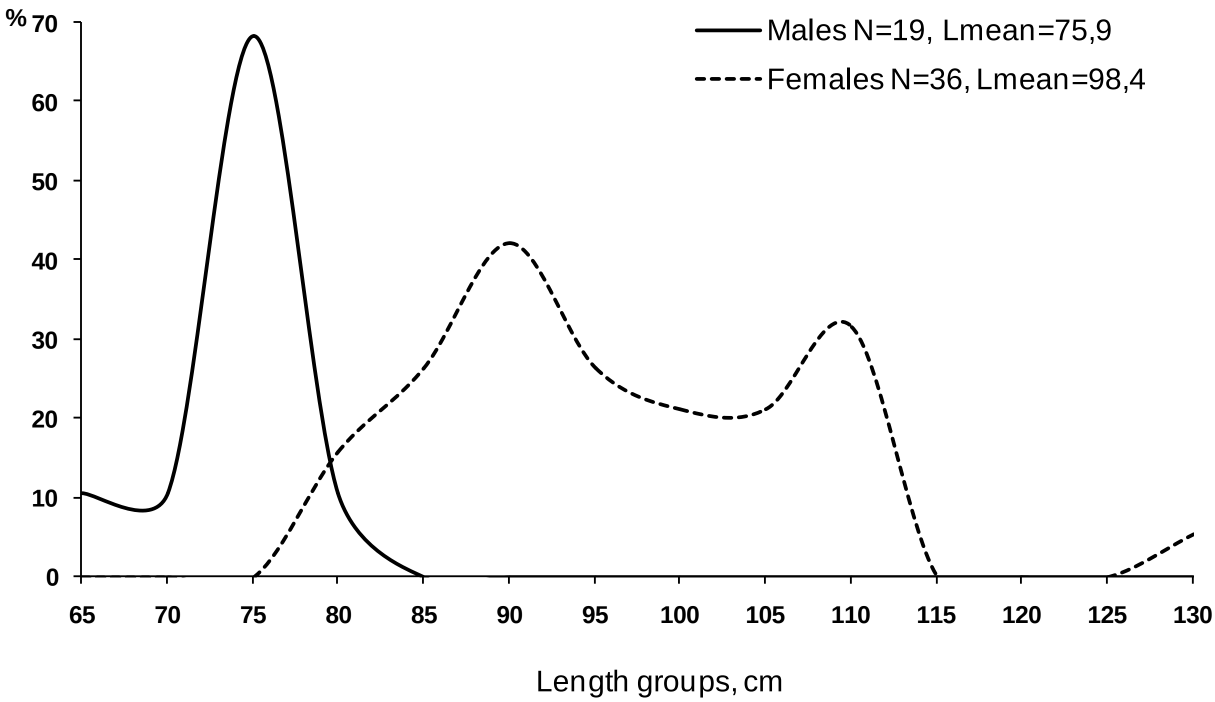


Fig. 8. Length composition of Ling in Eastern Greenland from commercial bottom trawl catches in June-October 2010.

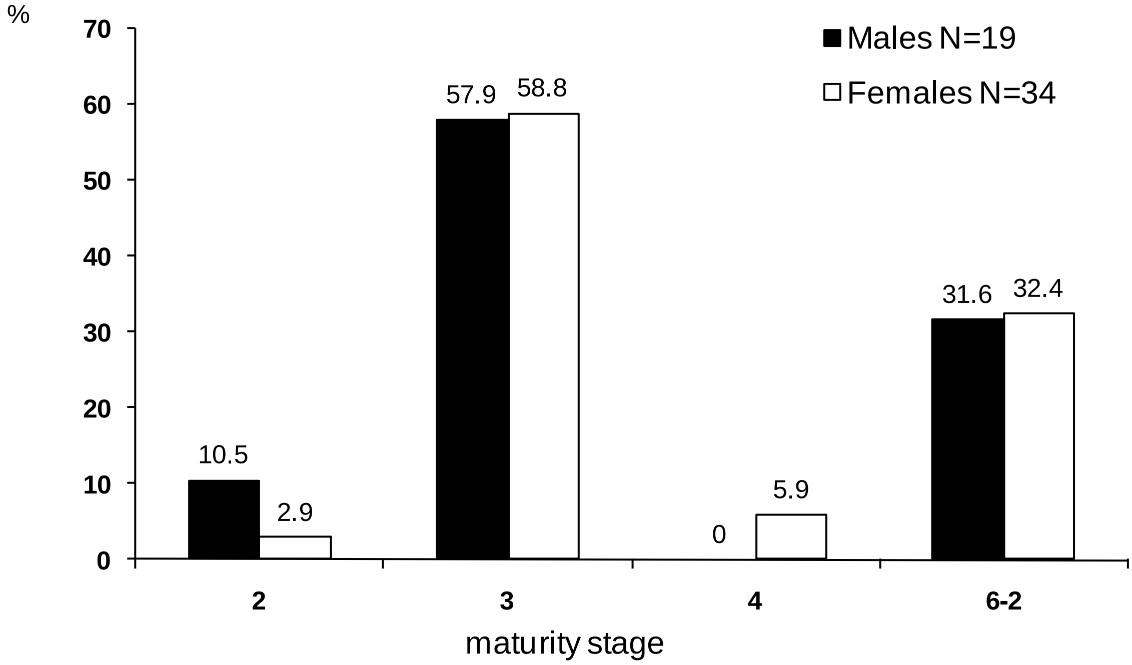


Fig. 9. Maturity of Ling in Eastern Greenland from commercial bottom trawl catches in June-October 2010.

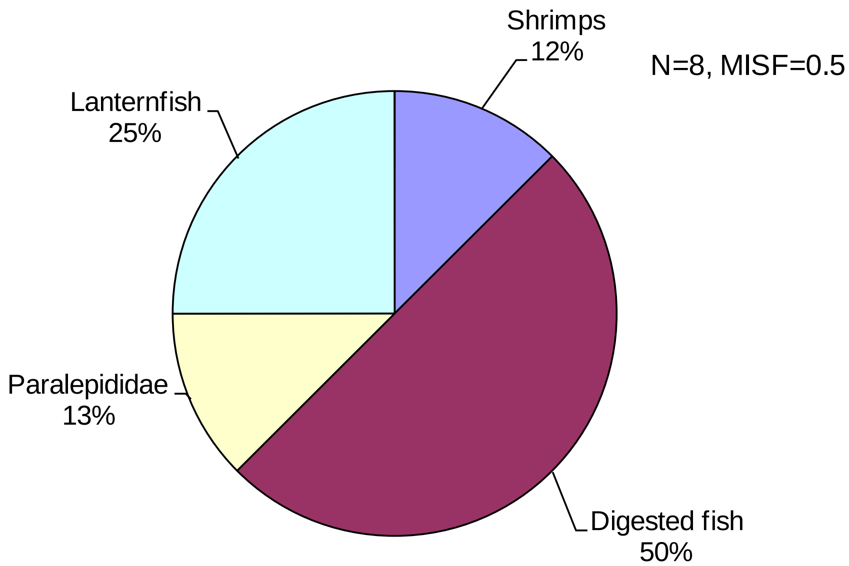


Fig. 10. Food composition of Ling in Eastern Greenland from commercial bottom trawl catches in June-October 2010, % by weight.

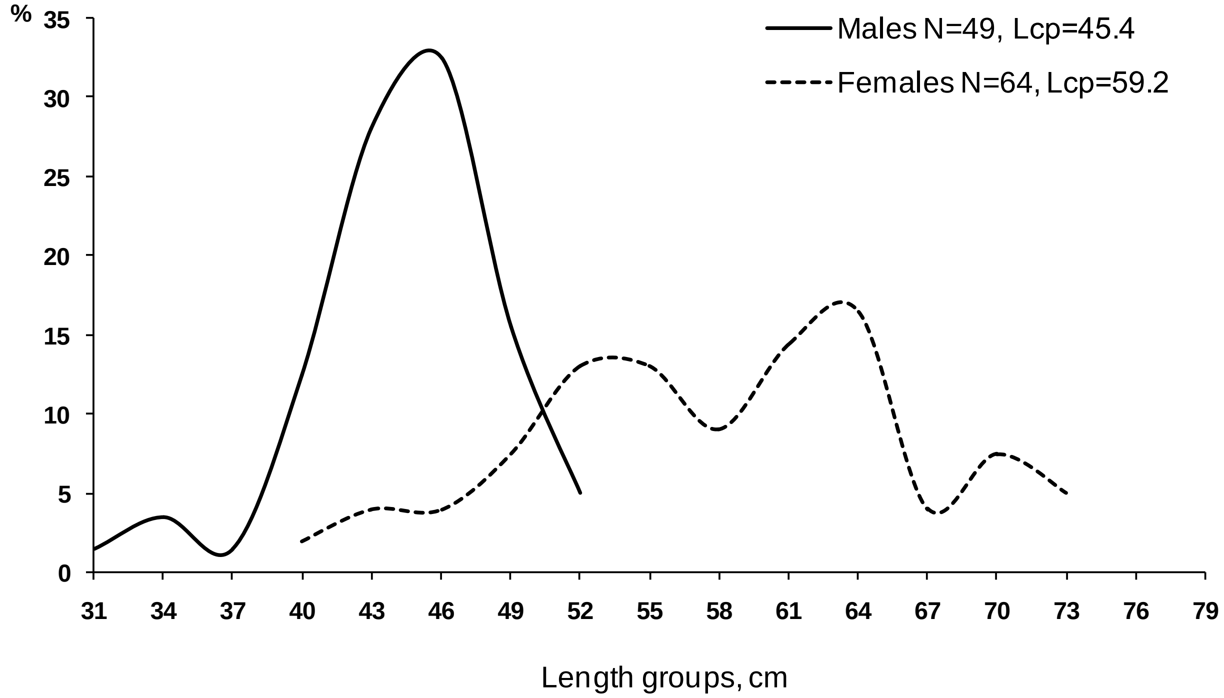


Fig. 11. Length composition of Roughhead grenadier from commercial bottom trawl catches in Eastern Greenland in October-November 2010.

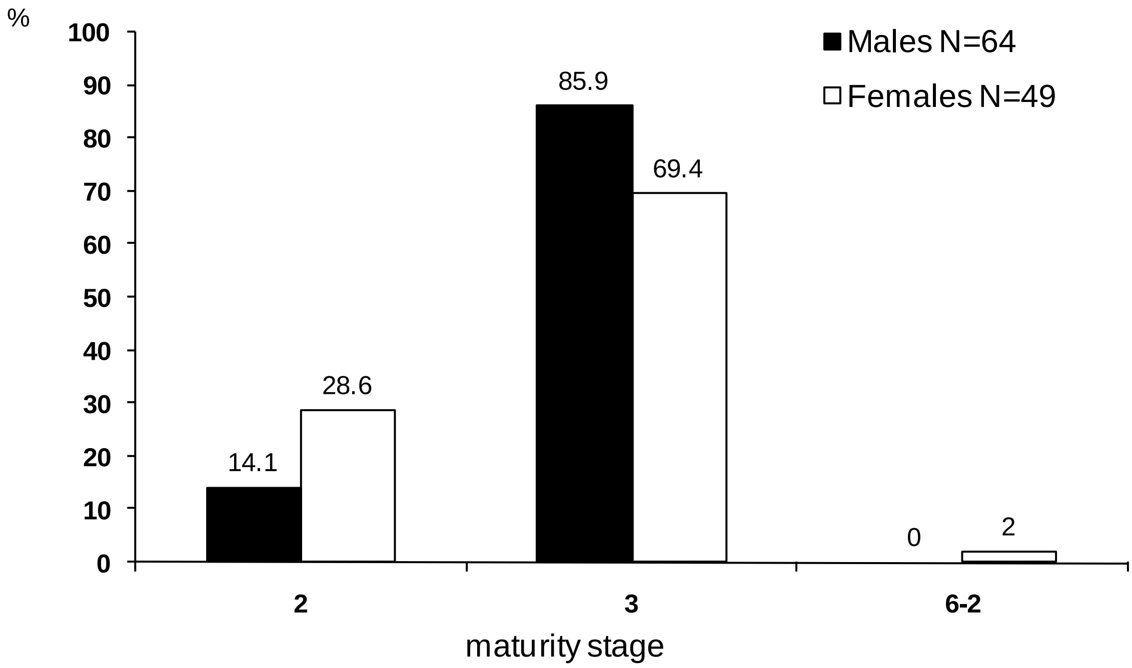


Fig. 12. Maturity of Roughhead grenadier in Eastern Greenland in October-November 2010.

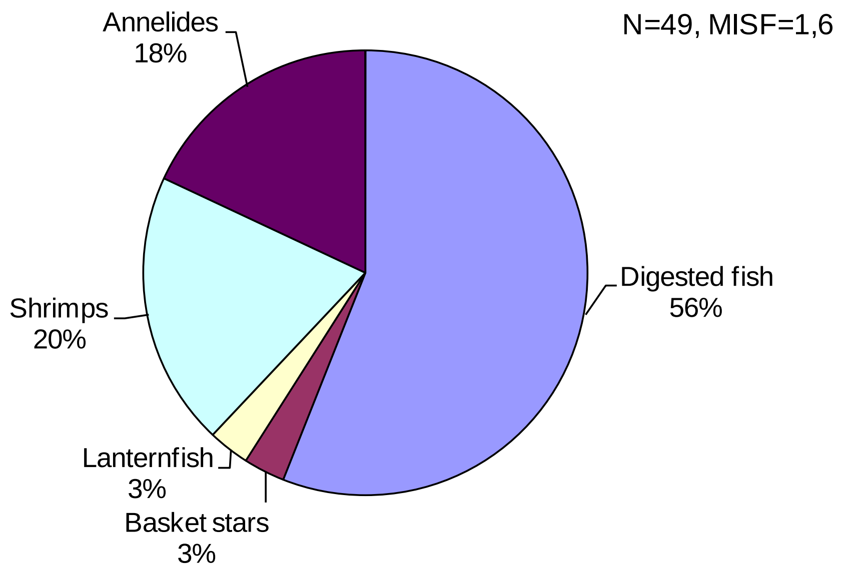


Fig. 13. Food composition of Roughhead grenadier in Eastern Greenland in October-November 2010, % by weight.

## Working Document for WGDEEP 2011

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# Summary results and outcomes from UK (England and Wales) deep-water scientific observer trips, 2004-2007.

**Philip A. Large, Lisa Readdy, Jonathan Ashworth, Robert Enever, Christopher Garrod.**

## Introduction

In 2003 the EC introduced a licensing scheme for deep-water fishing vessels operating in EU and international waters in the NE Atlantic (EC Council Regulation No 2347/2002). Articles 8 and 9 of this Regulation specify that to ensure the collection of representative data for the assessment and management of deep-water fish stocks, EU Member States must prepare a Sampling Plan for sampling landings at ports and/or the deployment of scientific observers. Historically, the majority of UK (England and Wales) licensed deep-water vessels have landed mostly at Spanish ports and it has not been possible for the Spanish Authorities to carry out biological sampling of landings. The UK therefore developed a Sampling Plan based extensively on a deep-water scientific observer scheme. The Sampling Plan comprises an England and Wales component managed by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) and a Scotland component managed by Fisheries Research Services (FRS). This Working document addresses the UK (England and Wales) component.

When the Observer Scheme commenced there were directed UK (England and Wales) trap and gillnet fisheries for deep-water red crab (mainly *Chaceon affinis*) and gillnet and longline fisheries for deep-water sharks (mainly the leafscale gulper shark, *Centrophorus squamosus*, and the Portuguese dogfish, *Centroscymnus coelolepis*). EC management measures introduced in 2006 (EC Regulation No. 41/2006) banned gillnet fisheries at depths >600 m in ICES areas VIa, b, VII b, c, j, k and XII east of 27$^{o}$ W, effectively closing the gillnet fisheries for red crab and sharks. An EU ban on all directed fisheries for deep-water sharks subsequently closed the longline fishery for these species. For UK (England and Wales) vessels only, a small trap fishery for red crab remained but this has now ceased.

The summary results and outcomes presented below will be analysed in greater detail and incorporated in a Journal paper on the history of UK (England and Wales) deep-water fisheries and fisheries research. This paper is currently in preparation.

## Material and methods

Under the UK (England and Wales) observer scheme, each year Cefas placed an observer on a minimum of 5% of trips where, on the basis or recent landings records, landings of licensed deep-water species were expected to exceed 10 t per trip. Sampled trips are listed in Table 1.

**Table 1. UK (England and Wales) deep-water trips sampled by observers**

| Vessel Number[1] | Fishing gear | Month and Year | Days at sea | Target species |
|---|---|---|---|---|
| 1 | Gillnet | Feb to March 2004 | 19 | Sharks |
| 2 | Longline | July to Sept. 2005 | 55 | Sharks |
| 3 | Gillnet | August to Sept 2005 | 38 | Sharks |
| 2 | Longline | March to May 2006 | 39 | Sharks |
| 4 | Trap | May to June 2007 | 32 | Red crab |

These amounted to one exploratory trip in 2004, two trips in 2005 and one trip in 2006, the latter reflecting the above-mentioned decline in UK (England and Wales) directed deep-water fishing activity. Since then the only directed fishing activity has been for red crab and as this is not a licensed species these trips do not require a deep-water Sampling Plan covering market sampling and/or observer coverage. Notwithstanding, a single observer trip was carried out in 2007 to obtain information regarding this poorly documented fishery. The UK (England and Wales) Observer Scheme was terminated in 2008.

Under EC Regulation No 2347/2002, on each trip the observer is required to collect information and data on the following:-

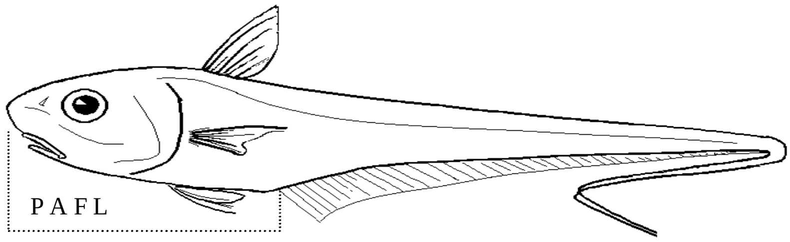
(i) type, configuration and dimensions of fishing gear;
(ii) soak time and fishing depths for each haul;
(iii) species composition of catches (including benthos and sea birds where possible) and quantities of catch retained and discarded;
(iv) length samples of retained and discarded catches of species listed in Annex 1 and 2 of EC Regulation No. 2347/2002;

Standard methods were used by Cefas staff for sorting and recording catches on commercial fishing vessels. Catches of each species were quantified in approximately 32 kg units and classified as discarded or retained according to advice from the fishing crew. For each component (retained and discarded), length measurements of were obtained and where possible the sex of the fish sampled was recorded. The following protocols were used for measuring fish:

*1. Pre-anal fin length (PAFL):-*

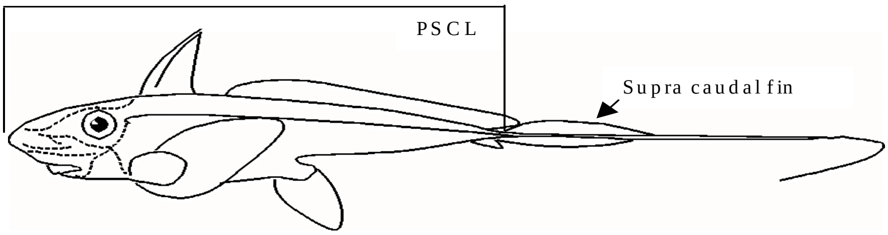
Definition end of snout to first ray of anal fin
Recorded to half cm below
Used for All Macrourids

[1] Vessel numbers have been anonymised to preserve confidentiality



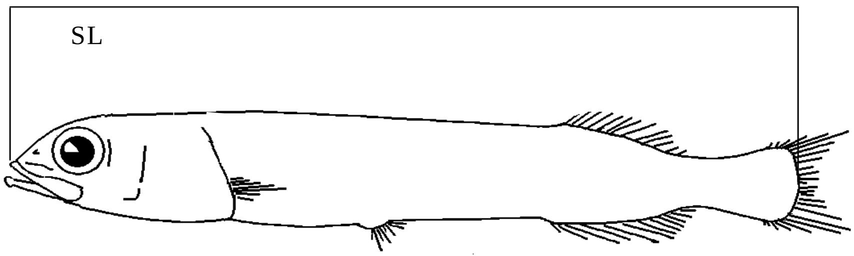

*2. Pre-supra caudal length (PSCL):*

| | |
|---|---|
| Definition | end of snout to start of supra caudal fin (see diagram) |
| Recorded to | whole cm below |
| Used for | All Holocephalans eg *Chimaera, Hariotta* etc |




*3. Standard length (SL):*

| | |
|---|---|
| Definition | end of snout to end of caudal peduncle (see diagram) |
| Recorded to | whole cm below |
| Used for | All Alepocephalids and Searsids |




*4. Total length (TL):*

| | |
|---|---|
| Definition | end of snout to longest part of caudal fin |
| Recorded to | whole cm below |
| Used for | all other fish not mentioned in protocols 1 to 3 above |

Deep-water crab species were measured on the basis of carapace width to the whole mm below.

When catches were sampled rather than fully measured, an appropriate raising factor was determined to allow the calculation of raised length distributions. Total whole live catch weights were calculated by applying species-specific length-weight relationships to raised length distributions (using the relationships developed for and used in Basson *et al* (2002)).

# Results

### Configuration and dimensions of fishing gears and soak times

**Gillnets**

For the gillnet trip in 2004, individual gillnet fleets were of a standard length of 7.4 km, comprised 148 gillnet panels and were set for an average soak time of 52 hours (95% confidence limits ± 11.8 hrs). The ends of each fleet comprised a surface dahn buoy (with lights) connected to three orange buffs (all labelled with vessel name and number). These arrays were each attached to a buoy line from the sea-surface to the seabed anchored by two anchors (iron rods with heavy chain attached) separated by around 35 m of groundline. At each end of the fleet, this groundline continued and was attached to the end gillnet panel by rope bridles. Each gillnet panel was 50 m in length, had a depth of 6.3 m and was attached to a floating headline and a leaded groundline. The mesh size of the monofilament nylon panels was 220 mm.

The only major differences observed on the gillnet trip in 2005 (which was on a different vessel to that in 2004) were that gillnet fleets had a standard length of 11.2 km, comprised 139 gillnet panels and were set for an average soak time of 102 hours (95% confidence limits ± 13.7 hrs).

**Longlines**

For the sampled longline trip in 2005, individual longlines averaged 14.2 km in length (95% confidence limits = ± 0.21 km ), had an average of 6752 hooks (95% confidence limits ±104) and were set for a standard soak time of 6 hours. The ends of each longline comprised a surface dahn buoy (with lights) connected to three orange buffs (all labelled with vessel name and number). These arrays were each anchored by a buoy line connected to two anchors (comprised of either a bucket of cement with pieces of iron embedded or two links of old anchor chain) separated by around 100 m of groundline between anchors. The groundline continued in between the two ends of the gear and carried hooks set about 2 m apart on 1 m snoods comprised of around 10 cm of light chain (nearest the hook) and around 90 cm of rope. All the rope used was floating rope to prevent snagging on any coral or rocks on the seabed and consequent gear loss. The bait used was mackerel (*Scomber scombrus*) and rocks were set at regular intervals weighting the goundline to the seabed. Each longline was shot at the normal steaming speed of the vessel i.e. 7-8 knots and set so that depth remained reasonably constant along the horizontal length of the gear. On slopes this meant that the gear was set parallel to slope contours and not necessarily in a straight line.

The only major differences observed on the trip in 2006 (which was on the same vessel) were that the dahn buoys were also fitted with radar reflectors and flags and the groundline carried plastic tags at regular intervals showing vessel name and number and call sign. Individual longlines averaged 13.8 km in length (95% confidence limits = ± 0.55 km), had an average of 6536 hooks (95% confidence limits ± 267) and were set for an average soak time of 8 hours (95% confidence limits = ± 0.93 hr).

**Traps**

For the single trip sampled in 2007, individual fleets of traps averaged 4.95 km in length (95% confidence limits = ± 0. 53 km), had an average of 152 traps (95% limits ± 25) and were set for an average soak time of 52 hours. The ends of each fleet comprised a surface dahn buoy (with lights and flags and, when visibility was poor, a radar transmitter)) connected to orange buffs (all labelled with vessel name and number). These arrays were each attached to a buoy line from the sea-surface to the seabed anchored by 3 frames each supporting 40-50 kg of anchor chain. A groundline extended in between the ends of the gear and the first trap was set approximately 200 m from the nearest anchor frame. Traps were set at 27-30 m intervals thereafter. Traps were mostly of an oblong pyramid shape with either 1 or 2 top entrances. Single entrance traps were 75 x 60 cm at the base and 60 x 45 cm at the top and approximately 50cm high, whereas the larger 2 entrance traps were 120 x 80 cm at the base and 90 x 50 cm at the top and 50 cm high. Entrance dimensions ranged from around 240-300 mm and none of the traps were equipped with escape panels or any other type of selectivity device. The smaller traps each weighed around 20 kg and were constructed of 10 mm diameter high tensile steel frame with plasticised garden trellis netting attached. The larger traps each weighed around 30 kg and had a galvanised steel rod frame with a galvanised mild steel wire cage tack-welded to it. The traps were set on snoods of 10 m of rope. As with longline gear, all the rope used was floating rope to prevent snagging on any coral or rocks on the seabed and consequent gear loss. Individual traps were set on snoods using short bridles one of which was a weak link (often a length of worn line), so that if the trap became fast this would part first and hopefully tip the trap, thus releasing it. Traps were baited with mackerel or horse mackerel (*Trachurus trachurus*), two to each trap, contained in oblong plastic net packets sewn together with twine and set inside the trap. The packets prevented the bait from being consumed by the first crabs entering the trap.

**Spatial and depth distribution of sampled hauls**

Across the five sampled trips, fishing activity was observed on a range of fishing grounds along the continental slope to the northwest, west and southwest of the British Isles and on various banks and seamounts further offshore, some of which are outside national EEZs and in the NEAFC Regulatory Area (Figure 1). Fishing on the gillnet trip in 2004 was carried out to the northwest of Rosemary Bank and on the southern areas of the western slope of the Rockall Trough (Figure 1). Fishing during the gillnet trip in 2005 mostly occurred on the continental slope north of Porcupine Seabight. In contrast, most of longline fishing observed on the two trips sampled in 2005 and 2006 occurred on the continental slope to the west of Scotland. Fishing throughout the red crab trip in 2007 was mostly confined to the vicinity of the southernmost part of the western slope of the Rockall Trough.

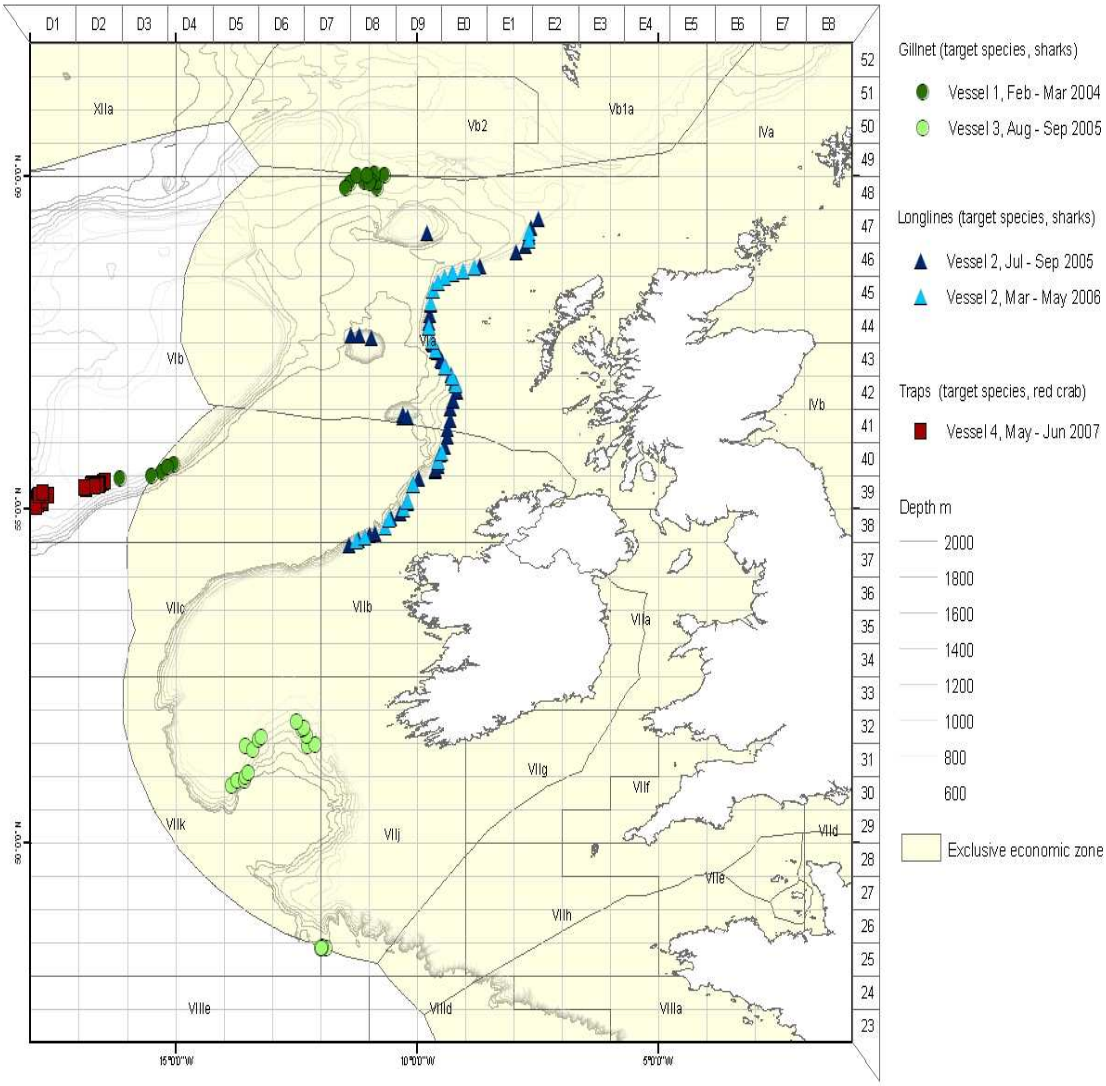



**Figure 1. Geographical distribution of sampled hauls on UK (England and Wales) deep-water observer trips, 2004-2007.**

With the exception of the trip targeting red crab (during which the observer was injured), almost all fishing hauls carried out during the trips were sampled by the observers (Table 2).

The depth distribution of sampled hauls varied between areas, gears and target species. In overall terms, most (85%) of the gillnet fishing for sharks took place within a depth range of 1000 to 1400 m and almost all (96%) of longline fishing for sharks was carried out within a depth range of 1000 to 1200 m. In contrast, sampled fishing for red crab took place at much shallower depths (600 to 1000 m).

**Table 2. Total and sampled hauls on UK (England and Wales) deep-water observer trips, 2004-2007.**

| Vessel, trip | Year | Total number of hauls | Fishing gear | ICES Division | Depth stratum (m) | Number of sampled hauls |
|---|---|---|---|---|---|---|
| Vessel 1 | 2004 | 19 | Gillnet | Vb | 1000-1200 | 4 |
| | | | | | 1200-1400 | 1 |
| | | | | VIa | 1000-1200 | 2 |
| | | | | | 1200-1400 | 4 |
| | | | | VIb | 600-800 | 1 |
| | | | | | 800-1000 | 1 |
| | | | | | 1000-1200 | 2 |
| | | | | | 1200-1400 | 1 |
| Vessel 2, trip 1 | 2005 | 53 | Longline | VIa | 800-1000 | 2 |
| | | | | | 1000-1200 | 50 |
| Vessel 3 | 2005 | 20 | Gillnet | VIIj | 1200-1400 | 1 |
| | | | | | 1400-1600 | 1 |
| | | | | | 1800-2000 | 1 |
| | | | | VIIk | 1000-1200 | 11 |
| | | | | | 1200-1400 | 4 |
| | | | | | 1400-1600 | 0 |
| | | | | | 1600-1800 | 1 |
| Vessel 2, trip 2 | 2006 | 30 | Longline | VIa | 800-1000 | 1 |
| | | | | | 1000-1200 | 29 |
| Vessel 4 | 2007 | 101 | Traps | VIb | 600-800 | 22 |
| | | | | | 800-1000 | 11 |

## Spatial distribution of catches by ICES rectangle

Information on the spatial distribution of catches by rectangle for each trip should be interpreted with caution because the underlying data are not adjusted for differences in the amount of standardised fishing effort between rectangles. Notwithstanding, the data allow a broad-scale interpretation to be made. The highest catches of leafscale gulper shark were taken mostly by longliners fishing in rectangles on the continental slope to the west of Scotland (Figure 2). Catches of Portuguese dogfish (Figure 3) were considerable lower than those of leafscale gulper shark on all gillnet and longline trips, with the highest rectangle catches occurring away from the continental slope in individual rectangles to the northwest of Rosemary Bank, on the southernmost part of the western slope of the Rockall Trough and in isolated rectangles on the continental slope north and south of the Porcupine Seabight. Catches of deep-water crab comprised mostly red crab (*Chacaeon affinis)* and, as indicated in Figure 4, catches were taken from just two main rectangles in the vicinity of the southernmost part of the western slope of the Rockall Trough.

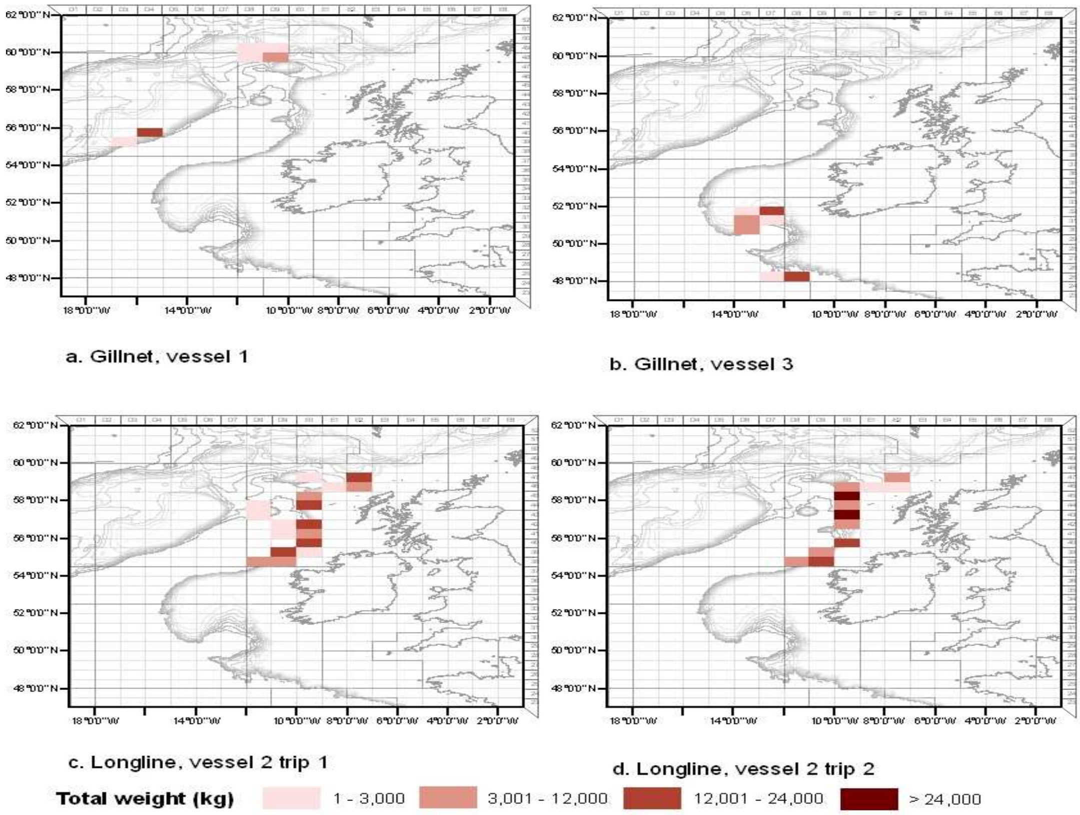



**Figure 2. Geographical distribution of catches of leafscale gulper shark by ICES rectangle on UK (England and Wales) deep-water observer trips, 2004-2006.**

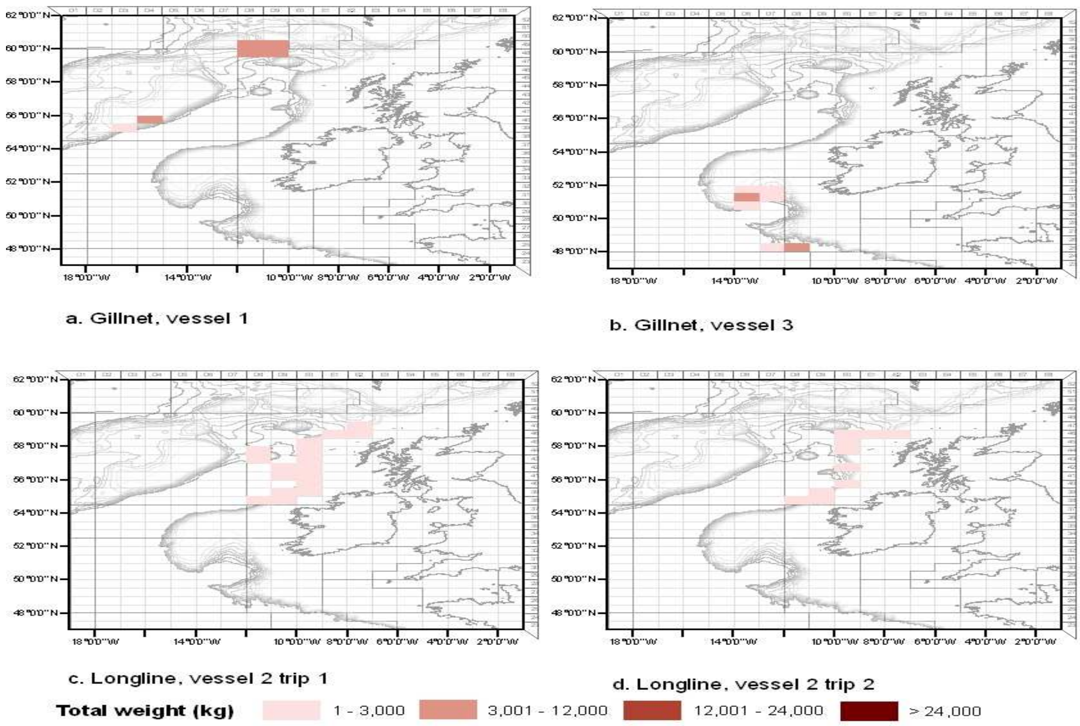



**Figure 3. Geographical distribution of catches of Portuguese dogfish by ICES rectangle on UK (England and Wales) deep-water observer trips, 2004-2006.**

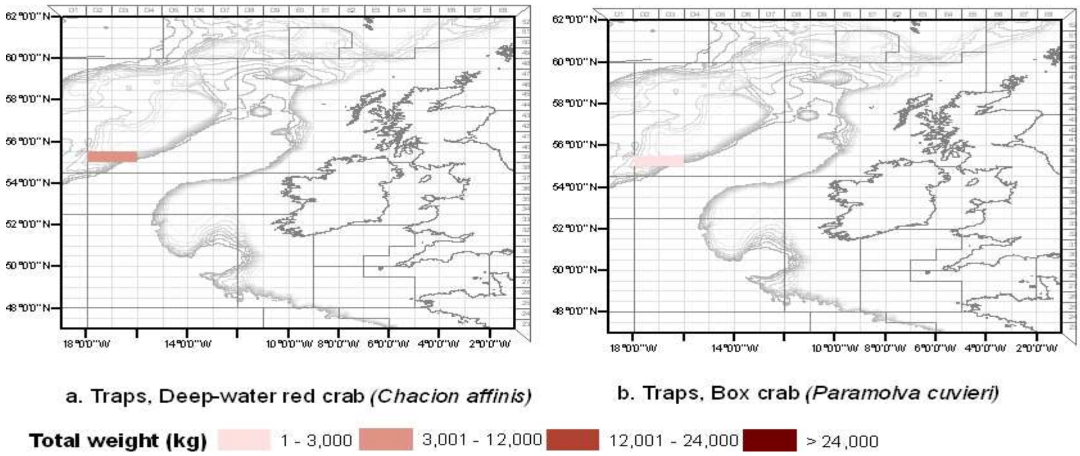



**Figure 4. Geographical distribution of catches of deep-water crab by ICES rectangle on a single UK (England and Wales) deep-water observer trip in 2007.**

## Sex composition of catches by ICES rectangle

The sex composition of catches of leafscale gulper shark varied between areas and trips (Figure 5). Catches in the gillnet trip in February to March 2004 comprised mostly females, particularly in the area to the northwest of Rosemary Bank. In contrast, during the gillnet trip in August to September 2005 the majority of catches were mostly males, particularly on the on the continental slope north of the Porcupine Seabight. Catches of this species during the longline trips most comprised males in July to Sept 2005 and both sexes in March to May 2006. Males and females in the catches from the latter show some evidence of spatial separation.

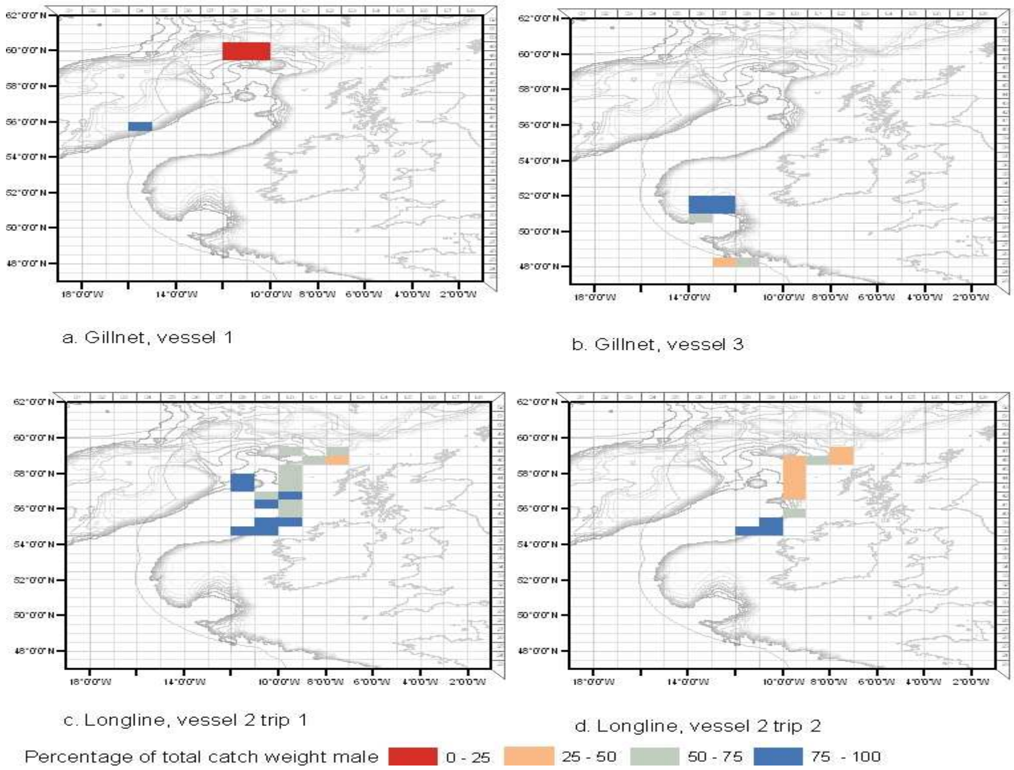



**Figure 5. Sex composition of catches of leafscale gulper shark by ICES rectangle on UK (England and Wales) deep-water observer trips, 2004-2006.**

In contrast, almost all catches of Portuguese dogfish from both gillnet and longline observation trips comprised mostly females in almost all rectangles fished (Figure 6).

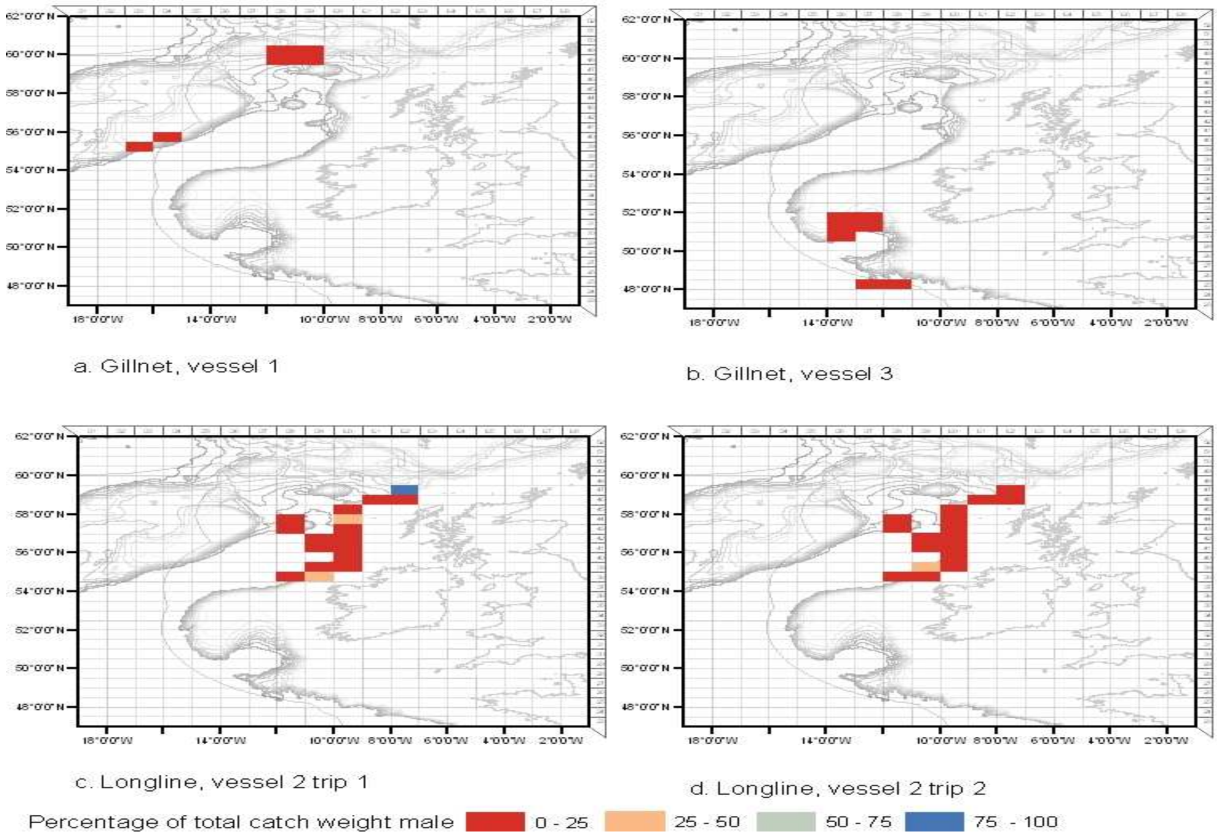



**Figure 6. Sex composition of catches of Portuguese dogfish by ICES rectangle on UK (England and Wales) deep-water observer trips, 2004-2006.**

Male deep-water red crabs and female box crabs (*Paramolva cuvieri*) were slightly the more predominant sex in catches of these species during the observer trip in May to June in 2007 (Figure 7).

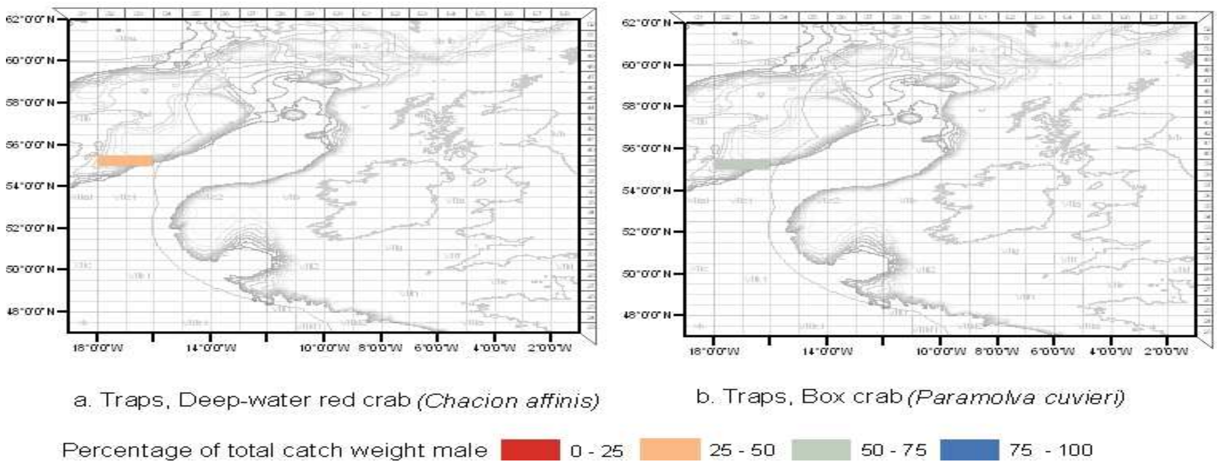



**Figure 7. Sex composition of catches of deep-water crabs by ICES rectangle on a single UK (England and Wales) deep-water observer trip in 2007.**

## Distribution of discards of fish and crabs by ICES rectangle

Total discards (i.e. of all fish and crab species combined) during the two longline trips and the trip for deep-water crabs were negligible. Discards during the two gillnet trips accounted for around 15% by whole live weight of the total trip catch (Table 3).

**Table 3. Retained/discarded quantities of all species by observer trip**

| Gear | Vessel, trip | Retained weight (kg) | Discarded weight (kg) | % discarded by weight | Retained numbers | Discarded numbers | % discarded by weight |
|---|---|---|---|---|---|---|---|
| Gillnet | Vessel 1 | 55,572 | 9,709 | 15 | 5,210 | 5,667 | 52 |
| Longline | Vessel 2, Trip 1 | 173,217 | 3,163 | 2 | 15,129 | 1,503 | 9 |
| Gillnet | Vessel 3 | 92,391 | 18,170 | 16 | 10,666 | 5,856 | 35 |
| Longline | Vessel 2, Trip 2 | 154,939 | 2,510 | 2 | 12,548 | 559 | 4 |
| Traps | Vessel 4 | 13,675 | 83 | 1 | 14,494 | 207 | 1 |

Discarding during the gillnet trips was fairly uniform across the ICES rectangles fished, although slightly high discards were observed in isolated rectangles (Fig. 8)

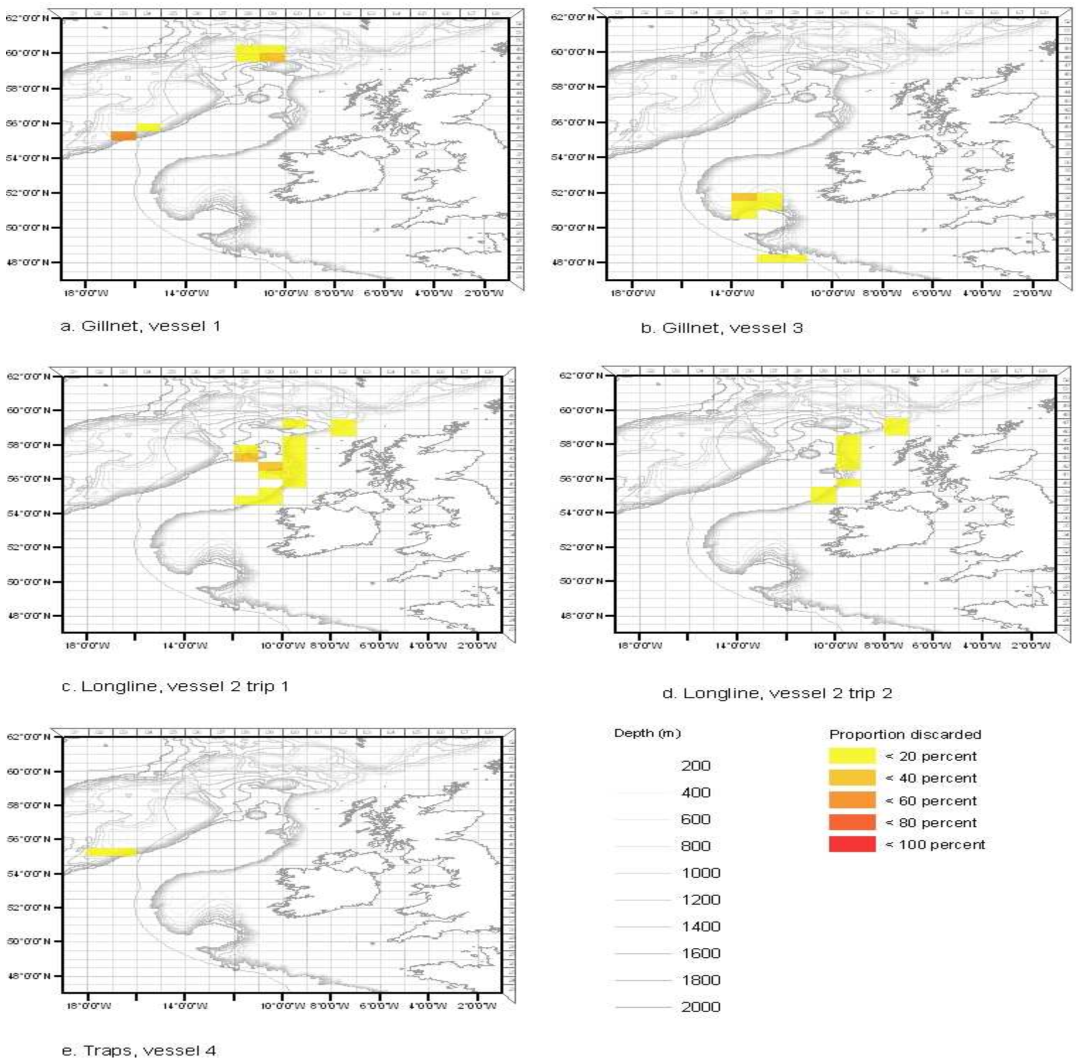



**Figure 8. Proportion of the total catch discarded by weight by ICES rectangle on UK (England and Wales) deep-water observer trips, 2004-2007.**

## Length composition of retained and discarded catches of the main target species

The length compositions of retained and discarded catches by trip are presented for each of the three main target species in Figures 9, 10 and 11.

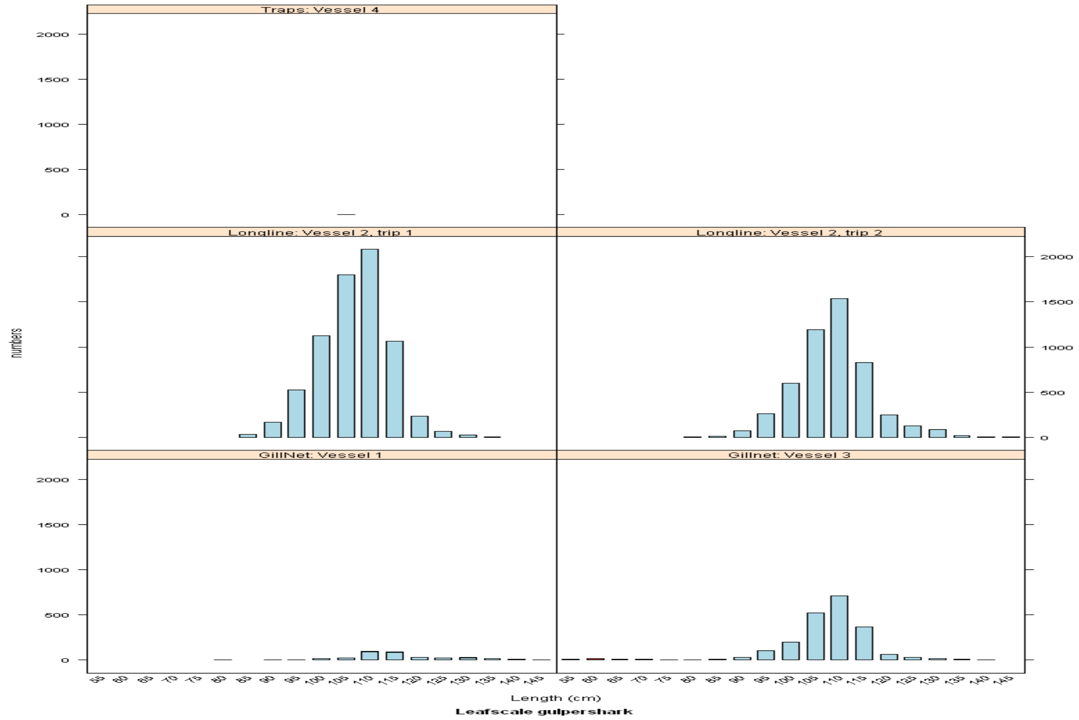



**Figure 9. Length composition of retained and discarded catches of leafscale gulper shark on UK (England and Wales) deep-water observer trips, 2004-2006 (blue - retained; red – discarded).**

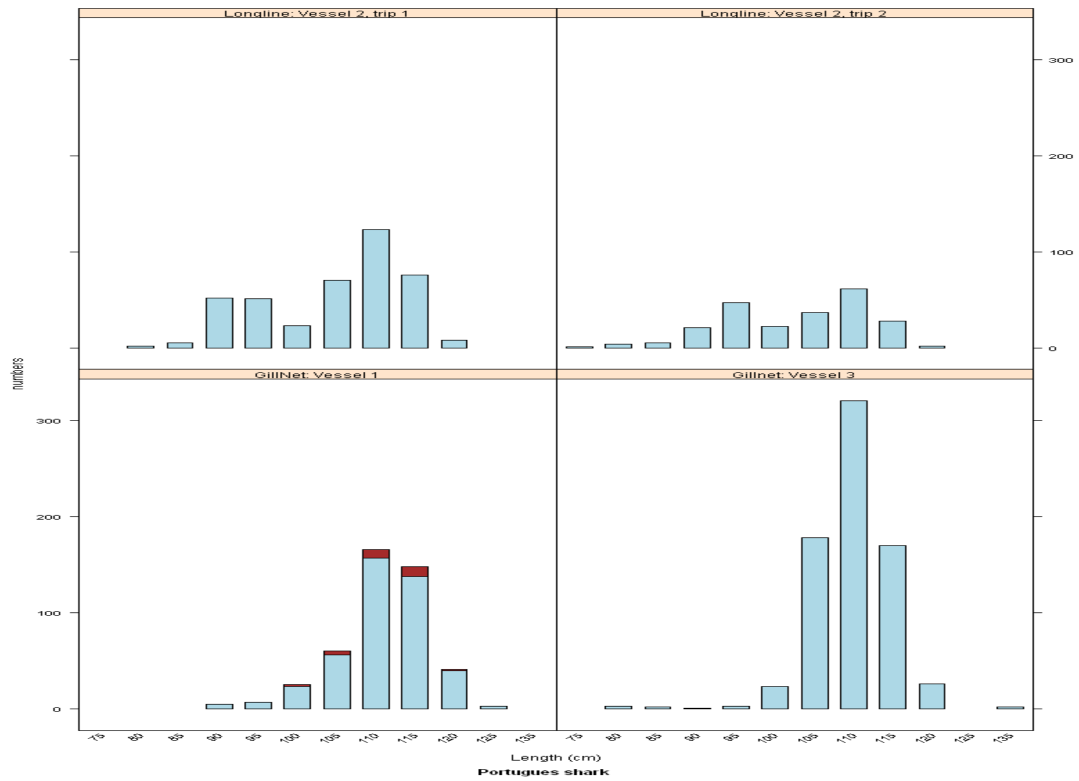



**Figure 10. Length composition of retained and discarded catches of Portuguese dogfish on UK (England and Wales) deep-water observer trips, 2004-2006 (blue - retained; red – discarded).**

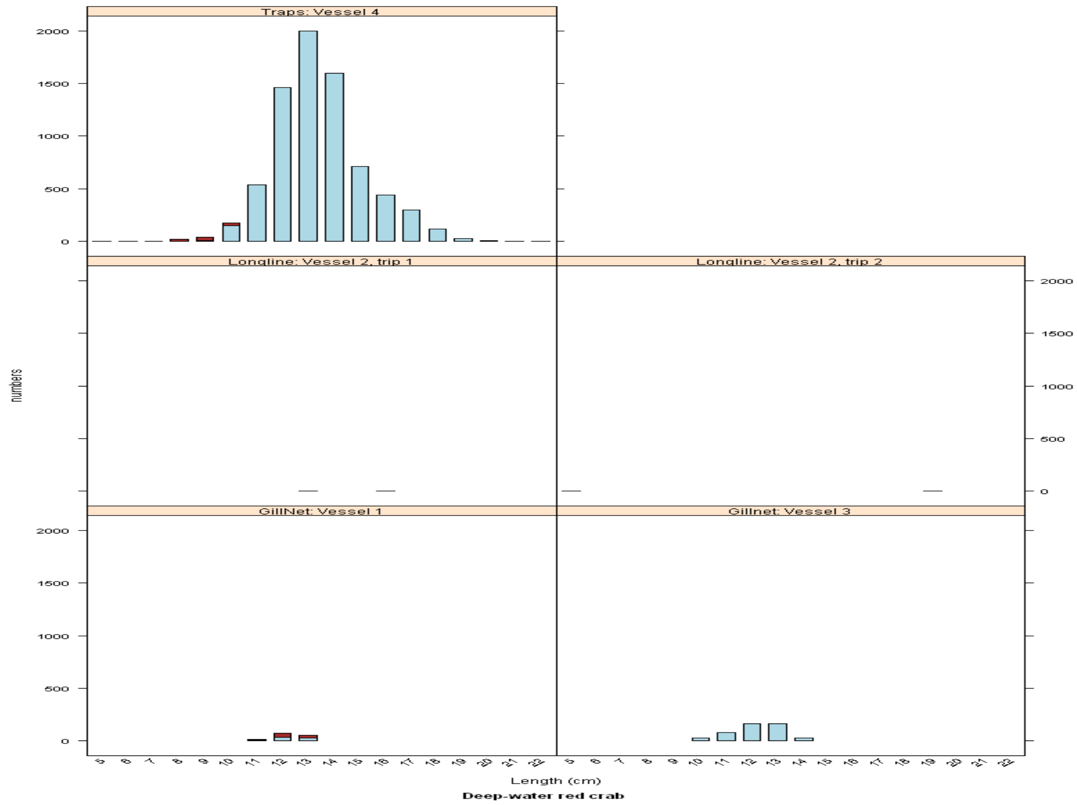



**Figure 11. Length composition of retained and discarded catches of deep-water red crab on a single UK (England and Wales) deep-water observer trips in 2007 (blue - retained; red – discarded).**

## Bycatches of benthos and incidental bycatches of seabirds

Bycatches of benthos and seabirds are summarized by trip, ICES Division and depthband in Table 4. During the two longline trips the bycatch of benthos was negligible, however greater quantities were observed in the two gillnet trips. Data by haul (not presented) show that a bycatch of benthos was observed in 16 of the 19 hauls carried out during the gillnet trip in 2004 and quantities per haul range from around <1 to 350 kg. No corals were present. Similar data for the gillnet trip in 2005 show that catches of benthos were observed in 4 of the 20 hauls fished and quantities per haul ranged from around 95 to 190 kg, all of which was dead and alive coral. There was no bycatch of benthos observed on the deep-water crab trip in 2007.

Incidental bycatches of seabirds (mainly fulmers (*Fulmarus glacialis*)) were observed on all trips except the trip for red crab (Table 4). Numbers were highest on  in the gillnet trip in 2004 where an incidental bycatch of fulmers was observed on 11 of the 19 hauls carried out and numbers per haul ranged from 1 to 11 birds.

**Table 4. Summarised data of benthos bycatch and incidental bycatch of seabirds**

| Vessel, trip | Gear | Total number of fishing operations | ICES division | Depth band | Estimated quantity of benthos (32 kg units) | Estimated quantity of coral included in benthos (32 kg units) | Total number of seabirds | Fulmer | Seagull | Unknown |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Gillnet | 19 | Vb | 1,200 | 3 | | 24 | 24 | | |
| | | | | 1,400 | 0 | | 5 | 5 | | |
| | | | VIa | 1,200 | 5 | | 3 | 3 | | |
| | | | | 1,400 | 0 | | 4 | 4 | | |
| | | | VIb | 800 | 11 | | | | | |
| | | | | 1,000 | 9 | | 2 | 2 | | |
| | | | | 1,200 | 10 | | | | | |
| | | | | 1,400 | 4 | | | | | |
| 2, 1 | Longline | 53 | VIa | 1,000 | <1 | | | | | |
| | | | | 1,200 | <1 | | 4 | 3 | | 1 |
| 3 | Gillnet | 20 | VIIj | 1,400 | 3 | 3 | | | | |
| | | | | 1,600 | 3 | 3 | | | | |
| | | | | 2,000 | 4 | 4 | | | | |
| | | | VIIk | 1,200 | | | 3 | | 2 | 1 |
| | | | | 1,400 | | | 1 | | 1 | |
| | | | | 1,800 | 6 | 6 | | | | |
| 2, 2 | Longline | 30 | VIa | 1,000 | <1 | | | | | |
| | | | | 1,200 | <1 | | 2 | 2 | | |
| 4 | Traps | 101 | VIb | 800 | 0 | | | | | |
| | | | | 1,000 | 0 | | | | | |


# Acknowledgements

We wish to thank the commercial fishers and their agents for their cooperation and assistance throughout the observer trips carried out under the UK (England and Wales) Observer Scheme.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Working document for expert group WGDEEP, Copenhagen, March 2011

# Total mortality estimates for roundnose grenadier in ICES Vb, VI, VII for the period 1990-2010 using multi-year catch curves

**Verena Trenkel, Ifremer, Nantes, France**

## Introduction

The multi-year catch curve model allows to estimate total annual mortality $Z_t$ taking account of interannual variations in recruitment. The data used are proportions-at-age in numbers by year and total catch (landings) in numbers by year. Here the method was fitted to landings and catch data for roundnose grenadier to the west of the British Isles (ICES areas Vb, VI, VII).

## Material and Methods

### *Data*

Two data sets were provided for roundose grenadier. In both cases the same age-length key was used for all years. The first one consisted of international landings-at-age for ICES areas Vb, VI and VII for the years 1990 to 2010. The second one were of catches-at-age (landings plus discard estimates) for the period 1997-2010. No discards estimates were available prior to 1997. The time trends of total catches and landings are similar during the period 1997-2010 (Figure 1).

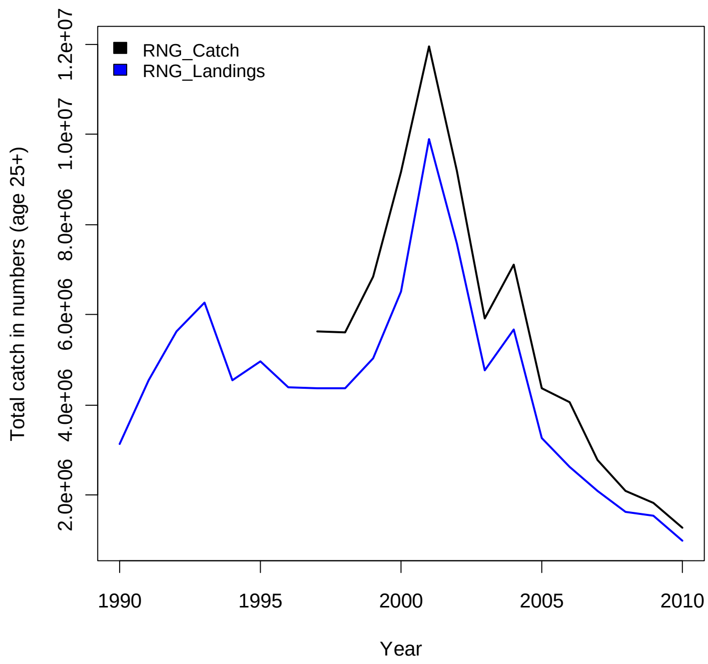


Figure 1. Roundnose grenadier catch and landings in ICES areas Vb, VI and VII.

For the analysis the data sets were restricted to the fully recruited age classes to avoid fitting catch curves to the ascending limb of the size distribution created by gear selectivity. Further, a plus group was created for ages 46 and above, called 46+. Visually the annual age distribution of landings and discards are rather similar for the age range 26 to 46+; they are descending in all years (Figure 2).

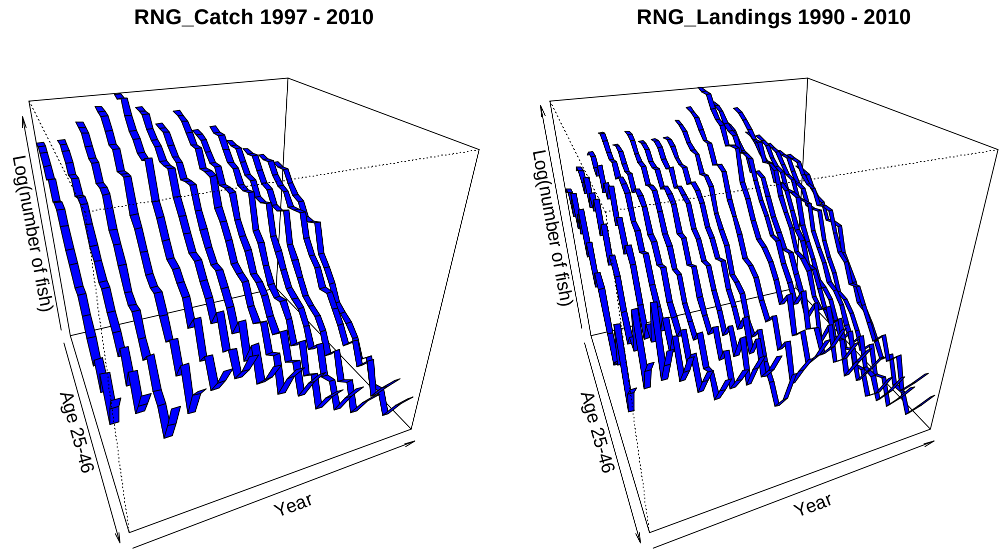


Figure 2. Log-numbers in catch and landings of roundnose grenadier for ages 26 to 46+.

## *Multi-Year Catch Curve model (MYCC)*

In the multi-year catch curves the population dynamics in numbers are modelled as

$$N_{a,t} = N_{a-1,\,t-1}\exp(-Z_{t-1}) \qquad a_r < a < A+ \tag{1}$$

$$N_{A+,t} = (N_{A+-1,\,t-1} + N_{A+,t-1})\exp(-Z_{t-1}) \qquad a = A+ \tag{2}$$

where $N_{a,t}$ are population numbers at age $a$ in year $t$, A+ is an age plus group and $Z_t$ are annual total mortality rates. Recruitment at age $a_r$ is assumed to vary randomly over time following a log-normal distribution

$$N_{1,t} = R_t \qquad R_t \sim \mathrm{logN}(\mu_R, \sigma_R) \tag{3}$$

where $\mu_R$ are the mean recruitment and $\sigma_R$ the standard deviation. For ease of interpretation the coefficient of variation ($CV_R$) instead of $\sigma_R$ was calculated making use of the fact that $\mathrm{var}(\ln(x)) \approx \ln(CV(x)^2 + 1)$. Recruitment is treated as a random effect In model fitting.

The initial state vector at the beginning of year t=1 is calculated assuming constant historic total mortality $Z0 = M + F0$

$$N_{a,1} = \exp((1-a)\,Z0)\,\mu_R \qquad a_r < a < A+ \tag{4}$$

The initial numbers in the plus group $N_{A+,1}$ are estimated as a separate model parameter.

The observation model has two parts, the first one for numbers-at-age $Y_{a,t}$ typically from onboard or harbour sampling, assumed to follow a multinomial distribution

$$Y_{a,t} \sim \mathrm{Multinom}(p_{a,t}, m_t) \qquad a_r \leq a \leq A+ \tag{5}$$

where $p_{a,t}$ are proportions-at-age and $m_t$ is the effective sample size in year $t$. It has been shown that due to the clustered nature of individuals, the sample size in trawl surveys or harbour sampling programs does not correspond to the number of individuals measured but is rather much smaller (Pennington and Vølstad, 1994). The result is that the oberved variability is much larger than would be expected given the number of measurements. Therefore after some trials the effective sample size was set to 50 for all years.

The second observation model is for the total catch (in numbers) which is assumed to follow a Gamma distribution with parameters $\alpha$ and $\beta$

$$C_t \sim \text{Gamma}(\alpha,\beta) \tag{6}$$

$$E[C_t]= (Z_t-M)/Z_t\,(1\text{-exp}(-Z_t))\,\Sigma N_{a,t} \tag{7}$$

The coefficient of variation (CV) of the Gamma distribution is related to the α parameter as CVc=1/sqrt(α ) and β = α /E[$C_t$]. As CVs are easier to handle, the model is parameterised in terms of CVc.

Not all model parameters **θ**={$Z_1$,..., $Z_T$, M, F0, $\mu_R$, $\sigma_R$, $N_{A+,1}$, $CV_R$ , CVc} can be estimated and some need to be fixed. The fixed parameters where set as follows:

- fishing mortality before the data series F0=0.001
- natural mortality M=0.1
- coefficient of variation of recruitement ($CV_R$= 0.1)
- coefficient of variation of landings or catch (CVc=0.05) to allow for some misreporting

Large scale fishing for roundnose grenadier to the west of the British isles started in the early 1990s (Pawlowski and Lorance 2009). Hence for the landings data set which starts in 1990 assuming fishing mortality F0 was very low previously seems justified, the assumption is less justified.
For roundnose grenadier recruitment age is $a_r$=26 and the age plus group A+=46.

Estimation of free model parameters **θ** was carried out by maximum likelihood based on the observation vector $\boldsymbol{y} = (C_1,..., C_T, Y_{ar,T,},..., Y_{A+,T})$ which has conditional density $f_\theta(\mathbf{y}|\mathbf{u})$ where $\boldsymbol{u} = (R_1,..., R_n)$ is the vector of the latent random recruitment variable with marginal density $h(\boldsymbol{u})$. The marginal likelihood function is obtained by integrating out **u** from the joint density $f_\theta(\mathbf{y}|\mathbf{u})h_\theta(\mathbf{u})$

$$L(\boldsymbol{\theta})=\int f_\theta(\mathbf{y}|\mathbf{u})h_\theta(\mathbf{u})\,d\mathbf{u} \tag{8}$$

The joint penalized loglikelihood is $PL(\theta)=\log(f_\theta(y|\mathbf{u}))+\log(h_\theta(\mathbf{u}))$ .
The integral in (8) is evaluated using the Laplace approximation as implemented in the random effects module of AD Model builder and described in Skaug and Fournier (2006). AD Model builder automatically calculates standard deviations of estimates based on the observed Fisher Information matrix.

## Results

MYCCs were fitted to landings and catches fixing natural mortality at 0.1 (Figure 3). The QQ-plots for the recruitment random effect showed that by fixing *M* the model asumptions were met for both data set (Figure 4left). Further, the QQ-plots also indicated that model assumptions were better met by the landings data compared to the catch data. Residuals for catch-at-age by year were generally positive younger ages and sometimes negative for the oldest age classes (Figure 4right). This might stems from the fact that all ages do not have the same total mortality as assumed in the model. Overall, the results obtained by fixing natural mortality and using the landings data set seem to be more reliable than all other estimates.

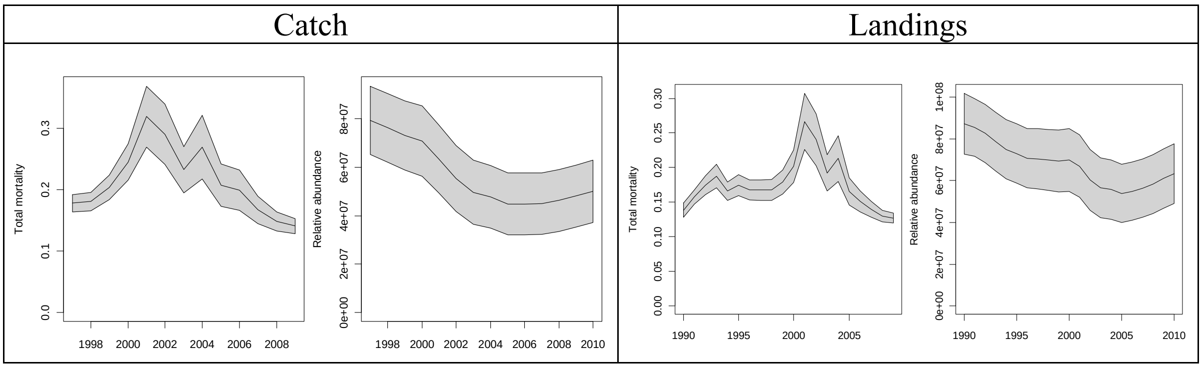


Figure 3. Time series of Z estimated from the MYCC run on catch-at-age and landings-at-age tables including international landings reported as roundnose grenadier in Vb, VI and VII, top row fixing natural mortality M=0.1.

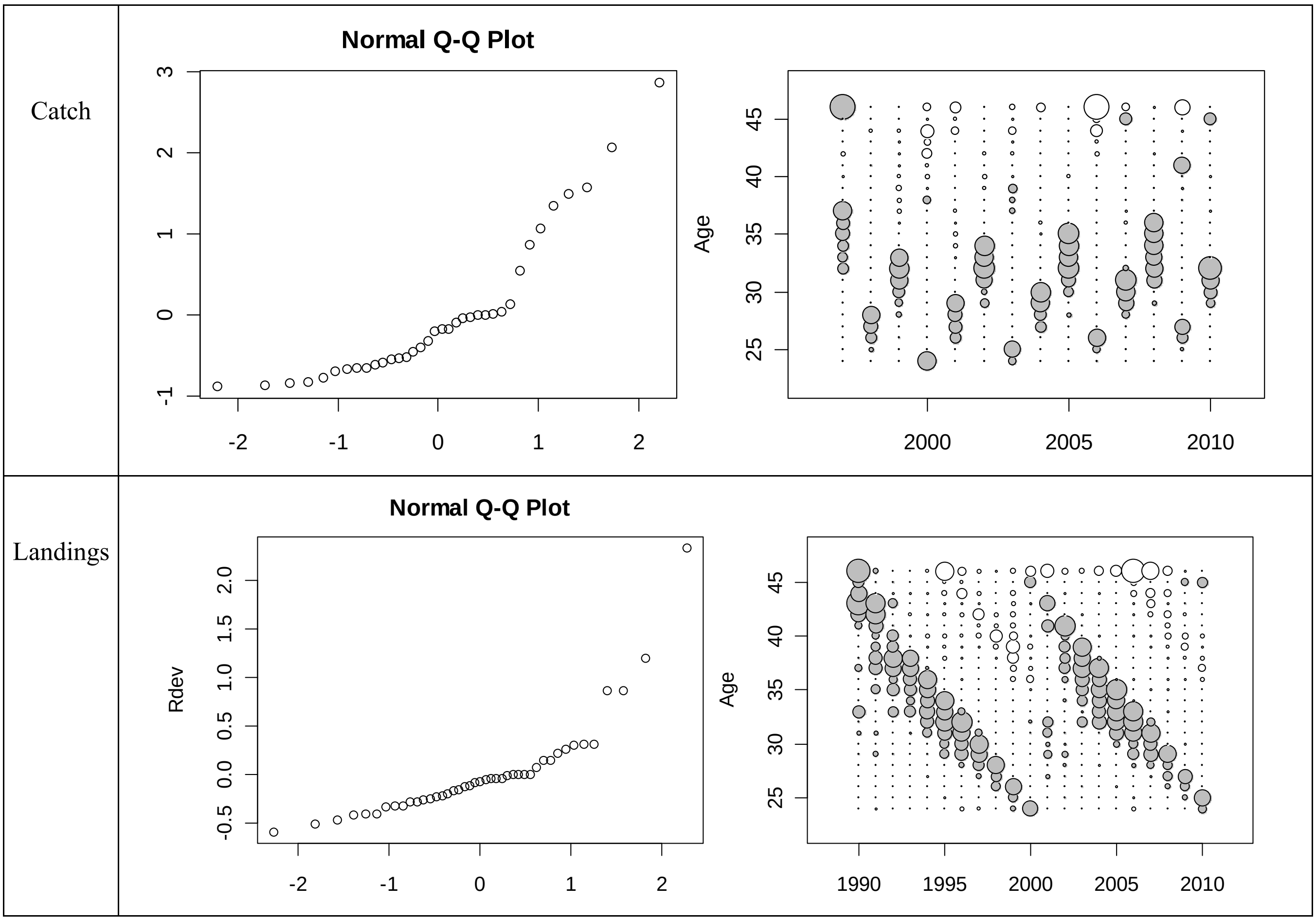


Figure 4. QQ-plot for recruitment random effect (left) and residuals for catch-at-age (right) for MYCC fits in figure 3. Positive residuals are grey and negative ones in white.

We now turn to interpreting the results for the landings data set obtained by fixing M=0.1. These results indicated that since the beginning of the time-series, *Z* increased and peaked at a high level in 2001-2003 (Figure 3 topright). Afterwards, Z declined toward lower levels, close to those from 1990 or even below in the most recent years. Taking M=0.1, Z=0.13 (2010) implies F=0.03, which is much below Fmsy taking Fmsy=M as a proxy. This suggests fishing mortality in recent years was below Fmsy. Further, the results suggest that stock abundance is following a rebuilding trajectory. Because individuals have higher survival more in recent years and hence the proportion in young individuals is increasing, the stock increase in biomass is less than in numbers shown here.

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ICES Working Group on the Biology and Assessment
of Deep-Sea Fisheries Resources (WGDEEP) 2011

Working Document 16

# Russian research of roundnose grenadier in the Mid-Atlantic Ridge area during 2010

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## *Introduction*

Abundant aggregations of roundnose grenadier (Coryphaenoides rupestris) at the seamounts of the northern Mid-Atlantic Ridge (MAR) were found by the Soviet research and scouting vessels in 1972-1973. Starting from 1974 the Soviet fishing vessels carried out regular fishery of grenadier with mid-water trawls. In some years the total catch attained 30 thousand tons (Vinnichenko, 2002). The Soviet fishery researches were fulfilled in MAR on the annual basis and the large amount of scientific-fishery information was collected. In 1990s the scale of the Russian deep-water fishery decreased owing to several reasons, and further, in the middle of the first decade of the 21st century the fishery was ceased. The extent of researches was reduced considerably, and the expeditions were absent for a long time period. They were resumed in May-July 2003, when research vessel STM “Atlantida” surveyed the Mid-Atlantic Ridge area between 47° and 58° N. The new data were obtained on grenadier biology, behavior, distribution and living conditions, the acoustic surveys of its biomass were carried out at several seamounts. The similar research was carried out at STM “Atlantida” in October 2010 in the Mid-Atlantic Ridge area between 44° and 50° N (Fig.1). Thus, the observations of grenadier stock condition over the seamounts became sufficiently regular. In this article the basic results of the Russian researches in 2010 were presented in comparison to the data of 2003 and the retrospective data.

## *Material and methods*

The acoustic surveys aimed at assessment of grenadier biomass were carried out using the research echo-sounder Simrad EK-60 and the software SonarData Echoview v.3.50.49.4151 for the acoustic data processing.
The data compilation and formation of echogram files (*.ek60) in the hard disc was fulfilled with SonarData Echolog 60 v. 3.50.1.2922.
The method of biomass assessment is based on estimation of aggregations density at an individual seamount and calculation of this aggregations size by means of accumulated echograms processing. The calculation procedure is presented in Oleynik (2003).
The scheme of the vessel tacks during the acoustic survey was selected for each seamount depending on its shape and size. The top surface of the most seamounts was extended from the north to the south with the long axis inclination to the north-west. For these seamounts the grid of zigzag tacks with inter-tacks distance from 0.5 to 1 n.mile was selected. The general direction of the survey was selected along the longest axis of the seamount with a tack of trawling along the seamount ridge across the echo-records obtained (Fig.2).The control hauls for biological

sampling were carried out with the mid-water trawl 80/140 “Makrurus” designed for STM-type vessels.

After each trawling the catch species composition, number of specimens and weight of each fish species were determined.

For grenadier catches 300 specimens were measured from each catch. If the number of specimens in the catch was below 300, all specimens were measured and weighted. Two lengths were measured for each fish: the absolute length and ante-anal distance (the distance from the tip of the mouth to the first ray of the anal fin). The measurements were fulfilled in males, females and juvenile fish separately. The maturity stages were determined using the scale adopted in AtlantNIRO and PINRO, where stage 1 – juvenile fish, stage 2 – immature fish, stage 3 – maturing fish, stage 4 – pre-spawning fish, stage 5 – spawning fish, stage 6 – post-spawning fish. Otoliths were samples for fish age study.

***Results and discussion***

During the cruise 17 seamounts were surveyed (Fig.1). The typical echograms of grenadier were obtained over 13 seamounts located to the north of 46° N. The distribution of grenadier aggregations was characterized with a disperse “cloudy” shape typical for this species in the seamounts area of MAR (Fig.3).

Grenadier distributed mostly at the slopes of seamounts within the depths range from 1200 to 1350 m, sometimes up to 1500m (Fig.4).

Similar to 2003, considerable increase of the grenadier distribution depths was observed as compared to 1970s-1980s, when the distribution depths range was mainly from 600 to 1200m.

According to the echo-records, the aggregations thickness varied from 140 to 380 m and the extension was from 0.7 to 3.5 n.miles. In most cases they were associated with the bottom, however, considerable vertical development allowed to fulfill effective hauls at the safe distance from the bottom.

At all seamounts slopes with grenadier aggregations the effective hauls were carried out. The catches varied from several kg to 10 t.

Large mature specimens of grenadier of 60-85 cm in length prevailed in catches.

The comparison of the length composition with the retrospective data for 1984-1988 and the data obtained in 2003 demonstrated that the length of fish caught in the surveyed MAR area (46°-50°N) decreased slightly as compared to 1980s.

The length curves in 2003 and 2010 are generally similar, however, in catches during 2010 the number of small immature grenadier up to 50 cm in length was lower (Fig.5). Therefore, the long-term structure of aggregations in the surveyed area varied insignificantly. Large mature specimens of 60-80 cm in length constituted the bulk of catches during all years. At the same time the occurrence of juvenile fish did not exceed 2-3%.

Gonads of grenadier were mostly at the stage of maturation (Table 1). The total proportion of females at pre-spawning and spawning states constituted 25%, which is comparable with the results observed in May-June 2003 (21%).

In 2010 the sex ratio was characterized with males prevalence (59.3%), while the proportion of females constituted 38.4% and that of juvenile fish – 2.3%. In 2003 a small number of juvenile specimens was also observed in catches (3.4%), while females predominated insignificantly in the sex ratio (50.5%).

Large amount of females at pre-spawning and spawning stages of gonads development, which constituted 20-25% of the total number of fish analyzed in summer 2003 and autumn 2010, confirmed the earlier made conclusions that MAR area between 46° and 50° N is the area of the active grenadier spawning.

The acoustic surveys were fulfilled at each seamount, where echo-records of grenadier were found.

The minimum biomass of grenadier at one seamount was 241 t, and the maximum – 4566 t. The comparison of the data obtained and the results of grenadier biomass assessment in 2003

indicated that biomass values were higher in 2010 at the most seamounts except for 476-A and 491-B (Table 2).
In 2010 the total biomass of grenadier at the seamounts of MAR between 46° and 50° N amounted to 59.4 thousand t. In 2003 the total biomass at 9 seamounts surveyed was 35.1 thousand t. Therefore, grenadier biomass per one seamount increased from 3.9 thousand t in 2003 to 4.6 thousand t in 2010.
On the basis of the survey results in 2003, 2010 and in the previous years and assuming the permanent length composition of grenadier in the MAR area between 46° and 50° N and increase of its biomass, it is possible to make a conclusion on the stable state of its stock.

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Table 1. Maturity stages and sex ratio of grenadier in 2010

| Sex | Maturity stages | | | | | Number of specimens | |
|---|---|---|---|---|---|---|---|
| | II | III | IV | V | VI | specimens | % |
| Females | 17.8 | 45.7 | 12.6 | 12.4 | 11.5 | 540 | 38.4 |
| Males | 24.8 | 55.6 | 17.4 | 1.3 | 1.0 | 835 | 59.3 |
| Juveniles | | | | | | 32 | 2.3 |
| Total | | | | | | 1407 | 100.0 |

Table 2. Results of the acoustic surveys at the seamounts of the Mid-Atlantic Ridge in 2003 and 2010.

| Seamount | Biomass (t) | |
|---|---|---|
| | 2003 | 2010 |
| 462 | Not surveyed | 2 188 |
| 473-A | 1662 | 10 259 |
| 473-B | 7016 | 6 417 |
| 476-A | 3159 | 4 357 |
| 485-A | 971 | 6 350 |
| 485-B | Not surveyed | 2 097 |
| 491-B | 3228 | 2 203 |
| 493-A | Acoustic searching, fish records are weak | 1 828 |
| 494-A | 18086* | 12 274 |
| 494-B | | 8 227 |

| | | |
|---|---|---|
| 495 | 977 | 1 350 |
| 495-B | Not surveyed | 241 |
| 496-A | Acoustic searching, fish records are weak | 1 573 |
| TOTAL | 35099 | 59364 |

*) – total for two seamounts

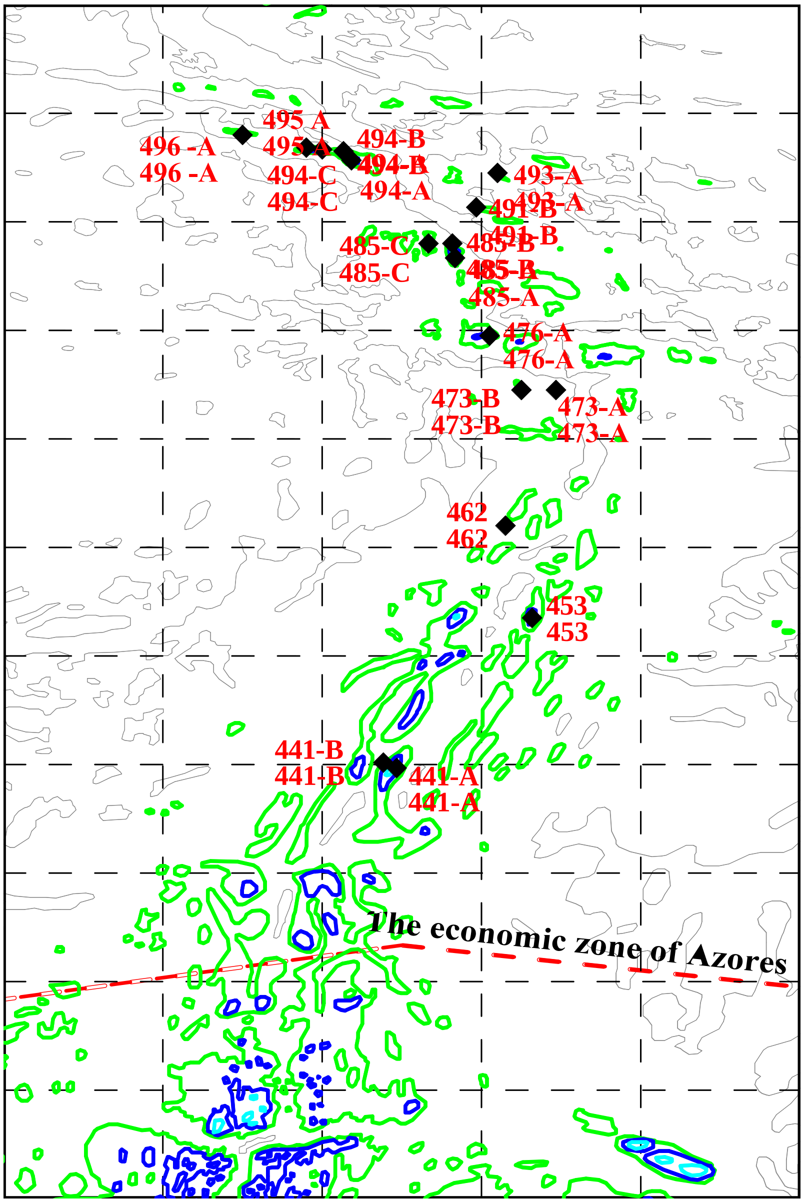

Fig.1. The Mid-Atlantic Ridge (MAR) area and location of seamounts surveyed at STM “Atlantida” in October 2010.

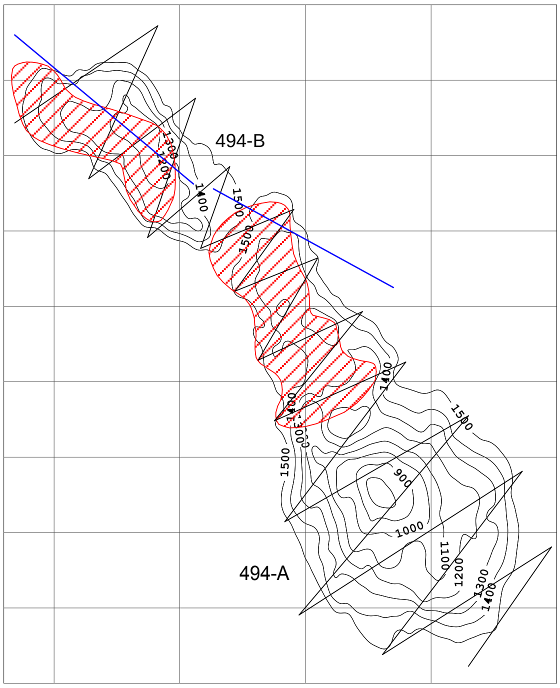


Fig.2. Scheme of tacks at the acoustic survey at the seamounts 494-A and 494-B.

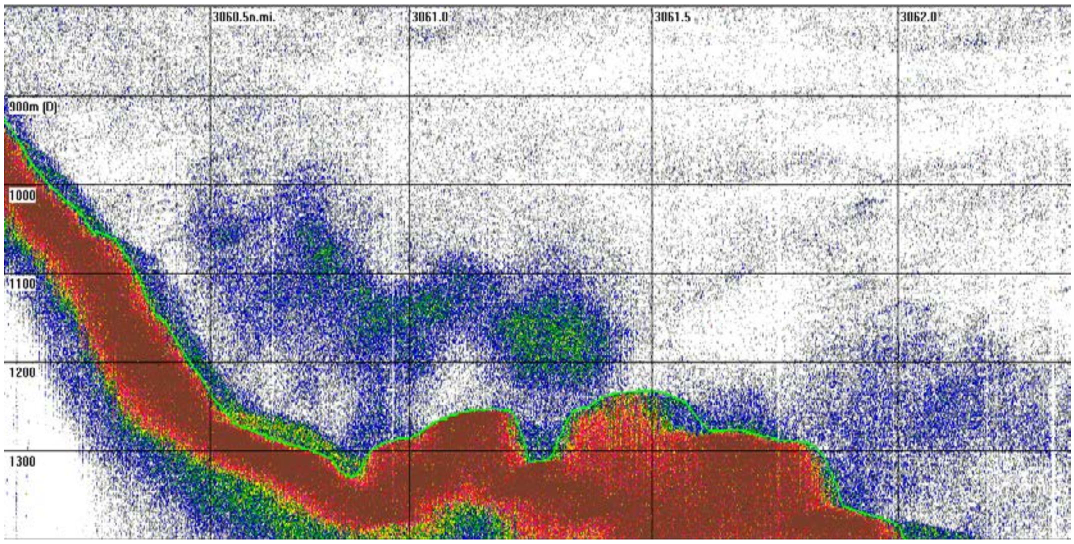

Fig.3. Echo-records of grenadier at the seamount 485-A.

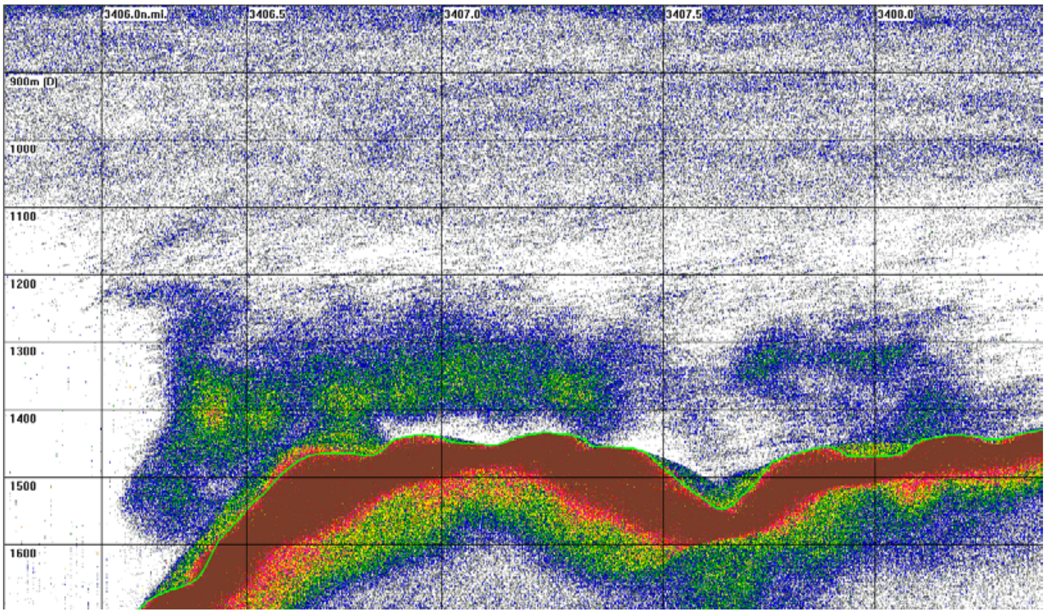


Fig. 4. Echo-records of grenadier at the seamount 494-A.

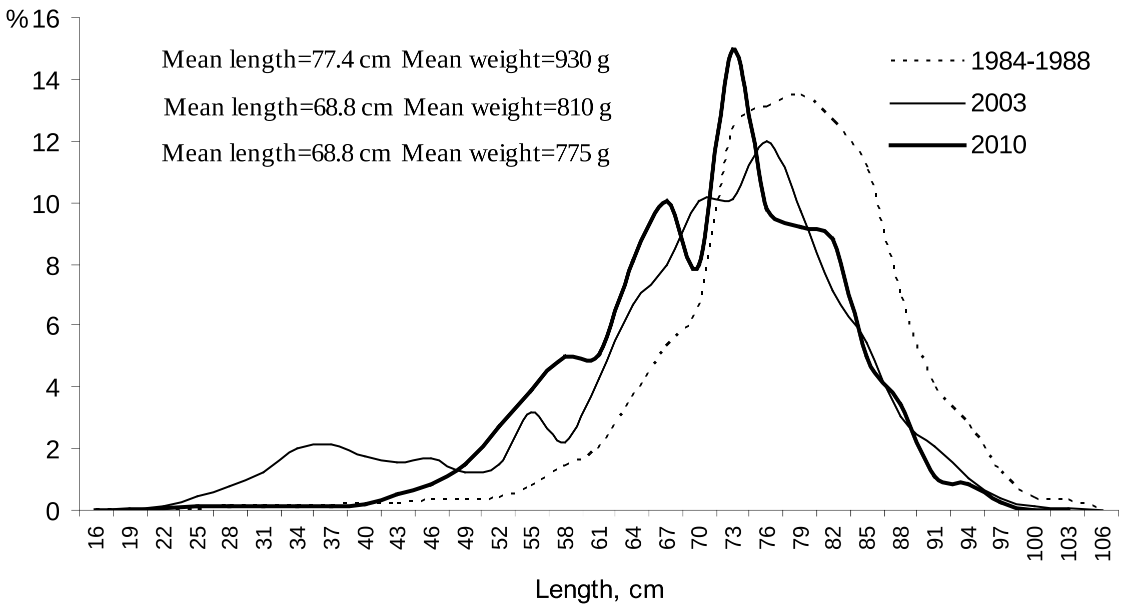


Fig. 5. Length composition of grenadier at seamounts of the Mid-Atlantic Ridge in 2010, 2003 and 1984-88 (1984-1988, 2003 - 47° - 51° N; 2010 - 46° - 50° N)

Working Document to be presented to the ICES Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP - Copenhagen 2-8 March 2011

# Morphometric and morphological studies of Red seabream (*Pagellus bogaraveo*) otoliths from the Strait of Gibraltar: Exploratory analysis of its application for ageing.

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**Abstract**

*In the last years, the otoliths have become a useful tool for the determination of ichthyic species, because these structures present a high morphologic specificity. Besides, its shape should change between the sampled ages. Thus, our study deals with several features of the otoliths (sagitta) related with the age of the individuals. 235 (Morphometry) and 53 (Morphology) otoliths from Red seabream samples, 2003 – 2008, of the Strait of Gibraltar were analyzed. The combined use of both features (morphometrics and morphological) resulted in a discriminant function which an ageing success higher than 70%.*

## 1. Introduction

The Red seabream is found in the NE Atlantic, from South of Norway to Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira, and Canary Archipelagos (Desbrosses, 1938). Adults inhabit depths ranging around 300-700 m. The vertical distribution of this species varies according to individual size (Desbrosses, 1938; Guegen, 1974; Silva *et al*., 1994; Gil, 2006).

The knowledge of the fish age is a major task in the analytical stocks assessment. Traditionally, the method used to estimate ages in fish is based on the study of bony fishes hard parts as otoliths, scales, spines... (Bermejo, 2007). In our case, the Spanish fishery of the Strait of Gibraltar, ALKs were obtained by three agreed otoliths readings collected from 2003 onwards. In the last ICES WGDEEP assessment the combined ALK (2003-2007) was obtained by 1242 three agreed readings from otoliths collected from 2003 onwards. It covers lengths from 24 to 62 cm. Combined ALK comprises ages between 3 and 10.

The age estimate from the reading of growth rings with binocular lens is complex, requires a lot of time-consuming and depends on the reader experience (Boehlert and Yoklavich, 1998). Besides is also a subjective method that requires reading agreements from more than a reader which is even greater cost and time investment. Therefore, the ideal would be to have an objective, reliable and accurate for the age estimates minimizing time and cost. Recently, several researchers have directed their efforts towards the analysis of changes in the otolith shape and its application in different fields of research, mainly stocks identity. Our proposal differs significantly because the otoliths study came from the population of the Strait of Gibraltar only, so a stock identity study is not acceptable. However, the study of possible differences between different age classes from the fishery is quite interesting, especially the practical usefulness it might have on the criteria adopted for the estimation of the Red seabream growth in the Strait of Gibraltar.

**2. Material and methods**

Table I presents the primarily otolith samples used for this study (266) by year and age class. From those, 235 were used in morphometrics, but only 156 can be used in Discriminant Analysis (the first ages have not a normal distribution). Morphometrics variables taken in account are: weigth (precision scale), thickness and curvature (gauge) and others by image analysis as: Area, Maxferet, MinFeret, EqDiameter, Circularity (Figure 1). For digital image capture and its analysis has been used NIS-Elements AR 3.2 NIKON Software.

Morphological variables were created transforming the 20 Fourier harmonics in Principal Components which could describe morphological variations.

Kolmogorov-Smirnoff and t de Student test were used to compare left and right otoliths measures. Also, mono and multivariant statistics tools were applied in the work development.

**3. Results and discussion**

Shape and structure of the otoliths has taxonomical specificitions (Volpedo and Echevarría, 2000). Morphology, morphometry and composition of the *sagitta* otoliths could be used for fish stock identification (Bori, 1986; Campana *et al*., 1996; Bermejo, 2007). The shape and structure also varies with the individual's age because the otolith growth is a result of the interaction between fish growth rate and the effects of environmental conditions (Campana and Nelson, 1985, Gutierrez and Morales-Nin, 1986; Radtke and Shafer, 1992). These clear morphological changes can be observed *de visu*. In general, there is an increase in the otolith size with age (Figure 2): Variables such area, perimeter, maximum otolith length (MaxFeret), width (MinFeret) or thickness increases gradually with age. While circularity decreases from the Red seabream early ages and since 3 years old the otolith is taking a more oblong shape (increasing the rate MaxFeret/MinFeret to reach the maximum value at older ages: 9-10).

The result of the statistical tests is the absence of significant differences ($p > 0.05$) between left and right otolith morphometrics. So only the left otolith measures were taken for the purposes of this work.

Morphometry

Figure 3 shows the trend of the different morphometric variables by age like the Von Bertalanffy growth function. Almost all the variables present an asymptotic increasing of the values with age. Circularity was the only exception. This variable does not show any clear trend, although its lower values appear at older ages (6-10 years).

Area and EqDiameter had an average upward trend: from 10.54 $mm^2$ to 91.33 $mm^2$ and from 3.66 $mm^2$ to 10.78 $mm^2$, respectively. Besides, the intervals between the upper and lower limits by age are clearly defined and there is no overlap between age range values.

However, a classification system (regression function) using only one morphometric variable does not seem the most appropriate. Time (in this case age) is a continuous variable and, in some ways, we are "discretizing" it comprising in a single age class individuals born from January to December of each year.

Table II shows the Discriminant Analysis final results. The total reclassification reaches 61.1% of success, lower than the successful value proposed by Palmer *et al*. in 2004 and Galley *et al*. in 2006. The highest percentage, more than 75%, was obtained at older ages, age classes 9 and 10 while age class 7 was the one that had the lowest number of matches, below 50%. However most of the otoliths that are not well classified by its morphometric variables are located below or above the agreed readings otolith estimates.

Morfology

Otolith shape is a phenotypic character and should vary between ages, sexes and cohorts in marine teleosts (Smith et *al*., 2002). These shape changes may be caused by the rate of growth, as in the case of Atlantic cod (Campana and Casselman, 1993). Experimental studies with freshwater fish (Reznick, 1989; Secor and Dean, 1989) suggest that such morphological changes have a strong environmental component related with growth rates differences. Fourier Analysis obtained harmonics for the Red seabream of the Strait of Gibraltar were the inputs of a Principal Components Analysis which results into 9 functions (or Principal Components: PCs). The first five (PC1 to PC5) explain the 81% of the observed variance in the otoliths shape and its scores were used as new morphological variables. Figure 4 shows the morphological variation described in each PC from the average values and its variation (mean ± 2 standard deviation). The left side of the figure reflects the shapes overlapping image.

Galley *et al*. in 2006 propose the idea of a Discriminant Analysis performance combining morphometric variables with Fourier shape descriptors. Table III shows the results of this kind of joint analysis (7 morphometric variables and 5 Fourier PCs) with otoliths from Red seabream samples of the Strait of Gibraltar. The total reclassification reaches 85.3% of success, which clearly exceeds the value adopted by Palmer *et al*. in 2004 and also Galley *et al*. in 2006 (70%). The maximum percentage (100%) was obtained in age classes 6, 9 and 10. Age class 5 is the only one with the least number of matches, below 70%.

Throughout this work morphometric and morphological differences between the age classes considered have been patents both, so it may be appropriate its future use as helpful tool to estimate ages of the Red seabream of the Strait of Gibraltar.

**4. Conclusions**

The Discriminant Analysis combining morphometric and morphological variables obtained the highest percentage of reclassification success (85.3%), well above from the 70% adopted by other authors.

Changes in the otolith shape could be related with the growth rate, so that might strongly influenced by environmental component. Therefore, future work should be done including the analysis of such influence through interannual variations.

**Acknowledgments**

We would like to express our most sincere gratefulness to Jorge Tornero Nuñez (called *Richar*) for his help and patience in the teaching of Image Analysis stuff.

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**Table I.** Red seabream otoliths from the Strait of Gibraltar: Number of samples primarily considered, by age class and year.

| AGE/YEAR | 1997 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| **0** | 17 | | | | | | | 17 |
| **1** | 5 | | | | | | | 5 |
| **2** | | 10 | 1 | | | 10 | 1 | 22 |
| **3** | | 8 | 5 | 5 | 5 | 6 | 12 | 41 |
| **4** | | 7 | 5 | 5 | 4 | 5 | 8 | 34 |
| **5** | | 5 | 5 | 5 | 5 | 6 | 9 | 35 |
| **6** | | 5 | 5 | 9 | 5 | 3 | 3 | 30 |
| **7** | | 5 | 5 | 9 | 5 | 5 | 4 | 31 |
| **8** | | 7 | 5 | 4 | 4 | 5 | 3 | 28 |
| **9** | | 4 | 2 | | 3 | 4 | 3 | 16 |
| **10** | | 2 | 2 | | | 3 | | 7 |
| **TOTAL** | 23 | 53 | 35 | 35 | 31 | 47 | 43 | **266** |

**Table II.** Red seabream otoliths from the Strait of Gibraltar: Reclassification success percentage from Discrimnant Analysis with morphometric variables.

| Age | Predicted belonging group | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4 | **66,7** | 23,3 | 10,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5 | 17,2 | **69,0** | 13,8 | 0,0 | 0,0 | 0,0 | 0,0 |
| 6 | 0,0 | 17,2 | **51,7** | 31,0 | 0,0 | 0,0 | 0,0 |
| 7 | 0,0 | 3,4 | 31,0 | **44,8** | 17,2 | 3,4 | 0,0 |
| 8 | 0,0 | 0,0 | 0,0 | 17,4 | **65,2** | 8,7 | 8,7 |
| 9 | 0,0 | 0,0 | 0,0 | 0,0 | 8,3 | **75,0** | 16,7 |
| 10 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 20,0 | **80,0** |

**Table III.** Red seabream otoliths from the Strait of Gibraltar: Reclassification success percentage from Discrimnant Analysis combining morphometric and morphological variables.

| Age | Predicted belonging group | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4 | **83,3** | 16,7 | 0 | 0 | 0 | 0 | 0 |
| 5 | 33,3 | **66,7** | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | **100,0** | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | **83,3** | 16,7 | 0 | 0 |
| 8 | 0 | 0 | 0 | 20,0 | **80,0** | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | **100,0** | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | **100,0** |

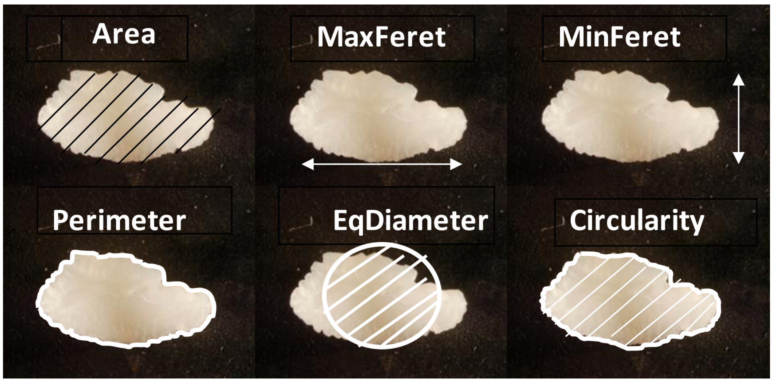


**Figure 1.** Red seabream otoliths from the Strait of Gibraltar: Description of the morphometric variables measured by image analysis.


**Figure 2.** Red seabream otoliths from the Strait of Gibraltar: Examples from different agreed age estimates.

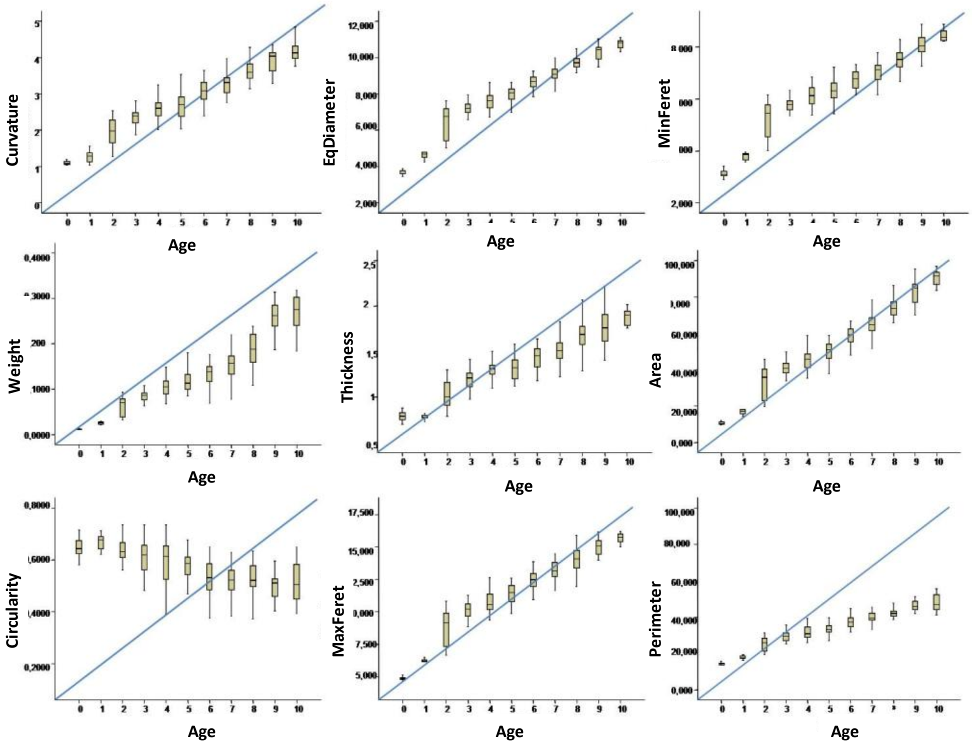


**Figure 3.** Red seabream otoliths from the Strait of Gibraltar: Descriptive statistics for the morphometric variables considered.

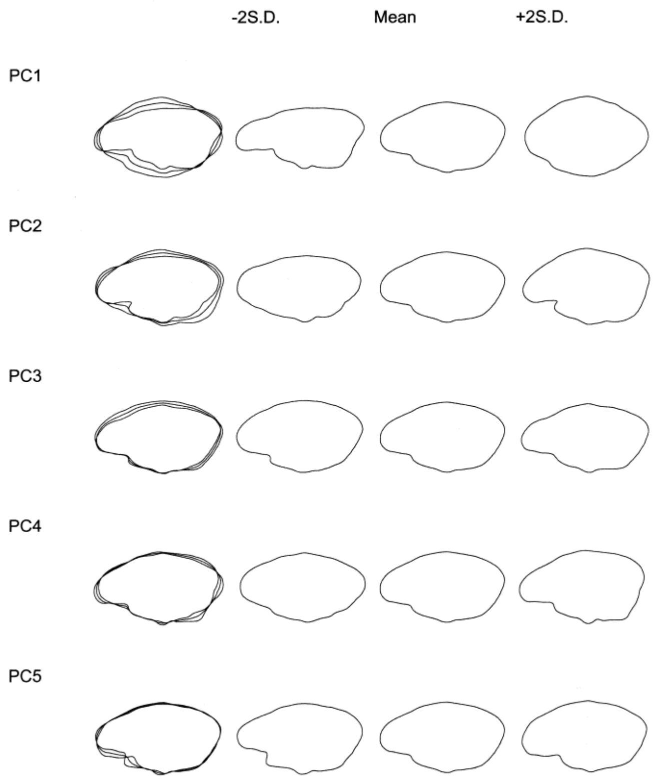


**Figure 4.** Red seabream otoliths from the Strait of Gibraltar: morphological variation by PC from Fourier Analysis results.

Working Document to be presented to the ICES Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP - Copenhagen 2-8 March 2011

# The Red seabream (*Pagellus bogaraveo*) fishery in the Strait of Gibraltar: ICES Subarea IX updated data.

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**Abstract**

*This paper presents the available information of the Red seabrem fishery in the Strait of Gibraltar and updates the documents presented in previous years with the information from the last analyzed year, 2010. The document presents data about landings, LPUE, length frequencies and also observers on board programme information which should be useful for considerations about the fishery.*

## 1. Introduction and fishery description

Since the earlies 1980´s an artisanal fishery targeted to the red seabream (*Pagellus bogaraveo*, namely "*voraz*") have been developing along the Strait of Gibraltar area (ICES IXa south). This fishery has already been broadly described in previous Working Documents presented to the ICES WGDEEP (Gil *et al*., 2000; Gil & Sobrino, 2001, 2002 and 2004; Gil *et al*., 2003, 2005, 2006, 2007, 2008, 2009 and 2010). Spanish red seabream fishery in the Strait of Gibraltar is almost a monospecific fishery with one clear target species which represents the 74% from the total landed species which constitutes a fleet component by himself (Silva *et al*., 2002).

The Instituto Español de Oceanografía (IEO) began the study and the fishery monitoring following the request from the Fishermen Corporations. In 2006, 2008 and 2010 assessment trials were attempted within the ICES WGDEEP (ICES, 2006, 2008 and 2010).

The main objective of this paper is to provide an updated summary of the current status of knowledge on the fishery and biology of this deep-water species in ICES area IX at the 2011 ICES WGDEEP meeting.

## 2. Material and methods

Fishery information was gathered for the period 1983-2010 from the sale sheets: monthly landings, monthly number of sales and the number of days in which those sales were carried out. Moreover, from the beginning of the IEO monitoring, June 1997, an *ad hoc* monthly length samplings from the different commercial sizes are carrying out to estimate the landings length distribution (Gil *et al*., 2000).

Besides, from 2005 to 2009 a scheme of observers on board "voracera" fleet has been carried out. Sampling level was 5 boats and 3 trips per month. Caught species were recorded in number (including length distribution). A Kolmogorov-Smirnoff test was applied for the comparison between landings and observers on board length distributions.

**3. Results and discussion**

- <u>Landings data</u>: Figure 1 shows a continuous increase of the landings to a maximum in 1994. Since 1994 landings have gone decreasing, except in 1996 and 1997, till arise the lowest value of the recent years in 2002. Then, from 2003 onwards it shows an increasing trend till reached the highest value of the last years in 2009, followed by a new decrease the last year. There´s still no scientific reasons which guarantee the sustainability of the recent landings increase in this fishery. Figure 2 shows a sort of fishery footprint from the information obtained with the observers on board programme. Fishing grounds are located at both sides of the Strait of Gibraltar and quite close to the main ports.

- <u>LPUEs and CPUEs</u>: Fishing effort increases too till 2009 (Figure 3). It is important to emphasize that the effort unit chosen (number of sales) cannot be too appropriate as do not consider the missing effort. Thus, in the years when the resource is not so abundant the missing effort increases substantially (fishing vessels with no catches, so no sale sheet were recorded). Thus, the LPUE trend from the decline of the fishery, 1997, should be interpreted with caution because it cannot be a real image of the resource abundance.

Whilst the CPUE trend from the tuning fleet (observers on board programme) shows a totally different situation. The Figure 4 presents the CPUE (number per line) from 2005 to 2009. Values vary around 3 red seabream per ±70 hooks but the general trend seems to be slightly decreasing.

- <u>Length frequencies</u>:

The fishery resource suffers a decrease of the landed mean length (Figure 5) mainly from 1995 to 1998. It is necessary to point out that species probably does not have a homogeneous geographic and bathymetric distribution related to their length. This fact could explain the different landed mean length between the main landing ports, Tarifa and Algeciras. The mean length of the landings gets progressively increasing from 1999 onwards, but along the last years the trend varies increasing again from 2006 on in both ports. However the median value from these years remains under the mean in every case and close to the minimum landing size in Algeciras. The mean length from both landing ports became lower in 2010.

Figure 6 presents the length distribution from the tuning fleet. Every year of comparison (2005-2009) presents significative differences between those and the landings length distribution. The differences among the sampling protocols adopted may be explained this fact: observes on board did a sort of concurrent sampling while in the fishmarket it had be done a stratified sampling (covering the 4 market categories).

**4. Conclusion**

There is no evidence of the fishery sustainability at the current levels. Control and enforcement of the management measures are desirable. From 2005 till 2009 landings increase every year, exceeding the fishing plans TAC. Landings and mean length decreasing in 2010 remember a recent and similar history from the middle 1990s.

**Acknowledgments**

We would like to express our most sincere gratefulness to all those institutions and people for his collaboration in the execution of the present work:

- Instituto Español de Oceanografía.

- Consejería de Agricultura y Pesca de la Junta de Andalucía.

- People from the Fishermen Brotherhood and Fishmarket of Tarifa, for their readiness and facilities offered to obtain the required samples, especially to Juan José Rodríguez-Santander.

- Ricardo Sánchez Leal (called *Jordi*) for his help with the length distribution figures.

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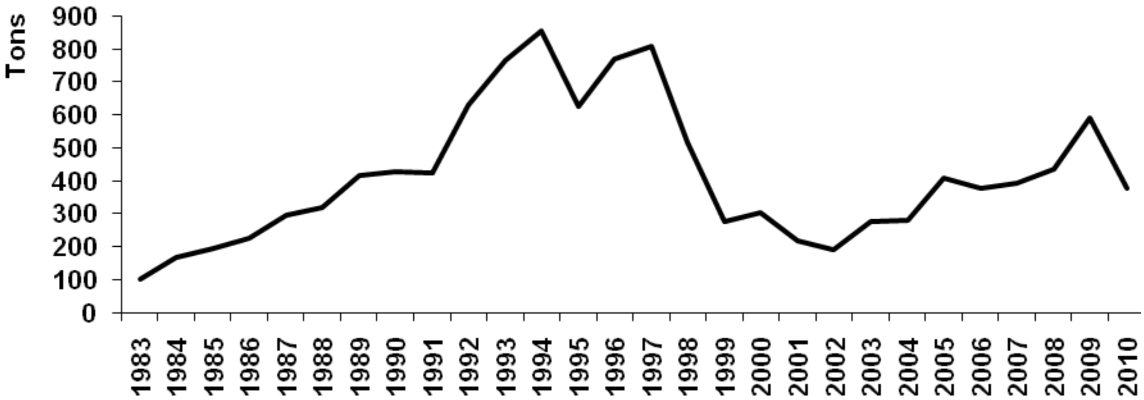



**Figure 1.** Red seabream Spanish fishery of the Strait of Gibraltar: Landings (1983-2010).

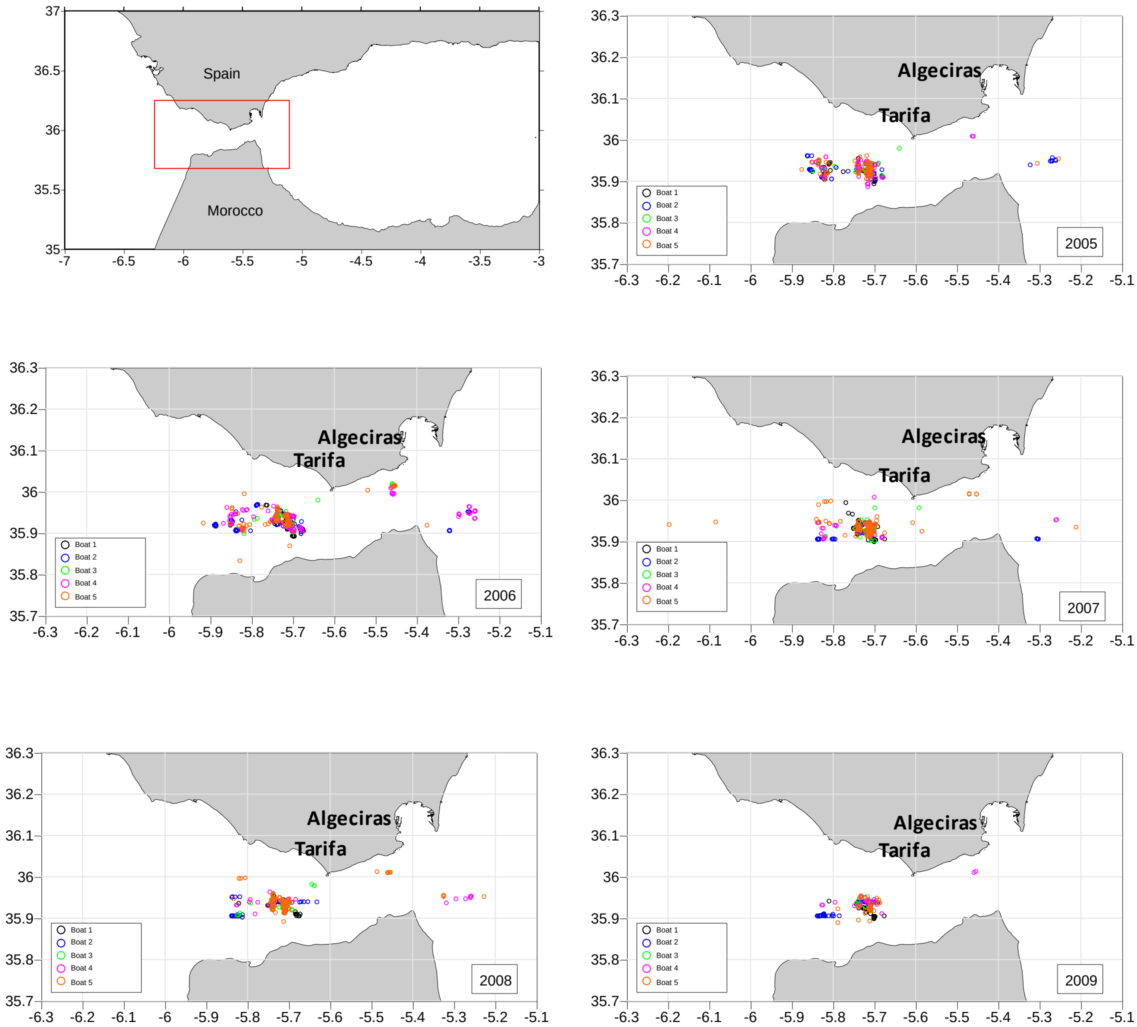



**Figure 2.** Red seabream Spanish fishery of the Strait of Gibraltar: Yearly soaking positions footprints from observers on board.

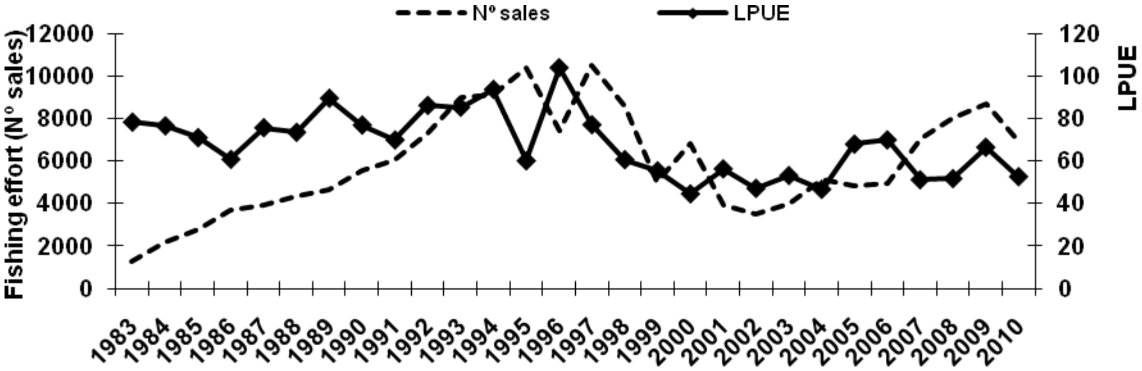



**Figure 3.** Red seabream Spanish fishery of the Strait of Gibraltar: Evolution of the chosen effort unit and estimated LPUE (1983-2010).

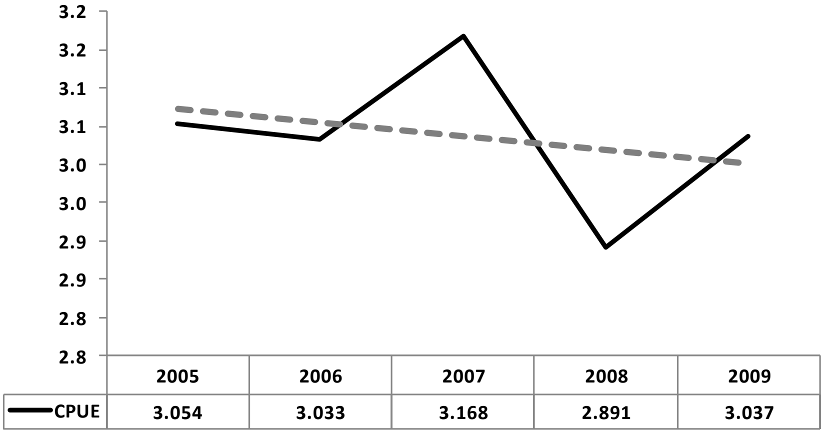
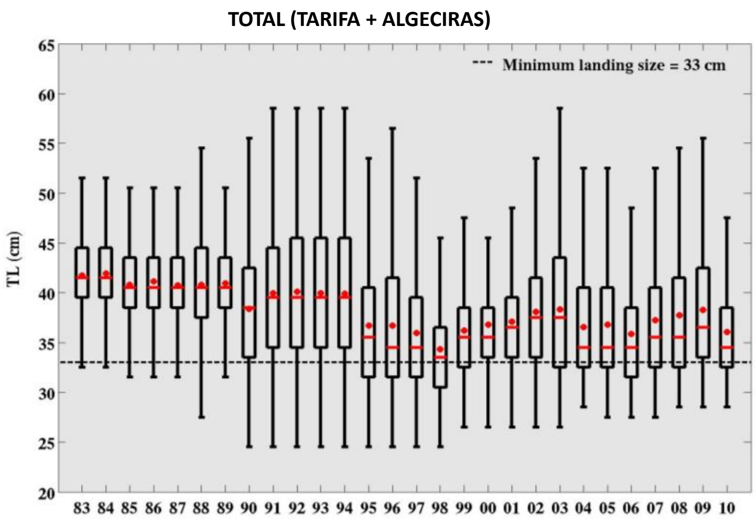



**Figure 4.** Red seabream Spanish fishery of the Strait of Gibraltar: Evolution of the CPUE from the observers on board programme (2005-2009).



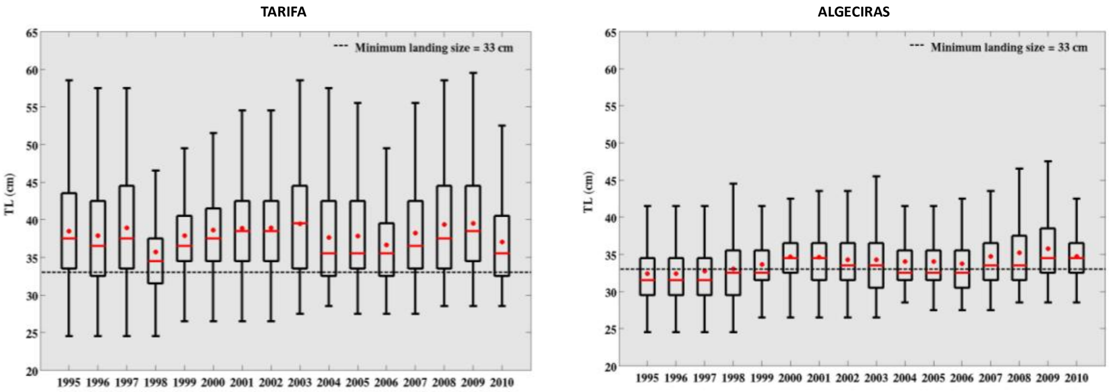



**Figure 5.** Red seabream Spanish fishery of the Strait of Gibraltar: Evolution of the landings length distribution descriptive statistics.

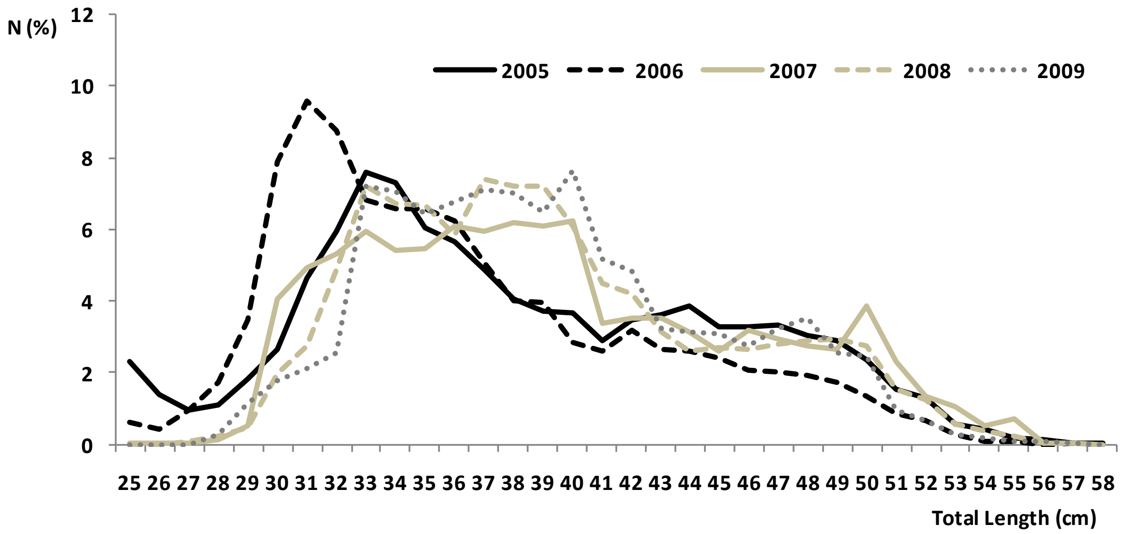



**Figure 6.** Red seabream Spanish fishery of the Strait of Gibraltar: Observers on board programme catches length distribution (2005-2009).

Working Document to be presented to the ICES Working Group on the
Biology and Assessment of Deep Sea Fisheries Resources

ICES WGDEEP - Copenhagen 2-8 March 2011

# Summary results about the Red seabream fishery of the Strait of Gibraltar joint assessment exercise between Spain and Morocco.

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**Abstract**

*This paper summarizes the results obtained from a joint assessment exercise of the red seabream fishery of the Strait of Gibraltar. A pseudocohort (Spain + Morocco) were performed from 2005-2007 length distribution available information. The exercise was carried out (LCA, YpR and VPA)* using VIT assessment software. *Results shows a fully exploited status of the stock which recommends not to increase the fishing effort and the adoption of similar management measures in both countries involved (Spain and Morocco) in the fishery.*

## 1. Introduction

During the 12th Session of the Scientific Advisory Committee (SAC) held in Budva (Montenegro, 25-29 January 2010) the Committee adopted the following recommendation: "*In relation to the assessment of the Blackspot seabream (Pagellus bogaraveo) carried out in GSA03, the Spanish delegation noted that this fishery extended into the Atlantic in GSA01 and proposed the establishment of a joint ad hoc working group involving Moroccan and Spanish scientists to analyze the existing information and the importance of presenting the outcome to SAC*".

In this context, a first meeting was held in Málaga (Spain) the last 22nd of July, at the FAO - CopeMed II Headquarters. Several experts from Morocco (INRH), Spain (IEO and Junta de Andalucía) and CopeMed II attended the meeting. A report of the meeting was produced including information prepared by the INRH on the Tangier bottom longline fleet; a revision by the FAO-ArtFiMed project on the artisanal fishery in Dikky (Morocco) targeting *P. bogaraveo*; information on the Spanish fishery in the area prepared by the IEO and information on the system of control of the Spanish fleet fishing in the Gibraltar Strait area managed by the Junta de Andalucía (Sistema de Localización y Seguimiento de Embarcaciones Pesqueras Andaluzas, SLSEPA). The stock assessment methodologies currently used by ICES and GFCM and the main results obtained in the last working groups are also reviewed. After the revision of the existing data in both countries, the meeting recommended to prepare and organize an assessment workshop at the IEO (Fuengirola, Malaga) the 21st – 22nd of September, because no joint assessment by Spain and Morocco on this Gibraltar Strait shared stock had ever been done before.

**2. Material and methods**

To avoid the problem of different measurement methods applied by each country, Spain (Total Length) *vs.* Morocco (Fork Length), the relationship proposed by Czerwinski et al. (2008): FL=-0.731 + 0.910*TL was accepted to transform to Total Length all the lengths from Morocco.

Two pseudocohorts (Spain and Morocco) were produced as an average of 2005 – 2007 length distribution data. A Kolmogorov-Smirnoff test was applied for the comparison between Spain and Morocco pseudocohorts. A total pseudocohort (Spain + Morocco) constituted the data file source for a Length Cohort Analysis (LCA).

The software VIT (Lleonart and Salat, 1997) was designed to analyze exploited marine populations based on catch data, structured by ages or sizes, from one or several gears. The main assumption is that of steady state because the program works with pseudo-cohorts, therefore it is not suitable for historic series. The parameters file was created using Spanish values (VBGF parameters, length – weight relationship, maturity…) presented in the CopeMed first meeting. M value of 0.2 and F terminal value of 0.5 (and/or 0.345 in VPA assessment) were adopted according to the previous attempt with Morocco data at the GFCM.

The exercise includes too a Yield per Recruit (YpR) model from the assessment estimates. Besides, lengths were transformed into ages by the slicing technique and consequently, a Virtual Population Analysis (VPA) was also attempted.

**3. Results and discussion**

The red seabream population of the Strait of Gibraltar should be considered as one unique and shared stock. Thus, the joint assessment exercise was presented in the last Working Group on Stock Assessment on Demersal Species at Istanbul, Turkey (18 - 23 October 2010). Moreover, the results obtained during this assessment session and the recommendations of the experts were also presented for general information to the last SCSA (SAC) meeting held in Malta (29 November - 2 December 2010). In the same way the work done are now presented to the ICES WGDEEP.

Figure 1 shows the pseudocohorts produced by country and the total used in the assessment. The Kolmogorov-Smirnoff test reflects significant differences ($p<0.05$) between the length distributions from Spain and Morocco (Figure 2). Variations among the sampling protocols adopted may be explained this fact: In Morocco the sampling cover only certain boats (random sampling) while in Spain the sampling were done covering the 4 market categories in the fishmarket (stratified sampling). Then when we weight the samples weight to the total catch differences may be obtained because the bathymetric distribution of this species varies according to individual size (Desbrosses, 1938; Guegen, 1974; Silva *et al*., 1994 and Gil, 2006). These bathymetric variations are related with the different fishing grounds along the Strait of Gibraltar.

Despite this inconvenience, a total pseudocohort was performed to run a Length Cohort Analysis (LCA). Table I presents the length classes analyzed and its mortality rates estimates while Table II includes a summary of the results. The Yield per Recruit model shows a fully exploited situation of the stock status (Figure 3). The main problem of the flat top curves is related with the $F_{MAX}$ value that is not currently considered precautionary because if the fishing effort increases the Y/R curve does not show any increase while the SSB/R curve shows a decrease. As an alternative value $F_{0.1}$ is usually adopted. Table III shows these F estimates. The obtained $F_{MAX}$ (0.37) and $F_{0.1}$ (0.18) values are lower than current F (0.39).

Lastly, a VPA was attempt. 33 length classes became in 16 age classes. Figure 4 shows F estimates by age class from two different starting values, 0.5 or 0.345. Both estimates converged from the age 9 till the youngest one.

**4. Conclusion**

All the stated above suggests a fully exploited status of the stock which recommends not to increase the fishing effort and the adoption of similar management measures in both countries involved (Spain and Morocco) in the Red seabream fishery of the Strait of Gibraltar, which is assessed in the Mediterranean as a shared stock (GSA 01: Northern Alboran Sea and GSA 03: Southern Alboran Sea).

**Acknowledgments**

We would like to express our most sincere gratefulness to all those institutions and people for his collaboration in the execution of the present work:

Colleagues from IEO and INRH

FAO - CopeMed II for his facilities and support in this initiative.

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**Table I:** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: Length classes considered in the analysis with its mortality rates estimates.

| Class | Mean Age | Lower Length | Mean Length | Maturity ratio | Lower Age | Total F | Z |
|---|---|---|---|---|---|---|---|
| **1** | 2.1 | 26 | 26.5 | 0 | 1.987 | 0.00 | 0.20 |
| **2** | 2.2 | 27 | 27.499 | 0 | 2.153 | 0.01 | 0.21 |
| **3** | 2.4 | 28 | 28.499 | 0 | 2.325 | 0.05 | 0.25 |
| **4** | 2.6 | 29 | 29.497 | 0 | 2.502 | 0.15 | 0.35 |
| **5** | 2.8 | 30 | 30.495 | 0 | 2.684 | 0.29 | 0.49 |
| **6** | 3.0 | 31 | 31.494 | 0 | 2.871 | 0.36 | 0.56 |
| **7** | 3.2 | 32 | 32.493 | 0 | 3.065 | 0.41 | 0.61 |
| **8** | 3.4 | 33 | 33.491 | 0 | 3.266 | 0.46 | 0.66 |
| **9** | 3.6 | 34 | 34.492 | 0 | 3.474 | 0.41 | 0.61 |
| **10** | 3.8 | 35 | 35.492 | 0 | 3.689 | 0.41 | 0.61 |
| **11** | 4.0 | 36 | 36.492 | 1 | 3.912 | 0.38 | 0.58 |
| **12** | 4.3 | 37 | 37.492 | 1 | 4.144 | 0.36 | 0.56 |
| **13** | 4.5 | 38 | 38.492 | 1 | 4.386 | 0.33 | 0.53 |
| **14** | 4.8 | 39 | 39.493 | 1 | 4.638 | 0.28 | 0.48 |
| **15** | 5.0 | 40 | 40.493 | 1 | 4.901 | 0.29 | 0.49 |
| **16** | 5.3 | 41 | 41.493 | 1 | 5.176 | 0.27 | 0.47 |
| **17** | 5.6 | 42 | 42.492 | 1 | 5.465 | 0.29 | 0.49 |
| **18** | 5.9 | 43 | 43.488 | 1 | 5.768 | 0.41 | 0.61 |
| **19** | 6.3 | 44 | 44.488 | 1 | 6.088 | 0.40 | 0.60 |
| **20** | 6.6 | 45 | 45.488 | 1 | 6.426 | 0.38 | 0.58 |
| **21** | 7.0 | 46 | 46.487 | 1 | 6.785 | 0.38 | 0.58 |
| **22** | 7.4 | 47 | 47.485 | 1 | 7.167 | 0.42 | 0.62 |
| **23** | 7.8 | 48 | 48.484 | 1 | 7.575 | 0.41 | 0.61 |
| **24** | 8.2 | 49 | 49.475 | 1 | 8.014 | 0.60 | 0.80 |
| **25** | 8.7 | 50 | 50.461 | 1 | 8.487 | 0.88 | 1.08 |
| **26** | 9.3 | 51 | 51.474 | 1 | 9.002 | 0.52 | 0.72 |
| **27** | 9.9 | 52 | 52.479 | 1 | 9.566 | 0.38 | 0.58 |
| **28** | 10.5 | 53 | 53.46 | 1 | 10.19 | 0.67 | 0.87 |
| **29** | 11.2 | 54 | 54.467 | 1 | 10.887 | 0.47 | 0.67 |
| **30** | 12.1 | 55 | 55.468 | 1 | 11.677 | 0.40 | 0.60 |
| **31** | 13.1 | 56 | 56.47 | 1 | 12.589 | 0.30 | 0.50 |
| **32** | 14.3 | 57 | 57.481 | 1 | 13.668 | 0.14 | 0.34 |
| **33** | 15.7 | 58 | 58.426 | 1 | 14.988 | 0.50 | 0.70 |

**Table II:** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: LCA summary results.

| Total Biomass balance (D): | | 641.028 |
|---|---|---|
| | | |
| | Critical age | Critical length |
| Current stock | 2.9 | 31 |
| Virgin stock | 6.1 | 44 |
| | | |
| | Biomass | Percentage |
| Recruitment | 222.173 | 34.66 |
| Growth | 418.855 | 65.34 |
| Natural death | 239.935 | 37.43 |
| Fishing | 401.093 | 62.57 |

**Table III:** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: Several F estimates which can be used as reference.

| | |
|---|---|
| $F_{CURRENT}$ | **0.40** |
| $F_{0.1}$ | **0.19** |
| $F_{mAX}$ | **0.37** |

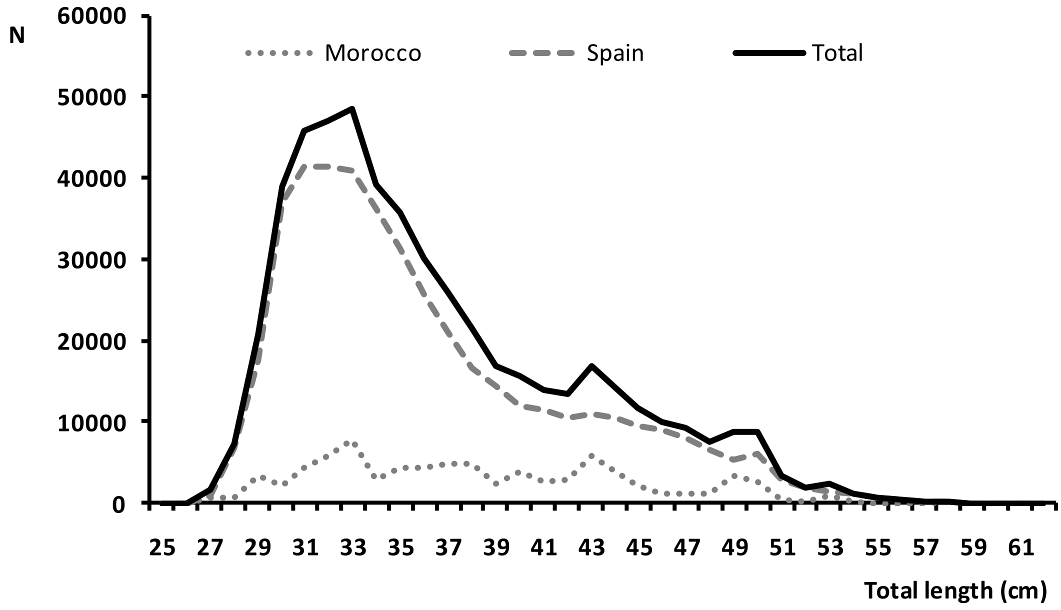


**Figure 1.** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: Spain, Morocco and Total pseudocohort from 2005-2007 length distribution data.

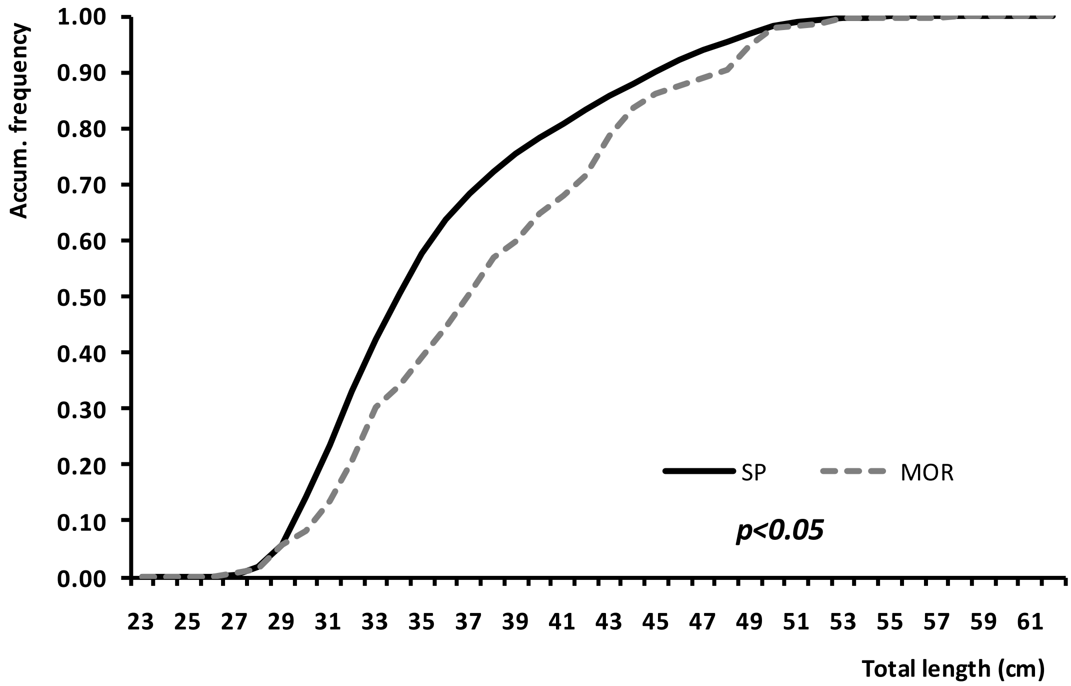


**Figure 2.** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: Results from Kolmogorov-Smirnoff test between the different pseudocohorts added for the LCA assessment.

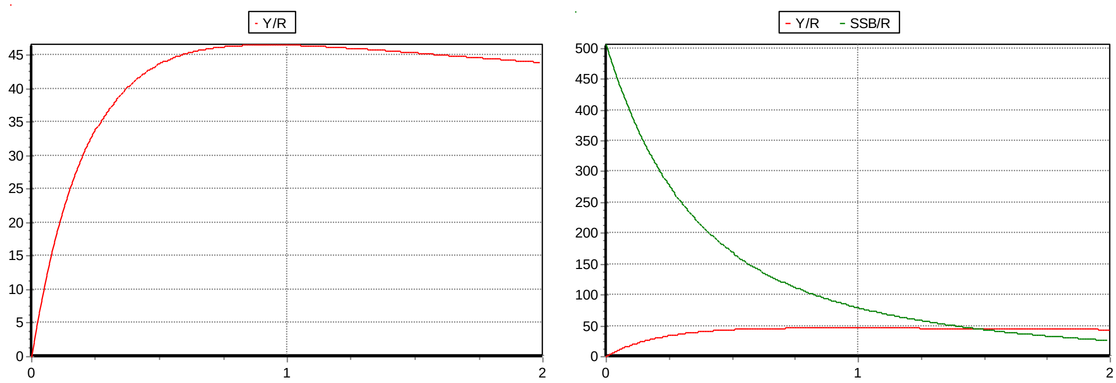


**Figure 3.** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: Yield per Recruit analysis estimates.

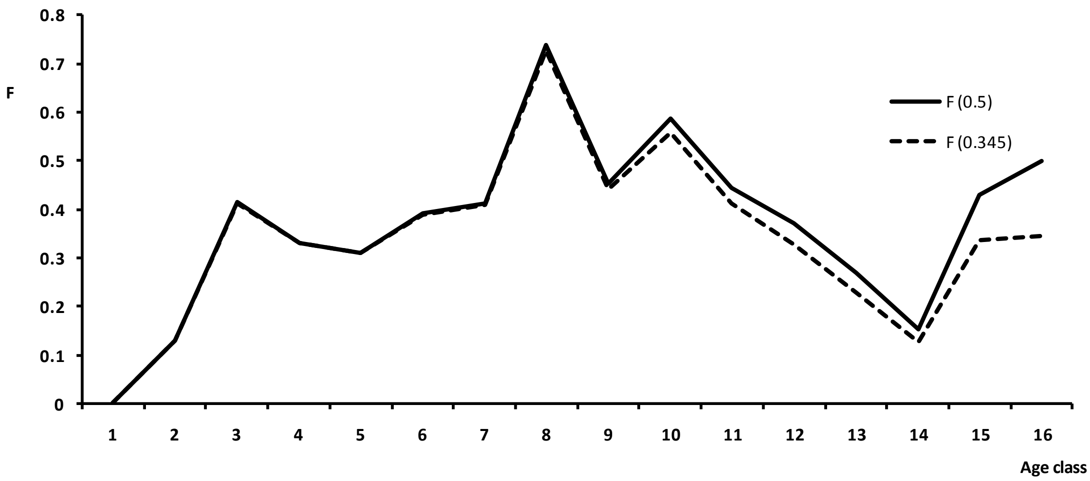


**Figure 4.** Joint assessment exercise of the Red seabream fishery of the Strait of Gibraltar: VPA F estimates by age class from two different starting values.

# Estimates of effort, cpue, and mean length for the Norwegian commercial catch of ling, blue ling and tusk: 2011 update

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## Introduction

Ling, tusk and blue ling have been fished by Norway for centuries and the amount landed has been recorded since 1896 (Figure 1). The major catches of these species are taken by longliners, and the catches are to a large degree bycatches. The fishery for these three species is mainly influenced by the size of various quotas for other species, especially the quota for Arcto Norwegian cod. Therefore the total catch may not be a good indicator of the condition of these stocks (Figure 2). Scientific surveys do not cover their main habitats, therefore, to track their relative abundance, indicators such as a cpue series need to be generated.

In order to construct a cpue series, the Institute of Marine Research (IMR), in cooperation with the Norwegian Directorate of Fisheries (NDF), began in 2003 to record in an electronic database the logbooks of long liners larger than 21 m. Vessels were selected that had a total landed catch of ling, tusk and blue ling that exceeded 8 tons in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. To obtain more detailed and targeted information, the IMR initiated in 2000 a program to collect data and biological samples directly from selected commercial long-liners, the so-called **“**reference fleet**.**” The fishers measure a subsample of fish at selected locations. Upon request they may also collect otoliths, stomachs, tissue for genetics, and other biological samples. Presently four long-liners are members of the reference fleet.

This report presents time-series of effort and cpue based on these two data sources and compares the 2000-2009 data with previously submitted data for the period 1986-1993. The previous series was for 1972-1993, but because the series used data from a mixture of hand baited lines and autolines during the period 1972 to 1985, it was determined that the series was inconsistent. We suggest that only the part of the old time series when just autolines were used (1986-1993) together with the new cpue series be used in any future assessment of the status of ling and tusk.

Based on the new series and reevaluation of the old time series, ling was in 2010 taken off the Norwegian Red List.

Because the WGDEEP meeting is relatively early in the year, the logbook data, the reference fleet data and associated estimates are not yet available for 2010.

**Development of the Norwegian fleet of long-liners, 1977- 2010**

In addition to data on total landings[*], the NDF also provides data on how many fishing vessels satisfying the above criteria participated in the fishery, the gear employed, areas fished and changes in vessel ownership. In Table 1 are the numbers of long liners during the period 1977 to 2019, the total landed catch by the fleet, and the average annual catch per vessel. The number of vessels increased from 36 in 1977 to a peak of 72 in 2000, and then the number decreased to 35 in 2006. After 2006 the number of vessels seemed to stabilize.

The number of vessels declined mainly because of changes in the law concerning quotas for catching cod. The decrease in vessels was followed by a reduction in total catches until 2004; afterwards there was an increase in total catch, especially in 2007 and 2008 (Figure 3a). The catch-per-vessel was relatively stable from 1980 until 2003. After 2003 there was a steady increase in catch-per-vessel (Figure 3b). New regulations have been suggested that would prevent any future increase in fleet size.

**Logbooks**

All available logbooks for the years 2000-2009 are now in the database, and the data have undergone extensive quality control procedures. Since the meeting is held so early this year no data is available for 2010. The quality of the logbooks varies considerably, and a serious problem is that some lack information on the number of hooks used per day.

**Days in the fishery**

The Norwegian longline logbooks provide information on the geographical distribution of the fleet. In Table 2 are the average number of days a vessel spent fishing for tusk, ling and blue ling, jointly or separately, for all ICES Subareas and Divisions. After 2000, when new quota regulations for cod were introduced, the number of days each vessel fished for the three deep-water species increased, and by 200 the number of days in the fishery was twice that in 2000. The data for 2006 show that the number of days in the fishery has decreased by more than 20 percent compared with 2005 and 2007. The data have been checked for errors but none were discovered. The number of fishing days in 2009 reached a new high of 211 days.

Division IIa was the main fishing area since 2000, followed by IVa and Vb. For both ling and tusk the number of fishing days have increased in the areas closest to Norway i.e. areas IIa and IVa.

[*] The data provided by the NDF are; the total landed catch, the logbook data, and the catch along with its location.

**Average number of hooks used per day**

In Table 3 are estimates of the average number of hooks used per day in each ICES area and in the total fishery for the years 2000-2009. For all areas combined there was a steady increase in the number of hooks used from 2000 through 2009. This is also the overall trend for the subareas (Figure 4). The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2009 show that the number of hooks has increased steadily from 10 000 hooks per day in 1972 to almost 40 000 in 2009 (Figure 6)

**Total number of hooks per year**

Based on the number of vessels, the number of hooks per day, and number of days each vessel participated in the fishery, estimates of the total number of hooks used per year were generated (Tables 1, 2 and 3). Table 4 and Figure 5 gives the estimated number of hooks (in thousands) set in each of the ICES subareas and in the total fishery for the years 2000-2009. During the period 1974 to 2009 the total number of hooks per year has varied considerably, but with no clear trend (Figure 6).

**Estimated mean length of ling, tusk and blue ling**

The method for estimating the average length is given in Helle *et al*., (2006).
In Tables 8, 9 and 10 are estimates of the average length of ling, tusk and blue ling in the commercial catch. The estimates of mean length for 1976-1995 are taken from Bergstad and Hareide (1996). During the years 2001, 2002 and to a lesser extent 2003, the reference fleet did not record the total catch from which the subsamples were taken and, therefore, the unweighted mean (eq. 2) was calculated for 2001, 2002 and for areas V and VIb in 2003 and the weighted mean (eq. 1) for the other years and areas. These estimates are in Tables 6, 7 and 8, along with sample size and estimated standard deviation (previous measurements) and standard errors for the reference fleet estimates. The estimates of mean length varied slightly from year to year but with no obvious trend.

**Ling removed from the Red List**

In 2006 ling was categorized as Near Threatened and placed on the Norwegian Red List. This had potentially severe consequences for the marketing of ling, and was a very controversial decision that was widely debated and criticized, especially by fishers and their organizations who considered that the ling was not being overfished.

The historical cpue series was based on data from only two or three vessels in each year, while the recent series included annual data from 20-50 vessels. This large difference in sampling intensity probably explains why the early series was so variable. It was also noted that the historical cpue series was based on boats fishing with both hand-baited longlines and automatically-baited longlines. A number of technical changes were addressed when constructing the early series, but the change in baiting techniques was not taken into account (ICES, 2006). Many Norwegian longline fishers claim that the bait is more securely attached to the hooks by hand-baiting and therefore, hand-baited lines are more efficient than autolines (Webjørn Barstad and Odd Nakken, pers. comm.).

Our results indicate that cpue was stable, there was no downward trend in the landings since 1985, and the increased landings per boat, which taken together strongly suggest that ling was not being overfished, or at the least that there was no scientific evidence to that effect. This changed the perception of the status of the ling stock (ICES, 2010). As a result, ling was removed from the Norwegian Red List in 2010.

We suggest that only the part of the old time series when just autolines were used (1986-1993) together with the new cpue series be used in any future assessment of the status of ling and tusk.

**Development of cpue for ling and tusk 2000-2009**

For all subareas there has been an upward trend in cpue for ling during the period 2000-2009, and it is at a higher level than before (Figure 7, Table 6).

Also for tusk there has been a positive development in all areas except in area VIb, Rockall (Figure 8, Table 5). This has traditionally been an important destination for the Norwegian fleet, but after the closure of the most important fishing areas, the number of fishing days has decreased considerably (sees Tables 2 and 5, Tables 5, 6 and 7).

**Conclusions and discussion**

There was an overall increase in cpue in all areas for both ling and tusk, which indicates that both stocks are in relatively good condition.

Legislation enacted since 2000 for regulating the cod fishery caused a continuous reduction in the number of longliners in the fishery for tusk, ling and blue ling and by 2009 there were only 34 vessels above 21 m in the fishery. Because of the reduction in; the number of vessels (52 % reduction since 2000), the total number of hooks employed and the total number of weeks fished, it is quite clear that there has been a significant reduction in effort. The decrease in total effort occurred even though there was an increase in the number of hooks set per vessel/day, and it is quite likely that the amount of applied effort has been reduced to the 1998-level

During the period 1998 through 2003 the total landings declined from 32 675 to 19 000 tons, while the catch-per-vessel remained relatively constant. The total catch was fairly stable in the years 2004 through 2006 and after that there was a sharp increase in 2007 and 2008. The average catch-per-vessel has increased considerably since 2004.

It should be noted that using the total catch as a measure of stock development can be very misleading. For example, there is a negative correlation between the catch of cod and the total catch of ling, blue ling and tusk (Figure 2), which is due to cod being the most valued species. Therefore, in this case the decrease in total catch does not indicate a reduced stock size, but only an increase in cod quotas.

If a stock is not covered by a scientific survey, then a commercial cpue index is often used to track temporal trends in abundance. It is widely recognised that caution must be used when interpreting a cpue series based on commercial catch data. But by considering: the application and distribution of fishing effort; species specific knowledge, such as if and when a species is targeted or if it is a preferred species; patterns in the total catch by fleet and by vessel; etc., then based on all these factors, a reliable assessment can be made of a stock's condition.

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Table 1. Summary statistics for the Norwegian long liner fleet during the period 1995-2010 (vessels exceeding 21m).

| Year | Number of longliners | Total landed catch by fleet | Catch per vesse (Tonnes) |
|---|---|---|---|
| 1977 | 36 | 8471 | 235 |
| 1978 | 38 | 9563 | 252 |
| 1979 | 40 | 14038 | 351 |
| 1980 | 41 | 15651 | 382 |
| 1981 | 44 | 15002 | 341 |
| 1982 | 46 | 19079 | 415 |
| 1983 | 43 | 18338 | 426 |
| 1984 | 41 | 18398 | 449 |
| 1985 | 44 | 21364 | 486 |
| 1986 | 42 | 19080 | 454 |
| 1987 | 48 | 17788 | 371 |
| 1988 | 53 | 16253 | 307 |
| 1989 | 53 | 29816 | 563 |
| 1990 | 51 | 27726 | 544 |
| 1991 | 54 | 27979 | 518 |
| 1992 | 61 | 29718 | 487 |
| 1993 | 60 | 32290 | 538 |
| 1994 | 59 | 26908 | 456 |
| 1995 | 65 | 26571 | 409 |
| 1996 | 66 | 28645 | 434 |
| 1997 | 65 | 20173 | 310 |
| 1998 | 67 | 32675 | 488 |
| 1999 | 71 | 31528 | 444 |
| 2000 | 72 | 28391 | 394 |
| 2001 | 65 | 23681 | 364 |
| 2002 | 58 | 24619 | 424 |
| 2003 | 52 | 18969 | 365 |
| 2004 | 43 | 17815 | 414 |
| 2005 | 39 | 19106 | 490 |
| 2006 | 35 | 19475 | 556 |
| 2007 | 38 | 23060 | 607 |
| 2008 | 36 | 25069 | 696 |
| 2009 | 34 | 21158 | 622 |
| 2010 | 35 | 24360 | 696 |

Table 2. Average number of days that each Norwegian long liner operated in an ICES subarea/division.

| All species | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 9 | 5 | 10 | 12 | 20 | 23 | 11 | 15 | 7 | 19 |
| **IIa** | 54 | 64 | 74 | 73 | 75 | 81 | 73 | 101 | 90 | 103 |
| **IIb** | 2 | 9 | 2 | 3 | 11 | 14 | 3 | 21 | 18 | 20 |
| **IIIa** | + | | | 1 | | | | | 1 | 1 |
| **IVa** | 24 | 22 | 29 | 21 | 22 | 25 | 38 | 27 | 26 | 49 |
| **IVb** | 2 | | | 1 | | | | 3 | | 1 |
| **Va** | | 1 | | 3 | 2 | 2 | 3 | 2 | 4 | 2 |
| **Vb** | 13 | 18 | 20 | 25 | 34 | 21 | 11 | 15 | 11 | 4 |
| **VIa** | 12 | 14 | 12 | 12 | 14 | 25 | 13 | 10 | 10 | 7 |
| **VIb** | 10 | 6 | 8 | 6 | 5 | 8 | 7 | 6 | 2 | 2 |
| **2VIIc** | 2 | 1 | | | 1 | 0,4 | | 1 | | |
| **XII** | + | 5 | 1 | 3 | 1 | | | | | |
| **XIVb** | 6 | 3 | 8 | 9 | 9 | 5 | | | 2 | 3 |
| **All areas** | 131 | 148 | 164 | 169 | 195 | 203 | 159 | 201 | 171 | 211 |

| Tusk | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 3 | 1 | 5 | 5 | 6 | 5 | 1 | 5 | 4 | 6 |
| **IIa** | 34 | 57 | 66 | 58 | 60 | 69 | 67 | 89 | 92 | 87 |
| **IIb** | 1 | | 2 | | 1 | 2 | 1 | 3 | 4 | 2 |
| **IVa** | 18 | 22 | 28 | 19 | 21 | 25 | 37 | 26 | 30 | 56 |
| **IVb** | 1 | | | 2 | | | | | | 2 |
| **Va** | | 1 | | 3 | 2 | 2 | 3 | 2 | 4 | 2 |
| **Vb** | 11 | 18 | 20 | 25 | 34 | 21 | 11 | 15 | 14 | 4 |
| **VIa** | 12 | 14 | 12 | 12 | 14 | 23 | 13 | 10 | 15 | 7 |
| **VIb** | 4 | 6 | 8 | 5 | 5 | 8 | 7 | 6 | 5 | 2 |
| **VIIc** | 2 | 1 | | | 1 | 0 | | 0 | | |
| **XII** | 1 | 3 | | | | | | | | |
| **XIVb** | 2 | 1 | 2 | 1 | 3 | 3 | | | | 1 |
| **All areas** | 88 | 124 | 141 | 130 | 148 | 158 | 140 | 157 | 169 | 159 |

| Ling | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **IIa** | 23 | 40 | 50 | 40 | 37 | 51 | 54 | 65 | 52 | 65 |
| **IIIa** | + | | | 1 | | | | | 1 | 1 |
| **IVa** | 19 | 22 | 29 | 20 | 22 | 25 | 38 | 27 | 25 | 49 |
| **IVb** | 1 | + | | 1 | | | | 3 | | |
| **Va** | | 1 | | 3 | 2 | 2 | 3 | 2 | 4 | 2 |
| **Vb** | 12 | 17 | 18 | 24 | 34 | 21 | 11 | 15 | 11 | 4 |
| **VIa** | 13 | 13 | 11 | 12 | 14 | 23 | 13 | 10 | 9 | 7 |
| **VIb** | 4 | 5 | 7 | 4 | 5 | 8 | 7 | 6 | 2 | 2 |
| **VIIc** | 3 | 1 | | | 1 | + | | 1 | | |
| **All areas** | 76 | 100 | 114 | 104 | 115 | 126 | 126 | 128 | 104 | 130 |

| Blue ling | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **IIa** | 1 | 1 | 1 | 1 | + | + | 1 | 1 | 2 | 1 |
| **IVa** | 1 | + | 1 | | 1 | 1 | 2 | 2 | 4 | 4 |
| **Va** | | 1 | | 1 | 2 | 1 | 2 | 1 | 3 | 2 |
| **Vb** | 4 | 3 | 4 | 5 | 5 | 1 | 4 | 5 | 4 | 3 |
| **VIa** | 9 | 6 | 4 | 8 | 6 | 10 | 8 | 6 | 10 | 6 |
| **VIb** | 1 | 1 | 2 | 2 | + | | + | 1 | | |
| **XII** | 2 | 5 | | 2 | | | | | | |
| **XIVb** | + | | + | + | + | + | | | 1 | 1 |
| **All areas** | 18 | 15 | 11 | 14 | 14 | 14 | 18 | 16 | 25 | 17 |

Table 3. Average number of hooks the Norwegian long liner fleet used per day in each of the ICES subareas/divisions and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling. n is the total number of days with hook information contained in the logbooks.

| **All** | **2000** | | **2001** | | **2002** | | **2003** | | **2004** | | **2005** | | **2006** | | **2007** | | **2008** | | **2009** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** | **Average** | **n** |
| **I** | 31688 | 353 | 33325 | 163 | 35432 | 263 | 35045 | 376 | 32431 | 433 | 32671 | 316 | 33182 | 187 | 34380 | 318 | 36833 | 96 | 39184 | 267 |
| **IIa** | 31439 | 1916 | 30703 | 2196 | 33431 | 2031 | 34766 | 1839 | 33475 | 1389 | 32861 | 1248 | 35140 | 1252 | 35207 | 2103 | 36890 | 1500 | 39142 | 1419 |
| **IIb** | 35409 | 71 | 34638 | 315 | 34756 | 45 | 34776 | 67 | 31859 | 217 | 35082 | 207 | 39298 | 57 | 37881 | 328 | 39650 | 297 | 43744 | 281 |
| **IIIa** | 30250 | 4 | | | | | 33037 | 27 | | | | | | | 35000 | 8 | 36467 | 15 | 34636 | 11 |
| **IVa** | 29378 | 685 | 30553 | 727 | 32291 | 667 | 33484 | 510 | 30934 | 439 | 34039 | 331 | 34561 | 673 | 33414 | 587 | 34056 | 395 | 38299 | 680 |
| **IVb** | 30263 | 38 | 33500 | 10 | 33867 | 15 | 32559 | 34 | | | | | | | 38086 | 58 | 31500 | 10 | 30167 | 6 |
| **Va** | | | | | | | 22605 | 38 | 25815 | 54 | 23100 | 30 | 21526 | 57 | 25414 | 58 | 32704 | 71 | 26106 | 33 |
| **Vb** | 24594 | 411 | 26760 | 613 | 25939 | 475 | 29513 | 515 | 31804 | 693 | 29885 | 374 | 27943 | 159 | 30681 | 355 | 27968 | 188 | 28123 | 57 |
| **VIa** | 22763 | 435 | 24419 | 447 | 21484 | 186 | 29421 | 302 | 25636 | 308 | 24807 | 369 | 22504 | 248 | 25958 | 249 | 26319 | 138 | 24455 | 99 |
| **VIb** | 30471 | 227 | 30340 | 140 | 31557 | 149 | 31325 | 97 | 31559 | 111 | 35949 | 137 | 32273 | 139 | 36400 | 145 | 33514 | 35 | 43645 | 31 |
| **VIIc** | 29600 | 80 | 33108 | 37 | | | | | 25250 | 28 | 33429 | 7 | | | 31071 | 14 | | | | |
| **XII** | 18136 | 22 | 17548 | 175 | | | 13063 | 48 | | | | | | | | | | | | |
| **XIVa** | 28333 | 6 | | | | | | | | | | | | | | | | | 7034 | 38 |
| **XIVb** | 2815 | 191 | 2465 | 135 | 9458 | 251 | 11515 | 228 | 12474 | 105 | 18960 | 91 | | | | | 9464 | 45 | 38127 | 2922 |
| **All areas** | 28325 | 4429 | 28743 | 4958 | 30432 | 4083 | 31794 | 4081 | 31285 | 3777 | 31438 | 3110 | 32959 | 2711 | 34110 | 4223 | 35042 | 2790 | 39184 | 267 |

Table 4. Estimated total number of hooks (in thousands) that the Norwegian long liner fleet used in each of the ICES subareas/divisions and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling.

| **All** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 20534 | 10831 | 20551 | 21868 | 27891 | 29306 | 12775 | 19081 | 9282 | 25313 |
| **IIa** | 117708 | 127724 | 143486 | 131972 | 107957 | 103808 | 89783 | 131569 | 119524 | 137075 |
| **IIb** | 5099 | 20263 | 4032 | 5425 | 15069 | 19155 | 4126 | 29434 | 25693 | 29746 |
| **IIIa** | 218 | | | 1718 | | | | 0 | 1313 | 1178 |
| **IVa** | 50765 | 43691 | 54313 | 36565 | 29264 | 33188 | 45966 | 33381 | 31876 | 63806 |
| **IVb** | 4358 | | | 1693 | | | | 4228 | | 1026 |
| **Va** | 0 | | | 3526 | 2220 | 1802 | 2260 | 1881 | 4709 | 1775 |
| **Vb** | 23020 | 31309 | 30089 | 38367 | 46497 | 24476 | 10758 | 17028 | 11075 | 3825 |
| **VIa** | 19667 | 22221 | 14953 | 18359 | 15433 | 24187 | 10239 | 9604 | 9475 | 5820 |
| **VIb** | 21939 | 11833 | 14642 | 9773 | 6785 | 11216 | 7907 | 8081 | 2413 | 2968 |
| **VIIc** | 4262 | 2152 | | | 1086 | 521 | | 1150 | 0 | 0 |
| **XII** | 1306 | 5703 | | 2038 | | | | 0 | 0 | 0 |
| **XIVb** | 1216 | 481 | 4389 | 5389 | 4827 | 3697 | | 0 | 681 | 717 |
| **All areas** | 267161 | 276508 | 289469 | 279406 | 262325 | 248895 | 183567 | 253676 | 215719 | 273523 |

Table 5. Estimated mean cpue ([kg/hook] x1000) based on log book data along with its standard error (*se*) and number of catches sampled for tusk.

| **Tusk** | **Area** | **I** | **IIA** | **IIB** | **IVA** | **IVB** | **VA** | **VB** | **VIA** | **VIB** | **VIIC** | **X** | **XII** | **XIVA** | **XIVB** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2000** | **cpue** | **21,6** | **59,5** | **4,1** | **35,7** | **18,1** | | **56,8** | **48** | **76,8** | **62,7** | | **47,2** | **74,6** | **40,9** |
| | **n** | 189 | 1678 | 8 | 664 | 17 | | 405 | 430 | 222 | 60 | | 17 | 6 | 84 |
| | **se** | 2,1 | 0,7 | 10,4 | 1,2 | 7,2 | | 1,5 | 1,4 | 2,0 | 3,8 | | 7,2 | 12,0 | 3,2 |
| **2001** | **cpue** | **18,8** | **52,5** | **10,8** | **32,6** | **16,5** | | **50,2** | **40,7** | **50,6** | **4,8** | | **28,2** | | **48,5** |
| | **n** | 53 | 1959 | 17 | 721 | 2 | | 608 | 444 | 132 | 25 | | 97 | | 48 |
| | **se** | 3,2 | 0,5 | 5,6 | 0,8 | 12,4 | | 1,0 | 1,1 | 2,0 | 4,6 | | 2,3 | | 3,3 |
| **2002** | **cpue** | **4,2** | **47** | | **25** | | | **50,1** | **45,9** | **55,2** | | | | | **85,1** |
| | **n** | 115 | 1809 | | 649 | | | 473 | 186 | 149 | | | | | 70 |
| | **se** | 2,0 | 0,5 | | 0,9 | | | 1,0 | 1,6 | 1,7 | | | | | 2,6 |
| **2003** | **cpue** | **11,9** | **40,1** | **5,3** | **29,8** | **7,22** | **105** | **53,7** | **36,1** | **44,9** | | | **6,47** | | **49,7** |
| | **n** | 141 | 1473 | 5 | 496 | 13 | 38 | 514 | 300 | 94 | | | 7 | | 42 |
| | **se** | 1,7 | 0,5 | 9,0 | 0,9 | 5,6 | 3,3 | 0,9 | 1,2 | 2,1 | | | 7,6 | | 3,1 |
| **2004** | **cpue** | **3,8** | **36,1** | **2,2** | **49,3** | | **165** | **59,3** | **50,3** | **62,7** | **7,05** | | | | **17,9** |
| | **n** | 122 | 1096 | 20 | 437 | | 54 | 693 | 307 | 111 | 23 | | | | 60 |
| | **se** | 2,2 | 0,8 | 5,6 | 1,2 | | 3,4 | 0,9 | 1,4 | 2,4 | 5,2 | | | | 3,2 |
| **2005** | **cpue** | **3,5** | **49,5** | **2,7** | **36,4** | | **184** | **66,5** | **59,1** | **72,5** | **15,9** | | | | **8,7** |
| | **n** | 73 | 1060 | 12 | 329 | | 30 | 374 | 368 | 136 | 7 | | | | 47 |
| | **se** | 3,7 | 1,0 | 9,2 | 1,8 | | 5,8 | 1,7 | 2,7 | 2,7 | 12,0 | | | | |
| **2006** | **cpue** | **7,8** | **56,3** | **5,62** | **44,6** | | **194** | **98,9** | **106** | **41,2** | | | | | |
| | **n** | 18 | 1145 | 6 | 664 | | 57 | 159 | 247 | 138 | | | | | |
| | **se** | 9,5 | 1,2 | 16,4 | 1,6 | | 5,3 | 3,2 | 2,6 | 3,4 | | | | | |
| **2007** | **cpue** | **7,95** | **53,1** | **2,85** | **51,2** | | **155** | **64,7** | **66,1** | **26,1** | **5,14** | | | | |
| | **n** | 108 | 1853 | 19 | 583 | | 58 | 353 | 249 | 135 | 10 | | | | |
| | **se** | 2,7 | 0,7 | 6,4 | 1,2 | | 3,7 | 1,5 | 2,4 | 2,4 | 8,8 | | | | |
| **2008** | **cpue** | **6,78** | **57,5** | **8,02** | **59,4** | | **131** | **78,9** | **126** | **29,6** | | | | | **59,3** |
| | **n** | 32 | 1247 | 68 | 395 | | 69 | 188 | 137 | 35 | | | | | 34 |
| | **se** | 6,38 | 1,03 | 4,42 | 1,83 | | 4,39 | 2,66 | 3,11 | 6,16 | | | | | 6,25 |
| **2009** | **cpue** | **3.76** | **57.6** | **2** | **32.3** | | **146** | **125** | **118** | **17.9** | | | | | **70.4** |
| | **n** | 78 | 1195 | 26 | 663 | | 33 | 57 | 99 | 27 | | | | | 20 |
| | **se** | 5.26 | 1.34 | 9.11 | 1.81 | | 8.1 | 6.16 | 4.67 | 8.94 | | | | | 10.4 |

Table 6. Estimated mean cpue ([kg/hook] x1000) based on log book data along with its standard error (*se*) and number of catches sampled for ling.

| **Ling** | **Area** | **I** | **IIA** | **IIIA** | **IVA** | **IVB** | **VA** | **VB** | **VIA** | **VIB** | **VIIC** | **XIVA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2000** | **cpue** | | **23,9** | **4,53** | **56,5** | **8,3** | | **71,9** | **101** | **45,4** | **82,9** | **3,75** |
| | **n** | | 1064 | 3 | 669 | 25 | | 399 | 421 | 211 | 78 | 6 |
| | **se** | | 0,7 | 13,3 | 0,9 | 4,6 | | 1,2 | 1,1 | 1,6 | 2,6 | 9,4 |
| **2001** | **cpue** | | **21,9** | | **48,1** | **2,4** | | **62,6** | **85,9** | **33,5** | **78,4** | |
| | **n** | | 1352 | | 729 | 12 | | 595 | 424 | 127 | 37 | |
| | **se** | | 0,6 | | 0,8 | 6,0 | | 0,8 | 1,0 | 1,8 | 3,4 | |
| **2002** | **cpue** | | **24,2** | | **55,5** | **1,4** | | **65,6** | **77,8** | **37,6** | | |
| | **n** | | 1345 | | 618 | 3 | | 466 | 177 | 149 | | |
| | **se** | | 0,5 | | 0,7 | 11,0 | | 0,9 | 1,4 | 2,2 | 0,0 | |
| **2003** | **cpue** | **1,7** | **29,1** | **2,4** | **57,2** | **2,9** | **70,6** | **71,3** | **76,4** | **67,9** | | |
| | **n** | 3 | 925 | 25 | 505 | 29 | 38 | 501 | 296 | 85 | | |
| | **se** | 12,7 | 0,7 | 4,4 | 1,0 | 4,1 | 3,6 | 1,0 | 1,3 | 2,4 | | |
| **2004** | **cpue** | | **37,3** | | **78,5** | | **46,6** | **71,7** | **102** | **71,9** | **122** | |
| | **n** | | 630 | | 439 | | 54 | 693 | 308 | 110 | 28 | |
| | **se** | | 0,9 | | 1,1 | | 3,2 | 0,9 | 1,3 | 2,3 | 4,5 | |
| **2005** | **cpue** | | **49,8** | | **85,1** | | **38,8** | **82** | **117** | **68,8** | **66,4** | |
| | **n** | | 775 | | 328 | | 29 | 373 | 369 | 137 | 7 | |
| | **se** | | 1,1 | | 1,7 | | 5,7 | 1,6 | 1,6 | 2,6 | 11,6 | |
| **2006** | **cpue** | | **42,3** | | **92,5** | | **68,4** | **84,3** | **94,5** | **90,4** | | |
| | **n** | | 928 | | 672 | | 56 | 157 | 248 | 138 | | |
| | **se** | | 0,9 | | 1,0 | | 3,5 | 2,1 | 1,7 | 2,2 | | |
| **2007** | **cpue** | | **40** | **6,52** | **76,6** | **5,18** | **84,6** | **77,5** | **107** | **89,2** | **79,2** | |
| | **n** | | 1334 | 8 | 586 | 56 | 58 | 349 | 248 | 145 | 14 | |
| | **se** | | 0,6 | 7,7 | 0,9 | 2,9 | 2,9 | 1,2 | 1,4 | 1,8 | 5,9 | |
| **2008** | **cpue** | | **47,6** | **7,39** | **83,8** | **3,91** | **83** | **95** | **72,4** | **147** | | **23,3** |
| | **n** | | 859 | 15 | 391 | 9 | 69 | 186 | 131 | 35 | | 1 |
| | **se** | | 0,93 | 7,02 | 1,37 | 9,06 | 3,27 | 1,99 | 2,38 | 4,6 | | |
| **2009** | **cpue** | | **52.6** | **7.37** | **97** | **7.61** | **128** | **98** | **97.7** | **113** | | |
| | **n** | | 889 | 11 | 680 | 6 | 33 | 57 | 98 | 31 | | |
| | **se** | | 1.38 | 10.4 | 1.57 | 14.1 | 7.14 | 5.43 | 4.14 | 7.37 | | |

Table 7. Estimated mean cpue ([kg/hook] x1000) based on log book data along with its standard error (*se*) and number of catches sampled for blue ling.

| Blue ling | Area | IIA | IVA | VA | VB | VIA | VIB | XII | XIVB |
|---|---|---|---|---|---|---|---|---|---|
| **2000** | **cpue** | **12** | **6,79** | | **8,1** | **8,28** | **61,3** | **213** | |
| | **n** | 14 | 10 | | 44 | 107 | 8 | 17 | |
| | **se** | 3,8 | 4,7 | | 2,2 | 1,4 | 5,0 | 3,5 | |
| **2001** | **cpue** | **7,89** | **5,5** | | **11,3** | **4,5** | **16,9** | **137** | |
| | **n** | 14 | 8 | | 84 | 140 | 11 | 123 | |
| | **se** | 10,2 | 13,5 | | 4,2 | 3,2 | 11,5 | 3,5 | |
| **2002** | **cpue** | **3,1** | **6,2** | | **8** | **8,9** | **2,6** | | **4,8** |
| | **n** | 5 | 14 | | 65 | 46 | 13 | | 3 |
| | **se** | 3,5 | 2,1 | | 1,0 | 1,1 | 2,1 | | 4,5 |
| **2003** | **cpue** | **4,9** | **8,3** | **7,3** | **25,4** | **7,4** | **113** | **25,1** | |
| | **n** | 6 | 14 | 9 | 68 | 125 | 12 | 36 | |
| | **se** | 7,7 | 5,1 | 6,3 | 2,3 | 1,7 | 5,5 | 3,1 | |
| **2004** | **cpue** | | **3,3** | **26,8** | **8,6** | **7,7** | | | **14,7** |
| | **n** | | 23 | 49 | 70 | 110 | | | 5 |
| | **se** | | 2,2 | 1,5 | 1,2 | 1,0 | | | 4,7 |
| **2005** | **cpue** | **3,2** | | **15,1** | **10,4** | **7,6** | | | |
| | **n** | 3 | | 21 | 20 | 162 | | | |
| | **se** | 4,3 | | 1,6 | 1,7 | 0,6 | | | |
| **2006** | **cpue** | **3,87** | **5,1** | **16,1** | **20,5** | **13,6** | **1,93** | | |
| | **n** | 17 | 47 | 42 | 57 | 156 | 6 | | |
| | **se** | 2,9 | 1,7 | 1,8 | 1,6 | 0,9 | 4,8 | | |
| **2007** | **cpue** | **4,14** | **5,31** | **4,1** | **53,5** | **7,53** | **1,81** | | |
| | **n** | 20 | 36 | 16 | 78 | 86 | 15 | | |
| | **se** | 6,0 | 4,5 | 6,7 | 3,0 | 2,9 | 6,9 | | |
| **2008** | **cpue** | **4,32** | **7,5** | **11,3** | **16,9** | **14,8** | **3,65** | | **40,6** |
| | **n** | 9 | 76 | 61 | 69 | 170 | 6 | | 12 |
| | **se** | 3,59 | 1,24 | 1,37 | 1,29 | 0,82 | 4,39 | | 3,1 |
| **2009** | **cpue** | **1.13** | **11.7** | **4.73** | **18.8** | **14.7** | | | **64.3** |
| | **n** | 14 | 61 | 21 | 43 | 88 | | | 14 |
| | **se** | 4.31 | 2.06 | 3.52 | 2.46 | 1.72 | | | 4.31 |

Table 8, Estimated mean length of ling in the period 1996-1995 are from Bergstad and Hareide (1996), The 2001-2009 estimates along with their standard errors (se) based on the reference fleet data, N denotes the number of fish measured and in parenthesis is the number of stations sampled, The unweighted mean was calculated for 2001, 2002 and areas V and VIb in 2003 and the weighted mean for the other years and areas.

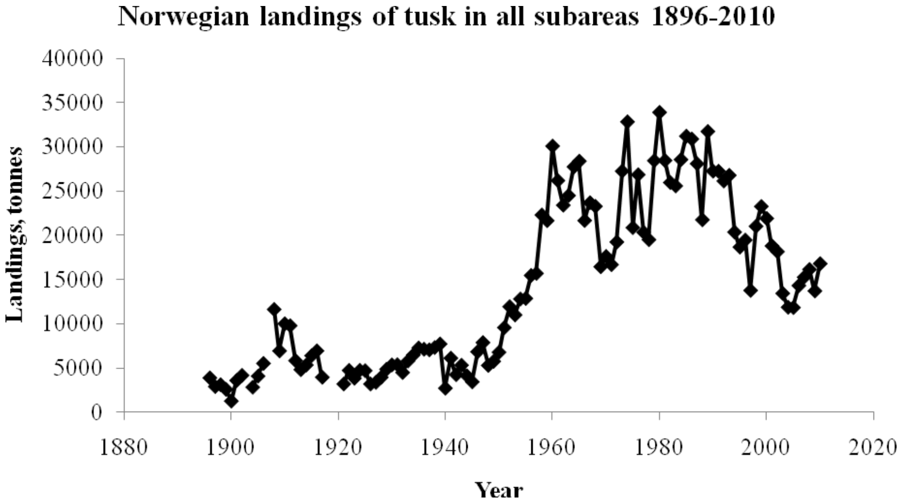
| **Ling ICES-area** | | **1976** | **1988** | **1989** | **1990** | **1991** | **1993** | **1994** | **1995** | | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IIa | Mean | | | 81,7 | 89,4 | 91,1 | 79,5 | 77,1 | | Mean | 90,78 | 88,81 | 80,42 | 86,19 | 86,73 | 87,34 | 86,7 | 85,88 | 86,37 |
| | Std,dev | | | 15,2 | 13,5 | 13,5 | 13,7 | 12,3 | 8,3 | se | | 1,6 | 0,55 | 1,05 | 0,42 | 0,11 | 0,09 | 0,09 | 0,15 |
| | N | | | 61 | 384 | 63 | 122 | 304 | 382 | N | 485 (13) | 4793 (72) | 4620 (102) | 4139 (102) | 11693 (216) | 17764 | 21907 | 20697 | 7310 |
| IVa | Mean | 87 | 81,1 | 76,8 | 81,1 | | 74,6 | 77 | 81,1 | Mean | | | 79,14 | 88,9 | 88,88 | 90,38 | 89,64 | | |
| | Std,dev | 13,8 | 14,4 | 12,5 | 12,3 | | 14,5 | 10,8 | 13 | se | | | 0,9 | 0,65 | 0,68 | 0,021 | 0,23 | | |
| | N | 1133 | 989 | 487 | 698 | | 589 | 830 | 2203 | N | | | 1702 (38) | 4654 (80) | 5109 (55) | 5124 | 3477 | | |
| Va | Mean | | | | | | | | | Mean | | | | 83,47 | | | 81,6 | | |
| | Std,dev | | | | | | | | | se | | | | 0,81 | | | 0,39 | | |
| | N | | | | | | | | | N | | | | 1502(29) | | | 1238 | | |
| Vb1 | Mean | | | 80 | | | 76,7 | | | Mean | | | 78,49 | 81,36 | 85,28 | 84,67 | 84,77 | 81,21 | 84,74 |
| | Std,dev | | | 13,7 | | | 12,1 | | | se | | | 1,84 | 2,66 | 0,5 | 0,028 | 0,22 | 0,26 | 0,29 |
| | N | | | 45 | | | 107 | | | N | | | 446 (9) | 290 (12) | 4130 (80) | 2734 | 3919 | 2641 | 1936 |
| Vb2 | Mean | 90,3 | | 82,7 | 85 | | | | | Mean | | | | | | | | | |
| | Std,dev | 13,8 | | 12 | 13,7 | | | | | se | | | | | | | | | |
| | N | 253 | | 614 | 318 | | | | | N | | | | | | | | | |
| VIa | Mean | 80 | | 79,1 | | | 71,9 | 72 | 73,7 | Mean | | 79,3 | 79,17 | | | | 78,95 | | 86,46 |
| | Std,dev | 11,5 | | 13,5 | | | 10,6 | 10,5 | 10 | se | | | 0,86 | | | | 0,39 | | 0,47 |
| | N | 492 | | 969 | | | 472 | 616 | 583 | N | | 160 (2) | 2590 (41) | | | | 1265 | | 752 |
| VIb | Mean | 89,7 | | 72,5 | 77,7 | | 79,8 | 92 | 88,3 | Mean | | 102,3 | 89,54 | | | 92,59 | 88,42 | 86,2 | 87,82 |
| | Std,dev | 9,8 | | 16,7 | 13,6 | | 12,4 | 16,2 | 12,2 | se | | | 1,1 | | | 0,28 | 0,33 | 0,24 | 0,21 |
| | N | 507 | | 518 | 261 | | 47 | 401 | 48 | N | | 367 (5) | 1393 (25) | | | 2734 | 1680 | 2999 | 3836 |
| All areas | Mean | 86,5 | 81,1 | 78,4 | 83,3 | 91,2 | 74,5 | 78,4 | 81,1 | | 91,49 | 89,48 | 81,71 | 87,49 | 87,76 | 88,15 | 86,37 | 85,45 | 86,49 |
| | Std,dev | 13 | 14,4 | 14,2 | 13,7 | 13,6 | 13,1 | 13,9 | 13 | | | | | | | | | | |
| | N | 2385 | 989 | 2694 | 1661 | 63 | 1337 | 2152 | 3220 | | 570 | 5325 | 10912 (215) | 10585 | 20934 | 28572 | 33557 | 26342 | 13880 |

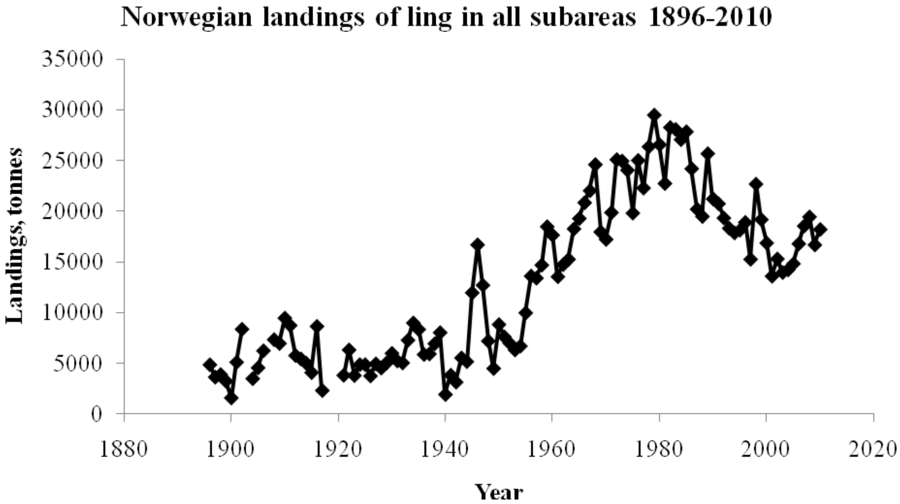
Table 9, Estimated mean length of tusk in the period 1996-1995 are from Bergstad and Hareide (1996), The 2001-2009 estimates along with their standard errors (se) based on the reference fleet data, N denotes the number of fish measured and in parenthesis is the number of stations sampled, The unweighted mean was calculated for 2001, 2002 and areas V and VIb in 2003 and the weighted mean for the other years and areas.

| **Tusk** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES-area** | | **1976** | **1988** | **1989** | **1990** | **1991** | **1993** | **1994** | **1995** | | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| I | Mean | | | | | | | | | Mean | | 50,89 | 57,45 | 59,89 | 57,54 | 57,36 | 55,7 | 57,97 | 55,53 |
| | | | | | | | | | | se | | 0,61 | 1,23 | 0,86 | 1,1 | 0,28 | 0,35 | 0,27 | 0,2 |
| | N | | | | | | | | | N | | 193 (2) | 365 (25) | 592 (33) | 495 (28) | 870 | 545 | 946 | 1691 |
| IIa | Mean | | 63,14 | 50,8 | 55,39 | 54,81 | 50,72 | 49,78 | 49,51 | Mean | 52,68 | 53,08 | 49,76 | 52,56 | 51,02 | 51,47 | 50,26 | 50,69 | 51,62 |
| | | | | | | | | | | se | 3,9 | 0,4 | 0,39 | 0,29 | 0,24 | 0,05 | 0,05 | 0,05 | 0,06 |
| | N | | 14 | 1231 | 1273 | 865 | 1374 | 1837 | 377 | N | 4145 (30) | 13183(5) | 13321 (174) | 11986 (278) | 15759 (268) | 25344 | 27509 | 30578 | 17534 |
| IIb | | | | | | | | | | Mean | | | | | | 56,46 | 54,1 | 52,96 | 51,29 |
| | | | | | | | | | | se | | | | | | 0,23 | 0,24 | 0,18 | 0,27 |
| | | | | | | | | | | N | | | | | | 1217 | 1166 | 2132 | 911 |
| IVa | Mean | 60,53 | 49,89 | 52,69 | 53,45 | | 46,8 | 49,87 | 54,62 | Mean | | | 49,45 | 50,14 | 51,79 | 52,43 | 50,39 | | |
| | | | | | | | | | | se | | | 0,7 | 0,67 | 0,84 | 0,13 | 0,17 | | |
| | N | 377 | 976 | 1329 | 636 | | 336 | 1379 | 1209 | N | | | 2465 (22) | 3394(80) | 3233 (63) | 3834 | 2285 | | |
| Va | Mean | | | | | | | | | Mean | | | | 57,68 | | | 55,29 | | |
| | | | | | | | | | | se | | | | 0,57 | | | 0,21 | | |
| | N | | | | | | | | | N | | | | 1832 (30) | | | 1440 | | |
| Vb1 | Mean | 65,44 | | 57,55 | | 54,23 | 48,24 | 52,07 | | Mean | | 65,41 | 54,25 | 51 | 49,42 | 49,58 | 49,46 | 49,62 | 50,99 |
| | | | | | | | | | | se | | 0,42 | 1,96 | 1 | 0,31 | 0,15 | 0,13 | 0,16 | 0,18 |
| | N | 289 | | 107 | | 139 | 466 | 201 | | N | | 392 (5) | 559(10) | 1064 (18) | 4916 (82) | 3068 | 4189 | 2640 | 1948 |
| Vb2 | Mean | 63,76 | | 55,78 | 56,64 | | | | | Mean | | | | | | | | | |
| | | | | | | | | | | se | | | | | | | | | |
| | N | 142 | | 470 | 852 | | | | | N | | | | | | | | | |
| VIa | Mean | 65,08 | | 57 | 60,34 | | 54,18 | 53,67 | 54,39 | Mean | | | 51,74 | | | | 56,03 | | 61,45 |
| | | | | | | | | | | se | | | 0,78 | | | | 0,23 | | 0,24 |
| | N | 150 | | 385 | 973 | | 190 | 206 | 72 | N | | | 938(39) | | | | 1224 | | 1140 |
| VIb | Mean | 67,28 | | 53,33 | | | 49,02 | 54,96 | | Mean | | 61,42 | 64,27 | | 56,93 | 59,84 | 65,64 | 58,63 | 57,24 |
| | | | | | | | | | | se | | 0,17 | 0,87 | | 2,42 | 0,21 | 0,24 | 0,18 | 0,16 |
| | N | 853 | | 945 | | | 341 | 916 | | N | | 2365 (11) | 2484(49) | | 180 (3) | 3068 | 1175 | 2328 | 2759 |
| All areas | Mean | 65,62 | 50,08 | 53,12 | 56,64 | 54,73 | 49,84 | 51,13 | 53,45 | | 52,68 | 54,58 | 51,84 | 53,33 | 51,38 | 52,07 | 51,19 | 51,4 | 52,85 |
| | N | 2148 | 990 | 4476 | 3734 | 1004 | 2707 | 4539 | 1658 | | 4145 | 16134 | 20196 | 18929 | 24601 | 35874 | 39533 | 38624 | 25983 |

Table 10. Unweighted estimates of the mean length of blue ling during 2003-2009, along with its standard error (se) and number of fish measured.

| **Blue ling**<br>**ICES-area** | | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|
| IIa | Mean | 89,44 | 77,46 | 91,91 | 79,5 | 65,04 | 85,58 | 88,79 |
| | se | 1,52 | 3,73 | 1,9 | 1,7 | 1,98 | 1,96 | 0,75 |
| | N | 61 | 13 | 56 | 146 | 22 | 185 | 466 |
| IVa | Mean | | | 54,19 | 74,9 | 74 | | |
| | se | | | 3,56 | 4,5 | | | |
| | N | | | 16 | 20 | 1 | | |
| Va | Mean | | 58,72 | | | | | |
| | se | | 0,62 | | | | | |
| | N | | 460 | | | | | |
| Vb | Mean | | 96,35 | 107,79 | 104,5 | 109,25 | 94,92 | 94,53 |
| | se | | 1,32 | 3,81 | 5,2 | 3,29 | 7,68 | 3,72 |
| | N | | 103 | 14 | 15 | 8 | 12 | 19 |
| VIa | Mean | 83,6 | | | | 91,49 | | 99,61 |
| | se | 1,88 | | | | 0,57 | | 2,53 |
| | N | 40 | | | | 263 | | 41 |
| VIb | Mean | 91,26 | | | | 96,86 | | 103,53 |
| | se | 0,16 | | | | 1,55 | | 3,93 |
| | N | 5743 | | | | 36 | | 17 |
| XII | Mean | 91,07 | | | | | | |
| | se | 0,56 | | | | | | |
| | N | 445 | | | | | | |
| All areas | Mean | 91,18 | 87,434 | 87,48 | 81,33 | 90,69 | 86,15 | 90,27 |
| | N | 6290 | 576 | 86 | 184 | 330 | 197 | 543 |



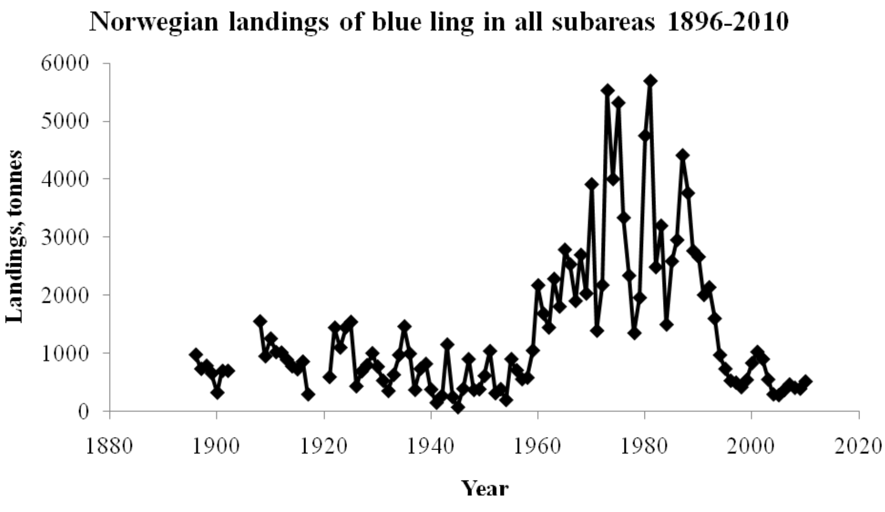




Figure 1. Reported Norwegian landings of tusk, ling and blue ling for the period 1896 -2010.

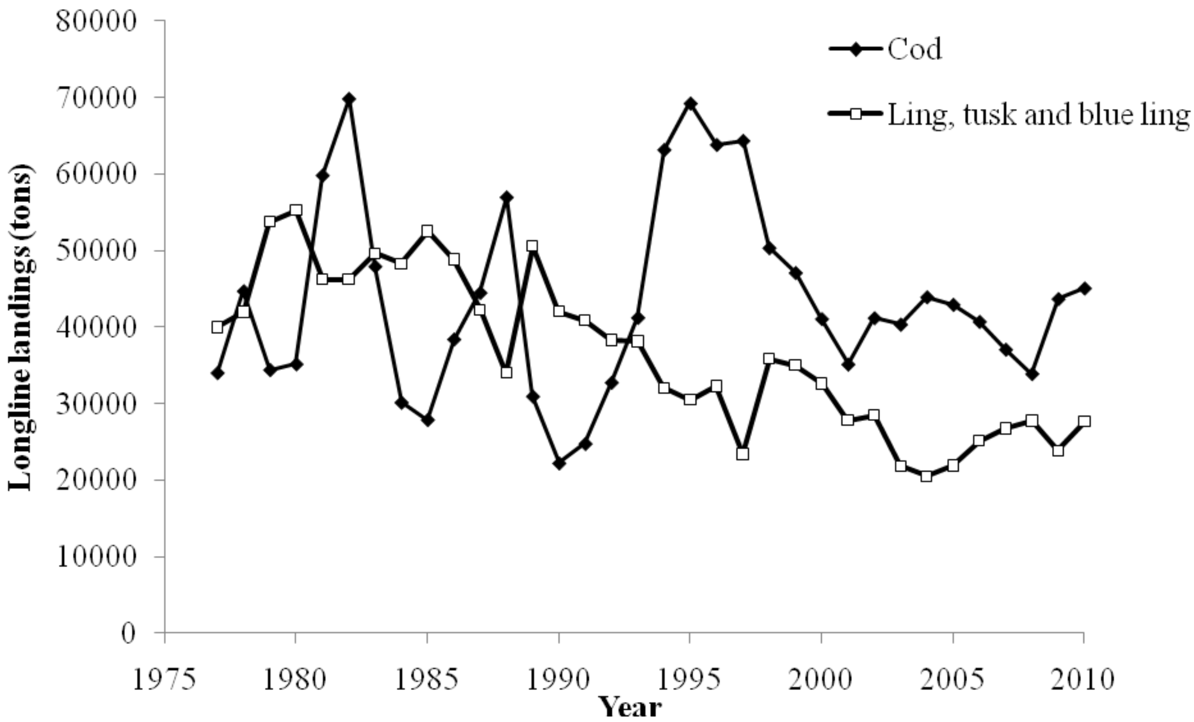
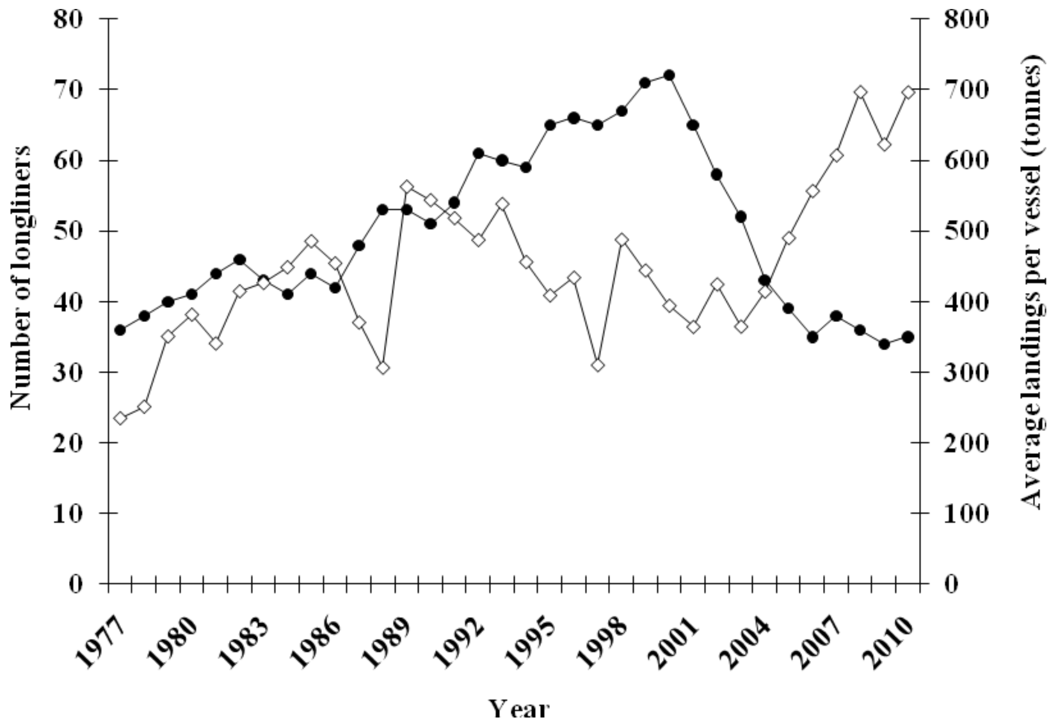



Figure 2. Total landings by longliners of cod (diamonds) and the combined total landings of ling, tusk and blue ling (open squares) for the period 1977- 2010.



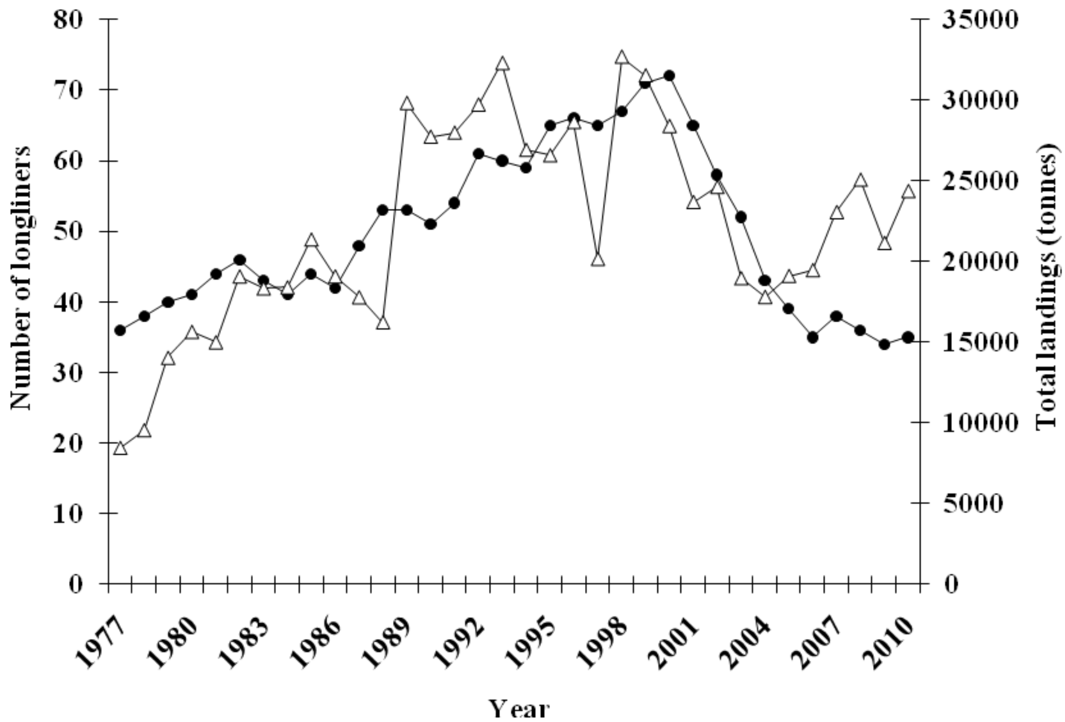




Figure 3. a) The number of long liners and average landings per vessel of ling and tusk in the period 1977-2010 and, b) the number of longliners and the total landings of ling and tusk.

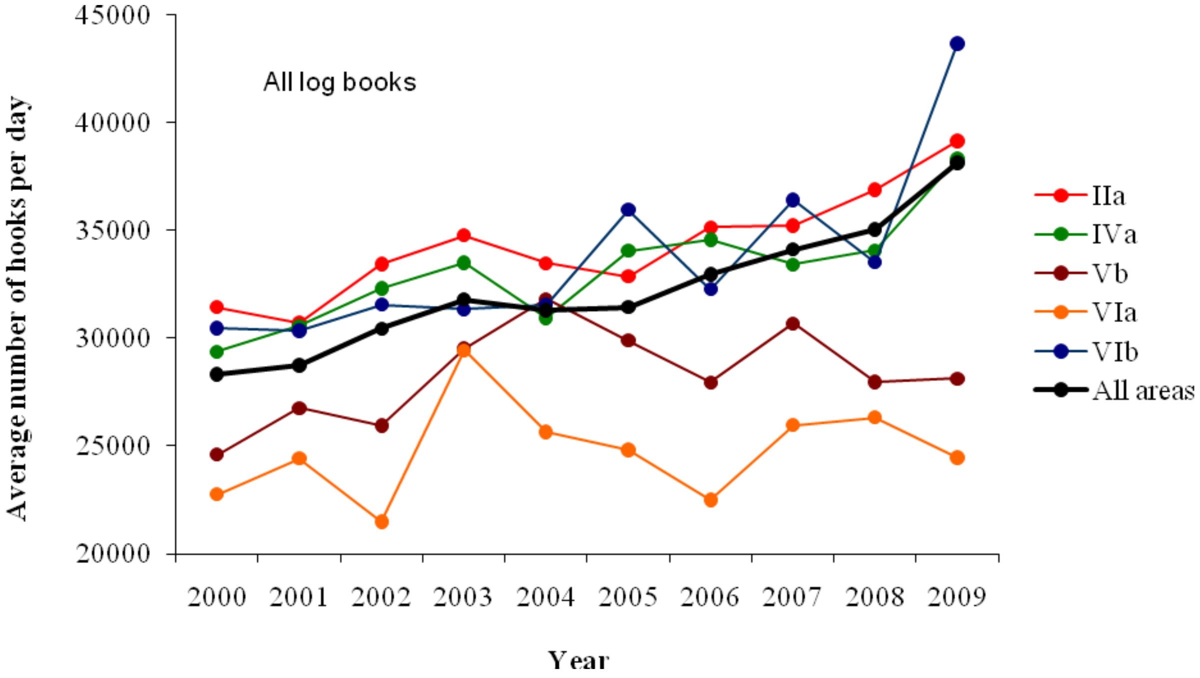



Figure 4. Average number of hooks the Norwegian long liner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling.

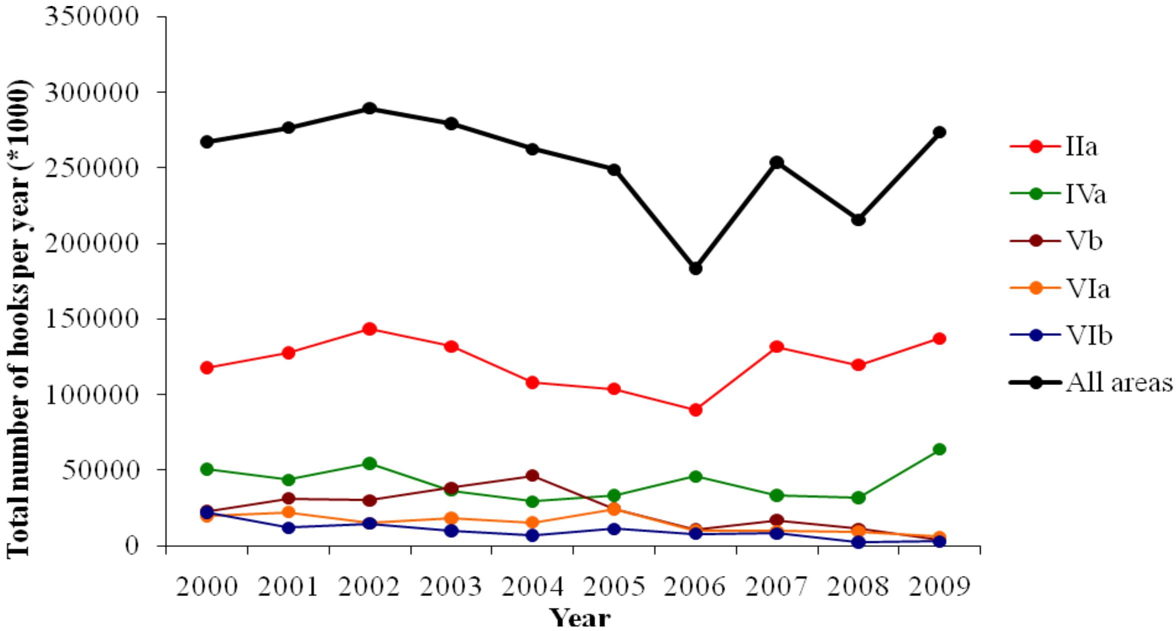
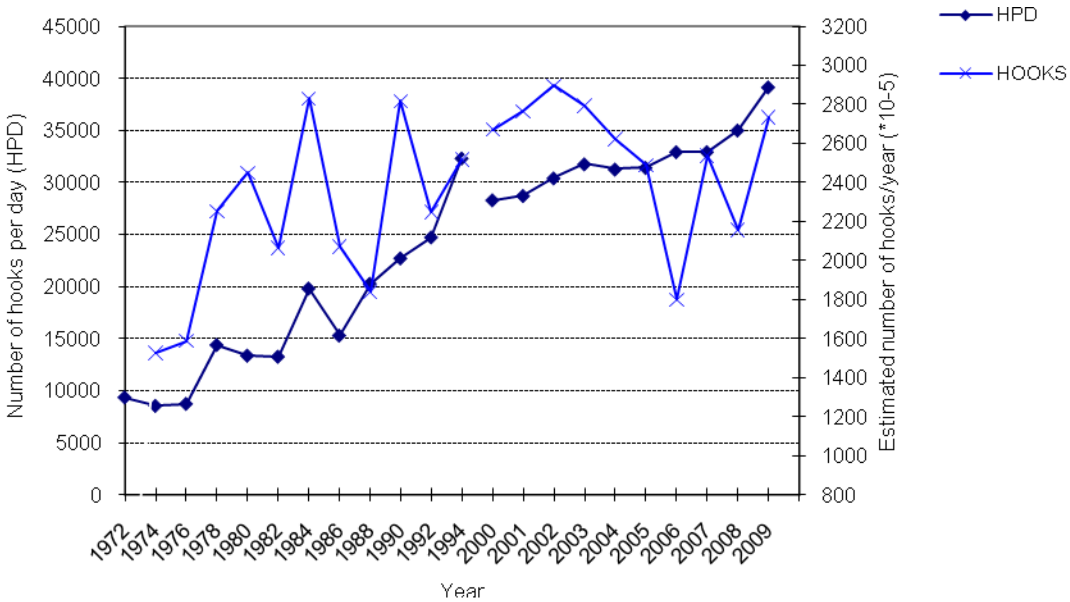



Figure 5. Estimated total number of hooks (in thousands) the Norwegian long liner fleet used in the ICES subareas with highest catches and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling.

a.




b.

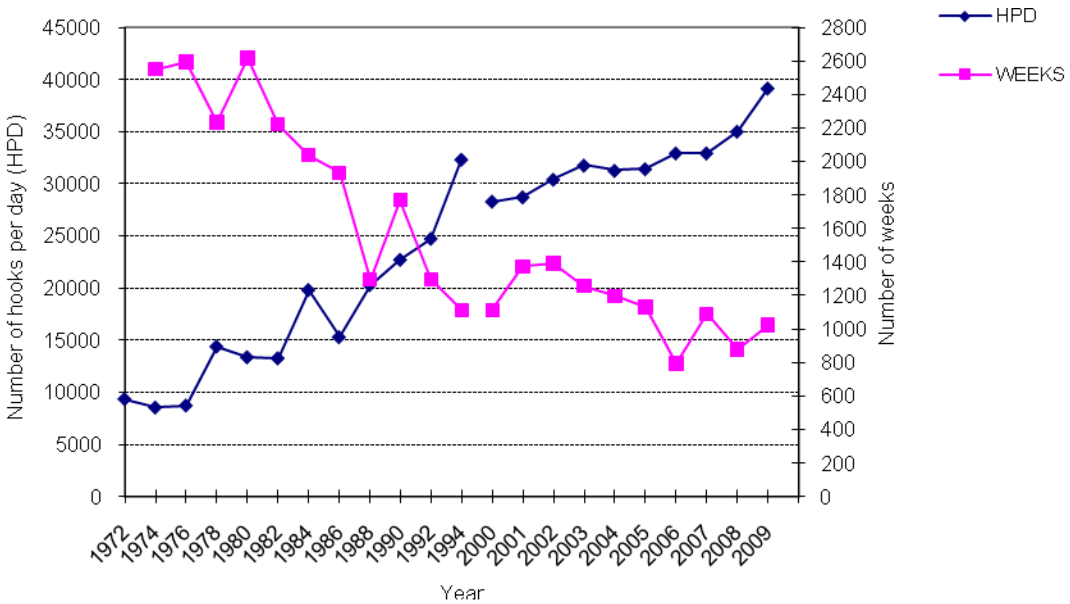



Figure 6. The combined time series for 1972-1994 (Bergstad and Hareide, 1996) and the series based on data from 2000-2009. a) The numbers of hooks used per day and the total number of hooks used per year. b) The numbers of hooks used per day and the total number of weeks the long liners participated in the fishery for ling and tusk.

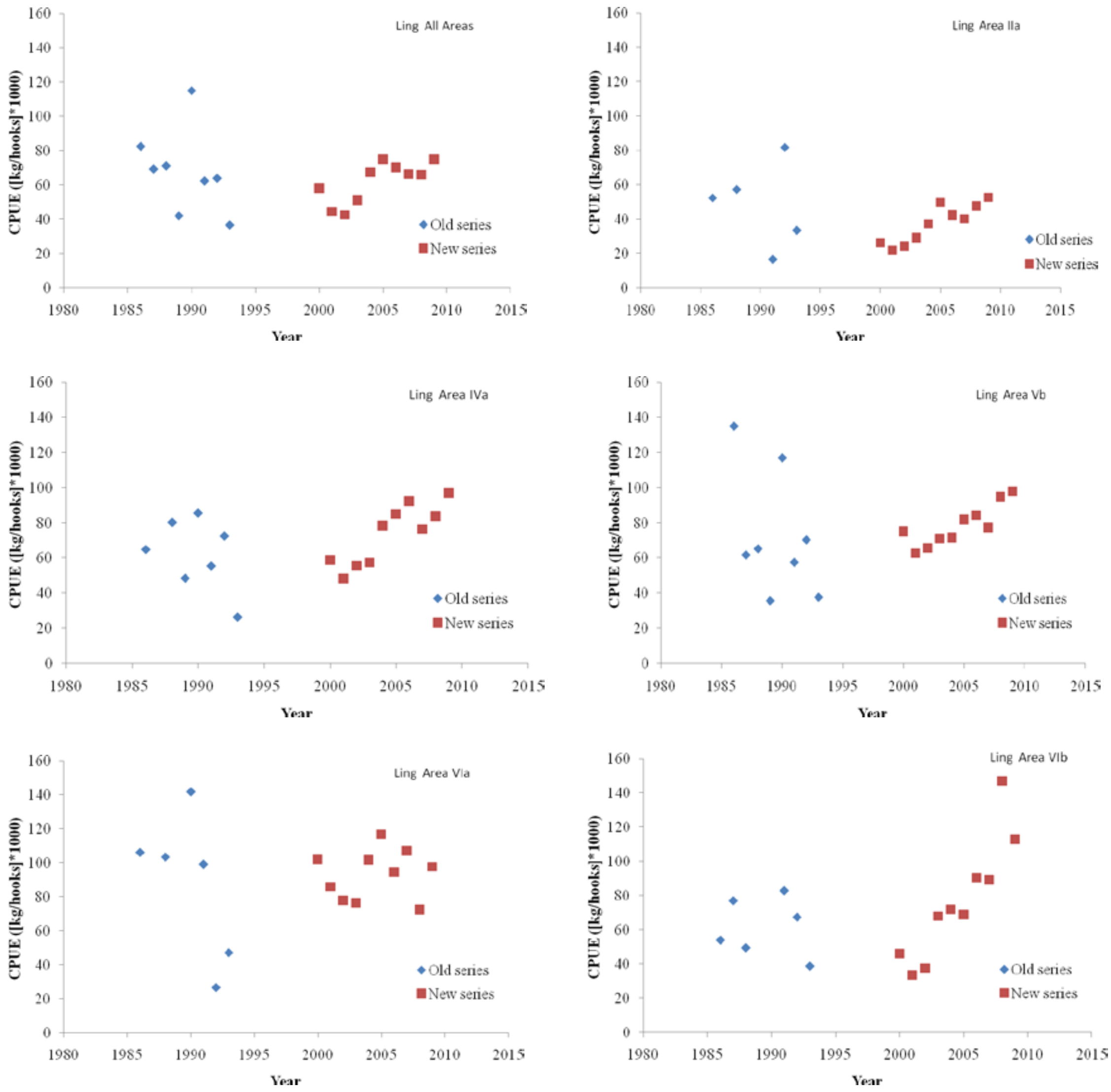



Figure 7. cpue ([kg/hook] x1000) for ling for all ICES subareas combined and separately for subareas IIa, IVa, Vb, VIa and VIb for the period 1986 through 1993 (blue diamonds) and for 2000 through 2009 (red squares).

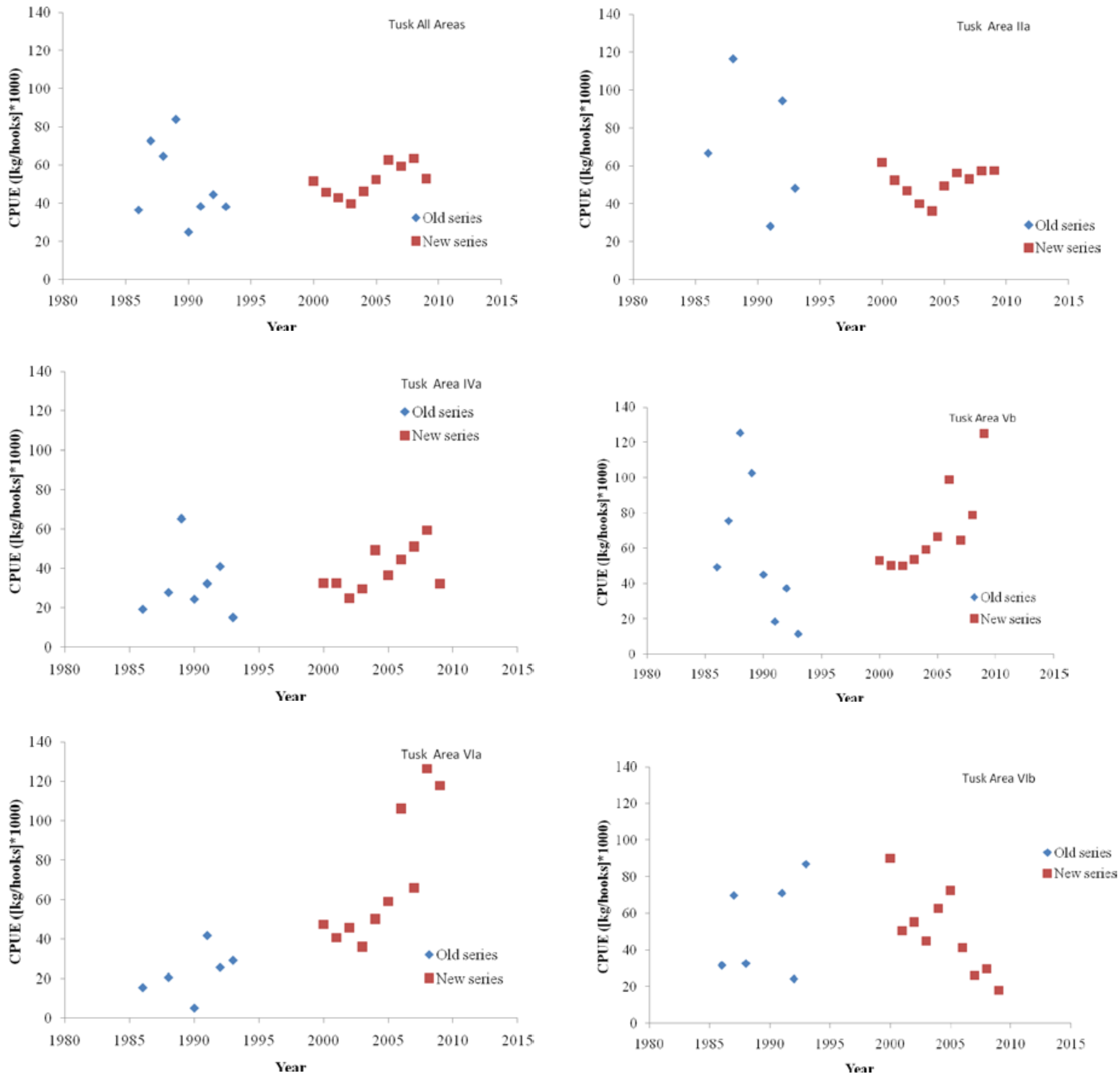



Figure 8. cpue ([kg/hook] x1000) for tusk for all the ICES subareas combined and separately for subareas IIa, IVa, Vb, VIa and VIb for the period 1986 through 1993 (blue diamonds) and for 2000 through 2009 (red squares).

# Working Paper submitted to ICES WGDEEP 2011

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# Exploratory assessment using stock reduction analysis to assess blue ling (*Molva dypterygia*) in Vb, VI, VII.

**Finlay Scott and Phil Large**

**This work was carried out with funding from the EU FP7 Project DEEPFISHMAN: Management And Monitoring Of Deep-sea Fisheries And Stocks**

## Introduction

In 2004, the results and outcomes of an exploratory assessment of blue ling using a stock reduction method developed by Chris Francis (New Zealand) was presented to ICES WGDEEP (ICES, 2004). Under the DEEPFISHMAN project, this method has been migrated to the FLR framework (Kell *et al*, 2007) by Finlay Scott (Cefas) and Charles Edwards (Imperial College, London). This working document presents the initial results from an exploratory assessment using the FLR package.

## Methods

Stock reduction analysis is a developed form of delay-difference model (Quinn and Deriso, 1999). The method uses biologically meaningful parameters and information for time delays due to growth and recruitment to predict the basic biomass dynamics of age structured populations without requiring information on age structure. Thus it can be considered to be a conceptual hybrid between dynamic surplus production and full age based models (Hilborn and Walters, 1992). A full description of the general approach can be found in Kimura and Tagart (1982), Kimura *et al* (1984) and Kimura (1985 and 1988); (Large, unpublished 2002).

This present exploratory assessment was carried out using *FLaspm*, a package for the statistical computing environment R (R Development Core Team, 2010). The package is open source and is currently hosted at GoogleCode (the source code is freely available at http://code.google.com/p/deepfishman/. *FLaspm* is part of the FLR project (Kell *et al*, 2007) and requires that the package *FLCore* is also installed (v > 2.3). The stock reduction model used in this analysis implements the model described in Francis (1992) and is capable of fitting multiple indices simultaneously. The method requires time-series data of annual catches, one or more abundance index and a range of biological parameters. The effect of these biological parameters on results is investigated using sensitivity analysis. A Beverton and Holt stock and recruitment relationship with a steepness of 0.75 is used throughout.

## Data

Total international landings data were available for 1966 to 2009. Three tuning indices were available: French abundance index derived from skipper tallybook data (2000 to 2009), Marine Scotland's FRV SCOTIA deep-water survey (1998 to 2009) and Irish (2006 to 2009) (**Erreur ! Source du renvoi introuvable.**).

| Year | Landings (t) | French abundance index (LPUE) | Scottish survey (mean kg per hour) | Irish survey (mean CPUE) |
|---|---|---|---|---|
| 1966 | 1289 | | | |
| 1967 | 1316 | | | |
| 1968 | 2787 | | | |
| 1969 | 1219 | | | |
| 1970 | 3242 | | | |
| 1971 | 1939 | | | |
| 1972 | 4643 | | | |
| 1973 | 25172 | | | |
| 1974 | 20622 | | | |
| 1975 | 14193 | | | |
| 1976 | 19249 | | | |
| 1977 | 30349 | | | |
| 1978 | 13000 | | | |
| 1979 | 10087 | | | |
| 1980 | 22287 | | | |
| 1981 | 13195 | | | |
| 1982 | 10912 | | | |
| 1983 | 11432 | | | |
| 1984 | 15437 | | | |
| 1985 | 19205 | | | |
| 1986 | 21018 | | | |
| 1987 | 17501 | | | |
| 1988 | 19105 | | | |
| 1989 | 15185 | | | |
| 1990 | 12432 | | | |
| 1991 | 13332 | | | |
| 1992 | 14632 | | | |
| 1993 | 13380 | | | |
| 1994 | 6662 | | | |
| 1995 | 7618 | | | |
| 1996 | 8591 | | | |
| 1997 | 10368 | | | |
| 1998 | 10705 | | 7.6 | |
| 1999 | 12421 | | | |
| 2000 | 11184 | 58.0 | 2.2 | |
| 2001 | 11889 | 40.5 | | |
| 2002 | 8512 | 39.8 | 5.3 | |
| 2003 | 7415 | 53.7 | | |
| 2004 | 6266 | 49.1 | 4.0 | |
| 2005 | 5807 | 47.9 | 2.8 | |
| 2006 | 5667 | 48.0 | 3.7 | 2.7 |
| 2007 | 5699 | 68.0 | 4.9 | 2.5 |
| 2008 | 3934 | 77.9 | 7.9 | 3.1 |
| 2009* | 2699 | 69.8 | 26.0 | 4.0 |

**Table 1.** Total international landings and standardised index data for blue ling in Vb, VI, VII.

Male and females were combined in the analysis. The biological parameters used in the stock reduction analysis are given in Table 2. It should be noted that as growth parameters gave a negative value for length in the first age group, the weight in that group is undefined. For the purposes of the model, the weight in the first age group was set to 0.

| **Parameter** | **Symbol** | **Value** |
|---|---|---|
| Maximum age | Amax | 30 |
| Natural mortality | m | 0.15 |
| Steepness of Beverton Holt stock recruitment relationship | h | 0.75 |
| Age of first selectivity | Asel | 7 |
| Age of maturity | Amat | 7 |
| von Bertalanffy growth parameters | Linf<br>k<br>t0 | 125 cm<br>0.152<br>1.552 |
| Length weight parameters | a<br>b | 2e-6<br>3.15 |

**Table 2.** Life history parameters for the stock reduction analysis

## Results

The biomass in 1966 was assumed to be virgin and was estimated by the deterministic model for a range of different values of natural mortality (M). The model was run using all three indices simultaneously. The fitted indices for the original value of M can be seen in Figure 1.

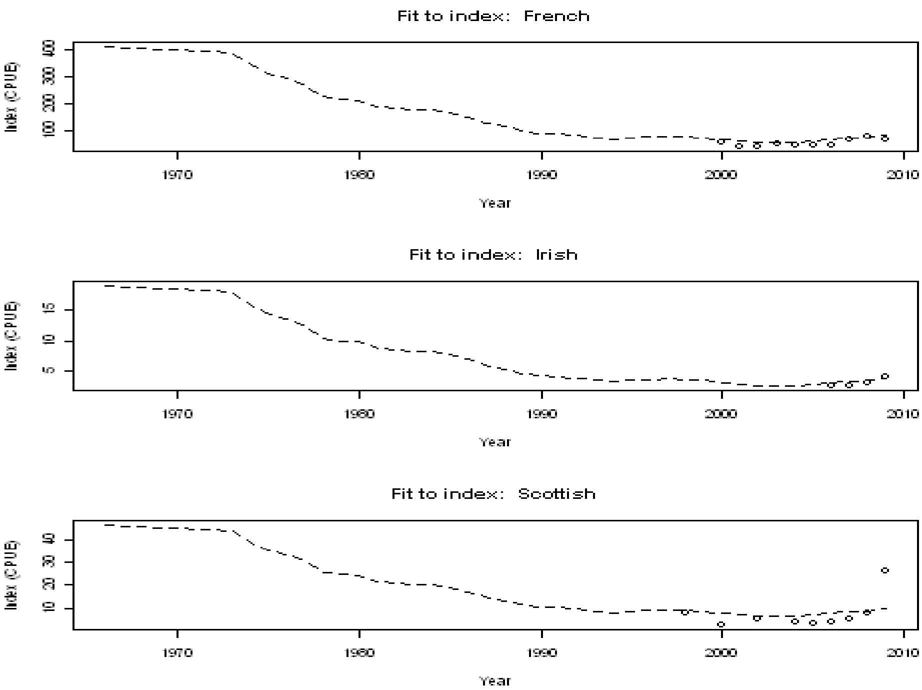


**Figure 1**. Fitted indices from original assessment (M = 0.15).

The corresponding estimated values of exploitable virgin biomass and exploitable biomass in 2009 can be seen in Table 3. They are clearly affected by the value of M, particularly the estimated virgin biomass.

**Table 3.** Estimated values of exploitable virgin biomass in 1966 and 2009 for a range of values of M.

| Natural mortality | Estimated exploitable virgin biomass in 1966 (t) | Estimated exploitable biomass in 2009 (t) |
|---|---|---|
| 0.05 | 445,493 | 146,705 |
| 0.10 | 304,182 | 70,640 |
| 0.15 | 242,825 | 49,472 |
| 0.20 | 205,236 | 50,296 |
| 0.25 | 187,492 | 91,537 |
| 0.30 | 169,623 | 99,105 |

The estimated exploitable biomass and fishing mortality trajectories for the different values of M can be seen in Figure 2. For the value of M accepted for this stock, the maximum fishing mortality observed was 0.43 in 2001.

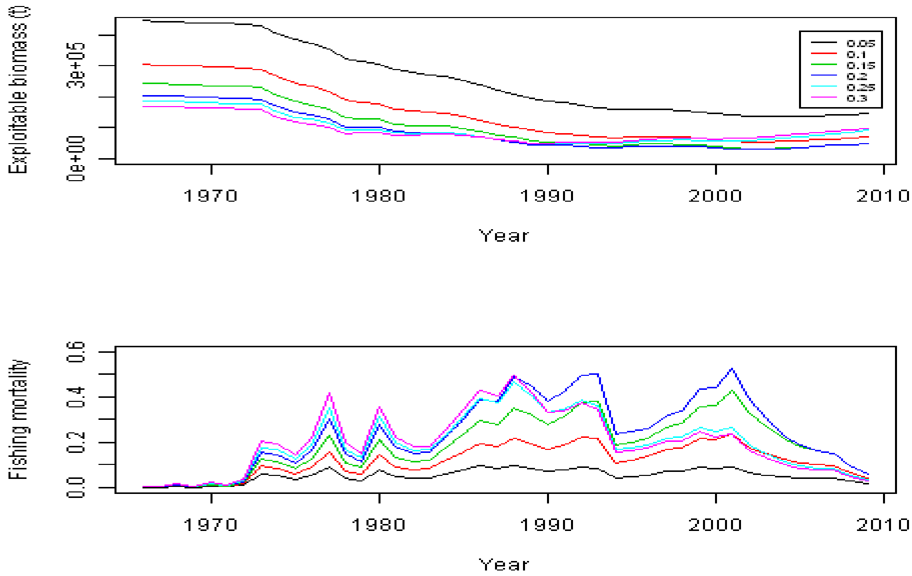


**Figure 2.** Estimated trajectory of exploitable biomass and fishing mortality for different values of M.

## Conclusions

FLaspm is currently a beta version. Testing of the software has so far been limited and consequently the results generated should be treated with caution. However, it is possible to reproduce Francis' New Zealand orange roughy assessment (Francis, 1992) giving confidence that the model has been implemented correctly. It is possible to use the software to estimate a probability distribution of the virgin biomass. However, the tools to perform this analysis are still in development and therefore not used here. Future developments may include the calculation of confidence intervals, estimates of MCY, and better evaluation of the uncertainty of the estimated parameter values.

## Acknowledgement

We wish to thank Pascal Lorance (Ifremer) for the provision of French abundance data.

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**WD 27**

## Working Paper submitted to ICES WGDEEP 2011

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# Exploratory assessment of the Roundnose Grenadier using a Bayesian Surplus production model

**Beatriz A. Roel, Lionel Pawlowski and Phil Large**

**This work was carried out with funding from the EU FP7 Project DEEPFISHMAN: Management And Monitoring Of Deep-sea Fisheries And Stocks**

## Introduction

In 2010, ICES WKDEEP considered the Bayesian Surplus Production Model as the most parsimonious short-term approach to assess this stock. Such an approach can be informative on relative trends such as changes in exploitation biomass and depletion. However, interpreting absolute levels may be inappropriate given the available data. This WD expands on that work.

## Data

The data used comprised time-series total international landings and an abundance index derived from French fisher tally-book data (Table 1)

**Table 1**: Round nose grenadier assessment, input data.

| Year | Catch | LPUE |
|---|---|---|
| 1988 | 33 | |
| 1989 | 2698 | |
| 1990 | 7279 | |
| 1991 | 10104 | |
| 1992 | 12155 | |
| 1993 | 11802 | |
| 1994 | 8528 | |
| 1995 | 8990 | |
| 1996 | 8173 | |
| 1997 | 8182 | |
| 1998 | 8031 | |
| 1999 | 8534 | |
| 2000 | 11606 | 1 |
| 2001 | 18143 | 0.884117 |
| 2002 | 13627 | 0.989177 |
| 2003 | 8717 | 0.47255 |
| 2004 | 9872 | 0.42096 |
| 2005 | 5777 | 0.454446 |
| 2006 | 4676 | 0.448211 |
| 2007 | 3778 | 0.535823 |
| 2008 | 3045 | 0.692778 |
| 2009 | 2167 | 0.60971 |

## Estimation of the intrinsic rate of growth (r)

The overall decreasing LPUE trend on this stock can be seen as a "one way trip" which can cause problems in accurately estimating *r* and *K*. In the context of the Bayesian framework, a distribution of *r* is derived from age at maturity, natural mortality and the stock-recruit parameter steepness (Fig. 1).

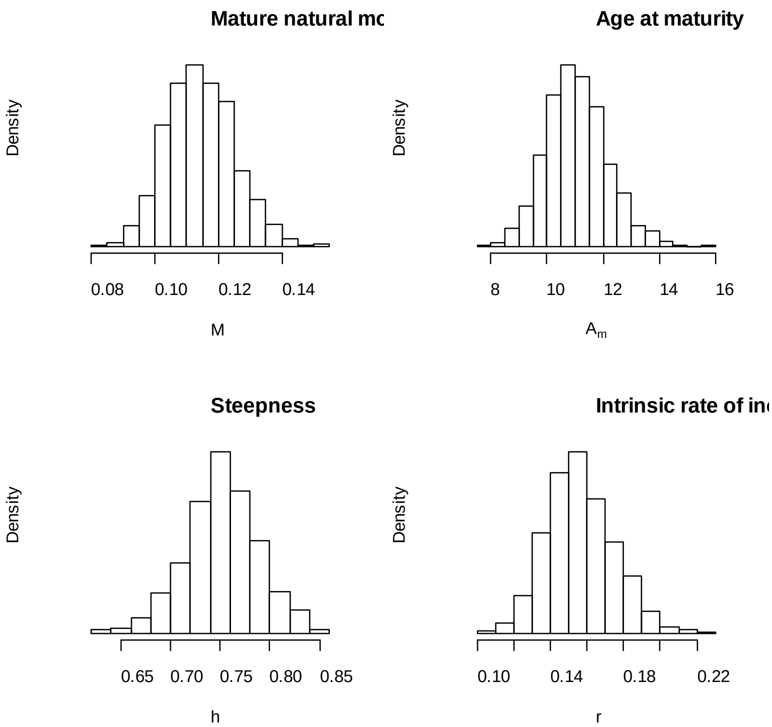


**Figure 1**: Example of an initial r distribution obtained from age at maturity, longevity and the stock and recruitment steepness distributions.

## Surplus production model

A surplus production model has been evaluated to assess the stock through a Bayesian implementation of the Schaefer surplus production model. The method used to compute the posterior distribution is the Markov Chain Monte Carlo (MCMC). To improve the MCMC performance, the original model is reparameterised by $Q = qK$, resulting in the following equation for the biomass dynamics:

$$B_y = B_{y-1} + r \cdot B_{y-1} \cdot \left(1 - B_{y-1}^{m-1}\right) - \frac{C_{y-1}}{K} \qquad (1)$$

The biomass index (*CPUE*) is modelled as

$$CPUE_y = Q\ B_y \qquad (2)$$

Where $B_y$ corresponds to the ratio of biomass in year $y$ over $K$, $r$ is the intrinsic growth rate, $K$ the carrying capacity, $q$ is catchability and $Cy$ the catch in year $y$. This model is a function available from the FLR FLBayes package.

**Base Case:** A base case was run with the following prior distributions:

| | |
|---|---|
| Mean Ln(Q) | 0 |
| Variance Ln(Q) | 100 |
| Mean r | -1.859 |
| variance r | 0.015 |
| Mean ln(K) | 11.513 |
| variance ln(K) | 1 |
| sigma shape | 2 |
| sigma rate | 1 |

## Results

The convergence statistic is 0.99, close to 1, for this run suggesting convergence although the Q and K plots in Fig 2 show patterns. In addition, the trace plots (Fig 2) suggest some correlation between $Q$ and $K$; the plot of $K$ vs $Q$ (Fig. 3) confirms this perception.

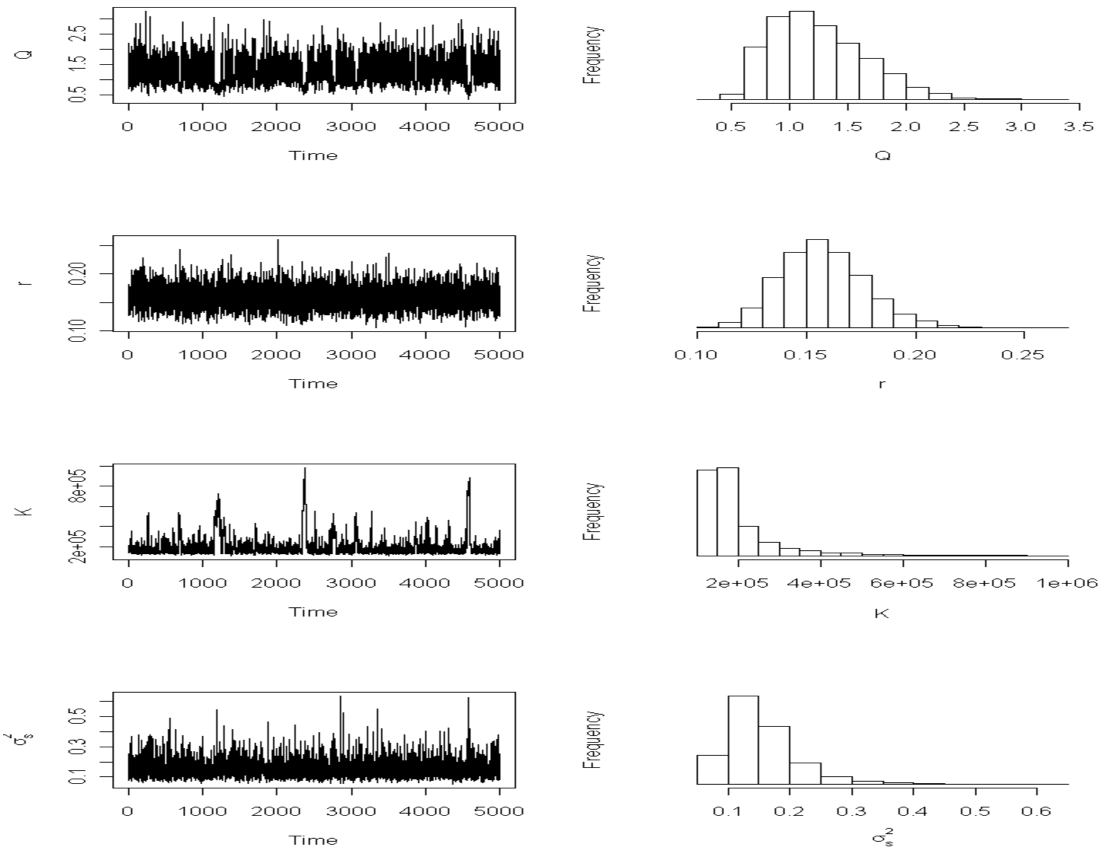


**Figure 2:** Base case. Plots of model parameter values included in the posterior sample as a function of the mcmc cycle number. The histograms on the right correspond to the posterior distributions of the model parameters.

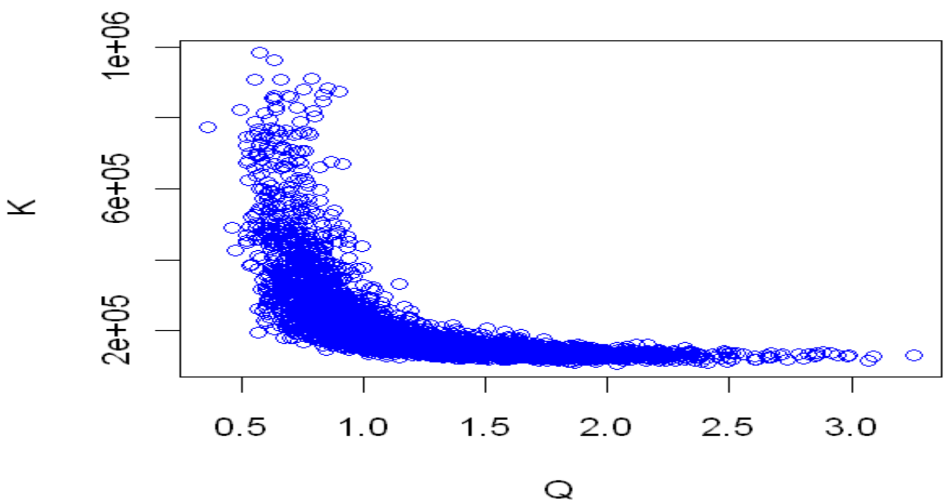


**Figure 3**. Plot of the parameter vectors K and Q as resulting from mcmc cycles.

The distribution of *K* is likely to be influenced by a rather informative prior (mean *K* = ln(1E5), var = 1). The stock biomass trajectory showed in Fig 4, a) suggests that the stock has declined since the start of exploitation but has increased in recent years.

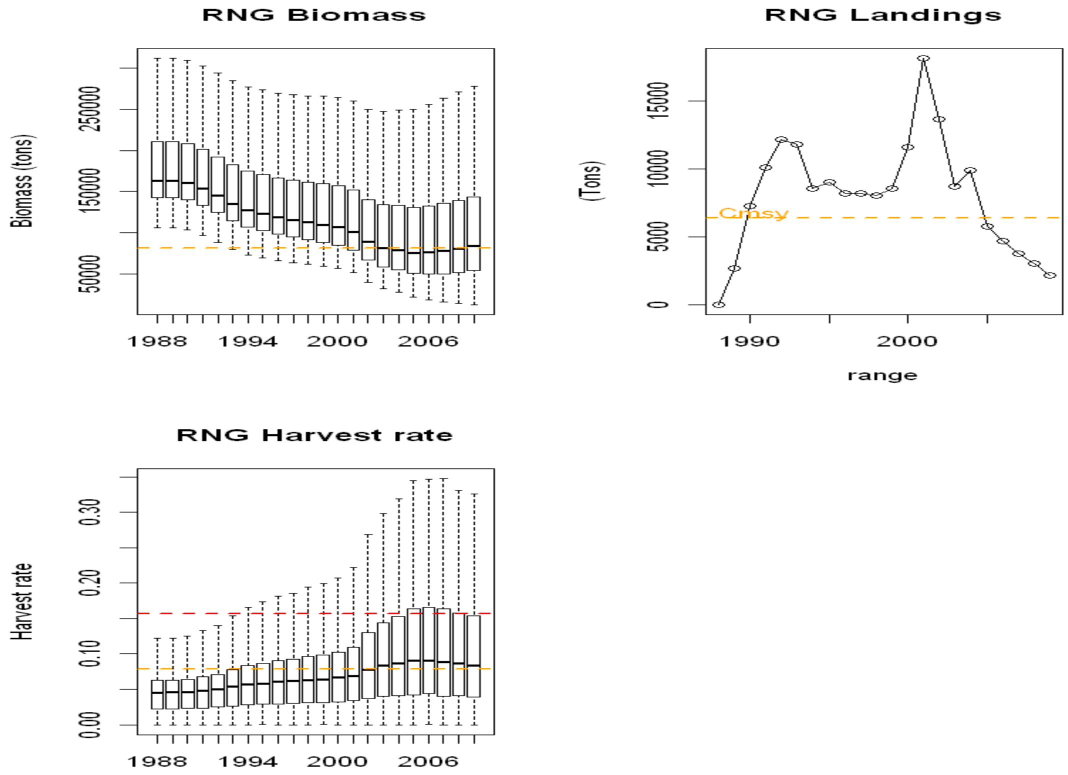


**Figure 4.** Base Case. Biomass (a) and harvest rate (c) historical trajectories and landings history (b) plotted against $C_{msy}$.

However, confidence intervals for the biomass estimates are very wide, the median of the distribution of 2009 biomass being just under $B_{msy}$ (Table 2). Recent catches appear well below the estimated MSY (Fig 4b, above).

**Table 2**: Results from the surplus production mcmc fit to roundnose grenadier landings and lpue data (base case and sensitivity test (see later)).

| | Median Biomass | Biomass std dev | Mean Biomass | Median Bmsy | Median Cmsy | Median Hmsy | Median Blast/Bmsy | Median Clast/Msy | Median Hlast/Hmsy |
|---|---|---|---|---|---|---|---|---|---|
| Base Case | 80531 | 119133 | 120996 | 81682 | 6397 | 0.078 | 0.99 | 0.48 | 1.10 |
| Sensitivity te | 127772 | 550130 | 340012 | 100878 | 7762 | 0.078 | 1.27 | 0.39 | 0.65 |

Examination of the posterior distribution of the model estimates expressed in relative terms (Figure 5) suggests that the current biomass is likely to be above $B_{msy}$ and that the current catch is below MSY. The current harvest rate is also likely to be below harvest rate MSY.

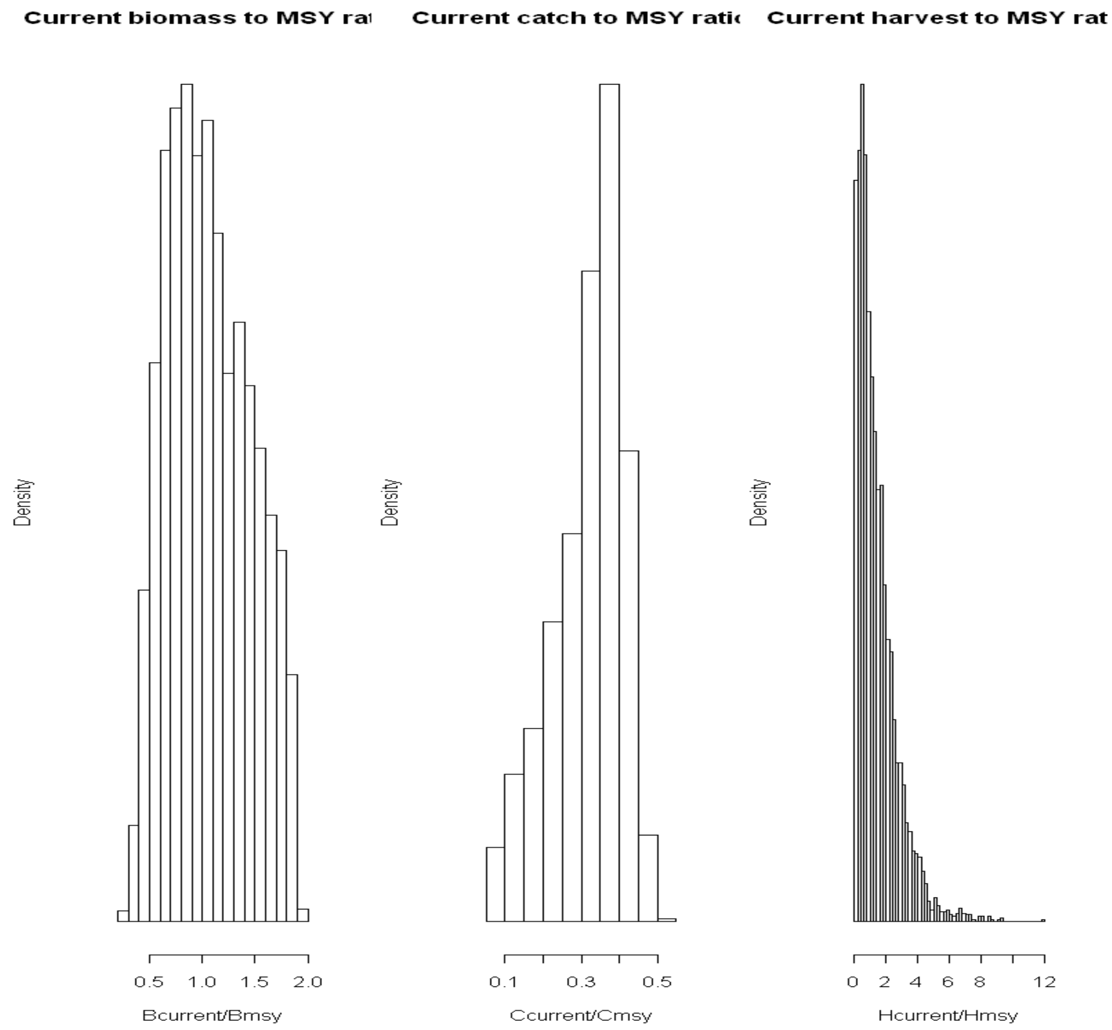


**Figure 5**: Posterior distributions illustrating the probabilities of having the stock status being above or under sustainable levels.

## Sensitivity test and Conclusions:

A model run using a less informative prior for *K*, i.e. with mean *K* =ln(1E5), variance of *K* = 5 was carried out to test the sensitivity to this prior. The results are given in Table 2 above and Figure 6 below.

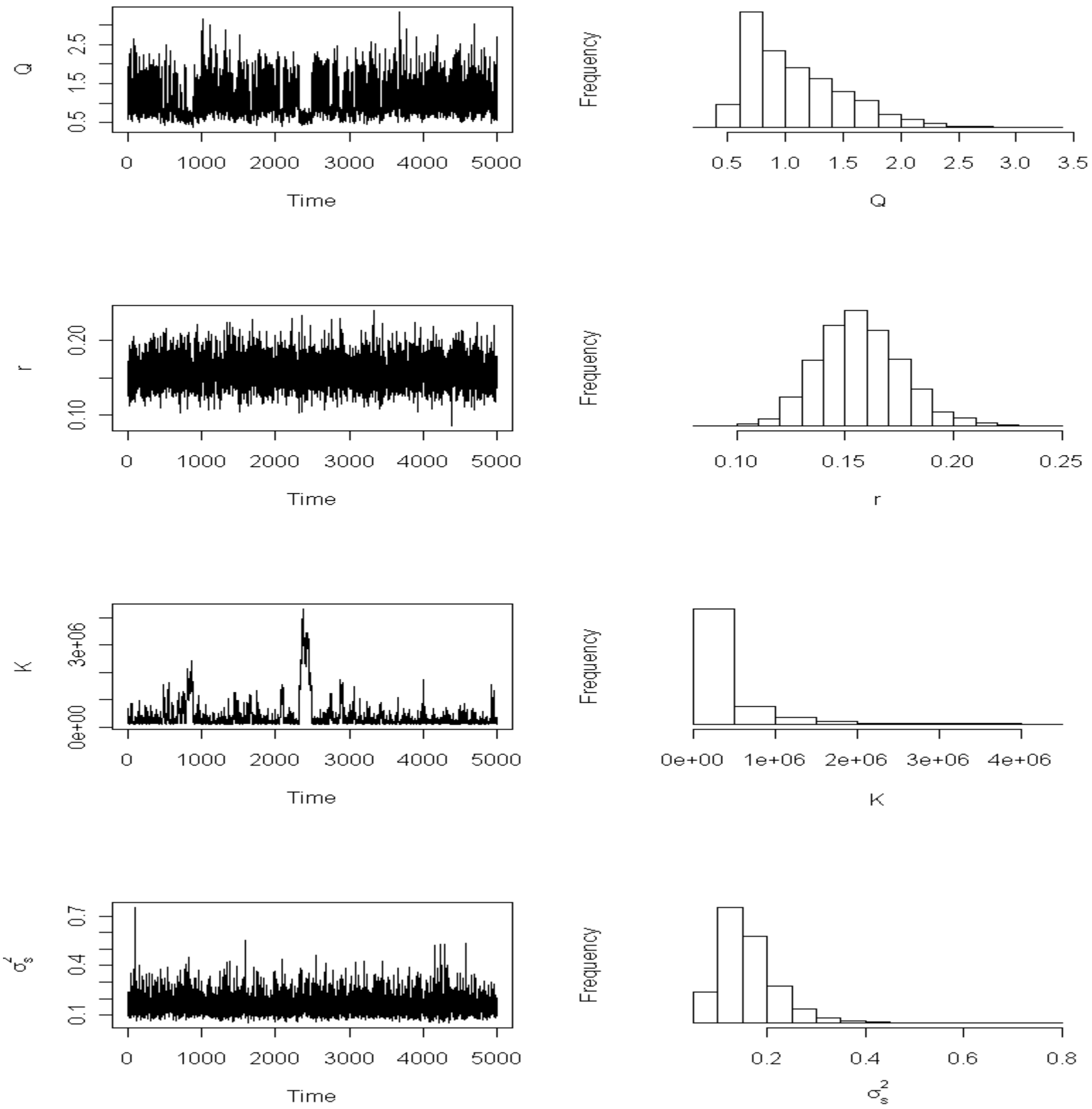


**Figure 6**. Sensitivity Test. Plots of model parameter values included in the posterior sample as a function of the mcmc cycle number. Parameter posterior distributions.

The resulting prior for *K* presented a much wider distribution than the one for the base case. This is suggesting that there is little information in the data to estimate *K*. However, the history of exploitation of the stock and the declining trend in LPUE data suggest that large values of *K* are unlikely and that proposing a more informative prior is probably defensible. However, given this sensitivity, relative parameters such as current biomass/$B_{msy}$ and current catch/MSY are likely to be more robust and therefore more appropriate for providing management advice. However, this species is long-lived (60+ years) and little is known about migration and movement patterns, so it may therefore be vulnerable to spatial sequential depletion. Abundance indices by sub-area should be scrutinised for differential trends with time and if such trends exist and are persistent then management advice should not be based solely on depletion ratios/rates as these may underestimate depletion. A further concern is that little is currently known about the stock structure of this species in the N. Atlantic.